Memorandum

Subject: **ACTION:** Minnesota DOT Braced Leg Sign Support Eligibility Letter SS-170

From: Michael S. Griffith  
Director, Office of Safety Technologies  
Office of Safety

To: William Stein, Safety Engineer  
Minnesota Division

This memorandum is in response to your request for the Federal Highway Administration (FHWA) to review a roadside safety system for eligibility for reimbursement under the Federal-aid highway program.

Name of system: Minnesota Type “C” and “D” Braced Leg Sign Supports

Type of system: U-Channel Sign Support System

Test Level: NCHRP Report 350 Test Level 3

Testing conducted by: Texas Transportation Institute.

Date of request: November 23, 2010

Date of completed package: September 26, 2012

Initially acknowledged: December 13, 2010

**Decision**

The following device is eligible, with details provided below and in the drawings attached as an integral part of this memorandum:

- Minnesota Type “C” and “D” Braced Leg U-Channel Sign Supports

Based on a review of crash test results submitted certifying the device described herein meets the crash test and evaluation criteria of the National Cooperative Highway Research Program (NCHRP) Report 350, the device is eligible for reimbursement under the Federal-aid highway program. Eligibility for reimbursement under the Federal-aid highway program does not establish approval or endorsement by the FHWA for any particular purpose or use.

The FHWA, the Department of Transportation, and the United States Government do not endorse products or services and the issuance of a reimbursement eligibility letter is not an endorsement of any product or service.
Requirements
To be found eligible for Federal-aid funding, roadside safety devices should meet the crash test and evaluation criteria contained in the NCHRP Report 350 or the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH).

Description
You requested that we review this system using two posts within a seven-foot span under the provisions of the NCHRP Report 350.

The dual-post test installation consisted of an 8-foot wide by 7-foot tall plywood sign panel mounted on two steel U-channel supports spaced 39 inches apart. The supports were joined in a nested splice with two stubs driven into "strong soil." The stubs were 84 inches long with an embedment depth of 42 inches. The length of the structural splice between the stub and the sign riser post was 30 inches, with the bottom of the riser post 12 inches above ground level. Structural splices for u-channel posts should be a minimum of 18-inches long with two fasteners at each end of the splice piece.

The sign supports were braced with two additional supports posts mounted diagonally at a slope of 1:2:1 to the rear of the installation. The braces were attached to the front supports with A-frame brackets at the sign panel and anchored to two 48-Inch stubs, located 5 feet, 3 inches behind the front support stubs at 27-inch on center spacing. The rear stubs were also driven into the crushed limestone to a depth of 44 inches leaving 4 inches projecting above ground level.

All posts and stubs were 2.5 pound-per-foot rerolled rail steel u-channel posts. Stub-post connections and posts splices were joined with 5/16-inch by 1 1/8-inch alloy bolts, nuts, and washers. Both posts were struck during the crash tests. A drawing of the test installation is enclosed for reference.

Later crash testing of a three-post support used a similar design with 3-pound-per-foot posts, but only two of the supports were impacted. Additional posts may be used to support wider signs, but no two posts may be closer than 7 feet.

Crash Testing
Four tests were conducted under NCHRP Report 230 criteria in 1988 and 1989. NCHRP Report 230 Tests 62 and 63 were conducted on both the Type "C" dual-post installation and the Type "D" triple-post installation. The dual-post 2.5-pound-per-foot installation yielded to the vehicle in both the high- and low-speed tests and allowed it to proceed downrange. In the low-speed test of the triple-post installation with two posts impacted, the two 3-pound-per-foot diagonal braces that were impacted by the test vehicle yielded by breaking from their stubs, but the two signposts subsequently brought the vehicle to a controlled stop. In the high-speed test both of the sign posts and diagonal braces fractured, allowing the test vehicle to proceed through. The third post that was not impacted held the sign in place. Copies of the Test Data Summary Sheets are enclosed for reference. Type "C" and "D" refer to the number of u-channel rails used as lateral braces on the back of "A Frame" signs. Type "C" is a single brace while Type "D" is a dual brace as noted on page 2 of 3 of the attached drawings.
Since NCHRP Report 230 tests 62 and 63 use the same 820-kg test vehicle as specified in NCHRP Report 350 and the evaluation criteria are comparable, these tests are considered compliant with NCHRP Report 350. The bottom of the signs that span two or three posts should be a minimum of 7 feet above the ground. Supplemental signs placed on just one of the posts may be mounted at 5 feet above the ground.

The results of this testing was known to the researchers who conducted a series of sign support tests at the FHWA’s Federal Outdoor Impact Laboratory in McLean, Virginia, from 1989 to 1991. When designing a braced-leg system of u-channel posts they made two significant changes to the Minnesota design. The first was to use a breakaway splice for the upright sign posts where the signpost overlapped the stub by six inches, with the stub projecting no more than 4 inches above the ground. The second innovation was to use aluminum fasteners to ease the separation of both the upright and diagonal posts from their respective stubs. These changes have the potential for improving the Minnesota braced leg design.

Summary and Standard Provisions
Therefore, the system described and detailed in the attached form is eligible for reimbursement and may be installed under the range of conditions tested.

Please note the following standard provisions that apply to FHWA eligibility letters:

- This finding of eligibility does not cover other structural features of the systems, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may influence system conformance with NCHRP Report 350 criteria will require a new reimbursement eligibility letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals safety problems, or that the system is significantly different from the version that was crash tested, we reserve the right to modify or revoke this letter.
- You are expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the crash test and evaluation criteria of the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of eligibility is designated as number SS-170 and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The FHWA does not become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Attachment
Test No............. 0375-1
Date............. 05/24/86
Test Article........ Sign Installation
Support........ Four, 2.5 lb-ft Rerolled Rail U-Post Supports
Vehicle........ 1979 Honda
Vehicle Weight
Test Inertia........ 1,800 lb (817 kg)
Gross Static........ 1,967 lb (892 kg)
Vehicle Damage Classification
TAD........ 12FD1
SAE........ 12FDLW1
Impact Speed........ 19.6 mi/h (31.5 km/h)
Change in Velocity........ 13.2 mi/h (21.3 km/h)
Change in Momentum........ 1,084 lb-s
Vehicle Accelerations (Max. 0.050-sec Avg)
Longitudinal........ -3.18 g
Lateral........ -1.10 g
Occupant Impact Velocity
Longitudinal........ 12.89 ft/s (3.93 m/s)
Lateral........ 4.51 ft/s (1.38 m/s)
Occupant Ridedown Accelerations
Longitudinal........ -2.01 g
Lateral........ -0.49 g

Figure 10. Summary of results for test 0375-1.
<table>
<thead>
<tr>
<th>Test No</th>
<th>0375-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>05/24/88</td>
</tr>
<tr>
<td>Test Article</td>
<td>Sign Installation</td>
</tr>
<tr>
<td>Support</td>
<td>Four, 2.5 lb-ft</td>
</tr>
<tr>
<td>Rerolled Rail U-Post Supports</td>
<td></td>
</tr>
<tr>
<td>Vehicle</td>
<td>1979 Honda</td>
</tr>
<tr>
<td>Test Inertia</td>
<td>1,800 lb (817 kg)</td>
</tr>
<tr>
<td>Gross Static</td>
<td>1,967 lb (892 kg)</td>
</tr>
<tr>
<td>Vehicle Damage Classification</td>
<td>TAD 12FD</td>
</tr>
<tr>
<td>SAE</td>
<td>12FDEN1</td>
</tr>
<tr>
<td>Impact Speed</td>
<td>61.9 mi/h (99.7 km/h)</td>
</tr>
<tr>
<td>Change in Velocity</td>
<td>11.5 mi/h (18.4 km/h)</td>
</tr>
<tr>
<td>Change in Momentum</td>
<td>939 lb-s</td>
</tr>
<tr>
<td>Vehicle Accelerations</td>
<td>(Max. 0.050-sec Avg)</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>-4.04 g</td>
</tr>
<tr>
<td>Lateral</td>
<td>-2.07 g</td>
</tr>
<tr>
<td>Occupant Impact Velocity</td>
<td>Longitudinal</td>
</tr>
<tr>
<td>Lateral</td>
<td>N/A</td>
</tr>
<tr>
<td>Occupant Ridedown Accelerations</td>
<td>Longitudinal</td>
</tr>
<tr>
<td>Lateral</td>
<td>NONE</td>
</tr>
<tr>
<td>Maximum Vehicle Crush</td>
<td>Bumper Height</td>
</tr>
</tbody>
</table>

*Figure 19. Summary of results for test 0375-2.*
Figure 8. Summary of results for test 0394-1.
TYPE C & D POST

- Riser post and splice permitted
- 2.5" Stainless steel bolts with nylon insert lock nuts placed in top and bottom holes.

Typical Type C Installation

- Riser
- Lateral brace
- Panel

Typical Type D Installation

- Riser
- Lateral brace
- Panel

U Post Splice

- Stainless steel washer and nylon washer (4"/4") Max. (3") Max. (2") Max.

U Post Mounting Type C Signs

- 1/4" Stainless steel bolt with nylon.

Modified Type C Installation

NOTES:
1. Use 3.25"/7" stub posts, riser posts, stringers, knee braces, lateral braces and knee brace stub posts, all shall conform to NHDOT 3400.
2. For Type D sign posts lengths and spacings, see sign data sheet.
3. Type D sign panels shall be bolted to stringers at 24" maximum intervals in accordance with the Type D stringer and panel joint detail (see standard signs manual).
4. Mounting punch code for Type C sign panels shall be the same as indicated in the standard signs manual, unless otherwise specified.
5. All riser vertically posts shall be spliced, driven.
6. Use stainless steel 5/16" bolts, washers and nylon insert lock nuts as shown for all ground mounted and overhead mounted signs.
7. Stainless steel washer with same dimensions shall be provided between all nylon washers and bolt head.
8. Bracing stubs shall be no more than 4" above ground and embedded at least 36".
9. A-frame bracket shall be steel conforming to U.S. DOT 3306 and galvanized in accordance with U.S. DOT 3394.
10. Collars shall be used to shaw overlays and demountable leged away from panel where interference with bolt heads is encountered.
11. 2 Post Type C signs shall be reinforced with at least one lateral brace, installations where the total panel height is 60" or more shall have two lateral braces located approximately at the quarter points.
12. Where 2 single post type C signs are installed side by side, they shall be reinforced laterally by at least 2 braces, bolted at each post and located approximately at the quarter points.
13. Where 3 or more type C signs are installed side by side, they shall be reinforced laterally by at least 3 braces, bolted at each post and post section and located approximately at the quarter points.

TYPE C & D SIGN STRUCTURAL DETAILS

Sheet 1 of 3

STATE: PROJ. NO.
SHEET NO. OF SHEETS