



U.S. Department  
of Transportation  
Federal Highway  
Administration

November 14, 2008

1200 New Jersey Avenue, SE.  
Washington, DC 20590

In Reply Refer To: HSSD/B-182

Mr. Scott K. Rosenbaugh  
Research Associate Engineer  
Midwest Roadside Safety Facility  
University of Nebraska-Lincoln  
527 Nebraska Hall  
Lincoln, Nebraska 38588-0529

Dear Mr. Rosenbaugh:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of a roadside safety system for use on the National Highway System (NHS).

Name of system: Vertical-Faced, Concrete Median Barrier Incorporating  
Head Ejection Criteria  
Type of system: Concrete Median Barrier  
Test Level: NCHRP Report 350 TL 5 & MASH-08 TL 5  
Testing conducted by: Midwest Roadside Safety Facility  
Date of request: February 27, 2008  
Date of completed package: October 14, 2008

You requested that we find this system acceptable for use on the NHS under the provisions of National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features" and the proposed American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware 2008 (MASH-08).

### Requirements

Roadside safety systems should meet the guidelines contained in the NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". FHWA Memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers. You have also chosen to anticipate the adoption of MASH-08, an option that FHWA has offered with the understanding that additional testing may need to be done if changes to the test criteria are made before MASH-08 is formally adopted.



## **Description**

This concrete median barrier is intended to safely redirect vehicles ranging from small cars to fully-loaded tractor trailers, while (1) maximizing stability in passenger vehicles by limiting wheel climb and roll, (2) addressing occupant safety by limiting peak impact forces, (3) preventing head slap, and (4) providing an economical alternative to existing concrete barrier designs. The profile of the upper 8 inches of the barrier is set back to accommodate a “head ejection envelope” which was determined through an analysis of previous full-scale crash tests involving passenger vehicles impacting vertical-faced barriers and other rigid concrete barriers. The geometry of this setback directly applies only to rigid barriers with a vertical or near vertical face, and for belted occupants meeting the measurements of the Hybrid III 50 and 95 percentile male dummies.

The final barrier cross section design is shown in the drawings which are enclosed for reference. Also shown is the barrier end section with a footer whose function is to provide sufficient torsion resistance to match the overturning moment of the end section.

## **Crash Testing**

Full-scale crash testing was conducted with a tractor-trailer rig having a test inertial weight of 36,154 kg (79,538 pounds) following NCHRP Report 350 Test 5-12 and MASH-08 Test 5-12. The enclosed test data summary page shows the impact velocity was 84.9 km/hr (55.7 mi/hr) at an angle of 15.4 degrees. During the impact, the maximum roll angle of the truck was 22.8 degrees. Although the dynamic deflection of the barrier was negligible (38 mm, or about 1.5 inches), the “working width” considering the incursion of the box over the top of the barrier was 1894 mm (75 inches).

## **Findings**

The concrete median barrier adequately contained and redirected the vehicle without permanent displacements of the barrier. Vehicle roll, pitch, and yaw angular displacements were deemed acceptable, because they did not adversely influence occupant risk safety criteria nor cause rollover. After collision, the vehicle rode down the face of the barrier and did not intrude into adjacent traffic lanes. Thus, the vehicle’s exit angle was less than 60 percent of the impact angle. Therefore, test TL5CMB-2 conducted on a concrete median barrier was determined to be acceptable according to the TL-5 safety performance criteria found in NCHRP Report 350. Note, the test also satisfies all evaluation criteria for test 5-12 found in MASH-08.

Therefore, the system described above and detailed in the enclosed drawings is acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency.

As NCHRP Report 350 does not have mandatory evaluation criteria regarding vehicle occupants contacting the hardware outside of the occupant compartment, this letter is limited to accepting the performance as a median barrier to contain and redirect vehicles, with no implication that head ejection criteria is a requirement. However, MASH-08 does identify the safety risk involved with occupants extending out of the vehicle and coming into direct contact with the test article in Section 4.2.1.5, Paragraph 2. This guidance recommends that dummies are to be

placed in the front seat on the impact side of passenger vehicles during tests of longitudinal barriers taller than 33 inches. Although a passenger vehicle test was not performed, the barrier geometry was designed to prevent such occupant-barrier contact.

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

- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-182 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 acceptance 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 acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

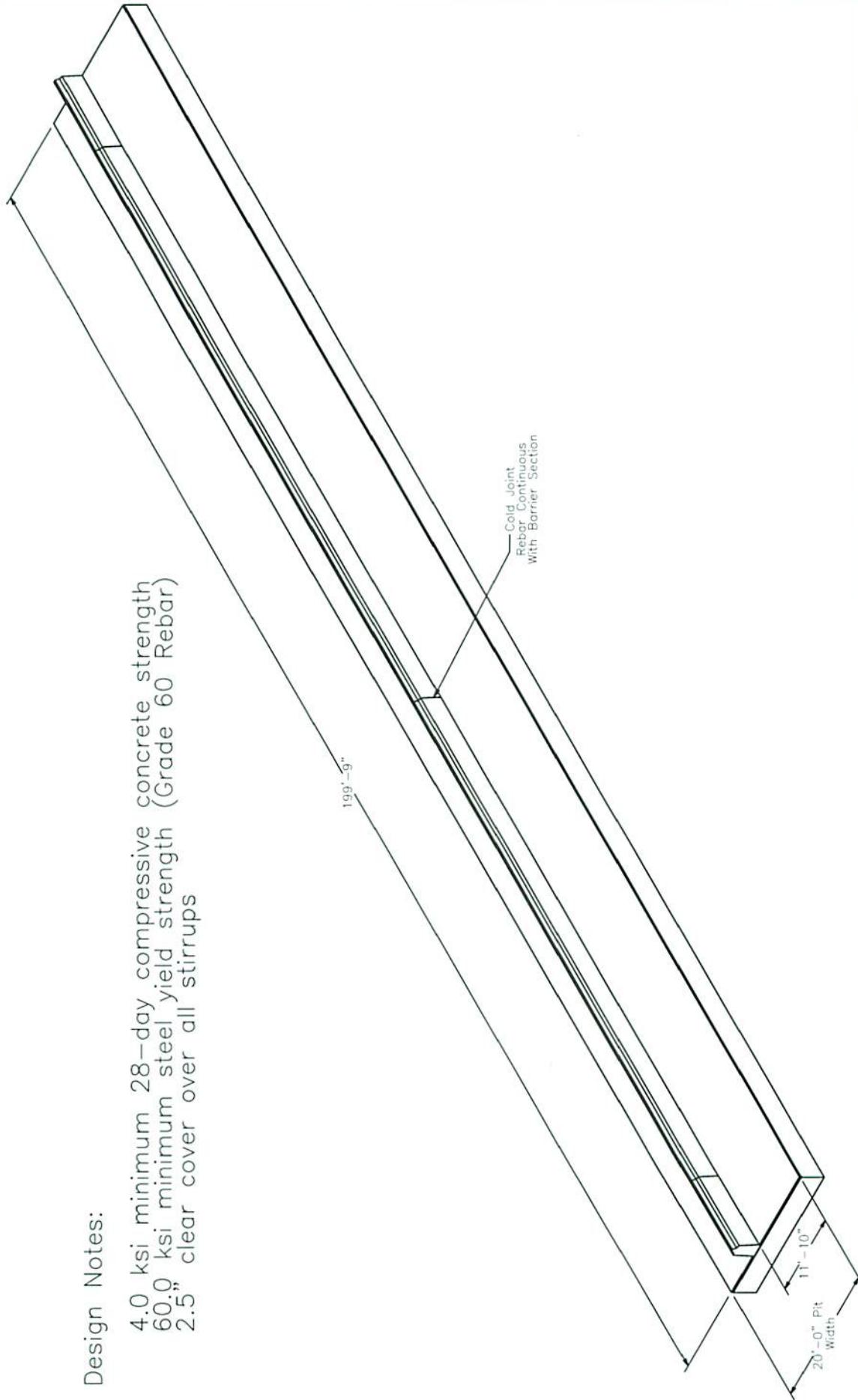


David A. Nicol  
Director, Office of Safety Design  
Office of Safety


Enclosures

Design Notes:

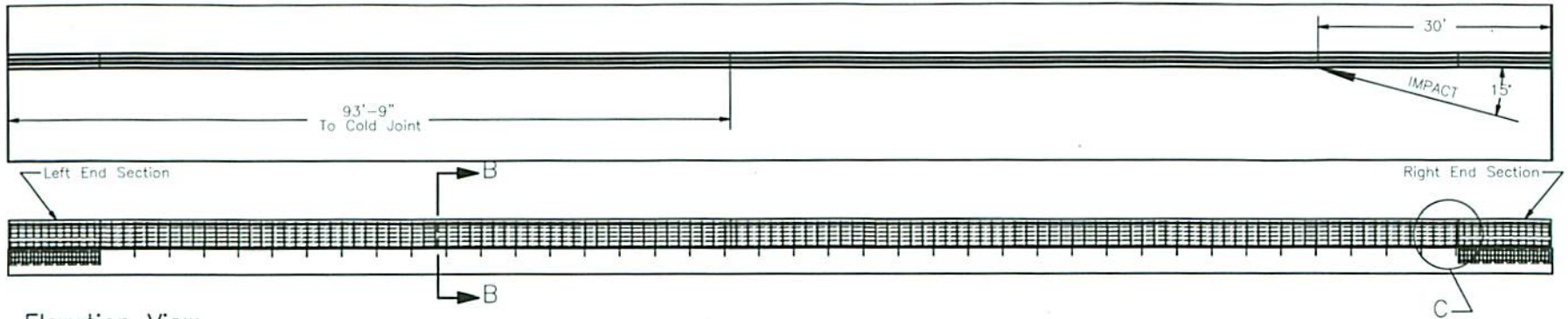
- 4.0 ksi minimum 28-day compressive concrete strength
- 60.0 ksi minimum steel yield strength (Grade 60 Rebar)
- 2.5" clear cover over all stirrups



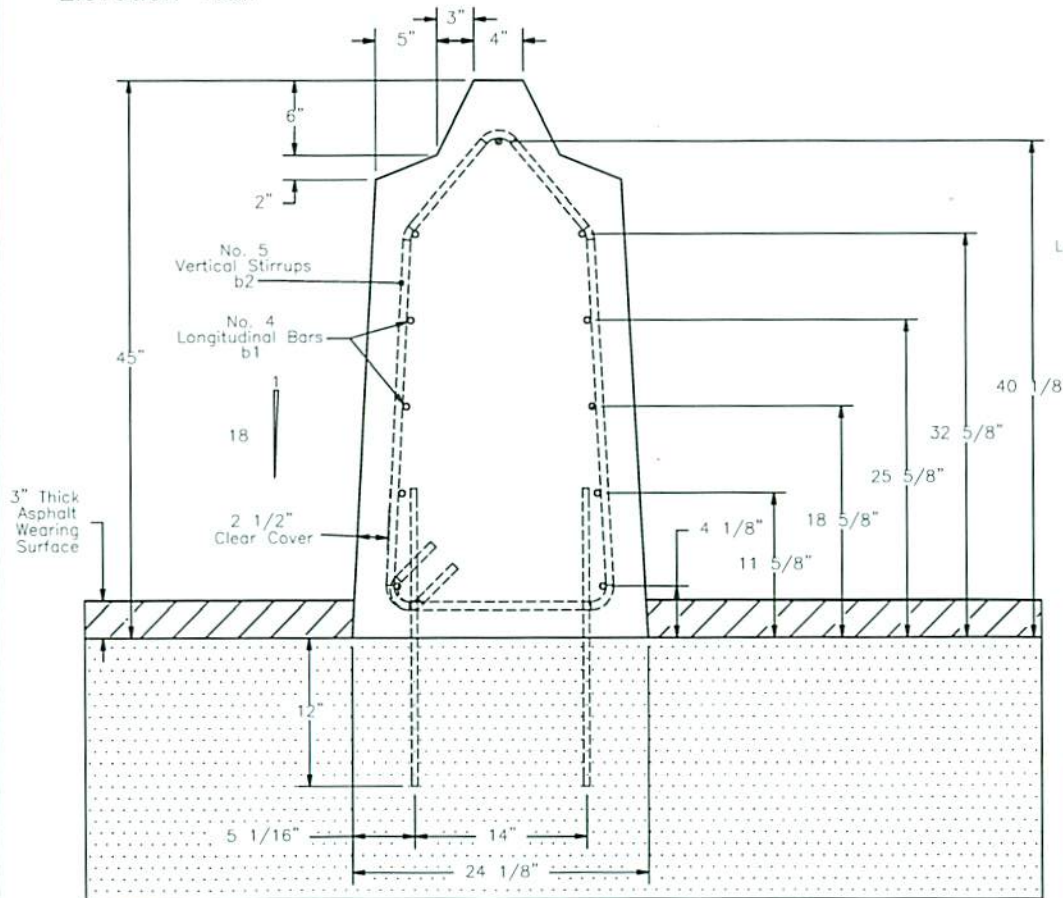
NOTE: (1) Asphalt wearing surface is flush with concrete mat  
 (2) 1" gap located between downstream end of barrier and concrete mat  
 (3) 2" gap located between upstream end of barrier and concrete mat  
 (4) Cold joint located 9.3' from end of barrier  
 (5) Impact location is 30' downstream of the upstream end of the barrier

	<b>TL-5 Concrete Median Barrier</b> System Layout		SHEET: 1 of 5
	DWG. NAME: TL-5_Median_Barrier_R9		DATE: 4/12/2007
<b>Midwest Roadside Safety Facility</b>		SCALE: None UNITS: inches	DRAWN BY: CSS
			REV. BY: KAP, RKF



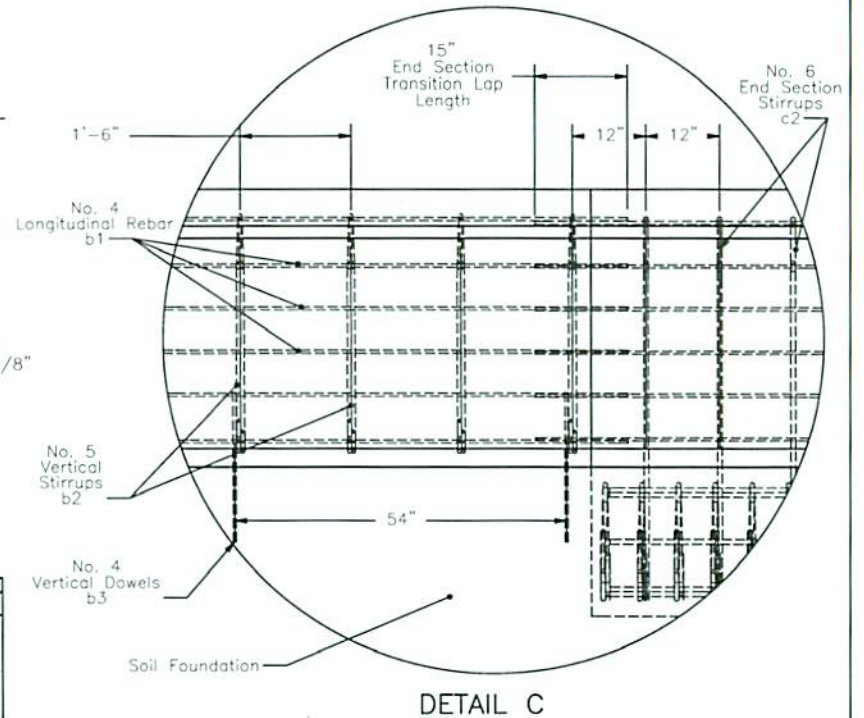


Elevation View



SECTION B-B  
SCALE 1:15

NOTE: Minimum lap length of longitudinal rebar in barrier is 12 inches. Minimum lap length between the end section and the remainder of the barrier is 15 inches.



DETAIL C



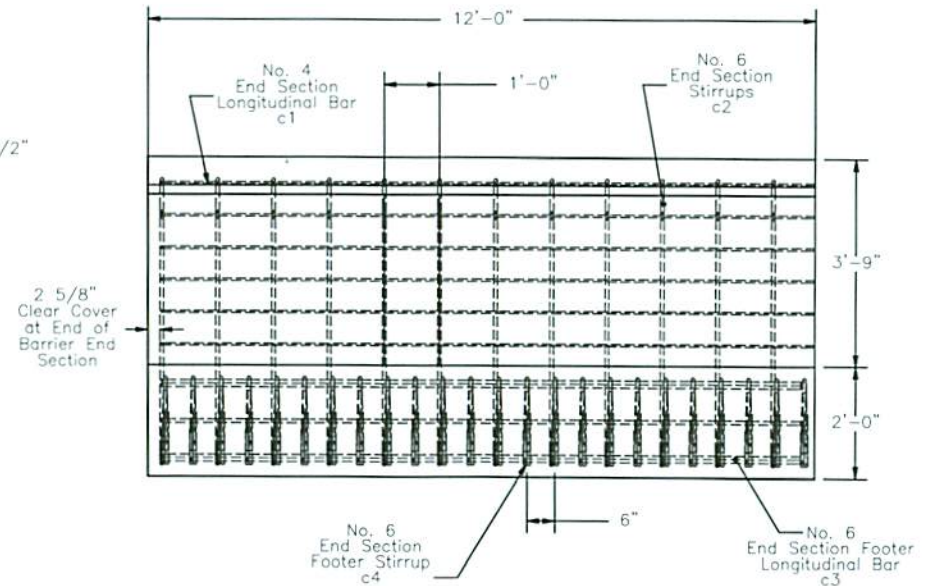
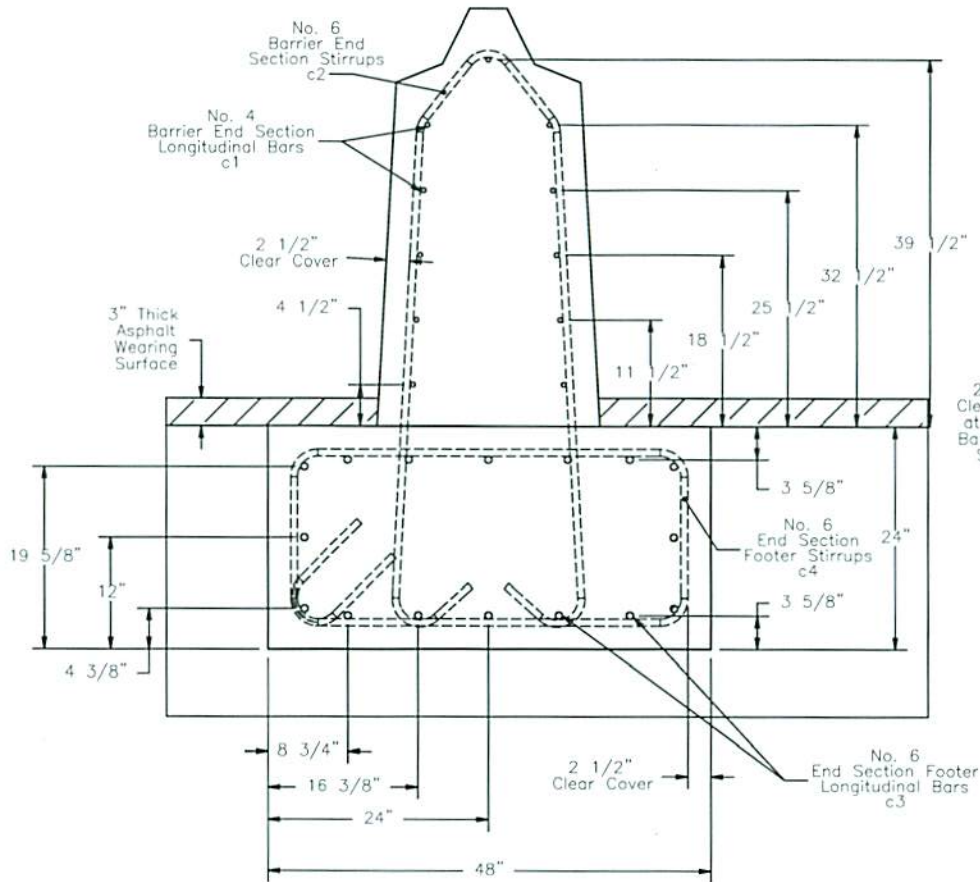
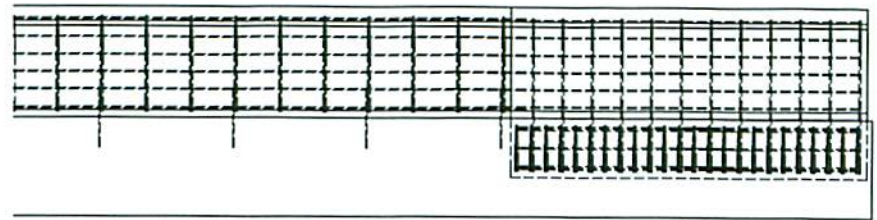
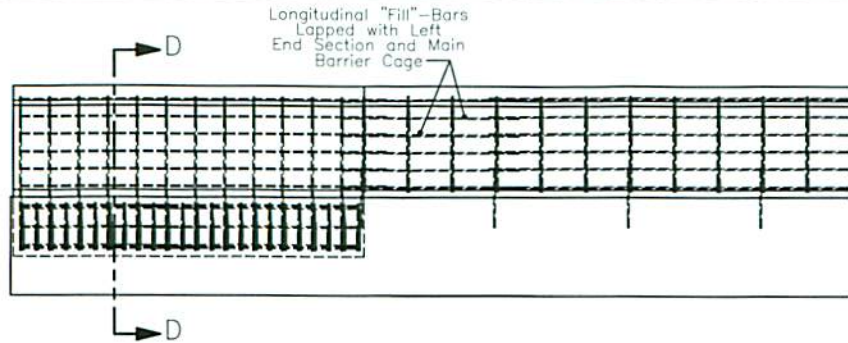
Midwest Roadside Safety Facility

TL-5 Concrete Median Barrier  
Interior Section  
Details

DWG. NAME:  
TL-5\_Median\_Barrier\_R9

SCALE: None  
UNITS: inches

SHEET:  
2 of 5  
DATE:  
4/12/2007  
DRAWN BY:  
CSS  
REV. BY:  
KAP, RKF



PLAN VIEW  
Left End Section  
Scale 1:40

NOTE: A 2' wide x 2' deep envelope of 350 soil fill surrounds both footers on all sides  
A 12' long x 4' wide x 6" deep aggregate 350 soil fill pad is located directly beneath the footer

SECTION D-D  
End Section  
Scale 1:20



Midwest Roadside  
Safety Facility

TL-5 Concrete Median Barrier  
End Section  
Details

DWG. NAME:  
TL-5\_Median\_Barrier\_R9

SCALE: None  
UNITS: inches

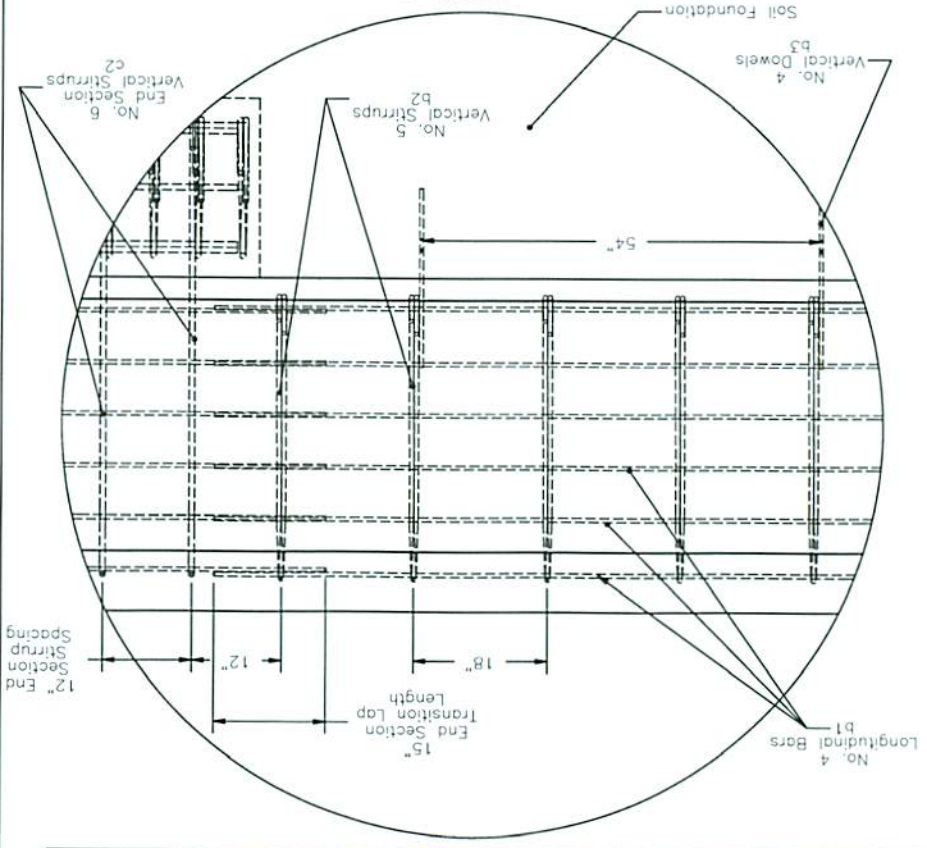
SHEET:  
3 of 5  
DATE:  
4/12/2007  
DRAWN BY:  
CSS  
REV. BY:  
KAP, RKF



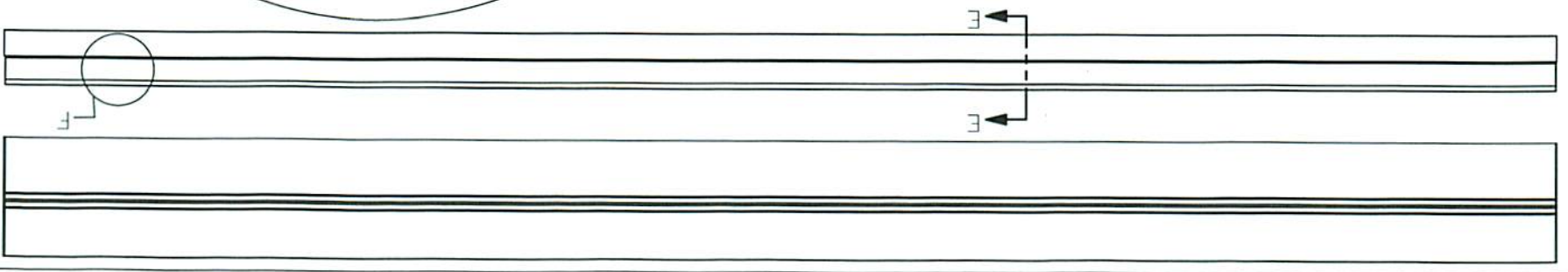
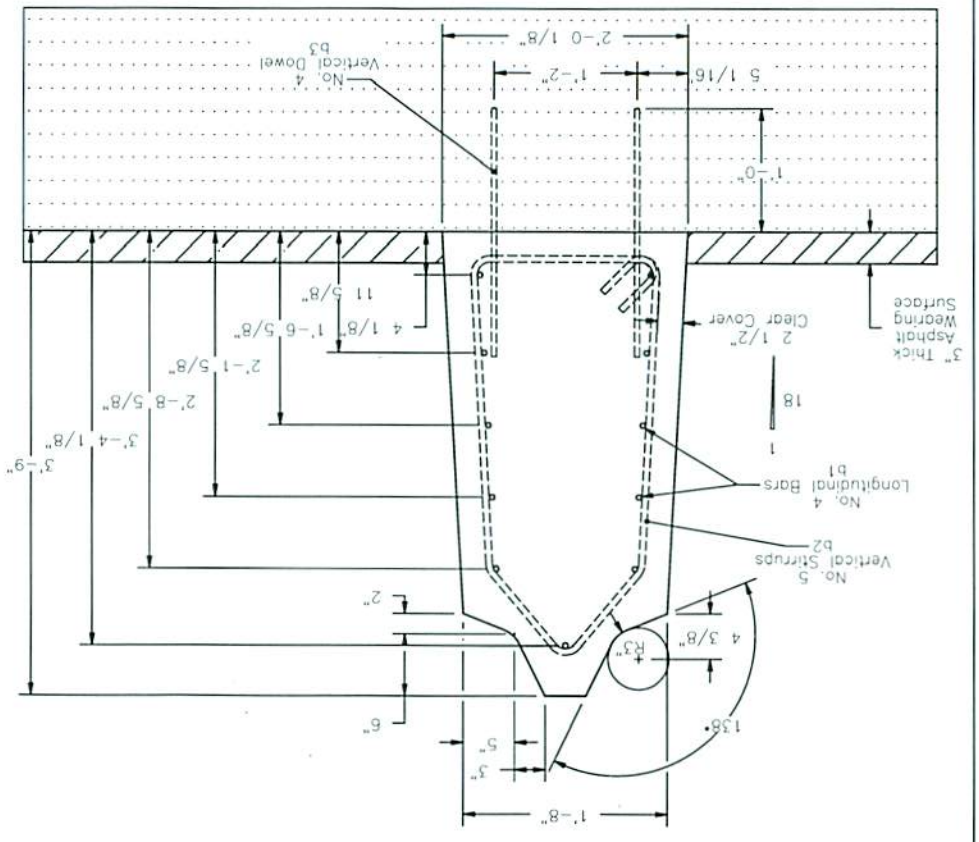
SHEET: 4 of 5	DATE: 4/12/2007	DRAWN BY: GSS	REV. BY: KAP, RKF	DLG. NAME: TL-5_Medion_Barrier_R9	SCALE: None	UNITS: inches
				Midwest Roadside Safety Facility		



DETAIL F  
SCALE 1 : 25

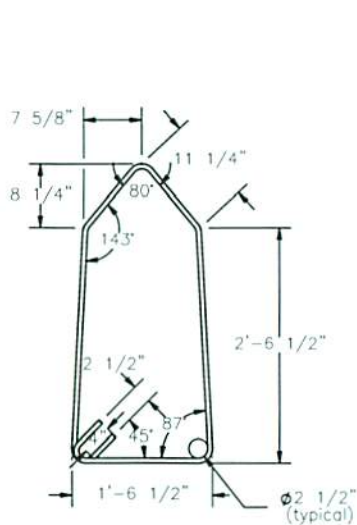


SECTION E-E  
SCALE 1 : 18



TL-5 Single-Slope Median Barrier - Bar Details

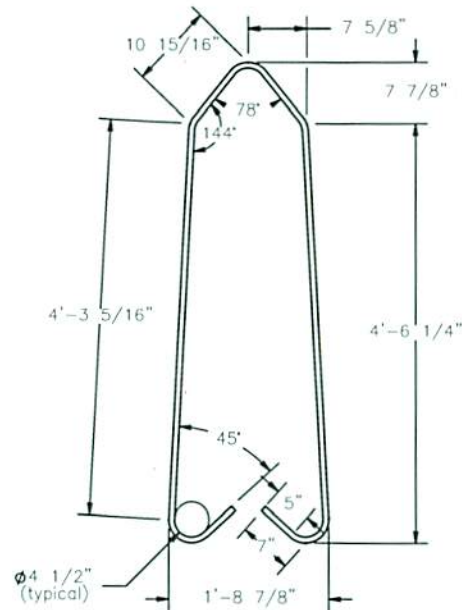
Item No.	QTY.	Pin Diameter	Length	Material Spec	Bar Size	Description
b1	99	-	240	Grade 60 Steel	No. 4	Longitudinal Bar, 11 per Section
b2	118	2.5"	111 1/2"	Grade 60 Steel	No. 5	Vertical Stirrup
b3	80	-	24"	Grade 60 Steel	No. 4	Vertical Dowel
b4	11	-	Not less than 72"	Grade 60 Steel	No. 4	Longitudinal "Fill" Bar, spliced with Left End Section and with remaining length of barrier section to close cage
c1	22	-	150"	Grade 60 Steel	No. 4	End Section Longitudinal Bar, 11 per End Section
c2	24	4.5"	147"	Grade 60 Steel	No. 6	End Section Stirrup
c3	32	-	138"	Grade 60 Steel	No. 6	End Section Footer Longitudinal Bar, 16 per End Section
c4	48	4.5"	141"	Grade 60 Steel	No. 6	End Section Footer Stirrup



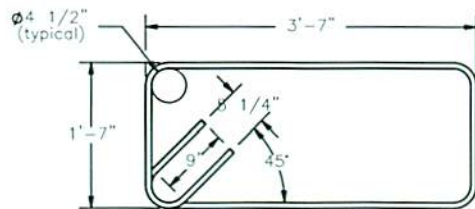
Vertical Stirrup  
Part b2



Vertical Dowel  
Part b3



End Section Stirrup  
Part c2



End Section Footer Stirrup  
Part c4



Longitudinal Bar  
Part b1



End Section Longitudinal Bar  
Part c1



End Section Footer Longitudinal Bar  
Part c3



Longitudinal "Fill" Bar  
Part b4



Midwest Roadside  
Safety Facility

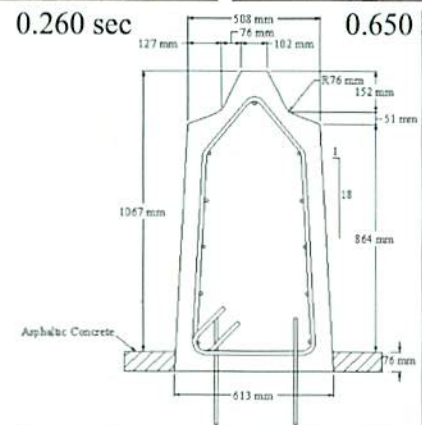
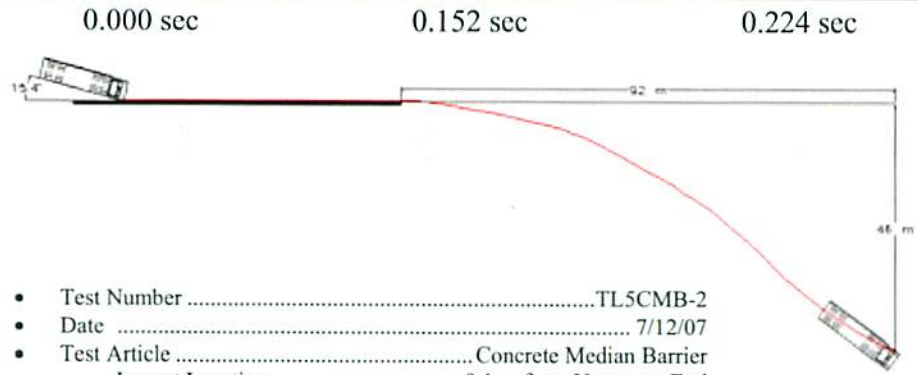
TL-5 Concrete Median Barrier  
Bill of Bars

DWG. NAME:  
TL-5\_Median\_Barrier\_R9

SCALE: 1:24  
UNITS: inches

SHEET:  
5 of 5  
DATE:  
4/12/2007  
DRAWN BY:  
CSS  
REV. BY:  
KAP, RKF





174

- Test Number ..... TL5CMB-2
- Date ..... 7/12/07
- Test Article ..... Concrete Median Barrier
  - Impact Location ..... 9.1 m from Upstream End
- Concrete Material ..... Nebraska L4000 mix
- Reinforcing Steel Material ..... Grade 60 Rebar
- Concrete Barrier
  - Length ..... 60.9 m
  - Base Width ..... 613 mm
  - Height Above Surface ..... 1,067 mm
  - Total Height ..... 1,143 mm
- Concrete Footers
  - Length ..... 3,658 mm
  - Width ..... 1,219 mm
  - Thickness ..... 610 mm
- Asphalt
  - Thickness ..... 76 mm
- Vehicle Model ..... 1991 White GMC Tractor
  - with 1988 Pines 48' Trailer
  - Curb ..... 13,072 kg
  - Test Inertial ..... 36,154 kg
  - Gross Static ..... 36,154 kg
- Vehicle Speed
  - Impact ..... 84.9 km/h
  - Exit ..... NA

- Vehicle Angle
  - Impact ..... 15.4 deg
  - Exit ..... NA
- Vehicle Stability ..... Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
  - Longitudinal ..... NA
  - Lateral ..... NA
- Occupant Impact Velocity
  - Longitudinal ..... NA
  - Lateral ..... NA
- Vehicle Damage ..... Moderate
  - TAD ..... 1-RFQ-5 and 1-RD-5
  - SAE ..... 1-FREN4 and 1-RDES1
- Vehicle Stopping Distance ..... 143 m downstream of impact
- Test Article Damage ..... Minimal
- Maximum Deflection
  - Permanent Set ..... NA
  - Dynamic ..... 38 mm
- Working Width ..... 1894 mm

Figure 65. Summary of Test Results and Sequential Photographs, Test TL5CMB-2