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In cooperation with  
Texas Department of Transportation  
and the FHWA

Summary Report

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## THE BEST OF BOTH: AESTHETICALLY PLEASING SAFETY APPROVED STEEL PIPE BRIDGE RAIL — TEXAS TYPE T421

### PROBLEM STATEMENT

Railings that withstand impact loads from vehicles of ever-increasing size have been developed; however, aesthetic considerations have been overshadowed by safety and structural requirements. Engineers rarely consider the impact of these structures on the landscape, particularly in city or urban areas. On the other hand, architects and developers often propose aesthetically pleasing railings that engineers cannot accept because of the structural or safety inadequacies.

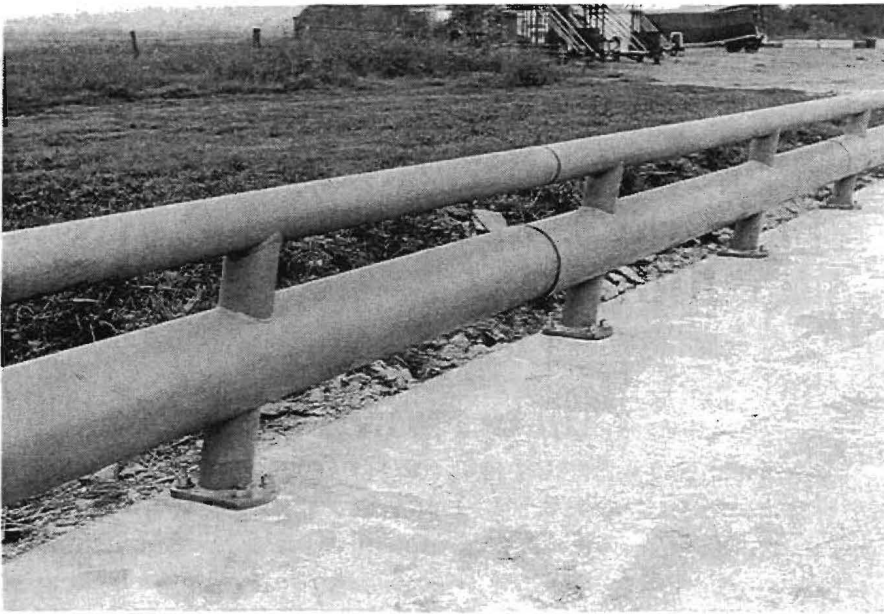
### OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 1185, *Aesthetically Pleasing Steel Pipe Bridge Rail — Texas Type T421*, in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA) to develop one or more aesthetic and structurally sound concrete, steel and aluminum railings, or combination railings. A ten-member study advisory committee composed of six TxDOT bridge/design engineers, two architects, and two TTI safety researchers reviewed design sketches of 22 different bridge rails before selecting a new steel pipe bridge rail — Texas Type T421.

### FINDINGS

The proposed bridge rail is constructed of standard steel pipe in 5 and 10 inch diameters. Originally, it was designed using steel tubing with a wall thickness of 0.25 inch, a yield strength of 42 ksi and a ductility of 23 percent in a 2-inch gage length (ASTM A500 Grade B). Plastic analysis of this design yielded a strength of 66 kips at an effective height of 17.5 inches. When the rail was fabricated for testing, standard steel pipe was used because it was readily available. Either material would perform satisfactorily.

In order to qualify this bridge rail for use on federal-aid highways, it was crash tested and evaluated in accordance with *National Cooperative Highway Research Programs (NCHRP) Report 230*. Two crash tests were required: Test Designation S13 with an 1800-lb passenger car at 60 mph and 20-degree impact angle and Test Designation 10 with a 4,500-lb passenger car at 60 mph and a 25-degree impact angle.



*Texas Type T421 is constructed of standard steel pipe in 5-inch diameters.*

A description of the instrumentation and data analysis is presented in Appendix A of the report.

The tests used a 1980 Honda Civic and a 1982 Oldsmobile 98 both directed at the T421 bridge rail with a reverse tow and guidance system.

## CONCLUSIONS

The new aesthetic bridge rail T421 performed impressively when crash tested in accordance with NCHRP 230 Test 10 and Test S13. None of the pipe

yielded or incurred any collapse. The bridge slab at one post was cracked moderately. Therefore, repairs of the rail itself would consist of cleaning and/or repainting after an accident.

In both tests the bridge rail contained and redirected the test vehicle. There were no detached elements or debris that could present undue hazard to other traffic. The vehicle remained upright and relatively stable during collision. The occupant/compartment impact velocities and 10-ms occupant ridedown accelerations were within normally accepted limits. The ve-

hicle trajectory at a loss of contact indicates no intrusion into adjacent traffic lanes (exit angles of 5 degrees and 7.6 degrees).

Punching shear cracks which develop in the bridge deck are typical of crash tests on steel beam and post bridge rails. These occurred only from the 4,500-lb Oldsmobile impacting at 62.4 mph and 26.6 degrees. This was a severe impact that most bridge rail installations rarely experience.

Although the aesthetically pleasing T421 meets structural and safety requirements, as of May 1990, no field installations have been performed.

*—Prepared by Casey Bunch, Research Associate, Texas Transportation Institute.*

The information described in this summary is detailed in TTI Research Report 1185-2, "Aesthetically Pleasing Steel Pipe Bridge Rail — Texas Type T421," T.J. Hirsch, C.E. Buth, Wanda Campise, and D. Kaderka, May 1990. This summary does not necessarily reflect the official views of TxDOT or the FHWA.

