Session 6: Length of Need and Special Considerations
Session 6: Length of Need and Special Considerations

Session 6 Learning Outcomes

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

- Define the Length of Need and apply the design principles for an optimal installation
- Modify guardrail for special situations
1. Eliminate obstacles or design proposed features free of obstacles (such as slope flattening to avoid barrier warrants, removing rock outcroppings, and removing point obstacles);
2. Relocate the obstacle;
3. Where applicable, make the obstacle breakaway (such as sign posts and luminaire supports);
4. Shield the obstacle with a roadside barrier, which is also considered an obstacle and should only be used when other alternatives cannot be achieved; or
5. Delineate the obstacle.

Length of Need (LON) Definition

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

Length of Need (LON) Theory

AASHTO

$\theta$ = Angle of Departure (Unknown)

$R$ = Runout Length
Runout Lengths AASHTO & MDT

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</table>

September 2016

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

LON Design Procedure for Approach Barrier Layout

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

MDT Guidance and Layout

See figure below

September 2016 MDT Road Design Manual

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Chapter 9—Roadside Safety

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Participant Notebook Page 6-5
**MDT Procedure**

Where:

\[ X = \frac{L_x (L_{o} - L_1)}{L_0} \]

\[ Y = L_1 \]

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

\[ L_C = \text{recommended clear zone.} \]

\[ L_0 = \text{distance from edge of traveled way to back of obstacle (i.e., the lateral extent of the obstacle). For a fixed object, the lateral extent of the obstacle (L_0) is the distance from the edge of the traveled way to the far side of the obstacle. If the obstacle is an embankment or a fixed object that extends beyond the clear zone, L_0 is measured to the outside edge of the clear zone (L_C); i.e., } L_0 = L_C. \]

**MDT Procedure – Modification**

9.4.3.3 Length of Need (Obstacle Within Recoverable Clear Zone)

\[ X = \frac{L_0 - L_1}{\tan 5^\circ} \]

Where:

\[ X, Y = \text{coordinates of beginning of barrier need.} \]

\[ L_0 = \text{distance from edge of traveled way to back of obstacle (i.e., the lateral extent of the obstacle).} \]

\[ L_1 = \text{distance from edge of traveled way to face of barrier.} \]

\[ 5^\circ = \text{departure angle.} \]
MDT Procedure – Modification

9.4.3.3 Length of Need (Obstacle Within Recoverable Clear Zone)

For obstacles located near the clear zone limit, check the necessary barrier length using both the LR formulas (Section 9.4.3.2) and the 5-degree angle formulas (Section 9.4.3.3). Use the method that produces the shorter overall length of barrier.

Suggestion: If \( \frac{L_R}{L_O} < 11.4 \), use the \( L_R \) formula.

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LON Design for Opposing Traffic

[Diagram of LON design for opposing traffic]

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Session 6
Length of Need on the Outside of a Horizontal Curve

Length of Need on the Inside of a Horizontal Curve

MDT Road Design Manual
September 2016
Chapter 9 — Roadside Safety

Session 6

Participant Notebook
Energy-Absorbing terminal on a curve

Energy-Absorbing terminals should be installed in a straight line over the length of the terminal proper. This may require the barrier to be extended in advance of the curve.

Step 1: Identify the Hazard

Lo
Length of Need – Adequate?

___________________________________________________________________________________

___________________________________________________________________________________

Length of Need – Adequate?

___________________________________________________________________________________
Session 6: Length of Need and Special Considerations

LON – with Box Beam

Still inadequate

Length of Need – Adequate?
Length of Need – Adequate?

Step 2: Define the Point of Departure

L or 5 degree angle
## MDT Runout Lengths

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<td>110</td>
<td>90</td>
</tr>
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</table>

### Step 3: Intersect the Hypotenuse

$X = \text{Adjacent Length of Need (LON) of Barrier}$

$L_O = \text{Length of Need (BLON) point}$

$L_R$ or 5 degree angle
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 (LO - 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 satisfies 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.

Downstream Termination
One Direction Traffic

An anchor must be ADDED at the end

Typically 90°

LO or 5 degree angle
Guardrail Placement

Place as far from traffic as practical (without affecting performance)
Session 6: Length of Need and Special Considerations

Guardrail Placement in Special Situations

- Turnout Conflict (Intersecting Roadway)
- 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
Intersecting Roadway Terminal

MDT – Intersecting Roadway Terminal

<table>
<thead>
<tr>
<th>RADIUS TABLE</th>
<th>METRIC RADIUS TABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADIUS</td>
<td>LENGTH OF CURVE</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1.51</td>
</tr>
<tr>
<td>12&quot;</td>
<td>5.07</td>
</tr>
<tr>
<td>18&quot;</td>
<td>9.60</td>
</tr>
<tr>
<td>24&quot;</td>
<td>14.12</td>
</tr>
</tbody>
</table>

8" RADIUS RADIUS CURVE LENGTH | 22' 3.58"

NOTE: THE VALUES FOR ANY PARTICULAR NEED TO BE IDENTIFIED.

ONTARIO ROADWAY TERMINAL SECTION (RCS)

U.S. Department of Transportation
Federal Highway Administration

Session 6

6-38
TxDOT MASH TL-3 Short Radius

On-going Research by Pool Fund – No Eligibility Letter
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.
MDT – Omitting 1 posts

Note: the opening/edge of deck must be located at or outside the back of the CRT posts.
MGS – Omitting 1 post

- No post modifications
- Can be used with wood or steel posts
- Can be used with 8” or 12” blockouts

Video Clip

Working Width 50.1”
Limit 1 per 50’
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.
**Extra Blocks – National Guidance**

- Two block-outs (up to 16" deep) may be used at any time, for any number of posts.
- Three block-outs may be used at one or two posts in a section of guardrail.

Ref: AASHTO Roadside Design Guide – 3rd Edition, Section 5.4.1.6

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**Leaveouts in Structural Pavement**

Ref: AASHTO Roadside Design Guide – 4th Edition, Figure 5-52
Guardrail Posts in Rock

Case 1

Plan View Steel Posts
Notes: For overlying soil depths (D) ranging from 9 to 460 mm the depth of required drilling (d) is equal to 0.7D mm.

<18"

21"

Case 2

Plan View Wood Posts
Notes: For overlying soil depths (D) ranging from 465 to 2620 mm the depth of required drilling (D) is equal to 2.5D mm. The desired embedment depth (e) is such that the depth of soil which cannot be placed is 150 mm.

≥18"

8"

23"

Eligibility Letter B-64B

Session 6

6-51
Height Transition – MGS to Metal Guardrail
Example – LON

**Determine Treatments for NB Traffic**

- Design speed: 70 mph
- ADT: 53,000
- Side slope: 10:1 Left, 6:1 Right

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**Determine Design Clear Zone**

The Clear Zone is a look up value from MDT Design Manual

- Design speed: 70 mph
- ADT: 53,000
- Side slope: 10:1 or 6:1
### MDT Design Clear Zone Distance – Fill

<table>
<thead>
<tr>
<th>Design Speed</th>
<th>Design AADT</th>
<th>Fill Slopes/Foreslopes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>6:1 or Flatter</td>
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<td>40 mph</td>
<td>&lt; 750</td>
<td>10</td>
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<tr>
<td></td>
<td>750-1499</td>
<td>14</td>
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<tr>
<td></td>
<td>&gt; 1500</td>
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<td>45 mph</td>
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**Design Speed 70 mph**

**AADT = 53,000**

**\( L_C = 32 \text{ ft.} \)**

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### Example – LON

Identify ALL the hazards

**NOT SHIELDED**

Sign supports – both sides
Calculating the Adjacent length of need (X) - MDT

\[ X = \frac{L_x(L_o - L_1)}{L_o} \quad \text{if } L_o \geq L_c \]

\[ X = \frac{L_o - L_1}{\tan 5^\circ} \quad \text{if } L_o < L_c \]
Step 2: Define the Point of Departure

L_R or 5 degree angle

Look up L_R:
Design Speed 70 mph
AADT = 53,000

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L_R = 360 ft.
Step 3: Intersect the Hypotenuse

$L_{ADJ} = \text{Adjacent Length of Need (LON)}$

$L_O = \text{Length of Need (LON) point}$

$L_R \text{ or } 5 \text{ degree angle}$

Example – LON – MDT

Determine $L_O - \text{distance to the backside of hazard}$

For the back of the sign support:

$L_O = 20 + 2 = 22'$
Find $L_1$

$L_1$ – Guardrail offset from edge of travel lane.

$L_1 = 6$ ft.

Calculate LON – Determine Bid Item MDT

$L_0 = 22$ ft  
$L_1 = 6$ ft  
$L_R = NA$

Using the formula $X = \frac{L_0 - L_1}{\tan 5^\circ}$

$= \frac{22 - 6}{0.087} = 184$ ft.

34.4’ is provided by the tangent terminal

Therefore $184 - 34.4 = 149.6$’ of standard barrier is required

Using 12.5 ft. panels, no of panels needed

$= 149.6/12.5 = 12$ panels; 150’ of guardrail required

A “One Way Departure Terminal” must be added
Calculate LON – Additional Offset

If guardrail is placed as far off as allowed:

Using the formula \( X = \frac{L_O - L_1}{\tan 5^\circ} \)

\[ X = \frac{22 - 14.5}{0.085} = 85 \text{ ft.} \]

34.4' is provided by the tangent terminal

Therefore \( 85 - 34.4 = 50.6' \) of standard barrier is required

Using 12.5 ft. panels, no of panels needed \( = \frac{50.4}{12.5}; \) use 4; 50' of guardrail required

A “One Way Departure Terminal” must be added

BIG savings by offsetting the barrier

AASHTO Procedure

32'

vs. 184’ using MDT procedure
Review Learning Outcomes

- Define the Length of Need and apply the design principles for an optimal installation
- Modify guardrail for special situations