Bridge Inspection and Rating Manual

Montana Department of Transportation

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MONTANA MDT DEPARTMENT OF TRANSPORTATION

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Introduction

This manual is intended for use by bridge inspectors for bridges on public roads within the state of Montana. It provides information about the inspection and evaluation of the bridges and bridge types that are within the state. The manual was compiled from many inspection resources and review of inspection activities. The procedures and descriptions in this manual conform to American Association of State Highway and Transportation Officials (AASHTO) standards, Federal Highway Administration (FHWA) administrative rules and Montana Department of Transportation (MDT) policy. Discussion and the examples in this manual represent the most common bridge types in Montana.

In the event of conflicting information or requirements between this manual and the National Bridge Inspection Standards (NBIS), the NBIS will govern. Inspectors are not relieved from the responsibility of complying with the NBIS even when a conflict exists. If a conflict is discovered, notify the Bridge Management Section as soon as possible.

During the compilation of this December 2015 manual the MDT staff is in the final stages of initializing a completely new Structure Management System (SMS). Some of the items in this manual were based on the most current version of the SMS and the final version of the new database may require a few slight modifications at a later date. Also, the FHWA is also in the beginning stages of updating the NBIS coding guide and the portions of this guide included in the manual will need to be changed depending on the final document.

As part of the new SMS the inspectors will be issued field tablet computers which will have this manual uploaded into the tablet for reference in the field or office. Due to the availablity of the manual digitally, a hard copy print version will not be published and distributed.

Manual Format

This manual is broken into chapters that cover major areas of inspection evaluation. Each chapter is divided into sections that cover specific issues and needs.

Chapter 1- Inspection and Rating Program
This Section covers the Inspection process. This includes the inspection staff qualifications, the roles and responsibility of the inspection organization and the inspection process. Additional technical information is given on identification of elements and examples of recording the condition of these elements.

Chapter 2 – Bridge Inspection

Chapter 3 – Deck, Slab and Top Flange Elements
Deck and Slab and Top Flange element inspection description and evaluation language is outlined. This section includes appropriate Smart Flags to be assigned to decks and slabs. Additional miscellaneous elements that are associated with decks are outlined. Descriptions of the environmental condition states are coved by geographical region.

Chapter 4 –Superstructure Elements
Superstructure element inspection description and evaluation language is outlined. This section includes painted and unpainted steel, prestressed reinforced concrete, mild steel reinforced concrete, timber and "other" types of superstructure elements. This section includes descriptions and evaluation of bearings, pins and hangers, and cable elements. Appropriate Smart Flags are presented and discussed. Descriptions of the environmental condition states are coved by geographical region.

Chapter 5-Substructure Elements
Substructure element inspection description and evaluation language is outlined. This section includes painted and unpainted steel, prestressed and mild steel reinforced concrete, timber, masonry, and "other" types of substructure elements. This section includes the Smart Flags that are appropriate for substructure elements. Descriptions of the environmental condition states are coved by geographical region.

Chapter 6 – Culvert Elements
Culvert element inspection description and evaluation language is outlined. This section includes steel, concrete, timber, and "other" types of culvert elements. This section includes the Smart Flags that are appropriate for culvers. Descriptions of the environmental condition states are coved by geographical region.

Chapter 7 – Steel, Pin and Hanger and Fracture Critical Inspections
Discussion in chapter 6 outlines the specialty inspection of steel bridges. This chapter includes the inspection and reporting of Fracture Critical and Other (Pin and Hanger) Inspections. The chapter includes the use of special inspection equipment and the recording of that data.

Chapter 8 – Bridge Load Rating and Posting
Bridge Load Rating procedures and MDT specific policies are located in this chapter. Inspectors will generally not need this information, but it is a guide for staff and consultant rating engineers.

Chapter 9 – Underwater Inspection
Underwater inspection procedures and requirements are outlined in this section. This chapter focuses on the Type 1 (Poke and Wade) substructure inspection. Discussion includes stream stability and scour and recording of this data.

Chapter 10 – NBI Coding Guide
The National Bridge Inventory (NBI) coding guide is covered in this section. This chapter is the FHWA Recording and Coding Guide for Structure Inventory and Appraisal of the Nation's Bridges. This chapter has been updated with FHWA addendums**.**

Chapter 11 – Commentary
The commentary section of this manual covers the changes to the manual from the last revision. This section will focus only on the changes and the location in the chapter and section.
Chapter, section, and page break down the page numbering for the manual. An example is 1.1.3 would be chapter 1, section 1 and page 3. This type of number system will allow a more efficient updating of the manual when sections change.

Revisions

The manual will be updated to incorporate periodic revisions based on the practices outlined by FHWA, AASHTO and the Department. The Bridge Management Section will review Montana bridge inspection practices and procedures for compliance with the Code of Federal Regulations (Title 23 CFR 650.3), AASHTO Manual for Bridge Evaluation, and FHWA Recording and Coding Guide for Structure Inventory and Appraisal of the Nation's Bridges. In addition, the Bridge Management Section will review comments from the MDT inspection community. We encourage users to submit any errors, recommendations or revisions to the Bridge Management Section.

Chapter 1 – Program Organization

Chapter 1 – Program Organization

1.1. Background

During the highway expansion of the 1950's and 1960's, inspection and maintenance of bridges was not considered a high priority. After the collapse of the Silver Bridge in Point Pleasant, West Virginia, a National Bridge Inspection program was developed. This program emphasized inspection frequency, inspector qualifications, reporting format, and inspection and rating procedures. Several other bridge disasters established the expansion of the national program to include culverts and underwater and fracture critical components. In the mid-1990s, there was a movement to evaluate individual components of a bridge utilizing the *AASHTO Guide for Commonly Recognized Structural Elements* (CoRE), published in 1998. In 2011 and updated in 2013, AASHTO revised their element definitions, and published the *AASHTO Guide Manual for Bridge Element Inspection* to replace the CoRE. This manual is based on the 1998 *AASHTO Guide for Commonly Recognized Structural Elements* and FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, published in 1995.

1.2. Overview

The MDT Bridge Inspection Program is administered by the Bridge Management Section of the Bridge Bureau, and operates under the auspices of the Federal Highway Administration in accordance with National Bridge Inspection Standards (NBIS). The five primary responsibilities of the Bridge inspection program are:

Maintain Public Safety and Confidence (Structural Concerns)
Protect Public Investment (Maintenance Concerns)
Maintain a Desired Level of Service (Functionality Concerns)
Provide Accurate Bridge Records
Fulfill Legal Responsibilities (Comply with the Code of Federal Regulations)

The MDT is responsible for the inspection of both on and off system bridges within the state. Approximately five thousand four hundred bridges are inspected by MDT with a little more than half of the bridges on the national and state highway systems. Each of the five districts is responsible for the inspection of both On- and Off- System bridges within their boundaries.

Bridges on the network are categorized by On or Off system; Major or Minor structures; and Structurally Sufficient, Structurally Deficient or Functionally Obsolete. These categories and their requirements are defined as follows:

1.2.1. On System Bridges

On-system bridges are bridges on any route of the National Highway System. This includes Interstate, Primary, Secondary, and Urban routes.

1.2.2. Off System Bridges

Off-system bridges are bridges on any route that is not an on-system route. Some off-system bridges are on State Highways. State Highways are not located on the National Highway System, but are on the state maintenance system.

1.2.3. Major Structures

Only major structures qualify for federal funding for inspection, replacement and rehabilitation work. A major structure is defined as a structure, including supports, erected over a depression or an obstruction, such as a water, highway or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet (6.1 meters) between under coping of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings are less than half of the smaller contiguous opening.

1.2.4. Minor Structures

Some structures not meeting major qualification still require inspection either due to FHWA exceptions or because of MDT requirements. On National and State Highway systems the inspection of bridges down to 2.4 meters (8 feet) in length is desirable. Box or buried structures are to be treated as culverts and need not be inspected unless considered a critical facility (TE Routes), or qualifying under major structure guidelines.

This means that we inspect bridges down to 8 feet in span length on Primaries, NHS routes, Urban Routes, State-Maintained Locals (Frontage Roads, or X Routes), and Interstate. We do not inspect bridges down to 8 feet in span length on county maintained local bridges, local urban bridges, municipal bridges, or bridges on Secondary Routes, regardless of whether they are state or county maintained.

Box or buried structures are those buried under a depth of fill equal to or greater than ¼ of the span length. Minor box or buried structures do not need to be inspected unless they are on a critical facility. Interstates and TE Routes are critical facilities. All box or buried structures with a single span of at least 8 feet on critical routes are to be inspected. Anything box or buried structures with a span of less than 8 feet are not to be inspected, regardless of how many smaller span there are. For example, two 6-foot culverts that are side-by-side add up to a span of more than 8 feet, but no single span is over 8 feet, so they do not need to be inspected.

1.2.5. Structurally Deficient

The term structurally deficient is a term used by FHWA in their oversight process of the National Bridge Inventory (NBI). The term is used to categorize bridges with structural issues or insufficient waterway capacity. In order to be considered structurally deficient a bridge needs to have a condition rating of ‘4’ or less for NBI item 58 – Deck, item 59 – superstructure, item 60 – substructure or item 62 – culvert, OR have an appraisal rating of ‘2’ or less for NBI item 67 – structural evaluation or item 71 – waterway adequacy.

1.2.6. Functionally Obsolete

The term functionally obsolete is a term used by FHWA in their oversight process of the National Bridge Inventory (NBI). The term is used to categorize bridges that are considered inadequate for current traffic requirements, or waterway adequacy. In order to be considered functionally obsolete a bridge needs to have an appraisal rating of ‘3’ or less for NBI item 68 – deck geometry, item 69 – under clearance or item 72 – approach roadway alignment, OR have an appraisal rating of '3' or less for NBI item 67 – structural evaluation or 71 – waterway adequacy.

In order to meet the requirements of MAP-21 the Department of Transportation is now developing bridge projects as part of an overall asset management system. MDT has adopted a number of Bridge Program Objectives and determined various Bridge Performance Measures required in order to meet those Objectives.

NBIS require each bridge inspection organization to prepare and maintain an inventory of all bridges for which they are responsible. The bridge inventory provides certain standard information about each bridge and is updated throughout the bridge's life until it is no longer in-service.

The MDT Structure Management System (SMS) contains the required FHWA fields as well as additional MDT defined fields to manage the bridge inventory. The NBIS information is transmitted to FHWA yearly to update the National Bridge Inventory Database.

1.3. Inspection Program Functions

Bridge inspection strictly refers to condition inspection of bridges. The NBIS requires all states to collect inspection data and maintain an inventory of all public bridges. Each state must have a bridge inspection organization capable of performing the required inspections, completing required reports, and maintaining inventory records. In Montana this responsibility is divided between the Bridge Management Section located in Helena and each of the five district offices.

1.3.1. Bridge Management Section

The Bridge Management Section is responsible for the overall Bridge inspection program and is a part of the Bridge Bureau in Helena. The section consists of a number of engineers and technicians that provide direction and support to the program. The primary responsibilities are given below.

- Set Inspection Standards
- Bridge Database Management
- Technical Support for the Districts
- Inspector Training Coordination and Certification
- Program Quality Assurance
- Research and Implementation of New methods and Techniques
- Backup Support and Coordination
- Bridge Rating
- Overweight Permitting
- Specialty Inspection Consultant Contract Administration
- Shop Drawing Reviews and Approvals

The Bridge Management Section also assists in updating the performance measures of structure condition and deck condition to determine whether proposed projects will assist in meeting program objectives.

Figure 3.1.1
Bridge Management Section Functions

1.3.2. District Offices

Each District office is responsible for inspecting the bridges within the District. The primary District functions are given below.

- Performing Bridge Inspections
- Safety Management for Inspections
- Scheduling
- Problem Identification and Follow-up
- Data Entry and Validation
- Inspection Quality Control
- Inspection Equipment and Resources
- Coordination with the Bridge Management Section, Counties, Cities, and other local entities

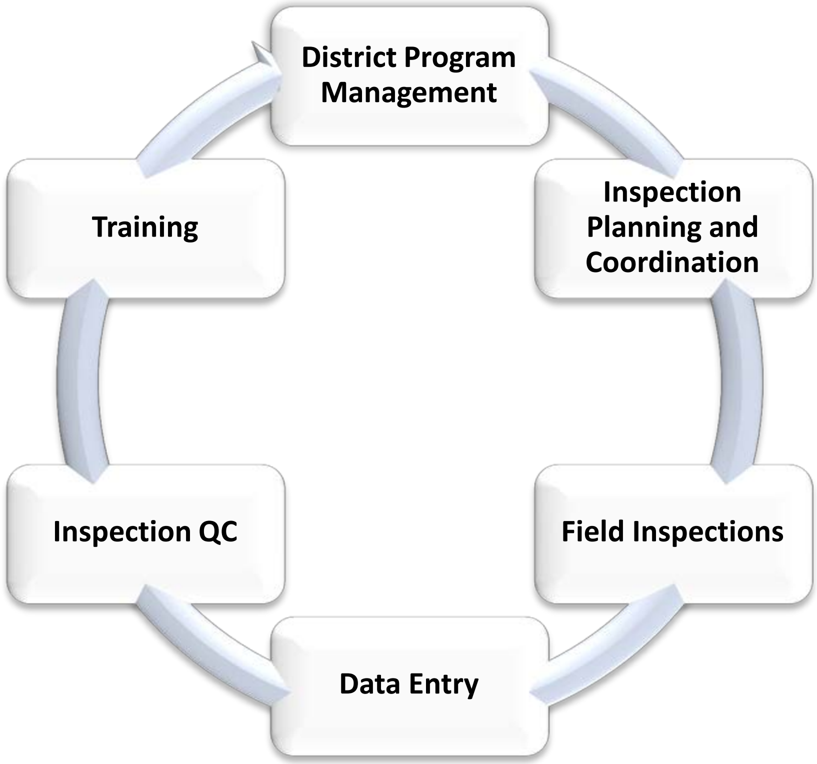

Figure 3.2.1
District Bridge Inspection Functions

3.2.1. Key Inspection Personnel and Qualifications

There are a minimum of two positions in each district that are dedicated to bridge inspection.

3.2.1.1. District Bridge Inspection Coordinator

The District Bridge Inspection Coordinator position is a full-time bridge inspection position responsible for inspection compliance at the District level. Duties of the position include scheduling inspection activities, performing Quality Control Checks on district inspections, and inspecting bridges. MDT requires this position to be a qualified Team Leader.

3.2.1.2. Assistant District Bridge Inspection Coordinator

The Assistant District Bridge Inspection Coordinator position is a full-time bridge inspection position. MDT requires this position to be a qualified Team Leader.

3.2.2. Inspection Crew

An inspection crew will have a minimum of two members. One of the members must be a qualified Team Leader. The crew is required to physically inspect the bridge and gather the required information. If the design of a bridge is such that it requires specialized knowledge, then the members of the crew will include persons with that special knowledge. This specialist may or may not be required to visit the site depending on the inspection requirements.

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Chapter 2 – Bridge Inspection

2.1. Team Leader Qualification

2.1.1 Initial Qualification

Qualification as a Team Leader requires any one of the following:

- Five years' experience in bridge inspection and successful completion of the Safety Inspection of In-Service Bridges course (NHI course no. 130055). A portion – up to but not more than 2.5 years - of the experience required to satisfy this requirement can be obtained through participation in construction inspection activities during a bridge construction project.
- Certification as a Level III or IV Bridge Safety Inspector (National Institute for Certification in Engineering Technologies), one year of experience in bridge inspection, and successful completion of the Safety Inspection of In-Service Bridges course (NHI course no. 130055).
- A Professional Engineering license for the State of Montana, one year of experience in bridge inspection, and successful completion of the Safety Inspection of In-Service Bridges course (NHI course no. 130055).
- A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology, a current Engineer Intern license from the Montana Board of Professional Engineers and Professional Land Surveyors, two years of inspection experience, and successful completion of the Safety Inspection of In-Service Bridges course (NHI course no. 130055).

Up to half of the experience required to satisfy any of these requirements may be obtained through participation in construction inspection activities during bridge construction projects. At least half of the experience required is to be obtained through in-service bridge inspection under a certified team leader.

2.1.2 Continuing Education Requirements

2.1.2.1 MDT Inspectors

To remain qualified to inspect bridges as a team leader, MDT requires inspectors to meet at least one of the following requirements every 2 years:

a) Attend at least 8 hours of a field Quality Assurance Review
b) Attend the entire Bridge Inspectors' Workshop

If one of these requirements is not met, MDT may accept other bridge inspection training on a case-by-case basis.

2.1.2.2 Consultant Inspectors

Consultants inspecting bridges for MDT are required to attend at least 8 hours of continuing education training related to bridge inspection every 2 years. This continuing education requirement can be met under the requirements for MDT inspectors, or can be met through attendance at any NHI class related to Bridge Inspection. Attendance at bridge inspection conferences is also acceptable training. Other training may be evaluated and accepted by MDT on a case-by-case basis.

Inspectors who do not meet continuing education requirements will be disqualified and no longer allowed to inspect bridges for MDT until they complete additional training as required by the Bridge Management Engineer. The type and amount of training will be decided on a case-by-case basis.

2.2. <u>Bridge Inspector Training</u>

2.1. NHI Courses

National Highway Institute (NHI) courses will be brought to MDT for inspector training on a rotating basis, or as-needed. These courses are listed below.

FHWA-NHI-130053 Bridge Inspection Refresher Training
FHWA-NHI-130054 Engineering Concepts for Bridge Inspectors*
FHWA-NHI-130078 Fracture Critical Inspection Techniques for Steel Bridges
FHWA-NHI-130055 Safety Inspection of In-Service Bridges
FHWA-NHI-135047 Stream Stability and Scour at Highway Bridges for Bridge Inspectors

*Prerequisite for FHWA-NHI-130055

2.2. On-Site Training

Every year, at least one Quality Assurance Review is conducted in each district. On-site training is provided by the Bridge Management Section during these reviews. This training is tailored to meet the needs of each district and the inspectors present during the review.

2.3. Bridge Inspectors' Meeting

The Bridge Inspectors' Meeting is held bi-annually. Inspector training is provided by the Bridge Management Section during this meeting.

2.4. Additional Training As Needed

Additional bridge inspector training is provided on an as-needed basis for issues such as changes that are made to MDT's Bridge Inspection Manual.

2.3. <u>Inspector Training and Experience Records</u>

3.1. Bridge Management Section

The Bridge Management Section keeps records on classes taken by all inspectors and inspection trainees, and the amount of time inspectors have spent on a QA review or attending the Bridge Inspectors Meeting as required.

3.2. District Offices

The District Inspection Coordinator is responsible for tracking inspection time that an inspection trainee has acquired, and keeping records for each trainee.

2.2 Inspection Types and Intervals

It is critical to inspect each bridge thoroughly to establish its condition and ensure the continued safe operation of the structure. There are five different inspection types:

- Inventory Inspection
- Regular NBI/Element Inspection
- Underwater Inspection
- Fracture Critical Inspection
- Damage Inspection
- In-Depth Inspection
- Other Inspection

Which inspection types are used for each bridge depends on several factors, including the type of bridge design, condition of the structure, and condition of the stream channel below the bridge.

2.2.1 Inventory Inspections

An Inventory Inspection is the first inspection of bridges that are not already in the Bridge Management System (BMS) and the first inspection of new bridges or rehabilitated bridges that were fully closed to traffic during rehabilitation work.

When a bridge is replaced by a new structure, or a bridge is fully closed to traffic during rehabilitation work, the Inventory Inspection will be completed and entered into BMS within 90 days of the bridge opening to traffic if the bridge is State-Maintained, and within 180 days for all other bridges.

For an existing bridge that is open to public traffic during rehabilitation work, regularly scheduled NBI/Element inspections will be performed. If an inspection cannot be conducted on or before its due date because of reasonable circumstances such as a hazardous project site or conditions unfavorable to complete an inspection, then those circumstances will be documented and sent to the Bridge Management Section and the inspection will be rescheduled at the earliest date possible – this date will be no later than 30 days past the original due date for the inspection.

An Inventory Inspection consists of up to 3 steps, depending on the bridge being inspected.

2.2.1.1 Determination of the Structure Location

For bridges that are new to the inventory (not previously in the BIMS), the structure location is determined using a GPS device and the aerial photos in the BIMS. The bridge ID will be assigned as a five digit number and entered into the BIMS.

2.2.1.2 Collection of Inventory Data

For bridges new to the inventory, the New Bridge Form will be completed and sent to the Bridge Management Section in Helena. If the new structure is a culvert, the New Culvert Form will be completed and submitted with the New Bridge Form. Once the New Bridge Form (and New Culvert Form as needed) has been submitted, Bridge Management Section personnel will enter a bridge “stub” into BIMS. The New Bridge Form and New Culvert Form are on BMS on the Inspection Aids page.

When available, the inspector will use the bridge construction plans to determine the measurements, design type, material, and other pertinent inventory information. The inspector is responsible for obtaining bridge construction plans and shop drawings from local agencies and forwarding these plans on to the Bridge Management Section in Helena. When plans are not available for the bridge, the inspector will determine the inventory information for the bridge during a site visit. This includes filling out Bridge Measurement Forms as needed. Copies of Bridge Measurement Forms can be found on BIMS on the Inspection Aids page.

2.2.1.3 Initial NBI/Element Inspection

The inspector will visit the bridge site to complete the initial NBI/Element inspection for the bridge. Then, the inspector will fully enter all inspection information into BIMS within the Initial Inspection time frame discussed previously.

2.2.2 Routine NBI/Element Inspections

An NBI/Element inspection is performed on all bridges at least every 24 months on the entire bridge throughout its life. Montana is allowed to extend the inspection interval to 48 months for bridges that meet certain conditions. If a bridge has received major structural repairs, by Maintenance authorities or under Maintenance contracts, the inspection cycle will be reduced to 24 months until the Bridge Management Engineer is satisfied that the repairs are performing satisfactorily. When a bridge becomes eligible for a 48 month inspection cycle, the inspector will contact the Bridge Management Section and recommend the bridge for an extended inspection cycle. Bridge Management Section personnel will set the inspection cycle to 48 months if they agree with the recommendation. When a bridge no longer meets the criteria listed for a 48-month inspection cycle, the Bridge Information Management System automatically changes the inspection cycle to 24 months. If major structural repairs are made to a bridge by Maintenance forces, the inspector will contact the Bridge Management Section to reduce the inspection cycle to 24 months.

2.2.3 Underwater Inspections

An underwater inspection will be performed on bridges with substructure elements located underwater and not visible for inspection during Routine NBI/Element Inspections. Structures requiring underwater inspection will be identified as needing further review by either inspection with special equipment such as a boat (Class I) or by an experienced consultant utilizing divers (Class II). Consultants are retained through the Bridge Management Section for Class II inspections. Structures requiring a Class I inspection are required every 48 months. Class II inspections are required every 60 months.

2.2.4 Fracture Critical Inspections

A fracture critical inspection is a focused, in-depth, arm's length inspection of fracture critical bridge members. A Fracture Critical Member (FCM) is defined as a steel member in tension or with a tension element, whose failure probably causes a portion of or the entire bridge to collapse. Fracture critical inspections are required every 24 months. See chapter 7 for more information on fracture critical inspections.

2.2.5 Damage Inspections

A damage inspection is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions, such as earthquakes or vehicular collisions. The scope of the inspection depends on the extent of the damage. Damage inspections are typically used in the decision making process for implementing emergency load restrictions and closure. They are also be used in the decision-making process to lift emergency restrictions that were put in place by Maintenance personnel until a Damage Inspection could be completed and the structure assessed for strength and structural stability.

2.2.6 In-Depth Inspections

According to the Bridge Inspector's Reference Manual,

> "An in-depth inspection is a close-up inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures. Hands-on inspection may be necessary at some locations. When appropriate or necessary to fully ascertain the existence of or the extent of any deficiencies, nondestructive field tests may need to be performed. The inspection may include a load rating to assess the residual capacity of the member or members, depending on the extent of the deterioration or damage. This type of inspection can be

scheduled independently of a routine inspection, though generally at a longer interval, or it may be a follow-up for other inspection types. For small bridges, the in-depth inspection includes all critical members of the structure. For large and complex structures, these inspections may be scheduled separately for defined segments of the bridge or for designated groups of elements, connections, or details."

2.2.7 Other Inspections

2.2.7.1 Pin and Hanger Inspections

Pin and Hanger assemblies on redundant structure types are inspected using non-destructive testing methods. The Bridge Management Section hires consultants to do these inspections. Pin and Hanger inspections are required every 48 months.

2.2.7.2 Special Inspections

Special inspections are performed on bridges with defects that require inspection more frequently than the regular inspection cycle. A special inspection can be set at any interval less than 24 months, depending on the type of defect needing inspection and its condition.

To establish a regular inspection schedule, each district is to review its inventory records to determine inspection frequency. Factors influencing the inspection schedule may be special inspection equipment needed, low or high water levels, snow and ice conditions, and proximity of bridges to one another. By considering all of these factors a manageable schedule of inspection for the district's jurisdiction can be established and carried out.

2.2.8 Inspection Equipment and Tools

It is important that bridge inspectors have the tools necessary to conduct a thorough inspection. A successful bridge inspection program is dependent upon proper planning and techniques; adequate equipment; and inspector understanding of the properties of bridge materials and the types of defects and their locations.

2.2.8.1 Required Manuals

Inspectors should have access to the following manuals or books available to provide assistance in the inspection of structures:

1. MDT Bridge Inspection and Rating Manual
2. Fracture Critical Inspection Techniques for Steel Bridges (FHWA-NHI 02-037)
3. Bridge Inspector's Reference Manual (FHWA NHI 03-001 and 002)

2.2.8.2 Equipment

Inspectors require the following equipment to inspect the wide variety of bridges encountered in Montana.

Digital Camera with Flash	Tool Belt	Binoculars
Tool Box	Clip Board	Shovel
Industrial Crayons	Ladder	Increment Borers and plugs
Geologist Hammer	Pocket Knife	Calipers
Fall Protection Harness and Lanyard	Flashlight	Screwdriver
Waders	Ice Pick	Sound Pole
Plumb Bob	Lead Line	Wire Brushes
100' & 25' Tapes	Boat	Temperature Gauge
6m, 15m, and 30m Tapes	Hard Hat and Safety Vest	Steel-Toe Boots
Depth Gauge		
Inspection Tablet	D-Meter	

2.2.9 Inspection Procedure and Data Collection

Inspectors need to organize their inspections to make the most efficient use of time, travel, and equipment. Ideally, the inspection workload from year to year will be divided equally, and structures in the same geographical area will be inspected together to avoid repetitious trips. Traffic flow and density need to also be considered when planning the time of day to be at the site. The inspection itself will be conducted in a systematic manner that will minimize the possibility of bridge elements being overlooked. The inspector will organize and download the digital inspection information for the bridges to be inspected on the inspection tablet. The

2.2.10 Review

Previous inspection reports will be reviewed before visiting the site. Additional reviews outside of the previous inspection report include previous testing and monitoring results; maintenance and repair records; and accident and damage history. During this review, the inspector will need to note the design(s) and material(s) of the structure. This will alert the inspector to any special inspection equipment needs or the need for an expanded inspection such as Fracture Critical, Underwater, or Pin and Hanger.

This pre-inspection review will need to include a general inspection plan as well as fracture critical and underwater inspection plans as necessary. These plans are to include assigning inspection responsibilities to appropriate team members and how the effective, efficient, and safe inspection of all bridge elements will be carried out. The inspection plan will need to consider the extent of the traffic control required at the bridge site, coordination of traffic control with MDT Maintenance personnel, coordination with railroad personnel and any special equipment required to carry out the inspection.

Before visiting the site, the inspector will need to consider the weather and other environmental conditions. These items include available daylight, periods of low or high water, snow, periods of high traffic volumes, frozen rivers and streams, and environmental restrictions.

The inspector may need to notify local authorities when they plan to be in the area and encourage their participation in the inspections. Local bridge foremen can help by keeping us informed of repair work done to structures, the types and amounts of traffic using the facilities, and any load or speed restrictions placed upon them. Additional notifications may need to include the utility companies, and in some cases, local law enforcement. The inspector is required to notify the railroad before inspecting all structures crossing their right-of-way.

2.2.11 Tablet Use

As part of the SMS system the inspector will be required to use a ruggedized tablet to collect and disperse data. In order to be consistent through the districts the following steps will be utilized to operate the tablets.

- Filter the database to develop an inspection group of bridges for the inspection period (day or week)
- Upload the bridge data on the tablet prior to departure from the office. Verify that the data has loaded onto the tablet successfully

- Use the tablet in the field at the bridge site(s) to create new inspections and update the inventory, element and defect data. The tablet camera will be used as much as possible, but additional pictures may be taken and uploaded from an additional digital camera
- Photos may be attached at the element or bridge level depending on the inspector preference
- All inspection data will be input in the field and verified prior to departure from the bridge site
- Tablets will be synchronized to the database as often as possible, either through the dock in the office or through WIFI or hardwire connections in hotels. This synchronization assures constant back-up of data
- Always secure the tablet to yourself or the snooper bucket to prevent drops and damage
- Keep the tablet as clean from dust and moisture as possible. Do not leave the tablet in a vehicle in cold weather. The sudden change from a very cold vehicle to a warm office environment may create condensation inside the tablet case which will damage the electronics

2.2.12 Inspection

The NBI/Element inspections are performed using two distinct inspection methodologies. The Element inspection concentrates on the bridge elements and the deterioration of the discrete components. The NBI inspection concentrates on the overall appraisal of the structure and how the structure functions in its environment.

2.2.13 NBI Inspection

The NBIS requirements include the appraisal of the aggregate bridge elements into four possible categories: deck, superstructure, substructure, and culvert elements. Additional appraisals include load rating, roadway evaluation, and waterway/channel evaluation. A full description of each NBI item is in chapter 10. The table below denotes which NBI items the inspector is responsible for coding and which items are coded by the Bridge Management Section or automatically calculated by the Structure Management System (SMS).

NBI Item Number	Item Description	Coding Responsibility	When Coded
1	State Code	Bridge Management System	
2	Highway Agency District	Inspector	I
3	County Code	Inspector	
4	Place Code	Bridge Management System	
5	Inventory Route	Inspector	
7	Facility Carried by Structure	Inspector	I
8	Structure Number	Inspector	I
9	Location	Inspector	I
10	Inventory Route, Minimum Vertical Clearance	Inspector	I
11	Kilometerpoint/Milepost	Inspector	I
12	Base Highway Network	Inspector	I
13	LRS Inventory Route, Subroute Number	Inspector	I
16	Latitude	Inspector	I
17	Longitude	Inspector	I
19	Bypass, Detour Length	Inspector	I

20	Toll	Inspector	I
21	Maintenance Responsibility	Inspector	I
22	Owner	Inspector	I
26	Functional Classification of Inventory Route	Inspector	I
27	Year Built	Inspector	I
28	Lanes On and Under the Structure	Inspector	I
29	Average Daily Traffic	On-System=Bridge Information Management System Off-System=Inspector	I
30	Year of Average Daily Traffic	On-System=Bridge Information Management System Off-System=Inspector	I
31	Design Load	Bridge Management Section	
32	Approach Roadway Width	Inspector	I
33	Bridge Median	Inspector	I
34	Skew	Inspector	I
35	Structure Flared	Inspector	I
36	Traffic Safety Features	Inspector	R
37	Historical Significance	Bridge Management Section	
38	Navigation Control	Inspector	I
39	Navigation Vertical Clearance	Inspector	I
40	Navigation Horizontal Clearance	Inspector	I
41	Structure Open, Posted, or Closed to Traffic	Inspector	R
42	Type of Service	Inspector	I
43	Structure Type, Main	Inspector	I
44	Structure Type, Approach Spans	Inspector	I
45	Number of Spans in Main Unit	Inspector	I
46	Number of Approach Spans	Inspector	I
47	Inventory Route, Total Horizontal Clearance	Inspector	I
48	Length of Maximum Span	Inspector	I
49	Structure Length	Inspector	I
50	Curb or Sidewalk Widths (left and right)	Inspector	I
51	Bridge Roadway Width, Curb to Curb	Inspector	I
52	Deck Width, Out to Out	Inspector	I
53	Minimum Vertical Clearance Over Bridge Roadway	Inspector	I
54	Minimum Vertical Underclearance	Inspector	I
55	Minimum Lateral Underclearance on Right	Inspector	I
56	Minimum Lateral Underclearance on Right	Inspector	I
58	Deck Condition Rating	Inspector	R
59	Superstructure Condition Rating	Inspector	R
60	Substructure Condition Rating	Inspector	R
61	Channel and Channel Protection Condition Rating	Inspector	R

62	Culvert Condition Rating	Inspector	R
63	Method Used to Determine Operating Rating	Bridge Management Section	
64	Operating Rating	Bridge Management Section	
65	Method Used to Determine Inventory Rating	Bridge Management Section	
66	Inventory Rating	Bridge Management Section	
67	Structural Evaluation	Bridge Information Management System	
68	Deck Geometry	Bridge Information Management System	
69	Underclearances, Vertical and Horizontal	Inspector	I
70	Bridge Posting	Inspector	R
71	Waterway Adequacy	Inspector	R
72	Approach Roadway Alignment	Inspector	R
75	Type of Work	Bridge Information Management System	
76	Length of Structure Improvement	Bridge Information Management System	
90	Inspection Date	Inspector	R
91	Designated Inspection Frequency	Inspector	I
92	Critical Feature Inspection	Inspector	I
93	Critical Feature Inspection Date	Inspector	R
94	Bridge Improvement Cost	Bridge Information Management System	
95	Roadway Improvement Cost	Bridge Information Management System	
96	Total Project Cost	Bridge Information Management System	
97	Year of Improvement Cost Estimate	Bridge Information Management System	
98	Border Bridge	Bridge Information Management Section	I
99	Border Bridge Structure Number	Bridge Information Management Section	
100	STRAHNET Highway Designation	Bridge Information Management Section	
101	Parallel Structure Designation	Inspector	I
102	Direction of Traffic	Inspector	I
103	Temporary Structure Designation	Inspector	I
104	Highway System of the Inventory Route	Inspector	I
105	Federal Lands Highways	Inspector	I
106	Year Reconstructed	Inspector	I
107	Deck Structure Type	Inspector	I
108	Wearing Surface/Protective System	Inspector	I
109	Average Daily Truck Traffic	On-System=Bridge Information Management System, Off-System=Inspector	I

110	Designated National Network	Bridge Information Management System	
111	Pier or Abutment Protection (for Navigation)	Inspector	I
112	NBIS Bridge Length	Inspector	I
113	Scour Critical Bridges	Bridge Information Management Section	
114	Future Average Daily Traffic	On-System=Bridge Information Management System, Off-System=Inspector	I
115	Year of Future Average Daily Traffic	Bridge Information Management System	
116	Minimum Navigation Vertical Clearance	Inspector	I

I = Initial inspection and whenever a change occurs
R = Every Routine Inspection

2.2.14 ***MDT Inspection Items***

Other items that the inspector needs to collect and record when visiting a bridge site include posting of bridge load limit signs, Transporter Erector (TE) Routes and Defense Highway designations. The Structure Management System (SMS) will require collection of the following information specific to Montana.

<u>MDT Item 1: Transporter Erector (TE) Route Indicator</u>
Certain Urban, Secondary and Local routes are designated as TE routes and are used to transport missiles to various sites within a one hundred mile radius of Malmstrom Air Force Base in Great Falls. These routes are identified on county maps that are on file in the Bridge Management Section in Helena. FHWA guidelines require those structures between 8 and 20 feet (2.4 and 6.1 meters) also be inspected on these routes, including culverts as outlined in Section 1 of this manual. Toggling to the “1” will record the TE designation.

<u>MDT Item 2: Depth of Cover</u>
This field is used by the rating engineers to determine how much dead load should be added to a bridge. It is measured in inches from the top of the original deck surfacing to the top of the existing surface. See Figure 2.2.1 for illustrations of this measurement on different types of bridges.

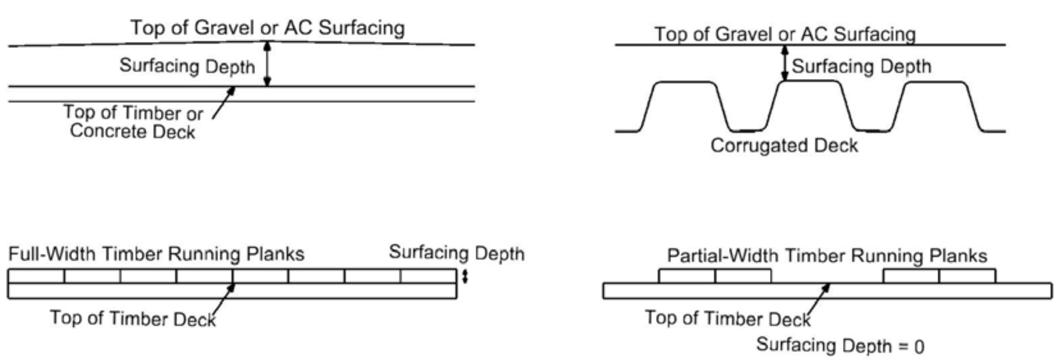

Figure 2.2.1

<u>MDT Item 3: Posting of Load Limits</u>
Statutory law governs the maximum weight of vehicles legally allowed to use the highways without special permits in order to serve the public interest in safety as well as economic concerns. When bridges do not have the capacity to carry legal loads they are required by

law to be load posted. One requirement of the NBIS is that each bridge inspected will be rated as to its safe load carrying capacity. If the maximum legal load of 40 tons for the AASHTO Type 3-3 truck exceeds its operating rating, the bridge must be posted in accordance with AASHTO requirements, found in the Manual for Bridge Evaluation (MBE).

In addition, any change in the posting status of a structure must be entered into the bridge inspection database within 180 days. Title 23, Section 1.36 of the Code of Federal Regulations allows FHWA to withhold federal funds to any jurisdiction not in compliance. For this reason, the Bridge Management Section established the County Posting Program. The current program used Metric number 14 as the definitive guide. When a bridge requires posting, a letter is sent to the county. The letter states MDT's requirement that the structure be posted at the inventory rating level, and includes the proper signing and placement instructions. At a minimum, the bridge must be posted for the Type 3 truck. The preferred option, though it is not required, is for the county to post for all three truck types. The county is instructed to sign and return the letter to MDT when the bridge has been posted. As soon as possible, but no later than the next regular inspection of the structure, weight-restriction posting signs will be confirmed with photos. Specialized Hauling Vehicle (SHV) ratings will be shown in the database, but at this time there is no specific requirement to post a bridge based on the load ratings for these vehicles.

MDT Item 4: Number of Crew Hours Required for a Regular Inspection
The number of hours it takes to complete an inspection on the bridge. This includes office time preparing for the inspection and data entry after the inspection. It does not include travel time to and from the bridge.

MDT Item 5: User Bridge Table MDT Snooper Required
Toggling to the "Y" indicates that a snooper is required for regular inspection of the bridge.

MDT Item 7: Number of Flagger Hours Required for a Regular Inspection
The number of hours that flaggers are needed to complete a regular inspection of the bridge.

MDT Item 8: Number of Special Crew Hours Required for a Regular Inspection
The number of hours that a special crew such as a climbing inspection team needs to conduct a regular inspection. District inspection personnel do not need to enter data into this field.

MDT Item 9: Number of Helper Hours Required for a Regular Inspection
The number of hours required for any personnel in addition to the inspection crew, such as administrative assistants and other helpers.

MDT Item 10: Agency Structure Name
This is the name the owner gives to the bridge. For example, counties sometimes name their bridges using an alpha-numeric system. On state-owned bridges, this field is typically left blank.

MDT Item 11: On/Off System
This indicates whether the bridge is on-system or off-system. See Section 1 for a description of on-system and off-system bridges.

MDT Item 12: Administrative Area or Geographic Stratification for the Structure
This is the administrative district where the bridge is located. A pick list is provided.

MDT Item 13: User Bridge Table MDT Drawing Number

This field is for the drawing number the Bridge Bureau assigns to the General Layout plan sheet for bridges constructed under an MDT contract. It is should not have a Q at the end. Drawing numbers with a Q at the end are for the quantity sheet, not the general layout. The general layout for a bridge typically has the same number as the quantity sheet, but without the Q. This is not always the case, however.

<u>MDT Item 14: User Bridge Table MDT Construction Station</u>
The station where the bridge is located within the MDT construction project limits. This is usually listed on the bridge's General Layout plan sheet.

<u>MDT Item 15: User Bridge Table MDT Project No</u>
The MDT construction project number the bridge was constructed or reconstructed under.

<u>MDT Item 16: User Bridge Table MDT Control Number</u>
The MDT control number for the construction project the bridge is constructed or reconstructed under.

<u>MDT Item 17: Structure Deck Area</u>
BMS will be updated to automatically calculate this item. Inspectors are not allowed to enter anything into this field.

<u>MDT Item 18: Date Load Rating Calculation Was Made</u>
The date the current load rating was completed. The load rater is responsible for populating this field.

<u>MDT Item 19: Initials of Load Rater/Engineer Responsible for Performing the Load Rating</u>
Initials of the person who completed the load rating. The load rater is responsible for populating this field.

<u>MDT Item 20: Operating Rating for Truck Type 1. AASHTO Type 3</u>
The Calculated Operating Rating for the AASHTO Type 3 truck. The load rater is responsible for populating this field.

<u>MDT Item 21: Operating Rating for Truck Type 2. AASHTO Type 3S2</u>
The Calculated Operating Rating for the AASHTO Type 3S2 truck. The load rater is responsible for populating this field.

<u>MDT Item 22: Operating Rating for Truck Type 3. AASHTO Type 3-3</u>
The Calculated Operating Rating for the AASHTO Type 3-3 truck. The load rater is responsible for populating this field.

<u>MDT Item 23: Operating Rating for Truck Type 4. AASHTO SHV 4</u>
The Calculated Operating Rating for the AASHTO SHV 4 truck. The load rater is responsible for populating this field.

<u>MDT Item 24: Operating Rating for Truck Type 5. AASHTO SHV 5</u>
The Calculated Operating Rating for the AASHTO SHV 5 truck. The load rater is responsible for populating this field.

<u>MDT Item 25: Operating Rating for Truck Type 6. AASHTO SHV 6</u>
The Calculated Operating Rating for the AASHTO SHV 6 truck. The load rater is responsible for populating this field.

<u>MDT Item 26: Operating Rating for Truck Type 7. AASHTO SHV 7</u>

The Calculated Operating Rating for the AASHTO SHV 7 truck. The load rater is responsible for populating this field.

<u>MDT Item 27: Inventory Rating for Truck Type 1. AASHTO Type 3</u>
The Calculated Inventory Rating for the AASHTO Type 3 truck. The load rater is responsible for populating this field.

<u>MDT Item 28: Inventory Rating for Truck Type 2. AASHTO Type 3S2</u>
The Calculated Inventory Rating for the AASHTO Type 3S2 truck. The load rater is responsible for populating this field.

<u>MDT Item 29: Inventory Rating for Truck Type 3. AASHTO Type 3-3</u>
The Calculated Inventory Rating for the AASHTO Type 3-3 truck. The load rater is responsible for populating this field.

<u>MDT Item 30: Inventory Rating for Truck Type 4. AASHTO SHV 4</u>
The Calculated Inventory Rating for the AASHTO SHV 4 truck. The load rater is responsible for populating this field.

<u>MDT Item 31: Inventory Rating for Truck Type 5. AASHTO SHV 5</u>
The Calculated Inventory Rating for the AASHTO Type 3-3 truck. The load rater is responsible for populating this field.

<u>MDT Item 32: Inventory Rating for Truck Type 6. AASHTO SHV 6</u>
The Calculated Inventory Rating for the AASHTO SHV 6 truck. The load rater is responsible for populating this field.

<u>MDT Item 33: Inventory Rating for Truck Type 7. AASHTO SHV 7</u>
The Calculated Inventory Rating for the AASHTO SHV 7 truck. The load rater is responsible for populating this field.

<u>MDT Item 34: User Bridge Table MDT Truck Type 1</u>
If this bridge is posted for the AASHTO Type 3 truck, the posted load is entered here. The inspector is responsible for this field. See figure 2.2.1 for examples of the posting signs.

<u>MDT Item 35: User Bridge Table MDT Truck Type 2</u>
If this bridge is posted for the AASHTO Type 3S2 truck, the posted load is entered here. The inspector is responsible for this field. See figure 2.2.1 for examples of the posting signs.

<u>MDT Item 36: User Bridge Table MDT Truck Type 3</u>
If this bridge is posted for the AASHTO Type 3-3 truck, the posted load is entered here. The inspector is responsible for this field. See figure 2.2.2 for examples of the posting signs.

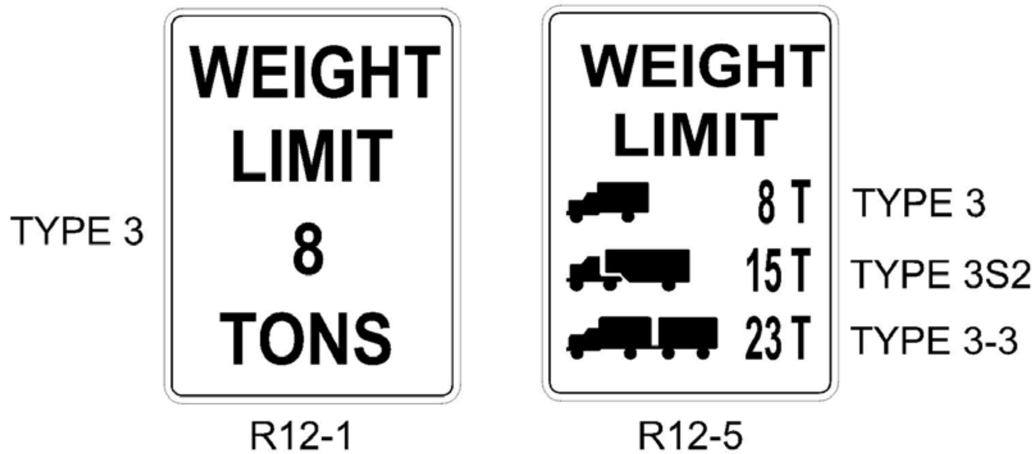

Figure 2.2.2

MDT Item 37: Roadway Name
The name of the roadway that serves the bridge. This field is printed in the inspection report to help locate the bridge.

MDT Item 38: Speed on Roadway, Either Actual Speed or Posted Speed Limit, miles/hr
This field is the speed of vehicles traveling on the roadway.

MDT Item 39: Speed for Detouring Vehicle, miles/hr
Leave this field blank.

MDT Item 40: Transit Bus Route Indicator
Leave this field blank.

MDT Item 41: User Roadway TE Route Designation
This field indicates whether the bridge is on a Transporter Erector (TE) route, or not. The two options are “1” designating a TE Route and “0” for not a TE Route. See Section 1 for a description of TE routes.

MDT Item 42: School Bus Route Indicator
This field indicates whether the bridge is on a school bus route or not.

MDT Item 43: User Roadway Table Both/South/West Dir Indicator Flag
This field indicates the direction of the roadbed that the User Roadway Table Both/South/West vertical and horizontal clearances are measured from. It is coded as the traveled direction of the roadbed given the inventory direction of the roadway. For I-15, it should be coded as South Dir (meaning the southbound roadbed), and for I-90 and I-94 it should be coded as West Dir (westbound roadbed). If the roadway is not a divided highway, this field should be coded as Both.

MDT Item 44: User Roadway Table North/East Dir Indicator Flag
This field indicates the direction of the roadbed that the User Roadway Table North/East vertical and horizontal clearances are measured from. It is coded as the traveled direction of the roadbed given the inventory direction of the roadway. For I-15, it should be coded as North Dir (meaning the northbound roadbed), and for I-90 and I-94 it should be coded as

East Dir (eastbound roadbed). If the roadway is not a divided highway, this field should be coded as N/A.

MDT Item 45: User roadway Both/South/West Vert Dist (feet)
This field is the minimum vertical clearance over the roadbed referenced by the User Roadway Table Both/South/West Dir Indicator Flag. It is measured as the minimum clearance for a 10 foot width of pavement or the traveled part of the roadway where the clearance is greatest, rounded to the nearest hundredth of a foot.

MDT Item 46: User Roadway North/East Vert Dist (feet)
This field is the minimum vertical clearance over the roadbed referenced by the User Roadway Table North/East Dir Indicator Flag. It is measured as the minimum clearance for a 10 foot width of pavement or the traveled part of the roadway where the clearance is greatest, rounded to the nearest hundredth of a foot. If User Roadway Table North/East Dir Indicator Flag is coded as N/A, this field should be left blank.

MDT Item 47: User Roadway South/West Horz Dist
This field is the horizontal clearance on the roadbed referenced by the User Roadway Table Both/South/West Dir Indicator Flag. It is measured as the total horizontal clearance between restrictive features (curbs, rails, walls, piers, or other structural features limiting the roadway), rounded to the nearest tenth of a foot. The purpose of this item is to give the largest available clearance for the movement of wide loads. Flush and mountable medians are not considered to be restrictions.

MDT Item 48: User Roadway North/East Horz Dist (feet)
This field is the horizontal clearance on the roadbed referenced by the User Roadway Table North/East Dir Indicator Flag. It is measured as the total horizontal clearance between restrictive features (curbs, rails, walls, piers, or other structural features limiting the roadway), rounded to the nearest tenth of a foot. The purpose of this item is to give the largest available clearance for the movement of wide loads. Flush and mountable medians are not considered to be restrictions. If User Roadway Table North/East Dir Indicator Flag is coded as N/A, this field should be left blank.

MDT Item 49: Number of Medians on the Roadway
This field is the number of medians on the bridge roadway.

MDT Item 50: Traffic Volume Class of the Roadway
This field is automatically updated by the Bridge Information Management System. Inspectors don’t need to enter anything into this field.

MDT Item 51: Average Annual Accident Count
This field is automatically updated by the Bridge Information Management System. Inspectors don’t need to enter anything into this field.

MDT Item 52: Estimated Accident Risk
This field is automatically updated by the Bridge Information Management System. Inspectors don’t need to enter anything into this field.

MDT Item 53: Actual Accident Rate in Number of Accidents Per 100m VMT
This field is automatically updated by the Bridge Information Management System. Inspectors don’t need to enter anything into this field.

MDT Item 54: Number of Accidents Recorded in Past 10 Years
This field is automatically updated by the Bridge Information Management System. Inspectors don’t need to enter anything into this field.

MDT Item 55: MDT Maintenance Section
This field is the MDT Maintenance Section with responsibility for maintenance of the bridge. There will be a drop down list to identify the various sections. Code it as None for bridges not maintained by MDT.

2.2.15 Element Inspection

An Element Level inspection differs from an NBIS inspection in the items that are rated as to their condition, and how the rating is recorded. All Bridges are composed of elements, each of which represents a particular part of the bridge and the material it is made of (e.g., steel girder, timber abutments, pourable joint seals). National Bridge Elements and Bridge Management Elements are used to standardize reporting of bridge elements and defect descriptions. There are 107 possible elements and 45 types of defect coding to be used in an Element Level inspection. These elements and defects are used throughout the country. There are also 30 Agency Defined Elements for items that are unique to MDT.

NBIS ratings are developed by averaging the good with the bad to come up with an overall rating for the item being inspected. In contrast, an Element Level inspection is done by rating bridge elements as quantitative units expressed as percentages of the total or actual quantity of the element in each condition state. For example, a stringer may have twenty percent in condition state 1 (good), twenty-five percent in condition state 2 (fair), fifty-five percent in condition state 3 (poor) and 0 percent in condition state 4 (severe).

Both the NBIS and Element Level inspections will be completed. The element level inspections will supplement the rating supplied by the traditional NBIS inspections.

2.2.15.1 Elements

Of the 107 different elements, up to forty elements per bridge could be used, but generally about four to twelve elements describe a bridge. The elements are grouped into a logical numbering sequence:

1-99	Deck Elements
100-199	Superstructure Elements
200-299	Substructure and Culvert Elements
300-599	Miscellaneous Elements
800-999	Agency Defined Elements
1000-7000	Defects

After the initial inspection is complete, inspection forms will show the element numbers and description for each structure. During each inspection, the inspector will verify that the elements describing the structure are correct and complete. The elements may change from year to year because of environmental conditions, maintenance, and/or construction activities. If an inspector discovers that an element is missing, or has been exposed due to environmental conditions, the inspector will add the new element to the Element Level Inspection form and rate the condition of the added element.

2.2.15.2 Defects

There are 45 possible defects for each bridge. These defects included material defects such as corrosion in steel as well as structural defects such as settlement.

Defects have unique codes that associate them with an element. Defects are coded much the same as elements and each condition state has descriptions of deterioration and other issues described for clarity and consistency. For overlaying defects the overriding defect will be coded. The defect hierarchy is noted later in this manual.

2.2.15.3 Environment

To model the deterioration of elements, knowing the environment of each element is necessary. Elements exposed to different environmental factors and service environments deteriorate differently. These factors may include:

- Operational activities from traffic volumes and truck movements,
- Exposure to water, road salt and other corrosive materials,
- Condition of protective and water proofing systems, or
- Temperature extremes, either from mature or human activity

When inventorying and assessing the condition of the elements, an inspector should consider the environment in which the element is operating. The environmental designation of an element can change over time; as it would, for example, if operating policies were changed to reduce the use of road salt. However, by definition, the environmental designation for any element cannot change as a result of maintenance work or deterioration. For Montana, different districts may have different environmental factors due to topography, humidity, freezing temperatures and greater chloride use as well as higher truck and general traffic volumes.

2.2.15.4 Condition State Rating

When a bridge is inspected, each element is rated by dividing it among four condition states. Parts of a given element on a bridge can then be distributed among any or all of the possible condition states. The inspector may choose to record condition states in actual element dimensions or in percentages. In either case the sum of the defect quantities in each condition state will not exceed the element quantity or the sum of the percentages in each condition state will add up to one hundred percent. The default for the inspection reports will be percentages.

2.2.16 Post-Inspection and Reporting

A completed inspection report is required for each bridge inspection performed. This report is essential as it provides specific details about the inspection and about the bridge itself. Standard report forms have been developed for NBI and element-level inspections. These forms provide a means of recording standard information pertinent to all bridges and special information unique to each particular bridge. If Fracture Critical inspections are performed at the same time as the routine inspection, a fracture critical plan will be developed prior to the field inspection and used in the field to identify the fracture critical members as well as to record any issues or deficiencies related to those fracture critical members. All elements that contain fracture critical components will be noted as fracture critical in the comments portion of that element, and their condition will also be noted in the comments. The drawings and forms used for the fracture critical plan will be updated and submitted with the final report. If the bridge requires a class 2 underwater inspection this inspection plan will be updated as part of the consultant diver report and included in the bridge file.

Inspection data gathered from the site will need to be compiled and entered into the inspection database. The inspectors must verify that the appropriate bridge elements are used, their total quantity is correct, and any inspection notes are documented. The Team Leader is required to perform quality assurance and approve and e-sign the inspection form that is stored in the BIMS. The first inspection of new or rehabilitated structures requires a full inventory of all element level data and revision as needed of all NBI and non-NBI fields. After the first inspection, the inspection forms will show the element designation, environment, total quantity, and percentage in each condition state for all elements from the previous inspection, along with the previous inspection ratings for the field inspected NBI items, and values entered for all non-NBI fields. Notes on the structures will be associated with the proper section of the inspection (i.e. element notes with the corresponding element and NBI notes in the General Inspection Notes section). These notes need to be clear and detailed enough to be interpreted later by interested parties.

A minimum of three photos (approach, profile, and underside) is required for each inspection, and additional photos are required when deterioration or a defect is found. Any signed weight or clearance limitations at the bridge site will be clearly shown in the photographs. If a photograph of the posting sign does not provide a close enough view of the bridge approach, an additional photo is to be provided. Where photos cannot properly describe a situation, sketches are required. Photos will be either taken with the inspection tablet, or downloaded into the tablet from a digital camera before the tablet inspection data is downloaded into the BIMS data store.

The inspector uploads the bridge inspection data into the Data Store, ensuring the data entered meets quality control guidelines established by the MDT Bridge Management Section. The inspector electronically signs the bridge inspection report and forwards to the District Bridge Inspection Coordinator (DBIC) for final acceptance. Once accepted by the DBIC, the inspection becomes the permanent record, subject to revisions made during Bridge Management QA/QC procedures.
The district inspection files are considered copies only.

Finalize NBI/Element bridge inspection data in the database within 2 weeks of the date that the bridge was inspected. Complete data verification within 4 weeks of the inspection date. Note that if inspection data is not entered into the Bridge Information Management System before the bridge is due for inspection the bridge will show up on the late inspection list. All bridges are to be inspected on or before their due date.

For state-maintained structures, a discussion of the structure after an inspection with state Maintenance forces is also required to resolve any maintenance needs. A copy of the inspection form for bridges on state-maintained routes will be given to the Division Maintenance Chiefs responsible for the bridges inspected so that they are aware of maintenance recommendations made by the inspector.

For bridges that are not maintained by the state, a letter from the District inspection office will accompany a copy of the inspection reports sent to local authorities responsible for the bridges inspected. This report will summarize any serious problems found with the local authority's structures and will stress that MDT does not assume responsibility for bridge maintenance on these structures or for warning the public if these bridges are unsafe. The inspection reports are intended to give them guidance in the maintenance, repair, and replacement of their structures and will provide some basis for possible future funding from state and federal monies.

2.2.16.1 Significant Change / Problem Reporting

Special reporting is required whenever a significant change or problem is noted. A significant change or problem is any issue that involves structural concerns, damage, or safety concerns. Structural concerns are items that may require re-rating the bridge, load limits and posting, or a significant change in condition state. Damage may be new or old. Safety concerns could be any condition that is noted such as a need for replacement of safety markers. Inspectors will have an option to request a load rating review.

Issues on state-maintained bridges will also be reported to the District Bridge Inspection Coordinator, the Maintenance Chief, and others as appropriate. The Work Items listed in the Bridge Management System may suffice for a part of this notification.

Issues with bridges not maintained by the state will be reported to the bridge's owner and the District Bridge Inspection Coordinator. Verbal notification to the owner will be done as soon as is reasonable after the inspection. These issues must be specifically included in the letter accompanying the inspection reports to the Owner.

2.2.16.2 Critical Findings Procedures

According to the Code of Federal Regulations Title 23, Subpart C, §650.305, a critical finding is a structural or safety related deficiency that requires immediate follow-up inspection or action. This can be further defined to note that immediate attention or follow-up is needed because the condition of the structure is a current or imminent danger or safety hazard to the traveling public.

2.2.16.2.1 *Critical Findings on State-Owned Bridges*

If a critical situation is discovered on a state-owned bridge, the inspector will immediately contact one of the engineers in the Bridge Management Section in Helena. The engineer will make the final decision on whether the issue is critical or not, and what actions need to be taken.

If a critical finding is declared, the engineer will enter a critical work item into the Bridge Management System, and send an e-mail explaining the critical finding to the following people:

Bridge Management Engineer
Bridge Engineer
Bridge Design Engineer
FHWA Montana Division Bridge Engineer
District Inspection Coordinator
Bridge Maintenance Engineer
Maintenance Chief

The inspector will take any action required at the bridge site as directed by the engineer to ensure the safety of the traveling public. These actions may include coordinating lane or road closures with the local MDT Maintenance section or county road crew until a temporary or permanent repair plan can be implemented.

The Bridge Maintenance Engineer will mark the work item as Approved and coordinate with MDT Maintenance crews on an immediate plan to ensure the safety of the traveling public. This plan may include road or lane closures, load restrictions, shoring, bracing, strengthening, or other actions for short or medium term repair or stabilization of the structure. Simultaneously, the Bridge Engineer will coordinate with design staff to nominate any project that may be necessary to repair or replace the structure. If necessary, the Bridge Maintenance Engineer will write up an action plan for monitoring the structure until it is repaired or replaced.

Once the structure has been repaired or replaced, the Critical Work Item will be marked as Completed in the Bridge Management System.

2.2.16.2.2 Critical Findings on Bridges Not Owned by MDT

If a critical situation is discovered on a bridge not owned by MDT, the bridge inspector will immediately contact the bridge owner. If the critical situation is to the extent that the bridge needs to be closed, the bridge inspector has the authority to recommend bridge closure. The inspector will notify the Bridge Management Section of the finding and what actions the inspector took in notifying the bridge owner as soon as is reasonable. If closure is not required the bridge will be rerated, and a load posting recommendation made to the owner.

2.2.16.3 Bridge Records

Comprehensive bridge records are maintained, both at the District level, and in the Bridge Management Section in Helena. These files must be kept up-to-date and include the following

2.2.16.4 Bridge Management Section Files

- E-signed, approved copy of the bridge inspection in the SMS data store
- Copy of any critical findings summaries and repair reports
- Any sketches made by the inspector
- Fracture Critical and/or Underwater Diving Inspection Plan(s)
- Bridge measurements, hard copy plans, electronic non-MDT plans by reference or stored in SMS, MDT plans by reference or MDT plans electronically in SMS
- Load rating calculation summaries
- Repair recommendations and repair actions taken
- General correspondence
- Channel cross-section information when required (stored electronically in SMS)
- Other relevant information

2.2.16.5 District File

- Copies of current and previous bridge inspection reports with photos as required by records disposal policies
- Any sketches made by the inspector
- Repair recommendations and other actions taken
- General Correspondence
- Other relevant information

2.2.17 Quality Control / Quality Assurance

The Quality Control / Quality Assurance processes are a vital part of the Bridge Inspection Program. MDT requires a high level of data integrity in order to meet its needs and responsibilities. Quality Control is a District function. Quality Assurance is a function of the Bridge Management Section in Helena.

2.2.17.1 Quality Control (by Districts)

Quality Control is the steps each District takes to monitor the accuracy of inspections and confirm that data collection is complete. Proper Quality Control will ensure the inspection data gathered is consistent and meets guidelines established by MDT.

The District Bridge Inspection Coordinator is responsible for administering the District Quality Control plan. The quality control plan may be customized to fit the procedures of the District, but must include the following minimum items.

Data Verification

An independent second party with proper training and experience will review each inspection report. This person will review the report for accuracy, completion, consistency, and the reasonableness of the inspection. Any errors noted or problems identified will be addressed with the individual who performed the inspection. If the issues cannot be resolved, the discussion may be elevated to the Bridge Management Section.

On-Time Inspections and Reporting

Ensure that bridge inspections are performed within the required intervals, inspection data is entered and reviewed within the time specified, and the inspection reports are signed and sent to the Bridge Management Section in Helena once data entry and quality control checks are complete.

Rotation of Inspectors

Each year, the district will rotate a minimum of 10% of its bridges to another inspector in that district. These bridges are to include a variety of bridge types with a diverse combination of material and design types. When significant differences are identified from one inspector to the next, the inspectors will schedule a meeting and discuss the differences.

Element Spot Check

Each year, the District Bridge Inspection Coordinator will randomly choose 5% of the district's bridges to review. These structures are to include a diverse combination of material and design types. This review will assess the accuracy and completion of the inspection. Data review will include element identification, environmental state, quantities, condition states, and all NBI and non-NBI fields the inspectors are responsible for. The Coordinator will also review consistency from inspection to inspection and throughout the district. Spot checks are an ongoing process that occurs throughout the year.

Internal Quality Assurance

District level Quality Assurance is a check on the administration and operation of the Quality Control plan. District Quality Assurance is performed on a semi-annual to annual basis. At the completion of the review, a compliance report is prepared that describes area of conformity and non-conformity and any corrective action taken. The report is sent to the Bridge Management Engineer and the District Bridge Inspection Coordinator retains a copy on file. These are intended to be learning opportunities in an ongoing process improvement.

2.2.17.2 Quality Assurance (by Bridge Management Section, Helena)

The purpose of the quality assurance review program is to evaluate program effectiveness, uniformity, and compliance with federal and state rules relating to bridge inspections. Quality assurance reviews may recommend program improvements and may require changes in a program. Inspector training is an integral part of the quality assurance process, and helps ensure uniformity of inspections throughout the state. The quality assurance review program, under the direction of the Bridge Management Section, involves two different levels of review: office review and field review.

Office Review

An office review consists of reviewing information such as inspection reports and bridge measurements submitted to the Bridge Management Section. These reviews occur on a random sample of at least 5 percent of inspections as inspection data arrives in the Bridge Management Section.

Field Review

The Bridge Management Section personnel will conduct a quality assurance inspection review of NBI/Element inspections performed by each district. Every year, a random sample of NBI/Element inspections will be reviewed for consistency and conformance with State and Federal policy and procedures. The Bridge Management Section will perform a yearly field review on the NBI/Element inspections of at least 2 percent of each District's bridges.

The District Bridge Inspection Coordinator, Assistant Bridge Inspection Coordinator, and at least one of Bridge Management Section's Bridge Conditions and Operations Engineers are required review team members. Other inspection personnel from the District being reviewed should also attend. Bridge Inspection staff from other districts may rotate onto the team as well as any new Bridge Management Section staff. Bridge design personnel are encouraged to participate in the Quality Assurance Review process as guest inspectors.

The quality assurance team will generate a totally independent inspection report for those bridges selected. The team will then compare their inspection report to the latest inspection reports and information. The accuracy of the condition ratings and the comments are reviewed to ensure they reflect the actual conditions of the bridge. Discrepancies are documented and discussed with the bridge inspector.

On-site inspector training is provided during these reviews as training needs are identified. The Bridge Management Section conducts this training and will tailor the training to the needs of each district. Training needs are identified through the Office Review process and on previous Field Reviews.

Internal Quality Control

Bridge Management Section personnel will check for errors as they work and update the SMS as required. At the end of each Quality Assurance Field Review, the engineers involved in the review will go through the file for each bridge reviewed to make sure all relevant information is in the file and to remove any duplicate information.

2.2.18 Consultant Inspections

MDT contracts with consultants to perform specialty and regular inspections. MDT does not have the resources or in-house expertise to perform diving (type II underwater) or climbing inspections and certain types of non-destructive testing (NDT). Consultants are also utilized when MDT resources are not available to complete all regularly scheduled inspections on time.

2.2.18.1 Specialty Inspections

MDT uses the following process to complete specialty consultant inspections.

- Consultants are hired using MDT's Consultant Design Section processes and access is granted to the SMS. See requirements below for external user access.
- The consultant performs bridge inspection utilizing their own mobile tablet devices that meet MDT specifications for use with the SMS.
- An electronic draft inspection is uploaded to SMS from the mobile device. The consultant performs Quality Control of a specialty inspection in alignment with the MDT inspection contract provisions.
- Consultant transmits inspection documents to MDT.
- MDT reviews the draft inspection and inspection documents. MDT requests correction and resubmittal as necessary. The consultant loads final inspection documents into the SMS and e-signs inspection, for approval by Bridge Management Section.
- Bridge Management Section approves the final signed and reviewed electronic inspection. The SMS application stores historical bridge inspection data and can generate a signed legal hard or electronic copy of an inspection report.
- Bridge Management Section distributes either electronic or hardcopy signed bridge inspection reports to bridge owners and entities responsible for bridge maintenance.

2.2.18.2 Regular Inspections

MDT uses the following process to complete a regular inspection performed by consultants.

- Consultants are hired using MDT's Consultant Design Section processes and access is granted to the SMS. See requirements below for external user access.
- The consultant performs bridge inspection utilizing their own mobile tablet devices that meet MDT specifications for use with the SMS.
- Consultant uploads the bridge inspection data into the Data Store, ensuring the data entered meets quality control guidelines established by MDT Bridge Management Section. Consultant electronically signs the bridge inspection report and forwards to the District Bridge Inspection Coordinator (DBIC) for final acceptance.
- DBIC completes quality control on bridge inspection and then sends it back to the consultant for correction and resubmittal, if necessary.

- DBIC accepts the final signed and reviewed electronic inspection. QC and QA of consultant regular inspections follow the processes outlined above.
- The SMS application stores historical bridge inspection data and can generate a signed legal hard or electronic copy of an inspection report.
- DBIC distributes either electronic or hardcopy signed bridge inspection reports to bridge owners and entities responsible for bridge maintenance.

2.2.19 Statewide Inspector Meetings

At least biannually, the Bridge Management Section will host a Bridge Inspector's Meeting to provide training to the inspectors based on training needs identified during QA Reviews and any new changes to the NBIS or Element Inspection standards. Also, the findings of all the Quality Assurance reviews will be discussed, and any questions or concerns the inspectors have will be addressed.

Element Descriptions and Identification

This section covers the the main structural elements used in element inspection and coding. This is not all-inclusive, but will give the inspector an idea of how a structure should be coded. The elements are listed by their generic names. Unless otherwise noted, these descriptions are for all material types.

Deck/Slab Elements

Deck

The deck is the part of the bridge that the vehicle drives on. It transfers the vehicle wheel loads to the superstructure.

Slab

A slab is a deck that acts as a superstructure. There are no other superstructure elements present with a slab. A slab transfers the vehicle load directly to the substructure.

Top Flange

The top flange is the portion of a tee-beam type structure that carries the traffic loads. This is defined as the part of the beam from the web fillet up to the riding surface, and is shaded gray in figure 0.4.1.

Superstructure Elements

Girder

Girders are longitudinal members that are the primary load carrying members of a superstructure. In the past, beams on short span bridges have been called stringers. The element inspection process has classified all longitudinal beams that are the primary load carrying elements of the superstructure, regardless of span length, as girders.

Since it is rather difficult to inspect girders that are enclosed, girder quantities are determined from the number of girders that can be seen from the underside of the bridge. This is done to simplify the inspection assessment since the inside of box girders cannot usually be seen.

Girders on tee-type bridges that make up the riding surface will require coding of two elements. The riding surface will be coded as a Top Flange. The web and bottom flange will be coded as a girder (below the top flange/web fillet). This is the unshaded area of the girders in figure 0.4.1.

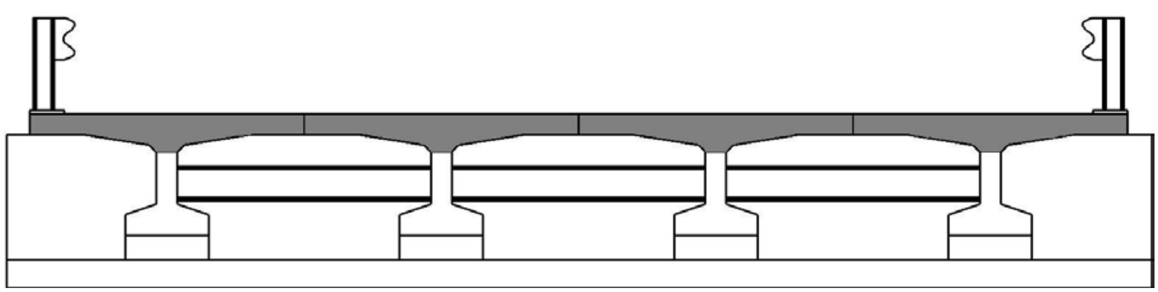

Figure 0.4.1
Typical Bulb-Tee Girders

Truss

A truss is a longitudinal main load carrying member that is made up of a top chord, bottom chord, verticals, and diagonals. There are through trusses, partial-through trusses, pony trusses, and deck trusses.

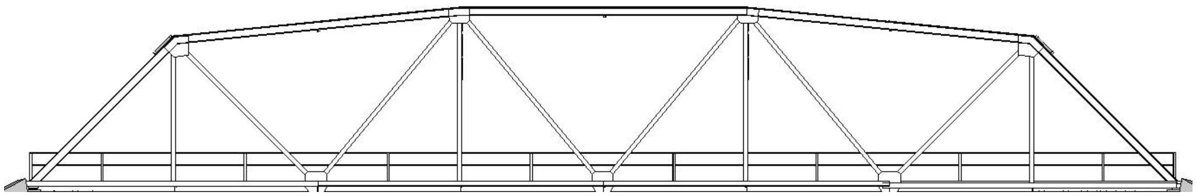

Figure 0.4.2
Typical Through Truss

Arch

An arch is a longitudinal main load carrying member that is shaped like an arc, and is always in compression.

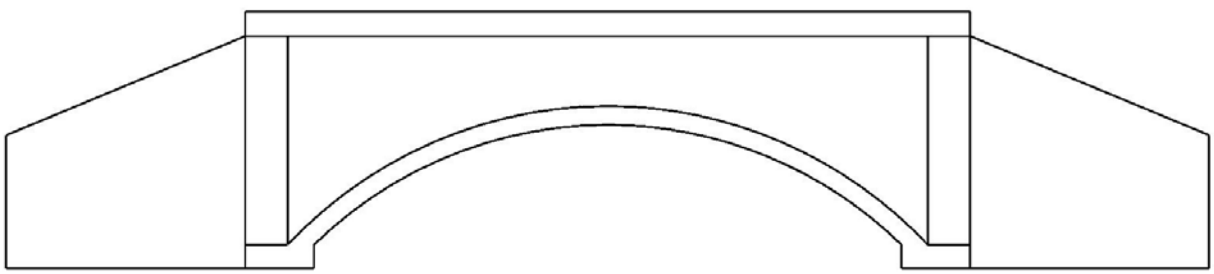

Figure 0.4.3
Typical Simple Arch

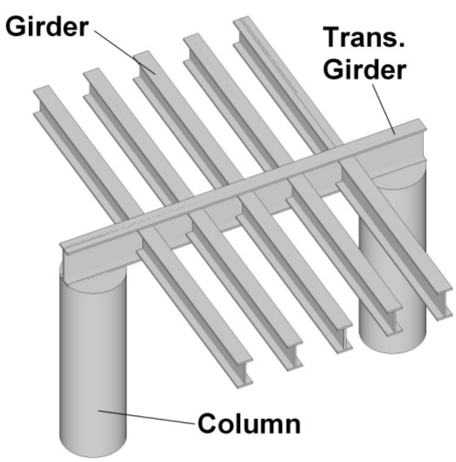

Figure 0.4.4
Typical Transverse Girder

Stringer

A stringer is a longitudinal element that transfers loads from the deck to the Floorbeams or Transverse Girders.

Floorbeam

A floorbeam is a transverse element that transfers loads from the deck and/or stringers to the main longitudinal superstructure members (girders, truss, or arch).

Transverse Girder

A transverse girder is an element that carries the load from the deck or stringers directly to the substructure through the bearings.

Substructure Elements

Column
A column is an element that transfers loads from the pier cap to the footing or pile cap.

Pier Wall
A pier wall is a wall that transfers loads either directly from the superstructure or from the pier cap to the pile cap, footing, or piles. Web walls are not pier walls, and should not be coded as pier walls.

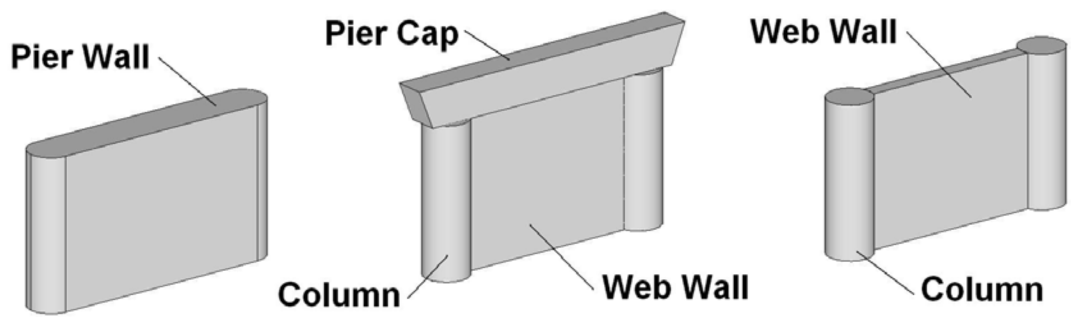

Figure 0.4.5
Typical Concrete Pier with Walls

Pier Cap
A pier cap is an element that transfers loads from the girders through the bearing devices to the column, pier wall, or piles.

Pile Cap
A pile cap is an element that transfers the loads from the pier wall or columns to the piles.

Footing
A footing is an element that transfers the loads from the pier wall or columns directly to the ground or piles.

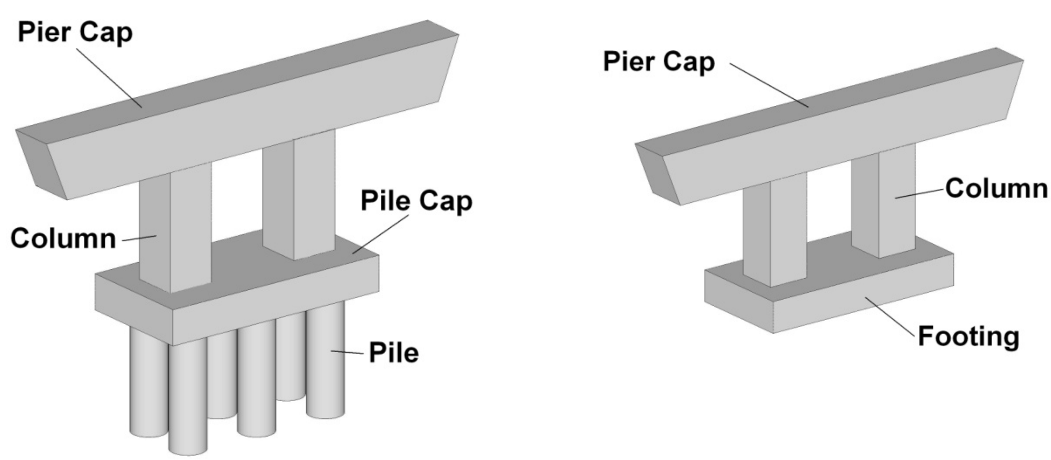

Figure 0.4.6
Typical Concrete Pier with Columns

Piles

Elements that transfer the load from the pile cap or pier cap to the ground. Note that piles above the ground and water surface are coded as pile extensions.

Abutment

An abutment is the support element that is at the beginning and ending of the structure. It transfers loads from the superstructure to the ground. Concrete abutments include the cap, piles, wingwalls, and backwall. Timber and steel abutments include the backwall, wingwalls, and wingwall piles. The caps and piles are coded separately for timber and steel abutments.

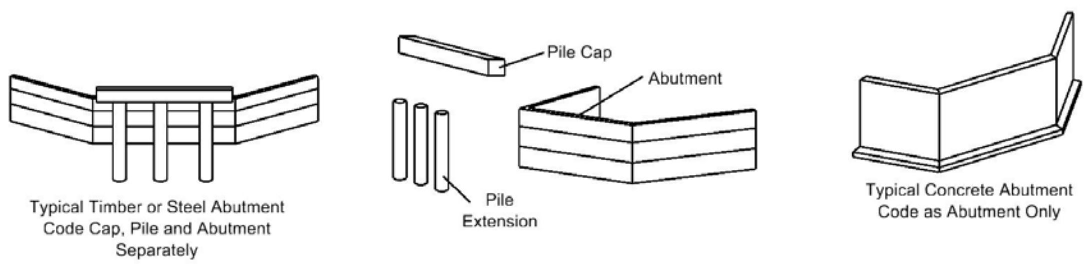

Figure 0.4.7
Typical Abutments

Column Tower (Trestle)

A column tower or trestle is built up or framed tower support. The steel version is a tower and the timber version is a trestle.

Submerged Pile

A submerged pile is the section of the pile that is below the water line.

Submerged Column

A submerged column is the section of the column that is below the water line.

Submerged Pier Wall

A submerged pier wall is that portion of the pier wall that is below the water line. This element does not apply to web walls between two or more columns.

Submerged Footing/Pile Cap

This element is for footings and pile caps that are underwater and are exposed by design or by scour of the soil around them.

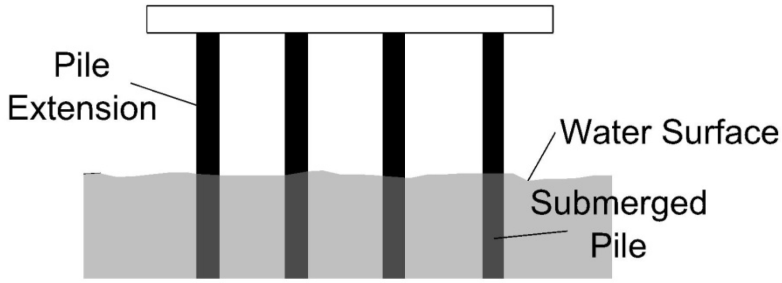

Figure 0.4.8
Submerged Piles

This section includes a matrix of all bridge elements including National Bridge Elements (NBE), Bridge Management Elements (BME) and Agency Defined Elements (ADE) as well as a matrix for element defects. Underlined elements are the Agency Defined Elements unique to MDT.

2.4.1. Decks, Slabs, Top Flanges, and Related Elements

Detailed descriptions of the Deck, Slab, and Top Flange elements along with their related elements – Joints, Approach Slabs, and Bridge Rail – can be found in Chapter 2.

Material	Units	Element Number (Decks)	Element Number (Slab)	Element Number (Top Flange)
Reinforced Concrete Deck/Slab	sq ft	12	38	16
Prestressed Concrete Deck/<u>Slab</u>	sq ft	13	<u>39</u>	15
Steel - Open Grid	sq ft	28		
Steel - Concrete Filled Grid	sq ft	29		
Steel - Corrugated/Orthotropic/Etc.	sq ft	30		
Timber	sq ft	31	54	
Other	sq ft	60	65	

Element	Units	Element Number
Joints		
Strip Seal Expansion Joint	ft	300
Pourable Joint Seal	ft	301
Compression Joint Seal	ft	302
Assembly Joint/Seal (modular)	ft	303
Open Expansion Joint	ft	304
Assembly Joint w/o Seal	ft	305
Other Joint	ft	306
Approach Slabs		
P/S Concrete Approach Slab	sq ft	320
Reinforced Concrete Approach Slab	sq ft	321
Bridge Rail		
Metal Bridge Rail	ft	330
Reinforced Concrete Bridge Rail	ft	331
Timber Bridge Rail	ft	332
Other Bridge Rail	ft	333
Masonry Bridge Rail	ft	334
Protective Systems		

Wearing Surfaces	sq ft	510
Steel Protective Coating	sq ft	515
Corrosion Resistant Reinforcing System – Metallic	sq ft	990
Corrosion Resistant Reinf System – Non-Metallic	sq ft	991
Concrete Reinforcing Steel Protective System	sq ft	520
Concrete Protective Coating	sq ft	521

2.4.2. Superstructure Elements

Detailed descriptions of superstructure elements can be found in Chapter 3.

Element	Units	Steel	P/S Concrete	Reinf. Concrete	Timber	Masonry	Other
Open Girder/Beam	ft	107	109	110	111		112
Closed Web/Box Girder	ft	102	104	105			106
Stringer	ft	113	115	116	117		118
Truss	ft	120			135		136
Arch	ft	141	143	144	146	145	142
Floor Beam	ft	152	154	155	156		157
Transverse Girder	ft	810	811				812
Railroad Car	ft	815					
Cable – Primary	Each	147					
Cable – Secondary	Each	148					149
Gusset Plate	Each	162					
Pin, Pin and Hanger Assembly, or Both	Each	161					
Truss Vertical Cross-Frame	ft	820					
Curved Girder Diaphragm	ft	821					
Post-Tensioning Anchor	Each	825					

Other Superstructure Elements	Units	Element Number

Protective Systems		
Steel Protective Coating	sq ft	515
Concrete Protective Coating	sq ft	521

2.4.3. Substructure Elements

Detailed Descriptions of Substructure Elements can be found in Chapter 4.

Element	Units	Steel	P/S Concrete	Reinf. Concrete	Timber	Masonry	Other
Column	Each	202	204	205	206		203
Column Tower (Trestle)	ft	207			208		
Pier Wall	ft			210	212	213	211
Abutment	ft	219		215	216	217	218
Pile	Each	225	226	227	228		229
Pier Cap	ft	231	233	234	235		236
Pile Cap/Footing	ft			220	855		
Submerged Column	Each	860	861	862	863		864
Submerged Pier Wall	ft			870	871	872	873
Submerged Pile	Each	880	881	882	883		884
Submerged Pile Cap/Footing	ft			890	891		
Non-Structural Retaining Wall	ft	911		912	913	914	915

Other Substructure Elements	Units	Element Number
Scour	Each	900
Scour Countermeasures	Each	901
GRS-IBS Retaining Wall	ft	910
Bearings		
Elastomeric Bearing	Each	310
Moveable Bearing (roller, sliding, etc.)	Each	311
Enclosed/Concealed Bearing	Each	312

Fixed Bearing	Each	313
Pot Bearing	Each	314
Disk Bearing	Each	315

2.4.4. Culverts

CULVERTS Chapter 4 Element	Units	Steel	P/S Concrete	Reinf. Concrete	Timber	Masonry	Other
Culvert	ft	240		241	242	244	243

2.4.5. Off-Bridge Elements

Element	Units	Steel	P/S Concrete	Reinf. Concrete	Timber	Masonry	Other
Approach Guardrail	ft	950		951	952		953
Approach Guardrail Ends	ft	960					

2.4.6. Material Defects

Defect Name (Number)	Used to Report	Materials
Corrosion (1000)	Corrosion of metal and other material elements.	Steel/Metal
		Other Materials
Cracking (1010)	Fatigue cracking in metal and other material elements.	Steel/Metal
		Other Materials
Connection (1020)	Connection distress in metal and other material elements.	Steel/Metal
		Timber
		Other Materials
Delamination/Spall/ Patched Area (1080)	Spalls, delamination, and patched areas in concrete, masonry, and other material elements.	Prestressed Concrete
		Reinf. Concrete
		Masonry
		Other Materials

Defect Name (Number)	Used to Report	Materials
Exposed Rebar (1090)	Exposed conventional reinforcing steel in reinforced and prestressed concrete beams.	Prestressed Concrete Reinf. Concrete
Exposed Prestressing (1100)	Exposed prestressing steel in concrete elements.	Prestressed Concrete
Cracking (PSC) (1110)	Cracking in Prestressed Concrete Elements	Prestressed Concrete
Efflorescence/Rust Staining (1120)	Efflorescence/rust staining in concrete and masonry elements.	Prestressed Concrete Reinf. Concrete Masonry Other Materials
Cracking (RC and Other) (1130)	Cracking in reinforced concrete and other materials.	Reinf. Concrete Other Materials
Decay/Section Loss (1140)	Decay (section loss) in timber elements.	Timber
Check/Shake (1150)	Checks and shakes in timber elements.	Timber
Crack (Timber) (1160)	Cracking in timber elements	Timber
Split/Delamination (Timber) (1170)	Splits/delaminations in timber elements.	Timber
Abrasion/Wear (Timber) (1180)	Abrasion/wear in timber elements.	Timber
Abrasion/Wear (Concrete) (1190)	Abrasion/wear in prestressed and reinforced concrete elements.	Prestressed Concrete Reinf. Concrete
Deterioration (Other) (1220)	General deterioration in elements constructed of other materials such as fiber reinforced plastics or similar.	Other Materials
Mortar Breakdown (Masonry) (1610)	Breakdown of masonry mortar between brick, block or stone.	Masonry
Split/Spall (Masonry) (1620)	Splits or spalls in brick, block or stone.	Masonry
Patched Area (Masonry) (1630)	Masonry patched areas.	Masonry
Masonry Displacement (1640)	Displaced brick, block or stone.	Masonry
Distortion (1900)	Distortion from the original line or grade of the element; used to capture all distortion regardless of cause.	Steel/Metal Prestressed Concrete Reinf. Concrete

Defect Name (Number)	Used to Report	Materials
		Masonry Timber Other Materials
Movement (2210)	Movement of bridge bearing elements.	Other Materials
Alignment (2220)	Alignment of bridge bearing elements.	Other Materials
Bulging, Splitting or Tearing (2230)	Bulging, slitting or tearing of elastomeric bearing elements.	Other Materials
Loss of Bearing Area (2240)	Loss of bearing area for bridge bearing elements.	Other Materials
Leakage (2310)	Leakage through or around sealed bridge joints.	Other Materials
Seal Adhesion (2320)	Loss of adhesion in sealed bridge joints.	Other Materials
Seal Damage (2330)	Damage to rubber in bridge joint seals.	Other Materials
Debris Impaction (2350)	Accumulation of debris in bridge joint seals that may or may not affect the performance of the joints.	Other Materials
Adjacent Deck or Header (2360)	Concrete deck damage in the area anchoring the bridge joint.	Other Materials
Metal Deterioration or Damage (2370)	Metal damage or deterioration in the bridge joint.	Other Materials
Delamination/Spall/Patched Area/Pothole (Wearing Surfaces) (3210)	Spalls, delaminations, patched areas, and potholes in wearing surface elements.	Wearing Surfaces
Crack (Wearing Surface) (3220)	Cracking in wearing surface elements.	Wearing Surfaces
Effectiveness (Wearing Surface) (3230)	Loss of effectiveness in the protection provided to the deck by the wearing surface elements.	Wearing Surfaces
Chalking (Steel Protective Coatings) (3410)	Chalking in metal protective coatings.	Steel/Metal Protective Coatings
Peeling/Bubbling/Cracking (Steel Protective Coatings) (3420)	Peeling, bubbling or cracking in metal protective coatings.	Steel/Metal Protective Coatings
Oxide Film Degradation Color/Texture Adherence	Oxide film degradation of texture in metal protective coatings.	Steel/Metal Protective Coatings

Defect Name (Number)	Used to Report	Materials
(Steel Protective Coatings) (3430)		
Effectiveness (Steel Protective Coatings) (3440)	Loss of effectiveness of metal protective coatings.	Steel/Metal Protective Coatings
Wear (Concrete Protective Coatings) (3510)	Wearing of concrete protective coatings.	Concrete Protective Coatings
Effectiveness (Concrete Protective Coatings) (3540)	Effectiveness of concrete protective coatings.	Concrete Protective Coatings
Effectiveness-Protective System (e.g. Cathodic) (3600)	Effectiveness of internal concrete protective systems (epoxy rebar, cathodic protection, etc.).	Concrete Reinforcing Steel Protective Systems
Settlement (4000)	Settlement in substructure elements.	Steel/Metal
		Prestressed Concrete
		Reinf. Concrete
		Masonry
		Timber
		Other Materials
Damage (7000)	Impact Damage	Steel/Metal
		Prestressed Concrete
		Reinf. Concrete
		Masonry
		Timber
		Other Materials
		Wearing Surfaces
		Steel/ Metal Protective Coatings
		Concrete Protective Coatings
		Concrete Reinforcing Steel Protective Systems

2.4.7 Defect Hierarchy

In some cases, there may be multiple overlapping defects noted for an element. In those overlapping cases, all defects will be recorded. When calculating the amount in each condition state for the parent element, only the prevailing defect will be used to determine the quantities in each condition state. When there are two or more defects in the same area then the defect in the worst condition state will be used to determine the condition state of the parent element. If the worse defect in an area is in Condition State 3, then that portion of the element is in condition state 3 regardless of how many other Condition State 2 defects share that space. However, if there are defects that appear to be in the same condition state, the inspector needs to know how to determine the "most important" defect to use in determining the condition state quantities of the parent element. In order to be consistent through the districts the following hierarchy will be followed. Only the most common issues with defect overlaps are shown. There may be additional defects that need to be added based on the judgement of the inspector.

2.4.7.1 Concrete

For concrete elements regardless of location use the following priority list:

Defect Number	Defect Name
1100	Exposed Prestressing
1090	Exposed Reinforcing
1080	Spalls/Delams/Patches
1120	Efflor/Rust Staining
1110/1130	Cracking
1190	Abrasion
7000*	Damage

2.4.7.2 Steel

For steel elements regardless of location use the following priority list.

Defect Number	Defect Name
1010	Cracking
1900	Distortion
1000	Corrosion
1020	Connections
7000*	Damage

2.4.7.3 Timber

For timber elements regardless of location use the following priority list.

Defect Number	Defect Name
1160	Cracks
1140	Decay/Section Loss
1170	Split/Delamination
1020	Connections
1150	Check/Shake
1190	Abrasion
7000*	Damage

2.4.7.4 Masonry

For Masonry elements use the following priority list.

Defect Number	Defect Name
1640	Displacement
1080	Spalls/Delams/Patches
1610	Mortar Breakdown
1120	Efflor/Rust Staining
1630	Patched Area
1900	Distortion
7000*	Damage

2.4.7.5 Bearings

For bearings on concrete and steel structures use the following priority list.

Defect Number	Defect Name
2220	Alignment
2210	Movement

2240	Loss of Bearing Area
2230	Bulging, Splitting or Tearing
1000	Corrosion
1020	Connection
7000*	Damage

2.4.7.6 Joints

For joints on concrete and steel structures use the following priority list.

Defect Number	Defect Name
2310	Leakage
2370	Metal Deterioration or Damage
2360	Adjacent Deck or Header
2350	Debris Impaction
7000*	Damage

*Note that the Damage defect is considered a sub-defect and is used only in conjunction with another defect and assumes the quantity of that other defect.

Appendix 2A
Climbing Bridge Inspection Guidance

Contents

General scope guidance/expectations for the 2018 climbing inspections

- Inspections are required to be sent to the MDT contract manager for QC review within 75 days of the inspection.
- Upload FC Inspection Procedure to SMS under Inventory Documents
- Inspection reports and summaries should avoid duplicating information, data, and photos contained in SMS, except for the NBI values and other content guidance recommended in the templates provided.
- Determine if the bridge complexity warrants a more detailed report. For less complex bridges the inspector is encouraged to substitute a brief *Bridge Inspection Brief Summary* (pg 5) document instead of a more detailed *Climbing Bridge Inspection Full Report* (pg 4) document. It is anticipated that bridges that received floor beam only inspections in the past are likely less complex and a *Bridge Inspection Brief Summary* document is sufficient.
- Format Inspection report in accordance with the table of contents template provided
    - Include both NBI Bridge ID # and the MDT Asset # on the cover sheet or first page of any documents uploaded to SMS
- Format FC Inspection Procedure in accordance with the template provided
- If applicable, determine if an Underwater inspection is required and update appropriate attributes in SMS.
- underwater inspections are not included or required in the scope for 2018 Climbing Inspections.
- Review and update all Inspector responsibility attributes in SMS. (List on Page 6)
- Where applicable, consider most recent UW Type II inspection report in evaluation of NBI rating for (60) substructure

Repair item Guidance

- Add Repair items to elements as appropriate
  I. Repair items added to SMS should be limited to work that can be completed by MDT maintenance staff, with or without the assistance of Bridge Maintenance Engineers. Other recommended repairs or maintenance should be noted in the inspection report, but should not show up in SMS repair items.
  II. A few examples of what to include in repair items in SMS

- ➢ Object marker repair/replace
- ➢ Approach Guardrail repairs
- ➢ Potholes/ deck spalls
- ➢ Missing bolts
- ➢ Loose nuts
- ➢ Clean debris out of deck drains
- ➢ Reset Elastomeric bearings
- ➢ Repairs to rotten, deteriorated, or shifted Timber elements (cap, piles, decks, girders, rails, etc.)
- ➢ Loose steel joints or guard angles (sliding plates and other embedded type joints and headers that pose a safety hazard when they come out)
- ➢ Repair impact damage (rails, posts, prestress or steel beams, etc.)
- ➢ Remove channel debris on piers/abutments
- ➢ Cracks in Steel members (these may or may not be critical; may require an immediate call to Helena)
- ➢ Clean debris out of joints
- ➢ Clean debris off caps/bearings
- ➢ Remove vegetation or clear trees that prevent inspection of bridge elements, grow within the shadow of the bridge, or could fall and damage the bridge
- ➢ Wingwall/backwall issues (including erosion under or around the wingwall)
- ➢ Approach roadway settlement or side slope erosion near the bridge

  III. A few examples of repairs/maintenance that should be noted in inspection report, but not included in repair items in SMS

- ➢ Deck seal or deck overlay
- ➢ Scour Issues
- ➢ Monitor…
- ➢ Larger repair items that will require a rehabilitation project
- ➢ Many gray areas, so don't be afraid to ask.
- ➢ Always call Helena with Anything urgent or critical

Climbing Bridge Inspection Full Report Guidance
(For complex bridges that require a more detailed report)

1 INTRODUCTION

2 INSPECTION FINDINGS

2.1 Deck

2.2 Superstructure

2.3 Substructure

2.4 Etc.

Subdivide the bridge into appropriate elements. Compare organization to previous climbing inspection report, if one exists. This will change from bridge to bridge, but my intent is that a specific bridge will have similarly formatted reports from one inspection cycle to the next.

3 CONCLUSION

Please include the following information in the Conclusion section:

- NBI ratings for Deck (58), Super (59), Substructure (60), Channel (61)
  - Substructure (60) should be an aggregate of the above water and below water condition, so where applicable please consider the most recent underwater inspection report available when evaluating the rating.
- NBI (41) Structure Open, Posted, or Closed to Traffic and a comment on if bridge is posted according to values in SMS.
- A recommendation to review the Load rating of bridge where applicable
- Underwater inspection recommendation if applicable (Only if MDT(061) is currently blank)
  - If the condition of the bridge was based on the above water condition only then a recommendation for an underwater inspection should also be included.
- Note if the Fracture Critical Inspection Procedure should be updated or state that no changes to the FC procedure are needed at this time.
- Repair/maintenance recommendations

APPENDICES

APPENDIX A – Fracture Critical Member Diagram

- Include defects and an individual floor beam sheet for each floor beam.

APPENDIX B – Photos (Try to avoid repeating any photos uploaded to SMS)

APPENDIX C – Fracture Critical Inspection Procedure

- Include one “template” floor beam sheet

APPENDIX D – Appendix D and additional appendices will likely be specific to individual bridges. Review previous routine inspection report and stay consistent where applicable.

Climbing Bridge Inspection Brief Summary Guidance
(For less complex bridges)

Summary Content Recommendation

Please include the following information in the Bridge Inspection Summary:

- NBI ratings for Deck (58), Super (59), Substructure (60), Channel (61)
  - Substructure (60) should be an aggregate of the above water and below water condition, so where applicable please consider the most recent underwater inspection report available when evaluating the rating.
- NBI (41) Structure Open, Posted, or Closed to Traffic and a comment on if bridge is posted according to values in SMS.
- A recommendation to review the Load rating of bridge where applicable
- Underwater inspection recommendation if applicable (Only if MDT(061) is currently blank)
  - If the condition of the bridge was based on the above water condition only then a recommendation for an underwater inspection should also be included.
- Note if the Fracture Critical Inspection Procedure should be updated or state that no changes to the FC procedure are needed at this time.
- Repair/maintenance recommendations

APPENDICES

APPENDIX A – Fracture Critical Member Diagram

- Include defects and an individual floor beam sheet for each floor beam.

APPENDIX B – Photos (only photos not already included in SMS)

APPENDIX C – Fracture Critical Inspection Procedure

- Include one “template” floor beam sheet

APPENDIX D – Appendix D and additional appendices will likely be specific to individual bridges. Review previous routine inspection report and stay consistent where applicable.

Template for Climbing Inspection FC Inspection Procedure

1. Fracture Critical (FC) Inspection Procedure

Example:

I. Review the following documents in SMS and discuss any questions with MDT:
   a. FC inspection Procedure
   b. Previous inspection report
   c. Most recent underwater inspection report if applicable
   d. Any other Special inspections or Repair items occurring since the most recent fracture critical inspection.

II. Team leader holds a pre-inspection meeting to review procedure with team

III. Notify MDT contract manager of anticipated inspection schedule

IV. Once team arrives onsite, team leader reviews safety risks and precautions with team before beginning inspection work.

V. Traffic control set up

VI. Team members perform inspection roles as directed by team leader and according to FC inspection sequence:

VII. Once inspection of all elements is complete, Onsite QC review performed.

VIII. Immediately notify MDT contact of any critical findings

2. Onsite Safety Risks and Precautions

Examples:

- Loose riprap at Abutment 2 is a falling hazard
- Poor vertical sight distance on approach to the North
- High voltage lines present onsite
- Small roadway shoulder provides poor parking and staging areas
- Wildlife (Osprey nest, or other?)

3. Traffic Control Measures Needed

4. Equipment Needed for Arm's Length Inspection of FC Members

5. Manpower Needed for Arm's Length Inspection of FC members

6. Staging Areas and Access Locations

7. Notification Required for Any Local Agencies

Example, Fresno Reservoir Spillway – contact BLM & Sheriff

8. Fracture Critical Risk Factors to consider.

Please include, describe, and comment on any applicable risk factors:

- ☐ Fatigue and fracture prone details
- ☐ Problematic materials
- ☐ Poor welding techniques
- ☐ Potential out-of-plane distortion details
- ☐ Previous cracking or repairs
    - o Source of cracking
- ☐ Cold service temperatures
- ☐ Superstructure condition code of 4 or less
- ☐ Subject to overloads or impact damage
- ☐ Load posted
    - o Missing or damaged posting signs
- ☐ Superstructure condition code of 4 or less
- ☐ Subject to overloads or impact damage
- ☐ Older service life
- ☐ Debris
- ☐ High ADTT

9. General Inspection Procedure Comments

Examples:

- Excessive bird dropping hinder adequate inspection of critical members. Contact MDT and recommend to removal/cle4aning prior to inspection
- Utility pipe requires aid to climb around
- 4 floor beams and panel points are easily inspected from ground
- All floor beams require aid 6 times per floor beam
- Significant section loss to stringer ends. Start on stringer ends.

10. Fracture Critical Member Inspection Sequence

General sequence is acceptable, but if a more detailed sequence is warranted then I encourage a detailed description. My thought on a general sequence is something like:

The following tasks were performed at the Big Fork Bridge by the inspection engineers from Fickett:

- Mobilization to the site daily and set up traffic control to warn oncoming motorists that work is being performed on the bridge
- Hands-on inspection of all steel members in the plane of the primary truss lines, and secondary bracing member connections
- Cursory inspection of secondary bracing members
- Hands-on inspection of the floor system
- Obtain all applicable photographs and note all deficiencies using tablets
- Perform element level inspection and NBI inspection

Figure 1 - Fickett 2017 FC Inspection Report Excerpt Asset # 02939

11. Sketch of Bridge with Fracture Critical Members Identified in Red

12. Floor beam FC Bridge Inspection Plan and Reporting Template

Attribute Data
Bridge Inspectors Responsibilities

Chapter	Attribute	Inspector Responsible	Review
A - Location Data			
	(MDT001) Agency structure name	X	
	(1) State Code		
	(MDT027) On|Off System	X	
	(MDT020) MDT Maintenance Division	X	
	(2) MDT Inspection District	X	
	(3) County Code	X	
	(4) Place Code		
	(6A) Feature Intersected	X	
	(7) Facility Carried by Structure	X	
	(22) Owner	X	
	(21) Maintenance Responsibility	X	
	(112) Nbis Bridge Length	X	
	(9) Location	X	
	(MDT031) Railroad Over/Underpass	X	
	(MDT032) Railroad Owner	X	
	(MDT014) Interchange Indicator	X	
	(MDT015) Interstate Ramp Indicator	X	
	(MDT078) MDT Maintenance Section		
B - Construction Data			
C - Improvement Cost Data			
D - Border State Data			
E - Historical Structure Data			
F - Bridge Location			
	(16) Latitude (DMS)	X	
	(17) Longitude (DMS)	X	
G - Span and Dimension Data			
	(33) Bridge Median	X	
	(34) Skew [%]	X	
	(35) Structure Flared	X	
	(42A) Type of Service on Bridge	X	
	(48) Length Of Maximum Span [ft]	X	
	(49) Structure Length [ft]	X	
	(53) Min Vert Clear Over Bridge Roadway [ft]	X	
	(101) Parallel Structure Designation	X	
	(103) Temporary Structure Designation	X	
	(38) Navigation Control	X	
	(39) Navigation Vertical Clearance [ft]	X	
	(40) Navigation Horizontal Clearance [ft]	X	
	(116) Minimum Navigation Vertical Clearance [ft]	X	
GG - Span Details			
	Span 1 Length (ft)	X	
H - Main Span Details			
	(43A) Main Span Material	X	
	(43B) Main Span Design Type	X	

	(45) Number Of Spans In Main Unit	X	
I - Approach Span			
	(44A) Approach Span Material	X	
	(44B) Approach Span Design Type	X	
	(46) Number Of Approach Spans	X	
J - Deck Data			
	(50A) Left Curb|Sidewalk Width [ft]	X	
	(50B) Right Curb|Sidewalk Width [ft]	X	
	(52) Out-to-Out Deck Width [ft]	X	
	(MDT006) Deck Area [Area]	X	
	(107) Deck Structure Type	X	
	(108A) Type of Wearing Surface	X	
	(108B) Type of Membrane	X	
	(108C) Deck Protection	X	
K - Under Bridge Service			
	(42B) Type of Service under	X	
	(54A) Minimum Vertical Underclearance-Reference Feature	X	
	(54B) Minimum Vertical Underclearance [ft]	X	
	(55A) Min Lateral Underclear On Right-Reference Feature	X	
	(55B) Minimum Lateral Underclearance on Right [ft]	X	
	(56) Min Lateral Underclear On Left [ft]	X	
	(111) Pier|abutment Protection	X	
	(113) Scour Critical Status		
	(69) Underclear, Vertical and Horizontal	X	
L - Load and Rating Data			
	(MDT016) Load Rating Date		
	(MDT022) Name of Load Rater		
	Bridge being Rated by Consultant		
	(31) Design load		
	(66) Inventory Rating [ton]		
	(65) Method Used To Determine Inventory Rating		
	(64) Operating Rating [ton]		
	(63) Method Used to Determine Operating Rating		
	(70) Legal Load Status		X
M - General Facility Data			
	(5A) Inventory Route-Record Type	X	
	(5C) Designated Level of Service	X	
	(5B) Route Signing Prefix	X	
	(5D) Route Number	X	
	(5E) Directional Suffix	X	
	(12) Base Highway Network	X	
	(13A) LRS Number	X	
	(13B) Inventory Route, Subroute Number-Subroute Number	X	
	(19) Bypass|Detour Length [mi]	X	
	(MDT009) Detour Speed [mi/hr]		
	(104) NHS Indicator	X	
	(MDT030) Posted speed limit (MPH) [mi/hr]	X	
	(11) Accumulated Miles [mi]	X	

	(MDT087) Mile Post	X	
N - Base Network Data			
	(28B) Lanes Under the Structure	X	
	(32) Approach Roadway Width [ft]	X	
	(51) Bridge Roadway Width Curb-To-Curb [ft]	X	
	(72) Approach Roadway Alignment	X	
	(28A) Lanes on the Structure	X	
O - Other Network Data			
	(20) Toll	X	
	(100) STRAHNET Highway Designation		
	(105) Federal Lands Highways	X	
	(110) National Truck Network		
	(MDT048) School Bus Route	X	
P - Roadway Size and Clearance Data			
	(10) Minimum Vertical Clearance [ft]	X	
	(47) Total Horizontal Clearance [ft]	X	
	(102) Direction of Traffic	X	
	(MDT007) Departmental Route	X	
	(MDT002) Both|South|West Direction	X	
	(MDT003) Both|South|West Vertical Distance [ft]	X	
	(MDT051) South|West Horizontal Distance	X	
Q - Traffic Data			
	(26) Functional Classification	X	
	(MDT060) Traffic Volume Class	X	
	(29) Average Daily Traffic		
	(30) Year of Average Daily Traffic		
	(109) Average Daily Truck Traffic (%)		
	(114) Future Average Daily Traffic		
	(115) Year Of Future Avg Daily Traffic		
R - Inspection			
	(36A) Traffic Safety Features - Bridge Railings	X	
	(36B) Traffic Safety Features - Transitions	X	
	(36C) Traffic Safety Features - Approach guardrail	X	
	(36D) Traffic Safety Features - Approach guardrail Ends	X	
	(41) Structure Open, Posted, or Closed to Traffic	X	
	(58) Deck Rating	X	
	(59) Superstructure	X	
	(60) Substructure	X	
	(62) Culvert	X	
	(61) Channel	X	
	(67) Structural Evaluation		
	(SR) Sufficiency Rating		
	(SRa) Asterisk Field in SR		
	(MDT058) Structurally Deficient|Functionally Obsolete		
	(68) Deck Geometry		
	(71) Waterway Adequacy	X	
	(90) Inspection Date	X	
	(MDT023) Next Inspection Date	X	

	(91) Regular Inspection Frequency (Months)	X	
	(92A-1) FC Inspection Required	X	
	(92A-2) FC Inspection Frequency (Months)	X	
	(93A) FC Inspection Date	X	
	(MDT011) FC Next Inspection Date	X	
	(MDT010) FC Inspection Details	X	
	(MDT074) Underwater Inspection Details	X	
	(MDT061) Type 1 Underwater Inspection Required	X	
	(MDT063) Type 1 Underwater Inspection Frequency (months)	X	
	(MDT062) Type 1 Underwater Inspection Date	X	
	(MDT064) Type 1 Underwater Inspection Next Date	X	
	(MDT076) Deck Condition	X	
	(92B-1) Type 2 Underwater Inspection Required	X	
	(MDT077) Structure Condition		
	(92B-2) Type 2 Underwater Inspection Frequency (Months)	X	
	(93B) Type 2 Underwater Inspection Date	X	
	(MDT086) Type 2 Underwater Next Inspection Date	X	
	(92C-1a) Other Inspection Required	X	
	(92C-2a) Other Inspection Frequency (Months)	X	
	(93Ca) Other Inspection Date	X	
	(MDT029) Other Inspection Next Date	X	
	(MDT028) Other Inspection Details	X	
	(92C-1b) Special Inspection Required	X	
	(92C-2b) Special Inspection Frequency (months)	X	
	(93Cb) Special Inspection Date	X	
	(MDT056) Special Inspection Next Date	X	
	(MDT005) Date Last QA		
	(MDT008) Depth of Cover [Depth]	X	
	(MDT067) Type 3 Truck Posting	X	
	(MDT073) Type 3S2 Truck Posting	X	
	(MDT070) Type 3-3 Truck Posting	X	
	(MDT034) Request Review of Load rating	X	
	(MDT090) Climbing Inspection Required	X	
	(MDT050) Snooper Required	X	
	(MDT049) Snooper Hours	X	
	(MDT004) Crew Hours	X	
	(MDT012) Flagger Hours	X	
	(MDT052) Special Crew Hours	X	
	(MDT013) Helper Hours	X	
	(MDT053) Special Equipment Hours	X	
Z - Administrator Approval			
	(AdminApp) Approved by :		
	(AdminApp) Approval date :		
	(8) NBI Structure Number		
	NBI Id of Previous Structure		
	MDT ID		

Chapter 3 – Deck, Slab, and Top Flange Elements

DETAILED ELEMENT DESCRIPTIONS

This, and subsequent chapters describe the elements ‘detailed use in inspection and bridge management. Each detailed element description is broken down into three subsections:

1. **Description**—Detailed identification and classification of the element, including units of measurement, and guidelines on how to collect the quantity of the element in a consistent manner.
2. **Condition State Definitions**—Defect descriptions and severity, with guidelines to the inspector for determining defect severity.
3. **Element Commentary**—Additional considerations for the inspector to be aware of during data collection.

All the elements described in this Section are included in the standard set of National Bridge Elements (NBEs), except where noted for Bridge Management Elements (BMEs), such as joints and approach slabs and (ADE), Agency Defined Elements such as different types of reinforcement and submerged elements. The elements are organized by major groupings such as Decks and Slabs, Superstructure, Substructure and Culvert elements. The common defects identified for each element material are further detailed in Chapter 2.

3.1.0—DECKS AND SLABS

These elements describe the component that is transferring load from the vehicle to the bridge. This Section does not include secondary deck elements such as joints, deck/slab protection systems, or wearing surfaces.

Deck elements transmit the loads into superstructure elements. Slab elements transmit the load into the substructure elements. Structures that include slab elements typically do not have superstructure elements. These elements transmit traffic loads directly into the substructure. All deck or slab elements can be supplemented with one or more associated protection systems or wearing surface elements.

3.1.1—Element 12—Reinforced Concrete Deck

Description: All reinforced concrete bridge decks regardless of the wearing surface or protection systems used.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states. Deck top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.1.2—Element 13—Prestressed Concrete Deck

Description: All prestressed concrete bridge decks regardless of the wearing surface or protection systems used.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern)map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states. Deck top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

The inspector should use judgement when utilizing the condition state defect definitions, especially for prestressed concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

3.1.3—Element 28—Steel Deck with Open Grid

Description: All open grid steel bridge decks with no fill.

Classification: NBE

Units of Measurement: ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states. When the steel grid deck has concrete fill in the wheel tracks only, use Element 29 for the concrete filled portion and Element 28 for the unfilled portion of the deck.

3.1.4—Element 29—Steel Deck with Concrete Filled Grid

Description: Steel bridge decks with concrete fill either in all of the openings or within the wheel tracks.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states. When the steel grid deck has concrete fill in the wheel tracks only, use Element 29 for the concrete filled portion and Element 28 for the unfilled portion of the deck.

3.1.5—Element 30—Steel Deck Corrugated/Orthotropic/Etc.

Description: Those bridge decks constructed of corrugated metal filled with portland cement, asphaltic concrete, or other riding surfaces. Orthotropic steel decks are also included.

Classification: NBE

Units of Measurement: ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion (1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="3">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking (1010)</td><td>None.</td><td>Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.</td><td>Identified crack that is not arrested by does not warrant structural review.</td></tr>
<tr><td>Connection (1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states. Materials added for riding surface are not part of the element condition.

3.1.6—Element 31—Timber Deck

Description: All timber bridge decks regardless of the wearing surface or protection systems used.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measureable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top and bottom surface, edges, or all; and being captured using the defined condition states.

Timber running planks shall be included under the wearing surface assessment.

3.1.7—Element 60—Other Deck

Description: All bridge decks constructed or other material regardless of the wearing surface or protection systems used.

Classification: NBE

Units of Measurement: ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The deck evaluation is three-dimensional in nature with the defects observed on the top and bottom surface, edges, or all; and being captured using the defined condition states.

The other material deck is intended for decks constructed of composite materials, or other materials that cannot be classified using any other defined deck element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.1.8—Element 38—Reinforced Concrete Slab

Description: All reinforced concrete bridge slabs regardless of the wearing surface or protection systems used.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the slab from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States 1 GOOD	Condition States 2 FAIR	Condition States 3 POOR	Condition States 4 SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012—0.05 in. or spacing of 1.0—3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The slab evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states.

Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

3.1.9—Element 54—Timber Slab

Description: All timber bridge slabs regardless of the wearing surface or protection systems used.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measureable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The slab evaluation is three-dimensional in nature with the defects observed on the top and bottom surface, edges, or all; and being captured using the defined condition states.

Timber running planks shall be included under the wearing surface assessment.

3.1.10—Element 65—Other Slab

Description: All slabs constructed or other material regardless of the wearing surface or protection systems used.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the slab from edge to edge, including any median areas and accounting for any flares or ramps present.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking,	Wide cracks or heavy pattern (map) cracking.	

Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The slab evaluation is three-dimensional in nature with the defects observed on the top and bottom surface, edges, or all; and being captured using the defined condition states.

The other material slab is intended for slabs constructed of composite materials, or other materials that cannot be classified using any other defined slab element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.2.0 – Top Flanges

The elements in this Article are concrete girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. These elements are for reinforced and prestressed concrete girders that require traffic to ride on the top flange.

3.2.1—Element 15—Prestressed Concrete Top Flange

Description: All prestressed bridge girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. These bridge types include bulb-tees, box girders, and girders that require traffic to ride on the top flange.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the top flange from edge to edge, including any median areas and accounting for any flares or ramps present. This quantity is for the top flange riding surface only. Girder web and bottom flange are to be evaluated by the appropriate girder element.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. diameter or less. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The flange evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, edges, or all; and being captured using the defined condition states. Flange top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

The inspector should use judgement when utilizing the condition state defect definitions, especially for prestressed concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

3.2.2—Element 16—Reinforced Concrete Top Flange

Description: All reinforced bridge girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. These bridge types include tee-beams, box girders, and girders that require traffic to ride on the top flange.

Classification: NBE **Units of Measurement:** ft^2

Quantity Calculation: Area of the top flange from edge to edge, including any median areas and accounting for any flares or ramps present. This quantity is for the top flange riding surface only. Girder web and bottom flange are to be evaluated by the appropriate girder element.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (PSC) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact	The element has impact damage. The specific damage caused by the impact	The element has impact damage. The specific damage caused by the impact

		has been captured in Condition State 2 under the appropriate material defect entry.	has been captured in Condition State 3 under the appropriate material defect entry.	has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The flange evaluation is three-dimensional in nature with the defects observed on the top surface, bottom surface, or both; and being captured using the defined condition states. Flange top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.3.0—WEARING SURFACES, PROTECTIVE COATINGS, AND CONCRETE REINFORCING STEEL PROTECTIVE SYSTEMS

The elements in this Article are wearing surfaces, steel and concrete protective coatings, and concrete reinforcing steel protection systems such as cathodic protection. These systems will influence the deterioration and condition of the underlying structural element.

3.3.1—Element 510—Wearing Surfaces

Description: All decks/slabs that have overlays made with flexible (asphaltic concrete), semi-rigid (epoxy and polyester material), and rigid (portland cement) materials; and timber running planks.

Classification: BME **Units of Measurement:** ft^2

Quantity Calculation: Should include the area of the deck/slab that is protected by this wearing surface.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area/Pothole (Wearing Surfaces) (3210)	None.	Delaminated. Spall less than 1 in. deep or less or less than 6 in. diameter. Patched area that is sound. Partial depth pothole.	Spall 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Full depth pothole.	The wearing surface is no longer effective.
Crack (Wearing Surface) (3220)	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012—0.05 in. or spacing of 1.0—3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Effectiveness (Wearing Surface) (3230)	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None

3.3.4—Element 520—Concrete Reinforcing Steel Protective System

Description: All types of protective systems used to protect reinforcing steel in concrete elements from corrosion.

Classification: BME **Units of Measurement:** ft^2

Quantity Calculation: Should include the entire surface of the protected element.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Effectiveness—Protective System (e.g. cathodic) (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This protection system element is intended to capture situations where the concrete element may be expected to deteriorate at a rate that is slower than unprotected situations. Protection systems may include rebar coatings, cathodic protection, or other similar protection methods. Wearing surfaces are addressed under the appropriate wearing surface element and not this element.

3.3.5—Element 521—Concrete Protective Coating

Description: Concrete elements that have a protective coating applied to them. These coatings include silane/siloxane water proofers, crack sealers such as High Molecular Weight Methacrylate (HMWM), or any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion.

Classification: BME **Units of Measurement:** ft^2 (surface)

Quantity Calculation: Should include the entire protected surface of the steel element.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Wear (Concrete Protective Coatings) (3510)	None.	Underlying concrete not exposed; coating showing wear from UV exposure; friction course missing.	Underlying concrete is not exposed; thickness of the coating is reduced.	Underlying concrete exposed. Protective coating no longer effective.
Effectiveness (Concrete Protective Coatings) (3540)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

3.3.2—Element 990—Concrete Reinforcing Protective System

Description: All types of metallic reinforcing systems other than carbon steel.

Classification: ADE **Units of Measurement:** ft^2

Quantity Calculation: Should include the entire surface of the protected element.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Effectiveness—Protective System (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This protection system element is intended to capture situations where the concrete element may be expected to deteriorate at a rate that is slower than unprotected situations. This protective system includes metallic systems that do not include standard carbon steel reinforcing. Solid stainless steel, aluminum or other metallic systems are included in this element. Wearing surfaces are addressed under the appropriate wearing surface element and not this element.

3.3.3—Element 991—Corrosion Resistant Reinforcing Protective System

Description: All types of non-metallic reinforcing systems.

Classification: ADE **Units of Measurement:** ft^2

Quantity Calculation: Should include the entire surface of the protected element.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Effectiveness—Protective System (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This protection system element is intended to capture situations where the concrete element may be expected to deteriorate at a rate that is slower than unprotected situations. This protective system includes non-metallic reinforcing systems such as glass, basalt or carbon fiber. Wearing surfaces are addressed under the appropriate wearing surface element and not this element.

3.4.0—JOINTS

This Article covers expansion joints, pourable joints, compression joints, and assembly joints.

3.4.1—Element 300—Strip Seal Expansion Joint

Description: Those expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion	Complete loss of adhesion.
Seal Damage (2330)	None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out or missing.
Seal Cracking (2340)	None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust, metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

3.4.2—Element 301—Pourable Joint Seal

Description: Those joints filled with a pourable seal with or without a backer.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion	Complete loss of adhesion.
Seal Damage (2330)	None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out or missing.
Seal Cracking (2340)	None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

3.4.3—Element 302—Compression Joint Seal

Description: Only those joints filled with a preformed compression type seal. This joint may or may not have an anchor system to confine the seal.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion	Complete loss of adhesion.
Seal Damage (2330)	None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out or missing.
Seal Cracking (2340)	None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

3.4.4—Element 303—Assembly Joint with Seal

Description: Only those joints filled with an assembly mechanism that has a seal.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion	Complete loss of adhesion.
Seal Damage (2330)	None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out or missing.
Seal Cracking (2340)	None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust, metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

3.4.5—Element 304—Open Expansion Joint

Description: Only those joints that are open and not sealed.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust, metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element is intended for joints designed as open joints; not for those joints that were designed to have a seal that is currently missing.

3.4.6—Element 305—Assembly Joint without Seal

Description: Only those assembly joints that are open and not sealed, including finger and sliding plate joints.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust, metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall include open joints with or without a drainage trough below the joint.

3.4.7—Element 306—Other Joint

Description: Only those other joints that are not defined by any other joint element.

Classification: BME **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of the joint measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts join movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust, metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material joint element is intended for joints constructed of materials that cannot be classified using any other defined joint element.

3.5.0—RAILINGS

This Article covers on-bridge and off-bridge rail, which may be fabricated from steel, other metal, concrete, masonry, and other materials.

3.5.1—Element 330—Metal Bridge Railing

Description: All types and shapes of metal bridge railing. Steel, aluminum, metal beam, rolled shapes, etc. will all be considered part of this element. Included in this element are posts of metal, timber, or concrete; blocking; and curb.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Number of rows of bridge rail times the length of the bridge. The element quantity includes only the rail on the bridge.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion (1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking (1010)</td><td>None.</td><td>Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection (1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.</td></tr>
<tr><td>Distortion (1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The number of rows of rail on a bridge is commonly two, one on each side of the traveled way. In some cases, there may be more than two rows when the bridge has a center median or protected pedestrian/bicycle lanes. Refer to the other bridge rail material elements (concrete, timber, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than metal.

3.5.2—Element 331—Reinforced Concrete Bridge Railing

Description: All types and shapes of reinforced concrete bridge railing. All elements of the railing must be concrete.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Number of rows of bridge rail times the length of the bridge. The element quantity includes only the rail on the bridge.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The number of rows of rail on a bridge is commonly two, one on each side of the traveled way. In some cases, there may be more than two rows when the bridge has a center median or protected pedestrian/bicycle lanes.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.5.3—Element 332—Timber Bridge Railing

Description: All types and shapes of timber bridge railing. Included in this element are posts of timber, metal, or concrete; blocking; and curb.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Number of rows of bridge rail times the length of the bridge; includes only the rail on the bridge.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The number of rows of rail on a bridge is commonly two, one on each side of the traveled way. In some cases, there may be more than two rows when the bridge has a center median or protected pedestrian/bicycle lanes. Refer to the other bridge rail material elements (metal, concrete, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than timber.

3.5.4—Element 333—Other Open Bridge Railing

Description: All types and shapes of bridge railing except those defined as metal, concrete, timber, or masonry.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Number of rows of bridge rail times the length of the bridge; includes only the rail on the bridge.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural	

			review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for materials not otherwise defined. The number of rows of rail on a bridge is commonly two, one on each side of the traveled way. IN some cases, there may be more than two rows when the bridge has a center median r protected pedestrian/bicycle lanes.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.5.5—Element 334—Masonry Bridge Railing

Description: All types and shapes of masonry block or stone bridge railing. All elements of the railing must be masonry block or stone.

Classification: NBE

Units of Measurement: ft

Quantity Calculation: Number of rows of bridge rail times the length of the bridge; includes only the rail on the bridge.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	T The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The number of rows of rail on a bridge is commonly two, one on each side of the bridge. In some cases, there may be more than two rows when the bridge has a center median or protected pedestrian/bicycle lanes.

3.5.6—Element 950—Metal Approach Guardrail

Description: All types and shapes of metal approach railing. Steel, aluminum, metal beam, rolled shapes, etc. will all be considered part of this element. Included in this element are posts of metal, timber, or concrete; blocking; and curb.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measured length of metal approach rail including the transition section. The element quantity includes only the approach rail not on the bridge.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None.</td><td>Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The approach rail will generally be located on all four corners of a bridge on two lane roads and at least the approach ends of the bridge rail on one or multiple lane, one-way roadways. If the roadway is multiple lanes in each direction separated by a median rail other than metal, just record the metal rail under this element and the different material median rail under the appropriate element. Refer to the other approach rail material elements (concrete, timber, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than metal.

3.5.7—Element 951—Reinforced Concrete Bridge Approach Railing

Description: All types and shapes of reinforced concrete approach railing including transition sections. All elements of the railing must be concrete.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measurement of the lineal feet of approach rail including transitions; includes only the rail off of the bridge.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The approach rail will generally be located on all four corners of a bridge on two lane roads and at least the approach ends of the bridge rail on one or multiple lane, one-way roadways. If the roadway is multiple lanes in each direction separated by a median rail other than reinforced concrete, just record the concrete rail under this element and the different material median rail under the appropriate element. Refer to the other approach rail material elements (steel, timber, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than reinforced concrete.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.5.8—Element 952—Timber Approach Railing

Description: All types and shapes of timber approach railing. Included in this element are posts of timber, blocking and curb.

Classification: ADE

Units of Measurement: ft

Quantity Calculation: Measurement of the lineal feet of the approach railing including transitions; includes only the rail off of the bridge.

Condition State Definitions

Defects	Condition States 1 GOOD	Condition States 2 FAIR	Condition States 3 POOR	Condition States 4 SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The approach rail will generally be located on all four corners of a bridge on two lane roads. Timber rail is generally not found on larger multi lane roadways. Refer to the other bridge rail material elements (metal, concrete, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than timber.

3.5.9—Element 953—Other Approach Railing

Description: All types and shapes of approach railing including transitions except those defined as metal, concrete or timber.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measurement of the lineal feet of approach rail including transitions; includes only the rail off of the bridge.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does	

			not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for materials not otherwise defined. The approach rail will generally be located on all four corners of a bridge on two lane roads and at least the approach ends of the bridge rail on one or multiple lane, one-way roadways. If the roadway is multiple lanes in each direction separated by a median rail of a defined material, just record the other rail under this element and the different material median rail under the appropriate element. Other material rail used for the protection of pedestrians will only be included if it is attached to a bridge rail element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

3.5.10—Element 960— Approach Guardrail Ends

Description: All types and shapes of approach rail end treatments.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Number of guardrail end treatments on the approach rail off of the bridge.

Condition State Definitions

<table>
<tr><td rowspan="3">Defects</td><td colspan="4">Condition States</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>GOOD</td><td>FAIR</td><td>POOR</td><td>SEVERE</td></tr>
<tr><td></td><td></td><td></td><td></td><td rowspan="3">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

Only three defects will be available for this element.

3.6.0—APPROACH SLABS

This Article will cover bridge approach slabs. These slabs will be constructed with concrete and mild or prestressed (post-tension) reinforcement. Approach slabs are Bridge Management Elements (BMEs) and are not included in the standard set of National Bridge Elements (NBEs).

3.6.1—Element 320—Prestressed Concrete Approach Slab

Description: Those structural sections between the abutment and the approach pavement that are constructed of prestressed (post-tensioned) reinforced concrete.

Classification: BME **Units of Measurement:** ft^2

Quantity Calculation: Should include the area of the approach slab(s) from edge to edge including any median areas and accounting for any flares or ramps present.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

3.6.2—Element 321—Reinforced Concrete Approach Slab

Description: Those structural sections between the abutment and the approach pavement that are constructed of mild steel reinforced concrete.

Classification: BME **Units of Measurement:** ft^2

Quantity Calculation: Should include the area of the approach slab(s) from edge to edge including any median areas and accounting for any flares or ramps present.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Delamination/Spall/ Patched Area (1080)</td><td>None.</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.</td><td>Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Exposed Rebar (1090)</td><td>None.</td><td>Present without measurable section loss.</td><td>Present with measurable section loss but does not warrant structural review.</td></tr>
<tr><td>Cracking (RC and Other) (1130)</td><td>Insignificant cracks or moderate-width cracks hat have been sealed.</td><td>Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.</td><td>Wide cracks or heavy pattern (map) cracking.</td></tr>
<tr><td>Abrasion/Wear (PSC/RC) (1190)</td><td>No abrasion or wearing.</td><td>Abrasion or wearing has exposed coarse aggregate by the aggregate remains secure in the concrete.</td><td>Coarse aggregate is loose of has popped out of the concrete matrix due to abrasion or wear.</td></tr>
<tr><td>Settlement (4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

Chapter 4 – Superstructure Elements

4.1—SUPERSTRUCTURE

Superstructure elements described in this Article transmit load from decks into the substructure. These elements include girders, trusses, arches, and floor systems. The floor systems include floor beams and stringers. Additional elements in this group include cables, gusset plates, transverse girders, vertical cross frames and pin or pin and hanger assemblies. Other covered elements are a curved girder diaphragm and post tensioning anchors. These elements do not include bracing members such as diaphragms in straight or skewed bridges or cross bracing.

4.1.0—Steel Elements

These steel elements transmit the loads from the deck into the substructure. Elements listed include steel closed web (boxes) and open girders (I-sections), trusses, arches and floor systems, transverse girders and other miscellaneous steel elements.

4.1.1—Element 102—Steel Closed Web/Box Girder

Description: All steel box girders or closed web girders. For all box girders regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each box girder section; can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The box girder evaluation is three-dimensional in nature, with the defects observed on exterior and interior surfaces being used to capture the condition states.

4.1.2—Element 107—Steel Open Girder/Beam

Description: All steel open girders regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each girder.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion (1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking (1010)</td><td>None</td><td>Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection (1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion (1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

Condition evaluation for this element includes the web face and the top and bottom faces of the flange.

4.1.3—Element 113—Steel Stringer

Description: Steel members that support the deck in a stringer floor beam system regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each stinger.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None</td><td>Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

Condition evaluation for this element includes the webs face and the top and bottom faces of the flange.

4.1.4—Element 120—Steel Truss

Description: All steel truss elements, including all tension and compression members for through and deck trusses. For all trusses regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each truss panel measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in truss vertical or diagonal members shall be reported as the length projected along the length of the truss.

4.1.5—Element 141—Steel Arch

Description: Steel arches regardless of type or protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each arch panel measured longitudinally along the travel way.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None</td><td>Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

Observed distress in arch diagonals and vertical members (including spandrel columns) shall be reported as the projected length along the arch length.

4.1.6—Element 147—Steel Main Cables

Description: All steel main suspension or cable stay cables not embedded in concrete. For all cable groups regardless of protective systems.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each main cable measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element is intended for use on main cables in suspension bridges or main cable stays in cable stayed bridges. Suspender cables or other smaller cables shall be captured using the secondary cable element.

4.1.7—Element 148—Secondary Steel Cables

Description: All steel suspender cables not embedded in concrete. For all individual or cable groups regardless of protective systems.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the individual cable or cable groups carrying the load from the superstructure to the main cable/arch elements.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element is intended for use on suspender cables, other smaller cables, or groups of cables in one location acting as a system to carry loads from the superstructure to the main cable/arch.

Suspension bridge main cables or cable stays shall be captured using the steel main cable element.

4.1.8—Element 152—Steel Floor Beam

Description: Steel floor beams that typically support stringers regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each floor beam.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Condition evaluation for this element includes the web faces and the top and bottom faces of the flange.

4.1.9—Element 161—Steel Pin and Pin & Hanger Assembly or both

Description: Steel pins and pin and hanger assemblies regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of pins, pin and hanger assemblies, or both.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Distress observed on either hanger assembly plate should be considered in the condition assessment.

4.1.10—Element 162—Steel Gusset Plate

Description: Only those steel gusset plate(s) connections that are on the main truss/arch panel(s). These connections can be constructed with one or more plates that may be bolted, riveted, or welded. For all gusset plates regardless of protective systems.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of primary load path gusset plate assemblies. For multiple plate gusset connections at a single panel point, the quantity shall be one gusset plate regardless of the number of individual plates at the single connection point.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

For built-up gusset plates, distress observed on any plate should be considered in the condition assessment.

4.1.11—Element 810—Steel Transverse Girder

Description: All steel girders not including floor beams that are mounted transversely on columns and support longitudinal girders, regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each rolled, built-up or box girder assembly, measured along the skew.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Condition evaluation for this element includes all visible faces of the girder(s). This element is considered fracture critical.

4.1.12—Element 815—Steel Railroad Car Girder

Description: All steel railroad car girders regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each railroad car girder.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None</td><td>Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

Condition evaluation for this element includes the car floor (deck) condition as well as the structural components underneath that comprise the total girder construction.

4.1.13—Element 820—Steel Vertical Cross Frame

Description: Steel cross frame elements that are sway frames on through trusses, regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each cross frame measured along the skew.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element may be comprised of single or multiple, built up steel sections for each cross frame. There will generally be a cross frame at every panel point as well as portal frames. Sway bracing between the cross frames is not included in the quantity.

4.1.14—Element 821—Steel Curved Girder Diaphragm

Description: All diaphragms on a steel curved girder system regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each diaphragm measured perpendicular to the radius of the curved girder or along the skew as required .

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion (1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking (1010)</td><td>None</td><td>Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection (1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion (1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

This element may be a solid rolled section or a built-up space frame section. Condition evaluation for this element includes the web face and the top and bottom faces of the flange for the rolled sections or all faces of the space frame components, including the connection plates.

4.1.15—Element 825—Post Tensioning Anchor

Description: All exposed post tensioning anchor ends in prestressed concrete box and slab sections, timber slabs and post tensioned concrete such as prestressed concrete transverse girders and decks regardless of protective system.

Classification: ADE **Units of Measurement:** Each

Quantity Calculation: The sum of individual anchor ends.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

4.1.16—Element 515—Steel Protective Coating

Description: Steel elements that have a protective coating such as paint, galvanization, weathering steel patina, or other top coat steel corrosion inhibitor.

Classification: BME **Units of Measurement:** ft^2 (surface)

Quantity Calculation: Should include the entire protected surface of the steel element.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Chalking (Steel Protective Coatings) (3410)	None.	Surface dulling.	Loss of pigment.	Not applicable.
Peeling/Bubbling/ Cracking (Steel Protective Coatings) (3420)	None.	Finish coats only.	Finish and primer coats.	Exposure of bare metal.
Oxide Film Degradation Color/Texture Adherence (Steel Protective Coatings) (3430)	Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adheared, capable of withstanding hammering or vigorous wire brushing.	Granular texture.	Small flakes, less than ½"-in. diameter.	Dark black color. Large flakes, ½-in. diameter or greater, or laminar sheets or nodules.
Effectiveness (Steel Protective Coatings) (3440)	Fully effective.	Substantially effective.	Limited effectiveness.	Failed; no protection of the underlying metal.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall describe all coating systems. This includes paint systems, oxide on weathering steel, and galvanization. Assess protective coatings based upon the defects that would apply.

4.2.0 – Reinforced Concrete

These reinforced concrete elements transmit the loads from the deck into the substructure. Elements listed include closed web (boxes) and girder (T-beams), arches, floor systems and other miscellaneous reinforced concrete superstructure elements.

4.2.1—Element 105—Reinforced Concrete Closed Web/Box Girder

Description: All reinforced concrete closed web girders. For all box girders regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the length of each box girder section. This quantity can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length of box section. Elements such as adjacent box girders are considered individual girders.

Condition State Definitions

Defects	**Condition States**			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Where traffic rides directly on the structural element regardless of the wearing surface, evaluation of the top flange above the fillet is considered with Element 16.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.2.2—Element 110—Reinforced Concrete Open Girder/Beam

Description: Mild steel reinforced concrete open web girders regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all of the lengths of each girder.

Condition State Definitions

Defects	Condition States 1 GOOD	Condition States 2 FAIR	Condition States 3 POOR	Condition States 4 SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Condition evaluation for this element includes the web faces and the top and bottom flange surfaces.

Where traffic rides directly on the structural element regardless of the wearing surface evaluation of the top flange above the fillet is considered with Element 16.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.2.3—Element 116—Reinforced Concrete Stringer

Description: Mild steel reinforced concrete members that support the deck in a stringer floor beam system regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all of the lengths of each stringer.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.2.4—Element 144—Reinforced Concrete Arch

Description: Only mild steel reinforced concrete arches regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all of the lengths of each arch panel measured longitudinally along the travel way.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in arch diagonals, vertical members (including spandrel columns) and spandrel walls shall be reported as the projected length along the arch length.

For filled arches, the arch quantity shall be measure from spring line to spring line. The length below the spring line is considered substructure.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.2.5—Element 155—Reinforced Concrete Floor Beam

Description: Mild steel reinforced concrete floor beams that typically support stringers regardless of protective system.

Classification: NBE

Units of Measurement: ft

Quantity Calculation: Sum of all of the lengths of each floor beam.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Delamination/Spall/ Patched Area (1080)</td><td>None.</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.</td><td>Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Exposed Rebar (1090)</td><td>None.</td><td>Present without measurable section loss.</td><td>Present with measurable section loss but does not warrant structural review.</td></tr>
<tr><td>Efflorescence/Rust Staining (1120)</td><td>None.</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Cracking (RC and Other) (1130)</td><td>Insignificant cracks or moderate-width cracks that have been sealed.</td><td>Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.</td><td>Wide cracks or heavy pattern (map) cracking.</td></tr>
<tr><td>Damage (7000</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.3.0 – Prestressed Concrete

These prestressed concrete elements transmit the loads from the deck into the substructure. Elements listed include closed web (boxes) and open girders (I-sections), arches, floor systems and other miscellaneous prestressed concrete superstructure elements.

4.3.1—Element 104—Prestressed Concrete Closed Web/Box Girder

Description: All pretensioned or post-tensioned concrete closed web girders or box girders. For all box girders regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the length of each box girder section. This quantity can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length of the box section. Elements such as adjacent box girders are considered individual girders.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The box girder evaluation is three-dimensional in nature, which includes defects observed on exterior and interior surfaces.

Where traffic rides directly on the structural element regardless of the wearing surface, evaluation of the top flange above the fillet is considered with Element 15.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

4.3.2—Element 109—Prestressed Concrete Open Girder/Beam

Description: All pretensioned or post-tensioned concrete open web girders or regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all lengths of each girder.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Delamination/Spall/ Patched Area (1080)</td><td>None.</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.</td><td>Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Exposed Rebar (1090)</td><td>None.</td><td>Present without measurable section loss.</td><td>Present with measurable section loss but does not warrant structural review.</td></tr>
<tr><td>Exposed Prestressing (1100)</td><td>None.</td><td>Present without section loss.</td><td>Present with section loss but does not warrant structural review.</td></tr>
<tr><td>Cracking (PSC) (1110)</td><td>Insignificant cracks or moderate-width cracks that have been sealed.</td><td>Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.</td><td>Wide cracks or heavy pattern (map) cracking.</td></tr>
<tr><td>Efflorescence/Rust Staining (1120)</td><td>None.</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Damage (7000</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

Where traffic rides directly on the structural element regardless of the wearing surface, evaluation of the top flange above the fillet is considered with Element 15.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

4.3.3—Element 115—Prestressed Concrete Stringer

Description: Pretensioned or post-tensioned concrete members that support the deck in a stringer floor beam system regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each stringer.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Condition evaluation for this element includes the web faces and the top and bottom flange surfaces.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

4.3.4—Element 143—Prestressed Concrete Arch

Description: Only pretensioned or post-tensioned concrete arches regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each arch panel measured longitudinally along the travel way.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate

		material defect entry.	material defect entry.	material defect entry.

Element Commentary

Observed distress in arch diagonals and vertical members (including spandrel columns) shall be reported as the projected length along the arch length.

For filled arches, the arch quantity shall be measured from spring line to spring line. The length below the spring line is considered substructure.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

4.3.5—Element 154—Prestressed Concrete Floor Beam

Description: Prestressed concrete floor beams that typically support stringers regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each floor beam.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

4.3.6—Element 811—Prestressed Concrete Transverse Girder

Description: All pretensioned or post-tensioned concrete girders that are not concrete caps and are mounted transversely on columns and support longitudinal girders, regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all lengths of each girder measured along the skew.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

4.4.0 – Timber

These timber elements transmit the loads from the deck into the substructure. Elements listed include open girders, arches, trusses, floor systems and other miscellaneous timber superstructure elements.

4.4.1—Element 111—Timber Open Girder Beam

Description: All timber open girders regardless of protection system.

Classification: NBE

Units of Measurement: ft

Quantity Calculation: Sum of all the lengths of each girder/beam.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

4.4.3—Element 117—Timber Stringer

Description: Timber members that support the deck in a stringer floor beam system regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each stringer.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

4.4.3—Element 135—Timber Truss

Description: All timber truss elements, including all tension and compression members for through and deck trusses. For all trusses regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each truss panel measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in truss vertical or diagonal members shall be reported as the length projected along the length of the truss.

4.4.4—Element 146—Timber Arch

Description: Only timber arches regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each arch panel measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in arch diagonal and vertical members (including spandrel columns) shall be reported as the projected length along the arch.

4.4.5—Element 156—Timber Floor Beam

Description: Timber floor beams that typically support stringers regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each floor beam.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

4.5.0 – Masonry

There is only one masonry superstructure element and that is for a masonry arch.

4.5.1—Element 145—Masonry Arch

Description: Masonry or stacked stone arches regardless of protective system.

Classification: NBE

Units of Measurement: ft

Quantity Calculation: Sum of all of the lengths of each arch section measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in arch spandrel walls shall be reported as the projected length along the arch length.

For filled arches, the arch quantity shall be measure from spring line to spring line. The length below the spring line is considered substructure.

4.6.0 – Other Materials

These other superstructure elements transmit the loads from the deck into the substructure. Elements listed include closed web (boxes) and open girders (I-sections), arches, floor systems and other miscellaneous superstructure elements.

4.6.1—Element 106—Other Closed Web/Box Girder

Description: All other material box girders or closed web girders. For all other material box girders regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the length of each box girder section. This quantity can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length of the box section. Elements such as adjacent box girders are considered individual girders.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	

Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The box girder evaluation is three-dimensional in nature, with the defects observed including exterior and interior surfaces being used to capture the condition states.

The other material box girder is intended for box girders constructed of composite materials, or other materials that cannot be classified using any other defined box girder element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.6.2—Element 112—Other Open Girder/Beam

Description: All other material girders regardless of protection system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each girder.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material open girder is intended for open girders constructed of composite materials, or other materials that cannot be classified using any other defined open girder element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.6.3—Element 118—Other Stringer

Description: All other material stringers regardless of protection system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each stringer.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material stringer is intended for stringers constructed of composite materials, or other materials that cannot be classified using any other defined stringer element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.6.4—Element 136—Other Truss

Description: All other material truss elements, including tension and compression members, and through and deck trusses. For all other material trusses regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each truss panel measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in truss diagonal and vertical members shall be reported as the projected length along the length of the truss.

The other material open truss is intended for trusses constructed of composite materials, or other materials that cannot be classified using any other defined truss element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.6.5—Element 142—Other Arch

Description: Other material arches regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each arch panel measured longitudinally along the travel way.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Observed distress in arch diagonals and verticals (including spandrel columns) shall be reported as the projected length along the arch length.

The other material arch is intended for arches constructed of composite materials, or other materials that cannot be classified using any other defined arch element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.6.6—Element 157—Other Floor Beam

Description: All other material floor beams that typically support stringers regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each floor beam.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material floor beam is intended for floor beams constructed of composite materials, or other materials that cannot be classified using any other defined floor beam element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

4.6.7—Element 812—Other Transverse Girder

Description: All other material girders that are mounted transversely on columns and support longitudinal girders, regardless of protection system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each girder.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material open girder is intended for transverse girders constructed of composite materials, or other materials that cannot be classified using any other defined transverse girder element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

Chapter 5 – Substructure Elements

5.1—SUBSTRUCTURE ELEMENTS

Substructure elements described in the Article transmit the load from the superstructure into the ground. These elements include columns, piles, pile caps/footings, pile extensions, pier/bent caps, pier walls, and abutments both above and below the water surface. This section also includes bearings. These substructures include elements of steel, concrete, timber, masonry, and other materials.

Also included in this section are structural and non-structural retaining wall systems.

5.1.0—Steel

This Article covers Steel substructure elements including columns, piles, abutments, pier walls, pile caps and submerged elements.

5.1.1—Element 202—Steel Column

Description: All steel columns regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of columns.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.1.2—Element 207—Steel Tower

Description: Steel built-up or framed tower supports regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the number of columns.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element is intended to be used for truss framed tower supports or built-up steel towers. It is intended to capture large supports and towers associated with suspension bridges, cable stayed bridges, movable bridges, or similar structural configurations.

5.1.3—Element 219—Steel Abutment

Description: Steel abutments, including the sheet material retaining the embankment, and monolithic wingwalls and abutment extensions. For all steel abutments regardless of protective systems.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with monolithic wingwalls and abutment extensions measured along the skew angle.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="6">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None.</td><td>Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.</td><td>Identified crack that is not arrested by does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Settlement
(4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td></tr>
<tr><td>~~Scour~~
~~(6000)~~
Use Scour Element 900</td><td>~~None.~~</td><td>~~Exists within tolerable limits or has been arrested with effective countermeasures.~~</td><td>~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~</td></tr>
</table>

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Monolithic wingwalls, up to the first construction joint (sheet pile joint, etc.), shall be considered in the quantity and assessment of the abutment element. Wingwalls that tare not monolithic with the abutment shall not be include in the quantity or assessment of the abutment element.

5.1.4—Element 225—Steel Pile

Description: Steel piles that are visible for inspection, including piles exposed from erosion or scour. Piles visible during an underwater inspection are inspected with Element 261, Submerged Steel Pile. For all steel piles above the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles above the water surface visible for inspection.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.1.5—Element 231—Steel Pier Cap

Description: Those steel pier caps that support girders and transfer load into piles or columns. For all steel pier caps regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the cap lengths measured along the skew angle.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="4">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None.</td><td>Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.</td><td>Identified crack that is not arrested by does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

None.

5.1.6—Element 860—Submerged Steel Column

Description: All steel columns under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of submerged columns.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.1.7—Element 880—Submerged Steel Pile

Description: Steel piles that are visible for inspection, including piles exposed from erosion or scour and piles visible during an underwater inspection. For all steel piles under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.1.8—Element 911—Steel Retaining Wall

Description: Steel retaining walls not considered a structural substructure element, including the sheet material retaining the embankment, wingwalls and retaining wall extensions. For all steel retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall including wingwalls and abutment extensions measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old steel abutments left in place for bank protection.

5.2.0—Reinforced Concrete

This Article covers Reinforced Concrete substructure elements including columns, piles, abutments, pier walls, pile caps and submerged elements.

5.2.1—Element 205—Reinforced Concrete Column

Description: All reinforced concrete columns regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the remainder of columns.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Delamination/Spall/ Patched Area (1080)</td><td>None.</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.</td><td>Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.</td><td rowspan="7">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Exposed Rebar (1090)</td><td>None.</td><td>Present without measurable section loss.</td><td>Present with measurable section loss but does not warrant structural review.</td></tr>
<tr><td>Efflorescence/Rust Staining (1120)</td><td>None.</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Cracking (RC and Other) (1130)</td><td>Insignificant cracks or moderate-width cracks that have been sealed.</td><td>Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.</td><td>Wide cracks or heavy pattern (map) cracking.</td></tr>
<tr><td>Abrasion/Wear (PSC/RC) (1190)</td><td>No abrasion or wearing.</td><td>Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.</td><td>Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.</td></tr>
<tr><td>Settlement (4000)</td><td>None.</td><td>Exixts within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td></tr>
<tr><td><s>Scour (6000)</s>
Use Scour Element 900</td><td><s>None.</s></td><td><s>Exists within tolerable limits or has been arrested with effective countermeasures.</s></td><td><s>Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.</s></td></tr>
</table>

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.2—Element 210—Reinforced Concrete Pier Wall

Description: Reinforced concrete pier walls above the water surface regardless of protective systems. For the portion of pier wall that is underwater, element 257 Submerged Reinforced Concrete Pier Wall will be used.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the lengths of the pier walls measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.3—Element 215—Reinforced Concrete Abutment

Description: Reinforced concrete abutments, including the material retaining the embankment and monolithic wingwalls and abutment extensions. For all reinforced concrete abutments regardless of protective systems.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with monolithic wingwalls and abutment extensions measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Monolithic wingwalls, up to the first construction joint (cold joint, water stop, etc.) shall be considered in the quantity and assessment of the abutment element. Wingwalls that are not monolithic with the abutment shall not be included in the quality or assessment of the abutment element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.4—Element 220—Reinforced Concrete Pile Cap/Footing

Description: Reinforced concrete pile caps/footings that are visible for inspection, including pile caps/footings exposed from erosion or scour. Those pile caps/footings visible during an underwater inspection will be evaluated using Element 269, Submerged Pile Cap/Footing. The exposure may be intentional or caused by erosion or scour.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of footings or pile caps above the water surface along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.5—Element 227—Reinforced Concrete Pile

Description: Reinforced concrete piles that are visible for inspection, including piles exposed from erosion or scour. Piles visible during an underwater inspection will be evaluated using Element 263, Submerged Reinforced Concrete Pile. For all reinforced concrete piles above the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.6—Element 234—Reinforced Concrete Pier Cap

Description: Those reinforced concrete pier caps that support girders and transfer load into piles or columns. For all reinforced concrete pier caps regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the cap length measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.7—Element 862—Submerged Reinforced Concrete Column

Description: All reinforced concrete columns under the water surface at the time of inspection regardless of protective system.

Classification: ADE

Units of Measurement: each

Quantity Calculation: Sum of the submerged columns.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.8—Element 870—Submerged Reinforced Concrete Pier Wall

Description: Reinforced concrete pier walls under the water surface at the time of inspection regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the lengths of the pier walls measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.9—Element 882—Submerged Reinforced Concrete Pile

Description: Reinforced concrete piles that are visible for inspection below the water surface at the time of inspection including piles exposed from erosion or scour. For all reinforced concrete piles regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection under the water surface.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.10—Element 890—Submerged Reinforced Concrete Pile Cap/Footing

Description: Reinforced concrete pile caps/footings that are visible below the water surface during the inspection, including pile caps/footings exposed from erosion or scour. The exposure may be intentional or caused by erosion or scour.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of footings or pile caps below the water surface along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.2.11—Element 912—Reinforced Concrete Retaining Wall

Description: Reinforced concrete retaining walls not considered a structural substructure element, including the material retaining the embankment, wingwalls and retaining wall extensions. For all reinforced concrete retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall, wingwalls and retaining wall extensions measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old reinforced concrete abutments left in place for bank protection.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.3.0—Prestressed Concrete

This Article covers Prestressed Concrete substructure elements including columns, piles, pile caps and submerged elements.

5.3.1—Element 204—Prestressed Concrete Column

Description: Prestressed concrete columns regardless of protective system.

Classification: NBE

Units of Measurement: each

Quantity Calculation: Sum of the number of columns.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

5.3.2—Element 226—Prestressed Concrete Pile

Description: Prestressed concrete piles that are visible for inspection, including piles exposed from erosion or scour. Piles visible during an underwater inspection will be inspected using Element 262, Submerged Prestressed Concrete Pile. For all prestressed concrete piles above the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection above the water surface.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

5.3.3—Element 233—Prestressed Concrete Pier Cap

Description: Those prestressed concrete pier caps that support girders and transfer load into piles or columns. For all prestressed concrete pier caps regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the cap lengths measured along the skew angle.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Delamination/Spall/ Patched Area (1080)</td><td>None.</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.</td><td>Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Exposed Rebar (1090)</td><td>None.</td><td>Present without measurable section loss.</td><td>Present with measurable section loss but does not warrant structural review.</td></tr>
<tr><td>Exposed Prestressing (1100)</td><td>None.</td><td>Present without section loss.</td><td>Present with section loss but does not warrant structural review.</td></tr>
<tr><td>Cracking (PSC) (1110)</td><td>Insignificant cracks or moderate-width cracks that have been sealed.</td><td>Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.</td><td>Wide Cracks or heavy pattern (map) cracking.</td></tr>
<tr><td>Efflorescence/Rust Staining (1120)</td><td>None.</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

5.3.4—Element 861—Submerged Prestressed Concrete Column

Description: Prestressed concrete columns that are under the water surface at the time of inspection regardless of protective system.

Classification: ADE

Units of Measurement: each

Quantity Calculation: Sum of the number of submerged columns.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

5.3.5—Element 881—Submerged Prestressed Concrete Pile

Description: Prestressed concrete piles that are visible for inspection below the water surface at the time of inspection including piles exposed from erosion or scour. For all submerged prestressed concrete piles regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection below the water surface.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

5.4.0—Timber

This Article covers Timber substructure elements including columns, piles, abutments, pier walls, pile caps and submerged elements.

5.4.1—Element 206—Timber Column

Description: All timber columns regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Number of columns.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.2—Element 208—Timber Trestle

Description: Framed timber supports. For all timber trestle/towers regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the heights of the built-up or framed tower supports.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element is intended to be used for truss framed trestle or towers. It is intended to capture large supports and towers associated with large deck truss bridges.

5.4.3—Element 212—Timber Pier Wall

Description: Those timber pier walls that include pile, timber sheet material, and filler above the water surface. For all pier walls regardless of protective systems. For those portions of the pier wall that are underwater, element 258, Submerged Timber Pier Wall will be used.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pier walls measured along the skew angle.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.</td><td rowspan="6">The condition warrants
a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Decay/Section Loss
(1140)</td><td>None.</td><td>Affects less than 10% of the member section.</td><td>Affects 10% or more of the member but does not warrant structural review.</td></tr>
<tr><td>Check/Shake
(1150)</td><td>Surface penetration less than 5% of the member thickness regardless of location.</td><td>Penetrates 5%–50% of the thickness of the member and not in a tension zone.</td><td>Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.</td></tr>
<tr><td>Crack (Timber)
(1160)</td><td>None.</td><td>Crack that has been arrested through effective measures.</td><td>Identified crack that is not arrested but does not require structural review.</td></tr>
<tr><td>Split/Delamination
(Timber)
(1170)</td><td>None.</td><td>Length less than the member depth or arrested with effective actions taken to mitigate.</td><td>Length equal to or greater than the member depth but does not require structural review.</td></tr>
<tr><td>Abrasion/Wear
(Timber)
(1180)</td><td>None or no measurable section loss.</td><td>Section loss less than 10% of the member thickness.</td><td>Section loss 10% or more of the member thickness but does not warrant structural review.</td></tr>
</table>

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.4—Element 216—Timber Abutment

Description: Timber abutments, including the sheet material retaining the embankment, integral wingwalls, and abutment extensions. For all abutments regardless of protective systems.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with integral wingwalls and abutment extensions measured along the new angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Monolithic wingwalls, up to the first construction joint (Plank butt joint, etc.) shall be considered in the quantity and assessment of the abutment element. Wingwalls that are not monolithic with the abutment shall not be included in the quantity or assessment of the abutment element.

5.4.5—Element 228—Timber Pile

Description: Timber piles that are visible for inspection, including piles exposed from erosion or scour Piles visible during an underwater inspection will be evaluated using Element 264, Submerged Timber Pile. For all timber piles above the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.6—Element 235—Timber Pier Cap

Description: Those timber pier caps that support girders that transfer load into piles, or columns. For all timber pier caps regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the pier cap lengths measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.7—Element 855—Timber Pile Cap/Footing

Description: Timber pile caps/footings that may be placed under one or more piles for element stabilization. To evaluate timber pile caps/footings under the water surface use element 271, Submerged Pile Cap/Footing. For all timber pile caps/footings above the water surface regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pile cap/footing measured along the skew angle of the pier or bent.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.8—Element 863—Submerged Timber Column

Description: All timber columns under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Number of columns.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.9—Element 871—Submerged Timber Pier Wall

Description: Those timber pier walls that include pile, timber sheet material, and filler. For all pier walls under the water surface at the time of inspection, regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pier walls measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.10—Element 883—Submerged Timber Pile

Description: Timber piles that are visible for inspection under the water surface at the time of inspection, including piles exposed from erosion or scour. For all submerged timber piles regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles under the water surface visible for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour~~ ~~(6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.4.11—Element 891—Submerged Timber Pile Cap/Footing

Description: Timber pile caps/footings that may be placed under one or more piles for element stabilization. This element will be used for evaluation of those portions of timber pile caps/footings under the water surface during the inspection. For all timber pile caps/footings regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pile cap/footing measured along the skew angle of the pier or bent.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.6.12—Element 913—Timber Retaining Wall

Description: Timber retaining walls not considered a structural substructure element, including the timber piling, timber plank or sheet material retaining the embankment, wingwalls, and retaining wall extensions. For all timber retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with wingwalls and retaining wall extensions measured along the new angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. Timber piling will not be assessed separately, but as part of the entirety of the retaining wall condition. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old timber abutments left in place for bank protection.

5.5.0—Masonry

This Article covers Masonry substructure elements including abutments, pier walls and submerged elements.

5.5.1—Element 213—Masonry Pier Wall

Description: Those pier walls constructed of block or stone above the water surface. The block or stone may be placed with or without mortar. For all masonry pier walls regardless of protective systems. For portions of the pier wall that are underwater, use element 259 Submerged Masonry Pier Wall will be used.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the wall lengths measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is liess than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.5.2—Element 217—Masonry Abutment

Description: Those abutments constructed of block or stone, including integral wingwalls and abutment extensions. The block or stone may be placed with or without mortar. For all masonry abutments regardless of protective systems.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with integral wingwalls and abutment extensions measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is liess than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Integral wingwalls, up to the first construction joint (cold joint, water stop etc.), shall be considered in the quantity and assessment of the abutment element. Wingwalls that are not monolithic with the abutment shall not be included in the quantity or assessment of the abutment element.

5.5.3—Element 872—Submerged Masonry Pier Wall

Description: Those pier walls constructed of block or stone. The block or stone may be placed with or without mortar. For all masonry pier walls under the water surface at the time of inspection, regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the wall lengths measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is liess than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.5.4—Element 914—Masonry Retaining Wall

Description: Those retaining walls not considered a structural substructure element constructed of block or stone, including wingwalls and retaining wall extensions. The block or stone may be placed with or without mortar. For all masonry retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall with wingwalls and retaining wall extensions measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is liess than the critical limits determined by scour evaluation and does not warrant structural review.~~	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old masonry abutments left in place for bank protection. Do not use this element for mortared stone bank protection.

5.6.0—Other Materials

This Article covers Other Material substructure elements including columns, piles, abutments, pier walls, pile caps and submerged elements.

5.6.2—Element 203—Other Column

Description: All other material columns regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of columns.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="7">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Cracking
(1010)</td><td>None</td><td>Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.</td><td>Identified crack that is not arrested but does not warrant structural review.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Delamination/Spall/ Patched Area
(1080)</td><td>None.</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.</td><td>Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.</td></tr>
<tr><td>Efflorescence/Rust Staining
(1120)</td><td>None.</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Cracking
(RC and Other)
(1130)</td><td>Insignificant cracks or moderate-width cracks that have been sealed.</td><td>Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking</td><td>Wide cracks or heavy pattern (map) cracking.</td></tr>
<tr><td>Deterioration (Other)
(1220)</td><td>None.</td><td>Initiated breakdown or deterioration.</td><td>Significant deterioration or breakdown but does not warrant structural review.</td></tr>
</table>

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material column is intended for columns constructed of composite materials, or other materials that cannot be classified using any other defined column elements.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.3—Element 211—Other Pier Wall

Description: Those pier walls constructed of other materials above the water surface regardless of protective systems. For the portions of the pier wall that are underwater, element 260 Submerged Other Material Wall will be used.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the number of the pier walls measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking	Width greater than 0.05 in. or spacing of less than 1 ft.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for pier walls constructed of other materials not otherwise defined.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.4—Element 218—Other Abutments

Description: Other material abutment systems, including the sheet material retaining the embankment, and integral wingwalls and abutment extensions. For all other material abutments regardless of protective systems.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with integral wingwalls and abutment extensions measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for abutments constructed of materials not otherwise defined.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.5—Element 229—Other Pile

Description: Other material piles that are visible for inspection, including piles exposed from erosion or scour. Piles visible during an underwater inspection will be inspected using element 265, Other Submerged Pile. For all other material piles above the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible for inspection.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	.
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour~~ ~~(6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material pile element is intended for piles constructed of composite materials, or other materials that cannot be classified using any other defined pile element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.6—Element 236—Other Pier Cap

Description: Other material pier caps that support girders that transfere load into piles or columns. For all other material pier caps regardless of protective system.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Sum of the pier cap lengths measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material pier cap element is intended for pier caps constructed of composite materials, or other materials that cannot be classified using any other defined pier cap element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.7—Element 864—Other Submerged Column

Description: All other material columns under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of columns.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material column is intended for columns constructed of composite materials, or other materials that cannot be classified using any other defined column elements.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.8—Element 873—Other Submerged Pier Wall

Description: Those pier walls constructed of other materials that are under the water surface at the time of inspection regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the number of the pier walls measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking	Width greater than 0.05 in. or spacing of less than 1 ft.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for pier walls constructed of other materials not otherwise defined.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.9—Element 884—Other Submerged Pile

Description: Other material piles that are visible for inspection below the water surface at the time of inspection, including piles exposed from scour. For all other material piles below the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles visible below the water surface for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	.
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material pile element is intended for piles constructed of composite materials, or other materials that cannot be classified using any other defined pile element.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.9—Element 910—Reinforced Earth – GRS-IBS Retaining Wall Systems

Description: Reinforced earth constructed retaining wall system used as the structural abutment. The facing for the wall may be concrete block or reinforced concrete precast panels. The caps that support the bearings will be accounted for under the appropriate substructure cap material item.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the wall inclusive of turnbacks as appropriate. For extended turnback sections adjacent to the bridge measure no further than 50 feet along the wall past the centerline bearing of the abutment.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists within tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.6.10—Element 915—Other Retaining Wall

Description: Other material retaining wall systems not considered a structural substructure element, including the sheet material retaining the embankment, wingwalls and retaining wall extensions. For all other material retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall, wingwalls and retaining wall extensions measured along the skew angle.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural	

			review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
~~Scour (6000)~~ **Use Scour Element 900**	~~None.~~	~~Exists witin tolerable limits or has been arrested with effective countermeasures.~~	~~Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.~~	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for abutments constructed of materials not otherwise defined.

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old other material abutments left in place for bank protection.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

5.7.0—BEARINGS

This Article covers fixed, movable and specialty bearings.

5.7.1—Element 310—Elastomeric Bearing

Description: Only those bridge bearings that are constructed primarily of elastomers, with or without fabric or metal reinforcement.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Movement (2210)	Free to move.	Minor restriction.	Restricted but not warranting structural review.	
Alignment (2220)	Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.	
Bulging, Splitting, or Tearing (2230)	None.	Bulging less than 15% of the thickness.	Bulging 155 or more of the thickness. Splitting or tearing. Bearing's surfaces are not parallel. Does not warrant structural review.	
Loss of Bearing Area (2240)	None.	Less than 10%.	10% or more but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.7.2—Element 311—Movable Bearing

Description: Only those bridge bearings that provide for both rotation and longitudinal movement by means of roller, rocker, or sliding mechanisms.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Movement
(2210)</td><td>Free to move.</td><td>Minor restriction.</td><td>Restricted but not warranting structural review.</td></tr>
<tr><td>Alignment
(2220)</td><td>Lateral and vertical alignment is as expected for the temperature conditions.</td><td>Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.</td><td>Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.</td></tr>
<tr><td>Loss of Bearing Area
(2240)</td><td>None.</td><td>Less than 10%.</td><td>10% or more but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

None.

5.7.3—Element 312—Enclosed/Concealed Bearing

Description: Only those bridge bearings that are enclosed so that they are not open for detailed inspection.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Movement (2210)	Free to move.	Minor restriction.	Restricted but not warranting structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Alignment (2220)	Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Loss of Bearing Area (2240)	None.	Less than 10%.	10% or more but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for box girder hinges. In cases where the bearing material is not visible, the inspector shall assess the condition based on alignment, grade across the joint, persistence of debris, or other indirect indicators of the condition.

5.7.4—Element 313—Fixed Bearing

Description: Only those bridge bearings that provide for rotation only (no longitudinal movement).

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Movement (2210)	Free to move.	Minor restriction.	Restricted but not warranting structural review.	
Alignment (2220)	Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.	
Loss of Bearing Area (2240)	None.	Less than 10%.	10% or more but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.7.5—Element 314—Pot Bearing

Description: Those high load bearings with confined elastomer. The bearing may be fixed against horizontal movement, guided to allow sliding in one direction, or floating to allow sliding in any direction.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Movement (2210)	Free to move.	Minor restriction.	Restricted but not warranting structural review.	
Alignment (2220)	Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.	
Bulging, Splitting or Tearing (2230)	None.	Bulging less than 15% of the thickness.	Bulging 15% or more of the thickness. Splitting or tearing. Bearing's surfaces are not parallel. Does not warrant structural review.	
Loss of Bearing Area (2240)	None.	Less than 10%.	10% or more but does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

5.7.6—Element 315—Disk Bearing

Description: Those high load bearings with a hard plastic disk. This bearing may be fixed against horizonatal movement, guided to allow movement in one direction, or floating to allow sliding in any direction.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Movement
(2210)</td><td>Free to move.</td><td>Minor restriction.</td><td>Restricted but not warranting structural review.</td></tr>
<tr><td>Alignment
(2220)</td><td>Lateral and vertical alignment is as expected for the temperature conditions.</td><td>Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.</td><td>Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.</td></tr>
<tr><td>Loss of Bearing Area
(2240)</td><td>None.</td><td>Less than 10%.</td><td>10% or more but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

None.

5.7.7—Element 316—Other Bearing

Description: All other material bridge bearings regardless of translation or rotation constraints.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of each bearing of this type.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Corrosion
(1000)</td><td>None.</td><td>Freckled rust. Corrosion of the steel has initiated.</td><td>Section loss is evident or pack rust is present but does not warrant structural review.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Connection
(1020)</td><td>Connection is in place and functioning as intended.</td><td>Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.</td><td>Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.</td></tr>
<tr><td>Movement
(2210)</td><td>Free to move.</td><td>Minor restriction.</td><td>Restricted but not warranting structural review.</td></tr>
<tr><td>Alignment
(2220)</td><td>Lateral and vertical alignment is as expected for the temperature conditions.</td><td>Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.</td><td>Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.</td></tr>
<tr><td>Loss of Bearing Area
(2240)</td><td>None.</td><td>Less than 10%.</td><td>10% or more but does not warrant structural review.</td></tr>
<tr><td>Damage
(7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

The other material bearing element is intended for bearings constructed of materials that cannot be classified using any other defined bearing element.

5.8.0—Scour

This Article covers the use of the Scour Element to better track scour issues at the bridge level. This Article also includes scour countermeasures.

5.8.1—Element 900—Bridge Scour

Description: This element is to track scour distresses which are evident during visual inspections. The primary purpose is to identify bridges that are experiencing scour and to provide some measure of the magnitude of scour. This element may be used as a substructure sub-element and used in support of the scour defect (6000)

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of substructure units affected by scour.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.

Element Commentary

None.

5.8.2—Element 901—Scour Countermeasures

Description: Substructure protection devices or systems installed to mitigate scour problems. This element is not for tracking typical bank protection placed during bridge construction.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of countermeasure protected elements or protection systems.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Settlement (4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td><td rowspan="3">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Scour (6000)</td><td>None.</td><td>Exists within tolerable limits or has been arrested with effective countermeasures.</td><td>Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

None.

Chapter 6 – Culvert Elements

6.1.0—CULVERTS

This Article covers, steel, prestressed and reinforced concrete, timber, masonry, and other types of culverts.

6.1.1—Element 240—Steel Culvert

Description: Steel culverts, including arched, round, or elliptical pipes.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Flow line length of the barrel times the number of barrels.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	

Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The inspector shall use such factors to assess the proper condition state.

6.2.1—Element 241—Reinforced Concrete Culvert

Description: Reinforced concrete culverts, including box, arched, round, or elliptical shapes.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Flow line length of the barrel times the number of the barrels.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural stress.	Exceeds tolerable limits but does not warrant structural review.	

Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The inspector shall use factors to assess the proper condition state.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

6.1.3—Element 242—Timber Culvert

Description: All timber culverts.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Flow line length of the barrel times the number of barrels.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The inspector shall use such factors to assess the proper condition state.

6.1.4—Element 243—Other Culvert

Description: Other material-type culverts, including arches, round, or elliptical pipes. These culverts are not included in steel, concrete, or timber material types.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Flow line length of the barrel times the number of barrels.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	

Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The inspector shall use such factors to assess the proper condition state.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

6.1.5—Element 244—Masonry Culvert

Description: Masonry block or stone culverts.

Classification: NBE

Units of Measurement: ft

Quantity Calculation: Flow line length of the barrel times the number of barrels.

Condition State Definitions

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Efflorescence/Rust Staining
(1120)
Patched Area
(1080)</td><td>None.</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td><td rowspan="7">The condition warrants
a structural review to determine the effect on strength or serviceability of the element or bridge;
OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Mortar Breakdown (Masonry)
(1610)</td><td>None.</td><td>Cracking or voids in less than 10% of joints.</td><td>Cracking or voids in 10% or more of the joints.</td></tr>
<tr><td>Split/Spall (Masonry)
(1620)</td><td>None.</td><td>Block or stone has split or spalled with no shifting.</td><td>Block or stone has split or spalled with shifting but does not warrant a structural review.</td></tr>
<tr><td>Patched Area (Masonry)
(1630)</td><td>None.</td><td>Sound patch.</td><td>Unsound patch.</td></tr>
<tr><td>Masonry Displacement
(1640)</td><td>None.</td><td>Block or stone has shifted slightly out of alignment.</td><td>Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.</td></tr>
<tr><td>Distortion
(1900)</td><td>None.</td><td>Distortion not requiring mitigation or mitigated distortion.</td><td>Distortion that requires mitigation that has not been addressed but does not warrant structural review.</td></tr>
<tr><td>Settlement
(4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td></tr>
</table>

Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is liess than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The inspector shall use such factors to assess the proper condition state.

6.1.6—Element 245—Prestressed Concrete Culvert

Description: All prestressed concrete culverts.

Classification: NBE **Units of Measurement:** ft

Quantity Calculation: Flow line length of the barrel times the number of barrels.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks hat have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	

Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The inspector shall use such factors to assess the proper condition state.

The inspector should use judgement when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

Chapter 7 – Steel, Pin and Hanger, and Fracture Critical Inspections

Introduction

On December 15, 1967, the Silver Bridge over the Ohio River in West Virginia collapsed, killing 46 people. The tragedy prompted Congress to enact the Federal-Aid Highway Act of 1968 initiating the National Bridge Inspection Standards (NBIS). By law, the states were now required to inspect all Federal-Aid System bridges on a regular two-year interval.

Ten years later, the Surface Transportation Assistance Act expanded the NBIS to include bridges on all public roads. From this point on, each state was responsible for the inspection of all bridges within its borders including those under county jurisdiction.

The collapse in June 1983 of the Mianus River Bridge in Greenwich, Connecticut, the result of the failure of one pin and hanger assembly, killed three people and severely injured three others. The FHWA immediately required a hands-on inspection of all similar assemblies on fracture critical bridges.

The wheels were set in motion for more extensive changes to the inspection program. The 1988 Revision to the NBIS required each state to:

1. Develop master lists of all bridges having fracture critical members
2. Establish procedures for the inspection of those members
3. Determine the frequency of those inspections.

The two bridge failures mentioned above had one similarity; both were almost instantaneous collapses brought on by the failure of fracture critical elements.

The failure in 2007 of the I-35W deck truss bridge in Minneapolis, Minnesota brought the inspection of gusset plates in bridges (already an FCM) to the forefront. The failure of an undersized gusset plate in this bridge under construction with both traffic and construction loads placed emphasis on inspecting and rating gusset plates. This collapse also brought a critical review of the bridge inspection program from the Inspector General which instigated the FHWA 23 metrics that are in use today for reviewing and verifying the adequacy of state bridge management and inspection programs.

The purpose of a fracture critical inspection

1. Find any flaws in a fracture critical member
2. Document flaw locations for the record

The Federal Highway Administration requires that all structures that are fracture critical or have unique features be placed on master lists. The structures on these master lists must receive special inspections. The structures that require these special inspections are identified in the NBIS coding items 92A - Fracture Critical Detail and 92C – Special Inspection Detail. This guide describes the inspection procedures for the structures identified in items 92A and 92C.

To truly understand what we are trying to accomplish with this type of program, we must understand the principals involved. AASHTO defines a fracture critical member (FCM) as:

> *A FCM is a steel member in tension or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.*

By definition, a fracture critical member is one, which performs a function absolutely essential to the stability of the bridge. A FCM is one whose function cannot be replaced by any other component of the structure.

The importance of a thorough inspection of fracture critical members cannot be over-emphasized. This section has, therefore, been written to help develop a quality fracture critical inspection program for the State of Montana.

Glossary

Axial Force	A force whose line of action is directed through the centroid of a member's cross-section.
Beam	A structural member subjected to transverse loading. Beam is a general term used to describe such members as girders, stringers, and floor beams.
Bearing	A structural member used to support a beam at its end or at some intermediate point.
Cantilever	A beam supported at one end only, or that portion of a beam which projects beyond a point of support.
Centroidal Axis	The axis of a structural member which passes through its cross sectional center of gravity.
Compression	The stress resulting from a member or portion of a member being squeezed or shortened.
Continuous Beam	A beam supported at intermediate points along its length. It must have at least one support between its exterior supports.
Contraflexure	See "inflection point."
Counter	Diagonal member of a truss panel, which is opposed, by a member in the same panel running in the opposite direction. Both members are very slender and, therefore, will accept only a very small compressive load. The counters work in tandem. As a live load crosses the bridge, only that member who carries the shear in that panel as a tension load will function.
Couple	Two forces heading in exactly the opposite direction and spread some distance apart. When acting on a body, a couple will cause it to rotate.
Dead Load	A fixed position gravity load. The permanent load on a structural member. The weight of the structure and any permanent attachments are dead loads.
Equilibrium	The state in which the resultant of all forces acting on a body is zero. For a body to remain at rest, this condition must be satisfied. If a body is in equilibrium, any isolated part of the body must also be in equilibrium.
Floor Beam	A transverse beam connecting main longitudinal components, usually trusses or large girders. A floor beam is used to support smaller longitudinal components (stringers), in effect creating a series of "mini-spans" within the main span.
Free Body Diagram	A sketch of an isolated body and all the external forces acting on it.
Inflection Point	The point in a continuous beam at which the moment due to dead loads is equal to zero. At these locations, the movement of live loads may cause the total stresses to fluctuate between tension and compression.

Line of Action A line through which a force is directed.

Live Load Gravity loads acting when a structure is in service, but varying in magnitude and location.

Moment The moment about a specific point within a body is the algebraic sum of all individual moments about that point. Each moment is equal to some force acting on the body multiplied by its moment arm to the point.

Moment Arm The distance perpendicular from the line of action of a force to the point about which the moment is being taken.

Neutral Axis Locations in the cross section of a member where bending stresses are zero. Usually, it coincides with the centroidal axis.

Principal Stress The stress applied normal (perpendicular) to the cross section of a member. It refers to the axial stress in a truss member and the tension and compression stresses in bending.

Propagate Term used to describe the continuation of the ends of a crack. This can only occur when the faces of the crack are being pulled apart by a tensile force.

Simple Beam A beam supported only at its ends. Bearing is all that is provided by the supports. The ends of the beam are free to rotate.

Stress The load intensity a material experiences when subjected to a force. It is the load per unit area.

Stress Cycle The range of stress from a minimum to a maximum that a member experiences during one application of a live load.

Stress Concentration An increase in stress caused by an irregularity in geometry. There is usually a localized variation in the overall stress in the immediate vicinity of the irregularity. The peak stress at these locations may be several times larger than the stress level in the bulk of the member.

Tension The stress resulting from a member or a portion of a member being pulled or stretched.

Yield Point The level of stress at which a material (steel) will begin to deform plastically. Before it reaches this level, the steel will behave elastically, meaning it will sustain a load and bounce back. After reaching this level, any deformation will be permanent.

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In most instances, a fracture is not the result of a single load overstressing the element to the point of failure. Generally, it is caused by the repeated application of loads, which do not stress the member to anywhere near the yield point. Cracking which occurs under these circumstances is known as fatigue cracking.

A member whose state of stress at rest or under pure dead load is far different than the stress imparted by a live load is very susceptible to fatigue. A very good example of this are counters in a truss. The dead load stress in a counter is almost negligible, while under a live load they are asked to carry a very high tensile stress. The large differential in the range of stresses these members must experience during a stress cycle make them very vulnerable to fatigue cracking.

It is obvious that fatigue has very little to do with the maximum stress a bridge member will encounter during its lifetime. The real issue here is the range between the lower and upper limits of its stress cycle. The larger the range the more fatigue prone the member will be.

Fatigue

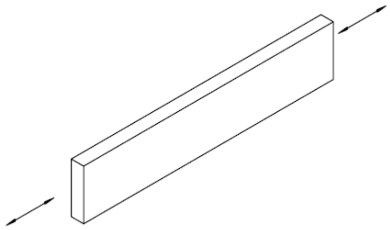
A fracture critical bridge may have numerous fatigue prone details. Fatigue prone details are only able to bend so many times before cracking occurs. These fatigue prone details would not cause the collapse of the bridge if the bridge were redundant. However, since the bridge does not have any built in ability to shift the load to other members if a fracture occurs the bridge may collapse.

A fracture critical member is a member in tension, which means it is being pulled apart. This causes cracks to grow and a fracture to occur. A member in axial tension is stressed the same throughout the cross section for the total length between connections. Hangers, suspension cables, and some truss members normally are stressed in axial tension. Direct tension members, even though they may have no welding associated with them, are the most critical because they are usually used in situations where virtually no redundancy exists, and defects can initiate and grow to possibly critical flaw size without being detected. Eyebars and hangers that have been repaired by field welding become highly susceptible to fatigue cracking.

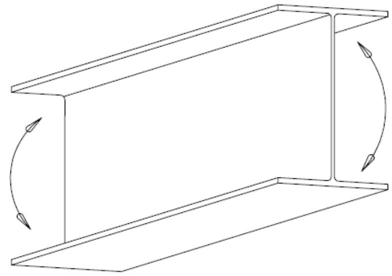
Any sudden change in the geometry of a structural member's cross-section can lead to a stress concentration. These are referred to as stress risers. Many of the problems being discovered in in-service bridges are associated with weld terminations or defects, which are inherent to the welding process. Welding of structures generally started in the 1950's. The state-of-the-art at that time, both from a welding procedure standpoint, as well as shop inspection techniques that were available, makes it very likely that fatigue prone defects are present. The bridge inspector now has to find these stress risers before they reach the critical flaw size. Welds made in the field are especially susceptible to fatigue cracking. Even tack welds could initiate cracking under certain conditions. Structural details are categorized by their fatigue strength. The categories range from A to E and E'.

Category A

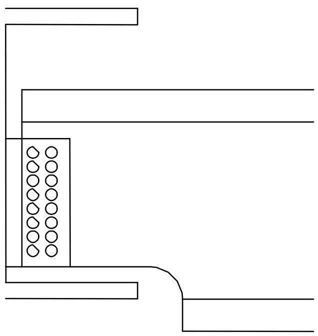
Category A fatigue strength detail refers to the "base metal" or plain material with rolled or cleaned surfaces away from welded, riveted or bolted connections. This is "ideal" condition. This category provides the highest fatigue strength. It is not necessary to examine the base metal regions for cracks unless the region is susceptible to distortion.



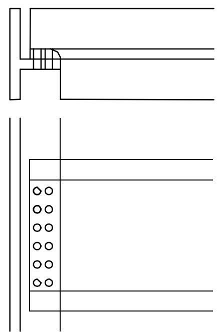
Base Metal for Bar



Base Metal for Beam



Coped Beam Flanges



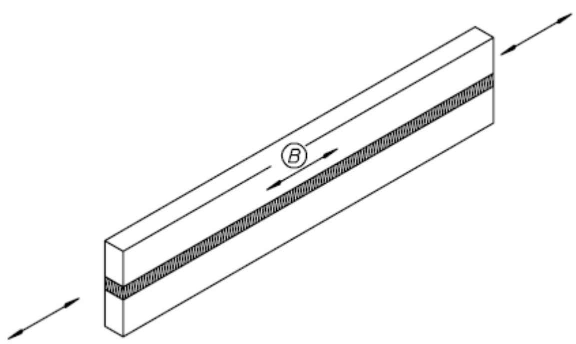
Blocked Beam Flanges

Category B

Category B includes a number of welded structural details and high strength bolted joints.

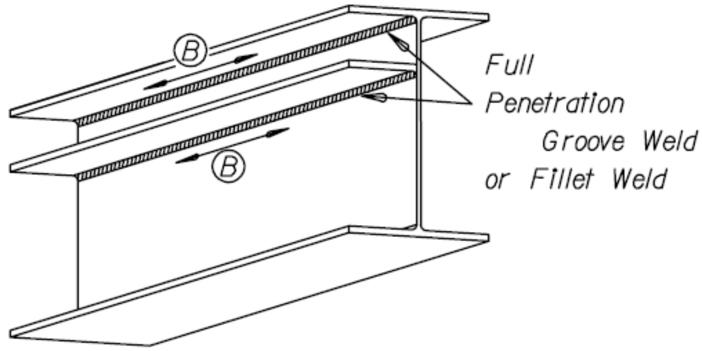
1. Longitudinal continuous welds in built-up plates and shapes. The fatigue strength of these details is primarily governed by subsurface discontinuities of flaws in the welds or surface notches.

Full penetration groove welds with backing bars removed.

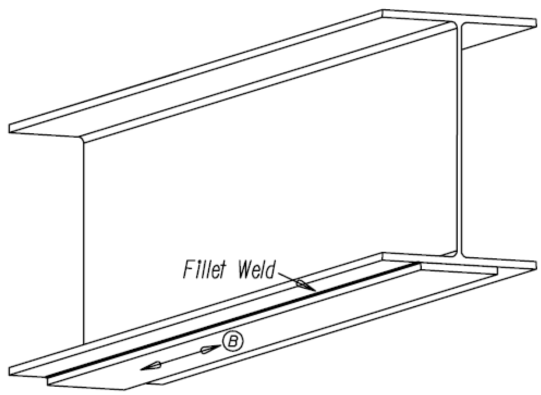


Full penetration groove welded or fillet welded web-to-flange connection in built-up plate girder.

Continuous fillet welds at longitudinal stiffeners except at ends of the welds.

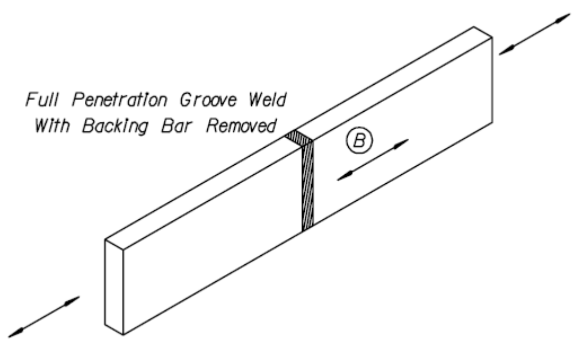


Fillet welds joining cover plates to girder flanges except at the ends of the welds.

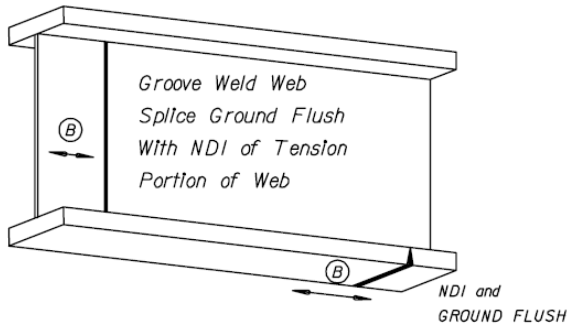


2. Transverse full penetration groove welds with weld reinforcement ground smooth and weld soundness established by non-destructive inspection.

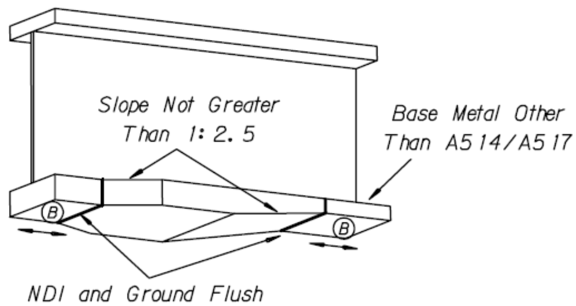
Butt jointed plates with uniform cross section.



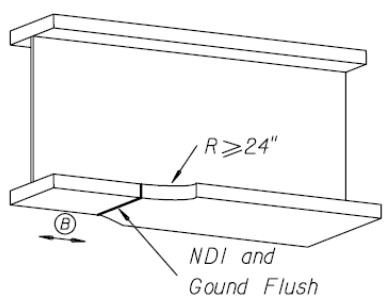
Flange and web butt joints with the same cross section on both sides.



Butt joints with a straight transition in width or thickness slope of the transition not steeper that 1 to 2.5, and with base metal other than A514 or A517.

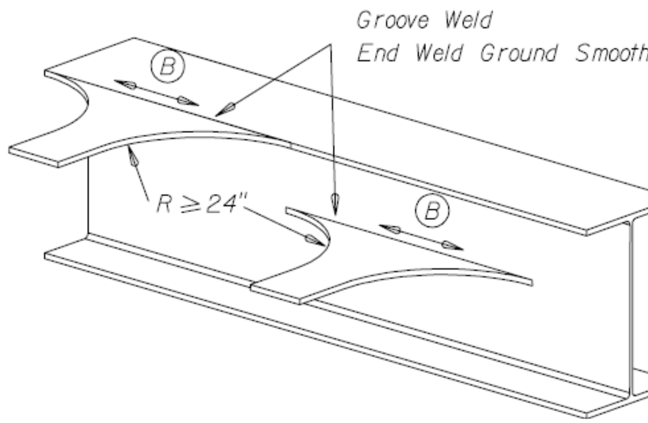


Butt joints with a curved transition and curved radius not less than 609.6 millimeters (24 inches).

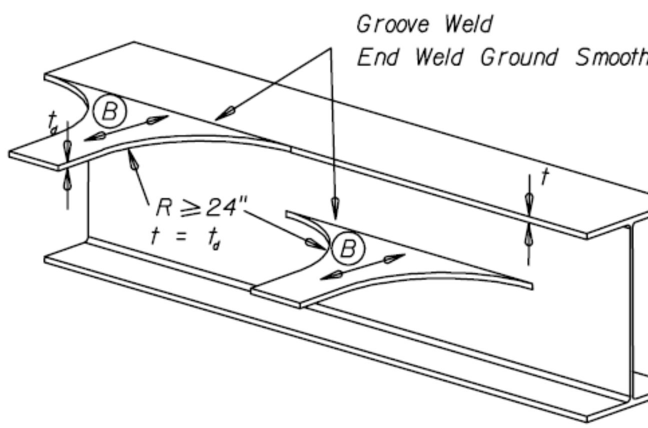


3. Groove welded attachments with a transition radius not less than 609.6 millimeters (24 inches).

Full or Partial penetration groove weld parallel to the direction of stress in the member and the end welds ground smooth.



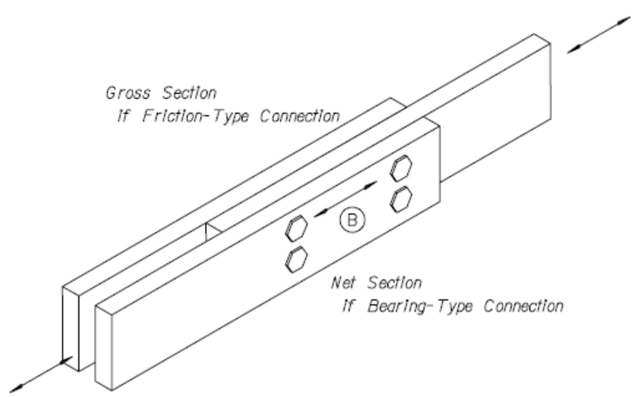
Full penetration groove weld transverse to the direction of stress of the attachment, plates of equal thickness, weld reinforcement removed and weld soundness transverse to direction of stress established by non-destructive inspection



4. High strength bolted connections

Gross section away from boltholes of slip-resistant, friction-type connections.

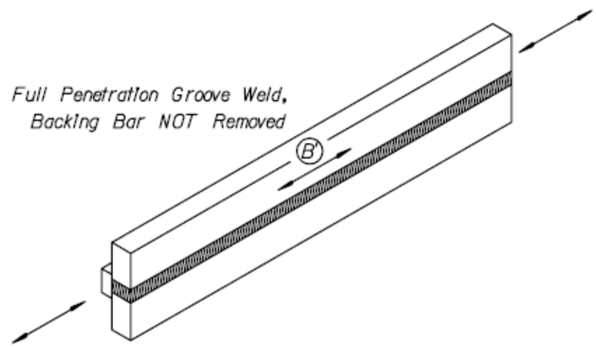
Net section through boltholes of bearing-type connections with tightened bolts.



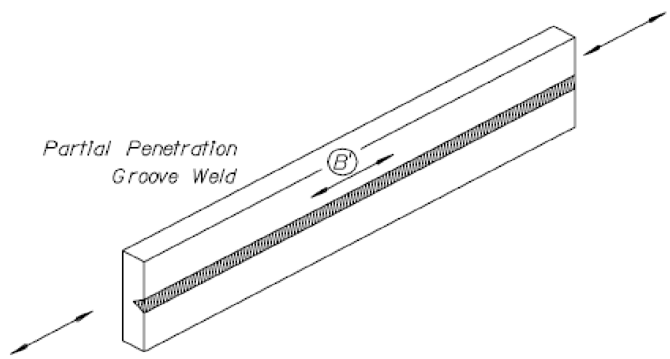
Category B'

Category B’ is a subcategory of the detail in Category B but are more sensitive to fatigue.
1.Longitudinal continuous welds in built-up plates and shapes. The fatigue strength of these details is primarily governed by subsurface discontinuities of flaws in the welds or surface notches.

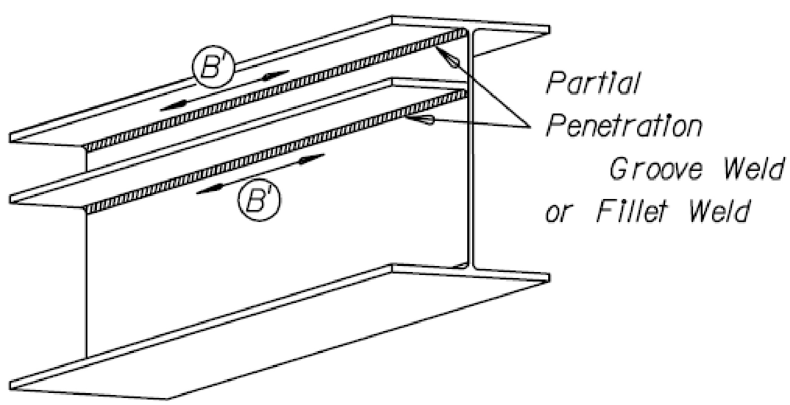
Full penetration groove welds with backing bars NOT removed.



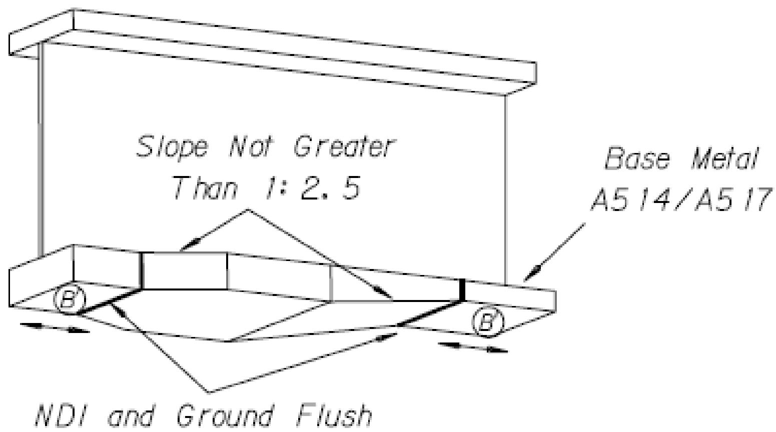
Partial penetration groove welds joining girder flange and web or longitudinal stiffener to web.



Partial penetration groove welded or fillet welded web-to-flange connection in built-up plate girder.

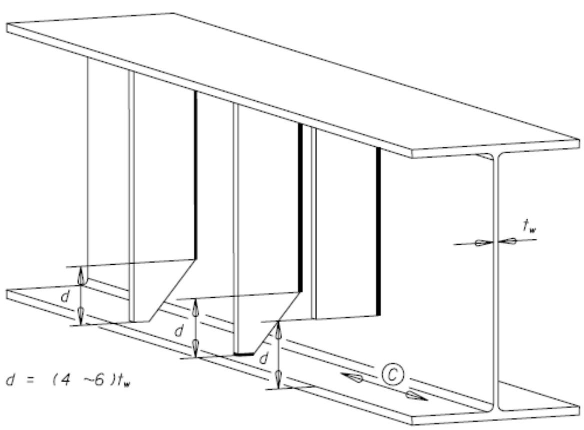


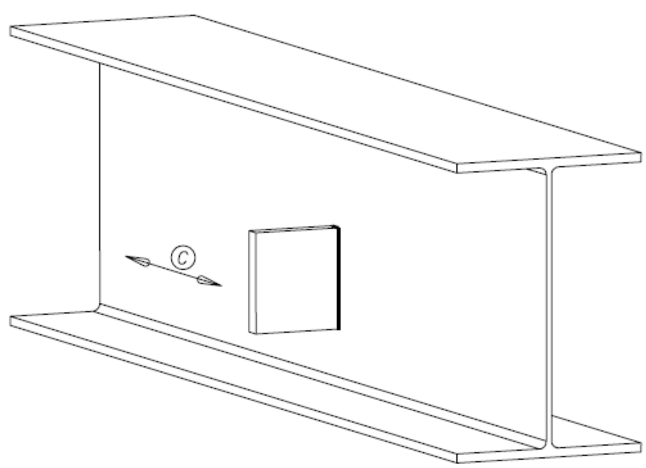
2. Transverse full penetration groove welds with reinforcement ground smooth to provide straight transition in width or thickness, slopes of transition not steeper that 1 to 2.5 and base metal being A514 or A517.



Category C

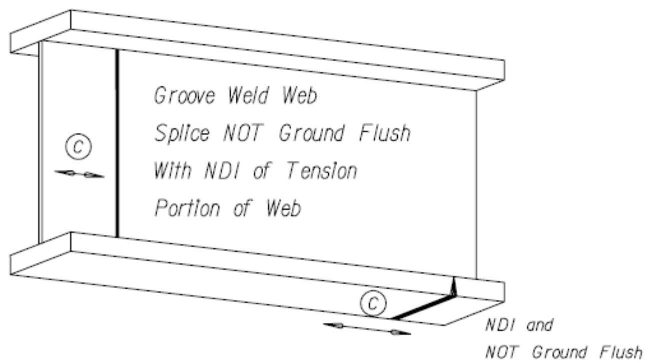
Category C details include transverse stiffeners, very short attachments, and transverse groove welds with reinforcements not removed.
1. Base metal at welds connecting transverse stiffeners or vertical gusset plates to connection and gusset plates to girder webs or flanges.



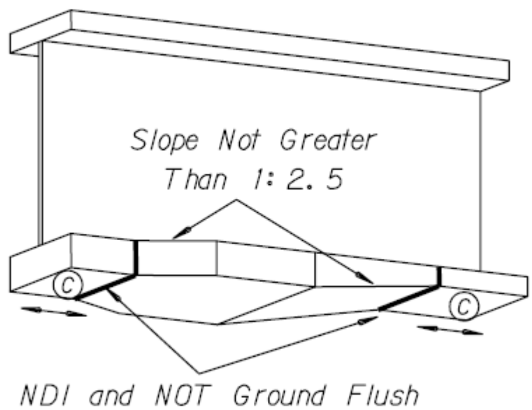


2. Transverse full penetration groove welds, weld reinforcements not removed, but with weld soundness established by non-destructive inspection. Notice that these are similar to elements in category B except the weld reinforcements are not removed.

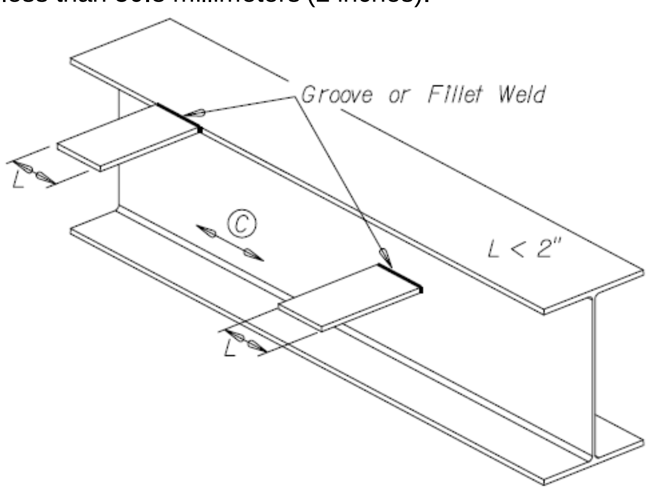
Flange and web butt splices with the same cross section on both sides.



Butt joints with width or thickness transition slope of straight transition not greater than 1 to 2.5.

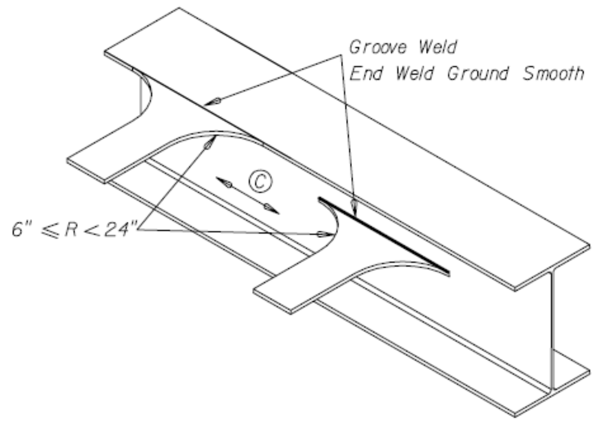


3. Groove or fillet-welded horizontal gusset or attachment, the length of which (in the direction of the main member) is less than 50.8 millimeters (2 inches).

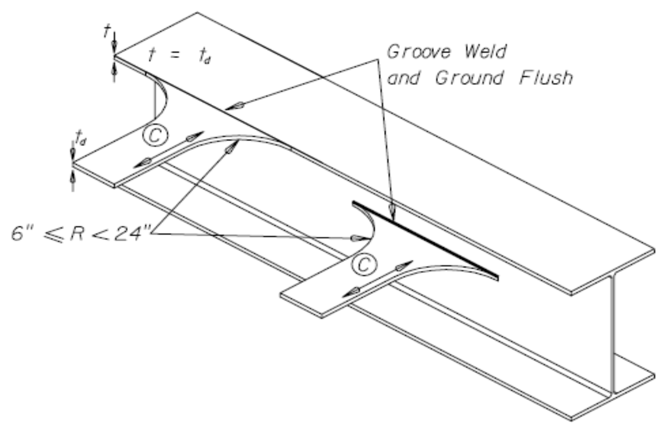


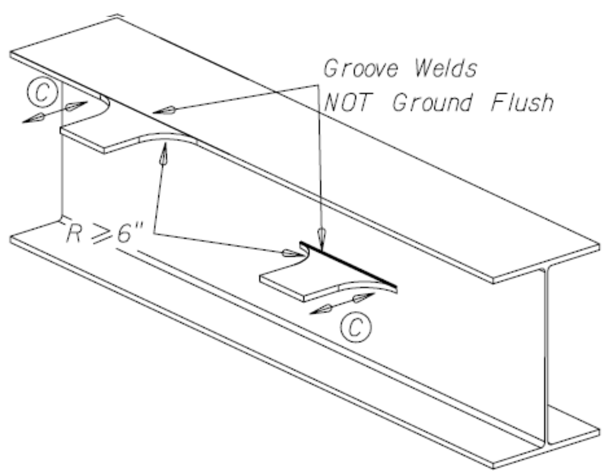
4. Groove welded attachments with transition radius between 154.2 millimeters (6 inches) and 609.6 millimeters (24 inches).

Full or partial penetration groove weld parallel to the direction of stress in the member with the end welds ground smooth.

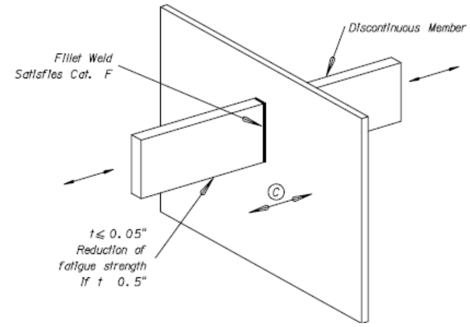


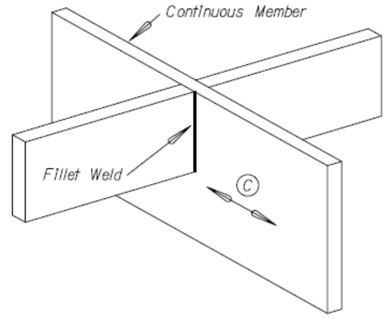
Full or partial penetration weld perpendicular to the direction of stress in the attachment, plates of equal thickness, and weld soundness transverse to direction of stress established by non-destructive inspection.





5. Intersecting plates connected by fillet welds with the discontinuous plate not more than 12.7 millimeters (0.5 inches) thick. If the plate is more than 12.7 millimeters (0.5 inches) or if sub size weld is used, the fatigue strength is substantially reduced.



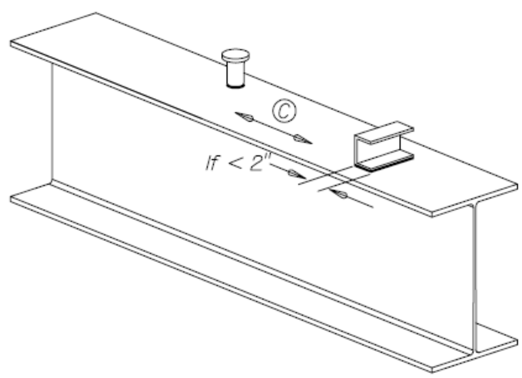


Load Carrying

6. Shear Connectors

Stud shear connectors.

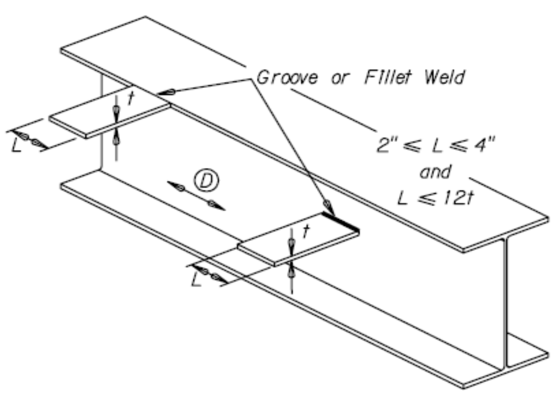
Channel shaped shear connectors with the length of weld along the longitudinal edge of channel flange not more that 50.8 millimeters (2 inches) long.



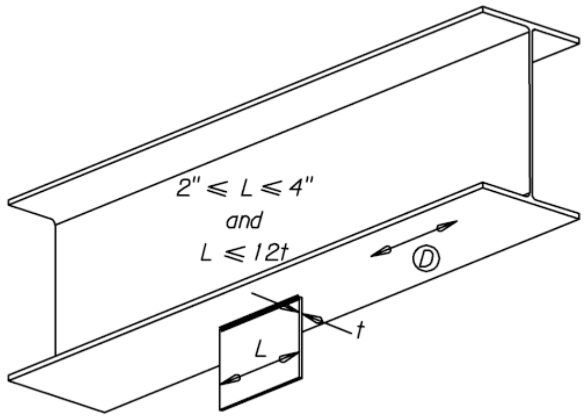
Category D

Category D detail includes welded short attachments, welded connections with short transition curves, and riveted joints.

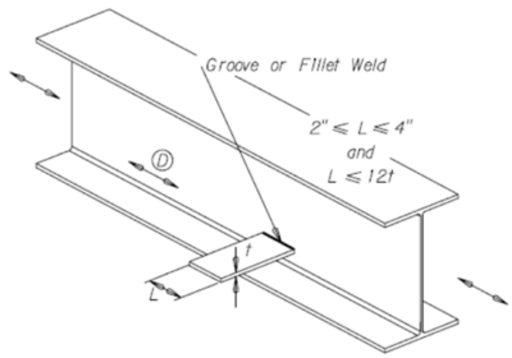
1. Welded attachments with groove or fillet weld in the direction of the main member between 50.8 millimeters (2 inches) and 101.6 millimeters (4 inches) long but less than 12 times the plate thickness.



Groove or Fillet Welded Attachment, Intermediate Length



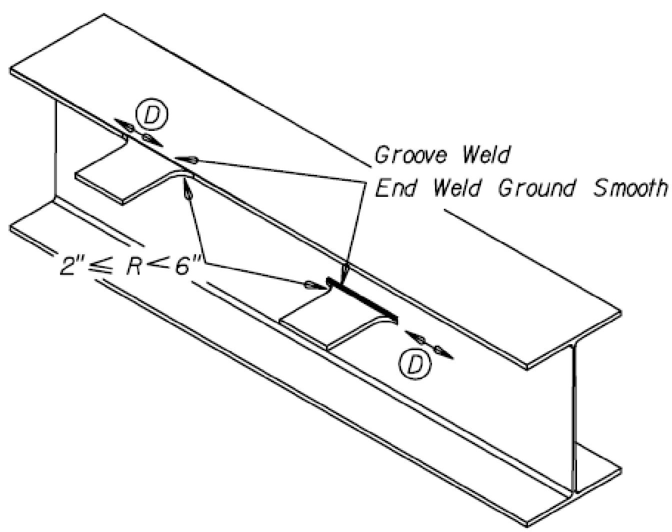
Welded Gusset Plate, Intermediate Length



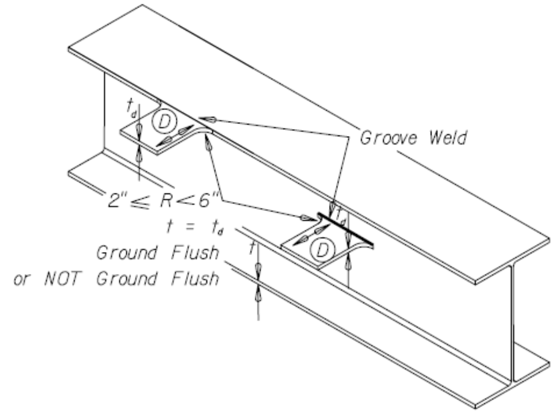
Welded Gusset Plate on Rolled Shape, Intermediate Length

2. Groove welded attachments with transition radius between 50.8 millimeters (2 inches) and 154.2 millimeters (6 inches).

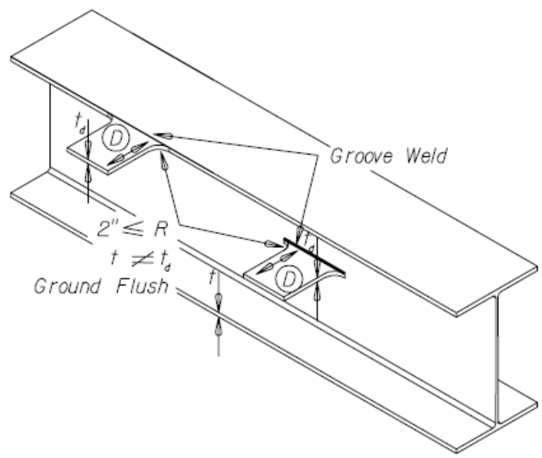
Full or partial penetration weld in the direction of main member with end welds ground smooth.



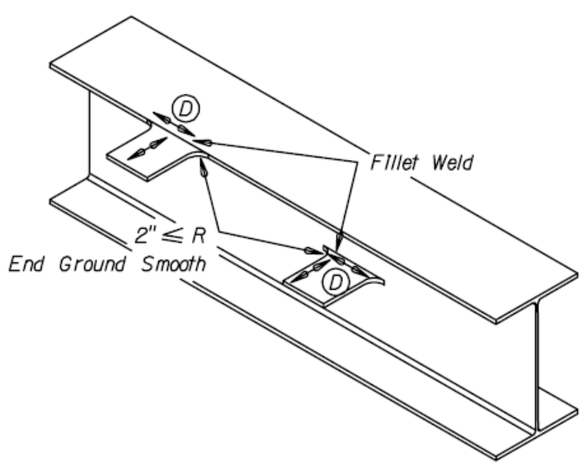
Full penetration weld perpendicular to the attachment, plates of equal thickness, weld reinforcement removed or not removed, and soundness established by non-destructive inspection.



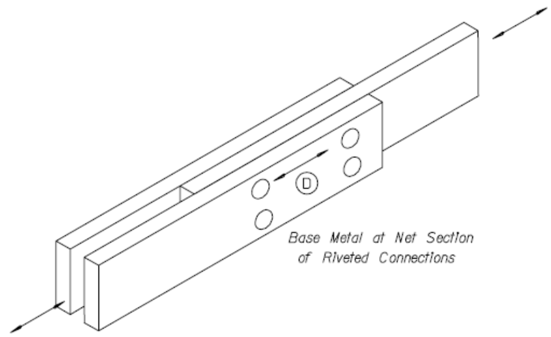
3. Groove welded attachments with unequal plate thickness, weld perpendicular to attachment, weld reinforcement removed, and a transition radius of at least 50.8 millimeters (2 inches).



4. Fillet – welded attachments with transition radius 50.8 millimeters (2 inches) or larger and end welds ground smooth.



5. Riveted connections, net section.

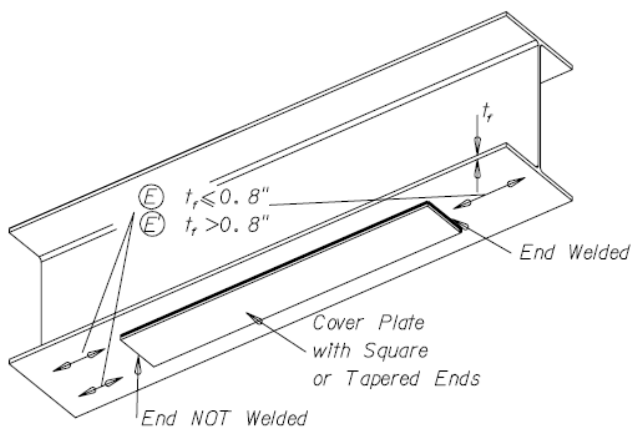


Category E and E'

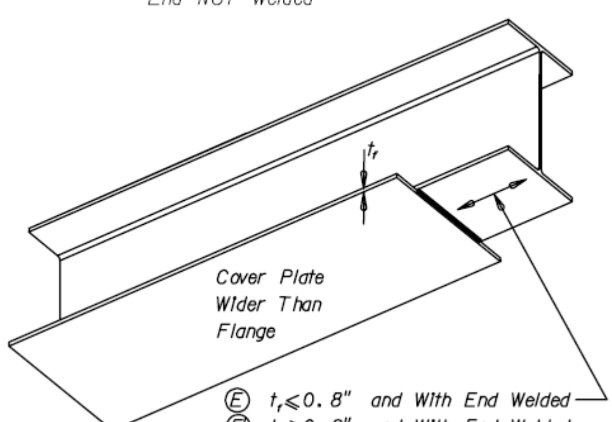
Category E and E' detail have the lowest fatigue strength. Category E and E' details have the same configuration. The exceptions are flange plate thickness exceeds 20.3 millimeters (0.8 inches) or the attachment plate thickness is 25.4 millimeters (1 inch) or greater.

1. Ends of partial length cover plates on girder or beam flanges

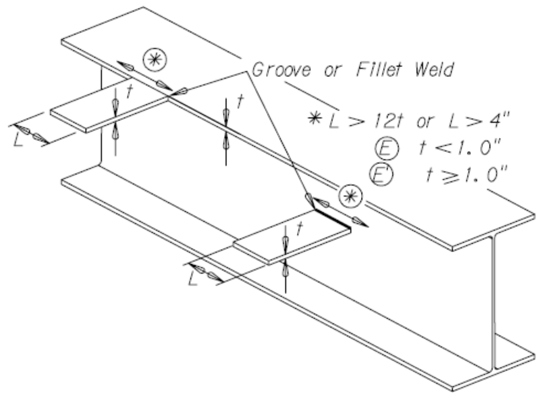
Cover plate narrower than flange plate, with square or tapered ends, with or without welds across the ends.

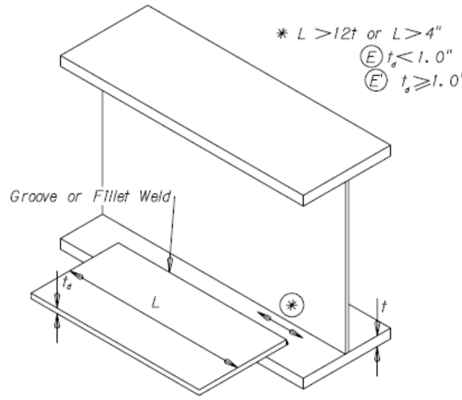


Cover plate wider than the flange plate.

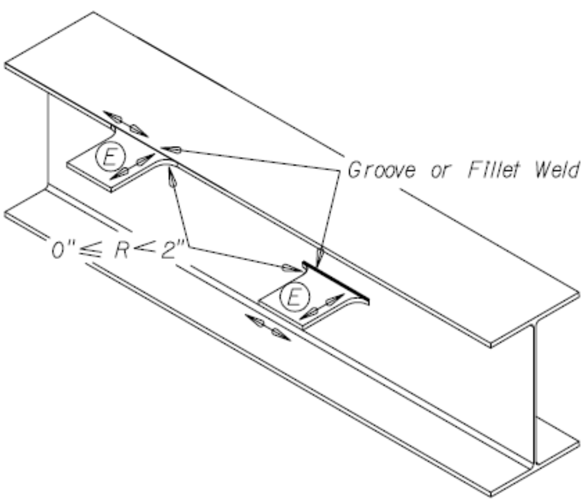


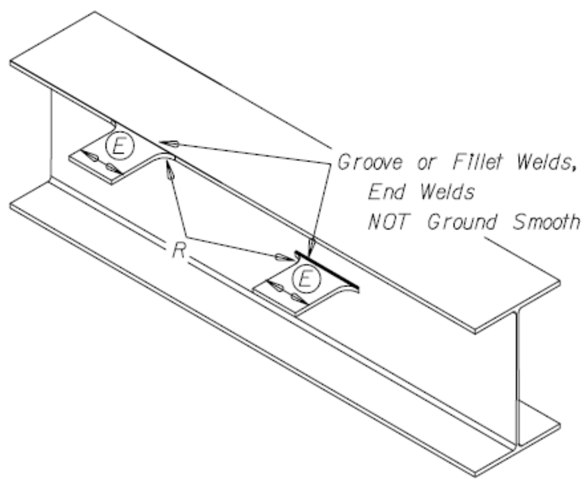
2. Welded attachment, with groove or fillet weld in the direction of the main member, more than 101.6 millimeters (4 inches) or 12 times the plate thickness. Plate thickness equal to or greater than 25.4 millimeters (1 inch), the detail is Category E'





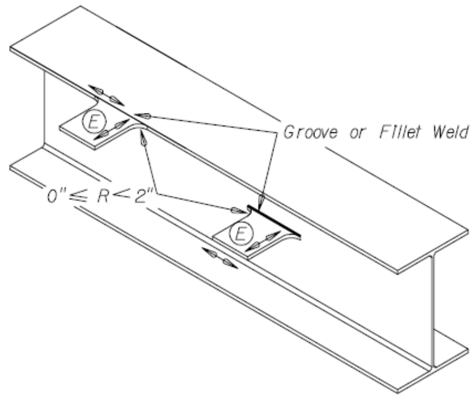
3. Welded attachment with curved transition. Transition radius less than 50.8 millimeters (2 inches) and welds ground smooth are Category E. Same detail without out welds ground smooth are Category E'.



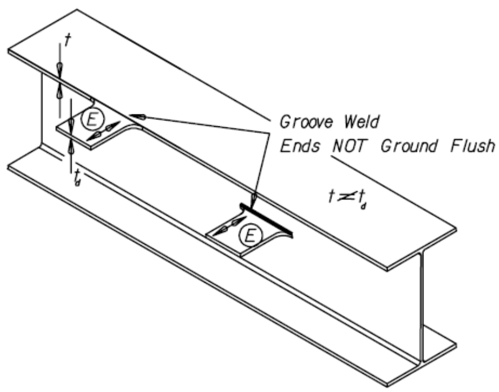


4. Welded attachment with loads transverse to welds.
Groove welded attachment, with soundness of the weld established by non-destructive inspection are Category E

Transition radius less than 50.8 millimeters (2 inches).

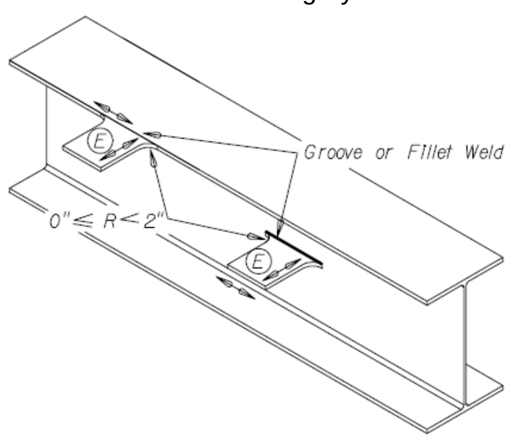


Unequal plate thickness and weld reinforcement not removed.

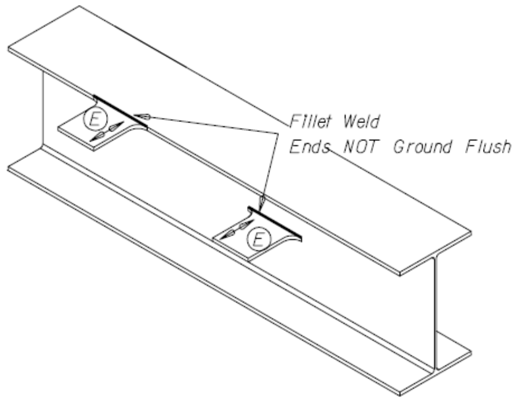


Fillet welded attachment that has and the end are Category E.

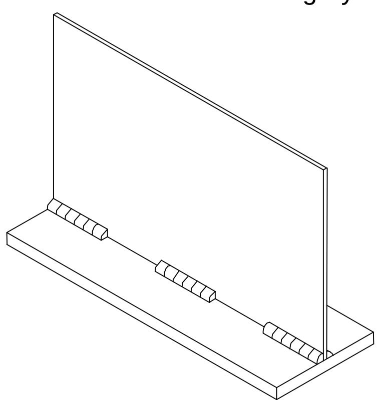
Transition radius less than 50.8 millimeters (2 inches) and welds ground smooth.



End welds not ground smooth.



5. Intermittent fillet welds are Category E.



Though not harmful by themselves, they will cause cracking in areas of high tension stress or stress reversal (fatigue). Most cracks found in the field are in the vicinity of a geometric stress riser.

Bolt and rivet holes are stress risers. So are sharp re-entrant corners such as a coped flange at a floor beam's connection to a main girder in a two-girder system. Many commonly used fabrication details are stress risers and, as such, are subject to fatigue.

A FCM is endangered by corrosion, which can lead to loss of section, pack rust, and shortened fatigue life. Proper maintenance and painting can reduce this problem. Rust can build up between plates and add additional stresses to members

Stress

An overview of the stresses a bridge member experiences will help in locating zones of tension stress. A load applied to any structural member will cause a force or moment, which is resisted by the entire cross-sectional area of the member. This distributing of the force or moment over the cross-sectional area is known as a stress distribution.

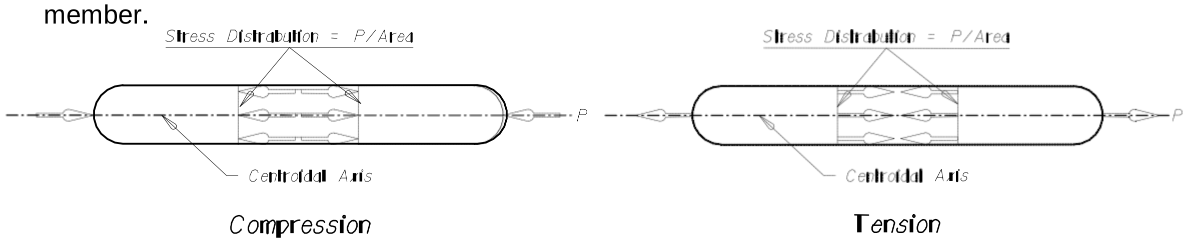
Axial Stress

A force whose line of action acts through a member's centroidal axis causes axial stresses. There are two types of axial forces:

Tension: the force which, when applied, tends to pull the member apart, and

Compression: the force which, when applied, tends to squeeze or contract the member.

Axial forces are resisted by a stress distribution of equal intensity over the entire cross section of the member.

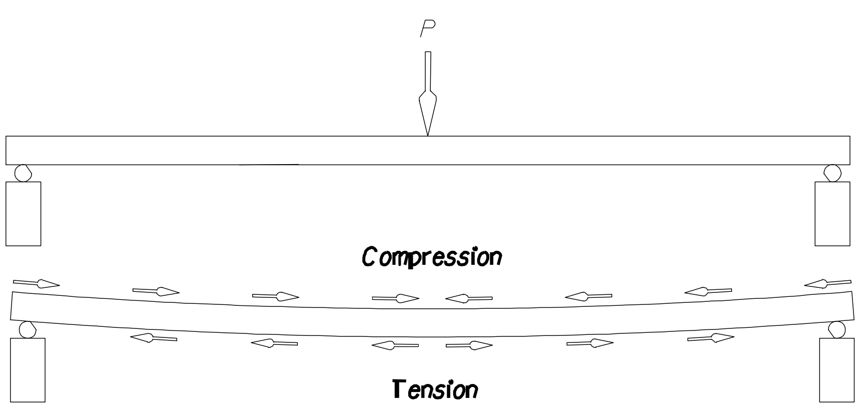


Bending and Shear Stresses

As opposed to axial stresses, which are caused by forces applied along the length of the member, bending deals with stresses due to forces acting transversely to the member. Here we are dealing with beams. A beam is a slender member (relative to its length) that is subjected to a transverse gravity load.

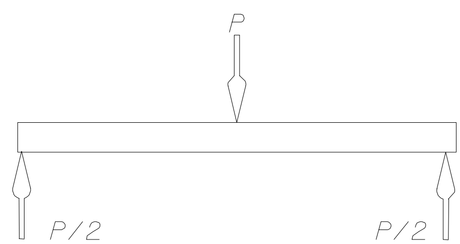
Members in bending have variable stresses throughout. On a simple beam, the maximum tension is in the bottom flange at midspan. An equally important location on a continuous span is the top flange over the support. High stress may also be concentrated at locations along a member where the cross section changes or where there is a discontinuity.

Consider the simple beam, shown supporting a weight "P" at midspan. This loading configuration causes the beam to deflect downward. As a result, the bottom of the beam is being stretched or pulled and is in tension. The top is being squeezed or contracted and is in compression. Therefore, what we have when we analyze bending is a combination of the two axial stresses: tension and compression.



In order for the beam to be in equilibrium, the sum of the forces at the end bearings must equal zero; therefore, the sum of the forces at the end bearings (reactions) must equal the load “P”. In this example, we will neglect the weight of the beam itself.

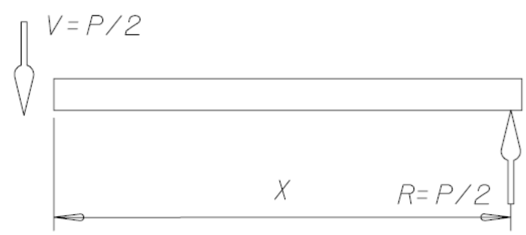
Since the load is applied directly at the center of the span, the reactions will act equally in resisting it. Therefore, each reaction (R) must equal P/2.



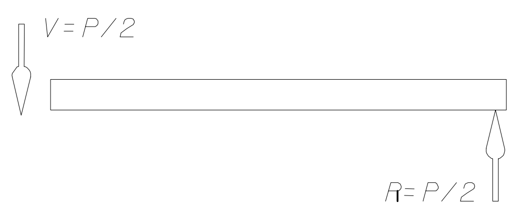
FREE BODY DIAGRAM OF BEAM

As stated, the beam under consideration is in equilibrium. This being the case, any portion of the beam must also be in equilibrium. We, therefore, can draw a free body diagram of any part of the beam we choose.

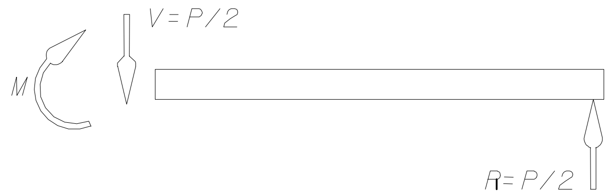
Take a segment of the beam a distance “x” from the right reaction.



As stated earlier, the reaction is equal to P/2. Because we know that this portion is in equilibrium, there must be a force just to the left of the cut equal in magnitude and opposite in direction to the reaction, P/2. This is called the shear force at this section and is designated “V”.



The sum of the vertical forces now equal zero; however, they have formed a couple which tends to rotate the member counterclockwise. For the segment to remain in equilibrium, this tendency must be resisted. This is done by an internal moment designated “M”. The final free body diagram of the segment is shown below.

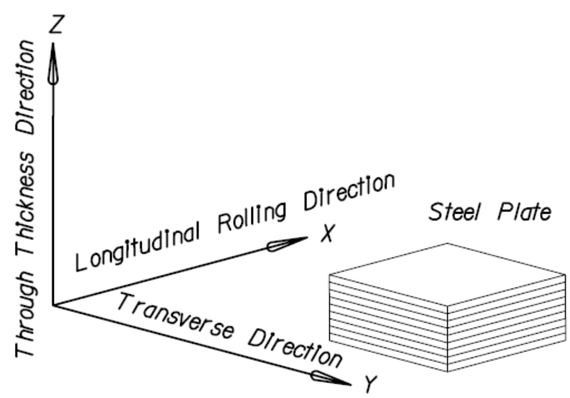


Laminations and Lamellar Tearing

Laminations, which generally occur during fabrication, are extensive and continuous imperfections lying parallel to the plate surface. Generally, they are aligned with the direction of principal stress and are seldom critical. However, they have been known to cause structural failures.

A lamination can result in an imperfection, which might lead to a stress concentration transverse to the applied stress and become critical. This is why all tension and stress reversal regions of a fracture critical member must be looked at, not just the fatigue-prone details.

Like laminations, lamellar tearing is a separation in the through-thickness direction of a plate.



LAMELLAR TEARING AND LAMINATION

While lamination occurs during the fabrication or rolling process, lamellar tearing is the result of welding attachments to the plate. It is caused by weld metal shrinkage in highly restrained joints. A weld connecting a transverse stiffener to a girder web is an example of such a location. As the weld metal cools, it will contract and try to pull the web with it. If the web is highly restrained such, as near the flange, it won’t be able to flex. Large stresses will result, and the web may separate along imperfections between the grains.

Beams

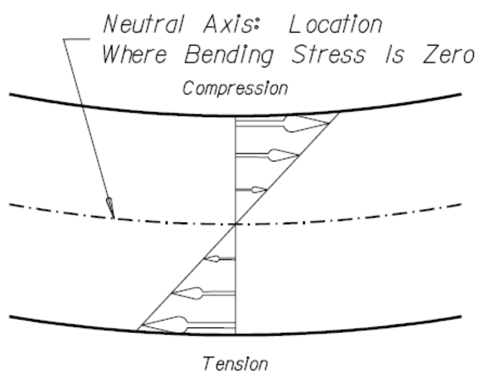
We have now established the stresses that occur in a beam.

Shear Stresses

Vertical forces that tend to displace vertically one part of a member relative to the adjacent part cause shear stresses. (Though this vertical displacement is impossible in real life, analysis and experimentation have shown the physical evidence of shear is cracks that appear at approximately a 45-degree angle with the horizontal.)

Bending Stresses

Tension and compression stresses, which vary linearly along the vertical face of the section. (When permanent deformation takes place, at the onset of yielding--refer to yield point in the glossary--this linear behavior no longer applies.)

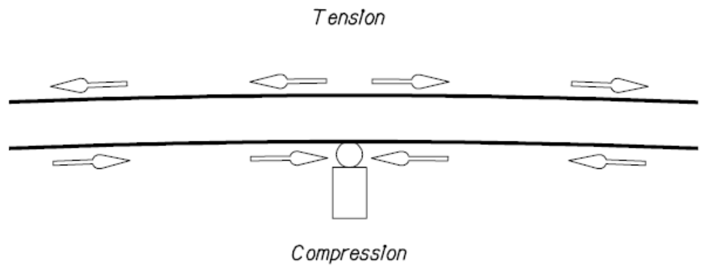


Stress Distribution Varies Linearly From Maximum Compression at the Top to Maximum Tension at the Bottom
BENDING STRESS DISTRIBUTION

For the purposes of fracture critical inspection, we will consider the neutral axis to be located halfway between the top and bottom flange. This is not necessarily the case, but will be close enough for our purposes.

Until now we have dealt with a simply supported beam. The moment has caused the portion of the beam below the neutral axis to be in tension. We refer to this situation as positive bending, or a positive moment region.

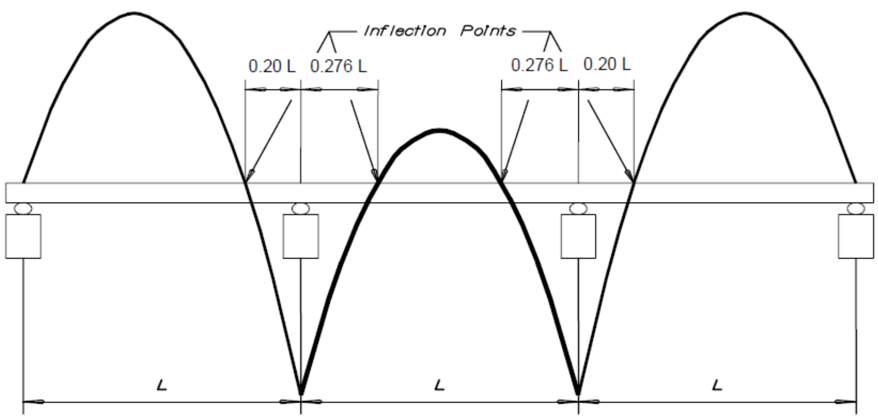
Now consider a continuously supported beam. As was the case for the simple beam, it will deflect downward near midspan. However, as the beam approaches a support, the amount of deflection will decrease until at the support it becomes zero. The situation here is reversed from the simple beam. Relative to the adjacent spans, the portion over the support is deflecting upward; hence, the top of the beam is in tension. We refer to this as negative bending, or a negative moment region.



NEGATIVE MOMENT

As the moment goes from negative at the support to positive at midspan, there must be some point between the two where the moment is zero. This point is called the inflection point, or the point of contra flexure. Because the live load moments at each section are constantly changing as a truck travels across the bridge, the inflection point is determined using only dead load moments.

An example of a graph, called a moment diagram, of the dead load moments at each section along the length of a three-span continuous beam.



MOMENT DIAGRAM - DEAD LOAD

The dead load moments in the region of the inflection point are relatively small and can be overcome by a large live load as it moves across the bridge. In this area, a negative dead load moment may be changed to a net positive moment by the addition of the live load moment. Or a positive dead load moment changed to negative. The overall effect is that a portion of the beam goes from being in a tension zone to compression and back again.

This portion of the beam is said to be in stress reversal for obvious reasons. This cyclic occurrence leads to fatigue in the member. It can cause cracking and eventual failure even though the stresses involved may never approach the yield point.

When inspecting beams, there are some important things to consider. In all instances, while inspecting steel I-beams, the flanges will carry the bending stresses as tension or compression. One flange will, therefore, be designated the tension flange, and the other the compression flange.

Almost exclusively the web will carry the shear stresses. In fracture critical inspections, shear stresses are not our primary concern. However, if a crack does develop in the web, its ability to carry shear stresses will be reduced, possibly increasing the serious nature of the situation. This is especially important in the top (tension) portion of the web over or near the support, where shear stresses are high.

Trusses

A truss may be thought of as a special I-beam with most of its web cut away. The functions of the flanges in the beam are the same as the function of the top and bottom chord in a truss. The function of the I-beam's web is the same as that of the diagonals and verticals.

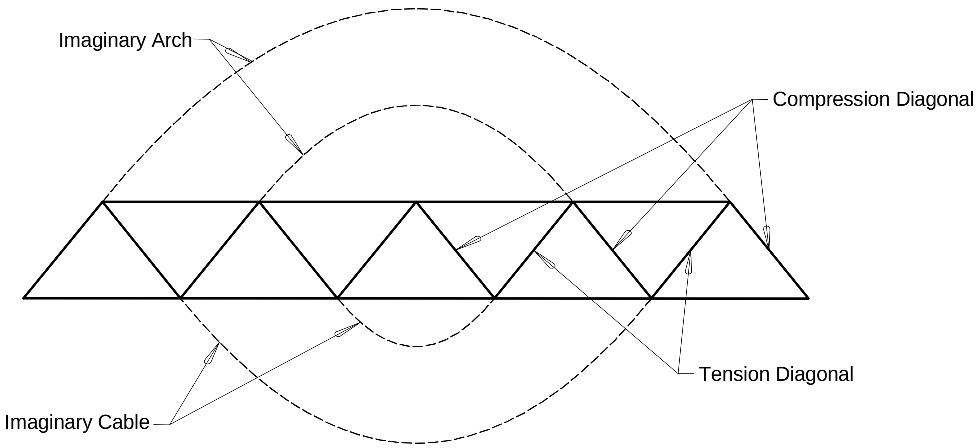
A truss is designed such that the overall bending stresses are carried as axial forces in individual members: the top and bottom chords. Likewise, the shear stresses are carried as axial forces in the diagonals and verticals.

Let's carry the correlation one step further. In the case of a beam, given a specific load and span length, we can decrease the bending stresses in the flanges by increasing the depth of the beam. In the same way, by increasing the depth of a truss, we can reduce the forces in the top and bottom chords.

A very small percentage, around four percent of truss bridges in Montana are continuous; therefore, in this manual we will concentrate on simple span trusses. Continuous trusses will be singled out and analyzed individually.

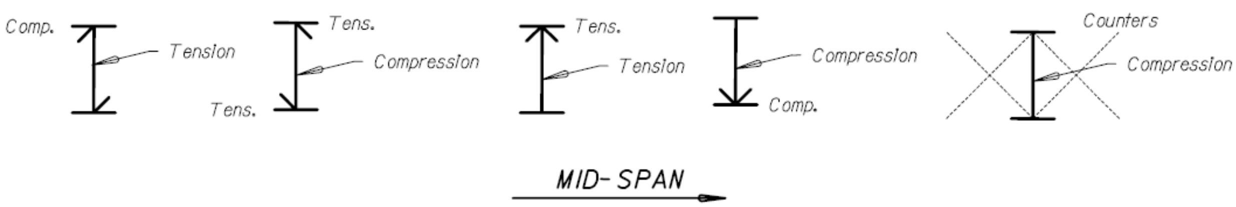
As was the case for the flanges in a simple beam, the top chord in a simply supported truss will be a compression member and the bottom chord a tension member. The distribution of shear forces is another matter. How each member of a truss panel will carry the forces in that panel depends upon the geometry of the truss. The following are some rules of thumb, which will help in determining how the diagonals and verticals react to loads applied to the truss.

Two exactly opposing structure types can help in this discussion: an arch and a suspended cable. In an arch bridge, the arch itself is always in compression. On the other hand, a suspended cable is always in tension. Using these two concepts will allow us to determine which diagonals are in compression and which are in tension.



DIAGONAL STRESS

After the stress in each diagonal is determined, stress in the verticals can be determined.



VERTICAL STRESS

1. Those diagonals, which incline upward toward the center of the span, may be thought of as the ends of an arch and are, therefore, compression members.

2. Those diagonals, which incline downward toward the center of the span, may be thought of as the ends of a suspended cable and are, therefore, in tension.

Because tension members are the focal point of a fracture critical inspection program, the bottom chord of a simple span truss must be checked thoroughly. Any diagonals and verticals, which were also determined to be tension members, must be examined as well.

Redundancy

Structures have properties that can compensate for failure. Failure from stress or fatigue can be compensated by the structure redistributing the load and load paths to alternate locations.

Redundancy is the ability of other members to help carry the load, providing duplication of replacement of some function, when a member becomes weak or fails. A bridge, which is considered fracture critical, is said to be non-redundant. Where bridges are concerned, the term redundancy can be divided into three distinct areas: load path, structural, and internal.

Load Path Redundancy

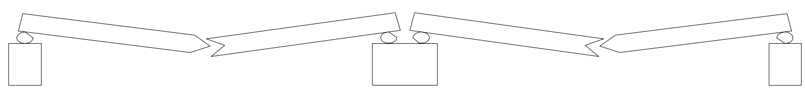
Load path redundancy considers the number of supporting members (e.g., stringers) that transfer the deck loads to the substructure. Each supporting member would be considered a separate load path.

An easy way to picture this is to look at the number of bearings at each bent or pier. The deck loads are delivered through the supporting members to the substructure at these locations. The number of bearings a bridge has at each bent can determine the number of load paths a structure has.

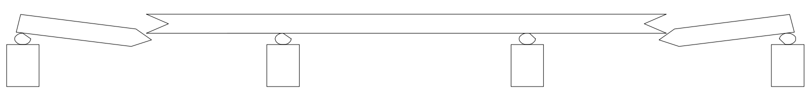
A structure is considered non-redundant if it has two or less load paths. A truss bridge, using only two trusses, has two bearings at each pier. Having only two load paths, it must be considered non-redundant or fracture critical. Conversely, multi-girder bridges with three or more girders and, therefore, three or more load paths, are redundant.

Structural Redundancy

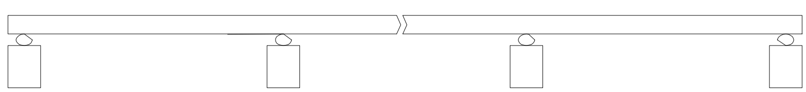
Structural redundancy refers to the number of substructure units and the way in which those units are used to support the superstructure. To be considered structurally redundant, a bridge must have a minimum of three continuous spans, and then only the middle span is redundant. A structure constructed of a simple span or a series of simple spans is considered structurally non-redundant.



Structurally Non-Redundant
(Two Simple Spans)



Spans 1 and 3 – Structurally Non-Redundant
(Three Span Continuous)



Span 2 – Structurally Redundant
(Three Span Continuous)

Internal Redundancy

Internal redundancy relates to a particular structural member and the redundancy created by the independence of its individual components. A good example of an internally redundant bridge member is a riveted plate girder. This type of girder is constructed of double angles (which provide the flanges) riveted to a web plate. A crack beginning in one leg of one of the angles may eventually separate the entire angle, but it will not travel into the web plate.

On the other hand, a welded plate girder cannot be considered internally redundant. The weld fuses the different components together so they become a single section. Cracks appearing in one portion will propagate into adjacent elements unhindered by the weld itself. In fact, far from hindering crack propagation, flaws in the weld in many instances are the cause of cracking found in welded plate girders.

Some examples of internally redundant and non-redundant members are given below.

Internally Redundant	Internally Non-redundant
Riveted plate girder	Welded plate girder
Cables constructed of several strands	Single strand cables
Multiple eyebars in a truss member	Single eyebar in a truss member
	Rolled sections

If a crack or flaw develops in a structural member, the only stresses, which will cause it to propagate, are tension stresses. For the ends of a crack to spread, the faces of the crack must be pulled apart. This can only occur in a tension zone and only when the crack is at a right angle or transverse to the applied tensile stress. Therefore, when inspecting fracture critical members, the compression areas of those members may be neglected.

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Chapter 7 – Section 3 – Inspection & Reporting Procedures

Preparation

A steel bridge inspection begins before the bridge inspection crew arrives at the bridge. The crew should study the bridge's history and inspection file carefully while still in the office and develop a fracture critical inspection plan. It is important for each inspector to understand which members are fracture critical and where the fracture critical zones are located. This process will require drawings of the members themselves. Fatigue prone details will also be identified. A copy of the plans with fracture critical areas marked on them and/or the bridge specific fracture critical drawing will be taken along. Bridge specific fracture critical drawings have been prepared by Bridge Management and are available on-line. The Bridge Bureau also has shop and construction drawings showing the fracture critical members for almost all State owned bridges and quite a few county owned bridges and will supply them to the districts as necessary. Records of damage to the structure due to collision or corrosion and repairs are also important and will be noted on the fracture critical drawings. The fracture critical plans will also include date, time and weather as well as information on equipment and personnel required for the inspection. I most cases it is desirable to perform the fracture critical inspection in conjunction with the element level bi-annual inspection.

When more than one inspector is making the inspection, it is important to coordinate the activities. It is the crew leader's responsibility to insure that duplications and omissions in inspection of fracture critical members are minimized. Data collection should also be coordinated so that it can be easily put into a report.

Inspections

The inspection will begin with a general evaluation of the structure and fracture critical members. Look for things such as misalignment of spans either horizontally or vertically. Unusual movement or noise might also indicate serious problems. During the overall evaluation, inspectors should also look for distortions or damage created by traffic, flooding and other environmental influences.

After the overall evaluation, each member of each fracture critical detail will be checked closely. The inspector needs to focus on tension zones of fracture critical members and fracture critical connections. A fracture critical inspection will involve looking very closely at those members considered absolutely necessary for a bridge to function. By definition, it will include tension members or tension areas of members whose failure could result in the bridge's total or partial collapse.

The inspector's eye will be within arms-length or about twenty-four (24) inches from the surface. A steel bridge inspection will require hands-on access to all features requiring this type of inspection. It does not require that ultrasound or any other nondestructive testing (NDT) method be used at all locations. It does, however, require that the inspector be able to look closely at and feel all portions of the member in question. Where visual inspection is not possible or when a visual inspection leaves unanswered questions, NDT methods will be required. The member should be viewed from all sides and all angles. The inspector may need to use additional light and magnification to evaluate the member if necessary.

Inspection Reports

By definition, fracture critical bridges are prone to failure that may result in partial or total collapse of the bridge. It is important that the inspection of a fracture critical bridge be documented thoroughly and accurately. This effort will include a narrative description of all fracture critical members as shown in the fracture critical inspection plan with problem areas noted.

Chapter 7 – Section 3 – Inspection & Reporting Procedures

Photographs and sketches are required in the final report. Where there are many details and findings, tables and charts may be necessary. The data should be organized efficiently for ease in interpreting the report. The inspection report of the findings will include:

- ❖ The initial fracture critical plan with FCM members identified and defects noted as applicable.
- ❖ Additional information as necessary to adequately describe the type, size and location of any defect.
- ❖ If a defect is a crack, determine the length and depth (non-destructive testing may be required). The crack width will also be measured and recorded.
- ❖ Any other specifics will be noted, including information that may help determine the age and severity of the defect.
- ❖ Record the condition state percentages and update the elements condition states. Note the defect in the element's comments field. The flaw will influence the condition state of the element and influence the inspection cycle of the structure.
- ❖ The inspector will provide an initial determination of defect origin when notifying the Bridge Management Section of specific problems (out-of-plain-bending, poor weld, fatigue prone detail, corrosion and/or other defects).
- ❖ The report will also include conclusions, and a summary of the findings.

The importance of these inspections cannot be overstated. We are looking for flaws in members which are vital to the integrity of the bridge. Along with stating the existing condition, the inspection report will provide an ongoing record of the condition of the bridge and verification of the thoroughness of the inspection activities. Occasionally there will be serious flaws that cannot be seen by the inspector. If a fracture occurs, the report can be used to verify that a proper inspection was made.

What To Do If A Flaw Or Crack Is Found

It would be very difficult to defend a situation where a bridge failed after the defect had been identified. It is therefore very important that the inspector communicates any serious findings in accordance with the current Critical Findings Policy found in Chapter 2, Section 2 of this manual. Other problems such as a flaw in a web may be reported when the inspector returns to the office. It is better for the inspector to error on the side of safety. If there is a question about the significance of a finding, the Bridge Bureau should be contacted as soon as possible.

When problems are identified, it is a good idea to go back and look at similar details throughout the bridge. Often inspectors have found cracks at other locations that had already been inspected after finding the first. This demonstrates that it helps to know exactly where to look and what to look for on the other details. After a flaw or crack has been identified, it may be helpful to do additional evaluation with NDT such as dye penetrate, magnetic particles, ultrasonic or radiographic testing.

A steel bridge inspection will require arms-length or hands on inspection. The basic steel bridge inspection does not require that ultrasound or any other nondestructive testing (NDT) method be used at all locations. It does, however, require that the inspector be able to look closely each member, connections and other fatigue prone details that may be an issue. A magnifying glass and flashlight will be necessary in many instances and should be included any time an inspector goes out to perform this type of inspection.

Where visual inspection is not possible or when a visual inspection leaves unanswered questions, NDT methods will be required. The state has a contract to use ultrasonic inspection for pins in pin and hanger type bridges.

There are three main types of fracture critical bridges in Montana:

- Trusses
- Two-girder systems
- Bridges using transverse girders

Truss Bridges

Only the tension members of a truss are singled out for fracture critical inspection. As is the case with any axial tension member, the critical locations are the connections at either end. While the entire member must be looked at, the inspector should be especially careful at the ends.

There are two types of trusses used in this state: riveted and pinned.

Riveted Truss - A truss constructed of structural sections riveted together using plates or lacing to connect the sections. Gusset plates and rivets are usually used at all connections. Some connections may be bolted depending on the construction requirements.

Pinned Truss - Compression members are built-up members similar to those of a riveted truss. Tension members are eyebars or rods. Pins are used at the connections.

Riveted Trusses

As connection points for riveted trusses, gusset plates will be checked very closely as they are considered a fracture critical member. Rivet holes are locations of stress concentration in the gusset plate. The critical portions of the gusset plate are the exterior lines of rivets at right angles to the applied stress (perpendicular to the centroidal axis of the member). The reason for this is that cracks will propagate at right angles to the tensile stress. The entire set of gusset plates at each connection point will be evaluated. If geometry of the connection precludes a full visual inspection and the inspector can find no problems in these critical areas, he/she can be fairly confident of the rest of the connection.

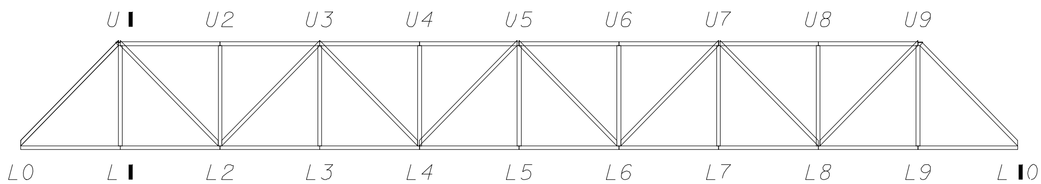
Pinned Trusses

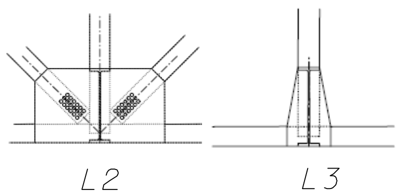
Again, as was the case for the riveted truss, the connections are crucial. In these trusses, the members are looped at the ends and held together with pins - see Figure 12.

The method used to form the ends of eyebars on these old bridges is called forge welding. It involved heating the metal to a plastic state and hammering it into shape. On the lighter bridges, one piece of steel (generally a circular rod) was used. The bar was heated, bent around a pin, and formed back on its self. On larger bridges, the ends of the eyebars (generally rectangular bars) were cast in a mold separately and then forge welded to the bar itself. A thorough visual inspection will be considered adequate at these locations.

NDT testing will very likely detect some sort of flaw at all connections using forge welding. Therefore, unless the flaw can be seen, it will not be considered critical.

Warren Truss





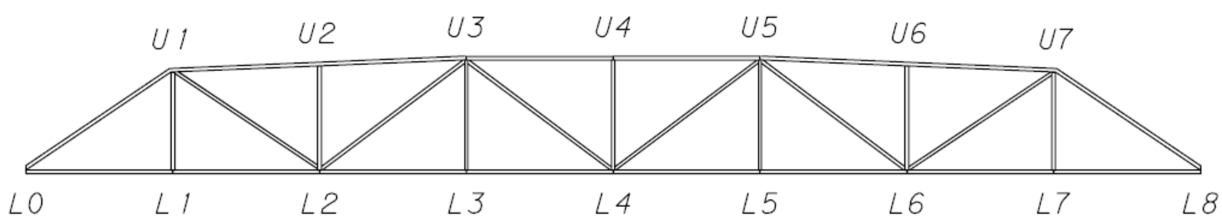
CONNECTION DETAIL

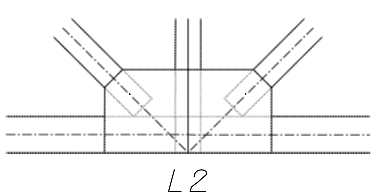
The diagonals in a warren truss will carry both compressive and tensile forces. Verticals that frame into the bottom chord by themselves (no diagonals frame into the bottom gusset plates) are tension members. The verticals which frame into the top chord by themselves serve only as bracing for the top chord and, therefore, may be considered compressive members only.

The exterior lines of rivets transverse to the applied stress are critical--in this case, the line of rivets at the front and back of the connection. If accessible, the entire connection should be looked at closely.

Diagonals U1-L2, U3-L4, L6-U7, and L8-U9 are the tension members for this particular truss. These members and their connections along with the bottom chord and the tension verticals will require the fracture critical inspection.

Camelback (Warren) Truss



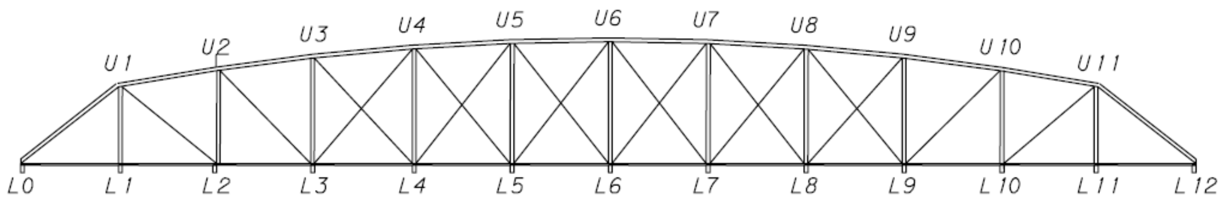


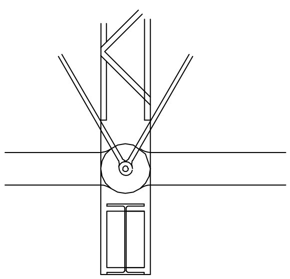
CONNECTION DETAIL

Sometimes referred to as a camelback because of its top chord having exactly five slopes, the truss pictured is actually a Warren.

The inspection requirements for the Warren truss will apply here, too. The tension diagonals are U1-L2, U3-L4, L4-U5, and L6-U7. These, the bottom chord, and the gusset connections and the tension verticals will require the fracture critical inspection.

Parker Truss



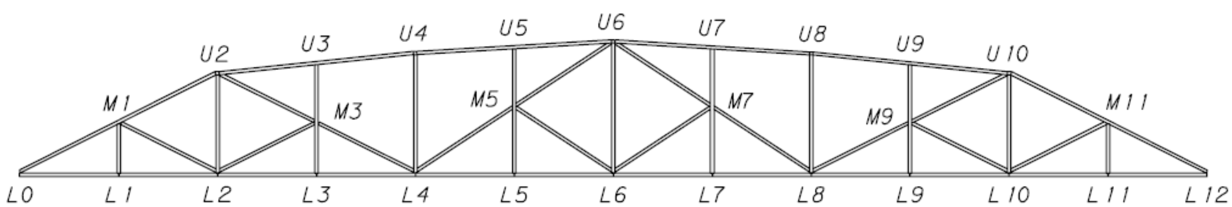


CONNECTION DETAIL

The verticals in this truss are all compression members. The diagonals are all tension members. This is one case in which the arch and suspender analogy will not apply because here we are dealing with counters. The diagonals in the middle six panels are all counters and, as such, are unable to accept any significant compressive load. The shear loads in each of these six panels are carried by one of the counters as a tensile load. When a truck crosses the bridge, one counter will carry the entire load until it begins to go into compression, at which point it becomes ineffective and the other counter takes over.

The connections in this truss are pinned. The bars, which are used as tension members have been forge welded. The lighter counters consist of a rod which has been bent around a pin and bent back on itself. The larger counters and the lower chord are bars whose ends have been cast separately. These have then been forge welded onto the bar itself. All of these connections must be visually inspected very thoroughly.

Pennsylvania Truss (Subdivided Parker)



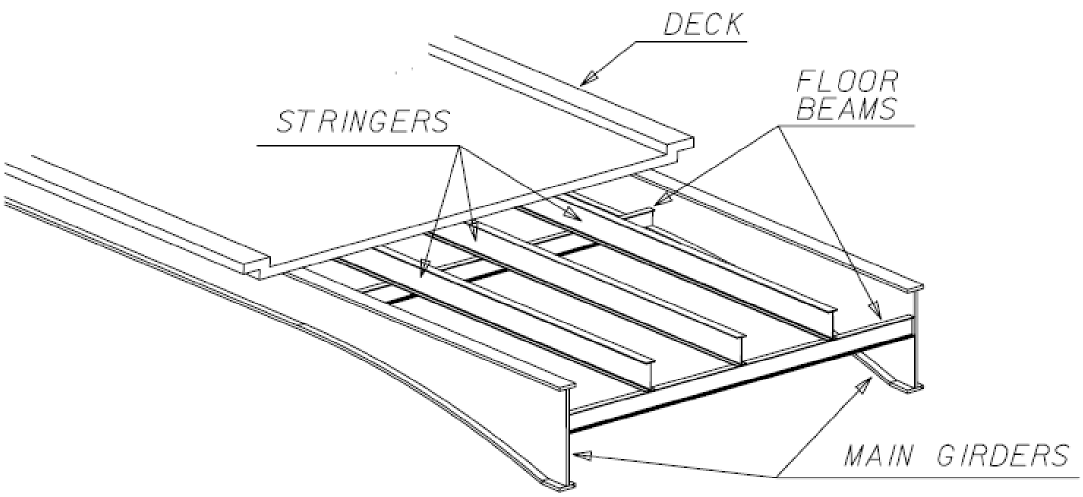
Sometimes for large span bridges, a truss will be subdivided to reduce member sizes and to shorten the span length between floor beams. The newly added members are referred to as sub-diagonals and sub-verticals. They may also be referred to as sub-struts (if they are compression members) or sub-ties (if they are tension members).

The main interior diagonals for the truss pictures will behave as given in the rules of thumb. That is, U2-L4 and L8-U10 are tension members. L4-U6 and U6-L8 are compression members. After determining the diagonal stresses, the vertical members will obey the tension and compression rules. The sub-verticals M1-L1, M3-L3, M5-L5, etc., will be tension members because they frame into the lower chord without the presence of diagonals. The sub-verticals U3-M3, U5-M5, U7-M7, and U9-M9 are braces for the top chord and are considered compression members. The main verticals U2-L2, U4-L4, U6-L6, etc., are compression members.

The only members of this truss where the rules of thumb do not apply are the sub-diagonals. They are all compression members no matter what direction they are inclined. Their only function is to prevent the main diagonals from being bent laterally due to the tensile loads being applied by the sub-verticals.

This truss may look complicated, but it really isn't. The members requiring a fracture critical inspection are the lower sub-verticals; the main diagonals inclined downward, U2-L4 and L8-U10, and the bottom chord.

Two-Girder Systems



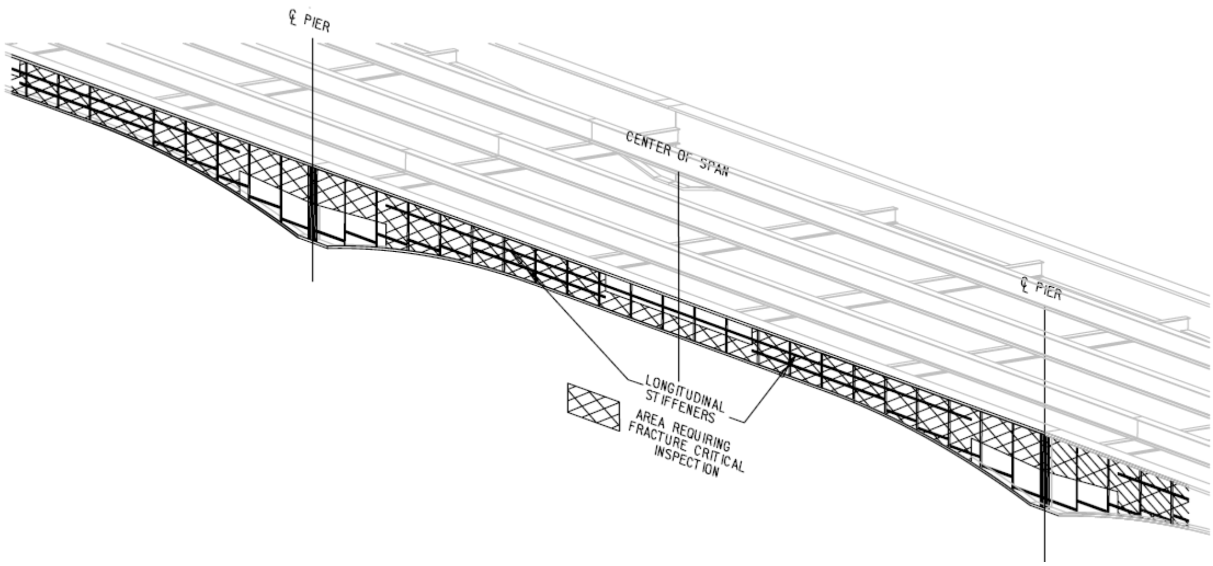
CROSS SECTION OF A TWO-GRIDER SYSTEM

The inspection of two-girder systems will generally follow the guidelines set forth in the article on beams. The inspector will need to determine the tension and stress reversal zones before beginning the inspection. In tension zones, only that half of the girder in tension needs the full fracture critical inspection. In areas of stress reversal, the full depth of the girder must be given this type of inspection.

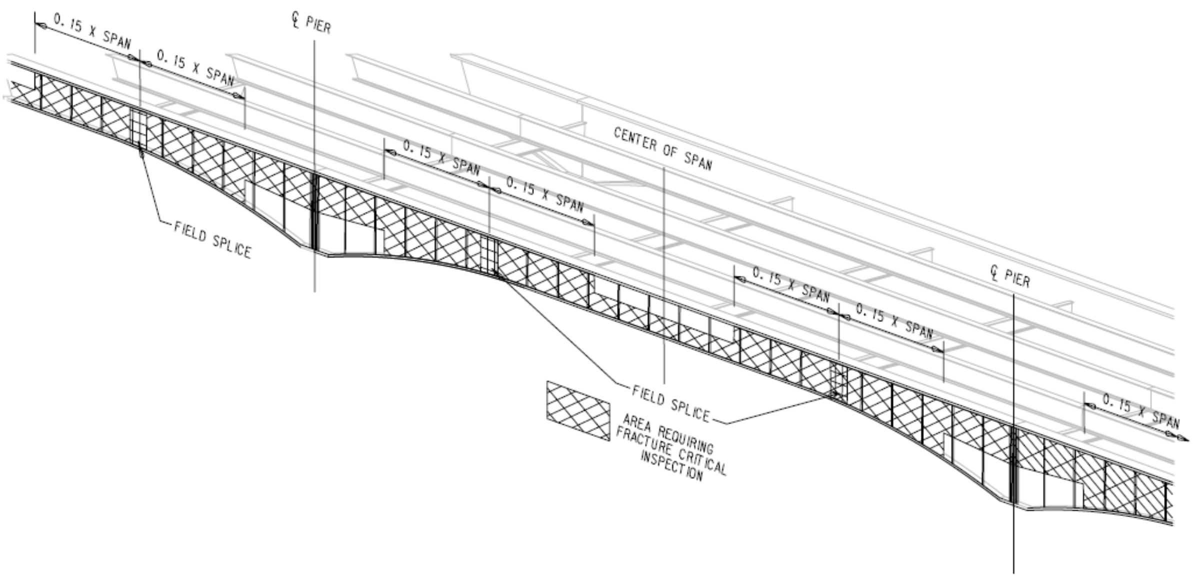
Locating Zones of Stress Reversal in Continuous Girders

In those cases where longitudinal stiffeners have been used, their placement near both the top and bottom flanges is an area of stress reversal as shown.

Without the presence of longitudinal stiffeners, inflection points are located between 20% and 30% of the span length from either side of each intermediate bent. In most cases, a field splice has been placed at these locations. In these instances, the zones of stress reversal will be taken as the area equal to 0.15 times the span length on both sides of these splices.



MAIN GRIDER INSPECTION WITH LONGITUDINAL STIFFENERS

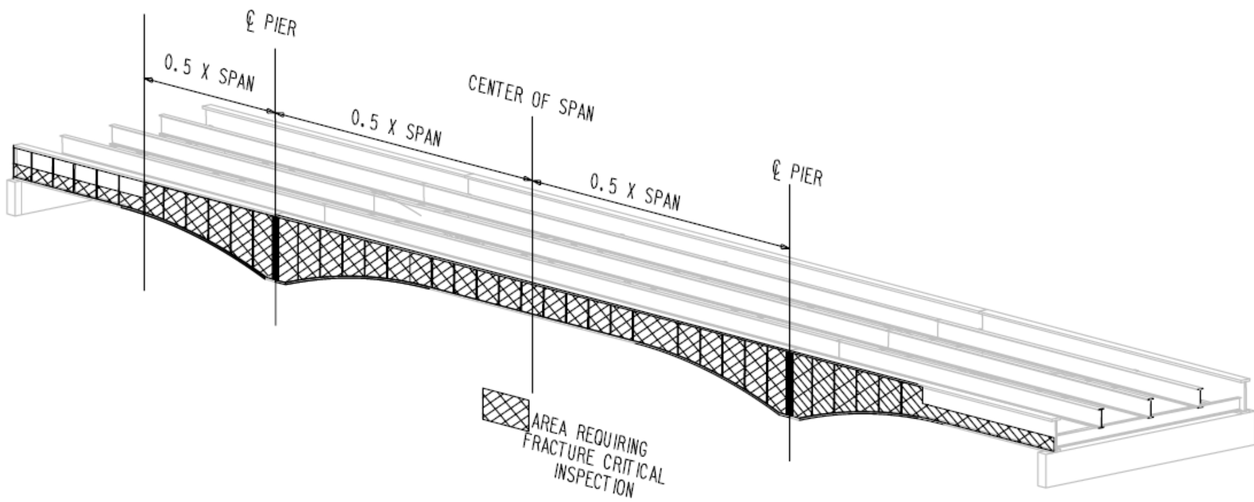


MAIN GRIDER INSPECTION WITH FIELD SPLICES

If field splices or longitudinal stiffeners have not been used, the inspector shall perform a full-depth inspection at each intermediate to a point 0.50 times the span length from the bent. This shall be done on both sides of the bent.

Gusset Plates

Gusset plates are used in many instances to attach lateral bracing to the web of the girder. Unlike the case with riveted trusses, the plates themselves are not fracture critical. However, the lateral bracing will vibrate as a vehicle crosses the bridge. This vibration can cause cracking in the girder's web at the gusset plate attachment. If this happens to be in a tension zone, the tensile stresses will cause the crack to propagate.



MAIN GRIDER INSPECTION WITH OUT FIELD SPLICES OR LONGITUDINAL STIFFERNERS

Transverse Stiffeners

In the case of a welded plate girder, any weld perpendicular to the direction of applied stress is critical and must be inspected thoroughly. The reason is that any flaw in this kind of weld is a point of stress concentration transverse to the direction of the principal stress.

The weld attaching a transverse stiffener, by definition, qualifies under this category as a critical detail. However, the weld is only critical when in a tension or stress reversal zone.

In riveted girders, the same rules apply as those used for gusset plates in riveted trusses. Rivet holes are points of stress concentration. The line of rivets is at a right angle to the direction of principal stress. So, again, this is a critical detail in a tension zone.

Longitudinal Stiffener

Longitudinal stiffeners are critical only when used on a welded girder. Their function is to reinforce the web in the area of the compression flange and, as such, they are not significant unless used in a zone of stress reversal as mentioned above.

Because the welds connecting longitudinal stiffeners are parallel to the direction of principal stress, they are not in and of themselves critical. However, discontinuities or flaws in the weld may cause stress concentrations that can be perpendicular to the applied stress. Such a flaw may propagate under cyclic loading.

Floor Beam to Girder Connection Near an Interior Support

Whether inspecting a welded plate girder or riveted girder, these locations need special attention. In these regions, the movement of both flanges, the top flange by the slab and the bottom by the bearing of the main girder, is restricted. As a truck deflects the floor beam, its bottom flange is pushed toward the girder while the top flange is pulled away. This prying action causes out-of-plane bending in the girder web. Because the flanges of the girder are restrained, the bending in the web results in stresses which will exceed the yield point.

Repeated loading can, in time, cause cracking in the web of the girder. Because this occurs near support, the tension zone is the upper half of the girder. It is this portion of the web that must be checked out thoroughly.

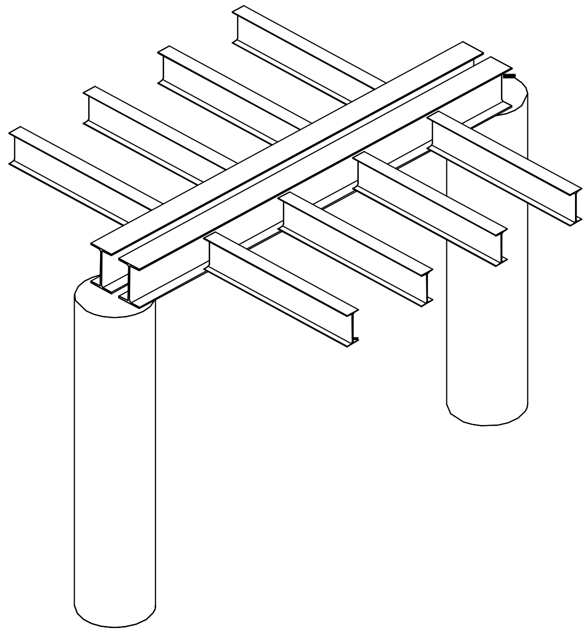
Welded Cover Plates

An abrupt change in the flange cross section is a stress riser which will cause a stress concentration in the fillet weld at the end of a cover plate. Whether or not the weld is brought around the end of a cover plate is of little consequence. The end of a cover plate has a low fatigue strength and is susceptible to cracking with or without a transverse end weld. The problem occurs mainly when the end of the cover plate is left in a region of positive moment (tension in the bottom flange).

Transverse Girder or Cross Beam

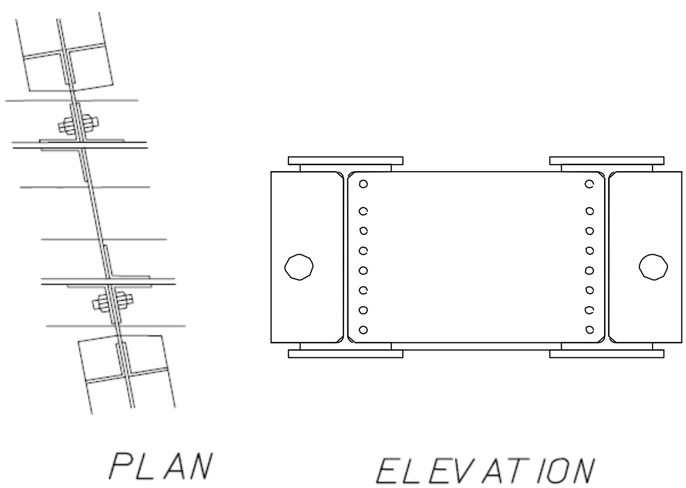
Transverse girders are used at overpasses where a long span length is needed, but clearance requirements will not allow the use of a deep section for the longitudinal beams. When two sections are used, it gives some measure of redundancy. However, should one section fail, the other cannot be expected to carry both spans. Therefore, whether a single member is used or not, the transverse girder must be considered fracture critical.

A good rule of thumb to tell the difference between a transverse girder and a steel cap is that the transverse girder transfers forces to the substructure from the bearings on the bottom of the girder. A steel cap has the bearings that transfer longitudinal girder loads on the top of the transverse member and is therefore considered a substructure member.



TRANSVERSE GIRDER

As a simply supported beam, the bottom half of the entire girder should be inspected closely. Special attention should be given to the stringer connections. The prying action mentioned in the discussion on the floor beam connection in a two-girder system can occur here too if a connection plate is used with rivets or bolts. If the connection is pinned, as shown, this pin as shown, will eliminate this problem. Also, the ends of welded cover plates are critical details and should be treated as such while inspecting transverse girders.



BEAM CONNECTION DETAIL

Pin and Hanger Assemblies

Another detail that has gained widespread notoriety with regard to this type of inspection is the pin and hanger assembly. Pin and hangars are not fracture critical unless they are used in conjunction with an already fracture critical member (e.g., main girder in a two-girder system or a truss). However, they are often used in multi-beam bridges. And there have been instances where the failure of one assembly has led to a domino-effect failure of successive assemblies. For this reason, they have been given a high priority for a fracture critical type inspection whether used in a fracture critical bridge or not. All bridges using pin and hangers will be included in this program.

A pin and hanger assembly is used to suspend a span from a cantilevered arm. The main reason for using this type of design is that it allows for economy in selecting structural members. It also lets us move the expansion joint out away from the bent. This keeps the joint from leaking on an abutment or pier. The problem is that, if the joint was going to leak on the abutment or pier, it would now leak on a pin and hanger assembly.

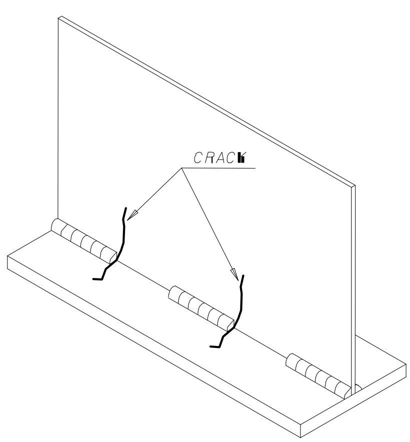
The thermal expansion and contraction that takes place in this type of bridge is accounted for in these assemblies. The hanger rotating around the pins allows for this movement. Water, and especially water in the presence of salt, will set up a corrosive action between the pin and hangers. This can build up until the hangers' ability to rotate becomes completely frozen. The inability for these details to move as the bridge expands or contracts will cause stresses in both the pin and hangers. Stresses could precipitate cracking and eventual failure.

Corrosion is important, but the bearing of stresses that these details experience can also cause problems that, in most instances, will be hidden from view. For this reason, the pin and hanger assembly should always be inspected using ultrasound. Section 6.5 gives the procedures for performing this type of inspection. The Department has purchased special 0.50-inch diameter, 3.5 MHz transducers for use with 10-degree wedges to provide greater access to the full length of the pin.

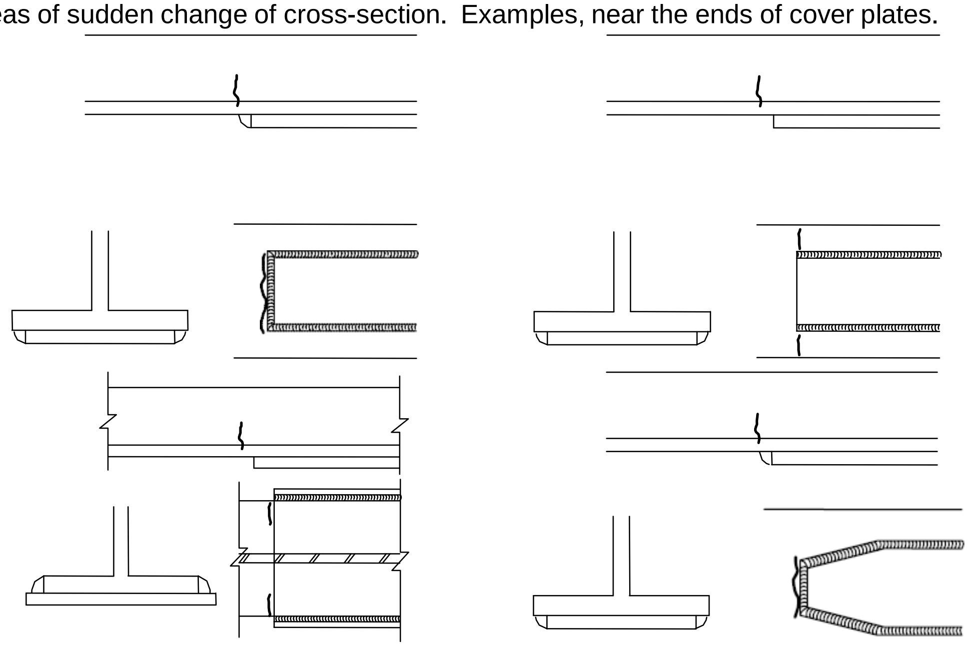
During the inspection of the structure, the inspector should be concerned with details and problem areas that influence the health and strength of the bridge. Some of these details and area are summarized below.

Examples of Details That Should be Checked Closely Are:

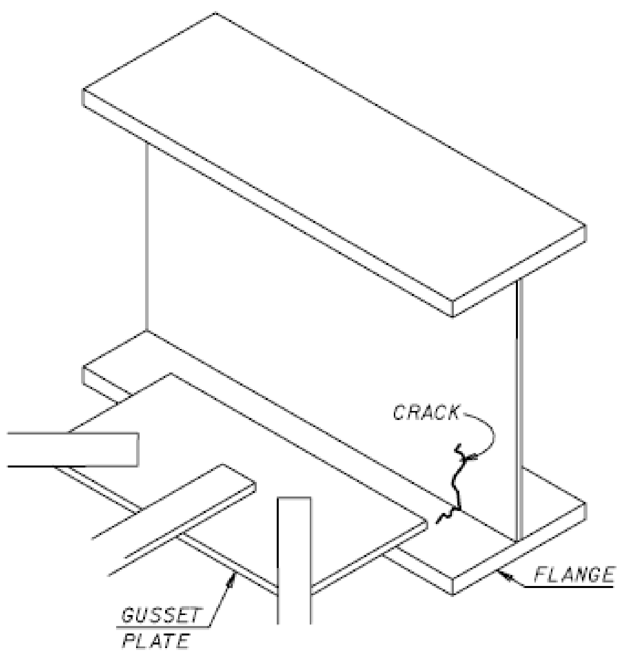
1. Intermittent welds between the web and tension flange.



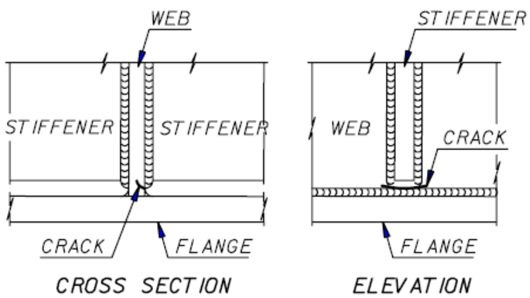
2. Areas of sudden change of cross-section. Examples, near the ends of cover plates.



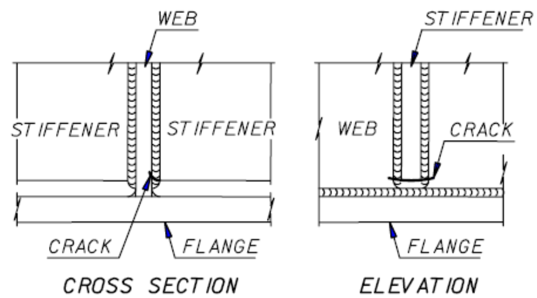
3. Location of stress risers such as nicks, scars, flaws, and holes that have plug welds, irregular weld profile, and areas where the base metal has been undercut during welding.
4. Locations where stiff bracing members of horizontal connection plates are attached to thin webs and girder flanges.



5. Gusset plates, improperly coped members re-entering corners, and the gap between web stiffeners and flanges.

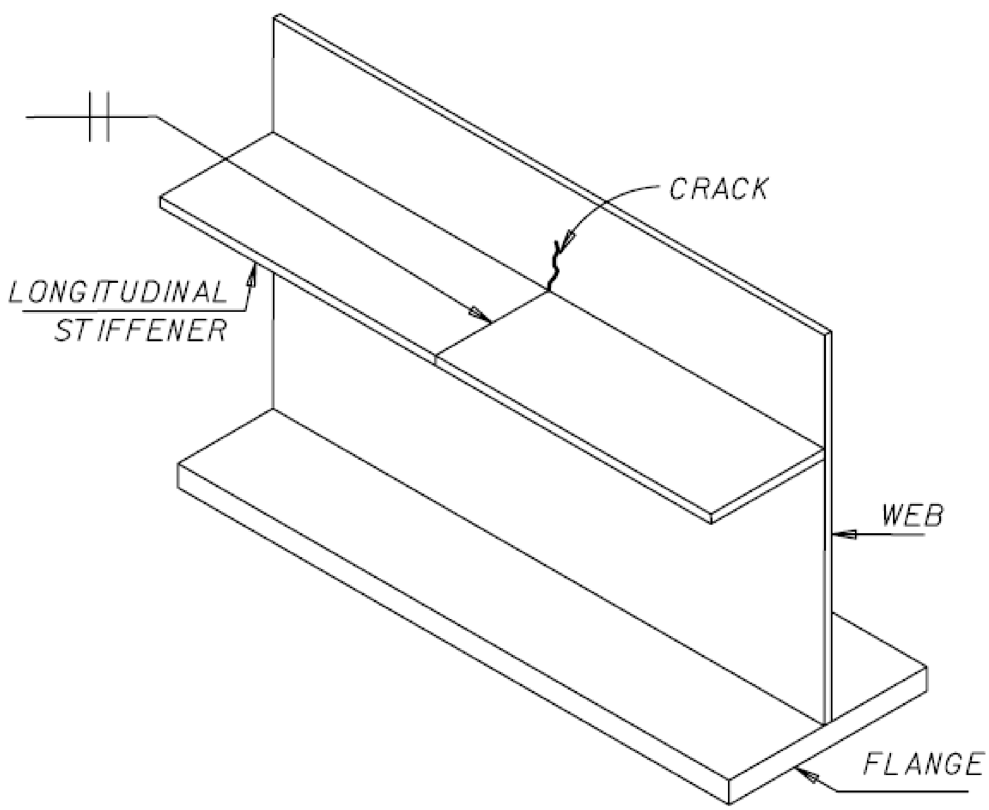


Schematic of crack at end of stiffener welds.

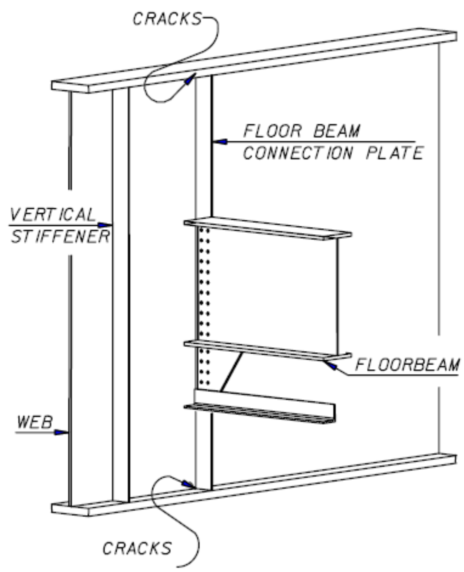


Schematic of crack at end of stiffener into weld (and web).

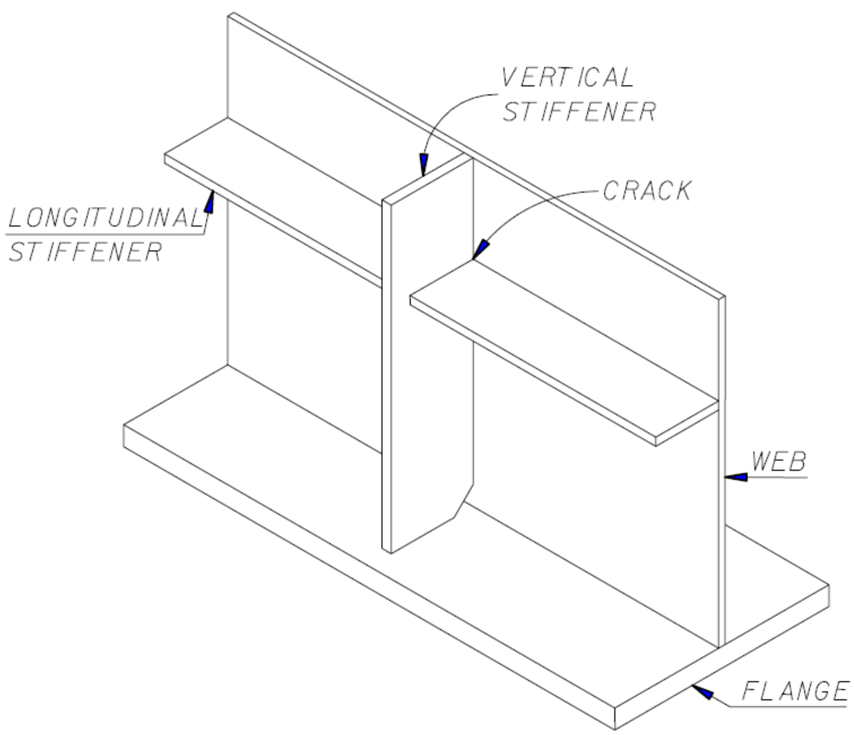
6. Stiffeners that have been connected together with butt welds.



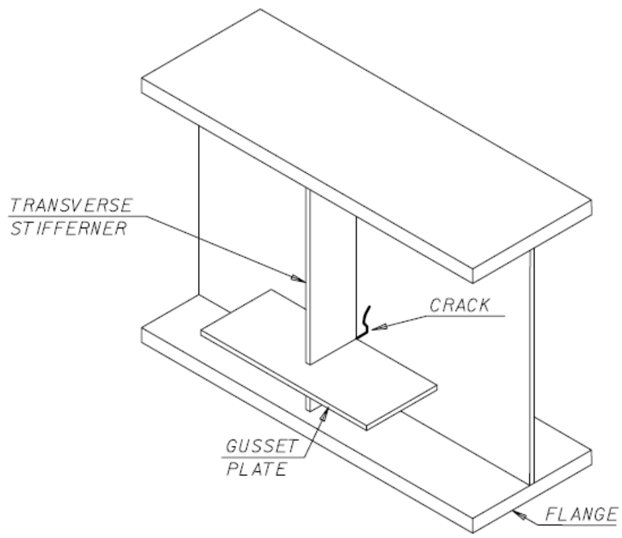
7. The web adjacent to a floor beam connection plate.



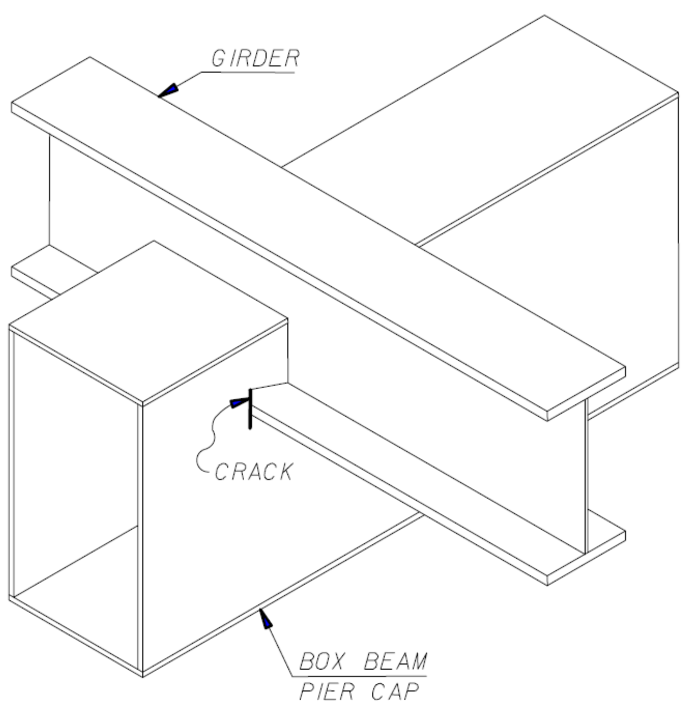
8. Longitudinal and vertical stiffener intersections.



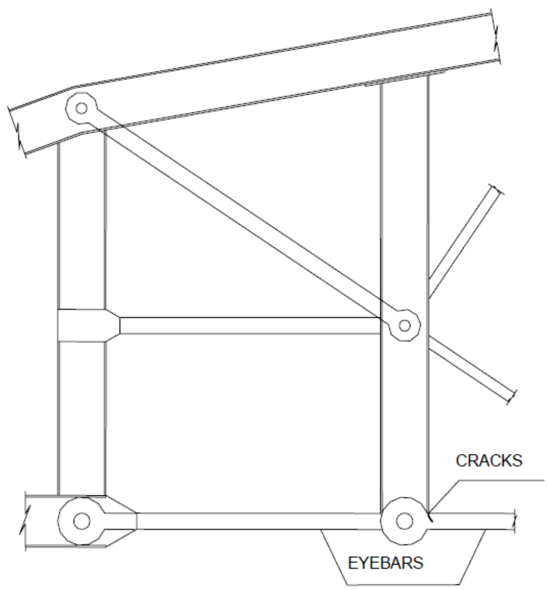
9. Location of welds at gusset plate-transverse stiffener-web or flange intersections.



10. Flanges that pass through a web, such as a girder flange passing through a box girder pier cap.



11. Eyebars.



Areas Where Corrosion Is Likely to Give Problems Are:

1. Under deck joints.
2. In the areas around scuppers and drainpipes.
3. On flat surfaces where debris accumulates.
4. At overlapping steel plates.
5. At corners of steel angles and channels.

Other Special Details That Should be Given Attention During FCM Inspection Are:

1. Tack welds on bolted or riveted connections.
2. Unfilled holes or holes filled with weld metal.
3. Field welds in tension zones.
4. Suspicious attachments made in tension zones, such as utility attachments.
5. Fabricator stamps on girders.

In June 1983, a failed hanger pin initiated the collapse of one span on the Mianus River Bridge on the Connecticut Turnpike. The incident resulted in the deaths of three motorists. Following the collapse, there was an immediate increase in interest in the inspection and condition assessment of bridge hanger pins.

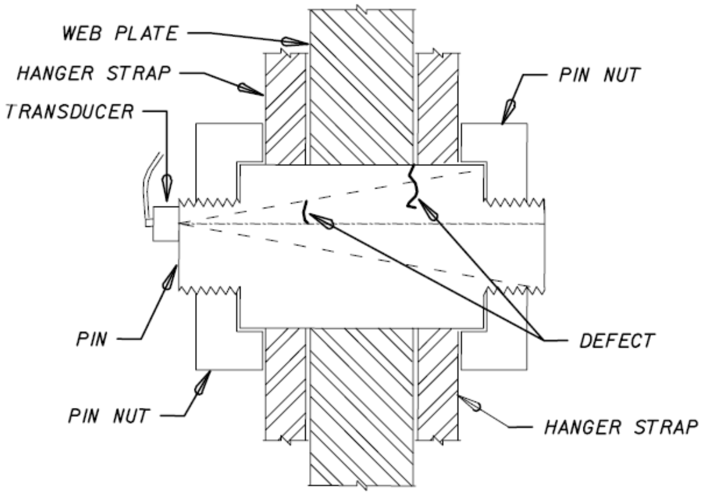


Figure 1: Pin and Hanger Assembly

Hanger pins are structural elements connecting the suspended span of a bridge to the fixed cantilever arm of the same bridge, a diagram of a pin and hanger assembly is shown in *Figure 1: Pin and Hanger Assembly*. The primary function of a pin and hanger connection is to allow for longitudinal thermal expansion and contraction in the bridge superstructure. These connections are designed to support the transfer of shear forces from the suspended span into the anchor span. As long as the connection is operating properly, neither shear forces from the anchor span nor moments from either span can be transmitted across the connection. In general, loads from the suspended span are transmitted into the anchor span as follows: The loads travel from the suspended girder web reinforcement plate to the lower hanger pin and into the hanger plates. From the hanger plates, the load is then transferred into the upper hanger pin and finally into the anchor girder web reinforcement plate. This load path creates two shear planes in each pin – one at each of the intersections of the web reinforcement plate and hanger plate. If a pin were to fail along both shear planes, the portion of the bridge section suspended by that pin would be unsupported.

Pin and hanger connections are typically located directly beneath bridge expansion joints. Consequently, they are frequently exposed to water, de-icer and debris that fall through the joint. The presence of moisture in the confined interfaces between the hanger plates, web and around the pins can lead to pack rust and corrosion of both of these elements and of the pin, at the critical shear planes. This corrosion can have two detrimental effects on the pin. First, the cross-section of the pin can decrease due to corrosive section loss. This corrosion produces pitting that may act as a crack-initiating site. Second, corrosion can effectively lock the pin within the connection so that no rotation about the pin occurs. This can lead to large torsional stresses, within a reduced section in the pin. The torsional stresses, combined with the shear stresses, provide a likely location for the development and propagation of cracks and the eventual failure of the connection. Therefore, the most likely location for a crack to be initiated is at the hanger to the web interface. This area of interest is closely examined using the Ultrasonic method.

Visual inspection is used only as a method to gather obvious information. Pin and hanger assembly, due to access limitations, visual inspections will not detect a defect that is not open to the surface or is covered with paint, rust or organics. The pins primary area of interest is the body of the pin, and is inaccessible due to the hanger assembly configuration.

Ultrasonic inspection is one of the most reliable methods used to inspect pins, and has become the primary method of performing a detailed inspection of an in service hanger pin. Ultrasonic Testing offers a reliable method by which pins may be inspected in the field without the removal of the pin being required. The portability of the equipment, reliability, and cost to complete an inspection makes Ultrasonic Testing the logical method for inspection.

Ultrasonic standards are fabricated using precise tolerances with induced defects of a known dimension. Calibrations are performed to ascertain reliability and sensitivity of the system used to inspect the pin. MDT has six standards produced with a reflector that is .006" in depth. This is a round pin 8" long and 3".

Technicians are trained in accordance with the American Society for Nondestructive Testing (ASNT), SNT TC-1A. Personnel Qualifications and Certification in Nondestructive testing. MDT Personnel are qualified to the level II requirements of this recommended practice. Pins are inspected using this MDT Task Specific calibration and practice.

Inspection

Visual Inspection Procedures

Visually inspect Pin & Hanger assembly for the following:

- Loose or missing nuts
- Pack-rust behind the hanger
- Proper movement of the hanger
- Deformations of the hanger assembly
- Cracks
- Nick's or gouges

Ultrasonic Inspection Procedures

Pre Cleaning

All surfaces to which a search unit is applied shall be free of weld spatter, dirt, grease, oil (other than used as couplant), paint and loose scale and shall have a contour permitting intimate coupling. Power wire brushing is the approved method for removal of material or a condition unsuitable for ultrasonic inspection. A side grinder with a sanding pad may be used for removal of weld spatter or to smooth the face of the pin & hanger for inspection. Care should be taken to remove a minimum of base metal or otherwise cause an irregular contour of the contact surface.

Hanger assembly should be cleaned to facilitate Ultrasonic (Shear Wave) inspection around the hole in the hanger assembly. Cleaning is based on the ability to contact the back wall of the hanger with a 45° angle search unit. This angular relation is based on three times the thickness of the hanger. So if the hanger is 1" thick then the minimum cleaning distance around the nut is 3". Clean from the outer edge of the nut for a distance three times the thickness of the hanger. Pin Face should be cleaned

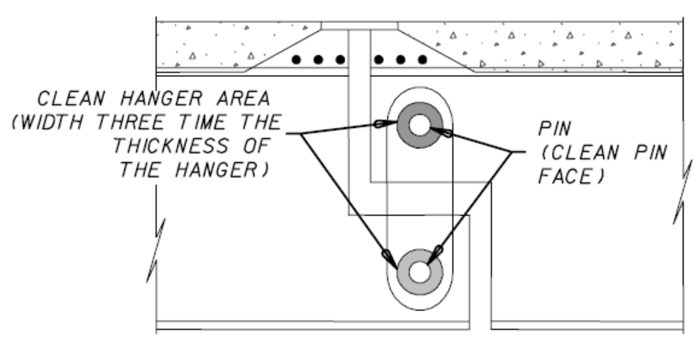


Figure 2: Pin and Hanger Assembly

to facilitate Ultrasonic inspection (Longitudinal Wave). Clean pin face to remove notches, gouges and hammer marks that would interfere with proper inspection. Care should be taken to remove only a minimum of material when preparing the face of the pin. Pin need not have a mirror finish when cleaned. Clean both ends of the pin.

Proper safety protection should be worn while grinding and wire brushing (i.e., safety glasses or goggles, work gloves, earplugs, hardhat, safety harness, long sleeve shirt or jacket and proper foot protection). Care should be taken when moving on or around inspected areas. Remaining couplant is slick and grip or footing can be affected.

Ultrasonic Equipment

Ultrasonic equipment shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedures 7.15. With the following exception [listed under Testing Procedure (Pin)] the transducer used will be a 3.5 MHz round by ½ “ and be fitted with a 10° shoe. Different shoes may be used upon approval. Phased Array equipment may substituted on a case-by-case basis as approved.

Reference Standards

Reference Standards shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedures 7.16. With the following exception [listed under Testing Procedure (Pin)], pin inspection sensitivity will be performed using an approved Standard fabricated by P.H. Tool of the following serial number’s 3909, 3910, 3911, 3912, 3913, 3914.

Equipment Qualification

Equipment Qualification Ultrasonic equipment shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedures 7.17.

Calibration for testing

Calibration for Testing shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedures 7.18.

Testing procedures (Hanger)

Testing procedures shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedures 7.19. With the following exception, this is a base metal inspection (any indication determined to be a crack is rejectable). Record any relevant indication that is above 20% of full screen height.

Testing Procedures (Pin)

Testing procedures shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedures 7.19. Pin testing will use the following exceptions use paragraphs: 7.19.3, 7.19.4 and an approved calibration block.

Preparation and disposition of reports (Pins) & (Hangers)

A report which clearly identifies the work and the area of inspection, shall be completed by the ultrasonic technician at the time of inspection. The report form for pins or hangers that are acceptable need only contain sufficient information to identify the pin or hanger, the Inspector’s signature and the acceptability of the pin or hanger. Forms will be designated in the calibration procedures. All calibration procedures must be submitted with the inspection reports.

Calibration of the Ultrasonic Unit with IIW or other approved Blocks

Calibrations shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedure

7.21.1 Longitudinal mode.

Shear Wave Mode (Transverse) (Hanger)

Calibrations shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedure 7.21.2.1

Equipment Qualification Procedures

Qualification procedures shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedure 7.22.

Decibel dB Accuracy Procedure

Procedure shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedure 7.22.2.

Shear Wave Decibel-calculating Equation

Calibrations shall meet the requirements of MDT Bridge Bureau Ultrasonic Calibration procedure 6.22.2.1

USK 7S Initial Settings

Coarse dB 20
Fine dB 20
Micro dB 0
Range Inch 10
Fine Range 500
Delay 500
Focus to Individual Preference
Reject Off
DTM Mode (INT) on back of DTM
Zero Range (Coarse) on back of DTM (Fine) for Thickness 4” or below
Zero 500 Face of DTM
MAT 500 Face of DTM

Longitudinal Calibration

a) Connect RG 58 BNC to BNC cable to Input port on scope, connect 2.25 MHz x .500” round transducer.
b) Turn Scope on to setting number 1.
c) Place Transducer in position “G” as shown in *Figure 3: Longitudinal Calibration and Transducer Position*.

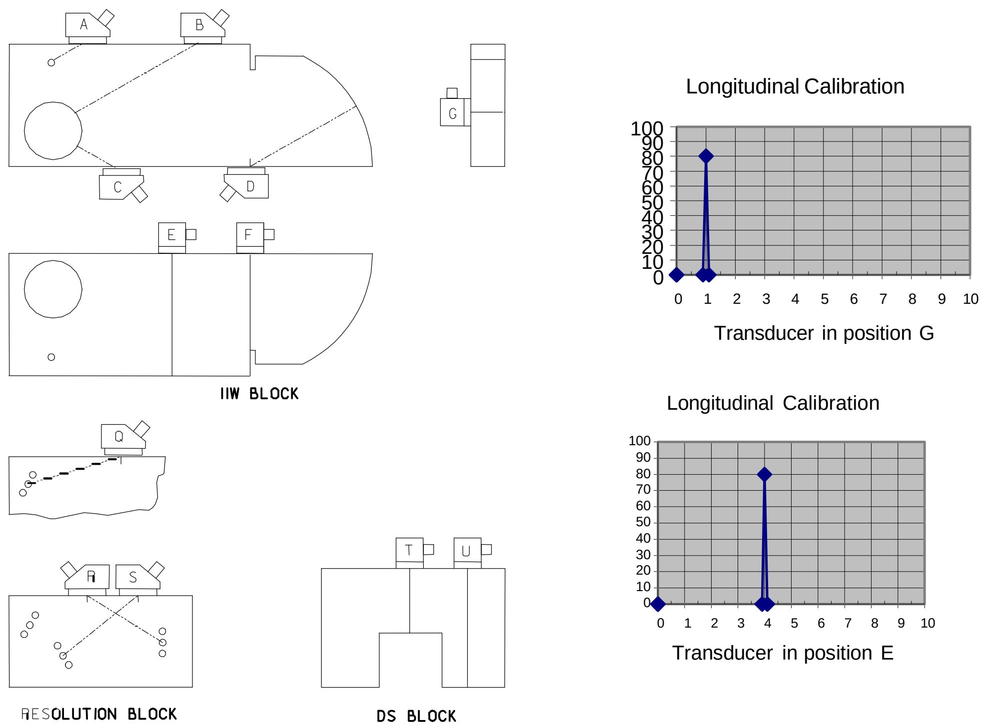


Figure 3: Longitudinal Calibration and Transducer Position

d) Adjust delay knob until the Initial Pulse is aligned with the trailing edge on the zero (0) marker on the CRT screen.
e) Adjust the fine knob to spread out the pulses.
f) Adjust delay until a back reflection is noted at 1”, 2” and 3”
g) Adjust fine until the back reflections leading edge is located on 1”, 2”, and 3”
h) Repeat steps (f) & (g) until no adjustment is required to maintain equal spacing. i) Adjust the Gain control until the 1” back reflection is reading 100 %FSH
j) Couple the transducer in position “E” as shown in *Figure 3: Longitudinal Calibration and Transducer Position*. Verify reading on the CRT at 4”. Should the indication be located other than at 4”, repeat adjustment of the delay and fine until no adjustment is required to maintain equal spacing.
k) Couple transducer to position three (3) on IIW Calibration block initial setup.
l) Adjust Gain control until a signal at 8” is produced at 80% FSH, couple transducer in position “E” and adjust delay and fine until the leading edge indications are located at 4” & 8”. Repeat until no further adjustment is required.
m) Lock and record all settings on.

When the thickness Calibration is complete, data may be recorded for pins' and hangers 1" or greater in thickness. Record the CRT data on UTT-4P for Pin data and UTT-4H for hanger data.

Hangers below 1" thickness, calibrate as described in longitudinal calibration. Calibrate using an AWS step wedge with values between 0.250" and 1.000" with a screen size of 1.000".

DTM Calibration for Longitudinal Wave Inspection of the Hanger

a) Place transducer in position three (3) on the IIW Type II calibration Block and maximize signal (*Figure 4: 10° Calibration and Transducer Position*). This should produce a signal at 8" on the CRT. Adjust the MAT until a value on the DTM reads 8.000" ±0.002" is achieved.

b) Place transducer in position two (2) and maximize the signal. This should produce a signal at 4" on the CRT. Adjust the Zero until 4.000" ±0.002 is achieved.

c) Repeat steps (a) and (b) until the transducer can be placed in position three (3) and two (2) and achieve the ±0.002 tolerance without adjusting the MAT or the Zero. d) Lock these settings and verify calibration.

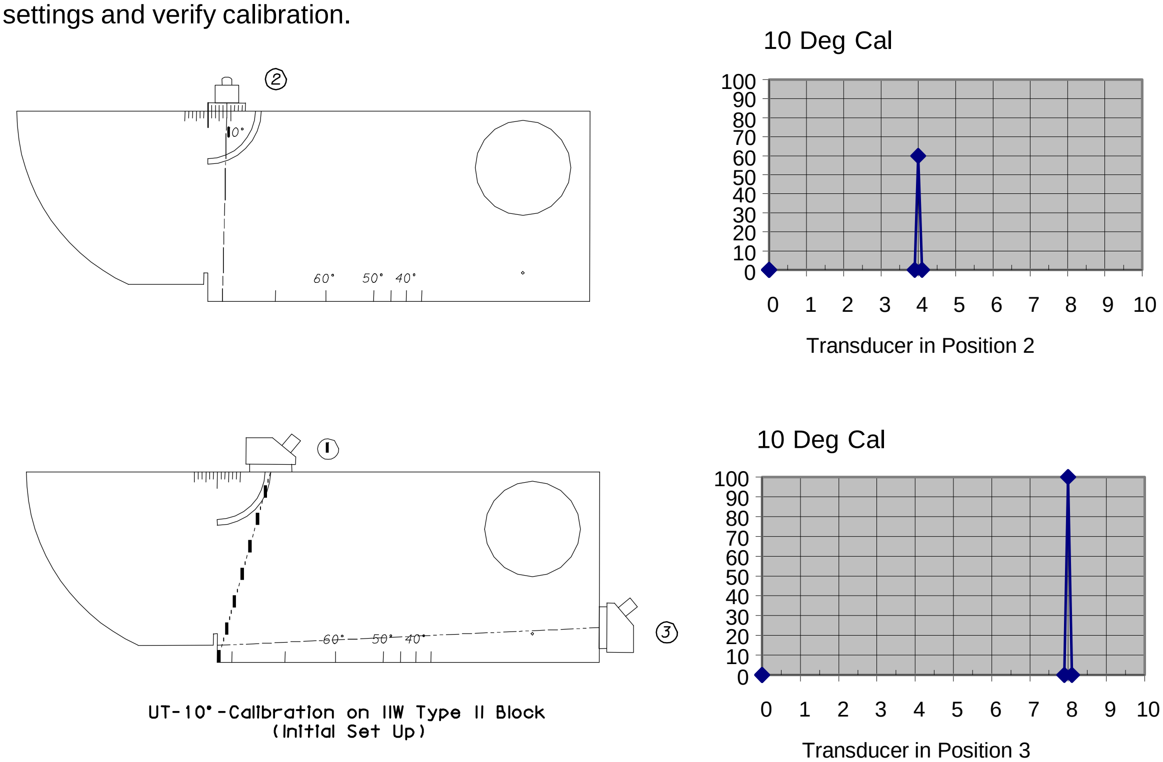


Figure 4: 10° Calibration and Transducer Position

Shear Wave Calibration for Hanger Assembly

a) Set the initial settings as detailed in *USK 7S Initial Settings*.

b) Connect RG 58 cable to AWS 2.25 MHz X 0.75 X 0.75 couple 45° angle wedge or (Shoe) SF-AWS to the transducer using couplant or light oil.

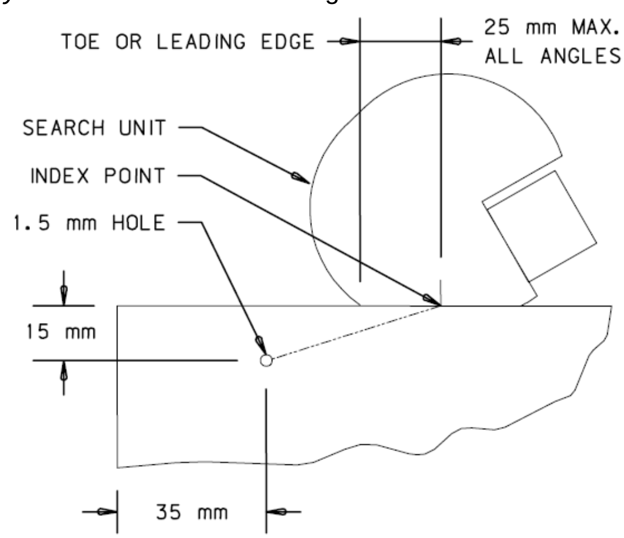
c) Place transducer on IIW Block position “D” (*Figure 3: Longitudinal Calibration and Transducer Position*).
d) Adjust Delay until the Initial Pulse trailing edge is located on the “0” scale on the CRT.
e) Rotate transducer 180° with the exit point of the transducer on “0” on the IIW Type II Calibration block. Maximize the signal produced by the 1” radius in the block (*Figure 3: Calibration and Transducer Position*).
f) Adjust the Delay until the signals trailing edge is located on the 1” on the CRT.
g) Place transducer on the IIW block position “D”. Maximize signal produced. Adjust the Delay until the trailing edge of the signal is located at 4” on the CRT.
h) Repeat step (e) and adjust Range fine until the signal trailing edge is located on the 1” on the CRT. i) Repeat steps (g) and (e) until the transducer can be placed to produce a signal at 1” and 4” without adjusting the Delay or the Range Fine.
j) Lock controls on the Delay and Fine Gain and verify signal.
k) Adjust Gate Start to ½” and Gate Stop to 10” on the CRT.

DTM Calibration for Shear Wave Inspection of Hanger

a) Place Transducer on IIW Type II calibration block in position “D” (*Figure 3: Longitudinal Calibration and Transducer Position*). A signal should be produced at 4” on the CRT. Maximize signal. Adjust MAT until a value of 4.000” ±0.002” is achieved on the DTM.
b) Rotate the transducer 180° to maximize a signal from the 1” radius in the block. A signal should be produced on the CRT at 1”. Maximize the signal. Adjust the Zero until a value of 1.000” ±0.002” is achieved on the DTM.
c) Repeat steps (a) and (b) until the values can be achieved by only rotating the transducer and no further adjustment of the MAT and Zero is required to produce the required values. Lock these settings.

Sensitivity Setting for Shear Wave inspection of Hanger

Place Transducer on IIW Type II calibration block in position “A” as shown in *Figure 5: Hanger Sensitivity Presentation*. Maximize signal of 0.060 hole to 80% of FSH using the dB gain control.



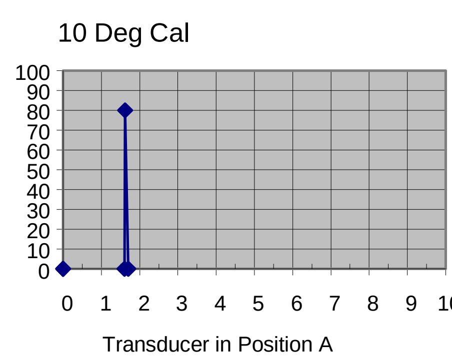


Figure 4: Hanger Sensitivity Presentation

Scanning Procedure for Hanger (Shear)

Scan the hanger with the sound path of the transducer parallel to the hole. Any relevant signal that is above 20% FSH shall be examined to determine the length and depth of the indication. Notify bridge bureau immediately if this condition exists. While scanning no indication should be seen on the CRT.

Calibration for inspection of Pin 10°L

a) Set the initial settings as detailed in *USK 7S Initial Settings.*

b) Connect RG 174 cable to KBA 3.5 MHz X 0.500" Round transducer and couple 10° angle wedge (or Shoe) to the transducer using couplant or light oil. Connect to the input port on the scope BNC to BNC connector.

c) Turn scope on to the number 1 setting.

d) Place transducer in position one (1) on the UT-10° (initial Setup) as shown in *Figure 4: 10° Calibration and Transducer Position*.

e) Adjust Delay until the trailing edge of the initial pulse is at "0" on the CRT.

f) Rotate the transducer 180° to position two (2) (the transducer is facing you). Maximize the signal. Adjust the Range Fine until the signals trailing edge is positioned at the 4" mark on the CRT.

g) Place the transducer in position three (3) on the calibration block and rotate the Delay until the trailing edge of the signal is positioned on 8" on the CRT. Peak the signal and then using the dB gain, adjust the signal to 80% FSH.

h) Repeat steps (f) and (g) until the transducer can be positioned in two (2) and three (3) and obtain signals at 4" and 8" without adjusting the Delay or Range fine.

i) Lock these settings and verify calibration.

j) Set gate Start at 2" and Gate stop at 10"

DTM Calibration for 10°L Wave Inspection of the Pin

a) Place transducer in position three (3) on the IIW Type II calibration Block and maximize signal (*Figure 4: 10° Calibration and Transducer Position*). This should produce a signal at 8" on the CRT. Adjust the MAT until a value on the DTM reads 8.000" ±0.002"is achieved.

b) Place transducer in position two (2) and maximize the signal. This should produce a signal at 4" on the CRT. Adjust the Zero until 4.000" ±0.002" is achieved.

c) Repeat steps (a) and (b) until the transducer can be placed in position three (3) and two (2) and achieve the ±0.002 tolerance without adjusting the MAT or the Zero. d) Lock these settings and verify calibration.

Sensitivity Calibration for 10°L Wave Inspection of the Pin

Place transducer on the Standard Pin fabricated by P.H. Tool as shown in *Figure 6: 10° Sensitivity Presentation*. Maximize the signal produced by the 2% EDM notch in the side of the pin. This notch is .006" in depth and is located 6" from the end of the pin. The signal produced should have a pulse at 6" from the Notch and a back Wall reflection at 8" from the end of the pin. The distance noted on the DTM should read 6.000" ±0.010" when the signal is maximized. If the signal is other than detailed, recalibrate the unit. Maximize the signal with the dB gain to 80% FSH.

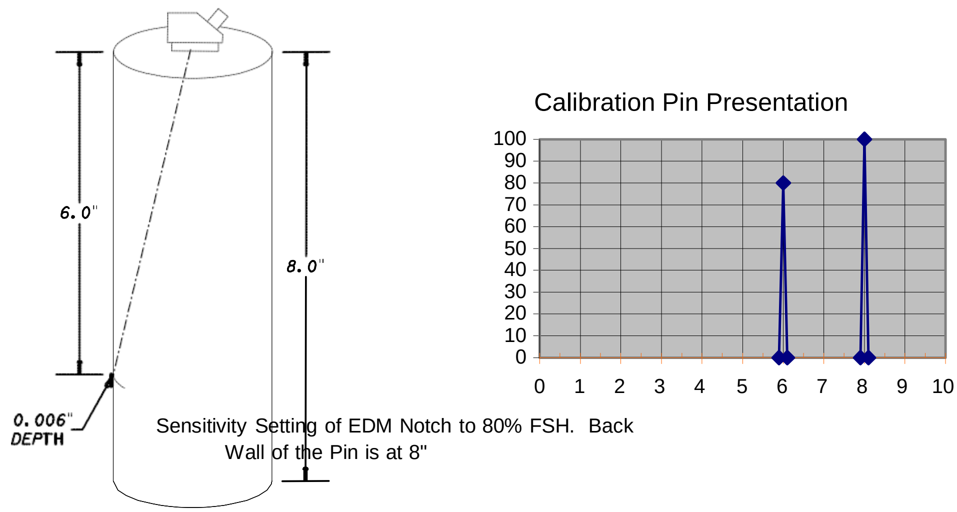


Figure 6: 10° Calibration and Transducer Position

Scanning pattern 10°L Wave Inspection of the Pin

a) Scan the pin in a radial pattern with the transducer facing the edge of the pin. Movements should be back to the center of the pin face and forward to the edge of the pin face. Overlap of the transducer shall be 10% until 100% of the pin face is covered.

b) Scan the pin from both ends with the transducer coupled to the pin face you will actually be inspecting for defects on the opposite end of the pin.

c) The presentation on the CRT should produce a signal of the shoulder on the opposite end of the pin and a back wall reflection on the end of the pin. The back wall reflection should coincide with the thickness value recorded on the pin.

d) The shoulder should produce a signal that is repeatable as the pin is inspected [If the pin is 8" long and the treaded portion of the pin is 1" long then the signal on the CRT that is present when scanning should be at 7" (shoulder) and 8" (Back wall) as illustrated in *Figure 7: Typical Pin Defect Presentation*]. Make note of the transducer position from the edge of the pin when a double signal is produced. Measure from the exit point on the transducer to the edge of the pin. The first signal at

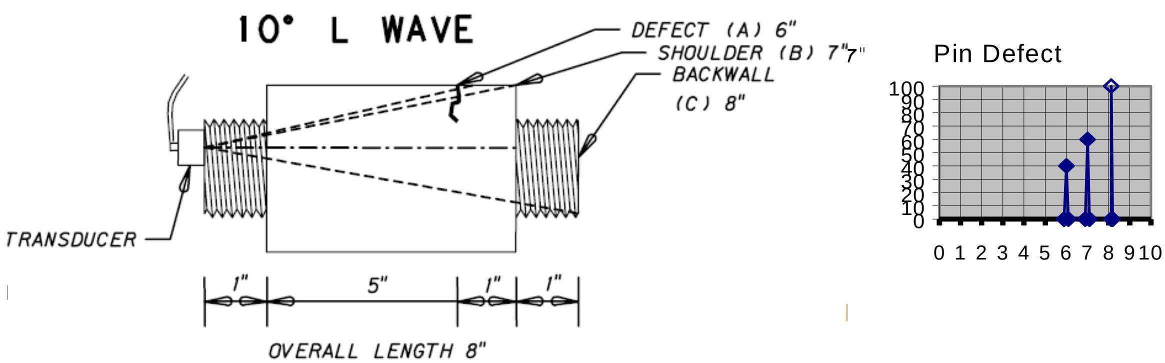


Figure 7: Typical Pin Defect Presentation

approximately 6” should be the defect. At the same distance from the edge of the pin to the exit point on the transducer, when a double signal is produced, this signal should be the same anywhere around the face as long as that distance is maintained.

e) (Defects) Signals that are produced before the shoulder, from approximately ½ the pin length to the shoulder, are Relevant Indications and care should be taken to record as much information on data form UT-5 so the indication can be evaluated and monitored or the pin replaced. Any indication in these areas that produces a maximized signal at scanning reference above 40% FSH shall be recorded. These indications must be reproducible before recording them on the inspection form.

Ultrasonic Calibration (Longitudinal)

	UT-2

Project Name:	Number:

Site:

Inspector:	ASNT Level:II	Company: MDT Bridge
Inspector:	ASNT Level:II	Company: MDT Bridge

Procedure #	Rev #
Report #	Cal Sheet #

EQUIPMENT DATA

Unit Mfg :	Mode:	Serial #:	Cal Due Date:

TRANSDUCER DATA

Mfg:	Model #	Serial #	Size:	MHz:

WEDGE (SHOE) DATA

Mfg:	Model #	Serial #	Material:	Angle:0 Deg

CABLE DATA

Mfg:	Model #	Connection Type:	Length:

COUPLANT DATA

Mfg:	Type:	Batch #

CALIBRATION BLOCK DATA

Mfg:	Type:	Serial #

Unit Settings

Transmit Mode:	Single: ☐	Pulse Echo ☐

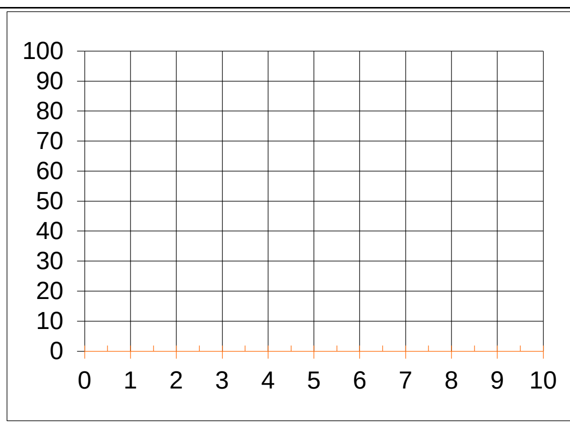
Gain:	Range:	Delay:	Zero:	Mtl Vel:	Scan Gain:

Gate Start:	Gate Stop:	% FSH 80	Reject:OFF

Simulator S/P:Back Wall	% FSH 10

S=	P=	D=

Calibration Presentation



Signature:	Date:

Ultrasonic Calibration (Shear) ***UT-3***

Cal Sheet # __________

Project #________________ Site ________________________ Date _____________________
Procedure #______________ Rev # ______________________
Examiner _______________________________Employee #__________ASNT Level ____________
Examiner _______________________________Employee # _________ASNT Level ____________

EQUIPMENT DATA

Unit Mfg _____ Model ______________________Serial # ____________Cal Due Date __________

TRANSDUCER DATA

Mfg _________Model #__________Serial # ___________ Size ____________Freq MHZ______
Mfg _________Model #_________Serial # ____________ Size ____________Freq MHZ_____

WEDGE (SHOE) DATA

Mfg _____________ Model # _______ Serial #________ Material ___________Angle ____

CABLE DATA

Mfg _____________Model # _____ Connection Type______________Length ________________

COUPLANT DATA

Mfg _______________Type _______________________Batch # __________________

CALIBRATION BLOCK DATA

Mfg _______________Type __________________Serial # _______________
Mfg ____________________Type _____________ Serial #_________________

Transmit Mode: Single _______________Shear __X___

dB Coarse ________ dB Fine_______ Scan ________

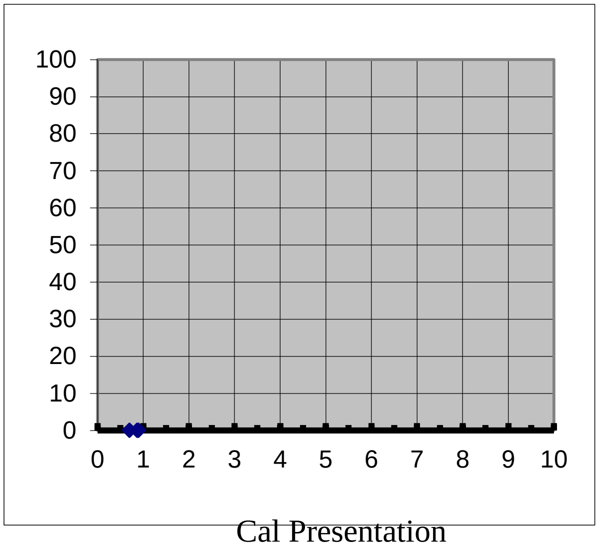
Range Coarse ____________ Range Fine ___________

Delay __________ Zero___________ Mat __________

Gate Start _______ Gate Stop ______ FSH ________ %

Shoe angle ____Verification + -_______ Deg

Simulator S/P ___________FSH ___ %
.060 Dia Hole



Cal Presentation

Signature: _____________________________ Date: _________________

Ultrasonic Length Data (Pin)

		UTT-4H
Project Name:	Number:	
Site:		
Inspector:	ASNT Level:II	Company: MDT Bridge
Inspector:	ASNT Level:II	Company: MDT Bridge
Procedure #		Rev #
Report #	Cal Sheet #	

Girder	Span	Pier	Top	Bottom	Right	Left	Thickness
			☐	☐	☐	☐	
			☐	☐	☐	☐	
			☐	☐	☐	☐	
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			☐	☐	☐	☐	

Comments:

Signature:	Date:

Ultrasonic Length Data (Pin)

		UTT-4PL
Project Name:	Number:	
Site:		
Inspector:	ASNT Level:II	Company: MDT Bridge
Inspector:	ASNT Level:II	Company: MDT Bridge
Procedure #		Rev #
Report #	Cal Sheet #	

Girder	Span	Pier	Top	Bottom	Right	Left	Thickness
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			☐	☐	☐	☐	
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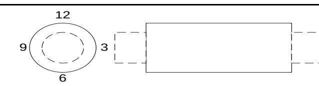
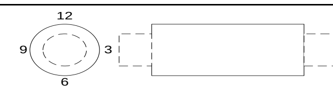
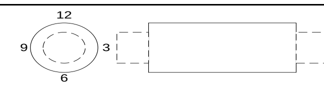
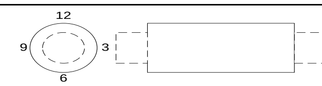
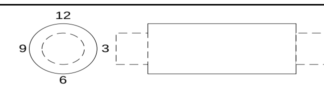
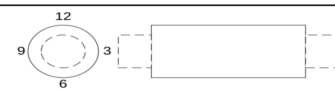
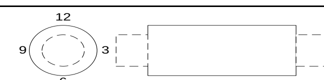
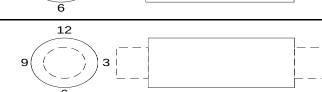
			☐	☐	☐	☐	

Comments:

Signature:	Date:

Ultrasonic Data (10 Deg) (pins)

Form UT-5 (1-21-2009)		**Page** of
Bridge Number:	Location:	District:
Inspector:	ASNT Level:	Company:
Inspector:	ASNT Level:	Company:
Procedure #		Rev #
Report #	Cal Sheet #	
Comments:		
Distance from exit point to edge: ”	Pin Length: ”	Pin Face Diameter: ”
Pin Body Diameter: ”	Shoulder to Face Length: ”	Shoulder at: ”

Girder Number	Span Number	Left Right	Top Bottom	Indication	Location	Defect Location Sketch
						
						
						
						
						
						
						
						

Signature:	Date:
Reviewer Signature:	Date:

Girder Number From Left To Right Up Station Ahead On Line;;
Span Number From Bridge General Layout Sheet And Up Station Ahead On Line;
Top/Bottom Indicates Top Or Bottom Pin In Pin And Hanger Configuration;
Indication - % Is The Screen Height At Reference Located At x.xx" From Scanning Surface;
Location - Clock Position Of Indication

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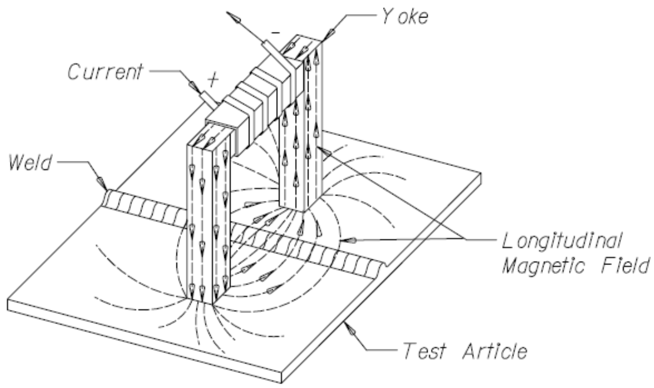
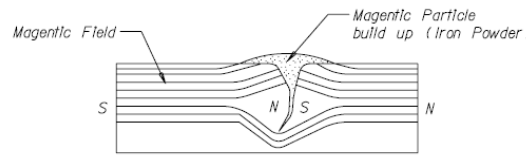
Magnetic Particle Testing (MT) is a nondestructive testing (NDT) method of revealing surface and slightly subsurface discontinuities in materials that can be magnetized. The testing method is based on the principal that magnetic flux in a magnetized object is locally distorted by the presence of a discontinuity. This distortion causes some of the magnetic field to exit and reenter the test object at the discontinuity. This phenomenon is called *magnetic flux leakage.* Flux leakage is capable of attracting finely divided particles of magnetic materials, which in turn form an outline, or indication of the discontinuity.





Montana Department of Transportation (MDT) personnel performing MT on state owned structures or equipment will be qualified in accordance with this procedure prior to performing any inspections or interpretations of discontinuities.

Inspector Requirements

Inspectors will be required to complete a training course that will qualify them to inspect structures and assemblies by the Yoke method.

Inspectors will complete a method specific MT with a passing score of 80% weighted between a general, specific and hands on practical test.

Level One (I)

Level One Inspector will complete eight (8) hours of classroom training and four (4) hours hands-on equipment specific training. Twenty (20) hours field training will be conducted with a current American Society of Nondestructive Testing (ASNT) Level II inspector.

MDT Level I individual will be qualified to properly perform specific calibrations, specific NDT, and specific evaluations for acceptance or rejection determinations according to written instructions. Level I inspectors may inspect materials but only qualified Level II or III inspectors will be allowed to interpret results and record results.

Level Two (II)

Level Two Inspector will complete four (4) hours of classroom training and four (4) hours hands-on equipment specific training. Twenty (20) hours field training will be conducted with a current ASNT Level II inspector.

MDT Level II individual will be qualified to set up and calibrate equipment and to interpret and evaluate results with respect to applicable codes, standards and specifications. The NDT level II should be thoroughly familiar with the scope and limitations of the methods for which qualified and should exercise responsibility for on-the-job training and guidance of trainees and NDT level I personnel. The NDT level II should be able to organize and report the results of NDT tests.

Level Three (III)

Level III Inspector certification is administered by ASNT.

MDT Level III individual should be capable of developing, qualifying and approving procedures, establish and approving techniques, interpreting codes, standards, specifications and procedures; and designating the particular NDT methods, techniques and procedures to be used. The MDT Level III should be responsible for the NDT operations for which qualified and assigned and should be capable of interpreting and evaluating results in terms of existing codes, standards and specifications. The MDT Level III individual should have sufficient practical background in applicable materials, fabrication and product technology to establish techniques and to assist in establishing acceptance criteria when none are otherwise available. The MDT Level III should have general familiarity with other appropriate NDT Methods, as demonstrated by an ASNT Level III Basic examination or other means. The MDT Level III, in the methods in which certified, should be capable of training and examining MDT Level I and II personnel for certification in those methods.

Material Testing

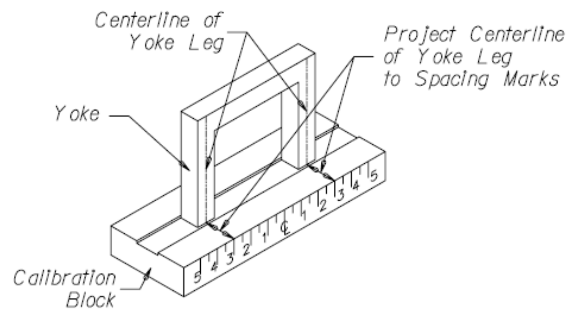
The test or (inspection) consists of six basic operations.

1. Calibration
2. Pre-cleaning
3. Establishing a suitable magnetic flux in the test object (Induced Field)
4. Apply magnetic particles
5. Examine the test object and interpret inspection results
6. Record and report the results.

Inspectors will be limited to the use of 110VAC portable test equipment and B300 AC Yoke. Equipment is to be calibrated using the ten (10) pound calibration block after eight (8) hours of continuous use or the beginning of each shift.

1. Calibration

Yoke must be calibrated prior to use or after eight (8) hours of continuous use. Using the ten (10) pound calibration block provided, adjust the legs of the yoke to the maximum spacing six (6) inches. Place the yoke on the calibration block as the spacing indicates at six (6) inches. Energize the Yoke holding the current button in the on position (Continuous Method) gently lift the calibration block off the table. The yoke should lift the ten (10) pound calibration block. Should the yoke drop the calibration block clean the legs on the yoke and repeat the calibration procedure. If the Yoke will not successfully complete this operation do not use the equipment for inspection.



2. Pre-cleaning

Remove all loose and flaking paint, rust, organics, water or anything that might interfere with the inspection process. Approved processes for removal are power wire brush, hand brushing or flapper disc sanding pad. MT inspection may be performed with a light covering of paint however; approved method would be to thoroughly clean the area as prescribed. Clean three (3) inches around the area to be inspected in all directions. Relevant indications that extend into the unclean area will be suitably cleaned. Care should be taken not to remove base material during cleaning.

3. Inducing a Magnetizing Field

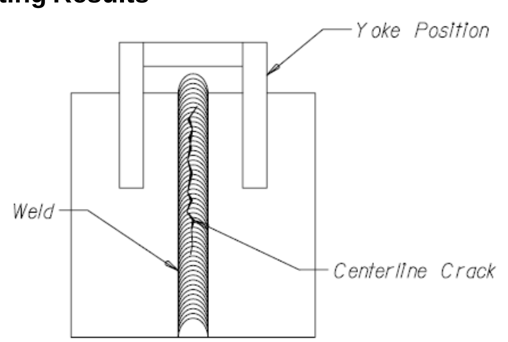
Magnetic Fields induced into the inspection area will be of the (Continuous Method) by energizing the Yoke and inspecting while AC current is on.

4. Applying Magnetic Particles

Magnetic particles will be applied using the dusting bulbs or bottles. A light coating of particles applied will form flux lines and be attracted by defects in the inspection areas. Inspection will be conducted with the unaided eye. Lighting conditions may be enhanced with a flashlight or inductive light on the yoke.

5. Examining the Test Object and Interpreting Results

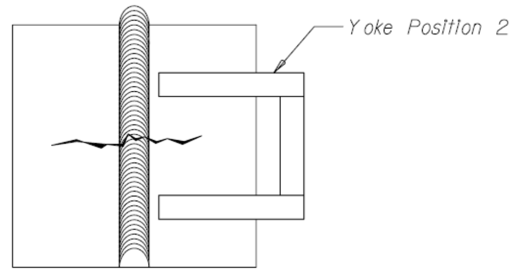
The yoke will be positioned to so the suspected defect and the yoke legs are perpendicular to each other.



Note:

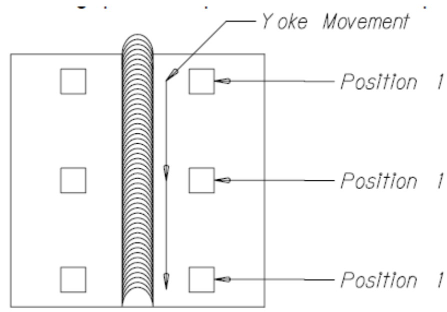
Yoke legs are transverse of the area of interest.
Position 1 – Cracks will appear perpendicular to the leg orientation

The yoke will be positioned to so the suspected defect and the yoke legs are perpendicular to each other. Rotate the yoke 90 degrees and inspect with the yoke in this position. This will reveal indications transverse of position 1.



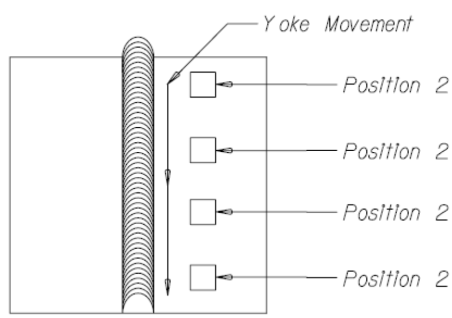
Note:
Rotate yoke 90 degrees from position 1.
Yoke legs positioned parallel with the weld to produce crack indication.

The yoke must be moved over the inspection area with an overlap of the legs by one (1) inch from Position 1.



Note:
Maximum leg spacing 6 inches overlap.
Spacing 5 inches overlap inspection 1 inch.

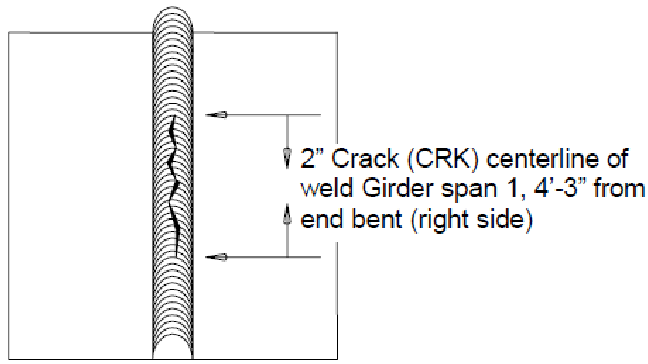
Rotate the yoke 90 degrees. Position 2 movement will overlap 1 inch.



Note:
Maximum leg spacing 6 inches overlap.
Spacing 5 inches overlap inspection 1 inch.

6. Record and Report Indications

Relevant indications that are revealed and hold powder will be recorded on Magnetic Particle Inspection Report form. Drawings or photos to be attached on a separate page(s). Record length and orientation. Mark the indication on the inspection piece at the ends of the crack, do not mark over the defect (crack). Mark the length of the indication on the test piece.



Typical Defect Marking

MONTANA DEPARTMENT OF TRANSPORTATION
BRIDGE BUREAU
MAGNETIC PARTICLE INSPECTION REPORT

Bridge Number:	Bridge Name:	
Bridge Location:		
Inspector:	ASNT Level:	Company:
Specification: In accordance with ANSI/AWSD1.5 -1996 Bridge Welding_Code [ ]		
Specification: In accordance with ANSI/AWSD1.5 -1996 Bridge Welding Code [ ]		

EQUIPMENT DATA					
Unit Mfg:	Model #	Serial #	Cal Date:		
Yoke:[ ]		Leg spacing: "			
METHOD					
Dry [ ]	Wet [ ]	AC [ ]	DC [ ]	Residual [ ]	Cont [ ]
PARTICLE					
Mfg:	Type:	Color:	Batch #		

Girder	Span	Pier	Indication #	Type	Left Side	Right Side	Accept	Reject

Additional space to orient the indications may be attached on a separate sheet

Comments:

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with the requirements of:

ANSI/AASHTO/AWS			
Inspector/	Signature	Level	Date:
Review/	Signature	Level	Date:

Chapter 8 – Bridge Load Rating and Posting

8.1 – Load Rating Overview

The Code of Federal Regulations, chapter 23, Subpart C, §650.313 requires states to rate each bridge as to its safe load-carrying capacity in accordance with the *AASHTO Manual for Bridge Evaluation*.

8.1.1 Philosophy

Bridge load rating differs from bridge design in key areas. This is best described in the AASHTO *Manual for Bridge Evaluation*, section 6A.1.3:

> "Bridge design and rating, though similar in overall approach, differ in important aspects. Bridge ratings generally require the Engineer to consider a wider range of variables than is typical in bridge design. Design may adopt a conservative reliability index and impose checks to ensure serviceability and durability without incurring a major cost impact. In rating, the added cost of overly conservative evaluation standards can be prohibitive as load restrictions, rehabilitation, and replacement become increasingly necessary." (American Association of State Highway and Transportation Officials, 2011 with 2013 Interims)

Load rating bridges requires a different mindset from designing bridges. The engineer may begin load rating using conservative numbers; however, before a load rating is complete, the engineer typically will need to do more in-depth analysis, coupled with engineering judgement, to come up with a reasonable load capacity.

8.1.2 Obtaining Rating Information

The Bridge Management Section is responsible for collecting relevant information for all bridges built under Federal or MDT administered contracts. For all other bridges, the bridge inspector is responsible for contacting the governing agency to obtain plans and shop drawings. These plans and shop drawings will be forwarded to the Bridge Management Section for use in load rating the bridges.

For all non-concrete bridges where plans are not available, the inspector will use the measurement forms provided by the Bridge Management Section to obtain the structural information needed for a bridge rating and forward that information on to the Bridge Management Section. The bridge measurement forms are available for download on the Bridge Management System website.

8.1.3 Load Rating Reference Material

For more information, see the reference materials listed below.

AASHTO Manual for Bridge Evaluation
AASHTO Standard Specifications for Highway Bridges – 17th Edition, 2002
AASHTO LRFD Bridge Design Specifications

MDT Bridge Memo 07-02	Rating New Bridges, use of Opis/Virtis
MDT Bridge Memo 09-02	Concrete Deck, Assumed Sacrificial Wearing Surface and Concrete Strength
MDT Bridge Memo 13-01	Safe Posting load, Railroad Car Bridges

FHWA Technical Advisory T5140.29: Load-carrying Capacity Considerations of Gusset Plates in Non-load-path-redundant Steel Truss Bridges

FHWA Policy Memo 11/05/1993	Bridge Load Ratings for the National Bridge Inventory
FHWA Policy Memo 12/22/1993	Bridge Load Ratings for the National Bridge Inventory
FHWA Policy Memo 10/30/2006	Bridge Load Ratings for the National Bridge Inventory
FHWA Policy Memo 01/22/2007	Clarification of LRFD Policy Memorandum
FHWA Policy Memo 02/22/2007	Oversight of Bridge Load Ratings and Postings
FHWA Policy Memo 09/29/2011	Assigned Load Ratings
FHWA Policy Memo 11/15/2013	Load Rating of Specialized Hauling Vehicles

FHWA Publication Number FHWA-IF-09-014 — Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges

Bibliography

American Association of State Highway and Transportation Officials. (2011 with 2013 Interims). *The Manual For Bridge Evaluation* (Second ed.). Washington, DC: American Association of State Highway and Transporation Officials.

Section 8.2 – Load Rating Policy

MDT's policy is to load rate bridges in accordance with the AASHTO *Manual for Bridge Evaluation*. Additional guidelines can be found in this section.

8.2.1 Load Rating Responsibility

Per MDT's Bridge Bureau Policy Memo 07-02, the initial data input for new bridges is the responsibility of the Bridge Design Section. At the completion of design, all new bridges will be rated using the AASHTOWARE Bridge Rating Software (BrR, formerly known as Virtis) if the bridge type is supported by BrR.

The Bridge Management Section is responsible for updating bridge ratings in the Bridge Management System. Once a new bridge designed MDT or under an MDT contract is fully constructed and the initial inspection completed, the Bridge Management Section will update the Load Rating in the Bridge Management System.

Bridges that pre-date Bridge Memo 07-02 and all bridges not designed by MDT or under an MDT contract are rated by the Bridge Management Section with the help of consultants and the design section as needed. See the AASHTO *Manual for Bridge Evaluation*, 6B.7 for information on evaluating the load capacity of bridges with unknown structural components.

A copy of all load rating documentation will be kept in each Bridge Inspection File. The Bridge Management personnel responsible for load rating will ensure that proper documentation is added to the bridge inspection file after a rating has been completed and updated in the Bridge Management System. This documentation will consist of all manual calculations or a printout of rating software input values when BrR or other rating or calculation support software is used and will include a summary of the load rating results. All assumptions made during load rating will be documented and attached to the load rating results.

8.2.2 Rating Loads

Bridges that were not designed under the AASHTO LRFD code will be rated for the HS 20-44 Truck; the AASHTO Type 3, Type 3S2, and Type 3-3 legal loads; and the AASHTO Single-Unit Specialized Hauling Vehicles (SHV) – SU4, SU5, SU6, AND SU7. Bridges designed under the AASHTO LRFD code will be rated for the HL-93 truck, all three AASHTO legal loads, and all four AASHTO SHV loads.

The likelihood of a sidewalk being fully loaded with pedestrians at the same time that the heaviest truck loading crosses the bridge is very low, so pedestrian loads are not applied when rating bridges.

8.2.3 Bridge Decks

Generally, bridge decks do not need to be rated to determine the load carrying capacity of the bridge. There are exceptions to this rule, however. Timber bridge decks of all types and corrugated steel decks will be load rated when determining the load capacity of a bridge. Also, in slab-type bridges where the deck transfers load directly to the substructure, the deck, or slab, will be rated.

8.2.4 Bridge Superstructures

All major load-carrying bridge superstructure components will be rated to determine the load carrying capacity of a bridge.

<u>8.2.5 Bridge Substructures</u>

Bridge substructures are generally not rated when determining the load capacity of a bridge. If a bridge's substructure has been damaged or has deteriorated to the point where the substructure may control the bridge rating, the substructure will be rated.

<u>8.2.6 Rating Guidelines</u>

Some bridge types require guidelines in addition to what is provided in the AASHTO Manual for Bridge Evaluation. Guidelines are described in the following sections.

8.2.6.1 General Rating Guidelines

When a bridge has sidewalks or medians, rating loads will be computed by placing truck and lane loads in the roadway only. Truck and lane loads will not be placed on sidewalks or medians, regardless of whether a barrier is present between the sidewalk or median and the roadway.

Except for Asphalt wearing surfaces, wearing surface unit loads will be values in section 3.3.6 of the AASHTO Standard Specifications for Highway Bridges or 3.5.1-1 of the AASHTO LRFD Bridge Design Specifications. A unit weight of 0.144 k/ft^3 will be used for asphalt wearing surfaces.

When rounding final load rating tonnages, use conventional rounding methods.
Examples:
16.52 tons rounds to 17 tons
16.48 tons rounds to 16 tons
17.5 tons rounds to 18 tons
16.5 tons rounds to 16 tons

8.2.6.2 Steel Bridges

8.2.6.2.1 Corrugated Steel Decks

Use a 20 in x 20 in patch for tire distribution when rating corrugated steel decks. Steel strength depends on the date the deck was fabricated. In some cases, the configuration of the corrugations can be a general indicator of the age of the deck and the steel strength.

8.2.6.2.2 Steel Railroad Car Bridges

MDT's policy on load posting of railroad car bridges is in the appendix of this chapter. Generally, MDT does not rate railroad car bridges because of the many unknowns and per the policy referenced above, assigns a 5 ton posing limit to the structure. A county that does not want to post a railroad car bridge at 5 tons is required to either hire a consultant to load rate the bridge and submit the calculations to the MDT bridge management section for approval, or load test the bridge to determine its load carrying capacity. A sample calculation of the load carrying capacity of a load tested bridge is in the appendix of this chapter.

8.2.6.2.3 Steel Girder Bridges

When rating steel girder bridges with timber decks or other types of decks that do not support the girders laterally, as long as the girders are not twisting due to overload, assume there is enough friction between the deck and girders to act as a single diaphragm at midspan.

Corrugated steel decks are typically tack welded to the top flange of steel girders. When rating steel girder bridges with a corrugated steel deck, assume that the deck provides lateral support of the top flange for the full length of the girder.

8.2.6.3 Timber Bridges

8.2.6.3.1 Timber Decks

Timber decks in good condition are typically rated with a bending capacity of 1.15 ksi before factoring (F_b). This value may be adjusted up or down depending on the quality and condition of the deck timber.

Increasing the Shear Stress Factor (C_H) should always be considered on members where the load is applied perpendicular to the wide face of the member, such as on plank decks, since any splits or checks will typically be oriented parallel to the load direction and not affect the shear strength of the member parallel to the grain.

Most timber decks have gravel, asphalt, or other material on them that holds moisture against the wood for at least a few months of the year. Use wet condition factors for rating timber decks regardless of the moisture condition at the time of the inspection/measurement when a cover or overlay is present on the deck. In cases where a timber deck is bare and is in a fairly dry environment, use the dry condition factors.

In the AASHTOWARE BrR software, always check the box for the deck being continuous over more than 2 spans.

When measurements of the actual dimensions of timber deck members are available, use the actual measurements for section property calculations, but use the nominal dimensions to calculate adjustment factors.

8.2.6.3.2 Sawn Timber Girders

The girders of all timber bridges designed and constructed by MDT were designed with a unit stress in bending (F_b) of 1.55 ksi and a unit stress in shear parallel to grain (F_v) of 0.120 ksi. These designs predate the Shear Stress Factor, C_H. C_H can range as high as 2.0. When using the original design values for shear when rating a timber bridge designed by MDT, use C_H = 1.0. Reduce F_v if the girder is subject to the check, split, or shake conditions as stated in table 13.5.1A, Footnote 6 of the AASHTO *Standard Specifications for Highway Bridges*, 17th edition.

For all timber bridges that were not designed and constructed by MDT, the default C_H value of 1.0 can be very conservative. It is not likely that shear will control a timber rating. However, when C_H = 1.0 is used, the numbers will show that shear controls. C_H should be evaluated for every bridge not designed and constructed by MDT and adjusted as appropriate.

As a general rule of thumb, use the dry condition factors when rating girders. If a girder is in a wet environment or shows signs of moisture (algae or mushroom growth, water staining), use the wet condition factors.

When rating a bridge with damaged girders, reduce the strength of the girder or reduce the size of the cross-section. If that girder then controls the rating, rate the bridge assuming the girder has failed – remove the girder from the model. Use whichever model yields the highest rating factor. Be sure to rate the deck in both models if it is timber or corrugated steel.

When rating a bridge with broken girders, remove the broken girder from the model, and rate the bridge as if that girder doesn't exist.

When rating a bridge with repaired girders, rate for the condition of the girder before the repair. If the girder was broken before the repair, treat it as a broken girder. If the girder was split or cracked before the repair, treat it as a damaged girder.

When measurements of the actual dimensions of timber girders are available, use the actual measurements for section property calculations, but use the nominal dimensions to calculate adjustment factors.

8.2.6.3.3 Glue-Laminated Timber Girders

BrR is not capable of rating Glue-Laminated timber bridges. MDT's in-house developed Mathcad sheets should be used for rating Glue-Laminated timber girders.

8.2.6.3.4 Timber Piles

As stated in section 8.2.5, substructures will very seldom govern the load capacity of a bridge. There are exceptions however, and generally those exceptions occur in bridges with timber substructures. When it can be determined from a bridge inspection that a timber pile has been compromised to the extent that it can no longer adequately support the loads it was intended to carry it will need to be removed from the bridge model. At that point the capacity of the pile cap between the adjacent "good" piles may govern the load rating for the bridge. Such an analysis must be included in the load rating when the capacity of a substructure unit is in question.

8.2.6.4 Prestressed Concrete Bridges

8.2.6.4.1 Prestressed Concrete Girders

When rating prestressed concrete girders, use transformed section properties, include elastic gains, and use the AASHTO refined method for calculating prestress losses.

8.2.6.5 Culverts

Reinforced concrete culverts should be rated using AASTHOWARE Bridge Rating Software (BrR).

BrR is not capable of rating steel culverts. Steel culverts should be rated using MDT's in-house developed spreadsheet for steel culvert rating.

8.2.7 MDT Preferences for Data Entry in AASHTO Bridge Rating Software (BrR)

8.2.7.1 Naming Convention

8.2.7.1.1 Bridge Definition

Bridge ID: MDT Bridge ID with an underscore instead of a + sign.
NBI Structure ID: MDT Bridge ID with an underscore instead of a + sign.
See figure 8.2-1.

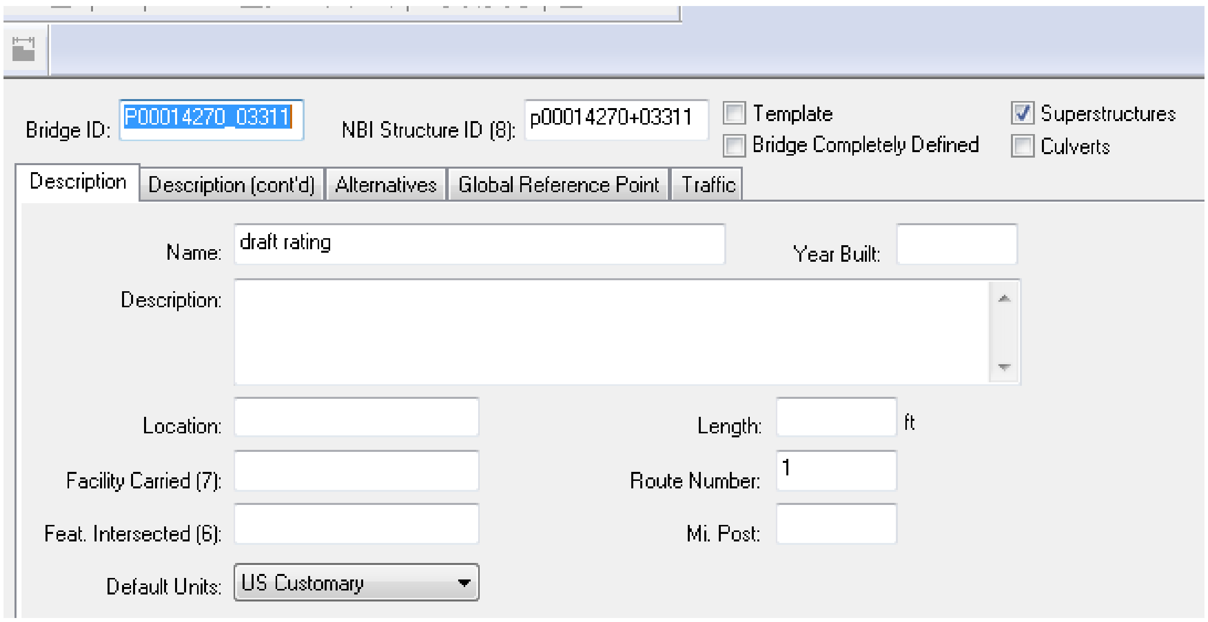


Figure 8.2-1

8.2.7.1.2 Superstructure Definitions

Naming conventions for simple span superstructure definitions include the span number, span length, and type of span. Only the span length and type is needed on single span bridges. Continuous span superstructure definitions will include the span numbers and type of span. See figures 8.2-2 and 8.2-3 for more information.

8.2.7.1.3 Bridge Alternatives

The Bridge Alternative will always be named As-built.

For single span bridges, the Superstructure will be named Single Span. For multiple span bridges, the Superstructures will be named for the span(s) they represent.

Consultants and raters may name the Superstructure Alternative whatever they wish. When the bridge rating is updated in the Bridge Management System, the MDT personnel responsible for updating the rating will change the Superstructure Alternative name to Rated (date rating was updated).

See the following figures for examples of proper naming on simple span bridges and on multiple-span bridges.

8.2.7.1.3a Single Span

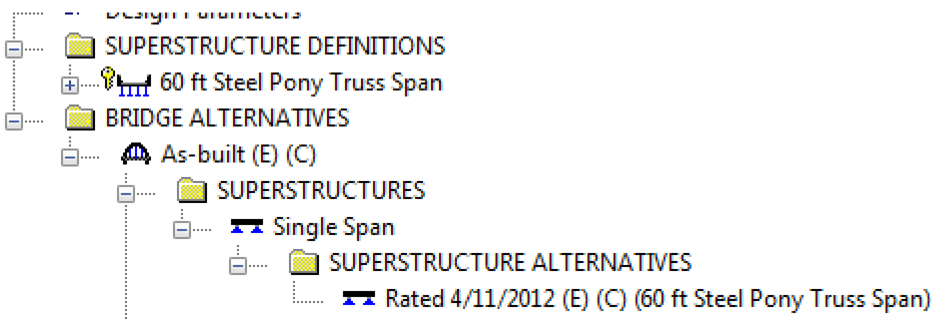


Figure 8.2-2

8.2.7.1.3b Multiple Spans with both Continuous and Simple Spans

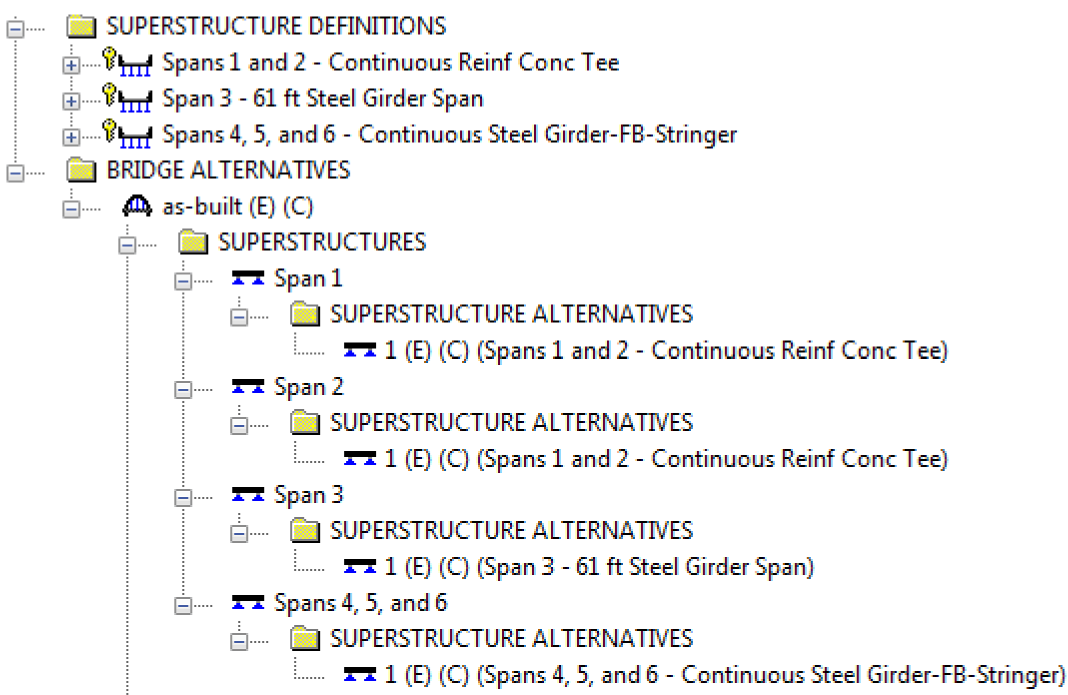


Figure 8.2-3

8.2.7.2 Other Preferences

8.2.7.2.1 Bridge Definition

Consultants and bridge raters do not need to fill out any data beyond the Bridge ID, NBI Structure ID, Route = 1, and AASHTOWare Association. All other fields will automatically fill in when MDT personnel associate the bridge to a bridge in the MDT Bridge Management System.

Under AASHTOWare Association, consultants and bridge raters will ensure that BrR is checked and "No" is checked for BrM. Whether BrD is checked or not does not matter for bridge rating. MDT personnel responsible for updating load ratings in MDT's Bridge Management System will check the BrM box and choose the proper association.

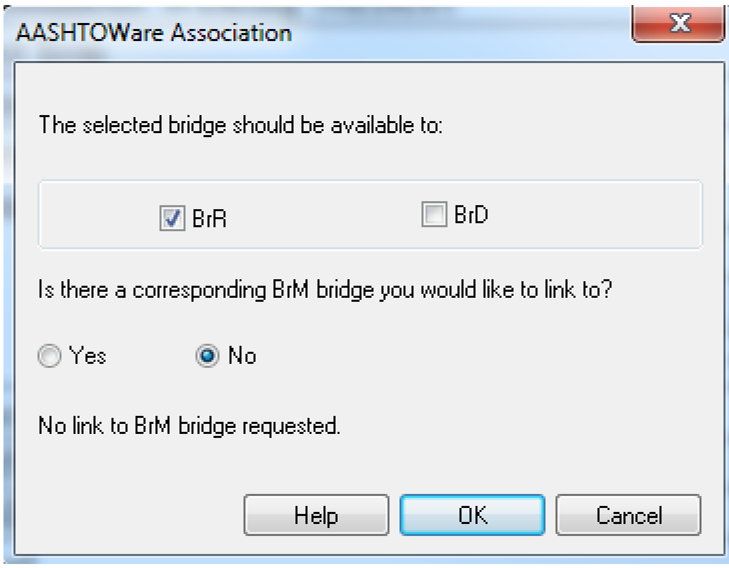


Figure 8.2-4

8.2.7.2.2 Superstructure and Girder Definitions

Whenever possible, enter superstructure definitions as Girder System superstructures, not Girder Line. Also, use Schedule Based for defining girder members whenever possible. Use Cross-Section-Based only when Schedule Based will not work.

8.2.7.2.2a <u>Linking Girders</u>

Linking girders saves time for both data input and analysis. Girders that are the same size, material, and condition may be linked provided that the girder with the lowest rating factor is the girder defined and all similar girders are linked to that one. Typically, the first exterior girder is defined, and the other exterior girder is linked to it when the rating for the two girders would be the same. Then the worst case interior girder is defined, and all of the similar girders are linked to it.

In figure 8.2-5, girder 1 has been defined, and girder 10 is of similar shape, material and condition and does not have higher distribution factors than girder 1; so girder 10 is linked to girder 1. Girders 2, 6, and 8 are the same shape, material and condition, and girder 6 has the highest distribution factors, so girder 6 has been defined and girders 2 and 8 are linked to it. Girders 2, 3, 4, 5, 7, and 9 are the same shape, material and condition, and girder 5 has the highest distribution factors, so girder 5 has been defined and all of the others are linked to it.

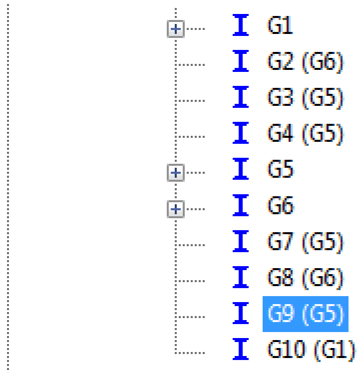


Figure 8.2-5

Section 8.3 – Load Rating Quality Control and Quality Assurance

MDT is committed to providing a transportation system that emphasizes quality, safety, cost effectiveness, economic vitality and sensitivity to the environment. A quality Bridge Inspection and Management Program is a part of that commitment. Implementation of Quality Control and Quality Assurance processes for bridge load ratings will strengthen our program and help us meet our overall goals.

Standard forms for use in documenting Quality Control and Quality Assurance reviews are in the appendix to this chapter.

8.3.1 Quality Control

Quality Control (QC) refers to the operational activities put in place to control the quality of bridge load ratings. This includes such activities as providing clear decisions and directions, constant supervision by experienced individuals, immediate review of completed activities for accuracy and completeness, and accurate documentation of all decisions, assumptions, and recommendations. QC procedures, if followed, should ensure that the work is done correctly the first time.

The level and depth of QC procedures is determined by the complexity and features of the load rating. Load rating of bridges in good condition and which are common designs will require less review than more complicated bridge design types and bridges in poorer condition.

8.3.1.1 MDT Internal Quality Control

Internal QC reviews are performed on load ratings that are calculated by MDT personnel. A QC form will be filled out at all review levels and attached to the front of the load rating before it is put in the bridge file. The person responsible for the load rating will ensure that the QC form moves through the QC steps and ends up in the Bridge Management Section for the final QC review. Bridge Management is responsible for finishing the form and attaching it to the load rating documentation. The internal QC steps are described as follows.

8.3.1.1.1 Individual Review

Individual QC reviews are completed by the person responsible for calculating the load rating. This person reviews all software input and calculations to ensure accuracy and completion of the load rating. The final load rating results are reviewed to ensure that they are reasonable for the bridge being rated. Individual QC reviews are performed on all load ratings. The process of filling out the QC form starts at this level.

8.3.1.1.2 Peer Review

Peer QC reviews are completed by a person experienced with load rating other than the person responsible for completing the original load rating. These reviews are in-depth checks of the load rating. The peer will review software input to check for accuracy and completion; review assumptions made and ensure adequate documentation is provided; and do a quick independent analysis, either by hand or using another piece of software to ensure that the final load rating results are reasonable for the bridge being rated. Any issues noted will be discussed with the individual responsible for the load rating and resolved between that individual and the peer. Peer QC reviews are not required for all bridges. The extent of these reviews and the decision on whether to do a peer review will be based on the experience of the load rater and the size or complexity of the bridge being rated.

8.3.1.1.3 Final Review

Final QC reviews are completed by a licensed professional engineer experienced in load rating. These reviews are not as in-depth as peer reviews. The final reviewer will check all assumptions to ensure they are valid, check the final load rating results to ensure they are reasonable for the bridge being rated, and spot-check data input and calculations to check for any common mistakes. Final reviews are performed on all bridges before the ratings are updated in the Bridge Management System.

8.3.1.2 Consultant Quality Control

Consultant QC reviews are entirely up to the consultant, and are outlined in the consultant's Statement of Qualifications when the consultant seeks a bridge load rating contract. Any changes to the QC plan outlined in the Statement of Qualifications will need to be approved by the Bridge Management Engineer.

8.3.2 Quality Assurance

Quality Assurance (QA) refers to the certainty that load ratings meet the requirements for quality. The objective of QA is the continual improvement of the total delivery process to enhance quality and productivity. Essentially, QA is what is done to confirm that a QC program is effective.

8.3.2.1 MDT Internal Quality Assurance

Quality Assurance reviews of load ratings calculated by MDT personnel are conducted alongside QA reviews of bridge inspections. Every bridge that receives a QA review of bridge inspection also receives a QA check of the inspection files to make sure the files are complete. This file review includes checking to make sure a bridge load rating is present in the file, contains the required information, has been updated to account for changes in the condition of the bridge, and yields reasonable rating factors for the bridge in question.

8.3.2.2 Consultant Quality Assurance

All load ratings completed by consultants are reviewed by a licensed professional engineer on the MDT staff with experience in load rating. QA reviews of consultant load ratings are very similar to the Final QC Review of internal load ratings. Consultant ratings are spot-checked for accuracy, and checked to ensure that they comply with MDT's load rating philosophy and policy. Any load ratings that do not pass QA review are sent back to the consultant for revision.

8.4 – Bridge Posting Policies and Procedures

MDT is committed to providing a transportation system that emphasizes quality, safety, cost effectiveness, economic vitality and sensitivity to the environment. Posting of bridges is essential to the safety aspect of this commitment.

8.4.1 Load Posting

NBI item 70 in the *FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* states "The National Bridge Inspection Standards require the posting of load limits only if the maximum legal load configurations in the State exceeds the load permitted under the operating rating."

MDT analyzes all three AASHTO Legal Load trucks for load rating, and uses the Type 3-3 truck as the trigger for posting requirements.

If the Operating Rating for the Type 3-3 truck is greater than or equal to 40 tons, the bridge does not require load posting.

If the Operating Rating for the Type 3-3 truck is less than 40 tons, the bridge requires posting at the Inventory Rating capacity for the Type 3 truck when using the R 12-1 sign, or the Inventory Rating capacity of each of the 3 AASHTO Legal Load trucks when using the R 12-5 sign. See figure 0.8.1 for more information.

If a bridge maintained by MDT requires load posting, Bridge Management personnel will coordinate with the District Administrator, District Maintenance personnel, and MCS personnel on erecting the proper posting signs.

If a bridge maintained by a county or other local agency requires posting, Bridge Management personnel will follow the procedures in MDT Bridge Memo 13-02, Guidelines for Working with Owners on Bridge Load Posting.

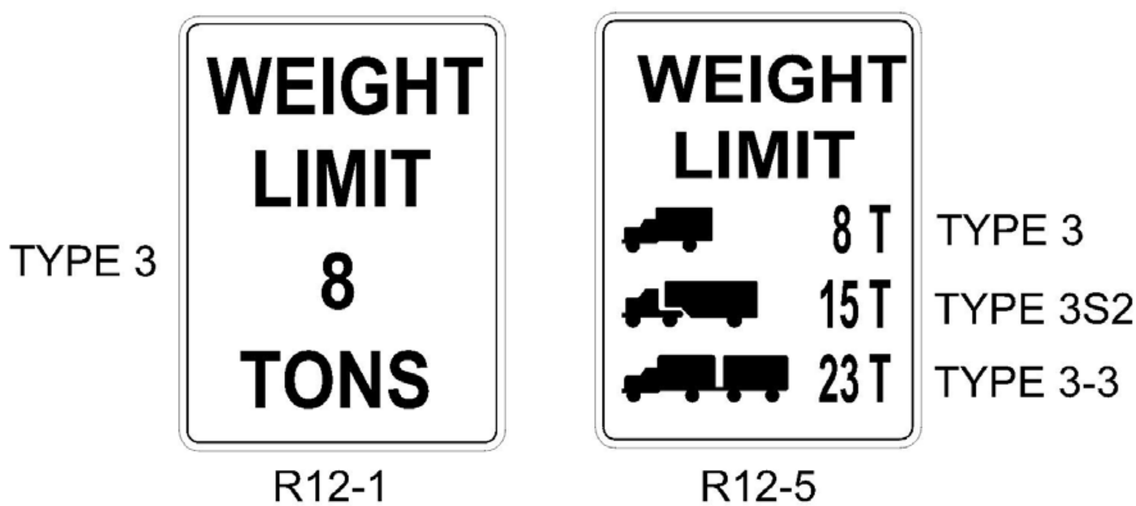


Figure 8.4-1

8.4.2 Posting for Non-Load

In some cases, a bridge may be posted for maximum speed, maximum number of vehicles on a bridge, or other types of non-load related posting. The decision to use this type of posting is left to the entities responsible for maintenance of the bridge.

8.4.3 Posting Decisions

Decisions on whether to post a bridge are made by licensed professional engineers on MDT's Bridge Management staff and approved by the Bridge Management Engineer and/or the Bridge Engineer. Consultants calculating load ratings for MDT are not responsible for making load posting decisions, and are not required to make load posting recommendations.

8.4.4 Reference Material

See the following reference material for more information on MDT's bridge posting policies and procedures.

8.4.4.1 MDT Bridge Memos

13-01 Safe Posting Load, Railroad Car Bridges
13-02 Guidelines for Working with Owners on Bridge Load Posting

8.4.4.2 Other MDT Memos

June 9, 2009 memo from Dwane Kailey, Chief Operations Officer of the Director's Office: Low Clearance Signs on Bridges

Appendix A

Montana Department of Transportation Bridge Design / Management Memo	Bridge Memo Number: 13-01 Date Issued: February 8, 2013 Date Effective: February 8, 2013 Date Revised:
Subject: Safe Posting Load, Railroad Car Bridges	

To: Bridge Bureau

From: Kent M. Barnes, P.E.
Bridge Engineer

☐ **In-House Design**	☐ **Consultant Design**
☒ **Bridge Management**	☒ **Condition Inspection**

Introduction

Old railroad cars are sometimes used as bridges. These cars can make good bridges. However, the differing configurations and unknown history makes full evaluation difficult. That evaluation is outside the scope of MDT's bridge inspection program.

Policy / Guidelines

There are 3 options for determining a safe Posting Load for these bridges. Bridge Bureau assumes Option 1. Options 2 or 3 may be selected by the bridge owner.

1) **Assign a 5 ton limit.**
2) **Load testing.**
   The owner may load test the bridge by placing a vehicle of known weight on the structure. The owner needs to provide the Bridge Bureau the axle configuration, front to back, and the weight applied to each axle along with a picture of the test. The Bridge Bureau will convert the test truck into an equivalent weight for a Type 3 truck. The safe Posting Load will be 40% of the equivalent Type 3 weight. The reduction accounts for the effects of moving vehicle impact and a factor of safety.
3) **Load rating by a Montana Professional Engineer.**
   The owner may have the bridge evaluated by a Montana Professional Engineer. The engineer will gather field data, perform any needed testing, research member properties and strengths, and perform load rating calculation to determine a safe Posting Load. The owner needs to provide the following items to the Bridge Bureau.
   - A letter signed by the Montana Professional Engineer giving the safe Posting Load.
   - For record purposes, provide copies of the following information;
     - Bridge measurements, drawings, and sketches used in rating analysis.
     - Results of any testing performed.
     - Engineering calculations supporting the safe Posting Load.

   Once this information is received, assign the safe Posting Load provided in the letter to the bridge. This option is likely to give the highest safe Posting Load.

Closing
MDT is committed to bridge safety. Adherence to this policy will promote bridge safety while allowing for owner options where situations warrant further effort.

KMB:BRIDGE MEMO 13-01

Copies file

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Bridge Bureau
Bridge Load Rating Review Summary

Bridge ID:

Feature Intersected:

Location:

Date: **Load Rater's Initials:** ___________________

Comments:

QC Peer Review Date: **Reviewer's Initials:** ____________________

Comments:

QC Final Review Date: **Reviewer's Initials:** ____________________

Comments:

QA Review Date: **Reviewer's Initials:** ____________________

Comments:

MONTANA
MDT
DEPARTMENT OF TRANSPORTATION

Bridge Bureau
Bridge Load Rating
Quality Assurance of Consultant Submittal

Bridge ID:

Feature Intersected:

Location:

Consultant:

Date Submittal Received:

QA Review Date: **Reviewer's Initials:** ____________________

Comments:

BY AKJ DATE 6/3/2013 SUBJECT Load Test SHEET NO. 1 OF 1

CHKD BY ______ DATE ______ BRIDGE ID: L03048001+08001

FEATURE INT AND LOCATION Lodge Creek 022, 2M E Chinook

83.167 ft span

Load Test = 1261 ft·K

90 − 80 = 10

83.167 − 80 = 3.167

$\frac{3.167}{10} = 0.3167$

Equivalent Type 3 Truck Load:

486.3 ft·K/WL − 423.9 ft·K/WL = 62.4 ft·K/WL

(62.4 ft·K/WL)(0.3167) = 19.762 ft·K/WL

423.9 ft·K/WL + 19.8 ft·K/WL = 443.7 ft·K/WL = 887.4 ft·K/truck

$\frac{1261 \text{ ftK loadtest}}{887.4 \text{ ft·K Type3}} = 1.421$

(25 tons)(1.421) = 35.5 tons

40% of equiv. Type 3 = (35.5 tons)(0.4) = 14 tons = Safe Load Posting

Type 3 inventory = 14 tons

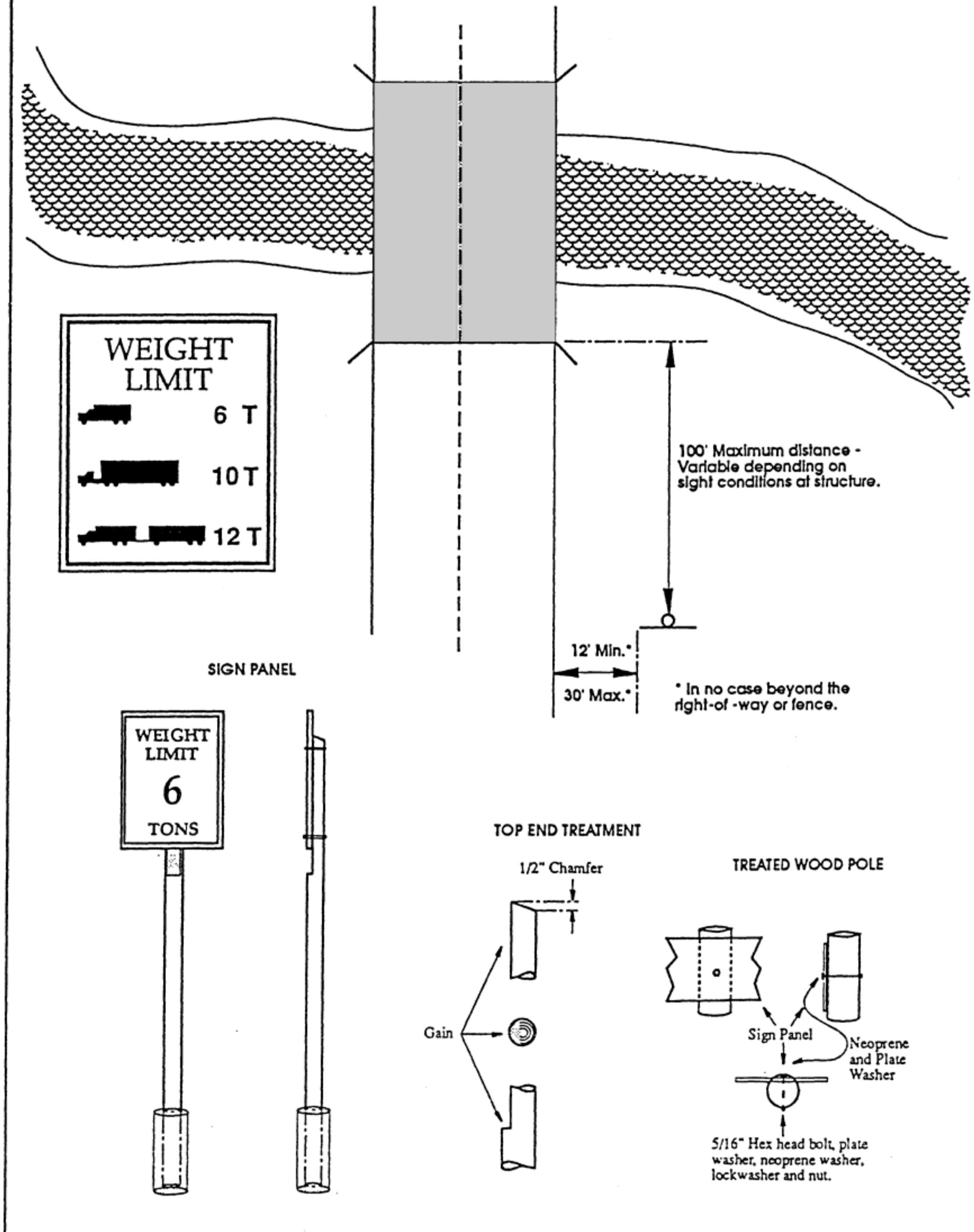
Type 3 operating = (14t)(1.67) = 23t

Other trucks:

Truck	90ft Moment ft·K/WL	80 ft Moment ft·K/WL	83.167ft Moment ft·K/WL	Load Test / Truck Load	Equiv Truck tons	Inventory Rating tons	Operating Rating tons
HS20-44	672.2	582.4	610.8	1.032	37	15	25
Type 3S2	576.4	487.1	515.4	1.223	44	18	29
Type 3-3	571.7	471.9	503.5	1.252	50	20	33

A Weight Limit sign shall be located immediately in advance of the section of highway or the structure to which it applies. To reduce costly delay and backtracking, a weight limit sign (R12-1) with an advisory message may be placed at approach road intersections or other points where the affected vehicle can detour or turn around. The standard, and minimum size shall be 24 X 30 inches but a larger size is desirable on major roads and streets.

TYPICAL WEIGHT LIMIT SIGN INSTALLATION

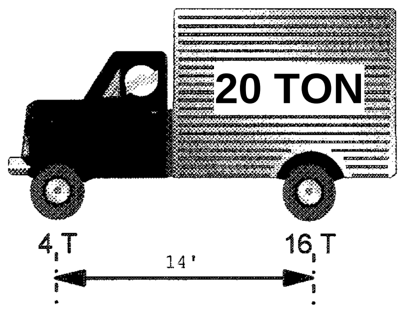


MONTANA MDT DEPARTMENT OF TRANSPORTATION

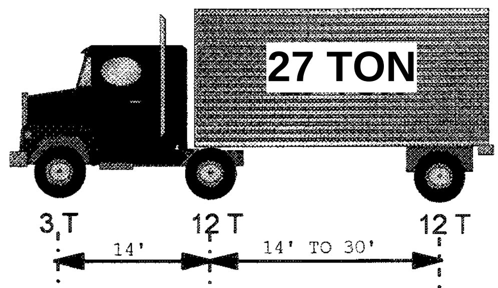
Typical Legal Loads

The axle spacings and weights of truck types 3, 3-S2 and 3-3 are based on actual vehicles; H and HS trucks are not, but are common to most states and governing agencies.

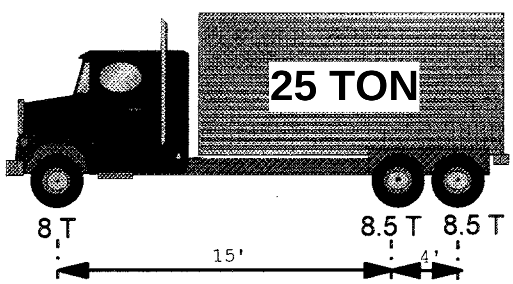
H20



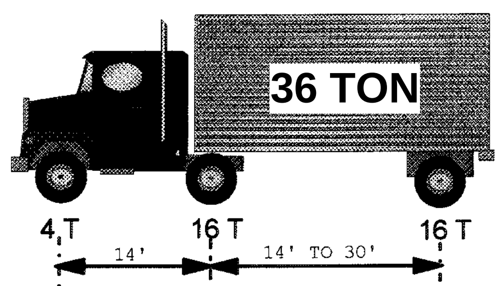
HS15



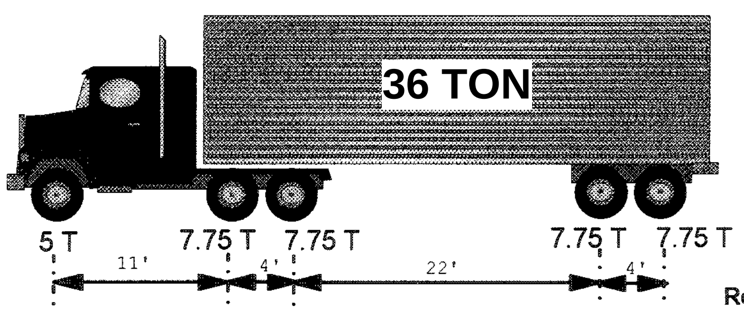
TYPE 3

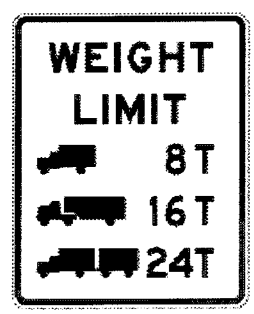


HS20



TYPE 3-S2

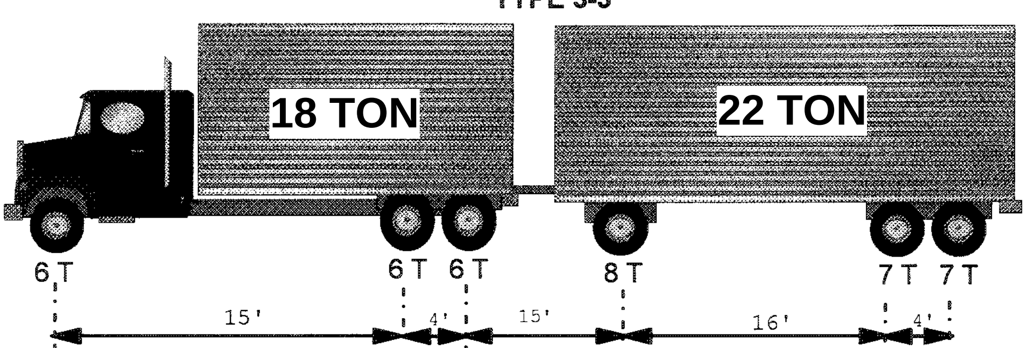




R 12-5

Regulatory sign for weight limits using three standard truck types (Types 3, 3-S2, 3-3)

TYPE 3-3



Truktype.pre

R12-1

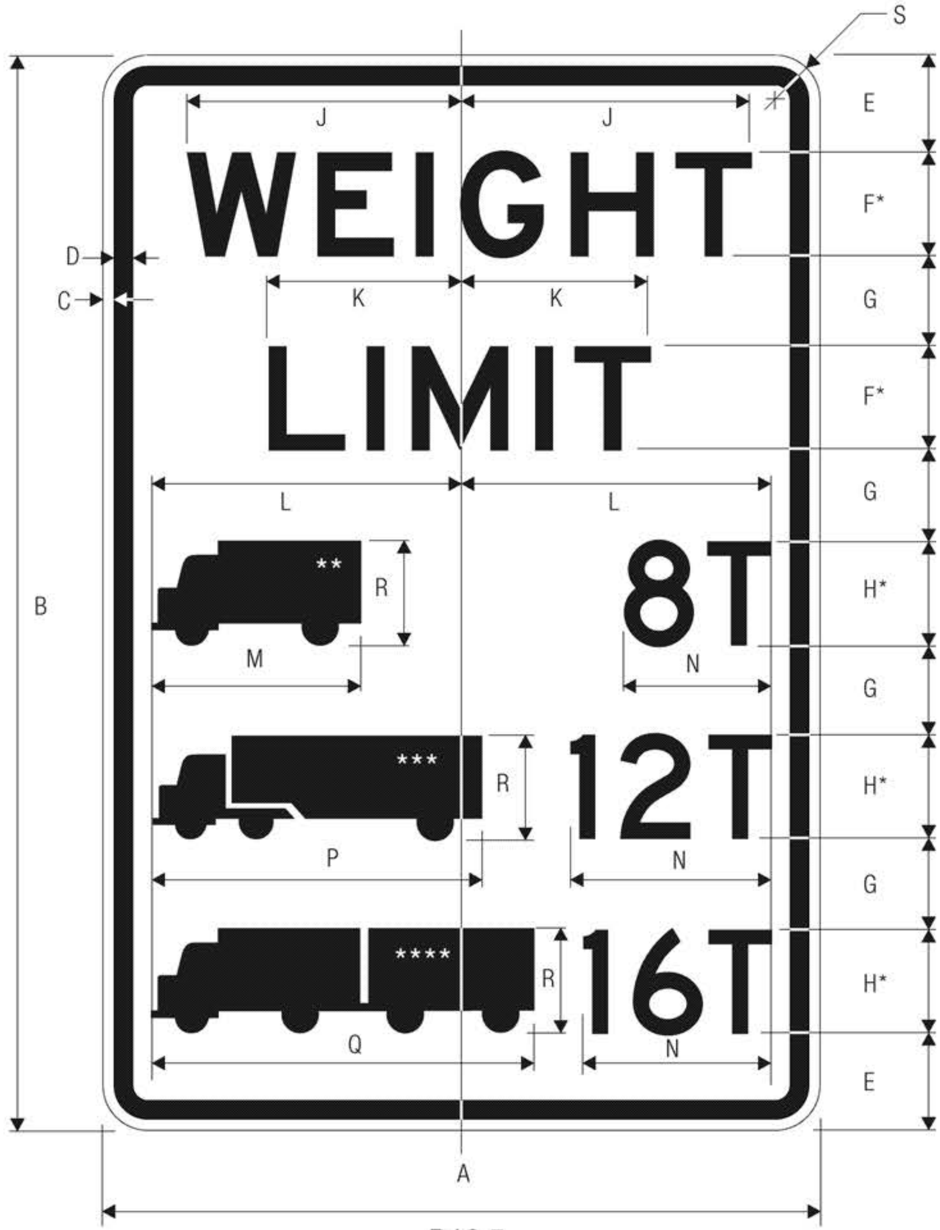
WEIGHT LIMIT

*Optically space numerals about centerline.

	A	B	C	D	E	F	G	H	J	K	L
C	24	30	.375	.625	3	4 D	1.75	2.125	5 E	5D	9
	36	48	.625	.875	4.75	6 D	3	3.75	8 E	8 D	13.5

M	N	P	Q
9.5	6.313	8.25	1.5
14.25	9.438	13.25	2.25

COLORS: LEGEND — BLACK
BACKGROUND— WHITE (RETROREFLECTIVE)



R12-5

WEIGHT LIMIT

*Series 2000 Standard Alphabets.
**See page 6-4 for design
***See page 6-5 for design
****See page 6-6 for design

	A	B	C	D	E	F	G	H	J	K	L	M
C	24	36	.375	.625	3.25	3.5 E	3	3.5 D	9.465	6.403	10.375	7
	30	42	.5	.75	3.75	4.5 E	3	4.5 D	12.016	8.192	13.188	9
	36	48	.625	.875	5	5 E	3.25	5 D	13.350	9.099	15	10
	48	60	.75	1.25	6	6 E	4.5	6 D	16.02	10.918	19	12

N	P	Q	R	S
VAR	11	12.813	3.5	1.5
VAR	13.438	16.438	4.5	1.875
VAR	15.438	18.375	5	2.25
VAR	19.688	22	6	3

COLORS: LEGEND — BLACK
BACKGROUND— WHITE (RETROREFLECTIVE)

Montana Department of Transportation **Bridge Design / Management Memo**	**Bridge Memo Number:** 13-02 **Date Issued:** February 22, 2013 **Date Effective:** February 22, 2013 **Date Revised:**
Subject: Guidelines For Working With Owners On Bridge Load Posting	

To: Bridge Bureau

From: Kent M. Barnes, P.E.
Bridge Engineer

☐ In-House Design	☐ Consultant Design
☒ Bridge Management	☒ Condition Inspection

Introduction

Bridges that need to be Load Posted are occasionally identified. The bridge condition may have changed or signs may be missing. For public safety, posting needs to be accomplished in a timely manner. This memo is intended to describe a general practice for working with bridge owners on the Load Posting needs. Each situation is unique and the process followed will be adjusted to meet the specific needs.

Guidelines

The Bridge Management Engineer determines the Safe Posting Load for a bridge and notifies the Owner.

- Notify the Owner by letter, email, and possibly telephone.
- Request that the District Administrator or the District Bridge Inspection Coordinator also contact the Owner.
- Follow-up as needed to achieve timely results.

The urgency for Load Posting varies with the individual situation. When a bridge closure is recommended, encourage the Owner to act immediately. Small changes in the Safe Posting Load are less time critical. In all cases, our goal should be to establish proper posting within 30 days of notifying the Owner.

Owners occasionally feel our Safe Posting Loads are excessively conservative. Owners may have their Engineer determine the Safe Posting Load. Request a letter signed by a Montana PE giving the Safe Posting Load and ask for documentation for our files. We don't need to formally review this documentation. The bridge should be posted to our Safe Posting Load while the Owner's Engineer determines the Owner's Safe Posting Load.

Closing

These guidelines are intended to help document our process for load posting bridges.

KMB:Bridge Memo 13-02

copies: file

Chapter 9 – Underwater Inspection

9.1 – Background and Inspection Determination

9.1.1 Background

On Sunday, April 5, 1987 the center and east center span of the 542-foot-long bridge on the New York State thruway over Schoharie Creek in Montgomery County, New York, collapsed during a near record flood. About an hour and a half later the west center span fell into the water and the western-most span slid off the abutment. One semitrailer and four automobiles fell into the river after the first span collapsed, resulting in ten fatalities.

The investigation of the tragedy indicated that there was a cumulative effect of local scour around pier three over the last ten years. The bridge was designed with shallow spread footings and riprap to protect the piers.

Following the collapse of the Schoharie Creek Bridge, the Federal Register in Part 650-Bridges, Structures, and Hydraulics, added the following:

> "The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting and inventory shall determine and designate on the individual inspection and inventory records and maintain a master list of … those bridges with underwater members which cannot be visually evaluated during periods of low flow or examined by feel for condition, integrity and safe load capacity due to excessive water depth or turbidity. These members shall be described, the inspection frequency stated, not to exceed five years, and the inspection procedure specified."

This statement is the basis for Montana's underwater inspection program. All states are required to have criteria and a master list of structures requiring underwater inspections.

In addition, the December, 2014 review of the Montana bridge inspection program found MDT to deficient under Metric 15. A review of MDT's bridge files found that "for all bridges over water, not all waterway information is collected and maintained (filed)". The waterway information in question was stream cross-sections. Due to this finding, MDT created a plan of action to correct this deficiency. The guidance below is intended to clarify MDT's policy on underwater inspection requirements, and correct the deficiency under Metric 15.

9.1.2 Underwater Inspection Purpose

The purpose of an underwater inspection of a bridge is twofold:

1. To assess the condition of those substructure units under water
2. To determine the bridge's susceptibility to scour

9.1.3 Underwater Inspection Determination

A bridge with substructure elements in water that is more than two feet deep year-round requires an underwater inspection.

Bridges whose substructure units at some time are dry or in very shallow water (making a full inspection possible without the use of special equipment) do not require an underwater inspection unless NBI item 113, Scour Critical Status, is coded as a 3. This includes single-span bridges where the abutments are not in the water.

If NBI item 113 is coded as a 3, regardless of whether the substructure units are dry or in very shallow water at the time of the inspection, cross-sections are required. This means that all bridges with NBI item 113 coded as 3 require an underwater inspection.

If element 900, Scour, has been added to the bridge, an underwater inspection is required.

If any undermining of the abutments is present, regardless of whether they are in the water when the inspection is done, an underwater inspection is required.

Once it has been determined that a bridge requires an underwater inspection, it will be placed in one of two categories:

1. Type 1 Underwater Inspection
2. Type 2 Underwater Inspection

The first determination an inspector must make is whether the bridge requires underwater inspection. See the guidelines above to determine whether a bridge requires underwater inspection. If a bridge does not meet the requirements above for an underwater inspection, the inspector may still do underwater inspections on the bridge if they are deemed necessary.

Keep in mind the time of year you are looking at the bridge, and what it may look like during a different time of the year.

Example: you're looking at a bridge in March trying to determine whether it requires an underwater inspection. The substructure units are in 3 to 4 feet of clear water, and for that reason you feel it requires a Type 1 Underwater Inspection. Consider the possibility that in October or November, a lower water level will allow complete visual access to all portions of the bridge. If – in your judgment – this is the case, the bridge does not require an underwater inspection. The regular inspection, however, MUST be conducted when the water is low and all of the substructure units can be visually inspected.

Next, the inspector needs to determine what kind of underwater inspection is required. On bridges where the substructure units remain under water year-round, the inspector must determine whether at some time it will be possible to adequately inspect all underwater portions using waders or a boat. If the answer is no, the inspector will notify the Bridge Management Section. Bridge Management Section personnel will review the recommendation, and change the underwater inspection requirements as needed.

9.1.3.1 Type 1 Underwater Inspection

Bridges that require an underwater inspection and can be inspected by personnel using special equipment (waders, boat, fathometer, probe), qualify for Type 1 Underwater Inspections.

The inspector must be able to fully evaluate the condition of the substructure unit using waders or working from a boat. To accomplish this, the water must be clear enough to allow a thorough visual examination of all substructure units. The inspector must be able to perform any cleaning which may be necessary to access all portions of the substructure unit.

If the water is not clear enough for a full visual inspection, it must be shallow enough to allow inspectors to feel the condition of all substructure units and determine the possibility of undermining.

These bridges will be given a 48 month inspection interval. Adjustments to the frequency of these inspections will be made if it is decided that the bridge requires more intensive monitoring.

9.1.3.1.1 Performing Type 1 Underwater Inspections

In the case of a pile cap or spread footing, the inspector will indicate to what extent, if any, the footings are exposed or undermined. The inspector will also record the condition of the underwater substructure elements and note the depth of any localized scour.

In the case of driven piles or drilled shafts, the inspector will determine the condition of the underwater substructure elements, and note the depth of any localized scour at the piles or shafts.

Type 1 Underwater Inspection – Streamflow Condition
The Type 1 Underwater Inspection form in SMS will be filled out to indicate the condition of the items listed in the form. Fields to fill out include inventory items such as the number of piers, pier width, and pier nose shape; and inspection items such as the angle of attack, whether flow is impinging on the abutment or wingwall, etc.

Type 1 Underwater Inspection – Element Condition
The condition of elements that are underwater, such as piles and footings, will be noted and entered into the inspection form. Only those elements underwater need to be inspected during an underwater inspection.

Type 1 Underwater Inspection – Cross-Sections
Inspectors will take cross-section measurements of the streambed along the upstream face of the bridge during all Type 1 Underwater Inspections. These cross-sections may be taken using survey equipment or using a survey rod or sonar device to determine the depth of the water at each point and measuring the vertical distance from the reference point to the water level. The reference point for all cross-sections is the paving notch at centerline at

abutment 1. See figure 9.1.3.1.1-1 for a sketch showing the cross-section reference point. Cross-section measurements will be entered into the appropriate form in the Bridge Management System.

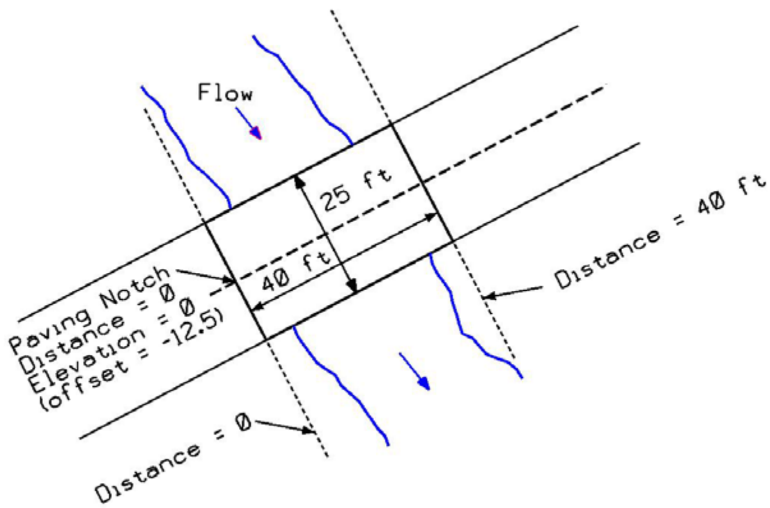


Figure 9.1.3.1.1-1

Cross-sections may also be taken farther upstream or downstream of the upstream face of the bridge as needed. These cross-sections will be entered with an offset measured from the upstream face of the bridge. The distance from the upstream face of the bridge will be entered as an offset. A offset distance upstream will be entered as a positive number, and the distance downstream will be entered as a negative number. See figure 9.1.3.1.1-2 for more information.

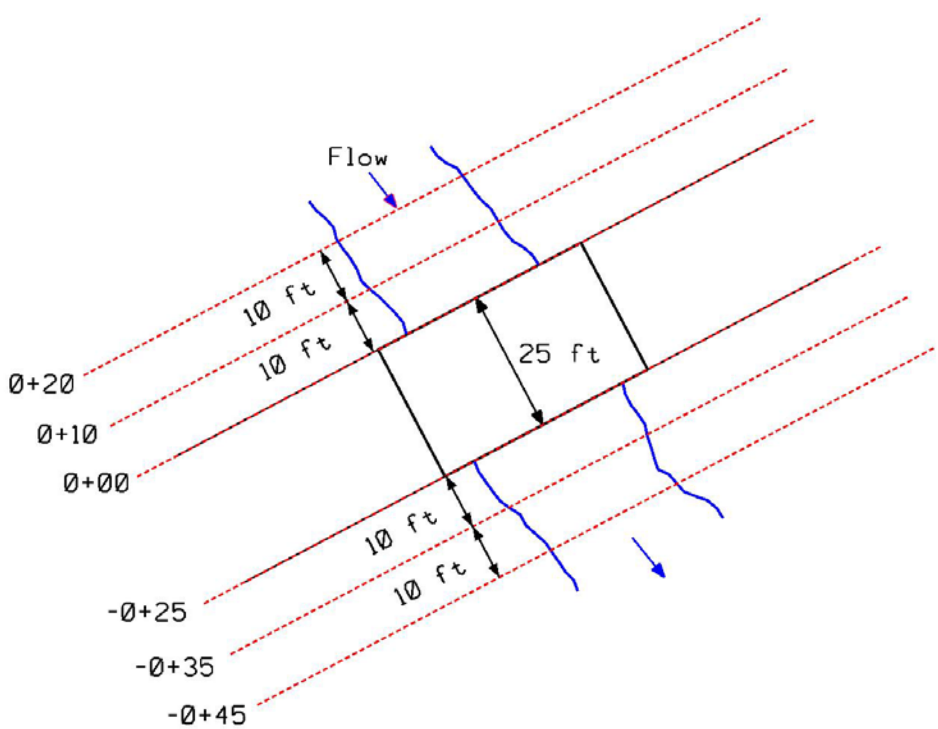


Figure 9.1.3.1.1-2

9.1.3.2 Type 2 Underwater Inspection

Bridges that require an underwater inspection, but cannot be inspected using Type 1 Underwater Inspection methods require inspection by a diver. Diving inspections are performed by consultants under a contract managed by the Bridge Management Section in Helena. Diving inspections include stream cross-sections taken by the consultant and entered into SMS using the procedures for cross-sections as described above for Type 1 Underwater Inspection - Cross-Sections.

Type 2 Underwater Inspections are given a 60 month inspection interval.

Streams are dynamic, and always changing their position, shape and other morphological characteristics with variation in discharge and the passage of time. When a channel at or near a bridge is modified, this local change frequently causes modification of the channel characteristics both upstream and downstream. Conversely, channel modifications above or below the bridge can affect channel characteristics within the bridge crossing. Understanding stream processes and the stream scour and stability factors will assist the inspector coding items as related to the element level inspection, NBIS inspection and the MDT Scour Appraisal.

Stability

Rivers and streams are dynamic and always changing the position, shape, and other characteristics with discharge and the passage of time. When a channel at or near a bridge is modified, this local change frequently case modification of channel characteristics both upstream and downstream.

Stream stability is dependent on several factors. Each factor relates to stream stability.

Stream Size

Flow depth tends to increase with increasing stream size. The potential for scour increases with increasing depth. Lateral erosion potential also increases with increasing stream size.

Flow Habit

Ephemeral	Flows in direct response to rainfall (including intermittent streams)
Perennial, but Flashy	Flows all or most of the year, but responds to precipitation by rapid changes in stage and discharge
Perennial	Flows all or most of the year

Bed Material

Streams can be classified by the dominant size of the sediment on their beds. There is no direct relation between bed material size and incidence of scour problems. Deep scour holes are generally more probable in fine bed material. All bed material can erode; it is a function of time.

Valley Setting

Streams in mountainous areas have high relief have low hydraulic problems at bridge crossings due to coarse bed material, narrow floodplains, and non-alluvial type conditions. In contrast streams in regions of lower relief are usually alluvial and have more problems due to more active channels.

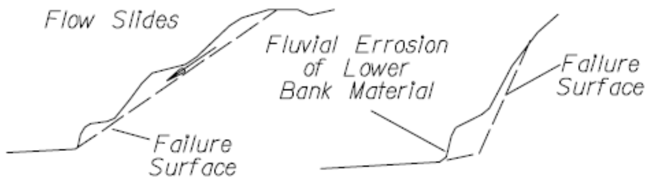
Floodplains

Floodplains width affects the length of the highway crossing, composed of the approach embankments and the bridge. For longer highway crossings there are usually more bridge components exposed to the flow.

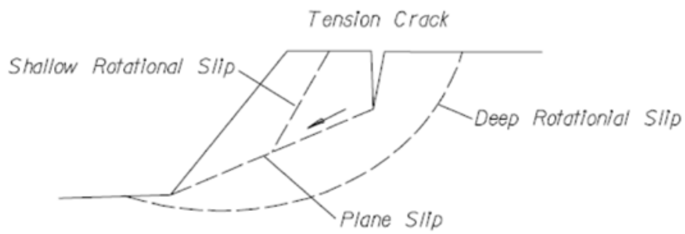
Channel Boundaries

Channel Boundaries may be alluvial, semi-alluvial, or non-alluvial. Alluvial channels may be defined as channels that are formed in materials that have been and can be transported by water. Non-alluvial channels may be defined as channels in bedrock or in very large material (cobbles or boulders).

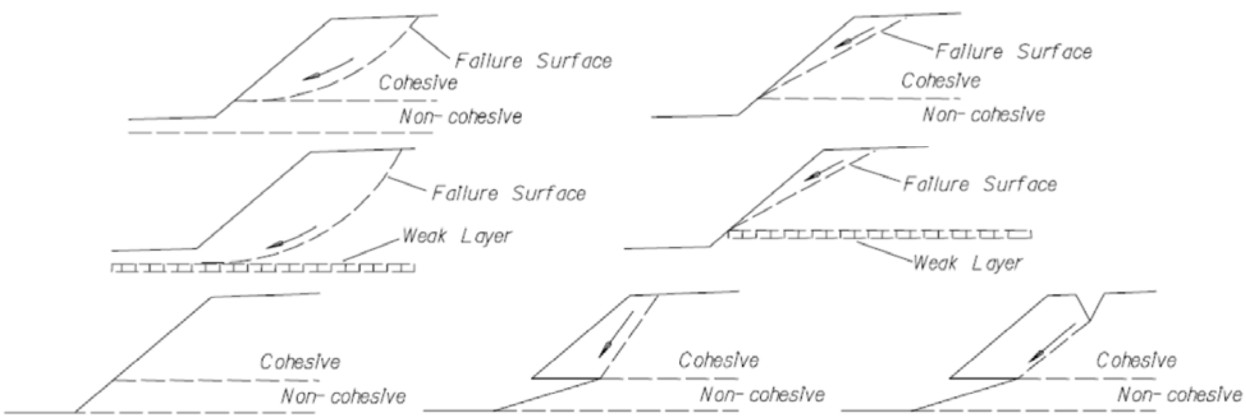
Bank appearance is good indicator of stability. Tree cover or vegetative cover on the channel banks or over-bank (riparian vegetation) can provide stability against lateral channel erosion. Typical bank failure can be categorized as non-cohesive, cohesive and composite failure.



Non-cohesive



Cohesive

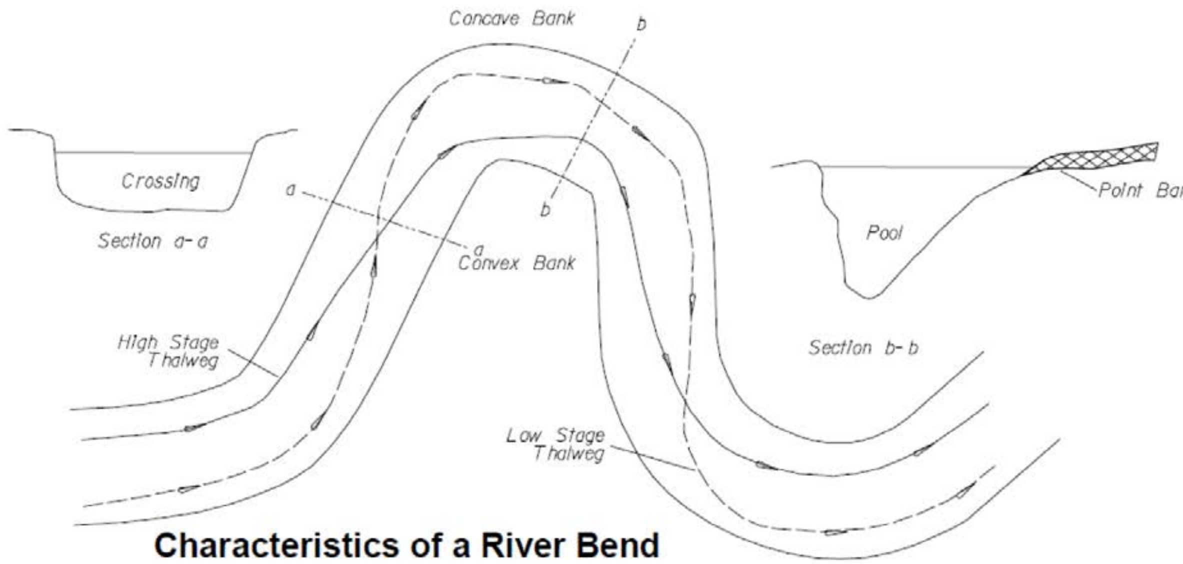


Composite

Meandering Streams
A meandering channel consists of pools and crossings. The thalweg, (deepest point in the cross section where the main current is flowing) water is flowing from pool to pool through the crossings in an S-shaped alignment.

The degree of meandering is described by sinuosity, defined as the ratio of the thalweg distance to the valley distance. Straight channels have a sinuosity of one.

For a meandering stream, erosion generally attacks the outside of the meander bend. Deposition occurs on the point bar on the inside of the bend.



Characteristics of a River Bend

Scour

In general scour involves the removal of material from the bed and banks across all or most of the width of a channel. General scour can result from a contraction of the flow, a change in downstream control of the water surface elevation, or the location of the bridge in relation to a bend. The most common form of general scour at a bridge is caused by the approach embankments to the bridge encroaching onto the flood plain or into the main channel with resulting contraction of the flow. General scour at a bridge can also be caused by a decrease in flow area or an increase in velocity. The decrease in flow area may be naturally occurring or may be caused by the structure. If the structure is located on or close to a bend, the concentration of the flow on the outer part of the channel can erode the bed. The contraction of flow at the bridge can be caused by a decrease in flow area of the stream channel by the abutments projecting into the channel, or the piers taking up a large portion of the flow area.

Aggradation and Degradation

Aggradation is deposition of material in the streambed. This deposition of material over time will raise the streambed. Degradation is the lowering or scouring of the bed of the stream over relatively long distances. Long-term degradation is generally estimated by comparing successive cross section plots or the change in thalweg profiles over time.

Contraction Scour

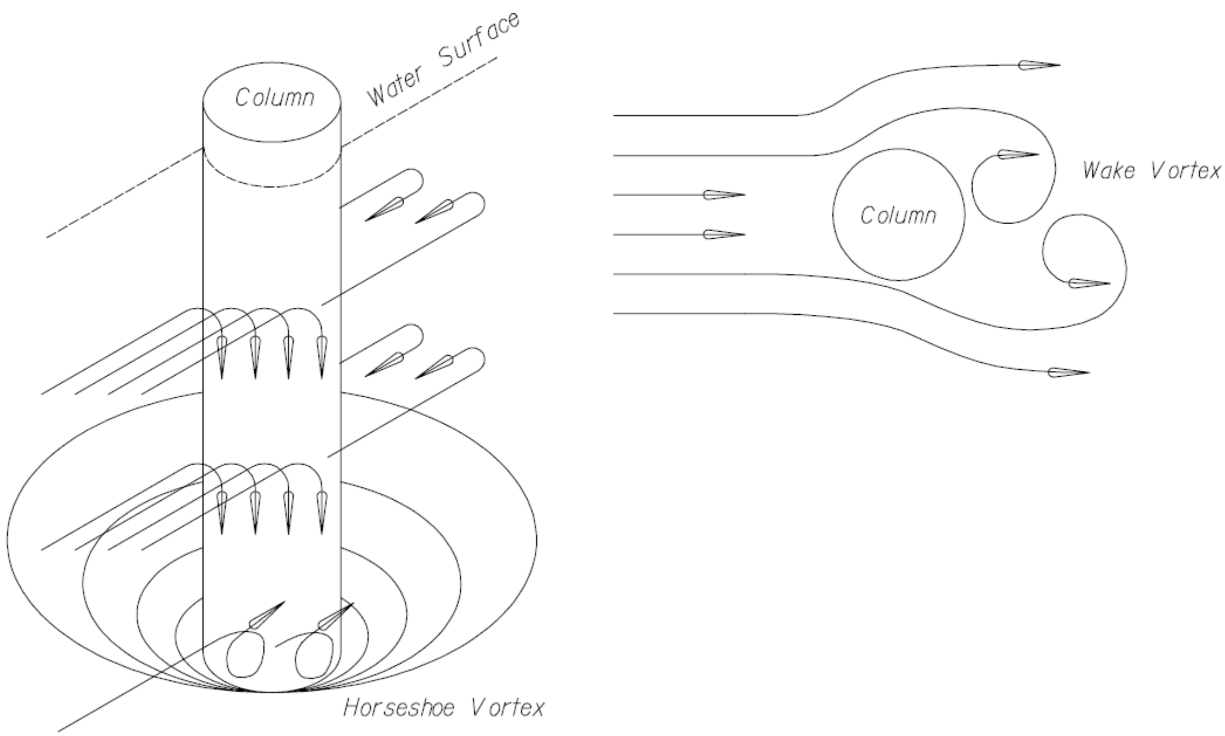
The flow will remain constant in the reach of river upstream and downstream of a bridge. Therefore, if the area of the bridge opening is smaller than the area of the channel, the velocity of the water through the bridge must be greater than the velocity upstream. Since the speed of the water increases as it travels through the bridge opening, its ability to scour the streambed also increases. For this reason the potential for scour is magnified at any bridge which constricts a channel.

The amount of scour that can take place depends a great deal on the size and type of streambed material. If a bridge is founded on bedrock, for example, the fact that it constricts the channel will have very little effect on its stability. Conversely if the streambed is a silt, constricting the channel may cause a very significant increase in the possibility of a failure due to scour. Between the two extremes are bed materials with varying degrees of scour susceptibility. It is very important, therefore, that the inspector note the makeup of the streambed in the vicinity of the bridge.

Local Scour

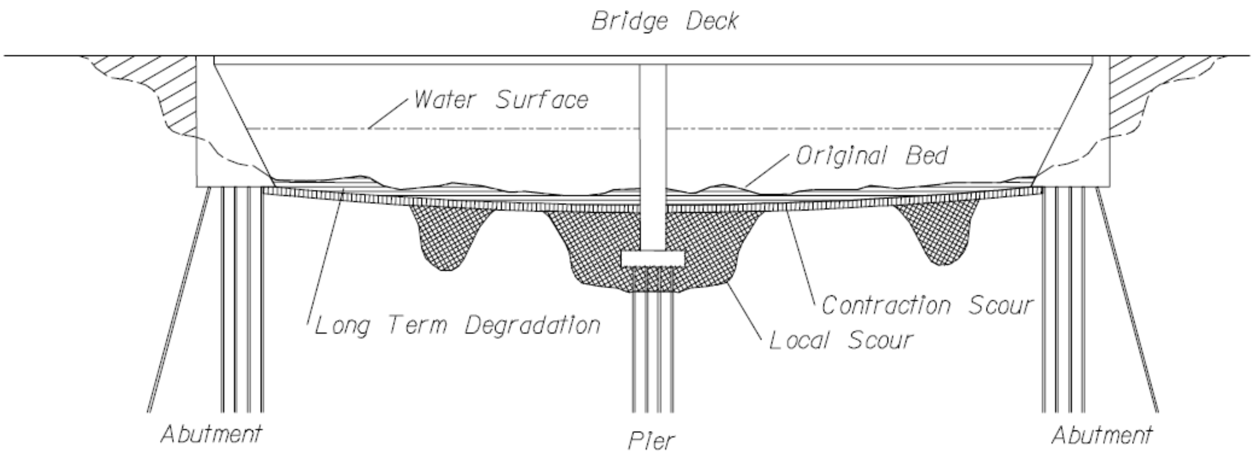
Obstructions to the flow such as a bridge pier will create a turbulence that can also cause scour. Local scour is dependent on the depth and velocity of flow, size of the bed material, the approach flow's angle of attack, the width of the pier and shape of the pier nose.

The extent to which this occurs relies largely on how streamlined the pier is. The pier, which splits the water with the least amount of disruption to the flow, will cause the least amount of turbulence. Therefore, the width of the pier as well as the shape of its nose will have a direct bearing on the amount of local scour.



Total Scour

Total scour is generally the sum of the aggradation or degradation, contraction and local scour.



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The underwater inspection involves assessing the condition of the bridge elements under water. In this regard an underwater inspection is no different than a normal above water inspection. The inspector must be able to thoroughly evaluate and rate the structural condition of the element in question.

An underwater inspection also involves determining the extent of scour present and the potential for future problems. For this the inspector must not only assess the condition of the bridge but the streambed as well. The inspector must determine the interaction between the bridge and stream. Measure how much the stream is affecting the bridge or the bridge affecting the stream.

The inspector will complete the underwater assessment, which incorporates both a structure condition appraisal and a scour evaluation. This evaluation includes:

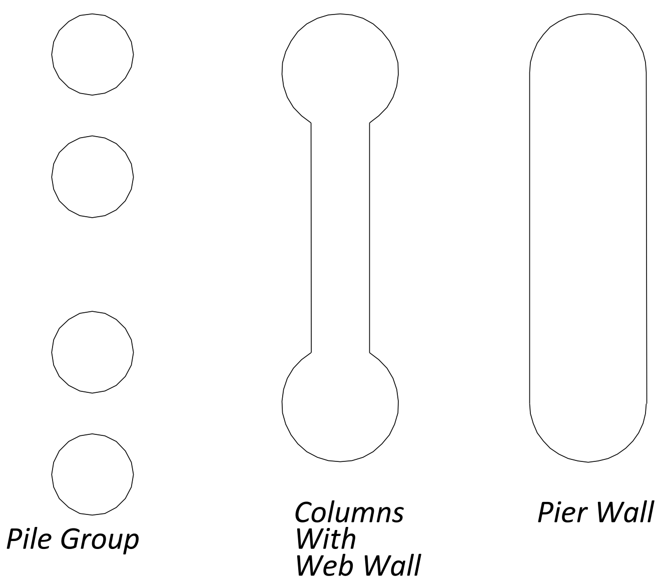
Element Level Inspection	Elements 200 through 299, 800 Through 899 Defect 4000 Settlement Element 900 Scour, 901 Countermeasures
NBIS Coding Items	Item 60 Substructure Item 61 Channel and Channel Protection Item 71 Waterway Adequacy
MDT Scour Appraisal	MDT's Twelve evaluation questions to assist in evaluation of NBIS Item 113 Scour Critical Bridges

Scour Appraisal

There are twelve evaluation questions for the scour appraisal and ranking of the bridge for scour susceptibility.

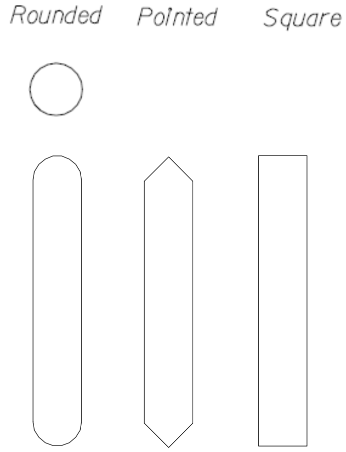
1. Number of Piers

Count the number of piers in the active channel. Each pier is one point.



Examples of Piers - Count as one pier

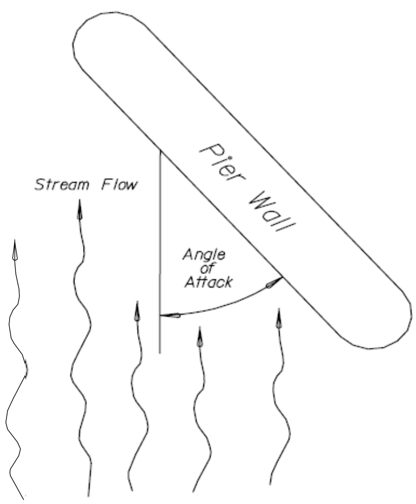
2. Pier Nose Shape



Record the pier nose shape.

Shape	Value
Rounded	0
Pointed	1
Square	2

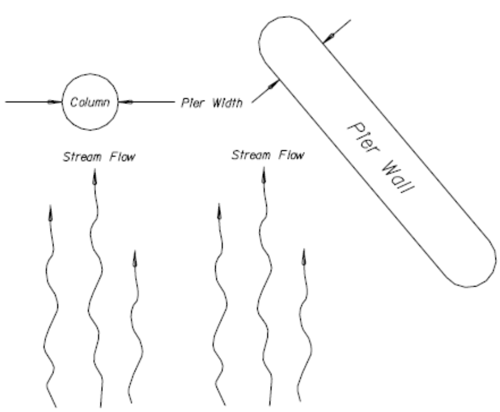
3. Angle of Attack



The acute angle between the pier and the direction of the stream flow.

Angle of Attack	Value
0° to 10°	0
11° to 20°	1
21° to 30°	2
31° to 40°	3
> 40°	4

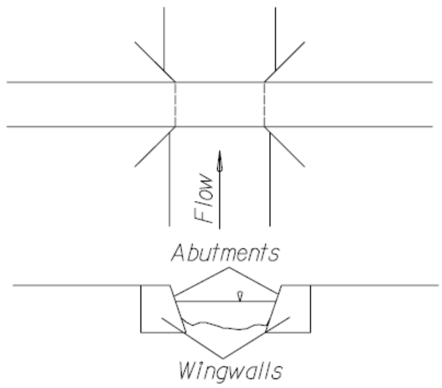
4. Pier Width



Measurement of the pier in the direction of flow.

Width	Value
< 3’	0
3’ to 4’	1
4’< to 7’	2
7’< to 9’	3

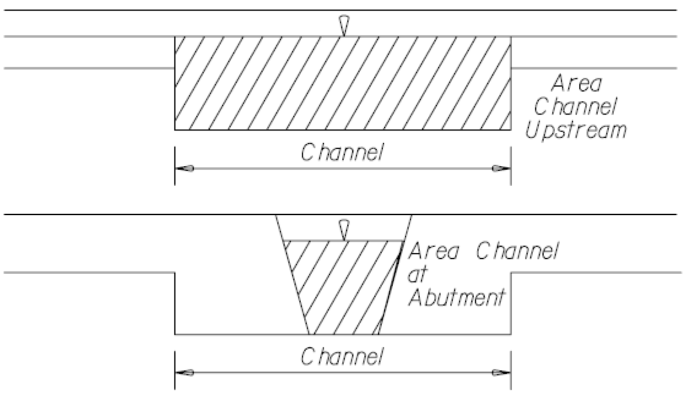
5. Flow impinging on abutment or wingwall



Stream flow hitting the abutment.

Impinging	Value
Yes	2
No	0

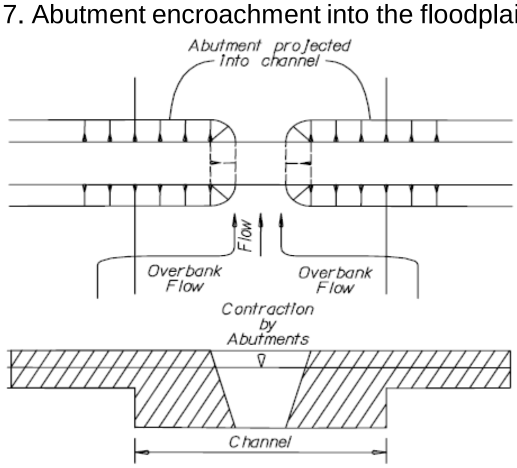
6. Amount of Channel Constriction
= Area at Bridge Opening /
Area of Upstream Channel



Estimate the area of the opening at the structure and divide by estimated nominal channel size upstream.

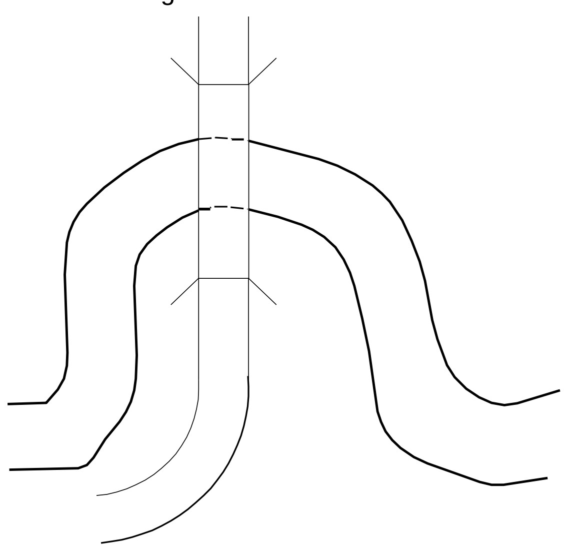
Area Percentage	Value
>90%	0
75% to 90%	1
50 to < 75%	2
< 50%	3

7. Abutment encroachment into the floodplain

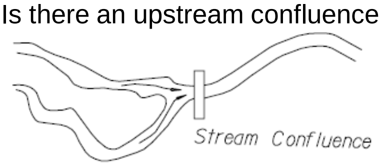


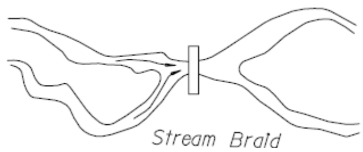
Does the bridge encroach into the stream floodplain?

Floodplain	Value
Yes	1
No	0

8. Constriction due to channel vegetation	Is there a large amount of vegetation growing in or encroaching into the stream channel restricting flow? Constriction — Value None — 0 Low — 1 Medium — 2 High — 3
9. Potential for Debris/Ice Accumulation	Material in the stream that will allow the accumulation of ice or debris causing scour or undermining of the bridge substructure Buildup Potential — Value None — 0 Low — 1 Medium — 2 High — 3
10. Bed Material	Makeup of the stream channel material. Material Type — Value Bedrock — 0 Boulder/Cobble — 1 Gravel — 2 Sand — 3 Silt/Clay — 4
11. Is the bridge located at a stream bend? 	Is the bridge located at a sharp bend on a meandering stream? Stream Bend — Value Yes — 1 No — 0

12. Is there an upstream confluence nearby?





Is the bridge located at near a confluence of two streams or braids?

Stream Confluence	Value
Yes	1
No	0

Cross Sections

Soundings shall be made along the circumference of all substructure components. Stream cross-sections shall be made within the limits established by the table below.

BRIDGE LENGTH	LIMITS OF STREAM CROSS SECTIONS (Up and Downstream)
< 100 feet	Length of bridge *
>= 100 feet	100 feet *

* If the inspector feels conditions at the site warrant the need for more cross sections, these limits should be extended.

The number of cross sections required will be left to the discretion of the inspector. There should be enough to adequately show the depth and extent of scour in the vicinity of the bridge. The soundings shall be taken continuously on a recording depth sounder, or at ten (10) foot intervals if spot sounding is used. In the latter case additional soundings shall be made as necessary to identify significant features or abrupt changes in the channel bottom.

After the initial soundings at the structure are made, Category I bridges will require only a single cross section at the upstream edge of the structure. If no change in the cross section is observed, no additional cross sections will be required.

The water surface and the datum used in taking the soundings shall be referenced to some point on the bridge. Generally this will be the top of deck or curb at a specific point, or the top of a pier. Piers and abutments shall be located on cross sections within bridge limits.

Contours

Where cross sections indicate the existence of scour problems a contour map shall be developed to establish the size, depth and location of each scour hole. The orientation and location of piers and abutments should be shown as well. If a footing is found to be exposed or undermined, the volume of the void should be dimensioned within an accuracy of half (1/2) foot in each direction.

Photos

As is the case with any inspection, photographs should be used to document the findings. These photos should include

- Inadequate waterway area
- Ice jams or flows
- Debris
- Channel and structure alignment
- Condition of the rip rap

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INTRODUCTION

The Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, hereafter referred to as the Guide, has been revised several times in the past. This latest edition revises the Guide to convert all of the units of measurement to the International System of Units (SI). It also provides more thorough and detailed guidance in evaluating and coding specific bridge data. New items have been added to include the reporting of Federal Lands Highway Systems, each State's existing linear referencing system (LRS), and the method used to determine the load ratings. Some items in the Guide have also been expanded to provide more definitive and explicit explanations and instructions for coding. Further, more basic definitions applicable to the instructions in the Guide are provided. The changes are based on comments received on the previous Guide and the metric version (January 1994) draft Guide. This revised Guide should be thoroughly reviewed by each individual involved with the National Bridge Inspection Program.

This Guide has been prepared for use by the States, Federal and other agencies in recording and coding the data elements that will comprise the National Bridge Inventory data base. By having a complete and thorough inventory, an accurate report can be made to the Congress on the number and state of the Nation's bridges. The Guide also provides the data necessary for the Federal Highway Administration (FHWA) and the Military Traffic Management Command to identify and classify the Strategic Highway Corridor Network and it's connectors for defense purposes.

The coded items in this Guide are considered to be an integral part of the data base that can be used to meet several Federal reporting requirements, as well as part of the States' needs. These requirements are set forth in the National Bridge Inspection Standards (23 CFR 650.3) which are included as Appendix C. A complete, thorough, accurate, and compatible data base is the foundation of an effective bridge management system. Reports submitted in connection with the Highway Bridge Replacement and Rehabilitation Program and the National Bridge Inspection Program also are related to this Guide.

The AASHTO Manual for Condition Evaluation of Bridges discusses the various items of information that are to be recorded as part of original bridge reports. That manual and the Bridge Inspector's Training Manual/90, with supplements, discuss inspection procedures and the preparation of detailed reports about the structure components. These reports will be the basis for recording values for many of the data elements shown in the Guide, particularly those having to do with the condition or the appraisal ratings.

Some bridge owners are collecting bridge condition ratings for items included in this Guide (Items 58-Deck, 59-Superstructure, 60-Substructure, and 62-Culvere) using the American Association of

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Highway and Transportation Officials' (AASHTO) Guide for Commonly Recognized (CoRe) Structural Elements. CoRe element inspection ratings provide detailed condition assessments that can serve as input into a comprehensive bridge management system (BMS). The FHWA has provided bridge owners with a computer program for translating bridge condition data in the CoRe element format to National Bridge Inventory (NBI) condition ratings for the purpose of NBI data submittal to FHWA. The purpose of the program is to permit bridge inspectors to record condition information in a format that satisfies both BMS and NBI data collection requirements.

The Structure Inventory and Appraisal (SI&A) Sheet and the sufficiency rating formula, with examples, are included as Appendices A and B, respectively. The SI&A sheet is intended to be a tabulation of the pertinent elements of information about an individual structure. Its use is optional, subject to the statements in the preceding paragraph of this Introduction. It is important to note that the SI&A Sheet is not an inspection form but merely a summary sheet of bridge data required by the FHWA to effectively monitor and manage a National bridge program.

States, Federal and other agencies are encouraged to use the codes and instructions in this Guide. However, its direct use is optional; each agency may use its own code scheme provided that the data are directly translatable into the Guide format. When data are requested by FHWA, the format will be based on the codes and instructions in this Guide. An agency choosing to use its own codes shall provide for translation or conversion of its own codes into those used in the Guide. In other words, agencies are responsible for having the capability to obtain, store, and report certain information about bridges whether or not this Guide or the SI&A Sheet is used. Any requests by the FHWA for submittals of these data will be based on the definitions, explanations, and codes supplied in the Guide, the AASHTO Manual for Condition Evaluation of Bridges and the Bridge Inspector's Training Manual/90 plus supplements.

The values provided in the tables or otherwise listed in this Guide are for rating purposes only. Current design standards must be used for structure design or rehabilitation. All possible combinations of actual site characteristics are not provided in this Guide. If a special situation not listed in the Guide is encountered, the evaluation criteria closest to the actual site situation should be used.

The implementation of this Guide may require some restructuring of an agency's data base and support software. If so, it is suggested that the agency consider the additional enhancements that would be necessary to support a bridge management system.

Appendix D is a Commentary that compares, item by item, the 1988 Guide to this Guide. The Commentary will provide a ready reference for item changes.

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DEFINITION OF TERMS

The definitions of terms used in the Guide are provided below.

(1) Bridge. The National Bridge Inspection Standards published in the Code of Federal Regulations (23 CFR 650.3) give the following definition:

A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet* between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.
* (6.1 meters)

(b) Culvert. A structure designed hydraulically to take advantage of submergence to increase hydraulic capacity. Culverts, as distinguished from bridges, are usually covered with embankment and are composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert. Culverts may qualify to be considered "bridge" length.

(c) Inventory Route. The route for which the applicable inventory data is to be recorded. The inventory route may be on the structure or under the structure. Generally inventories along a route are made from west to east and south to north.

(d) National Bridge Inventory (NBI). The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards. Each State shall prepare and maintain an inventory of all bridges subject to the NBIS.

(e) National Bridge Inventory (NBI) Record. Data which has been coded according to the Guide for each structure carrying highway traffic or each inventory route which goes under a structure. These data are furnished and stored in a compact alphanumeric format on magnetic tapes or disks suitable for electronic data processing.

(f) National Bridge Inspection Standards (NBIS). Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a State bridge inventory. The NBIS apply to all structures defined as bridges located on all public roads.

(g) Public Road. Any road under the jurisdiction of and maintained by a public authority and open to public travel.

(h) Structure Inventory and Appraisal (SI&A) Sheet. The graphic representation of the data recorded and stored for each NBI record in accordance with this Guide.

(i) Strategic Highway Corridor Network (STRAHNET). A system of highways which are strategically important to the defense of the United States. It includes the Interstate Highways and 25,215 kilometers of other non-interstate highways. The Military Traffic Management Command Report SE 89-4b-27, Strategic Highway Corridor Network, January 1991, contains additional information on STRAHNET.

(j) STRAHNET Connectors are roads that connect military installations and ports of embarkation to the STRAHNET. The connector routes represent about 3,042 kilometers of roads that complement STRAHNET.

(k) Indian Reservation Road (IRR). A public road that is located within or provides access to an Indian reservation as described in Title 23, U.S.C., Sect.101. The terminus of a road providing access to an Indian reservation or other Indian land is defined as the point at which the road intersects with a road functionally classified as a collector or higher classification (outside the reservation boundary) in both urban and rural areas. In the case of access from an Interstate Highway, the terminus is the first interchange outside the reservation.

(l) Land Management Highway System (LMHS). Consists of adjoining state and local public roads that provide major public access to Bureau of Land Management administered public lands, resources, and facilities.

(m) Forest Highway (FH). A road, under the jurisdiction of, and maintained by, a public authority and open to public travel; wholly or partly within, or adjacent to, and serving the National Forest System (NFS) and which is necessary for the protection, administration, and utilization of the NFS and the use and development of its resources. (23 CFR 660).

(n) Forest Service Development Road. A forest road wholly under the jurisdiction of the Forest Service, which may be "open to public travel". Bridges on Forest Service Development Roads which are "open to public travel" are subject to the NBIS.

(o) Base Highway Network. The Base Highway Network includes the through lane (mainline) portions of the NHS, rural/urban principal arterial system and rural minor arterial system. Ramps, frontage roads and other roadways are not included in the Base Network.

(p) Highway Performance Monitoring System. The Highway Performance Monitoring System (HPMS) is a database of universe and sample data that describes the nation's public road mileage. The data are annually updated and submitted to FHWA by the State Highway Agencies, Puerto Rico and the District of Columbia. The universe data provides some basic characteristics of all public road mileage while the sample of the arterial and collector systems allows for assessment of the condition, performance, usage and additional characteristics of the nation's major highway systems.

(q) Conversion of Numerical Data. Throughout this Guide the following conversion factors are used:

Convert
- foot to meter multiply by 0.3048
- mile to kilometer multiply by 1.609
- english ton to metric ton multiply by .9

(r) Rounding and Truncating of Numerical Data. All numeral values in this Guide, except as specifically noted, will follow standard rounding criteria, that is, 5 and above will be rounded up to the next higher unit and 4 and below will be rounded down to the next lower unit. This is applicable to all decimal roundings. **In certain items where rounding may cause a safety hazard for clearance, the numeric measurements will be truncated at the appropriate decimal place.** This means that a fractional portion less than a whole unit will be dropped to the lower whole number, for example 2.88 would be truncated to 2.8 when using tenth of a meter accuracy. All decimal points are assumed in the locations as specified in the Guide.

(s) Commonly Recognized (CoRe) Structural Elements). A group of structural elements endorsed by AASHTO as a means of providing a uniform basis for data collection for any bridge management system, to enable the sharing of data between States, and to allow for a uniform translation of data to NBI Items 58, 59, 60 and 62.

(t) Bridge management System (BMS). A system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation and replacement of bridges.

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Section 2 – NBI Coding Items

Item 1 - State Code **3 digits**

The first 2 digits are the Federal Information Processing Standards (FIPS) code for States, and the third digit is the FHWA region code. (New Jersey and New York will retain an FHWA region code of 2.)

Code	State	Code	State
014	Alabama	308	Montana
020	Alaska	317	Nebraska
049	Arizona	329	Nevada
056	Arkansas	331	New Hampshire
069	California	342	New Jersey
088	Colorado	356	New Mexico
091	Connecticut	362	New York
103	Delaware	374	North Carolina
113	District of Columbia	388	North Dakota
124	Florida	395	Ohio
134	Georgia	406	Oklahoma
159	Hawaii	410	Oregon
160	Idaho	423	Pennsylvania
175	Illinois	441	Rhode Island
185	Indiana	454	South Carolina
197	Iowa	468	South Dakota
207	Kansas	474	Tennessee
214	Kentucky	486	Texas
226	Louisiana	498	Utah
231	Maine	501	Vermont
243	Maryland	513	Virginia
251	Massachusetts	530	Washington
265	Michigan	543	West Virginia
275	Minnesota	555	Wisconsin
284	Mississippi	568	Wyoming
297	Missouri	721	Puerto Rico

Item 2 - Highway Agency District **2 digits**

The highway agency district (State or Federal) in which the bridge is located shall be represented by a 2-digit code. Existing district numbers shall be used where districts are identified by number. Where districts are identified by name, a code number shall be assigned based on an alphabetical or organizational listing of the districts.

Item 3 - County (Parish) Code **3 digits**

Counties shall be identified using the Federal Information Processing Standards (FIPS) codes given in the current version of the Census of Population and Housing - Geographic Identification Code Scheme.

<u>Item 4 - Place Code</u> **5 digits**

Cities, towns, townships, villages, and other census-designated places shall be identified using the Federal Information Processing Standards (FIPS) codes given in the current version of the <u>Census of Population and Housing - Geographic Identification Code Scheme</u>. If there is no FIPS place code, then code all zeros.

<u>Item 5 - Inventory Route</u> **9 digits**

The inventory route is a 9-digit code composed of 5 segments.

Segment	Description	Length
5A	Record Type	1 digit
5B	Route Signing Prefix	1 digit
5C	Designated Level of Service	1 digit
5D	Route Number	5 digits
5E	Directional Suffix	1 digit

<u>Item 5A - Record Type</u> **1 digit**

There are two types of National Bridge Inventory records: "on" and "under". Code the first digit (leftmost) using one of the following codes:

Code	Description
1	Route carried "on" the structure
2	Single route goes "under" the structure
A through Z	Multiple routes go "under" the structure

A signifies the first of multiple routes under the structure.
B signifies the second of multiple routes under the structure.
Z signifies 26 routes under the structure.

"On" signifies that the inventory route is carried "on" the structure. Each bridge structure carrying highway traffic must have a record identified with a type code = 1 (numeric). All of the NBI data items must be coded, unless specifically excepted, with respect to the structure and the inventory route "on" it.

"Under" signifies that the inventory route goes "under" the structure. If an inventory route beneath the structure is a Federal-aid highway, is a STRAHNET route or connector or is otherwise important, a record must be coded to identify it. The type code must be 2 or an alphabetic letter A through Z. Code 2 for a single route under the structure. If 2 or more routes go under a structure on <u>separate</u> roadways, the code of 2 shall not be used. Code A, B, C, D, etc. consecutively for multiple routes on separate roadways under the same structure. STRAHNET routes shall be listed first. When this item is coded 2 or A through Z, only the following items must be coded: Items 1, 3-13, 16, 17, 19, 20, 26-30, 42, 43, 47-49, 100-104, 109 and 110. All other items may remain blank.

<u>Item 5A - Record Type</u> (cont'd)

It cannot be overemphasized that all route-oriented data must agree with the coding as to whether the inventory route is "on" or "under" the structure.

Tunnels shall be coded only as an "under" record; that is, they shall not be coded as a structure carrying highway traffic.

There are situations of a route "under" a structure, where the structure does not carry a highway, but may carry a railroad, pedestrian traffic, or even a building. These are coded the same as any other "under" record and no "on" record shall be coded.

<u>Item 5B - Route Signing Prefix</u> **1 digit**

In the second position, identify the route signing prefix for the inventory route using one of the following codes:

Code	Description
1	Interstate highway
2	U.S. numbered highway
3	State highway
4	County highway
5	City street
6	Federal lands road
7	State lands road
8	Other (include toll roads not otherwise indicated or identified above)

When 2 or more routes are concurrent, the highest class of route will be used. The hierarchy is in the order listed above.

<u>Item 5C - Designated Level of Service</u> **1 digit**

In the third position, identify the designated level of service for the inventory route using one of the following codes:

Code	Description
0	None of the below
1	Mainline
2	Alternate
3	Bypass
4	Spur
6	Business
7	Ramp, Wye, Connector, etc.
8	Service and/or unclassified frontage road

Item 5D - Route Number **5 digits**

Code the route number of the inventory route in the next 5 positions. This value shall be right justified in the field with leading zeros filled in. (See examples below.)

If concurrent routes are of the same hierarchy level, denoted by the route signing prefix, the lowest numbered route shall be coded. Code 00000 for bridges on roads without route numbers.

Item 5E - Directional Suffix **1 digit**

In the last position, code the directional suffix to the route number of the inventory route when it is part of the route number, using one of the following codes:

Code	Description
0	Not applicable
1	North
2	East
3	South
4	West

In some cases, letters may be used with route numbers and as part of the route numbers and not to indicate direction. In such cases, the letter should be included in the 5-position route number field.

EXAMPLES:	Record	Code
Interstate 95, on	1 1 1 00095 0	111000950
Interstate 70S, under	2 1 1 00070 3	211000703
State Highway 104, Spur, under	2 3 4 00104 0	234001040
U.S. 30E Bypass, on	1 2 3 00030 2	123000302
City street, on	1 5 0 00000 0	150000000
Ramp from I-81, under	2 1 7 00081 0	217000810
County Highway 173 on	1 4 1 00173 0	141001730
Interstate 84 under	2 1 1 00084 0	211000840
Interstate 495 on	1 1 1 00495 0	111004950
State Hwy 120 (STRAHNET Rte) under	A 3 1 00120 0	A31001200
Alternate State Hwy 130 under	B 3 2 00130 0	B32001300
Tunnel on Interstate 70	2 1 1 00070 0	211000700

Item 6 - Features Intersected **25 digits**

This item contains a description of the features intersected by the structure and a critical facility indicator. When Item 5A indicates an "under" record, this item describes the inventory route and/or features under the structure. There are 25 digits divided into 2 segments.

Segment	Description	Length
6A	Features Intersected	24 digits
6B	No Longer Coded (Blank)	1 digit

The information to be recorded for this item in the first 24 digits shall be the name or names of the features intersected by the structure. When one of the features intersected is another highway, the signed number or name of the highway shall appear first (leftmost) in the field. The names of any other features shall follow, separated by a semicolon or a comma. Parentheses shall be used to provide a second identification of the same feature (see third example). Abbreviations may be used where necessary, but an effort shall be made to keep them meaningful. The data in this segment shall be left justified in the first 24 positions without trailing zeros.

EXAMPLES:

I 81, US 51, MILL ROAD
MISSISSIPPI RIVER
SR 42 (POND ROAD)

Item 7 - Facility Carried by Structure **18 digits**

The facility being carried by the structure shall be recorded and coded. In all situations this item describes the use "on" the structure. This item shall be left justified without trailing zeros.

EXAMPLES:

US 66
MAIN STREET
COUNTY ROAD 450
C & 0 RAILROAD (appropriate for "under" record only)
PEDESTRIAN BRIDGE (appropriate for "under" record only)

Item 8 - Structure Number **15 digits**

It is required that the official structure number be recorded. It is not necessary to code this number according to an arbitrary national standard. Each agency should code the structure number according to its own internal processing procedures. When recording and coding for this item and following items, any structure or structures with a closed median should be considered as one structure, not two. Closed medians may have either mountable or non-mountable curbs or barriers.

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Item 8 - Structure Number (cont.) **15 digits**

The structure number must be unique for each bridge within the State, and once established should preferably never change for the life of the bridge. If it is essential that structure number(s) must be changed, all 15 digits are to be filled. For any structure number changes, a complete cross reference of corresponding "old" and "new" numbers must be provided to the FHWA Bridge Division. The cross reference shall include both a computer tape or diskette and a printed listing in the FHWA required format.

The identical structure number must appear on the "on" and all "under" records associated with a particular structure. (Refer to Item 5 - Inventory Route).

Item 9 - Location **25 digits**

This item contains a narrative description of the bridge location. It is recommended that the location be keyed to a distinguishable feature on an official highway department map such as road junctions and topographical features. This item shall be left justified without trailing zeros.

EXAMPLES:

6 km SW. OF RICHMOND
3.5 km S. OF JCT. SR 69

Item 10 - Inventory Route, Minimum Vertical Clearance **4 digits**
(XX.XX meters)

Code the minimum vertical clearance over the inventory route identified in Item 5, whether the route is "on" the structure or "under" the structure. The minimum clearance for a 3-meter width of the pavement or traveled part of the roadway where the clearance is the greatest shall be recorded and coded as a 4-digit number truncated to the hundredth of a meter (with an assumed decimal point). For structures having multiple openings, clearance for each opening shall be recorded, but only the greatest of the "minimum clearances" for the two or more openings shall be coded regardless of the direction of travel. This would be the practical maximum clearance. When no restriction exists or when the restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30.0 and 99.99 meters to an exact measurement is optional.

Item 11 - Kilometerpoint (XXXX.XXX) **7 digits**

The linear referencing system (LRS) kilometerpoint is used to establish the location of the bridge on the Base Highway Network (see Item 12). It must be from the same LRS Inventory Route and kilometerpoint system as reported in the Highway Performance Monitoring System (HPMS). The kilometerpoint coded in this item directly relates to Item 13 - LRS Inventory Route, Subroute Number.

This item must be coded for all structures located on or overpassing the Base Highway Network. Code a 7-digit number to represent the LRS kilometer-point distance in kilometers to the nearest thousandth (with an assumed decimal point). For structures carrying the LRS Inventory Route, code the kilometerpoint at the beginning of the structure (i.e. the lowest kilometer-point on the bridge). When the LRS Inventory Route goes under the structure (Item 5A coded 2 or A-Z), then code the kilometerpoint on the underpassing route where the structure is first encountered.

Item 11 - Kilometerpoint (cont.)(XXXX.XXX) 7 digits

Code all zeros in this field for all records where kilometerpoints are not provided. Kilometerpoints may be coded for bridges that are not located on the Base Highway Network, however Item 12 - Base Highway Network shall be coded 0 for these records.

The kilometerpoint is coded aligned to the assumed decimal point and zero filled where needed to fill the 7 digits.

EXAMPLES:	Code
Kilometerpoint is 130.34	0130340
Kilometerpoint is 9.60	0009600

Item 12 - Base Highway Network 1 digit

This item is to be coded for all records in the inventory. The Base Highway Network includes the through lane (mainline) portions of the NHS, rural/urban principal arterial system and rural minor arterial system. Ramps, frontage roads and other roadways are not included in the Base Network. For the inventory route identified in Item 5 - Inventory Route, indicate whether the inventory route is on the Base Highway Network or not on that network. Use one of the following codes:

Code	Description
0	Inventory Route is not on the Base Network
1	Inventory Route is on the Base Network

Item 13 - LRS Inventory Route, Subroute Number 12 digits

If Item 12 - Base Highway Network has been coded 1, the information to be recorded for this item is inventory route for the State's linear referencing system (LRS). If Item 12 has been coded 0, this entire item should be left blank. This item is a 12-digit code composed of 2 segments.

Segment	Description	Length
13A	LRS Inventory Route	10 digits
13B	Subroute Number	2 digits

The LRS inventory route and subroute numbers to be reported in this item must correspond to the LRS inventory route and subroute numbers reported by the State for the HPMS. The LRS inventory route number is coded in the ten positions of segment 13A, right justified and zero filled. The subroute number, if it exists, is coded in the two positions of segment 13B, right justified and zero filled.

Item 13 - LRS Inventory Route, Subroute Number (cont.) **12 digits**

The LRS inventory route number can be alphanumeric, but must not contain blanks. The LRS inventory route number is not necessarily the same as that posted along the roadway, but is a number used to uniquely identify a route within at least a county and perhaps throughout the State.

The subroute number is a number that uniquely identifies portions of an inventory route sections where duplicate kilometerpoints occur. These subroute numbers, if they exist, are identified in the State's HPMS-LRS records. If there is no subroute number, code 00 in this segment.

EXAMPLES:	Code
Inventory Route 2775, Subroute Number 0	000000277500
Inventory Route 2775, Subroute Number 3	000000277503

Item 14 and Item 15

(Reserved)

Item 16 - Latitude (XX degrees XX minutes XX.XX seconds) 8 digits

For bridges on STRAHNET and STRAHNET Connector highways and on the NHS, record and code the latitude of each in degrees, minutes and seconds to the nearest hundredth of a second (with an assumed decimal point). The point of the coordinate may be the beginning of the bridge in the direction of the inventory or any other consistent point of reference on the bridge which is compatible with the LRS. If the bridge is not on a STRAHNET highway or the NHS, a code of all zeros is acceptable, but it is preferable to code the latitude if available.

The reason for the increased precision is to facilitate the use of Global Positioning System (GPS) data directly into this item. The increased precision is not currently mandatory and, if GPS readings are not available, the current measuring methods and level of precision may continue to be used. The minimum precision should be to the nearest minute, but the preferred precision is to the nearest hundredth of a second using GPS methods.

EXAMPLE:	Code
Latitude is 35°27.3' (current precision)	35271800
(acceptable coding)	35270000
35°27'18.55" (GPS reading)	35271855

Item 17 - Longitude (XXX degrees XX minutes XX.XX seconds) 9 digits

For bridges on STRAHNET and STRAHNET Connector highways and on the NHS, record and code the longitude of each in degrees, minutes and seconds to the nearest hundredth of a second (with an assumed decimal point). A leading zero shall be coded where needed. The point of the coordinate may be the beginning of the bridge in the direction of the inventory or any other consistent point of reference on the bridge which is compatible with the LRS. If the bridge is not on a STRAHNET highway or the NHS, a code of all zeros is acceptable, but it is preferable to code the longitude if available.

<u>Item 17 - Longitude</u> (XXX degrees XX minutes XX.XX seconds) (cont.) 9 digits

The reason for the increased precision is to facilitate the use of Global Positioning System (GPS) data directly into this item. The increased precision is not currently mandatory and, if GPS readings are not available, the current measuring methods and level of precision may continue to be used. The minimum precision should be to the nearest minute, but the preferred precision is to the nearest hundredth of a second using GPS methods.

EXAMPLE:	Code
Longitude is 81°5.8' (current precision)	081054800
(acceptable coding)	081060000
81°5'50.65" (GPS reading)	081055065

<u>Item 18</u>

(reserved)

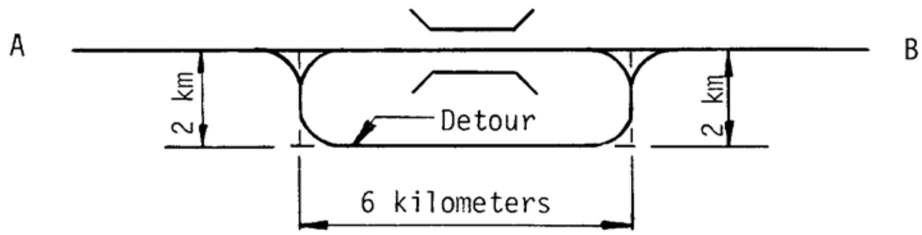
<u>Item 19 - Bypass, Detour Length</u> (XXX kilometers) 3 digits

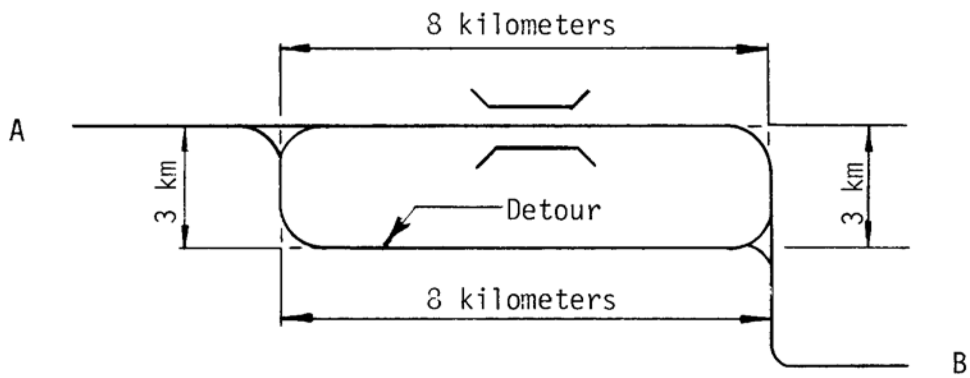
Indicate the actual length to the nearest kilometer of the detour length. The detour length should represent the total additional travel for a vehicle which would result from closing of the bridge. The factor to consider when determining if a bypass is available at the site is the potential for moving vehicles, including military vehicles, around the structure. This is particularly true when the structure is in an interchange. For instance, a bypass likely would be available in the case of diamond interchanges, interchanges where there are service roads available, or other interchanges where the positioning and layout of the ramps is such that they could be used without difficulty to get around the structure. If a ground level bypass is available at the structure site for the inventory route, record and code the detour length as 000.

If the bridge is one of twin bridges and is not at an interchange, code 001 where the other twin bridge can be used as a temporary bypass with a reasonable amount of crossover grading. The detour route will be established following allowable criteria determined by the governing authority. (Some authorities will not allow a designated detour over a road or bridge of lesser "quality.") Code 199 for 199 kilometers or more.

EXAMPLES:	Code
Diamond interchange, structure bypassable	000
Cloverleaf, not bypassable; 18-kilometer detour	018
Structure over river; 121-kilometer detour	121
Structure over highway, no interchange, bypassable at ground level	000
Structure on dead end road	199

<u>Item 19 - Bypass, Detour Length</u> (XXX kilometers) (cont) **3 digits**





Bypass, Detour Length A to B = 0 kilometers

<u>Item 20 - Toll</u> **1 digit**

The toll status of the structure is indicated by this item. Interstate toll segments under Secretarial Agreement (Title 23 - United States Code - Highways Section 129 as amended by 1991 ISTEA and prior legislation) shall be identified separately. Use one of the following codes:

Code		Description
1	Toll bridge.	Tolls are paid specifically to use the structure.
2	On toll road.	The structure carries a toll road, that is, tolls are paid to use the facility, which includes both the highway and the structure.
3	On free road.	The structure is toll-free and carries a toll-free highway.
4	On Interstate toll segment under Secretarial Agreement.	Structure functions as a part of the toll segment.
5	Toll bridge is a segment under Secretarial Agreement.	Structure is separate agreement from highway segment.

Item 21 - Maintenance Responsibility **2 digits**

The actual name(s) of the agency(s) responsible for the maintenance of the structure shall be recorded on the inspection form. The codes below shall be used to represent the type of agency that has primary responsibility for maintaining the structure. If more than one agency has equal maintenance responsibility, code one agency in the hierarchy of State, Federal, county, city, railroad, and other private.

Code	Description
01	State Highway Agency
02	County Highway Agency
03	Town or Township Highway Agency
04	City or Municipal Highway Agency
11	State Park, Forest, or Reservation Agency
12	Local Park, Forest, or Reservation Agency
21	Other State Agencies
25	Other Local Agencies
26	Private (other than railroad)
27	Railroad
31	State Toll Authority
32	Local Toll Authority
60	Other Federal Agencies (not listed below)
61	Indian Tribal Government
62	Bureau of Indian Affairs
63	Bureau of Fish and Wildlife
64	U.S. Forest Service
66	National Park Service
67	Tennessee Valley Authority
68	Bureau of Land Management
69	Bureau of Reclamation
70	Corps of Engineers (Civil)
71	Corps of Engineers (Military)
72	Air Force
73	Navy/Marines
74	Army
75	NASA
76	Metropolitan Washington Airports Service
80	Unknown

Item 22 - Owner **2 digits**

The actual name(s) of the owner(s) of the bridge shall be recorded on the inspection form. The codes used in Item 21 - Maintenance Responsibility shall be used to represent the type of agency that is the primary owner of the structure. If more than one agency has equal ownership, code one agency in the hierarchy of State, Federal, county, city, railroad, and other private.

Item 23 through Item 25

(Reserved)

2000

Item 26 - Functional Classification of Inventory Route **2 digits**

For the inventory route, code the functional classification using one of the following codes:

Code	Description
Rural	
01	Principal Arterial - Interstate
02	Principal Arterial - Other
06	Minor Arterial
07	Major Collector
08	Minor Collector
09	Local
Urban	
11	Principal Arterial - Interstate
12	Principal Arterial - Other Freeways or Expressways
14	Other Principal Arterial
16	Minor Arterial
17	Collector
19	Local

The bridge shall be coded rural if not inside a designated urban area. The urban or rural designation shall be determined by the bridge location and not the character of the roadway.

Item 27 - Year Built **4 digits**

Record and code the year of construction of the structure. Code all 4 digits of the year in which construction of the structure was completed. If the year built is unknown, provide a best estimate. See also Item 106 - Year Reconstructed.

EXAMPLES:

		Code
Construction completed	1956	1956
	1892	1892

Item 28 - Lanes On and Under the Structure **4 digits**

Record and code the number of lanes being carried by the structure and being crossed over by the structure as a 4-digit number composed of 2 segments. The number of lanes should be right justified in each segment with leading zero(s) coded as required.

Segment	Description	Length
28A	Lanes on the structure	2 digits
28B	Lanes under the structure	2 digits

Include all lanes carrying highway traffic (i.e., cars, trucks, buses) which are striped or otherwise operated as a full width traffic lane for the entire length of the structure or under the structure by the owning/maintaining authority. This shall include any full width merge lanes and ramp lanes, and shall be independent of directionality of usage (i.e., a 1-lane bridge carrying 2-directional traffic is still considered to carry only one lane on the structure). It should be noted here that for the purpose of evaluating the Deck Geometry - Item 68, any "1-lane" bridge, not coded as a ramp (Item 5C = 7), which has a Bridge Roadway Width, Curb-to-Curb - Item 51 coded 4.9 meters or greater shall be evaluated as 2 lanes.

Item 28 - Lanes On and Under the Structure (cont.) **4 digits**

When the inventory route is "on" the bridge (the first digit of Item 5 - Inventory Route is coded 1), the sum of the total number of lanes on all inventoried routes under the bridge shall be coded. When the inventory route is "under" the bridge (the first digit of Item 5 - Inventory Route is coded 2 or A through Z), only the number of lanes being identified by that "under" record shall be coded in Item 28B.

When the inventory route is "under" the structure, the obstruction over the inventory route may be other than a highway bridge (railroad, pedestrian, pipeline, etc.). Code 00 for these cases if there are no highway lanes on the obstructing structure.

Double deck bridges may be coded as 1 or 2 structures as noted in the examples on the next page. Either method is acceptable, however, all related data must be compatible with the method selected.

EXAMPLES*:	Code
1 lane on, 0 lanes under	0100
3 lanes on, 1 lane under	0301
8 lanes on 2-way, 12 lanes under **	0812
5 lanes on double deck each direction, 2 lanes under	1002***
5 lanes on double deck each direction, 2 lanes under	0502****
Railroad and pedestrian on, 4 lanes under	0004

* For the inventory route on the bridge, the first digit of Item 5 - Inventory Route is coded 1.

** This example has 3 inventory routes under the bridge of 6, 4, and 2 lanes of 2-way traffic respectively. When coding an "under" record for each of these inventory routes, the first digit of Item 5 - Inventory Route is coded A, B, and C, and Item 28 is coded 0806, 0804, and 0802 respectively for the 3 required records.

***Acceptable if coded as 1 bridge. However, other data such as ADT, curb- to-curb width, etc., must be for both decks (preferred method).

****Acceptable if coded as 2 separate bridges. However, other data such as ADT, curb-to-curb width, etc., must be for a single deck.

Item 29 - Average Daily Traffic **6 digits**

Code a 6-digit number that shows the average daily traffic volume for the inventory route identified in Item 5. Make certain the unit's position is coded even if estimates of ADT are determined to tens or hundreds of vehicles; that is, appropriate trailing zeros shall be coded. The ADT coded should be the most recent ADT counts available. Included in this item are the trucks referred to in Item 109 - Average Daily Truck Traffic. If the bridge is closed, code the actual ADT from before the closure occurred.

The ADT must be compatible with the other items coded for the bridge. For example, parallel bridges with an open median are coded as follows: if Item 28 - Lanes On and Under the Structure and Item 51 - Bridge Roadway Width, Curb-to-Curb are coded for each bridge separately, then the ADT must be coded for each bridge separately (not the total ADT for the route).

EXAMPLES:

		Code
Average Daily Traffic	540	000540
	15,600	015600
	24,000	024000

Item 30 - Year of Average Daily Traffic **4 digits**

Record the year represented by the ADT in Item 29. Code all four digits of the year so recorded.

EXAMPLE:

	Code
Year of ADT is 1994	1994

Item 31 - Design Load **1 digit**

Use the codes below to indicate the live load for which the structure was designed. The numerical value of the railroad loading should be recorded on the form. Classify any other loading, when feasible, using the nearest equivalent of the loadings given below.

Code	Metric Description		English Description
1	M 9	or	H 10
2	M 13.5		H 15
3	MS 13.5		HS 15
4	M 18		H 20
5	MS 18		HS 20
6	MS 18+Mod		HS 20+Mod
7	Pedestrian		Pedestrian
8	Railroad		Railroad
9	MS 22.5		HS 25
0	Other or Unknown (describe on inspection reporting form)		

<u>Item 32 - Approach Roadway Width</u> (XXX.X meters) 4 digits

Code a 4-digit number to represent the <u>normal</u> width of usable roadway approaching the structure measured to the nearest tenth of a meter (with an assumed decimal point). Usable roadway width will include the width of traffic lanes and the widths of shoulders where shoulders are defined as follows:

> Shoulders must be constructed and normally maintained flush with the adjacent traffic lane, and must be structurally adequate for all weather and traffic conditions consistent with the facility carried.

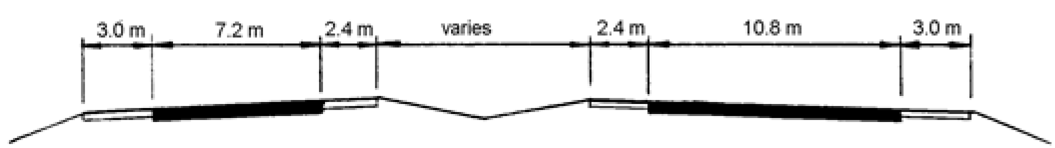
Unstabilized grass or dirt, with no base course, flush with and beside the traffic lane is not to be considered a shoulder for this item.

For structures with medians of any type and double-decked structures, this item should be coded as the sum of the usable roadway widths for the approach roadways (i.e., all median widths which do not qualify as shoulders should <u>not</u> be included in this dimension). When there is a variation between the approaches at either end of the structure, record and code the most restrictive of the approach conditions.

EXAMPLES:

Left Shoulder	Left Roadway	Median Shoulders	Right Roadway	Right Shoulder	Code
1.2	-	-	4.8	1.8	0078
1.8	-	-	10.8	3.6	0162
3.6	14.4	9.0	14.4	3.6	0450
3.0	7.2	4.8	10.8	3.0	0288

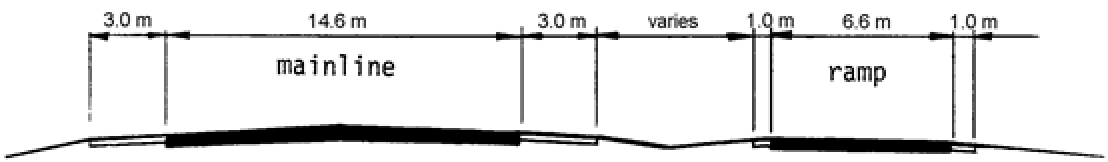
The last example above represents the coding method for a structure in which the most restrictive approach has the cross-section shown below:



Regardless of whether the median is open or closed, the data coded must be compatible with the other related route and bridge data (i.e., if Item 51 - Bridge Roadway Width, Curb-to-Curb is for traffic in one direction only, then Items 28, 29, 32, etc. must be for traffic in one direction only).

If a ramp is adjacent to the through lanes approaching the structure, it shall be included in the approach roadway width. The total approach roadway width for the example below is 29.2 meters (a code of 292).

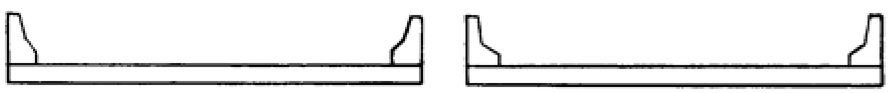
Item 32 – Approach Roadway Width (cont.)



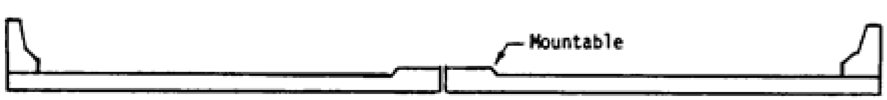
Item 33 - Bridge Median **1 digit**

Indicate with a 1-digit code if the median is non-existent, open or closed. The median is closed when the area between the 2 roadways at the structure is bridged over and is capable of supporting traffic. All bridges that carry either 1-way traffic or 2-way traffic separated only by a centerline will be coded 0 for no median.

Code	Description
0	No median
1	Open median
2	Closed median (no barrier)
3	Closed median with non-mountable barriers

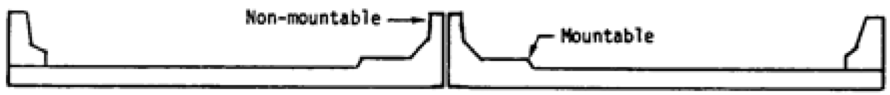


Open Median



Closed Median

Item 33 - Bridge Median (cont.)



Closed Median with Non-mountable Barrier

Item 34 - Skew (XX degrees) **2 digits**

The skew angle is the angle between the centerline of a pier and a line normal to the roadway centerline. When plans are available, the skew angle can be taken directly from the plans. If no plans are available, the angle is to be field measured if possible. Record the skew angle to the nearest degree. If the skew angle is 0E, it should be so coded. When the structure is on a curve or if the skew varies for some other reason, the average skew should be recorded, if reasonable. Otherwise, record 99 to indicate a major variation in skews of substructure units. A 2-digit number should be coded.

EXAMPLES:	Skew Angle	Code
	0°	00
	10°	10
	8°	08
	29°	29

Item 35 - Structure Flared **1 digit**

Code this item to indicate if the structure is flared (i.e., the width of the structure varies). Generally, such variance will result from ramps converging with or diverging from the through lanes on the structure, but there may be other causes. Minor flares at ends of structures should be ignored.

Code	Description
0	No flare
1	Yes, flared

Item 36 - Traffic Safety Features **4 digits**

Bridge inspection shall include the recording of information on the following traffic safety features so that the evaluation of their adequacy can be made.

(A) Bridge railings: Some factors that affect the proper functioning of bridge railing are height, material, strength, and geometric features. Railings must be capable of smoothly redirecting an impacting vehicle. Bridge railings should be evaluated using the current AASHTO Standard Specifications for Highway Bridges, which calls for railings to meet specific geometric criteria and to resist specified static loads without exceeding the allowable stresses in their elements. Bridge railing should be crash tested per FHWA policy.

Item 36 - Traffic Safety Features (cont'd)

Railings that meet these criteria and loading conditions are considered acceptable. Other railings that have been successfully crash tested are considered acceptable even though they may not meet the static loading analysis and geometric requirements. Acceptable guidelines for bridge railing design and testing are also found in the AASHTO Guide Specifications for Bridge Railings 1989. Additional guidance for testing is found in National Cooperative Highway Research Program - Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features 1993

(B) Transitions: The transition from approach guardrail to bridge railing requires that the approach guardrail be firmly attached to the bridge railing. It also requires that the approach guardrail be gradually stiffened as it comes closer to the bridge railing. The ends of curbs and safety walks need to be gradually tapered out or shielded.

(C) Approach guardrail: The structural adequacy and compatibility of approach guardrail with transition designs should be determined. Rarely does the need for a barrier stop at the end of a bridge. Thus, an approach guardrail with adequate length and structural qualities to shield motorists from the hazards at the bridge site needs to be installed. In addition to being capable of safely redirecting an impacting vehicle, the approach guardrail must also facilitate a transition to the bridge railing that will not cause snagging or pocketing of an impacting vehicle. Acceptable guardrail design suggestions are contained in the AASHTO Roadside Design Guide and subsequent FHWA or AASHTO guidelines.

(D) Approach guardrail ends: As with guardrail ends in general, the ends of approach guardrails to bridges should be flared, buried, made breakaway, or shielded. Design treatment of guardrail ends is given in the AASHTO Roadside Design Guide.

The data collected shall apply only to the route on the bridge. Collision damage or deterioration of the elements are not considered when coding this item. Traffic safety features is a 4-digit code composed of 4 segments.

Segment	Description	Length
36A	Bridge railings	1 digit
36B	Transitions	1 digit
36C	Approach guardrail	1 digit
36D	Approach guardrail ends	1 digit

The reporting of these features shall be as follows:

Code	Description
0	Inspected feature does not meet currently acceptable standards or a safety feature is required and none is provided.*
1	Inspected feature meets currently acceptable standards.*
N	Not applicable or a safety feature is not required.*

* For structures on the NHS, national standards are set by regulation. For those not on the NHS, it shall be the responsibility of the highway agency (state, county, local or federal) to set standards

Item 36 - Traffic Safety Features (cont'd)

EXAMPLE:	Code
All features meet currently acceptable standards except transition	1011

Item 37 - Historical Significance **1 digit**

The historical significance of a bridge involves a variety of characteristics: the bridge may be a particularly unique example of the history of engineering; the crossing itself might be significant; the bridge might be associated with a historical property or area; or historical significance could be derived from the fact the bridge was associated with significant events or circumstances. Use one of the following codes:

Code	Description
1	Bridge is on the National Register of Historic Places.
2	Bridge is eligible for the National Register of Historic Places.
3	Bridge is possibly eligible for the National Register of Historic Places (requires further investigation before determination can be made) or bridge is on a State or local historic register.
4	Historical significance is not determinable at this time.
5	Bridge is not eligible for the National Register of Historic Places.

Item 38 - Navigation Control **1 digit**

Indicate for this item whether or not navigation control (a bridge permit for navigation) is required. Use one of the following codes:

Code	Description
N	Not applicable, no waterway.
0	No navigation control on waterway (bridge permit not required).
1	Navigation control on waterway (bridge permit required).

<u>Item 39 - Navigation Vertical Clearance</u> (XXX.X meters)   4 digits

If Item 38 - Navigation Control has been coded 1, record the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency. The measurement shall be coded as a 4-digit number truncated to the tenth of a meter (with an assumed decimal point). This measurement will show the clearance that is allowable for navigational purposes. In the case of a swing or bascule bridge, the vertical clearance shall be measured with the bridge in the closed position (i.e., open to vehicular traffic). The vertical clearance of a vertical lift bridge shall be measured with the bridge in the raised or open position. Also, Item 116 - Minimum Navigation Vertical Clearance Vertical Lift Bridge shall be coded to provide clearance in a closed position. If Item 38 - Navigation Control has been coded 0 or N, code 000 to indicate not applicable.

EXAMPLES:

Measured Vertical Clearance	Code
50.00 meters	0500
20.65 meters	0206
24.28 meters	0242

<u>Item 40 - Navigation Horizontal Clearance</u> (XXXX.X meters)   5 digits

If Item 38 - Navigation Control has been coded 1, record the horizontal clearance measurement imposed at the site that is shown on the navigation permit. This may be less than the structure geometry allows. If a navigation permit is required but not available, use the minimum horizontal clearance between fenders, if any, or the clear distance between piers or bents. Code the clearance as a 5-digit number truncated to the tenth of a meter (with an assumed decimal point). If Item 38 - Navigation Control has been coded 0 or N, code 0000 to indicate not applicable.

EXAMPLES:

Horizontal Clearance	Code
53.57 meters	00535
95.00 meters	00950
202.09 meters	02020

<u>Item 41 - Structure Open, Posted, or Closed to Traffic</u>   1 digit

This item provides information about the actual operational status of a structure. The field review could show that a structure is posted, but Item 70 - Bridge Posting may indicate that posting is not required. This is possible and acceptable coding since Item 70 is based on the operating stress level and the governing agency's posting procedures may specify posting at some stress level less than the operating rating. One of the following codes shall be used:

Code	Description
A	Open, no restriction
B	Open, posting recommended but not legally implemented (all signs not in place or not correctly implemented)
D	Open, would be posted or closed except for temporary shoring, etc. to allow for unrestricted traffic
E	Open, temporary structure in place to carry legal loads while original structure is closed and awaiting replacement or rehabilitation

Item 41 - Structure Open, Posted, or Closed to Traffic (cont'd)

G	New structure not yet open to traffic
K	Bridge closed to all traffic
P	Posted for load (may include other restrictions such as temporary bridges which are load posted)
R	Posted for other load-capacity restriction (speed, number of vehicles on bridge, etc.)

Item 42 - Type of Service **2 digits**

The type of service on the bridge and under the bridge is indicated by a 2-digit code composed of 2 segments.

Segment	Description	Length
42A	Type of service on bridge	1 digit
42B	Type of service under bridge	1 digit

The first digit indicates the type of service "on" the bridge and shall be coded using one of the following codes:

Code	Description
1	Highway
2	Railroad
3	Pedestrian-bicycle
4	Highway-railroad
5	Highway-pedestrian
6	Overpass structure at an interchange or second level of a multilevel interchange
7	Third level (Interchange)
8	Fourth level (Interchange)
9	Building or plaza
0	Other

The second digit indicates the type of service "under" the bridge and shall be coded using one of the following codes:

Code	Description
1	Highway, with or without pedestrian
2	Railroad
3	Pedestrian-bicycle
4	Highway-railroad
5	Waterway
6	Highway-waterway
7	Railroad-waterway
8	Highway-waterway-railroad
9	Relief for waterway
0	Othe

<u>Item 43 - Structure Type, Main</u> **3 digits**

Record the description on the inspection form and indicate the type of structure for the main span(s) with a 3-digit code composed of 2 segments.

Segment	Description	Length
43A	Kind of material and/or design	1 digit
43B	Type of design and/or construction	2 digits

The first digit indicates the kind of material and/or design and shall be coded using one of the following codes:

Code	Description
1	Concrete
2	Concrete continuous
3	Steel
4	Steel continuous
5	Prestressed concrete *
6	Prestressed concrete continuous *
7	Wood or Timber
8	Masonry
9	Aluminum, Wrought Iron, or Cast Iron
0	Other

* Post-tensioned concrete should be coded as prestressed concrete.

The second and third digits indicate the predominant type of design and/or type of construction and shall be coded using one of the following codes:

Code	Description
01	Slab
02	Stringer/Multi-beam or Girder
03	Girder and Floorbeam System
04	Tee Beam
05	Box Beam or Girders - Multiple
06	Box Beam or Girders - Single or Spread
07	Frame (except frame culverts)
08	Orthotropic
09	Truss - Deck
10	Truss - Thru
11	Arch - Deck
12	Arch - Thru
13	Suspension
14	Stayed Girder
15	Movable - Lift
16	Movable - Bascule
17	Movable - Swing
18	Tunnel
19	Culvert (includes frame culverts)
20 *	Mixed types
21	Segmental Box Girder
22	Channel Beam

<u>Item 43 - Structure Type, Main</u> (cont'd)

00	Other

* Applicable only to approach spans - Item 44

EXAMPLES:	<u>Code</u>
Wood or Timber Through Truss	710
Masonry Culvert	819
Steel Suspension	313
Continuous Concrete Multiple Box Girders	205
Simple Span Concrete Slab	101
Tunnel in Rock	018

<u>Item 44 - Structure Type, Approach Spans</u> **3 digits**

Indicate with a 3-digit code composed of 2 segments, the type of structure for the approach spans to a major bridge or for the spans where the structural material is different. The codes are the same as for Item 43 preceding. However, code 000 if this item is not applicable. Use code 20 (Item 44B) when no one type of design and/or construction is predominate for the approach units. If the kind of material (Item 44A) is varied, code the most predominant.

<u>Segment</u>	<u>Description</u>	<u>Length</u>
44A	Kind of material and/or design	1 digit
44B	Type of design and/or construction	2 digits

EXAMPLES:	<u>Code</u>
Simple prestressed concrete I-beam	502
Continuous concrete T-beam	204
Continuous steel deck truss	409

<u>Item 45 - Number of Spans in Main Unit</u> **3 digits**

Record the number and indicate with a 3-digit number the number of spans in the main or major unit. This item will include all spans of most bridges, the major unit only of a sizable structure, or a unit of material or design different from that of the approach spans.

<u>Item 46 - Number of Approach Spans</u> **4 digits**

Record the number and indicate with a 4-digit number the number of spans in the approach spans to the major bridge, or the number of spans of material different from that of the major bridge.

<u>Item 47 - Inventory Route, Total Horizontal Clearance</u> **3 digits** **(XX.X meters)**

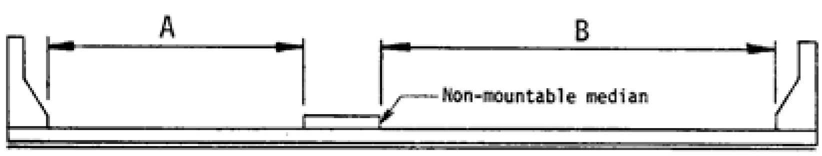
The total horizontal clearance for the inventory route identified in Item 5 should be measured and recorded. The clearance should be the available clearance measured between the restrictive features -- curbs, rails, walls, piers or other structural features limiting the roadway (surface and shoulders). The measurement should be recorded and coded as a 3-digit number truncated to the nearest tenth of a meter (with an assumed decimal point). When the restriction is 100 meters or greater, code 999.

The purpose of this item is to give the largest available clearance for the movement of wide loads. Flush and mountable medians are not considered to be restrictions. This clearance is defined in 2 ways; use the most applicable:

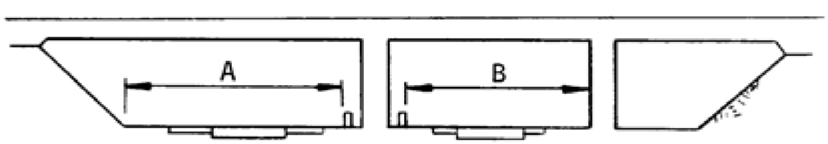
1. Clear distance between restrictions of the inventory route either "on" or "under" the structure.

2. Roadway surface and shoulders - when there are no restrictions.

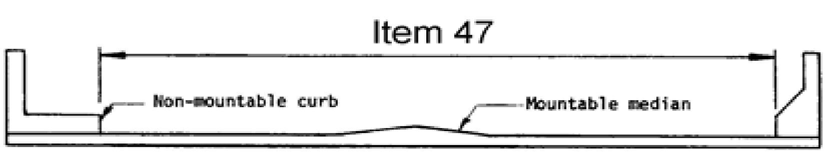
For a divided facility with a raised or non-mountable median, or an "under" route divided by piers, record the greater of the restricted widths in either direction, not both directions.



Raised Median or Non-mountable Median
B > A Item 47 = B



Clearance A > B Item 47 = A



No Median or Flush or Mountable Median

Item 48 - Length of Maximum Span (XXXX.X meters) 5 digits

The length of the maximum span shall be recorded. It shall be noted whether the measurement is center to center of bearing points or clear open distance between piers, bents, or abutments. The measurement shall be along the centerline of the bridge. For this item, code a 5-digit number to represent the measurement to the nearest tenth of a meter (with an assumed decimal point).

EXAMPLES: Length of Maximum Span	Code
35.5 meters	00355
117.0 meters	01170
1219.2 meters	12192

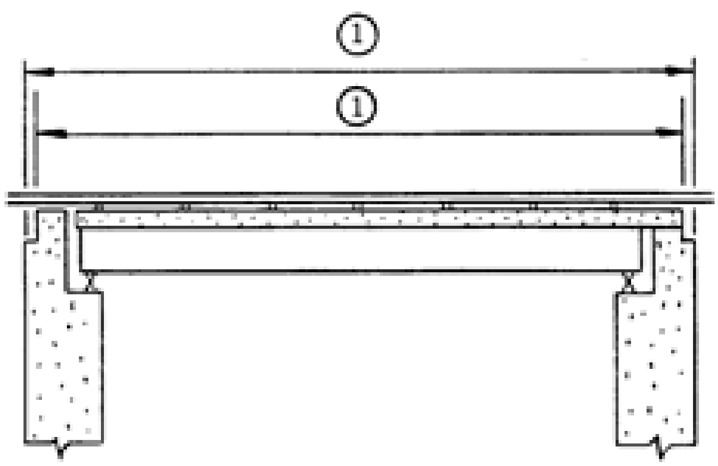
Item 49 - Structure Length (XXXXX.X meters) 6 digits

Record and code a 6-digit number to represent the length of the structure to the nearest tenth of a meter (with an assumed decimal point). This shall be the length of roadway which is supported on the bridge structure. The length should be measured back to back of backwalls of abutments or from paving notch to paving notch.

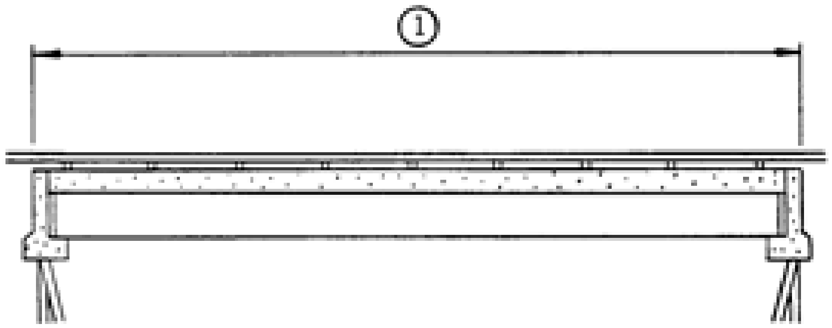
Culvert lengths should be measured along the center line of roadway regardless of their depth below grade. Measurement should be made between inside faces of exterior walls. Tunnel length should be measured along the centerline of the roadway. Be sure to code Item 5A = 2 for all tunnels.

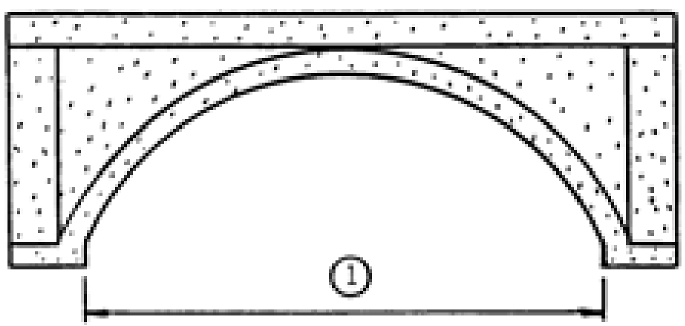
EXAMPLES: Structure Length	Code
35.5 meters	000355
542.1 meters	005421
333.0 meters	003330
10 123.5 meters	101235

(1) Item 49 - Structure Length

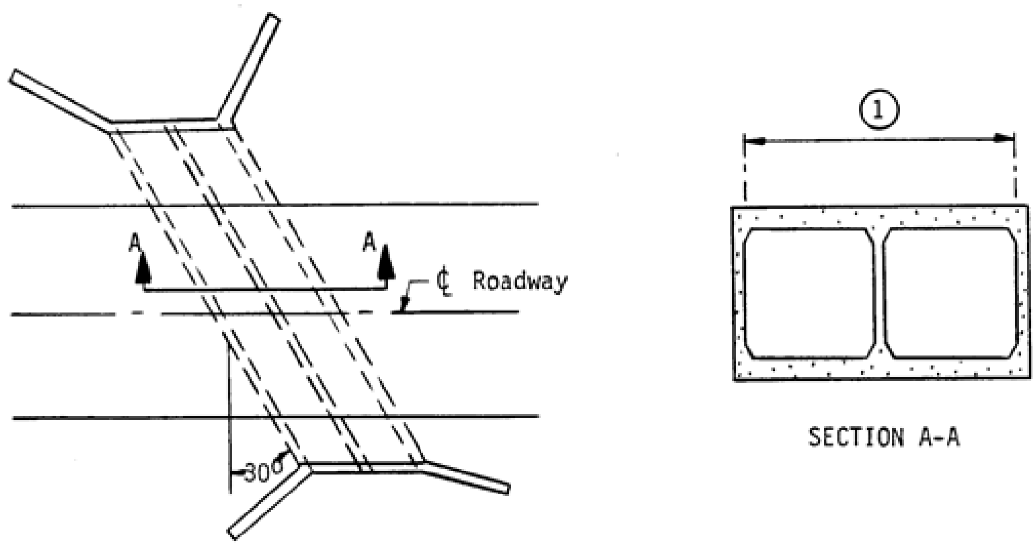


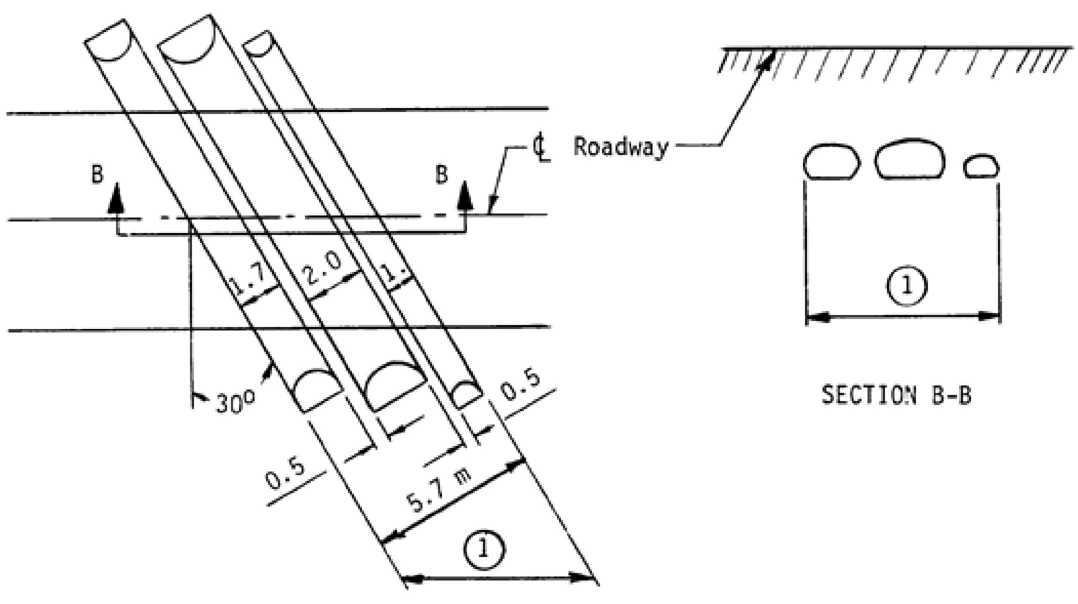
1) Item 49 - Structure Length (cont.)





1) Item 49 - Structure Length (cont.)





<u>Code</u>

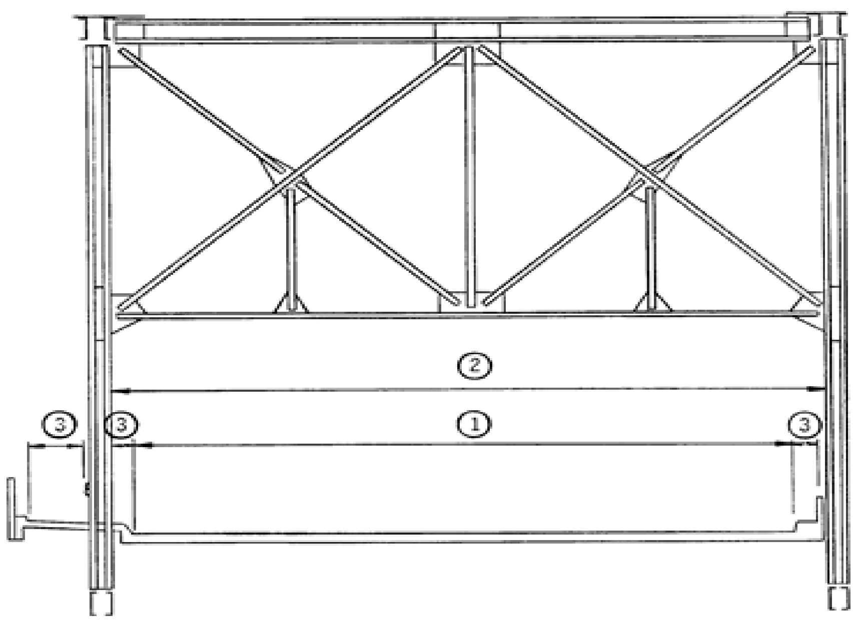
(1) Item 49 - Structure Length = $\frac{5.7\text{ m}}{\cos 30^{o}}$ = 6.58 m 000066

<u>Item 50 - Curb or Sidewalk Widths</u> (XX.X meters, XX.X meters) 6 digits

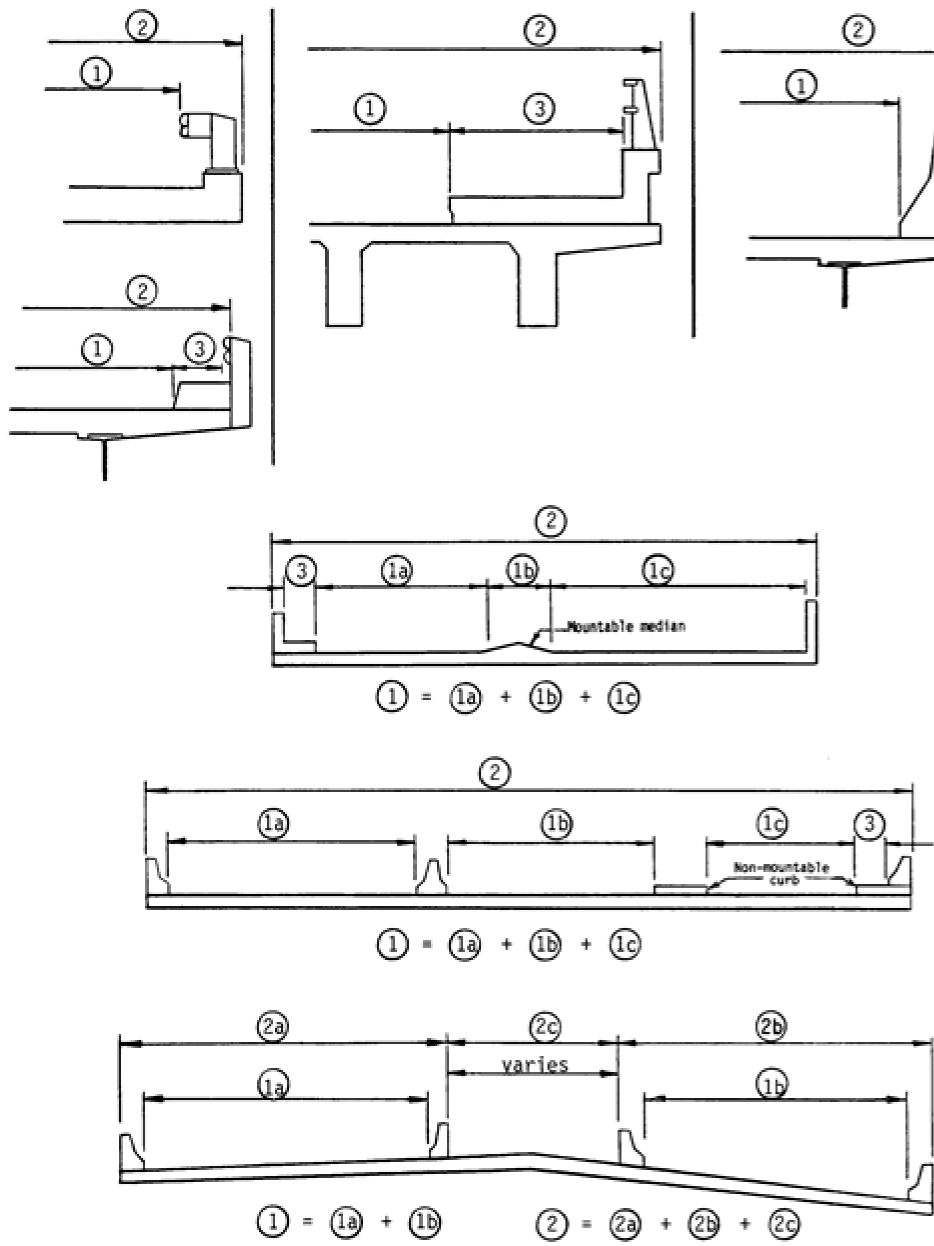
Record and code two contiguous 3-digit numbers to represent the widths of the left and right curbs or sidewalks to nearest tenth of a meter (with assumed decimal points). This is a 6-digit number composed of 2 segments, with the leftmost 3 digits representing the left curb or sidewalk and the rightmost 3 digits representing the right curb or sidewalk. "Left" and "Right" should be determined on the basis of direction of the inventory.

Segment	Description	Length
50A	Left curb or sidewalk width	3 digits
50B	Right curb or sidewalk width	3 digits

EXAMPLES:	Left Side	Right Side	Code
Curb or sidewalk	None	2.3 meters	000023
	3.0 meters	4.1 meters	030041
	3.3 meters	None	033000
	12.1 meters	11.5 meters	121115
	None	None	000000
	0.6 meters	1.5 meters	006015



(1) Item 51 - Bridge Roadway Width, Curb-to-Curb
(2) Item 52 - Deck Width, Out-to-Out
(3) Item 50 - Curb or Sidewalk Width



<u>Item 50 - Curb or Sidewalk Widths</u> (cont'd)

EXAMPLES:

(1) Item 51 - Bridge Roadway Width, Curb-to-Curb
(2) Item 52 - Deck Width, Out-to-Out
(3) Item 50 - Curb or Sidewalk Width

<u>Item 51 - Bridge Roadway Width, Curb-to-Curb</u> (XXX.X meters) 4 digits

The information to be recorded is the most restrictive minimum distance between curbs or rails on the structure roadway. For structures with closed medians and usually for double decked structures, coded data will be the sum of the most restrictive minimum distances for all roadways carried by the structure*. The data recorded for this item must be compatible with other related route and bridge data (i.e., Items 28, 29, 32, etc.). The measurement should be exclusive of flared areas for ramps. A 4-digit number should be used to represent the distance to the nearest tenth of a meter (with an assumed decimal point). See examples on pages 30 and 31.

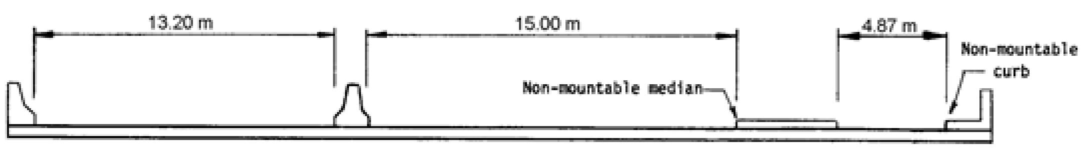
Where traffic runs directly on the top slab (or wearing surface) of a culvert- type structure, e.g. an R/C box without fill, code the actual roadway width (curb-to-curb or rail-to-rail). This will also apply where the fill is minimal and headwalls or parapets affect the flow of traffic.

Where the roadway is on fill carried across a structure and the headwalls or parapets do not affect the flow of traffic, code 0000. This is considered proper inasmuch as a filled section simply maintains the roadway cross-section. However, for sidehill viaduct structures code the actual full curb-to-curb roadway width. See figure in the Commentary Appendix D.

* Raised or non-mountable medians, open medians, and barrier widths are to be excluded from the summation along with barrier-protected bicycle and equestrian lanes.

EXAMPLES:	Bridge Roadway Width	Code
	16.00 meters wide	0160
	21.43 meters wide	0214
	33.07 meters wide	0331

The last example above would be the coded value for the deck section shown below.



<u>Item 52 - Deck Width, Out-to-Out</u> (XXX.X meters) 4 digits

Record and code a 4-digit number to show the out-to-out width to the nearest tenth of a meter (with an assumed decimal point). If the structure is a through structure, the number to be coded will represent the lateral clearance between superstructure members. The measurement should be exclusive of flared areas for ramps. See examples on pages 30 and 31.

Where traffic runs directly on the top slab (or wearing surface) of the culvert (e.g., an R/C box without fill) code the actual width (out-to-out). This will also apply where the fill is minimal and the culvert headwalls affect the flow of traffic. However, for sidehill viaduct structures code the actual out-to-out structure width. See figure in the Commentary Appendix D.

Where the roadway is on a fill carried across a pipe or box culvert and the culvert headwalls do not affect the flow of traffic, code 0000. This is considered proper inasmuch as a filled section over a culvert simply maintains the roadway cross-section.

<u>Item 53 - Minimum Vertical Clearance Over Bridge Roadway</u> 4 digits
(XX.XX meters)

The information to be recorded for this item is the actual minimum vertical clearance over the bridge roadway, including shoulders, to any superstructure restriction, rounded down to the nearest hundredth of a meter. For double decked structures code the minimum, regardless whether it is pertaining to the top or bottom deck. When no superstructure restriction exists above the bridge roadway, or when a restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30 meters and 99.99 meters to an exact measurement is optional. A 4-digit number should be coded to represent the clearance to the nearest hundredth of a meter (with an assumed decimal point).

EXAMPLES: Minimum Vertical Clearance	Code
No restriction	9999
5.25 meters	0525
23.00 meters	2300
38.50 meters	9999

<u>Item 54 - Minimum Vertical Underclearance</u> 5 digits
(X code, XX.XX meters)

Using a 1-digit code and a 4-digit number, record and code the minimum vertical clearance from the roadway (travel lanes only) or railroad track <u>beneath</u> the structure to the underside of the superstructure. (When both a railroad and highway are under the structure, code the most critical dimension.)

Segment	Description	Length
54A	Reference feature	1 digit
54B	Minimum Vertical Underclearance	4 digits

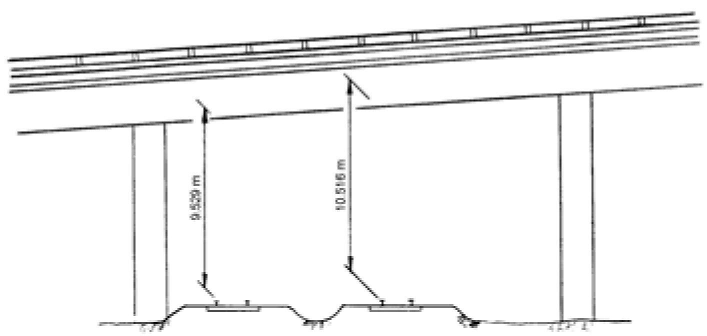
Item 54 - Minimum Vertical Underclearance (cont'd)

Using one of the codes below, code in the first position, the reference feature from which the clearance measurement is taken:

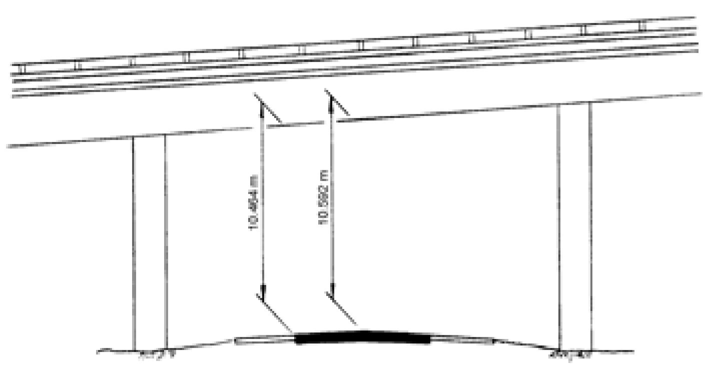
Code	Description
H	Highway beneath structure
R	Railroad beneath structure
N	Feature not a highway or railroad

In the next 4 positions, code a 4-digit number to represent the minimum vertical clearance from that feature to the structure, truncated to the hundredth of a meter (with an assumed decimal point). When a restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30 meters and 99.99 meters to an exact measurement is optional. If the feature is not a highway or railroad, code the minimum vertical clearance 0000.

EXAMPLES:	CODE
River beneath structure	N0000



Railroad 9.529 meters beneath structure R0952



<u>Item 55 - Minimum Lateral Underclearance on Right</u> **4 digits**
(X code, XX.X meters)

Using a 1-digit code and a 3-digit number, record and code the minimum lateral underclearance on the right to the nearest tenth of a meter (with an assumed decimal point). When both a railroad and highway are under the structure, code the most critical dimension (Refer to Item 69 - Underclearances, Horizontal - Table 3B).

Segment	Description	Length
55A	Reference feature	1 digit
55B	Minimum Lateral Underclearance	3 digits

Using one of the codes below, code in the first position the reference feature from which the clearance measurement is taken:

Code	Description
H	Highway beneath structure
R	Railroad beneath structure
N	Feature not a highway or railroad

In the next 3 positions, code a 3-digit number to represent the minimum lateral underclearance on the right. The lateral clearance should be measured from the right edge of the roadway (excluding shoulders) or from the centerline (between rails) of the right-hand track of a railroad to the nearest substructure unit (pier, abutment, etc.), to a rigid barrier (concrete bridge rail, etc.), or to the toe of slope steeper than 1 to 3, e.g. 1 to 1 or 2 to 1. The clearance measurements to be recorded will be the minimum after measuring the clearance in <u>both</u> directions of travel. In the case of a dual highway this would mean the outside clearances of both roadways should be measured and the smaller distance recorded and coded.

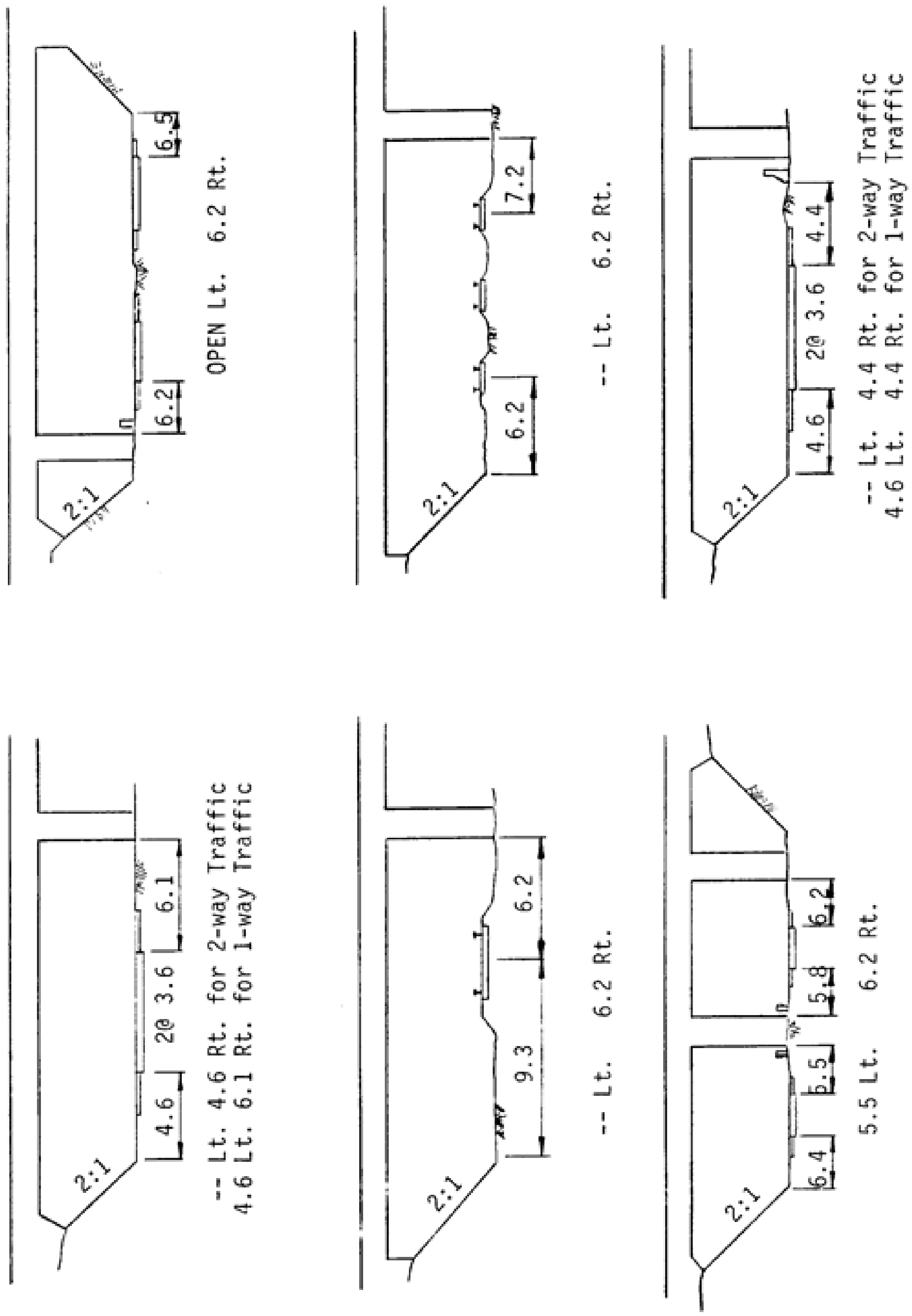
If two related features are below the bridge, measure both and record the lesser of the 2. An explanation should be written on the inspection form as to what was recorded. When the clearance is 30 meters or greater, code 999. Coding of actual clearances between 30 meters and 99.9 meters to an exact measurement is optional.

If the feature beneath the structure is not a railroad or highway, code N000 to indicate not applicable.

The presence of ramps and acceleration or turning lanes is not considered in this item; therefore, the minimum lateral clearance on the right should be measured from the right edge of the <u>through</u> roadway.

EXAMPLES:	Code
Railroad 6.22 meters centerline to pier	R062
Highway 6.16 meters edge of pavement to pier	H062
Creek beneath structure	N000

Item 55 – Minimum Lateral Underclearance on Right **(cont'd)**
EXAMPLES:



Item 56 - Minimum Lateral Underclearance on Left **3 digits**
(XX.X meters) (code only for divided highways, 1-way streets, and ramps; not applicable to railroads)

Using a 3-digit number, record and code the minimum lateral under- clearance on the left (median side for divided highways) to the nearest tenth of a meter (with an assumed decimal point). The lateral clearance should be measured from the left edge of the roadway (excluding shoulders) to the nearest substructure unit, to a rigid barrier, or to the toe of slope steeper than 1 to 3. Refer to examples on page 34 under Item 55 - Minimum Lateral Underclearance on Right.

In the case of a dual highway, the median side clearances of both roadways should be measured and the smaller distance recorded and coded. If there is no obstruction in the median area, a notation of "open" should be recorded and 999 should be coded. For clearances greater than 30 meters, code 998. Coding of actual clearances greater than 30 meters to an exact measurement is optional. Code 000 to indicate not applicable.

Item 57

(Reserved)

Items 58 through 62 - Indicate the Condition Ratings

In order to promote uniformity between bridge inspectors, these guidelines will be used to rate and code Items 58, 59, 60, 61, and 62. The use of the AASHTO Guide for Commonly Recognized (CoRe) Structural Elements is an acceptable alternative to using these rating guidelines for Items 58, 59, 60, and 62, provided the FHWA translator computer program is used to convert the inspection data to NBI condition ratings for NBI data submittal.

Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition. Evaluation is for the materials related, physical condition of the deck, superstructure, and substructure components of a bridge. The condition evaluation of channels and channel protection and culverts is also included. Condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated. Conversely, they are improperly used if they attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread throughout the component being rated.

The load-carrying capacity will not be used in evaluating condition items. The fact that a bridge was designed for less than current legal loads and may be posted shall have no influence upon condition ratings.

Portions of bridges that are being supported or strengthened by temporary members will be rated based on their actual condition; that is, the temporary members are not considered in the rating of the item. (See Item 103 - Temporary Structure Designation for the definition of a temporary bridge.)

Completed bridges not yet opened to traffic, if rated, shall be coded as if open to traffic

Condition Ratings (cont'd)

The following general condition ratings shall be used as a guide in evaluating Items 58, 59, and 60:

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION - no problems noted.
7	GOOD CONDITION - some minor problems.
6	SATISFACTORY CONDITION - structural elements show some minor deterioration.
5	FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	POOR CONDITION - advanced section loss, deterioration, spalling or scour.
3	SERIOUS CONDITION - loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
1	"IMMINENT" FAILURE CONDITION - major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.
0	FAILED CONDITION - out of service - beyond corrective action.

Item 58 - Deck **1 digit**

This item describes the overall condition rating of the deck. Rate and code the condition in accordance with the above general condition ratings. Code N for culverts and other structures without decks e.g., filled arch bridge.

Concrete decks should be inspected for cracking, scaling, spalling, leaching, chloride contamination, potholing, delamination, and full or partial depth failures. Steel grid decks should be inspected for broken welds, broken grids, section loss, and growth of filled grids from corrosion. Timber decks should be inspected for splitting, crushing, fastener failure, and deterioration from rot.

The condition of the wearing surface/protective system, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rail, and scuppers shall not be considered in the overall deck evaluation. However, their condition should be noted on the inspection form.

Decks integral with the superstructure will be rated as a deck only and not how they may influence the superstructure rating (for example, rigid frame, slab, deckgirder or T-beam, voided slab, box girder, etc.). Similarly, the superstructure of an integral deck-type bridge will not influence the deck rating.

Item 59 - Superstructure **1 digit**

This item describes the physical condition of all structural members. Rate and code the condition in accordance with the previously described general condition ratings. Code N for all culverts.

The structural members should be inspected for signs of distress which may include cracking, deterioration, section loss, and malfunction and misalignment of bearings.

The condition of bearings, joints, paint system, etc. shall not be included in this rating, except in extreme
Item 59 Superstructure (cont.)

situations, but should be noted on the inspection form.

On bridges where the deck is integral with the superstructure, the superstructure condition rating may be affected by the deck condition. The resultant superstructure condition rating may be lower than the deck condition rating where the girders have deteriorated or been damaged.

Fracture critical components should receive careful attention because failure could lead to collapse of a span or the bridge.

Item 60 - Substructure **1 digit**

This item describes the physical condition of piers, abutments, piles, fenders, footings, or other components. Rate and code the condition in accordance with the previously described general condition ratings. Code N for all culverts.

All substructure elements should be inspected for visible signs of distress including evidence of cracking, section loss, settlement, misalignment, scour, collision damage, and corrosion. The rating given by Item 113 - Scour Critical Bridges, may have a significant effect on Item 60 if scour has substantially affected the overall condition of the substructure.

The substructure condition rating shall be made independent of the deck and superstructure.

Integral-abutment wingwalls to the first construction or expansion joint shall be included in the evaluation. For non-integral superstructure and substructure units, the substructure shall be considered as the portion below the bearings. For structures where the substructure and superstructure are integral, the substructure shall be considered as the portion below the superstructure.

Item 61 - Channel and Channel Protection **1 digit**

This item describes the physical conditions associated with the flow of water through the bridge such as stream stability and the condition of the channel, riprap, slope protection, or stream control devices including spur dikes. The inspector should be particularly concerned with visible signs of excessive water velocity which may affect undermining of slope protection, erosion of banks, and realignment of the stream which may result in immediate or potential problems. Accumulation of drift and debris on the superstructure and substructure should be noted on the inspection form but not included in the condition rating.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

Code	Description
N	Not applicable. Use when bridge is not over a waterway (channel).
9	There are no noticeable or noteworthy deficiencies which affect the condition of the channel.
8	Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have

Item 61 - Channel and Channel Protection (cont.)

widespread minor damage. There is minor stream bed movement evident. Debris is restricting the channel slightly.

5 Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.

4 Bank and embankment protection is severely undermined. River control devices have severe damage. Large deposits of debris are in the channel.

3 Bank protection has failed. River control devices have been destroyed. Stream bed aggradation, degradation or lateral movement has changed the channel to now threaten the bridge and/or approach roadway.

2 The channel has changed to the extent the bridge is near a state of collapse.

1 Bridge closed because of channel failure. Corrective action may put back in light service.

0 Bridge closed because of channel failure. Replacement necessary.

Item 62 - Culverts **1 digit**

This item evaluates the alignment, settlement, joints, structural condition, scour, and other items associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint shall be included in the evaluation. For a detailed discussion regarding the inspection and rating of culverts, consult Report No. FHWA-IP-86-2, Culvert Inspection Manual, July 1986.

Item 58 - Deck, Item 59 - Superstructure, and Item 60 - Substructure shall be coded N for all culverts.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

Code	Description
N	Not applicable. Use if structure is not a culvert.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.
6	Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion or moderate pitting.

Item 62 - Culverts (cont'd)

5 Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.

4 Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.

3 Any condition described in Code 4 but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.

2 Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.

1 Bridge closed. Corrective action may put back in light service.

0 Bridge closed. Replacement necessary.

Item 63 - Method Used to Determine Operating Rating **1 digit**

Use one of the codes below to indicate which load rating method was used to determine the Operating Rating coded in Item 64 for this structure.

Code	Description
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor (LRFR)
4	Load Testing
5	No rating analysis performed

Item 64 - Operating Rating (XX.X metric tons) **3 digits**

This capacity rating, referred to as the operating rating, will result in the absolute maximum permissible load level to which the structure may be subjected for the vehicle type used in the rating. Code the operating rating as a 3-digit number to represent the total mass in metric tons of the entire vehicle measured to the nearest tenth of a metric ton (with an assumed decimal point).

It should be emphasized that only MS loading shall be used to determine the operating rating. This is the metric equivalent of an HS loading. The total mass in tons of the entire vehicle should be coded; that is, MS18 which has a mass of 32.4 metric tons shall be coded '324', and likewise, a MS13.5 shall be coded '243'.

Item 64 - Operating Rating (cont.)

The AASHTO Manual for Condition Evaluation of Bridges provides a choice of load rating methods, such as the new load and resistance factor (LRFR) rating method, in addition to the traditional allowable stress (AS) and load factor (LF) methods. Of the three rating methods, the LF method is the most suitable for use as a national standard, therefore the FHWA has chosen the LF method as the standard for computing inventory and operating ratings reported to the NBI. The highway agencies may, however, elect to use LF, AS or LRFD to establish load limits for purposes of load posting.

If the bridge will not carry a minimum of 2.7 metric tons of live load, the operating rating shall be coded '000'; and consistent with the direction of the AASHTO Manual, it shall be closed.

The use or presence of a temporary bridge requires special consideration in coding. In such cases, since there is no permanent bridge, Items 64 and 66 should be coded as 000 even though the temporary structure is rated for as much as full legal load.

A bridge shored up or repaired on a temporary basis is considered a temporary bridge and the inventory and operating rating shall be coded as if the temporary shoring were not in place. See Item 103 - Temporary Structure Designation for definition of a temporary bridge.

Code 999 for a structure under sufficient fill such that, according to AASHTO design, the live load is insignificant in the structure load capacity.

EXAMPLES:	Code
MS27	486
Temporary bridge	000
Shored-up bridge	030*
Structure under fill (not affected by live load)	999

* load capacity without shoring.

Item 65 - Method Used to Determine Inventory Rating **1 digit**

Use one of the codes below to indicate which load rating method was used to determine the Inventory Rating coded in Item 66 for this structure.

Code	Description
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor (LRFR)
4	Load Testing
5	No rating analysis performed

Item 66 - Inventory Rating (XX.X metric tons) **3 digits**

This capacity rating, referred to as the inventory rating, will result in a load level which can safely utilize an existing structure for an indefinite period of time. Only the MS loading shall be used to determine the inventory rating. Code the Inventory Rating as a 3-digit number to represent the total mass in metric tons of the entire vehicle measured to the nearest tenth of a metric ton (with an assumed decimal point). The statements in Item 64 - Operating Rating apply to this item also.

Item 66 - Inventory Rating (cont.)

Code 999 for a structure under sufficient fill such that, according to AASHTO design, the live load is insignificant in the structure load capacity.

Items 67, 68, 69, 71, and 72 - Indicate the Appraisal Ratings

The items in the Appraisal Section are used to evaluate a bridge in relation to the level of service which it provides on the highway system of which it is a part. The structure will be compared to a new one which is built to current standards for that particular type of road as further defined in this section except for Item 72 - Approach Roadway Alignment. See Item 72 for special criteria for rating that item.

Items 67, 68, 69, 71, and 72 will be coded with a 1-digit code that indicates the appraisal rating for the item. The ratings and codes are as follows:

Code	Description
N	Not applicable
9	Superior to present desirable criteria
8	Equal to present desirable criteria
7	Better than present minimum criteria
6	Equal to present minimum criteria
5	Somewhat better than minimum adequacy to tolerate being left in place as is
4	Meets minimum tolerable limits to be left in place as is
3	Basically intolerable requiring high priority of corrective action
2	Basically intolerable requiring high priority of replacement
1	This value of rating code not used
0	Bridge closed

The FHWA Edit/Update computer program calculates values for Items 67, 68 and 69 according to the tables provided in this manual. These tables and the table for Item 71 shall be used by all evaluators to rate these items. They have been developed to closely match the descriptions for the appraisal evaluation codes of 0 to 9. The tables shall be used in all instances to evaluate the item based on the designated data in the inventory, even if a table value does not appear to match the descriptive codes. For unusual cases where the site data does not exactly agree with the table criteria, use the most appropriate table to evaluate the item. The code of N is not valid for use with Items 67 and 72.

Completed bridges not yet opened to traffic, if rated, shall be appraised as if open to traffic. Design values, for example ADT, shall be used for the evaluation. The data provided will include a code of G for Item 41 - Structure Open, Posted, or Closed to Traffic.

Item 67 - Structural Evaluation 1 digit

This item is calculated by the Edit/Update Program based on Table 1, and need not be coded by the bridge inspector. The following specifications are used by the Edit/Update Program:

- For structures other than culverts, the lowest of the codes obtained from Item 59 - Superstructure, Item 60 - Substructure, or Table 1 is used.
- For culverts, the lowest of the codes obtained from Item 62 - Culverts, or Table 1 is used.
- If Item 59, Item 60 or Item 62 is coded 1, then Item 67 is equal to zero (0), regardless of whether the structure is actually closed. However, if the structure is closed, it does not mean that this value is zero (0) unless the overall condition and appraisal ratings indicate that a code of 0 is appropriate.

Table 1 Notes:

1. Use the lower rating code for values between those listed in the table.
2. Inventory Ratings are shown in metric tons with decimal point.
3. To use Table 1, the Inventory Rating must be the coded MS rating or its equivalent. If the comparable MS equivalent is not calculated for the controlling rating, using a factor to determine the MS equivalent is acceptable even though converting other rating loads to an MS equivalent is not a constant.
4. All bridges with Item 26 - Functional Class coded Interstate, Freeway or Expressway shall be evaluated using the ADT column of >5000 regardless of the actual ADT on the bridge.

Table 1. Rating by Comparison of ADT - Item 29
and Inventory Rating - Item 66

Structural Evaluation Rating Code	Inventory Rating		
	Average Daily Traffic (ADT)		
	0-500	501-5000	>5000
9	>32.4 (MS18)*	>32.4 (MS18)	>32.4 (MS18)
8	32.4 (MS18)	32.4 (MS18)	32.4 (MS18)
7	27.9 (MS15.5)	27.9 (MS15.5)	27.9 (MS15.5)

6	20.7 (MS11.5)	22.5 (MS12.5)	24.3 (MS13.5)
5	16.2 (MS9)	18.0 (MS10)	19.8 (MS11)
4	10.8 (MS6)	12.6 (MS7)	16.2 (MS9)
3	Inventory rating less than value in rating code of 4 and requiring corrective action.		
2	Inventory rating less than value in rating code of 4 and requiring replacement.		
0	Bridge closed due to structural condition.		

*MS Designation (typical)

Item 68 - Deck Geometry **1 digit**

This item is calculated by the Edit/Update Program and need not be coded by the bridge inspector.

The overall rating for deck geometry includes two evaluations: (a) the curb-to-curb or face-to-face of rail bridge width using Table 2A, B, C or D and (b) the minimum vertical clearance over the bridge roadway using Table 2E. The lower of the codes obtained from these tables is used by the Edit/Update Program. When an individual table lists several deck geometry rating codes for the same roadway width under a specific ADT, the lower code is used. (For example, Table 2A lists deck geometry rating codes of 6, 7 and 8 for a 13.4 meter roadway width and an ADT of >5000. Use the code of 6.) For values between those listed in the tables, the lower code is used.

The curb-to-curb or face-to-face of rail dimension shall be taken from Item 51 - Bridge Roadway Width, Curb-to-curb. Item 53 - Minimum Vertical Clearance Over Bridge Roadway is used to evaluate the vertical clearance.

For culverts which have Item 51 - Bridge Roadway Width coded 0000, the Deck Geometry code will be equal to N.

The values provided in the tables are for rating purposes only. Current design standards must be used for structure design or rehabilitation.

Item 68 - Deck Geometry (cont'd)

Table 2A & 2B. Rating by Comparison of ADT - Item 29 and
Bridge Roadway Width, Curb-to-Curb - Item 51

TABLE 2A							TABLE 2B	
Deck Geometry Rating Code	Bridge Roadway Width 2 Lanes; 2 Way Traffic						Bridge Roadway Width 1 Lane; 2-Way Traffic	
	ADT (Both Directions)						ADT (Both Directions)	
	0-100	101-400	401-1000	1001-2000	2001-5000	>5000	0-100	>100
9	>9.8	>11.0	>12.2	>13.4	>13.4	>13.4	-	-
8	9.8	11.0	12.2	13.4	13.4	13.4	<4.9	-
7	8.5	9.8	11.0	12.2	13.4	13.4	4.6	-
6	7.3	8.5	9.1	10.4	12.2	13.4	4.3	-
5	6.1	7.3	7.9	8.5	10.4	11.6	4.0	-
4	5.5	6.1	6.7	7.3	8.5	9.8 (8.5)*	3.7	-
3	4.9	5.5	6.1	6.7	7.9	9.1 (7.9)*	3.4	<4.9
2	Any width less than required for a rating code of 3 and structure is open.							
0	Bridge Closed							

* Use value in parentheses for bridges longer than 60 meters.

Notes:

1. Use the lower rating code for values between those listed in the table.
2. Dimensions are in meters.
3. For 1 lane of one-way traffic Table 2A is used.
4. For 3 or more undivided lanes of 2-way traffic, use Table 2C, Other Multilane Divided Facilities.
5. Do not use Table 2B for code 9 and for codes 8 through 4 inclusive when the ADT >100. Single lane bridges less than 4.9 meters wide carrying 2-way traffic are always appraised at 3 or below if they carry more than an ADT of 100.
6. One-lane bridges 4.90 meters and greater in roadway width, which are not ramps, are evaluated as a 2-lane bridge using Table 2A.

Item 68 - Deck Geometry (cont'd)

Table 2C & 2D. Rating by Comparison of Number of Lanes - Item 28
and Bridge Roadway Width, Curb-to-Curb - Item 51

TABLE 2C					TABLE 2D	
Deck Geometry Rating Code	Bridge Roadway Width 2 or More Lanes				Bridge Roadway Width 1-Way Traffic	
	Interstate and Other Divided Freeways		Other Multilane Divided Facilities		Ramps Only (Item 5C = 7)	
	2 Lanes 1-way	3 or more Lanes	2 Lanes 1-way	3 or more Lanes	1 Lane	2 or more Lanes
9	>12.8	>3.7N+7.3	>12.8	>3.7N+5.5	>7.9	>3.7N+3.7
8	12.8	3.7N+7.3	12.8	3.7N+5.5	7.9	3.7N+3.7
7	12.2	3.7N+6.1	11.6	3.7N+4.6	7.3	3.7N+3.0
6	11.6	3.7N+4.9	11.0	3.7N+3.7	6.7	3.7N+2.4
5	11.0	3.7N+4.3	10.1	3.4N+3.0	6.1	3.7N+1.8
4	10.4	3.4N+3.7	9.1	3.4N+1.8	5.5	3.7N+1.2
4	(8.8)*	(3.4N+2.1)*	9.1	3.4N+1.8	5.5	3.7N+1.2
3	10.1	3.4N+3.4	8.2	3.4N+1.5	4.9	3.7N+0.6
3	(8.5)*	(3.4N+1.8)*	8.2	3.4N+1.5	4.9	3.7N+0.6
2	Any width less than required for a rating code of 3 and structure is open.					
0	Bridge Closed					

* Use value in parentheses for bridges longer than 60 meters.
N = Total number of lanes of traffic on the structure.

<u>Notes</u>

1. Use the lower rating code for values between those listed in the tables.
2. Dimensions are in meters.
3. Use Table 2C, Other Multilane Divided Facilities, for 3 or more undivided lanes of 2-way traffic.

<u>Item 68 - Deck Geometry</u> (cont'd)

Table 2E. Rating by Comparison of Minimum Vertical Clearance over Bridge Roadway - Item 53 and Functional Classification - Item 26

Deck Geometry Rating Code	Minimum Vertical Clearance		
	Functional Class		
	Interstate and Other Freeway	Other Principal and Minor Arterial	Major and Minor Collectors and Locals
9	>5.18	>5.02	>5.02
8	5.18	5.02	5.02
7	5.10	4.72	4.72
6	5.02	4.41	4.41
5	4.80	4.34	4.34
4	4.57	4.26	4.26
3	Vertical clearance less than value in rating code of 4 and requiring corrective action.		
2	Vertical clearance less than value in rating code of 4 and requiring replacement.		
0	Bridge Closed.		

<u>Notes</u>

1. Use the lower rating code for values between those listed in the table.
2. Dimensions are in meters.

<u>Item 69 - Underclearances, Vertical and Horizontal</u> **1 digit**

This item is calculated by the Edit/Update Program and need not be coded by the bridge inspector.

Vertical and horizontal underclearances are measured from the through roadway to the superstructure or substructure units, respectively. Code "N" is used unless the bridge is over a highway or railroad.

The vertical underclearance is evaluated using Table 3A. The horizontal underclearance is evaluated using Table 3B. The lower of the codes obtained from Table 3A and Table 3B is used by the Edit/Update Program.

Bridges seldom are closed due to deficient underclearances, however, these bridges may be good candidates for rehabilitation or replacement.

Item 54 - Minimum Vertical Underclearance, Item 55 - Minimum Lateral Underclearance on Right, and Item 56 - Minimum Lateral Underclearance on Left are used to evaluate this item.

The functional classification used in the table is for the underpassing route. Therefore, the functional classification is obtained from the record for the route "under" the bridge (see Item 5 - Inventory Route).

If the underpassing route is not on a Federal-aid system, is not a defense route, or is not otherwise important, an "under" record may not be available. If no "under" record exits, it is assumed that the route under the bridge is a major or minor collector or a local road for the purpose of using Tables 3A and 3B.

Table 3A. Rating by Comparison of Minimum Vertical Underclearance -
Item 54 and Functional Classification of Underpassing Route - Item 26

Under-clear-ance Rating Code	Minimum Vertical Underclearance			
	Functional Class			Railroad
	Interstate and Other Freeway	Other Principal and Minor Arterial	Major and minor Collectors and Locals	
9	>5.18	>5.02	>5.02	>7.01
8	5.18	5.02	5.02	7.01
7	5.10	4.72	4.72	6.85
6	5.02	4.41	4.41	6.70
5	4.80	4.34	4.34	6.40
4	4.57	4.26	4.26	6.09
3	Underclearance less than value in rating code of 4 and requiring corrective action.			
2	Underclearance less than value in rating code of 4 and requiring replacement.			

0	Bridge closed.

<u>Notes</u>

1. Use the lower rating code for values between those listed in the tables.
2. Dimensions are in meters.
3. The functional classification of the underpassing route shall be used in the evaluation. If an "under" record is not coded,the underpassing route shall be considered a major or minorcollector or a local road.

Table 3B. Rating by Comparison of Minimum Lateral Underclearances Right & Left - Items 55 & 56 and Functional Classification of Underpassing Route - Item 26

<table>
<tr><td rowspan="6">Under-clear-ance Rating Code</td><td colspan="7">Minimum Lateral Underclearance</td></tr>
<tr><td colspan="6">Functional Class</td><td rowspan="5">Railroad</td></tr>
<tr><td colspan="4">1-Way Traffic</td><td colspan="2">2-Way Traffic</td></tr>
<tr><td colspan="4">Principal Arterial-Interstate, Freeways or Expressways</td><td rowspan="3">Other Principal and Minor Arterial</td><td rowspan="3">Major and Minor Collectors and Locals</td></tr>
<tr><td colspan="2">Main Line</td><td colspan="2">Ramp</td></tr>
<tr><td>Left</td><td>Right</td><td>Left</td><td>Right</td></tr>
<tr><td>9</td><td>>9.1</td><td>>9.1</td><td>>1.2</td><td>>3.0</td><td>>9.1</td><td>>3.7</td><td>>6.1</td></tr>
<tr><td>8</td><td>9.1</td><td>9.1</td><td>1.2</td><td>3.0</td><td>9.1</td><td>3.7</td><td>6.1</td></tr>
<tr><td>7</td><td>5.5</td><td>6.4</td><td>0.9</td><td>2.7</td><td>6.4</td><td>3.4</td><td>5.2</td></tr>
<tr><td>6</td><td>1.8</td><td>3.7</td><td>0.6</td><td>2.4</td><td>3.7</td><td>3.0</td><td>4.3</td></tr>
<tr><td>5</td><td>1.5</td><td>3.4</td><td>0.6</td><td>1.8</td><td>3.0</td><td>2.4</td><td>3.4</td></tr>
<tr><td>4</td><td>1.2</td><td>3.0</td><td>0.6</td><td>1.2</td><td>1.8</td><td>1.2</td><td>2.4</td></tr>
<tr><td>3</td><td colspan="7">Underclearance less than value in rating code of 4 and requiring corrective action.</td></tr>
<tr><td>2</td><td colspan="7">Underclearance less than value in rating code of 4 and requiring replacement.</td></tr>
<tr><td></td><td colspan="7"></td></tr>
</table>

0	Bridge closed.

Notes:

1. Use the lower rating code for values between those listed in the tables.
2. Dimensions are in meters.
3. When acceleration or deceleration lanes or ramps are providedunder 2-way traffic, use the value from the right ramp columnto determine code.
4. The functional classification of the underpassing route shallbe used in the evaluation. If an "under" record is no tcoded, the underpassing route shall be considered a major or minor collector or a local road.

Item 70 - Bridge Posting **1 digit**

The National Bridge Inspection Standards require the posting of load limits only if the maximum legal load configurations in the State exceeds the load permitted under the operating rating. If the load capacity at the operating rating is such that posting is required, this item shall be coded 4 or less. If no posting is required at the operating rating, this item shall be coded 5.

This item evaluates the load capacity of a bridge in comparison to the State legal load. It differs from Item 67 - Structural Evaluation in that Item 67 uses Item 66 - Inventory Rating, while the bridge posting requirement is based on Item 64 - Operating Rating.

Although posting a bridge for load-carrying capacity is required only when the maximum legal load exceeds the operating rating, highway agencies may choose to post at a lower level. This posting practice may appear to produce conflicting coding when Item 41 - Structure Open, Posted or Closed to Traffic is coded to show the bridge as actually posted at the site and Item 70 - Bridge Posting is coded as bridge posting is not required. Since different criteria are used for coding these 2 items, this coding is acceptable and correct when the highway agency elects to post at less than the operating rating. Item 70 shall be coded 4 or less only if the legal load of the State exceeds that permitted under the operating rating.

The use or presence of a temporary bridge affects the coding. The actual operating rating of the temporary bridge should be used to determine this item. However the highway agency may choose to post at a lower level. This also applies to bridges shored up or repaired on a temporary basis.

Code	Description
4 or less	Posting required
5	No posting required

The degree that the operating rating is less than the maximum legal load level may be used to

Item 70 - Bridge Posting (cont.)

differentiate between codes. As a guide and for coding purposes only, the following values may be used to code this item:

Code	Relationship of Operating Rating to Maximum Legal Load

5	Equal to or above legal loads
4	0.1 - 9.9% below
3	10.0 - 19.9% below
2	20.0 - 29.9% below
1	30.0 - 39.9% below
0	> 39.9% below

Item 71 - Waterway Adequacy **1 digit**

This item appraises the waterway opening with respect to passage of flow through the bridge. The following codes shall be used in evaluating waterway adequacy (interpolate where appropriate). Site conditions may warrant somewhat higher or lower ratings than indicated by the table (e.g., flooding of an urban area due to a restricted bridge opening).

Where overtopping frequency information is available, the descriptions given in the table for chance of overtopping mean the following:

Remote	-	greater than 100 years
Slight	-	11 to 100 years
Occasional	-	3 to 10 years
Frequent	-	less than 3 years

Adjectives describing traffic delays mean the following:

Insignificant	-	Minor inconvenience. Highway passable in a matter of hours.
Significant	-	Traffic delays of up to several days.
Severe	-	Long term delays to traffic with resulting hardship.

Functional Classification

Principal Arterials - Interstates, Freeways, or Expressways (Code)	Other Principal and Minor Arterials and Major Collectors (Code)	Minor Collectors, Locals (Code)	Description
N	N	N	Bridge not over a waterway.
9	9	9	Bridge deck and roadway approaches above flood water elevations (high water). Chance of overtopping is remote.
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.
6	6	7	Slight chance of overtopping bridge deck and roadway approaches.
4	5	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays.

(codes continued on the next page)

Item 71 - Waterway Adequacy (cont'd)

Functional Classification

Principal Arterials - Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Locals	Description
Code			
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays.
2	3	4	Occasional overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	3	Frequent overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays.
0	0	0	Bridge closed.

Item 72 - Approach Roadway Alignment **1 digit**

Code the rating based on the adequacy of the approach roadway alignment. This item identifies those bridges which do not function properly or adequately due to the alignment of the approaches. It is not intended that the approach roadway alignment be compared to current standards but rather to the existing highway alignment. This concept differs from other appraisal evaluations. The establishment of set criteria to be used at all bridge sites is not appropriate for this item. The basic criteria is how the alignment of the roadway approaches to the bridge relate to the general highway alignment for the section of highway the bridge is on.

The individual structure shall be rated in accordance with the general appraisal rating guide described on page 453 in lieu of specific design values. The approach roadway alignment will be rated intolerable (a code of 3 or less) only if the horizontal or vertical curvature requires a substantial reduction in the vehicle operating speed from that on the highway section. A very minor speed reduction will be rated a 6, and when a speed reduction is not required, the appraisal code will be an 8. Additional codes may be selected between these general values.

For example, if the highway section requires a substantial speed reduction due to vertical or horizontal alignment, and the roadway approach to the bridge requires only a very minor additional speed reduction at the bridge, the appropriate code would be a 6. This concept shall be used at each bridge site.

Speed reductions necessary because of structure width and not alignment shall not be considered in evaluating this item.

Item 73 and Item 74

(Reserved)

Item 75 - Type of Work 3 digits

The information to be recorded for this item will be the type of work proposed to be accomplished on the structure to improve it to the point that it will provide the type of service needed and whether the proposed work is to be done by contract or force account. Code a 3-digit number composed of 2 segments.

Segment	Description	Length
75A	Type of Work Proposed	2 digits
75B	Work Done by	1 digit

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. To be eligible, a bridge must carry highway traffic, be deficient and have a sufficiency rating of 80.0 or less. This item may be coded for other bridges at the option of the highway agency. Use one of the following codes to represent the proposed work type, otherwise leave blank:

Code	Description
31	Replacement of bridge or other structure because of substandard load carrying capacity or substandard bridge roadway geometry.
32	Replacement of bridge or other structure because of relocation of road.
33	Widening of existing bridge or other major structure without deck rehabilitation or replacement; includes culvert lengthening.
34	Widening of existing bridge with deck rehabilitation or replacement.
35	Bridge rehabilitation because of general structure deterioration or inadequate strength.
36	Bridge deck rehabilitation with only incidental widening.
37	Bridge deck replacement with only incidental widening.
38	Other structural work, including hydraulic replacements.

If segment A is blank, leave segment B blank. Otherwise, the third digit shall be coded using one of the following codes to indicate whether the proposed work is to be done by contract or by force account:

Code	Description
1	Work to be done by contract
2	Work to be done by owner's forces

EXAMPLES:	Code
A bridge is to be replaced by contract because it has deteriorated to the point that it can no longer carry legal loads. The same code should be used if the bridge is replaced because it is now too narrow or the original design was too light to accommodate today's legal loads.	311
A bridge is to be replaced because the roadway must be straightened to eliminate a dangerous curve. The work will be done by contract.	321
A bridge is to be widened to increase shoulder width or the number of traffic lanes. The existing deck is in good condition and will be incorporated as is into the new structure. The work is to be done by contract.	331
A culvert is to be extended by contract to accommodate additional roadway width as part of a reconstruction contract to improve the safety of the adjacent slopes.	331
A deck is to be rehabilitated and the bridge widened to provide a full 3.6 meter shoulder. The existing shoulder is only .2 meters wide and an extra line of girders with appropriate substructure widening must be added. The work will be done by contract.	341
A bridge superstructure and substructure are to be rehabilitated by State forces to increase the bridge's load capacity.	352
A bridge deck is to be rehabilitated by contract and a safety curb to be removed which results in incidental widening of 0.6 meters.	361
A bridge deck is to be replaced by contract and the deck cantilever overhang extended 0.6 meters, which is the maximum that can be done without adding another line of stringers or girders to the superstructure.	371
A bridge which is no longer needed is to be demolished and an at-grade crossing built by State forces. (This code could also be used to designate incidental safety work on a bridge such as bridge-rail upgrading or replacement.)	382

Item 76 - Length of Structure Improvement (XXXXX.X meters) 6 digits

Code a 6-digit number that represents the length of the proposed bridge improvement to the nearest tenth of a meter (with an assumed decimal point). For replacement or rehabilitation of the entire bridge, the length should be back to back of backwalls of abutments or from pavement notch to pavement notch. For replacement or rehabilitation of only part of the structure, use the length of the portion to be improved.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

For culvert improvements, use the proposed length measured along the centerline of the barrel regardless of the depth below grade. The measurement should be made between the inside faces of the top parapet or edge-stiffening beam of the top slab.

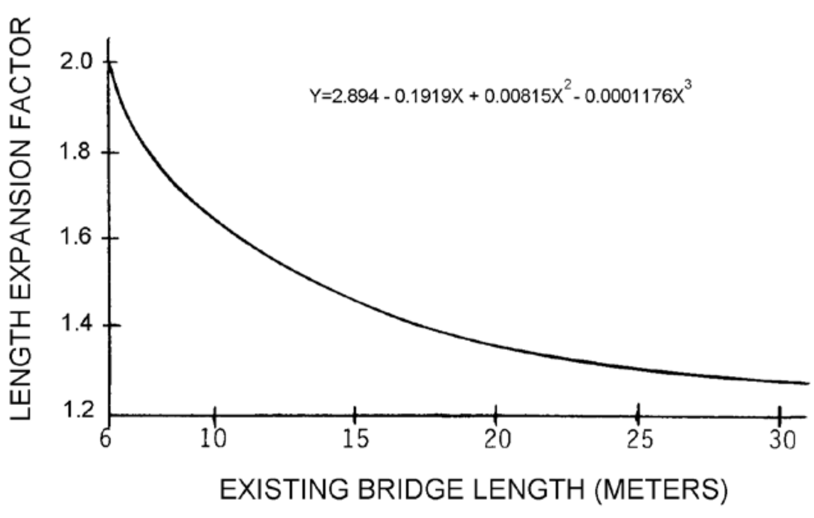
EXAMPLES:

		Code
Length of Structure Improvement	76.2 meters	000762
	1200 meters	012000
	12,345 meters	123450

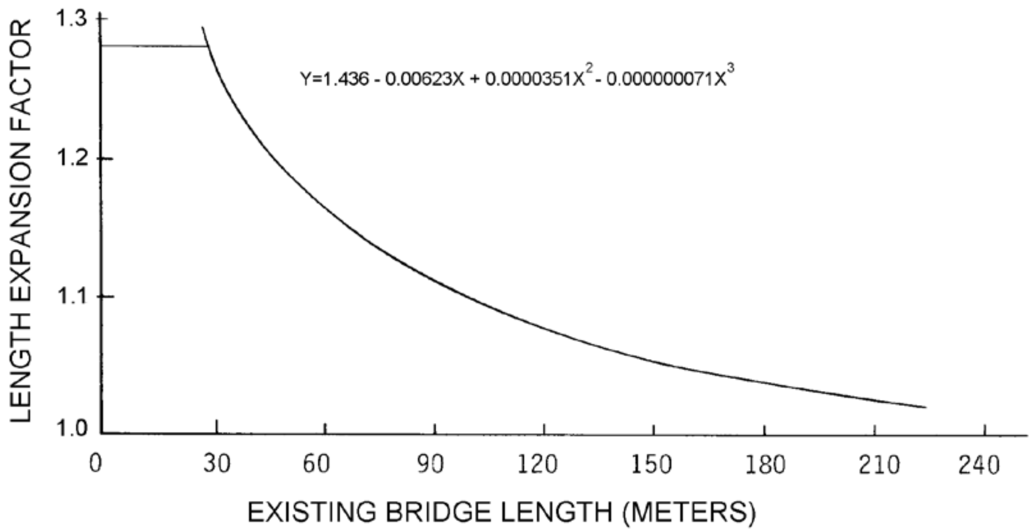
For substructure or channel work only, code the length of superstructure over, or supported by, the substructure or channel.

Typically, a replacement bridge is longer than the existing bridge. Nationwide averages for the increase in bridge length with replacement as a function of the existing length are given in the following figures. The length-expansion factors represent data for the years 1981 to 1985. Where site-specific data is lacking, these factors are suggested for estimating the length of replacement bridges. For exceedingly long bridges (i.e., 300 meters or more) the length-expansion factor approaches 1.0.

INCREASED LENGTH OF REPLACEMENT BRIDGES



Item 76 – Length of Structure Improvement (cont.)



X = EXISTING BRIDGE LENGTH
Y = LENGTH EXPANSION FACTOR

REPLACEMENT BRIDGE LENGTH = EXISTING BRIDGE LENGTH x LENGTH EXPANSION FACTOR

Item 77 through Item 89

(Reserved)

Item 90 - Inspection Date **4 digits**

Record the month and year that the last routine inspection of the structure was performed. This inspection date may be different from those recorded in Item 93 - Critical Feature Inspection Date. Code a 4-digit number to represent the month and year. The number of the month should be coded in the first 2 digits with a leading zero as required and the last 2 digits of the year coded as the third and fourth digits of the field.

EXAMPLES:	Code
Inspection date November 1992	1192
March 1994	0394

Item 91 - Designated Inspection Frequency **2 digits**

Code 2 digits to represent the number of months between designated inspections of the structure. A leading zero shall be coded as required. This interval is usually determined by the individual in charge of the inspection program. For posted, understrength bridges, this interval should be substantially less than the 24-month standard. The designated inspection interval could vary from inspection to inspection depending on the condition of the bridge at the time of inspection.

EXAMPLES:	Code
Posted bridge with heavy truck traffic and questionable structural details which is designated to be inspected each month	01
Bridge is scheduled to be inspected every 24 months	24

It should be noted that bridges will also require special non-scheduled inspections after unusual physical traumas such as floods, earthquakes, fires or collisions. These special inspections may range from a very brief visual examination to a detailed in-depth evaluation depending upon the nature of the trauma. For example, when a substructure pier or abutment is struck by an errant vehicle, in most cases only a visual examination of the bridge is necessary. After major collisions or earthquakes, in-depth inspections may be warranted as directed by the engineer in overall charge of the program. After and during severe floods, the stability of the substructure of bridges may have to be determined by probing, underwater sensors or other appropriate measures. Underwater inspection by divers may be required for some scour critical bridges immediately after floods. See Item 113 - Scour Critical Bridges.

Item 92 - Critical Feature Inspection **9 digits**

Using a series of 3-digit code segments, denote critical features that need special inspections or special emphasis during inspections and the designated inspection interval in months as determined by the individual in charge of the inspection program. The designated inspection interval could vary from inspection to inspection depending on the condition of the bridge at the time of inspection.

Segment	Description	Length
92A	Fracture Critical Details	3 digits
92B	Underwater Inspection	3 digits
92C	Other Special Inspection	3 digits

For each segment of Item 92A, B, and C, code the first digit Y for special inspection or emphasis needed and code N for not needed. The first digit of Item 92A, B, and C must be coded for all structures to designate either a yes or no answer. Those bridges coded with a Y in Item 92A or B should be the same bridges contained in the Master Lists of fracture critical and special underwater inspection bridges. In the second and third digits of each segment, code a 2-digit number to indicate the number of months between inspections only if the first digit is coded Y. If the first digit is coded N, the second and third digits are left blank.

Item 92 - Critical Feature Inspection (cont.)

Current guidelines for the maximum allowable interval between inspections can be summarized as follows:

Fracture Critical Details	24 months
Underwater Inspection	60 months
Other Special Inspections	60 months

EXAMPLES:

	Item	Code
A 2-girder system structure which is being inspected yearly and no other special inspections are required.	92A 92B 92C	Y12 N__ N__
A structure where both fracture critical and underwater inspection are being performed on a 1-year interval. Other special inspections are not required.	92A 92B 92C	Y12 Y12 N__
A structure has been temporarily shored and is being inspected on a 6-month interval. Other special inspections are not required.	92A 92B 92C	N__ N__ Y06

Item 93 - Critical Feature Inspection Date **12 digits**

Code only if the first digit of Item 92A, B, or C is coded Y for yes. Record as a series of 4-digit code segments, the month and year that the last inspection of the denoted critical feature was performed.

Segment	Description	Length
93A	Fracture Critical Details	4 digits
93B	Underwater Inspection	4 digits
93C	Other Special Inspection	4 digits

For each segment of this item, when applicable, code a 4-digit number to represent the month and year. The number of the month should be coded in the first 2 digits with a leading zero as required and the last 2 digits of the year coded as the third and fourth digits of the field. If the first digit of any part of Item 92 is coded N, then the corresponding part of this item shall be blank.

EXAMPLES:

	Item	Code
A structure has fracture critical members which were last inspected in March 1986. It does not require underwater or other special feature inspections.	93A 93B 93C	0386 (blank) (blank)
A structure has no fracture critical details, but requires underwater inspection and has other special features (for example, a temporary support) for which the State requires special inspection. The last underwater inspection was done in April 1986 and the last special feature inspection was done in November 1985.	93A 93B 93C	(blank) 0486 1185

Item 94 - Bridge Improvement Cost **6 digits**

Code a 6-digit number to represent the estimated cost of the proposed bridge or major structure improvements in thousands of dollars. This cost shall include only bridge construction costs, excluding roadway, right of way, detour, demolition, preliminary engineering, etc. Code the base year for the cost in Item 97 - Year of Improvement Cost Estimate. Do not use this item for estimating maintenance costs.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

EXAMPLES:

		Code
Bridge Improvement Cost	$ 55,850	000056
	250,000	000250
	7,451,233	007451

Nationally, the deck area of replaced bridges is averaging 2.2 times the deck area before replacement. The deck area of rehabilitated bridges is averaging 1.5 times the deck area before rehabilitation. Widening square meter costs are typically 1.8 times the square meter cost of new bridges with similar spans. For example, if the average cost of a new bridge is $500 per square meter, the average cost of the widened area would be $900 per square meter.

Each highway agency is encouraged to use its best available information and established procedures to determine bridge improvement costs. In the absence of these procedures, the highway agency may wish to use the following procedure as a guide in preparing bridge improvement cost estimates.

Apply a construction unit cost to the proposed bridge area developed by using (1) current State deck geometry design standards and (2) proposed bridge length from Item 76 - Length of Structure Improvement.

Item 95 - Roadway Improvement Cost **6 digits**

Code a 6-digit number to represent the cost of the proposed roadway improvement in thousands of dollars. This shall include only roadway construction costs, excluding bridge, right-of-way, detour, extensive roadway realignment costs, preliminary engineering, etc. Code the base year for the cost in Item 97 - Year of Improvement Cost Estimate. Do not use this item for estimating maintenance costs.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

In the absence of a procedure for estimating roadway improvement costs, a guide of 10 percent of the bridge costs is suggested.

Item 97 - Year of Improvement Cost Estimate **4 digits**

Record and code the year that the costs of work estimated in Item 94 - Bridge Improvement Cost, Item 95 - Roadway Improvement Cost, and Item 96 - Total Project Cost were based upon. This date and the data provided for Item 94 through Item 96 must be current; that is, Item 97 shall be no more than 8 years old.

EXAMPLES:

		Code
Year of Cost Estimate	1994 costs	1994
	2000 costs	2000

Item 98 - Border Bridge **5 digits**

Use this item to indicate structures crossing borders of States. Code a 5-digit number composed of 2 segments specifying the percent responsibility for improvements to the existing structure when it is on a border with a neighboring State. Code the first 3 digits with the neighboring State code using State codes listed in Item 1 - State Code. Code the fourth and fifth digits with the percentage of total deck area of the existing bridge that the neighboring State is responsible for funding.

Segment	Description	Length
98A	Neighboring State Code	3 digits
98B	Percent Responsibility	2 digits

If a neighboring State codes the structure and accepts 100% of the responsibility, but your State still codes a record for the structure, then Item 98B in your State's record should be coded 99 to represent that your State has no responsibility for the structure.

For the special case of a structure on the border with Canada or Mexico, code the State code value = CAN or MEX respectively. If structure is not on a border, leave blank.

EXAMPLES:	Code
A structure connects your State with New Jersey and New Jersey is responsible for funding 45 percent of future improvement costs.	34245
A structure connects your State with Mexico and Mexico is not responsible for any funding of future improvement costs.	MEX00

Item 99 - Border Bridge Structure Number **15 digits**

Code the neighboring State's 15-digit National Bridge Inventory structure number for any structure noted in Item 98 - Border Bridge. This number must match exactly the neighboring State's submitted NBI structure number. The entire 15-digit field must be accounted for including zeros and blank spaces whether they are leading, trailing, or embedded in the 15-digit field. If Item 98 is blank, this item is blank.

In the above example where Mexico (or a neighboring State) has 00% responsibility, and, if there is no NBI Structure Number in that State's inventory file, then the entire 15-digit field shall be coded zeroes.

Item 100 - STRAHNET Highway Designation **1 digit**

This item shall be coded for all records in the inventory. For the purposes of this item, the STRAHNET Connectors are considered included in the term STRAHNET. For the inventory route identified in Item 5, indicate STRAHNET highway conditions using one of the following codes:

Code	Description
0	The inventory route is not a STRAHNET route.
1	The inventory route is on a Interstate STRAHNET route.
2	The inventory route is on a Non-Interstate STRAHNET route.

Item 100 - STRAHNET Highway Designation (cont.)

3 The inventory route is on a STRAHNET connector route.

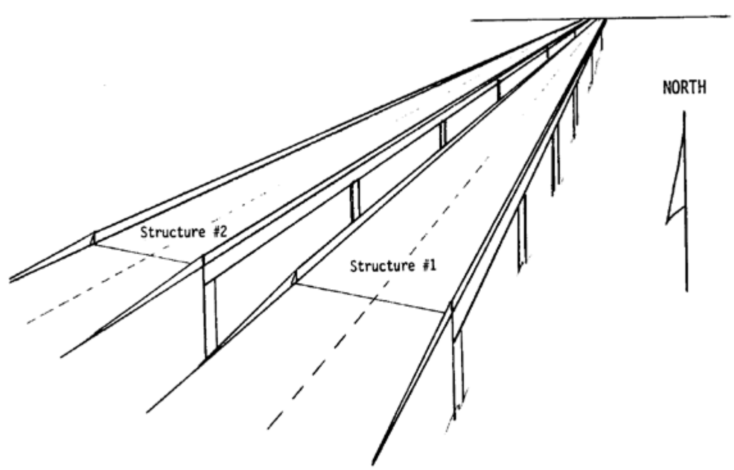
Item 101 - Parallel Structure Designation **1 digit**

Code this item to indicate situations where separate structures carry the inventory route in opposite directions of travel over the same feature. The lateral distance between structures has no bearing on the coding of this item. One of the following codes shall be used:

Code	Description
R	The right structure of parallel bridges carrying the roadway in the direction of the inventory. (For a STRAHNET highway, this is west to east and south to north.)
L	The left structure of parallel bridges. This structure carries traffic in the opposite direction.
N	No parallel structure exists.

EXAMPLE:

	Code
Structure #1	R
Structure #2	L



Item 102 - Direction of Traffic **1 digit**

Code the direction of traffic of the inventory route identified in Item 5 as a 1-digit number using one of the codes below. This item must be compatible with other traffic-related items such as Item 28A Lanes on the Structure, Item 29 - Average Daily Traffic, Item 47 - Total Horizontal Clearance and Item 51 - Bridge Roadway Width, Curb-to-Curb.

Code	Description
0	Highway traffic not carried
1	1-way traffic
2	2-way traffic
3	One lane bridge for 2-way traffic

Item 103 - Temporary Structure Designation **1 digit**

Code this item to indicate situations where temporary structures or conditions exist. This item should be blank if not applicable.

Code	Description
T	Temporary structure(s) or conditions exist.

Temporary structure(s) or conditions are those which are required to facilitate traffic flow. This may occur either before or during the modification or replacement of a structure found to be deficient. Such conditions include the following:

- Bridges shored up, including additional temporary supports.
- Temporary repairs made to keep a bridge open.
- Temporary structures, temporary runarounds or bypasses.
- Other temporary measures, such as barricaded traffic lanes to keep the bridge open.

Any repaired structure or replacement structure which is expected to remain in place without further project activity, other than maintenance, for a significant period of time shall not be considered temporary. Under such conditions, that structure, regardless of its type, shall be considered the minimum adequate to remain in place and evaluated accordingly.

If this item is coded T, then all data recorded for the structure shall be for the condition of the structure without temporary measures, except for the following items which shall be for the temporary structure:

Item 10 - Inventory Route, Minimum Vertical Clearance
41 - Structure Open, Posted, or Closed to Traffic
47 - Inventory Route, Total Horizontal Clearance
53 - Minimum Vertical Clearance Over Bridge Roadway
54 - Minimum Vertical Underclearance
55 - Minimum Lateral Underclearance on Right
56 - Minimum Lateral Underclearance on Left
70 - Bridge Posting

Item 104 - Highway System of the Inventory Route **1 digit**

This item is to be coded for all records in the inventory. For the inventory route identified in Item 5, indicate whether the inventory route is on the National Highway System (NHS) or not on that system. Initially, this code shall reflect an inventory route on the NHS "Interim System" description in Section 1006(a) of the 1991 ISTEA. Upon approval of the NHS by Congress, the coding is to reflect the approved NHS. Use one of the following codes:

Code	Description
0	Inventory Route is not on the NHS
1	Inventory Route is on the NHS

Item 105 - Federal Lands Highways **1 digit**

Structures owned by State and local jurisdictions on roads which lead to and traverse through federal lands sometimes require special coded unique identification because they are eligible to receive funding from the Federal Lands Highway Program. One of the following codes shall be used:

Code	Description
0	Not applicable
1	Indian Reservation Road (IRR)
2	Forest Highway (FH)
3	Land Management Highway System (LMHS)
4	Both IRR and FH
5	Both IRR and LMHS
6	Both FH and LMHS
9	Combined IRR, FH and LMHS

Item 106 - Year Reconstructed **4 digits**

Record and code the year of most recent reconstruction of the structure. Code all 4 digits of the latest year in which reconstruction of the structure was completed. If there has been no reconstruction code 0000.

For a bridge to be defined as reconstructed, the type of work performed, whether or not it meets current minimum standards, must have been eligible for funding under any of the Federal-aid funding categories. The eligibility criteria would apply to the work performed regardless of whether all State or local funds or Federal-aid funds were used.

Some types of eligible work not to be considered as reconstruction are listed:

- Safety feature replacement or upgrading (for example, bridge rail, approach guardrail or impact attenuators).

- Painting of structural steel.

- Overlay of bridge deck as part of a larger highway surfacing project (for example, overlay carried across bridge deck for surface uniformity without additional bridge work).

- Utility work.

Item 106 - Year Reconstructed (cont.)

- Emergency repair to restore structural integrity to the previous status following an accident.
- Retrofitting to correct a deficiency which does not substantially alter physical geometry or increase the load-carrying capacity.
- Work performed to keep a bridge operational while plans for complete rehabilitation or replacement are under preparation (for example, adding a substructure element or extra girder).

EXAMPLE:	Code
Reconstruction completed 1970	1970

Item 107 - Deck Structure Type **1 digit**

Record the type of deck system on the bridge. If more than one type of deck system is on the bridge, code the most predominant. Code N for a filled culvert or arch with the approach roadway section carried across the structure. Use one of the following codes:

Code	Description
1	Concrete Cast-in-Place
2	Concrete Precast Panels
3	Open Grating
4	Closed Grating
5	Steel plate (includes orthotropic)
6	Corrugated Steel
7	Aluminum
8	Wood or Timber
9	Other
N	Not applicable

Item 108 - Wearing Surface/Protective System **3 digits**

Information on the wearing surface and protective system of the bridge deck shall be coded using a 3-digit code composed of 3 segments.

Segment	Description	Length
108A	Type of Wearing Surface	1 digit
108B	Type of Membrane	1 digit
108C	Deck Protection	1 digit

Item 108 - Wearing Surface/Protective System (cont.)

1st Digit - Type of Wearing Surface (Item 108A):

Code	Description
1	Monolithic Concrete (concurrently placed with structural deck)
2	Integral Concrete (separate non-modified layer of concrete added to structural deck)
3	Latex Concrete or similar additive
4	Low Slump Concrete
5	Epoxy Overlay
6	Bituminous
7	Wood or Timber
8	Gravel
9	Other
0	None (no additional concrete thickness or wearing surface is included in the bridge deck)
N	Not Applicable (applies only to structures with no deck)

2nd Digit - Type of Membrane (Item 108B):

Code	Description
1	Built-up
2	Preformed Fabric
3	Epoxy
8	Unknown
9	Other
0	None
N	Not Applicable (applies only to structures with no deck)

3rd Digit - Deck Protection (Item 108C):

Code	Description
1	Epoxy Coated Reinforcing
2	Galvanized Reinforcing
3	Other Coated Reinforcing
4	Cathodic Protection
6	Polymer Impregnated
7	Internally Sealed
8	Unknown
9	Other
0	None
N	Not Applicable (applies only to structures with no deck)

<u>Item 109 - Average Daily Truck Traffic</u> (XX percent) 2 digits

Code a 2-digit percentage that shows the percentage of Item 29 - Average Daily Traffic that is truck traffic. Do not include vans, pickup trucks and other light delivery trucks in this percentage.

If this information is not available, an estimate which represents the average percentage for the category of road carried by the bridge may be used. May be left blank if Item 29 - Average Daily Traffic is not greater than 100.

EXAMPLES:		Code
Average Daily Traffic	7% trucks	07
	12% trucks	12

<u>Item 110 - Designated National Network</u> 1 digit

The national network for trucks includes most of the Interstate System and those portions of Federal-Aid highways identified in the Code of Federal Regulations (23 CFR 658). The national network for trucks is available for use by commercial motor vehicles of the dimensions and configurations described in these regulations. For the inventory route identified in Item 5, indicate conditions using one of the following codes:

Code	Description
0	The inventory route is not part of the national network for trucks.
1	The inventory route is part of the national network for trucks.

Item 111 - Pier or Abutment Protection (for Navigation) 1 digit

If Item 38 - Navigation Control has been coded 1, use the codes below to indicate the presence and adequacy of pier or abutment protection features such as fenders, dolphins, etc. The condition of the protection devices may be a factor in the overall evaluation of Item 60 - Substructure. If Item 38 - Navigation Control has been coded 0 or N, leave blank to indicate not applicable.

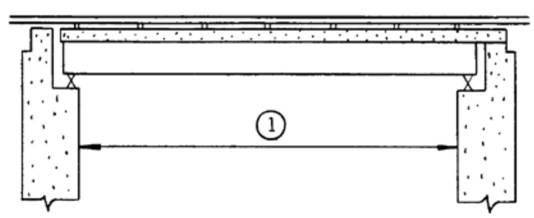
Code	Description
1	Navigation protection not required
2	In place and functioning
3	In place but in a deteriorated condition
4	In place but reevaluation of design suggested
5	None present but reevaluation suggested

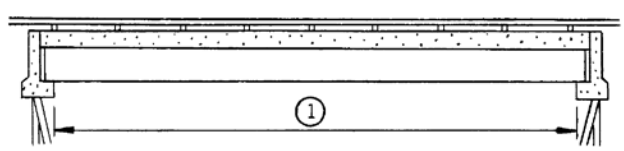
<u>Item 112 - NBIS Bridge Length</u> **1 digit**

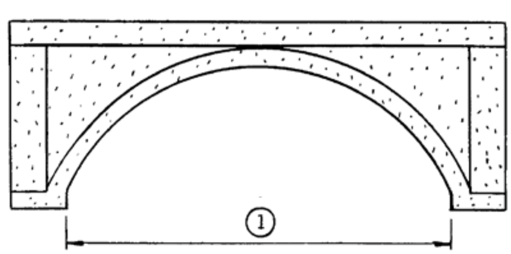
Does this structure meet or exceed the minimum length specified to be designated as a bridge for National Bridge Inspection Standards purposes? The following definition of a bridge is to be used:

> A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than
> 20 feet* between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.
> * (6.1 meters).

Code	Description
Y	Yes
N	No





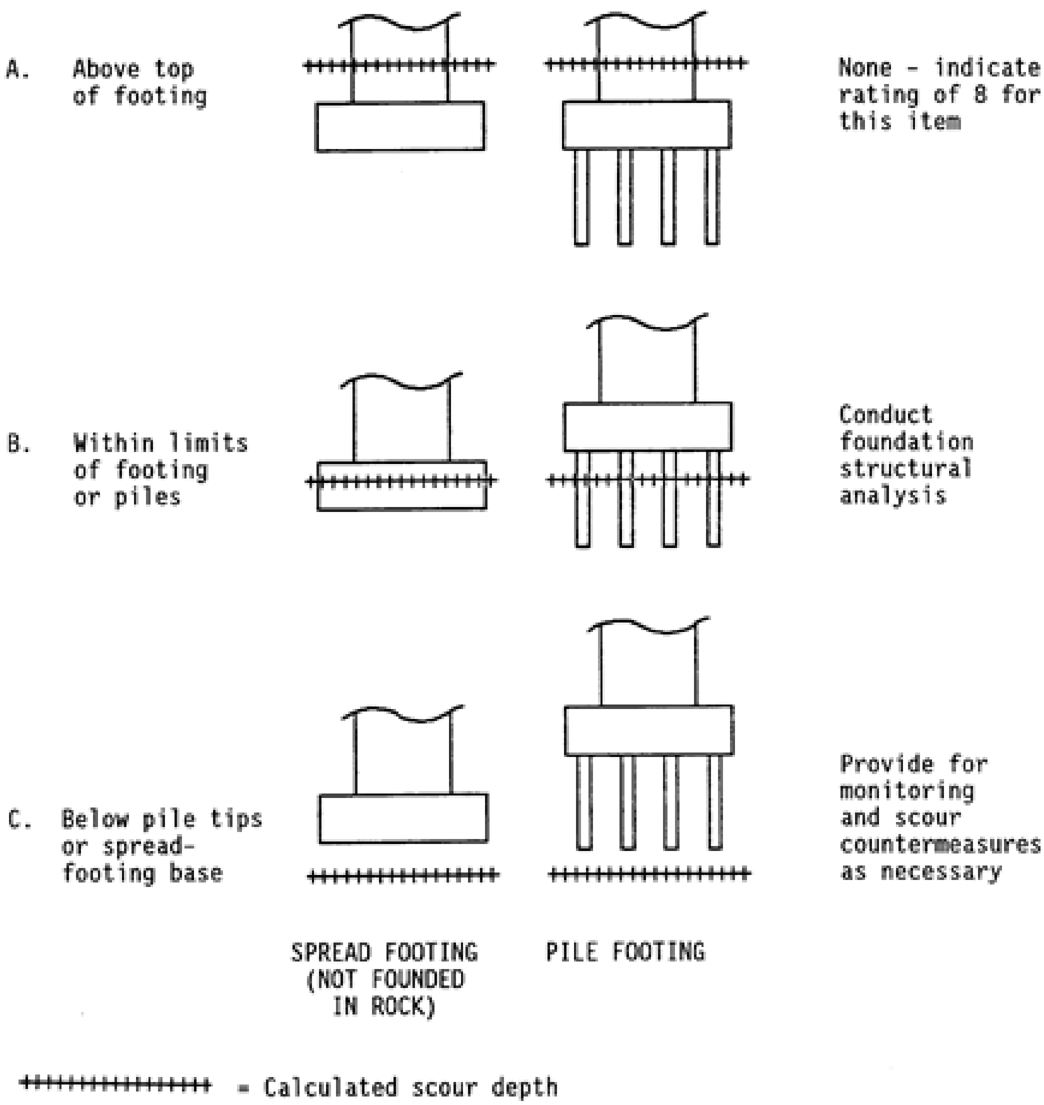


Item 113 - Scour Critical Bridges **1 digit**

Use a single-digit code as indicated below to identify the current status of the bridge regarding its vulnerability to scour. Scour analyses shall be made by hydraulic/geotechnical/structural engineers. Details on conducting a scour analysis are included in the FHWA Technical Advisory 5140.23 titled, "Evaluating Scour at Bridges." Whenever a rating factor of 4 or below is determined for this item, the rating factor for Item 60 - Substructure may need to be revised to reflect the severity of actual scour and resultant damage to the bridge. A scour critical bridge is one with abutment or pier foundations which are rated as unstable due to (1) observed scour at the bridge site or (2) a scour potential as determined from a scour evaluation study.

Code	Description
N	Bridge not over waterway.
U	Bridge with "unknown" foundation that has not been evaluated for scour. Since risk cannot be determined, flag for monitoring during flood events and, if appropriate, closure.
T	Bridge over "tidal" waters that has not been evaluated for scour, but considered low risk. Bridge will be monitored with regular inspection cycle and with appropriate underwater inspections. ("Unknown" foundations in "tidal" waters should be coded U.)
9	Bridge foundations (including piles) on dry land well above flood water elevations.
8	Bridge foundations determined to be stable for assessed or calculated scour conditions; calculated scour is above top of footing. (Example A)
7	Countermeasures have been installed to correct a previously existing problem with scour. Bridge is no longer scour critical.
6	Scour calculation/evaluation has not been made. (Use only to describe case where bridge has not yet been evaluated for scour potential.)
5	Bridge foundations determined to be stable for calculated scour conditions; scour within limits of footing or piles. (Example B)
4	Bridge foundations determined to be stable for calculated scour conditions; field review indicates action is required to protect exposed foundations from effects of additional erosion and corrosion.
3	Bridge is scour critical; bridge foundations determined to be unstable for calculated scour conditions: - Scour within limits of footing or piles. (Example B) - Scour below spread-footing base or pile tips. (Example C)
2	Bridge is scour critical; field review indicates that extensive scour has occurred at bridge foundations. Immediate action is required to provide scour countermeasures.
1	Bridge is scour critical; field review indicates that failure of piers/abutments is imminent. Bridge is closed to traffic.
0	Bridge is scour critical. Bridge has failed and is closed to traffic.

Item 113 - Scour Critical Bridges (cont.)



Item 114 - Future Average Daily Traffic **6 digits**

Code for all bridges the forecasted average daily traffic (ADT) for the inventory route identified in Item 5. This shall be projected at least 17 years but no more than 22 years from the year of inspection. The intent is to provide a basis for a 20-year forecast. This item may be updated anytime, but must be updated when the forecast falls below the 17-year limit. If planning data is not available, use the best estimate based on site familiarity.

The future ADT must be compatible with the other items coded for the bridge. For example, parallel bridges with an open median are coded as follows: if Item 28 -Lanes On and Under the Structure and Item 51 - Bridge Roadway Width, Curb-to-Curb are coded for each bridge separately, then the future ADT must be coded for each bridge separately (not the total for the route).

EXAMPLES:		Code
Future ADT	540	000540
	15,600	015600
	240,000	240000

Item 115 - Year of Future Average Daily Traffic **4 digits**

Record and code the year represented by the future ADT in Item 114. The projected year of future ADT shall be at least 17 years but no more than 22 years from the year of inspection.

EXAMPLE:		Code
Year of Future ADT is	2014	2014

Item 116 - Minimum Navigation Vertical Clearance, Vertical Lift Bridge (XXX.X meters) **4 digits**

Record and code as a 4-digit number truncated to the tenth of a meter (with an assumed decimal point), the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency. Code this item only for vertical lift bridges in the dropped or closed position, otherwise leave blank.

EXAMPLES:		Code
Vertical Clearance	10.67 meters	0106
	24.22 meters	0242

GENERAL

Inspection reports should generally include the following:

1. A statement of action taken, if any, pursuant to findings of inspection.
2. Any special findings stemming from the inspection and evaluation of fracture critical members, underwater inspections, and special feature inspection.
3. Any features which should be monitored closely during subsequent inspections as should any specific descriptions, instructions, or concerns.

Measurements, sketches, diagrams, test results, or calculations should generally be included on separate sheets

Section 3 – NBI Coding Guide Commentary

December 1994 Commentary

This commentary provides a ready reference for item by item changes between the 1988 Coding Guide and this proposed revision. Items not specifically mentioned here are essentially unchanged except for SI metric conversion.

Introduction

- Mentions new items and their use.
- References to Defense Bridges removed and STRAHNET added.
- Federal agencies specifically included in this Guide.
- Minor editorial changes and reference revisions have been made to bring the text up to date.

Definition of Terms

The order of the definitions has changed and the following added or modified:

(a) Bridge length has been converted to metric.
The length of 20 feet has been changed to 6.1 meters.
(b) Culvert.
(i) Strategic Highway Corridor Network (STRAHNET). Replaces Defense Items, which were dropped.
(j) STRAHNET Connectors.
(k) Indian Reservation Road definition has been added.
(l) Land Management Highway System (LMHS)
(m) Forest Highway (FH)
(n) Forest Service Development Road.
(o) Base Highway Network.
(p) Highway Performance Monitoring System.
(q) Conversion of Numerical Data
(r) Rounding and Truncating of Numerical Data.

Item 2 - Highway Agency District

- Name of item changed to reflect inclusion of federal bridges.

Item 5A - Record Type

- Clarification has been made for the case of 2 or more routes passing under a structure.
- Items 30, and 109 have been added to the list of items required to be coded for "under" records.

Item 6 - Features Intersected

- Item coding requirements have been clarified for "under" records.
- References to defense highway and FHPM 6-10-2 have been eliminated.

- Critical facilities are now STRAHNET and STRAHNET Connectors.

Item 7 - Facility Carried by Structure

- Item coding requirements have been clarified for "under" records.
- Temporary use of this item for coding IRR has been changed to Item 105.

Item 8 - Structure Number

- Closed median has been described.
- Additional emphasis has been given to the need to have all 15 digits filled.

Item 10 - Inventory Route, Minimum Vertical Clearance

- Units of measurement have been converted to metric, using a 3-meter width of pavement.
- Vertical restrictions 30 meters or greater may now be coded 9999, with exact actual clearances in this range optional.

Item 11 - Kilometer Point

- Units of measurement and the description of the item have been converted to metric.
- Seven digits will be coded instead of six.

Item 12 - Base Highway Network

- New item added for use in identifying Linear Referencing System (LRS).

Item 13 - LRS Inventory Route, Subroute Number

- New item added for identifying LRS.

Item 16 - Latitude and Item 17 - Longitude

- Number of digits have been expanded to 8 and 9 digits, respectively.
- The format of the item allows an increased precision of measurement (not mandatory) to accommodate the use of the Global Positioning System (GPS). Current measuring methods and level of precision may continue to be used.
- References to defense highways changed to STRAHNET.
- Location where measurement is taken must be compatible with the LRS.

Item 19 - Bypass, Detour Length

- Number of digits has been expanded to three to accommodate metric.

Item 20 - Toll

- Reference to Secretarial Agreement updated

Item 21 - Maintenance Responsibility and Item 22 - Owner

- Several federal agencies have been added.

Item 26 - Functional Classification of Inventory Route

- This item is no longer compatible with Item 104 and appropriate revisions have been made.

Item 28 - Lanes On and Under the Structure

- Text clarified for "under" records.
- Text has been added advising that any "1-lane" bridge 4.9 meters or greater in curb-to curb width is evaluated as 2 lanes or more in Item 68 -Deck Geometry.

Item 29 - Average Daily Traffic

- Text has been added explaining that if the bridge is closed, the coding is to be the actual ADT from the period before the closure occurred.

Item 30 - Year of Average Daily Traffic

- Field expanded to four digits to allow coding of complete year.

Item 31 - Design Load

- Codes have been converted from the H and HS loadings to metric M and MS loadings.

Item 32 - Approach Roadway Width

- A hard conversion of the units of measure has been used to match the metric standards of AASHTO.

Item 36 - Traffic Safety Features

- Add and update reference publications.
- Segment A has been updated to include the latest FHWA policy on crash testing and other recommended barrier specifications.
- Note on national set of standards updated.

Item 38 - Navigation Control

Term bridge permit clarified.

Item 41 - Structure Open, Posted or Closed to Traffic

Code B has been clarified concerning signs not correctly implemented. An example of "not correctly implemented" is existing posting signs not changed to indicate a lower load posting calculated for more recent inspection conditions.

Code P expanded to include temporary bridges which are load posted.

Item 43 - Structure Type, Main

Segment A codes 5 and 6 have been noted to include post-tensioned concrete.

Segment B code 07 has been noted that frame culverts are excluded.
Code 19 has been noted that frame culverts are included.

Item 47 - Inventory Route, Total Horizontal Clearance

FHPM reference has been eliminated.

In addition to the metric changes and editorial clarifications, the definition for clearance has been modified.

Item 48 - Length of Maximum Span

The units of measurement have been converted to metric and the number of digits expanded to 5 digits to accommodate the metric values.

Center to center measurements specified to be center of bearing points.

Item 49 - Structure Length

In addition to the metric changes, an explanation has been added concerning the measuring and coding of tunnels.

Item 50 - Curb or Sidewalk Widths

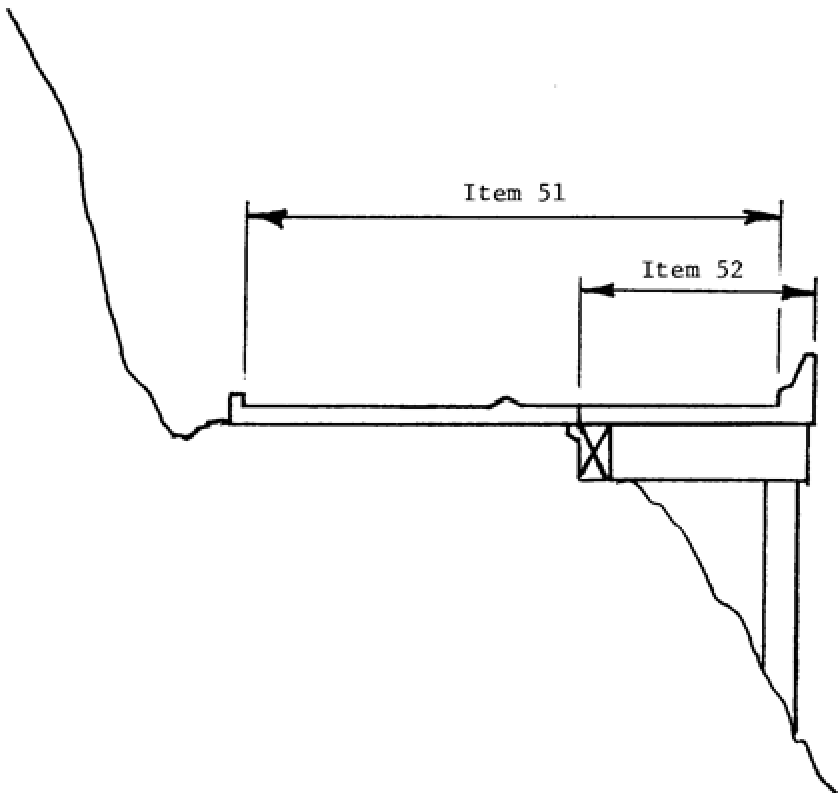
Example figure modified to accentuate the mountable median.

Item 51 - Bridge Roadway Width, Curb-to-Curb

In addition to the metric changes, a reference has been added for the case of sidehill viaducts. A sidehill viaduct has a portion of its width on embankment and a portion on structure. The problem arises in calculating Item 68, the sufficiency rating and the deck area of the bridge. Commentary Figure 1 illustrates the coding of sidehill viaducts.

Commentary Figure 1

FIGURE ILLUSTRATING CODING
OF SIDEHILL VIADUCTS



Associated Items:

Item 28A - Lanes On Structure
Item 29 - ADT = Total for entire structure
Item 32 - Approach Roadway Width
Item 102 - Direction of Traffic = 2 for 2-way

Item 53 - Minimum Vertical Clearance Over Bridge Roadway

- Units of measurement have been converted to metric.
- Clarification has been added for recording the minimum vertical clearance for double decked structures.
- Restrictions of 30 meters or greater or no superstructure restriction are now both to be coded 9999. However coding of actual clearances between 30 and 99.99 meters to an exact measurement is optional.

Item 54 - Minimum Vertical Underclearance

- In addition to metric changes, instructions have been given to code restrictions of 30 meters or greater as code 9999. However coding of actual clearances between 30 and 99.99 meters to an exact measurement is optional.

Item 55 - Minimum Lateral Underclearance on Right

- In addition to metric changes, instructions have been given for the coding of restrictions 30 meters or greater. The numeric value in segment B is to be coded 999 for restrictions of 30 meters or greater. However coding of actual clearances between 30 and 99.9 meters to an exact measurement is optional.
- If the feature beneath the structure is not a railroad or highway, the code 000 in the numeric value for segment B is to indicate that the item is not applicable. This replaces the previous code of 999 to indicate that the item is not applicable.

Item 56 - Minimum Lateral Underclearance on Left.

- Care should be used in coding bridges with "open" medians, they should be coded 999. Those with clearances greater than 30 meters may be coded 998. However coding of actual clearances between 30 and 99.8 meters to an exact measurement is optional. When indicating that the item is not applicable code 000.

Item 58 - Deck

- Clarification has been added for "structures without decks".

Item 61 - Channel and Channel Protection

- The word channel is now consistently used in this item.

Item 63 - Method Used to Determine Operating Rating.

- New item added for use with Operating Rating.

Item 64 - Operating Rating

- The entire item has been redefined using the MS rating system instead of the previous HS vehicle ratings. Instructions have been given to code a 3 digit number representing the total weight in metric tons of the entire vehicle (maximum load).
- A description has been added indicating that the load factor (LF) method is to be used for determining operating ratings and inventory ratings.

- A change has been made to advise that with the coding for metric tonnage, the codes 200 or 900 are not appropriate for temporary bridges. Code 000 is to be used.

- Instructions have been given to use code 999 for a structure under a fill where live load is insignificant in the structure load capacity.

<u>Item 65 - Method Used to Determine Inventory Rating</u>

- New item added for use with Inventory Rating.

<u>Item 66 - Inventory Rating</u>

- See commentary for Item 64 - Operating Rating.

<u>Items 67, 68, 69, 71, and 72 - Indicate the Appraisal Ratings</u>

- Information has been provided advising that the Edit/Update computer calculates the codes for Items 67, 68 and 69, based on the Coding Guide tables for these items. Values entered by bridge owners or inspectors are not used.

- Because the level of service concept is no longer being considered, all reference to level of service has been eliminated.

<u>Item 67 - Structural Evaluation</u>

- This item is calculated by the Edit/Update program and need not be coded in the field. The reference to how the item was to be coded by bridge inspectors has been eliminated. Editorial changes have also been made to indicate the specifications on which the Edit/Update program is based.

- The load rating vehicle conversion factors have been eliminated as only MS (previously HS) ratings are to be coded into the inventory rating item.

- Table 1 has been converted to metric values for the MS inventory ratings. Note that the inventory ratings have been shown in total metric tons with the decimal point included instead of assumed. The MS equivalent values have been included in the table.

<u>Item 68 - Deck Geometry</u>

- This item is calculated by the Edit/Update program and need not be coded in the field. Editorial changes have also been made to indicate the specifications on which the Edit/Update program is based.

- A statement has been added to advise that culverts coded 0000 for roadway width will be given the coding of N for this item.

- All tables have been converted to metric units of measurement. Where appropriate, a hard conversion has been used to match the metric standards of AASHTO.

- A note has been added to advise that one-lane bridges 4.90 meters and greater in deck width are evaluated as a 2-lane bridge using Table 2A.

Item 69 - Underclearances, Vertical Horizontal

- This item is calculated by the Edit/Update program and need not be coded in the field. Editorial changes have also been made to indicate the specifications on which the Edit/Update program is based.
- All tables have been converted to metric units of measurement. Where appropriate, a hard conversion has been used to match the metric standards of AASHTO.

Item 75 - Type of Work

- Segment A code "38" has been expanded to include hydraulic replacements.
- In addition to metric changes, editorial additions have been made, such as that this item may be left blank if not required.

Item 76 - Length of Structure Improvement

- Formulae for graphs have been added.

Item 92 - Critical Feature Inspection

- Text has been added to give the current guidelines on maximum allowable inspection intervals.

Item 94 - Bridge Improvement Cost.

- The examples showing average cost per unit of area have been changed to reflect in metric units. The value used is for example only.

Item 97 - Year of Improvement Cost Estimate

- Field expanded to four digits to allow coding of complete year.

Item 99 - Border Bridge Structure Number

- Text has been added to clarify the coding.

Item 101 - Parallel Structure Designation

- Clarification of distance between structures coding.

Item 102 - Direction of Traffic

- Text has been added to clarify the coding.

Item 104 - Highway System of the Inventory Route

- With the passage of the 1991 ISTEA, the previous designation of highway systems has been eliminated. This item has been changed to identify structures that are on inventory routes that are on the National Highway System.

Item 105 - Federal Lands Highways

- New item used to indicate special federal lands highways.

Item 108 - Wearing Surface/Protective System

- Wearing surface type code 3 or latex concrete has been modified to include "similar" types of additive enhanced concrete, i.e. silica fume.
- A note has been added to the code 0 description of Segment A to make it clear that code 0 is to be used if no additional concrete thickness or thickness of a wearing surface is included in the bridge deck.

Item 110 - Designated National Network

- Consistent with the changes caused by the 1991 ISTEA, the reference to the Primary System has been changed to Federal-aid highways.

Item 112 - NBIS Bridge Length

- Bridge length has been defined in metric terms to be structures greater than 6.1 meters.

Section 4 – NBI Sufficiency Rating

OMB No. 2125-0501

Structure Inventory and Appraisal Sheet

NATIONAL BRIDGE INVENTORY - - - - - - - STRUCTURE INVENTORY AND APPRAISAL 10/15/94

********** IDENTIFICATION **********************

(1) STATE NAME - ____________ CODE ___
(8) STRUCTURE NUMBER #____________
(5) INVENTORY ROUTE (ON/UNDER) - ____ = ________
(2) HIGHWAY AGENCY DISTRICT ___
(3) COUNTY CODE ___ (4) PLACE CODE _____
(6) FEATURES INTERSECTED - ____________________
(7) FACILITY CARRIED - ______________
(9) LOCATION - ____________________
(11) MILEPOINT/KILOMETERPOINT ____.___
(12) BASE HIGHWAY NETWORK - __________ CODE _
(13) LRS INVENTORY ROUTE & SUBROUTE #__________
(16) LATITUDE __ DEG __ MIN __.__ SEC
(17) LONGITUDE ___ DEG __ MIN __.__ SEC
(98) BORDER BRIDGE STATE CODE ___ % SHARE __ %
(99) BORDER BRIDGE STRUCTURE NO. #____________

********** STRUCTURE TYPE AND MATERIAL *********

(43) STRUCTURE TYPE MAIN: MATERIAL - ___________
TYPE - ________________ CODE ___
(44) STRUCTURE TYPE APPR: MATERIAL - ___________
TYPE - ________________ CODE ___
(45) NUMBER OF SPANS IN MAIN UNIT ___
(46) NUMBER OF APPROACH SPANS ____
(107) DECK STRUCTURE TYPE - ______________ CODE _
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE - ___________ CODE _
B) TYPE OF MEMBRANE - ___________ CODE _
C) TYPE OF DECK PROTECTION - ___________ CODE _

********** AGE AND SERVICE *********************

(27) YEAR BUILT ____
(106) YEAR RECONSTRUCTED ____
(42) TYPE OF SERVICE: ON - ____________________
UNDER - ____________________ CODE __
(28) LANES: ON STRUCTURE __ UNDER STRUCTURE __
(29) AVERAGE DAILY TRAFFIC ______
(30) YEAR OF ADT ____ (109) TRUCK ADT __ %
(19) BYPASS, DETOUR LENGTH ___ KM

********** GEOMETRIC DATA **********************

(48) LENGTH OF MAXIMUM SPAN ____._ M
(49) STRUCTURE LENGTH _____._ M
(50) CURB OR SIDEWALK: LEFT __._ M RIGHT __._ M
(51) BRIDGE ROADWAY WIDTH CURB TO CURB ___._ M
(52) DECK WIDTH OUT TO OUT ___._ M
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) ___._ M
(33) BRIDGE MEDIAN - ________________ CODE _
(34) SKEW __ DEG (35) STRUCTURE FLARED __
(10) INVENTORY ROUTE MIN VERT CLEAR __.__ M
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR __._ M
(53) MIN VERT CLEAR OVER BRIDGE RDWY __.__ M
(54) MIN VERT UNDERCLEAR REF - ______ __.__ M
(55) MIN LAT UNDERCLEAR RT REF - ______ __._ M
(56) MIN LAT UNDERCLEAR LT __._ M

********** NAVIGATION DATA *********************

(38) NAVIGATION CONTROL - _____________ CODE _
(111) PIER PROTECTION - _____________ CODE _
(39) NAVIGATION VERTICAL CLEARANCE __._ M
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR __._ M
(40) NAVIGATION HORIZONTAL CLEARANCE ___._ M

****

SUFFICIENCY RATING = ___._
STATUS = ______________________

********** CLASSIFICATION ***************** CODE

(112) NBIS BRIDGE LENGTH - ___
(104) HIGHWAY SYSTEM - ________________ _
(26) FUNCTIONAL CLASS - ________________ __
(100) DEFENSE HIGHWAY - ________________ _
(101) PARALLEL STRUCTURE - ________________ _
(102) DIRECTION OF TRAFFIC - ______________ _
(103) TEMPORARY STRUCTURE - ______________ _
(105) FEDERAL LANDS HIGHWAYS - ____________ _
(110) DESIGNATED NATIONAL NETWORK - ________ _
(20) TOLL - ____________________ _
(21) MAINTAIN - ____________________ __
(22) OWNER - ____________________ __
(37) HISTORICAL SIGNIFICANCE - ____________ _

********** CONDITION ********************** CODE

(58) DECK _
(59) SUPERSTRUCTURE _
(60) SUBSTRUCTURE _
(61) CHANNEL & CHANNEL PROTECTION _
(62) CULVERTS _

********** LOAD RATING AND POSTING ******** CODE

(31) DESIGN LOAD - ________ OR ________ _
(63) OPERATING RATING METHOD - ____________ _
(64) OPERATING RATING - ________ __._
(65) INVENTORY RATING METHOD - ____________ _
(66) INVENTORY RATING - ________ __._
(70) BRIDGE POSTING - ______________ _
(41) STRUCTURE OPEN, POSTED OR CLOSED - _
DESCRIPTION - ______________

********** APPRAISAL ********************** CODE

(67) STRUCTURAL EVALUATION _
(68) DECK GEOMETRY _
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL _
(71) WATERWAY ADEQUACY _
(72) APPROACH ROADWAY ALIGNMENT _
(36) TRAFFIC SAFETY FEATURES ____
(113) SCOUR CRITICAL BRIDGES _

********** PROPOSED IMPROVEMENTS ***************

(75) TYPE OF WORK - ________________ CODE ___
(76) LENGTH OF STRUCTURE IMPROVEMENT _____._ M
(94) BRIDGE IMPROVEMENT COST $___,___,000
(95) ROADWAY IMPROVEMENT COST $___,___,000
(96) TOTAL PROJECT COST $___,___,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE ____
(114) FUTURE ADT ______
(115) YEAR OF FUTURE ADT ____

********** INSPECTIONS *************************

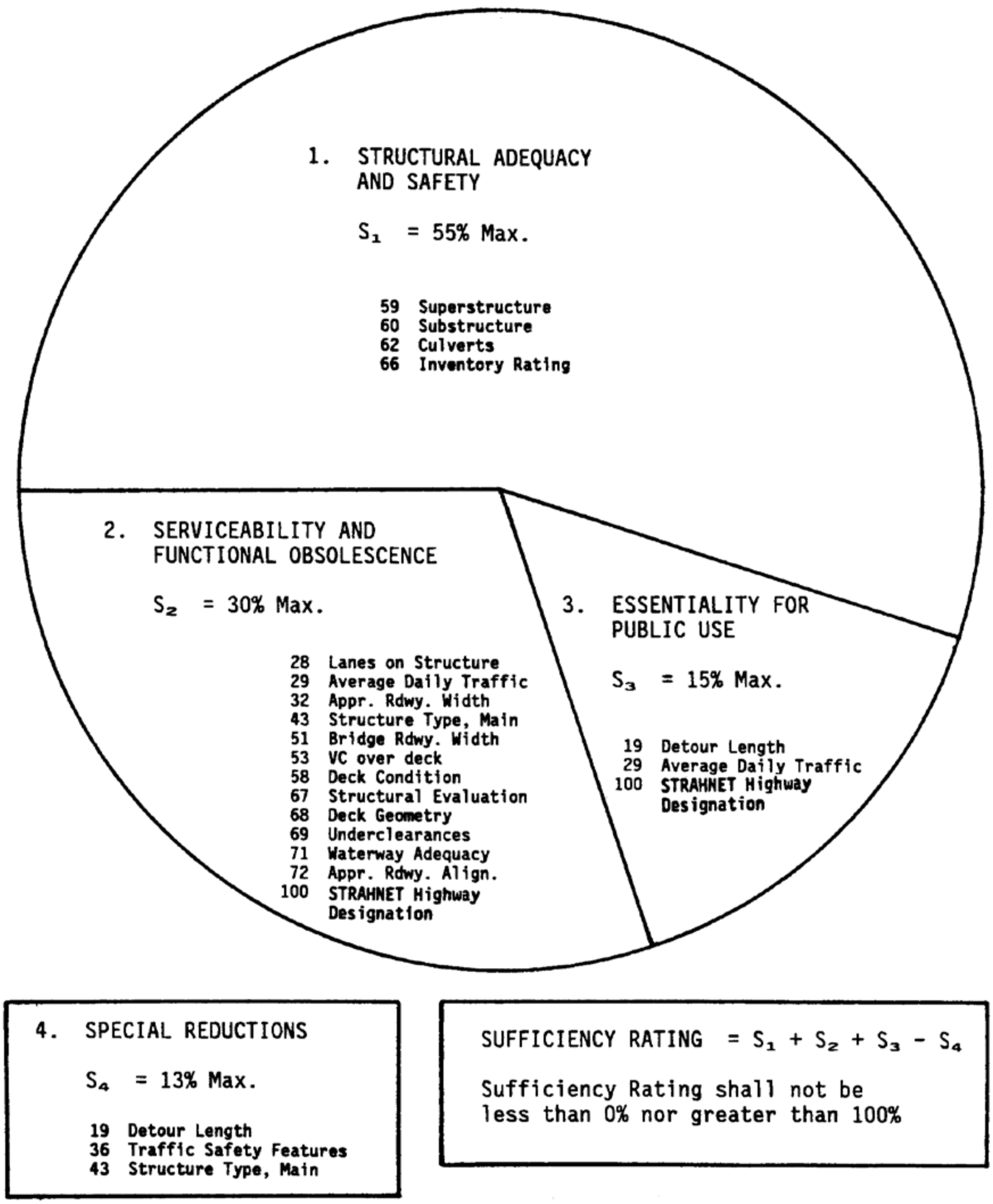
(90) INSPECTION DATE __/__ (91) FREQUENCY __ MO
(92) CRITICAL FEATURE INSPECTION: (93) CFI DATE
A) FRACTURE CRIT DETAIL - __ - __ MO A) __/__
B) UNDERWATER INSP - __ - __ MO B) __/__
C) OTHER SPECIAL INSP - __ - __ MO C) __/__

Section 4 -- Sufficiency Rating Formula and Example

The sufficiency rating formula described herein is a method of evaluating highway bridge data by calculating four separate factors to obtain a numeric value which is indicative of bridge sufficiency to remain in service. The result of this method is a percentage in which 100 percent would represent an entirely sufficient bridge and zero percent would represent an entirely insufficient or deficient bridge.

An asterisk prefix is used to identify a sufficiency rating that was calculated even though some essential data was missing or coded incorrectly. The Edit/Update Program will substitute a value for the unusable data (which will not lower the rating) and calculate the sufficiency rating. The asterisk is dropped when the unusable data is corrected. It is normal that all culverts with Bridge Roadway Width, Curb-to-Curb - Item 51 coded '0000' will have an asterisk prefixed sufficiency.

Figure 1. Summary of Sufficiency Rating Factors



Sufficiency Rating Formula

1. Structural Adequacy and Safety (55% maximum)

a. Only the lowest rating code of Item 59, 60, or 62 applies.

If Item 59 (Superstructure Rating) or
Item 60 (Substructure Rating) is ≤ 2 then A = 55%
= 3 A = 40%
= 4 A = 25%
= 5 A = 10%

If Item 59 and Item 60 = N and
Item 62 (Culvert Rating) is ≤ 2 then A = 55%
= 3 A = 40%
= 4 A = 25%
= 5 A = 10%

b. Reduction for Load Capacity:

Calculate using the following formulas where
IR is the Inventory Rating (MS Loading) in tons
or use Figure 2:

$B = (32.4 - IR)^{1.5} \times 0.3254$

or

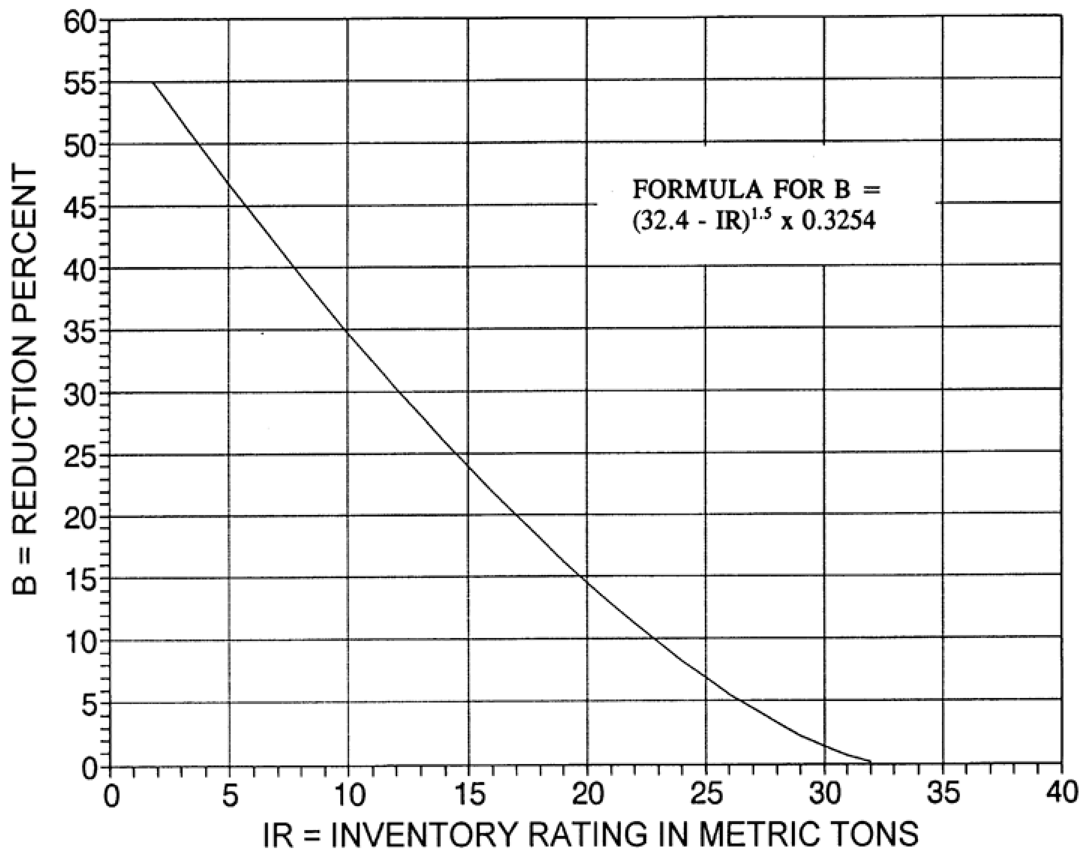
If $(32.4 - IR) \leq 0$, then B = 0

"B" shall not be less than 0% nor greater than 55%.

$\mathbf{S_1 = 55 - (A + B)}$

S_1 shall not be less than 0% nor greater than 55%.

FIGURE 2. Reduction for Load Capacity



2. Serviceability and Functional Obsolescence (30% maximum)

a. Rating Reductions (13% maximum)

If #58 (Deck Condition) is ≤ 3 then A = 5%
= 4 A = 3%
= 5 A = 1%

If #67 (Structural Evaluation) is ≤ 3 then B = 4%
= 4 B = 2%
= 5 B = 1%

If #68 (Deck Geometry) is ≤ 3 then C = 4%
= 4 C = 2%
= 5 C = 1%

If #69 (Underclearances) is ≤ 3 then D = 4%
= 4 D = 2%
= 5 D = 1%

If #71 (Waterway Adequacy) is ≤ 3 then E = 4%
= 4 E = 2%
= 5 E = 1%

If #72 (Approach Road Alignment) is ≤ 3 then F = 4%
= 4 F = 2%
= 5 F = 1%

J = (A + B + C + D + E + F)

J shall not be less than 0% nor greater than 13%.

b. Width of Roadway Insufficiency (15% maximum)

Use the sections that apply:

(1) applies to all bridges;
(2) applies to 1-lane bridges only;
(3) applies to 2 or more lane bridges;
(4) applies to all <u>except</u> 1-lane bridges.

Also determine X and Y:

$$X \text{ (ADT/Lane)} = \frac{\text{Item 29 (ADT)}}{\text{first 2 digits of \#28 (Lanes)}}$$

$$Y \text{ (Width/Lane)*} = \frac{\text{Item 51 (Bridge Rdwy. Width)}}{\text{first 2 digits of \#28 (Lanes)}}$$

*A value of 10.9 Meters will be substituted when item 51 is coded 0000 or not numeric.

(1) Use when the last 2 digits of #43 (Structure Type) are not equal to 19 (Culvert):

If(#51 + 0.6 meters) < #32 (Approach Roadway Width) G = 5%

(2) For 1-lane bridges only, use Figure 3 or the following:

If the first 2 digits of #28 (Lanes) are equal to 01 and

Y < 4.3 then H = 15%

Y $\geq$ 4.3 < 5.5 H = $15\left[\frac{5.5-Y}{1.2}\right]\%$

Y $\geq$ 5.5 H = 0%

(3) For 2 or more lane bridges. If these limits apply, do not continue on to (4) as no lane width reductions are allowed.

If the first 2 digits of #28 = 02 and Y $\geq$ 4.9, H = 0%

If the first 2 digits of #28 = 03 and Y $\geq$ 4.6, H = 0%

If the first 2 digits of #28 = 04 and Y $\geq$ 4.3, H = 0%

If the first 2 digits of #28 $\geq$ 05 and Y $\geq$ 3.7 H = 0%

(4) For all <u>except</u> 1-lane bridges,use Figure 3 or the following:

If Y < 2.7 and X > 50 then H = 15%

Y < 2.7 and X $\leq$ 50 H = 7.5%

Y $\geq$ 2.7 and X $\leq$ 50 H = 0%

If X > 50 but $\leq$ 125 and

Y < 3.0 then H = 15%

Y $\geq$ 3.0 < 4.0 H = 15(4-Y)%

Y $\geq$ 4.0 H = 0%

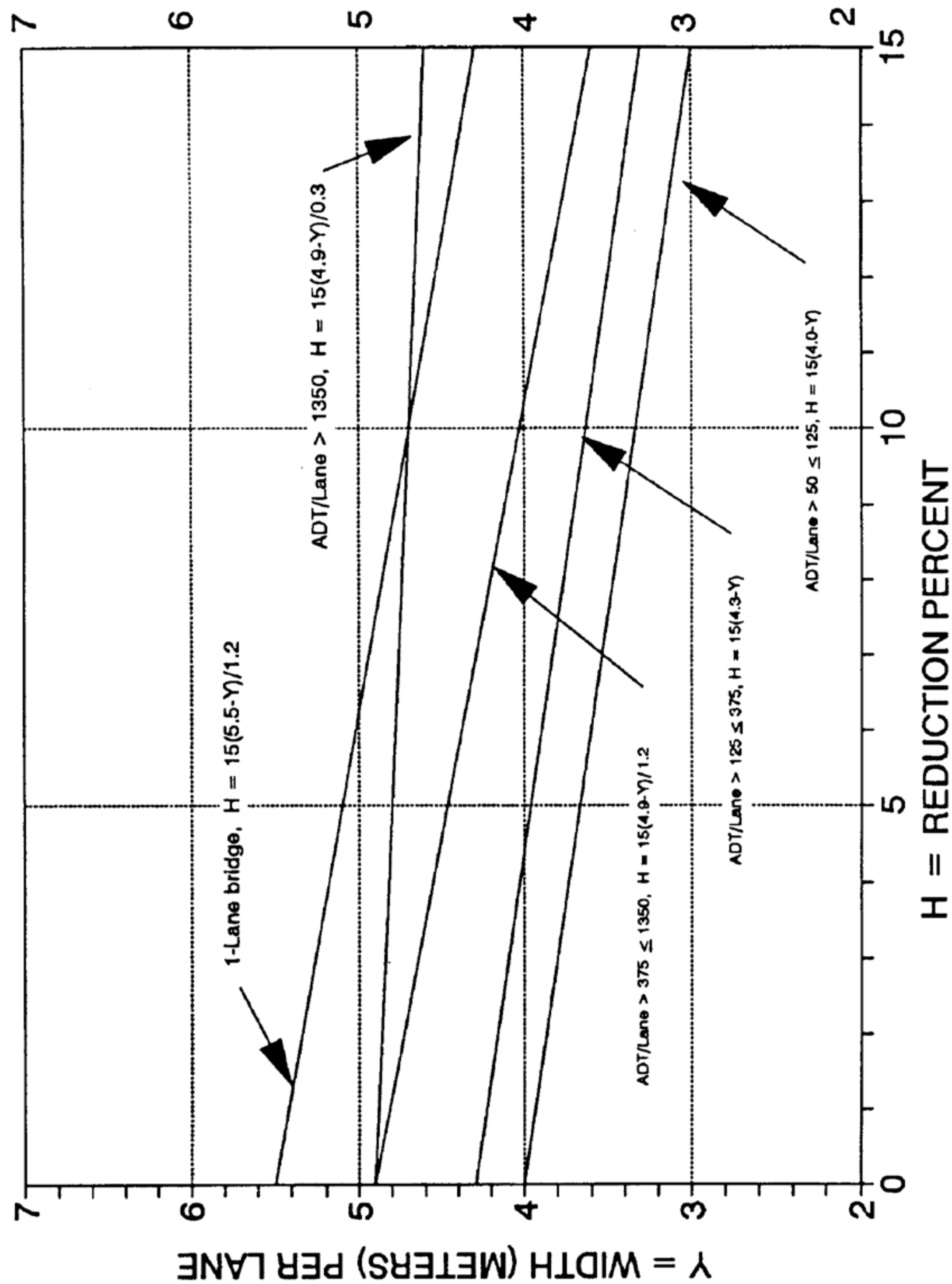
If X > 125 but $\leq$ 375 and

Y < 3.4 then H = 15%

Y $\geq$ 3.4 < 4.3 H = 15(4.3-Y)%

Y $\geq$ 4.3 H = 0%

Figure 3. Width of Roadway Insufficiency



If X > 375 but ≤ 1350 and

Y < 3.7 then H = 15%

Y ≥ 3.7 < 4.9 H = $15\left[\frac{4.9-Y}{1.2}\right]\%$

Y ≥ 4.9 H = 0%

If X > 1350 and

Y < 4.6 then H = 15%

Y ≥ 4.6 < 4.9 H = $15\left[\frac{4.9-Y}{1.2}\right]\%$

Y ≥ 4.9 H = 0%

G + H shall not be less than 0% nor greater than 15%.

c. Vertical Clearance Insufficiency - (2% maximum)

If #100 (STRAHNET Highway Designation) > 0 and

#53 (VC over Deck) ≥ 4.87 then I = 0%

#53 < 4.87 I = 2%

If #100 = O and

#53 ≥ 4.26 then I = 0%

#53 < 4.26 I = 2%

S_2 = 30 - [J + (G + H) + I]

S_2 shall not be less than 0% nor greater than 30%.

3. Essentiality for Public Use (15% maximum)

a. Determine:

$$K = \frac{S_1 + S_2}{85}$$

b. Calculate:

$$A = 15\left[\frac{\#29(ADT)x\#19(DetourLength}{320{,}000xK}\right]$$

"A" shall not be less than 0% nor greater than 15%.

c. STRAHNET Highway Designation:

If #100 is > 0 then B = 2%

If #100 = 0 then B = 0%

S_3 = 15 - (A + B)

S_3 shall not be less than 0% nor greater than 15%.

4. Special Reductions (Use only when $S_1 + S_2 + S_3 \geq 50$)

a. Detour Length Reduction, use Figure 4 or the following:

$A = (\#19)^4 \times (7.9 \times 10^{-9})$

"A" shall not be less than 0% nor greater than 5%.

b. If the 2nd and 3rd digits of #43 (Structure Type, Main) are equal to 10, 12, 13, 14, 15, 16, or 17; then

B = 5%

c. If 2 digits of #36 (Traffic Safety Features) = 0 C = 1%
If 3 digits of #36 = 0 C = 2%
If 4 digits of #36 = 0 C = 3%

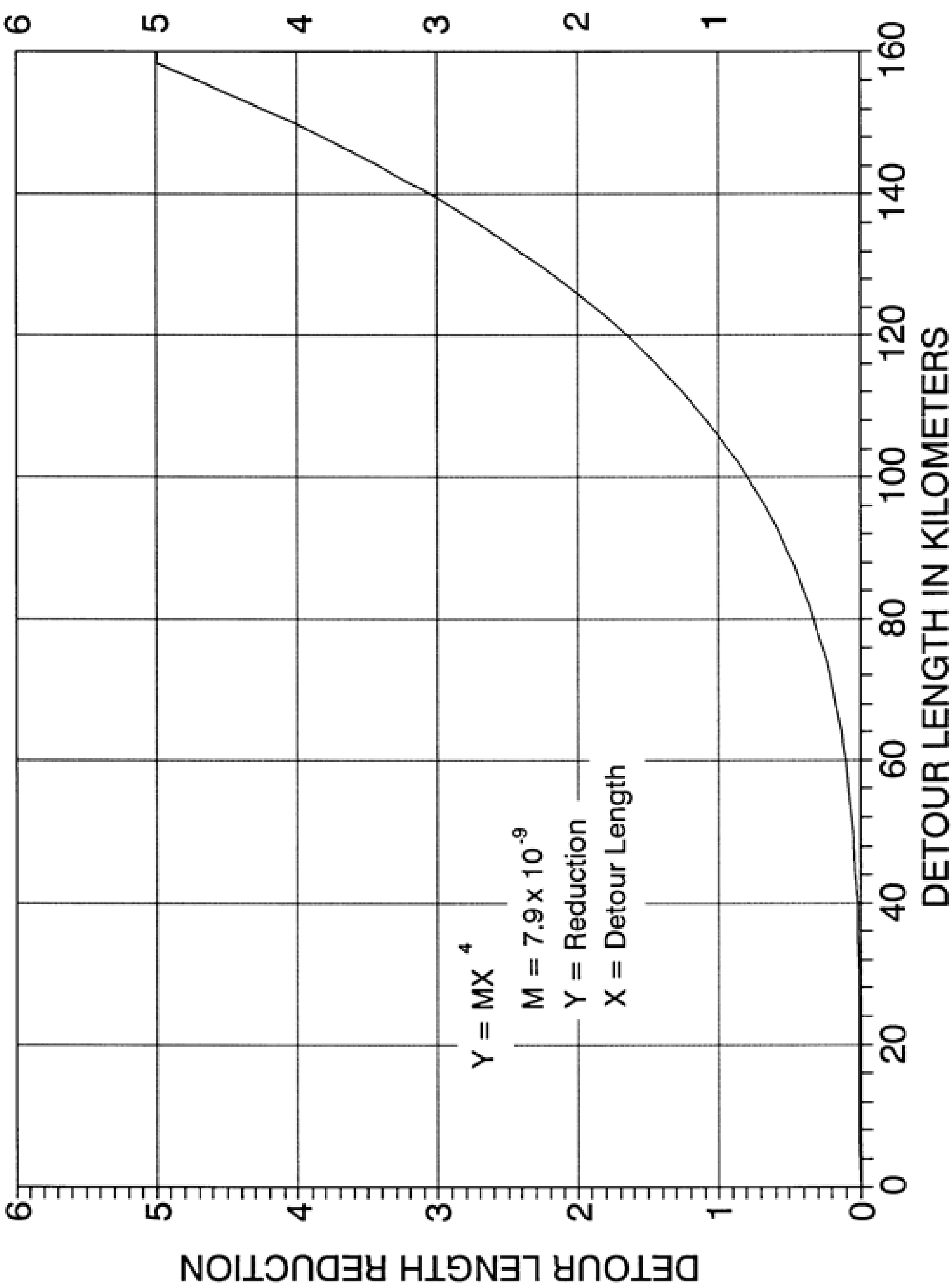
S_4 = A + B + C

S_4 shall not be less than 0% nor greater than 13%.

Sufficiency Rating = $S_1 + S_2 + S_3 - S_4$

The Rating shall not be less than 0% nor greater than 100%.

Figure 4. Special Reduction for Detour Length



EXAMPLE

Calculation of Sufficiency Rating

1. Structural Adequacy and Safety

A = 10%

B = [32.4 - (19.8 metric tons)]$^{1.5}$ x 0.3254 = 14.6

$\mathbf{S_1 = 55 - (10 + 14.6) = 30.4}$

2. Serviceability and Functional Obsolescence

A = 3%, B = 1%, C = 4%, D = NA, E = NA, F = NA

J = (3 + 1 + 4) = 8%

$X = \frac{18500}{2} = 9250 \quad Y = \frac{7.9\ m}{2} = 3.95$

(1) If (7.9 + 0.6) < 12.2 then G = 5

(2) Not Applicable

(3) Not Applicable

(4) If X = 9250 and Y = 3.95 then H = 15

G + H = 5 + 15 = 20 (however, maximum allowable = 15)

I = 0

$\mathbf{S_2 = 30 - [\ 8 + (15) + 0\ ] = 7.0}$

3. Essentiality For Public Use

$K = \frac{30.4 + 7.0}{85} = 0.44$

$$A = 15\left[\frac{18{,}500x12.8Km}{320{,}000x0.44}\right] = 25.2(however, \max .allowable = 15)$$

B = 0

$\mathbf{S_3 = 15 - (15 + 0) = 0}$

4. Special Reductions

$S_1 + S_2 + S_3 = (30.4 + 7.0 + 0.0) = 37.4 < 50$

S_4 = NA

SUFFICIENCY RATING = 30.4 + 7.0 + 0.0 = 37.4

EXAMPLE DATA

OMB No. 2125-0501
NATIONAL BRIDGE INVENTORY - - - - - - - STRUCTURE INVENTORY AND APPRAISAL 10/15/94

********** IDENTIFICATION **********************
(1) STATE NAME - YOUR STATE NAME CODE 999
(8) STRUCTURE NUMBER
(5) INVENTORY ROUTE (ON/UNDER) - ON = 131000440
(2) HIGHWAY AGENCY DISTRICT 03
(3) COUNTY CODE 075 (4) PLACE CODE 59767
(6) FEATURES INTERSECTED - SR 772, ROARING LION R. *
(7) FACILITY CARRIED - STATE ROUTE 44
(9) LOCATION - 9.7 KM SW. OF RICHMOND
(11) MILEPOINT/KILOMETERPOINT 0036.008
(12) BASE HIGHWAY NETWORK - PART OF NET CODE 1
(13) LRS INVENTORY ROUTE & SUBROUTE #000000277503
(16) LATITUDE 35 DEG 27 MIN 18.55 SEC
(17) LONGITUDE 081 DEG 05 MIN 50.65 SEC
(98) BORDER BRIDGE STATE CODE 888 % SHARE 40 %
(99) BORDER BRIDGE STRUCTURE NO. #ABC003790243009

********** STRUCTURE TYPE AND MATERIAL *********
(43) STRUCTURE TYPE MAIN: MATERIAL - STEEL
TYPE - DECK TRUSS CODE 309
(44) STRUCTURE TYPE APPR: MATERIAL - STEEL
TYPE - GIRDER & FLOORBEAM SYSTEM CODE 303
(45) NUMBER OF SPANS IN MAIN UNIT 002
(46) NUMBER OF APPROACH SPANS 0004
(107) DECK STRUCTURE TYPE - CONCRETE C-I-P CODE 1
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE - CONCRETE CODE 1
B) TYPE OF MEMBRANE - NONE CODE 0
C) TYPE OF DECK PROTECTION - UNKNOWN CODE 8

********** AGE AND SERVICE *********************
(27) YEAR BUILT 1948
(106) YEAR RECONSTRUCTED 0000
(42) TYPE OF SERVICE: ON - HIGHWAY-PEDESTRIAN
UNDER - HIGHWAY-WATERWAY CODE 56
(28) LANES: ON STRUCTURE 02 UNDER STRUCTURE 02
(29) AVERAGE DAILY TRAFFIC 019500
(30) YEAR OF ADT 1993 (109) TRUCK ADT 05 %
(19) BYPASS, DETOUR LENGTH 013 KM

********** GEOMETRIC DATA **********************
(48) LENGTH OF MAXIMUM SPAN 0097.5 M
(49) STRUCTURE LENGTH 00312.0 M
(50) CURB OR SIDEWALK: LEFT 00.0 M RIGHT 02.5 M
(51) BRIDGE ROADWAY WIDTH CURB TO CURB 007.9 M
(52) DECK WIDTH OUT TO OUT 011.8 M
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) 12.2 M
(33) BRIDGE MEDIAN - NO MEDIAN CODE 0
(34) SKEW 00 DEG (35) STRUCTURE FLARED NO
(10) INVENTORY ROUTE MIN VERT CLEAR 99.99 M
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR 07.9 M
(53) MIN VERT CLEAR OVER BRIDGE RDWY 99.99 M
(54) MIN VERT UNDERCLEAR REF - HIGHWAY 10.46 M
(55) MIN LAT UNDERCLEAR RT REF - HIGHWAY 06.2 M
(56) MIN LAT UNDERCLEAR LT 00.0 M

********** NAVIGATION DATA *********************
(38) NAVIGATION CONTROL - BR PERMIT REQ CODE 1
(111) PIER PROTECTION - FUNCTIONING CODE 2
(39) NAVIGATION VERTICAL CLEARANCE 18.3 M
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR __._ M
(40) NAVIGATION HORIZONTAL CLEARANCE 047.2 M

****

SUFFICIENCY RATING = 37.4
STATUS = STRUCTURALLY DEFICIENT

********** CLASSIFICATION ******************CODE
(112) NBIS BRIDGE LENGTH - YES
(104) HIGHWAY SYSTEM - ROUTE ON NHS 1
(26) FUNCTIONAL CLASS - OTHER PRIN ART URBAN 14
(100) DEFENSE HIGHWAY - NOT DEFENSE 0
(101) PARALLEL STRUCTURE - NONE EXISTS N
(102) DIRECTION OF TRAFFIC - 2 WAY 2
(103) TEMPORARY STRUCTURE - NOT TEMPORARY _
(105) FEDERAL LANDS HIGHWAYS - NOT APPLICABLE 0
(110) DESIGNATED NATIONAL NETWORK - PART OF NET 1
(20) TOLL - ON FREE ROAD 3
(21) MAINTAIN - STATE HIGHWAY AGENCY 01
(22) OWNER - STATE HIGHWAY AGENCY 01
(37) HISTORICAL SIGNIFICANCE - NOT ELIGIBLE 5

********** CONDITION ********************** CODE
(58) DECK 4
(59) SUPERSTRUCTURE 5
(60) SUBSTRUCTURE 6
(61) CHANNEL & CHANNEL PROTECTION 8
(62) CULVERTS N

********** LOAD RATING AND POSTING ******** CODE
(31) DESIGN LOAD - H-15 OR M-13.5 2
(63) OPERATING RATING METHOD - LOAD FACTOR 1
(64) OPERATING RATING - MS-14 25.2
(65) INVENTORY RATING METHOD - LOAD FACTOR 1
(66) INVENTORY RATING - MS-11 19.8
(70) BRIDGE POSTING - POSTING REQUIRED 2
(41) STRUCTURE OPEN, POSTED OR CLOSED - P
DESCRIPTION - POSTED FOR LOAD

********** APPRAISAL ********************** CODE
(67) STRUCTURAL EVALUATION 5
(68) DECK GEOMETRY 3
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL 6
(71) WATERWAY ADEQUACY 8
(72) APPROACH ROADWAY ALIGNMENT 8
(36) TRAFFIC SAFETY FEATURES 1100
(113) SCOUR CRITICAL BRIDGES 8

********** PROPOSED IMPROVEMENTS ***************
(75) TYPE OF WORK - REPLACE FOR DEFICIENCY CODE 311
(76) LENGTH OF STRUCTURE IMPROVEMENT 00317.0 M
(94) BRIDGE IMPROVEMENT COST $ 4,200,000
(95) ROADWAY IMPROVEMENT COST $ 300,000
(96) TOTAL PROJECT COST $ 5,000,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE 1995
(114) FUTURE ADT 025600
(115) YEAR OF FUTURE ADT 2014

********** INSPECTIONS *************************
(90) INSPECTION DATE 03/94 (91) FREQUENCY 12 MO
(92) CRITICAL FEATURE INSPECTION: (93) CFI DATE
A) FRACTURE CRIT DETAIL - YES - 06 MO A) 09/94
B) UNDERWATER INSP - NO - __ MO B) __/__
C) OTHER SPECIAL INSP - NO - __ MO C) __/__

Chapter 11 – Commentary