King K. Mak, P.E.
Research Engineer
The Texas A&M University System
Texas Transportation Institute
College Station, Texas 77843-3135

Dear Mr. Mak

In your October 12 letter, you requested the Federal Highway Administration's (FHWA) acceptance of two transition designs. These designs will be used to connect a standard box beam approach guardrail to two Wyoming Department of Transportation bridge railing designs that were accepted for use on the National Highway System in Mr. Seppo Sillan's July 1, 1998 memorandum to Mr. Vincent Schimmoler. Mr. Schimmoler was the FHWA Regional Administrator in Denver at that time. Included with your request were two copies of the September 1999 Texas Transportation Institute report, "NCHRP REPORT 350 TESTING AND EVALUATION OF THE WYOMING TL-3 AND TL-4 BRIDGE RAIL TO BOX BEAM GUARDRAIL TRANSITION DESIGNS," by Mak, Buth, Bligh, and Menges, and videotapes of the crash tests you conducted to verify acceptable impact performance.

Both transition designs use the same components to the extent practical, the only significant differences being the connection details at the bridge railings and adjustments to the mounting heights to match the two different bridge railing designs. These details are shown in Enclosure 1. The ground-mounted post sizes and spacing are the same for both transitions, i.e., five W150 x 13 (W6 x 9) x 1625-mm (till-inches) steel posts with soil plates on 1220-mm (4-foot) centers, one same-size post at 1830 mm (6-feet), followed by standard S75 x 8.5 ( x 5.7) box beam line posts on 1830-mm (h-foot) centers. The lower bridge rail element for both bridge railing designs is continued off the bridge to serve as a rub rail until it is terminated behind the ninth guardrail post off the bridge.

Both of the transition designs were tested to NCHRP Report 350 test level 3 (TL-3). Test 3-20 was successfully run on the transition to the TL-3 bridge railing, which is essentially the same as the transition to the TL-4 bridge railing. We agreed previously that both tests would not be needed. Test 3-21 was run at two locations: the first to check for a snagging potential at the point where the Lower rail is terminated behind post nine, and the second to test the transition to the TL-4 bridge railing itself. Again, we agreed earlier that the transition to the TL-4 bridge railing presented the greater likelihood of snagging and a successful test of this design would eliminate the need to run test 3-21 on the transition to the TL-3 bridge railing. Summary reports of each of the tests run are shown in Enclosure 2.
Based on our review of the information you submitted, we find that the two designs for attaching a standard box beam guardrail to the Wyoming Z-tube, curb-mounted TL-3 and TL-4 bridge railings meet the appropriate crash test evaluation criteria for NCHRP Report 350 test level 3 (TL-3) transitions. They may be used on the National Highway System when such use is requested by a State transportation agency. We understand that neither the bridge railing designs nor the transition designs are proprietary and that plans and specifications for both can be obtained directly from the Wyoming Department of Transportation.

Finally, you stated that minor changes were made to the TL-4 bridge railing design to accommodate the transition design. The most significant changes were the thickness reduction of the upper bridge rail element from 7.9 mm (5/16 inch) to 6.4 mm (5/16 inch) and the cross-section reduction at the ends of both the upper and lower bridge rail elements to match the connection sleeves. We concur with your assessment that these changes are not likely to lessen the performance of the TL-4 bridge railing. Please call Mr. Richard Powers of my staff at (202) 366-1320 if you have any questions or wish to discuss any of the above in more detail.

Sincerely yours,

Dwight A. Home
Director, Office of Highway Safety Infrastructure

2 Enclosures
25 Ø HOLES IN TS152 X 152 X 4.8 RAIL FOR M20 X 200 HS BOLT & NUT W/ ONE HARDENED WASHER & ONE LOCK WASHER PER BOLT

25 Ø HOLES IN TS152 X 51 X 6.4 RAIL FOR M20 X 100 HS BOLT & NUT W/ ONE HARDENED WASHER & ONE LOCK WASHER PER BOLT

SLOTS ARE LOCATED IN THE SLEEVE ONLY, NOT IN RAIL ELEMENTS

CONNECTION SLEEVE

CONNECTION TO TL3 STEEL BRIDGE RAILING
UPPER RAIL PLAN

LOWER RAIL PLAN

ELEVATION

CONNECTION TO TL4 STEEL BRIDGE RAILING
<table>
<thead>
<tr>
<th>General Information</th>
<th>Impact Conditions</th>
<th>Test Article Deflections (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Agency: Texas Transportation Institute</td>
<td>Speed (km/h)</td>
<td>Dynamic: 0.12</td>
</tr>
<tr>
<td>Test No.: 473160-12</td>
<td>Angle (deg)</td>
<td>Permanent: 0.06</td>
</tr>
<tr>
<td>Date: 04113199</td>
<td>Exit Conditions</td>
<td>Vehicle Damage Ex</td>
</tr>
<tr>
<td>Test Article</td>
<td>Speed (km/h)</td>
<td>CDC</td>
</tr>
<tr>
<td>Type: Transition</td>
<td>Angle (deg)</td>
<td>&amp;01RYE9W3</td>
</tr>
<tr>
<td>Name or Manufacturer: Wyoming TL-4 Transition</td>
<td>Exit Velocity Values</td>
<td>Maximum Exterior</td>
</tr>
<tr>
<td>Installation Length (m): 46.8</td>
<td>Impact Velocity (m/s)</td>
<td>Exterior</td>
</tr>
<tr>
<td>Material or Key Elements: TS152x152x4.8 Rail &amp; TS152x51x8.4</td>
<td>x-direction</td>
<td>CDC</td>
</tr>
<tr>
<td>Soil Type and Condition: Rub-Rail on W150x131x1625 Posts</td>
<td>y-direction</td>
<td>01RFQ4</td>
</tr>
<tr>
<td>Test Vehicle</td>
<td>THV (km/h)</td>
<td>Max. Occ. Compartment</td>
</tr>
<tr>
<td>Type: Production</td>
<td>27.8</td>
<td>Deformation (mm)</td>
</tr>
<tr>
<td>Designation: 1993 Chevrolet 2500 pickup truck</td>
<td>Ridedown Accelerations (g's)</td>
<td>Max. Yaw Angle (deg)</td>
</tr>
<tr>
<td>Model: 2000P</td>
<td>x-direction</td>
<td>Max. Pitch Angle (deg)</td>
</tr>
<tr>
<td>Mass (kg): Curb</td>
<td>y-direction</td>
<td>AX</td>
</tr>
<tr>
<td>2059</td>
<td>Max. Roll Angle (deg)</td>
<td>4.4</td>
</tr>
<tr>
<td>Mass (kg): Test Inertia</td>
<td>z-direction</td>
<td>0.05-s Average (g's)</td>
</tr>
<tr>
<td>2000</td>
<td>Deformation during 1.0 s after impact</td>
<td>Max. 0.05-s Average (g's)</td>
</tr>
<tr>
<td>Dummy: No Dummy</td>
<td>0.05-s Average (g's)</td>
<td>Max. Yaw Angle (deg)</td>
</tr>
<tr>
<td>Gross Static</td>
<td>0.05-s Average (g's)</td>
<td>Max. Pitch Angle (deg)</td>
</tr>
<tr>
<td>2000</td>
<td>0.05-s Average (g's)</td>
<td>Max. Roll Angle (deg)</td>
</tr>
</tbody>
</table>

Summary of results for test 473160-12, NCHRP Report 350 test 3-21
General Information
Test Agency: Texas Transportation Institute
Test No.: 473160-7
Date: 07/21/96
Test Article
Type: Transition
Name: Wyoming Transition
Installation Length (m): 46.8
Material or Key Elements: TS152x152x4.8 Rail & TS152x51x6.4
Rub-Rail on S75x8.5x1825 Posts
Soil Type and Condition: Standard Soil, Dry
Test Vehicle
Type: Production
Designation: 2000P
Model: 1993 GMC 2500 pickup truck
Mass (kg): Curb: 2041, Test Inertial: 2000, Dummy: No dummy
Gross Static: 2000

Impact Conditions
Speed (km/h): 100.4
Angle (deg): 25.3
Exit Conditions (km/h): 63.5
Angle (deg): 19.9
Occupant Risk Values
Impact Velocity (m/s)
x-direction: 3.5
y-direction: 4.5
THIV (km/h): 15.6
Ridedown Accelerations (g's)
x-direction: -7
y-direction: -3.5
PHD (g's): 10.2
ASI: 0.050-s
Max. 0.050-s Average (g's)
x-direction: -4.1
y-direction: -5.5
z-direction: 3.0

Test Article Deflections (m)
Dynamic: 1.17
Permanent: 0.87
Vehicle Damage
Exterior
VDS: 01RFQ
CDC: 01FREK3
& 01RYER3
Maximum Exterior
Vehicle Crush (mm): 370
Interior
OCID: FS0004000
Max. Occ. Compartment
Deformation (mm): 25
Post-Impact Behavior
(during 1.0 s after impact)
Max. Yaw Angle (deg): -32
Max. Pitch Angle (deg): 4
Max. Roll Angle (deg): 4

Summary of results for test 473160-7, NCHRP Report 350 test 3-21