RESEARCH NOTES
THE ROADSIDE SAFETY RESEARCH GROUP
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Caltrans

Development and Crash Testing of a Bridge Rail Transition Barrier

***RESULTS:* Three bridge rail transition designs were developed and crash tested in an effort to meet National Highway Safety Research Program (NCHRP) Report 350 test level 4. Designs 1 and 2 failed due to excessive floorboard deformation to test vehicle and excessive deflection, respectively. Design 3 is recommended for operational use as a test level 4 transition for concrete bridge rails.**

Why We Pursued This Research

A study administered by the Federal Highway Administration (FHWA) determined that existing transition designs failed to meet National Highway Safety Research Program Report (NCHRP) Report 350 TL–4 criteria. Caltrans then initiated a project to develop a bridge rail transition that would meet NCHRP 350 criteria. The objective of this project was to develop and crash test a bridge rail transition that will successfully contain 820 to 8000kg vehicles impacting between 80 and 100 km/hr and at angles of 15° to 25°.

Figure 1 – Transition Design 3

What We Did

The design of the transition underwent three iterations. The primary objectives for the design of each transition were: 1) Gradually increase the stiffness of the transition between the upstream W-beam guardrail and the concrete bridge rail, 2) Minimize pocketing potential for the 2000 kg pickup, and 3) Minimize the snagging potential for both the pickup and the small vehicle.

A total of five vehicles were used during development, all of which complied with NCHRP Report 350. All vehicles were in good condition, free of major damage, and were not missing structural parts. The pickups and 8000 kg truck were self-powered, and a speed control device limited acceleration once the impact speed was reached. Steering was accomplished by means of a guidance rail anchored to the ground. A short distance before the point of impact, each vehicle was released from the guidance rail. Remote braking was possible at any time during the test by means of a tether line for the pickups, and by radio control for the 8000 kg truck.

In order to improve control and safety of test vehicles, additional modifications were implemented. The first modification was substituting a safety fuel tank for the stock fuel tank. Also, gaseous carbon dioxide was added to the stock fuel tank in order to purge the gas vapors and eliminate oxygen.

Figure 2 – Safety Fuel Tank in Cargo Area of Truck

Other equipment added to the test vehicles included: one pair of 12 V, wet cell, motorcycle batteries to run the additional equipment, an accelerator switch to actuate the pneumatic ram attached to the pedal, an ignition cut-out

module to regulate the speed of the vehicle, a microswitch to control the ignition circuit, and a 4800-kPa carbon dioxide system to control brake and gas pedals, as needed.

With the use of accelerometers and integration, we were able to determine the acceleration, velocity, and distance vs. time of the test vehicles.

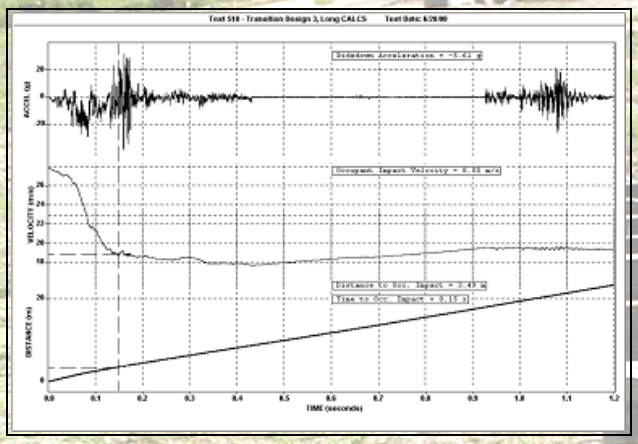

Figure 3 – Longitudinal Acceleration, Velocity, and Distance vs. Time for Test 518

What Can Be Concluded

The reactions during the testing of Transition Design 1 and 2 helped the designers to understand the design flaws. Transition 1 was a good starting point, but failed due to rail pocketing. Transition Design 2 solved the pocketing problem of the first design, but failed due to excessive rail deflection causing the test vehicle to roll over. Transition Design 3 was a success. The vehicle was smoothly redirected with no tendency toward pocketing of the rail, and vehicle damage was in the acceptable range for NCHRP Report 350 criteria.

Figure 4 – Transition Design 2 Test Vehicle Post-Impact

Figure 5 – Transition Design 3 Test Vehicle Post-Impact

The Researchers Recommend

NCHRP Report 350 stipulates that crash test performance is assessed according to three evaluation factors: 1) Structural Adequacy, 2) Occupant Risk, and 3) Vehicle Trajectory. Transition Design 3 rated acceptable in all these categories. For Structural Adequacy, there was some movement of the rail, and minor amounts of scraping and spalling of the barrier. For Occupant Risk, there were no signs of snagging or pocketing of the rail, as well as no sign of spalled concrete penetrating the occupant compartment of the vehicles. Finally Vehicle Trajectory, the test vehicle remained relatively straight after impact. Therefore, Transition Design 3 is recommended as an NCHRP Report 350 Test Level 4 transition for concrete bridge rails.

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