Michael Baker Jr., Inc.
6955 South Union Park Center, Suite 370
Midvale, UT 84047

UDOT DESIGN MANUAL PHASE I

UDOT PIN 9091
BAKER PROJECT NO. 123248

UDOT STANDARD CONCRETE BARRIER CALCULATIONS AND DOCUMENTATION

November 2011

11/23/2011

Prepared for:
Utah Department of Transportation
Structures Department
Salt Lake City, UT

Table of Contents

Clear Zone Definition

AASHTO Roadside Design Guide Chapter 3

- The maximum value will be used (Tables 3.1 and 3.2). Drawings notes will read "maximum required AASHTO clear zone."
- The original BA standards used 1.2 times the minimum clear zone. The maximum clear zone is roughly equivalent. This was prescribed by Glenn Schulte (UDOT Traffic and Safety).

Bridge Column Protection

AASHTO LRFD 2.3.2.2.1

- Provide the AASHTO Clear Zone, if possible.
- When impractical, the columns should be protected by barrier. The barrier should be "independently supported with its roadway face at least 2.0 ft. from the face of pier or abutment, unless a rigid barrier is provided."

AASHTO LRFD 3.6.5.1

- Column protection will be provided to eliminate the Vehicular Collision Force (CT).
- There are three options:
  - An embankment
  - A structurally independent, 54-inch barrier that meets TL-5. Use when barrier is located within 10.0 ft from the column.
  - A structurally independent, 42-inch barrier that meets TL-5. Use when barrier is located more than 10.0 ft from the column.

UDOT Requirement (will be in UDOT Design Manual)

- Design column for the 400 kip load (AASHTO LRFD 3.6.5.1) if face of barrier is 4 ft or less from the face of column.

Documentation of Barrier Sections

Barrier Shapes

- The following shapes and approved test levels are provided in the AASHTO Roadside Design Guide (Section 5.4.1 and 6.4.1):
  - New Jersey 32" – TL-4
  - Single Slope 42" – TL-5
- "These shapes when adequately designed and reinforced may all be considered TL-4 designs at the standard height of 32 inches and TL-5 designs at the heights 42 inches and higher" (AASHTO Roadside Design Guide 6.4.1).

Precast 32" NJ Shape (Full or Half)

- This barrier is similar to Idaho Transportation Department's standards
- It has been accepted as a TL-3 barrier (FHWA Acceptance Letter B-70)

Cast-In-Place 32" NJ Shape to the 42" Constant Slope Transition

- This section was developed with reference to the I-15; Utah Co Line to 10600 S Project (2004)

Cast-In-Place 42" Constant Slope

- This section is similar to the Caltrans Type 60 and extruded to a height of 42"

- The Type 60 has been accepted as TL-3 (FHWA Acceptance Letter B-45)

Precast 42" Single Slope

- This design is based on the Ohio DOT 50" portable concrete barrier.
- The pin and loop connection has been accepted by FHWA as a TL-3 system.
- FHWA approval was obtained for this system by Glenn Schulte.

Cast-In-Place 42" Constant Slope Half Barrier

- This barrier is similar to the Caltrans Type 60D and the Ohio DOT's Single Slope Barrier, Type D
- The barrier was used on the I-15 Design Build (in SLC) Project (1998)
- The Type 60 is accepted as TL-3 (FHWA Acceptance Letter B-45)

Precast 42" Constant Slope Half Barrier

- The precast version of this section was created with reference to the UDOT CIP version and the precast 32" NJ Half Barrier.

Cast-In-Place 54" Constant Slope

- This section was developed with reference to the Caltrans Type 60G
- The barrier was used on the I-15 Design Build (in SLC) Project (1998)
- The Type 60G has been accepted as TL-3 (FHWA Acceptance Letter B-45)

Test Level 5 Constant Slope (42" and 54")

- The MwRSF Research Report No. TRP-03-194-07 documents the TL-5 crash testing of a similar shape. An equivalent amount of longitudinal reinforcement was used (7.35 lb/ft was used in the barrier of the report).
- The 54" shape was extrapolated using a similar structural capacity.

Precast or Cast-In-Place Median Small Sign Barrier

- These sections were developed with reference to the I-15; Utah Co Line to 10600 S Project (2004)

Cast-In-Place Median Sign or Lighting Structure Transition (42" and 54")

- These sections were developed with reference to the 114th South (2009) and I-15 CORE (2010) Projects

Cast-In-Place Stepped Median Barrier (42" and 54")

- These details were developed with reference to:
    - Caltrans Type 60C, Type 60GC, and Type 60SC
    - Kansas DOT Type III (F-Shape)
    - Ohio DOT Type C and Type C1

S.O. No. 123248

Subject: Concrete Barrier Standards

Sheet No. 3 of ____

Drawing No. ____

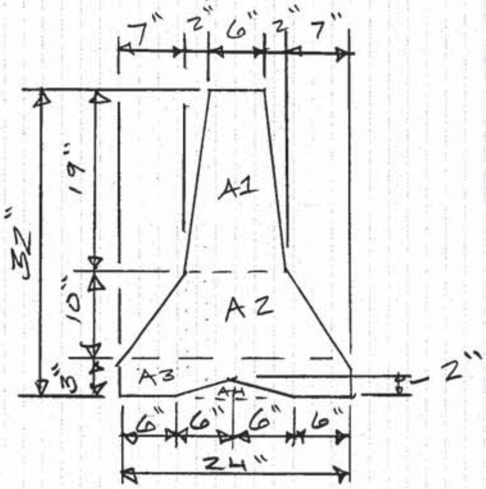
Computed by AFY Checked By ____ Date ____

Baker

AREAS AND WEIGHTS

32" NJ

Standard Shape:



$A_1 = \left(\frac{10+6}{2}\right)(19) = 152 \text{ in}^2$

$A_2 = \frac{(10+24)}{2}(10) = 170 \text{ in}^2$

$A_3 = 3(24) = 72 \text{ in}^2$

$A_4 = -\frac{1}{2}(12)(2) = -12 \text{ in}^2$

$\Sigma A = 382 \text{ in}^2 = 2.65 \text{ ft}^2$

$w = 0.150(\Sigma A) = 0.398 \text{ k/ft}$

$\gamma_{CONCRETE}$

$L = 20'$

$W = 7.96 \text{ k}$

Scuppers : $(0.15)\,2(24 \times 24 \times 2 - 24 \times \frac{1}{2}(12) \times 2)/12^3$

$= 0.15 \text{ k}$

Blockouts : $0.15(4)[4.125 \times 1.375 \times 7.5 + 7 \times 5.5 \times 3.5 \times 0.5] / 12^3$

$= 0.04 \text{ k}$

$W = 7.96 - 0.15 - 0.04 \text{ k} = 7.77 \text{ k}$

$= 3.9$ Tons

Sloped End Section:

$A_{END} = 4(24)/12^2 = 0.67 \text{ ft}^2$

$w = 0.15 A_{END} = 0.1 \text{ k/ft}$

$W = 0.398(1) + \frac{0.398 + 0.1}{2}(19) = 5.13 \text{ k}$

$= 2.6$ Tons

Small Sign Section:

$A_{MIDDLE} = 2.65 + \frac{10(32)}{12^2} = 4.87 \text{ ft}^2$

$w = 0.15 A_{MIDDLE} = 0.73 \text{ k/ft}$

$W = 0.73(3.33) + 2\left(\frac{0.398 + 0.73}{2}\right)(8.33)$

$= 11.83 \text{ k}$

$= 5.9$ Tons

S.O. No. 123248

Subject: Concrete Barrier Standards

Sheet No. 4 of

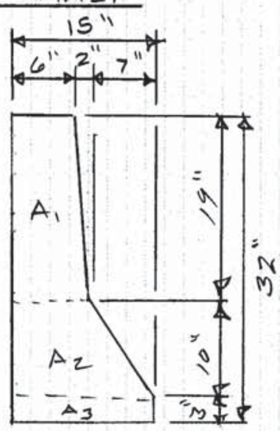
Drawing No.

Computed by AFY Checked By Date

Baker

AREAS AND WEIGHTS CONT.

32" NJ HALF



$A_1 = \left(\frac{6+8}{2}\right)(19) = 133 \text{ in}^2$

$A_2 = \left(\frac{8+15}{2}\right)(10) = 115 \text{ in}^2$

$A_3 = 3(15) = 45 \text{ in}^2$

$\Sigma A = 293 \text{ in}^2 = 2.03 \text{ ft}^2$

$\omega = 0.15\,\Sigma A = 0.305 \text{ k/ft}$

$W_{20'} = 6.10 \text{ k} = 3.0 \text{ Tons}$

$W_{12.5'} = 3.81 \text{ k} = 1.9 \text{ Tons}$

S.O. No. 123248

Subject: Concrete Barrier Standards

Sheet No. 5 of

Drawing No.

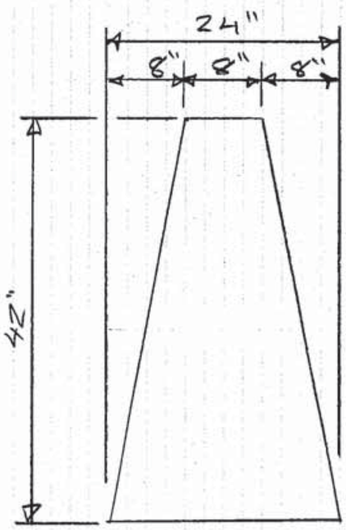
Computed by AFY Checked By Date

Baker

AREAS AND WEIGHTS CONT.

42" CONSTANT SLOPE (PRECAST)

Standard Section:



$A = \frac{(8+24)}{2}(42) = 672 \text{ in}^2$

$= 4.67 \text{ ft}^2$

$w = 0.15 A = 0.700 \text{ klf}$

$W = 14.833 (0.700) = 10.38 \text{ k}$

$= 5.2 \text{ Tons}$

Sloped End Section: $A_{END} = 4(24)/12^2 = 0.67 \text{ ft}^2$

$w = 0.15 A_{END} = 0.100 \text{ k/f}$

$W = 0.700(1) + \frac{0.700 + 0.100}{2}(19) = 8.3 \text{k}$

$= 4.2 \text{ Tons}$

Median Small Sign Section: $A_{MIDDLE} = 4.67 + \frac{8(42)}{12^2} = 7.00 \text{ ft}^2$

$w = 0.15 A_{MIDDLE} = 1.050 \text{ k/f}$

$W = 1.5(1.05) + 2\left(\frac{1.050 + 0.700}{2}\right) 6.67 = 13.24 \text{k}$

$= 6.6 \text{ Tons}$

32" NJ To 42" CS Transition: $W = \left(\frac{0.398 + 0.700}{2}\right) 9.833 = 5.40 \text{ k}$

$= 2.7 \text{ Tons}$

S.O. No. 123248

Subject: Concrete Barrier Standards

Sheet No. 6 of

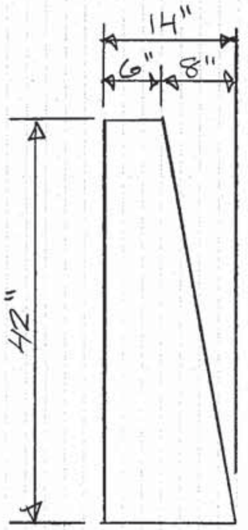
Drawing No.

Computed by AFY Checked By Date

Baker

AREAS AND WEIGHTS CONT.

42" CONSTANT SLOPE HALF BARRIER (PRECAST)



$A = \left(\frac{6+14}{2}\right) 42 = 420 \text{ in}^2 = 2.92 \text{ ft}^2$

$w = 0.15\,A = 0.438 \text{ k/ft}$

$W = 14.833(0.438) = 6.49 \text{ K}$

$= 3.2$ Tons

Retaining Barrier Calculations - 32" NJ Barrier

Assume pins provide sliding resistance. Assume pins do not provide any restoring moment resistance.

Load Definitions and Material Assumptions

Barrier				
Concrete Density,	γ_{conc} =	**0.150**	kcf	
Area,	A =	**2.653**	ft^2	
Weight,	P =	0.398	k/ft = $\gamma_{conc}A$	
Width,	w =	**24.0**	in	
Soil - 2:1 Backslope with No Live Load Surcharge				
Soil Unit Weight,	γ_{soil} =	**0.120**	kcf	
Effective Angle of Internal Friction,	ϕ'_f =	**30**	°	
Angle of BF of Wall to the Horizontal,	θ =	**74**	°	
Angle of Fill to the Horizontal,	β =	**26.6**	°	
Friction Angle of Dissimilar Materials,	δ =	**24.0**	°	
	Γ =	1.569		AASHTO LRFD EQTN 3.11.5.3-2
Coefficient of Active Lateral Earth Pressure,	$k_{a\text{-}2:1}$ =	0.848		AASHTO LRFD EQTN 3.11.5.3-1
Soil - Level with Live Load Surcharge				
Equivalent Height of Soil for Vehicular Loading,	h_{eq} =	**2.000**	ft	AASHTO LRFD Table 3.11.6.4-1
Effective Angle of Internal Friction,	ϕ'_f =	30	°	
Angle of BF of Wall to the Horizontal,	θ =	74	°	
Angle of Fill to the Horizontal,	β =	**0**	°	
Friction Angle of Dissimilar Materials,	δ =	24	°	
	Γ =	3.032		AASHTO LRFD EQTN 3.11.5.3-2
Coefficient of Active Lateral Earth Pressure,	$k_{a\text{-}LS}$ =	0.439		AASHTO LRFD EQTN 3.11.5.3-1
Load Factors				
Barrier Self/Weight,	DC =	0.90		
Soil Active Lateral Force,	EH =	1.50	(max)	
		0.90	(min)	
Live Load Surcharge,	LS =	1.75		

Permissible Soil Heights

2:1 Backslope with No Live Load Surcharge

Retained Soil Height,	H =	29.087	in		
Retained Soil Force,	F_{soil1} =	0.267	k/ft = $\cos(\beta)0.5\gamma_{soil}k_{a\text{-}2:1}H^2$		
	F_{soil2} =	0.134	k/ft = $\sin(\beta)0.5\gamma_{soil}k_{a\text{-}2:1}H^2$		
Retained Soil Moment,	M_{soil1} =	2.591	k-in/ft = $F_{soil1}H/3$		
	M_{soil2} =	-1.606	k-in/ft = $-F_{soil2}w/2$		
Soil Above Barrier Width,	b =	8.341	in = $\tan(90-\theta)H$		
Soil Above Barrier Force (Vertical),	F_{soil3} =	0.101	k/ft = $-0.5\gamma_{soil}Hb$		
Soil Above Barrier Moment,	M_{soil3} =	-0.932	k-in/ft = $-F_{soil3}(w/2-b/3)$		
Factored Overturning Moment,	$M_{overturn}$ =	1.603	k-in/ft = ΣEH^*M_{soil}		
Resultant of Vertical Forces,	R =	0.267	k/ft = $DC^*P+EH^*F_{soil3}$		
Eccentricity of Resultant,	e =	6.000	in = $M_{overturn}/R$		
Maximum Eccentricity,	w/4 =	6.000	in	OK	AASHTO LRFD 11.6.3.3

Level Backslope with Live Load Surcharge

Retained Soil Height,	H =	13.839	in		
Retained Soil Force,	F_{soil1} =	0.035	k/ft = $\cos(\beta)0.5\gamma_{soil}k_{a\text{-}LS}H^2$		
	F_{soil2} =	0.000	k/ft = $\sin(\beta)0.5\gamma_{soil}k_{a\text{-}LS}H^2$		
Retained Soil Moment,	M_{soil1} =	0.162	k-in/ft = $F_{soil1}H/3$		
	M_{soil2} =	0.000	k-in/ft = $-F_{soil2}w/2$		
Soil Above Barrier Width,	b =	3.968	in = $\tan(90-\theta)H$		
Soil Above Barrier Force (Vertical),	F_{soil3} =	0.023	k/ft = $-0.5\gamma_{soil}Hb$		
Soil Above Barrier Moment,	M_{soil3} =	-0.244	k-in/ft = $-F_{soil3}(w/2-b/3)$		
Live Load Surcharge Equivalent Soil Height,	h_{eq} =	24.000	in		
Soil Force,	F_{LS} =	0.121	k/ft = $\gamma_{soil}k_{a\text{-}LS}h_{eq}H$		
Overturning Moment,	M_{LS} =	0.840	k-in/ft = $F_{LS}H/2$		
Factored Overturning Moment,	$M_{overturn}$ =	1.493	k-in/ft = $\Sigma EH^*M_{soil}+LS^*M_{LS}$		
Resultant of Vertical Forces,	R =	0.249	k/ft = $DC^*P+EH^*F_{soil3}$		
Eccentricity of Resultant,	e =	6.000	in = $M_{overturn}/R$		
Maximum Eccentricity,	w/4 =	6.000	in	OK	AASHTO LRFD 11.6.3.3

Retaining Barrier Calculations - 42" Constant Slope Barrier

Assume pins provide sliding resistance. Assume pins do not provide any restoring moment resistance.

Load Definitions and Material Assumptions

Barrier				
Concrete Density,	γ_{conc} =	**0.150**	kcf	
Area,	A =	**4.667**	ft^2	
Weight,	P =	0.700	k/ft = $\gamma_{conc}A$	
Width,	w =	**24.0**	in	
Soil - 2:1 Backslope with No Live Load Surcharge				
Soil Unit Weight,	γ_{soil} =	**0.120**	kcf	
Effective Angle of Internal Friction,	ϕ'_f =	**30**	°	
Angle of BF of Wall to the Horizontal,	θ =	**79**	°	
Angle of Fill to the Horizontal,	β =	**26.6**	°	
Friction Angle of Dissimilar Materials,	δ =	**24.0**	°	
	Γ =	1.554		AASHTO LRFD EQTN 3.11.5.3-2
Coefficient of Active Lateral Earth Pressure,	$k_{a\text{-}2:1}$ =	0.729		AASHTO LRFD EQTN 3.11.5.3-1
Soil - Level with Live Load Surcharge				
Equivalent Height of Soil for Vehicular Loading,	h_{eq} =	**2.000**	ft	AASHTO LRFD Table 3.11.6.4-1
Effective Angle of Internal Friction,	ϕ'_f =	30	°	
Angle of BF of Wall to the Horizontal,	θ =	79	°	
Angle of Fill to the Horizontal,	β =	**0**	°	
Friction Angle of Dissimilar Materials,	δ =	24	°	
	Γ =	2.922		AASHTO LRFD EQTN 3.11.5.3-2
Coefficient of Active Lateral Earth Pressure,	$k_{a\text{-}LS}$ =	0.388		AASHTO LRFD EQTN 3.11.5.3-1
Load Factors				
Barrier Self/Weight,	DC =	0.90		
Soil Active Lateral Force,	EH =	1.50	(max)	
		0.90	(min)	
Live Load Surcharge,	LS =	1.75		

Permissible Soil Heights

2:1 Backslope with No Live Load Surcharge

Retained Soil Height,	$H =$	35.236	in	
Retained Soil Force,	$F_{soil1} =$	0.337	k/ft = $\cos(\beta)0.5\gamma_{soil}k_{a\text{-}2:1}H^2$	
	$F_{soil2} =$	0.169	k/ft = $\sin(\beta)0.5\gamma_{soil}k_{a\text{-}2:1}H^2$	
Retained Soil Moment,	$M_{soil1} =$	3.960	k-in/ft = $F_{soil1}H/3$	
	$M_{soil2} =$	-2.026	k-in/ft = $-F_{soil2}w/2$	
Soil Above Barrier Width,	$b =$	6.849	in = $\tan(90-\theta)H$	
Soil Above Barrier Force (Vertical),	$F_{soil3} =$	0.101	k/ft = $-0.5\gamma_{soil}Hb$	
Soil Above Barrier Moment,	$M_{soil3} =$	-0.977	k-in/ft = $-F_{soil3}(w/2-b/3)$	
Factored Overturning Moment,	$M_{overturn} =$	3.237	k-in/ft = ΣEH^*M_{soil}	
Resultant of Vertical Forces,	$R =$	0.540	k/ft = $DC^*P+EH^*F_{soil3}$	
Eccentricity of Resultant,	$e =$	6.000	in = $M_{overturn}/R$	
Maximum Eccentricity,	$w/4 =$	6.000	in OK	AASHTO LRFD 11.6.3.3

Level Backslope with Live Load Surcharge

Retained Soil Height,	$H =$	19.722	in	
Retained Soil Force,	$F_{soil1} =$	0.063	k/ft = $\cos(\beta)0.5\gamma_{soil}k_{a\text{-}LS}H^2$	
	$F_{soil2} =$	0.000	k/ft = $\sin(\beta)0.5\gamma_{soil}k_{a\text{-}LS}H^2$	
Retained Soil Moment,	$M_{soil1} =$	0.413	k-in/ft = $F_{soil1}H/3$	
	$M_{soil2} =$	0.000	k-in/ft = $-F_{soil2}w/2$	
Soil Above Barrier Width,	$b =$	3.834	in = $\tan(90-\theta)H$	
Soil Above Barrier Force (Vertical),	$F_{soil3} =$	0.032	k/ft = $-0.5\gamma_{soil}Hb$	
Soil Above Barrier Moment,	$M_{soil3} =$	-0.338	k-in/ft = $-F_{soil3}(w/2-b/3)$	
Live Load Surcharge Equivalent Soil Height,	$h_{eq} =$	24.000	in	
Soil Force,	$F_{LS} =$	0.153	k/ft = $\gamma_{soil}k_{a\text{-}LS}h_{eq}H$	
Overturning Moment,	$M_{LS} =$	1.508	k-in/ft = $F_{LS}H/2$	
Factored Overturning Moment,	$M_{overturn} =$	2.954	k-in/ft = $\Sigma EH^*M_{soil}+LS^*M_{LS}$	
Resultant of Vertical Forces,	$R =$	0.492	k/ft = $DC^*P+EH^*F_{soil3}$	
Eccentricity of Resultant,	$e =$	6.000	in = $M_{overturn}/R$	
Maximum Eccentricity,	$w/4 =$	6.000	in OK	AASHTO LRFD 11.6.3.3

Retaining Barrier Calculations - 42" Constant Slope Half Barrier

Assume pins provide sliding resistance. Assume pins do not provide any restoring moment resistance.

Load Definitions and Material Assumptions

Barrier

Concrete Density,	γ_{conc} =	**0.150**	kcf	
Area,	A =	**3.354**	ft^2	
Weight,	P =	0.503	k/ft = $\gamma_{conc}A$	
Width,	w =	**17.0**	in (C.G. is 9.55" from toe of traffic face)	

Soil - 2:1 Backslope with No Live Load Surcharge

Soil Unit Weight,	γ_{soil} =	**0.120**	kcf	
Effective Angle of Internal Friction,	ϕ'_f =	**30**	°	
Angle of BF of Wall to the Horizontal,	θ =	**86**	°	
Angle of Fill to the Horizontal,	β =	**26.6**	°	
Friction Angle of Dissimilar Materials,	δ =	**24.0**	°	
	Γ =	1.544		AASHTO LRFD EQTN 3.11.5.3-2
Coefficient of Active Lateral Earth Pressure,	$k_{a\text{-}2:1}$ =	0.595		AASHTO LRFD EQTN 3.11.5.3-1

Soil - Level with Live Load Surcharge

Equivalent Height of Soil for Vehichular Loading,	h_{eq} =	**2.000**	ft	AASHTO LRFD Table 3.11.6.4-1
Effective Angle of Internal Friction,	ϕ'_f =	30	°	
Angle of BF of Wall to the Horizontal,	θ =	86	°	
Angle of Fill to the Horizontal,	β =	**0**	°	
Friction Angle of Dissimilar Materials,	δ =	24	°	
	Γ =	2.815		AASHTO LRFD EQTN 3.11.5.3-2
Coefficient of Active Lateral Earth Pressure,	$k_{a\text{-}LS}$ =	0.327		AASHTO LRFD EQTN 3.11.5.3-1

Load Factors

Barrier Self/Weight,	DC =	0.90	
Soil Active Lateral Force,	EH =	1.50	(max)
		0.90	(min)
Live Load Surcharge,	LS =	1.75	

Permissible Soil Heights

2:1 Backslope with No Live Load Surcharge

Retained Soil Height,	$H =$	**28.953**	in		
Retained Soil Force,	$F_{soil1} =$	0.186	k/ft = $\cos(\beta)0.5\gamma_{soil}k_{a\text{-}2:1}H^2$		
	$F_{soil2} =$	0.093	k/ft = $\sin(\beta)0.5\gamma_{soil}k_{a\text{-}2:1}H^2$		
Retained Soil Moment,	$M_{soil1} =$	1.795	k-in/ft = $F_{soil1}H/3$		
	$M_{soil2} =$	-0.792	k-in/ft = $-F_{soil2}w/2$		
Soil Above Barrier Width,	$b =$	2.025	in = $\tan(90-\theta)H$		
Soil Above Barrier Force (Vertical),	$F_{soil3} =$	0.024	k/ft = $-0.5\gamma_{soil}Hb$		
Soil Above Barrier Moment,	$M_{soil3} =$	-0.165	k-in/ft = $-F_{soil3}(w-9.55-b/3)$		
Factored Overturning Moment,	$M_{overturn} =$	1.831	k-in/ft = ΣEH^*M_{soil}		
Resultant of Vertical Forces,	$R =$	0.431	k/ft = $DC^*P+EH^*F_{soil3}$		
Eccentricity of Resultant,	$e =$	4.250	in = $M_{overturn}/R$		
Maximum Eccentricity,	$w/4 =$	4.250	in	OK	AASHTO LRFD 11.6.3.3

Level Backslope with Live Load Surcharge

Retained Soil Height,	$H =$	**15.314**	in		
Retained Soil Force,	$F_{soil1} =$	0.032	k/ft = $\cos(\beta)0.5\gamma_{soil}k_{a\text{-}LS}H^2$		
	$F_{soil2} =$	0.000	k/ft = $\sin(\beta)0.5\gamma_{soil}k_{a\text{-}LS}H^2$		
Retained Soil Moment,	$M_{soil1} =$	0.163	k-in/ft = $F_{soil1}H/3$		
	$M_{soil2} =$	0.000	k-in/ft = $-F_{soil2}w/2$		
Soil Above Barrier Width,	$b =$	1.071	in = $\tan(90-\theta)H$		
Soil Above Barrier Force (Vertical),	$F_{soil3} =$	0.007	k/ft = $-0.5\gamma_{soil}Hb$		
Soil Above Barrier Moment,	$M_{soil3} =$	-0.048	k-in/ft = $-F_{soil3}(w-9.55-b/3)$		
Live Load Surcharge Equivalent Soil Height,	$h_{eq} =$	24.000	in		
Soil Force,	$F_{LS} =$	0.100	k/ft = $\gamma_{soil}k_{a\text{-}LS}h_{eq}H$		
Overturning Moment,	$M_{LS} =$	0.766	k-in/ft = $F_{LS}H/2$		
Factored Overturning Moment,	$M_{overturn} =$	1.541	k-in/ft = $\Sigma EH^*M_{soil}+LS^*M_{LS}$		
Resultant of Vertical Forces,	$R =$	0.363	k/ft = $DC^*P+EH^*F_{soil3}$		
Eccentricity of Resultant,	$e =$	4.249	in = $M_{overturn}/R$		
Maximum Eccentricity,	$w/4 =$	4.250	in	OK	AASHTO LRFD 11.6.3.3

Impact Analysis

Design Approach

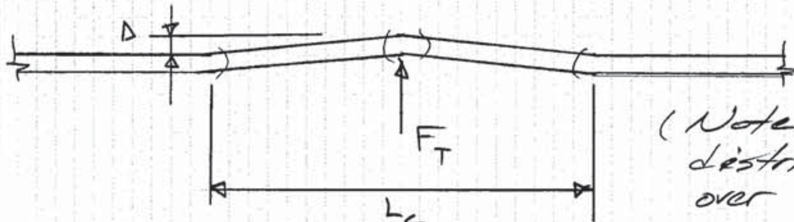
- A linear elastic analysis is not appropriate for roadside barrier due to the dynamic nature of the loading and the inelastic action of the barrier and pavement.
- AASHTO LRFD Bridge Specifications (Section 13) provide suggested load definitions; however, this approach is intended for elements with fixed anchorages such as bridge parapets or moment slabs.
- Yield line analysis is an approximate approach that can be used for an understanding of the behavior of the system (see following calculations). An estimated length of engagement can be determined by balancing the impact work with the work required to yield the section. The limitation of this approach is that it does not take into account the contribution of the foundation.
- The only accepted method of rating barrier for impact loading is to use crash testing according to NCHRP 350. See "Documentation of Barrier Sections" for accepted test level ratings of barrier sections.

Baker

ESTIMATED LENGTH OF ENGAGEMENT
MEDIAN BARRIER

ANALYSIS METHOD

Use yield line analysis:



(Note: AASHTO LRFD A13.2 distributes this, F_T, for over a length of, L_T, For ease of calculations neglect this distribution)

$Work = F_T \Delta$ ← Impact Work

or

$= M\Theta$ ← Assume all Material Work is done by rotation and flexure of barrier

Yield Line Work $= \Sigma M\Theta$

$\Theta = \tan^{-1}\left(\frac{\Delta}{L_c/2}\right) \approx \frac{2\Delta}{L_c}$ (Rotation about a vertical axis)

$Work = 4 M_n \left(\frac{2\Delta}{L_c}\right)$ (4 locations of flexure)

Set Impact Work equal to Yield Line Work

$$F_T \Delta = 4 M_n \left(\frac{2\Delta}{L_c}\right)$$

$$\boxed{L_c = \frac{8 M_n}{F_T}}$$

(Note: This equation is independent of Δ)

→ M_n can be obtained from sectional analysis

→ F_T can be obtained from AASHTO LRFD A 13.2

→ Equation is identical to a fixed-fixed beam; therefore,

$$\boxed{\Delta = \frac{F_T L_c^3}{192 EI}}$$

S.O. No. 123248

Subject: Concrete Barrier Standards

Sheet No. 1□ of 61

Drawing No.

Computed by AFY Checked By Date 10/20/11

ESTIMATED LENGTH OF ENGAGEMENT
MEDIAN BARRIER

BARRIER BEHAVIOR

42" Constant Slope:

$M_n = 104\ k \cdot ft$

$F_T = 54\ k$ (TL-3)

$E = 3605\ ksi$

$I = 17{,}920\ in^4\ (1/2) = 8960\ in^4$ (cracked)

$L_c = \frac{8(104)}{54} = 15.4\ ft$

$\Delta = \frac{54(15.4 \times 12)^3}{192(3605)(8960)} = 0.05\ in$

42" Constant Slope (TL-5):

$M_n = 146\ k \cdot ft$

$F_T = 124.0\ k$

$L_c = 21.6\ ft$

$\Delta = 0.35\ in$

54" Constant Slope: By inspection, the flexural capacity of this barrier will be comparable because the additional material is added at the neutral axis.

→ The length of engagement is approximately 15'-20.'

→ The foundation stiffness is not taken into account. The barrier deflection is expected to be primarily dependent on this. The barrier pins can only be accurately analyzed by crash testing.

```
                   oooooo                 o
                  oo    oo               oo
 ooooo    oooooo  oo          ooooo      oo       oo   oo   o oooooooooo    o ooooo
oo    o   oo   oo oo         oo   oo     oo       oo   oo    oo   oo   oo    oo   oo
oo        oo   oo oo         oo   oo     oo       oo   oo    oo   oo   oo    oo   oo
 ooooo    oo   oo oo         oo   oo     oo       oo   oo    oo   oo   oo    oo   oo
     oo   oooooo  oo         oo   oo     oo       oo   oo    oo   oo   oo    oo   oo
o    oo   oo      oo    oo   oo   oo     oo   o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo       oooooo     ooooo       ooo      ooooo o   oo   oo   oo    oo   oo (TM)
```

==

spColumn v4.60 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

==

General Information:

File Name: P:\proj\123248\AJ Work\42 Inch Constant Slope.col
Project: UDOT Barrier
Column: 42" CS — Engineer: AFY
Code: ACI 318-08 — Units: English

Run Option: Investigation — Slenderness: Not considered
Run Axis: Y-axis — Column Type: Structural

Material Properties:

f'c = 4 ksi — fy = 60 ksi
Ec = 3605 ksi — Es = 29000 ksi
Ultimate strain = 0.003 in/in
Beta1 = 0.85

Section:

Exterior Points

No.	X (in)	Y (in)	No.	X (in)	Y (in)	No.	X (in)	Y (in)
1	-4.0	42.0	2	4.0	42.0	3	12.0	0.0
4	-12.0	0.0						

Gross section area, Ag = 672 in^2
Ix = 90552 in^4 — Iy = 17920 in^4
rx = 11.6082 in — ry = 5.16398 in
Xo = 0 in — Yo = 17.5 in

Reinforcement:

Bar Set: ASTM A615

Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Pattern: Irregular
Total steel area: As = 2.48 in^2 at rho = 0.37% (Note: rho < 0.50%)
Minimum clear spacing = 5.37 in

Area in^2	X (in)	Y (in)	Area in^2	X (in)	Y (in)	Area in^2	X (in)	Y (in)
0.31	-9.0	3.0	0.31	-7.0	15.0	0.31	-5.0	27.0
0.31	-3.0	39.0	0.31	3.0	39.0	0.31	5.0	27.0
0.31	7.0	15.0	0.31	9.0	3.0			

Control Points:

Bending about	Axial Load P kip	X-Moment k-ft	Y-Moment k-ft	NA depth in	Dt depth in	eps_t	Phi
Y @ Max compression	1576.4	-26.61	-0.00	67.67	21.00	-0.00207	0.650
@ Allowable comp.	1261.1	-142.67	188.94	20.17	21.00	0.00012	0.650
@ fs = 0.0	1317.5	-141.97	163.41	21.00	21.00	0.00000	0.650
@ fs = 0.5*fy	888.4	-45.64	289.64	15.62	21.00	0.00103	0.650
@ Balanced point	610.2	36.80	296.45	12.43	21.00	0.00207	0.650
@ Tension control	314.2	215.80	274.98	7.88	21.00	0.00500	0.900
@ Pure bending	-0.0	162.83	103.89	4.14	21.00	0.01220	0.900
@ Max tension	-133.9	39.06	0.00	0.00	21.00	9.99999	0.900
-Y @ Max compression	1576.4	-26.61	-0.00	67.67	21.00	-0.00207	0.650
@ Allowable comp.	1261.1	-142.67	-188.94	20.17	21.00	0.00012	0.650
@ fs = 0.0	1317.5	-141.97	-163.41	21.00	21.00	0.00000	0.650
@ fs = 0.5*fy	888.4	-45.64	-289.64	15.62	21.00	0.00103	0.650
@ Balanced point	610.2	36.80	-296.45	12.43	21.00	0.00207	0.650
@ Tension control	314.2	215.80	-274.98	7.88	21.00	0.00500	0.900
@ Pure bending	-0.0	162.83	-103.89	4.14	21.00	0.01220	0.900
@ Max tension	-133.9	39.06	0.00	0.00	21.00	9.99999	0.900

*** End of output ***

```
                     oooooo               o
                    oo    oo             oo
 ooooo    oooooo    oo          ooooo    oo      oo   oo   o oooooooooo    o ooooo
oo    o   oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
oo        oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
 ooooo    oo   oo   oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
     oo   oooooo    oo         oo   oo   oo      oo   oo    oo   oo   oo    oo   oo
o    oo   oo        oo    oo   oo   oo   oo  o   oo   oo    oo   oo   oo    oo   oo
 ooooo    oo         oooooo     ooooo     ooo     ooooo o   oo   oo   oo    oo   oo (TM)
```

==

spColumn v4.60 (TM)

Computer program for the Strength Design of Reinforced Concrete Sections

==

General Information:

File Name: P:\proj\123248\AJ Work\42 Inch Constant Slope - TL5.col
Project: UDOT Barrier
Column: 42" CS   Engineer: AFY
Code: ACI 318-08   Units: English

Run Option: Investigation   Slenderness: Not considered
Run Axis: Y-axis   Column Type: Structural

Material Properties:

f'c = 4 ksi   fy = 60 ksi
Ec = 3605 ksi   Es = 29000 ksi
Ultimate strain = 0.003 in/in
Beta1 = 0.85

Section:

Exterior Points

No.	X (in)	Y (in)	No.	X (in)	Y (in)	No.	X (in)	Y (in)
1	-4.0	42.0	2	4.0	42.0	3	12.0	0.0
4	-12.0	0.0						

Gross section area, Ag = 672 in^2
Ix = 90552 in^4   Iy = 17920 in^4
rx = 11.6082 in   ry = 5.16398 in
Xo = 0 in   Yo = 17.5 in

Reinforcement:

Bar Set: ASTM A615

Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Pattern: Irregular
Total steel area: As = 3.72 in^2 at rho = 0.55% (Note: rho < 1.0%)
Minimum clear spacing = 5.37 in

Area in^2	X (in)	Y (in)	Area in^2	X (in)	Y (in)	Area in^2	X (in)	Y (in)
0.31	-9.0	3.0	0.31	-3.0	39.0	0.31	3.0	39.0
0.31	9.0	3.0	0.31	7.8	10.2	0.31	-7.8	10.2
0.31	6.6	17.4	0.31	-6.6	17.4	0.31	5.4	24.6
0.31	-5.4	24.6	0.31	4.2	31.8	0.31	-4.2	31.8

Control Points:

Bending about	Axial Load P kip	X-Moment k-ft	Y-Moment k-ft	NA depth in	Dt depth in	eps_t	Phi
Y @ Max compression	1622.0	-39.92	-0.00	67.67	21.00	-0.00207	0.650
@ Allowable comp.	1297.6	-151.74	193.78	20.32	21.00	0.00010	0.650
@ fs = 0.0	1343.9	-150.57	172.70	21.00	21.00	0.00000	0.650
@ fs = 0.5*fy	902.5	-50.42	302.93	15.62	21.00	0.00103	0.650
@ Balanced point	611.2	36.49	313.91	12.43	21.00	0.00207	0.650
@ Tension control	290.3	230.38	297.82	7.88	21.00	0.00500	0.900
@ Pure bending	0.0	209.74	146.20	4.80	21.00	0.01014	0.900
@ Max tension	-200.9	58.59	0.00	0.00	21.00	9.99999	0.900
-Y @ Max compression	1622.0	-39.92	-0.00	67.67	21.00	-0.00207	0.650
@ Allowable comp.	1297.6	-151.74	-193.78	20.32	21.00	0.00010	0.650
@ fs = 0.0	1343.9	-150.57	-172.70	21.00	21.00	0.00000	0.650
@ fs = 0.5*fy	902.5	-50.42	-302.93	15.62	21.00	0.00103	0.650
@ Balanced point	611.2	36.49	-313.91	12.43	21.00	0.00207	0.650
@ Tension control	290.3	230.38	-297.82	7.88	21.00	0.00500	0.900
@ Pure bending	0.0	209.74	-146.20	4.80	21.00	0.01014	0.900
@ Max tension	-200.9	58.59	0.00	0.00	21.00	9.99999	0.900

*** End of output ***

S.O. No. 123248

Subject: Concrete Barrier Standards

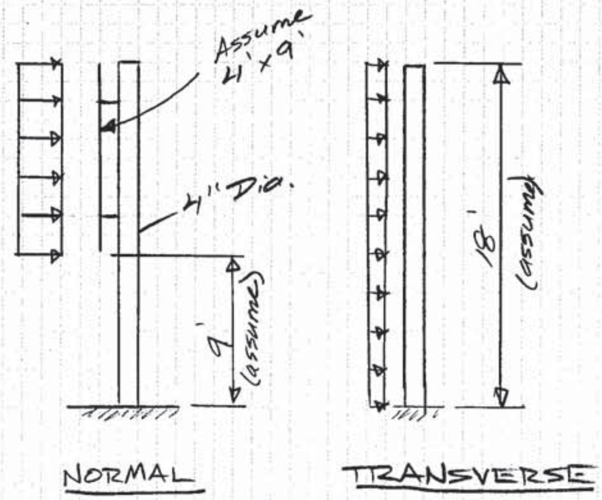
Sheet No. ____ of 61

Drawing No. ____

Computed by AFY Checked By ____ Date 10/21/11

Baker

SMALL SIGN EMBEDMENT



$P_z = 0.00256 K_z G V^2 I_r C_d$

$V = 90$ mph

$I_r = 0.71$ (10-yr Recurrence Interval, see Table 3-3)

$G = 1.14$

$K_z = 0.94$ (24.6' height, conservative)

$C_d = 1.10$ post ($C_v V d = 0.84(90)(0.33) = 25 \leq 39$ mph-ft)

$= 1.19$ sign ($L/W = 9/4 = 2.25$)

$P_z = 17.4$ psf post

$= 18.8$ psf sign

Use AASHTO LRFD $\therefore$ $\phi M_n \geq \gamma M_u$ (γ = 1.40 (STR III))

Normal – $V = 4(9)(18.8) = 677$ lb

$h = 9 + 9/2 = 13.5$ ft

$M_u = Vh = 9.14$ k·ft

$\gamma M_u = 12.8$ k·ft

Transverse – $V = 0.33(18)(17.4) = 103$ lb

$h = 18/2 = 9'$

$M_u = Vh = 0.93$ k·ft

$\gamma M_u = 1.30$ k·ft

S.O. No. 123248

Subject: Concrete Barrier Standards

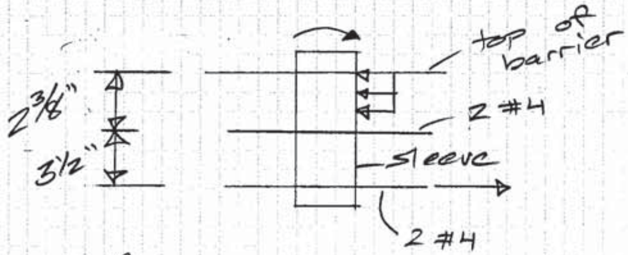
Drawing No.

Computed by AFY Checked By Date 10/21/11

SMALL SIGN EMBEDMENT CONT.

Resistances:

Normal -



b = 16"

(approach is conservative)

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.80(60)}{0.85(4)(16)} = 0.882$ in

$\phi M_n = 0.9 A_s f_y (d - \frac{a}{2}) = 197$ k·in $= 16.4$ k·ft

D/C = 0.78

$f_r = 0.74$ ksi $= 0.37\sqrt{f'_c}$

$S_c = bh^2/6 = 16(5.875)^2/6 = 92.0$ in^3

$M_{cr} = 0.74(144)(92.0) = 9.80$ k·ft

$1.2M_{cr} = 11.8$ k·ft ← Controls

$1.33M_u = 17.0$ k·ft

D/C = 0.72

Transverse - Use the same except use shear capacity of bar instead of tension capacity

$A_s = 0.6(0.80) = 0.48$ in^2

$a = 0.529$ in

$\phi M_n = 114$ k·in $= 9.48$ k·ft

D/C = 0.14

$1.2M_{cr} = 11.8$ k·ft

$1.33 M_u = 1.73$ k·ft ← Controls

D/C = 0.18

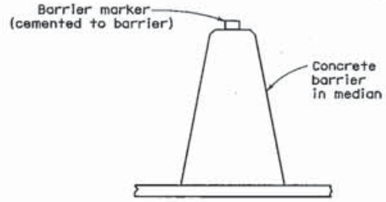
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Randell D. Hiatt
REGISTERED CIVIL ENGINEER
June 6, 2008
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

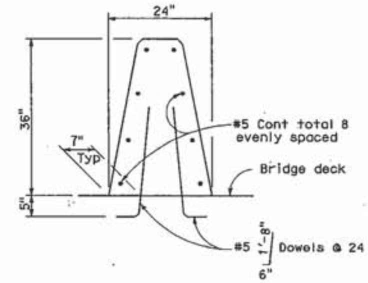
REGISTERED PROFESSIONAL ENGINEER Randell D. Hiatt No. C50200 Exp. 6-30-09 CIVIL STATE OF CALIFORNIA

To accompany plans dated ____________



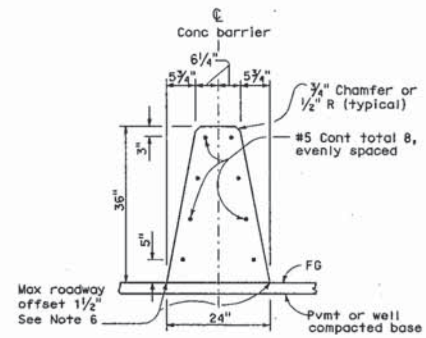
CONCRETE BARRIER TYPE 60 DELINEATION

See Notes 7 and 8

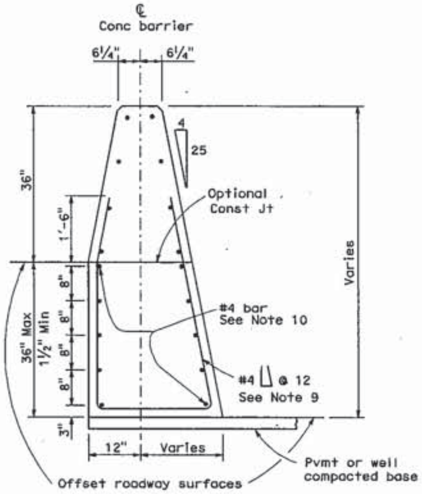


CONCRETE BARRIER TYPE 60A

Details similar to Type 60 except as noted.

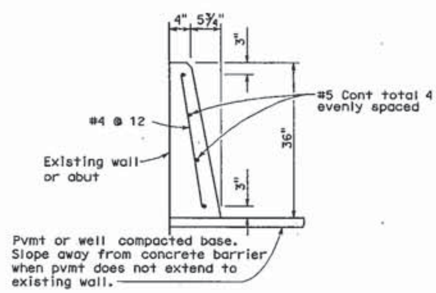


CONCRETE BARRIER TYPE 60



CONCRETE BARRIER TYPE 60C

Details similar to Type 60 except as noted.
Concrete barrier end anchor when necessary.
36" roadway surfaces offset shown.



CONCRETE BARRIER TYPE 60D

NOTES:

1. See Standard Plan A76B for details of Concrete Barrier Type 60 end anchors, connection to structures and transitions to Concrete Barrier Type 50 and Concrete Barrier Type 60S.
2. See Standard Plan A76C for Concrete Barrier Type 60 transitions at bridge column and sign pedestals.
3. Where glare screen is required on Concrete Barrier Type 60, use Concrete Barrier Type 60G.
4. Where the concrete barrier is added to the face of existing concrete structure, match existing weep holes.
5. Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or ½" minimum.
6. Where roadway offset is greater than 1½", see Concrete Barrier Type 60C.
7. Barrier delineation to be used when required by the Special Provisions.
8. Spacing of barrier markers to match spacing of raised pavement markers on the adjacent median edgeline pavement delineation.
9. Reinforcing stirrup not required for roadway offsets less than 1'-0".
10. For roadway surfaces offset greater than 1½" to 3", no rebars required. For roadway surfaces offset greater than 3" to 8" use two #4 rebars at 3" above the lower roadway surface. For roadway surfaces offset greater than 8" to 12", use two #4 rebars at 3" above the lower roadway surface and two #4 rebars at 8" above the lower roadway surface. For roadway surfaces offset greater than 12" to 36", use two #4 rebars at 3" above the lower roadway surface and two #4 rebars at every 8" increment vertical spacing above the first two #4 rebars.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60

NO SCALE

RSP A76A DATED JUNE 6, 2008 SUPERSEDES STANDARD PLAN A76A DATED MAY 1, 2006 - PAGE 29 OF THE STANDARD PLANS BOOK DATED MAY 2006.

REVISED STANDARD PLAN RSP A76A

5-21-08

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

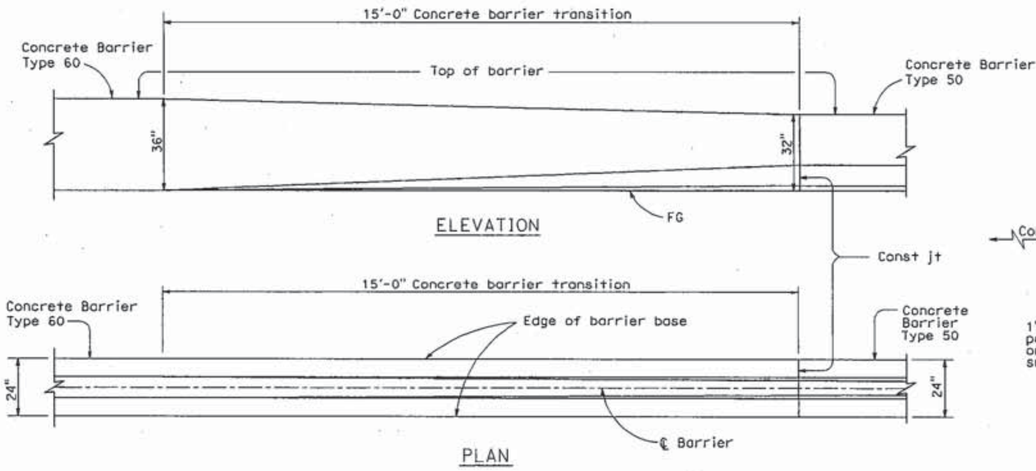
Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 1, 2006
PLANS APPROVAL DATE

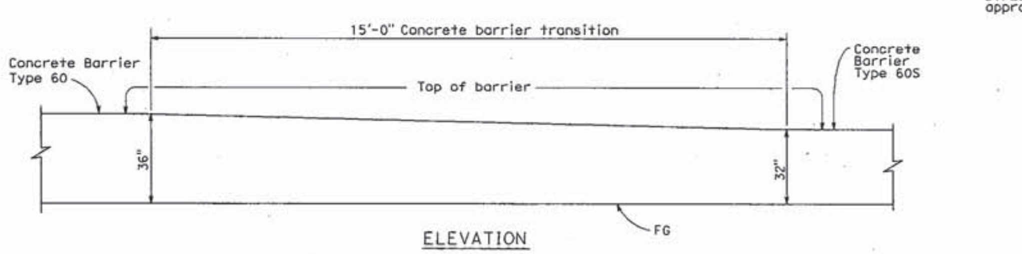
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER Randell D. Hiatt No. C50200 Exp. 6-30-07 CIVIL STATE OF CALIFORNIA

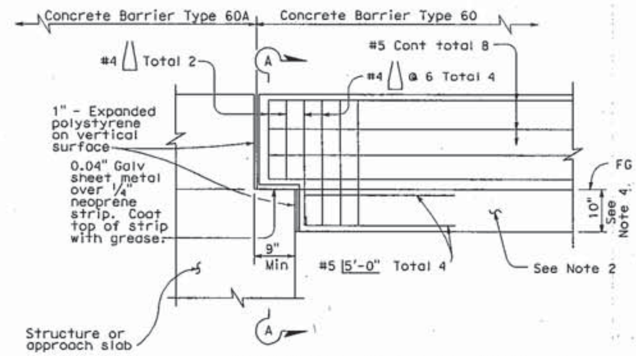
To get to the Caltrans web site, go to: http://www.dot.ca.gov



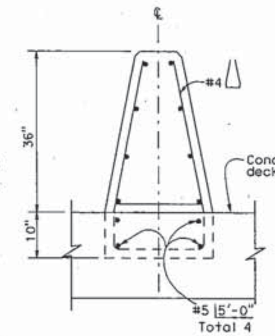
TRANSITION CONCRETE BARRIER TYPE 60 TO CONCRETE BARRIER TYPE 50



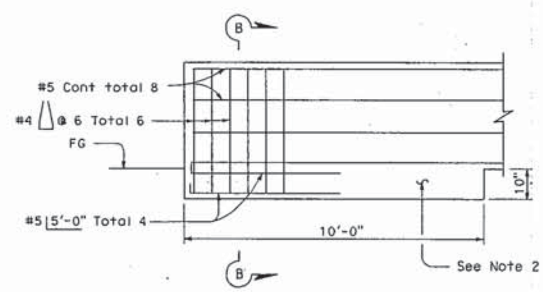
TRANSITION CONCRETE BARRIER TYPE 60 TO CONCRETE BARRIER TYPE 60S



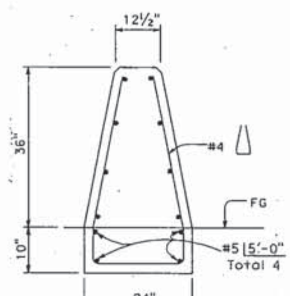
CONCRETE BARRIER TYPE 60
CONNECTION TO STRUCTURE



SECTION A-A



CONCRETE BARRIER TYPE 60
END ANCHORAGE



SECTION B-B

NOTES:

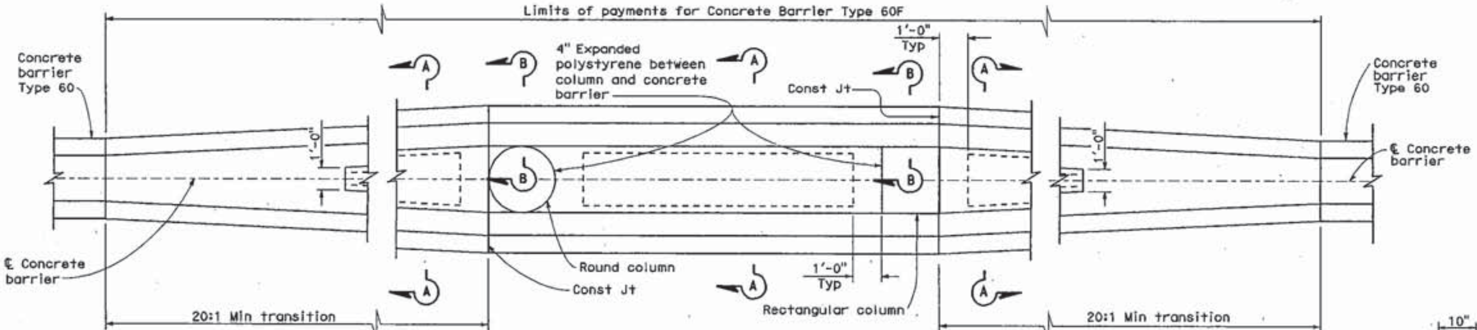
1. See Standard Plan A76A for Concrete Barrier Type 60 and Type 60A.
2. Footing monolithic or doweled with 2-#8 x 8" @ 2'-0". The footing is required at concrete barrier ends and at interruptions in concrete barrier.
3. Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or ½" minimum.
4. 10" Concrete barrier footing extends 10' back from structure.
5. See Standard Plan A78I for transition to Thrie Beam Barrier.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60

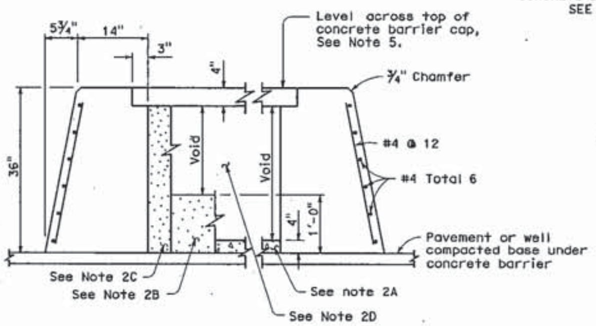
NO SCALE

A76B

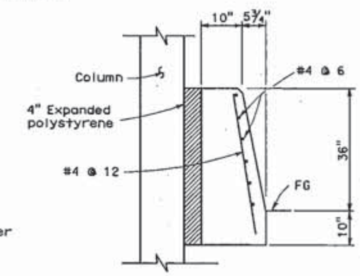


TRANSITION AT BRIDGE COLUMNS

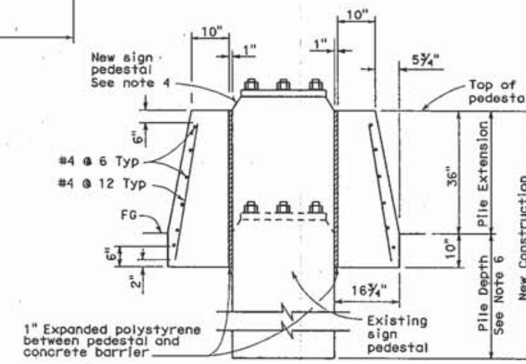
CONCRETE BARRIER TYPE 60F
SEE NOTE 7



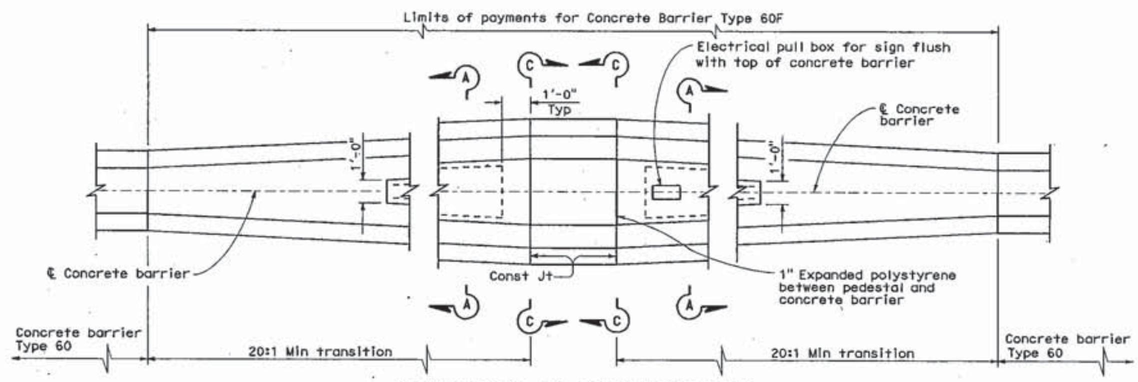
SECTION A-A



SECTION B-B



SECTION C-C



TRANSITION AT SIGN PEDESTAL

CONCRETE BARRIER TYPE 60F
SEE NOTE 7

NOTES:

1. See Revised Standard Plan RSP A76A for Concrete Barrier Type 60.
2. Contractor options for fill between concrete barrier walls:
   A. Place 4" PCC at base between concrete barrier walls.
   B. Place 1'-0" of granular material at base between walls.
   C. Place granular material from base to bottom of 4" cap.
   D. Monolithic concrete with foam blockouts is not permitted.
3. Reinforcing steel shall extend continuous through construction joints.
4. See "Overhead Sign" plans for sign pedestal elevations on new construction.
5. Adjust height of concrete barrier wall on low side of offset or superelevated roadways to provide level grade across top of concrete barrier cap.
6. See Overhead Signs Standard Plan Pile Foundation Tables.
7. All locations with limited shoulder width available for barrier, see Revised Standard Plan RSP A76F for use of Concrete Barrier Type 60GE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 20, 2011
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER Randell D. Hiatt No. C50200 Exp. 6-30-11 CIVIL STATE OF CALIFORNIA

To accompany plans dated ________

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60F

NO SCALE

RSP A76C DATED MAY 20, 2011 SUPERSEDES STANDARD PLAN A76C DATED MAY 1, 2006 - PAGE 31 OF THE STANDARD PLANS BOOK DATED MAY 2006.

REVISED STANDARD PLAN RSP A76C

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

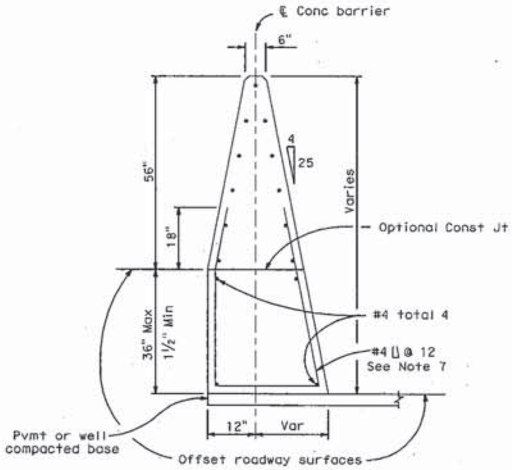
Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 1, 2006
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Randell D. Hiatt — No. C50200 — Exp. 6-30-07 — CIVIL — STATE OF CALIFORNIA

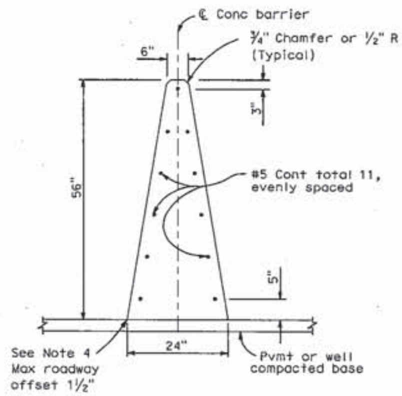
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

To get to the Caltrans web site, go to: http://www.dot.ca.gov



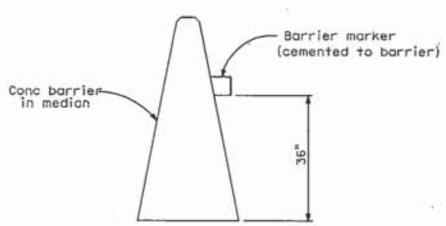
CONCRETE BARRIER TYPE 60GC

Details similar to Type 60G except as noted.



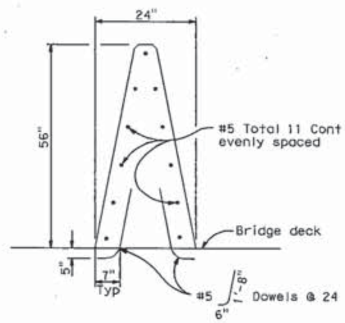
CONCRETE BARRIER TYPE 60G

(Monolithic concrete glare screen/barrier)



CONCRETE BARRIER TYPE 60G DELINEATION

See Notes 5 and 6



CONCRETE BARRIER TYPE 60GA

Details similar to Type 60G except as noted.

NOTES:

1. See Standard Plan A76E for details of Concrete Barrier Type 60G end anchors, connection to structures and transitions to Concrete Barrier Type 60.
2. See Standard Plan A76F for Concrete Barrier Type 60G transitions at bridge column and sign pedestals.
3. Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or ½" minimum.
4. Where roadway offset is greater than 1½", see Concrete Barrier Type 60GC.
5. Barrier delineation to be used when required by the Special Provisions.
6. Spacing of barrier markers to match spacing of raised pavement markers on the adjacent median edgeline pavement delineation.
7. Reinforcing stirrup not required for offsets less than 1'-0".

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60G

NO SCALE

A76D

2006 STANDARD PLAN A76E

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

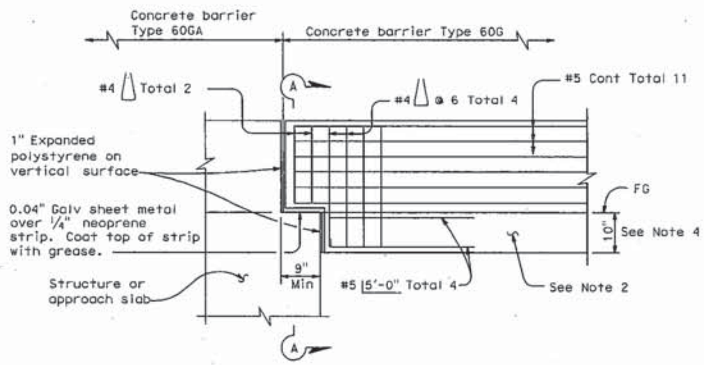
Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 1, 2006
PLANS APPROVAL DATE

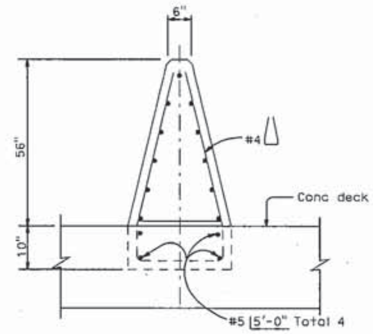
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER
Randell D. Hiatt
No. C50200
Exp. 6-30-07
CIVIL
STATE OF CALIFORNIA

To get to the Caltrans web site, go to: http://www.dot.ca.gov



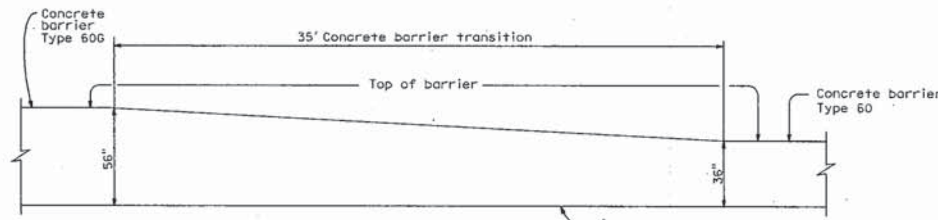
CONCRETE BARRIER TYPE 60G CONNECTION TO STRUCTURE



SECTION A-A

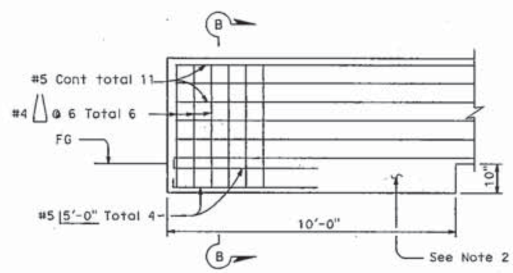
NOTES:

1. See Standard Plan A76D for Concrete Barrier Type 60G and Type 60GA.
2. Footing monolithic or doweled with 2-#8 x 8" @ 2'-0". The footing is required at concrete barrier ends and at interruptions in concrete barrier.
3. Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or 1/2" minimum.
4. 10" Concrete barrier footing extends 10' back from structure.
5. See Standard Plan A78I for transition to Thrie Beam Barrier.

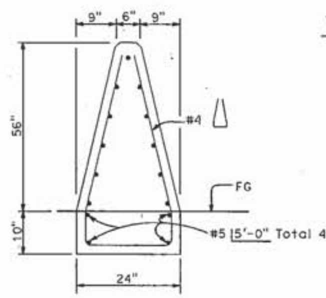


ELEVATION

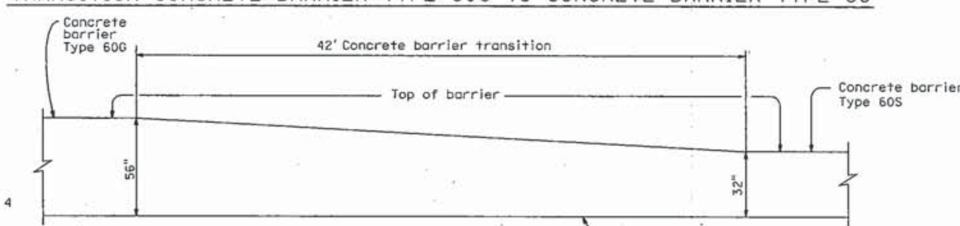
TRANSITION CONCRETE BARRIER TYPE 60G TO CONCRETE BARRIER TYPE 60



CONCRETE BARRIER TYPE 60G END ANCHORAGE



SECTION B-B



ELEVATION

TRANSITION CONCRETE BARRIER TYPE 60G TO CONCRETE BARRIER TYPE 60S

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60G

NO SCALE

A76E

7-17-05

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

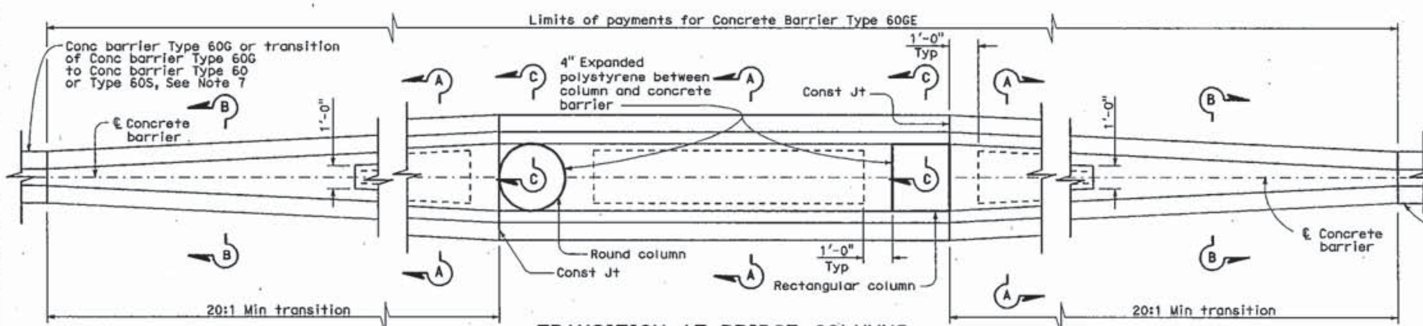
Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 20, 2011
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

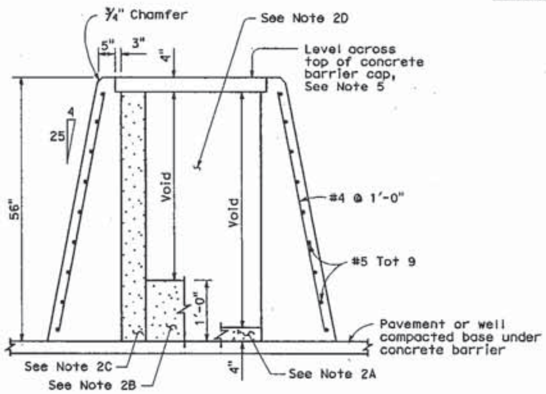
REGISTERED PROFESSIONAL ENGINEER — Randell D. Hiatt — No. C50200 — Exp. 6-30-11 — CIVIL — STATE OF CALIFORNIA

To accompany plans dated

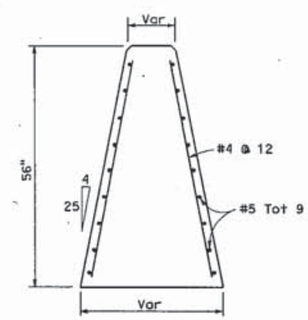


TRANSITION AT BRIDGE COLUMNS

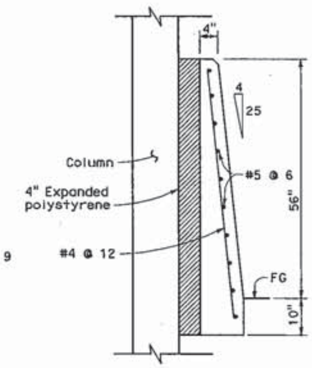
CONCRETE BARRIER TYPE 60GE



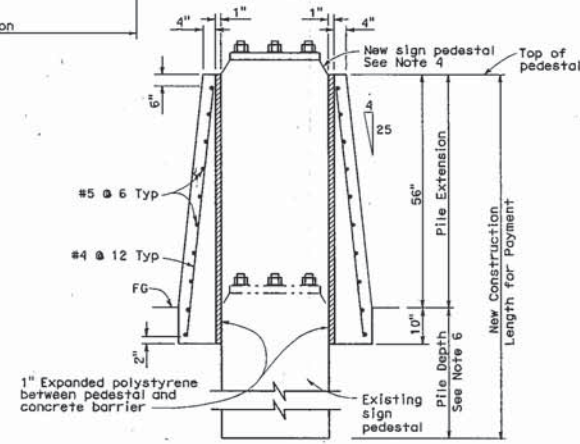
SECTION A-A



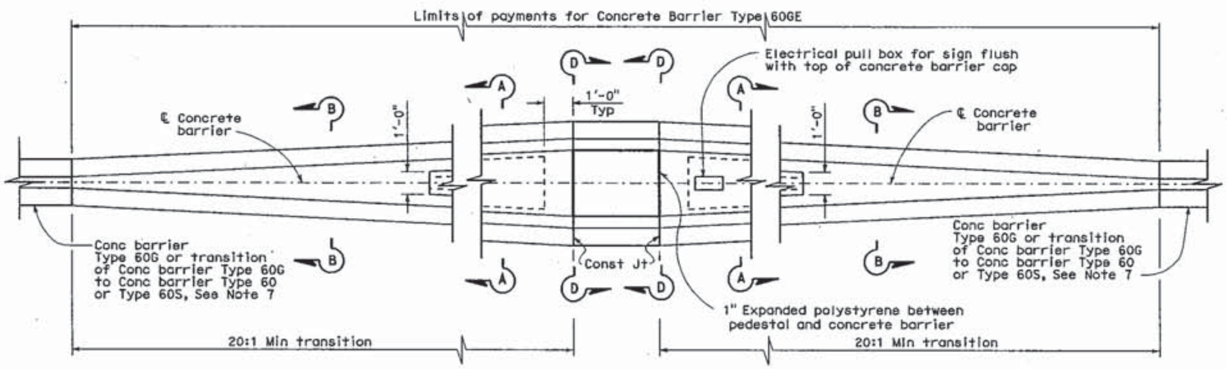
SECTION B-B



SECTION C-C



SECTION D-D



TRANSITION AT SIGN PEDESTAL

CONCRETE BARRIER TYPE 60GE

NOTES:

1. See Standard Plan A76D for Concrete Barrier Type 60G.
2. Contractor options for fill between concrete barrier walls:
   A. Place 4" PCC at base between concrete barrier walls.
   B. Place 1'-0" of granular material at base between walls.
   C. Place granular material from base to bottom of 4" cap.
   D. Monolithic concrete with foam blockouts is not permitted.
3. Reinforcing steel shall extend continuous through construction joints.
4. See "Overhead Sign" plans for sign pedestal elevations on new construction.
5. Adjust height of concrete barrier wall on low side of offset or superelevated roadways to provide level grade across top of concrete barrier cap.
6. See Overhead Signs Standard Plan Pile Foundation Tables.
7. See Revised Standard Plan A76E for concrete barrier transitions.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60GE

NO SCALE

RSP A76F DATED MAY 20, 2011 SUPERSEDES STANDARD PLAN A76F DATED MAY 1, 2006 - PAGE 34 OF THE STANDARD PLANS BOOK DATED MAY 2006.

REVISED STANDARD PLAN RSP A76F

4-6-11

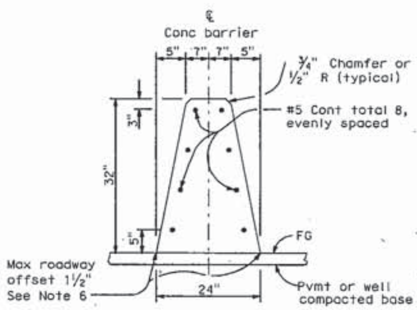
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Randell D. Hiatt
REGISTERED CIVIL ENGINEER

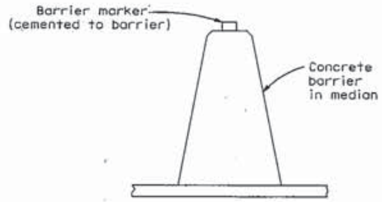
May 1, 2006
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Randell D. Hiatt — No. C50200 — Exp. 6-30-07 — CIVIL — STATE OF CALIFORNIA

To get to the Caltrans web site, go to: http://www.dot.ca.gov

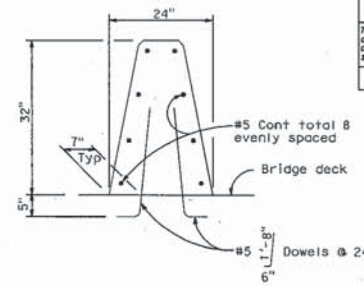


CONCRETE BARRIER TYPE 60S



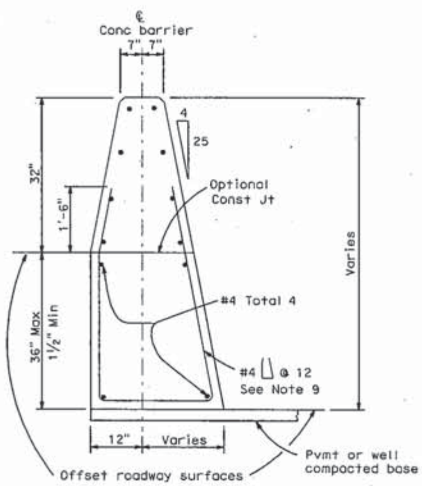
CONCRETE BARRIER TYPE 60S DELINEATION

See Notes 7 and 8



CONCRETE BARRIER TYPE 60SA

Details similar to Type 60S except as noted.



CONCRETE BARRIER TYPE 60SC

Details similar to Type 60S except as noted.
Concrete barrier end anchor when necessary.

NOTES:

1. See Standard Plan A76H for details of Concrete Barrier Type 60S end anchors, connection to structures and transitions to Concrete Barrier Type 50.
2. See Standard Plan A76 for Concrete Barrier Type 60S transitions at bridge column and sign pedestals.
3. Where glare screen is required on top of concrete barrier, use Concrete Barrier Type 60G.
4. Where the concrete barrier is added to the face of existing concrete structure, match existing weep holes.
5. Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or ½" minimum.
6. Where roadway offset is greater than 1½" see Concrete Barrier Type 60SC.
7. Barrier delineation to be used when required by the Special Provisions.
8. Spacing of barrier markers to match spacing of raised pavement markers on the adjacent median edgeline pavement delineation.
9. Reinforcing stirrup not required for roadway offsets less than 1'-0".

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60S

NO SCALE

A76G

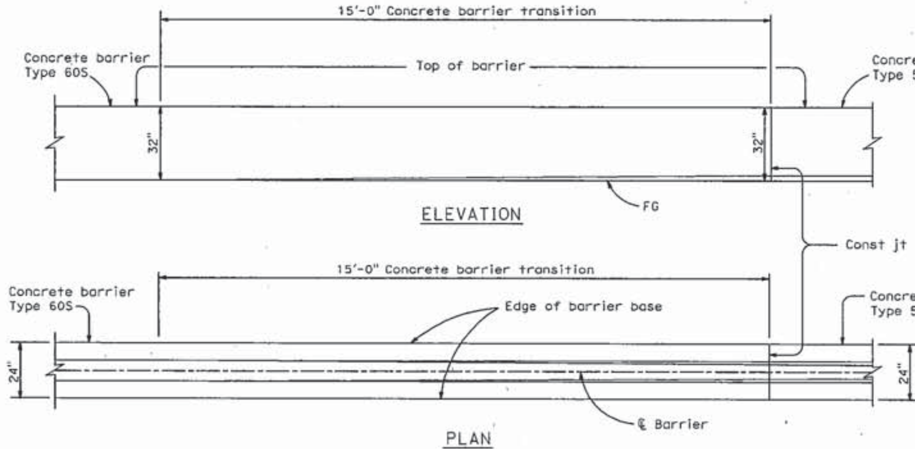
1-17-05

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 1, 2006
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Randell D. Hiatt No. C50200 Exp. 6-30-07 CIVIL STATE OF CALIFORNIA



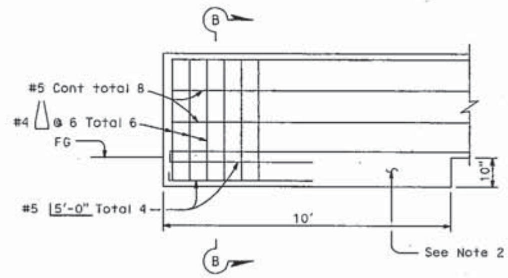
ELEVATION

PLAN

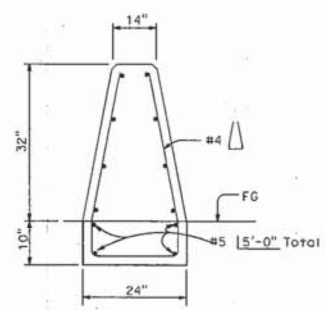
TRANSITION TYPE 60S CONCRETE BARRIER TO TYPE 50 CONCRETE BARRIER

NOTES:

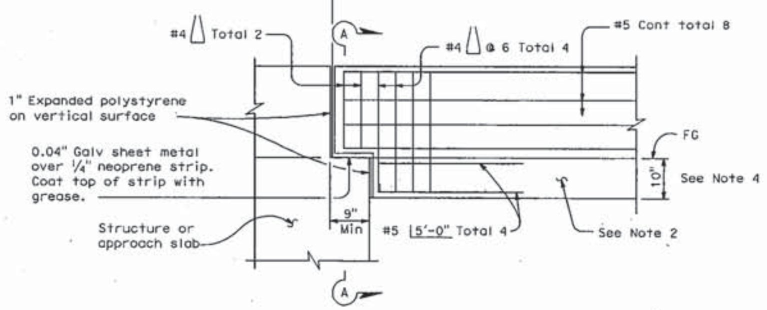
1. See Standard Plan A76G for Concrete Barrier Type 60S and Type 60SA.
2. Footing monolithic or doweled with 2-#8 x 8" @ 2'-0". The footing is required at concrete barrier ends and at interruptions in concrete barrier.
3. Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or ½" minimum.
4. 10" Concrete barrier footing extends 10'-0" back from structure.
5. See Standard Plan A78I for transition to Thrie Beam Barrier.



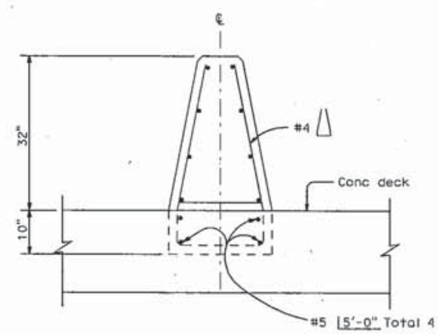
CONCRETE BARRIER TYPE 60S END ANCHORAGE



SECTION B-B



CONCRETE BARRIER TYPE 60S CONNECTION TO STRUCTURE



SECTION A-A

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60S

NO SCALE

A76H

7-17-05

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

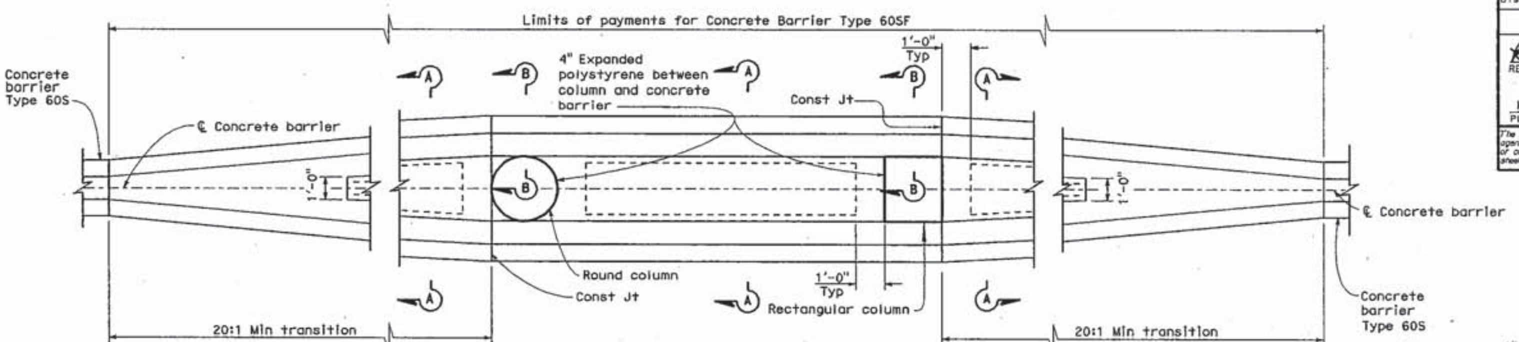
Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 20, 2011
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

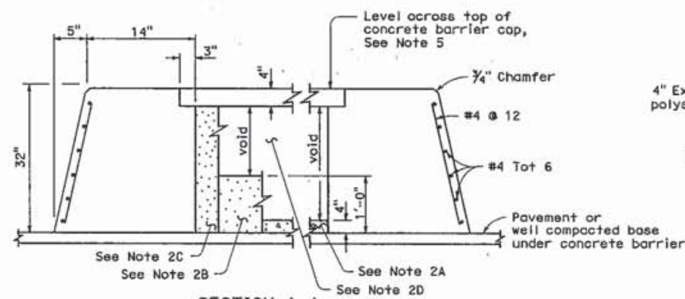
REGISTERED PROFESSIONAL ENGINEER Randell D. Hiatt No. C50200 Exp. 6-30-11 CIVIL STATE OF CALIFORNIA

To accompany plans dated ____________

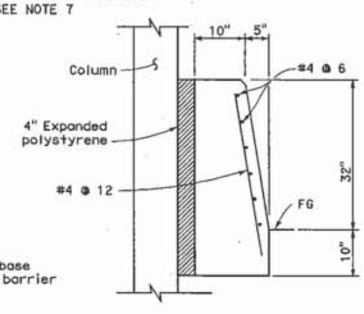


TRANSITION AT BRIDGE COLUMNS

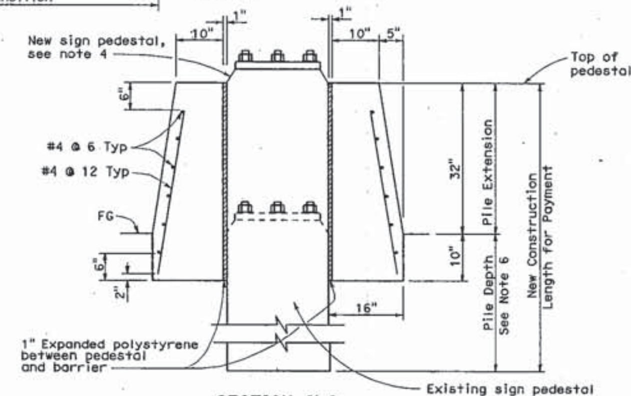
CONCRETE BARRIER TYPE 60SF
SEE NOTE 7



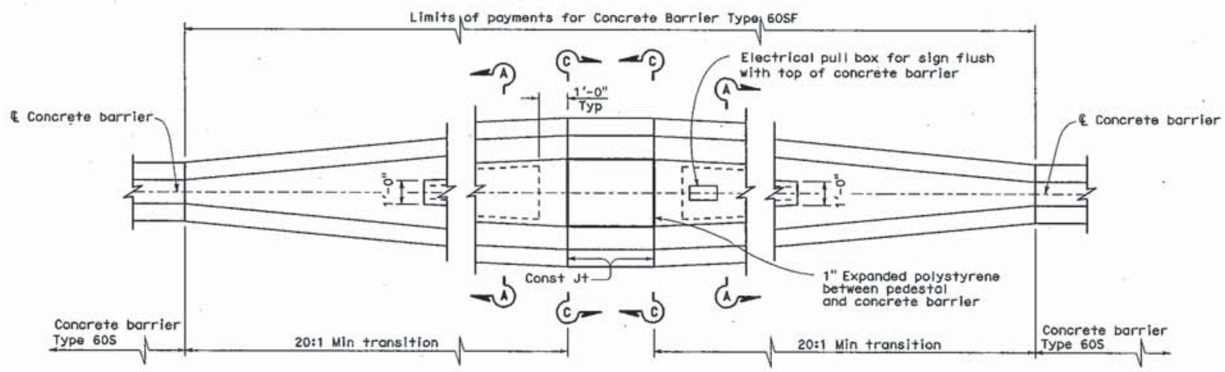
SECTION A-A



SECTION B-B



SECTION C-C



TRANSITION AT SIGN PEDESTAL

CONCRETE BARRIER TYPE 60SF
SEE NOTE 7

NOTES:

1. See Standard Plan A76G for Concrete Barrier Type 60S.
2. Contractor options for fill between concrete barrier walls:
   A. Place 4" PCC at base between concrete barrier walls.
   B. Place 1'-0" of granular material at base between walls.
   C. Place granular material from base to bottom of 4" cap.
   D. Monolithic concrete with foam blockouts is not permitted.
3. Reinforcing steel shall extend continuous through construction joints.
4. See "Overhead Sign" plans for sign pedestal elevations on new construction.
5. Adjust height of concrete barrier wall on low side of offset or superelevated roadways to provide level grade across top of concrete barrier cap.
6. See Overhead Signs Standard Plan Pile Foundation Tables.
7. All locations with limited shoulder width available for barrier, see Revised Standard Plan RSP A76F for use of Concrete Barrier Type 60GE.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

CONCRETE BARRIER TYPE 60SF

NO SCALE

RSP A76I DATED MAY 20, 2011 SUPERSEDES STANDARD PLAN A76I DATED MAY 1, 2006 - PAGE 37 OF THE STANDARD PLANS BOOK DATED MAY 2006.

REVISED STANDARD PLAN RSP A76I

4-6-11

U.S. Department
of Transportation

**Federal Highway
Administration**

400 Seventh St., S.W.
Washington, D.C. 20590

February 4, 1998

Refer to: HNG-14

Mr. Rich Peter
Chief, Roadside Safety Technology Unit
Office of Materials Engineering and
Testing Services - MS #5
P.O. Box 19128
Sacramento, California 95819-0128

Dear Mr. Peter:

In your January 12 letter to Mr. Henry H. Rentz, you requested the Federal Highway Administration's formal acceptance of your Type 60G median barrier for use on the National Highway System (NHS). This is a slip-formed, reinforced concrete barrier having a constant slope face of 9.1 degrees, versus the 10.8-degree slope developed and first used by Texas for a similar barrier. The Type 60G barrier has a 610-mm base width, a 150-mm top width, and a total height of 1420 mm. The barrier itself is slip-formed on grade with no embedment, but each end has a 3050-mm long by 250-mm deep footing and contains additional reinforcing steel as shown in Enclosure 1. To support your request, you sent us a copy of the Caltrans report titled "Vehicular Crash Tests of a Slip-Formed, Single Slope, Concrete Median Barrier With Integral Concrete Glare Screen," dated December 1997, and video tapes of the full-scale tests that you conducted.

Two tests, test 3-10 and test 3-11, are recommended in the National Cooperative Highway Research Program (NCHRP) Report 350 to qualify a longitudinal barrier as crashworthy at test level 3 (TL-3). Test 3-10 requires an 820-kg car to impact the barrier at 100 km/h and 20 degrees. These impact conditions were attained in your Test 511, which met all appropriate evaluation criteria. We noted, however, that a shorter design (called the Type 60), also with a 610-mm base width and a 9.1 degree sloped face, but with an overall height of only 810 mm, was used for this test. Nevertheless, we concur with your assertion that the test results would have been the same with the taller Type 60G design. Test 3-11 requirements were satisfied by your Test 534, a 97.7 km/h impact at 25.2 degrees with a 2000-kg pickup truck into the Type 60G design. Again, we noted that all NCHRP Report 350 evaluation criteria were met. Enclosure 2 consists of summaries of both of these acceptance tests.
It appears that this barrier is an improvement over both the standard New Jersey concrete barrier shape and the Texas constant slope barrier because of the reduced vehicular climb seen upon impact with this barrier's 9.1 degree sloped-face and on the less severe post-crash vehicular trajectories observed in the crash test videos.

Based on our review of the information you provided, we consider both the Type 60 and Type 60G barriers to be acceptable at TL-3 for use on the NHS. We will so advise our field offices via copies of this letter.

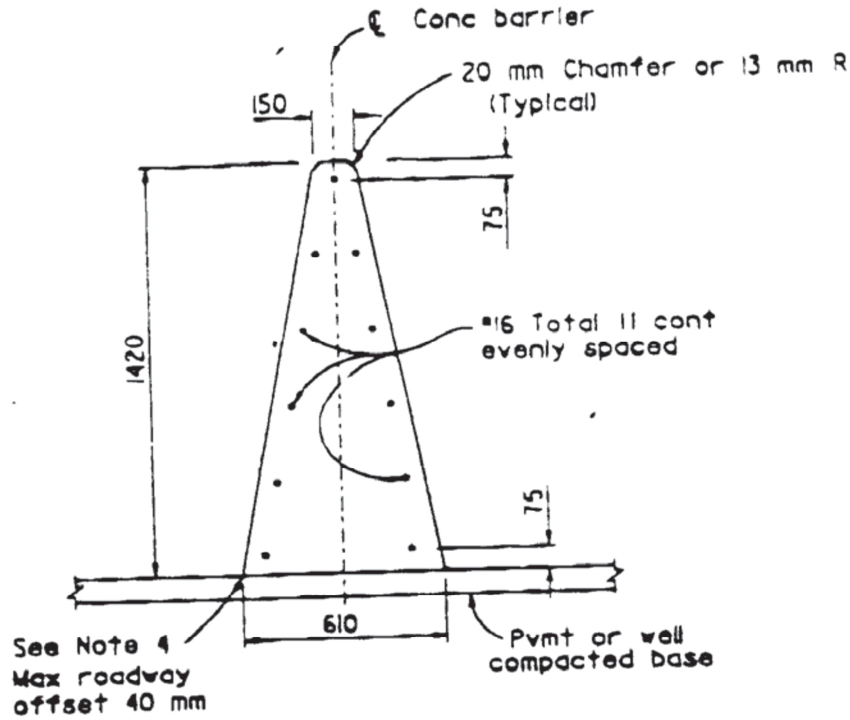
Sincerely yours,

Dwight A. Horne

Dwight A. Horne
Chief, Federal-Aid and Design Division

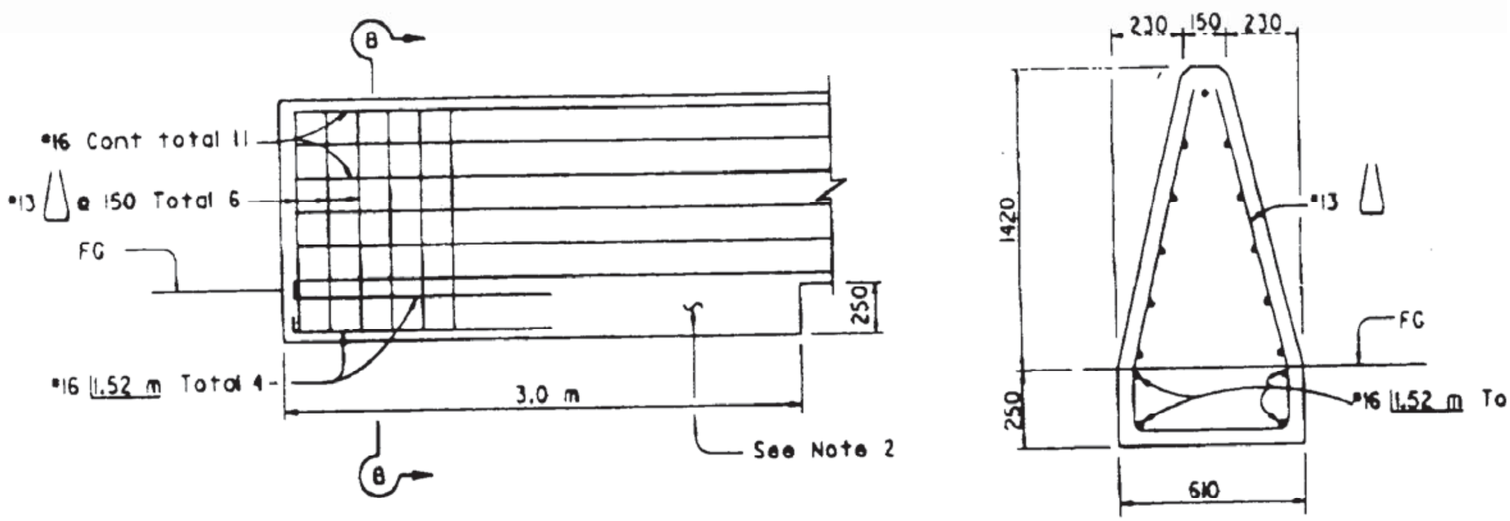
2 Enclosures

Geometric and Safety Design Group Acceptance Letter BB-45



CONCRETE BARRIER TYPE 60G

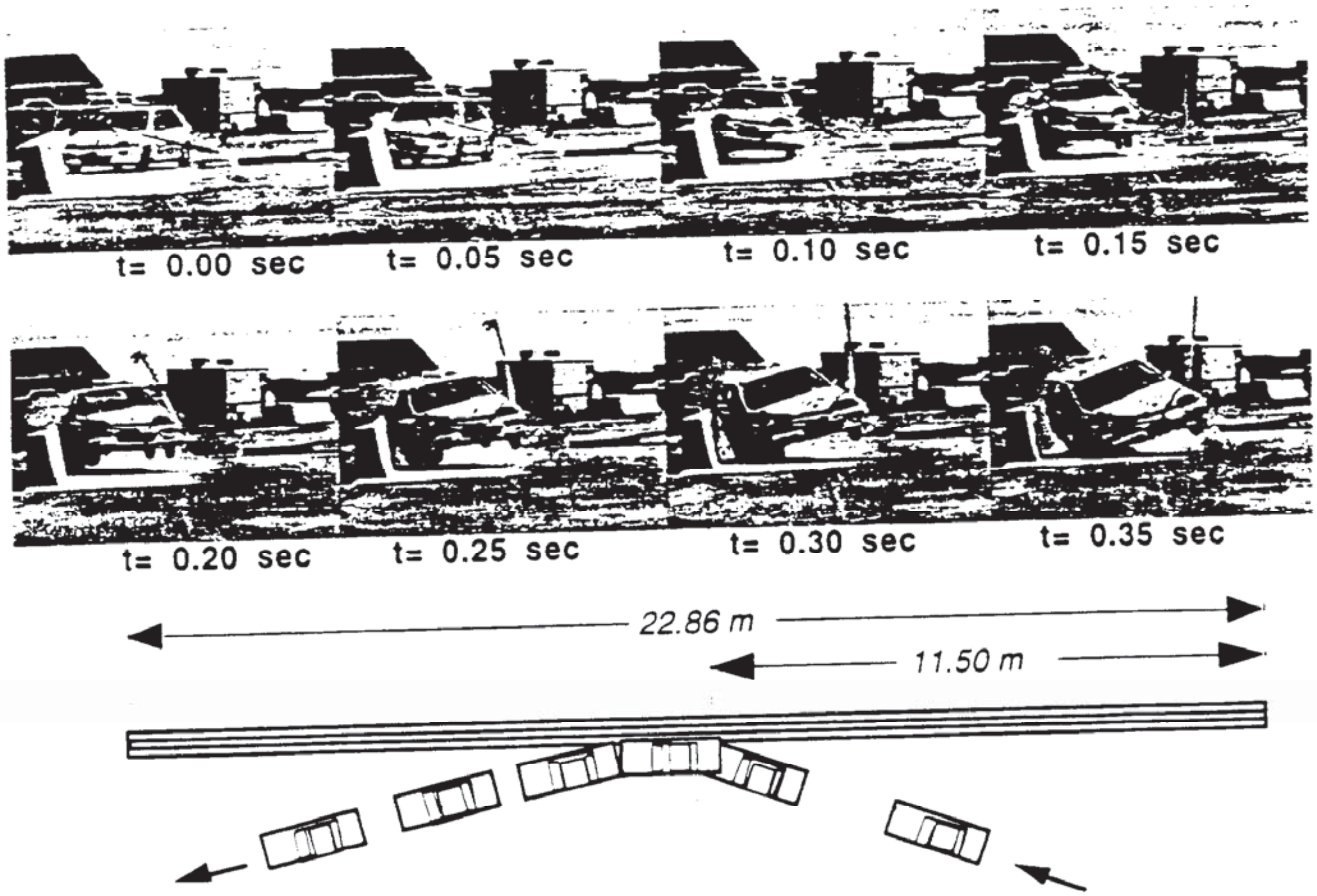
(Monolithic concrete
glare screen/barrier)



SECTION B-B

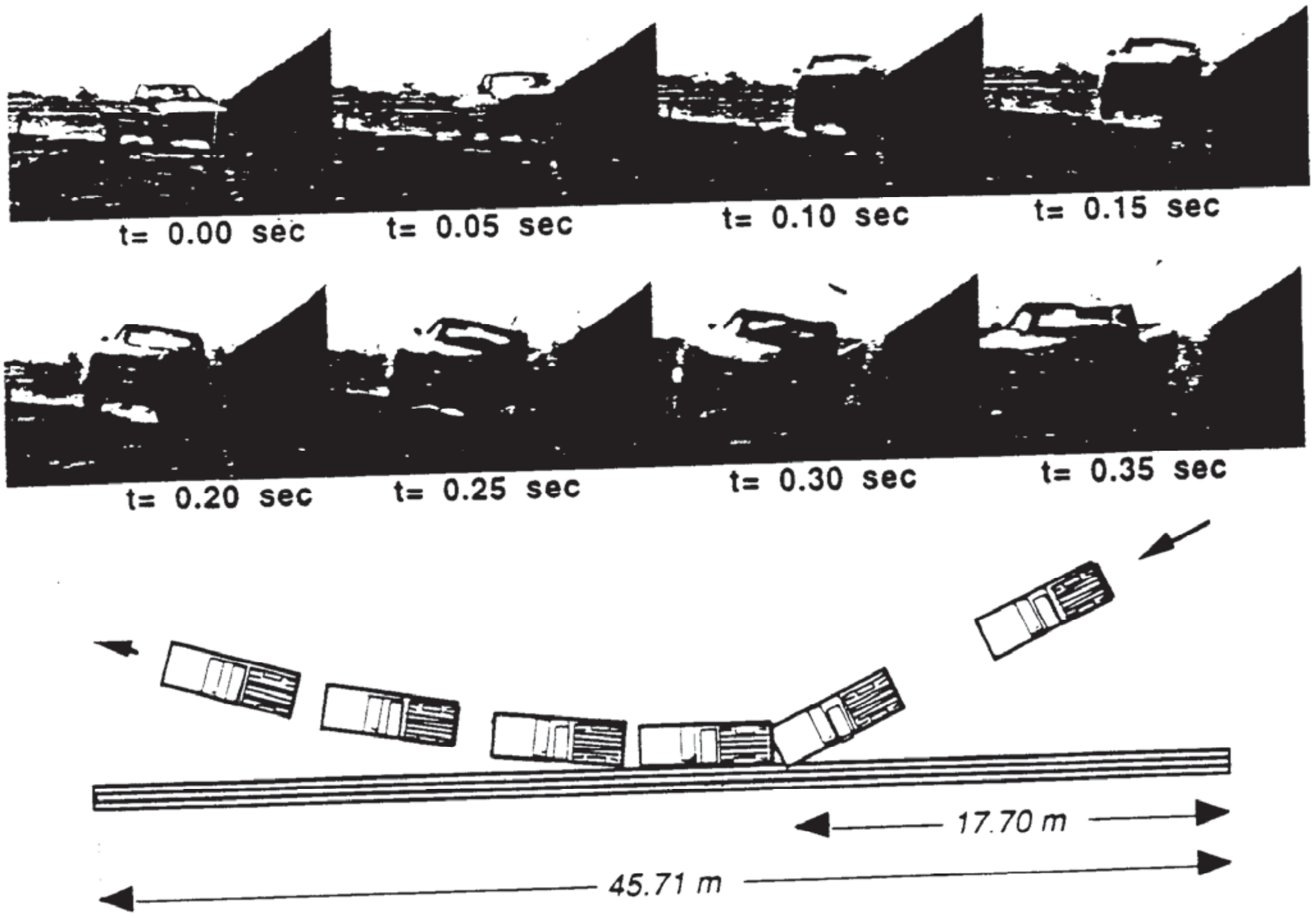
CONCRETE BARRIER TYPE 60G
CONCRETE BARRIER END ANCHORAGE

Figure 2.43 - Test 511 Data Summary Sheet



Test Barrier		
Type:	Type 70 Bridge Rail	
Length:	22.86 meters	
Test Date:	April 6, 1997	
Test Vehicle:		
Model:	1992 Geo Metro	
Inertial Mass:	843 kg	
Impact / Exit Velocity:	104.1 km/h / 92 km/h	
Impact / Exit Angle:	20.0 / 12.1°	
Test Dummy:		
Type:	Hybrid III	
Weight / Restraint:	74.8 kg / lap and shoulder	
Position:	Front Right	
Test Data:		
Occ. Impact Velocity (Long / Lat):		4.51 m/s / 7.22 m/s
Ridedown Acceleration (Long / Lat):		-2.9g / -16.0g
Max. 50 ms Avg. Accel (Long / Lat):		-7.0g / -13.4g
Exterior: VDS/CDC[9]		FR-5, RD-4 / 12RFEW3
Interior: OCDI[10]		RF0000110
Barrier Damage:		Only superficial scuffing

Figure 2.34 - Test 534 Data Summary Sheet



Test Barrier
- Type: Type 60G
- Length: 50 meters

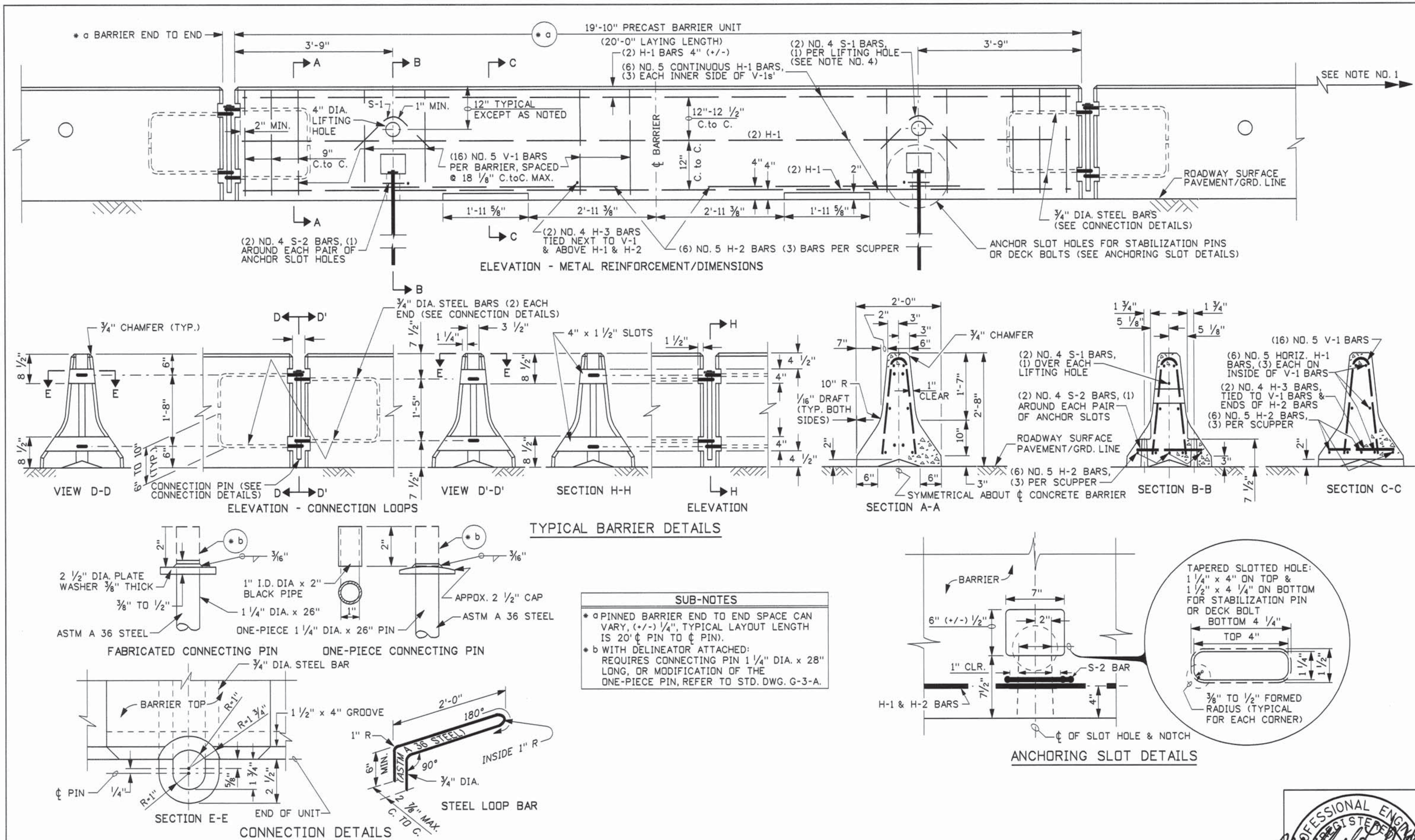
Test Date: November 28, 1995

Test Vehicle:
- Model: 1991 Chevy pickup
- Inertial Mass: 2000 kg
- Impact / Exit Velocity: 97.7 km/h / 83.1 km/h
- Impact / Exit Angle: 25.2° / 6.5°

Test Dummy:
- Type: None
- Weight / Restraint: NA
- Position: NA

Test Data:
- Occ. Impact Velocity (Long / Lat): 6.8 m/s / -9.51 m/s
- Ridedown Acceleration (Long / Lat): -6.7g / 2.3g
- Max. 50 ms Avg. Accel (Long / Lat): -8.9g / 15.7g
- Exterior: VDS/CDC[9] FL-3, LD-4 / 12LFEK3
- Interior: OCDI[10] LF1111131

Barrier Damage: Only superficial scuffing



REVISIONS

NO.	DATE	BY	NO.	DATE	BY	NO.	DATE	BY
1	8-00	MSM	6	6-04	MSM			
2	12-01	MSM	7	10-04	MSM			
3	7-02	MSM						
4	7-03	MSM						
5	9-03	MSM						

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY

CADD FILE NAME g2a11004.std

DRWG. ORIG. DATE: NOVEMBER, 1999

IDAHO TRANSPORTATION DEPARTMENT

BOISE IDAHO

ASSISTANT CHIEF ENGINEER (DEVELOPMENT)

CHIEF ENGINEER

STANDARD DRAWING

20' CONCRETE BARRIER

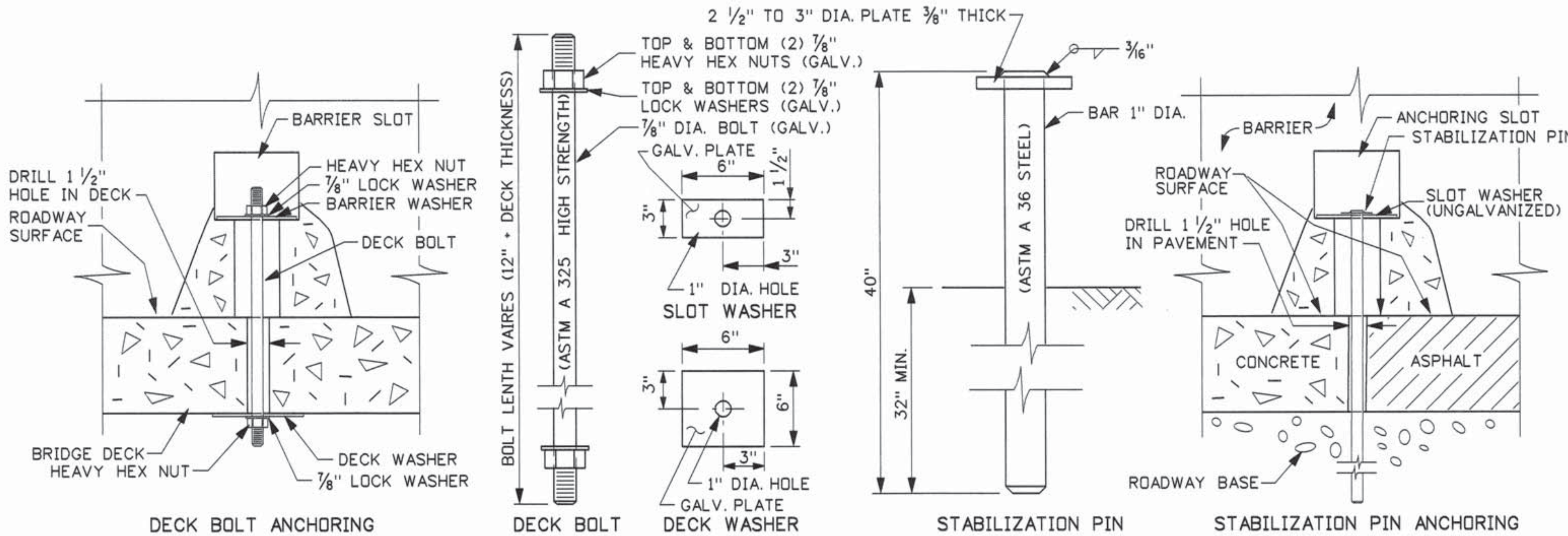
REQUIRES SHEET 2 OF 2

English

STANDARD DRWG. NO. G-2-A-1

SHEET 1 OF 2

REGISTERED PROFESSIONAL ENGINEER 2240 10/13/04 STATE OF IDAHO MILFORD L. MILLER

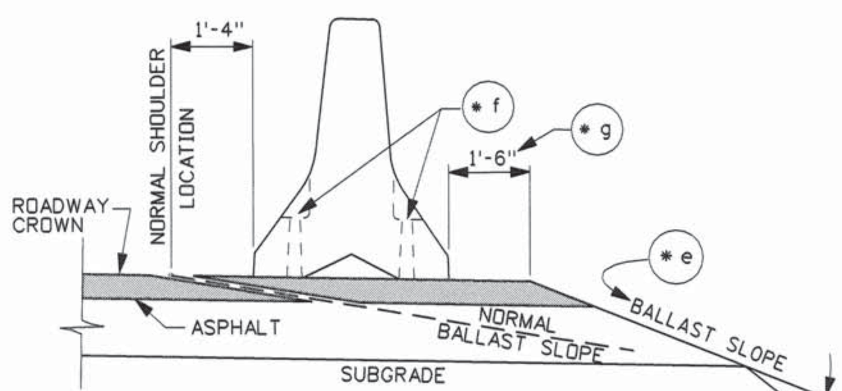


ANCHORING ASSEMBLY CON'T.

(SEE NOTE NOS. 1, 3, 5, & 7)

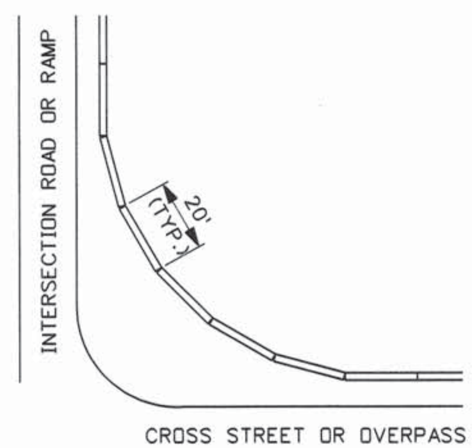
METAL REINFORCEMENT TABLE (SEE SUB-NOTES * c & * d)				
MARK	LOCATION	BAR SIZE	(NO.BARS)	SKETCH
H-1	HORIZONTAL IN BARRIER TIED INSIDE V-1 BARS	NO. 5	(6)	19'-3"
H-2	CENTERED ABOVE SCUPPERS LONG. & TRANSVERSELY	NO. 5	(6)	6'-6"
H-3	TIED ABOVE H-1 BARS TO SUPPORT H-2, TIED TO V-1	NO. 4	(2)	1'-6"
S-1	HORIZ. IN TOP OF WING WALL & IN FLOOR BACK WALL	NO. 4	(2)	2'-5"; LIFTING HOLE; 90°; 3 3/8" R
S-2	HORIZ. AROUND SLOTS BETWEEN V-I'S @ SCUPPERS	NO. 4	(2)	5'-3" BAR W/(4) 1 1/2" R BENDS & MIN. 1'-0" OVERLAP; 1 1/2" R; SLOTS; 1' MIN. OVRLP.; 8" * d O.to O.; 1'-6 1/2"; * d O.to O.; 1" MIN. CLEAR TO BAR
V-1	VERTICAL IN BARRIER(3) EACH END & (2) AT EACH SCUPPER	NO. 5	(16)	TOTAL LENGTH 4'-9"; 2" R; * d O.to O.; 12°; * d O.to O.; 10" (+/-); 4 7/8"; 2'-1 3/8"

SUB-NOTES
* c ALL METAL REINFORCEMENT BENDS ARE TO BE ACCORDING TO THE LATEST A.C.I. STANDARD PRACTICE AND AASHTO SPECIFICATIONS.
* d DIMENSIONS SHOWN IN THE "METAL REINFORCEMENT TABLE" ARE OUT-TO-OUT (O.to O.) OF BEND POINTS AND/OR END OF BARS UNLESS OTHERWISE NOTED.



SUB-NOTES CON'T.
* e BALLAST SLOPE VARIABLE BU T NOT STEEPER 2:1.
* f NO STABILIZATION PINS (SEE NOTE NOS. 1 & 3)
* g WHEN BARRIER IS ANCHORED THE SHOULDER OFFSET MAY BE 0'-0".

STANDARD INSTALLATION



BARRIER ARRANGED ON A CURVE
MAY BE USED: 1. WHERE POSTED SPEED IS 35 mph OR LESS (SEE NOTE NO. 8). 2. WHERE BARRIER IS OUTSIDE THE CLEAR ZONE.
NOTE: NORMALLY PINS CAN BE USED UNTIL CURVING EXCEEDS 10° BETWEEN UNITS.

CURVED LAYOUT

(SEE NOTE NO. 9)

GENERAL NOTES

1. ANCHORING THIS BARRIER IS NOT REQUIRED TO MEET NCHRP 350, TL-3 REQUIREMENTS: HOWEVER, THE BARRIER MUST BE PROPERLY TERMINATED (THIS IS A "STANDARD INSTALLATION"). ANCHORING IS ALLOWED IN SITUATIONS WHERE LATERAL MOVEMENT MUST BE RESTRICTED (NOTE: ANCHORING ASSEMBLIES INCLUDE DECK BOLTS AND STABILIZATION PINS).
2. WHEN CONNECTING 10' TO 20' CONCRETE BARRIER THE EXPOSED CONNECTINGLOOPS MAY NEED TO BE BENT (MECHANICALLY, NOT WITH HEAT) TO FIT.
3. WHEN INSTALLING UNANCHORED 20' CONCRETE BARRIER ALLOW FOR 3' OF LATERAL MOVEMENT BEHIND THE BARRIER.
4. A 4" WHITE PVC SLEEVE MAY BE USED TO FORM THE LIFTING HOLE AND IF USED THE SLEEVE IS TO BE LEFT IN PLACE.
5. ANCHORED BARRIER UNITS SHALL HAVE FOUR ANCHOR ASSEMBLIES.
6. THE UNIT SHALL BE PRECAST USING CONCRETE CLASS 40B. THE MINIMUM CONCRETE COVER OVER REINFORCEMENT STEEL SHALL BE 2" UNLESS OTHERWISE NOTED.
7. WHEN ANCHORING A BARRIER SYSTEM USE AND DO THE FOLLOWING:
   a. DO NOT DRILL ANCHOR HOLES INTO PRESTRESSED CONCRETE DECK PANELS.
   b. EXPANSION ANCHORS WILL NOT BE PERMITTED FOR USE ON BRIDGE DECKS.
   c. USE ASTM A 325 HIGH STRENGTH GALVANIZED STEEL FOR DECK BOLTS.
   d. A ONE PIECE STABILIZATION PIN WITH A 3" ROUNDED TOP THAT MEETS ASTM A 36 REQUIREMENTS IS ALLOWED.
   e. BRIDGE DECK ANCHOR HOLES SHALL BE DRILLED/CORED SMOOTH AND ROUND.
   f. FOR BARRIER UNITS THAT EXTEND ACROSS BRIDGE EXPANSION JOINTS, DO NOT ANCHOR THE BARRIER (ANCHORED INSTALLATIONS REQUIRE SECURING ALL FOUR ANCHOR SLOTS).
   g. TIGHTEN DECK BOLTS DOWN WELL, BOLT LENGTH SHOULD ALLOW AT LEAST ONE COURSE OF THREADS SHOW OUTSIDE OF THE NUT WHEN TIGHTENED.
   h. DO NOT PROTRUDE THE TOP OF THE DECK BOLT/STABILIZATION PIN HEAD/END BEYOND WHERE THE SLOT EDGE MEETS THE EXTERIOR BARRIER SURFACE.
8. FOR SPEEDS GREATER THAN OR EQUAL TO 35 mph BARRIERS MUST BE PINNED TOGETHER AND CAN NOT EXCEED THE TABLE OF MAXIMUM TAPERS.
9. THE PIN CONNECTED 20' BARRIER DESIGN ALLOWS FOR:
   a. APPROXIMATELY TEN TO ELEVEN PINNED BARRIER UNITS TO COMPLETE A 90° TURN.
   b. CONNECTION JOINTS CAN BEND UP TO 10° BEFORE MEETING RESISTANCE WITH THE ADJACENT BARRIER.
10. NOT TO SCALE.

TABLE OF MAXIMUM TAPERS FOR CONCRETE BARRIER	
DESIGN SPEED (mph)	TAPER
70	20:1
60	17:1
50	14:1
45	13:1
40	11:1
35	10:1

REVISIONS								
NO.	DATE	BY	NO.	DATE	BY	NO.	DATE	BY
1	8-00	MSM	6	6-04	MSM			
2	12-01	MSM	7	10-04	MSM			
3	7-02	MSM						
4	7-03	MSM						
5	9-03	MSM						

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY

CADD FILE NAME g2a11004.std

DRWG. ORIG. DATE: NOVEMBER, 1999

IDAHO TRANSPORTATION DEPARTMENT

BOISE IDAHO

Steven C. Hutchinson

ASSISTANT CHIEF ENGINEER (DEVELOPMENT)

Jimmy D. Ross

CHIEF ENGINEER

STANDARD DRAWING

20' CONCRETE BARRIER

REQUIRES SHEET 1 OF 2

English

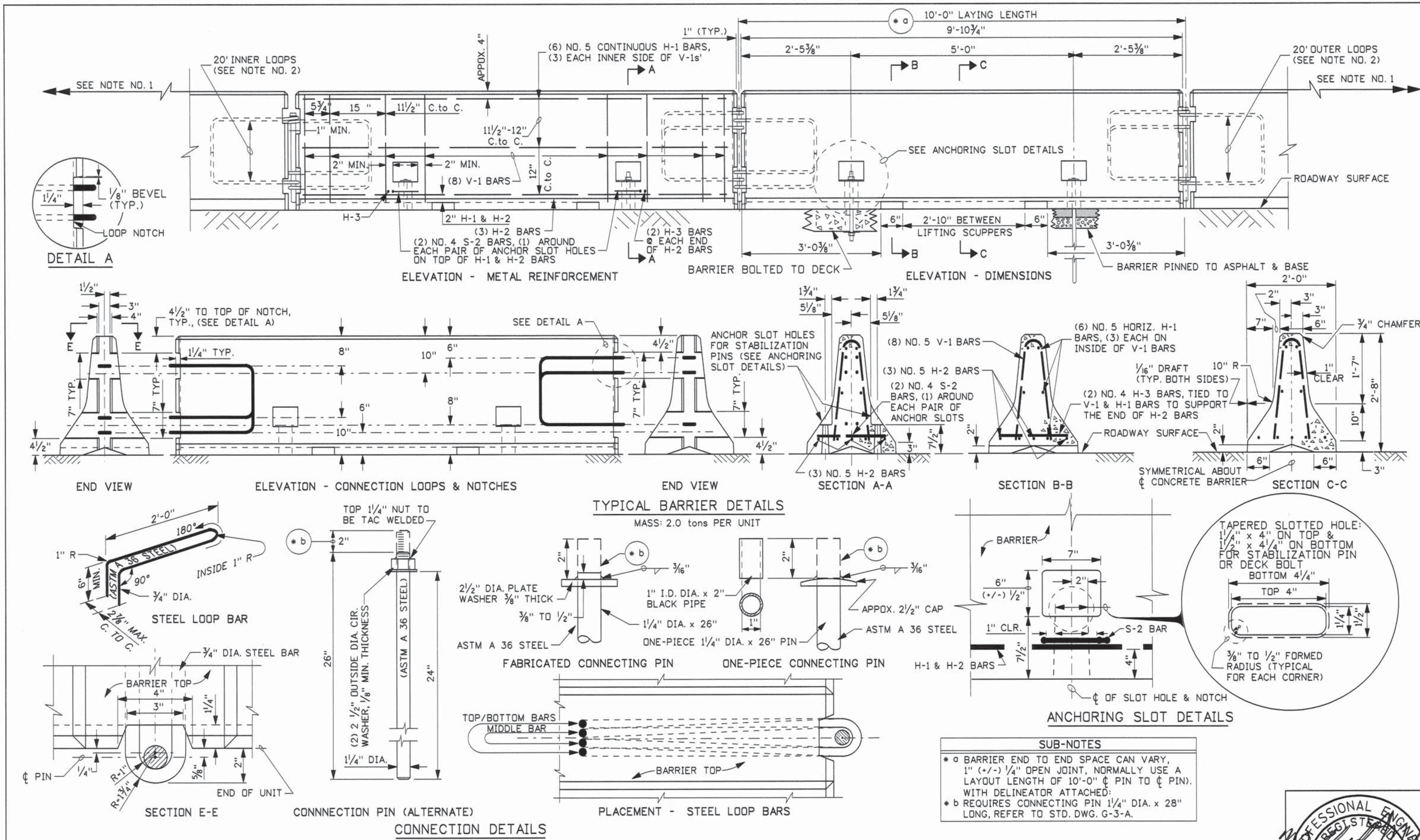
STANDARD DRWG. NO.

G-2-A-1

SHEET 2 OF 2

PROFESSIONAL ENGINEER REGISTERED 2240 10/13/04 STATE OF IDAHO MILFORD L. MILLER

Milford L. Miller



REVISIONS								
NO.	DATE	BY	NO.	DATE	BY	NO.	DATE	BY
1	6-02	MSM						
2	7-03	MSM						
3	6-04	MSM						
4	11-04	MSM						

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY

CADD FILE NAME g2a21104.std

DRWG. ORIG. DATE: APRIL, 2002

IDAHO TRANSPORTATION DEPARTMENT

BOISE IDAHO

ASSISTANT CHIEF ENGINEER (DEVELOPMENT)

CHIEF ENGINEER

STANDARD DRAWING

10' CONCRETE BARRIER

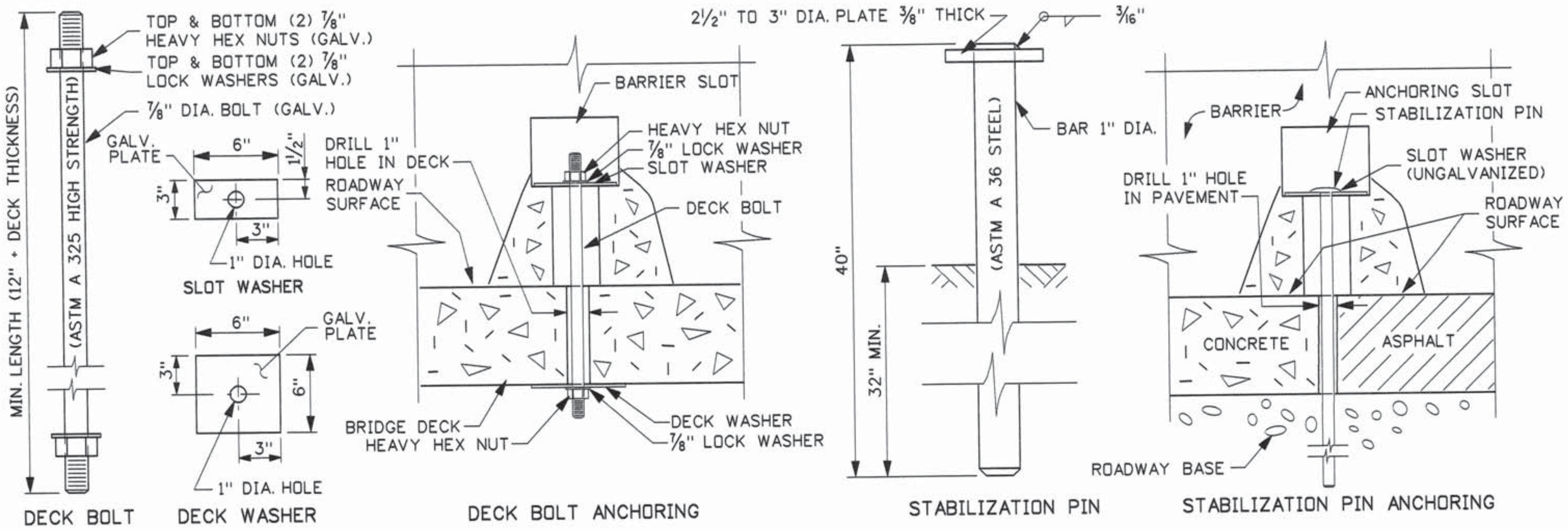
REQUIRES SHEET 2 OF 2

English

STANDARD DRWG. NO.

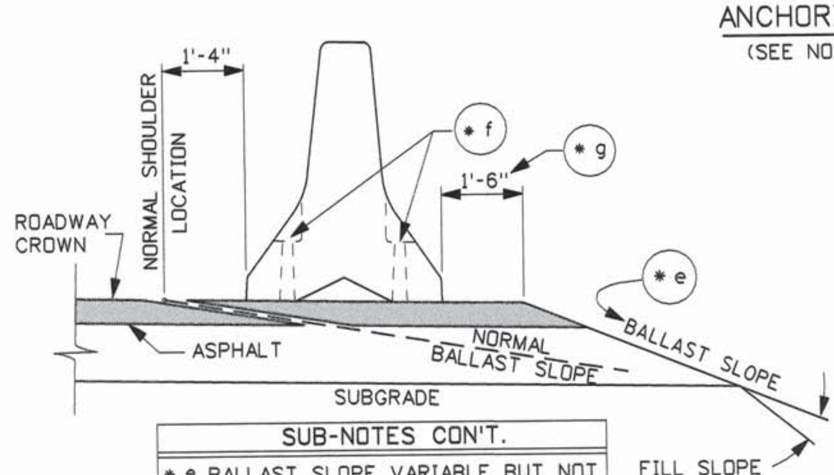
G-2-A-2

SHEET 1 OF 2



ANCHORING ASSEMBLIES
(SEE NOTE NOS. 1, 3, 4, & 5)

METAL REINFORCEMENT TABLE (SEE SUB-NOTES * c & * d)				
MARK	LOCATION	BAR SIZE	(NO. BARS)	SKETCH
H-1	HORIZONTAL IN BARRIER TIED INSIDE V-1 BARS	NO. 5	(6)	9'-6"
H-2	SPACED EVENLY ABOVE SCUPPERS	NO. 5	(3)	6'-6"
H-3	TIED ABOVE H-1 & H-2 BARS @ EACH SIDE OF ANCHOR SLOTS, TIED TO V-1	NO. 4	(2)	1'-6"
V-1	VERTICAL IN BARRIER (3) EACH HALF & (2) CENTERED OVER EACH ANCHORING SLOT	NO. 5	(8)	2" R TOTAL LENGTH 4'-9"; 12°; 0. to 0.; 4 7/8"; 2'-1 3/8"; 0. to 0.; 10" (+/-)
S-2	HORIZ. AROUND ANCHOR SLOTS BETWEEN V-1's	NO. 4	(2)	TOTAL LENGTH 5'-3"; 1 1/2" R; SLOTS; 1' MIN. OVRLP.; 1" MIN. CLEAR TO BAR; 0. to 0.; 5'-3" BAR W/(4) 1 1/2" R BENDS & MIN. 1'-0" OVERLAP; 8"; 1'-6 1/2" 0. to 0.

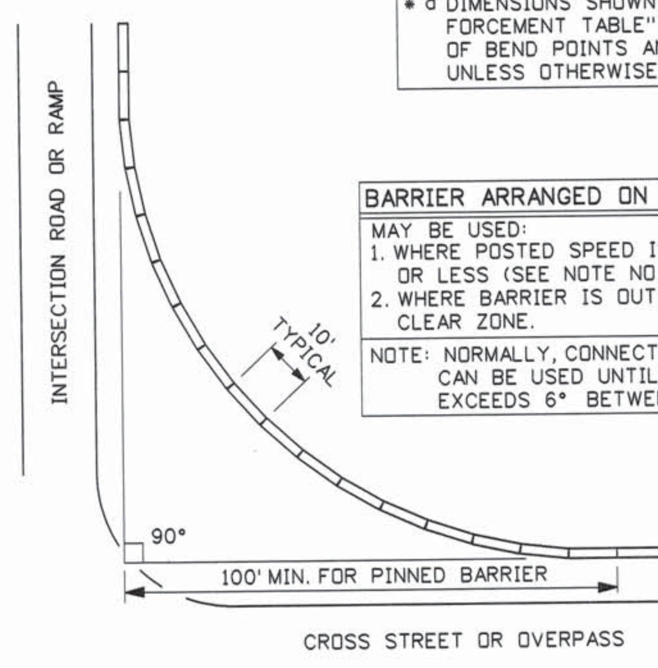


SUB-NOTES CON'T.
* e BALLAST SLOPE VARIABLE BUT NOT STEEPER 2:1.
* f NO STABILIZATION PINS (SEE NOTE NOS. 1 & 3).
* g WHEN BARRIER IS ANCHORED THE SHOULDER OFFSET MAY BE 0'-0".

STANDARD INSTALLATION

TABLE OF MAXIMUM TAPERS FOR CONCRETE BARRIER	
DESIGN SPEED (mph)	TAPER
70	20:1
60	17:1
50	14:1
45	13:1
40	11:1
35	10:1

SUB-NOTES
* c ALL METAL REINFORCEMENT BENDS ARE TO BE ACCORDING TO THE LATEST A.C.I. STANDARD PRACTICE AND AASHTO SPECIFICATIONS.
* d DIMENSIONS SHOWN IN THE "METAL REIN-FORCEMENT TABLE" ARE OUT-TO-OUT (0. to 0.) OF BEND POINTS AND/OR END OF BARS UNLESS OTHERWISE NOTED.



BARRIER ARRANGED ON A CURVE
MAY BE USED: 1. WHERE POSTED SPEED IS 35 mph OR LESS (SEE NOTE NO. 6). 2. WHERE BARRIER IS OUTSIDE THE CLEAR ZONE.
NOTE: NORMALLY, CONNECTING PINS CAN BE USED UNTIL CURVING EXCEEDS 6° BETWEEN UNITS.

CURVED LAYOUT
(SEE NOTE NO. 7)

GENERAL NOTES

1. ANCHORING THIS BARRIER IS NOT REQUIRED TO MEET NCHRP 350, TL-3 REQUIREMENTS: HOWEVER, THE BARRIER MUST BE PROPERLY TERMINATED (THIS IS A "STANDARD INSTALLATION"). ANCHORING IS REQUIRED IN SITUATIONS WHERE LATERAL MOVEMENT MUST BE RESTRICTED (NOTE: ANCHORING ASSEMBLIES INCLUDE DECK BOLTS AND STABILIZATION PINS).
2. WHEN CONNECTING 10' TO 20' CONCRETE BARRIER THE EXPOSED CONNECTING LOOPS MAY NEED TO BE BENT (MECHANICALLY, NOT WITH HEAT) TO FIT.
3. WHEN INSTALLING UNANCHORED 10' CONCRETE BARRIER ALLOW FOR 3' OF LATERAL MOVEMENT BEHIND THE BARRIER.
4. IT IS RECOMMENDED THAT ANCHORED BARRIER UNITS HAVE TWO ANCHOR ASSEMBLIES ON THE TRAFFIC SIDE OF THE BARRIER OR FOUR WHEN THE BARRIER IS EXPOSED TO TRAFFIC ON BOTH SIDES (NOTE: EXCEPT WHEN BARRIER IS LYING ACROSS AN EXPANSION JOINT).
5. WHEN ANCHORING A BARRIER SYSTEM USE AND DO THE FOLLOWING:
   a. DO NOT DRILL ANCHOR HOLES INTO PRESTRESSED CONCRETE DECK PANELS.
   b. EXPANSION ANCHORS WILL NOT BE PERMITTED FOR USE ON BRIDGE DECKS.
   c. USE ASTM A 325 HIGH STRENGTH GALVANIZED STEEL FOR DECK BOLTS AND NUTS.
   d. ASTM A 36 STEEL SHALL BE USED FOR CONNECTION LOOPS, THE CONNECTION PIN, AND THE STABILIZATION PIN. A ONE PIECE STABILIZATION PIN WITH A 3" ROUNDED TOP THAT MEETS ASTM A 36 REQUIREMENTS IS ALLOWED.
   e. BRIDGE DECK ANCHOR HOLES SHALL BE DRILLED/CORED SMOOTH AND ROUND.
   f. WHEN A BARRIER UNIT EXTENDS ACROSS AN EXPANSION/CONTRACTION JOINT, ANCHOR ONLY ONE SIDE OF THE UNIT. INSTALL TWO ANCHOR BOLTS ON FARTHEST END FROM THE JOINT (NORMAL INSTALLATION REQUIRES TWO BOLTS ON THE TRAFFIC SIDE).
   g. TIGHTEN DECK BOLTS DOWN WELL, TIGHTEN NUTS SO AT LEAST ONE COURSE OF THREADS SHOW OUTSIDE OF THE NUT.
   h. DO NOT PROTRUDE THE TOP OF THE DECK BOLT/STABILIZATION PIN HEAD OR END BEYOND WHERE THE SLOT EDGE MEETS THE EXTERIOR BARRIER SURFACE.
6. FOR SPEEDS GREATER THAN OR EQUAL TO 35 mph BARRIERS MUST BE PINNED TOGETHER AND CAN NOT EXCEED THE TABLE OF MAXIMUM TAPERS.
7. THE DESIGN FOR PIN CONNECTED 10' BARRIER ALLOWS FOR:
   a. APPROXIMATELY FIFTEEN TO SIXTEEN PINNED BARRIER UNITS TO COMPLETE A 90° TURN.
   b. BARRIER JOINTS CAN BEND APPROX. 6° BEFORE MEETING RESISTANCE.
8. THE UNIT SHALL BE PRECAST USING CONCRETE CLASS 40B. THE MIN. CONCRETE COVER OVER REINFORCEMENT STEEL SHALL BE 2" UNLESS OTHERWISE NOTED.
9. NOT TO SCALE.

PROFESSIONAL ENGINEER REGISTERED 2240 11/5/04 STATE OF IDAHO MILFORD L. MILLER

REVISIONS								
NO.	DATE	BY	NO.	DATE	BY	NO.	DATE	BY
1	6-02	MSM						
2	7-03	MSM						
3	6-04	MSM						
4	11-04	MSM						

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY

CADD FILE NAME g2a21104.std

DRWG. ORIG. DATE: APRIL, 2002

IDAHO TRANSPORTATION DEPARTMENT

BOISE IDAHO

ASSISTANT CHIEF ENGINEER (DEVELOPMENT)

CHIEF ENGINEER

STANDARD DRAWING

10' CONCRETE BARRIER

REQUIRES SHEET 1 OF 2

English

STANDARD DRWG. NO. G-2-A-2

SHEET 2 OF 2

U.S. Department
of Transportation

Federal Highway Administration

400 Seventh St., S.W
Washington, D.C. 20590

JUL 17 2000

Refer to: HSA-B70

Milford L. Miller, P.E./L.S.
Standard Drawing Engineer
State of Idaho Transportation Department
P.O. Box 7129
Boise, Idaho 83707-l 129

Dear Mr. Miller:

In your June 20 letter you requested formal Federal Highway Administration acceptance of the Idaho Transportation Department's 6095-mm (20-foot) long precast concrete barrier for use on the National Highway System (NHS) as a test level 3 (TL-3) barrier. To support your request, you also sent a copy of an April 2000 test report prepared by E-TECH Testing Services, Inc., in Rockland, California, entitled "NCHRP Report 350 Crash Test Results for the Idaho 6095-mm Concrete Barrier" and a video tape of the two tests that were conducted.

The barrier you tested was a standard New Jersey profile concrete barrier 8 1 O-mm (32-inches) tall and 6.095-m (20-feet) long. The base width was 610-mm (24 inches) and the top width was 150-mm (6 inches). Each segment weighed approximately 3630 kg (8000 pounds). Adjacent segments were connected using 3 1.8-mm (1.25-inch) diamctcr steel pins passed through four loops made from 19-mm (.75-inch) diameter steel bars. Longitudinal reinforcement consisted primarily of six no. 16 bars per segment. Two different connection designs were tested. The first consisted of galvanized 32-mm (1.25-inch) diameter by 638-mm (25-inch) long A307 hex bolts secured by 32-mm (1.25-inch) A536 heavy hex nuts. Two F844 Wide Type A washers were used, one under the bolt head and one above the nut. Enclosure 1 is a schematic drawing of this connection detail. The connection in the second test was a 32-mm (1.25-inch) diameter A36 steel pin that was 660-mm (26-inches) long. No locking nut or other pin retention device was used in this design. The steel loops were identical in both tests.

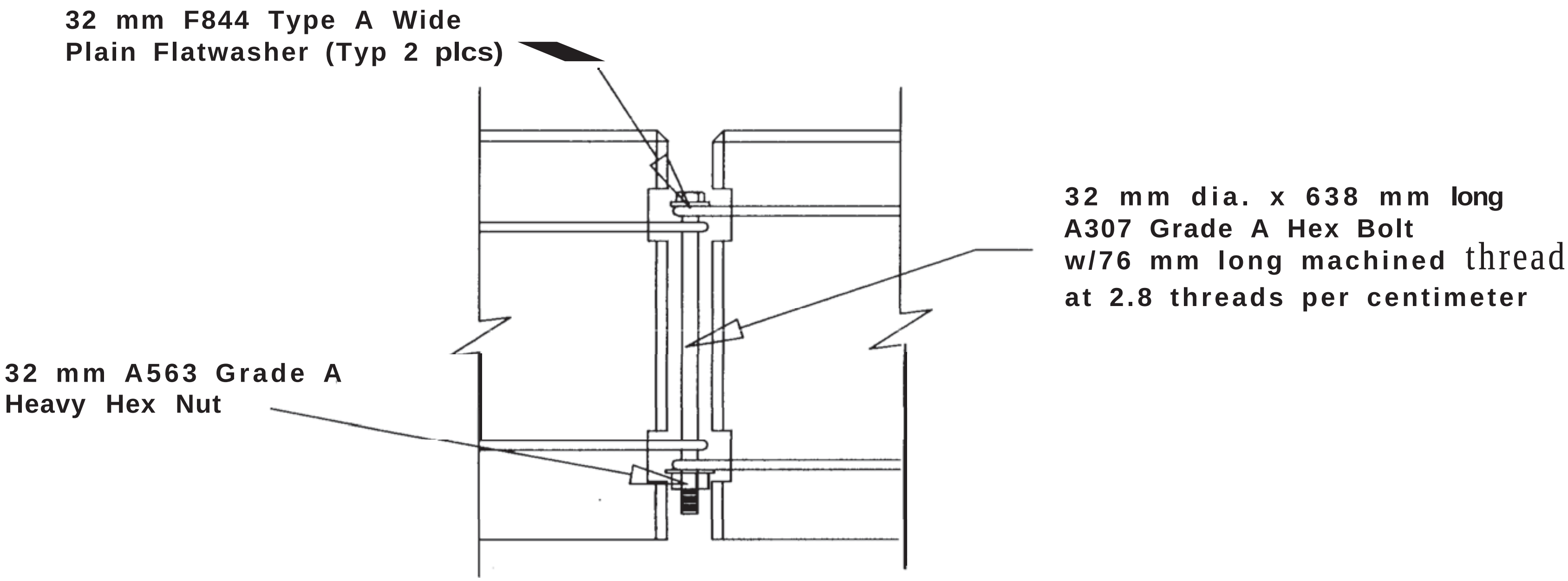
Staff members have reviewed the results of the two tests you conducted and concur with your assessment that appropriate NCHRP Report 350 evaluation criteria were met. They also agree that it is not necessary to test the 860-kg car since the barrier is identical to California's K-Rail which was successfully tested with the small car. The summary results of each test are shown in Enclosure 2. Maximum permanent deflection was 1 .O m with the bolted connection and 1.1 m with the pinned connection. The test installation was 73.2 m long and the pickup truck impacted 1.2 m from the mid-point in both tests. Impacts nearer the ends of an installation would be expected to increase the deflection distance under similar impact conditions. Based on these test results, the Idaho Concrete Barrier, with either the bolted pin connection or the drop-pin connection, may be considered acceptable for use as an NCHRP Report 350 TL-3 barrier on the NHS when such use is requested by a State transportation agency. I understand that this design remains nonproprietary and that anyone wanting to obtain detailed specifications and plan sheets for this barrier (can request them by calling you directly at (208) 334-8475.

Sincerely yours,

Janet G. Coleman
for

Frederick G. Wright, Jr.
Program Manager, Safety

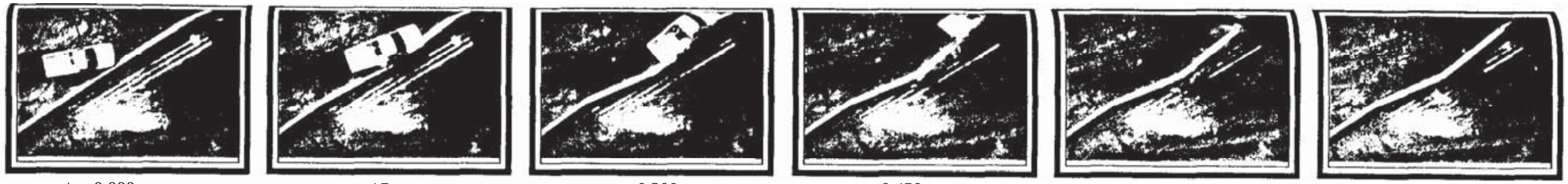
2 Enclosures



Note: All fasteners galvanized per Al53 Class C. Drawing not to scale.

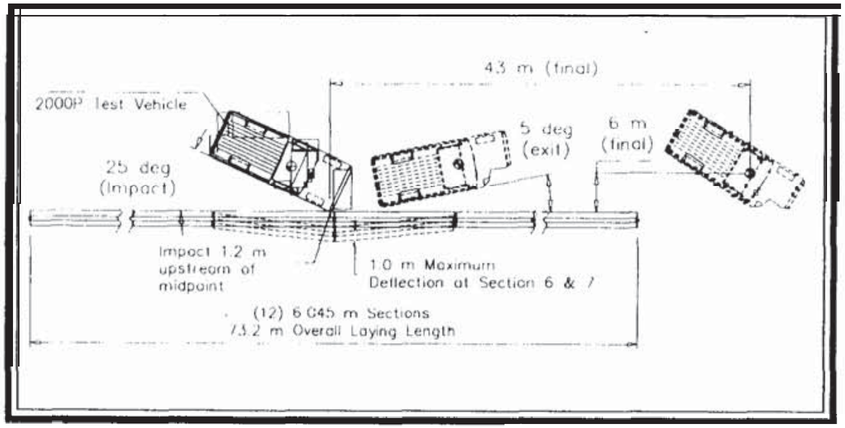
BOLTED CONNECTION

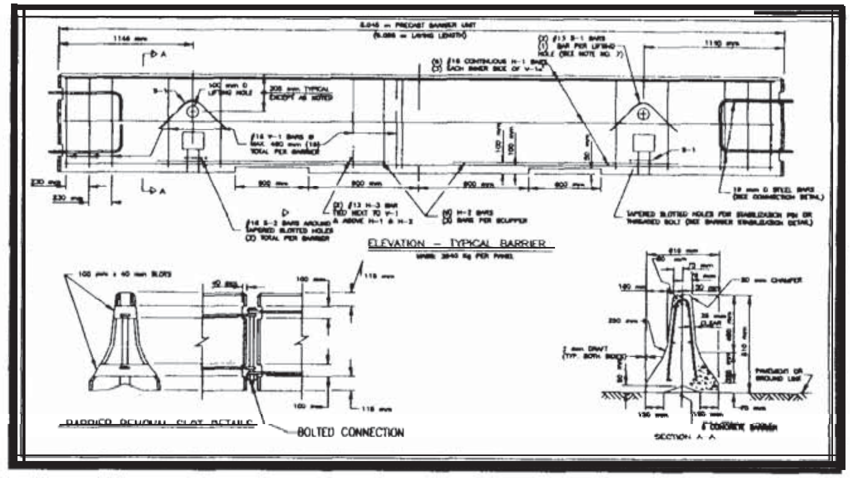
Illustration D-2 Bolted Connection and Material Certifications (1 of 2)



t = 0.000 set | t=o.15osec | t = 0.300 sex | t = 0.450 set | t = 0.600 SW | t = final

E-TECH Testing Services, Inc.



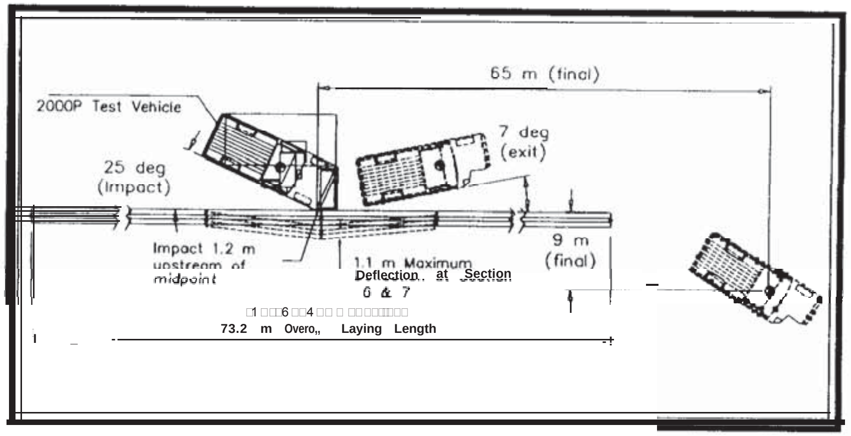


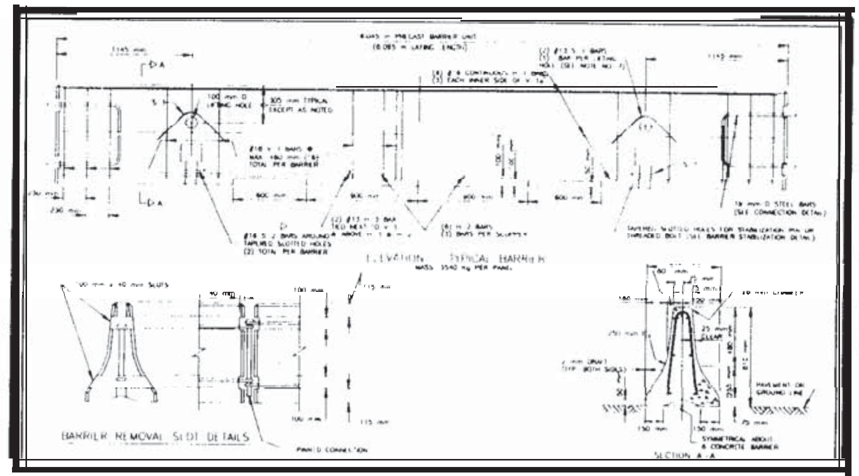
General Information	
Test Agency	E-TECH Testing Services, Inc.
Test Designation	NCHRP 350 Test 3-l 1
Test No.	13-4300-001
Date	3/16/00
Test Article	
Type	IdahoTransportationDepartment 6095 mm Concrete Barrier
Installation Length, (m)	73.2 (overall installation)
Material and key elements	6095 -mm !ong .NJ Shaped Concrete Harrier section with 32 mm dia. bolted connection and 19 mm dia. solid steel loops
Foundation Type and Condition	Aged chip-sealed asphalt
Test Vehicle	
Type	Production Model
Designation	2OooP
Model	1993 Chevrolet C2.500 314 Ton Pickup
Mass (kg)	
Curb	1859
Test inertial	1975
Dummy	N/A
Gross Static	1975
Impact Conditions	
Speed(km/h)	101.1
Angle (deg)	25
Impact Severity (kJ)	138.9

Exit conditions	
Speed (km/h)	76
Angle (deg)	5
Occupant Risk Values	
Impact Velocity (m/s)	
x-direction	5.2
y-direction	-5.9
ridedown Acceleration (g's)	
x-direction	-11.7
y-direction	-10.1
European Committee for Normalization (CEN) Values	
THIV (m/s)	7.9
PIID (g's)	13.8
AS1	1.2
Test Article Dellections (m)	
Dynamic	1.0
Permanent	1.0
Vehicle Damage	
Exterior	
VDS	RFQ-5
CDC	01RFEW3
Interior	
OCDI	RF0001000
Post-Impact Vehicular Behavior (deg - rate gyro)	
Maximum Roll Angle	-52.7
Maximum Pitch Angle	16.4
Maximum Yaw Angle	-69.5

Figure 1. Summary of Results - Idaho 6095 mm Concrete Barrier Test 13-4300-001

t = 0.360 sec | t = 0.54 set | t = 0.720 WC | t = final





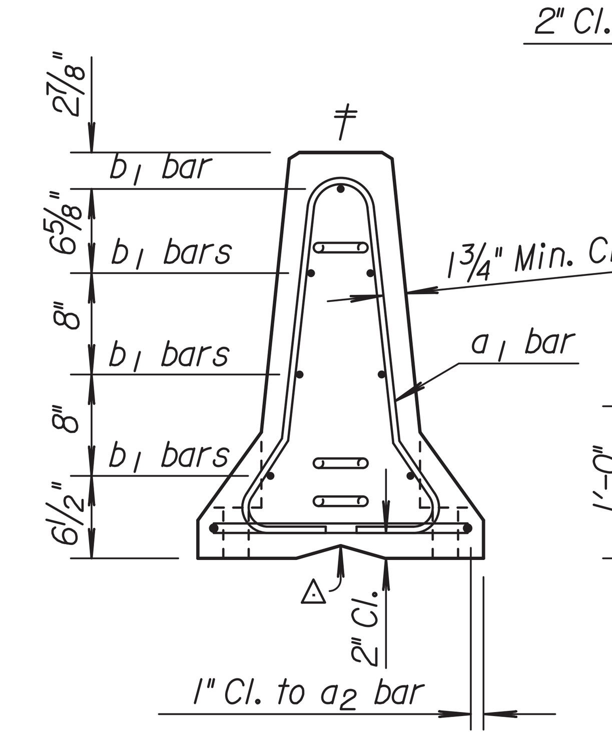
E-TECH Testing Services, Inc.

General Information	
Test Agency	E-TECII Testing Services, Inc.
Test Designation	NCHRP 350 Test 3-11
Test No.	13-4300-002
Date	4/l l/00
Test Article	
Type	Idaho Transportation Department
	6095 mm Concrete Harrier
Installation Length, (m)	73.2 (overall installation)
Material and key elements	6095 mm long NJ Shaped
	Concrete Barrier section with
	32 mm dia. pinned connection and
	19 mm dia. solid steel loops
Foundation Type and Condition	Aged chip-sealed asphalt
Test Vehicle	
Type	Production Model
Designation	20001'
Model	1995 Chevrolet C2SOO
	314 Ton Pickup
Mass (kg)	
Curb	1972
Test inertial	1994
Dummy	N/A
Gross Static	1994
Impact Conditions	
Speed (km/h)	99.0
Angle (deg)	25
Impact Severity (kJ)	134.6

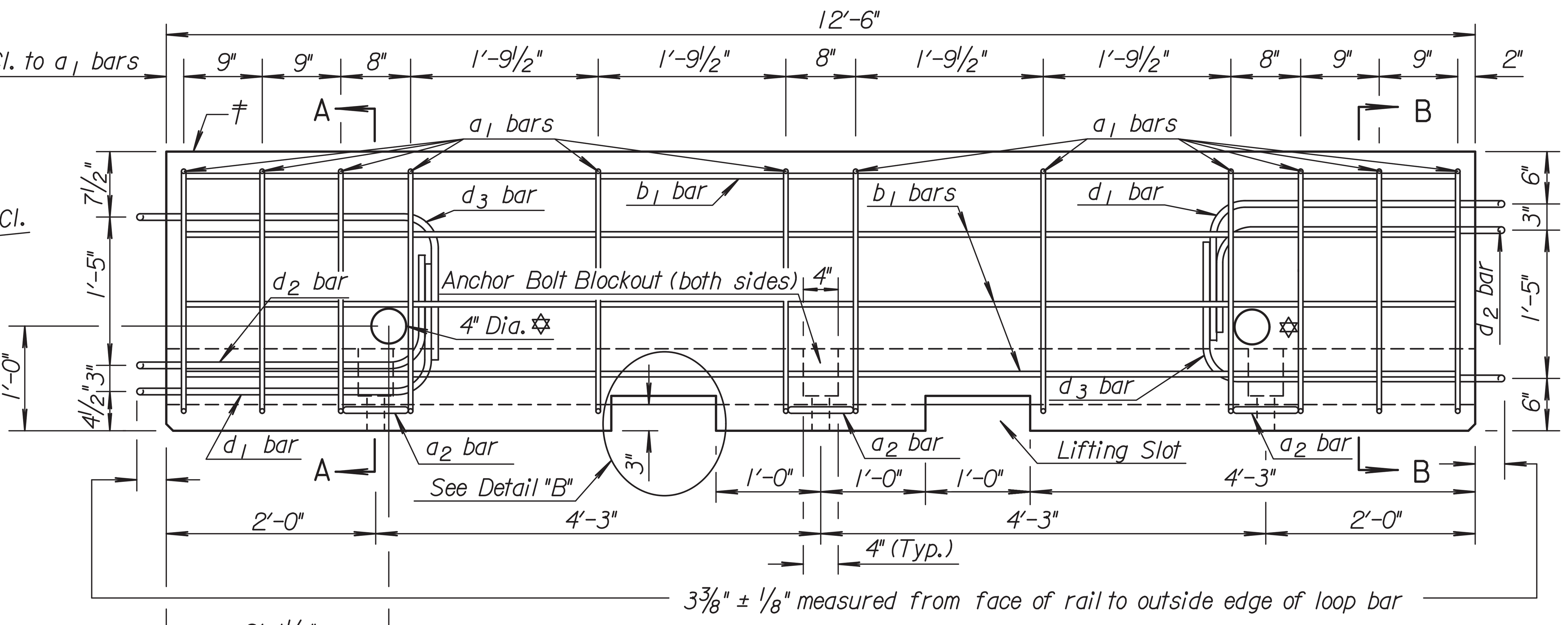
Exit conditions	
Speed (km/h)	72
Angle (deg)	7
Occupant Risk Values	
Impact Velocity (m/s)	
x-direction	4.9
y-direction	-5.8
[illegible]	
x-direction	-4.0
y-direction	-8.8
European Commitlee for Normalization (CEN) ValucT	
TIIIV (m/s)	7.8
PIID (g's)	x.9
AS1	1.2
Test Article Deflections (m)	
Dynamic	1.1
Permanent	1.1
Vehicle Damage	
Exterior	
VDS	RI'Q-5
CDC	01 RIWW3
Interior	
<WI)1	AS0000000
Post-Impact Vehicular Behavior (deg - rate gyro)	
Maximum Roll Angle	23.3
Maximum Pitch Angle	2x.3
Maximum Yaw Angle	135.x

Figure 6. Summary of Results - Idaho 6095 mm Concrete Barrier Test 13-4300-002

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS				

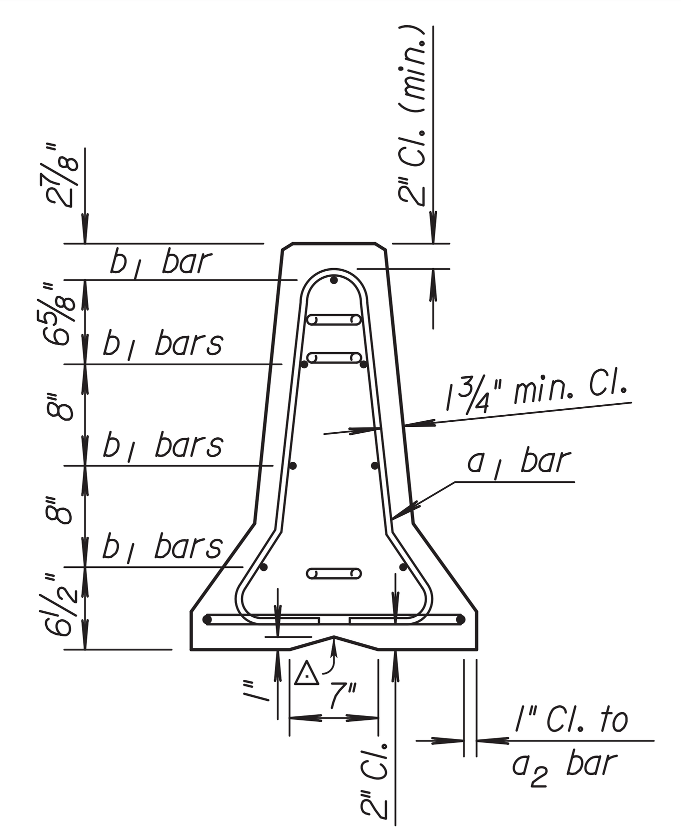


SECTION A-A
TYPICAL SECTION
(Stirrup Placement)

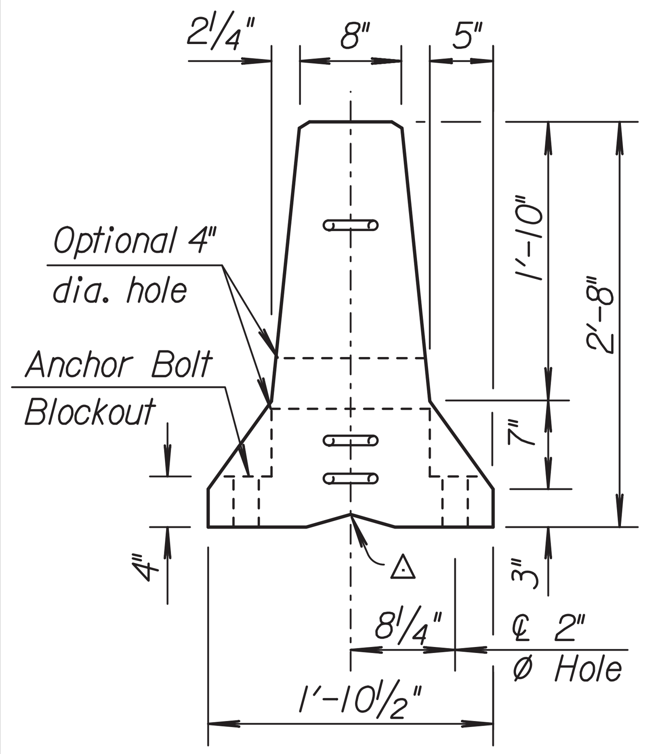


ELEVATION (SECTION)

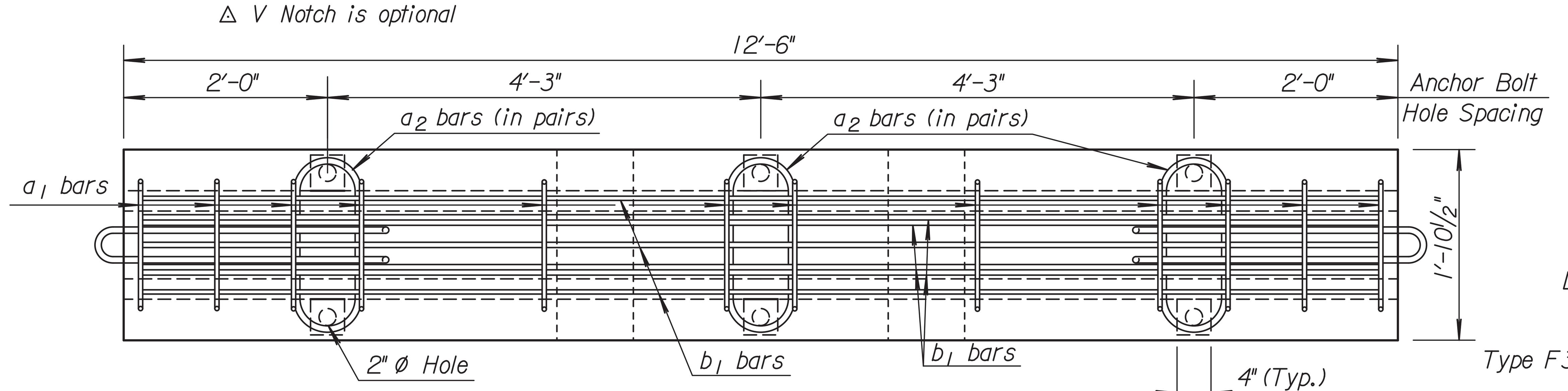
† Marked End
✡ 4" diameter - 11 gauge steel round mechanical tubing sleeve. These holes are optional.
△ V Notch is optional



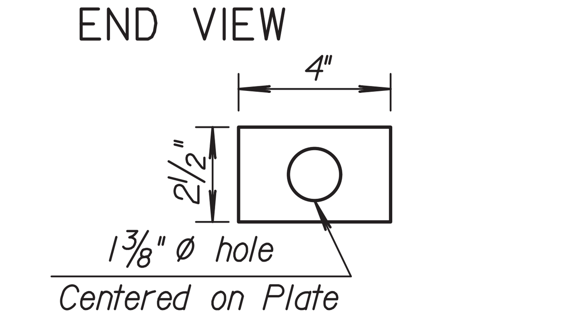
SECTION B-B
TYPICAL SECTION
(Stirrup Placement)



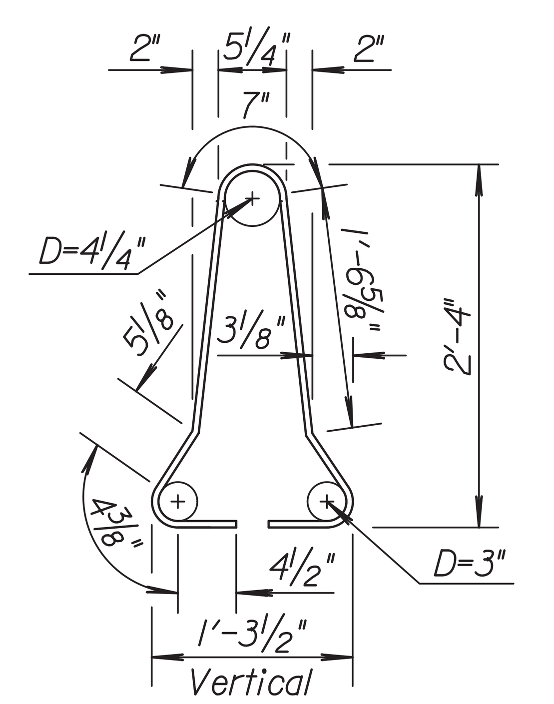
END VIEW



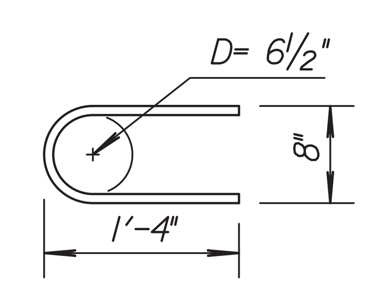
PLAN (SECTION)



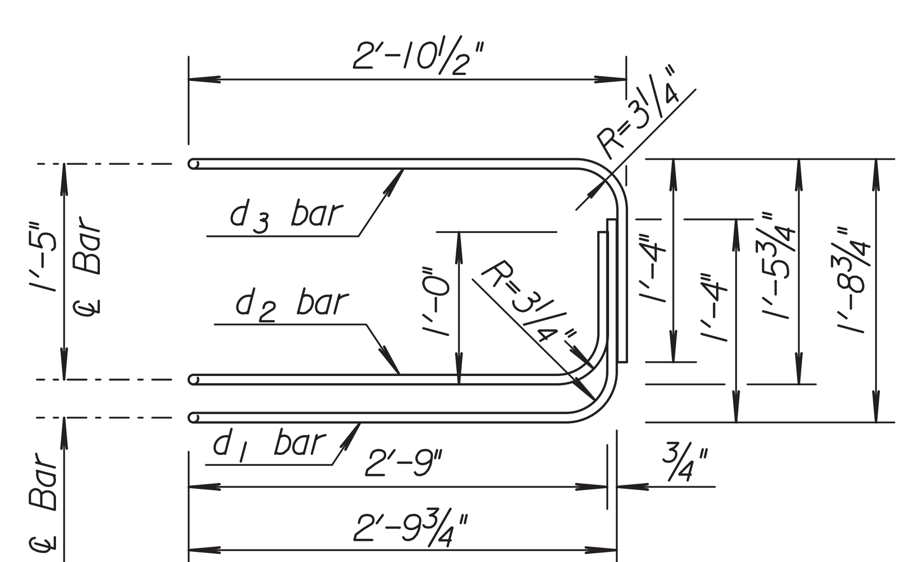
(1/2" Top Plate Detail)



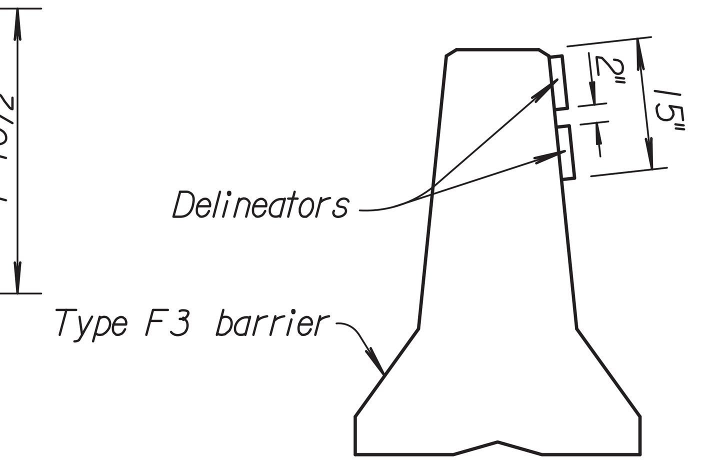
a_1 bar



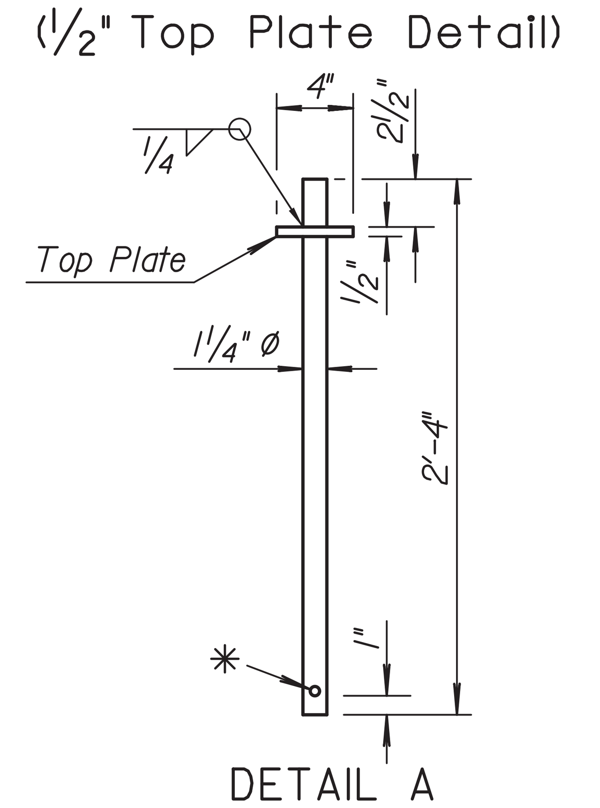
a_2 bar



ELEVATION

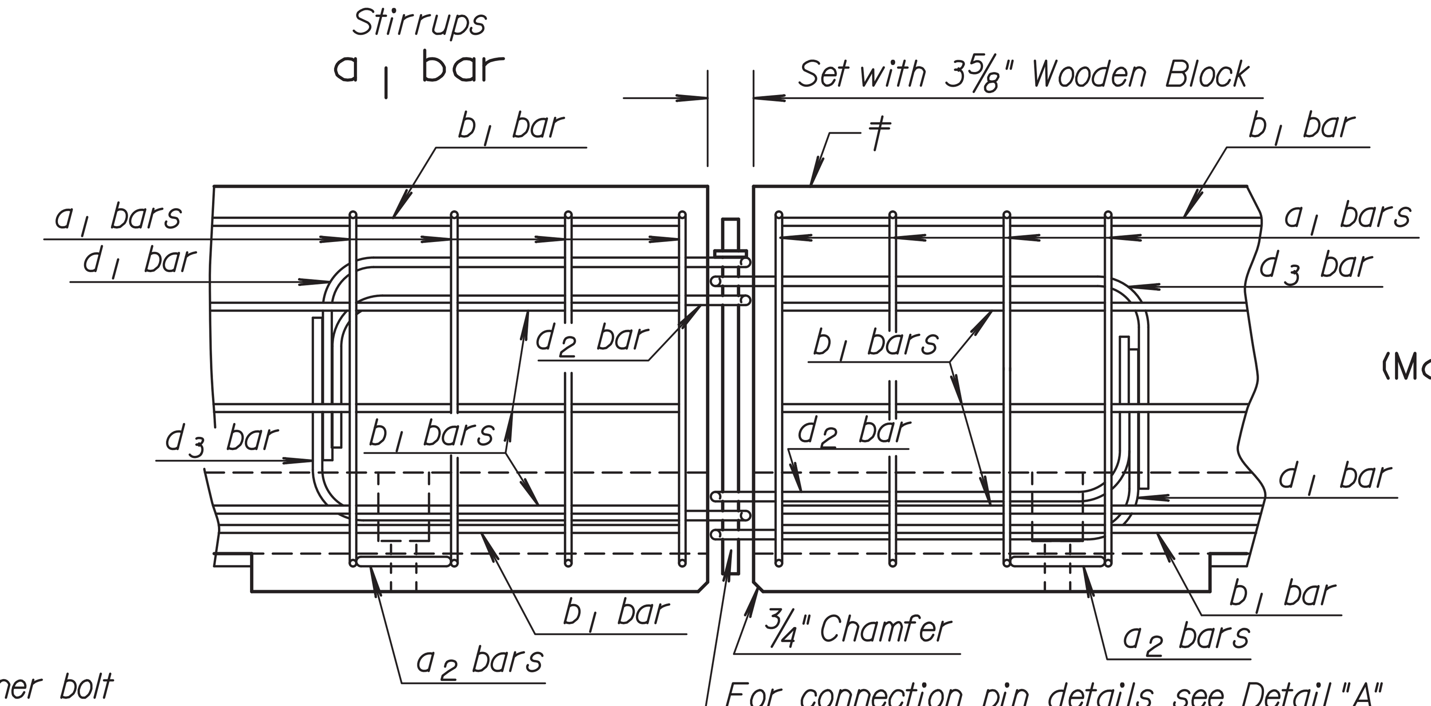


DELINEATOR DETAILS

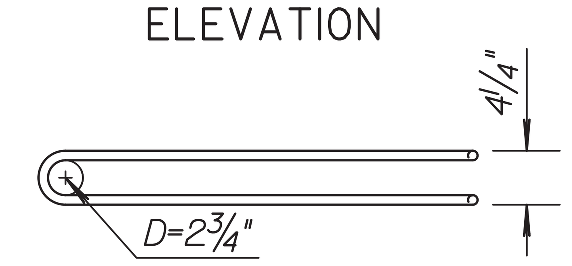


DETAIL A
CONNECTION PIN
(A36 Steel) 10.9 lbs. each

✳ 5/8" Ø hole for retainer bolt. The retainer bolt & nut are installed at Contractor's option.
Note: Retainer bolt & nut required with Tie Down Strap.



DETAILS OF BARRIER CONNECTION



PLAN
LOOP BAR ASSEMBLY
(Marked end shown, invert for other end)
(Material as stated in General Notes)

NOTE: At no time shall the barriers be lifted, moved, etc. by use of the loop bars: d_1, d_2 or d_3.

GENERAL NOTES:

MATERIAL: Use ASTM A615, Grade 60 reinforcing bars, except for the loop bars (d_1, d_2 and d_3).
The loop bars (d_1, d_2 and d_3) shall be 3/4" smooth steel bars with a minimum yield of 60 ksi, a tensile strength of not less than 1.25 times the yield strength but a minimum of 80 ksi, a minimum 14% elongation in 8 inches, and passing a 180 degree bend test using a 3.5" D pin bend diameter. The loops shall be installed within 1/8" of the plan dimensions.
Use air-entrained concrete with f'c = 5,000 p.s.i.

SECTION: The section furnished must generally comply with dimensions shown. Requests for minor variations in section geometry and attachments may be submitted to the Engineer for approval.

LIFTING SLOTS: Lifting slots shall be constructed where specified on the plans to facilitate the drainage of water after installation on the roadway.

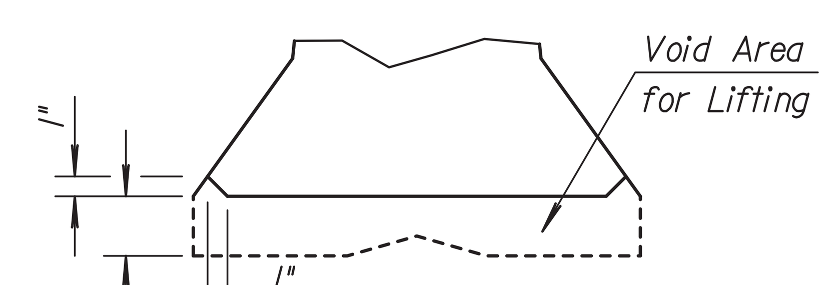
TEMPORARY CONCRETE SAFETY BARRIER: Furnishing and placing of all materials when required and all labor and equipment required to position the temporary barrier shall be included in the Contract unit price bid for "Concrete Safety Barrier (Type F3)(Temporary)". Any relocation of the barrier required for the project shall be paid in accordance with the Special Provisions under the bid item "Concrete Safety Barrier (Type F3) (Temporary-Relocate)". Unless otherwise noted on the Plans, the Temporary Concrete Safety Barrier shall become the property of the Contractor and shall be removed from the site upon acceptance of the completed project. Approximate weight of one unit equals 2.7 tons.

SURFACE PREPARATION: Barrier shall be placed on a paved surface. All loose dirt and sand shall be removed from the roadway surface just prior to placement of the barrier.

MARKING: The left end (†) of each barrier shall be permanently marked by stamping or forming into the barrier the following information:
- Type F3
- Manufacturer code (as specified by KDOT Bureau of Const. & Maint.)
- Date manufactured (month and year)

DELINEATION: Delineators shall be spaced on 50' centers, except through curves having 1900' or greater curvature where they shall be spaced on 25' centers.
The delineation shall be mounted on the side of the Temporary Concrete Safety Barrier with two delineators at each location. Each delineator shall have a minimum height-to-width ratio of 1.75, and a minimum reflective surface area of 7 sq. in.. The delineators shall be affixed to the Temporary Concrete Safety Barrier as recommended by the manufacturer.
Delineators shall be attached to bridge rail or other structures in construction zones when roadway is narrowed and traffic is adjacent to the structure. The method and location of placement shall be similar to permanent barrier delineation.
When traffic flow is in one direction, the delineators shall be yellow when used on the left, white when used on the right. When traffic flow is in both directions delineators shall be placed back-to-back, and shall correspond to the color of the edge line.
The work and materials required for the installation of delineators as mentioned shall be subsidiary to the bid item "Concrete Safety Barrier (Type F3) (Temporary).

Note: If necessary, include Standard Drawing RD622A for Taper Section, Standard drawing RD622B for anchor and tie down details, Standard Drawing RD622C for Bridges with thermal expansion of 1 1/2" or greater and Standard Drawing RD622D for Barrier Layouts.



DETAIL 'B'
LIFTING SLOT DETAIL
(1" Chamfer to prevent spalling)

Per 12'-6" Barrier Section

Bar	Bar Size	Shape	No. of Bars	Length Ft.	Weight Lbs.
REINFORCING A615 Gr. 60					
a_1	#4		12	6'-0"	48.1
a_2	#6		6	2'-11"	26.3
b_1	#5		7	12'-2"	88.8
LOOP ASSEMBLY					
d_1	#6		2	8'-5"	25.3
d_2	#6		2	7'-7"	22.8
d_3	#6		2	8'-6"	25.5

Concrete Quantity = 1.3 C.Y.
(Dimensions are out to out of bars unless otherwise noted.)

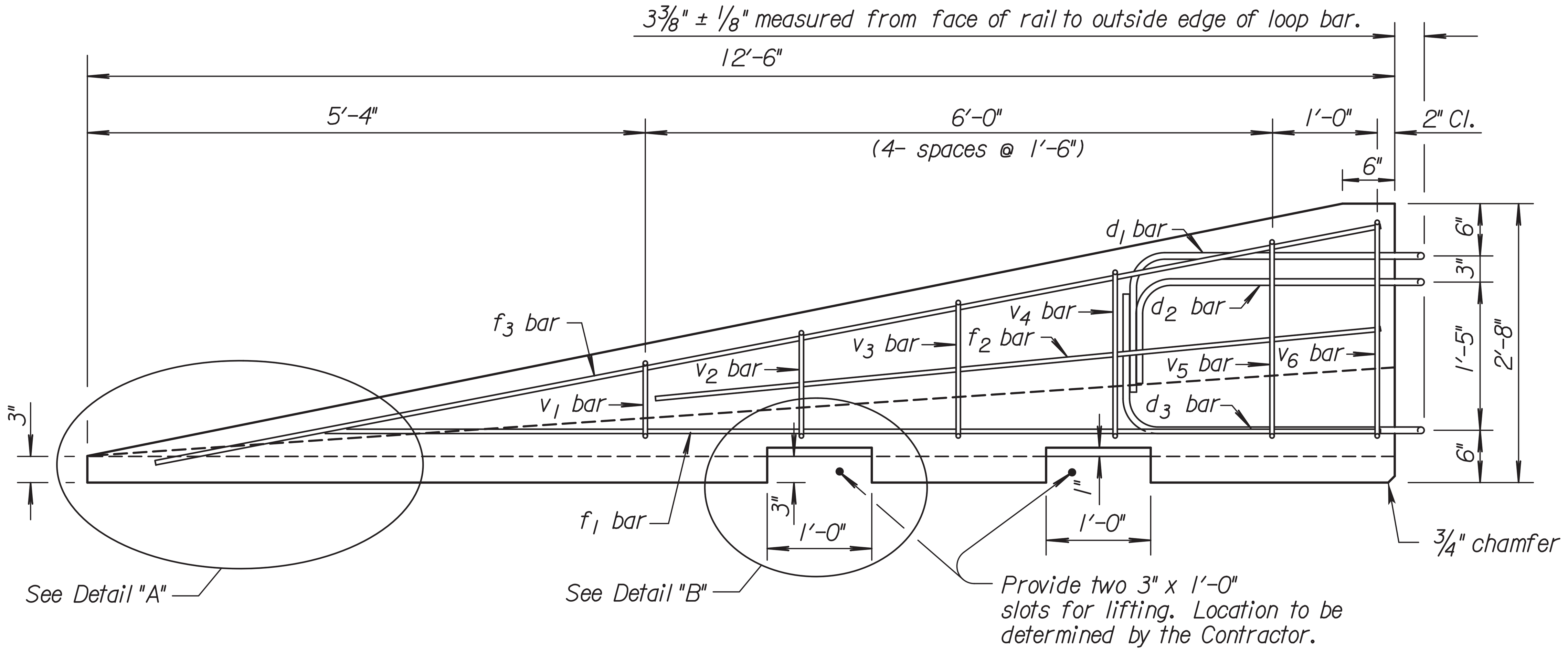
NO.	DATE	REVISIONS	BY	APP'D
3				
2	2-6-07	Revised additional sheets note	S.W.K.	J.O.B.
1	1-10-07	Rev. layout & notes, add. Delineation	S.W.K.	J.O.B.

KANSAS DEPARTMENT OF TRANSPORTATION
TEMPORARY
CONCRETE SAFETY BARRIER
TYPE F3

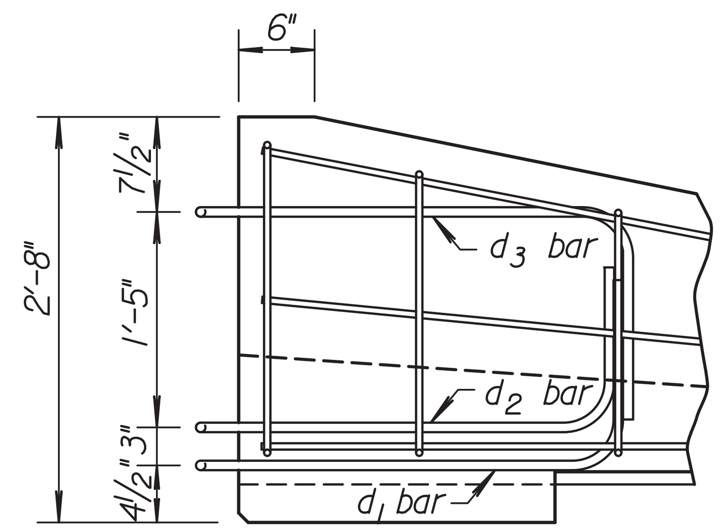
RD622

FHWA APPROVAL	1-19-07	APP'D. James O. Brewer	
DESIGNED	DETAILED	QUANTITIES	TRACED Bowser
DESIGN CK.	DETAIL CK.	QUAN.CK.	TRACE CK. King

Plotted : 22-MAR-2007 10:52
Drawn By : bert
File : rd622.dgn (rd622)



ELEVATION (SECTION)
(For connection to left end of Barrier)



ELEVATION (SECTION)
(For connection to right end of Barrier)

GENERAL NOTES:

MATERIAL: Use ASTM A615, Grade 60 reinforcing bars, except for the loop bars (d_1, d_2 and d_3). The loop bars (d_1, d_2 and d_3) shall be ¾" smooth steel bars with a minimum yield of 60 ksi, a tensile strength of not less than 1.25 times the yield strength but a minimum of 80 ksi, a minimum 14% elongation in 8 inches, and passing a 180 degree bend test using a 3.5" D pin bend diameter. The loops shall be installed within ⅛" of the plan dimensions.
Use air-entrained concrete with f'c = 5,000 p.s.i.

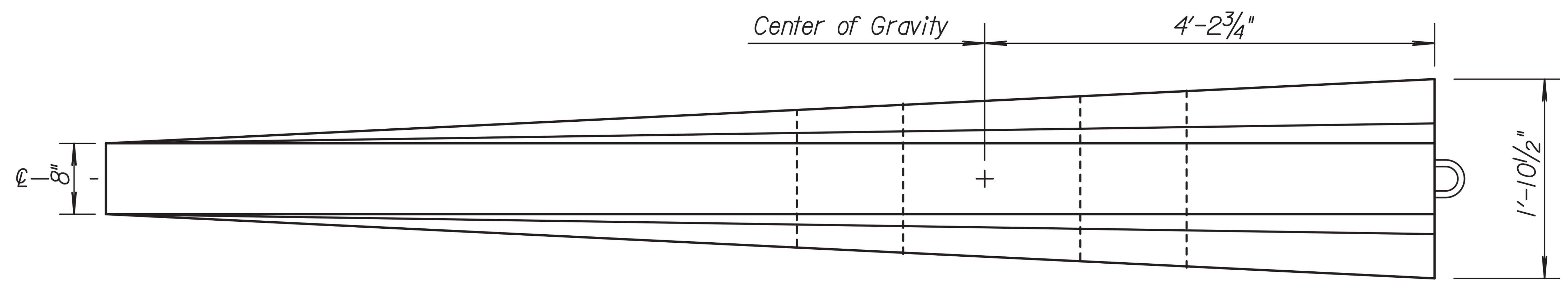
SECTION: The section furnished must generally comply with dimensions shown. Requests for minor variations in section geometry and attachments may be submitted to the Engineer for approval.

LIFTING SLOTS: Lifting slots shall be constructed where specified on the plans to facilitate the drainage of water after installation on the roadway.

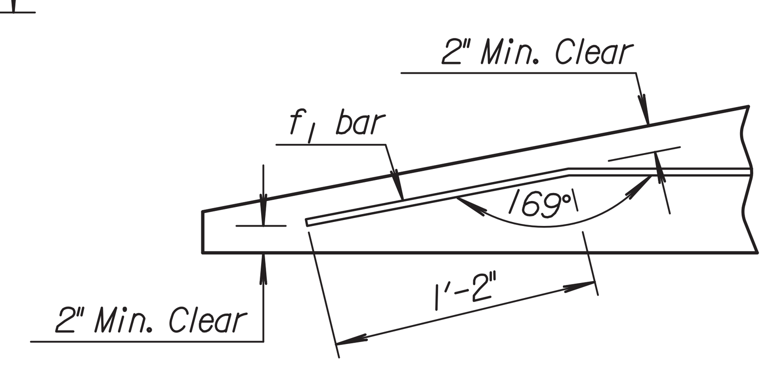
TEMPORARY CONCRETE SAFETY BARRIER: One section of Taper Barrier shall be bid as one section of Type F3 Barrier. Type F3 barrier taper sections shall be used only for low speed (40 mph or less) applications or where a barrier terminates beyond the roadway clear zone. Where a barrier terminates within the clear zone of a high speed roadway, an appropriate impact attenuator shall be installed on the approach end. Furnishing and placing of all materials when required and all labor and equipment required to position the temporary barrier shall be included in the Contract unit price bid for "Concrete Safety Barrier (Type F3)(Temporary)". Any relocation of the barrier required for the project shall be paid in accordance with the Special Provisions under the bid item "Concrete Safety Barrier (Type F3)(Temporary-Relocate)". Unless otherwise noted on the Plans, the Temporary Concrete Safety Barrier shall become the property of the Contractor and shall be removed from the site upon acceptance of the completed project. Approximate weight of one unit equals 1.3 tons.

SURFACE PREPARATION: Barrier shall be placed on a paved surface. All loose dirt and sand shall be removed from the roadway surface just prior to placement of the barrier.

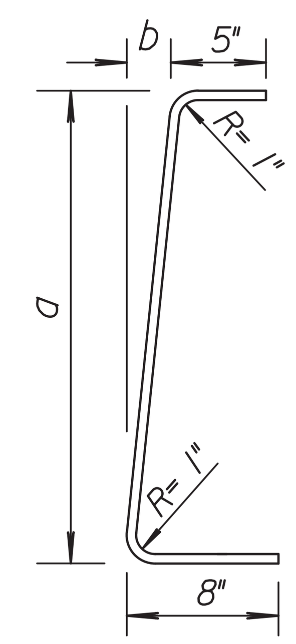
MARKING: Each barrier shall be permanently marked by stamping or forming into the barrier the following information:
- Type F3
- Manufacturer code (as specified by KDOT Bureau of Const. & Maint.)
- Date manufactured (month and year)



PLAN



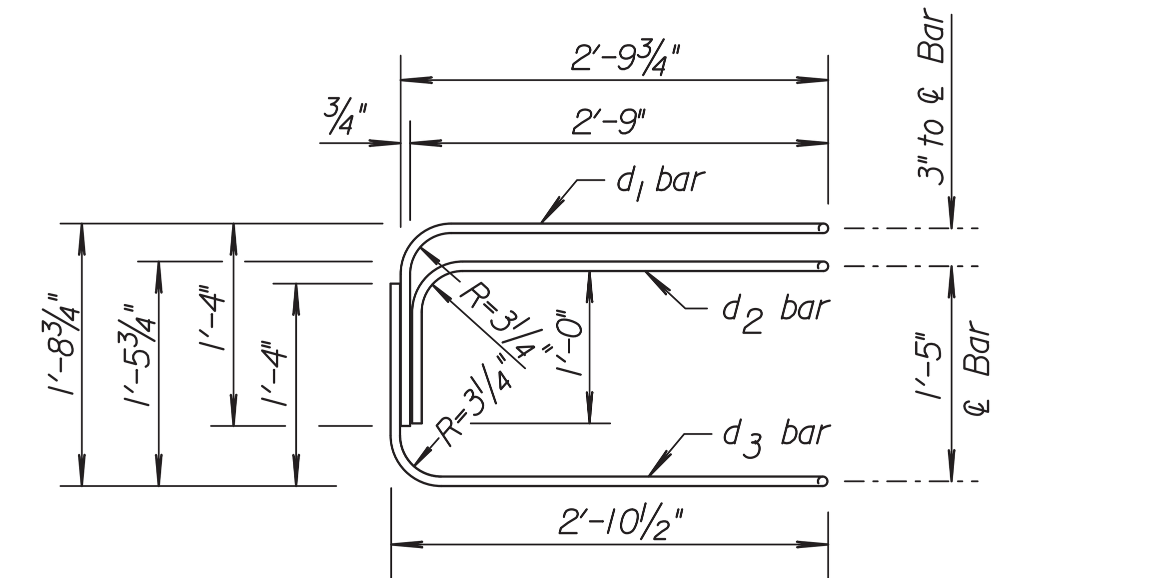
DETAIL "A" BENT BAR DETAIL



v bars

2 at each size required for stirrup assembly

Bar	a	b
v_1	10"	1"
v_2	1'-1"	1¼"
v_3	1'-5"	1⅝"
v_4	1'-8"	1⅞"
v_5	2'-0½"	2⅜"
v_6	2'-3"	2¾"

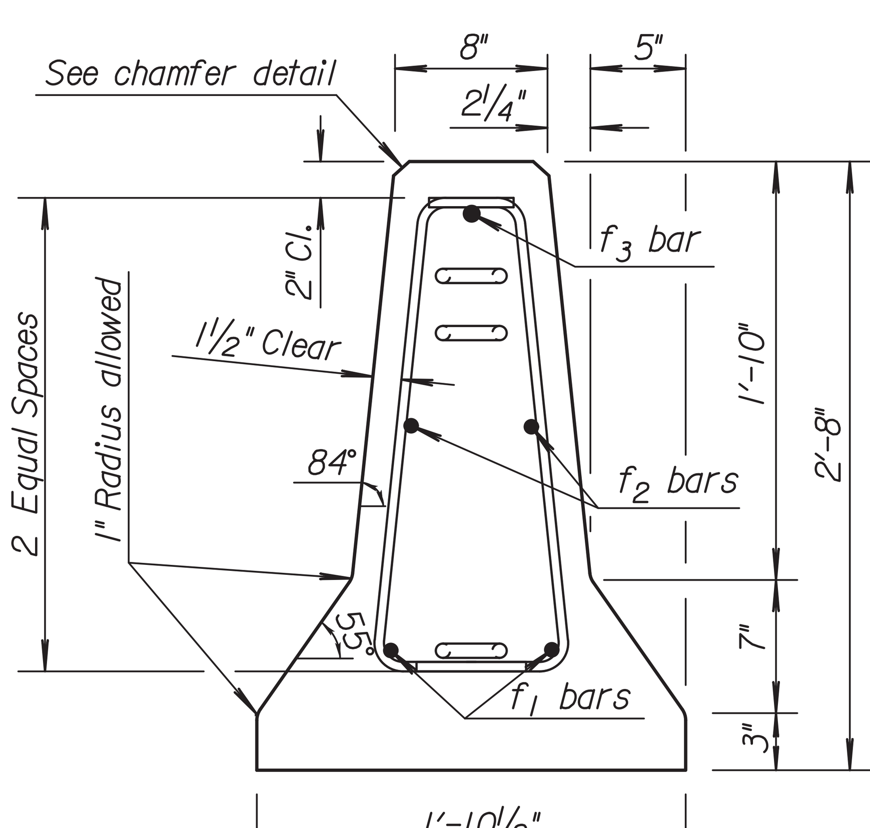


ELEVATION

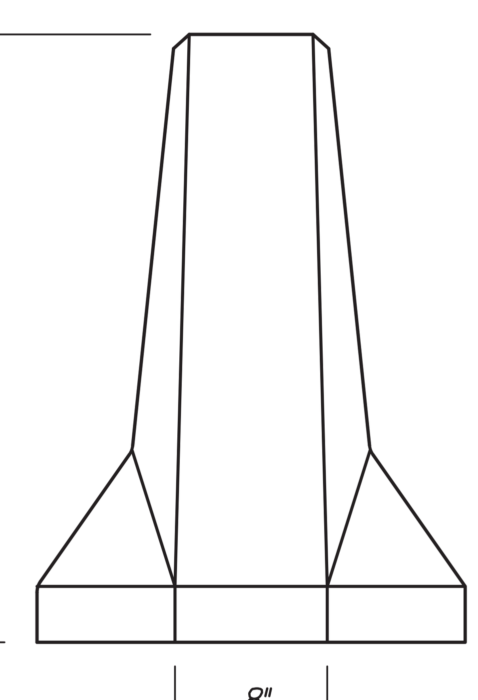
PLAN

LOOP BAR ASSEMBLY

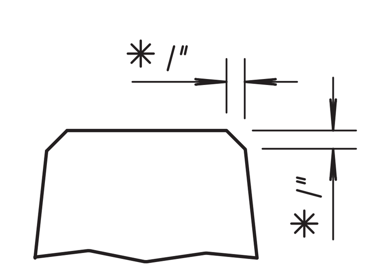
(Left Barrier Connection shown, invert for other end)



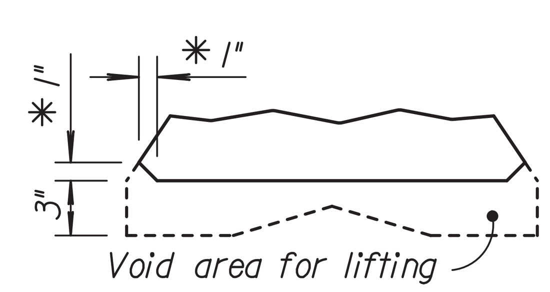
END SECTION



END VIEW



CHAMFER DETAIL



DETAIL "B" LIFTING SLOT DETAIL

✱ 1" Chamfer to prevent spalling

Per 12'-6" Barrier Taper Section

Bar	Bar Size	Shape	No. of Bars	Length ft.	Weight lbs.
REINFORCING A615 Gr. 60					
v_1	#4	[	2	1'-11"	2.6
v_2	#4	[	2	2'-2"	2.9
v_3	#4	[	2	2'-6"	3.3
v_4	#4	[	2	2'-9"	3.7
v_5	#4	[	2	3'-2"	4.2
v_6	#4	[	2	3'-4"	4.5
f_1	#4	——	2	12'-0"	16.0
f_2	#4	——	2	7'-6"	10.0
f_3	#5	——	1	11'-9"	12.3
LOOP ASSEMBLY					
d_1	#6	┌──	1	8'-5"	12.6
d_2	#6	┌──	1	7'-7"	11.4
d_3	#6	┌──	1	8'-6"	12.8

Concrete Quantity = 0.6 C.Y.

Note: At no time shall the barriers be lifted, moved, etc. by use of the loop bars: d_1, d_2 or d_3.

NO.	DATE	REVISIONS	BY	APP'D
3				
2				
1	1-10-07	Revised layout & notes	S.W.K.	J.O.B.

KANSAS DEPARTMENT OF TRANSPORTATION

TEMPORARY CONCRETE SAFETY BARRIER TAPER SECTION TYPE F3

RD622A

FHWA APPROVAL	1-19-07	APP'D. James O. Brewer	
DESIGNED	DETAILED	QUANTITIES	TRACED B.N.B.
DESIGN CK.	DETAIL CK.	QUAN.CK.	TRACE CK. S.W.K.

Plotted : 22-MAR-2007 10:55
Drawn By : bert
File : rd622a.dgn (rd622a)

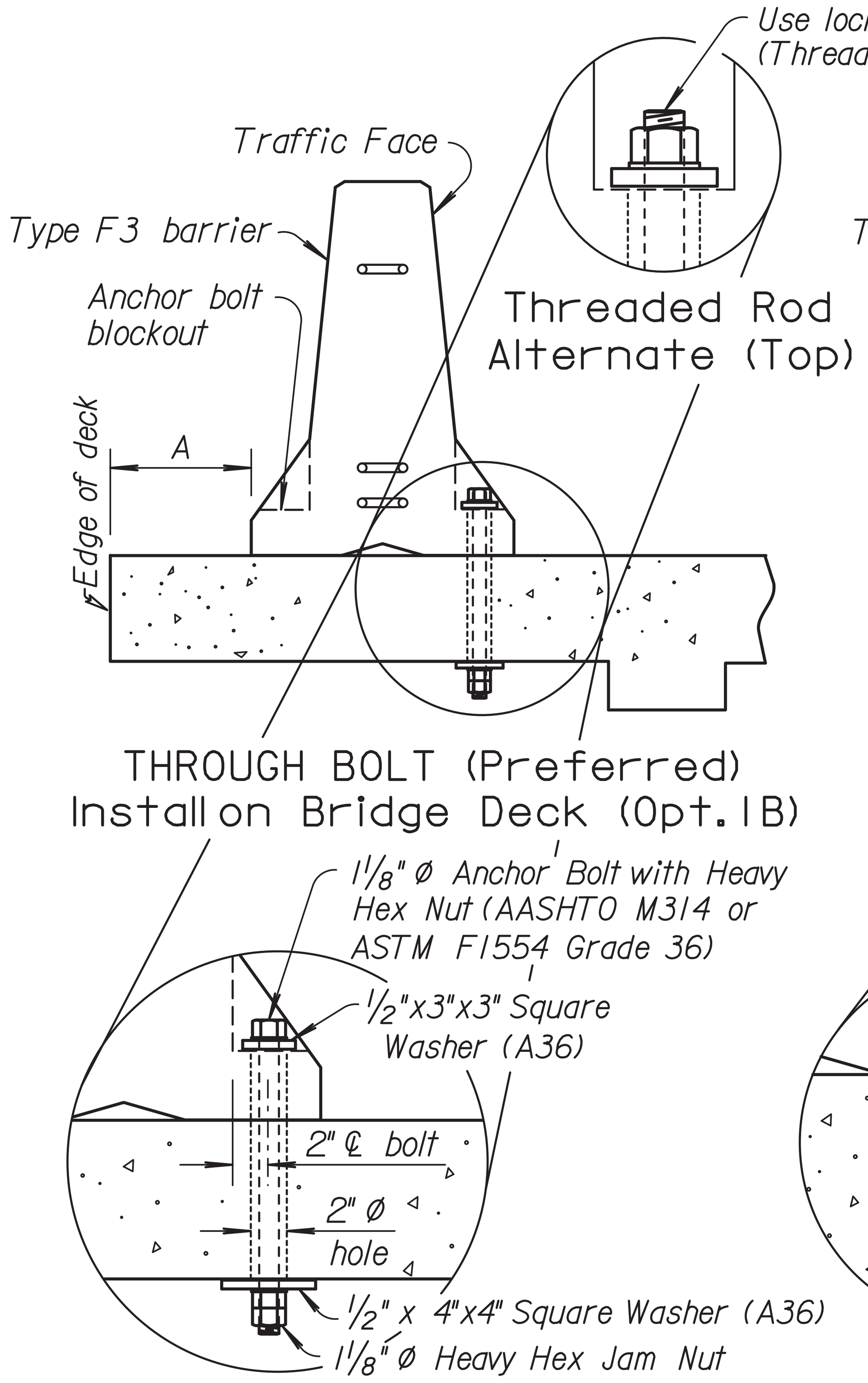
STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS				

Option	BRIDGE DECK APPLICATION	
1 B	0′ ≤ A < 2′	Anchor each barrier with 3 bolts on traffic face
2 B	Δ2′ ≤ A < 4′	Anchor with strap connector
3 B	A ≥ 4′	No anchorage required unless shown on plans

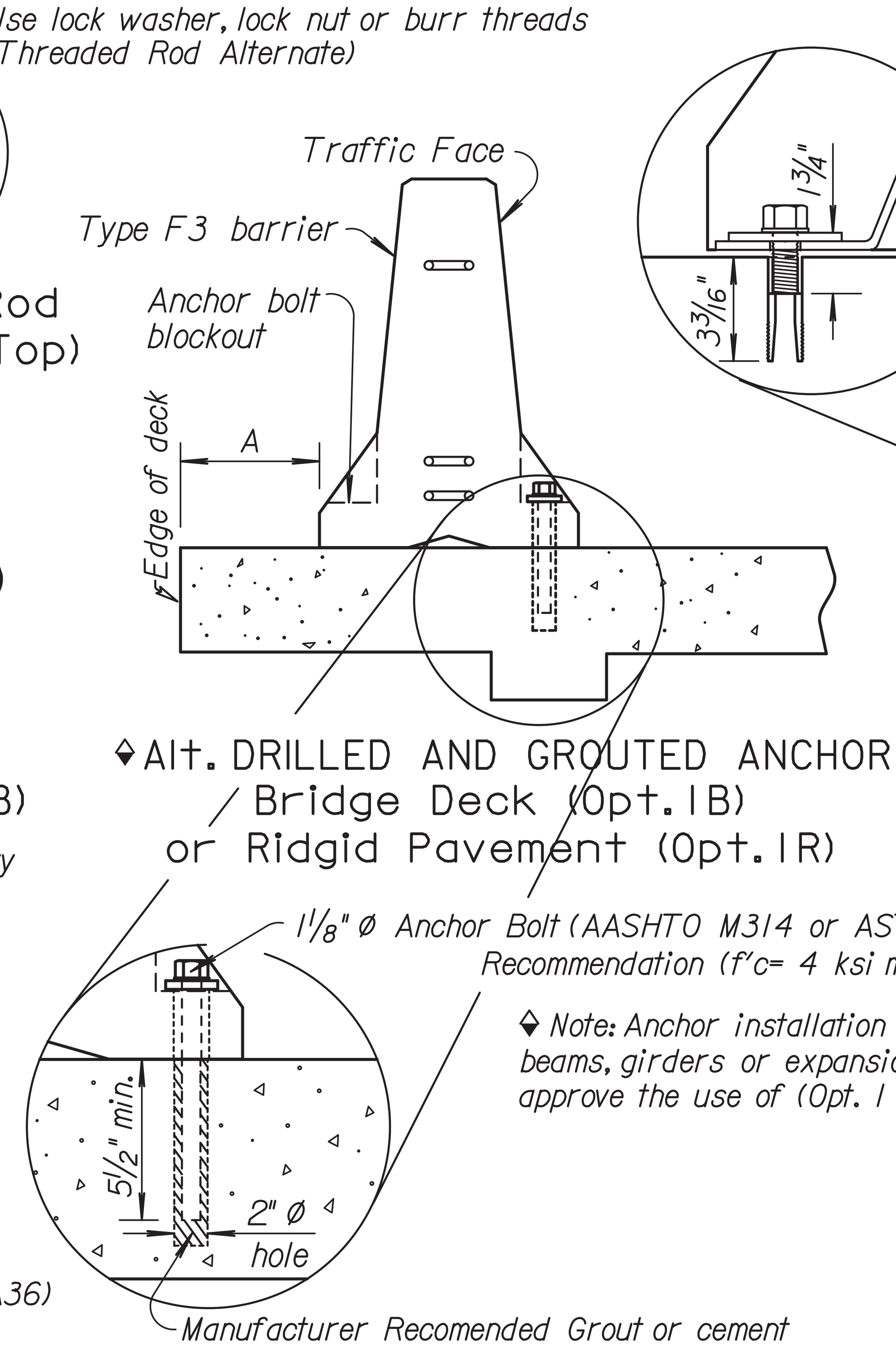
Δ This dimension may be reduced to 1′ on a newly constructed Bridge Deck.

Note: BRIDGE APPLICATION (Opt. 1 B) may be used in lieu of (Opt. 2 B) with prior approval from the State Bridge Office.

Option	ROAD PAVEMENT APPLICATION	
1 R	0″ ≤ A < 2′	Anchor each barrier with 3-bolts on traffic face
2 R	6″ ≤ A < 2′	Anchor with Strap Connector or Staked Down (flexible)
3 R	A ≥ 2′	No anchorage required

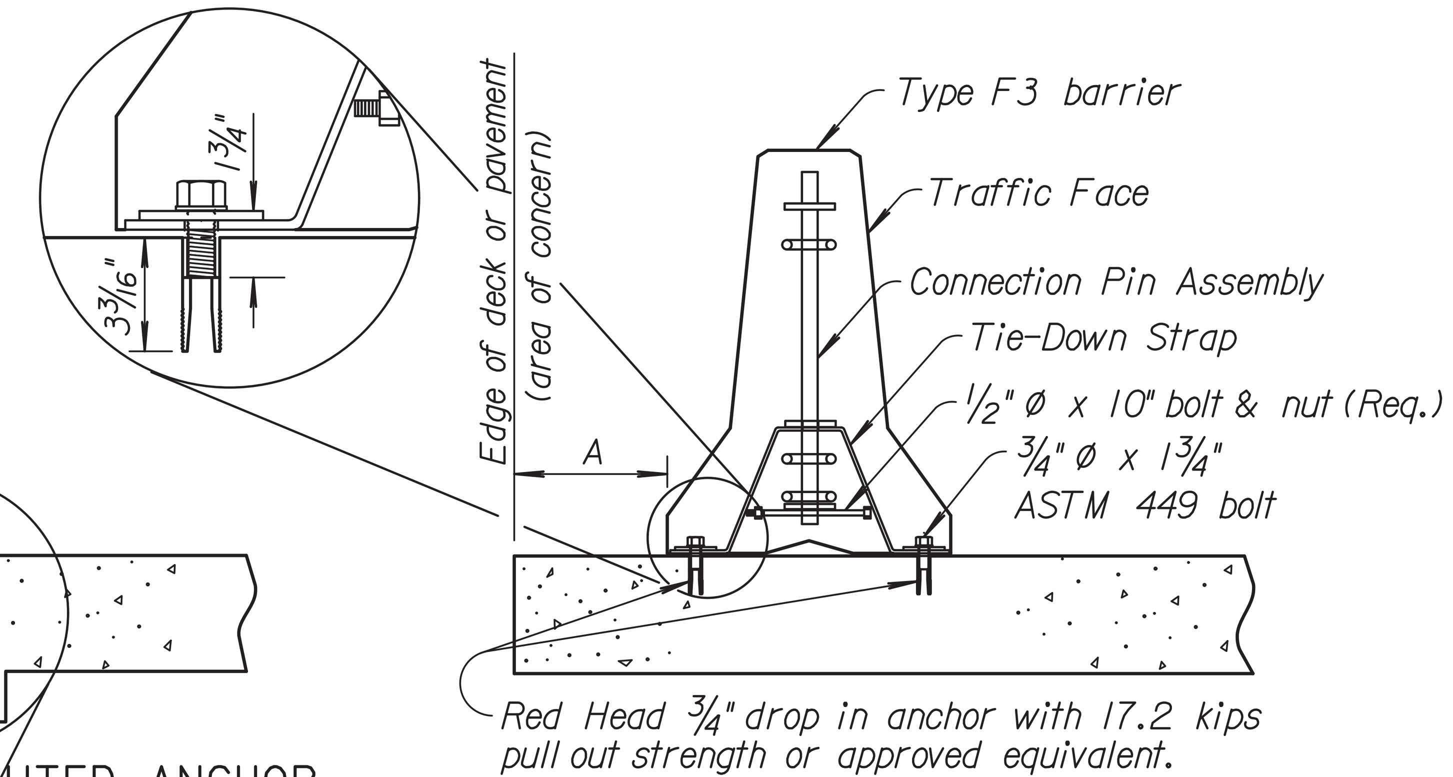


THROUGH BOLT (Preferred)
Install on Bridge Deck (Opt. 1B)

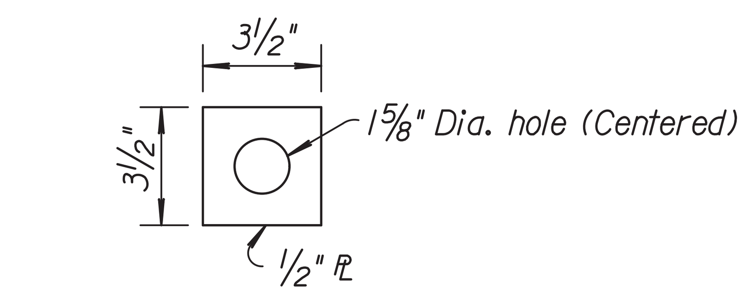


♦ Alt. DRILLED AND GROUTED ANCHOR
Bridge Deck (Opt. 1B)
or Ridgid Pavement (Opt. 1R)

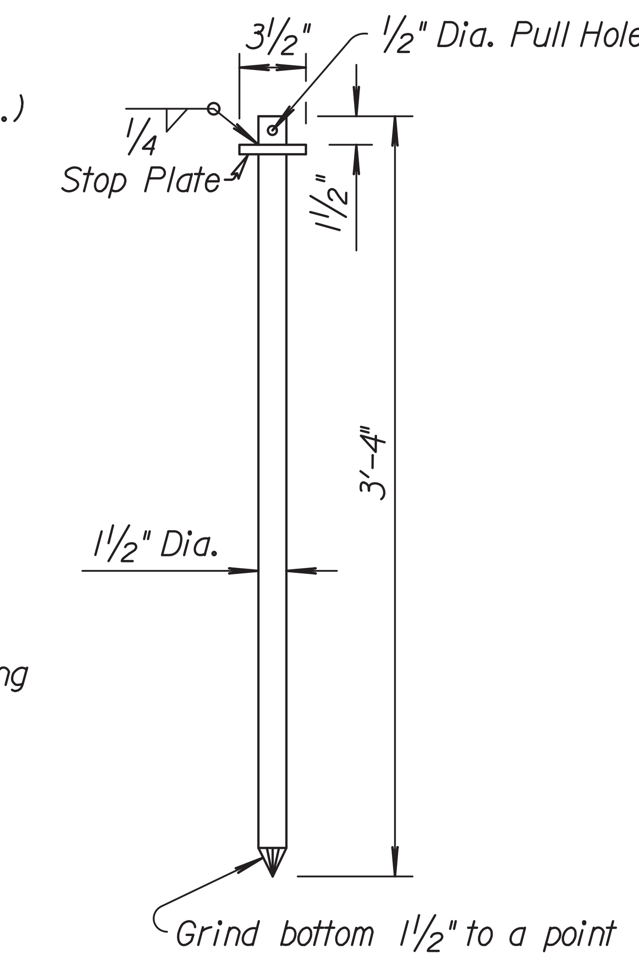
♦ Note: Anchor installation (Opt. 1 B) avoids damage to the support beams, girders or expansion joint. The State Bridge Office shall approve the use of (Opt. 1 B).



ANCHOR STRAP
Rigid Pavement (Opt. 2 R) or
Bridge Deck (Opt. 2 B)



STOP PLATE DETAIL



STAKE DETAIL

GENERAL NOTES:

INSTALLATION: Holes into the pavement to anchor the concrete safety barrier may be drilled after positioning barrier. Barrier units may be installed with Through Anchor Bolt where possible. Grouted Anchor bolts may be used where Through Anchor Bolt isn't possible. Do not drill into or otherwise damage support beams, girders, or expansion joints. All work and materials required for the installation of the anchors shall be subsidiary to the bid item "Concrete Safety Barrier".

UTILITIES & STRUCTURES (Stakes) Verify buried utilities and structures within stake depth. If conflicts between stake and buried elements exist, up to 2 stakes maximum in a single barrier may be omitted if adjacent barriers have 3 stakes each.

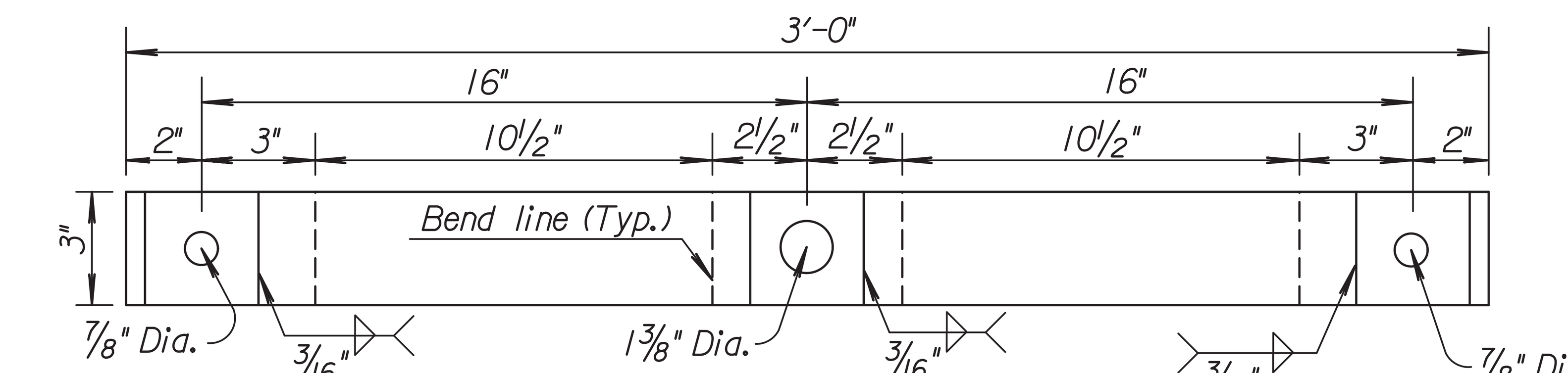
ANCHORAGE: Grouted Anchor Bolts, Through Anchor Bolts, Nuts & Washers shall be Galvanized and meet Standard Specifications.
Install three Anchor Bolts or Asphalt Pins per Barrier on the Traffic side except on Transition Barrier as shown.

BARRIER REMOVAL: Remove Grouted or Wedge Anchor System by drilling the anchor with a core barrel 2x the diameter of the insert. Core to a depth equal to the installed depth and remove the core. Prepare the hole by removing any dust and debris. Follow the manufacture procedures for mixing, hole preparation and curing. Use materials which meet KDOT Prequalified "Non-Shrink Grouts for Grouting Anchor Bolts and Reinforcing into Previously Poured Concrete".
Remove Through Bolt Anchor and completely fill the hole with approved grout using instructions for Drop-In Anchors above except no coring is required of through deck hole.
Remove all Stakes completely on removed or relocated barrier, fill holes completely in flexible pavement with hot or cold asphalt patch material. Work and materials required to remove and patch anchor holes shall be subsidiary to the bid item "Concrete Safety Barrier".

SIGNING: For sign spacing, details of other traffic control devices and reference notes, see Index of Sheets for location.

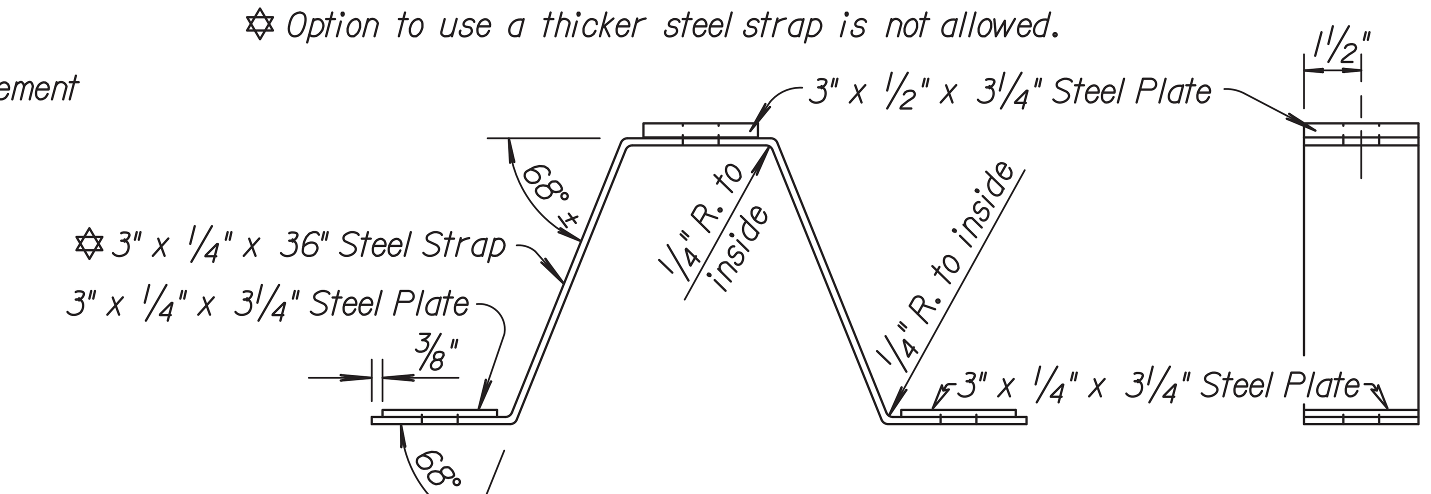
TEMPORARY BARRIERS: Barriers constructed to the details of this drawing shall not be used in permanent installations.

Note: See Std. Drawing No. RD622 for details and quantities not shown on this sheet.



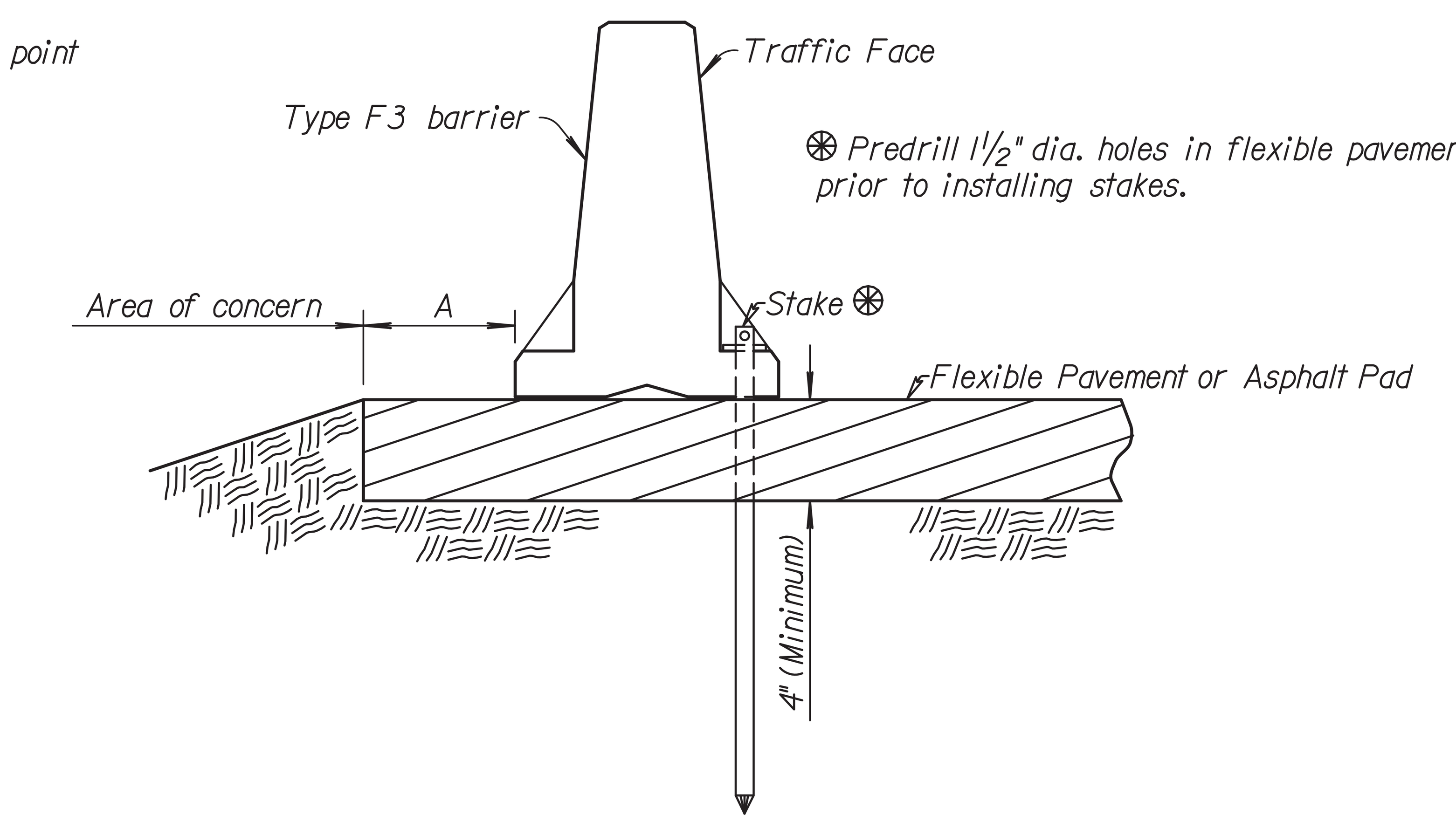
PLAN

✡ Option to use a thicker steel strap is not allowed.

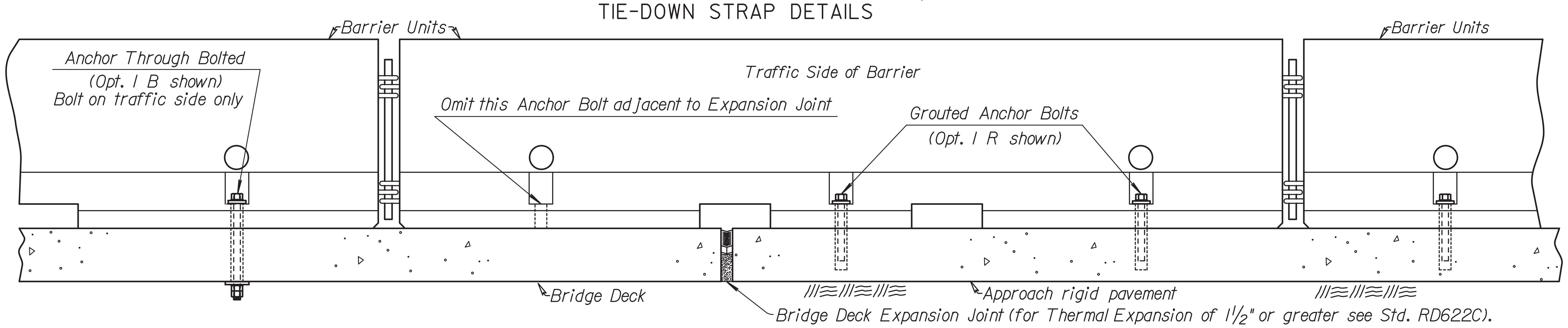


ELEVATION END VIEW

TIE-DOWN STRAP DETAILS



FLEXIBLE PAVEMENT ROAD APPLICATION
ELEVATION - STAKED DOWN (Opt. 2 R)



ELEVATION

TREATMENT AT BRIDGE DECK EXPANSION JOINT SCHEMATIC (Expansion < $1\frac{1}{2}$")

Note to Designer: For use on Haunched slab bridges, the Road Designer shall coordinate with the Bridge Designer for "corridor in the reinforcing steel layout to accomodate barrier anchoring".
Road Designer shall coordinate barrier layout with Bridge Designer to accomodate for expansion during construction.

NO.	DATE	REVISIONS	BY	APP'D
3				
2	10-2-07	Rev. anchor bolt call-out	S.W.K.	J.O.B.
1	1-30-07	Rev. traffic face location call-out	S.W.K.	J.O.B.

KANSAS DEPARTMENT OF TRANSPORTATION

TEMPORARY CONCRETE SAFETY BARRIER TYPE F3 ANCHORAGE

RD622B

FHWA APPROVAL	12-19-07	APP'D. James O. Brewer	
DESIGNED	DETAILED	QUANTITIES	TRACED Bowser
DESIGN CK.	DETAIL CK.	QUAN.CK.	TRACE CK. King

Plotted: 02-JAN-2008 07:08
Drawn By: bert
File: rd622b.dgn (rd622b)

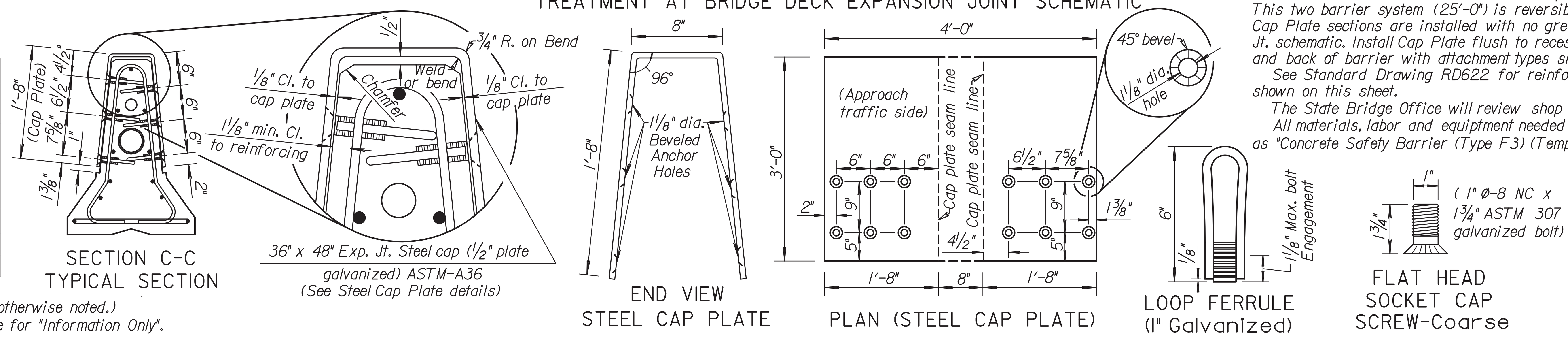
Note to Designer: This F3 Barrier Anchorage at Expansion Joint is only for use on bridges with thermal expansion of $1\frac{1}{2}$" or greater at the recommendation and review of Bridge Designer. Bridges longer than 1,000 feet require a Special Design.

Ψ If two or more Anchor Bolts are omitted, then add an additional cable.

Per 12'-6" Barrier Section

REINFORCING A615 Gr. 60					
Bar	Bar Size	Shape	No. of Bars	Length Ft.	Weight Lbs.
a_1	#4		16	6'-0"	64.1
a_2	#6	⊂	6	2'-11"	26.3
b_1	#5	——	9	12'-2"	114.2
LOOP ASSEMBLY					
d_4	#6	═	3	8'-2"	36.8
½" Structural Steel Cap Plate					201.3

Concrete Quantity = 1.3 C.Y.
(Dimensions are out to out of bars unless otherwise noted.)
Reinf., Struct. and Concrete quanitities are for "Information Only".



GENERAL NOTES

Installation of F3 Barrier with Steel Cap Plate is for thermal expansion joint with ≥ $1\frac{1}{2}$". This two barrier system (25'-0") is reversible to match with regular F3 Barrier layout. The Cap Plate sections are installed with no greater than 4" gap and pinned as shown in Expansion Jt. schematic. Install Cap Plate flush to recess on Traffic Approach side and bolt in place front and back of barrier with attachment types shown.

See Standard Drawing RD622 for reinforcing bending diagrams and additional details not shown on this sheet.

The State Bridge Office will review shop details before fabrication begins.

All materials, labor and equiptment needed for (Type F3) (25' Expansion Joint Unit) shall be bid as "Concrete Safety Barrier (Type F3) (Temporary)".

NO.	DATE	REVISIONS	BY	APP'D
3	7-26-07	Chg. flat head screw & ferrul to 1" ø	S.W.K.	J.O.B.

KANSAS DEPARTMENT OF TRANSPORTATION

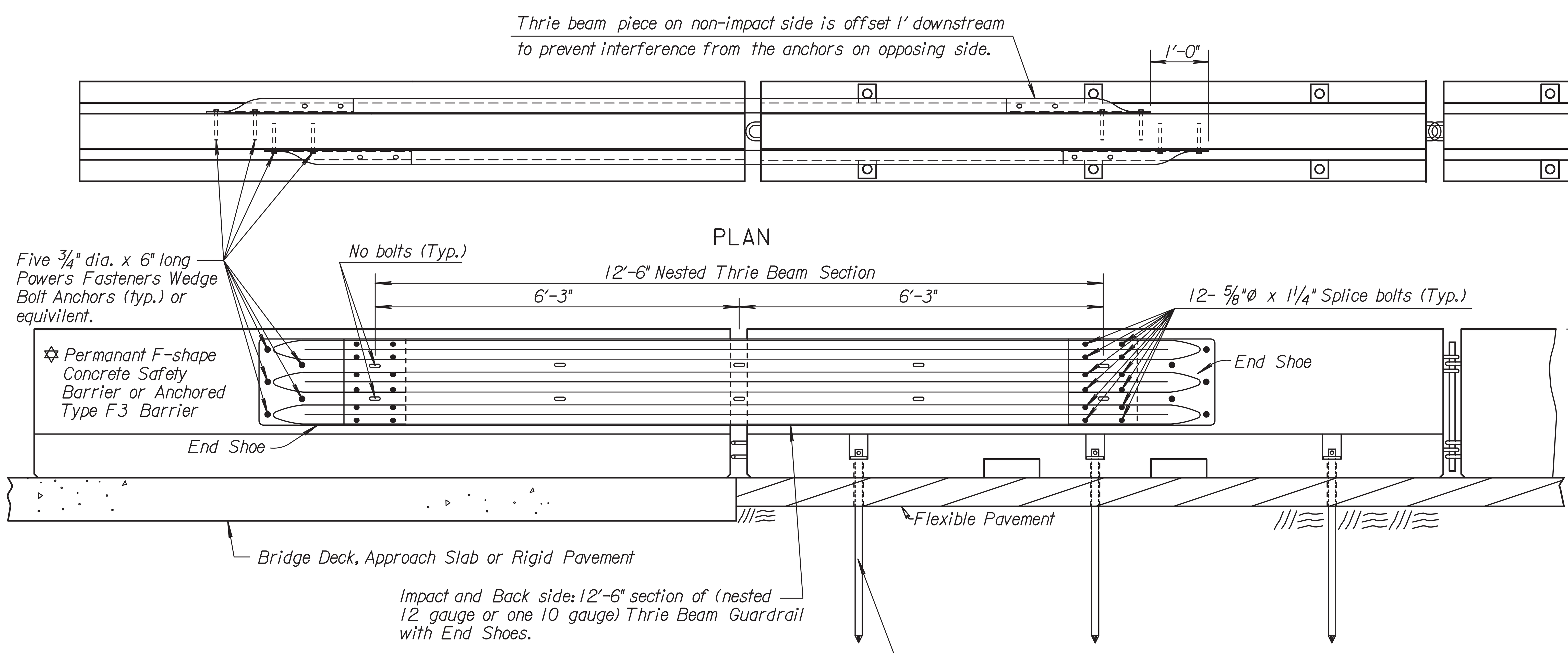
TEMPORARY CONCRETE SAFETY BARRIER TYPE F3 ANCHORAGE at EXPANSION JT.

RD622C

FHWA APPROVAL	10-05-07	APP'D. James O. Brewer	
DESIGNED J.P.J.	DETAILED	QUANTITIES	TRACED B.N.B.
DESIGN CK.	DETAIL CK.	QUAN.CK.	TRACE CK. S.W.K.

Plotted : 07-NOV-2007 11:29
Drawn By : bert
File : rd622c.dgn (rd622c)

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS				



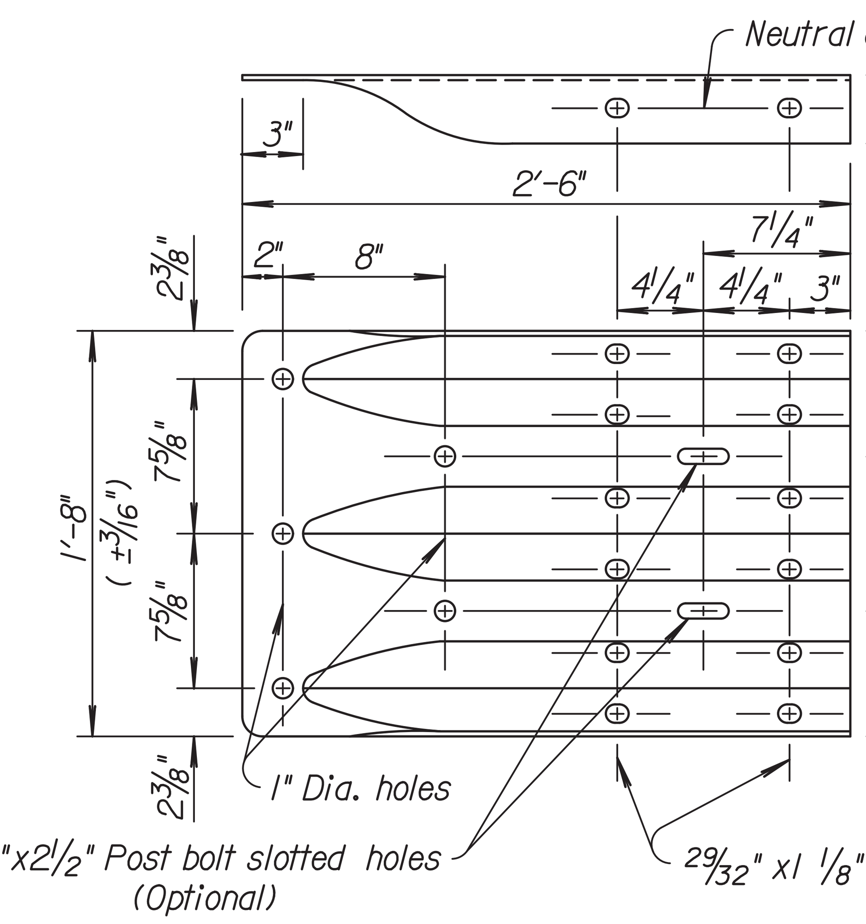
ELEVATION

✡ GUARDRAIL CONNECTION

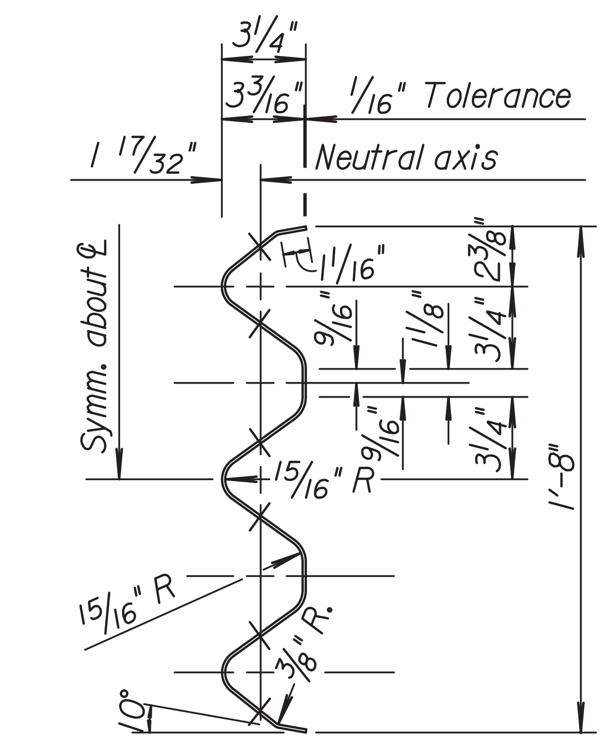
ANCHORED/RIGID BARRIER TO FREESTANDING BARRIER

GENERAL NOTES:

The work and materials required for the installation & removal of the guardrail connection and barrier anchors as shown on this sheet shall be subsidiary to the "Concrete Safety Barrier" bid item.



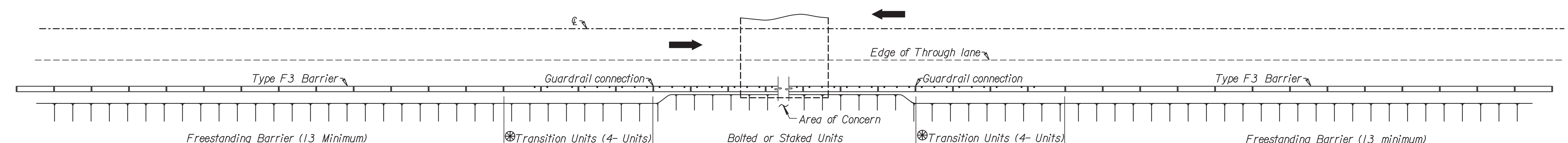
TERMINAL CONNECTOR



THRU RAIL ELEMENT

TYPICAL THRIE BEAM

PLAN (Transition Units)



✡APPROACH TRANSITION FROM FREESTANDIING TO ANCHORED (BOLTED OR STAKED) TYPE F-3 CONCRETE BARRIER

✡ TYPICAL INSTALLATIONS

1) Type F3 barrier anchored to rigid pavement with bolted connection or bolted to a bridge deck.
 -the transtion between this anchored barrier and the freestanding needs the transition barriers plus guardrail as shown above.
2) Permanent F-shape barrier
 -the transtion between this permanent barrier and the freestanding Type F3 needs the transition barriers plus guardrail as shown above.
3) Type F3 barrier anchored with straps on rigid pavement or a bridge deck
 -the transtion between this anchored barrier and the freestanding needs NO transition barriers or NO guardrail.
4) Type F3 barrier pinned/staked to asphalt pavement
 -the transtion between this anchored barrier and the freestanding needs the transition barriers but NO guardrail.

NO.	DATE	REVISIONS	BY	APP'D
3				
2				
1	1-30-07	Rem. temp. details from perm. barrier	S.W.K.	J.O.B.

KANSAS DEPARTMENT OF TRANSPORTATION

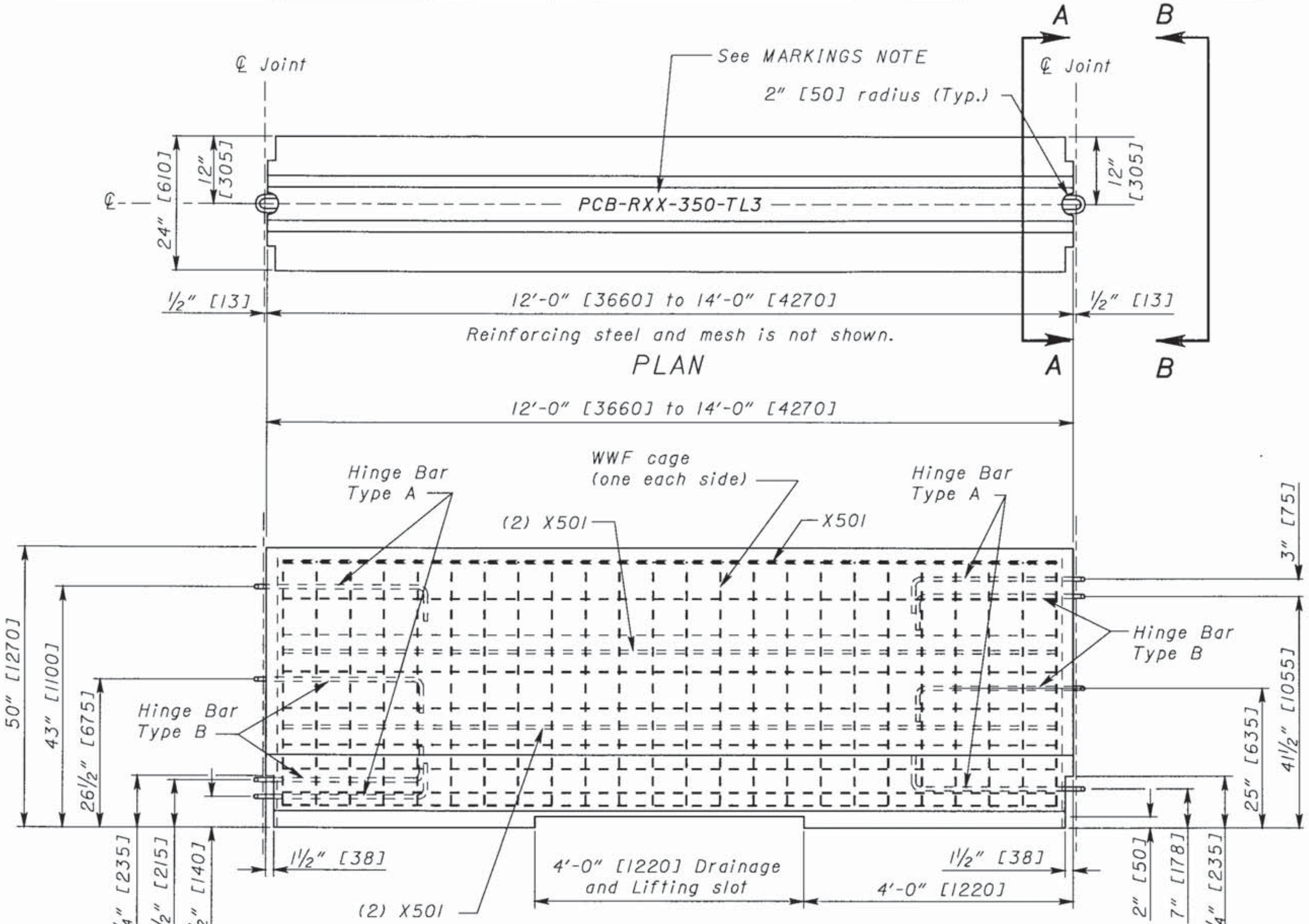
TEMPORARY CONCRETE SAFETY BARRIER TYPE F3 TRANSITION LAYOUTS

RD622D

FHWA APPROVAL	1-19-07	APP'D. James O. Brewer	
DESIGNED	DETAILED	QUANTITIES	TRACED Bowser
DESIGN CK.	DETAIL CK.	QUAN.CK.	TRACE CK. King

Plotted : 22-MAR-2007 11:23

Drawn By : bert
File : rd622d.dgn (rd622d)



ELEVATION

50" [1270] BARRIER SECTION

NOTES

GENERAL: See CMS 622 for additional information. The minimum design strength of the concrete is 4,000 psi, and will meet the requirements of CMS 499.

PORTABLE CONCRETE BARRIER (PCB): as shown is not to be used on bridge deck edges, or similar dropoffs. The only suitable barrier in this situation is a 32" PCB as detailed on **Structural Engineering's Standard Drawing PCB-91.**

50-Inch TRANSITION SECTION: Only segments shown on SCD RM-4.2, or approved Impact Attenuators, may be attached to the 32" [813] side of a 50" [1270] transition section. Do not connect an Impact Attenuator to a 50" [1270] barrier end.

HINGE AND REINFORCING BARS: The ¾" [19] hinge bars may be ASTM A 36. Reinforcing steel shall meet the requirements of CMS 509 (ASTM A 615 Grade 60). Wire mesh shall meet CMS 709.10. Black steel is permitted.

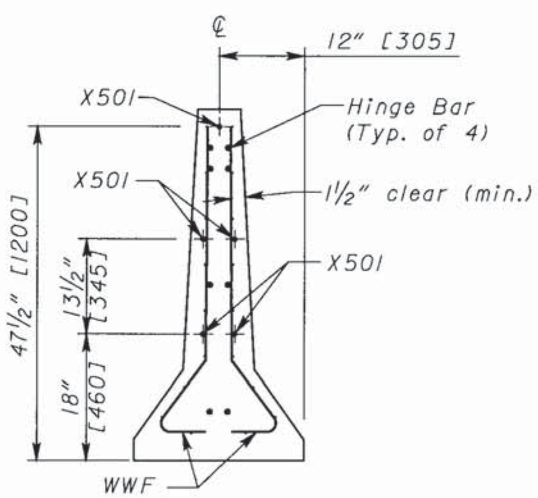
CONNECTING HARDWARE: Galvanize bolts, washers and hex nuts after fabrication per CMS 711.02 and meeting the requirements of CMS 711.09, except that the Rotational Capacity test specifed in ASTM A 325 shall be waived.

HANDLING DEVICES: Such devices may be used in lieu of the lifting slot for moving the barrier. They may be of any design sufficient to handle the weight of the section being lifted. No handling devices shall protrude from the surface of the barrier when in place.

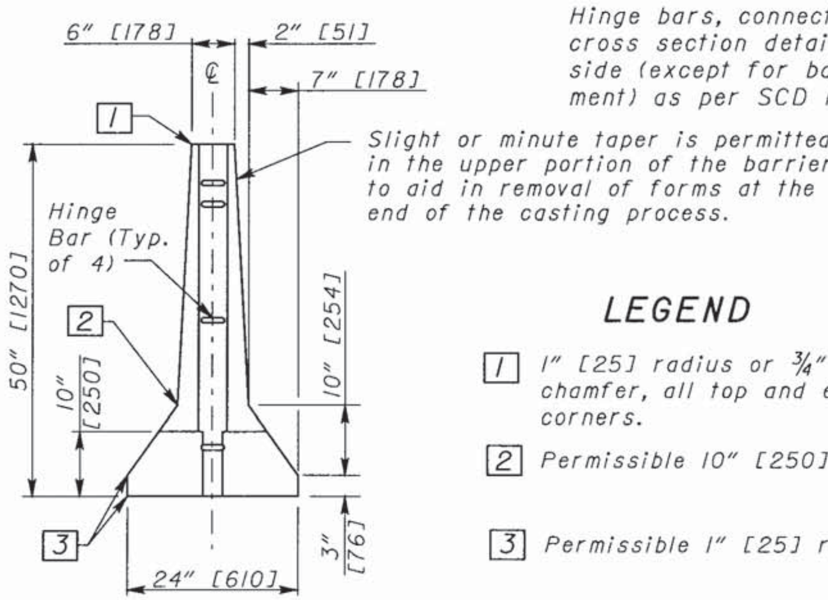
MARKING: All barrier segments are to be marked as shown, where XX indicates the year cast. Permanently impress these marking on the barrier using a minimum of 2 inch [50] high lettering.

On the top of each barrier segment, including the transition section, permanently mark a unique identification as to its manufacturer. And somewhere on the barrier, permanently mark the day and month the barrier was manufactured.

REFLECTORIZATION: Install barrier reflectors in accordance with **Traffic Engineering Standard Drawing MT-101.70,** when specified in the plans.



SECTION A-A



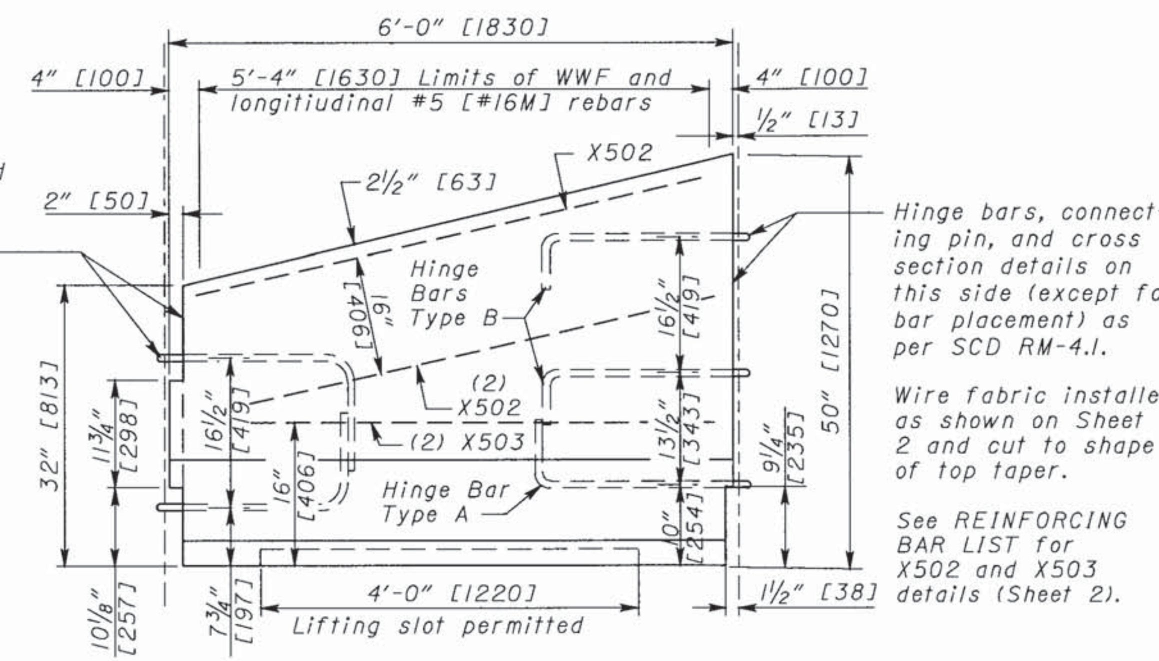
VIEW B-B

LEGEND

1 1" [25] radius or ¾" [19] chamfer, all top and end corners.

2 Permissible 10" [250] radius.

3 Permissible 1" [25] radius.

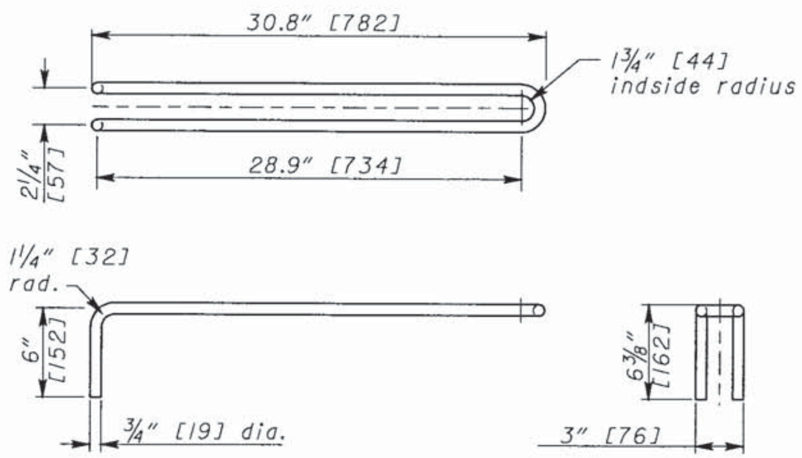


ELEVATION

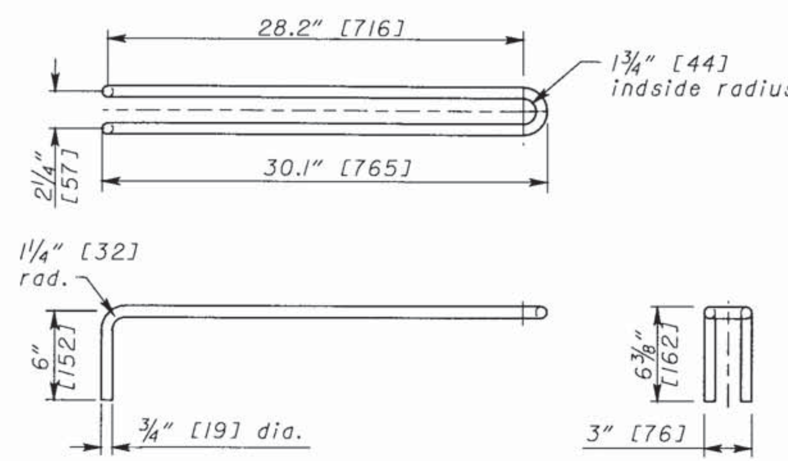
50" [1270] TRANSITION SECTION

NEW DRAWING

OHIO DEPARTMENT OF TRANSPORTATION
ROADWAY DESIGN ENGINEER
10-20-06
DATE
STDS. ENGR. D. Focke
All metric dimensions (in brackets [ ]) are in millimeters unless otherwise noted.
ROADWAY ENGINEERING SERVICES
STANDARD ROADWAY CONSTRUCTION DRAWING
50" PORTABLE CONCRETE BARRIER
NUMBER RM-4.1

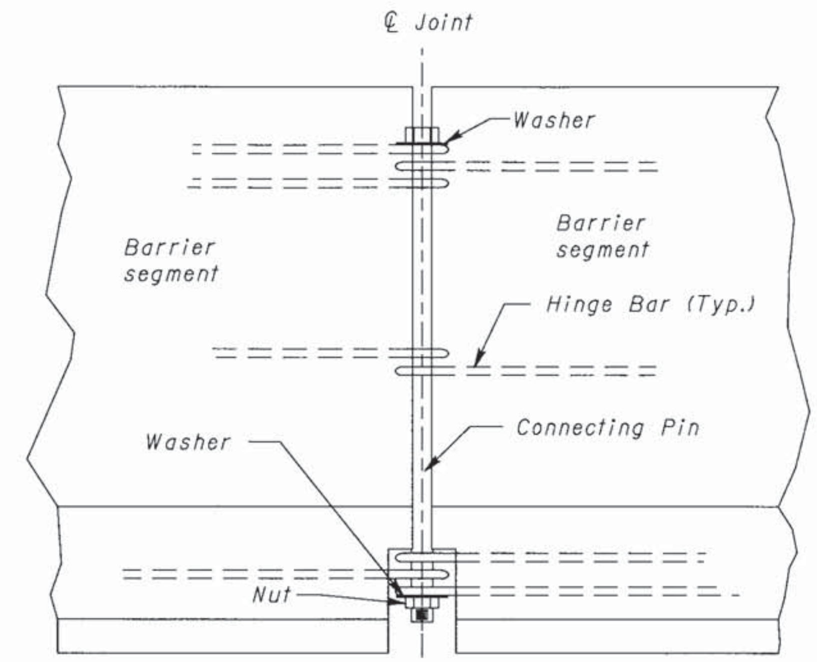


Hinge Bar Type A
¾" [19] dia. x 87.9" [2230].
Four per segment.



Hinge Bar Type B
¾" [19] dia. x 86.4" [2195].
Four per segment.

HINGE BAR DETAILS

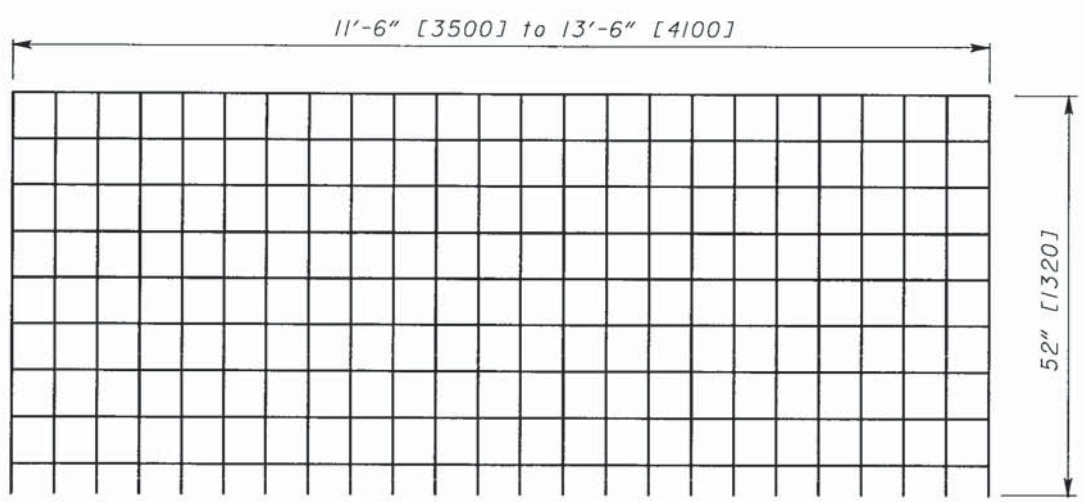


Connecting Pin is a 1¼" [32] diameter by 43" [1190] Grade 5 galvanized high strength steel bolt, with 3" [75] of threads, (Each bolt passes through eight hinge bar loops - four on each segment.)

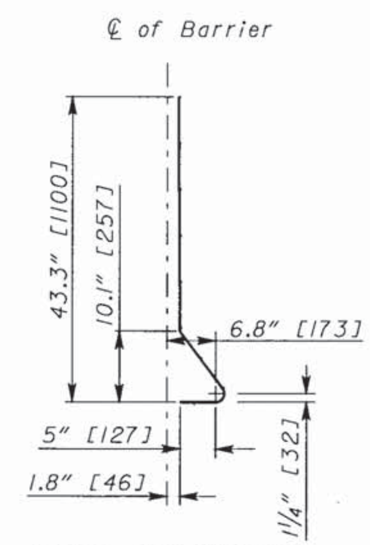
The assembly requires two F436 1¼" [32] flat washer with an ID of 1⅜" [35] and an OD of 2.5" [64]. The thickness is 0.156" [4]. The flat washer is hot dipped galvanized.

The assembly also requires one 11/4" [32] -7 heavy hex nut The nut is hot dipped galvanized and waxed and is catergorized 2H/DH.

CONNECTING PIN ASSEMBLY

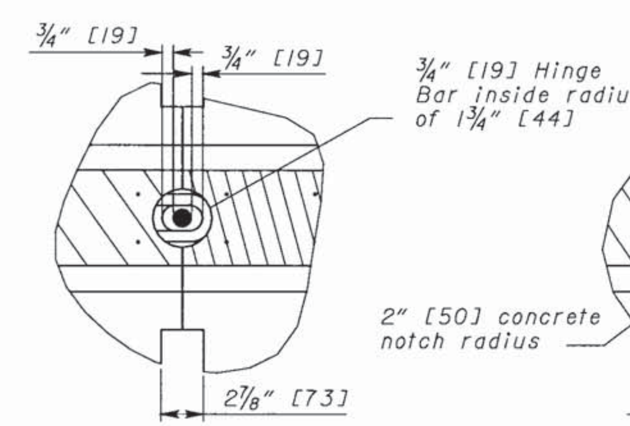


WWF ELEVATION
Showing mesh before bending



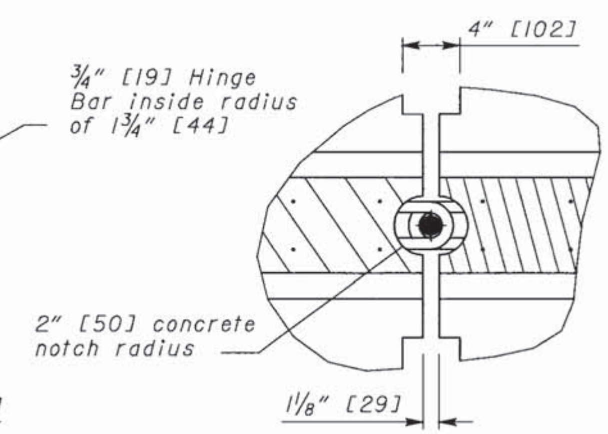
WWF SECTION
Showing mesh bent to shape

REINFORCING BAR LIST					
	Mark	Bar	Bar Length	Shape	Quantity
BARRIER SECTION (reinforced)	X501	#5 [#16M]	11'-6" [3500] to 13'-6" [4100]	Str.	5
50" TAPERED END	X502	#5 [#16M]	5'-8" [1730]	Str.	3
	X503	#5 [#16M]	5'-4" [1630]	Str.	2



SECTION A-A
CLOSED JOINT

Barriers shall initially be placed close together so that Bolts can be easily inserted through Hinge Bar loop.



SECTION A-A
OPEN JOINT
NORMAL OPERATION

Barrier joints shall be fully open before the Nut is tightened onto Bolt.

JOINT CONNECTION DETAIL

NEW DRAWING

OHIO DEPARTMENT OF TRANSPORTATION
ROADWAY DESIGN ENGINEER
10-20-06
DATE

STDS. ENGR.
D. Focke

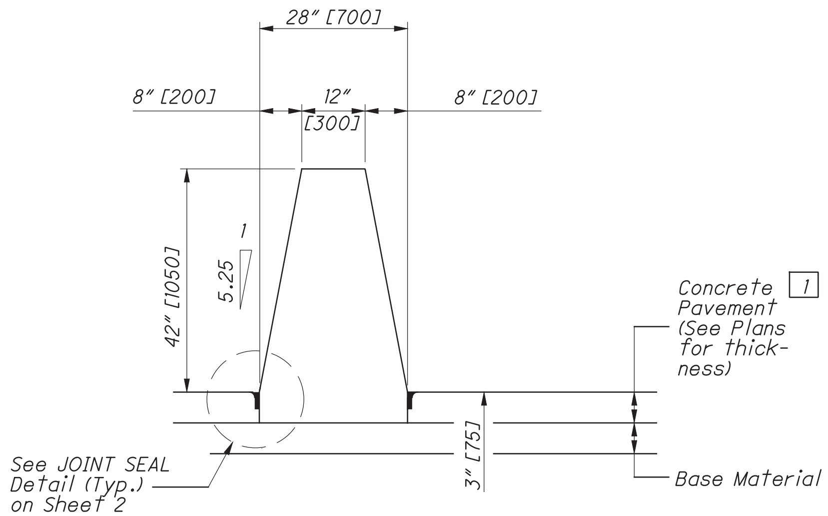
All metric dimensions (in brackets [ ]) are in millimeters unless otherwise noted.

ROADWAY ENGINEERING SERVICES

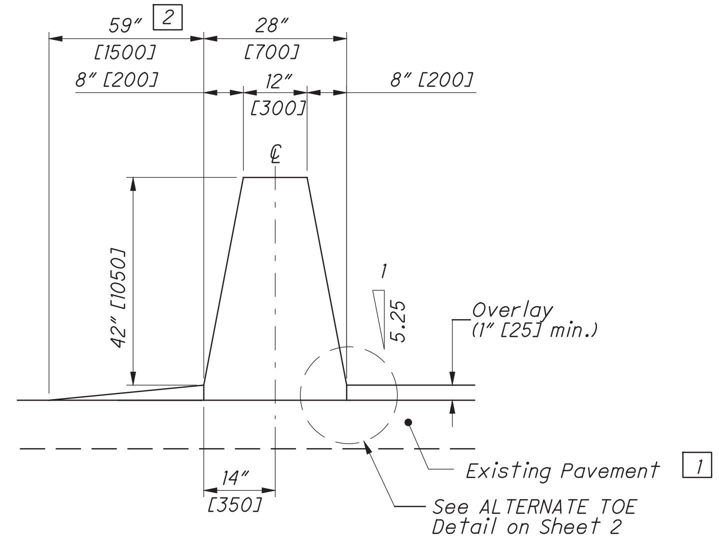
STANDARD ROADWAY CONSTRUCTION DRAWING
50" PORTABLE CONCRETE BARRIER

NUMBER
RM-4.1

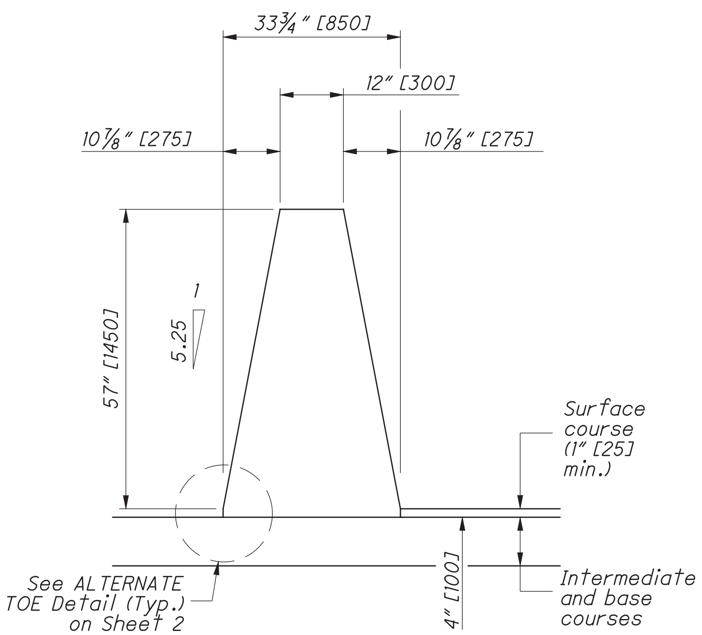
2/2



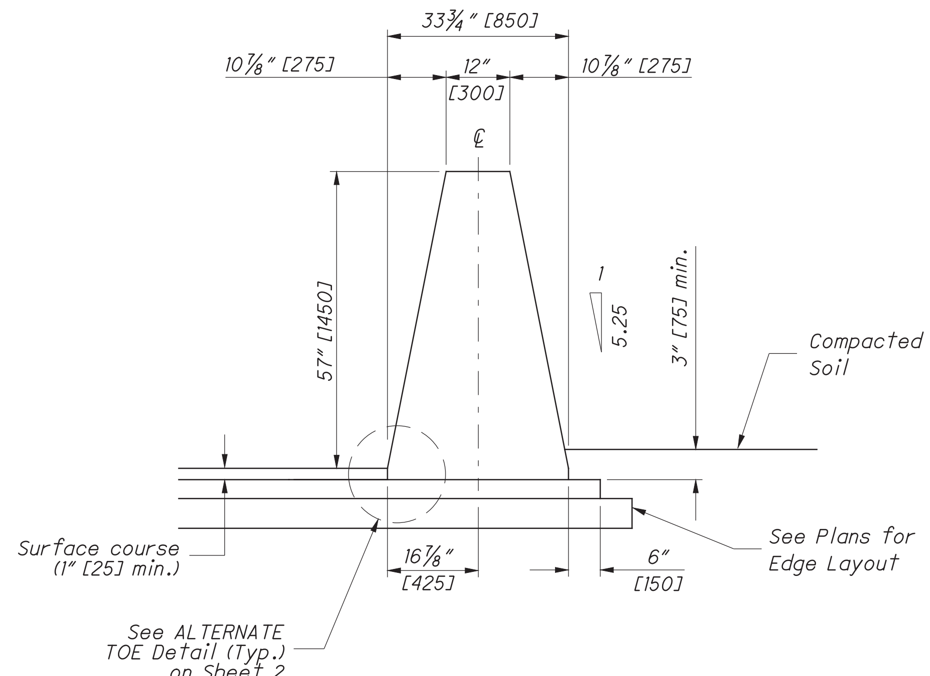
TYPE B
(SHOWN WITH NEW CONCRETE PAVEMENT)



TYPE B
(SHOWN WITH EXISTING PAVEMENT)



TYPE B1
(SHOWN WITH NEW ASPHALT PAVEMENT)



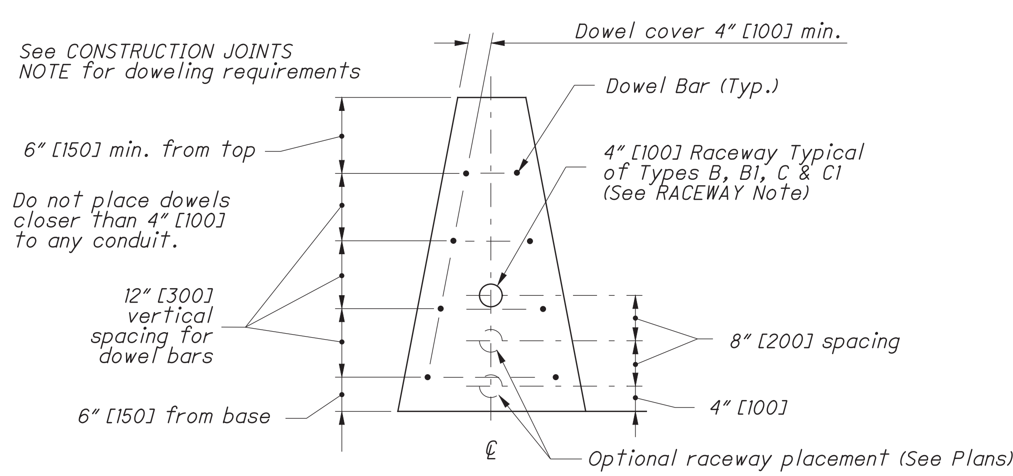
TYPE B1
(SHOWN WITH PAVEMENT ON ONE SIDE ONLY)

LEGEND

1 See DOWELING DETAILS on Sheet 2 for alternate construction with concrete pavement.

2 See ADJOINING PAVEMENT Note.

See Sheet 2 for Types C and C1.



RACEWAY AND DOWEL BAR PLACEMENT

NOTES

SINGLE SLOPE CONCRETE BARRIER *may be cast-in-place or slip formed. See Sheet 2 for Types C and C1. See* ***SCD RM-4.5*** *for Type D barrier. See* ***SCD RM-4.6*** *for End Sections.*

MATERIALS: *Construct using Class C concrete. Construct top and end edges with either a 1″ [25] radius or ¾″ [19] chamfer, except at light pole foundations.*

CONTRACTION JOINTS: *Maximum allowable spacing of unsealed joints is 20′ [6.0 m] throughout the run of the barrier. Construct joints by using metal inserts inside the forms, preformed full width joint filler, a grooving tool, or by sawing. Inserts, tooled, or sawed joints will have a 3″ [75] depth. Construct all joints for the full height of the barrier. Saw as soon as curing will allow to prevent spalling. When used in conjunction with concrete pavement, match joints to those in the concrete pavement but not exceeding the maximum allowable spacing.*

ADJOINING PAVEMENT: *When the barrier is constructed in conjunction with new asphalt pavement, place it directly on the intermediate course. Construct the surface course directly against the barrier. Set barrier placed on existing pavement with a continuous wedge of surface material tapering from a 1″ [25] minimum thickness at the toe of the barrier to zero. For bidirectional installations construct the wedge on both sides of the barrier. For unidirectional installations, construct the wedge on the traveled way side and the width may be reduced to 12″ [300] minimum.*

When the barrier is constructed in conjunction with new concrete pavement, place it directly on the base material. Construct the concrete slab against the barrier.

Barrier may be placed on top of existing concrete pavement and doweled as shown in DOWELING DETAILS (see Sheet 2). When pavement is to be constructed on one side of the barrier only, then compacted soil on the opposite side must be placed against the barrier at a minimum height of 3″ [75].

SEALING JOINTS: *Use a butt longitudinal joint between the barrier and adjoining concrete pavement sealed with CMS 705.04 joint sealer. See detail on Sheet 2.*

TRANSITIONS: *Make linear transitions between different types of barrier within a 20′ [6.0 m] length.*

CONSTRUCTION JOINTS: *Barrier runs with abutting vertical surfaces at either required or permissible construction joints are to be doweled to each other by use of ¾″ [19] dia. by 18″ [450] long epoxy coated deformed dowel bars as per CMS 622.02. Bars are to be placed as shown on the RACEWAY and DOWEL BAR PLACEMENT detail on this sheet. Provide a 4″ clearance to barrier surfaces and to any raceways.*

STATION MARKINGS: *Impress markings in the "green" concrete on both sides at the top of the barrier. The cost is incidental to the unit cost bid for this barrier.*

RACEWAY: *Locate as shown on in RACEWAY PLACEMENT Detail, unless otherwise directed by the Engineer. Ensure that the electrical raceway is clear of obstructions.*

Cost of the 4″ [100] polyvinyl chloride raceway is included where shown on the plans. The cost for additional raceways and No. 10 AWG copperclad or aluminum-clad wire is also included where shown on the plans for future installation of circuits.

PAYMENT *will be made at the unit price bid per Foot [Meter] for* ***Item 622 - Concrete Barrier, Single Slope, Type ____ .*** *Include all materials, labor, raceways, dowel holes, markings and other incidentals necessary to construct the barrier, except as follows:*

Item 604 Barrier Median Inlet	***20 ft. [6 meters]***
Item 625 Light Pole Foundation or Pullbox	***4 ft. [1.2 meters]***
Item 630 Overhead Sign Support Foundation	***10 ft. [3 meters]***
Item 630 Barrier Wall Assembly	***10 ft. [3 meters].***

Payment for any reinforced end anchorages, as shown on the END ANCHORAGE details shown on sheet 2, will be made at the unit price bid per Each for ***Item 622 - Concrete Barrier End Anchorage, Reinforced.*** *This includes all materials, labor, and other incidentals necessary to construct this anchor.*

THIS DRAWING REPLACES RM-4.3 DATED 1-7-09.

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

Dirk B. Gross
ADMINISTRATOR

10-16-09
DATE

STDS. ENGINEER M. Bline

ALL METRIC DIMENSIONS (IN BRACKETS [ ]) ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

OFFICE OF ROADWAY ENGINEERING

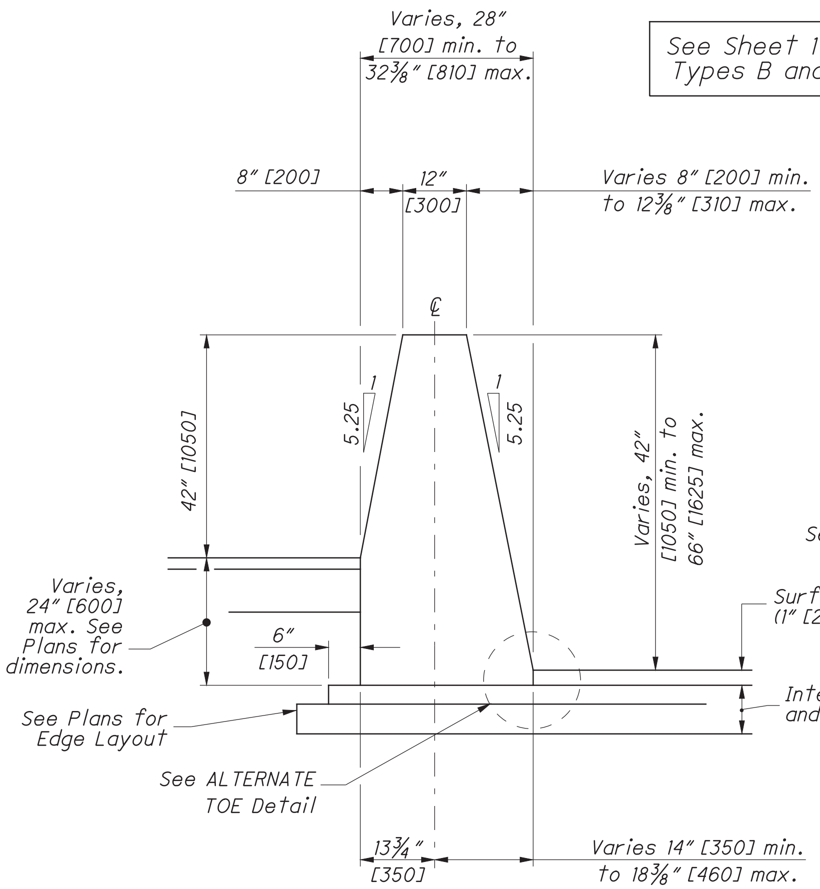
STANDARD ROADWAY CONSTRUCTION DRAWING

SINGLE SLOPE BARRIER, TYPES B, C, B1, & C1

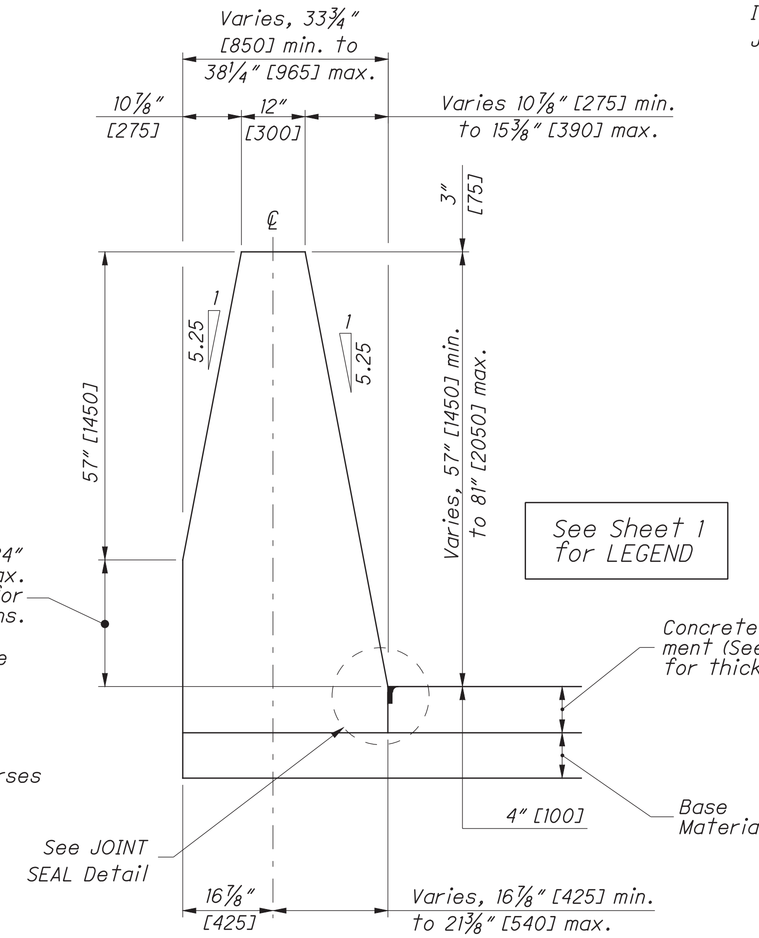
SCD NUMBER **RM-4.3**

1/2

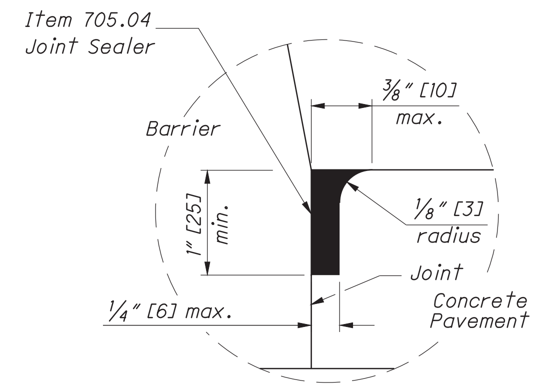
X:\Standards\Publications\LDM\Distributions\ldm 2009-10-16\rm4.3_jan07_V8.dgn 08-OCT-2009 12:39PM mbline



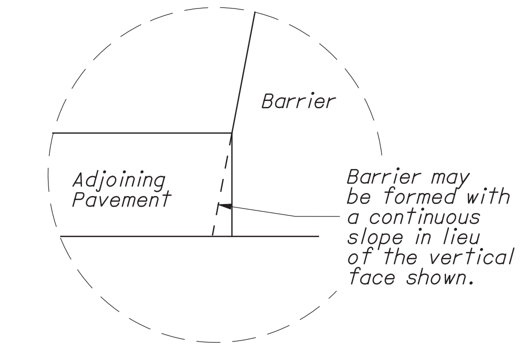
TYPE C
(SHOWN WITH NEW ASPHALT PAVEMENT)



TYPE C1
(SHOWN WITH NEW CONCRETE PAVEMENT)



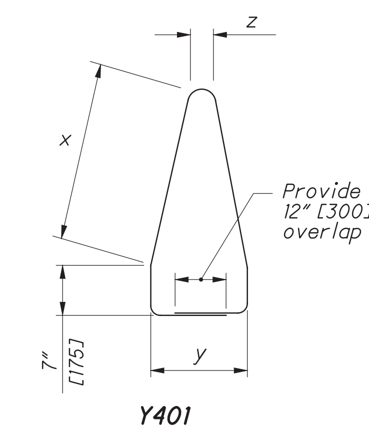
JOINT SEAL DETAIL



ALTERNATE TOE DETAIL

Dimensions for Y401 (English)				
Barrier Type	x	y	z	Length
B	37"	24"	8"	10'-10"
B1	51"	24"	8"	13'-2"

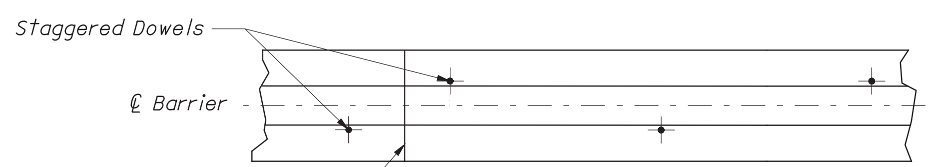
Dimensions for Y401 (Metric)				
Barrier Type	x	y	z	Length
B	940	600	200	3300
B1	1300	600	200	4000



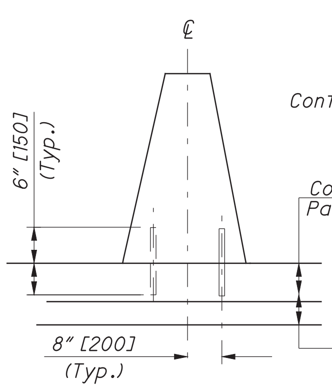
Y401
#4 [#13M]

Y401 STEEL LIST & BENDING DIAGRAM

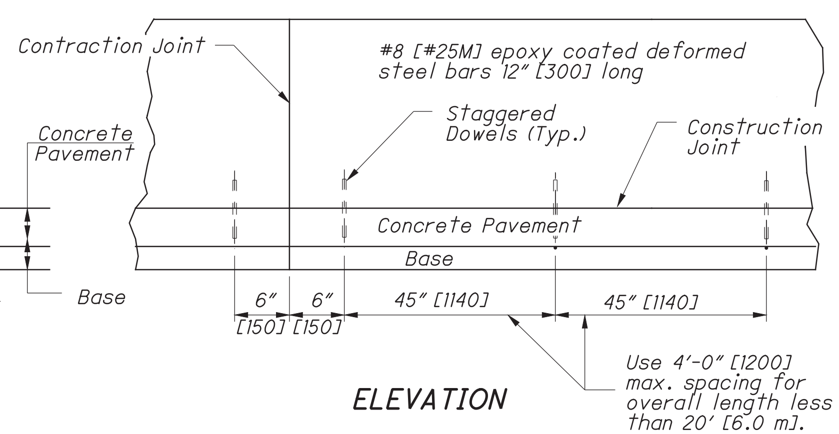
Steel dimensions for Types C and C1 barriers are not shown.



PLAN



SECTION



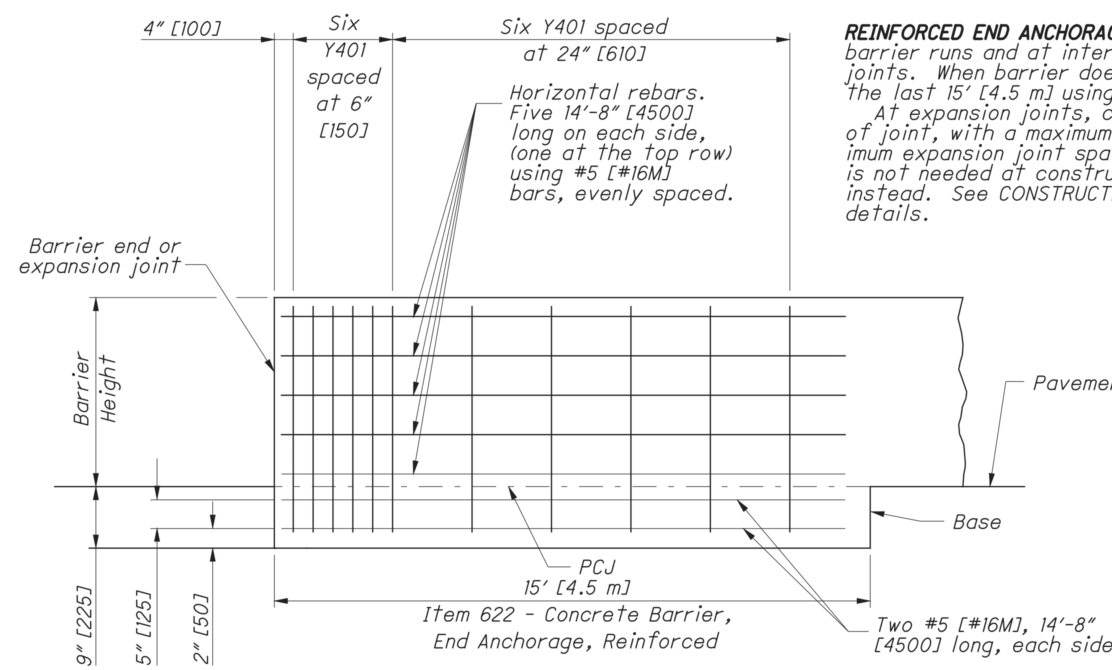
ELEVATION

Horizontal rebars not shown.

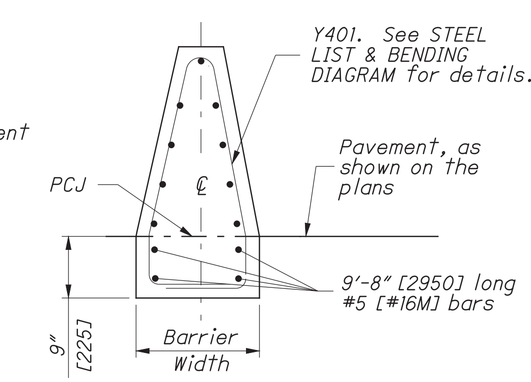
DOWELING DETAILS

See ADJOINING PAVEMENT Notes on Sheet 1

REINFORCED END ANCHORAGES are required at the ends of concrete barrier runs and at interruptions in barrier caused by expansion joints. When barrier does not abut another barrier run, construct the last 15' [4.5 m] using the END ANCHORAGE Detail as shown here.
At expansion joints, construct an End Anchorage on both sides of joint, with a maximum gap of 2" [50] for the open joint. The maximum expansion joint spacing shall be 800' [250 m]. This anchorage is not needed at construction joints, provide dowel bar connections instead. See CONSTRUCTION JOINT NOTE on Sheet 1 for doweling details.



ELEVATION

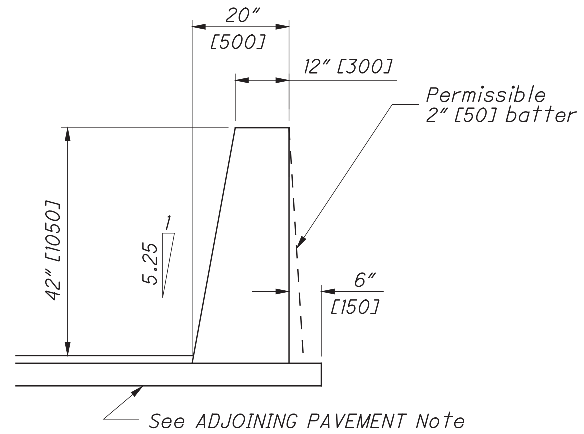


SECTION

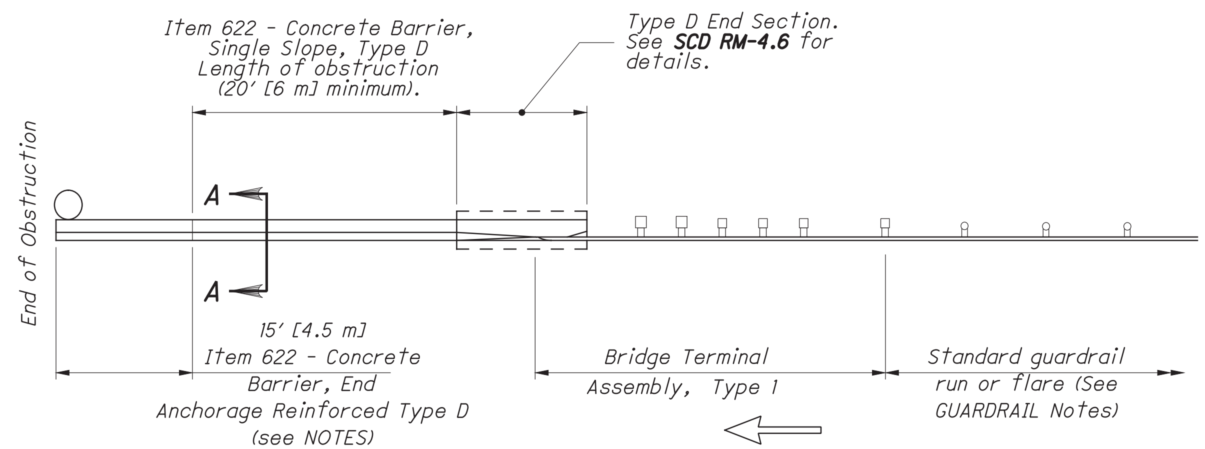
END ANCHORAGE

THIS DRAWING REPLACES RM-4.3 DATED 1-19-07.

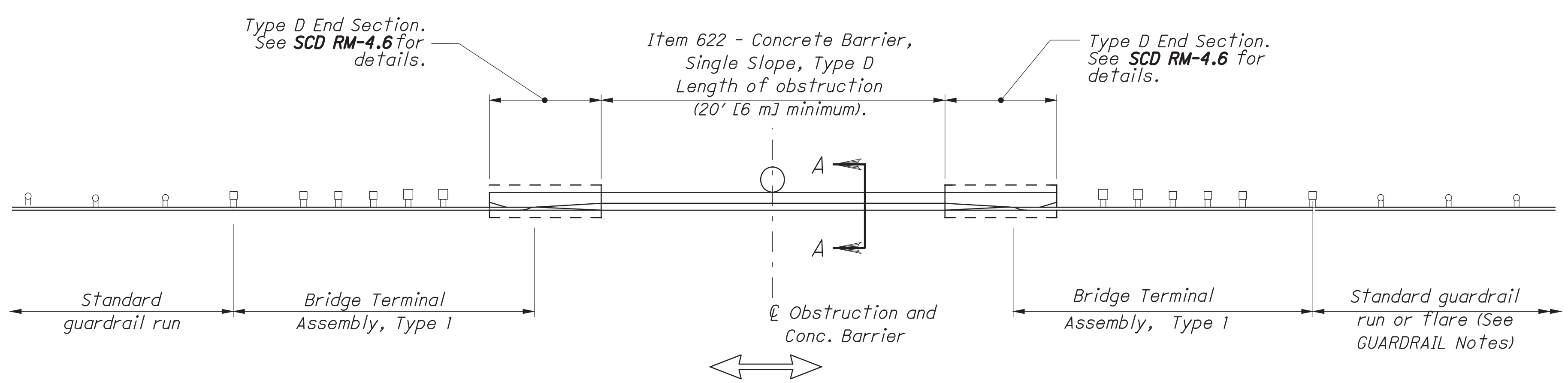
STATE OF OHIO DEPARTMENT OF TRANSPORTATION
10-16-09
DATE
ADMINISTRATOR
STDS. ENGINEER M. Bline
ALL METRIC DIMENSIONS (IN BRACKETS [ ]) ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
OFFICE OF ROADWAY ENGINEERING
STANDARD ROADWAY CONSTRUCTION DRAWING
SINGLE SLOPE BARRIER, TYPES B, C, B1, & C1
SCD NUMBER RM-4.3
2/2



SECTION A-A



Directional Travel where no trailing guardrail is used.



Use Bridge Terminal Assembly, Type 2 for directional roadways where trailing guardrail is used and is out of the Clear Zone of opposite direction traffic.

Bi-directional Travel or Directional Travel where trailing guardrail is used.

TYPICAL INSTALLATIONS CONCRETE BARRIER AT OBSTRUCTIONS

NOTES

GENERAL: Single Slope Concrete Barrier, Type D, may be cast-in-place or slip-formed. See **SCD RM-4.3** for other standard barrier types and any details not shown, including materials, adjoining pavement, and doweling details. Longitudinal steel is not required when top width of barrier is 12" [300] or greater.

CONTRACTION JOINTS: Maximum allowable spacing of unsealed joints is 20' [6.0 m] throughout the run of the barrier. Construct joints by using metal inserts inside the forms, preformed full width joint filler, a grooving tool, or by sawing. Inserts, tooled or sawed joints will have a 3" [75] minimum depth.

Construct all joints for the full height of the barrier. Saw as soon as curing will allow to prevent spalling. When used in conjunction with concrete pavement, match joints to those in the concrete pavement but not exceeding the maximum allowable spacing.

ADJOINING PAVEMENT: When the barrier is constructed in conjunction with new asphalt pavement, place it directly on the intermediate course. Construct the surface course directly against the barrier. Set barrier placed on existing pavement with a continuous wedge of surface material tapering from a 1" [25] minimum thickness at the toe of the barrier to zero. For unidirectional installations, construct the wedge on the traveled way side and the width may be reduced to 12" [300] minimum.

When the barrier is constructed in conjunction with new concrete pavement, place it directly on the base material. Construct the concrete slab against the barrier.

Barrier may be placed on top of existing concrete pavement and doweled as shown in DOWELING DETAILS (see Sheet 2). When pavement is to be constructed on one side of the barrier only, then compacted soil on the opposite side must be placed against the barrier at a minimum height of 3" [75].

SEALING JOINTS: Use a butt longitudinal joint between the barrier and any adjoining concrete pavement sealed with CMS 705.04 joint sealer.

CONSTRUCTION JOINTS: Barrier runs with abutting vertical surfaces at either required or permissible construction joints are to be doweled to each other by use of ¾" [19] dia. by 18" [450] long epoxy coated deformed dowel bars as per CMS 622.02. Bars are to be placed as shown on the DOWEL BAR PLACEMENT detail on Sheet 2.

RACEWAYS: Raceways on Type D barriers are typically not embedded within the barrier, but are mounted outside of it on the back side and not exposed to traffic.

END SECTIONS: End Sections are used when barrier connects to Bridge Terminal assemblies, Guardrail runs, or Impact Attenuators. See **SCD RM-4.6** for Type D End Section details.

END ANCHORAGE: At other barrier ends, or at vertical construction joints, construct a reinforced End Anchorage as shown on Sheet 2.

GUARDRAIL: For Bridge Terminal Assembly, Type 1, details and connections, see **SCD GR-3.1.**

Barrier installations that cannot be constructed at the normal guardrail offset and are to be connected to the approach or trailing guardrail runs shall have a 25:1 guardrail taper to meet the existing or normal guardrail offset.

Installations that are not to be connected to the approach or trailing guardrail runs must include the standard guardrail flare as per **SCD GR-5.1.**

PAYMENT: will be made at the unit price bid per Feet [Meter] for **Item 622 - Concrete Barrier, Single Slope, Type D.** Include all materials and labor to construct the Barrier.

Payment for any reinforced end anchorages, as shown on the END ANCHORAGE details shown on sheet 2, will be made at the unit price bid per Each for **Item 622 - Concrete Barrier End Anchorage, Reinforced Type D.** This includes all materials, labor, and other incidentals necessary to construct this anchor.

THIS DRAWING REPLACES RM-4.5 DATED 1-19-07.

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

ADMINISTRATOR

10-16-09
DATE

STDS. ENGINEER M. Bline

ALL METRIC DIMENSIONS (IN BRACKETS [ ]) ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

OFFICE OF ROADWAY ENGINEERING

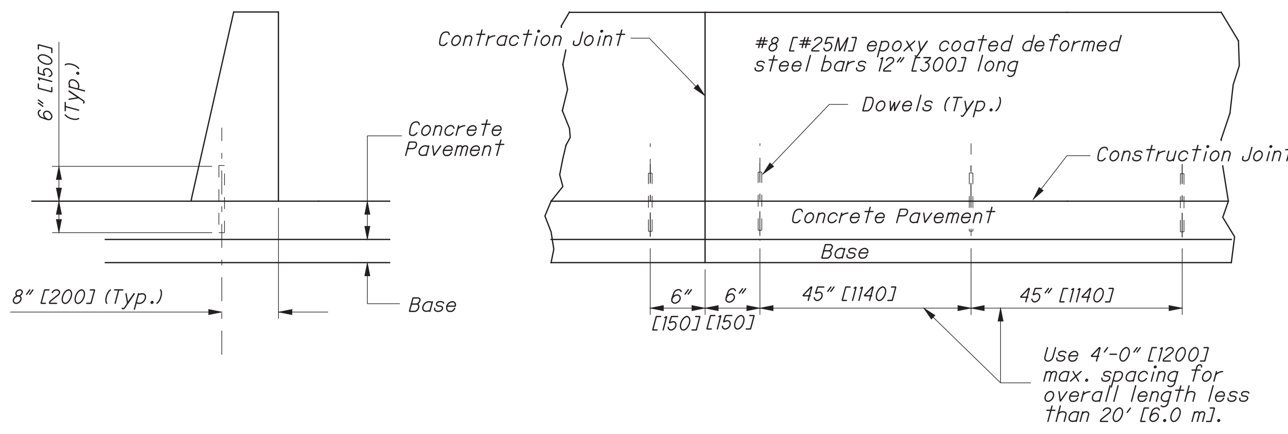
STANDARD ROADWAY CONSTRUCTION DRAWING

SINGLE SLOPE BARRIER, TYPE D

SCD NUMBER RM-4.5

1/2

X:\Standards\Publications\LDM\Distributions\ldm 2009-10-16\rm4.5_jan07_V8.dgn 08-OCT-2009 12:41PM mbline

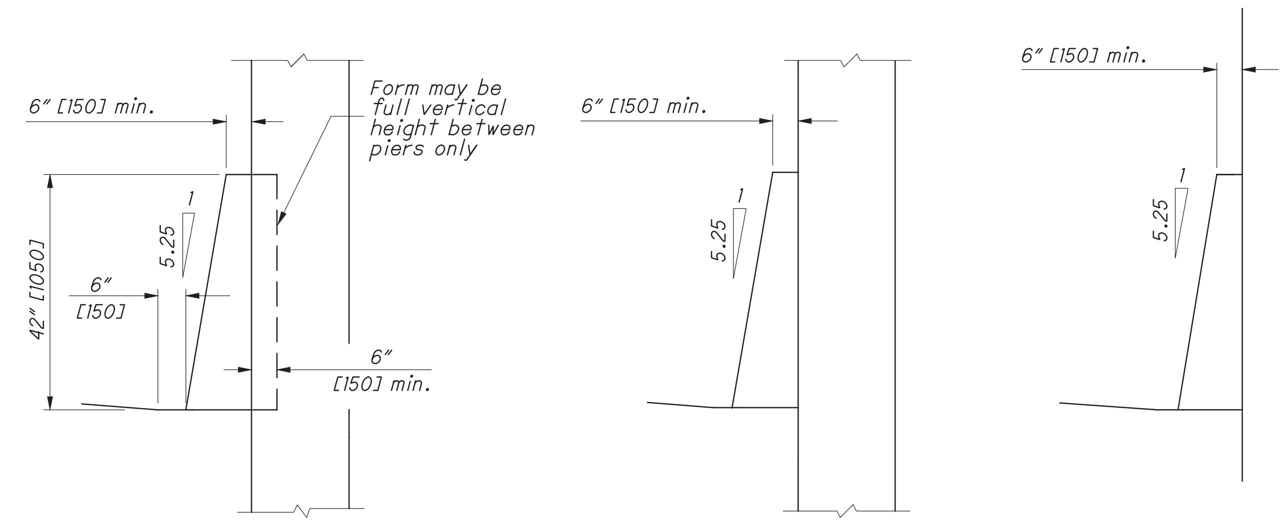


SECTION

ELEVATION

DOWELING DETAILS

See ADJOINING PAVEMENT Notes on Sheet 1



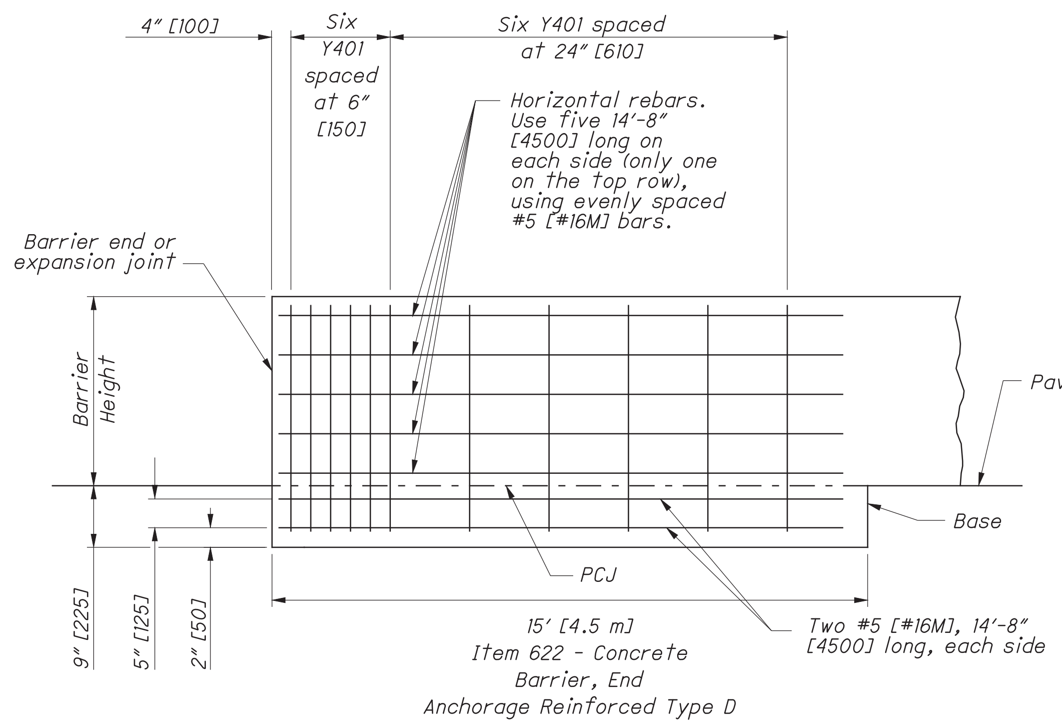
Pier (optional)

Pier

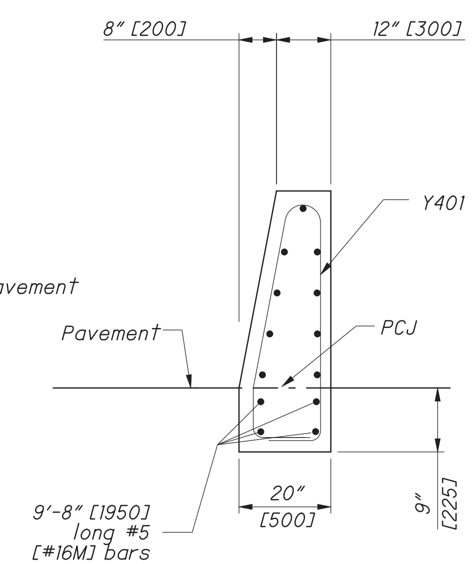
Vertical Wall

INCORPORATED INSTALLATIONS: For barrier installations that cannot be constructed at the normal guardrail offset the incorporated installations shown on Sheet 2 may be installed at vertical walls, piers or other similar obstructions.
For pier-incorporated installations the contractor may use the optional treatment, forming the back face of the Single Slope Barrier, Type D, to the location shown (between piers only), with any additional cost being included in the cost of Item 622.

INCORPORATED INSTALLATIONS

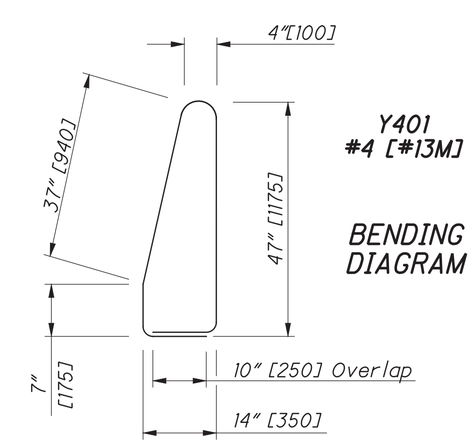


ELEVATION



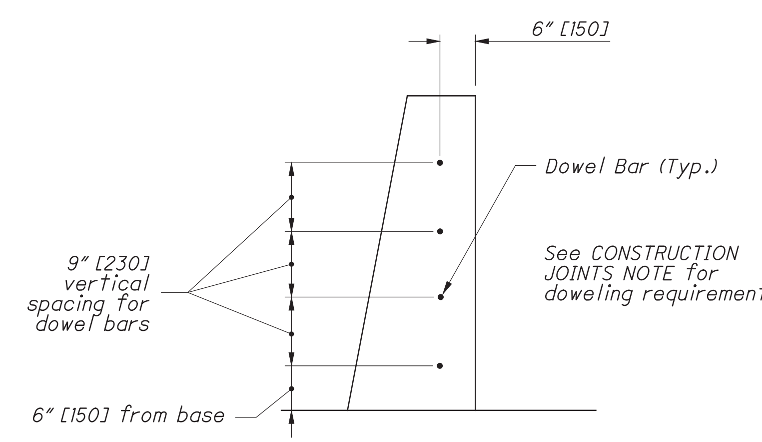
SECTION

REINFORCED END ANCHORAGES are required at the ends of concrete barrier runs and at interruptions in barrier caused by expansion joints. When barrier does not abut another barrier run, construct the last 15' [4.5 m] using the END ANCHORAGE Detail as shown here.
At expansion joints, construct an End Anchorage on both sides of joint, with a maximum gap of 2" [50] for the open joint. The maximum expansion joint spacing shall be 800' [250 m]. This anchorage is not needed at construction joints, provide dowel bar connections instead. See CONSTRUCTION JOINT Note.



Y401
#4 [#13M]

BENDING DIAGRAM



DOWEL BAR PLACEMENT

END ANCHORAGE

See Notes on Sheet 1.

THIS DRAWING REPLACES RM-4.5 DATED 1-19-07.

STATE OF OHIO DEPARTMENT OF TRANSPORTATION
ADMINISTRATOR
10-16-09
DATE

STDS. ENGINEER M. Bline

ALL METRIC DIMENSIONS (IN BRACKETS [ ]) ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

OFFICE OF ROADWAY ENGINEERING

STANDARD ROADWAY CONSTRUCTION DRAWING

SINGLE SLOPE BARRIER, TYPE D

SCD NUMBER **RM-4.5**

U.S. Department of Transportation
Federal Highway Administration

May 19, 2006

400 Seventh St., S.W.
Washington, D.C. 20590

In Reply Refer To:
HSA-10/B149

Chuck Plaxico, Ph.D.
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201-2693

Dear Dr. Plaxico:

In Mr. Michael Halladay's January 8, 2002, letter to the Ohio Department of Transportation's Mr. Larry Sutherland, the Federal Highway Administration (FHWA) agreed that the Ohio Department of Transportation 32-inch high precast New Jersey shape concrete barrier with a standard pin and loop connection met the evaluation criteria for an National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3) temporary traffic barrier. In your May 1, 2006, letter to Mr. Richard Powers of my staff, you requested the FHWA's concurrence that a new barrier, a 50-inch high precast safety shape with a unique pin and loop connection, also be accepted as a TL-3 design.

Prior to conducting a full-scale crash test, Battelle developed a new design for the pin and loop connection through a series of finite element analyses that predicted the design would meet all Report 350 evaluation criteria for a TL-3 temporary barrier. The Ohio Department of Transportation's tall barrier is a 50-inch high, modified New Jersey shape concrete barrier with each segment being 12-feet long. Since the base width remained a standard 24 inches and the top width remained 6 inches, the extended upper sloped face was about 3 degrees steeper than the upper slope of a 32-inch tall New Jersey shape. Reinforcement consisted of five #5 steel bars and two sections of 6 x 6 x W2.9 welded wire fabric. Segments were connected by 1.25-inch diameter x 43-inch long galvanized Grade 5 (high strength) steel bolts passing through 8 loops (4 loops at the ends of each segment). These loops are made from 0.75-inch diameter A36 steel bars bent to an inside radius of 2.25 inches. There are two loops at the top of each segment at one end and a single upper loop at the opposite end. The bottom loops are reversed, with a single loop beneath the upper double loops and vice versa. Each segment also has a single loop, approximately centered between the upper and lower sets of loops. This design, shown as Enclosure 1, was successfully tested at the Transportation Research Center in East Liberty, Ohio on April 12, 2006. Total installation length was about 200 feet and the impact point was approximately 80 feet from the upstream end, resulting in a dynamic deflection of 1.9 meters. Equally severe impacts closer to either unanchored end would be expected to result in greater deflections. Enclosure 2 is the test summary sheet. Vehicular pitch and roll were significantly less than typically noted in concrete barrier tests, probably due to the increase in height and the steeper upper slope that minimizes vehicular climb and roll upon contact.

Based on the crash test results, I agree that this 50-inch high New Jersey portable concrete barrier may be considered an NCHRP Report 350 TL-3 design and used on the National Highway System at the State's discretion. The same barrier design in a 20-foot length may also be considered a TL-3 barrier, provided the longitudinal reinforcement is equivalent to that contained in any other 20-ft segment that has been crash tested successfully. California, New York, and Virginia each have such designs. Please note also that the Oregon Department of Transportation successfully tested a 42-inch tall F-shape concrete barrier with a similar double-shear pin connection to NCHRP Report 350 TL-4. It is very likely that the Ohio Department of Transportation 50-inch tall barrier would have similar capacity.

Sincerely yours,

/original signed by/

John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

2 Enclosures

DWG NO	SH	REV
G005063-30	1	A

REVISION HISTORY

ZONE	REV	DESCRIPTION	DATE	APPROVED
1 D3	A	(1) 144.000 WAS 120.00.	2005-08-25	
1 B2		(2) 48.00 WAS 36.00.		
1 A3		(3) ITEM #5 LENGTH 138.00 WAS 114.00.		
1 A3		(4) HINGE BAR DIAMETER IS: .75, WAS #6		
1 D8		(5) ADDED MATERIAL SPECIFICATIONS TO CONNECTING HARDWARE, HINGE AND REINFORCING BARS.		
2 B5		(6) (144.000) WAS 120.000.		
2 D3		(7) 3X 47.50 WAS 47.50.		
3 B4		(8) 138.000 WAS 114.000.		
3 B7		(9) G005063-21-10 WAS SPLIT IN HALF ALONG THE VERTICAL PLANE AND WAS CONNECTED AT THE TOP BY A RADIAL BEND.		

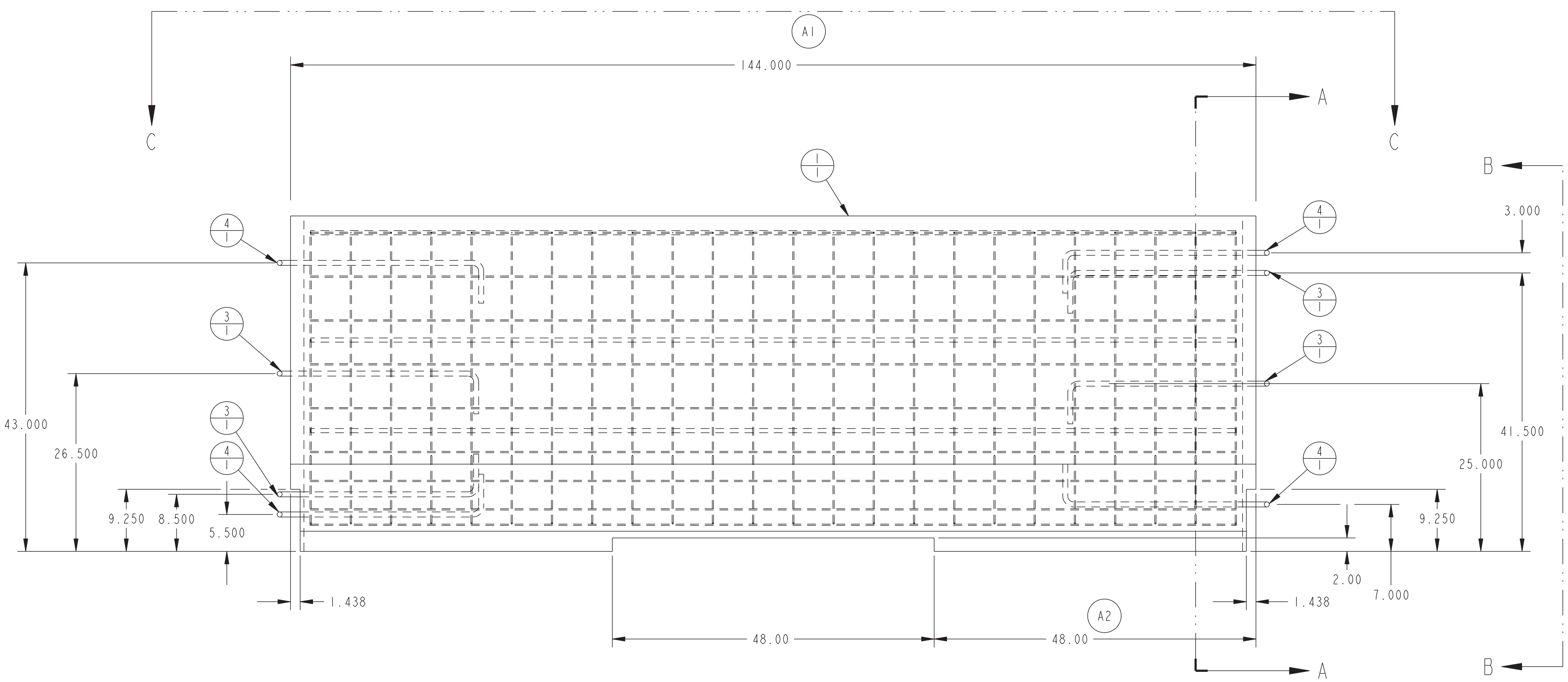
NOTES:

1. APPLICABLE STANDARDS/SPECIFICATIONS:
   ASME Y14.5M-1994, DIMENSIONS AND TOLERANCES
   ASME Y14.38, ABBREVIATIONS
2. BARRIER SPECIFICATIONS, INCLUDING BARS AND CONCRETE, SHALL BE PER CMS 622.

(A5) HINGE AND REINFORCING BARS:
THE .75 HINGE MAY BE ASTM A-36. REBARS SHALL MEET THE REQUIREMENTS OF CMS 509. BLACK STEEL IS PERMITTED.

CONNECTING HARDWARE:
BOLTS, WASHERS AND HEX NUTS SHALL BE GALVANIZED AFTER FABRICATION PER CMS 711.02 AND SHALL MEET THE REQUIREMENTS OF CMS 711.09 EXCEPT THAT THE ROTATIONAL CAPACITY TEST SPECIFIED IN ASTM A-325 SHALL BE WAIVED.

3. MARKING:
   MARK WITH DAY, MONTH, YEAR OF CAST AND UNIQUE IDENTIFICATION NUMBER IN THE LOCATION SHOWN.
   MARKINGS SHALL BE PERMANENTLY IMPRESSED IN THE BARRIER USING A MINIMUM OF 2 IN HIGH LETTERING.
4. REFLECTORIZATION:
   BARRIER REFLECTORS SHALL BE INSTALLED IN ACCORDANCE WITH TRAFFIC ENGINEERING'S STANDARD DRAWING MT-95.82, WHEN SPECIFIED IN THE PLANS.



	QTY REQD -10	FIND NO	PART OR IDENTIFYING NO	CAGE CODE	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
A3	5	5	G005063-19-01		BAR, REINF, STR, #5 X 138.00	2
A4	4	4	G005063-14-01		BAR, HINGE, .75 X 87.87	2
	4	3	G005063-13-01		BAR, HINGE, .75 X 86.37	2
A9	2	2	G005063-21-10		WWF, 6 X 6 X W2.9 X W2.9	2
	1	1	G005063-11-01		BARRIER, CONCRETE	2

PARTS LIST

NEXT ASSY	USED ON
G005063-40	

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
DECIMAL: .XX ±0.25 .XXX ±0.125
FRACTIONAL: ±1/32 ANGULAR: ±0.5°
THIRD ANGLE PROJECTION

CONTRACT NO

APPROVAL		DATE
DRAWN	J. V.	2005-05-25
CHECKED		
ENGINEER		

Battelle
The Business of Innovation
505 King Avenue
Columbus, Ohio 43201-2693
Telephone (614) 424-6424

TITLE
BARRIER, ASSEMBLY

SIZE	CAGE CODE	DWG NO	REV
D	79986	G005063-30	A

SCALE 1/10 DO NOT SCALE DRAWING SHEET 1 OF 3

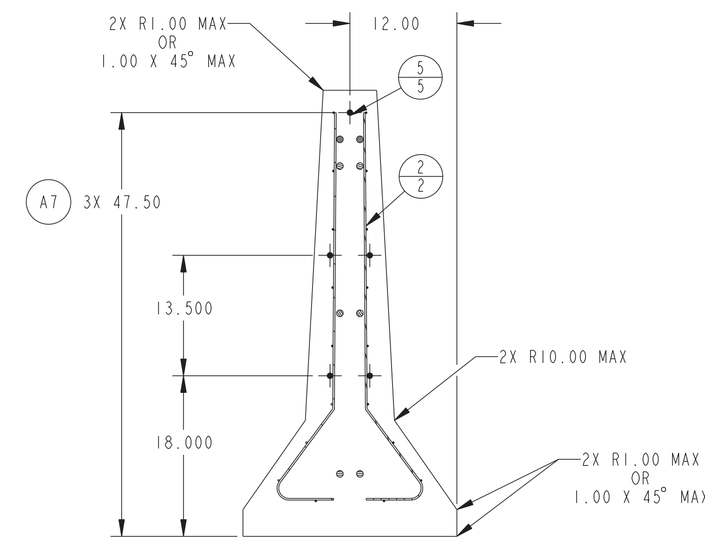
COMPUTER FILE NAME
DRAWING G005063-30
MODEL ASSEM G005063-30

NAME:HARRISS OBJECT:G005063-30_1 DATE:01-Sep-05 09:14:20

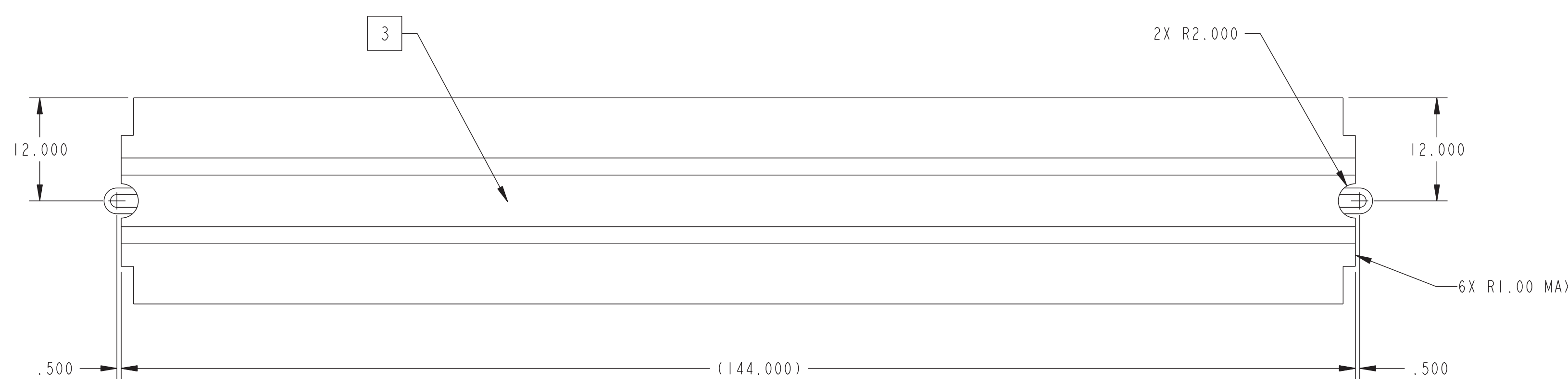
DWG NO	SH	REV
G005063-30	2	A

REVISION HISTORY

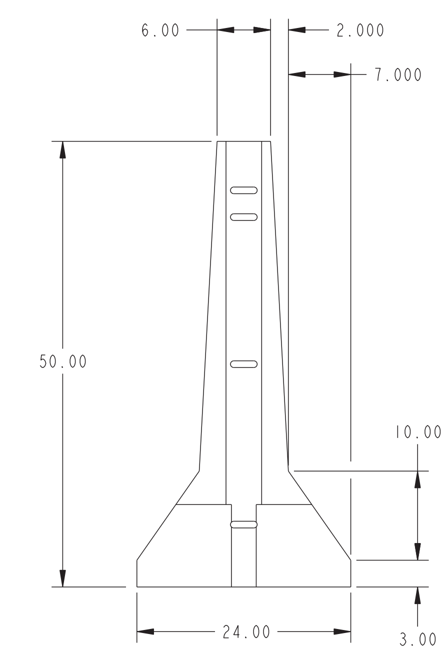
ZONE	REV	DESCRIPTION	DATE	APPROVED



SECTION A-A



VIEW C-C



VIEW B-B

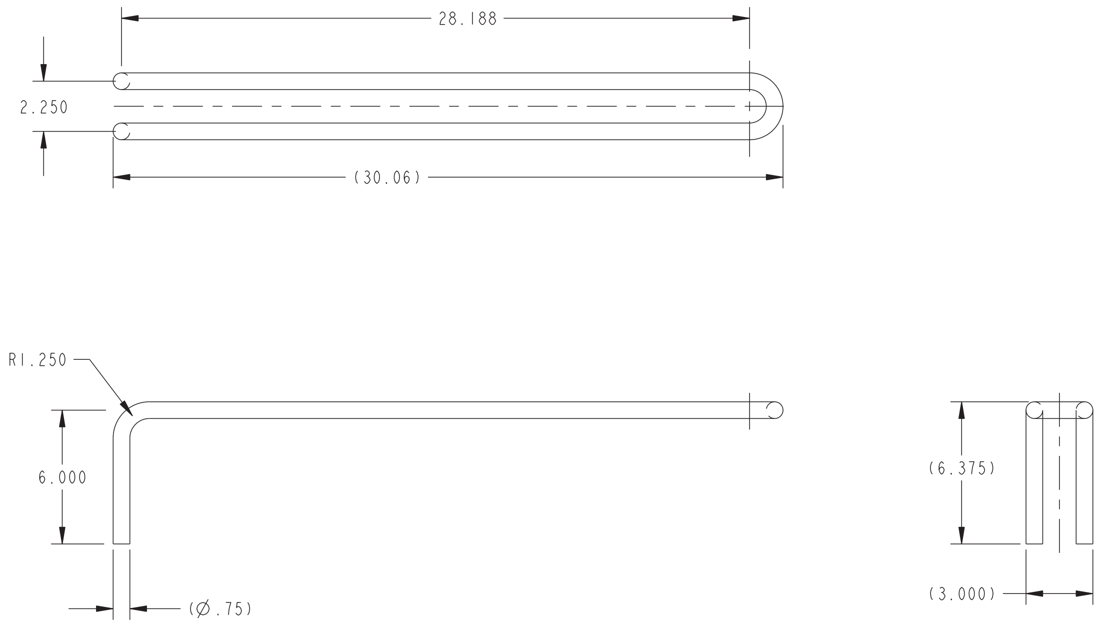
SIZE	CAGE CODE	DWG NO	REV
D	79986	G005063-30	A
SCALE 1/10	DO NOT SCALE DRAWING	SHEET 2 OF 3	

NAME:HARRISS OBJECT:G005063-30_2 DATE:01-Sep-05 09:14:20

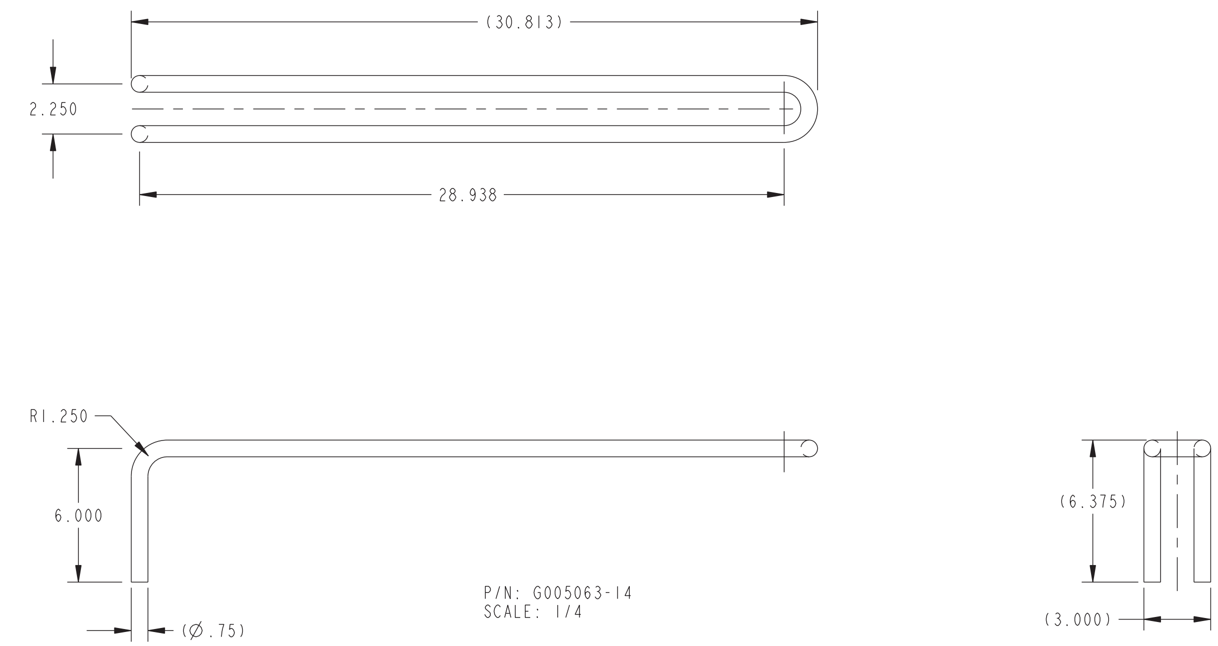
DWG NO	SH	REV
G005063-30	3	A

REVISION HISTORY

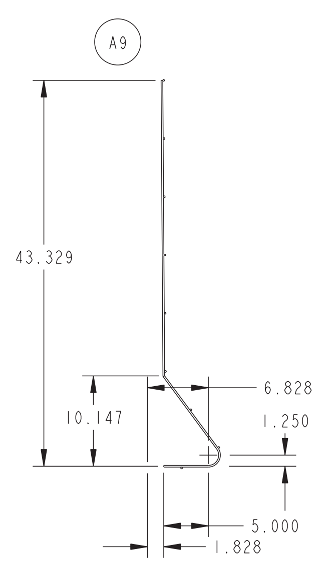
ZONE	REV	DESCRIPTION	DATE	APPROVED

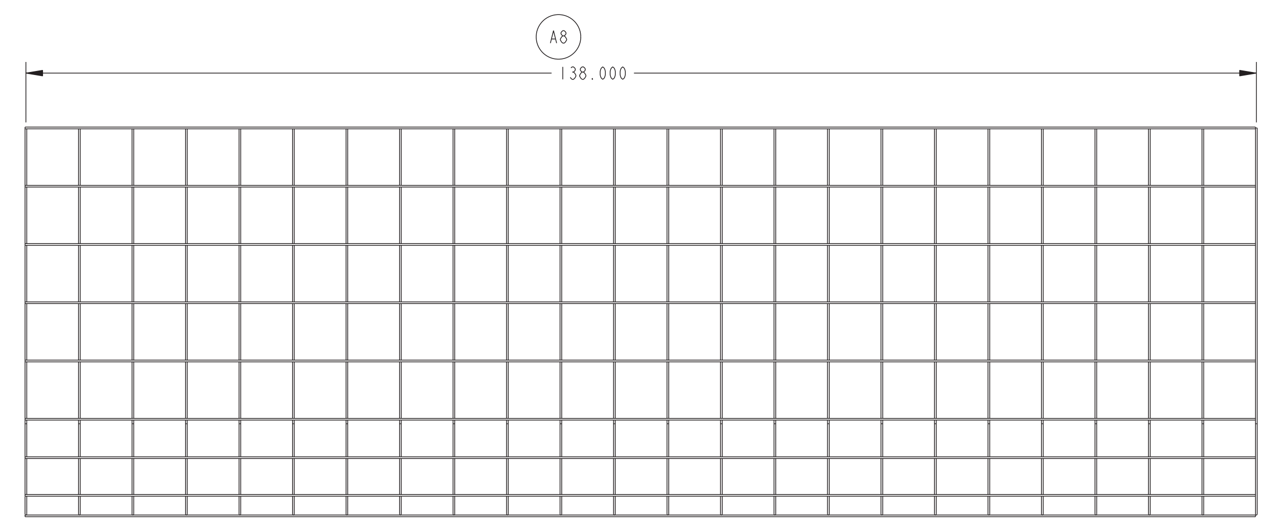


P/N: G005063-13
SCALE: 1/4



P/N: G005063-14
SCALE: 1/4





SIZE	CAGE CODE	DWG NO	REV
D	79986	G005063-30	A
SCALE 1/10	DO NOT SCALE DRAWING	SHEET 3 OF 3	

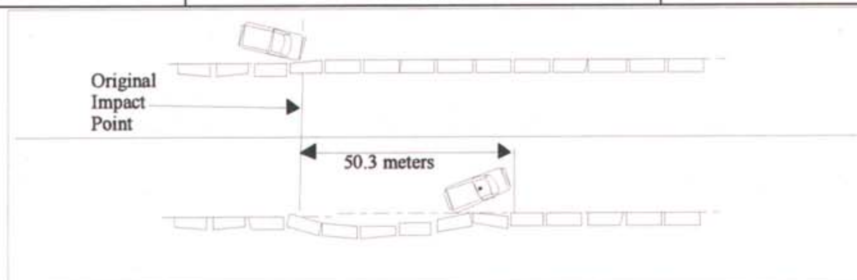
NAME:HARRISS OBJECT:G005063-30_3 DATE:01-Sep-05 09:14:21

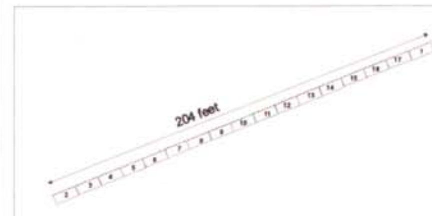
0.000 s

0.260 s

0.480 s

0.800 s





General Information	
Test Agency	Transportation Research Center Inc. (TRC Inc.)
Test No.	060412
Date	April 12, 2006
Test Article	
Type	Longitudinal median barrier system
Name or Manufacturer	Battelle Memorial Institute
Size and/or dimension and material of key elements	17-50" x 12' steel reinforced portable concrete barriers
Soil Type and Condition	N/A
Test Vehicle	
Type	Production Model
Designation	2000P
Model	2003 Chevrolet 2500 Pickup truck
Mass (kg)	
Curb	2254.3
Test Inertial	2040.6
Dummy(s)	N/A
Gross Static	2040.6

Impact Conditions	
Speed (km/h)	100.5
Angle (deg)	25.0
Exit Conditions	
Speed (km/h)	N/A
Angle (deg)	N/A
Occupant Risk Values	
Impact Velocity (m/s)	
x-direction	4.5
y-direction	6.1
THIV (optional)	N/A
Ridedown Acceleration (g's)	
x-direction	5.4
y-direction	8.6
PHD (optional)	N/A
ASI (optional)	N/A
Max. 0.050 –s Average (g's)	
x-direction	N/A
y-direction	N/A
z-direction	N/A

Test Article Deflections (m)	
Dynamic	~1.6
Permanent	~1.6
Vehicle Damage	
Exterior	
VDS	N/A
CDC	02FZEW3
Interior	
OCDI	FS0000000
Maximum Exterior Vehicle Crush (mm)	N/A
Max. Occ. Compart. Deformation (mm)	25
Post-Impact Vehicular Behavior	
Maximum Roll Angle (deg)	16.2
Maximum Pitch Angle (deg)	-10.2
Maximum Yaw Angle (deg)	-45.1

Vehicle Trajectory Post Test	The impacting vehicle was redirected by the test article 50.3 meters downstream and 2.1 meters left of the barrier.

Figure 9. Summary of results for test 060412