AASHTO Manual for Assessing Safety Hardware, 2015

AASHTO/FHWA Joint Implementation Plan
Standing Committee on Highways
September 24, 2015
Full Scale MASH Crash Tests
(NCHRP 22-14(02))

- Conducted several full-scale crash tests of existing hardware, including:
  - Strong Post W-Beam System
  - Midwest Guardrail System
  - New Jersey Shaped Concrete Barrier
  - F-Shape temp. concrete barrier with 3-loop connection
  - Iowa Transition
  - Tangent Guardrail terminal
  - New Jersey Shaped Concrete Barrier (32 inches), failed TL-4 under MASH
MASH TL-3
27 in. W-Beam Strong Post (Wood)
MASH TL-3, 31 in. MGS
Based on crash testing and finite element impact simulations, a height of 36 in. has been selected as the minimum barrier height required for vehicle stability for MASH TL-4.
MASH TL-4 TEST ON 32-INCH JERSEY BARRIER
MASH TL-4 TEST ON 36-INCH SINGLE SLOPE BARRIER

1. Concrete is Class S (4000 psi) for the deck, and Class C (5000 psi) for the parapet.
2. Transverse bars in deck weld to existing rebar (not shown) protruding from runway.
3. Deck is cantilevered 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 stnup.

The Texas A&M University System

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>By</th>
<th>Chk</th>
<th>Texas Transportation Institute College Station, Texas 77843</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2010-07-22</td>
<td>GES</td>
<td>1:10</td>
<td>Sheet No. 1 of 3</td>
</tr>
<tr>
<td>2</td>
<td>4200020-9</td>
<td></td>
<td></td>
<td>Single Slope Barrier (SSTR)</td>
</tr>
</tbody>
</table>
CONCLUSIONS FOR MASH TL-4 LOADS

Lateral force increases as barrier height increases
Vehicle contact area changes (box structure engaged)
Less vehicle roll (more mass engaged)

Comparison of contact area

36 in. Tall Barrier

42 in. Tall Barrier
CONCLUSIONS FOR MASH TL-4 LOADS

Minimum barrier height for truck stability = 36 inches.

Magnitude and resultant height of lateral impact force ($F_t$) varies with barrier height.

For 36-inch tall barrier: $F_t = 67.2$ kips and $H_e = 25.1$ in.
For 42-inch tall barrier: $F_t = 79.1$ kips and $H_e = 30.2$ in.

Although $F_t$ has 24% increase for 36-inch tall MASH TL-4 barrier compared to Table A13.2-1 *Design Forces for Traffic Railings*, associated moment for deck cantilever design does not change.

Table A13.2-1 $\rightarrow$ 54 kips x 32 in. = **1,728 in-kips**
*MASH* 36-inch barrier $\rightarrow$ 67.2 kips x 25.1 in. = **1,687 in-kips**
## MASH 2009 to MASH 2015

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MASH 2009</th>
<th>MASH 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hood Height Measurement Reference Point</strong></td>
<td>N/A</td>
<td>Clarification for rounded hoods on new vehicle models</td>
</tr>
<tr>
<td><strong>Tractor Trailer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Maximum Overall Length</td>
<td>50 ft</td>
<td>53 ft *</td>
</tr>
<tr>
<td>• Cargo Bed Height</td>
<td>52 in. (+/- 2 in.)</td>
<td>50 in. (+/- 2 in.)*</td>
</tr>
</tbody>
</table>

* Proposed to match current fleet based on testing experience and manufacturers survey

(1) Allows 1° tolerance on impact angle at target impact speed
## MASH 2009 to MASH 2015

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MASH 2009</th>
<th>MASH 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single Unit Truck</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cargo Bed Height</td>
<td>51 in. (+/- 2 in.)</td>
<td>49 in. (+/- 2 in.)*</td>
</tr>
<tr>
<td><strong>Impact Severity Tolerances</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• TL-3: ±8%</td>
<td></td>
<td>TL-3: ±8%</td>
</tr>
<tr>
<td>• TL-4: ±8%</td>
<td></td>
<td>TL-4: ±13%(1)</td>
</tr>
<tr>
<td>• TL-5: ±8%</td>
<td></td>
<td>TL-5: ±13%(1)</td>
</tr>
</tbody>
</table>

* Proposed to match current fleet based on testing experience and manufacturers survey

(1) Allows 1° tolerance on impact angle at target impact speed
### MASH 2009 to MASH 2015

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Vehicle Type</th>
<th>Barrier Position</th>
<th>Key Evaluation Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-10</td>
<td>1100C</td>
<td>Level Terrain</td>
<td>Stability &amp; Occ. Crush/Penetration</td>
</tr>
<tr>
<td>3-11</td>
<td>2270P</td>
<td>Level Terrain</td>
<td>Working Width &amp; Barrier Strength</td>
</tr>
<tr>
<td>3-13</td>
<td>2270P</td>
<td>Front Slope*</td>
<td>Override &amp; Stability</td>
</tr>
<tr>
<td>3-14</td>
<td>1100C</td>
<td>Front Slope*</td>
<td>Penetration, Stability, &amp; Occ. Crush</td>
</tr>
<tr>
<td>3-15</td>
<td>1100C</td>
<td>Back Slope*</td>
<td>Underride, Stability, &amp; Occ. Risk</td>
</tr>
<tr>
<td>3-16</td>
<td>1100C</td>
<td>Back Slope*</td>
<td>Override (Bounce) &amp; Occ. Crush</td>
</tr>
<tr>
<td>3-17</td>
<td>1500A</td>
<td>Front Slope(^{(1)})</td>
<td>Penetration &amp; Occ. Crush</td>
</tr>
<tr>
<td>3-18</td>
<td>2270P</td>
<td>Back Slope*</td>
<td>Override (Bounce) &amp; Stability</td>
</tr>
</tbody>
</table>

* Exact locations within ditch provided based on ditch slope and intended use of barrier

\(^{(1)}\) Barrier positioned to maximize potential for vehicle penetration
MASH Implementation Plan
Current Implementation Agreement

• As of January 1, 2011, all newly developed hardware must be tested using MASH
• NCHRP 350-compliant hardware does not have to be re-tested to MASH
• NCHRP 350-compliant hardware may remain in-place and continue to be installed
• Non-compliant hardware with no suitable alternatives may be left in place and continue to be installed
Innovation?

- “Parallel approach” was supposed to allow manufacturers time to develop new products
- Over four years later, very few proprietary MASH systems exist
- Additional safety benefits of MASH can only be realized if new hardware is developed
- Sunsetting 350 would provide the incentive
- Joint FHWA/AASHTO/TCRS group formed
Proposed Implementation Agreement

- Applies to National Highway System
- TCRS develops and maintains the evaluation criteria (MASH)
- FHWA continues reviewing and determining eligibility of highway safety hardware for federal-aid reimbursement
Proposed Implementation Agreement

• All NCHRP 350- or MASH 2009-compliant permanent hardware may remain in place unless damaged beyond repair.

• Existing NCHRP 350- or MASH 2009-compliant temporary devices, including portable concrete barrier, may continue to be used through their normal service lives.
Proposed Implementation Agreement

• Upon adoption of MASH 2015, any newly developed hardware must utilize MASH 2015 for evaluation and testing
• Modifications of eligible hardware shall utilize MASH 2015 for re-evaluation and/or retesting
• Non-significant modifications of eligible hardware that have a positive or inconsequential effect on performance may continue to be evaluated using Finite Element Analysis
• FHWA will not issue eligibility letters for new or revised hardware tested using MASH 2009 criteria after December 31, 2016
Proposed Implementation Agreement

• Utilization of *MASH 2015*-compliant hardware will be required on new permanent installations and full replacements for projects let after the dates below
  – W-beam barrier and cast-in-place concrete barrier: December 31, 2017
  – W-beam terminals: June 30, 2018
  – Cable barrier, cable barrier terminals, and crash cushions: December 31, 2018
  – Bridge rails, transitions, all other longitudinal barriers (including portable barriers installed permanently), all other terminals, sign supports, and all other breakaway hardware: December 31, 2019
Proposed Implementation Agreement

• Urges agencies to establish a process to replace existing hardware that has not been successfully tested to *NCHRP Report 350* or later criteria.

• Encourages agencies to upgrade existing hardware to comply with the *MASH 2015* when:
  – Damaged beyond repair, or
  – Agency’s policies require an upgrade to the safety hardware
Anticipated Costs

Testing of non-proprietary devices
• NCHRP
• Pooled-fund program
• Individual states (unique designs they may use)

**MASH**-compliant longitudinal barrier systems
• Multiple systems currently available (various types)
• No increase in cost versus previous system

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