

Investigation of the Crashworthiness of Barrier Mounted Hardware: Barrier Mounted Sign and Signpost

RESULTS: A 46m (150ft) section of Caltrans Type 60 concrete median barrier (910 mm (36") high) had a HOV sign and 101.6mm (4in) O.D. signpost mounted onto it for the purpose of investigating the effect the signpost has on a ¾-ton pick-up truck impacting the barrier. The parameters and conditions used for this test were in compliance with NCHRP Report 350. The test involved a 1993 Chevy Cheyenne pick-up truck impacting the signpost mounted onto the barrier at 25.5° and a velocity of 99.1km/h (61.6mph). The barrier redirected the vehicle, but the impact with the barrier created a high risk to its occupants and the surrounding area (flying debris).

Why We Pursued This Research

All concrete barriers must be tested using the criteria listed in the National Cooperative Highway Research Program (NCHRP) Report 350 before being installed on California roadways. Over the years, various types of signs, fences, and associated mounting hardware have been placed on top of concrete barriers. Recent research has indicated that such items should not be placed within a "zone of intrusion". This zone is defined as the area behind the barrier face which an impacting vehicle can reach due to crush and/or vehicle leaning. Caltrans designers have already placed many types of hardware within this zone, and continue to do so because the selection guidelines are based on sign warrants only, with minimal guidance regarding crash-worthiness. As a result, many of the configurations being specified have not been crash tested to ensure they meet NCHRP Report 350 Criteria. The concern is that these types of hardware will become a snagging hazard or a danger to opposing traffic.

What We Did

The test was designated Test SS641 and was held at the Caltrans Dynamic Testing Facility in West Sacramento on a preexisting 46m (150ft) section of Type 60 Concrete Barrier. The design of the barrier conformed to Caltrans 1999 Standard Plans A76A and A76B which has a height of 910 mm (36 inches). The signpost is a typical, but untested, sign support system used in several California districts. Two 914mm (3ft) by 1524mm (5ft) aluminum signs were mounted back to back on a signpost that had a 102mm (4.0in) outside diameter. The signs were mounted perpendicular to the barrier. The mass of the test vehicle, a 1993 Chevy Cheyenne, was 1952.6kg which is 2.4kg below the minimum weight given in Report 350. However, the impact severity at nominal speed and angle was 134.8kJ, which is within the tolerance for a NCHRP Report 350 TL-3 test.

Due to an instrumentation malfunction, there is no electronic data of the impact. However, since the primary purpose of this test was to evaluate the potential hood snagging of the impacting vehicle on the barrier mounted signpost, the loss of the electronic data was not critical.

There was significant damage to the driver's side front quarter of the vehicle. The hood was pushed back and penetrated the windshield 250mm (9.8in), measured from the center of the windshield to the resting place of the hood. The driver's side front wheel was pushed backward 340mm (13.4in) from its initial location. There was a jagged slash down the entire driver's side of the truck caused by the two bolts that hold the signpost assembly to the barrier. The front grill of the truck broke off and traveled over the barrier into the opposing traffic side of the barrier. The top of the driver's side door deformed outward from the vehicle's frame. Inspection of the occupant compartment revealed that the dashboard



Figure 1 – Downstream View of the Barrier and Vehicle

was pushed back 202mm (8.0in). The driver side had a peak loss of 98mm (4.0in) measured between the bottom of the dashboard and the floorboard.



Figure 2 – Vehicle Impacting Barrier and Signpost

What Can Be Concluded

Based on the performance of the test it can be concluded that even though the barrier and sign post received minimal damage, a 2000kg pick-up truck impacting at 25 degrees and freeway speeds can result in unacceptable occupant risk and increased danger to on-coming traffic. The effect that the barrier and signpost assembly had on the pick-up truck was unacceptable. The hood penetrating the windshield provides a danger to the occupants of the vehicle. The front grill braking off and falling into opposing traffic lanes could create a situation that could lead to further collisions. The deformation of the occupant compartment could cause the occupants to sustain significant injuries. Under the criteria given in NCHRP Report 350, this test was a failure.



Figure 3 – Vehicle After Test

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. For Structural Adequacy, the barrier successfully redirected the vehicle with only minor cosmetic damage. Also, the signpost remained on the barrier and would require only minor maintenance. For Occupant Risk, Test SS641 failed due to the windshield being penetrated, hazardous debris, and high occupant compartment deformation. The vehicle's exit angle and rate of return into traffic were within the guidelines given for Vehicle Trajectory. Since this test failed, it is recommended that Caltrans consider not using this method of mounting signs on median barriers and develop safer ways to display signage.



Figure 4 – Impact Area After Test

Implementation

The Offices of Structures Design and Traffic Operations will be responsible to collaborate and develop policies for mounting sign and signpost structures on median barriers based on the information provided in this report

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