Changes in Guardrail Standards

2011 Transportation Short Course

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Roadside Safety Problem

- 3,071 traffic fatalities in Texas (2009)
- Approx. 1/3 of fatalities result from single vehicle run-off-road crashes
- Proper design, selection, and placement of guardrail can influence crash frequency and severity
Crash Testing Guidelines

• Uniform guidance for testing roadside safety features
  - Collective judgment & expertise
  - Test matrices
    - Vehicle, speed, angle, location
  - Evaluation criteria

• Periodically updated
  - Changes in vehicle fleet & highway network
  - Advances in knowledge & technology
Guideline Evolution

- 1962 - Highway Research Circular 482
  - 1-page document
- 1974 - NCHRP Report 153
- 1978 - Transportation Res. Circular 191
- 1981 - NCHRP Report 230
- 1993 - NCHRP Report 350
  - 132 pages
• Next step in advancement & evolution of roadside safety testing & evaluation
• Update of NCHRP Report 350
• Developed under NCHRP Project 22-14(02)
• Published in 2009 as AASHTO document
Key Changes in MASH

• Small Design Test Vehicle
  - Weight increased from 1800 lb to 2425 lb
    - 2nd percentile lightest vehicle (i.e., 98% of vehicles sold weigh more than 2425 lbs)
    - 34% increase in energy

• Large Design Test Vehicle
  - Changed from ¾-ton, 2-door to ½-ton, 4-door pickup
  - Weight increased from 4410 lb to 5000 lb
    - Increased impact severity
  - Minimum c.g. height = 28 in
Standard W-Beam Guardrail
(Steel Post)

- 12 ga. W-beam rail
- 27 ¾ inch mounting height
- 6 ft long W6x9 steel posts at 6 ft-3 in spacing
  - 43 ¼ inch embedment depth
- 6 in. x 8 in. x 14 in. wood blockouts
Steel Post W-beam Guardrail

Test: 2214WB-1
5,000-lb, ¾-ton standard cab GMC 61.1 mi/h 25.6
Standard W-Beam Guardrail (Wood Post)

- 12 ga. W-beam rail
- 27-inch mounting height
- 6 in. x 8 in. x 6 ft long wood posts at 6 ft-3 in spacing
- 6 in. x 8 in. x 14 in. wood blockouts
Wood Post W-beam Guardrail

Test: 476460-1-5
5,000-lb, ½-ton Chevrolet 4-door  64.4 mph  26.1
**Problem Statement**

- Current Strong-Post W-Beam Guardrail at Performance Limits
  - *Both Strength and Stability*
  - *No Reserve Capacity or Safety Factor*
- Many SUVs & Pickups Heavier & Have Higher C.G. than test vehicle
- Need Improved Impact Performance to Accommodate Broader Range of Vehicles
Increased Rail Height

• Improves Ability to Contain & Redirect High C.G. Vehicles
  ▪ Vehicle Stability

• Increases Potential for Small Cars to Snag on Posts and/or Underride Rail
Splice Location

• Splice is Weakest Location of W-Beam Rail
  - Reduced cross-sectional area
  - Stress concentrations

• Moving Splice Away from Post Effectively Increases Rail Strength
  - Simplifies stress state
  - Provides additional capacity for containing heavier vehicles
Midwest Guardrail System (MGS)

Dimensions:
- Length: 1905 mm (6'-3'')
- Height: 810 mm (31.89'')
- Post: 1019 mm (40.12'')
- Width: 305 mm (12'')
- Knee Rail: 632 mm (24.89'')
- Top Rail: 787 mm (31'')
Midwest Guardrail System
Midwest Guardrail System

Test: 2214MG-2

2002 ½-ton, Dodge 4-door   62.8 mph   25.5
Midwest Guardrail System

Test: 2214MG-3
2002 Kia Rio     97.8 km/h     25.4
FHWA Guidance

• Issued Technical Memorandum on Guardrail Height (May 17, 2010)
  ▪ Documents performance issues

• Transportation Agencies Should Ensure Minimum Guardrail Height = 27 ¾ in.
  ▪ Includes construction tolerance
  ▪ Addresses only New Installations on NHS
FHWA Guidance

- Request States Consider Adopting 31-inch Guardrail Height
  - Nominal height with +/- 1 inch construction tolerance
  - Improved impact performance
  - Increased capacity
- MGS or Crashworthy Alternative
Blockouts

• Offset Rail from Posts to Reduce Severity of Snagging Between Vehicle & Post
• Can Influence Rail Height as Guardrail Deflects Laterally
• TxDOT Expressed Concern Regarding Use of Larger Blockouts
  ▪ Cost and space
Proposed TxDOT Guardrail

- 12 Gauge W-Beam Rail
- 31” Mounting Height to Top of Rail
- Rail Splices Mid-Span Between Posts
- Steel or Wood Posts
  - 6-ft long
- 8-in Deep Offset Blocks
- Evaluate Impact Performance with Small Car
Proposed TxDOT Guardrail

Test: 420020-5
2,435-lb Kia Rio  60.4 mph  25.6
Guardrail-Bridge Rail Transitions

• TL-3
  - Current Nested Thrie Beam System with Curb Complies with MASH
    • Uses Non-Symmetric Transition Section

• TL-2
  - New design developed and successfully tested
    • 9 ft – 4 ½ in. long
    • Short, 10-gauge thrie beam
    • Non-symmetric transition section
    • Half post spacing
TL-2 Transition
Guardrail End Terminals

• Terminal Systems Successfully Tested in Conjunction with 31” Guardrail
  - SKT-31 and ET-31
  - Testing based on NCHRP Report 350
    • Systems not yet tested under MASH
  - 43 ft-9 in standard installation length
  - Steel and wood post versions
Downstream Anchor Terminal

- Developed and Tested for Use with 31” Guardrail
  - Replaces Turndown Anchor
  - Terminates Downstream Guardrail End Outside Clear Zone for Opposing Traffic
    - Not crashworthy in end-on impacts
  - *SGT*-Style Cable Anchor System
    - Breakaway wood posts in steel foundation tubes accommodate reverse direction impact
Downstream Anchor Terminal
Summary

• New Strong-Post W-Beam Guardrail
  - Meets MASH performance requirements

• 31 in. Mounting Height
  - Provides improved interaction & stability for high C.G. vehicles
  - Provides construction tolerance

• Midspan Rail Splices
  - Increases effective rail strength
  - Improves containment capability for heavier vehicles

• Standard 8-in Deep Offset Block
  - No additional space required

• Design deflections comparable to current strong-post guardrail system
Summary

• High-Speed and Low-Speed Transitions
  ▪ Meet MASH performance requirements

• Single Guardrail Terminals (SGTs)
  ▪ Compatible with 31-inch guardrail
  ▪ Comply with NCHRP Report 350
    • Not yet tested to MASH

• Downstream Anchor Terminal
  ▪ Replaces turndown anchor on downstream end outside clear zone
  ▪ Meets MASH performance criteria for reverse direction impact
Benefits

- Improved Safety
- Accommodates Wider Range of Vehicles
- Increased Effective Strength
Status

• Standards Being Developed for Possible Implementation
• Recommendations Under Review by TxDOT Administration
Questions