SUMMARY REPORT 230-2(S)

ANALYTICAL EVALUATION OF TEXAS BRIDGE RAILS TO CONTAIN BUSES AND TRUCKS

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Analytical Evaluation of Texas Bridge Rails to Contain Buses and Trucks

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The recent multiple fatality anhydrous ammonia truck-bridge rail accident in Houston, Texas, and school bus-bridge rail accident near Martinez, California, emphasize the need for a bridge rail to contain heavy trucks and buses. Present bridge rails are only designed to restrain and redirect passenger cars up to 4500 lb (2041 kg) in weight traveling 60 mph (97 kph) and impacting the rail at a 25° angle. The current bridge rails must be at least 27 in. (69 cm) high and be able to resist a static load of 10,000 lb (4536 kg) without exceeding a specified allowable working stress based on an elastic analysis.

Bridge rails designed in accordance with the present criteria have in general performed well in restraining passenger cars. Recent truck and Concrete Median Barrier (CMB) crash tests have indicated that some of our traffic rails designed by the present criteria have considerable reserve strength and are capable of redirecting heavy buses and trucks.

The objective of the report summarized in these pages is to present an analytical evaluation of the capabilities of six standard Texas bridge rails to contain automobiles, buses and trucks. This evaluation consisted of an analysis of the strength of the bridge rails to determine if they were strong enough to resist the impact forces. In addition, an analysis was made to determine if they are high enough to prevent high center-of-gravity buses and trucks from rolling over the rails. See Figure 1.

This analytical evaluation considered four sizes or types of vehicles as follows:

1. passenger cars up to 4500 lb (2041 kg) with a center of gravity about 20 to 24 in. (51 to 61 cm) above the road;

2. vans, recreational vehicles, and school buses up to 20,000 lb (9702 kg) with a center of gravity of from 50 to 60 in. (127 to 153 cm);

3. large intercity buses up to 40,000 lb (18,144 kg) with a center of gravity of from 52 to 64 in. (132 to 163 cm); and

4. large tractor-trailers up to 72,000 lb (32,659 kg) with a center of gravity from 45 to 78 in. (114 to 198 cm).

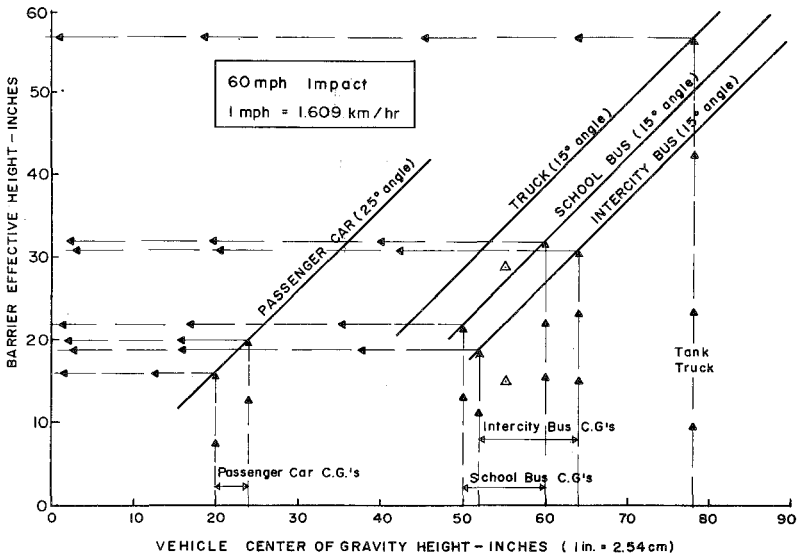

Figure 1. Comparison of required effective height to vehicle center of gravity height for four selected vehicles (large passenger car, school bus, intercity bus, and HS20-44 truck).

All impact forces were based on a 60 mph (97 kph) impact at 15 degrees for the heavy buses and trucks and 25 degrees for the passenger car. See Figure 2.

One metal rail, the Texas T101 steel rail, three concrete parapet rails (Texas T201, T202, and T5), and two combination concrete parapet and metal rails (Texas T4 steel and C4 steel) were evaluated. See Figure 3. Since concrete bridge decks in Texas vary in thickness from 6.75 in. (17.1 cm) to 8.75 in. (22.2 cm) and in amount of reinforcement, the deck was not considered at this time to limit the capacity of the bridge rail.

From this analysis it appears that the following conclusions can be drawn.

1. All six rails (T101, T201, T202, T5, T4, and C4) can restrain and redirect 4500 lb (2041 kg) passenger cars at 60 mph (97 kph) and 25-degree angle.

2. The combination metal rail and concrete parapet C4 and concrete parapet T5 bridge rails should restrain and redirect a school bus at 60 mph (97 kph) and 15 degrees. The weaker and lower combination T4 rail and the T101 metal rail are also probably capable of restraining and redirecting a school bus.

3. The combination C4 and concrete parapet T5 bridge rails

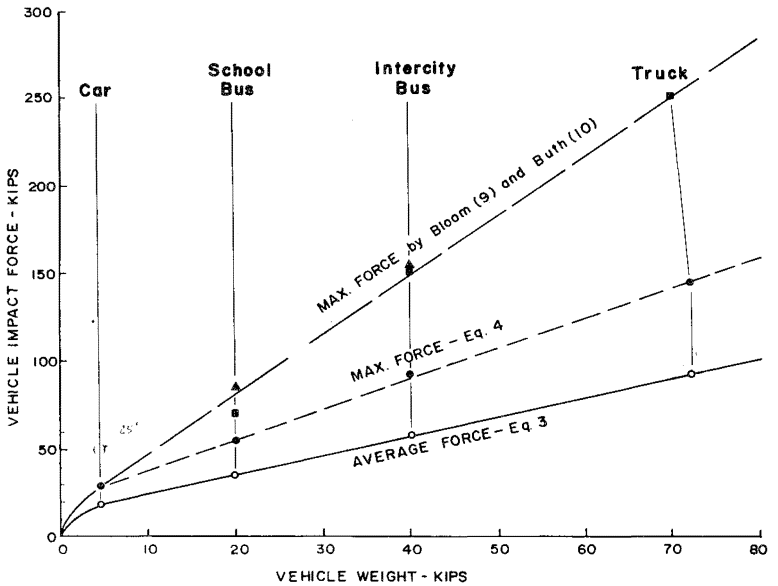

Figure 2. Summary of rigid traffic rail impact forces at 60 mph (96.5 km/hr) and 15-degree angle.

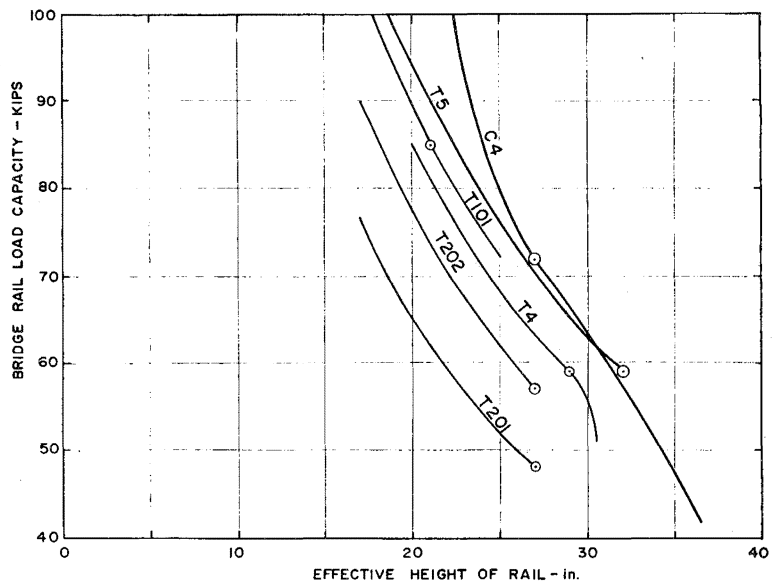

Figure 3. Summary of strength and effective height evaluation of Texas bridge rails.

have a chance of redirecting a large intercity bus at 60 mph (97 kph) and 15 degrees.

4. None of the six rails evaluated appear to have a chance of redirecting a loaded, high center of gravity, HS20-44 tractor-trailer at 60 mph (97 kph) and 15 degrees.

All of these conclusions should be confirmed by full-scale crash tests since they are based on relatively simple theory applied to a very complex problem.

The published version of this report may be obtained by addressing your request as follows:

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