

<b>Project Title:</b>	Development of a Thrie-Beam Retrofit for Upgrading Obsolete Bridge Railings
<b>Project Synopsis:</b>	<p>State transportation agencies may need to resort to a thrie-beam retrofit design when an obsolete bridge railing needs to be brought up to acceptable performance levels, and complete bridge railing replacement is impractical or impossible. Furthermore, an ideal retrofit design should allow for the existing bridge railing to remain in place for historical purposes and/or safety reasons.</p>
<b>Project Goal(s):</b>	<ol style="list-style-type: none"> <li>1. Develop a post-mounted, thrie-beam retrofit design meeting the requirements of MASH, TL-3.</li> <li>2. Develop thrie-beam retrofit options acceptable for use with a wide variety of bridge railing designs (e.g., concrete parapet bridge railings, composite (concrete and steel) bridge railings, concrete post-and-beam, metal post-and-beam, etc.).</li> <li>3. Develop guidelines for transitioning from traditional steel beam guardrail (e.g., 31" tall w-beam guardrail with 8" offset blocks) to thrie-beam retrofit.</li> <li>4. Establish minimum requirements for proper use and installation of thrie-beam retrofit options (e.g., minimum bridge deck thickness, minimum brush block thickness, minimum concrete strength requirements, anchoring requirements, minimum offset requirements between thrie-beam retrofit and existing bridge railing, lateral offset requirements between thrie-beam retrofit and face of brush block, minimum length of thrie-beam retrofit, etc.).</li> <li>5. Develop guidelines for different anchoring options (e.g., adhesive-anchored bolts to curb/deck, bolt-through anchors to curb/deck, and anchoring to bridge railing), and provide recommended design impact loads at anchors for the different anchoring options (i.e., propose recommended minimum design loads for anchors for use when it is necessary for designers to make minor modifications to thrie-beam retrofit anchorages). Recommended design impact loads for anchors should be based on actual crash test data, so strain gauges should be installed as part of any crash test to measure the impact load at each anchor.</li> </ol>
<b>Project Background:</b>	<p>Michigan – Michigan currently uses thrie-beam retrofit designs attached to the face of a substandard bridge railing by driving bolts through the substandard bridge railing. However, Michigan is willing to consider adopting other thrie-beam retrofit options.</p> <p>Florida and Oregon – both states currently use thrie-beam retrofit designs where the thrie-beam guardrail is mounted on posts which are secured to an existing curb (brush block) with epoxy/resin bonded anchors.</p>

<p><b>Proposed Work Plan:</b></p>	<p>TTI will design, build and test a new thrie beam retrofit bridge railing consisting of 10-gauge thrie beam guardrail element attached to steel posts that are placed on top of and epoxy anchored into a 9-inch high curb that is on top of a concrete deck. The 9-inch high curb will be cast separately from the concrete deck, and the curb will contain steel reinforcement epoxy anchored into the concrete deck. The posts will likely be on 3' - 1 1/2" centers with wood blockouts.</p> <p>The project will have the following tasks.</p> <ol style="list-style-type: none"> <li>1.) Task 1 - Literature Review – Look at systems that have already been tested.</li> <li>2.) Task 2 – Engineering Design and detailing</li> <li>3.) Task 3 – Construction of full scale test installation</li> <li>4.) Task 4 – Full-scale crash testing – MASH Tests 3-10 &amp; 3-11.</li> </ol>														
<p><b>Deliverables:</b></p>	<ol style="list-style-type: none"> <li>1. A comprehensive report, including design details of the tested thrie-beam retrofit design(s).</li> <li>2. The results of all crash tests performed, including pictures and videos of all crash tests performed.</li> <li>3. Establishing whether the tested design meets the requirements of MASH, TL-3.</li> <li>4. Developing and providing guidelines for transitioning from traditional steel beam guardrail (e.g., 31" tall w-beam guardrail with 8" offset blocks) to thrie-beam retrofit, establish minimum requirements for proper use and installation of thrie-beam retrofit options (e.g., minimum bridge deck thickness, minimum brush block/curb thickness, minimum concrete strength requirements, anchoring requirements, minimum offset requirements between thrie-beam retrofit and existing bridge railing, lateral offset requirements between face of thrie-beam retrofit and face of brush block, minimum length of thrie-beam retrofit, etc.).</li> <li>5. Developing and providing guidelines for different anchoring options (e.g., adhesive-anchored bolts to curb/deck, bolt-through anchors to curb/deck, etc.), and provide recommended design impact loads at anchors for the different anchoring options (i.e., propose recommended minimum design loads for anchors for use when it is necessary for designers to make minor modifications to thrie-beam retrofit anchorages).</li> </ol>														
<p><b>Urgency and Expected Benefit:</b></p>	<p>A thrie-beam retrofit option is beneficial in cases where complete bridge railing replacement is not viable for economical or historical reasons. Therefore, the urgency for a MASH-compliant retrofit option is high for transportation agencies relying on this type of design.</p>														
<p><b>Problem Funding and Research Period:</b></p>	<p>The estimated cost for the project is approximately \$225,000. The breakdown of costs is listed below:</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 80%;">1-Lit Review</td> <td style="text-align: right;">\$5,750</td> </tr> <tr> <td>2 - Engineering Design &amp; Detail</td> <td style="text-align: right;">\$26,300</td> </tr> <tr> <td>3- Construction</td> <td style="text-align: right;">\$110,200</td> </tr> <tr> <td>Test 3-10</td> <td style="text-align: right;">\$37,000</td> </tr> <tr> <td>Test 3-11</td> <td style="text-align: right;">\$44,000</td> </tr> <tr> <td><u>3- Demo</u></td> <td style="text-align: right;"><u>\$2,200</u></td> </tr> <tr> <td><b>Total Estimated Cost - All Tasks</b></td> <td style="text-align: right;"><b>\$225,450</b></td> </tr> </table>	1-Lit Review	\$5,750	2 - Engineering Design & Detail	\$26,300	3- Construction	\$110,200	Test 3-10	\$37,000	Test 3-11	\$44,000	<u>3- Demo</u>	<u>\$2,200</u>	<b>Total Estimated Cost - All Tasks</b>	<b>\$225,450</b>
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**Developer(s) of  
the Problem  
Statement:**

Name: Carlos Torres, Derwood Sheppard, Alex Lim, Alexander Bardow

Email: [torresc@michigan.gov](mailto:torresc@michigan.gov) [Derwood.Sheppard@dot.state.fl.us](mailto:Derwood.Sheppard@dot.state.fl.us)  
[Alex.K.LIM@odot.state.or.us](mailto:Alex.K.LIM@odot.state.or.us) [alexander.bardow@state.ma.us](mailto:alexander.bardow@state.ma.us)

Phone: (517) 335-2852, (850) 414-4334, (503) 986-3402