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

Guardrail Placement

Place AS FAR AWAY as Possible

without affecting function
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

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

Results of Inadequate Deflection Distance
Session 4

Deflection – MDT Detailed Drawings

Principle 2: Slope in Front of Guardrail

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

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.
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)

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 bottom.*
Location of Cable in Swales

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

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.
Principle 3: Guardrail and Curbs
Box Beam and Curbs

Not allowed by MDT guidance
Terminals and Curbs

2” maximum height recommended

CURRENTLY UNDER STUDY – DO NOT BURY BEARING PLATE

MASH Tested – TL-2
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Terminals and Curbs – TL-2

Video Clip

Principle 4: Soil Backing For Fill Locations
Soil Backing Recommendation

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
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2:1 FILL SLOPE

Principle 5: Flare Rate
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.

Restrictions of flared barriers:

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

Excessive Flare

Length of Need (LON) Definition

AASHTO

The length of effective barrier needed IN ADVANCE OF the hazard to intercept and redirect an encroaching vehicle.
The following equation is used to determine the total barrier length for a given roadside condition:

\[ L_{\text{total}} = L_{\text{adjacent}} + L_{\text{obstacle}} + L_{\text{opposing}} \]

Where:

- **L_{\text{adjacent}}**: The length needed in advance of the obstacle required to protect traffic in adjacent lanes.
- **L_{\text{obstacle}}**: The length of the obstacle itself.
- **L_{\text{opposing}}**: The length in advance of the obstacle needed to protect traffic in opposing lanes.

**Length of Need (LON) Theory**

**AASHTO**

- HAZARD 
- Edge of Traveled Way
- \( \theta \) = Angle of Departure (Unknown)
- \( R \) = Runout Length

**MDT Road Design Manual**

September 2016

Chapter 9—Roadside Safety

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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:
  \[ X = \frac{L_A - L_2}{L_A/L_R} \]

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.
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
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MDT – Intersecting Roadway Terminal

MGS – Omitting 3 posts

Working Width – 94”
Eligibility Letter B-189
Note: the opening/edge of deck must be located at or outside the back of the CRT posts.
MDT – Omitting 2 posts

Note: the opening/edge of deck must be located at or outside the back of the CRT posts.
Openings in Barriers

Check with maintenance, ROW, etc
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.

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