Background

The Texas Department of Transportation (TxDOT) requires that on roadways exceeding certain annual traffic frequency, bridge columns adjacent to roadways be designed for impacts from heavy trucks, or be shielded with a 54-inch-tall barrier that has a structurally independent foundation. This barrier should meet American Association of State Highway and Transportation Officials Manual for Assessing Safety Hardware (MASH) Test Level 5 (TL-5) testing requirements. Currently, there is no available design for a 54-inch-tall barrier with a structurally independent foundation that meets MASH TL-5 requirements.

What the Researchers Did

In this project, researchers developed structurally independent foundation designs for a 54-inch-tall single-slope concrete barrier (SSCB) that meet the impact performance requirements of MASH TL-5.

Researchers developed seven preliminary foundation design concepts for the SSCB. Of these, TxDOT selected three for further development. The concepts selected were a shallow moment slab, a vertical beam, and a drilled shaft foundation. TTI researchers developed simulation models of the selected preliminary designs and performed vehicle impact simulations to determine the performance of these systems under MASH Test 5-12 impact conditions, which involve impacting the barrier with a 36000V tractor-van trailer vehicle at an impact speed and angle of 50 mi/h and 15°, respectively.

Simulations were used to optimize the foundation sizes, after which researchers developed reinforcement details for the three barrier and foundation systems. The drilled shaft foundation design was determined to be the most critical of the three systems and was selected for crash testing. The Texas A&M Transportation Institute constructed the 54-inch-tall SSCB barrier with the drilled shaft foundation and performed MASH Test 5-12.

What They Found

During the full-scale crash test, the 54-inch-tall SSCB with the drilled shaft foundation contained and redirected the 36000V vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 2.9 inches, and the working width...
was 40.2 inches. The vehicle remained upright during and after the collision event, and the barrier performed acceptably for MASH Test 5-12. Figure 1 shows the barrier and the interaction with the TL-5 test vehicle.

**What This Means**

Using the results of the crash test and the simulation analyses, researchers developed guidance on the distance that should be maintained between the 54-inch-tall SSCB and the bridge columns supporting an overpass. To protect the bridge columns from any impact from the tractor trailer, the bridge columns should be placed at an offset equivalent to the distance the vehicle is expected to reach on the field side as it leans over the barrier during an impact. Table 1 presents this offset distance for the three foundation systems. In the interest of simplifying implementation, a minimum 2-ft offset behind the barrier may be recommended for all three foundation systems.

TxDOT’s Bridge Division can achieve statewide implementation of the 54-inch-tall SSCB and its foundation designs through the development and issuance of new standard detail sheets.

<table>
<thead>
<tr>
<th>Foundation System</th>
<th>Offset behind Barrier (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment Slab</td>
<td>25.15</td>
</tr>
<tr>
<td>Concrete Beam</td>
<td>22.45</td>
</tr>
<tr>
<td>Drilled Shaft</td>
<td>19.45</td>
</tr>
</tbody>
</table>

**Figure 1. MASH Test 5-12 on 54-Inch-Tall SSCB with the Drilled Shaft Foundation.**

This research was performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented here. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product endorsement.