National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: November 19, 2009

In reply refer to: H-09-25 and -26

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The National Transportation Safety Board (NTSB) is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The NTSB is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

These recommendations address the need for criteria for the selection of appropriate bridge railing designs. The recommendations are derived from the NTSB's investigation of the August 8, 2008, motorcoach accident that occurred in Sherman, Texas, and are consistent with the evidence we found and the analysis we performed.[1] As a result of this investigation, the NTSB issued 12 safety recommendations, 2 of which are addressed to the American Association of State Highway and Transportation Officials (AASHTO). Information supporting these recommendations is discussed below. The NTSB would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

About 12:45 a.m., central daylight time, on Friday, August 8, 2008, a 2002 56-passenger Motor Coach Industries, Inc., motorcoach, operated by Iguala BusMex, Inc., was northbound on U.S. Highway 75 (US-75) when it was involved in a single-vehicle, multiple-fatality accident in Sherman, Texas. The chartered motorcoach had departed the Vietnamese Martyrs Catholic Church in Houston, Texas, at approximately 8:30 p.m. on August 7, 2008, with a driver and 55 passengers onboard, en route to the Marian Days Festival in Carthage, Missouri. When the

[1] See *Motorcoach Run-Off-the-Bridge and Rollover, Sherman, Texas, August 8, 2008*, Highway Accident Report NTSB/HAR-09/02 (Washington, DC: National Transportation Safety Board, 2009), which is available on the NTSB website at http://www.ntsb.gov/publictn/2009/HAR0902.pdf.

accident occurred, the motorcoach had completed about 309 miles of the approximately 600-mile-long trip.

Before the crash, the motorcoach was traveling in the right lane of the four-lane divided highway. As the motorcoach approached the Post Oak Creek bridge at a speed of about 68 mph, its right steer axle tire failed. The motorcoach departed the roadway on an angle of about 4 degrees to the right, overrode a 7-inch-high, 18-inch-wide concrete curb, and struck the metal bridge railing. After riding against the bridge railing for about 120 feet and displacing approximately 136 feet of railing, the motorcoach went through the bridge railing and off the bridge. It fell about 8 feet and slid approximately 24 feet on its right side before coming to rest on the inclined earthen bridge abutment adjacent to Post Oak Creek. As a result of the accident, 17 motorcoach passengers died; 12 passengers were found to be dead at the crash site, and 5 others later died at area hospitals. In addition, the 52-year-old driver received serious injuries, and 38 passengers received minor-to-serious injuries.

The National Transportation Safety Board determined that the probable cause of this accident was the failure of the right steer axle tire, due to an extended period of low-pressure operation, which resulted in sidewall, belting, and body ply separation within the tire, leading to loss of vehicle control. Contributing to the severity of the accident was the failure of the bridge railing to redirect the motorcoach and prevent it from departing the bridge. The lack of an adequate occupant protection system contributed to the severity of the passenger injuries.

Among the safety issues the NTSB identified during the investigation was the failure of the bridge railing and the need for criteria for the selection of appropriate bridge railing designs. The bridge railing on US-75 at the Post Oak Creek bridge failed to keep the motorcoach on the roadway, allowing it to penetrate the railing completely and to fall 8 feet to the earthen bridge abutment below, where it slid approximately 24 feet on its right side before coming to a stop. Additionally, the 7-inch-high, 18-inch-wide concrete curb above the bridge deck allowed the motorcoach to ramp upward before it struck the railing. A curb should not be used in front of a bridge railing, because it may result in a dynamic jump by the vehicle before it strikes the barrier.[2] The failure of the bridge railing to keep the motorcoach on the roadway contributed to the severity of the accident. Although the Post Oak Creek bridge railing appears to have in the past kept striking passenger cars on the bridge, it has twice failed to retain large, heavy vehicles. The NTSB concluded that a higher performance bridge railing at the accident location might have prevented the motorcoach's departure from the bridge.

Bridge Railing Design Guidelines

The design of bridge railings is summarized in the AASHTO *Roadside Design Guide*. More detailed information about the engineering performance and structural requirements for bridge railings is contained in a variety of supporting reference documents, including AASHTO's

[2] *Highway Design and Operational Practices Related to Highway Safety* (Washington, DC: American Association of State Highway and Transportation Officials, 1967), p. 30.

Standard Specifications for Highway Bridges,[3] the *Load and Resistance Factor Design (LRFD) Bridge Design Specifications,*[4] and the *Manual for Assessing Safety Hardware* (MASH).[5]

The safety performance of a bridge railing is evaluated through crash testing. Since 1986, the Federal Highway Administration (FHWA) has required that bridge railings used on Federal-aid projects meet full-scale crash-test criteria. A 1997 FHWA policy memorandum stated that all new or replacement safety features on the National Highway System (NHS) should be in accordance with National Cooperative Highway Research Program (NCHRP) Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*, with the minimum acceptable bridge railing being Test Level Three (as defined in NCHRP Report 350), unless supported by a rational selection procedure. The FHWA also stated, however, that it does not intend the requirement to result in the replacement or upgrading of existing installed features, beyond the course of normal improvements.

The road design of US-75 at the Post Oak Creek bridge, including the bridge railing, was in compliance with the design standards for a principal urban artery at the time of the bridge's construction in 1958. The bridge railing at the accident site was a Type II[6] railing designed in accordance with the 1953 American Association of State Highway Officials *Bridge Specifications Manual*. According to the Texas Department of Transportation (TxDOT), the bridge railing design used at the accident site had never been crash-tested; as such, when the accident occurred, the railing did not meet current NHS standards.[7] Approximately one-quarter of the bridges in the NHS have been superseded by structural or test requirements associated with present highway design standards. If the current bridge railing standards were applied to all bridges in the United States (not just those in the NHS), approximately one-half would not meet current design standards.[8]

With over 100,000 bridges in the NHS and nearly 600,000 bridges in the United States, it would be impractical to update them as frequently as design standards improve. Design standards, when they are revised, generally apply to new construction projects and, when practical, to bridge rehabilitation and upgrade projects. Because the accident bridge railing had not undergone a qualifying bridge resurfacing, restoration, or rehabilitation project, it was not required to meet current design standards. Older bridge decks and structures that would not

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[3] *Standard Specifications for Highway Bridges*, 17th edition (Washington, DC: American Association of State Highway and Transportation Officials, September 1, 2002).

[4] The 2007 *LRFD Bridge Design Specifications* replaced the 1989 *Guide Specifications for Bridge Railings*, which relies on three levels of bridge railing performance (PL-1, PL-2, and PL-3).

[5] The 2009 MASH is intended to replace National Cooperative Highway Research Program Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*.

[6] "Type II" is an identifying name, not a category, and use of the term does not mean that the design met NCHRP Report 350 Test Level Two design requirements.

[7] The 2006 *Roadside Design Guide* states that bridge railing designs predating 1964 typically are considered substandard in that they have not been crash-tested in accordance with either NCHRP Report 230, *Recommended Procedures for the Safety Performance Evaluation of Highway Safety Appurtenances*, or NCHRP Report 350 (section 7.7.1, pp. 7–8).

[8] FHWA data from December 31, 2007, showed that the NHS contained 116,144 bridges; of these, 29,579 had bridge railings that did not meet current standards. The total number of bridges on NHS and non-NHS roads was 599,765; of these, 287,469 did not meet current bridge railing standards.

support larger, heavier barriers often have bridge railings with designs based on earlier specifications. Consequently, upgrade projects are postponed until a larger bridge rehabilitation project, such as lane widening and deck replacement, can be planned and funded. If a bridge meets the warrants for higher performance railings, as determined by the FHWA and AASHTO, designers integrate the new designs into rehabilitation or upgrade projects; if the upgraded railings cannot be integrated into a proposed highway improvement project, the FHWA may grant the bridge owner an exception.

Warrants

Bridge owners, usually state departments of transportation, are responsible for determining when bridge railing improvements are needed and what performance level is appropriate for the given location. The various guidance documents available concerning the design and construction of bridge railings, including the AASHTO *Roadside Design Guide* and the *LRFD Bridge Design Specifications*, indicate that the owner should develop the appropriate test level or warrant for the site in question.

TxDOT, the owner of the Post Oak Creek bridge, has developed guidance for retrofit and rehabilitation bridge projects, but it has no selection criteria or warrants for the installation of high-performance barriers, including bridge railings. When NTSB investigators asked other state departments of transportation what guidance they use for selecting a barrier system for a specific site, many replied that they use the *LRFD Bridge Design Specifications*; however, that document contains only general guidance and directs state agencies to develop objective guidelines for bridge railing selection.

Recent research activities as part of NCHRP Report 638, *Guidelines for Guardrail Implementation*,[9] have resulted in the development of warrants indicating when some higher performance roadside safety hardware should be used, but bridge railings were not addressed in these activities. The 1989 *Guide Specifications for Bridge Railings* contained criteria for the selection of an appropriate bridge railing design for a specific project location, but their use is not mandatory. Currently, no mandatory warrants indicate when a higher performance bridge railing[10] should be used.

The 2007 *LRFD Bridge Design Specifications* and the 2006 *Roadside Design Guide* advise bridge owners to develop their own bridge railing warrants. Available bridge railing guidance focuses on the performance test level of railing designs, offering only a list of considerations to guide highway engineers in selection of appropriate designs based on location. The NTSB concluded that bridge owners lack warrants to guide them in making high-performance bridge railing selections for specific project applications.

The NTSB recognizes that it may be necessary to conduct research and crash tests to support establishing warrants for higher performance bridge barriers appropriate for motorcoach traffic. For example, experimental tests conducted in 1978–1981 at the Texas Transportation

[9] This research was conducted by the University of Nebraska for the Transportation Research Board Research Committee.

[10] Higher performance bridge railings would be those that conform to Test Level Four, Five, or Six from NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*.

Institute at Texas A&M University showed that a Test Level Three (Texas Traffic-202) bridge railing modified with the addition of an aluminum rail to a height of 42 inches was able to redirect 32,000-pound motorcoaches operating at speeds up to 60 mph and encroachment angles up to 15 degrees. However, motorcoaches of that period were smaller and lighter than current fleet vehicles.[11]

As a result of the investigation, the NTSB makes the following recommendations to the American Association of State Highway and Transportation Officials:

> Work with the Federal Highway Administration to establish performance and selection guidelines for bridge owners to use to develop objective warrants for high-performance Test Level Four, Five, and Six bridge railings applicable to new construction and rehabilitation projects where railing replacement is determined to be appropriate, and include the guidelines in the *Load and Resistance Factor Design (LRFD) Bridge Design Specifications*. (H-09-25)

> Revise section 13 of the *Load and Resistance Factor Design (LRFD) Bridge Design Specifications* to state that bridge owners shall develop objective warrants for the selection and use of high-performance Test Level Four, Five, and Six bridge railings applicable to new construction and rehabilitation projects where railing replacement is determined to be appropriate. (H-09-26)

The NTSB also issued safety recommendations to the Federal Highway Administration, the Federal Motor Carrier Safety Administration (FMCSA), the National Highway Traffic Safety Administration (NHTSA), the American Association of Motor Vehicle Administrators, and Motor Coach Industries, Inc. The NTSB also reiterated previous recommendations to the FMCSA and NHTSA.

In response to the recommendations in this letter, please refer to Safety Recommendations H-09-25 and -26. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our Tumbleweed secure mailbox procedures. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Chairman HERSMAN, Vice Chairman HART, and Member SUMWALT concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman

[11] The Sherman motorcoach had a 54,000-pound gross vehicle weight rating.