Performance Evaluation of
the Post-Mate TM Punched Square Tube Signpost

by

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Research Associate

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for

Allied Tube and Conduit Corporation
Mechanical Tube Division
Harvey, Illinois

and

Tapsco
Division of Leahy Supply Co., Inc.
Auburn, Illinois

Texas A&M Research Foundation
Texas Transportation Institute
The Texas A&M University System

May 1984
We are sorry but some of the older reports are as is.
The pictures are of poor quality.
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Introduction

The purpose of these tests was to determine whether the Post-Mate™ signpost (2 1/4" x 2 1/4" x 0.105" punched steel tube) meets safety performance requirements recommended in NCHRP Report 230 (1).

Test Installation

A signpost installation consisting of a standard 30 x 36 x 1/10 in. aluminum highway sign mounted on a Post-Mate™ punched square tube post was embedded in soil which met NCHRP Report 230 (1) recommendations. The Post-Mate™ was a 2-1/4 in. square steel tube 0.105 in. thick (12 ga). Seven-sixteenths inch diameter holes on one inch centers were punched along the centerline of the post on two opposite sides for the entire length. The 13.0 (4.0 m) ft Post-Mate™ was embedded 4.0 ft (1.2 m) in crushed limestone base material. The aluminum sign was mounted with two 5/16 x 3 1/2 in. grade 2 carriage bolts. The bottom of the sign was 74 in. above the groundline. The manufacturer's specifications on the Post-Mate™ are given in Appendix A. Mechanical and chemical properties of the two posts tested are presented in Appendix B. Photographs of the installation are presented in Figure 1.

Instrumentation and Data Analysis

The vehicle was equipped with triaxial accelerometers mounted near the center of gravity. Yaw, pitch and roll rates were measured by rate gyros. Gyro data were intergrated to obtain angular positions of the vehicle after impact. The electronic signals were telemetered to a base station for recording on magnetic tape and for display on a 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.
Figure 1. Test Installation.
Tape switches near the impact area were actuated by the vehicle to indicate the elapsed time over a known distance to provide a quick check of impact velocity. The initial contact also produced an "event" mark on the data record to establish the instant of impact.

Data from the electronic transducers were digitized, using a microcomputer, for analyses and evaluation of performance. Several computer programs on the Amdahl 470/V6/V8 mainframe computer were used to process various types of data from the test vehicle.

Still and motion photography were used to document the test, to obtain time-displacement data, and to observe phenomena occurring during the impact. Still photography was used to record conditions of the test vehicle and signpost installation before and after the test. Motion photography was used to record the collision event.

TEST 7001-1 (20 mph)

A 1978 Honda Civic was directed into the signpost at 20.2 mph (32.5 kph). Test inertia mass of the vehicle was 1667 lbs (757 kg) and its gross static mass was 1776 lbs (815 kg). The vehicle was free-wheeling and unrestrained at impact. Impact was 15 in. (0.4 m) to the right of the vehicle centerline. Relative positions of the vehicle and signpost are shown in Figure 2.

Shortly after impact the signpost bent and then broke approximately 18 in. (0.5 m) above groundlevel allowing the vehicle to ride over the sign. There was very little damage to the vehicle (dented bumper) and it exited the site in a very stable manner coming to rest approximately 46 ft (14.0 m) from the signpost. Damage to the signpost and vehicle is shown in Figures 3 and 4. Sequential photographs are presented in Figure 5.

At loss of contact (0.176 sec) the vehicle was traveling at 12.4 mph
Figure 2. Relative Positions of Vehicle and Signpost for Test 7001-1.
Figure 3. Test Installation After Test 7001-1.
Figure 4. Vehicle After Test 7001-1.
Figure 5. Sequential Photographs for Test 7001-1.
(20.0 kph), a change in speed of 7.8 mph (12.6 kph) and a change in momentum of 638 lb-sec. The maximum 50 msec longitudinal acceleration was -2.7 g and there was no occupant impact during the impulse period. A summary of data for test 7001-1 is provided in Figure 6. Vehicle longitudinal acceleration is shown in Figure 7 and vehicle angular displacements are plotted in Figure 8.

**TEST 7001-2 (60 mph)**

A new signpost was installed and the 1978 Honda Civic (see Figure 4) used in the first test was directed into the signpost at 60.8 mph (97.8 kph). Impact was 15 in. (0.4 m) to the left of vehicle centerline. The vehicle was free-wheeling and unrestrained at impact.

After impact the signpost deformed around the front of the vehicle and at approximately 0.091 sec the signpost pulled out of the ground. This time was also considered to be loss of contact because resistance from the signpost ended. The vehicle exited the site in a relatively stable manner and stopped approximately 160 ft (48.8 m) from the initial location of the signpost. It yawed approximately 90 degrees to the right before coming to rest. Sequential photographs of the test are presented in Figure 9.

The signpost was deformed and torn in two places as shown in Figure 10. The signpost was torn apart 22 in. above the ground and was partially torn 5 1/2 in. below the ground. The vehicle sustained minimal damage to the left front quarter. Damage to the vehicle is shown in Figure 11.

The speed of the vehicle at 0.091 sec was 53.1 mph (85.4 kph). The change in speed was 7.7 mph (12.4 kph) and the change in momentum was 630 lb-sec. The maximum 50 msec average longitudinal acceleration was -5.4 g. Occupant impact velocity was 12.9 fps (3.9 m/s) and the occupant ridedown acceleration was -0.6 g, both taken in the longitudinal direction. The data
<table>
<thead>
<tr>
<th>Test No.</th>
<th>7001-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>3/29/84</td>
</tr>
<tr>
<td>Test Article</td>
<td>Post-Mate™</td>
</tr>
<tr>
<td></td>
<td>Punched Square</td>
</tr>
<tr>
<td></td>
<td>Tube Signpost</td>
</tr>
<tr>
<td>Vehicle</td>
<td>1978 Honda Civic</td>
</tr>
<tr>
<td>Vehicle Weight</td>
<td></td>
</tr>
<tr>
<td>Test Inertia</td>
<td>1667 lbs (757 kg)</td>
</tr>
<tr>
<td>Gross Static</td>
<td>1776 lbs (815 kg)</td>
</tr>
<tr>
<td>Vehicle Damage Classification</td>
<td></td>
</tr>
<tr>
<td>TAD</td>
<td>12FRO</td>
</tr>
<tr>
<td>CDC</td>
<td>12FREN1</td>
</tr>
</tbody>
</table>

**Impact Speed.** 20.2 mph (32.5 kph)

**Speed at loss of contact.** 12.4 mph (20.0 kph)

**Change in Velocity.** 7.8 mph (12.6 kph)

**Change in Momentum.** 630 lb-sec

**Vehicle Accelerations** (Max. 0.050 sec Avg)

- Longitudinal: -2.7 g
- Lateral: 0.4 g

**Occupant Impact Velocity**

- Longitudinal: NONE
- Lateral: NONE

**Occupant Ridedown Accelerations**

- Longitudinal: No Contact
- Lateral: No Contact

---

Figure 6. Data Summary for Test 7001-1.
Figure 7. Vehicle Longitudinal Accelerometer Trace for Test 7001-1.
Figure 8. Vehicle Angular Displacements for Test 7001-1.
Figure 9. Sequential Photographs for Test 7001-2.
Figure 10. Signpost After Test 7001-2.
Figure 11. Vehicle After Test 7001-2.
from test 7001-2 is summarized in Figure 12. Vehicle longitudinal acceleration is shown in Figure 13 and vehicle angular displacements are plotted in Figure 14.

Conclusions

NCHRP Report 230 (1) contains recommended evaluation criteria for impact performance of sign supports and places limits on these criteria for acceptable performance. According to the results of the two vehicle crash tests reported herein, the Post-Mate™ readily yielded allowing the vehicle to proceed to a safe stop with no penetration of the occupant compartment; and the occupant risk factors were well within the acceptable limits. Therefore, the 2-1/4 in. square by 0.105 in. thick. Post-Mate™ punched square tube signpost meets the criteria set forth in NCHRP Report 230 (1) for single post installation.
Test No. .............. 7001-2
Date ................. 3/29/84
Test Article ........ Post-Mate™
                    Punched Square Tube Signpost
Vehicle ............. 1978 Honda Civic
Vehicle Weight
  Test Inertia ........ 1667 lbs (755 kg)
  Gross Static ........ 1796 lbs (815 kg)
Vehicle Damage Classification
  TAD ............... 12FL1
  CDC ............... 12FLEN1

Impact Speed ........ 60.8 mph (97.8 kph)
Speed at loss of contact .... 53.1 mph (85.4 kph)
Change in Velocity ........ 7.7 mph (12.4 kph)
Change in Momentum ........ 638 lb-sec
Vehicle Accelerations
  (Max. 0.050 sec Avg)
  Longitudinal ........ -5.4 g
  Lateral ............. 1.8 g
Occupant Impact Velocity
  Longitudinal ........ 12.9 fps (3.9 m/s)
  Lateral ............. NONE
Occupant Ridedown Accelerations
  Longitudinal ........ -0.6 g
  Lateral ............. No Contact

Figure 12. Data Summary for Test 7001-2.
Figure 13. Vehicle Longitudinal Accelerometer Trace for Test 7001-2.
Axes are vehicle fixed.
Sequence for determining orientation is:
1. Yaw
2. Pitch
3. Roll

Figure 14. Vehicle Angular Displacements for Test 7001-2.
Appendix A

Manufacturer's Specifications

For Post-Mate™

Punched Square Tube Signpost

FINISH The square signpost tubing shall be given triple coated protection by in-line application of hot dip galvanized zinc per AASHTO M-120 followed by a chromate conversion coating and a cross-linked polyurethane acrylic exterior coating. The inside surface shall be given corrosion protection by in-line application of a full zinc base organic coating after fabrication, tested in accordance with ASTM B-117.

SHAPE The cross section of the post shall be square tubing formed of 12 gauge (.105" USS gauge) steel, carefully formed into size and, if necessary, shall be welded in such a manner that weld or flash shall not interfere with telescoping.

RULES Hole diameter shall be seven-sixteenths plus or minus one sixty-fourth inch on 1" centers, on at least two opposite sides for the entire length of the post. Holes shall be on the centerline of each side in true alignment and opposite to each other.

YIELD/TENSILE PROPERTIES

<table>
<thead>
<tr>
<th>Nominal Dimensions</th>
<th>Minimum Yield</th>
<th>Minimum Tensile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3/4&quot; x 1-3/4&quot; x .105</td>
<td>50,000 PSI</td>
<td>55,000 PSI</td>
</tr>
<tr>
<td>2&quot; x 2&quot; x .105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1/4&quot; x 2-1/4&quot; x .105</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOLERANCES Tolerances on outside sizes:

<table>
<thead>
<tr>
<th>Nominal Outside Dimensions</th>
<th>Outside Tolerance at All Sides at Corners</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3/4&quot; x 1-3/4&quot;</td>
<td>plus or minus .008&quot;</td>
</tr>
<tr>
<td>2&quot; x 2&quot;</td>
<td>plus or minus .008&quot;</td>
</tr>
<tr>
<td>2-1/4&quot; x 2-1/4&quot;</td>
<td>plus or minus .010&quot;</td>
</tr>
</tbody>
</table>
TOLERANCES (Cont.)

Note: Measurements for outside dimensions shall be made at least 2" from end of tube.

Wall Thickness Tolerance: Permissible variation in wall thickness is plus .011", minus .008".

Convexity and Concavity: Measured in the center of the flat side tolerance is plus or minus 0.10" applied to the specific size determined at the corner.

Squareness of Sides and Twist:

<table>
<thead>
<tr>
<th>Nominal Outside Dimensions</th>
<th>Squareness Tolerance</th>
<th>Twist Permissible in 3' Lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3/4&quot; x 1-3/4&quot;</td>
<td>plus or minus .010&quot;</td>
<td>.062&quot;</td>
</tr>
<tr>
<td>2&quot; x 2&quot;</td>
<td>plus or minus .012&quot;</td>
<td>.062&quot;</td>
</tr>
<tr>
<td>2-1/4&quot; x 2-1/4&quot;</td>
<td>plus or minus .014&quot;</td>
<td>.062&quot;</td>
</tr>
</tbody>
</table>

Note: A sample shall be considered to fail if its sides are not 90 degrees to each other by the tolerance listed above.

Straightness Tolerance: Permissible variation in straightness is one-sixteenth of an inch in three feet.

Corner Radii: Standard outside corner radius shall be five-thirty seconds of an inch plus or minus one-thirty second of an inch.

LENGTH The length of each post shall be as specified and have a permissible length tolerance of plus or minus 1/4".

CROSS SECTION Posts shall be of one or more of the following sizes:

<table>
<thead>
<tr>
<th>Size</th>
<th>Gauge</th>
<th>Weight Per Foot, Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3/4&quot; x 1-3/4&quot;</td>
<td>12</td>
<td>2.175</td>
</tr>
<tr>
<td>2&quot; x 2&quot;</td>
<td>12</td>
<td>2.532</td>
</tr>
<tr>
<td>2-1/4&quot; x 2-1/4&quot;</td>
<td>12</td>
<td>2.890</td>
</tr>
</tbody>
</table>

TELESCOPING PROPERTIES The finished posts shall be straight and shall have a smooth uniform finish. It shall be possible to telescope all consecutive sizes of square tubes freely and for not less than ten feet of their length without the necessity of matching any particular face to any other face. All holes and ends shall be free from burrs and ends shall be cut square.
Appendix B

Mechanical and Chemical Properties
of Posts Used in Tests 1 and 2
MECHANICAL AND CHEMICAL PROPERTIES OF POSTS
USED IN TESTS 1 AND 2

Test 1

O.D. = 2.265"
t. = 0.100"
ULT. = 65,000 psi
Yield = 57,500 psi
% E = 30%
Carbon Content = 0.10%
Manganese = 0.32%
Phosphorus = 0.010%
Sulfur = 0.011%
AISI = 1010 carbon steel

Test 2

O.D. = 2.265"
t. = 0.101"
ULT. = 59,600 psi
Yield = 53,100 psi
% E = 28%
Carbon Content = 0.09%
Manganese = 0.30%
Phosphorus = 0.009%
Sulfur = 0.010%
AISI = 1010 carbon steel

min = 50 yield
min = 55 tensile