Ongoing MwRSF Research on Bridge Railings, Culvert Barriers, & Transitions

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June 14, 2017
Research Project Overview – Active & Planned

- **Year 25 – Midwest States Pooled Fund Program (FY2015)**
  - RPFP-15-AGT-1: TL-3 Development of a Standardized Concrete Buttress for MGS Thrie Beam Transitions

- **Year 27 – Midwest States Pooled Fund Program (FY2017)**
  - RPFP-17-AGT-3: Continued TL-3 Development of a Standardized Concrete Buttress for MGS Thrie Beam Transitions

- **Nebraska Department of Roads**
  - 34-In. Tall Thrie-Beam Approach Guardrail Transition

- **Year 26 – Midwest States Pooled Fund Program (FY2016)**
  - RPFP-16-MGS-4: Development of a Top-Mounted Socket for Weak-Post Guardrail on Culverts
Research Project Overview – Active & Planned

- Wisconsin Department of Transportation
  - Evaluation of a Culvert-Mounted, Strong-Post MGS to MASH TL-3

- Nebraska Department of Roads
  - Cost-Efficient, TL-2 Bridge Rail for Low Volume Roads

- Year 27 – Midwest States Pooled Fund Program (FY2017)
  - RFP-17-CONC-2: Development of an Optimized MASH TL-4 Concrete Bridge Rail (Phase I Funding)

- Iowa Department of Transportation
  - Iowa DOT Combination Bridge Separation Barrier with Bicycle Railing

- Ohio/Illinois Department of Transportation
  - MASH TL-4 Steel-Tube Bridge Rail and Guardrail Transition
Approach Guardrail Transitions

- TL-3 Development of a Standardized Concrete Buttress for MGS Thrie Beam Transitions

- Objective
  - Develop concrete end buttress that is compatible with NCHRP 350 and MASH approved thrie-beam approach guardrail transitions (with or without curbs)

- Recent Developments
  - Continuation Study Funded (YR 27)
  - Modified End Buttress Design
Original Standardized Buttress

- Dual chamfer versus single chamfer
  - upper chamfer - 4”x4” to provide adequate lateral rail support
  - lower chamfer - 4”x12” to mitigate concerns for wheel snag
- 6H:1V upper slope w/ height transition from 32” to 36”
Test No AGTB-1

- Excessive ORA values
- Modify buttress and retest
## Design Modifications

<table>
<thead>
<tr>
<th></th>
<th>Original Design</th>
<th>Modified Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td>36”</td>
<td>36”</td>
</tr>
<tr>
<td><strong>Width</strong></td>
<td>12”</td>
<td>12”</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>7 ft</td>
<td>7 ft</td>
</tr>
<tr>
<td><strong>Vertical Taper</strong></td>
<td>4”x24” 1:6 Slope</td>
<td>4”x24” 1:6 Slope</td>
</tr>
<tr>
<td><strong>Top Chamfer</strong></td>
<td>4”x4”</td>
<td>3”x4”</td>
</tr>
<tr>
<td><strong>Bottom Chamfer</strong></td>
<td>4”x12” 3:1 Slope</td>
<td>4.5”x18” 4:1 Slope</td>
</tr>
<tr>
<td><strong>Ht of Bottom Chamfer</strong></td>
<td>11”</td>
<td>14” (blockouts)</td>
</tr>
</tbody>
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Retest ➔ Summer 2017
NDOR 34-in. AGT

• Objective
  ▪ Develop and evaluate a 34” tall thrie beam AGT for future overlays
    ■ Utilize modified standardized buttress design
  ▪ Bridge rails being installed 3” taller than nominal for compatibility with future overlays
    ■ AGTs replaced/raised following overlay
    ■ Attachment to buttress difficult

• Recent Developments
  ▪ Design Selected
  ▪ Full-Scale Crash Testing (2 of 2)
34-in. AGT Design

First Installation

After 3” Overlay
Test No. 34AGT-1

- Met MASH TL-3 test no. 3-21 criteria
Test No. 34AGT-2

- Met MASH TL-3 test no. 3-20 criteria
Barriers Attached to Culvert Structures

• Development of a Top-Mounted Socket for Weak-Post Guardrail on Culverts

• Objective
  ▪ Develop top-mounted, socketed attachment for Weak-Post MGS used on culverts with soil fill heights between 1 ft and 3 ft

• Recent Developments
  ▪ Steel and Concrete Sockets Developed
  ▪ Component Testing
Steel Socket

- HSS 4x4x3/8 tube, gusset plates, and base plate (epoxy anchored)
Steel Socket Component Testing

0° Impact (Weak Axis)

90° Impact (Strong Axis)
Concrete Foundation Design

- Based off socketed foundations for S3x5.7 cable posts
- #4 vertical bars epoxied into top slab
- #4 loops @ 4”
Concrete Foundation Testing

0° Impact (Weak Axis)

90° Impact (Strong Axis)
Conclusions

• Steel Socket and Concrete Foundation
  ▪ Crashworthy supports for weak-post MGS
  ▪ No damage to sockets/foundation
  ▪ Minimal displacement
  ▪ Applicable for fill heights 12.5” – 36”

• Future Work
  ▪ Summary report and FHWA eligibility letter
Barriers Attached to Culvert Structures

• Evaluation of Culvert-Mounted, Strong-Post MGS to MASH TL-3 (WisDOT)

• Objective
  ▪ Evaluate MGS version of MwRSF’s strong-post culvert attachment

• Recent Developments
  ▪ Begin construction of barrier system
  ▪ Two-full-scale crash tests summer 2017
    ▪ Test nos. 3-10 and 3-11
MwRSF Culvert Mounted Guardrail

- NCHRP 350
  - Modified G4(1S)
  - ½-post spacing
- MASH
  - MGS
  - 12-in. offset to headwall
  - Epoxy or through-bolt anchorage options
Bridge Rail Systems

• Cost Efficient, TL-2 Bridge Rail for Low Volume Roads (NDOR)

• Objective
  ▪ Develop an Optimized Bridge Railing
    ■ MASH TL-2 compliant
    ■ Side mounted posts
    ■ Minimize costs (material and labor)
    ■ Prevent deck damage during impacts
  ▪ Minimize length of need

• Plan to design and test by end of 2017
Rural Bridge Rails

- No Anchorage – no rail tension
- Blunt Rail Ends – spearing
- No Length of Need – hazard not protected
- Large Posts – snagging potential
NDOR TL-2 Bridge Rail

- Based on TL-3 MGS Bridge Rail
  - W-beam Guardrail w/ 12” Backup Plates
  - S3x5.7 Posts – increase spacing to 75”
  - Side mounted posts (nothing on top of deck)
- Directly Connects to Adjacent MGS
- Applicable for C.I.P. or Precast Decks
- Post-to-Deck Attachment - TBD
Bridge Rail Systems

• Development of an Optimized MASH TL-4 Concrete Bridge Rail Objective
  ▪ Develop optimized, concrete bridge rail to MASH TL-4 safety performance standards

• Recent Developments
  ▪ Literature Review
    ■ MASH TL-4 barriers, concrete barrier shapes, yield-line analysis

• Future Work
  ▪ Barrier and deck conceptual design
  ▪ Design optimization
  ▪ Full-scale crash testing
    ■ MASH 4-12 with 10000S
Bridge Rail Systems

• Combination Bridge Separation Barrier with Bicycle Railing (IaDOT)

• Objective
  ▪ Develop MASH TL-2, low-height, vertical-face barrier with an attached bicycle railing
  ▪ Determine minimum TL-2 vertical parapet height
  ▪ Combination rail must meet AASHTO LRFD guidance

Figure 1: Iowa DOT Standard Separation Barrier (in service)
Iowa TL-2 Combination Rail

• Current progress
  ▪ Analysis of 24-in. vertical parapet at MASH TL-2
  ▪ ZOI analysis for vertical parapet

• Future work
  ▪ Design of parapet and combination rail
  ▪ Full-scale crash testing
    ▪ MASH test no. 2-11
Bridge Rail Systems

• MASH TL-4 Steel-Tube Bridge Rail and Guardrail Transition (Ohio/Illinois)

• Objective
  ▪ Develop MASH 2016 TL-4, steel-tube bridge railing
    ■ Side mounted
    ■ Limit deck damage
    ■ Considers future roadway overlays
  ▪ Develop MASH TL-3 AGT
    ■ Attachment to existing MASH thrie beam AGTs