Manual for Assessing Safety Hardware (MASH) Implementation

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Outline

- Background on MASH
- Implementation of MASH – Design Guidelines
- Items Requiring MASH Testing
- Items Tested and Implemented
- Items Not Tested
- How Design Process Is Affected
How Are Devices Tested?

Photos from Test Report 9-1002-3, Texas Transportation Institute
MASH Test 3-11
What is MASH (Manual for Assessing Safety Hardware)?

- MASH is the latest set of performance criteria used in crash testing to evaluate safety hardware.

- Several Test Levels (TL)
  - Test Levels 1–3 includes cars and pickups
  - Test Level 4 includes cars, pickups, and single unit trucks
  - Test Levels 5–6 includes cars, pickups, and tractor trucks
Background MASH

- MASH Needed because changes in the vehicle fleet since NCHRP Report 350 criteria were adopted in 1993

- MASH first edition was published in 2009, but not required.

- FHWA issued memo issued on January 7, 2016 which laid out the implementation of MASH

- MASH 2016 second edition required
Significant changes between NCHRP Report 350 and MASH

<table>
<thead>
<tr>
<th>Topic</th>
<th>NCHRP 350</th>
<th>MASH</th>
</tr>
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<tbody>
<tr>
<td>Small car test vehicle</td>
<td>820C vehicle (1,800 lbs.)</td>
<td>1100C vehicle (2,420 lbs.)</td>
</tr>
<tr>
<td>Small car impact angle</td>
<td>20 degrees</td>
<td>25 degrees</td>
</tr>
<tr>
<td>Light truck test vehicle: 3/4 ton 2-door to 1/2 ton 4-door</td>
<td>2000P vehicle (4,400 lbs.)</td>
<td>2270P vehicle (5,000 lbs.)</td>
</tr>
<tr>
<td>Gating terminals and crash cushion impact angle</td>
<td>15 degrees</td>
<td>5 degrees</td>
</tr>
<tr>
<td>Variable message signs and arrow board trailers</td>
<td>No mention</td>
<td>Added to TMA crash test matrix</td>
</tr>
<tr>
<td>Support structure and work zone traffic control device testing</td>
<td>Only small car tested</td>
<td>Small car and light truck tested</td>
</tr>
<tr>
<td>Windshield damage criteria</td>
<td>Subjective/Qualitative</td>
<td>Objective/Quantitative</td>
</tr>
<tr>
<td>Vehicle rebound in crash cushion tests</td>
<td>None</td>
<td>Required</td>
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</table>
Temporary work zone devices manufactured after 12/31/19 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 through their normal service life.
Implementation Timeline by NDDOT – 2018 Construction

- NDDOT Implemented MASH using the Design Guidelines (Section I-06)
- Plans to include MASH for projects bid in October 2017 and later
- Implement MASH when items are available
Design Guidelines
Roadway Improvement Strategies

- **Minor Rehab & Structural Improvement**
  - Changed minimum from NCHRP Report 230 to NCHRP Report 350
  - Upgrade to MASH if not in conformity to NCHRP Report 350

- **Major Rehab & New/Reconstruction**
  - Changed minimum from NCHRP Report 350 to MASH

- If safety hardware is not available for MASH performance criteria, use NCHRP Report 350 minimum.
New or Reconstruction category

- Use MASH TL–4
- Texas Single Slope Bridge Rail
Design Guidelines
Bridge Improvement Strategies

- Rehabilitation category
  - Bridge rail remains if it meets NCHRP Report 350 TL–3
  - Jersey Barrier meets MASH TL–3
  - Alaska Two-Tube meets NCHRP 350 TL–4
Design Guidelines
Bridge Improvement Strategies

- Rehabilitation category
  - If bridge rail does not meet NCHRP Report 350 TL–3, upgrade to MASH TL–3 or higher
  - Do not remove a portion of deck to upgrade to MASH
  - If MASH TL–3 or higher is not available, upgrade to meet NCHRP Report 350 TL–3
Bridge Rail Retrofit to MASH is currently not available

- Alaska Two-tube bridge rail to be tested for MASH TL-4
AASHTO LRFD

- MASH loads have not been published in AASHTO LRFD yet

- Currently designing for MASH which exceeds NCRHP Report 350

<table>
<thead>
<tr>
<th>Design Forces and Designations</th>
<th>Included in AASHTO LRFD</th>
<th>New</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Barrier Height 32 in.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barrier Height 36 in.</td>
<td></td>
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<tr>
<td>$F_t$ Lateral (kip)</td>
<td>54</td>
<td>67.2</td>
</tr>
<tr>
<td>$F_L$ Long. (kip)</td>
<td>18</td>
<td>21.6</td>
</tr>
<tr>
<td>$F_v$ Vertical (kip)</td>
<td>18</td>
<td>37.8</td>
</tr>
<tr>
<td>$L_t$ and $L_L$ (ft)</td>
<td>3.5</td>
<td>4</td>
</tr>
<tr>
<td>$H_e$ (in.)</td>
<td>32</td>
<td>25.1</td>
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Items Requiring MASH Testing

- Guardrail
- Bridge Rail
- Attenuation Devices/Crash Cushions
- Sign Supports
- Breakaway Light and Traffic Signal Standards
- Temporary Barriers
- Traffic Control Devices
Items Tested and Implemented

- Guardrail
- Bridge Rail
- Attenuation Devices/Crash Cushions
Guardrail

- Longitudinal section
- Transition
- End Terminals
Guardrail Longitudinal Section

- Midwest Guardrail System (MGS)
  - Will be NDDOT standard W-beam guardrail
  - 31” high instead of 28”
  - Splices are mid span not at the post

- 3 Cable (low tension)
  - Only meets NCHRP 350
Guardrail Transition

- Connects MGS guardrail to bridge rail
  - To concrete jersey barrier
  - To concrete Texas single slope barrier
  - To concrete safety shape transition
Guardrail Terminals

- Flared guardrail
- Non-flared guardrail
Guardrail Terminals

- Flared guardrail
  - MGS FLEAT
Guardrail Terminals

- Flared guardrail
  - MGS FLEAT
- Non-Flared guardrail
  - MGS Slotted Rail Terminal (MGS SRT)
Guardrail Terminals

- Flared guardrail
  - MGS FLEAT
- Non-Flared guardrail
  - MGS Slotted Rail Terminal (MGS SRT)
  - MASH SoftStop End Terminal
Guardrail Terminals

- Flared guardrail
  - MGS FLEAT
- Non-Flared guardrail
  - MGS Slotted Rail Terminal (MGS SRT)
  - MASH SoftStop End Terminal
  - MASH Sequential Kinking Terminal (SKT)
Bridge Rail

- **Jersey Shape**
  - 32” MASH TL–3 Compliant

- **Texas Single Slope**
  - MASH TL–4 Compliant

- **Alaska Two Tube**
  - Not tested to MASH TL–4 yet
  - Pooled Fund – Alaska and North Dakota
Attenuation Devices / Crash Cushions

- Manufacturers develop and crash test devices.
- Several different crash cushions tested and meet MASH.
Items Not Tested

- Sign Supports
- Breakaway Light and Traffic Signal Standards
- Temporary Barriers
- Traffic Control Devices
Sign Supports

- Nothing tested to match our type of current supports.
Breakaway Light and Traffic Signal Standards

- Light standards
- Type II, V, VI, and VII Traffic Signal Standards
Temporary Barriers

- Implementation date – December 31, 2019
- State Furnished Precast Concrete Median Barriers
Traffic Control Devices

- Implementation date – December 31, 2019
How Design Process is Affected

- Survey
  - No Change

- Safety Review
  - Design Philosophy
  - Guardrail Height
    - NCHRP 350 (Max=31”, Min=26.5”)
    - MASH (Max=34”, Min=28”)
  - Safety Review Templates

- Plan Set
Standard Drawings

- D–764–1 thru D–764–32
  - Existing NCHRP 350 standards (15 drawings)
  - Remain in place

- D–764–38 thru D764–64
  - New MASH standards (13 drawings)
Summary

- MASH to be implemented for projects constructed in 2018
- Implementing items that meet MASH if available
- Watch for additional items as they meet testing requirements for MASH
Questions
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