



U.S. Department  
of Transportation  
Federal Highway  
Administration

September 8, 2008

1200 New Jersey Avenue, SE.  
Washington, DC 20590

In Reply Refer To: HSSD/B-180

Mr. Bob Bielenberg  
Research Associate Engineer  
Midwest Roadside Safety Facility  
University of Nebraska – Lincoln  
P.O. Box 880529  
Lincoln, NE 68588-0529

Dear Mr. Bielenberg:

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:	Tie-down system for temporary concrete barrier on asphalt Transition system for temporary concrete barrier on asphalt
Type of system:	Portable concrete F-Shape barrier
Test Level:	NCHRP Report 350 Test Level 3 (TL-3)
Testing conducted by:	Midwest Roadside Safety Facility (MwRSF)
Test Sponsors:	Florida Department of Transportation and the Midwest States Pooled Fund Program
Date of request:	January 30, 2008

You requested that we find this system acceptable for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features.”

### Requirements

Roadside safety systems should meet the guidelines contained in the NCHRP Report 350. 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 the Manual on Assessing Safety Hardware-2008 (MASH08), 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 MASH08 is formally adopted.



## **Description**

Your request covers two applications of portable F-shape concrete barriers on asphalt pavements. The barrier used was the Kansas F-shape temporary concrete barrier that was developed for bolting through to concrete roadways. The barrier segments were 3.81 m (12.5 ft) long and 813 mm (32 in) tall with three 51 mm (2.0 in) diameter holes cast on each side in the toe of the barrier. Additional steel reinforcement was required around the holes to provide sufficient resistance and containment for the retainer bolts. As seen in the drawings enclosed for reference, adjacent barriers were joined using a pin and loop connection comprised of three sets of rebar loops – two at the top of one barrier meeting one on the top of the other barrier, and vice-versa on the bottom. This detail provided double shear at two locations on each pin, eliminating the need for a retainer bolt at the bottom of the pin.

The first application was placement of the barrier near the edge of an asphalt pavement adjacent to a drop off. To limit deflection and rotation of the barrier 38.1 mm (1.5 inch) diameter steel pins were inserted through the tie-down holes in the traffic side face of the barrier and driven through the asphalt pavement. Steel plates are welded near the top of the pins to help constrain the barrier upon impact. The system was crash tested on a 51 mm (2 in) thick asphalt pad. The second application was a transition between a free-standing Kansas F-shape temporary barrier on asphalt pavement, and a rigid concrete barrier. The transition used four barrier units and 38.1 mm (1.5 inch) diameter pins. The first unit in the transition had one pin at the down stream end. The second unit had pins installed in the two outside hole locations. The final two units had all three pins installed. All pins were installed in the traffic side face of the barrier. In addition, nested 12 ga thrie beam was bolted across both sides of the barrier at the joint between the pinned barriers and the rigid barrier to reduce the potential for vehicle snagging at the joint.

## **Crash Testing**

One NCHRP Test 3-11 using the 2000P vehicle was conducted on each application. The test data summary sheets are enclosed for reference. The FTB-1 was the test of the tie-down design, and FTB-2 was the test of the transition. In test FTB-1 the asphalt pavement fractured when the barrier was struck, leading to a maximum dynamic deflection of 554 mm (21.8 in) and a permanent set of 283 mm (11.1 in).

In test FTB-2 the impact point was evaluated using finite element analysis, and it was determined that the critical impact point was just upstream of the joint between the first two pinned barriers (the first having one pin in the downstream hole only, and the second barrier having pins at the two ends.) Because of the known stiffness of the next two barriers anchored with three pins, it was determined that the connection between the last two pinned barriers and the rigid concrete barrier would not require a separate crash test. Upon impact the vehicle was redirected with the right rear tire and the pickup truck box landing on the top of the barrier on the traffic side before exiting the system. The maximum permanent set and dynamic barrier deflections were measured to be 133 mm (5.25 in) and 467 mm (18.375 in), respectively.

Results of FTB-1 and FTB-2 met the test and evaluation criteria in NCHRP Report 350 for Test 3-11.

## Findings

You asked for acceptance of both the tie-down system for F-shape temporary concrete barriers on asphalt pavements and the approach transition between free-standing temporary concrete barriers and rigid concrete barrier. The tie-down system for F-shape temporary concrete barriers on asphalt pavements was tested with the back face of the barriers positioned 0.15 m (6 in) from the edge of a vertical drop-off in order to represent a worst case impact scenario. You also requested that the tie-down system be accepted for both installations adjacent to a drop-off as tested and installations on standard asphalt paved surfaces. This request is based on the successful results from the dynamic component testing, computer simulation modeling of the barrier system, and full-scale vehicle crash testing of both the tie-down and approach transition designs. We concur in these requests.

The tie-down system for temporary concrete barrier on asphalt and transition system for temporary concrete barrier on asphalt described above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency.

In your original letter requesting acceptance MwRSF also noted some specific recommendations for the tie-down and transition regarding the use of the system near a drop-off. You also made a recommendation regarding the use of the tie-down and transition with other barrier designs. We concur that these recommendations should be included in the letter.

“It should also be noted that the tie-down and transition systems described herein were designed for use with the Kansas F-shape temporary concrete barrier system, and therefore, they should not be used with other temporary barrier systems or joint connections without further study. Although it is very likely that this tie-down system can be adapted to other approved temporary barrier systems, it is necessary to utilize some criteria to aid in that determination. They are as follows:

1. Joints between barrier segments must have comparable or greater torsional rigidity about the longitudinal barrier axis when compared to that of the as-tested configuration.
2. Alternative barrier segment lengths would be acceptable as long as they are at least 3.81-m (12.5 ft) long and utilize an equivalent or greater number of anchors per foot of barrier length. With shorter barrier lengths, it is believed that additional barrier rotation will occur due to the greater number of joints, thus resulting in the propensity for increased climbing and rollover.
3. Alternative barrier segments should have comparable mass per unit length.
4. Alternative barrier segments should have equal or greater reinforcement than the F-shape barrier described herein. This reinforcement recommendation is to include the longitudinal steel, shear stirrups, and containment steel bars surrounding the anchor boxes used with the vertical anchor rods.
5. The shape of alternative barrier segments may require further study. Past research has shown that the F-shape provides slightly improved results over those observed using the New Jersey shape barrier. Therefore, further study may be needed to assure safe performance when applying the designs to other barrier shapes.”

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

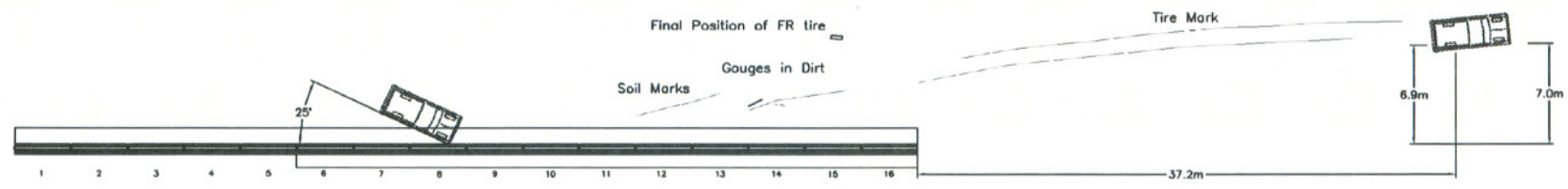
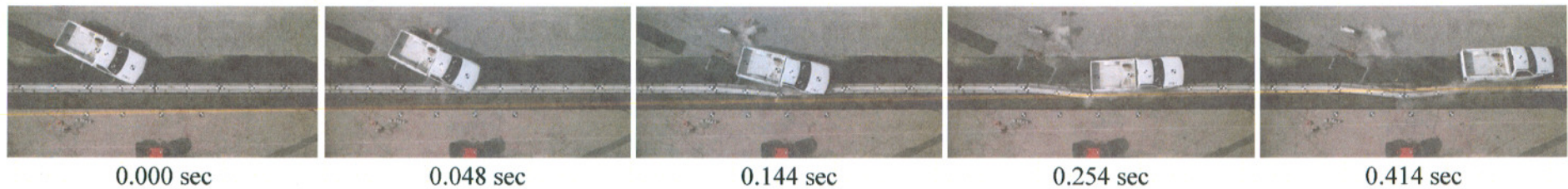
- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance 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-180 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, P.E.  
Director, Office of Safety Design  
Office of Safety

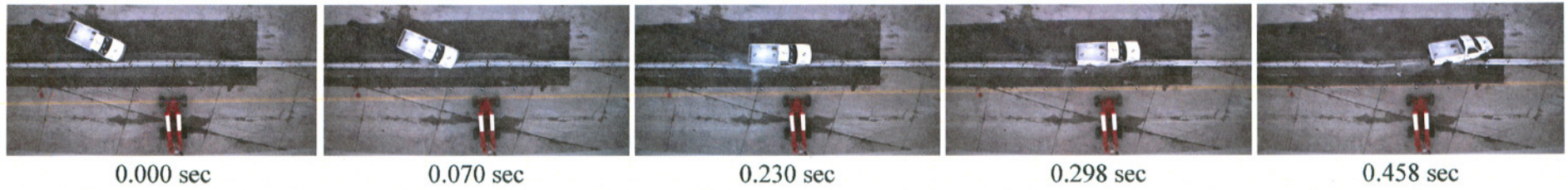
Enclosures



- Test Number ..... FTB-1
- Date ..... 9/27/04
- NCHRP 350 Test Designation ..... 3-11
- Appurtenance ..... F-Shape PCB Asphalt Pin Tie-Down
- Total Length ..... 62.34 m
- Overall Height ..... 813 mm
- Placement ..... 152 mm from edge of 914 mm vertical drop
- Barrier Elements ..... 16 F-Shape Kansas Temporary Concrete Barriers
- Barrier Joint Pin Connections ..... 32-mm diameter by 712-mm long A36 steel pin with a 64x102x132-mm plate
- Tie-Down Anchors ..... Three 38.1-mm dia. x 914-mm long A36 steel pins per barrier on the traffic side face only
- Vehicle Model ..... 1998 GMC C2500 Pickup Truck
  - Curb ..... 1,954 kg
  - Test Inertial ..... 2,011 kg
  - Gross Static ..... 2,011 kg
- Impact Location ..... 1,219 mm of joint between barrier nos. 8 and 9
- Vehicle Speed
  - Impact ..... 98.7 km/h
  - Exit ..... NA

- Vehicle Angle
  - Impact ..... 25.4 deg
  - Exit ..... 14.8 deg
- Vehicle Snagging ..... Minor
- Vehicle Stability ..... Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
  - Longitudinal ..... 18.89 g's < 20 g's
  - Lateral (not required) ..... 14.00 g's < 20 g's
- Occupant Impact Velocity
  - Longitudinal ..... 3.93 m/s < 12 m/s
  - Lateral (not required) ..... 5.73 m/s < 12 m/s
- Vehicle Damage ..... Moderate
  - TAD ..... 1-RFQ-3
  - SAE ..... 1-REAW3
- Vehicle Stopping Distance ..... 69.7m downstream
  - 6.9 m from traffic-side face
- Barrier Damage ..... Moderate
- Maximum Rail Deflections
  - Permanent Set ..... 283 mm
  - Dynamic ..... 554 mm (top of barrier)
- Working Width ..... 1,125 mm

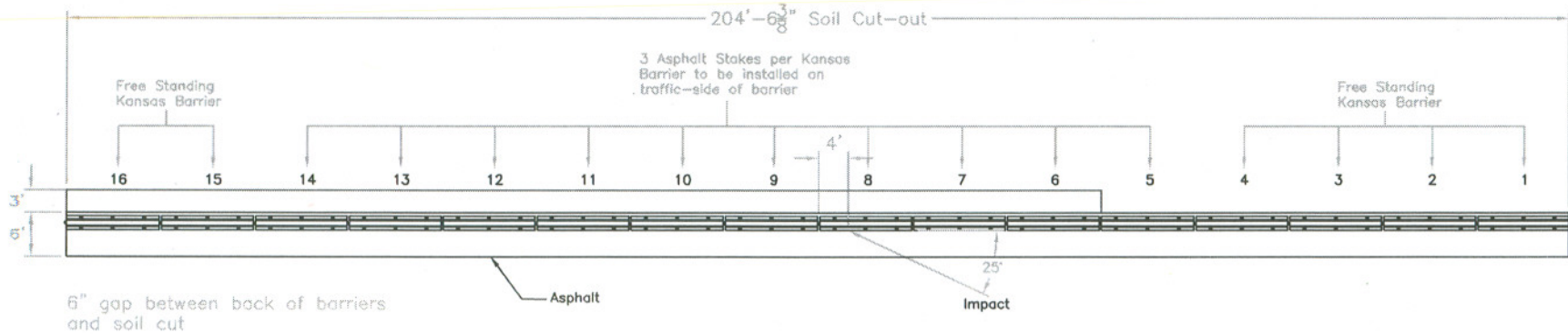
Figure 6. Summary of Test Results and Sequential Photographs, Test FTB-1



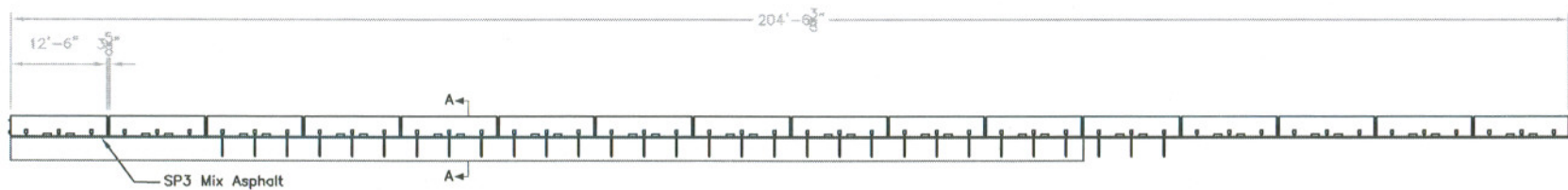
- Test Number ..... FTB-2
- Date .. 4/20/05
- NCHRP 350 Test Designation ..... 3-21
- Appurtenance ..... F-Shape PCB Transition
- Total Length ..... 62.34 m
- Overall Height ..... 813 mm
- Barrier Elements ..... 22 F-Shape Kansas Temporary Concrete Barriers
- Barrier Joint Pin Connections ..... 32-mm diameter by 712-mm long A36 steel pin with a 64x102x132-mm plate
- Asphalt Tie-Down Anchors ..... 38.1-mm dia. x 978-mm long A36 steel pins on the traffic side face only
- Concrete Tie-Down Anchors ..... 28.6-mm dia. B7 threaded rods epoxied and embedded 305 mm into the concrete
- Transition Beam ..... Nested 12 gauge thrie beam on front and back
- Vehicle Model ..... 2000 GMC C2500 Pickup Truck
  - Curb ..... 1,993 kg
  - Test Inertial ..... 2,030 kg
  - Gross Static ..... 2,030 kg
- Impact Location ..... 1,219 mm of joint between barrier nos. 14 and 15
- Vehicle Speed
  - Impact ..... 102.7 km/h
  - Exit ..... NA

- Vehicle Angle
  - Impact ..... 26.1 deg
  - Exit ..... 9.8 deg
- Vehicle Snagging ..... Minor
- Vehicle Stability ..... Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
  - Longitudinal ..... 7.25 g's < 20 g's
  - Lateral (not required) ..... 12.66 g's < 20 g's
- Occupant Impact Velocity
  - Longitudinal ..... 5.04 m/s < 12 m/s
  - Lateral (not required) ..... 5.69 m/s < 12 m/s
- Vehicle Damage ..... Moderate
  - TAD ..... 1-RFQ-4
  - SAE ..... 1-RFAW4
- Vehicle Stopping Distance ..... 62.4m downstream  
1.4 m from traffic-side face
- Barrier Damage ..... Moderate
- Maximum Rail Deflections
  - Permanent Set ..... 133 mm
  - Dynamic ..... 467 mm (top of barrier)
- Working Width ..... 668 mm

Figure 11. Summary of Test Results and Sequential Photographs, Test FTB-2



Plan View



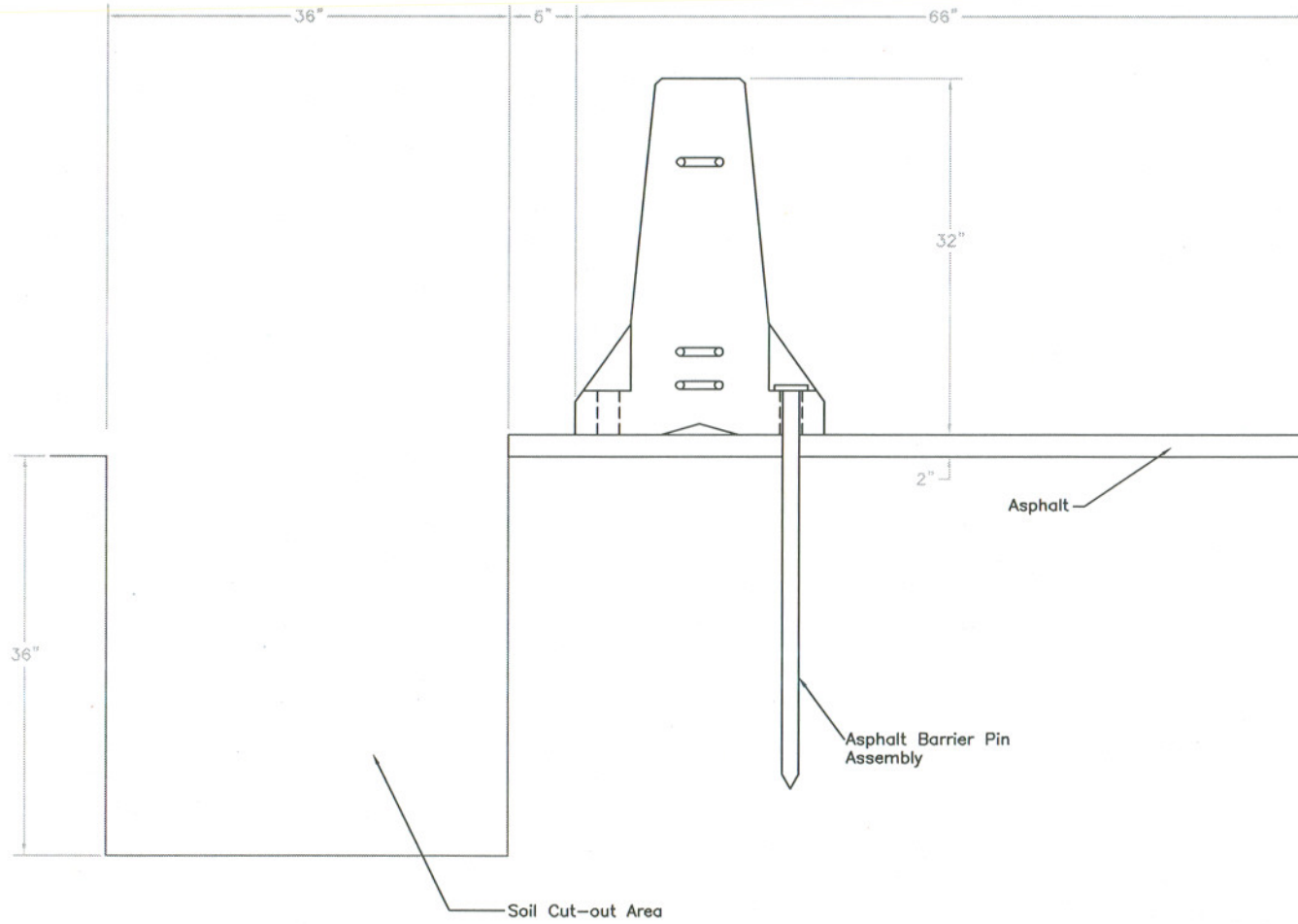
Front Elevation

- Note: 1) Barriers 5-13 are new Barriers.  
 2) Use minimum 28-day concrete compressive strength of 5000 psi.  
 3) Use native fill soil under asphalt




**Midwest Roadside  
 Safety Facility**

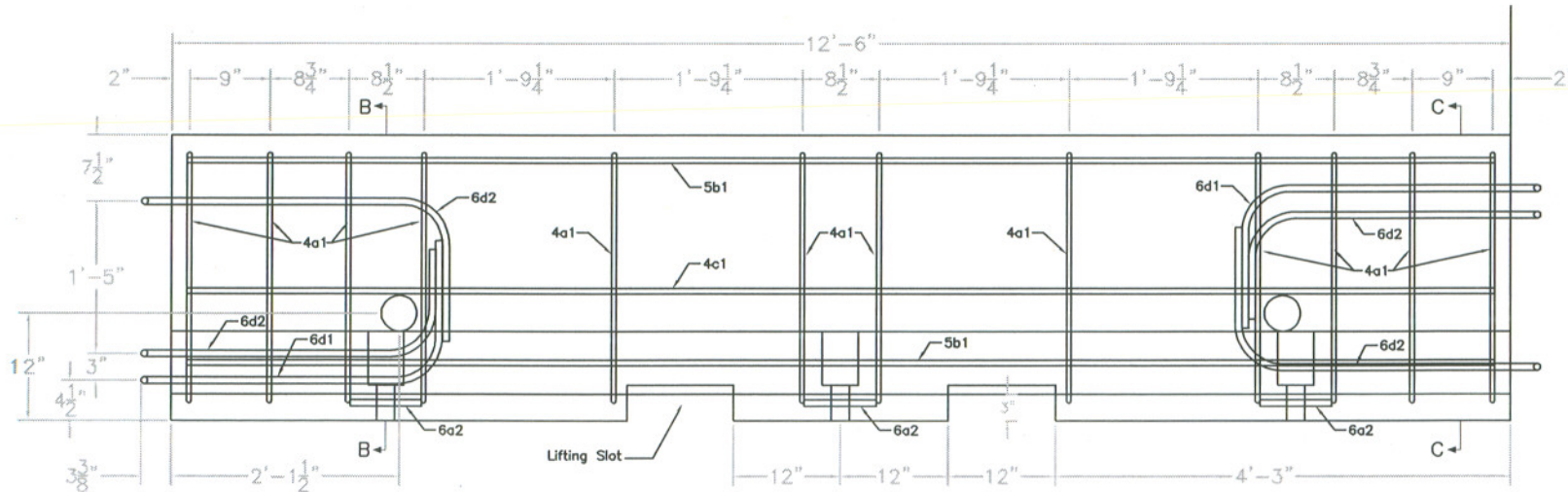
Florida Temporary Barrier Connection to Asphalt  Layout		Sheet: 1 of 7
		Date: 09/28/2004
Drawing Name: FL AspTrans R5.dwg		By: GEP/DTK
		Rev: KAP/BWB
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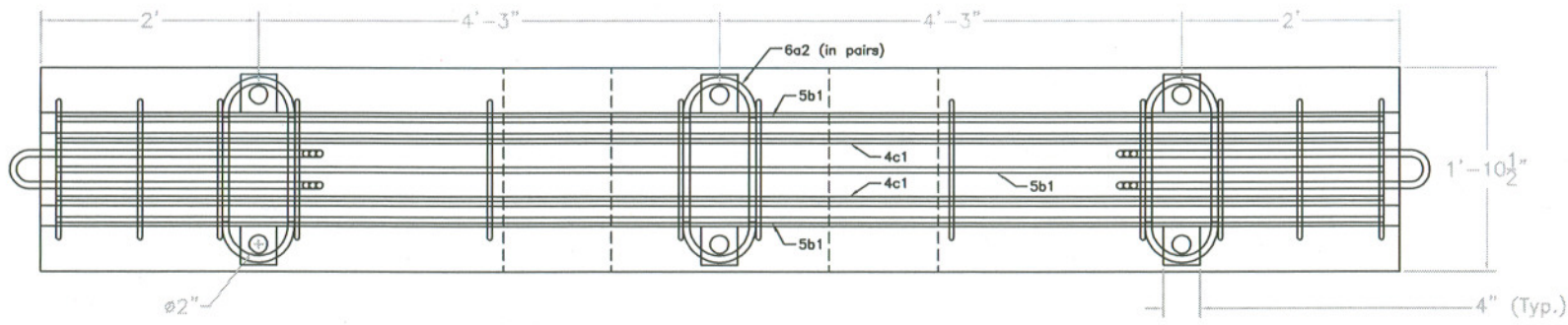
Note: Reinforcement rebar not shown

	Florida Temporary Barrier Connection to Asphalt		Sheet: 2 of 7
	Section A-A		Date: 09/28/2004
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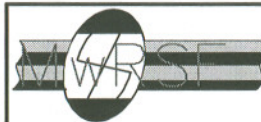




Elevation View



Plan View



**Midwest Roadside  
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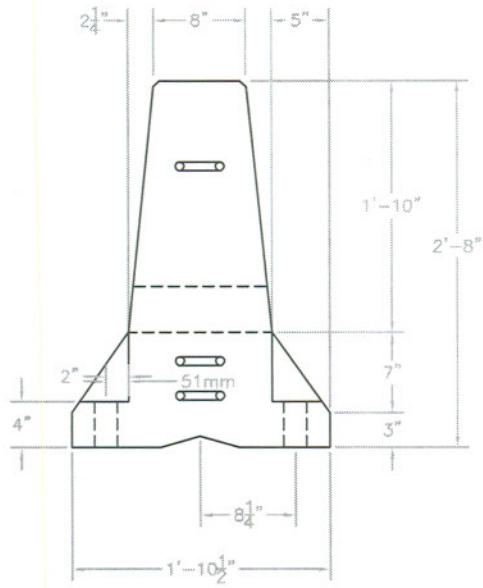
Florida Temporary Barrier  
Connection to Asphalt

Barrier

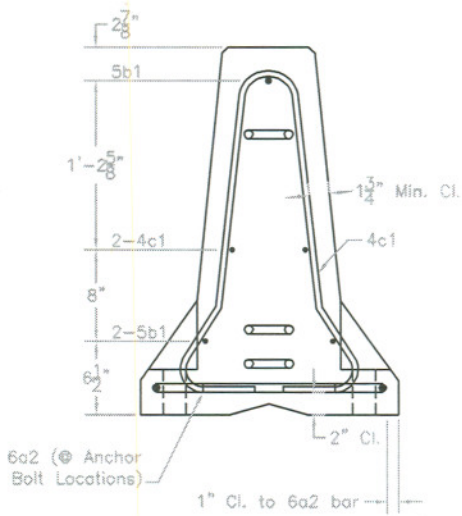
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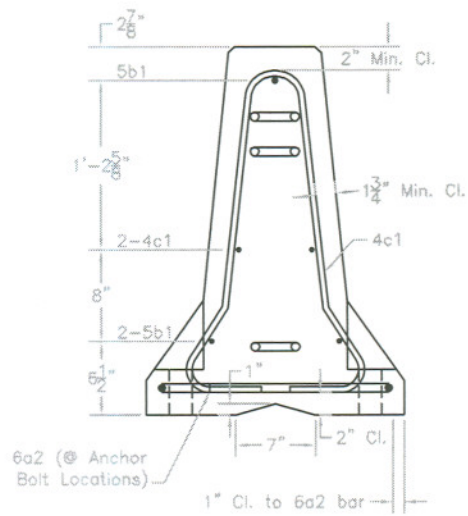
Sheet:  
3 of 7  
Date:  
09/28/2004  
By:  
GEP/DTK  
Rev:  
KAP/BWB



End View



Section B-B (Typ.)



Section C-C (Typ.)



**Midwest Roadside  
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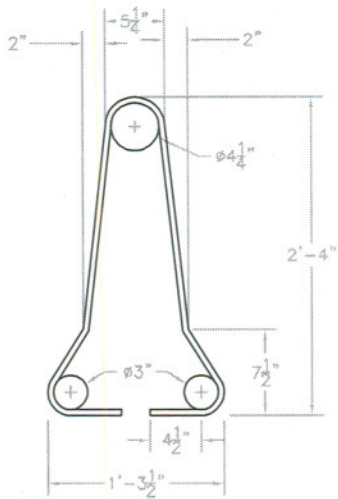
Florida Temporary Barrier  
Connection to Asphalt

Profile and Tie Down Details

Drawing Name:  
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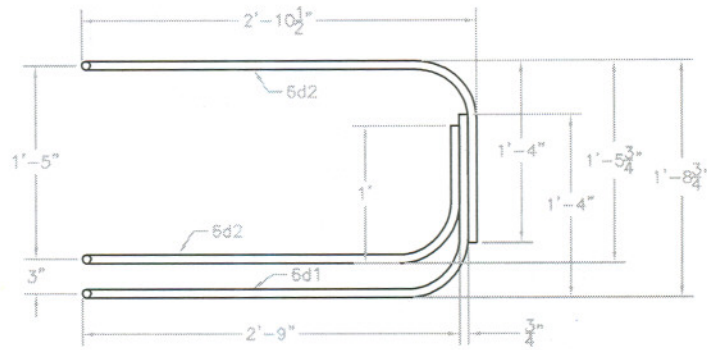
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By: GEP/DTK
Rev: KAP/BWB

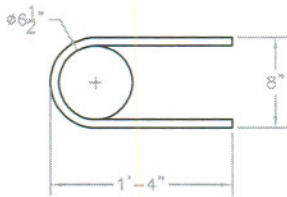


4a1

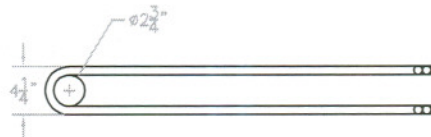
Loop Bar Assembly



Elevation View



6a2



Plan View

BILL OF BARS					
Mark	Bar No.	No.	Length	Material	Pin Dia.
4a1	4	12	6'-0"	A615 Gr. 60	3" & 4 1/4"
6a2	6	6	2'-11"	A615 Gr. 60	6 1/2"
5b1	5	3	12'-2"	A615 Gr. 60	
4c1	4	2	12'-2"	A615 Gr. 60	
6d1	6	2	8'-5"	A706 Gr. 60	
6d2	6	2	7'-7"	A706 Gr. 60	
6d3	6	2	8'-6"	A706 Gr. 60	



Midwest Roadside  
Safety Facility

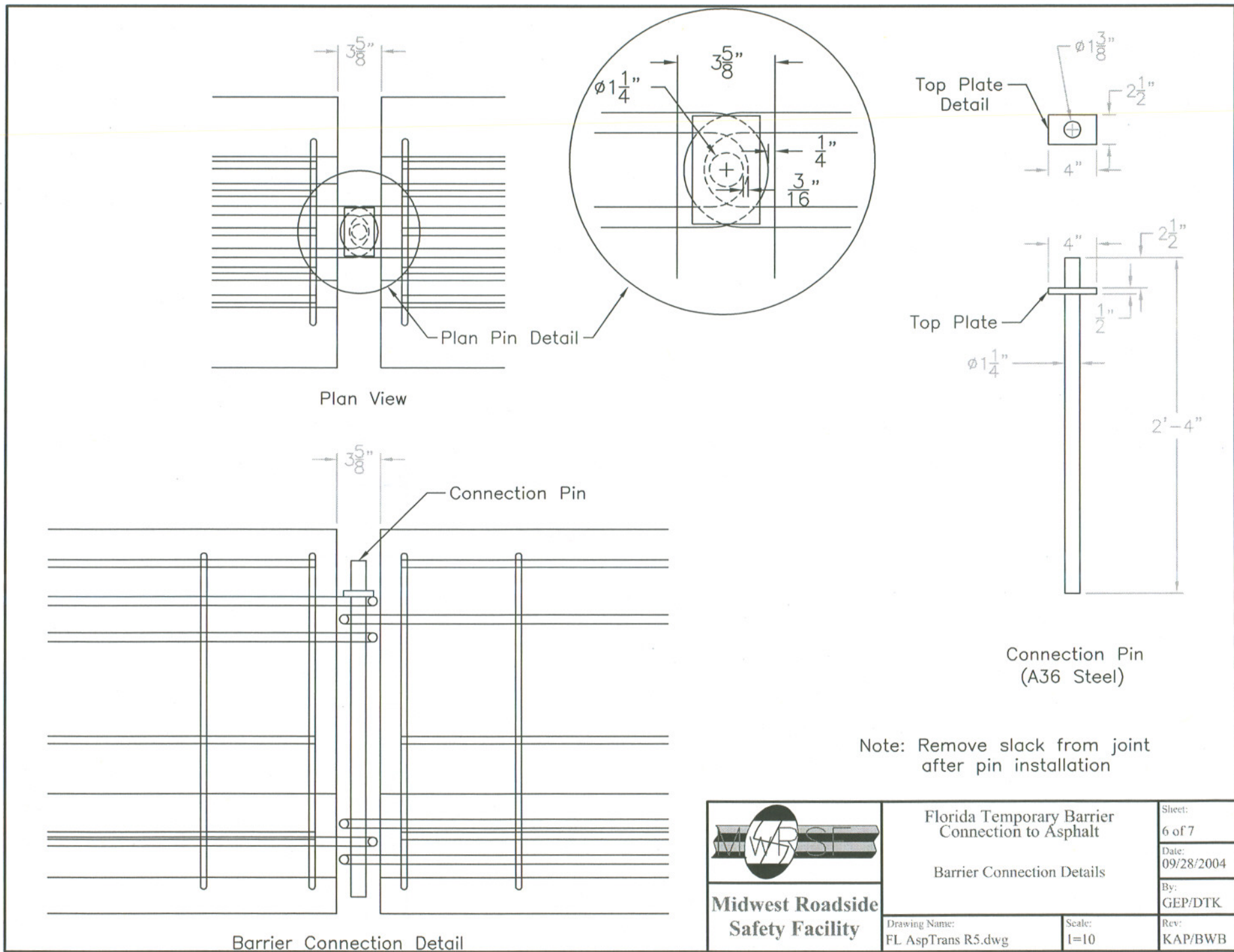
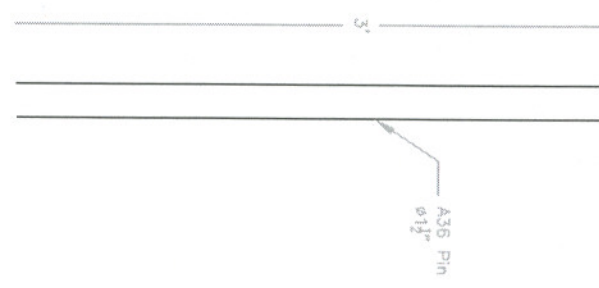
Florida Temporary Barrier  
Connection to Asphalt

Bill of Bars

Drawing Name:  
FL AspTrans R5.dwg

Scale:  
1=16

Sheet:  
5 of 7  
Date:  
09/28/2004  
By:  
GEP/DTK  
Rev:  
KAP/BWB



Florida Temporary Barrier Connection to Asphalt		Sheet: 6 of 7
Barrier Connection Details		Date: 09/28/2004
		By: GEP/DTK
Drawing Name: FL AspTrans R5.dwg	Scale: 1=10	Rev: KAP/BWB