Implementation of AASHTO’s Manual for Assessing Safety Hardware (MASH)
2016 AASHTO SCOBS ANNUAL MEETING

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LOUISIANA DOTD, Bridge Design Engineer Administrator
• Overview
• Background
• Ballot Results/Dates – MASH 2016
• MASH Implementation Agreement
• Availability of MASH Hardware
• Anticipated Costs
• Implementation Needs
• Available Resources
Overview

• AASHTO Technical Committee on Roadside Safety (TCRS)
  – Technical Committee under AASHTO SCOD
  – Responsibilities – AASHTO RDG & MASH publication
  – TCRS LIASONS TO AASHTO SCOBS T-7

• MASH vs. Roadside Design Guide (RDG)
  – MASH: Assessment of roadside hardware
  – RDG: Use of roadside hardware

• Roadside hardware:
  – Barriers – guardrail, cable barrier, rigid concrete barrier, crash cushions, work-zone devices, bridge rails, signing/lighting breakaway supports, etc.
BACKGROUND – CRASH TESTING

• 1962: HRCS Circular 482 – one-page document, specified vehicle mass, impact speed, and approach angle for crash tests.

• 1973: NCHRP Report 153 – 16-page document, based on technical input from 70+ individuals and agencies and a special ad-hoc panel.


• 1980: NCHRP Report 230 – 36-page document, brought procedures up to date with available technology and practices, updated the evaluation criteria.

• 1993: NCHRP Report 350 – Comprehensive update of 230

• 2009: AASHTO Manual for Assessing Safety Hardware (MASH)

• 2016: Proposed AASHTO Manual for Assessing Safety Hardware (MASH) currently being balloted by AASHTO.
NCHRP 350
CRASH TESTING GUIDELINES

- NCHRP Report 350 created 6 Test Levels
- Levels 1-3 based on speed
  - TL1 – 50 km/h (31 mph)
  - TL2 – 70 km/h (43 mph)
  - TL3 – 100 km/h (62 mph)
- Levels 4-6 add large trucks
NCHRP 350 to MASH 2009 (Revolution)

• Knowledge gained from use of devices and test methods
• Advances in the science of crash testing
• Additional tests and evaluation criteria
• Changes in nationwide vehicle fleet
NCHRP 350 VS. AASHTO MASH 2009 CHANGES

- TEST VEHICLES UPDATED TO WHAT’S BEING PRODUCED AND SOLD TODAY
- IMPACT CONDITION CRITERIA UPDATE TO CORRECT NEEDED CONDITIONS.
- PROMOTE MORE IN-SERVICE EVALUATIONS IN THE FIELD.
- SMALL CAR INCREASED FROM 1,800 LBS. TO 2,420 LBS.
- SMALL CAR IMPACT ANGLE INCREASED FROM 20 TO 25 DEGREES
- PICKUP TRUCKS INCREASED FROM 4,400 LBS TO 5,000 LBS.
- TL - 4 SINGLE UNIT TRUCK INCREASED FROM 17,600 LBS. TO 22,000 LBS.
- TL -4 SINGLE UNIT TRUCK SPEED INCREASED FROM 50 MPH TO 56 MPH
## MASH GENERAL TEST LEVELS

<table>
<thead>
<tr>
<th>TEST LEVEL - TL</th>
<th>TEST VEHICLE Type – (weight Lbs)</th>
<th>SPEED mph</th>
<th>ANGLE OF IMPACT</th>
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<tbody>
<tr>
<td>1</td>
<td>PASSENGER CAR – (2,420) PICKUP TRUCK – (5,000)</td>
<td>31 31</td>
<td>25 25</td>
</tr>
<tr>
<td>2</td>
<td>PASSENGER CAR – (2,420) PICKUP TRUCK – (5,000)</td>
<td>44 44</td>
<td>25 25</td>
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<td>3</td>
<td>PASSENGER CAR – (2,420) PICKUP TRUCK – (5,000)</td>
<td>62 62</td>
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<tr>
<td>4</td>
<td>PASSENGER CAR – (2,420) PICKUP TRUCK – (5,000) SINGLE UNIT TRUCK – (22,000)</td>
<td>62 62 56</td>
<td>25 25 15</td>
</tr>
<tr>
<td>5</td>
<td>PASSENGER CAR – (2,420) PICKUP TRUCK – (5,000) TRACTOR VAN TRAILER – (79,300)</td>
<td>62 62 50</td>
<td>25 25 15</td>
</tr>
<tr>
<td>6</td>
<td>PASSENGER CAR – (2,420) PICKUP TRUCK – (5,000) TRACTOR TANK TRAILER – (79,300)</td>
<td>62 62 50</td>
<td>25 25 15</td>
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</table>
Old vs. New

Two trucks are shown side by side, one white and one red, highlighting the differences between the old and new models.
AASHTO/FHWA MASH 2009 Implementation Agreement

• Did not sunset use of NCHRP 350 hardware

• Anticipated manufacturers would take the initiative to develop MASH-compliant devices (but this didn’t happen)
MASH 2009 to MASH 2016 (Evolution)

• Major change: Crash testing criteria for cable barriers on slopes

• Minor changes:
  – Soil strength testing
  – Improved documentation of vehicle damage
  – Longer tractor-trailer lengths
CURRENT AASHTO MASH 2016 Ballot Results/Dates

• TCRS – final draft approved April 13, 2016
• SCOD – passed May 1, 2016
• SCOH – pending?
• MASH 2016 publish date – late summer or end of year if SCOH approves?
Recent 2016 MASH AASHTO/FHWA Implementation Agreement

• Additional safety benefits of MASH could only be realized if new hardware was developed

• Incentive: sunset NCHRP 350 criteria for new devices

• Joint FHWA/AASHTO/TCRS group formed, final agreement issued on 1/7/2016

• “Staggered” implementation approach
Overview - Agreement Details

• The AASHTO TCRS will continue to be responsible for developing and maintaining the evaluation criteria as adopted by AASHTO.

• FHWA will continue its role in issuing letters of eligibility of highway safety hardware for federal-aid reimbursement.
Overview - Agreement Details

Agencies are urged to establish a process to replace existing highway safety hardware that has not been successfully tested to NCHRP Report 350 or later criteria.
Overview - Agreement Details

• Agencies are encouraged to upgrade existing highway safety hardware to comply with MASH either when it becomes damaged beyond repair, or when an individual agency’s policies require an upgrade to the safety hardware.
Overview - Agreement Details

• For contracts on the National Highway System with a letting date after the sunset dates, only safety hardware evaluated using the MASH criteria will be allowed for new permanent installations and full replacements.
Overview - Sunset Dates

- **December 31, 2017**: w-beam barriers and cast-in-place concrete barriers
- **June 30, 2018**: w-beam terminals
- **December 31, 2018**: cable barriers, cable barrier terminals, and crash cushions
- **December 31, 2019**: bridge rails, transitions, all other longitudinal barriers (including portable barriers installed permanently), all other terminals, sign supports, and all other breakaway hardware
Overview - Agreement Details

• Temporary work zone devices, including portable barriers, manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH.

• Such devices manufactured on or before this date, and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, may continue to be used throughout their normal service lives.
Overview - Agreement Details

• Regarding the federal-aid eligibility of highway safety hardware, after December 31, 2016:
  – FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully crash tested to the 2016 edition of MASH.
Overview - Agreement Details

– Modifications of eligible highway safety hardware must utilize criteria in the 2016 edition of MASH for re-evaluation and/or retesting.

– Non-significant modifications of eligible hardware that have a positive or inconsequential effect on safety performance may continue to be evaluated using finite element analysis.
Availability of MASH Hardware

• Longitudinal w-beam barrier and cast-in-place concrete barrier (12/31/17):
  – Able to be ready for sunset dates as long as each state does not need to test own configuration
  – Many w-beam systems have been tested
  – Some cast-in-place concrete systems may need additional tests

• W-beam terminals (6/30/2018)
  – A few proprietary systems are available
Availability of MASH Hardware

- Cable barriers, cable barrier terminals, crash cushions (12/31/2018)
  - Expect cable barrier to be ready
  - Cable terminals will be more challenging but are also expected to be ready
  - Some transitions require testing
  - Crash cushions should be ready; thrie-beam bullnose testing needs to be funded soon
Availability of MASH Hardware

- Bridge rails, transitions, all other longitudinal barriers and terminals; all breakaway hardware (12/31/2019)
  - Many types of bridge rails in use among the states; testing needs not yet fully known
  - NCHRP 20-7 project initiated to evaluate “grandfathering” of historical commonly used bridge rail designs
  - NCHRP 03-119 project initiated to examine sign supports and breakaway hardware
  - At the AASHTO TCRS June 2016 meeting, TCRS is considering submitting a full NCHRP research proposal for MASH Bridge rail testing for systems not covered by the 20-07 project.
Availability of MASH Hardware

- New MASH hardware
  - FHWA eligibility review letters are normally provided, but not mandatory.
  - Some unknown State Systems probably being used without FHWA eligibility letters based on previous testing.
  - Approvals received thru local FHWA division office.
Anticipated Costs

• Testing of non-proprietary devices
  • NCHRP, pooled-fund programs, individual state research (unique designs they may use)

• MASH-compliant longitudinal barrier systems
  • Multiple systems currently available (various types)
  • No noted increase in cost vs. previous systems

• MASH-compliant terminals
  • Few systems currently available
  • Initial increase in cost ($200-$700)

• Bridge barrier rail height and deck design increase cost
31” MASH” GUADRAIL STANDARDS

31-in. guardrail system benefits
- Increased Safety
- Reduced high CG vehicles rollover
- Improved re-directive capacity
- Improved height tolerance

Midwest Guardrail System with 12” Blockouts

31” No Blockouts
1. Concrete is Class S (4000 psi) for the deck, and Class C (3600 psi) for the parapet.
2. Transverse bars in deck weld to existing rebar (not shown) protruding from runway.
3. Deck is canti-levered from runway. Moment slab is back-filled with compacted crushed limestone.
4. Transverse bars at 6\" spacing in top mat, 18\" at bottom.
5. Rebar lap splices are 17\" for #4's and 21\" for #5's.
6. This bar may be adjusted laterally +/- 3\" to allow tying to stirrup.

The Texas A&M University System

Texas Transportation Institute
College Station, Texas 77843

<table>
<thead>
<tr>
<th>Revisions</th>
<th>Texas Transportation Institute College Station, Texas 77843</th>
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<td>4.</td>
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<td>5.</td>
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420020-9 Single Slope Barrier (SSTB)
LA DOTD PROJECT FOR MASH BRIDGE RAIL REHABILITATION

Approx. Linear Feet of Each Barrier Type

<table>
<thead>
<tr>
<th>P/R (Post and Rail)</th>
<th>S (Solid Parapet)</th>
<th>Combo (Combination of P/R and S)</th>
<th>Special (Detail Barrier)</th>
<th>TOTAL FEET OF RETROFIT NEEDED</th>
<th>TOTAL MILES</th>
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<tr>
<td>724,662</td>
<td>221,468</td>
<td>129,584</td>
<td>3,072</td>
<td>1,129,782</td>
<td>213.97</td>
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</table>

*Values include both sides of the structure*

**Structures in Orange are associated with a future project.**

P/R (Post and Rail Barrier)  
S (Solid Parapet Barriers)  
Height Varies 6" to 22"  
Wood: Height 7.5" (max)  

Special Case  
Combination  
Degraded roadway 1' Each side of chasm  
Width: max 7'2"  
Height: max 3'2"
Implementation Needs

• Develop a MASH hardware catalog – FHWA is assisting
• Sharing of State DOT MASH details not on FHWA eligibility lists.
• Sharing state QPLs
• Sharing draft state policies
• Encourage states Road Side Safety pooled fund participation!
  – Midwest Pooled Fund (Univ. of Nebraska)
  – Roadside Pooled Fund (Texas A&M)
CRASH TESTING ASSISTANCE

Random video from this site

Background

Many state DOTs have sponsored research on roadside safety issues that include crash testing of features in accordance with FHWA adopted standards (NCHRP Report 350 and MASH). Many of the research and functional problems are common to more than one state and so there is efficiency and cost-effectiveness in pooling resources to conduct certain crash tests.

Objective

To establish an ongoing roadside safety research program that meets the research and functional needs of participating states in a cost-effective and timely manner.

Scope

A committee of representatives from participating states formed a technical committee to identify common research needs, select projects for funding and oversee implementation of results. Specific research activities addressed within the program include the design...
OTHER NCHRP MASH RELATED RESEARCH PROJECTS

• NCRHP 22-12(03) RECOMMENDED GUIDELINES FOR THE SELECTION OF MASH BRIDGE TEST LEVELS TL-2 through TL-5.
  • RESEARCH COMPLETED AND READY FOR PUBLICATION.
  • AASHTO TCRS ANTICIPATING TO PUBLISH IN RDG AND T-7 REFERENCE IN AASHTO LRFD BARRIER RAIL CHAPTER.

• NCHRP 12-90, GUIDELINES FOR SHIELDING BRIDGE PIERS.
  • PROJECT IS STILL IN PROGRESS
Available Resources

• Task Force 13 Barrier Hardware Guide

• FHWA website of crash-tested hardware and eligibility letters
  – Completed NCHRP Roadside Safety Projects

• TRB Standing Committee on Roadside Safety Design, AFB 20