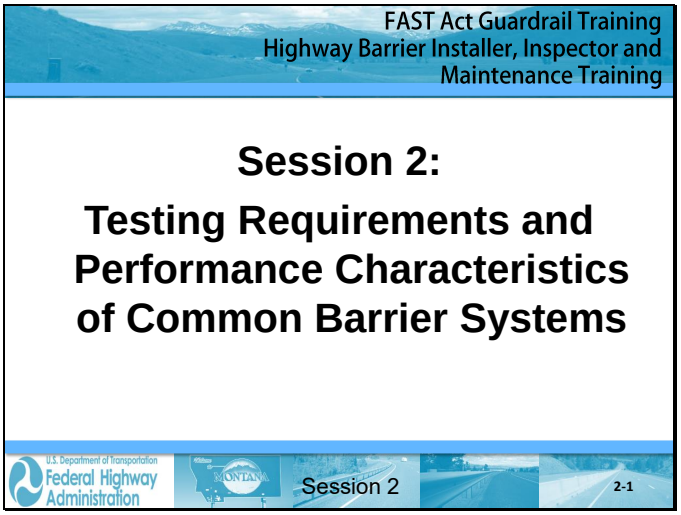
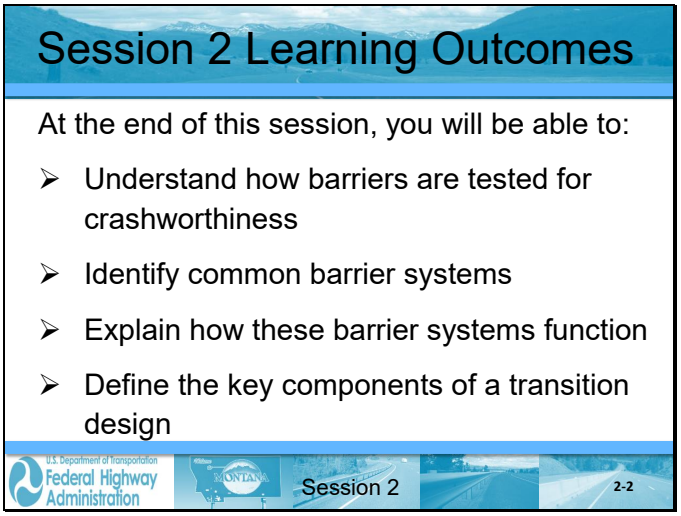
Session 2: Testing Requirements and Performance Characteristics of Common Barrier Systems


FAST Act Guardrail Training
Highway Barrier Installer, Inspector and Maintenance Training
Session 2:
Testing Requirements and Performance Characteristics of Common Barrier Systems
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-1


Session 2 Learning Outcomes
At the end of this session, you will be able to:
Understand how barriers are tested for crashworthiness
Identify common barrier systems
Explain how these barrier systems function
Define the key components of a transition design
U.S. Department of Transportation
Federal Highway Administration
Session 2
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Crash Testing Guidelines

- In 1993, crash testing and evaluation criteria were published as NCHRP Report 350
- In 2009, the Manual for Assessing Safety Hardware (MASH) was published by AASHTO. It was used by FHWA as the testing standard for all new products
- In 2016, an update to MASH was adopted and a timetable for implementation of new installations complying with this edition was signed between FHWA and AASHTO

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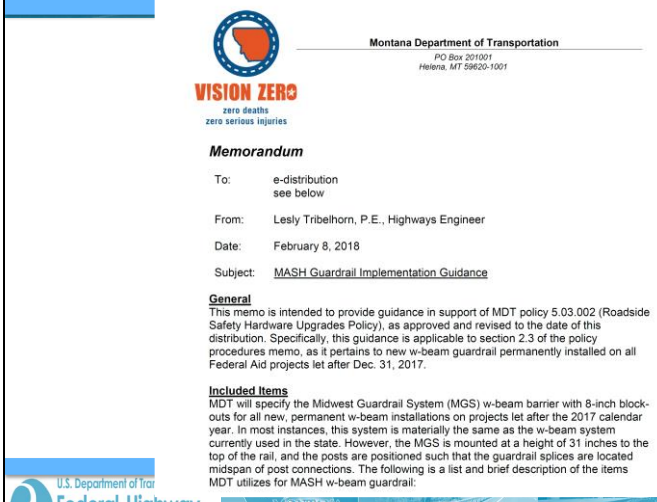
MDT MASH Implementation



Montana Department of Transportation
PO Box 201001
Helena, MT 59620-1001

VISION ZERO
zero deaths
zero serious injuries

Memorandum

To: e-distribution
see below

From: Lesly Tribelhorn, P.E., Highways Engineer

Date: February 8, 2018

Subject: MASH Guardrail Implementation Guidance

General
This memo is intended to provide guidance in support of MDT policy 5.03.002 (Roadside Safety Hardware Upgrades Policy), as approved and revised to the date of this distribution. Specifically, this guidance is applicable to section 2.3 of the policy procedures memo, as it pertains to new w-beam guardrail permanently installed on all Federal Aid projects let after Dec. 31, 2017.

Included Items
MDT will specify the Midwest Guardrail System (MGS) w-beam barrier with 8-inch block-outs for all new, permanent w-beam installations on projects let after the 2017 calendar year. In most instances, this system is materially the same as the w-beam system currently used in the state. However, the MGS is mounted at a height of 31 inches to the top of the rail, and the posts are positioned such that the guardrail splices are located midspan of post connections. The following is a list and brief description of the items MDT utilizes for MASH w-beam guardrail:

Included terminals by 12/31/17

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MASH Test Conditions

Selection of a performance level is based on speed and traffic mix.

- **TL-1**, **TL-2**, and **TL-3**: crash tests with small car and pickup truck with a 25˚ impact angle at 31, 44, and 62 mph, respectively.

2,420 lbs.
1100C

5,000 lbs.
2270P

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NCHRP 350 comparison with MASH Crew Cab Truck

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MASH Test Conditions (cont'd)

- **TL- 4**: TL-3 + 15˚ impact angle, 56 mph Single-Unit Truck
- **TL- 5**: TL-3 + 15˚ impact angle, 50 mph Tractor-Van Trailer
- **TL- 6**: TL-3 + 15˚ impact angle, 50 mph Tractor-Tank Trailer

22,000 lbs.

80,000 lbs.

80,000 lbs.

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Standard Barrier Systems

- Rigid Systems
- Semi-Rigid Systems
- Flexible Systems
- Median Barrier Systems

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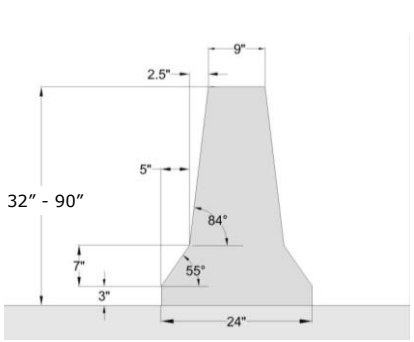
Barrier Systems: Rigid Barriers

Rigid Barrier Systems have little (between 0 to 1 ft.) deflection under the TL-3 pickup impact. They are generally anchored by some acceptable means.

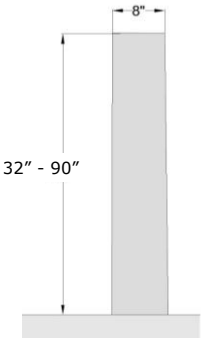
Examples include:

- New Jersey Safety Shape Concrete Barrier
- F-shape Concrete Barrier
- Single or Slope Concrete Barrier
- Vertical Wall

Rigid Barrier

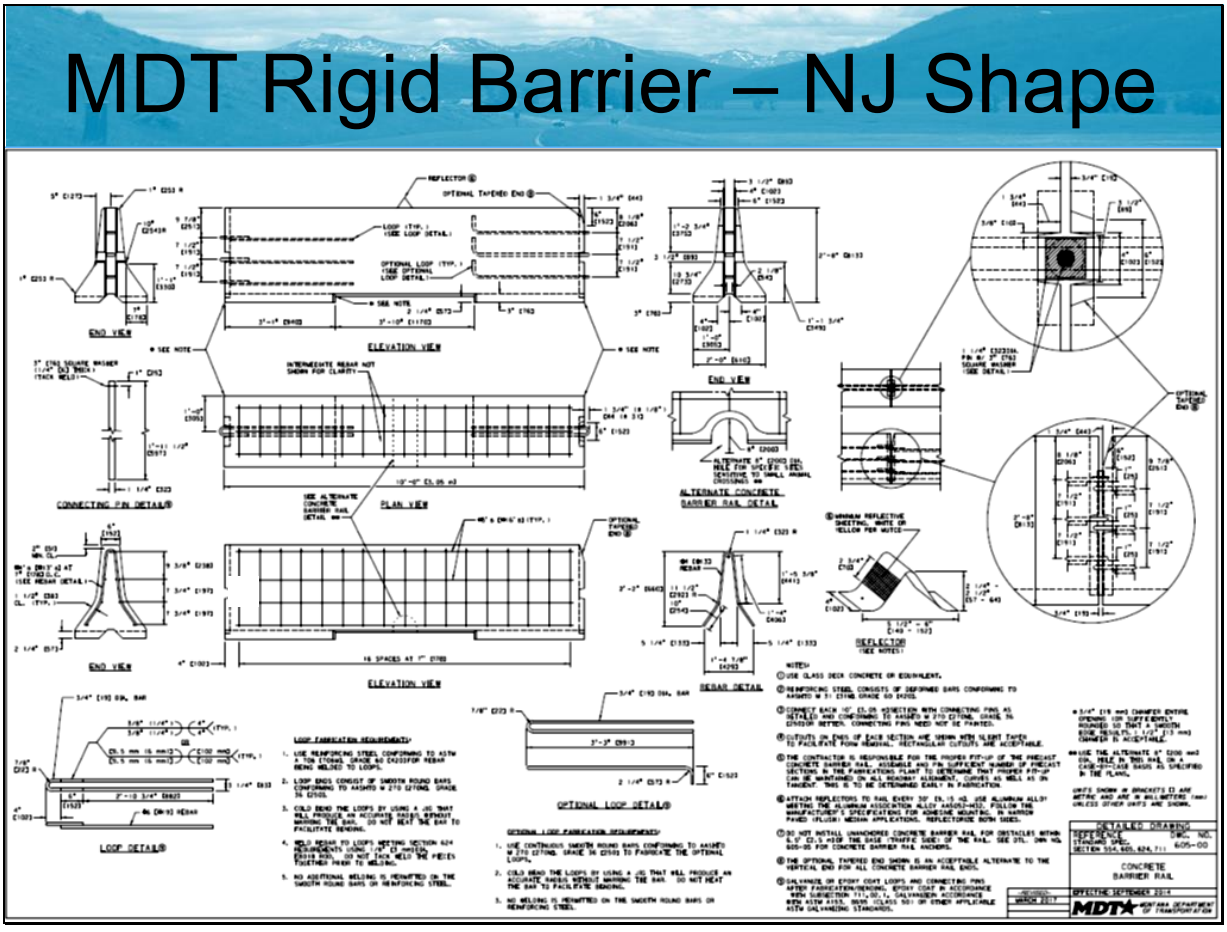


F-Shape

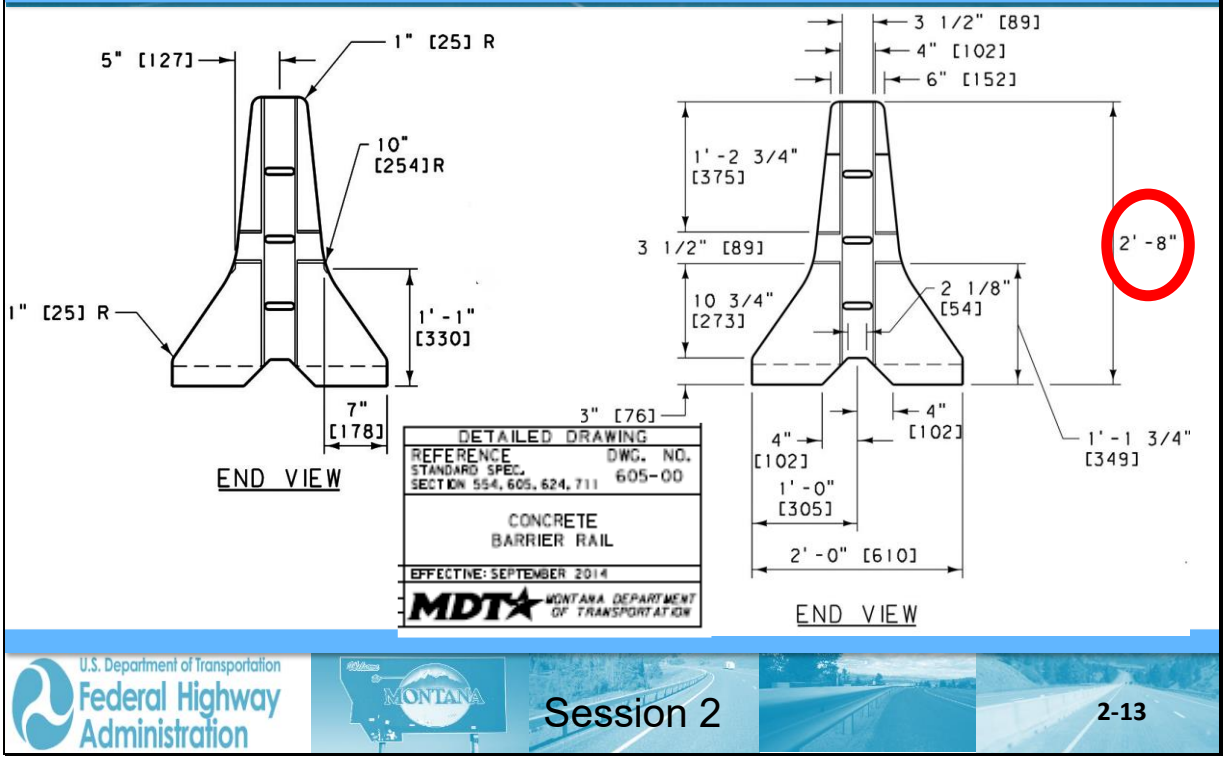


Vertical Wall


MASH Testing
of 32" New
Jersey Shaped
Concrete
Barrier
Video Clip


MDT Rigid Barrier – NJ Shape

MDT Rigid Barrier – NJ Shape




MUST MAINTAIN TENSION IN BARRIER SYSTEM
U.S. Department of Transportation
Federal Highway Administration
MONTANA
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MUST MAINTAIN TENSION IN BARRIER SYSTEM
U.S. Department of Transportation
Federal Highway Administration
MONTANA
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Barrier Systems: Semi-Rigid

Semi-Rigid Barrier Systems have deflections of a few feet (between 2 to 5 ft.) under the TL-3 pickup impact.

Typically consist of beam and post elements.

Barrier Systems: Semi-Rigid

- W-Beam Steel Guardrail – **"Old", 350 Guardrail**
  - 12" wide W-beam rail section (12-gauge thickness).
  - Posts are spaced at 6'-3" centers, and the nominal rail height is 27" – 29"
  - Rail splice at the post.
  - Two post options:
    - Steel posts, W6 x 8.5/9.0 x 6'-0" long.
    - Wood posts, 6" x 8" x 6'-0" long.
  - Blocks: 6" x 8" wood or plastic.

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SPWB with Steel Post & Steel Block-Out
27 5/8" Height

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SPWB with Wood Post & Wood Block-Out
27 5/8" Height
Video Clip
Failed Test!!!
U.S. Department of Transportation
Federal Highway Administration
Session 2
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SPWB with Steel Post & Wood Block-Out
27 5/8" Height
Video Clip
U.S. Department of Transportation
Federal Highway Administration
Session 2
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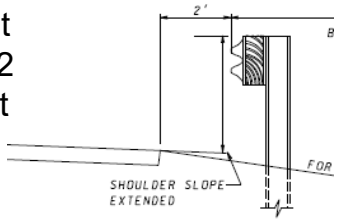
Steel Guardrail - Height Measurement ONLY "Old", 350 Guardrail

For slopes 10:1 or flatter, the height is measured from the ground directly beneath the rail

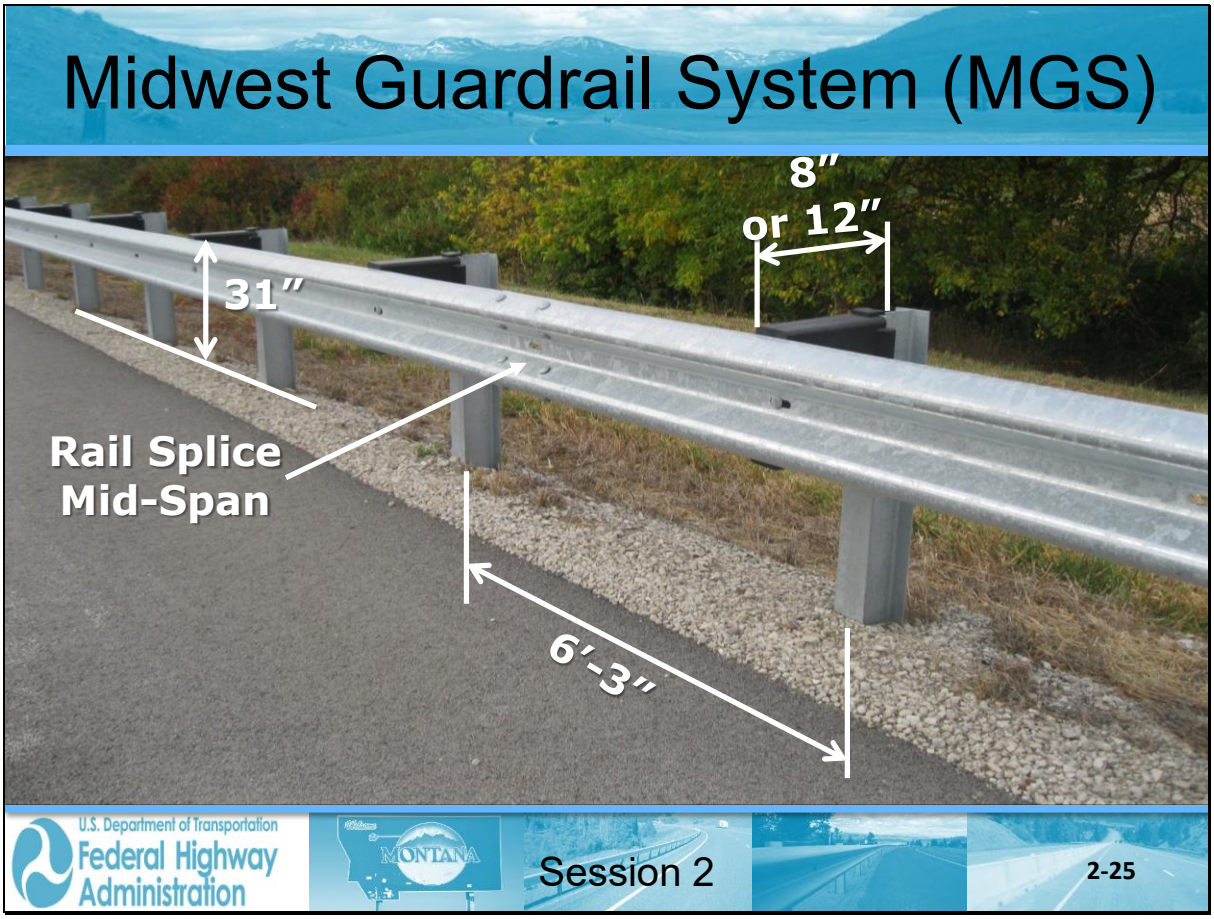
For slopes steeper than 10:1 but no steeper than 6:1, and within 2 feet of the breakpoint, the height is measured from the shoulder slope extended as shown



PLACEMENT ON SLOPE

Barrier Systems: Semi-Rigid

- Midwest Guardrail System (MGS)
  - 31" Height – Tolerance 1"
  - Rail Splice mid-span.
  - Post spacing 6'-3"
  - Two post options:
    - Steel posts, W6 x 8.5/9.0 x 6'
    - Wood posts, 6" x 8" x 6'
    - Block: 8" (or 12") wood or composite


Midwest Guardrail System (MGS)
8"
or 12"
31"
Rail Splice
Mid-Span
6'-3"
U.S. Department of Transportation
Federal Highway Administration
MONTANA
Session 2
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MGS MASH Test 3-11
Video Clip
U.S. Department of Transportation
Federal Highway Administration
MONTANA
Session 2
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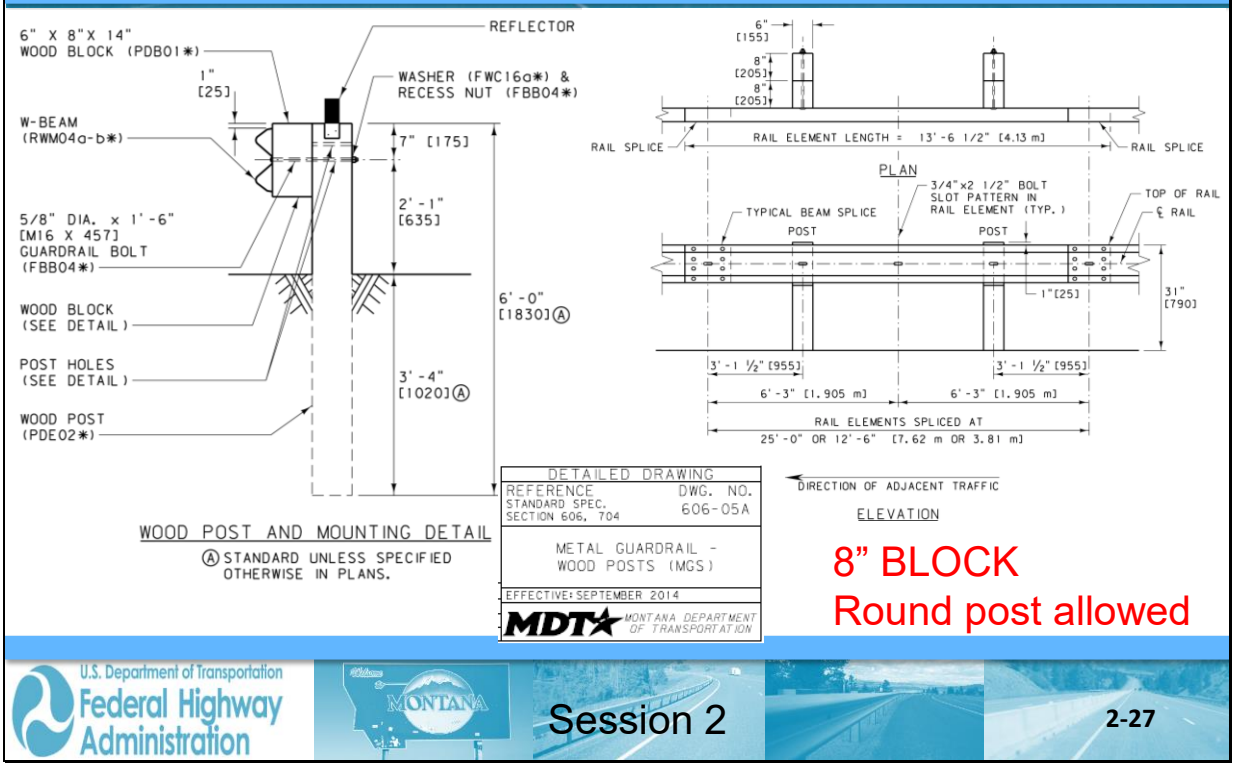
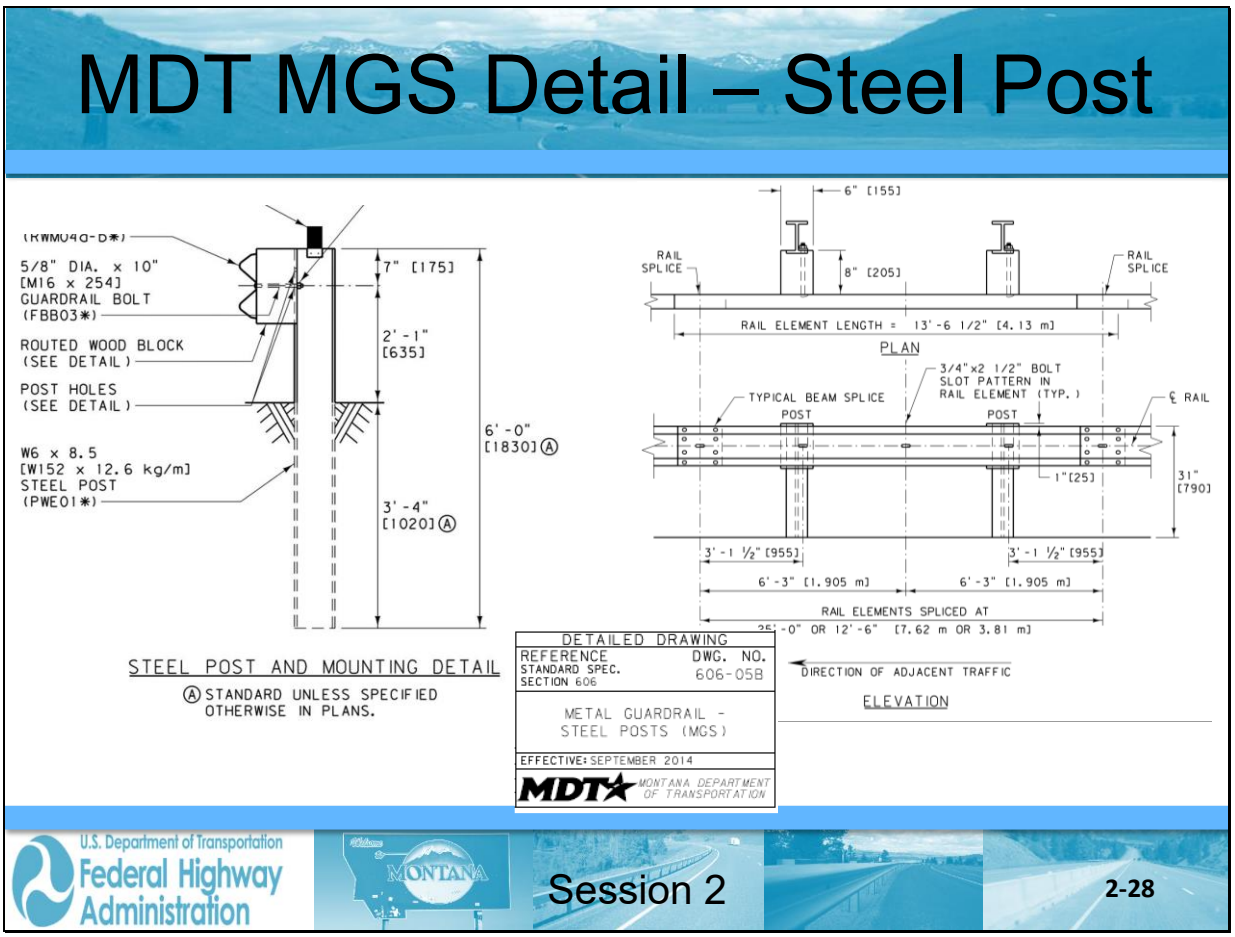
MDT MGS Detail – Wood Post



MDT MGS Detail – Steel Post

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Federal Highway Administration
MONTANA
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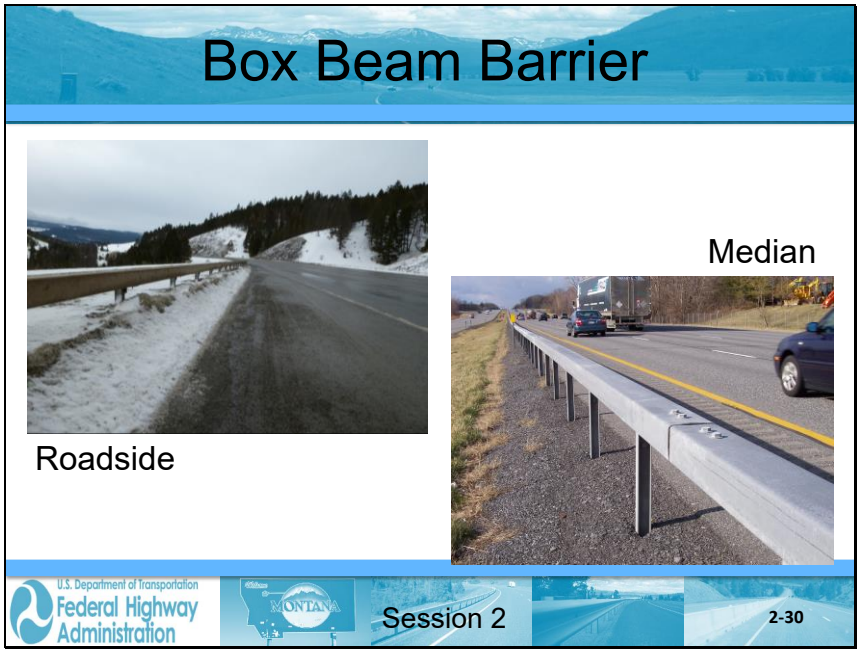
Box Beam Barrier
Roadside
Median
U.S. Department of Transportation
Federal Highway Administration
MONTANA
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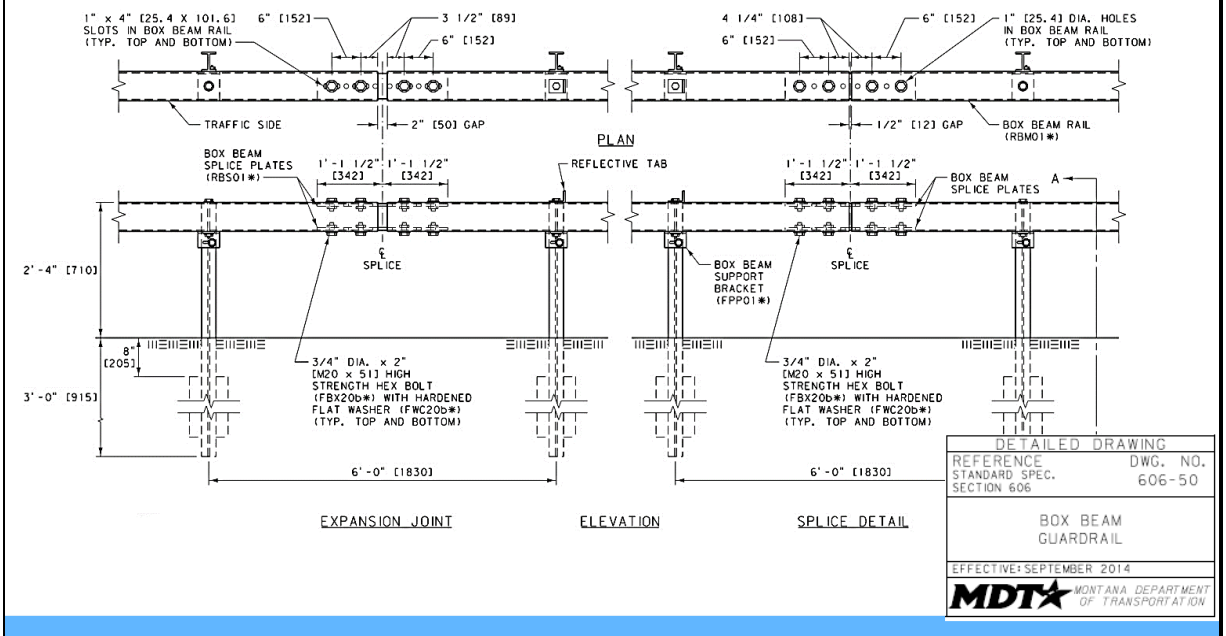
Box Beam Barrier MASH Test 3-31

U.S. Department of Transportation Federal Highway Administration | Session 2 | 2-31

MDT Box Beam Detail



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Barrier Systems: Flexible Barriers

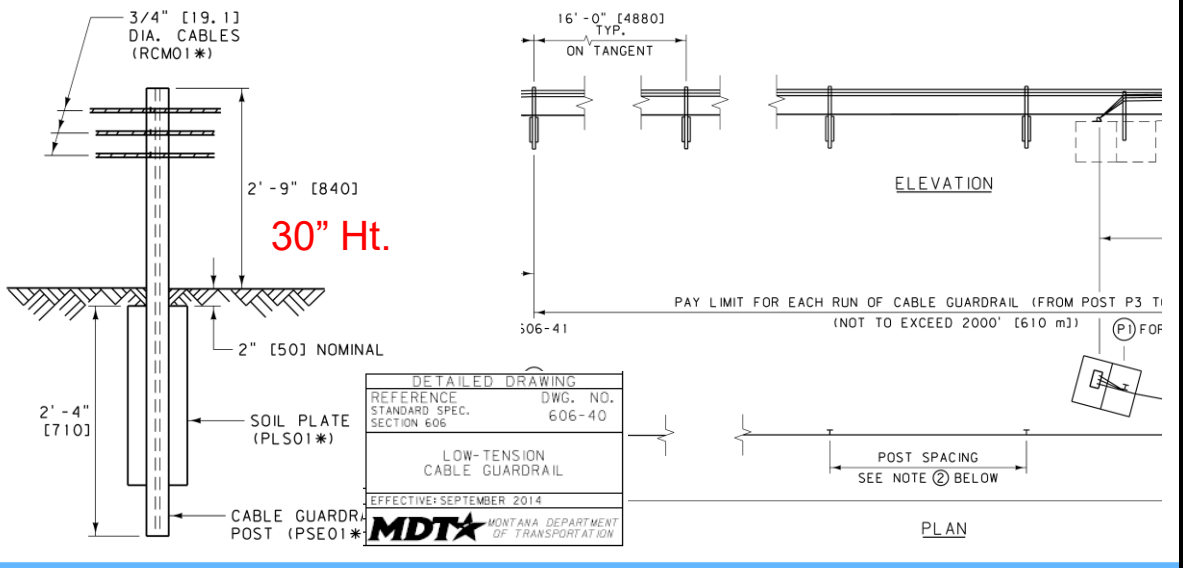
Flexible Barrier Systems typically have relatively large deflections

Examples of Flexible Barriers include:

- Weak post W-beam Not presented
- Low tension cable
- High tension cable

Barrier Systems: Flexible Barriers

- Low Tensioned Cable Barrier



Barrier Systems: Flexible Barriers

- High Tensioned Cable Barrier
  - Five different proprietary designs available
  - Each requires a unique proprietary terminal
  - Somewhat reduced deflections
  - Generally easier maintenance
  - Can retain effectiveness after most impacts

High-Tension Cable Systems

- Brifen
- ★ Safence
- ★ CASS (Trinity Steel)
- Nucor
- ★ Gibraltar

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Four Cable System
Video Clip
U.S. Department of Transportation
Federal Highway Administration
Session 2
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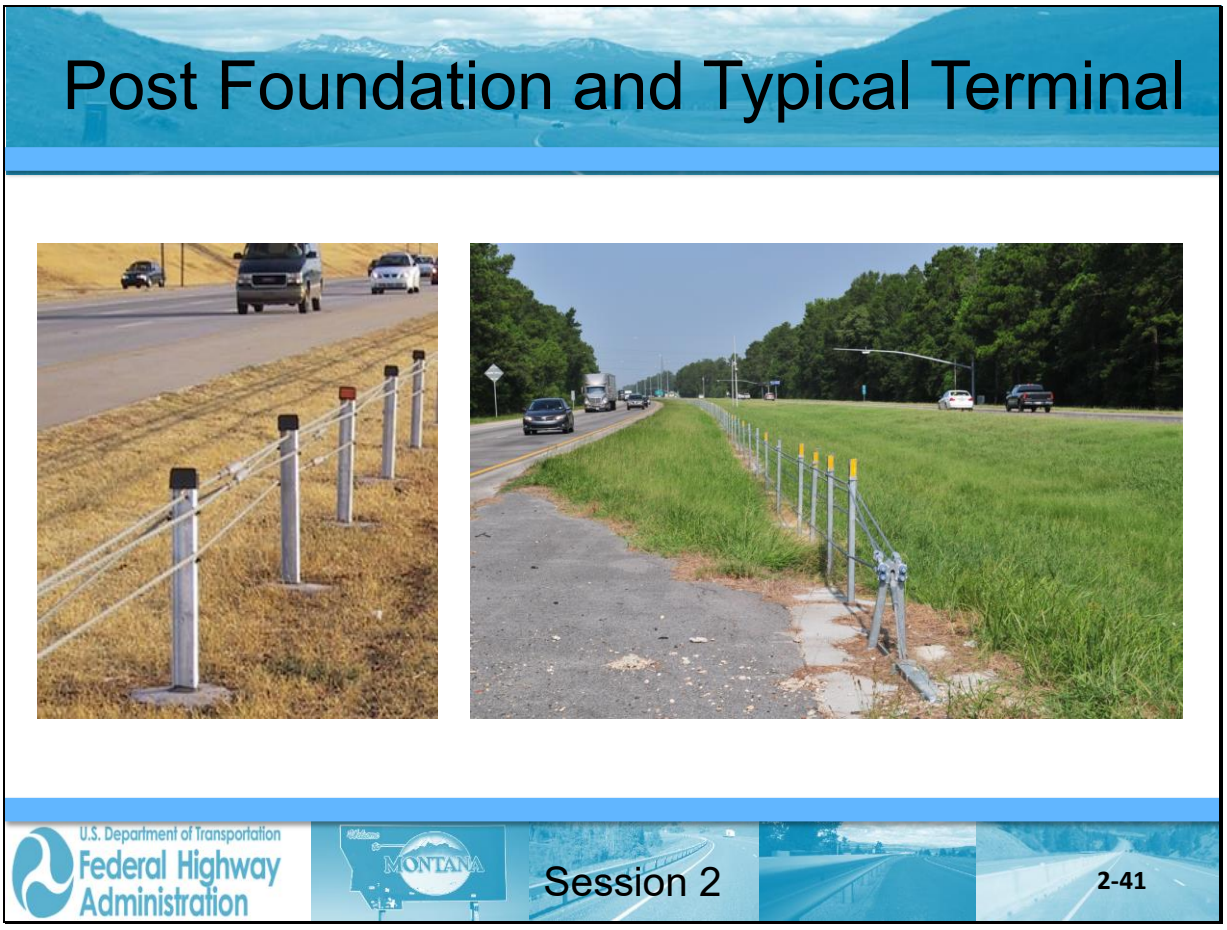
Post Foundation and Typical Terminal
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Federal Highway Administration
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HTC On 4:1 Slope

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Barriers in the Median

- Used to separate opposing traffic on a divided highway or to separate through traffic from local traffic.
- Many barriers approved for roadside applications can be modified for use in the median.
- Width of the median is an important consideration.
- Also must consider the dynamic deflection of the barrier to avoid intrusion into opposing traffic.
- There are terminals designed specifically to shield the ends of median barriers.

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MASH 27” W-Beam Median Barrier Test
Video Clip
Failed Test!!!
U.S. Department of Transportation
Federal Highway Administration
Session 2
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MASH MGS Median Barrier Test
Video Clip
U.S. Department of Transportation
Federal Highway Administration
Session 2
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Flexible Median Barriers

Advantage of high tension cable is it may remain effective after impact.

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Flexible Median Barriers

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Session 2
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Work Zone Barriers

Types of work zone barriers include:

- Concrete safety shape barrier
- Portable steel barriers
- Plastic, water-filled barriers

Dynamic deflection of the barrier is an important consideration in choosing a work zone barrier.

Work Zone Barrier Performance


Pinned Jersey Shape TL-3
Video Clip
U.S. Department of Transportation
Federal Highway Administration
MONTANA
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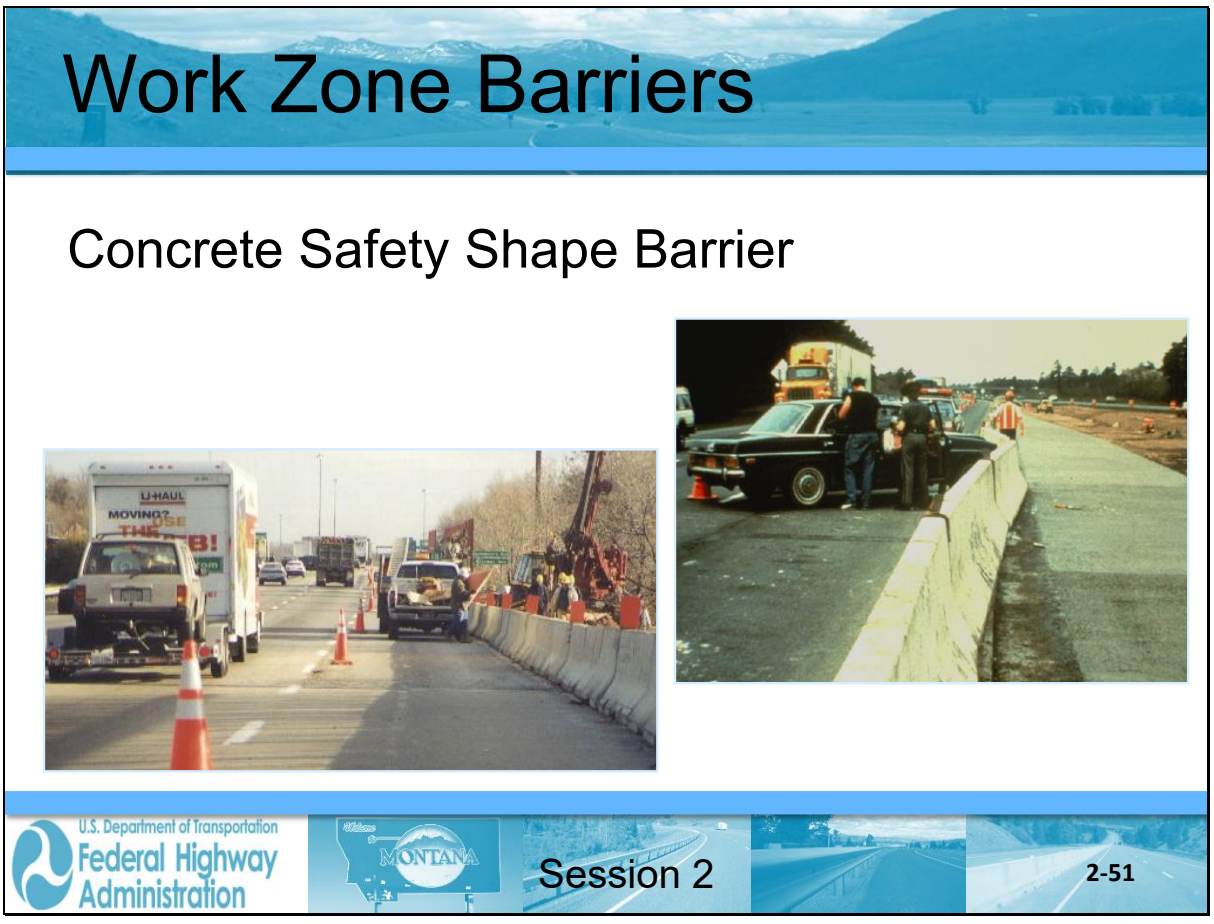
Work Zone Barriers
Concrete Safety Shape Barrier
U-HAUL
MOVING?
U.S. Department of Transportation
Federal Highway Administration
MONTANA
Session 2
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Transition Sections

- When a softer (more flexible) barrier precedes a stiffer barrier, a gradual stiffening must occur between the two systems.
- An effective transitions must provide the following:
  - Adequate connection (TENSION continuity)
  - Adequate length to gradually increase stiffness.

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Inadequate Transition

U.S. Department of Transportation Federal Highway Administration | MONTANA | Session 2 | 2-53

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Transition Sections

Successfully crash-tested transitions include the following essential elements (in addition to a structural connection):

- Additional and/or Larger Posts
- Nested rail (w-beam or Thrie-beam)
- Curbs (only as crash-tested transition unit), Rub Rails, and/or Flared Parapet Wall to Prevent Snagging

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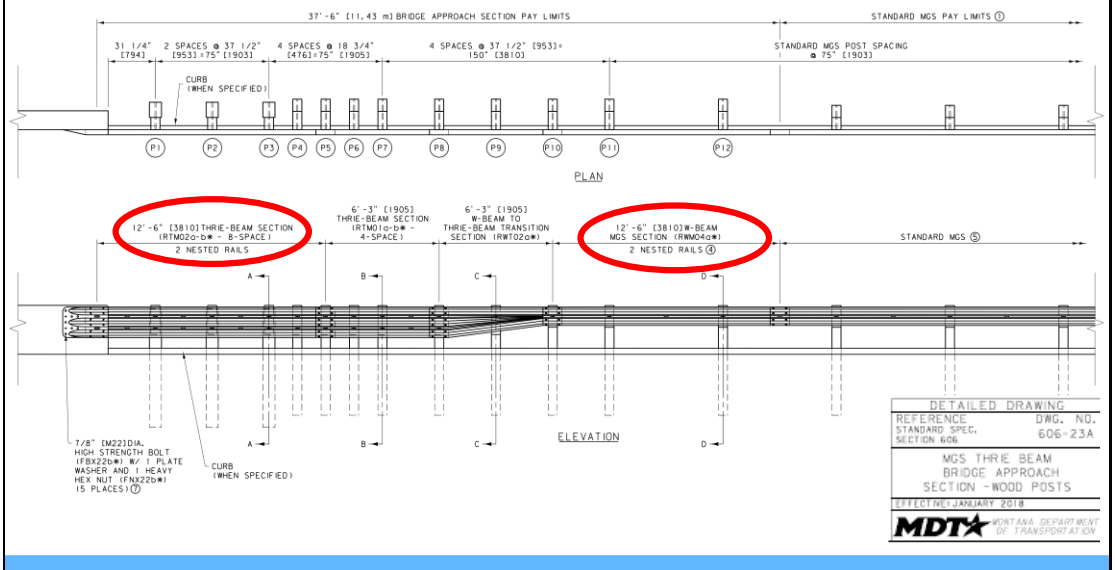
MDT Transition – MGS



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MGS Transition
Video Clip
U.S. Department of Transportation
Federal Highway Administration
Session 2
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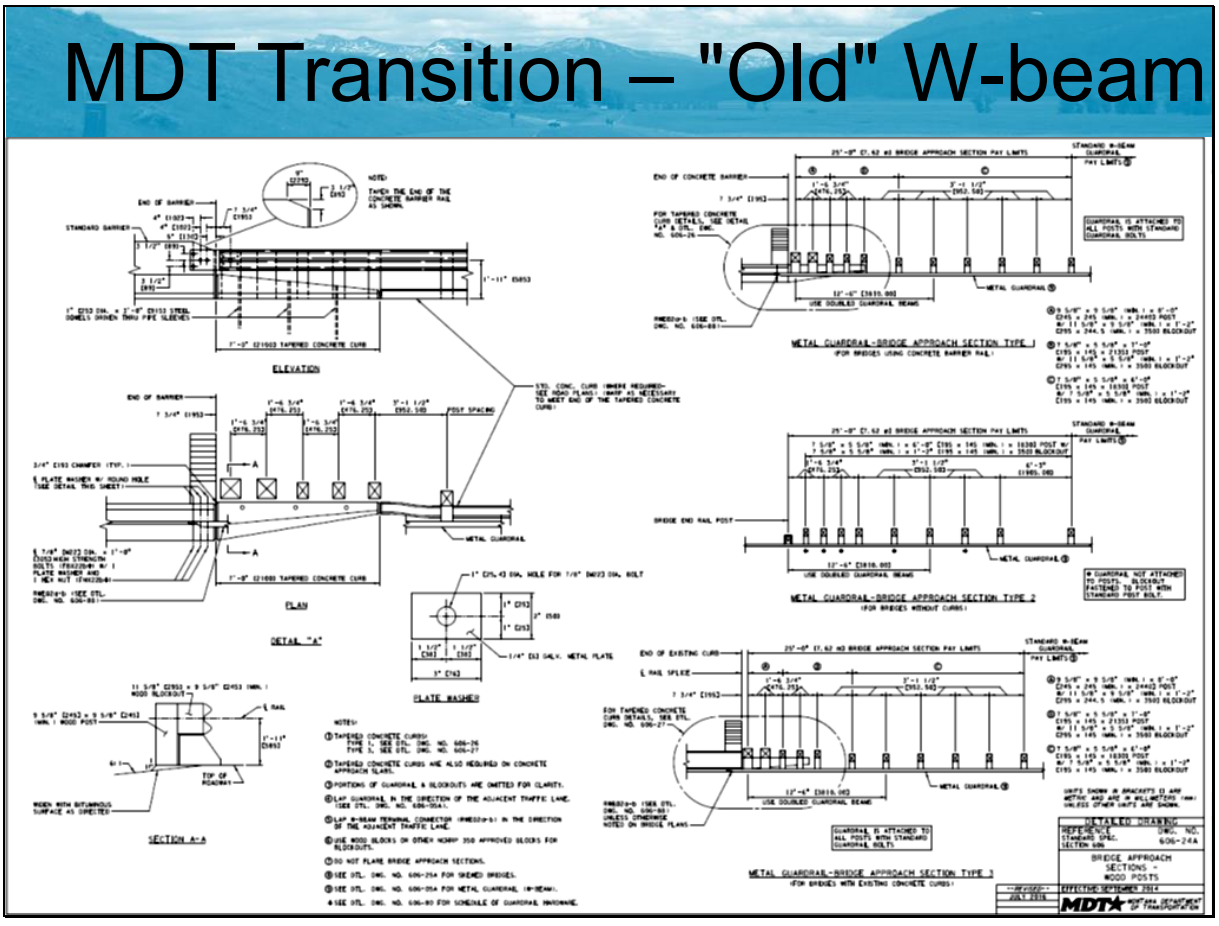
MDT Transition – "Old" W-beam
ELEVATION
PLAN
DETAIL "A"
PLATE WASHER
SECTION A-A
METAL GUARDRAIL-BRIDGE APPROACH SECTION TYPE 1
(FOR BRIDGES USING CONCRETE BARRIER RAIL)
METAL GUARDRAIL-BRIDGE APPROACH SECTION TYPE 2
(FOR BRIDGES WITHOUT CURBS)
METAL GUARDRAIL-BRIDGE APPROACH SECTION TYPE 3
(FOR BRIDGES WITH EXISTING CONCRETE CURBS)
DETAILED DRAWING
BRIDGE APPROACH SECTIONS - WOOD POSTS
MDT

Connections to Low Parapets or Combination Rails

If the concrete parapet or portion of a combination rail is less than the transition height (29”, or 32” for thrie beam), a steel plate may be applicable to adjust the height.


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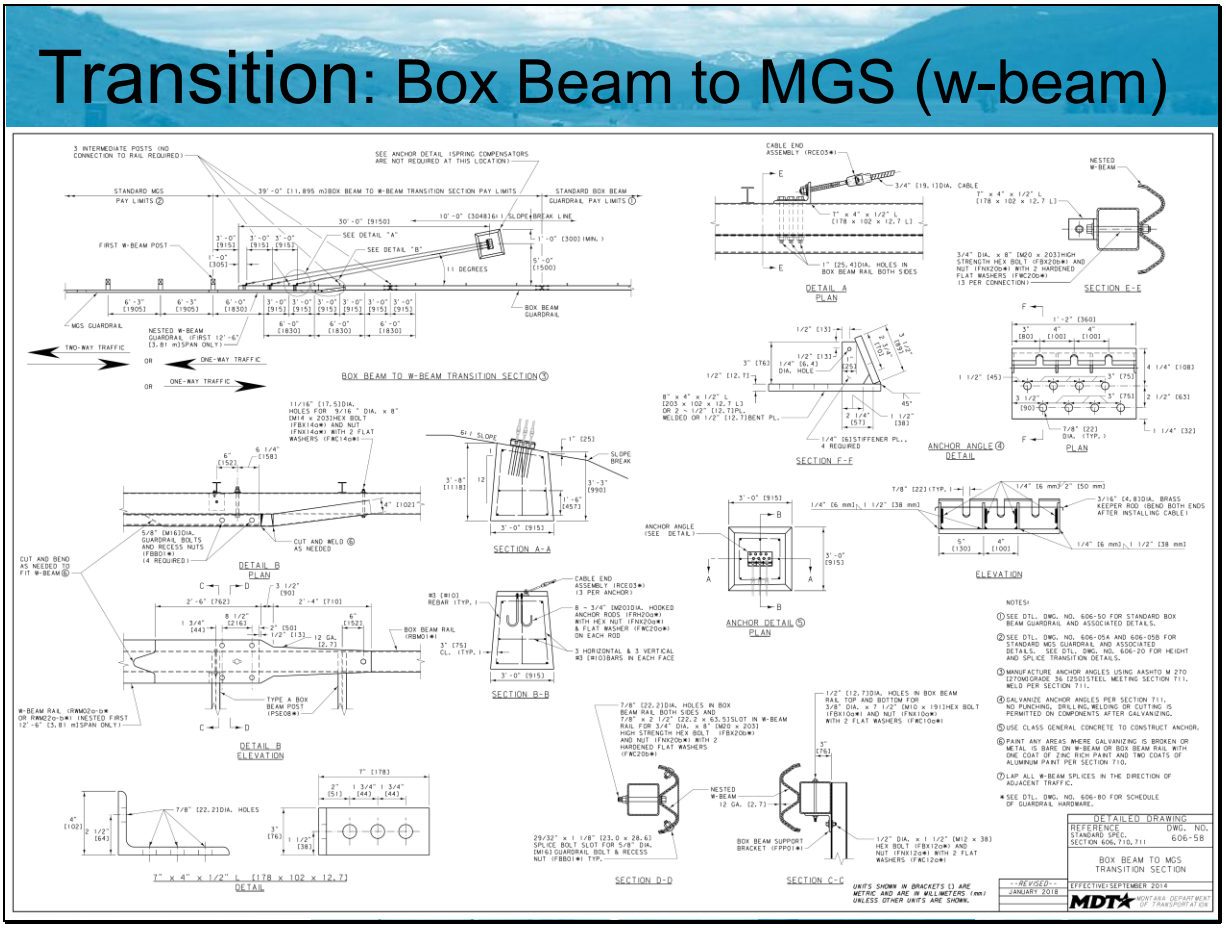
Transition: Box Beam to MGS (w-beam)



Participant Notebook Page 2-3σ


Transition: Box Beam to MGS (w-beam)
No stiffening required as relatively same stiffness; must have tension continuity
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Transition: HTC to Guardrail (Spatial)
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Federal Highway Administration
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High Tension Cable to W-Beam Transition

Manufacturers may not be providing this under MASH 16

Review Learning Outcomes

- Understand how barriers are tested for crashworthiness
- Identify common barrier systems
- Explain how these barrier systems function
- Define the key components of a transition design