

"The car was only slightly damaged, and deceleration records indicated that its occupants would have experienced nothing worse than minor injuries and, while sprung slightly, the rail and wood posts would be repaired inexpensively.

"Similar successful tests from the standpoint of passenger safety were run with the "W" section beam ribbon mounted on steel and reinforced concrete posts. These tests were also made at 35 miles per hour and 20 degrees.

"Ribbon mounted on steel 'I' beam posts remained intact, with only slight deformation and post damage and the reinforced concrete post installation fared almost as well, with the major post and ribbon damage occurring at the point of impact.

"The next installation tested was a standard four steel cable design mounted on steel 'I' beams spaced at 12½-foot intervals. This test is a 20-degree impact at 41 miles per hour.

"The passenger hazard on any guardrail impact is well illustrated by this slow-motion sequence. Observe the reactions of the unrestrained dummies during impact. The cable installations tend to snare the car, but in so doing, create extensive vehicle damage.

"The next test of 4-cable guardrail was from 60 mph and 20-degree angle. Two of the four cables failed completely, allowing excessive penetration by the test vehicle. Because of the initial success with the 'W'-beam rail, tests were made at higher speeds to evaluate post materials and spacing.

"These are 40-mile-per-hour, 20-degree impacts into 'W'-section, beam rail, mounted directly to reinforced concrete posts, spaced at 12½ feet. Under these conditions, the reinforced concrete posts failed almost completely, and the damage inflicted on the vehicles is mute testimony of the deceleration and passenger danger that results because of post characteristics. Further tests at higher speeds were run with other types of reinforced concrete posts, but none provided the strength and shock resistance needed.

"This is a test of steel 'I' beam posts at 12½-foot intervals. While the impact is from 30 degrees, at 45 miles per hour, this and other tests produced similar results, moderately severe pocketing, with substantial vehicle damage and presumed passenger danger, despite the fact that deceleration effects were reduced by the vehicle climbing onto the rail.

"Tests with 6 by 8 inch wood posts continued to produce good results. The addition of spring brackets between post and rail improved over-all performance. Ribbon and post damage was minor, and vehicle damage was slight, considering the 19-degree impact angle, and 45 mph speed. Further tests would now be made at higher speeds.

"This test proved that post material alone was not the answer at higher speeds.

"At 65 miles per hour and 20 degrees, wood posts spaced at 12½ feet deflected the cars, but produced severe pocketing and high decelerations. The resulting damage was clear evidence that greater structural strength was needed to deflect a car safely at turnpike speeds. By reducing the post interval to 6¼ feet, pocketing is virtually eliminated and deceleration is reduced to a reasonable level, even at impact speeds of 65 miles per hour and 20 degree impact angle.

"Notice the minor damage to the guardrail and moderate vehicle damage sustained from the high speed impact. This test is proof that the installation can deflect almost any vehicle at highway speed.

"The full impact of this 50-mile-per hour, 20-degree test is better illustrated by this black-and-white high speed sequence. Considering the angle, velocity and 16,000 pound weight of the vehicle, damage to the guardrail and truck are slight. This test is vivid testimony that W-beam rail and 6¼-foot post intervals will safely deflect almost any vehicle.

"Even with concrete posts, this installation satisfactorily restrained and deflected this heavy bus from 15 degrees and 40 miles per hour. With the problem of glancing impacts resolved, other tests were conducted to explore the problem of end impacts.

"The extreme danger of the common end treatment is vividly illustrated by these results. Actually, this 30-mile-per-hour test was mild when compared to some of the serious accidents that have resulted on the public highways. To eliminate these hazards and to improve the uniformity and strength of the structure, a variety of sloped end treatments were tried. While these tests verified that it was considerably safer to impact a modified end treatment due to the lower deceleration and lessened damage, GM engineers determined that the safest treatment was to anchor the guardrail in this manner so as to absolutely prevent