

# Vehicle Crash Tests of Concrete Median Barrier Retrofitted with Slipformed Concrete Glare Screen

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Two vehicle crash tests were performed on a retrofit concrete glare screen (CGS) slipformed on top of an existing concrete safety shape barrier 0.81 m (32 in.) high. The CGS is intended as a replacement for the current standard expanded metal mesh glare screen. This CGS is 0.51 m (20 in.) high, 0.15 m (6 in.) thick at the base, and tapers slightly to 0.13 m (5 in.) thick at the top. Reinforcing consists of two longitudinal #4 bars tied to vertical #5 hoops (inverted U-shaped stirrups). At the base of the glare screen is a 19-mm (3/4-in.) chamfer to match that at the top of the concrete barrier. The two test vehicles included a pickup truck ballasted to 2447 kg (5,390 lb) traveling 89 km/hr (55.3 mph) and impacting at 20 degrees; and a station wagon ballasted to 1979 kg (4,360 lb), traveling 90 km/hr (56.2 mph) and impacting at 25 degrees. Both tests showed that a CGS can successfully withstand the impact of both a pickup truck and a heavy passenger car, and satisfy the requirements for structural adequacy, occupant risk and vehicle trajectory in *NCHRP Report 230* under these impact conditions. Maintenance costs for the CGS should be less than those for the metal mesh glare screen.

Since the early 1970s, headlight glare from opposing traffic has been of concern to traffic engineers. The standard material now used to screen glare in California is an expanded metal mesh mounted on top of concrete median barriers between opposing streams of traffic (1). This glare screen is installed only on barriers in medians that are less than 6.1 m (20 ft) in width, to shield driver's eyes from the headlight glare of oncoming vehicles (2).

In the mid 1980s the Division of Highway Maintenance concluded that the amount of time spent maintaining expanded metal mesh was excessive and exposed maintenance personnel and the traveling public to potential traffic safety hazards. Glare screens in the narrow medians appeared to be damaged easily by repeated wind gusts from passing trucks, wind, vandalism, roadway debris, and vehicle impacts. A value engineering team from the California Department of Transportation (Caltrans) recommended that the expanded mesh glare screen be replaced with a reinforced concrete glare screen (CGS) because of its greater strength and durability, its excellent glare protection, its low maintenance, and its added barrier protection. A CGS design needed to be crash tested to verify that it would not increase any safety concerns in an automobile crash.

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## SCOPE OF RESEARCH

A retrofit CGS slipformed on top of an existing safety shape concrete median barrier (CMB) was designed and crash-tested to be qualified for use on California state highways. This design, when adopted and implemented, would replace one using expanded metal mesh glare screen mounted on top of the CMB.

## TEST BARRIER DESIGN AND CONSTRUCTION

The type 50R barrier that was crash-tested was a standard Caltrans slipformed CMB (Concrete Barrier Type 50) retrofitted with a slipformed CGS on top. The barrier design is shown in Figure 1. The barrier design was a joint effort by the researchers and personnel from the Caltrans Division of Structures. A California barrier contractor with considerable slipforming experience advised the researchers that it would probably be feasible to slipform a CGS on top of a CMB.

The CGS was lightly reinforced. Minimal reinforcement was needed to anchor the CGS to the existing CMB and to hold the CGS together if it was shattered during an impact by a passenger vehicle, to prevent large chunks of concrete from flying into the opposing lanes. Nevertheless, the reinforcement could not be so congested that the concrete could not be vibrated and consolidated properly during the slipform operation.

The CGS was 0.15 m (6 in.) wide where it sat on top of the CMB, the same as the 0.15-m (6 in.) stem width of the CMB. The CGS tapered slightly to a 0.13-m (5-in.) top width. Minimum taper was used to get as thick a CGS as possible for added strength and ease of slipforming, but it was also thought that a slight taper was required to slipform the CGS properly. The minimum concrete strength for the test barrier was specified to be 2.11 MPa (3,000 psi). It was intended that the strength not be too high so the test conditions would be conservative. Test cylinders made during construction showed a 7-day strength of 2.42 MPa (3,440 psi), and a 14-day strength of 2.72 MPa (3,870 psi). It was necessary to control the slump of the concrete during the slipforming operation in order for the concrete to hold its shape.

The height selected for the Type 50R barrier was 1.32 m (52 in.): a 0.81-m (32-in.) CMB plus a 0.51-m (20-in.) CGS. This is 51 mm (2 in.) higher than the minimum height recommended in the NCHRP Synthesis on glare screens (3). It is also higher than the vertical center of gravity height for

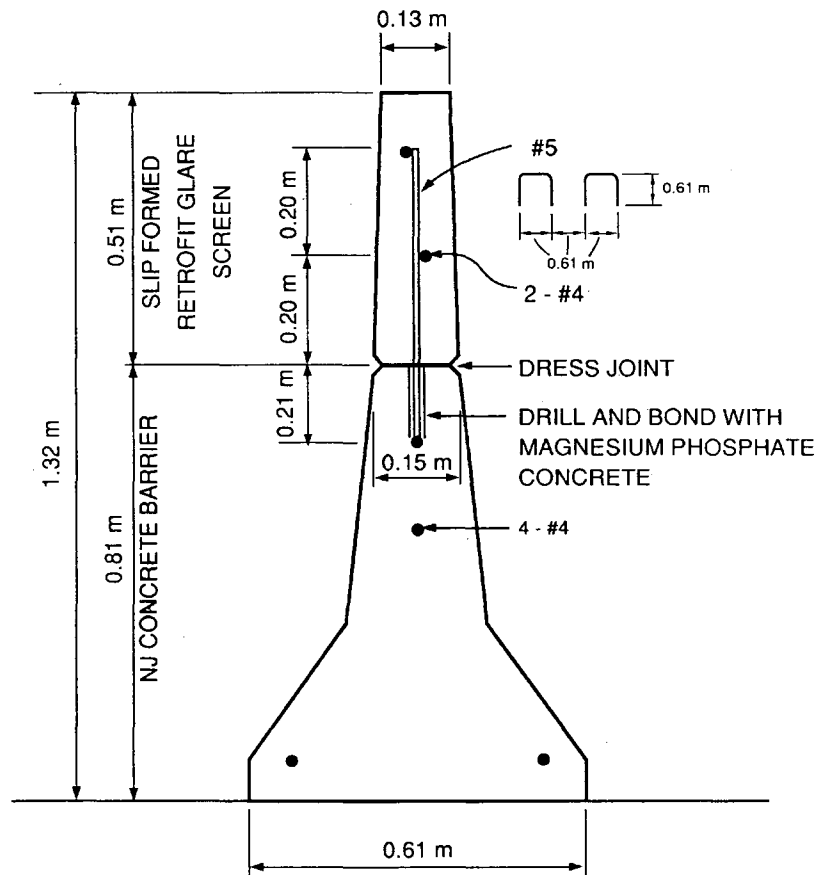


FIGURE 1 Type 50R typical cross section.

most vehicles. It is questionable whether a CGS this thin could be much higher and still be slipformed satisfactorily.

Scuppers, which are rectangular drainage slots in the barrier at ground level, were included in the test barrier design to provide the maximum weakness to the CMB that might be expected in practice.

The length of the test barrier was 45.7 m (150 ft). The construction operation had three major phases. First the CMB was built. Second, the reinforcement for the CGS was constructed on top of the CMB, and finally, the CGS was slipformed. The contractor had to build a new mule to accommodate the shape of the CGS.

**TEST CONDITIONS**

**Test Facilities**

The two impact tests were conducted at the Caltrans Dynamic Test Facility in West Sacramento, California. The tests were performed on a large flat asphalt-concrete surface. The test barrier was placed on the pavement.

**Test Vehicles**

Both vehicles used in these tests were in good condition and free of any major body damage or missing parts. They had

front-mounted engines and automatic transmissions. The vehicle models and weights are given in the following table:

Test	Vehicle	Steel Plate Ballast Weight [kg (lb)]	Total Test Inertial Weight [kg (lb)]
481	1985 Chevrolet pickup	386 (850)	2445 (5,390)
482	1982 Mercury station wagon	136 (300)	1977 (4,360)

The vehicles were self-powered in all tests, with the engine being cut off before impact.

**Test Instrumentation**

Test vehicles were instrumented with two sets of three accelerometers (independently recorded) and rate gyros near the center of gravity of the vehicle. Potentiometers were attached to the top of the CGS in the impact area. They measured the dynamic deflection of the CGS during impact. Several high-speed cameras were used to record the impact.

**Other Tests**

Two tests were performed to check the integrity of the barrier and its materials. In the first a couple of typical cross sections were cut out to check for rebar arrangement and concrete consolidation. A circular saw was used to cut two cross-sections

0.15 m (6 in.) thick from the barrier. These cross sections showed that the final position of the rebars was the same as the plans. They also showed a homogeneous, well-consolidated concrete mixture with no air pockets.

The second test was a radiography test performed using standard radiographic methods. The main purpose here was to locate the rebar in the barrier so that the typical cross-sections could be cut out at an appropriate location along the barrier. The x-rays were also used to check for air pockets in the concrete, to check whether there was any considerable movement in the rebar during the slipform operation, to check for uniform concrete density along the barrier, and to see whether the concrete was intimately in contact with the rebars. A secondary purpose of these tests was to check for cracks in the concrete.

**TEST RESULTS**

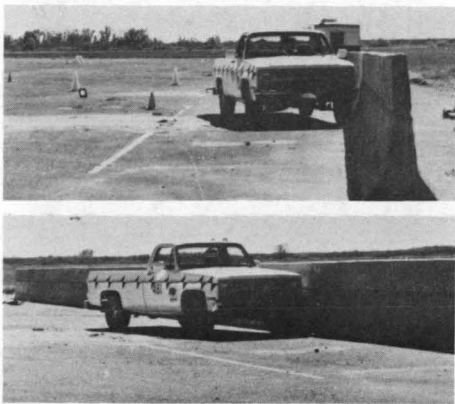
**Test 481**

The planned test conditions for Test 481 were 2450 kg (5,400 lb) at 97 km/hr (60 mph) and 20 degrees (Figure 2).

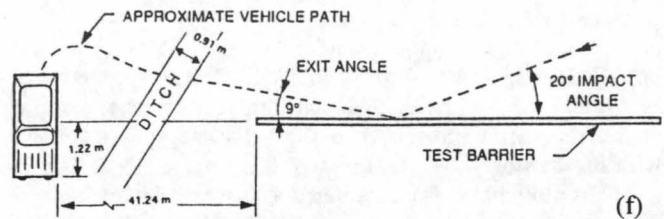
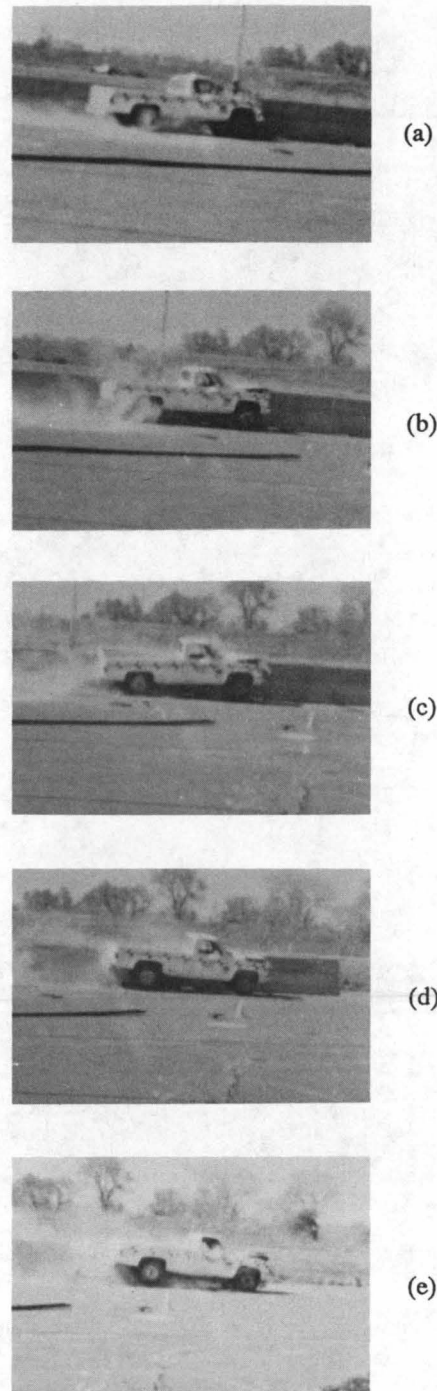
*Test Description*

The left front tire of the vehicle made first contact with the face of the barrier 32.9 m (108 ft) from the upstream end of the barrier (see Figures 3 and 4). The vehicle impact speed was 89 km/hr (55.3 mph) and the impact angle was 20 degrees. The vehicle rose about 0.8 m (2.75 ft) above the ground as evidenced by the marks on the barrier. The left front corner of the vehicle remained in contact with the barrier for a distance of about 5.2 m (17.2 ft).

The left rear tire touched the lower part of the barrier 34.0 m (111.5 ft) from the upstream end of the barrier. The highest mark of the left rear tire on the barrier was 0.94 m (37 in.). The length of vehicle contact with the barrier was about 5.6 m (18.3 ft). The body contact of the vehicle with the concrete glare screen began 24.5 m (107 ft) from the upstream end of the barrier and ran for a length of about 3.3 m (11 ft). The



**FIGURE 2** Test 481, preimpact photographs.



**FIGURE 3** Test 481, vehicle trajectory and sequential test: (a)  $t = 0.00$  sec; (b)  $t = 0.05$  sec; (c)  $t = 0.10$  sec; (d)  $t = 0.15$  sec; (e)  $t = 0.20$  sec; (f) vehicle trajectory.

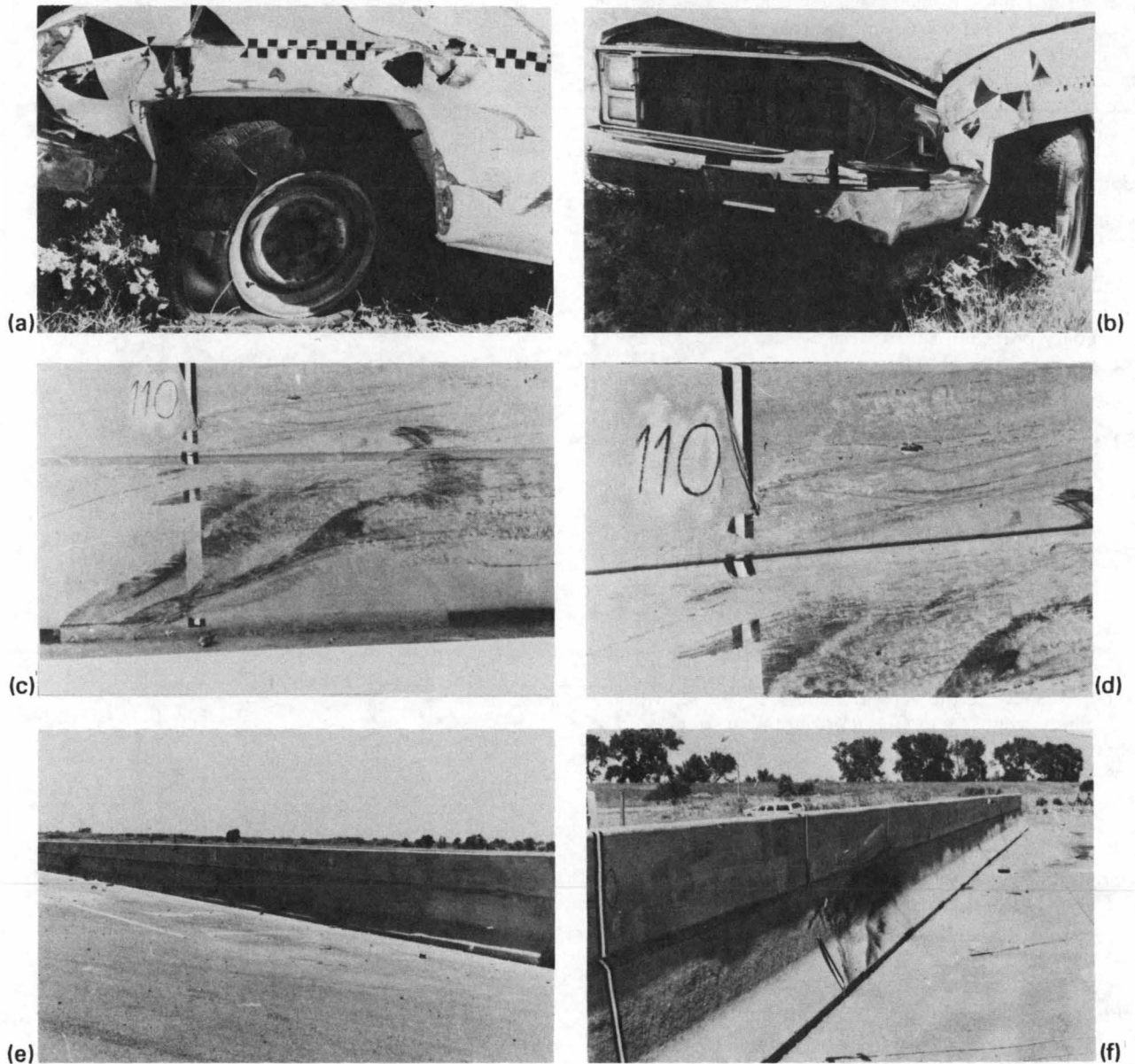


FIGURE 4 Test 481, postimpact photographs: (a) left front tire of vehicle, (b) left front corner of vehicle, (c–f) barrier.

maximum height of tire marks on the barrier was 0.94 m (37 in.).

The pickup truck was redirected smoothly and lost contact with the barrier at an exit angle of 6 degrees without exhibiting any tendency to snag or pocket. During barrier impact, the truck experienced a maximum roll towards the barrier of 13.1 degrees and a pitch-up of 9.4 degrees. The vehicle remained upright throughout and after collision. The exit speed was 73.6 km/hr (45.7 mph). Exit velocity and angle were measured at the time after impact when the vehicle first lost contact with the barrier.

The remote brakes were applied after the vehicle lost contact with the barrier and went off the paved area. The vehicle rested perpendicularly at 41.3 m (135.3 ft) downstream from the downstream end of the test barrier. The vehicle was severely damaged. The maximum 50-msec average accelerations

were  $-11.3$  g in the lateral direction and  $-4.6$  g in the longitudinal direction. The values of occupant impact velocity were 6.3 m/sec (20.6 ft/sec) in the lateral direction and 3.0 m/sec (9.9 ft/sec) in the longitudinal direction. The ridedown accelerations were  $-20.7$  g laterally and 1.4 g longitudinally.

#### Barrier Damage

There was no evidence of any structural distress of the CGS or CMB (see Figure 4). A few hair-like cracks were observed but were indistinguishable from cracks due to shrinkage. They may have existed before the crash. Lateral movement of the CGS was measured during the test; dynamic deflection was up to 10 mm (0.39 in.) at the top face, but there was no permanent deflection.

The only damage to the barrier were a few scrapes and tire marks. The length of gouge marks was 3.3 m (11 ft) on the CGS and about 3.6 m (12 ft) on the CMB. The tire marks of the left front wheel scuffed a length of 1.6 m (5.2 ft) on the CMB. The left rear tire marks were 3.5 m (11.4 ft) long on the CMB and 0.76 m (2.5 ft) on the CGS.

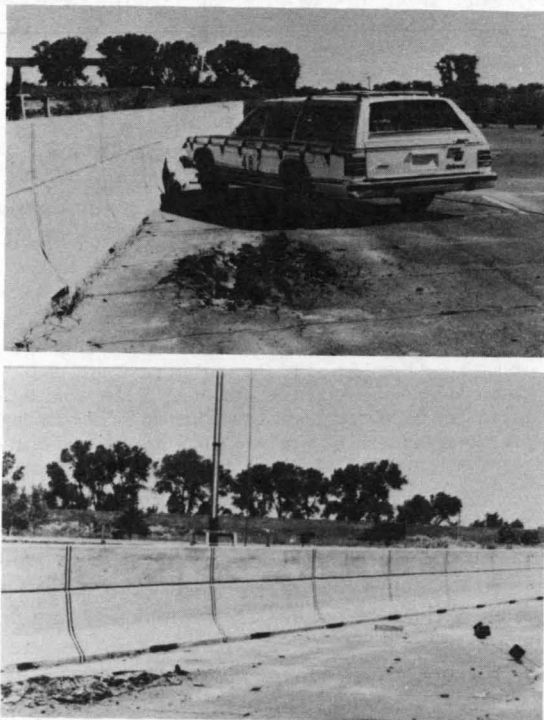
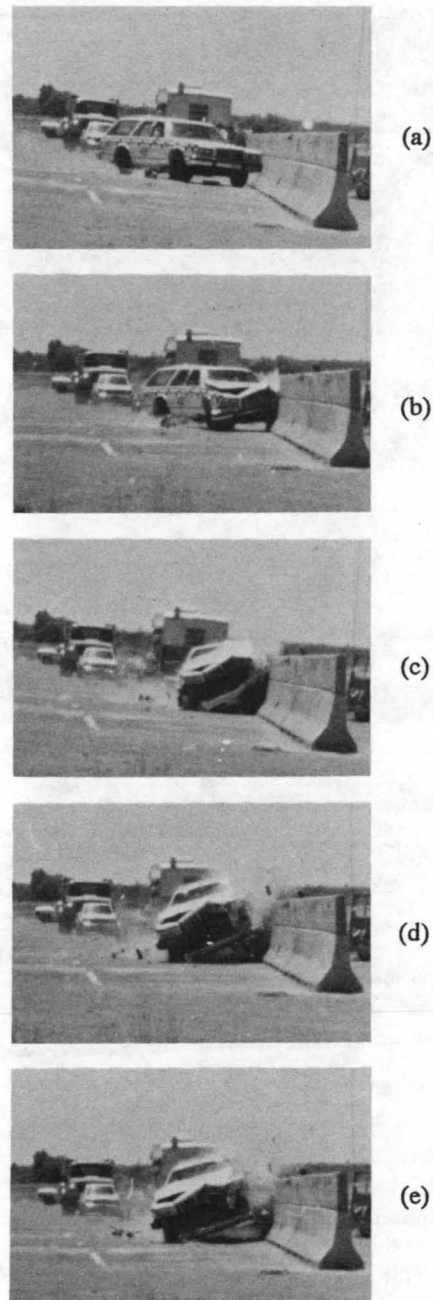
**Test 482**

The planned test conditions for Test 482 were 2043 kg (4,500 lb) at 97 km/hr (60 mph) and 25 degrees (Figure 5).

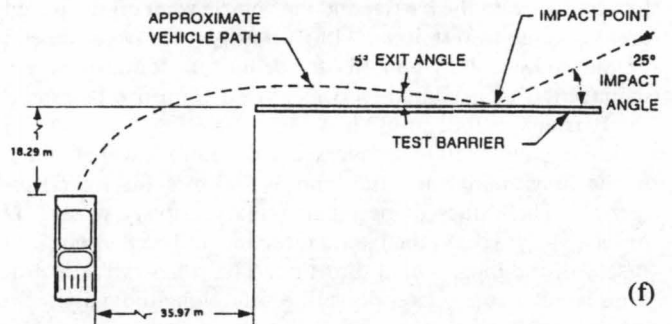
*Test Description*

The left front bumper of the vehicle first contacted the barrier face 15 m (49.2 ft) from the upstream end of the barrier (see Figures 6 and 7). The measured impact speed was 90.4 km/hr (56.2 mph), at an impact angle of 25 degrees. The left front tire initially contacted the lower part of the CMB 15.3 m (50.3 ft) from the upstream end. The highest mark on the barrier was 0.8 m (32 in.). The body contact with the CMB extended for a length of 3.8 m (12.5 ft) starting 15 m (49.3 ft) from the upstream end of the barrier. The length of the body contact with the CGS began 15.5 m (50.8 ft) from the upstream end of the barrier.

The test vehicle was redirected smoothly without exhibiting any tendency to snag or pocket with an exit angle of 5 degrees. It remained upright throughout and after collision. The exit velocity was 68.8 km/hr (42.6 mph). Exit velocity and angle



**FIGURE 5** Test 482, preimpact photographs: *top*, vehicle; *bottom*, barrier.



**FIGURE 6** Test 482, vehicle trajectory and sequential test: (a)  $t = 0.00$  sec; (b)  $t = 0.05$  sec; (c)  $t = 0.10$  sec; (d)  $t = 0.15$  sec; (e)  $t = 0.20$  sec; (f) vehicle trajectory.

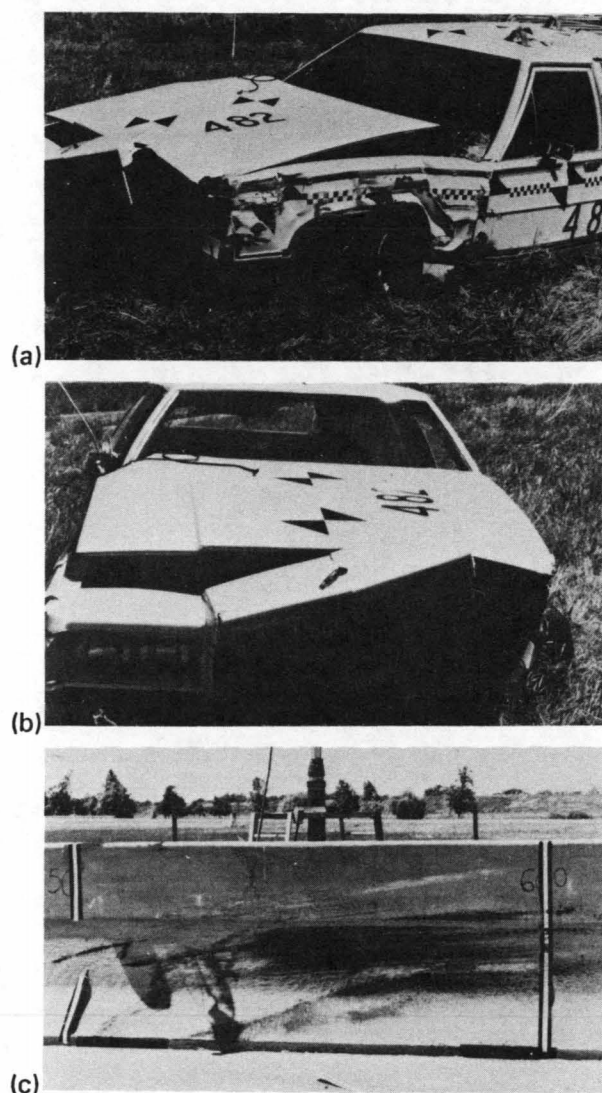


FIGURE 7 Test 482, postimpact photographs: (a,b) vehicle, (c) barrier.

are measured at the time after impact when the vehicle loses contact with the barrier.

During redirection, the test vehicle experienced a maximum roll towards the barrier of 18 degrees and a pitch-down of 5 degrees. The remote brakes were applied after the vehicle lost contact with the barrier and the vehicle went off the paved area. It came to rest 36 m (118 ft) downstream from the end of the CGS and 18.3 m (60 ft) behind it. It was severely damaged. The maximum rise measured from tire marks on the barrier was 0.81 m (32 in.).

The maximum 50-msec average accelerations were  $-6.6 g$  in the longitudinal direction and  $-10.0 g$  in the lateral direction. The values of occupant impact velocity were 6.47 m/sec (21.2 ft/sec) in the lateral direction and 6.68 m/sec (21.9 ft/sec) in the longitudinal direction. The ridedown accelerations were  $-16.3 g$  laterally and  $-5.5 g$  longitudinally.

#### Barrier Damage

There was no evidence of any structural distress of the CGS or CMB (see Figure 7). The only damage imparted to the

barrier was minor extension of a few preexistent hair line cracks. About eight hair-like cracks 25 to 114 mm (1 to 4½ in.) long developed on the top face of the CGS over a length of 1.1 m (3.5 ft) upstream from the 18.3-m (60-ft) mark. A preexisting crack root on the barrier face at about 18.3 m (60 ft) from the barrier upstream end went on for an additional 38 mm (1.5 in.). Two preexisting contraction cracks on the back of the barrier branched out into five hair-like cracks 76 to 102 mm (3 to 4 in.) long. These preexisting cracks were located at 0.12 m (0.4 ft) and 1.95 m (6.4 ft) downstream from the 18.3-m (60-ft) mark.

The length of gouges from the vehicle was 3.1 m (10 ft) on the CGS and about 3.8 m (12.5 ft) on the CMB. The tire marks covered a length of 3.2 m (10.5 ft) on the CMB. An oil spill on the barrier face covered a length of about 2.7 m (9 ft) starting at 1.4 m (4.7 ft) downstream from the 15.2-m (50-ft) mark.

The maximum dynamic lateral displacement was 5.2 mm (0.21 in.) measured 13 mm (½ in.) from the top, and there was no permanent deflection.

## DISCUSSION OF TEST RESULTS

### General Safety Evaluation Guidelines NCHRP Report 230

Three evaluation factors were used in judging the impact test performance of the test barrier, as recommended by NCHRP Report 230 (4). These factors are (a) structural adequacy, (b) occupant risk, and (c) vehicle trajectory. Tests 481 and 482 were performed to verify the structural adequacy of the CGS. The occupant risk and vehicle trajectory requirements were satisfied in other New Jersey shape barrier tests. Nevertheless, they were analyzed in these tests for comparison with past tests.

### Structural Adequacy

The structural adequacy was evaluated by comparison of test results with the following criteria from Table 6 of NCHRP Report 230 (4).

- A. Test article shall smoothly redirect the vehicle; the vehicle shall not penetrate or go over the installation, although controlled lateral deflection of the test article is acceptable.
- D. Detached elements, fragments or other debris from the test article shall not penetrate or show potential for penetrating the passenger compartment or present undue hazard to other traffic.

These criteria were met completely in both Test 481 and Test 482. The CMB/CGS demonstrated its ability to retain and redirect the test vehicles under different impact conditions. Vehicle redirection was very smooth in both tests. The vehicles were redirected adequately without penetration, and the overall adequacy of the barrier and the concrete glare screen were demonstrated. In these tests there was no evidence of any structural distress of the barrier; however, there were some minor surface cracks. No pieces of the barrier were broken, and no portions of the barrier showed potential for penetrating the passenger compartment. Both Test 481 and Test 482 were performed on the same barrier with impact

points 15.3 m (50 ft) apart. Lateral movement of the CGS was measured during the test; dynamic deflection was up to 10 mm (0.4 in.), but there was no permanent deflection.

### Occupant Risk

The occupant risk was evaluated by comparison of test results with the following criterion from Table 6 of *NCHRP Report 230* (4).

- E. The vehicle shall remain upright during and after collision although moderate roll, pitching and yawing are acceptable. Integrity of the passenger compartment must be maintained with essentially no deformation or intrusion.

Table 1 presents maximum roll, airborne distance, and maximum 50-msec average accelerations for both Tests 481 and 482. Included in the table, for comparison, are similar data from previous tests on concrete safety shape barriers tested by Caltrans. Note that the magnitude of roll in Tests 481 and 482 is generally lower than in some other tests of concrete safety shape barriers. In both tests the amount of roll and pitch may be considered low to moderate. Neither of the two test cars showed any indication of being close to rollover. There was no deformation or intrusion into the passenger compartment.

The values of longitudinal occupant impact velocity in Tests 481 and 482 were lower than the NCHRP-recommended maximum value and also lower than in some other Caltrans tests on concrete median barriers. Limiting values of occupant impact velocity are given in Criterion F; however, they apply only to lightweight car tests. Nevertheless, the values were calculated and are reported here for comparison with those in similar tests.

The second part of Criterion F in *NCHRP Report 230* calls for a highest 10-msec average value of longitudinal and lateral vehicle acceleration of 15 g after the theoretical occupant/compartment impact occurs. The threshold value is specified as 20 g. Even though the lateral ridedown acceleration for Test 481 was 20.7 g, we feel that the test essentially met this

criterion. Since so many uncontrolled variables contribute to the outcome of these crash tests, the value of 20.7 g would be within statistical error bounds. Test 482 had both longitudinal and lateral acceleration values below threshold.

Values of occupant impact velocity were not reported for the previous Caltrans tests on CMB because they were conducted before 1981 (when *NCHRP Report 230* was first published). Occupant impact velocities were introduced for the first time in that report. The maximum 50-msec average value of acceleration is a comparable measurement and was reported for all previous Caltrans CMB tests. These values for the CMB/CGS in Tests 481 and 842 are generally less than the values for the previous tests with similar test conditions. Hence, it can be concluded that the occupant risk for the CMB/CGS barrier is no worse than that for the Caltrans standard CMB.

The maximum vehicle rise in these tests ranged between 10.1 and 20.1 m (33 and 66 in.) compared with 9.8 and 11.3 m (32 and 37 in.) for the CGS tests. It should also be noted that the vehicle roll experienced in the CGS tests are comparable to the lowest roll values from previous tests.

It should also be noted that even though the impact speed of the vehicles was below that recommended in NCHRP 230 and the lateral kinetic energy was not within the bounds given in NCHRP 230, these parameters are used to determine the strength of the barrier, not the CGS. The barrier on which the CGS was mounted for testing was a standard California Type 50 (New Jersey profile) barrier which has been tested extensively and has passed NCHRP 230 criteria. The CGS does not reduce the structural strength of the barrier, it adds to it, and hence the lower speed impacts and lower lateral kinetic energies were sufficient for testing the strength of the CGS.

None of these means of evaluating occupant risk are exact methods of predicting injury levels during impacts. *NCHRP Report 230* states that "whereas the highway engineer is ultimately concerned with safety of the vehicle occupants, the occupant risk criteria should be considered as the guidelines for generally acceptable dynamic performance. These criteria are not valid, however, for use in predicting occupant injury in real or hypothetical accidents." The explanation is given

**TABLE 1 Comparison of CGS Tests 481 and 482 to Concrete Safety Shape Barriers Tested by Caltrans**

Test# / Year	Ref. #	Weight (kg) Speed (km/h) Angle (°)	Exit Speed (km/h) Angle (°)	Severity Index (kN.m)	Airborne Distance (m)	Max. Roll (°)	50 ms avg. Accel. Long.	50 ms avg. Accel. Lat.
481 / 1990		2447 / 89.3 / 20.0	73.6 / 9	88.0	0	13.1	-4.6 g	-11.3 g
482 / 1990		1979 / 90.5 / 25.0	68.8 / 5	111.4	0	18	-6.6 g	-10 g
261 / 1972	5	2252 / 98.2 / 9.5	na / 0	22.8	na	na	0.6 g	3.9 g
262 / 1972	5	2252 / 95.0 / 25.0	91.8 / na	139.6	15.3	na	7.0 g	11.6 g
264 / 1972	5	2206 / 103.0 / 25.0	86.9 / 5	161.1	6.1	na	5.2 g	13.0 g
291 / 1972	5	2206 / 104.7 / 7.0	86.9 / 18	13.8	na	18	1.2 g	3.4 g
292 / 1972	5	2206 / 109.5 / 23.0	na / na	155.4	17.1	61	6.8 g	11.8 g
293 / 1973	5	2206 / 106.3 / 40.0	na / na	396.2	18.3	18	12.8 g	6.5 g
294 / 1974	5	2134 / 62.8 / 25.0	na / 4	57.9	4.9	33	2.7 g	5.5 g
301 / 1974	6	2206 / 109.5 / 27.0	80.5 / 13.8	209.7	9.2	26.5	11.7 g	13.8 g
321 / 1976	7	2134 / 98.2 / 26	72.5 / 7	152.3	1.5	48	4.4g	9.9g

Conversion Factors: 1 kg = 2.20 lb, 1 m = 3.28 ft, 1 km/h = 0.62 mph, 1 kN.m = 0.74 kip.ft.

that "relationship between vehicle dynamics and probability of occupant injury and degree of injury sustained is tenuous, because it involves such important but widely varying factors as occupant physiology, size, seating position, restraint, and vehicle interior geometry and padding." However, low occupant impact velocity and ridedown acceleration values indicate relatively safe roadside safety features.

### Vehicle Trajectory

The vehicle trajectory was evaluated by comparison of test results with the following criteria from Table 6 of *NCHRP Report 230 (4)*:

- H. After collision, the vehicle trajectory and final stopping position shall intrude a minimum distance, if at all, into adjacent traffic lanes.
- I. In tests where the vehicle is judged to be redirected into or stopped while in adjacent traffic lanes, vehicle speed change during test article collision should be less than 15 mph and the exit angle from the test article should be less than 60% of test impact angle, both measured at time of vehicle loss of contact with test device.

The same report stresses that "trajectory evaluation for re-directional type of tests is focused on the vehicle at the time it loses contact with the test article, and the subsequent part of the trajectory is not evaluated." The exit angles for both tests did not exceed the recommended upper limit of 60 percent of the impact angle (4).

The vehicle speed change was less than the 24.2-km/hr (15-mph) limit for both tests. These low changes in vehicle speed correspond to the relatively low values of longitudinal vehicle acceleration.

Regardless of speed change and exit angles, the barrier demonstrated its ability to retain a vehicle under very severe impact conditions. There was no tendency to pocket or snag the vehicle.

The vehicle post impact trajectories followed the same patterns in both tests. The vehicles were redirected toward the line of the barrier. Following the barrier impact, both vehicles rebounded from the barrier in a disabled condition and traveled 36 to 41.2 m (118 to 135 ft) before coming to a stop. The final positions were across the line of the barrier. If the barrier had extended further downstream, the vehicle would have impacted it a second time in both tests. The differences in vehicle trajectory may be attributed to variations in the timing of brake application and vehicle characteristics, such as weight distribution, suspension system, tires, vehicle stability after impact, and vehicle damage.

For both tests, the post-impact trajectory was as expected for a longitudinal concrete median barrier with or without concrete glare screen. *NCHRP Report 230 (4)* points out that "the after collision trajectory may be one of the least repeatable performance factors" and that there is no assurance that existing hardware or certain classes of appurtenances will perform within NCHRP 230 limits for exit angle and speed.

In summary, the CMB/CGS met the vehicle trajectory requirements of NCHRP 230 (4).

### CONCLUSION

- The CMB, as tested previously, was structurally adequate to meet present standards as specified in *NCHRP Report 230 (4)* including both the strength and stability requirements. The CGS on the test barrier did not diminish the structural adequacy of the CMB.

- The CGS retrofitted on top of the CMB had the structural integrity to fully contain an impact of a 2449-kg (5,400-lb) pickup truck at 88 km/hr (55 mph) and 20 degrees with no evidence of structural distress or debris generation (including debris from vehicle).

- Large passenger vehicles can be redirected smoothly by the barrier with satisfactory occupant risk factors, according to *NCHRP Report 230 (4)*.

- In both tests, the exit speeds and angles of the vehicles met NCHRP 230 (4) requirements. The vehicle post-impact trajectory resulted in a smooth redirection of the vehicle back toward the concrete barrier.

- The two impact tests showed that the slipform construction of concrete glare screen to a total height of 0.51 m (20 in.) above a CMB is feasible and that the completed product has considerable structural strength. There is a need for tight control of the slump of the concrete mix with existing construction equipment so that the concrete holds its shape during the slipforming operation. The CMB/CGS should provide long life and low maintenance usually associated with structural concrete.

- Some safety enhancements may result from the additional height and strength of the CGS. For example, depending on the speed, weight, and angle, an errant vehicle might be somewhat less likely to climb over a CGS-equipped barrier.

- There was no penetration of test vehicle parts beyond the face of the CMB/CGS structure.

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