Session 4: Guardrail Design, Length of Need, and Site-specific Installation Considerations

FAST Act Guardrail Training
Highway Barrier Installation, Inspection and Maintenance Training

Session 4: Guardrail Design, Length of Need, and Site-specific Installation Considerations

Session 4 4-1

Session 4 Learning Outcomes

At the end of this session, you will be able to:

- Understand the design principles affecting an optimal barrier installation
- Apply a field procedure to check Length of Need
- Be familiar with special designs to address site-specific installation considerations

Session 4 4-2

Guardrail Placement

Place AS FAR AWAY as Possible

without affecting function

Session 4 4-3

Barrier Design Principles

1. Deflection
2. Slope in Front of Barrier
3. Guardrail and Curb
4. Soil Backing for Fill Locations
5. Flare Rate

Deflection Distance / Working Width

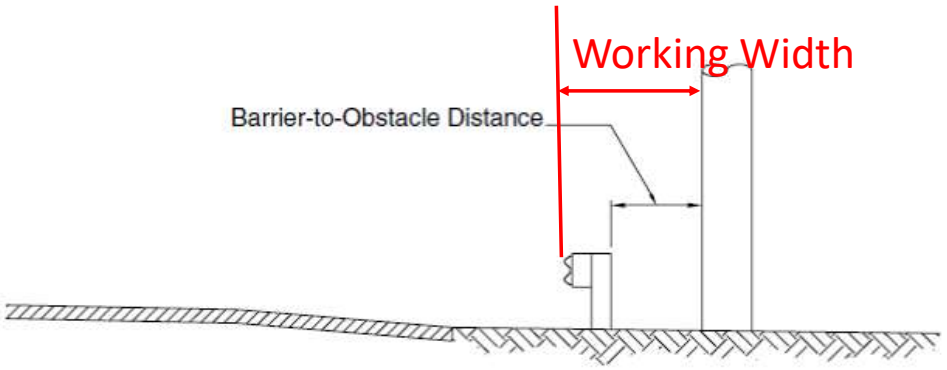
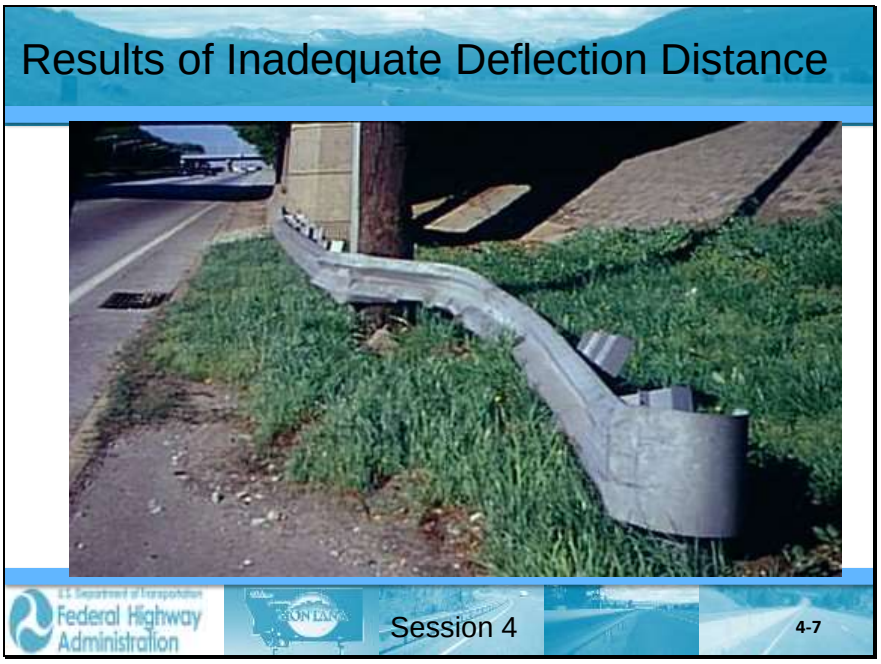


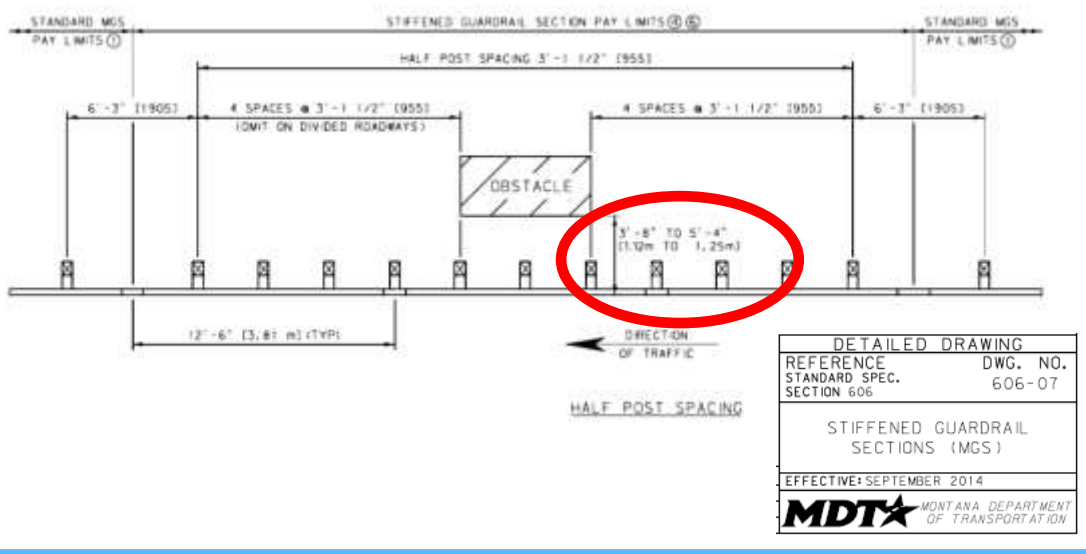
Figure 5-33. Recommended Barrier Placement for Optimum Performance

Ref: AASHTO ROADSIDE DESIGN GUIDE, 4th EDITION – Figure 5-33


Deflection
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-6


Results of Inadequate Deflection Distance
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-7

Deflection – MDT Detailed Drawings



U.S. Department of Transportation Federal Highway Administration

Session 4

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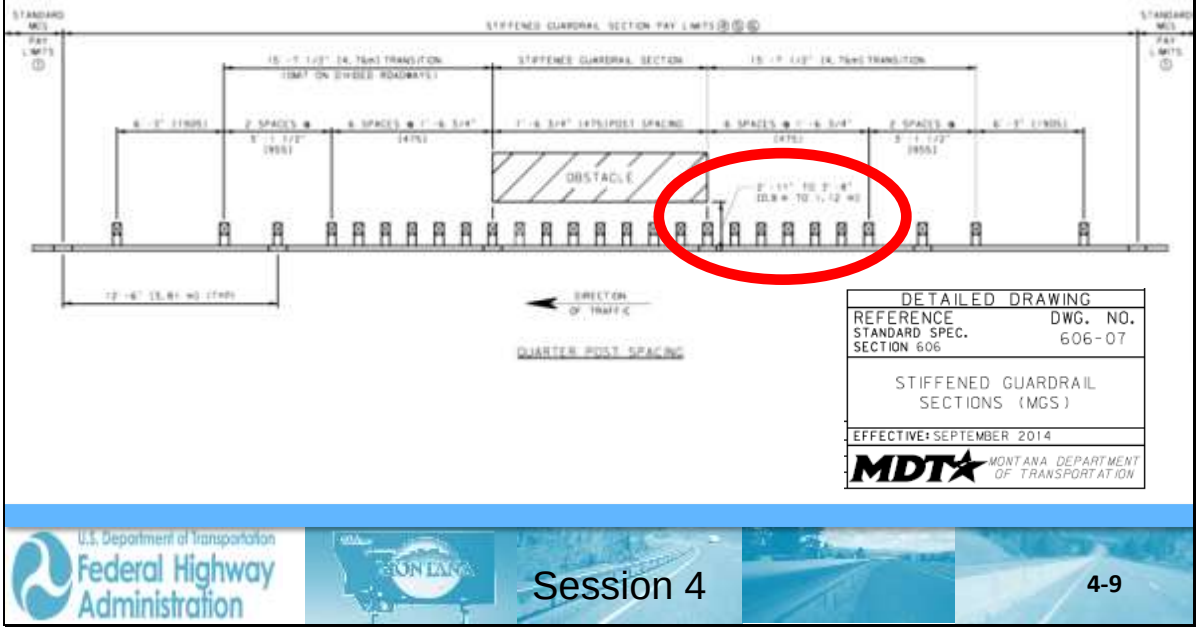
Deflection – MDT Detailed Drawings



U.S. Department of Transportation Federal Highway Administration — Session 4 — 4-9

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Principle 2: Slope in Front of Guardrail

Any barrier may be placed anywhere on a 10H:1V or flatter slope.

U.S. Department of Transportation Federal Highway Administration — Session 4 — 4-10

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Guardrail on Slopes - Generic

- Any barrier may be placed anywhere on a 10H:1V or flatter slope.
- No barrier should be placed on a slope steeper than 6H:1V (exception: some high tension cable designs).
- Cable Guardrail may be placed on slopes of 6H:1V or flatter, but restriction apply when placed in a swale.
- "Old" w-beam guardrail ONLY: On slopes steeper than 10H:1V but no steeper than 6H:1V, metal beam guardrail may be placed outside 2'-12'

CAUTION

U.S. Department of Transportation Federal Highway Administration

Session 4

4-11

Slope in Front of Barrier - MDT

9.4.3.7 Placement on Slopes

Slopes in front of a barrier should be 10:1 or flatter. This also applies to the areas in front of the flared section of guardrail and to the area approaching the terminal ends. See the MDT Detailed Drawings.

Page 9-32
Chapter 9—Roadside Safety

MDT Road Design Manual

U.S. Department of Transportation Federal Highway Administration

Session 4

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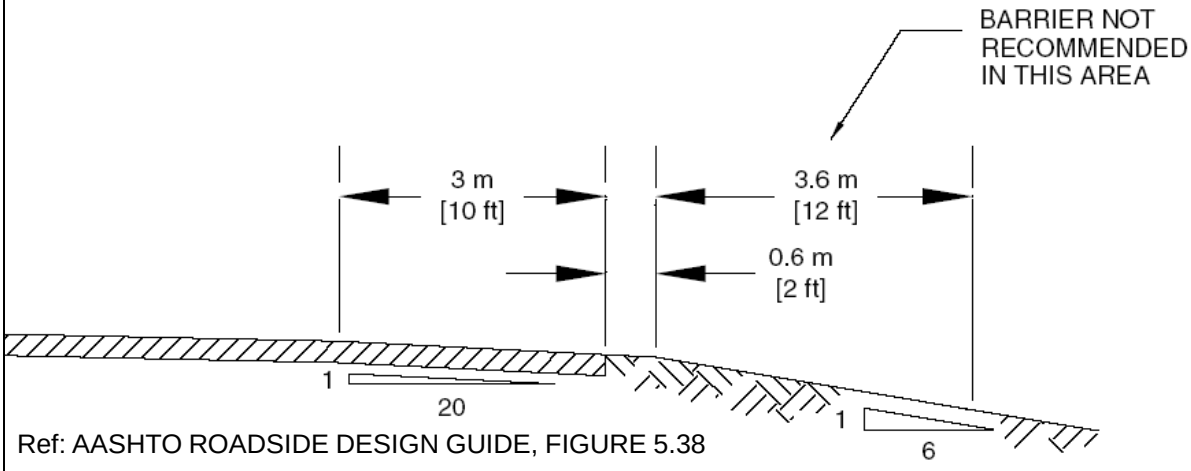
Principle 2: Slope in Front of Barrier

W-Beam Guardrail placement on slopes: "Old" Guardrail ONLY

On slopes steeper than 10H:1V but no steeper than 6H:1V, "old" metal beam guardrail should be placed as shown below.

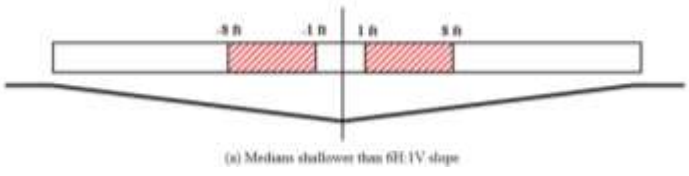


Ref: AASHTO ROADSIDE DESIGN GUIDE, FIGURE 5.38

Violates Placement on Slopes
(and Flare rate)

Slope in Front of Cable Barrier – 6:1

- Cable barrier may be placed anywhere on a 10H:1V or flatter slope.
- Cable barrier may be placed on slopes of 6H:1V or flatter, but not in the area from 1 ft. to 8 ft. from the ditch buttom.*



(a) Medians shallower than 6H:1V slope

* NCHRP Report 711 Guidance for the Selection, Use and Maintenance of Cable Barrier Systems

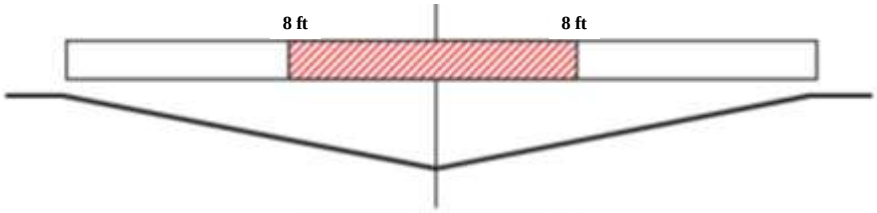
Location of Cable in Swales

CABLE SHOULD NOT BE PLACED BETWEEN 1' AND 8' BEYOND THE BOTTOM OF A DITCH

Federal Highway Administration | Session 4 | 4-17

Slope in Front of Cable Barrier – 4:1

- Cable barrier may be placed on 4H:1V slopes with a maximum offset of 4 ft. from the shoulder.



(b) Medians steeper than 6H:1V slope

Figure 6.1. Underride criteria for V-shaped medians.

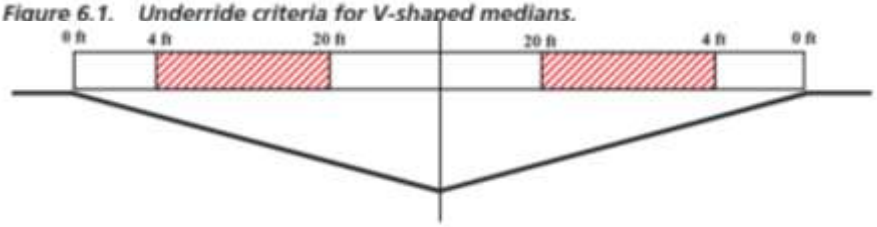


Figure 6.2. Override criteria for V-shaped medians steeper than 6H:1V slope.

* NCHRP Report 711 Guidance for the Selection, Use and Maintenance of Cable Barrier Systems

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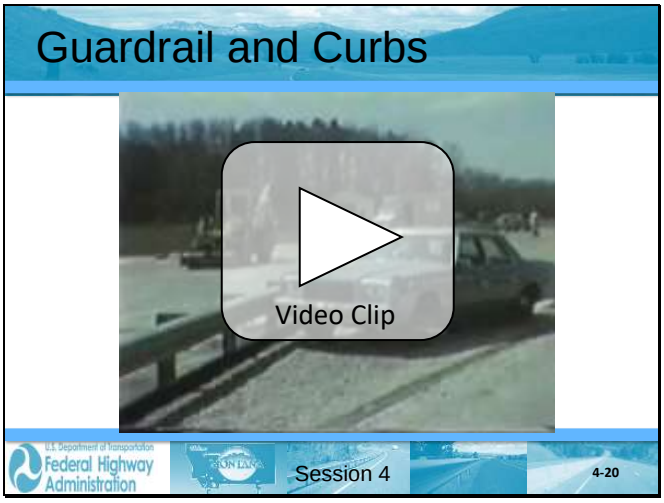
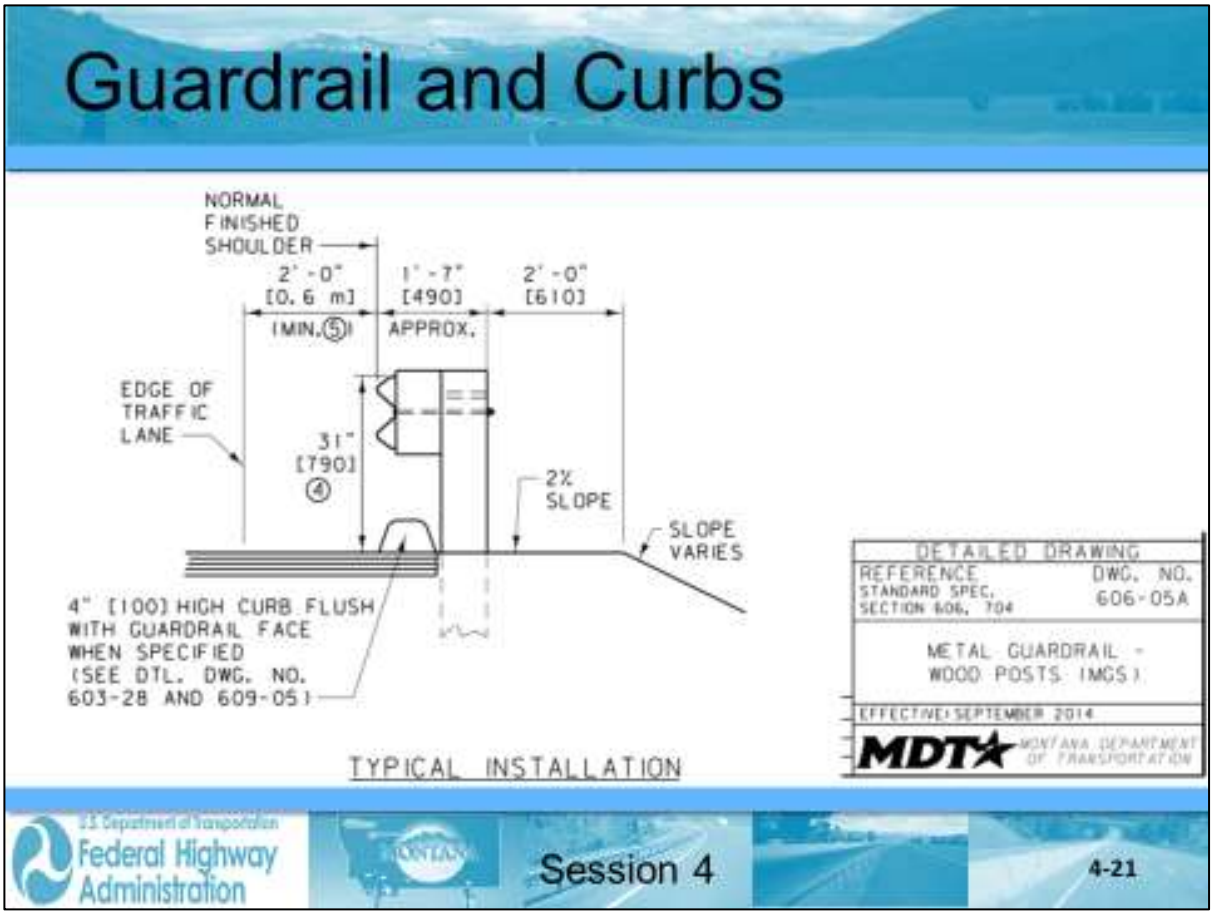
Principle 3: Guardrail and Curbs
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-19


Guardrail and Curbs
Video Clip
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-20


Guardrail and Curbs
NORMAL FINISHED SHOULDER
2'-0" [0.6 m] (MIN.⑤)
1'-7" [490] APPROX.
2'-0" [610]
EDGE OF TRAFFIC LANE
31" [790] ④
2% SLOPE
SLOPE VARIES
4" [100] HIGH CURB FLUSH WITH GUARDRAIL FACE WHEN SPECIFIED (SEE DTL. DWG. NO. 603-28 AND 609-05)
TYPICAL INSTALLATION
DETAILED DRAWING
REFERENCE STANDARD SPEC. SECTION 606, 704
DWG. NO. 606-05A
METAL GUARDRAIL - WOOD POSTS (MGS)
EFFECTIVE: SEPTEMBER 2014
MDT MONTANA DEPARTMENT OF TRANSPORTATION
U.S. Department of Transportation Federal Highway Administration
Session 4
4-21


Box Beam and Curbs
Not allowed by MDT guidance
U.S. Department of Transportation Federal Highway Administration
Session 4
4-22


Terminals and Curbs
CURRENTLY UNDER STUDY –
DO NOT BURY BEARING PLATE
2" maximum height recommended
Federal Highway Administration
Session 4
4-23


MASH Tested – TL-2
Federal Highway Administration
Session 4
4-24


Terminals and Curbs – TL-2
Video Clip
Federal Highway Administration
Session 4
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Principle 4: Soil Backing For Fill Locations
U.S. Department of Transportation
Federal Highway Administration
Session 4
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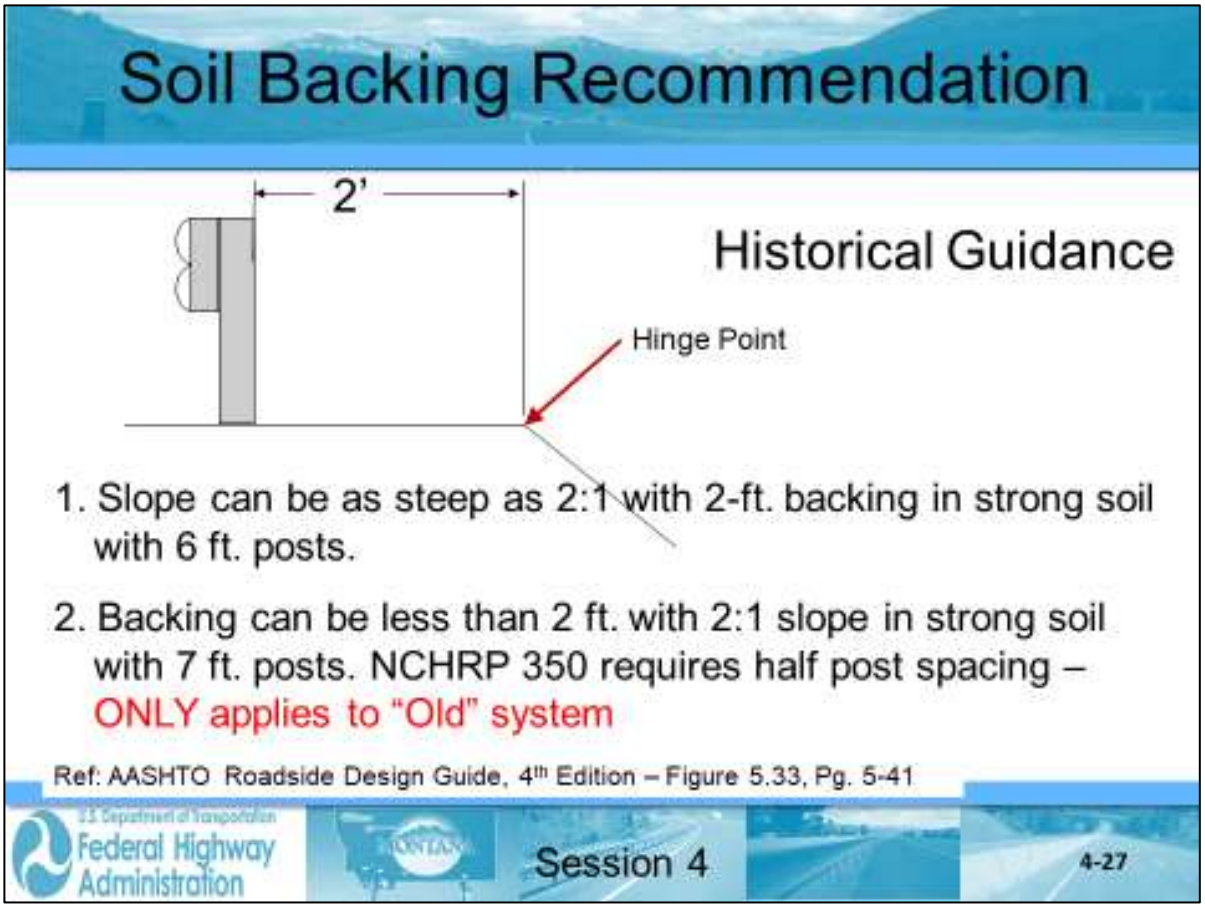
Soil Backing Recommendation
2'
Historical Guidance
Hinge Point
1. Slope can be as steep as 2:1 with 2-ft. backing in strong soil with 6 ft. posts.
2. Backing can be less than 2 ft. with 2:1 slope in strong soil with 7 ft. posts. NCHRP 350 requires half post spacing – ONLY applies to "Old" system
Ref: AASHTO Roadside Design Guide, 4th Edition – Figure 5.33, Pg. 5-41
U.S. Department of Transportation
Federal Highway Administration
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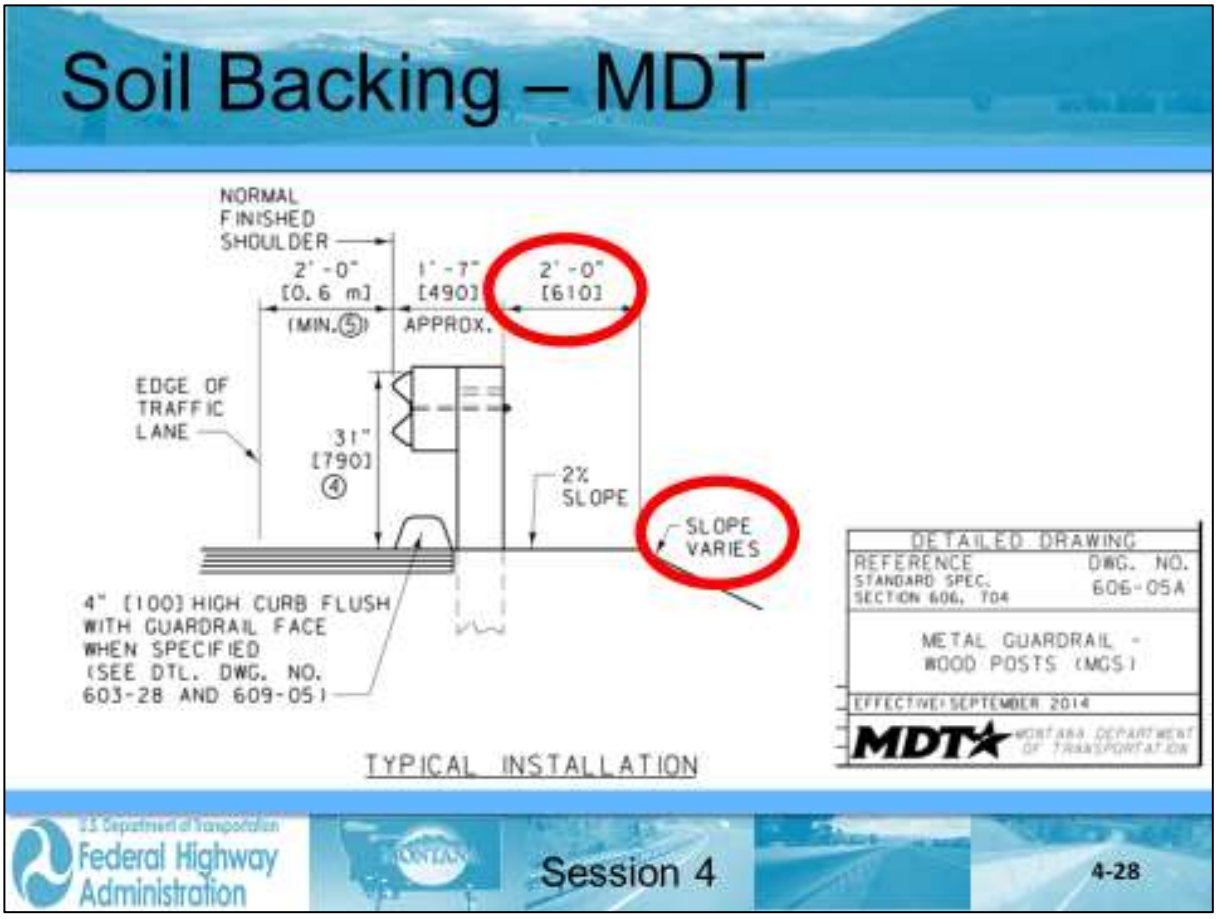
Soil Backing – MDT
NORMAL FINISHED SHOULDER
2'-0" [0.6 m] (MIN.⑤)
1'-7" [490] APPROX.
2'-0" [610]
EDGE OF TRAFFIC LANE
31" [790] ④
2% SLOPE
SLOPE VARIES
4" [100] HIGH CURB FLUSH WITH GUARDRAIL FACE WHEN SPECIFIED (SEE DTL. DWG. NO. 603-28 AND 609-05)
TYPICAL INSTALLATION
DETAILED DRAWING
REFERENCE STANDARD SPEC. SECTION 606, 704
DWG. NO. 606-05A
METAL GUARDRAIL - WOOD POSTS (MGS)
EFFECTIVE: SEPTEMBER 2014
MDT
MONTANA DEPARTMENT OF TRANSPORTATION
U.S. Department of Transportation
Federal Highway Administration
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2:1 FILL SLOPE
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-29


Principle 5: Flare Rate
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-30

Flare Rate

Flared barriers are those that are not parallel to the edge of the traveled way. They are used to:

- Locate barrier, and terminals, farther from the roadway.
- Lessen driver reaction to a roadside obstacle.
- Reduce total length of rail needed.
- Reduce nuisance hits.

U.S. Department of Transportation Federal Highway Administration
Session 4
4-31

Flare Rate

Restrictions of flared barriers:

- Flared barriers can only be placed on 10:1 or flatter slopes.
- Maximum flare rate varies with design speed.

U.S. Department of Transportation Federal Highway Administration
Session 4
4-32

Flared W-Beam Guardrail Example

U.S. Department of Transportation Federal Highway Administration | Session 4 | 4-33

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Length of Need (LON) Definition

AASHTO

The length of effective barrier needed IN ADVANCE OF the hazard to intercept and redirect an encroaching vehicle.

U.S. Department of Transportation Federal Highway Administration | Session 4 | 4-34

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Length of Need (L) - MDT

The following equation is used to determine the total barrier length for a given roadside condition:

$$L_{TOTAL} = L_{ADJACENT} + L_{OBSTACLE} + L_{OPPOSING}$$

Where:

$L_{ADJACENT}$	=	The length needed in advance of the obstacle required to protect traffic in adjacent lanes.
$L_{OBSTACLE}$	=	The length of the obstacle itself.
$L_{OPPOSING}$	=	The length in advance of the obstacle needed to protect traffic in opposing lanes.

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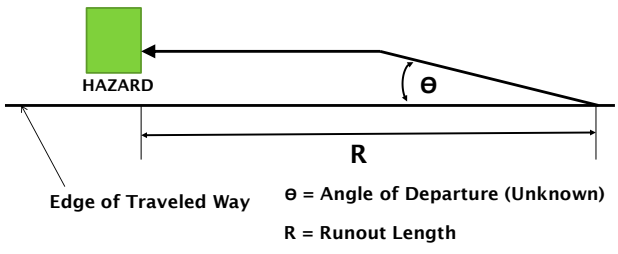
Federal Highway Administration Session 4 4-35

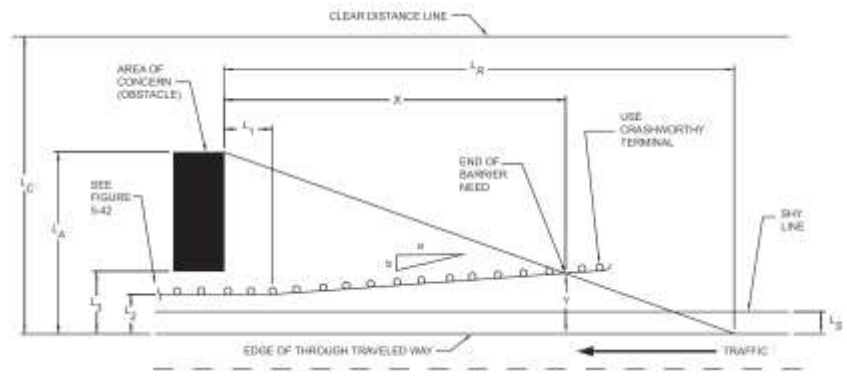
Length of Need (LON) Theory

AASHTO



Federal Highway Administration Session 4 4-36

LON Design Procedure for Approach Barrier Layout



Ref: AASHTO Roadside Design Guide, 4th Edition, Figure 5.39, Pg. 5-49

Length of Need - AASHTO

- Calculating the length of need (X) for straight or nearly straight sections of roadway:
  - For flared guardrail installations:

$$X = \frac{L_A + (b/a)\,(L_1) - L_2}{(b/a) + (L_A/L_R)}$$

  - For parallel guardrail installations:

$$X = \frac{L_A - L_2}{L_A/L_R}$$

Ref: AASHTO Roadside Design Guide, 4th Edition, Equation 5-1 and 5-2, Pg 5-51

Quick Field Check of LON

1. Stand on roadway edgeline opposite the upstream edge of the hazard.
2. Pace upstream along edgeline 12 times the distance from ETL to the outside edge of hazard (L_O - MDT procedure)
3. Turn and look at the upstream, outside edge of hazard.
4. If planned (or existing) barrier run intercepts this line of sight, it approximates design procedure for adjacent length of need.
5. Check for ALL hazards that should be shielded in this area
6. Check for better terminal location if needed by extending barrier a short distance.


Beginning of BIG hole
POOR LON
U.S. Department of Transportation
Federal Highway Administration
Session 4
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U.S. Department of Transportation
Federal Highway Administration
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Guardrail Placement in Special Situations

- Turnout Conflict (IRT's)
- Long Span (Omitted Post{s})
- Gaps between runs of barrier
- Extra Blocks
- Leaveouts (Blockouts) for Posts in Structural Pavement
- Guardrail Post in Rock


Turnout Conflict
Federal Highway Administration
Session 4
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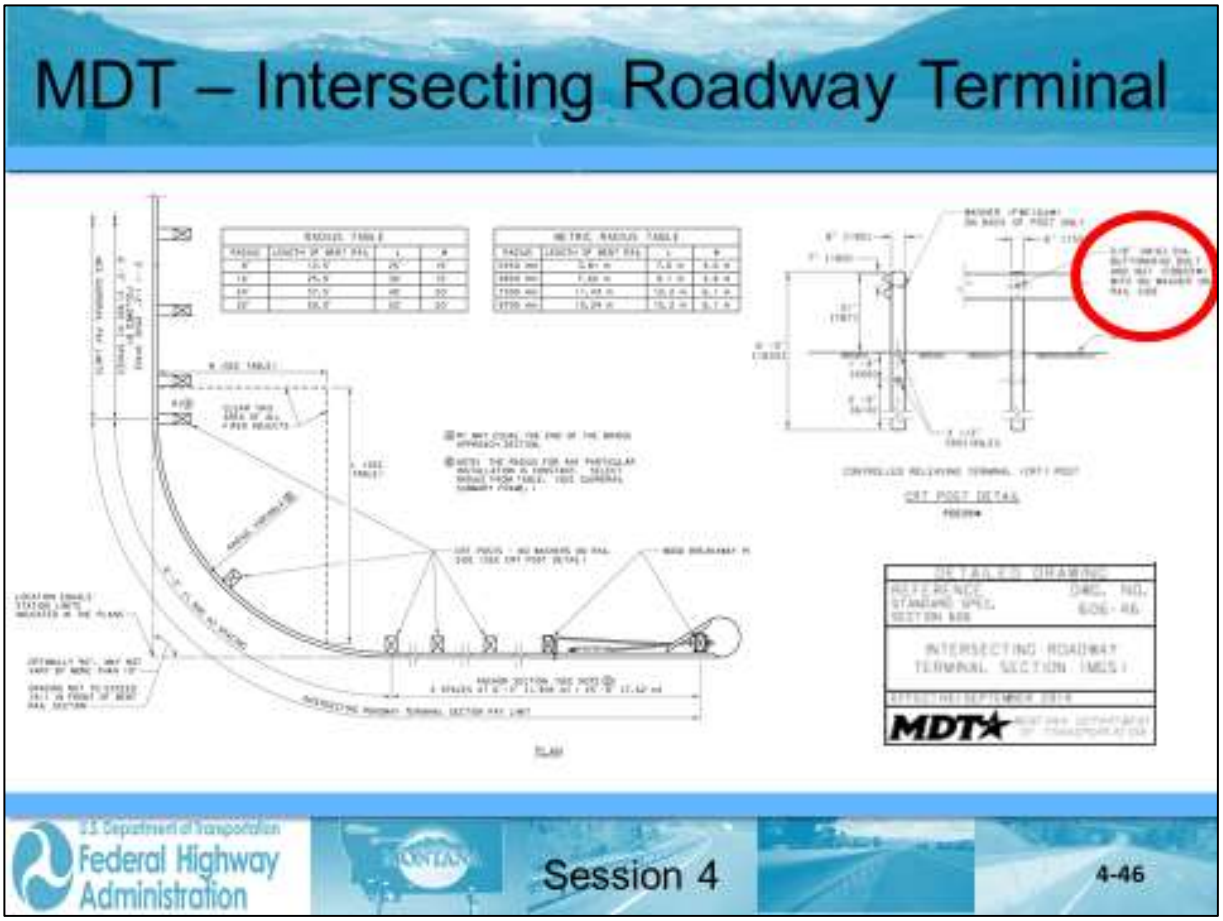
Intersecting Roadway Terminal
Federal Highway Administration
Session 4
4-45


MDT – Intersecting Roadway Terminal
DETAILED DRAWING
INTERSECTING ROADWAY TERMINAL SECTION (MES)
MDT
U.S. Department of Transportation
Federal Highway Administration
Session 4
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MGS – Omitting 3 posts
Video Clip
Working Width – 94”
Eligibility Letter B-189
Federal Highway Administration
Session 4
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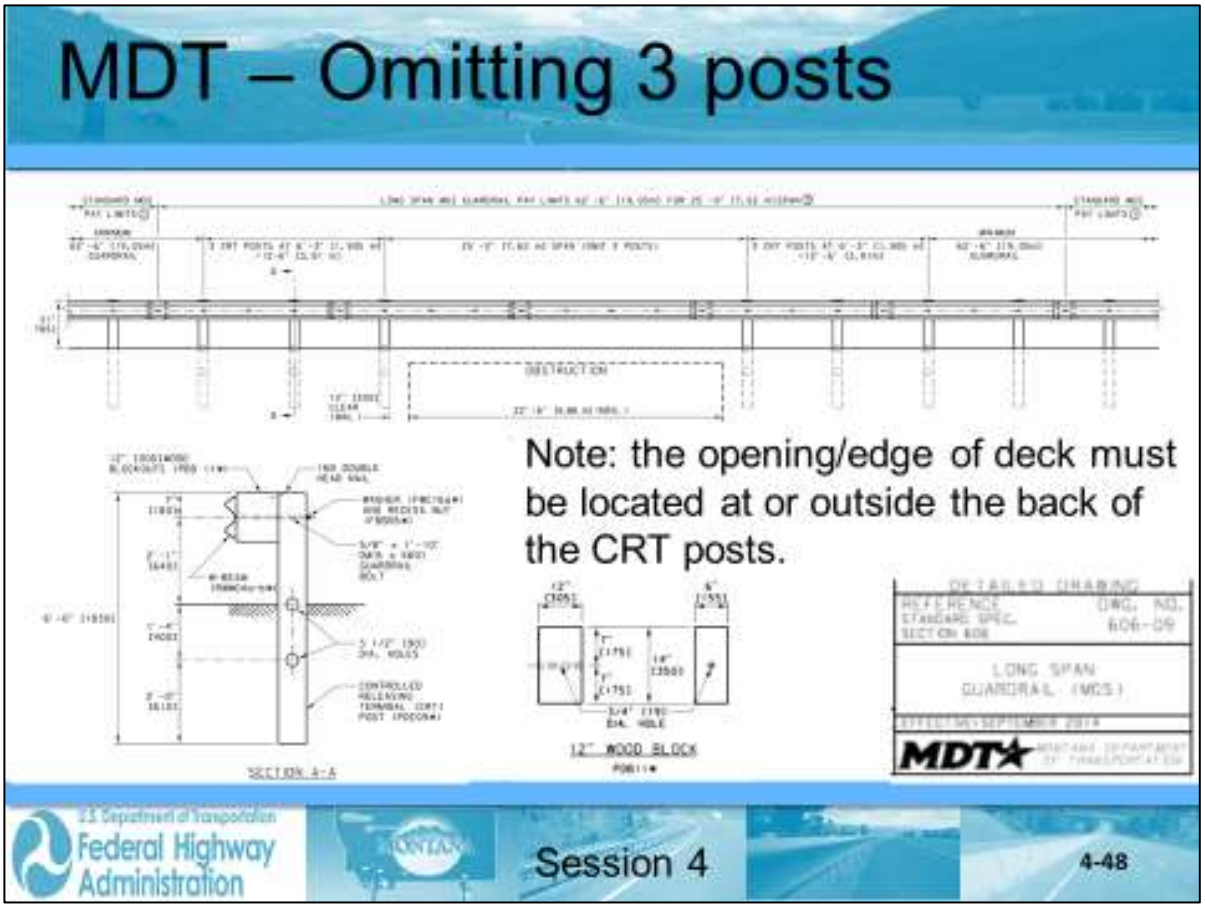
MDT – Omitting 3 posts
Note: the opening/edge of deck must be located at or outside the back of the CRT posts.
12" WOOD BLOCK
LONG SPAN GUARDRAIL (MGS)
MDT
U.S. Department of Transportation
Federal Highway Administration
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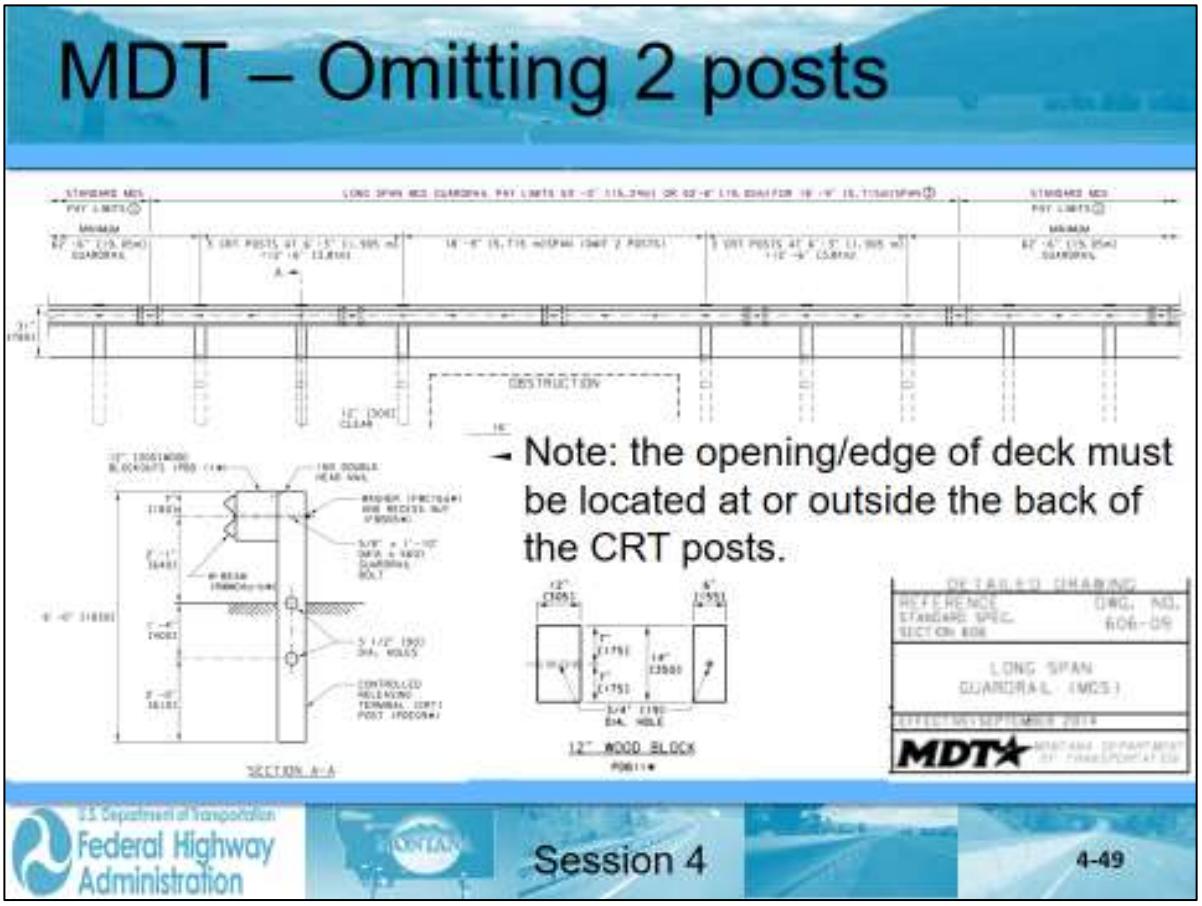
MDT – Omitting 2 posts
Note: the opening/edge of deck must be located at or outside the back of the CRT posts.
OBSTRUCTION
SECTION A-A
12" WOOD BLOCK
LONG SPAN GUARDRAIL (MGS)
MDT
U.S. Department of Transportation
Federal Highway Administration
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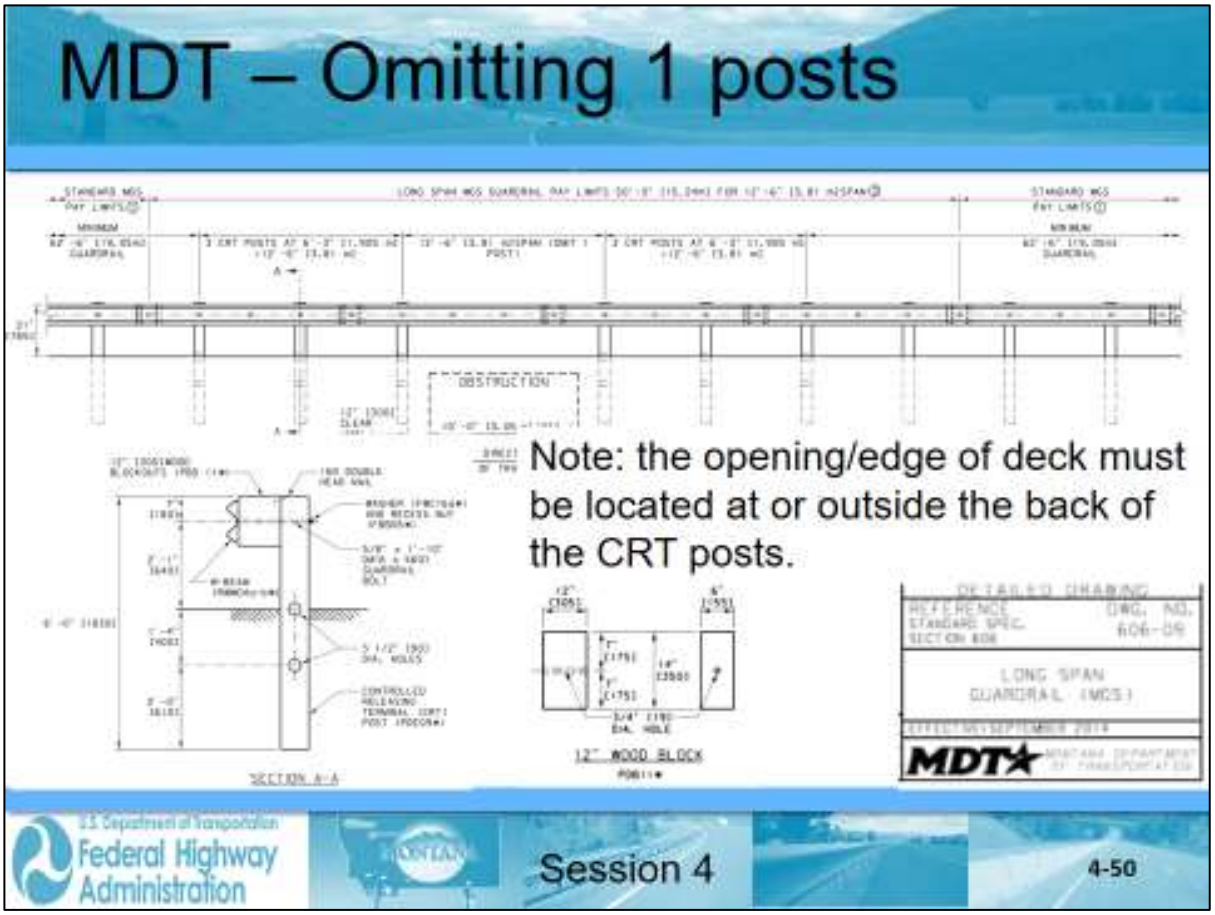
MDT – Omitting 1 posts
OBSTRUCTION
Note: the opening/edge of deck must be located at or outside the back of the CRT posts.
SECTION A-A
12" WOOD BLOCK
LONG SPAN GUARDRAIL (MGS)
MDT
U.S. Department of Transportation
Federal Highway Administration
Session 4
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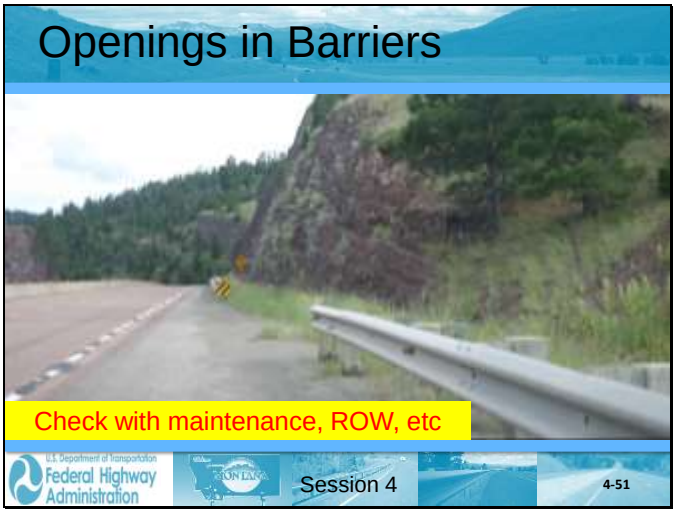
Openings in Barriers
Check with maintenance, ROW, etc
U.S. Department of Transportation
Federal Highway Administration
Session 4
4-51

Openings in Barriers

9.4.3.9 Minimum Length/Gaps

Short runs of barrier have limited value and should be avoided. Generally, a barrier should have at least 100 feet of standard rail section exclusive of terminal sections and/or transition sections (does not include rail connected to structures or other blunt ends). Short gaps between runs of barrier are undesirable. Therefore, gaps of less than 165 feet between barrier termini should be connected into a single run. Exceptions may be necessary for access, or other project considerations.

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MDT Road Design Manual

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Review Learning Outcomes

- Understand the design principles affecting an optimal barrier installation
- Apply a field procedure to check Length of Need
- Be familiar with special designs to address site-specific installation considerations

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