U.S. Department of Transportation
Federal Highway Administration

Memorandum

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

Date: NOV 30 2012

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

In Reply Refer To:
HSST

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 ½:1 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 ½-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.

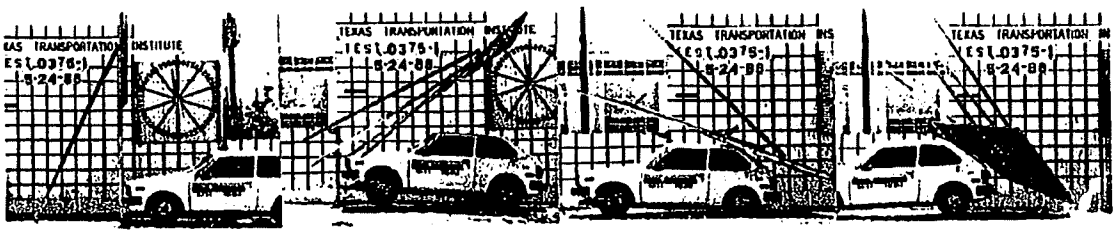
Summary and Standard Provisions

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.

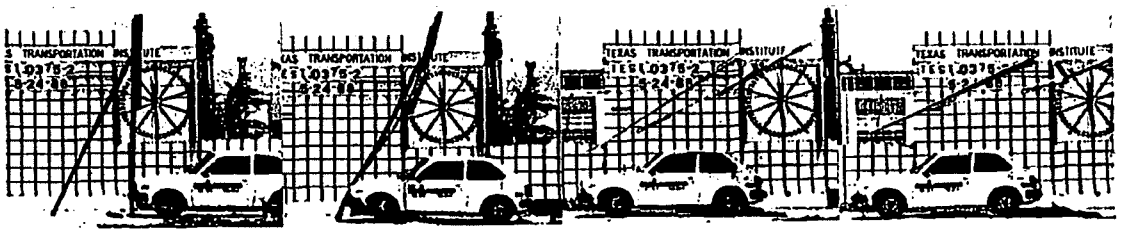
Attachment



0.000 s 0.398 s 0.795 s 1.193 s

Test No	0375-1	Impact Speed	19.6 mi/h (31.5 km/h)
Date	05/24/88	Change in Velocity	13.2 mi/h (21.3 km/h)
Test Article	Sign Installation	Change in Momentum	1,084 lb-s
Support	Four, 2.5 lb-ft Rerolled Rail U-Post Supports	Vehicle Accelerations (Max. 0.050-sec Avg)	
Vehicle	1979 Honda	Longitudinal	-3.18 g
Vehicle Weight		Lateral	-1.10 g
Test Inertia	1,800 lb (817 kg)	Occupant Impact Velocity	
Gross Static	1,967 lb (892 kg)	Longitudinal	12.89 ft/s (3.93 m/s)
Vehicle Damage Classification		Lateral	4.51 ft/s (1.38 m/s)
TAD	12FD1	Occupant Ridedown Accelerations	
SAE	12FDLW1	Longitudinal	-2.01 g
		Lateral	-0.49 g

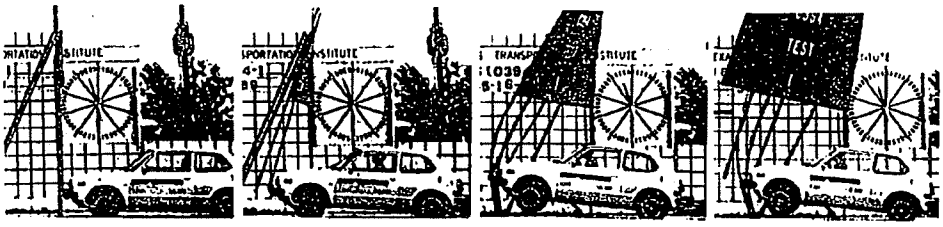
Figure 10. Summary of results for test 0375-1.



0.000 s 0.055 s 0.110 s 0.165 s

Test No	0375-2
Date	05/24/88
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	12FDEW1
Impact Speed	61.9 mi/h (99.7 km/h)
Change in Velocity	11.5 mi/h (18.4 km/h)
Change in Momentum	939 lb-s
Vehicle Accelerations (Max. 0.050-sec Avg)	
Longitudinal	-4.04 g
Lateral	-2.07 g
Occupant Impact Velocity	
Longitudinal	11.70 ft/s (3.57 m/s)
Lateral	N/A
Occupant Ridedown Accelerations	
Longitudinal	-1.18 g
Lateral	NONE
Maximum Vehicle Crush	
Bumper Height	4.0 in (10.2 cm)

Figure 19. Summary of results for test 0375-2.

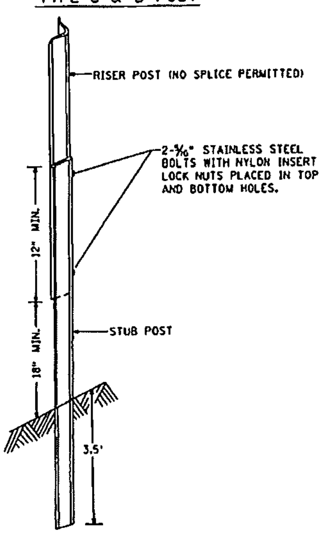


0.000 s 0.124 s 0.247 s 0.469 s

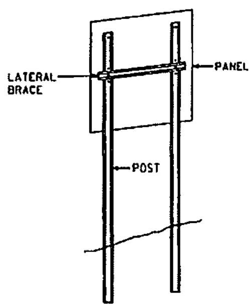
Test No.	0394-1	Impact Speed	21.4 mi/h (34.4 km/h)
Date	05/16/89	Change in Velocity	11.9 mi/h (19.2 km/h)
Test Article	Minnesota Type "D" Braced Sign Installation	Change in Momentum	977 lb-s
		Vehicle Accelerations (Max. 0.050-sec Avg)	
Support	Three 3-lb/ft Rerolled Rail U-Posts	Longitudinal	-2.9 g
		Lateral	1.1 g
		Occupant Impact Velocity	
Vehicle	1979 Honda Civic	Longitudinal	11.0 ft/s (3.3 m/s)
Vehicle Weight		Lateral	-6.7 ft/s (2.0 m/s)
Test Inertia	1,800 lb (817 kg)	Occupant Ridedown Accelerations	
Gross Static	1,965 lb (891 kg)	Longitudinal	-2.3 g
Vehicle Damage Classification		Lateral	1.2 g
TAD	12FD1		
SAE	12FDLN1		

Figure 8. Summary of results for test 0394-1.

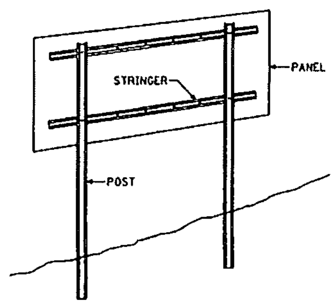
TYPE C & D POST



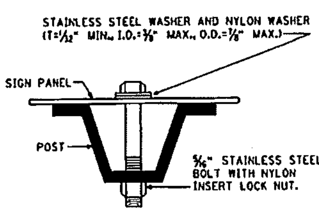
U POST SPLICE



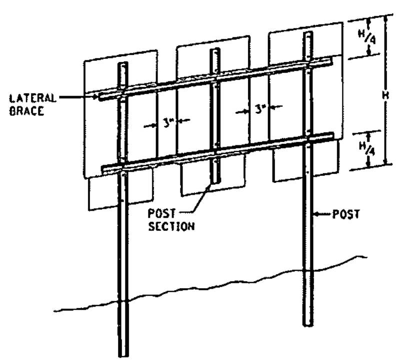
TYPICAL TYPE C INSTALLATION



TYPICAL TYPE D INSTALLATION



U POST MOUNTING
TYPE C SIGNS



MODIFIED TYPE C INSTALLATION

NOTES:

1. USE 3 LB/FT STUB POSTS, RISER POSTS, STRINGERS, KNEE BRACES, LATERAL BRACES AND KNEE BRACE STUB POSTS. ALL SHALL CONFORM TO MN/DOT 3401.
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 AS INDICATED IN THE STANDARD SIGNS MANUAL UNLESS OTHERWISE SPECIFIED.
5. ALL RISER (VERTICAL) U POSTS SHALL BE SPLICED. DRIVEN STUB POSTS SHALL BE AT LEAST 7' LONG.
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 HEADS.
8. BRACING STUBS SHALL BE NO MORE THAN 4" ABOVE GROUND AND EMBEDDED AT LEAST 3½'.
9. A-FRAME BRACKET SHALL BE STEEL CONFORMING TO MN/DOT 3306 AND GALVANIZED IN ACCORDANCE WITH MN/DOT 3394.
10. COLLARS SHALL BE USED TO SHIM OVERLAYS AND DEMOUNTABLE LEGEND AWAY FROM PANEL WHERE INTERFERENCE WITH BOLT HEADS IS ENCOUNTERED. MN/DOT 3352.2A5.
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 2 BRACES, BOLTED AT EACH POST AND POST SECTION AND LOCATED APPROXIMATELY AT THE QUARTER POINTS AS SHOWN IN MODIFIED TYPE C INSTALLATION.

TYPE C & D SIGN

STRUCTURAL DETAILS

Sheet 1 of 3

PLOTTED/REVISED 10/28/2008

DISTRICT #: METRO
PLOT NAME: C&D-SIGN-Groundmounted2
PATH & FILENAME: H:\SIGNING\WEB 2008\C&D-SIGN-Groundmounted.dgn

REVISED: 6-5-08

STATE PROJ. NO.	SHEET NO.	OF	SHEETS

PLOTTED/REVISED: 10/28/2008
DISTRICT 4, METRO
IPLOT NAME: C&D SIGN-Groundmounted
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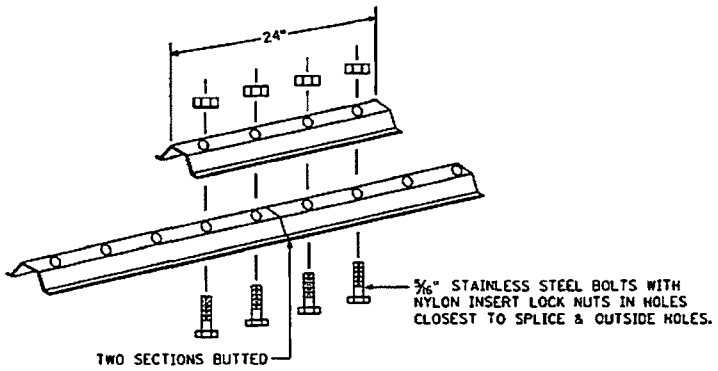
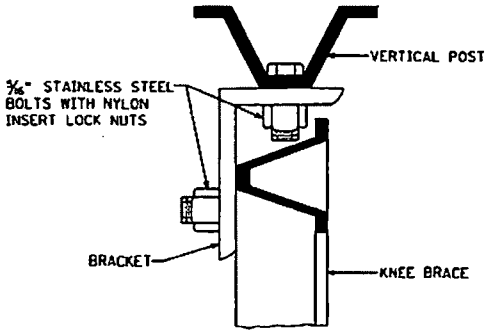
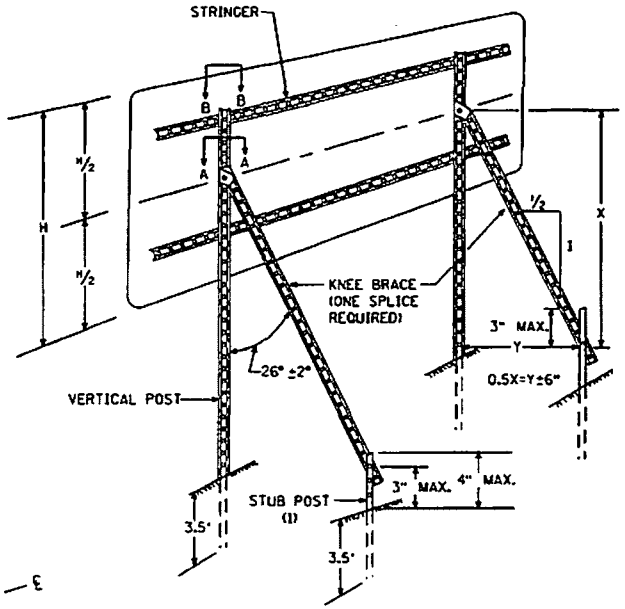


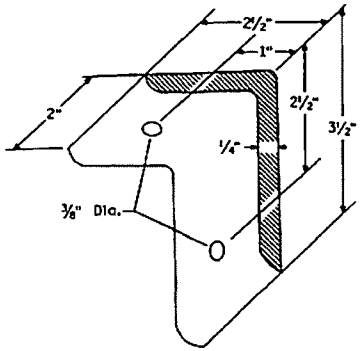
LATERAL BRACE OR STRINGER SPLICE DETAIL (EXPLODED VIEW)



SECTION A-A

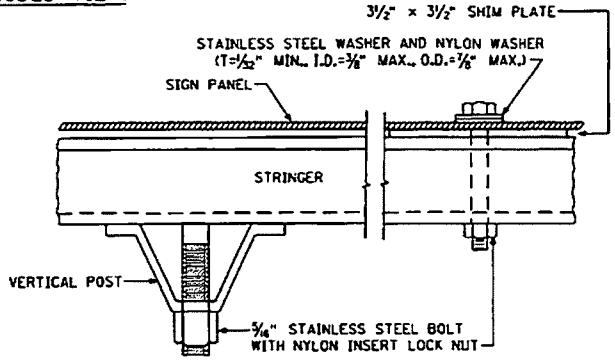


TYPICAL "A-FRAME" INSTALLATION
TYPE "D" SIGNS

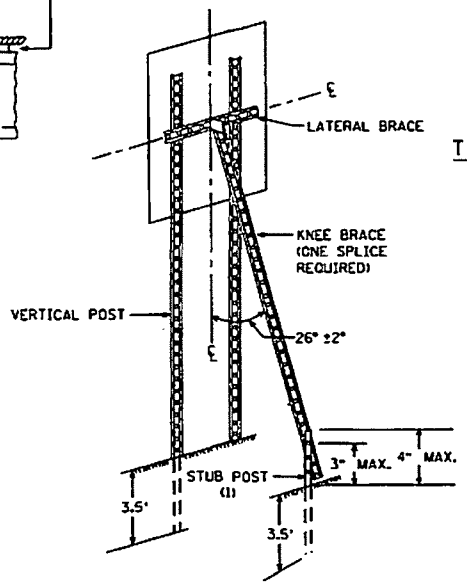


A-FRAME BRACKET

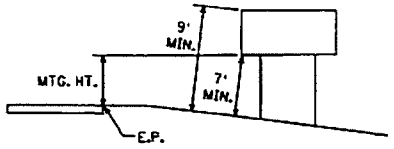
(STEEL MN/DOT 3306 GALVANIZED PER MN/DOT 3394)



SECTION B-B

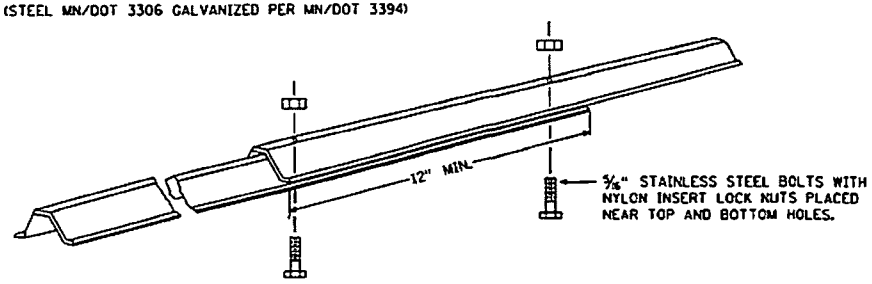


TYPICAL "A-FRAME" INSTALLATION
TYPE "C" SIGNS



TYPICAL MOUNTING

(1) OFFSET STUB POST 1' TOWARD ROADWAY RELATIVE TO VERTICAL POST. ATTACH STUB POST AND KNEE BRACE BACK TO BACK.



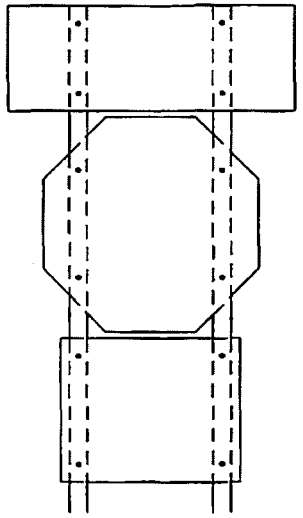
KNEE BRACE SPLICE

TYPE C & D SIGN
STRUCTURAL DETAILS

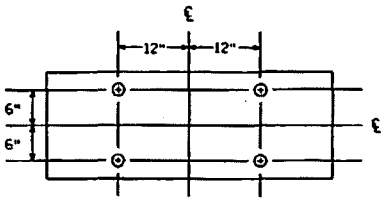
Sheet 2 of 3

REVISED: 1-7-08

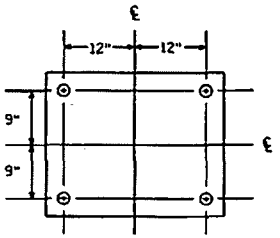
STATE PROJ. NO.	SHEET NO.	OF	SHEETS



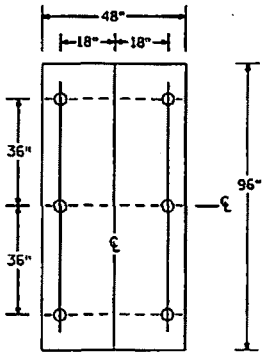
R6-1, R1-1 & (R6-3 OR R6-3a) MOUNTING



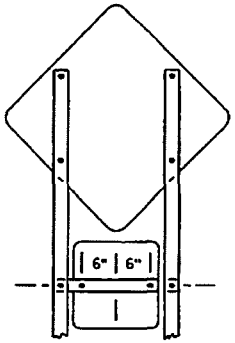
PUNCHING FOR R6-1(48"x18")



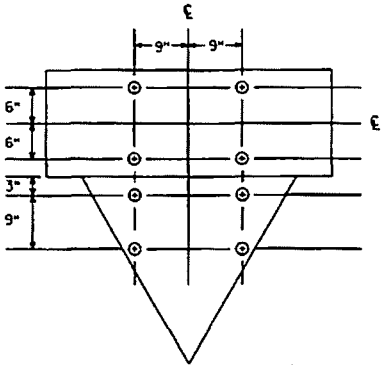
PUNCHING FOR R6-3 OR R6-3a(30"x24")



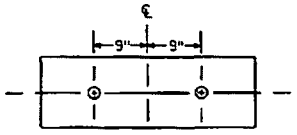
PUNCHING FOR R2-4b SPEED LIMIT



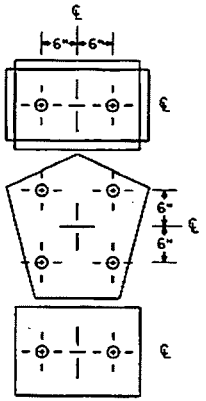
(W1-1, W1-2, W1-3, W1-4 OR W1-5) & W13-1 MOUNTING



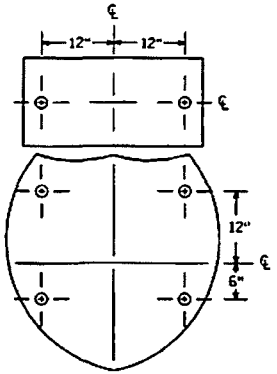
PUNCHING FOR R6-1(48"x18") & R1-2(36"x36"x36")



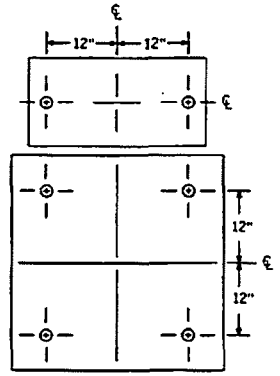
PUNCHING FOR R6-1(36"x12")



M2-1A (21"x15") OR (M3-1A, M3-2A, M3-3A OR M3-4A) (24"x12") AND M1-6 (24"x24") AND (M5-1A, M5-2A, M6-1A, M6-2A, M6-3A M6-4A, M6-5A OR M6-6A) (21"x15") PUNCHING



(M3-1A, M3-2A, M3-3A OR M3-4A) (30"x15") AND M1-1 (45"x36" OR 36"x36") PUNCHING



(M3-1, M3-1A, M3-2, M3-2A, M3-3, M3-3A M3-4 OR M3-4A) (30"x15") AND (M1-4 OR M1-5A) (36"x36") PUNCHING

TYPE C & D SIGN
STRUCTURAL DETAILS

Sheet 3 of 3

REVISED: 10-28-08

STATE PROJ. NO.	SHEET NO.	OF	SHEETS