Fatal Crashes

- 2006-2008 Averages

KYTC FHWA ACEC Partnering
Conference Sep 2012
2008 National Fatal Crashes

34,017 U.S. Fatal Crashes

17,818 U.S. Roadway Departure Crashes

- **Roadway Departure Crash** - A non-intersection crash in which a vehicle crosses an edge line, a centerline, or otherwise leaves the traveled way.

KYTC FHWA ACEC Partnering Conference Sep 2012
Roadway Departure:
“A non-intersection crash which occurs after a vehicle crosses an edge line or centerline, or otherwise leaves the traveled way.”
2008 RwD Fatal Crashes

- **Unknown**
- **Urban**
- **Rural**

- **Multi-Vehicle**
- **Single Vehicle**

KYTC FHWA ACEC Partnering
Conference Sep 2012
Percent distribution of fixed-object fatalities by object struck, 2008
RwD Crash Types

First Harmful Event in Fatal RwDs

- Fixed Object: 59%
- Opposing Direction: 23%
- Overturn: 16%
- Other: 2%

Source: FARS (Averaged over 2006-2008)

KYTC FHWA ACEC Partnering Conference Sep 2012
RDG Update Objectives

- Statistics Updated
- Incorporated Research
- Incorporated AASHTO “MASH” document
- Referenced safety hardware websites for designer use.
New Crash Test Criteria

- Crash Test Criteria evolves with vehicle fleet and improvements in roadside hardware

- MASH replaces NCHRP Report 350 Criteria
  - Primary changes to vehicle mass, speed and angle of impact
  - Biggest Change is impact angle on end terminals and crash cushions
  - TL-4 Test has more energy
MASH Testing Concerns

- 32” Concrete Jersey Barrier, TL - 3 and TL - 4 Tests
MASH vs 350 Impact Severity

\[ I.S. = \frac{1}{2} m (v \sin \theta)^2 \]

**NCHRP 350 vs. MASH**

- No Change at TL-5 and TL-6
- Both 439 kip-ft

**Impact Severity (I.S.)**
- kip/ft

**Test Level (TL)**
- 1, 2, 3, 4

KYTC FHWA ACEC Partnering
Conference Sep 2012
350 vs MASH
Test Level 4
RDG 2011 – Highlights of Changes

Chapter 1 – An Introduction to Roadside Safety

• Update roadside crash statistics and web site references for more detailed data
• Reference New Crash Test Procedures for MASH (2009) and Barrier Test Matrix
• Reference AASHTO/FHWA Joint Implementation Plan for Continued Use of Report 350 Accepted Hardware
• Reference FHWA Acceptance Letter Web Site and AASHTO TF-13 Web Site
Links to Task Force 13 Guide to Standardized Highway Barriers

• Appendices B & C deleted

• Link to details of barriers are available by links to TF 13
<table>
<thead>
<tr>
<th>System</th>
<th>Test Level</th>
<th>FHWA Acceptance Letter</th>
<th>System Designation</th>
<th>Reference Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-Beam (Weak Post)</td>
<td>2</td>
<td>B-64</td>
<td>SGR02</td>
<td>5.4.1.3</td>
</tr>
<tr>
<td>Three-Strand Cable (Weak Post)</td>
<td>3</td>
<td>B-64</td>
<td>SGR01a and b</td>
<td>5.4.1.1</td>
</tr>
<tr>
<td>High-Tension Cable Barriers</td>
<td>3 and 4</td>
<td>Various</td>
<td>Various</td>
<td>5.4.1.2</td>
</tr>
<tr>
<td>Modified W-Beam (Weak Post)</td>
<td>3</td>
<td>B-64</td>
<td>SGRO2</td>
<td>5.4.1.3</td>
</tr>
<tr>
<td>Ironwood Aesthetic Barrier</td>
<td>3</td>
<td>B-56, 56-A, and 56-B</td>
<td></td>
<td>5.4.1.4</td>
</tr>
<tr>
<td><strong>FLEXIBLE SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SEMI-RIGID SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel Post with Steel Blockout</td>
<td>2</td>
<td>B-64</td>
<td>SGR04a</td>
<td>5.4.1.6</td>
</tr>
<tr>
<td>Box Beam (Weak Post)</td>
<td>3</td>
<td>B-64</td>
<td>SGR03</td>
<td>5.4.1.5</td>
</tr>
<tr>
<td>Steel or Wood Post with Wood or Plastic Blockout</td>
<td>3</td>
<td>B-64</td>
<td>SGR04a and b</td>
<td>5.4.1.6</td>
</tr>
<tr>
<td>NU-GUARD by Nucor Marion</td>
<td>3</td>
<td>B-162</td>
<td></td>
<td>5.4.1.8</td>
</tr>
<tr>
<td>Trinity T-31 and Trinity Guardrail System</td>
<td>3</td>
<td>B-140</td>
<td></td>
<td>5.4.1.8</td>
</tr>
<tr>
<td>Gregory (GMS)</td>
<td>3</td>
<td>B-150</td>
<td></td>
<td>5.4.1.8</td>
</tr>
<tr>
<td>Midwest Guardrail System (MGS)</td>
<td>3</td>
<td>B-133</td>
<td></td>
<td>5.4.1.7</td>
</tr>
<tr>
<td>Blocked-out Thrie-Beam (Strong Post)</td>
<td>3</td>
<td>B-64</td>
<td>SGR09b SGR09a</td>
<td>5.4.1.9.1</td>
</tr>
<tr>
<td>Merritt Parkway Aesthetic Guardrail</td>
<td>3</td>
<td>B-38</td>
<td></td>
<td>5.4.1.10</td>
</tr>
<tr>
<td>Steel-Backed Timber Guardrail</td>
<td>2 and 3</td>
<td>B-64-D</td>
<td></td>
<td>5.4.1.11</td>
</tr>
</tbody>
</table>
Task Force 13 Home Page - Windows Internet Explorer

News and Bulletins

- Our Fall meeting will be in Rapid City, SD. See the News and Bulletins page for more info.
- For Minutes from previous meetings, see the News and Bulletins page.

Task Force 13 develops, recommends, and promotes standards and specifications for bridge and road hardware used by highway and transportation agencies on the nation's roadways. Task Force 13 is a committee of concerned and experienced representatives from industry, academia, and state and federal transportation departments. Task Force 13 serves the Joint AASHTO-AGC-ARTBA Subcommittee on New Highway Materials and Technologies, whose mission is to develop guide specifications for new materials and technologies identified for use in highway construction projects. The present Joint Committee was established in 1972 uniting the American Association of State Highway and Transportation Officials (AASHTO) and Associated General Contractors of America (AGC) committee with the American Road and Transportation Builders Association (ARTBA). Task Force 13 is the longest standing of all existing subcommittee Task Forces.

Standards are documented agreements containing technical specifications and criteria to be used consistently as rules, guidelines, or definitions to ensure that material, products, processes and services are fit for their purpose. For example, the construction details of the guardrail barrier common on America's roadside are derived from a 1995 standard "A Guide to Standardized Highway Barrier Hardware." Adhering to this standard ultimately means that highway barriers will perform consistently from State to State to make roadides safer for errant vehicles that leave the roadway. Standards thus contribute to making life simpler, and to increasing the safety, reliability and effectiveness of the goods and services we use.


The Roadside Design Guide is an AASHTO publication that synthesizes current information and operating practices related to roadside safety presented both in metric and U.S. customary units. It focuses on safety treatments that can minimize the likelihood of serious injuries when a motorist leaves the roadway.

Chapters 3 through 9 of the Roadside Design Guide refer to many of the systems available in the online guides offered by Task Force 13. The links below DO NOT point to AASHTO's Roadside Design Guide, but rather to the specific types of systems referred to in those chapters. To obtain more information or to purchase a copy of the Roadside Design Guide, please click the following cover image below.

For more information or to purchase a copy.

Publications of Task Force 13

For more information on each guide or to access the online version, click on the links below.

Chapter 3: Roadside Topography and Drainage Features
Chapter 4: Sign, Signal, and Luminaire Supports, Utility Poles, Trees and Similar Roadside Features
Chapter 5: Roadside Barriers
Chapter 6: Median Barriers
Chapter 7: Bridge Railings
Chapter 8: Barrier End Treatments and Crash Cushions
Chapter 9: Traffic Barriers, Traffic Control Devices, and Other Safety Features for Work Zones

Additional information can be found at The National Work Zone Safety Information Clearinghouse.
## INTENDED USE
Strong-post W-beam guardrails should be used in locations where a maximum dynamic deflection of 36 inches [900 mm] or less is acceptable. W-beam guardrails should be anchored and terminated using a suitable end treatment. SGR-04a (steel posts) with steel blockouts is a Test Level 2 barrier. SGR-04b (wood posts) with wood, steel or plastic blockouts is a Test Level 3 barrier, SGR-04c (steel posts) with wood or plastic blockouts is also a Test Level 3 barrier.

## COMPONENTS

<table>
<thead>
<tr>
<th>Designator</th>
<th>Component</th>
<th>Unit length</th>
<th>System</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBB01</td>
<td>Splice bolt and nut</td>
<td>150 inches</td>
<td>a-c</td>
<td>8</td>
</tr>
<tr>
<td>FBB02</td>
<td>Guardrail-post bolt and nut</td>
<td>150 inches</td>
<td>a</td>
<td>2</td>
</tr>
<tr>
<td>FBB03</td>
<td>Guardrail-post bolt and nut</td>
<td>150 inches</td>
<td>c</td>
<td>2</td>
</tr>
<tr>
<td>FBB04</td>
<td>Guardrail-post bolt and nut</td>
<td>150 inches</td>
<td>b</td>
<td>2</td>
</tr>
<tr>
<td>FBB04c</td>
<td>Guardrail-post bolt and nut</td>
<td>150 inches</td>
<td>b</td>
<td>2</td>
</tr>
<tr>
<td>FRX16a</td>
<td>Post blockout bolt (1.5 inches [40 mm]) and nut</td>
<td>150 inches</td>
<td>a</td>
<td>4</td>
</tr>
<tr>
<td>FWC16a</td>
<td>Round washer</td>
<td>150 inches</td>
<td>b,c</td>
<td>2</td>
</tr>
<tr>
<td>PDB01a</td>
<td>Timber post blockout</td>
<td>150 inches</td>
<td>b</td>
<td>2</td>
</tr>
<tr>
<td>PDB01b</td>
<td>Timber post blockout</td>
<td>150 inches</td>
<td>c</td>
<td>2</td>
</tr>
<tr>
<td>PDE02</td>
<td>Timber post</td>
<td>150 inches</td>
<td>b</td>
<td>2</td>
</tr>
<tr>
<td>or PDE13</td>
<td>Timber post</td>
<td>150 inches</td>
<td>b</td>
<td>2</td>
</tr>
<tr>
<td>PWE01</td>
<td>Steel post</td>
<td>150 inches</td>
<td>a,b</td>
<td>2</td>
</tr>
<tr>
<td>PWE02</td>
<td>Steel post</td>
<td>150 inches</td>
<td>a,b</td>
<td>2</td>
</tr>
<tr>
<td>or PWE02</td>
<td>Steel post</td>
<td>150 inches</td>
<td>a,b</td>
<td>2</td>
</tr>
<tr>
<td>RWB01a</td>
<td>W-beam backup plate</td>
<td>150 inches</td>
<td>a</td>
<td>1</td>
</tr>
<tr>
<td>RWMO2a</td>
<td>W-beam rail</td>
<td>150 inches</td>
<td>a-c</td>
<td>1</td>
</tr>
</tbody>
</table>

## APPROVALS
FHWA Acceptance Letter B-64, 2/14/00.

## REFERENCES


RDG 2011 – Highlights of Changes

Chapter 2 – Economic Evaluation of Roadside Safety

• Reference to RSAP being updated under Project 22-27 and reference to TRB website for status (and download)
• Reference to AASHTO Highway Safety Manual (2010) Chapter 7 economic appraisal procedures
• Added Section 2.3 for In-Service Performance Evaluation
RDG 2011 – Highlights of Changes

Chapter 3 – Roadside Topography and Drainage Features

• “Clear-Zone” terminology coordinated with Green Book
• Clear-Zone for auxiliary lanes defined
• Curb discussion moved to Chapter 5
• Expanded examples for clear zone evaluation
Culvert Opening Protection
Chapter 4 of the RDG

• Sign, Signal, and Luminaire Supports, Utility Poles, Trees, and Similar Roadside Features
  – Breakaway Devices
    • Not all signs applicable
  – Sign Supports
  – Utility Poles
  – Trees
  – MASH - windshield penetration criteria for signs
Highlights of Changes 4th Ed. RDG

• Chapter 5 – **Roadside Barriers**
  – Reference to MASH and Implementation Plan
  – Brief discussion of motorcycles w/barriers
  – Task Force 13 / FHWA Acceptance Letters
  – New W-beam systems
    • MGS and Proprietary 31-inch systems
Highlights of Changes 4\textsuperscript{th} Ed. RDG

• Chapter 5 – Continued
  – Zone of Intrusion concept
  – Revised discussion of guardrail behind curbs
  – Runout lengths reduced for barrier design
  – Guardrail posts in rock or mow strips
  – Upgrading existing systems revised
    • Plus or minus 3” is gone
Highlights of Changes 4th Ed. RDG

• Chapter 5 – Roadside Barriers
  – Guardrail height for new construction
    • TL-3 on NHS
      – 27.75” Min
      – 29” with +/- 1”
      – +/- 3” Gone G4(1S) & G4(2W)
      – 26.5” Low Tolerance for 3R on NHS
Background and Design Considerations

• Concerns with current W-beam design
  – Light truck and high cg rollover rates
  – Installation height sensitivity
  – Rail ruptures
Test No. 4798-7
1,963 kg/95.3 km/hr/24.0 deg
686 mm (27 in.) Height
Vehicle Rollover (Failure)
Dynamic Deflection = 28.1 in.
Test No. 471470-27
2,075 kg/101.4 km/hr/26.1 deg
686 mm (27 in.) Height
Vehicle Rollover (Failure)
Dynamic Deflection = 35.8 in.
Test No. MIW-1
2,007 kg/99.8 km/hr/25.8 deg
686 mm (27 in.) Height
Vehicle Rollover (Failure)
Dynamic Deflection = 39.4 in.
Test No. NEC-1
1,979 kg/103.2 km/hr/24.5 deg
706 mm (27.8 in.) Height w/ Curb Rail Rupture & Vehicle Penetration (Failure)
31” Guardrail

• **Benefits**
  
  – Improved Performance
    
    • High CG vehicles
    
    • Improved re-directive capacity
    
    • Improved height tolerance
  
  – Better performance in non-standard installations
  
  – Equal or reduced cost

• **Four designs**
  
  – Three proprietary and one non-proprietary
Midwest Guardrail System (MGS)

- Standard W-beam with minor changes
  - Mid-span splices
  - Increased mounting height
  - Increased blockout depth
  - Reduced post embedment
Midwest Guardrail System (MGS)

- Std., ½ and ¼ post spacing
- Offset from curbs
- Long Span
- Steep Slopes
- Steep Flare Rates
- 8:1 Foreslopes
- Thrie to W-Beam Transition
- End Terminals
- 3:1 without blockouts
Typ. W-Beam  MGS
Gregory Mini Spacer (GMS) System

- Mini Spacer post-to-rail attachment
- Standard 6’ long W6x9 or W6x8.5 posts
- Splices at mid-span or at post
- No spacer block
T-31 Guardrail System

- 6’-0” Steel Yielding Line Post (SYLP)
- Splices at mid-span
- Countersunk-head post bolt
- 6” backup plate
- No spacer block
NU-Guard 31

- 6’-6” RIB-BAK U-Channel post with slot
- 3 1/2” washer between post and rail
- Posts at splice
- No spacer block
Figure 5-39. Approach Barrier Layout Variables

\[ X = \frac{L_A + \left( \frac{b}{a} \right)(L_1) - L_2}{\left( \frac{b}{a} \right) + \left( \frac{L_A}{L_R} \right)} \]
NOT THIS SHORT
<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Over 10,000</th>
<th>5,000-10,000</th>
<th>1,000-5,000</th>
<th>Under 1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>470</td>
<td>430</td>
<td>380</td>
<td>330</td>
</tr>
<tr>
<td>70</td>
<td>360</td>
<td>330</td>
<td>290</td>
<td>250</td>
</tr>
<tr>
<td>60</td>
<td>300</td>
<td>250</td>
<td>210</td>
<td>200</td>
</tr>
<tr>
<td>50</td>
<td>230</td>
<td>190</td>
<td>160</td>
<td>150</td>
</tr>
<tr>
<td>40</td>
<td>160</td>
<td>130</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>110</td>
<td>90</td>
<td>80</td>
<td>70</td>
</tr>
</tbody>
</table>
Zone of Intrusion
RDG Guidance

* Reviewed TL-3 sloped-faced concrete barrier heights fall in a range of 762 mm (30 in.) to 813 mm (32 in.)

** Reviewed TL-3 steel tubular barrier on curb (curb greater than 6") heights fall in a range of 813 mm (32 in.) to 864 mm (34 in.)
Zone of Intrusion

*Reviewed TL-4 barrier heights fell in a range of 737 mm (29 in.) to 1067 mm (42 in.)
Truck into CMB
Chapter 5 addresses the LFRD Bridge Pier Protection Guidelines

New Research (NCHRP 12-90) underway to develop risk based guidelines

• AADT
• Route Classification
• Bridge Type
• Site Location
• Risk vs Benefit of Tall Barrier (higher TL)
• Length of barrier for vehicle larger then TL-3
Pier Protection
Impact into Bridge Column
2006 Changes

• New Guidelines for the use of median barrier
• High-tension cable barrier information added
• Added guidance on placement of cable barrier in the median
2011 Changes

• Incorporated guardrail height requirements per 2010 FHWA memo

• Included height tolerances for rigid and flexible barriers

• Added information on high-tension cable barrier on 4:1 slopes
Lessons learned
Lessons learned
Lessons learned

KYTC FHWA ACEC Partnering
Conference Sep 2012
Lessons learned
Chapter 7 – Bridge Railings

- Discusses MASH and LRFD
- Incorporates “Protective Screening at Overpasses”
- References Task Force 13 Bridge Rail Guide
Chapter 8 – End Terminals and Crash Cushion

• Anchorages vs. terminals
• Discussion of MASH, NCHRP 350
• Introduction of the Work-Energy principle
• "Crash cushion" instead of "attenuator"
Chapter 8 – End Terminals and Crash Cushion

• Updated lists to show commonly-used and/or currently-marketed devices
• References to FHWA acceptance letters and Task Force 13 drawings
• Terminals and crash cushions further broken out by type
Chapter 8 – End Terminals and Crash Cushion

Terminals classified into:

• Cable barrier terminals
  – 3-strand, high-tension

• W-beam terminals
  – Tangent, flared, median, 31-inch

• Box-beam terminals
Chapter 8 – End Terminals and Crash Cushion

Crash cushions classified into:

• Sacrificial
• Reusable
• Low-maintenance and/or self-restoring
• Other (sand barrels and miscellaneous)
• Chapter 9 – **Work Zone Devices**

  – Generic and Proprietary PCB designs enumerated
  – Reduce deflection / pinned barriers
  – Water filled barriers v longitudinal channelizers
• Chapter 10 – *Roadside Safety in Urban or Restricted Environments*

– Describes an urban enhanced lateral offset of 4 feet minimum, 6 feet desirable
– Urban control zone concept: keep obstacles away from intersections, driveways, speed change lanes
– Emphasizes 1.5 foot min lateral offset to obstructions is *not* a clear zone
• Chapter 11 - **Mailboxes**
  – Vandal proof mailboxes
  – Secure, locked mailboxes
  – Lightweight plastic designs
• Chapter 12 - **ROADSIDE SAFETY ON LOW-VOLUME ROADS AND STREETS**
  – New chapter to RDG
  – Low cost strategies: SIGNING, MARKING, AND DELINEATION
  – Clear zone
  – Roadside hardware
For additional information please contact:

Rod Lacy. P.E.
Kansas Department of Transportation
Engineering Manager – State Road Office
785-296-3901
rlacy@ksdot.org