FULL-SCALE CRASH TEST OF
TRU-BEAM ALUMINUM BRIDGE RAILING

Prepared for
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Test Railing Installation

The test railing installation was the Modified Indiana Type 5A bridge rail with the 4 3/4 in. x 3 3/4 in. semi-elliptical top rail element and the Magnode Tru-Beam bottom rail. Figure 1 details the placement of these rail elements on the modified AASHTO-ARBA BR2, type D fabricated post (1). The solid base plate (full depth front to back) with steel nuts were used. Figure 2 details the rails and base plate used. As in the previous tests, approximately 28 m (93 ft) of railing was installed on a rigid simulated bridge deck with no curb. An anchor was provided on the downstream end to simulate a continuous rail as shown in Figure 3. Hardware for the installation was fabricated by Magnode Corporation, Trenton, Ohio. The bridge rail hardware conforms dimensionally with ARBA Technical Bulletin No. 268-A, July 1973, with the exception of the modifications as noted. The interior rail sections were in 8 m (26 ft) lengths.

Instrumentation

The vehicle was equipped with triaxial accelerometers mounted near the center of gravity. Yaw, pitch, and roll were sensed by on-board gyroscopic instruments. The analog signals were telemetered to a base station for recording on magnetic tape and display on real-time strip chart. Provision was made for transmission of calibration signals before and after the test, and an accurate time reference signal was simultaneously recorded with the data.

Tape switches near the impact area were actuated by the vehicle to indicate elapsed time over a known distance to provide a quick check of impact speed, and the initial contact also produces an "event" mark on the data record to establish the instant of impact.
High-speed motion pictures were obtained from various locations, including overhead, to document the events and provide a time-displacement history. Film and electronic data were synchronized through a visual/electronic event signal at initial contact.

Test Description

A 1976 Plymouth Grand Fury weighing 2,041 kg (4,500 lb) was directed into the rail at an angle of 27.2 deg and 94.7 km/h (58.9 mph). The impact point was 76.2 cm (30 in.) upstream from post 7. The vehicle was free-wheeling and unrestrained at impact.

Figures 4 and 5 depict the test area and vehicle before, during, and after the test. The vehicle exited the rail between posts 9 and 10 at an angle of 6 deg and 58 km/h (36 mph).

Results

Overhead and rearview sequential photographs taken from the high-speed movie films are shown along with a summary of other test data in Figures 6a, 6b, and 6c. Figure 7 pictures the post and railing before the test. Figures 8 and 9 show the damage to the post and rail elements. The rivets connecting the post to the sail were sheared at posts 7, 8, and 9. Damage to the rail was restricted to the area between posts 6 and 10. The lower rail element was bent, incurred some loss of section, and sustained modest tearing without loss of continuity. Splice performance was acceptable with little movement. Figures 10a, 10b, and 10c are analog reproductions of the individual vehicle accelerations as a function of time. Figure 10d represents the resultant absolute acceleration which has a maximum 0.050 sec interval average value of 11.8 g. The longitudinal and transverse 0.050 sec average accelerations were -8.8 g and 8.7 g, respectively.
Figures 11a, 11b, and 11c depict vehicle yaw, pitch, and roll, respectively, as a function of time.

The vehicle was contained, redirected, and did not penetrate or snag on the rail. By this criteria, the test meets the guidelines described in Transportation Research Circular No. 191, "Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances", February 1978 (2).

Conclusion

The tested system meets AASHTO geometric requirements for traffic railing (3) and fully satisfies containment criteria as detailed in Transportation Research Circular No. 191.
Figure 1. The Modified Indiana Type 5A Rail with the Magnode Tru-Beam.
Figure 2. Post and Rail Element Detail.
Figure 3. Test Installation of Modified Indiana Bridge Railing with the Magnode Tru-Beam Bottom Rail Element.
Figure 4. Railing Before, During and After Test 4182-3.
Figure 5. Vehicle Before and After Test 4182-3.
Figure 6a. Sequential Photographs and Data Summary for Test 4182-3.
Figure 6b. Sequential Photographs for Test 4182-3.
Figure 6c. Sequential Photographs for Test 4182-3.
Figure 7. Close Up of Railing Before Test 4182-3.
Figure 8. Damage to Railing After Test 4182-3.
Figure 9. Damage to Railing After Test 4182-3.
Figure 10a. Vehicle Longitudinal Accelerometer Trace for Test 4182-3.
Figure 10b. Vehicle Transverse Accelerometer Trace for Test 4182-3.
Figure 10c. Vehicle Vertical Accelerometer Trace for Test 4182-3.
Figure 10d. Vehicle Resultant Accelerometer Trace for Test 4182-3.
Initial position is at contact.

Sequence:
yaw - first
pitch - second
roll - third

Figure 11a. Vehicle Yaw Angle for Test 4182-3.
Initial position is at contact.

Sequence:
- yaw - first
- pitch - second
- roll - third

Figure 11b. Vehicle Pitch Angle for Test 4182-3.
Initial position is at contact.

Sequence:
- yaw - first
- pitch - second
- roll - third

Figure 11c. Vehicle Roll Angle for Test 4182-3.
References

