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

MDT MASH Implementation

Memorandum

To: see distribution

From: Leaky Tribblehorn, P.E., Highway Engineer

Date: February 9, 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 e-beam guardrail permanently installed on all Federal Aid projects by 12/31/17.

Included Items

- MDS will specify the Midwest Guardrail System (MDG) as shown herein with 8-inch blockouts for all new, permanent e-beam installations on projects last after the 2017 calendar year. In most instances, the MDG is materially the same as the e-beam system currently used in the state; however, the MDG is mounted at a height of 8 inches from the top of the rail, and the posts are positioned such that the guardrail splices are located midway of post connections. The following is a list and brief description of the items MDS selects for MDG e-beam guardrail.
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.

**MASH Test Conditions**

- 2,420 lbs. (1100C)
- 5,000 lbs. (2270P)

**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.

Standard Barrier Systems

- Rigid Systems
- Semi-Rigid Systems
- Flexible Systems
- Median Barrier Systems
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
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MASH Testing of 32" New Jersey Shaped Concrete Barrier

MDT Rigid Barrier – NJ Shape
MDT Rigid Barrier – NJ Shape

Session 2

MDT Rigid Barrier – NJ Shape
MUST MAINTAIN TENSION IN BARRIER SYSTEM
Session 2

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

Failed Test!!!

Video Clip
SPWB with Wood Post & Wood Block-Out
27 5/8" Height

Failed Test!!!
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.

 placing 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)

Rail Splice Mid-Span

31”

8” or 12”

6’-3”

Video Clip
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MDT MGS Detail – Wood Post

8” BLOCK
Round post allowed
MDT MGS Detail – Steel Post

STEEL POST AND MOUNTING DETAIL

STANDARD UNLESS SPECIFIED OTHERWISE IN PLANS.

MDT MGS Detail – Steel Post

Session 2

U.S. Department of Transportation
Federal Highway Administration

Session 2
2-28
Box Beam Barrier

Roadside

Median
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
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Barrier Systems: Flexible Barriers

- Low Tensioned Cable Barrier

30" Ht.
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]

**Post Foundation and Typical Terminal**

- [Image: Post Foundation]
- [Image: Typical Terminal]

- [Image: Video Clip]
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

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

Flexible Median Barriers
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

Video Clip
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Pinned Jersey Shape TL-3

Video Clip

Work Zone Barriers

Concrete Safety Shape Barrier
Transition Sections

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

Video Clip

MDT Transition – "Old" W-beam
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)

No stiffening required as relatively same stiffness; must have tension continuity

Transition: HTC to Guardrail (Spatial)
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High Tension Cable to W-Beam Transition

Manufacturers may not be providing this under MASH 16

Review Learning Outcomes

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