Note: This memo has been canceled. See the NCHRP Report 537 – Recommended Guidelines for Curb and Curb-Barrier Installations.

Memorandum

U.S. Department of Transportation
Federal Highway Administration

Subject: INFORMATION: Performance of Guardrail/Curb Combinations

Date: FEB 28 1992

From: Chief, Federal-Aid and Design Division

Reply to: AWP of

To: Regional Federal Highway Administrators Federal Lands Highway Program Administrator

For many years, most design engineers assumed that a curb in front of a W-beam guardrail was acceptable if the curb was no closer to traffic than the face of the W-beam. However, it has been shown that such curbs can still degrade barrier performance. This happens because the semi-rigid guardrail will deflect under relatively severe impact conditions, thereby allowing wheel contact with the curb and possible vaulting over or onto the barrier.

A series of tests were conducted recently to quantify barrier performance when the guardrail was behind a curb. (Note: Summary sheets for each of the following tests are attached for your information. Each sheet includes a sketch of the curb with dimensions and its location in relation to the guardrail.)

In Test Number 1862-1-88, a 2,450 kg (5,400-pound) pickup truck vaulted over a G4(IS) W-beam on strong post guardrail after an impact at 100 km/h (60 mi/h), and 20 degrees. The guardrail had a 20 cm (8-inch) high concrete curb (AASHTO Type I) installed behind the face of the W-beam rail. In Test Number 1862-5-89, a 2040 kg (4,500-pound) sedan impacted at 100 km/h (60 mi/h), and 25 degrees, and vaulted over a G4(IS) guardrail with a 15 cm (6-inch) high asphalt dike. In both tests, the guardrail deflected enough for the wheels to impact the curb. The resulting compression of the suspension systems produced upward forces on the vehicles that caused them to vault over the guardrail.

In Test Number 1862-4-89, the same guardrail/asphalt dike combination smoothly redirected an 820 kg (1,800-pound) car that impacted at 100 km/h (60 mi/h), and 20 degrees. In this test, the guardrail did not deflect enough for the wheels to contact the curb.

In Test Number 1862-12-90, the G4(IS) guardrail had a 10 cm (4-inch) high concrete curb (AASHTO Type H). When a 2040 kg (4,500-pound) sedan impacted this combination at 100 km/h (60 mi/h), and 25 degrees, the car became airborne but did not vault the rail. This test showed that reducing the curb height to 10 cm (4-inches) or less is one solution to the vaulting problem. However, stiffening the guardrail to reduce its deflection, as noted below, may be a better approach because the vehicles in these tests were redirected in a more stable manner.
In Test Number 1862-13-91, a G4(1S) guardrail with a 15 cm (6-inch) asphalt dike was stiffened by bolting an extra W-beam to the back of the steel posts. This retrofitted guardrail successfully redirected a 2040 kg (4,500-pound) sedan impacting at 100 km/h (60 mi/h), and 25 degrees. In Test Number 1862-14-91, a G4(1S) guardrail with a 15 cm (6-inch) asphalt dike was modified by adding a C6x8.2 hot-rolled channel rub rail. This design also worked well, smoothly redirecting a 2040 kg (4,500-pound) sedan impacting at 100 km/h (60 mi/h), and 25 degrees.

Except for specific guardrail-to-bridgerail transition designs that include a curb and have been successfully crash-tested, the continued use of any guardrail/curb combinations should be discouraged at locations where high-speed, high-angle impacts are likely. Where there are no feasible alternatives to guardrail/curb combinations, the use of a low curb no higher than 10 cm (4-inches) and/or one of the modifications to the W-beam guardrail described above will usually prove satisfactory. On lower speed facilities, a vaulting potential still exists, but since the risk of such an occurrence is lessened, a design change may not be cost-effective. Such locations are best analyzed on a case-by-case basis, taking actual or anticipated operating speeds into account and considering the consequences of vehicular penetration.

L. A. Staron

Attachments
Figure 4. Test summary, test FM-2-1-88.
Figure 4. Test summary, Test 1862-5-89.
Figure 4. Test summary, test 1862-4-89.
Figure 4. Test summary, test: 1862-12-90.
13. Vehicle Analysis:

VHCRP 210:

Longitudinal:
- Delta-V at 2 ft: -24.4 ft/s 30/40 ft/s
- Ridedown Acceleration: -9.3 g's 15/20 g's
  Driver:
  Delta-V at 3.17 ft (actual): -35.6 ft/s 30/40 ft/s
  Ridedown Acceleration: -9.3 g's 15/20 g's
  Passenger:
  Delta-V at 1.83 ft (actual): -24.5 ft/s 30/40 ft/s
  Ridedown Acceleration: -9.3 g's 15/20 g's

5. Impact Location:
- Planted: 50.3 mph
- Actual: 61.3 mph
- Angle: 26° Midspan, posts 11 and 12
- Double Post 11 and 12

9. Ridedown Moments: 5045 lb-sec

Figure 1. Test summary, test 1862-13-91.
Figure 4. Test summary, test 1862-14-91.