TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 0-4564-S
Project 0-4564: Guardrail to Concrete Bridge Rail Transitions
Author: Roger P. Bligh, P.E.

PROJECT SUMMARY REPORT

Performance Evaluation of Guardfence to Bridge Rail Transitions

In December 2001, the Design Division and Bridge Division of the Texas Department of Transportation (TxDOT) released a new standard for an approach guardfence to concrete bridge rail transition that complies with the testing requirements of *NCHRP Report 350* for use on high-speed roadways. Because there are no national transition designs that have been developed and tested for lower-speed conditions, the same transition standard is typically applied to all roadways regardless of speed. However, the new thrie beam transition design represents a significant increase in installation cost and complexity over the previous design. Thus, it may be cost-prohibitive to require use of the new design on all roadways. The purpose of this research was to develop a transition that is suitable for use on lower-speed roadways that is less expensive and complex than the current high-speed design.

A second objective of the project was to evaluate the need for the curb detail that is one of the design elements of the newly adopted thrie beam transition design. The curb requirement increases the cost and complexity of the transition installation and requires

Modified Thrie Beam Transition.

modification of the bridge end drainage, particularly in retrofit and upgrade applications. Elimination of the curb would greatly enhance installation flexibility and reduce installation cost.

What We Did...

Thrie Beam Transition without Curb

Details of a new metal beam guardfence transition are provided on TxDOT Standard Drawing MBGF(TR), which was initially released in December 2001. The design consists of a nested thrie beam rail supported on 7 ft (2.1 m) long steel or wood posts spaced at 18.75 in. (476 mm). A 5.75 in. (146 mm) tall Type II curb runs along the length of the nested thrie beam section.

Because this transition system was initially crash tested with a curb present, the Federal Highway Administration (FHWA) approval of the system for use on federal-aid projects on the National Highway System (NHS) is predicated on the presence of the curb. A full-scale crash test, *NCHRP Report 350* Test 3-21, was performed to determine if the Type II curb detail can be eliminated from the current nested thrie beam transition system without adversely affecting impact performance. This test involves a 4409 lb (2000 kg) pickup truck impacting at the critical impact point (CIP) of the transition section at speed of 62 mi/h (100 km/h) and an angle of 25 degrees. Except for elimination of the curb, the thrie beam transition system was constructed following the details shown on TxDOT Standard Drawing MBGF(TR).

TL-2 Transition prior to Testing.

TL-2 Transition after Test.

TL-2 Transition

The researchers met with TxDOT personnel and discussed the design requirements and constraints associated with the development of a Test Level 2 (TL-2) transition from standard W-beam approach guardfence to a rigid concrete bridge parapet. Emphasis was placed on developing a system that entails low cost and is simple to install and maintain. Further, the project advisory panel instructed the researchers to design the system using standard TxDOT hardware items to the extent possible. It was also desirable for the height of the transition to be 27 in. (686 mm). This would greatly simplify the ability to connect the transition to existing 27 in. (686 mm) tall bridge rails. Although a 27 in. (686 mm) tall transition section was not feasible for high-speed impact conditions, the reduced impact severity associated with the lower TL-2 impact speed makes a 27 in. (686 mm) tall transition a realistic possibility.

Analyses assessed the ability of selected design concepts to meet *NCHRP Report 350* impact performance criteria prior to full-scale crash testing. Computer simulation techniques supported the analysis efforts. Variables that were investigated include post spacing and post size. Use of the simulation code provided more detailed understanding of the influence of these key transition design parameters on dynamic barrier deflection and the severity of wheel snagging on the end of the concrete parapet.

Upon selection of a design by the project advisory panel, a prototype transition installation was constructed to include an appropriate length of bridge parapet, approach guardfence, and a single guardrail terminal. The transition consists of a 12.5 ft (3.8 m) long section of nested, 12-gauge W-beam rail mounted to standard guardfence support posts at a height of 27 in. (686 mm) to the top of the rail. The spacing of the posts in the transition section was reduced from 75 in. to 37.5 in. (1905 mm to 953 mm).

A full-scale crash test, *NCHRP Report 350* Test 2-21, was conducted to evaluate the safety performance of the TL-2 transition. This test involves a 4409 lb (2000 kg) pickup truck impacting at the CIP of the transition section at speed of 44 mi/h (70 km/h) and an angle of 25 degrees.

What We Found...

Thrie Beam Transition without Curb

When subjected to a full-scale crash test, the nested thrie beam transition without curb did not meet the requirements of *NCHRP Report 350*. The vehicle rolled onto its left side as it exited the test site, and occupant compartment deformation was 6.8 in. (172 mm), which is more than the 6.0 in. (150 mm) considered acceptable by FHWA.

TL-2 Transition

The new TL-2 nested W-beam transition met all the requirements of *NCHRP Report 350*. The test vehicle was successfully contained and redirected in a stable manner. Damage to the system after the crash test was relatively minor and required only minimal repair, indicating that the transition should be easy to maintain.

The Researchers Recommend...

Thrie Beam Transition without Curb

Crash testing demonstrated that the nested thrie beam transition does not meet the requirements of *NCHRP Report 350* when the Type II curb is not present and is, therefore, not suitable for implementation. The current metal beam guardfence transition design, detailed on TxDOT Standard Drawing MBGF(TR), should continue to be used on high-speed roadways when warranted.

Further research is needed to determine if other design modifications would enable the transition to meet impact performance requirements without the Type II curb. Possible alternatives include the addition of a lower rubrail or incorporating a blockout to offset the nested thrie beam from the face of the concrete parapet. These alternatives are intended to mitigate the snagging contact between the vehicle and the end of the concrete bridge rail.

TL-2 Transition

A new TL-2 nested W-beam transition was successfully developed and found to meet the impact performance requirements of *NCHRP Report 350*. The transition is suitable for use with W6x9 steel posts, 7 in. (178 mm) diameter round wood posts, and 6 in. x 8 in. (152 mm x 203 mm) rectangular wood posts. The system is entirely comprised of standard hardware components and represents a significant savings in terms of both material and installation cost compared to the high-speed nested thrie beam transition. The 27 in. (686 mm) mounting height greatly simplifies the ability to connect the transition to existing bridge rails. The minor damage sustained by the system during the design crash test also suggests that the transition should be easy to maintain.

Statewide implementation of the new TL-2 nested W-beam transition system has been accomplished through a new standard detail sheet (MBGF(TL2)-03) that was developed by personnel in TxDOT's Design Division. The system is considered suitable for use on roadways with speeds of 45 mi/h (70 km/h) or less.

For More Details . . .

The research is documented in Report 4564-1, *Evaluation of Guardrail to Concrete Bridge Rail Transitions*.

Research Supervisor: Roger P. Bligh, TTI, rbligh@tamu.edu (979) 845-4377

Researchers: Wanda L. Menges, TTI, w-menges@tamu.edu, (979) 845-6157
Rebecca R. Haug, TTI, r-haug@tamu.edu, (979) 845-8971

TxDOT Project Director: Rory Meza, TxDOT, ameza@dot.state.tx.us, (512) 416-2678

To obtain copies of reports, contact Dolores Hott, Texas Transportation Institute, TTI Communications, (979) 845-4853, or e-mail d-hott@tamu.edu. See our online catalog at http://tti.tamu.edu.

TxDOT Implementation Status
March 2004

The purpose of the research was to develop a guardrail to concrete bridge rail transition suitable for use on lower-speed roadways and that was less expensive and complex than the current high-speed design. A low-cost transition was successfully evaluated at a 45 mph impact speed under *NCHRP Report 350* Test Level 2 conditions. The new standard has been implemented by TxDOT.

For more information, contact Bill Knowles, P.E., RTI Research Engineer, at (512) 465-7403 or e-mail wknowle@dot.state.tx.us.

YOUR INVOLVEMENT IS WELCOME!

Disclaimer

This research project was conducted under a cooperative program between the Texas Transportation Institute, the Texas Department of Transportation, and the U.S. Department of Transportation, Federal Highway Administration.