# Concrete Safety Shape Research

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Use of the concrete safety shape, which is a widely specified traffic barrier, is greatly on the increase. Recognizing the need for research on concrete safety shapes, 21 transportation agencies entered into a Highway Planning and Research pooled-funds study administered by the Federal Highway Administration (FHWA) Office of Research.

## BACKGROUND

As reported in an FHWA notice (1) in 1971, 36 states employed a concrete safety shape to some extent. Of these 36 states, 19 specified the shape first used by New Jersey [denoted as MB5 by Michie and Bronstad (2)]; 8 specified a shape developed by General Motors [denoted as MB6 by Michie and Bronstad (2)]; and the remaining states used some variation of these two shapes. Although crash test investigations had been conducted on both the MB5 and MB6 shapes (3, 4, 5, 6), tests of the two shapes were not comparable because of wide variation in test conditions.

Accordingly, one of the early tasks of the concrete barrier research was to conduct base-line tests by using identical test conditions on the two widely used shapes. In addition, in recognition of the increasing number of small cars in today's traffic, subcompact baseline tests were subsequently added to the program. An added stimulus to this investigation was an accident report from an FHWA region (7) that indicated a high incidence of rollover when subcompact vehicles impacted the MB6 shape.

Mathematical simulations (when compared with crash tests) permit low-cost examination of barrier performance. The highway-vehicle-object simulation model (HVOSM) (8, 9) program was used to investigate several variations of the MB5 shape as shown in Figure 1. Based on the results of these investigations, configuration F was determined to offer potential improvement in performance, and base-line crash tests were programmed for this shape. This program used the same types of vehicles as were used in the previous base-line tests.

## OBJECTIVE

The objective of the research discussed in this paper was to obtain comparable information on three different concrete safety shapes impacted by both standard sedans and subcompact sedans at 96.6 km/h (60 mph) and at angles of 7 and 15 deg.

## TEST RESULTS

### Standard Sedan Base-Line Tests

All standard sedan tests were conducted with 1972 Ford Galaxie sedans weighing 1982 kg (4370 lb). Because these vehicles were from a police fleet, they were in similar condition. Table 1 gives a summary of standard sedan test data. Figures 2 and 3 illustrate performance of the shapes.

### Subcompact Vehicle Baseline Tests

All subcompact tests were conducted with 1971 Chevrolet Vegas weighing 1021 kg (2250 lb). Table 2 gives a summary of subcompact vehicle test data. Figures 4 and 5 illustrate performance of the shapes.

## DISCUSSION OF RESULTS

Based on results of the base-line crash tests, four conclusions can be stated:

1. Vehicle roll angles in all tests were greatest for the MB6 shape and the smallest for the new configuration F. An exception was the 15-deg test 12 with configuration F. A higher roll angle was observed in this test although vehicle climb was less. The higher roll angle may be attributed to the higher speed of this configuration F test.
2. Vehicle rollover occurred with the MB6 shape during a subcompact crash at 91.9 km/h (57.1 mph) and angle of 16.5 deg.

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**Figure 1. Barrier profiles, parametric studies.**

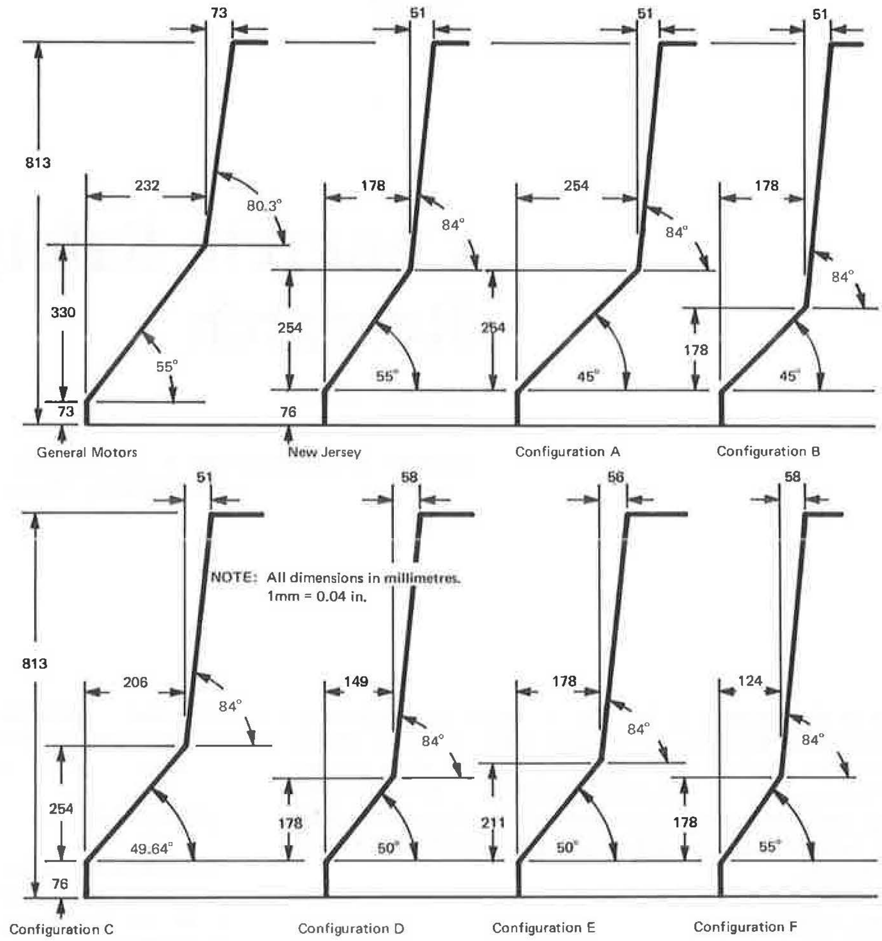


**Figure 2. Standard vehicle, 7-deg tests.**

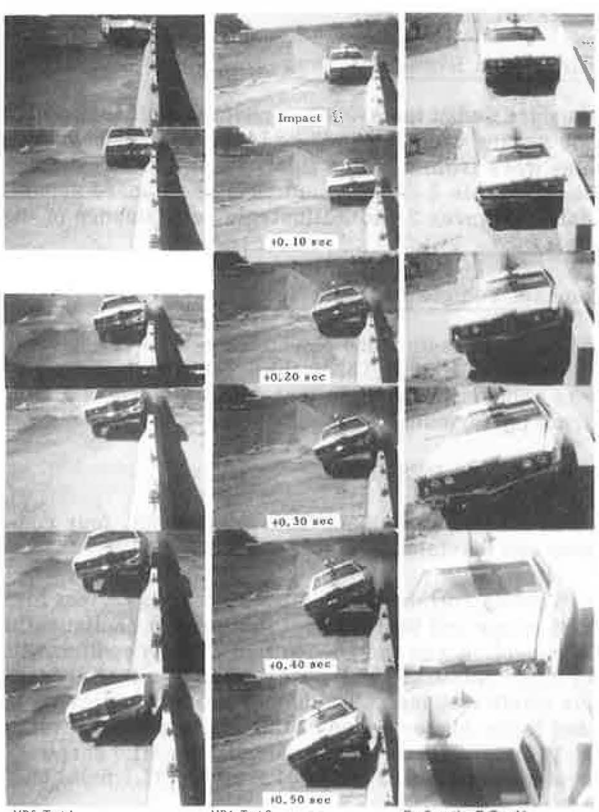


**Figure 3. Standard vehicle, 15-deg tests.**

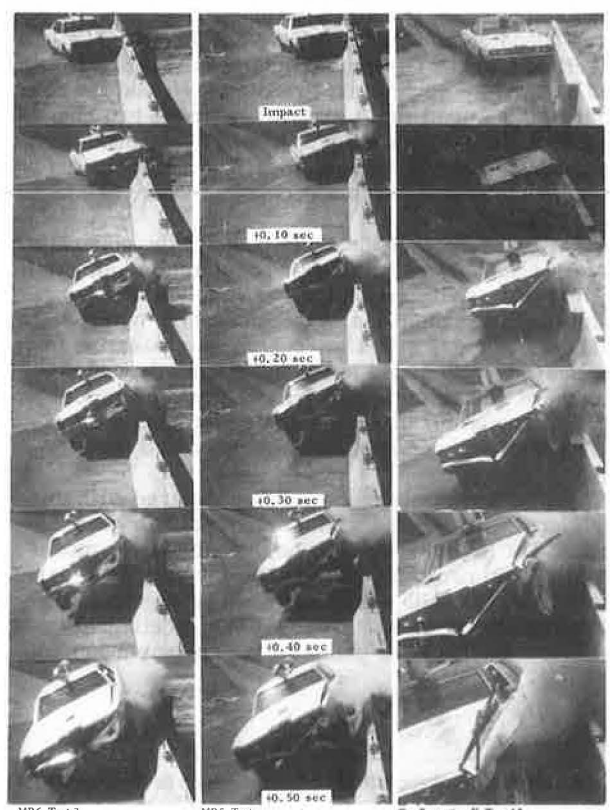

**Table 1. Summary of standard vehicle base-line crash tests.**

| Test Angle (deg) | Test Number | Barrier Shape | Impact Speed (km/h) | Impact Angle (deg) | Maximum Roll Angle (deg) | | Maximum Acceleration[a] (g) | | | | Maximum Vertical Acceleration (g) | Duration of Peak g (ms) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Film | | Accelerometer | | | |
| | | | | | Test | HVOSM | Longitudinal | Lateral | Longitudinal | Lateral | | |
| 7 | 1 | MB5 | 97.0 | 7.5 | 15 | 2 | -1.7 | -5.0 | -0.9 | -2.0 | 14 | 12.5 |
| | 2 | MB6 | 99.1 | 7.3 | 20 | 5 | -1.5 | -3.6 | -2.2 | -2.8 | 11 | 12.5 |
| | 11 | Configuration F | 93.3 | 8.0 | 11 | | -1.4 | -3.4 | -3.0 | -3.9 | | |
| 15 | 3 | MB5 | 90.9 | 15.5 | 20 | 26 | -3.3 | -10.1 | -1.6 | -5.2 | 28 | 10.9 |
| | 4 | MB6 | 89.9 | 15.9 | 20 | 17 | -5.0 | -10.1 | -1.6 | -5.5 | 32 | 13.4 |
| | 12 | Configuration F | 98.8 | 15.2 | 21 | 6 | -5.1 | -6.6 | —[b] | -6.7 | | |

Notes: 1 km/h = 0.621 mph.
All vehicles tested were 1982-kg (4370-lb) 1972 Ford Galaxies.
[a]50 ms average. [b]Not applicable.

**Table 2. Summary of subcompact base-line crash tests.**

| Test Angle (deg) | Test Number | Barrier Shape | Impact Speed (km/h) | Impact Angle (deg) | Maximum Roll Angle (deg) | | Maximum Acceleration[a] (g) | | | | Maximum Vertical Acceleration (g) | Duration of Peak g (ms) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Film | | Accelerometer | | | |
| | | | | | Test | HVOSM | Longitudinal | Lateral | Longitudinal | Lateral | | |
| 7 | 5 | MB6 | 86.7 | 8.4 | 31 | 20 | -2.4 | -4.3 | -1.4 | -2.0 | 18 | 12 |
| | 6 | MB6 | 87.9 | 9.2 | 21 | 20 | -2.7 | -5.3 | -1.9 | -2.4 | 21 | 5 |
| | 8 | MB5 | 89.96 | 8.0 | 20 | 14 | — | — | -1.0 | -3.2 | 22.0 | 9 |
| | 10 | Configuration F | 95.4 | 6.8 | 10 | | -3.4 | -4.6 | -3.3 | —[b] | | |
| 15 | 7 | MB6 | 91.9 | 16.5 | —[c] | —[c] | -5.3 | -8.3 | -3.4 | -4.6 | 19 | 6 |
| | 9 | MB5 | 94.8 | 15.5 | 20 | 27 | -3.6 | -5.1 | -0.9 | -6.0 | 27.6 | 11 |
| | 13 | Configuration F | 91.2 | 14.6 | 13 | | -3.9 | -4.6 | —[b] | -7.3 | | |

Notes: 1 km/h = 0.621 mph.
All vehicles tested were 1021-kg (2250-lb) 1971 Chevrolet Vegas.
[a]50-ms average. [b]Not applicable. [c]Rollover.

**Figure 4. Subcompact vehicle, 7-deg tests.**

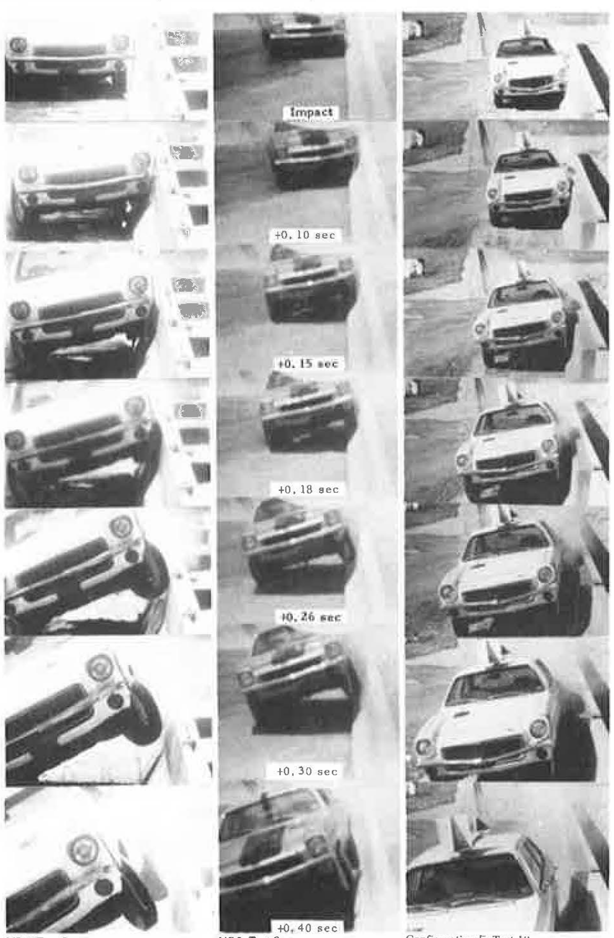


**Figure 5. Subcompact vehicle, 15-deg tests.**

3. Vehicle damage was generally less with the MB6 shape except for the rollover. Large-vehicle damage was less with the new configuration F, but small-vehicle damage was greater with the MB5 shape.

4. Average vehicle decelerations indicate that similar performance can be expected with the three shapes, but the new configuration F shape appears to provide the lower values.

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