

MINNESOTA DEPARTMENT OF TRANSPORTATION

Bridge Office

Bridge Standard Plans Manual

MnDOT BRIDGE OFFICE

Bridge Standards Plan Manual

Box Culverts

Minnesota Department of Transportation
3485 Hadley Avenue North • Mail Stop 610
Oakdale, MN 55128-3307
Phone: (651) 366-4500 Fax (651) 366-4497

Last Date Revised: October 22, 2019

BRIDGE STANDARD PLANS MANUAL *
(BOX CULVERTS)

October 22, 2019

Index (1)

FIGURE NO.	DESCRIPTION	DATE APPROVED	DATE REVISED
5-395.100(A)	Precast Concrete Box Culvert - Basis of Design	Mar. 24, 2011	Nov. 08, 2018
5-395.100(B)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.100(C)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.100(D)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.100(E)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.101(A)	Precast Concrete Barrel Details	Mar. 24, 2011	Feb. 22, 2018
5-395.101(B)	Precast Concrete Barrel Details (Special Design)	Mar. 24, 2011	Feb. 22, 2018
5-395.102	Precast Concrete End Section Type I – Single or Double Barrel For Skews Up To 7 ¹ / ₂ °	Mar. 24, 2011	Feb. 22, 2018
5-395.104(A)	Precast Concrete End Section Type III – Single or Double Barrel For Skews Up To 7 ¹ / ₂ °	Mar. 24, 2011	Feb. 22, 2018
5-395.104(B)	Precast Concrete End Section Type III – Single or Double Barrel For Skews Up To 7 ¹ / ₂ °	Mar. 24, 2011	Oct. 09, 2015
5-395.110(A)	Precast Concrete End Section Type III – Single or Double Barrel For Skews 7 ¹ / ₂ ° To 45°	Mar. 24, 2011	Feb. 22, 2018
5-395.110(B)	Precast Concrete End Section Type III – Single or Double Barrel For Skews 7 ¹ / ₂ ° To 45°	Mar. 24, 2011	Oct. 09, 2015
5-395.111	Alternate Dropwalls for Box Culverts	Mar. 24, 2011	Oct. 09, 2015
5-395.115	Embankment Protection for Box Culverts	Sept. 11, 2014	Oct. 22, 2019

* Refer to <http://www.dot.state.mn.us/bridge/> for current Bridge CADD Standards

BASIS OF DESIGN

DESIGNED IN ACCORDANCE WITH 2017 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS AND MNDOT BRIDGE DESIGN MANUAL.

MATERIAL PROPERTIES:

WELDED WIRE REINFORCEMENT, MINIMUM SPECIFIED YIELD STRESS	65 KSI
REBAR REINFORCEMENT, MINIMUM SPECIFIED YIELD STRESS	60 KSI
CONCRETE, MINIMUM SPECIFIED COMPRESSIVE STRENGTH	5 OR 6 KSI (SEE TABLES)

SOIL DATA:

UNIT WEIGHT	120 lb/ft ³
RATIO OF LATERAL TO VERTICAL PRESSURE FROM WEIGHT OF EARTH	0.50 MAX TO 0.25 MIN
INTERNAL FRICTION ANGLE OF BACKFILL	30 DEGREES
SOIL STRUCTURE INTERACTION FACTOR, F _o	F _o = 1 + 0.20(H/B) ^c

RESISTANCE FACTORS
(FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS):

FLEXURE	1.0
SHEAR	0.90

LOADING DATA:

LOAD MODIFIERS:

DUCTILE STRUCTURES	η = 1.0
FOR EARTH FILL: NON-REDUNDANT MEMBER	η = 1.05
FOR LIVE LOAD: REDUNDANT MEMBER	η = 1.0

LOAD FACTORS: (STRENGTH)

DEAD LOAD	MAX DC = 1.25, MIN DC = 0.90
EARTH LOAD (VERTICAL)	MAX EV = 1.30, MIN EV = 0.90
EARTH LOAD (HORIZONTAL)	MAX EH = 1.35, MIN EH = 0.90
LIVE LOAD	LL = 1.75
APPROACHING VEHICLE LOAD	LS = 1.75
WATER	WA = 1.0

STRENGTH LIMIT STATE	
MAX V/MAX H	1.25DC + 1.30EV + 1.75(LL+IM) + 1.35EH + 1.75LS
MAX V/MIN H	1.25DC + 1.30EV + 1.75(FILL+IM) + 1.00WA + 0.9EH
MIN V/MAX H	0.90C + 0.9EV + 1.35EH + 1.75LS

SERVICE LIMIT STATE	
MAX V/MAX H	1.00C + 1.0EV + 1.0(LL+IM) + 1.0EH + 1.0LS
MAX V/MIN H	1.00C + 1.0EV + 1.0(LL+IM) + 1.0WA + 1.0EH
MIN V/MAX H	1.00C + 1.0EV + 1.0EH + 1.0LS

LIVE LOAD

GREATER OF:

TRUCK AXLE LOAD	32 kips
TANDEM AXLE LOAD	2 AT 25 kips EACH

LIVE LOAD DISTRIBUTION

IF DEPTH OF FILL, H < 2 FT.

DIRECTION PERPENDICULAR TO SPAN	E = 96 (ln _v) + 1,44SPAN (ft.)
DIRECTION PARALLEL TO SPAN	Espan = 10 (ln _v) + 1,15H (ln _v)

IF DEPTH OF FILL, H ≥ 2 FT.

DIRECTION PERPENDICULAR TO SPAN	W = 20 (ln _v) + 1,15H (ln _v)
DIRECTION PARALLEL TO SPAN	L = 10 (ln _v) + 1,15H (ln _v)

CONSTRUCTION COMPACTOR LOAD

MULTIPLE PRESENCE FACTOR

55 kips DISTRIBUTED OVER 84 in. X 24 in.
MPF = 1.2 (FOR ONE LANE)

DYNAMIC LOAD ALLOWANCE (VARIABLE WITH DEPTH)

LANE LOAD (APPLIED TO BOXES WITH SPANS OF 15 FT. OR GREATER)

APPROACHING VEHICLE LOAD (PARALLEL TO SPAN)

(TRAPEZOIDAL PRESSURE) ②

LS = K + Ys + heq
K = 0.33 ②
Ys = 120 lb/ft³
heq =

EQUIVALENT FILL HEIGHT	
ABUTMENT HEIGHT (ft.) ①	heq (ft.)
< 5.0	4.0
5.0 TO 10.0	5 - 0.2*(ABUTMENT HEIGHT)
10.0 TO 20.0	4 - 0.1*(ABUTMENT HEIGHT)
> 20.0	2.0

① THE ABUTMENT HEIGHT CORRESPONDING TO THE LATERAL PRESSURE AT THE TOP OF THE CULVERT IS THE DISTANCE FROM THE TOP OF THE TOP SLAB TO THE TOP OF THE PAVEMENT OR FILL.

THE ABUTMENT HEIGHT CORRESPONDING TO THE LATERAL PRESSURE AT THE BOTTOM OF THE CULVERT IS THE DISTANCE FROM THE BOTTOM OF THE BOTTOM SLAB TO THE TOP OF THE PAVEMENT OR FILL.

② TRAPEZOIDAL LATERAL LIVE LOAD PRESSURE METHODOLOGY WAS USED TO APPROXIMATE A BOUSSINESQ DISTRIBUTION.

WATER
DEPTH OF WATER IN BOX SECTION EQUAL TO INSIDE RISE

MINIMUM DISTANCE BETWEEN ADJACENT LINES OF BOX CULVERTS:
THE USE OF "U BOLT TIES" (REFER TO ROADWAY STD PLATE 3145) TO SECURE CULVERT SECTIONS REQUIRES APPROXIMATELY 18" OF ROOM BETWEEN ADJACENT LINES OF BOX CULVERTS TO ALLOW FOR INSTALLATION OF THE TIE. THIS DISTANCE CAN BE REDUCED TO AS LITTLE AS 6" BY USING A "DOUBLE CONNECTION TIE" (REFER TO ROADWAY STD PLATE 3145) AND PLACING THE TIE ON THE INTERIOR SIDE OF THE SECOND (AND THIRD) CULVERT LINE. PROVIDE A NUT AND WASHER AT EACH END OF THE DOUBLE CONNECTION TIE ROD. IN NO CASE SHALL THE DISTANCE BETWEEN ADJACENT BOXES BE LESS THAN 6".

LOAD RATING
ALL STANDARD CONCRETE BOX CULVERTS WERE DESIGNED TO MEET THE 2014 AASHTO LRFR REQUIREMENTS WITH A MINIMUM LRFR BRIDGE OPERATING RATING FACTOR = 1.3 FOR HL-93, MNDOT STANDARD PERMIT TRUCKS G-80, AND MNDOT STANDARD PERMIT TRUCKS G-07, HL-93 WAS THE GOVERNING LOAD.

STRUCTURAL ARRANGEMENT:
REINFORCEMENT AREAS SHOWN ON FIGURES 5-395.100(B)-(E) ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS AND AREAS ARE FOR WELDED WIRE REINFORCEMENT. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL OF CRACKING BY DISTRIBUTION OF REINFORCEMENT".

TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN.

LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

REINFORCEMENT SPACING 4.0 in. MAX.
SPACE CENTER TO CENTER OF TRANSVERSE WIRES NOT LESS THAN 2" NOR MORE THAN 4". SPACE CENTER TO CENTER OF LONGITUDINAL WIRES NOT MORE THAN 8".

CONCRETE COVER OVER REINFORCEMENT (ALL FACES) 1 1/2 in. MIN., 2 in. MAX.
③ HAUNCH DIMENSIONS 12 in. VERTICAL, 12 in. HORIZONTAL (ALL SPANS AND RISES)

CULVERTS CONSTRUCTED WITHOUT HAUNCHES REQUIRE SPECIAL DESIGN NOT INCLUDED IN THESE STANDARDS.

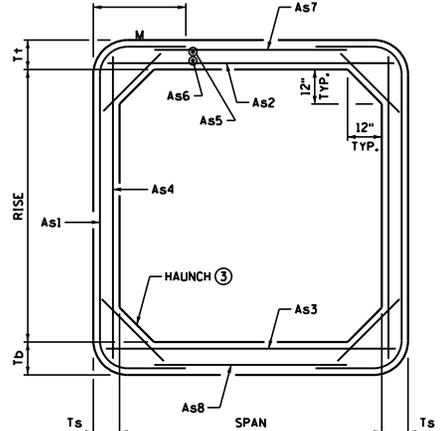
MINIMUM REINFORCING PARALLEL TO SPAN,
INCLUDING As1, As2, As3, As4, As7, As8 0.002 * b * h, (b = THICKNESS OF SLAB, h = 12 in.)
PERPENDICULAR TO SPAN, INCLUDING As5, As6 0.06 in²/ft

SKREW BOX CULVERT SECTIONS WERE DESIGNED ASSUMING TRAFFIC TRAVELING PARALLEL TO THE SPAN AND UP TO A SKEW ANGLE OF 45°. IF CULVERT SECTIONS ARE PLACED IN A DIFFERENT ARRANGEMENT, THEY MAY NEED TO BE REDESIGNED. BOX CULVERT END SECTIONS WERE DESIGNED FOR SKEW EFFECTS AND ARE LOCATED ON FIG. 5-395.102 THROUGH 5-395.110(B).

AXIAL THRUST THE BENEFIT OF AXIAL THRUST WAS NOT INCLUDED IN THE BOX CULVERT DESIGN FOR THE STRENGTH LIMIT STATE, HOWEVER IT WAS INCLUDED IN THE SERVICE LIMIT STATE CRACK CONTROL CHECK.

SHEAR SHEAR CHECKED AT 1.0 d_v FROM TIP OF HAUNCH PER AASHTO 5.13.3.6.1. FOR SLABS OF BOXES WITH LESS THAN 2.0 FT. OF FILL AND FOR WALLS OF BOXES OF ALL FILL HEIGHTS SHEAR RESISTANCE CALCULATED PER AASHTO 5.8. SECTIONAL METHOD GENERAL PROCEDURE. FOR SLABS OF BOXES WITH 2 FT. OF FILL OR GREATER THE SHEAR RESISTANCE WAS CALCULATED PER AASHTO 5.14.5.3. UP TO A MAXIMUM THICKNESS OF 12 INCHES. FOR SUCH SLABS WITH THICKNESSES EXCEEDING 12 IN., CONTACT THE BRIDGE STANDARDS UNIT FOR SHEAR PROVISIONS.

CRACK CONTROL CRACK CONTROL CHECK PER AASHTO 5.7.3.4 ASSUMING CLASS 2 EXPOSURE CONDITIONS. THE STRESS IN THE STEEL REINFORCEMENT CALCULATED PER AASHTO C12.11.3 AND LIMITED TO 0.6*fy, INCLUDE AXIAL THRUST IN SERVICE LIMIT STATE ANALYSIS.



BOX CULVERT CROSS SECTION

FIG. 5-395.100(A)

REVISION: 11-08-2018

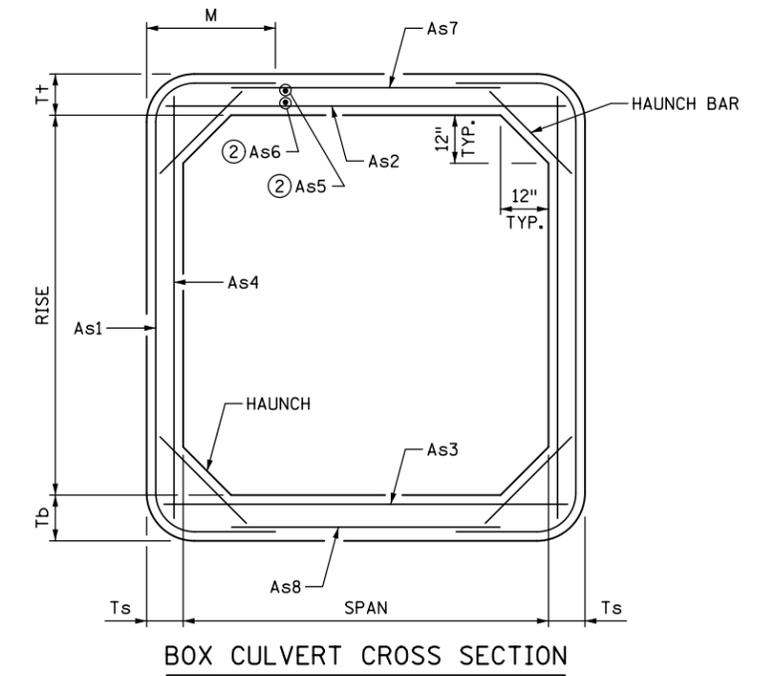
APPROVED: MARCH 24, 2011

Nancy Daubenberger
STATE BRIDGE ENGINEER

DO NOT INCLUDE WITH PLAN

TITLE: PRECAST CONCRETE BOX CULVERT- BASIS OF DESIGN

								REINFORCEMENT REQUIREMENTS ①										
SIZE SPAN x RISE (ft.)	CLASS	f' _c (psi)	FILL HEIGHT RANGE (ft.)	T ₊ (in.)	T _b (in.)	T _s (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
6x4	1	5000	<3	8	8	8	2575	0.29	10'-2"	2'-8"	0.36	6'-6"	0.30	6'-6"	0.20	4'-6"	0.20	4'-6"
	2	5000	3 - 9	8	8	8	2575	0.24	10'-2"	2'-8"	0.27	6'-6"	0.28	6'-6"	0.20	4'-6"	0.20	4'-6"
	3	5000	9 - 25	8	8	8	2575	0.52	10'-2"	2'-8"	0.59	6'-6"	0.60	6'-6"	0.20	4'-6"	0.20	4'-6"
6x5	1	5000	<3	8	8	8	2775	0.26	11'-2"	2'-8"	0.40	6'-6"	0.35	6'-6"	0.20	5'-6"	0.20	4'-6"
	2	5000	3 - 9	8	8	8	2775	0.22	11'-2"	2'-8"	0.30	6'-6"	0.31	6'-6"	0.20	5'-6"	0.20	4'-6"
	3	5000	9 - 25	8	8	8	2775	0.46	11'-2"	2'-8"	0.64	6'-6"	0.66	6'-6"	0.20	5'-6"	0.20	4'-6"
6x6	1	5000	<3	8	8	8	2975	0.24	12'-2"	2'-8"	0.43	6'-6"	0.39	6'-6"	0.20	6'-6"	0.20	4'-6"
	2	5000	3 - 9	8	8	8	2975	0.20	12'-2"	2'-8"	0.32	6'-6"	0.34	6'-6"	0.20	6'-6"	0.20	4'-6"
	3	5000	9 - 25	8	8	8	2975	0.41	12'-2"	2'-8"	0.67	6'-6"	0.69	6'-6"	0.20	6'-6"	0.20	4'-6"
8x4	1	5000	<3	9	10	8	3325	0.43	10'-8"	2'-10"	0.38	8'-6"	0.38	8'-6"	0.20	4'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3325	0.36	10'-8"	2'-10"	0.35	8'-6"	0.36	8'-6"	0.20	4'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3325	0.59	10'-8"	2'-10"	0.60	8'-6"	0.61	8'-6"	0.20	4'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3325	0.85	10'-8"	2'-10"	0.83	8'-6"	0.85	8'-6"	0.20	4'-6"	0.24	6'-3"
8x5	1	5000	<3	9	10	8	3525	0.38	11'-8"	2'-10"	0.42	8'-6"	0.43	8'-6"	0.20	5'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3525	0.31	11'-8"	2'-10"	0.39	8'-6"	0.41	8'-6"	0.20	5'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3525	0.51	11'-8"	2'-10"	0.65	8'-6"	0.68	8'-6"	0.20	5'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3525	0.74	11'-8"	2'-10"	0.91	8'-6"	0.93	8'-6"	0.20	5'-6"	0.24	6'-3"
8x6	1	5000	<3	9	10	8	3725	0.35	12'-8"	2'-10"	0.46	8'-6"	0.47	8'-6"	0.20	6'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3725	0.28	12'-8"	2'-10"	0.41	8'-6"	0.44	8'-6"	0.20	6'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3725	0.46	12'-8"	2'-10"	0.69	8'-6"	0.72	8'-6"	0.20	6'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3725	0.66	12'-8"	2'-10"	0.96	8'-6"	0.99	8'-6"	0.20	6'-6"	0.24	6'-3"
8x7	1	5000	<3	9	10	8	3925	0.31	13'-8"	2'-10"	0.49	8'-6"	0.51	8'-6"	0.20	7'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3925	0.26	13'-8"	2'-10"	0.43	8'-6"	0.47	8'-6"	0.20	7'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3925	0.42	13'-8"	2'-10"	0.72	8'-6"	0.75	8'-6"	0.20	7'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3925	0.60	13'-8"	2'-10"	0.99	8'-6"	1.02	8'-6"	0.20	7'-6"	0.24	6'-3"
8x8	1	5000	<3	9	10	8	4125	0.29	14'-8"	2'-10"	0.52	8'-6"	0.54	8'-6"	0.20	8'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	4125	0.24	14'-8"	2'-10"	0.45	8'-6"	0.49	8'-6"	0.20	8'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	4125	0.39	14'-8"	2'-10"	0.73	8'-6"	0.77	8'-6"	0.20	8'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	4125	0.55	14'-8"	2'-10"	1.01	8'-6"	1.04	8'-6"	0.20	8'-6"	0.24	6'-3"
10x4	1	5000	<3	9	10	8	3800	0.66	10'-8"	2'-10"	0.50	10'-6"	0.48	10'-6"	0.20	4'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	3800	0.55	10'-8"	2'-10"	0.47	10'-6"	0.48	10'-6"	0.20	4'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	3800	0.90	10'-8"	2'-10"	0.78	10'-6"	0.79	10'-6"	0.20	4'-6"	0.24	8'-10"
	4	6000	15 - 25	10	10	8	3950	1.33	11'-9"	3'-4"	1.17	10'-6"	1.19	10'-6"	0.20	4'-6"	0.24	8'-11"
10x5	1	5000	<3	9	10	8	4000	0.59	11'-8"	2'-10"	0.56	10'-6"	0.54	10'-6"	0.20	5'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4000	0.50	11'-8"	2'-10"	0.52	10'-6"	0.54	10'-6"	0.20	5'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4000	0.79	11'-8"	2'-10"	0.86	10'-6"	0.88	10'-6"	0.20	5'-6"	0.24	8'-6"
	4	6000	15 - 25	10	10	8	4150	1.15	12'-3"	3'-1"	1.29	10'-6"	1.31	10'-6"	0.20	5'-6"	0.24	8'-11"
10x6	1	5000	<3	9	10	8	4200	0.54	12'-8"	2'-10"	0.61	10'-6"	0.59	10'-6"	0.20	6'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4200	0.45	12'-8"	2'-10"	0.56	10'-6"	0.59	10'-6"	0.20	6'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4200	0.71	12'-8"	2'-10"	0.92	10'-6"	0.94	10'-6"	0.20	6'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4350	1.02	12'-10"	2'-10"	1.37	10'-6"	1.40	10'-6"	0.20	6'-6"	0.24	8'-11"
10x7	1	5000	<3	9	10	8	4400	0.50	14'-4"	3'-2"	0.66	10'-6"	0.63	10'-6"	0.20	7'-6"	0.24	7'-8"
	2	5000	3 - 7	9	10	8	4400	0.42	13'-8"	2'-10"	0.59	10'-6"	0.63	10'-6"	0.20	7'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4400	0.65	13'-8"	2'-10"	0.97	10'-6"	1.00	10'-6"	0.20	7'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4550	0.92	13'-9"	2'-10"	1.43	10'-6"	1.46	10'-6"	0.20	7'-6"	0.24	8'-8"
10x8	1	5000	<3	9	10	8	4600	0.46	14'-8"	2'-10"	0.69	10'-6"	0.66	10'-6"	0.20	8'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4600	0.39	14'-8"	2'-10"	0.62	10'-6"	0.66	10'-6"	0.20	8'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4600	0.60	14'-8"	2'-10"	1.00	10'-6"	1.04	10'-6"	0.20	8'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4750	0.85	14'-9"	2'-10"	1.52	10'-6"	1.57	10'-6"	0.20	8'-6"	0.24	8'-5"
10x9	1	5000	<3	9	10	8	4800	0.43	15'-8"	2'-10"	0.73	10'-6"	0.70	10'-6"	0.20	9'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4800	0.36	15'-8"	2'-10"	0.65	10'-6"	0.70	10'-6"	0.20	9'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4800	0.56	15'-8"	2'-10"	1.03	10'-6"	1.07	10'-6"	0.20	9'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4950	0.79	17'-1"	3'-6"	1.54	10'-6"	1.60	10'-6"	0.20	9'-6"	0.24	6'-11"
10x10	1	5000	<3	9	10	8	5000	0.42	16'-8"	2'-10"	0.77	10'-6"	0.74	10'-6"	0.20	10'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	5000	0.42	16'-8"	2'-10"	0.68	10'-6"	0.73	10'-6"	0.20	10'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	5000	0.56	18'-0"	3'-6"	1.05	10'-6"	1.09	10'-6"	0.22	10'-6"	0.24	6'-11"
	4	6000	15 - 25	10	11	9	5575	0.74	18'-4"	3'-7"	1.34	10'-6"	1.43	10'-6"	0.22	10'-6"	0.27	6'-11"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MNDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3552 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MNDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

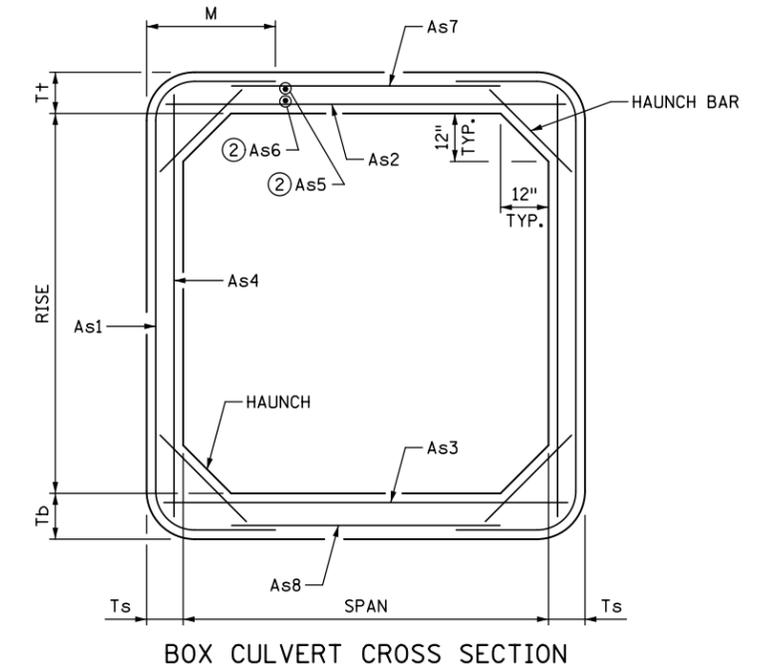
① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

REVISION: 10-09-2015
 APPROVED: MARCH 24, 2011
Nancy Subenberger
 STATE BRIDGE ENGINEER

FIG. 5-395.100(B)
 DO NOT INCLUDE TABLES WITH PLAN
 PRECAST CONCRETE BOX CULVERT TABLES

								REINFORCEMENT REQUIREMENTS ①										
SIZE SPAN x RISE (ft.)	CLASS	f'c (psi)	FILL HEIGHT RANGE (ft.)	T+ (in.)	Tb (in.)	Ts (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
12x4	1	5000	<3	9	10	8	4275	0.91	12'-9"	3'-10"	0.65	12'-6"	0.63	12'-6"	0.20	4'-6"	0.24	8'-10"
	2	5000	3 - 7	9	10	8	4275	0.83	12'-5"	3'-8"	0.63	12'-6"	0.63	12'-6"	0.20	4'-6"	0.24	8'-11"
	3	5000	7 - 15	10	10	9	4575	1.21	13'-11"	4'-5"	0.92	12'-6"	0.94	12'-6"	0.22	4'-6"	0.24	8'-11"
	4	6000	15 - 22	11	11	9	4925	1.57	14'-4"	4'-6"	1.25	12'-6"	1.26	12'-6"	0.22	4'-6"	0.27	8'-11"
12x5	1	5000	<3	9	10	8	4475	0.83	13'-6"	3'-9"	0.72	12'-6"	0.71	12'-6"	0.20	5'-6"	0.24	8'-10"
	2	5000	3 - 7	9	10	8	4475	0.74	13'-1"	3'-6"	0.70	12'-6"	0.71	12'-6"	0.20	5'-6"	0.24	8'-11"
	3	5000	7 - 15	10	10	8	4650	1.16	12'-7"	3'-3"	1.13	12'-6"	1.15	12'-6"	0.20	5'-6"	0.24	10'-11"
	4	6000	15 - 22	11	11	9	5150	1.36	13'-3"	3'-6"	1.37	12'-6"	1.39	12'-6"	0.22	5'-6"	0.27	10'-11"
12x6	1	5000	<3	9	10	8	4675	0.77	14'-3"	3'-7"	0.78	12'-6"	0.77	12'-6"	0.20	6'-6"	0.24	8'-10"
	2	5000	3 - 7	9	10	8	4675	0.66	12'-8"	2'-10"	0.75	12'-6"	0.77	12'-6"	0.20	6'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	4850	1.04	13'-2"	3'-0"	1.21	12'-6"	1.24	12'-6"	0.20	6'-6"	0.24	10'-11"
	4	6000	15 - 22	11	11	9	5375	1.23	13'-10"	3'-3"	1.49	12'-6"	1.52	12'-6"	0.22	6'-6"	0.27	10'-11"
12x7	1	5000	<3	9	10	8	4875	0.71	15'-1"	3'-6"	0.83	12'-6"	0.82	12'-6"	0.20	7'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	4875	0.61	13'-8"	2'-10"	0.80	12'-6"	0.82	12'-6"	0.20	7'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5050	0.95	13'-9"	2'-10"	1.27	12'-6"	1.31	12'-6"	0.20	7'-6"	0.24	11'-0"
	4	6000	15 - 22	11	11	9	5600	1.12	14'-6"	3'-1"	1.56	12'-6"	1.60	12'-6"	0.22	7'-6"	0.27	10'-11"
12x8	1	5000	<3	9	10	8	5075	0.67	16'-0"	3'-6"	0.88	12'-6"	0.87	12'-6"	0.20	8'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5075	0.57	14'-8"	2'-10"	0.84	12'-6"	0.87	12'-6"	0.20	8'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5250	0.87	14'-9"	2'-10"	1.32	12'-6"	1.37	12'-6"	0.20	8'-6"	0.24	10'-9"
	4	6000	15 - 22	11	11	9	5825	1.04	15'-3"	3'-0"	1.62	12'-6"	1.67	12'-6"	0.22	8'-6"	0.27	10'-11"
12x9	1	5000	<3	9	10	8	5275	0.62	17'-0"	3'-6"	0.92	12'-6"	0.92	12'-6"	0.20	9'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5275	0.53	15'-8"	2'-10"	0.87	12'-6"	0.92	12'-6"	0.20	9'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5450	0.82	15'-9"	2'-10"	1.36	12'-6"	1.42	12'-6"	0.20	9'-6"	0.24	10'-7"
	4	6000	15 - 22	11	11	9	6050	0.97	16'-3"	3'-0"	1.66	12'-6"	1.72	12'-6"	0.22	9'-6"	0.27	10'-8"
12x10	1	5000	<3	9	10	8	5475	0.59	18'-0"	3'-6"	0.97	12'-6"	0.96	12'-6"	0.20	10'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5475	0.50	16'-8"	2'-10"	0.90	12'-6"	0.96	12'-6"	0.20	10'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5650	0.77	18'-3"	3'-7"	1.39	12'-6"	1.52	12'-6"	0.20	10'-6"	0.24	8'-11"
	4	6000	15 - 22	11	11	9	6275	0.92	18'-10"	3'-9"	1.69	12'-6"	1.76	12'-6"	0.22	10'-6"	0.27	8'-11"
12x11	1	5000	<3	9	10	8	5675	0.59	19'-0"	3'-6"	1.01	12'-6"	1.00	12'-6"	0.23	11'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5675	0.51	19'-0"	3'-6"	0.93	12'-6"	1.00	12'-6"	0.23	11'-6"	0.24	8'-11"
	3	5000	7 - 15	10	10	8	5850	0.80	19'-4"	3'-7"	1.41	12'-6"	1.56	12'-6"	0.23	11'-6"	0.24	8'-11"
	4	6000	15 - 22	11	11	9	6500	0.92	19'-10"	3'-9"	1.71	12'-6"	1.79	12'-6"	0.23	11'-6"	0.27	8'-11"
12x12	1	5000	<3	9	10	8	5875	0.60	20'-0"	3'-6"	1.05	12'-6"	1.04	12'-6"	0.31	12'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5875	0.60	21'-4"	4'-2"	0.96	12'-6"	1.04	12'-6"	0.31	12'-6"	0.24	7'-7"
	3	5000	7 - 15	10	10	9	6375	0.76	21'-7"	4'-3"	1.33	12'-6"	1.43	12'-6"	0.31	12'-6"	0.24	7'-9"
	4	6000	15 - 22	11	11	10	7075	0.89	20'-11"	3'-10"	1.62	12'-6"	1.71	12'-6"	0.31	12'-6"	0.27	8'-11"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3S52 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

REVISION: 10-09-2015

APPROVED: MARCH 24, 2011

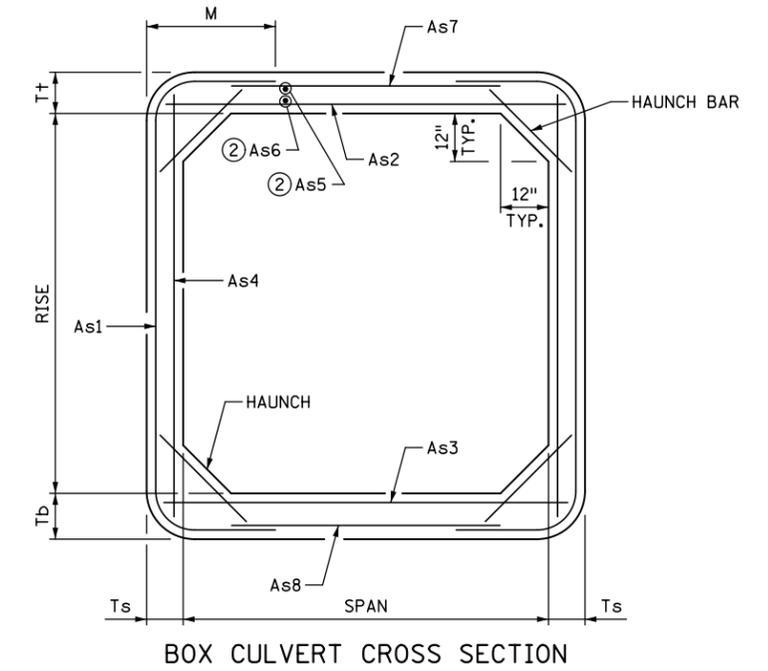
Nancy Dubenberger
STATE BRIDGE ENGINEER

FIG. 5-395.100(C)

DO NOT INCLUDE TABLES WITH PLAN

TITLE
PRECAST CONCRETE
BOX CULVERT TABLES

								REINFORCEMENT REQUIREMENTS ①										
SIZE SPAN x RISE (ft.)	CLASS	f'c (psi)	FILL HEIGHT RANGE (ft.)	Tt (in.)	Tb (in.)	Ts (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
14x4	1	5000	<3	10	10	8	4950	1.11	13'-5"	4'-2"	0.76	14'-6"	0.73	14'-6"	0.20	4'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	4950	1.05	13'-2"	4'-0"	0.73	14'-6"	0.73	14'-6"	0.20	4'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	5075	1.33	15'-8"	5'-3"	0.94	14'-6"	0.95	14'-6"	0.22	4'-6"	0.24	9'-7"
	4	6000	11 - 16	11	12	10	5825	1.49	14'-7"	4'-7"	1.11	14'-6"	1.13	14'-6"	0.24	4'-6"	0.29	10'-11"
14x5	1	5000	<3	10	10	8	5150	0.99	14'-2"	4'-0"	0.84	14'-6"	0.81	14'-6"	0.20	5'-6"	0.24	10'-10"
	2	5000	3 - 6	10	10	8	5150	0.93	13'-10"	3'-10"	0.81	14'-6"	0.81	14'-6"	0.20	5'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	5300	1.22	15'-0"	4'-5"	1.03	14'-6"	1.06	14'-6"	0.22	5'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6075	1.34	15'-5"	4'-6"	1.21	14'-6"	1.25	14'-6"	0.24	5'-6"	0.29	10'-11"
14x6	1	5000	<3	10	10	8	5350	0.90	14'-8"	3'-9"	0.91	14'-6"	0.88	14'-6"	0.20	6'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	5350	0.84	12'-9"	2'-10"	0.87	14'-6"	0.88	14'-6"	0.20	6'-6"	0.24	12'-8"
	3	5000	6 - 11	10	10	9	5525	1.13	15'-8"	4'-3"	1.11	14'-6"	1.14	14'-6"	0.22	6'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6325	1.23	16'-1"	4'-4"	1.30	14'-6"	1.35	14'-6"	0.24	6'-6"	0.29	10'-11"
14x7	1	5000	<3	10	10	8	5550	0.83	15'-7"	3'-9"	0.97	14'-6"	0.94	14'-6"	0.20	7'-6"	0.24	10'-10"
	2	5000	3 - 6	10	10	8	5550	0.77	13'-9"	2'-10"	0.92	14'-6"	0.94	14'-6"	0.20	7'-6"	0.24	12'-5"
	3	5000	6 - 11	10	10	9	5750	1.06	16'-5"	4'-2"	1.18	14'-6"	1.22	14'-6"	0.22	7'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6575	1.15	16'-9"	4'-2"	1.39	14'-6"	1.44	14'-6"	0.24	7'-6"	0.29	10'-11"
14x8	1	5000	<3	10	10	8	5750	0.76	16'-4"	3'-7"	1.02	14'-6"	1.00	14'-6"	0.20	8'-6"	0.24	10'-10"
	2	5000	3 - 6	10	10	8	5750	0.71	14'-9"	2'-10"	0.97	14'-6"	1.00	14'-6"	0.20	8'-6"	0.24	12'-3"
	3	5000	6 - 11	10	10	9	5975	1.00	17'-3"	4'-1"	1.24	14'-6"	1.29	14'-6"	0.22	8'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6825	1.08	17'-7"	4'-1"	1.43	14'-6"	1.53	14'-6"	0.24	8'-6"	0.29	10'-11"
14x9	1	5000	<3	10	10	8	5950	0.70	17'-2"	3'-6"	1.07	14'-6"	1.05	14'-6"	0.20	9'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	5950	0.66	15'-9"	2'-10"	1.01	14'-6"	1.05	14'-6"	0.20	9'-6"	0.24	12'-3"
	3	5000	6 - 11	10	10	9	6200	0.95	18'-0"	3'-11"	1.29	14'-6"	1.35	14'-6"	0.22	9'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	7075	1.01	18'-4"	4'-0"	1.50	14'-6"	1.59	14'-6"	0.24	9'-6"	0.29	10'-11"
14x10	1	5000	<3	10	10	8	6150	0.68	18'-1"	3'-6"	1.12	14'-6"	1.09	14'-6"	0.20	10'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	6150	0.62	16'-9"	2'-10"	1.05	14'-6"	1.09	14'-6"	0.20	10'-6"	0.24	12'-3"
	3	5000	6 - 11	10	10	9	6425	0.90	18'-11"	3'-11"	1.33	14'-6"	1.40	14'-6"	0.22	10'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	7325	0.96	19'-2"	3'-11"	1.54	14'-6"	1.64	14'-6"	0.24	10'-6"	0.29	10'-11"
14x11	1	5000	<3	10	10	8	6350	0.67	19'-1"	3'-6"	1.15	14'-6"	1.14	14'-6"	0.20	11'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	6350	0.60	19'-1"	3'-6"	1.08	14'-6"	1.14	14'-6"	0.20	11'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	6650	0.86	19'-9"	3'-10"	1.37	14'-6"	1.52	14'-6"	0.22	11'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	7575	0.91	20'-1"	3'-10"	1.58	14'-6"	1.69	14'-6"	0.24	11'-6"	0.29	10'-11"
14x12	1	5000	<3	10	10	8	6550	0.67	20'-1"	3'-6"	1.29	14'-6"	1.19	14'-6"	0.26	12'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	6550	0.62	20'-1"	3'-6"	1.11	14'-6"	1.19	14'-6"	0.26	12'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	6875	0.83	21'-10"	4'-4"	1.40	14'-6"	1.57	14'-6"	0.26	12'-6"	0.24	9'-9"
	4	6000	11 - 16	11	12	10	7825	0.90	21'-0"	3'-10"	1.61	14'-6"	1.73	14'-6"	0.26	12'-6"	0.29	10'-11"
14x13	1	5000	<3	10	10	8	6750	0.69	22'-5"	4'-2"	1.57	14'-6"	1.23	14'-6"	0.36	13'-6"	0.24	9'-7"
	2	5000	3 - 6	10	10	8	6750	0.69	23'-3"	4'-7"	1.14	14'-6"	1.23	14'-6"	0.36	13'-6"	0.24	8'-9"
	3	5000	6 - 11	10	10	9	7100	0.85	22'-10"	4'-4"	1.43	14'-6"	1.62	14'-6"	0.36	13'-6"	0.24	9'-10"
	4	6000	11 - 16	11	12	10	8075	0.91	23'-5"	4'-6"	1.64	14'-6"	1.77	14'-6"	0.36	13'-6"	0.29	9'-7"
14x14	1	6000	<3	10	10	8	6950	0.73	26'-9"	5'-10"	1.83	14'-6"	1.27	14'-6"	0.47	14'-6"	0.24	6'-3"
	2	5000	3 - 6	10	10	8	6950	0.73	25'-11"	5'-5"	1.17	14'-6"	1.27	14'-6"	0.47	14'-6"	0.24	7'-1"
	3	5000	6 - 11	10	10	10	7725	0.81	24'-10"	4'-10"	1.36	14'-6"	1.55	14'-6"	0.47	14'-6"	0.24	8'-10"
	4	6000	11 - 16	11	12	11	8725	0.87	24'-7"	4'-7"	1.56	14'-6"	1.71	14'-6"	0.47	14'-6"	0.29	9'-6"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MNDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3S52 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MNDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

REVISION: 10-09-2015

APPROVED: MARCH 24, 2011

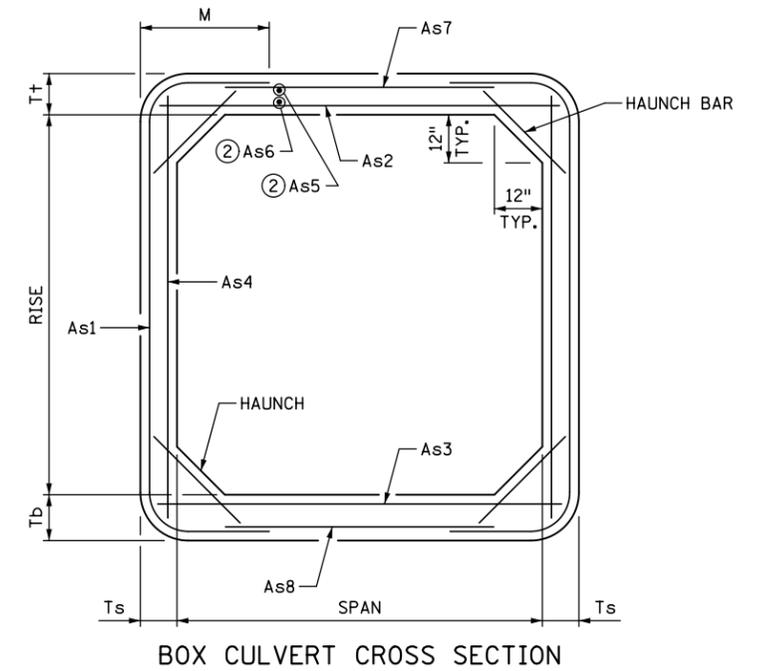
Nancy Dubenberger
STATE BRIDGE ENGINEER

FIG. 5-395.100(D)

DO NOT INCLUDE TABLES WITH PLAN

TITLE
PRECAST CONCRETE
BOX CULVERT TABLES

									REINFORCEMENT REQUIREMENTS ①									
SIZE SPAN x RISE (ft.)	CLASS	f' _c (psi)	FILL HEIGHT RANGE (ft.)	T _t (in.)	T _b (in.)	T _s (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
16x4	1	5000	<3	10	11	9	5800	1.33	16'-11"	5'-10"	0.87	16'-6"	0.81	16'-6"	0.22	4'-6"	0.27	10'-5"
	2	5000	3 - 6	10	11	9	5800	1.24	15'-7"	5'-2"	0.83	16'-6"	0.81	16'-6"	0.22	4'-6"	0.27	11'-5"
	3	5000	6 - 10	10	11	10	5950	1.48	17'-4"	6'-1"	1.01	16'-6"	1.00	16'-6"	0.24	4'-6"	0.27	10'-5"
	4	6000	10 - 16	12	12	11	6750	1.85	16'-8"	5'-7"	1.30	16'-6"	1.32	16'-6"	0.27	4'-6"	0.29	11'-1"
16x5	1	5000	<3	10	11	9	6025	1.23	17'-7"	5'-8"	0.95	16'-6"	0.90	16'-6"	0.22	5'-6"	0.27	10'-5"
	2	5000	3 - 6	10	11	9	6025	1.14	16'-3"	5'-0"	0.91	16'-6"	0.90	16'-6"	0.22	5'-6"	0.27	11'-5"
	3	5000	6 - 10	10	11	10	6200	1.36	17'-4"	5'-7"	1.09	16'-6"	1.11	16'-6"	0.24	5'-6"	0.27	11'-3"
	4	6000	10 - 16	12	12	10	6850	1.84	15'-10"	4'-8"	1.55	16'-6"	1.57	16'-6"	0.24	5'-6"	0.29	12'-9"
16x6	1	5000	<3	10	11	9	6250	1.15	17'-3"	5'-0"	1.01	16'-6"	0.98	16'-6"	0.22	6'-6"	0.27	11'-5"
	2	5000	3 - 6	10	11	9	6250	1.06	17'-0"	4'-11"	0.98	16'-6"	0.98	16'-6"	0.22	6'-6"	0.27	11'-5"
	3	5000	6 - 10	10	11	9	6250	1.38	18'-1"	5'-5"	1.27	16'-6"	1.32	16'-6"	0.22	6'-6"	0.27	11'-5"
	4	6000	10 - 16	12	12	10	7100	1.69	16'-10"	4'-8"	1.66	16'-6"	1.69	16'-6"	0.24	6'-6"	0.29	12'-9"
16x7	1	5000	<3	10	11	8	6250	1.13	16'-10"	4'-4"	1.17	16'-6"	1.16	16'-6"	0.20	7'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6250	1.05	16'-6"	4'-2"	1.14	16'-6"	1.16	16'-6"	0.20	7'-6"	0.27	12'-10"
	3	5000	6 - 10	10	11	9	6475	1.29	17'-5"	4'-7"	1.34	16'-6"	1.41	16'-6"	0.22	7'-6"	0.27	12'-10"
	4	6000	10 - 16	12	12	10	7350	1.57	17'-10"	4'-8"	1.76	16'-6"	1.80	16'-6"	0.24	7'-6"	0.29	12'-9"
16x8	1	5000	<3	10	11	8	6450	1.05	17'-6"	4'-2"	1.23	16'-6"	1.23	16'-6"	0.20	8'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6450	0.97	17'-2"	4'-0"	1.20	16'-6"	1.23	16'-6"	0.20	8'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	6700	1.20	18'-2"	4'-6"	1.41	16'-6"	1.50	16'-6"	0.22	8'-6"	0.27	12'-10"
	4	6000	10 - 16	12	12	10	7600	1.47	18'-10"	4'-8"	1.84	16'-6"	1.89	16'-6"	0.24	8'-6"	0.29	12'-9"
16x9	1	5000	<3	10	11	8	6650	0.98	18'-4"	4'-1"	1.29	16'-6"	1.28	16'-6"	0.20	9'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6650	0.90	17'-11"	3'-10"	1.24	16'-6"	1.28	16'-6"	0.20	9'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	6925	1.13	18'-11"	4'-4"	1.53	16'-6"	1.57	16'-6"	0.22	9'-6"	0.27	12'-9"
	4	6000	10 - 16	12	12	10	7850	1.36	19'-8"	4'-7"	1.90	16'-6"	1.97	16'-6"	0.24	9'-6"	0.29	12'-9"
16x10	1	5000	<3	10	11	8	6850	0.93	19'-1"	3'-11"	1.34	16'-6"	1.34	16'-6"	0.20	10'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6850	0.84	18'-9"	3'-9"	1.29	16'-6"	1.34	16'-6"	0.20	10'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	7150	1.07	19'-8"	4'-3"	1.58	16'-6"	1.64	16'-6"	0.22	10'-6"	0.27	12'-10"
	4	6000	10 - 16	12	12	10	8100	1.29	20'-6"	4'-6"	1.96	16'-6"	2.06	16'-6"	0.24	10'-6"	0.29	12'-9"
16x11	1	5000	<3	10	11	8	7050	0.91	20'-0"	3'-11"	1.39	16'-6"	1.39	16'-6"	0.20	11'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	7050	0.83	19'-8"	3'-9"	1.33	16'-6"	1.39	16'-6"	0.20	11'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	7375	1.02	20'-6"	4'-2"	1.63	16'-6"	1.70	16'-6"	0.22	11'-6"	0.27	12'-9"
	4	6000	10 - 16	12	12	10	8350	1.23	21'-3"	4'-5"	2.03	16'-6"	2.12	16'-6"	0.24	11'-6"	0.29	12'-9"
16x12	1	5000	<3	10	11	8	7250	0.90	21'-1"	3'-11"	1.43	16'-6"	1.44	16'-6"	0.24	12'-6"	0.27	12'-7"
	2	5000	3 - 6	10	11	8	7250	0.83	20'-9"	3'-9"	1.37	16'-6"	1.44	16'-6"	0.24	12'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	7600	0.99	22'-7"	4'-8"	1.67	16'-6"	1.75	16'-6"	0.24	12'-6"	0.27	11'-7"
	4	6000	10 - 16	12	12	11	8950	1.20	22'-2"	4'-4"	1.92	16'-6"	2.02	16'-6"	0.24	12'-6"	0.29	12'-11"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MnDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3S52 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MnDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

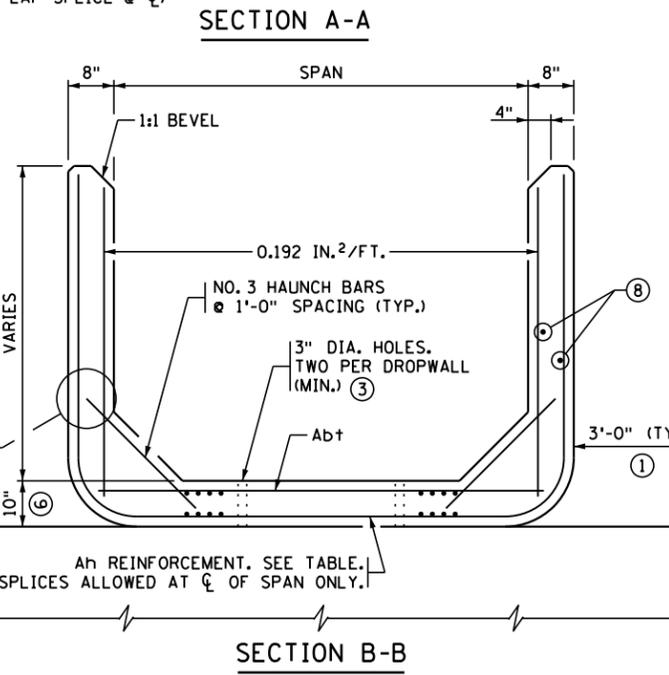
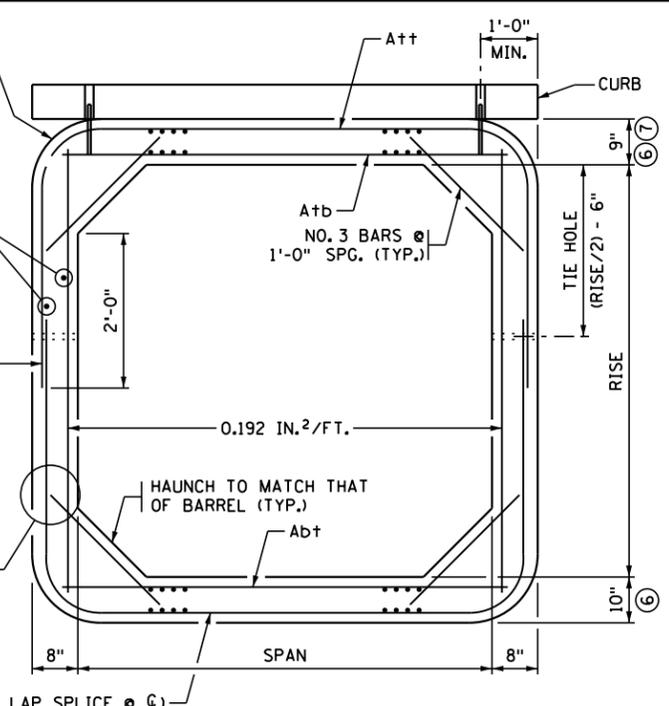
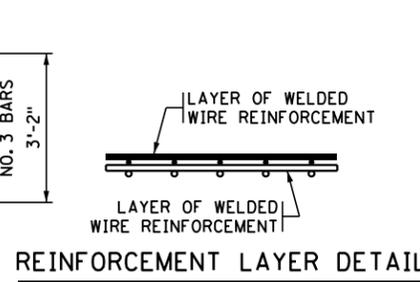
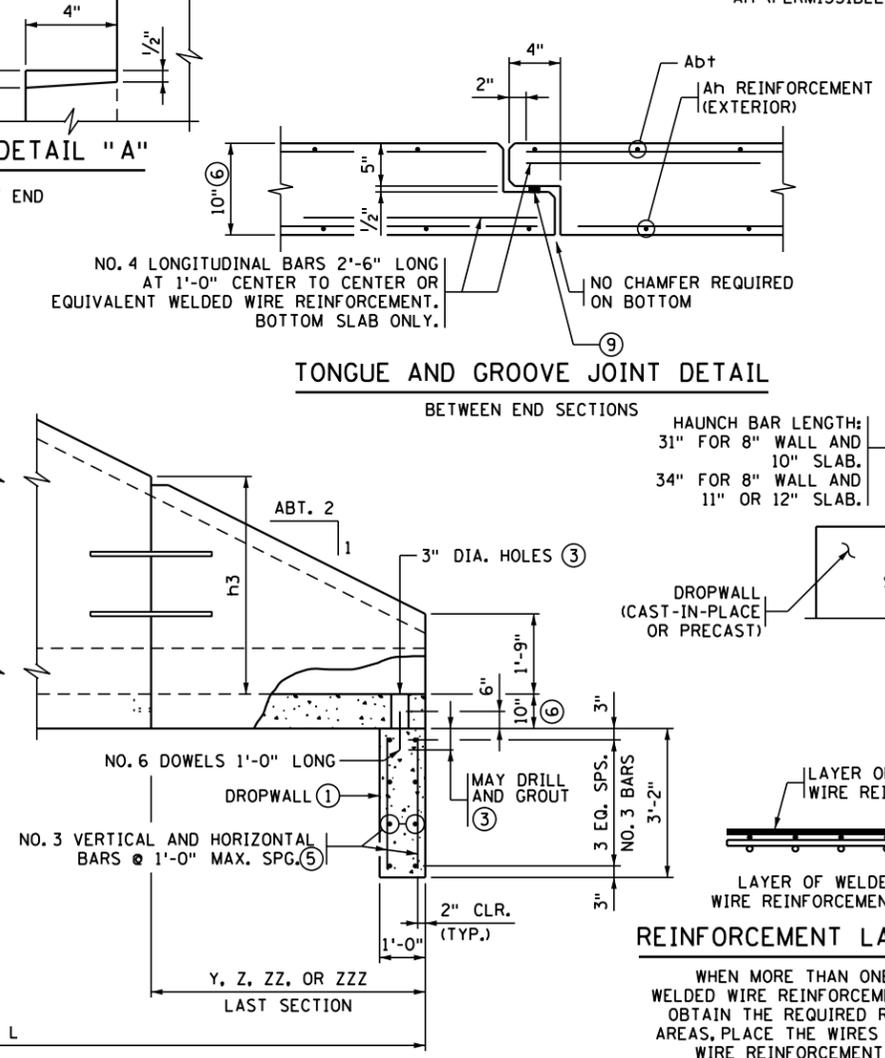
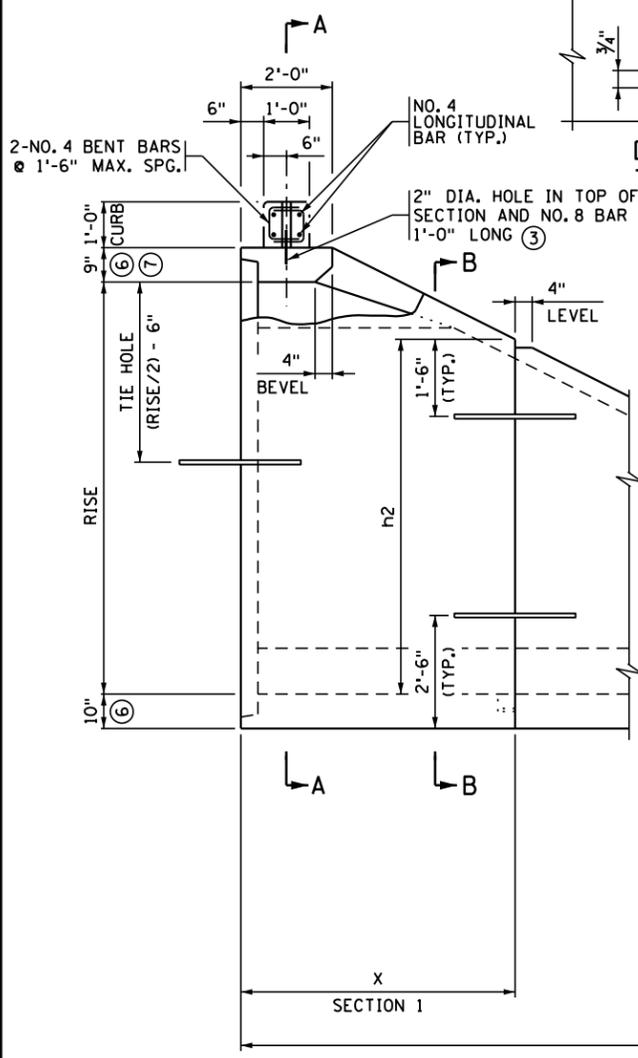
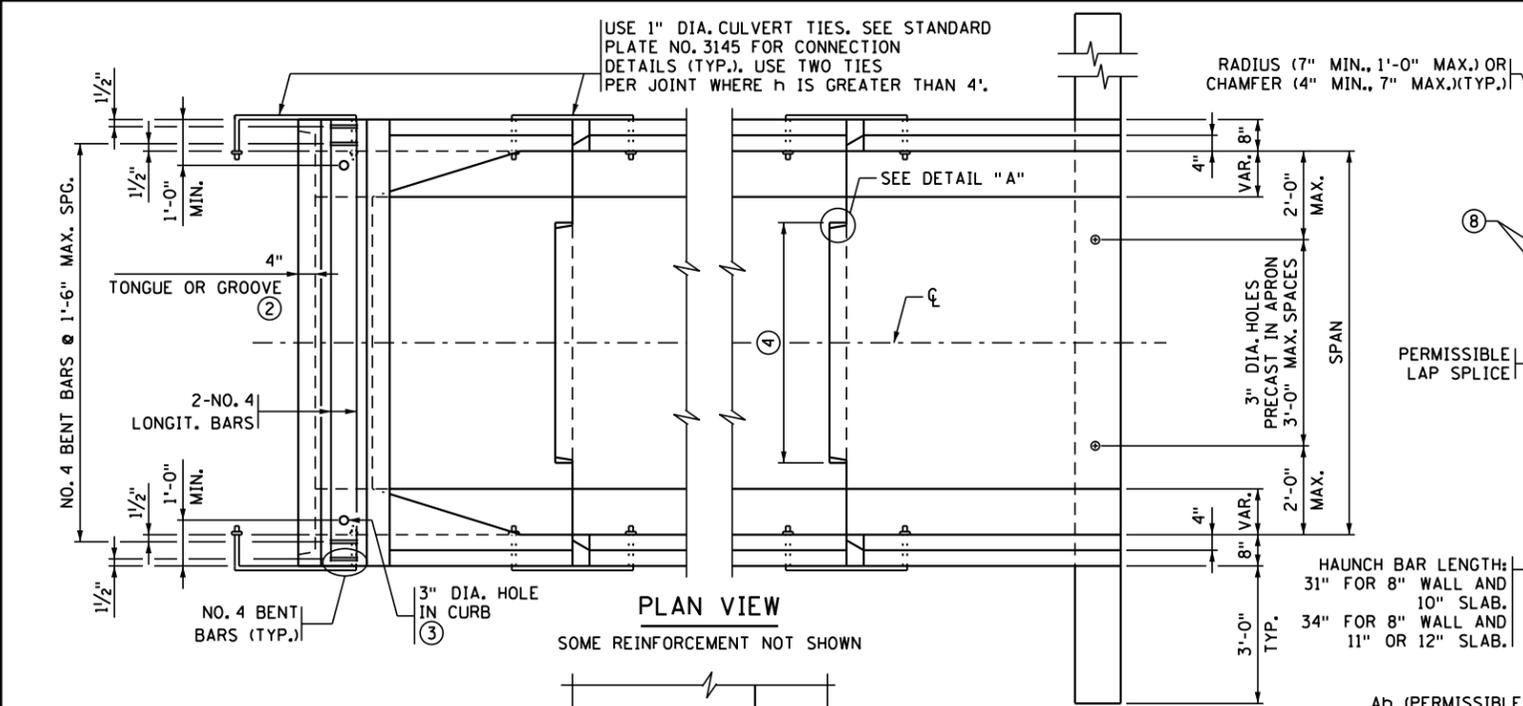
① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

REVISION: 10-09-2015
 APPROVED: MARCH 24, 2011
Nancy Subenberger
 STATE BRIDGE ENGINEER

DO NOT INCLUDE TABLES WITH PLAN

FIG. 5-395.100(E)
 PRECAST CONCRETE
 BOX CULVERT TABLES



- ### CONSTRUCTION NOTES
- SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.
- USE CONCRETE MIX NO. 3W82 WITH NO CALCIUM CHLORIDE ALLOWED.
- ALL END SECTIONS REQUIRE CURB ON LINTEL BEAM.
- ON ALL END SECTIONS FOR WATERWAYS, USE DROPWALLS ON INLET AND OUTLET ENDS.
- SEE STANDARD FIG. 5-395.115 FOR EMBANKMENT PROTECTION.
- FINISH ALL EXPOSED EDGES OF CONCRETE WITH 1/2" OR 3/4" CHAMFER OR RADIUS UNLESS OTHERWISE NOTED.
- MAXIMUM SIZE OF REINFORCEMENT BARS IS NO. 6, EXCEPT NO. 7 OR 8 BARS MAY BE USED FOR A+b ON SPANS GREATER THAN 14'. THE MAXIMUM WELDED WIRE REINFORCEMENT SIZE IS W23 PER LAYER (MAXIMUM OF 2 LAYERS).
- WITH DOUBLE BOXES LOCATE DROPWALL JOINTS BETWEEN END SECTIONS. SEE STANDARD FIG. 5-395.111 FOR ALTERNATE DROPWALLS. LIMITS OF EXCAVATION FOR DROPWALL ARE APPROXIMATELY THE SAME AS DROPWALL DIMENSIONS. DROPWALL CONCRETE MIX IS 3S52, OR 3Y82 IF PRECAST. FURNISHING AND INSTALLATION OF DROPWALL TO BE INCLUDED IN PRICE BID FOR END SECTIONS. DROPWALL NOT REQUIRED FOR NON-WATERWAY USE.
 - CHECK LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED.
 - FILL HOLE WITH GROUT. GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".
 - 3'-6" MIN. TONGUE AND 3'-7" MIN. GROOVE FOR CULVERTS WITH 6'-0" SPANS. 5'-0" MIN. TONGUE AND 5'-1" MIN. GROOVE FOR CULVERTS WITH SPANS GREATER THAN 6'-0". CENTER TONGUE AND GROOVE ON C OF EACH APRON JOINT. TONGUE AND GROOVE JOINT ON ALL THREE SIDES OF APRON IS PERMISSIBLE.
 - WELDED WIRE REINFORCEMENT OF EQUAL AREA MAY BE SUBSTITUTED FOR REBAR.
 - APRON TOP AND BOTTOM SLAB THICKNESS MAY BE 8" FOR CULVERTS WITH 6' SPANS ONLY. BOTTOM SLAB THICKNESS MAY BE INCREASED UP TO 2" MAX. PROVIDED CONCRETE COVER IS 1/2" MIN., 2" MAX.
 - 10" MINIMUM TOP SLAB FOR 14' AND 16' SPANS.
 - PLACE LONGITUDINAL REINFORCEMENT PERPENDICULAR TO THE CULVERT SPAN WITH A MINIMUM OF 0.06 SQUARE INCHES PER PERIPHERAL FOOT ON ALL FACES OF THE BARREL.
 - REFER TO SPEC. 2412 FOR SEALANT REQUIREMENTS.

A++ , A+b REINFORCEMENT		
SPAN (FT.)	A++ (IN²/FT.)	A+b (IN²/FT.)
6	0.27	0.44
8	0.47	0.60
10	0.62	0.74
12	0.88	1.06
14	1.20	1.58
16	1.52	2.09

Ab+ REINFORCEMENT	
SPAN (FT.)	Ab+ (IN²/FT.)
6-10	0.20
12	0.30
14	0.39
16	0.39

RISE FT.	L FT.	APRON DIMENSIONS & Ah REINFORCEMENT														
		SECTION 1 X	h2	SECTION 2 Y	h3	SECTION 3 Z	h4	SECTION 4 ZZ	h5	SECTION 5 ZZZ	h6					
4	8	8' (4')	0.192	1'-9" (3'-9")	(4')	0.192	(1'-9")									
5	10	6'	0.192	3'-9"	4'	0.192	1'-9"									
6	12	6'	0.192	4'-9"	6'	0.192	1'-9"									
7	14	6'	0.192	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")						
8	16	6'	0.20	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"						
9	18	6'	0.29	7'-9"	6'	0.20	4'-9"	6'	0.192	1'-9"						
10	20	6'	0.42	8'-9"	6'	0.29	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")			
11	22	6'	0.60	9'-9"	6'	0.42	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"			
12	24	6'	0.78	10'-9"	6'	0.60	7'-9"	6'	0.20	4'-9"	6'	0.192	1'-9"			
13	26	6'	1.03	11'-9"	6'	0.78	8'-9"	6'	0.28	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")
14	28	6'	1.38	12'-9"	6'	1.03	9'-9"	6'	0.40	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"

NOTE: Ah IS AREA OF REINFORCEMENT PER FOOT OF LENGTH (IN²/FT.) VALUES IN () MAY BE USED FOR END SECTIONS WITH SPANS OF 14' AND 16' ONLY.

REVISION: FEBRUARY 22, 2018
 APPROVED: MARCH 24, 2011
Nancy J. Subenberger
 STATE BRIDGE ENGINEER

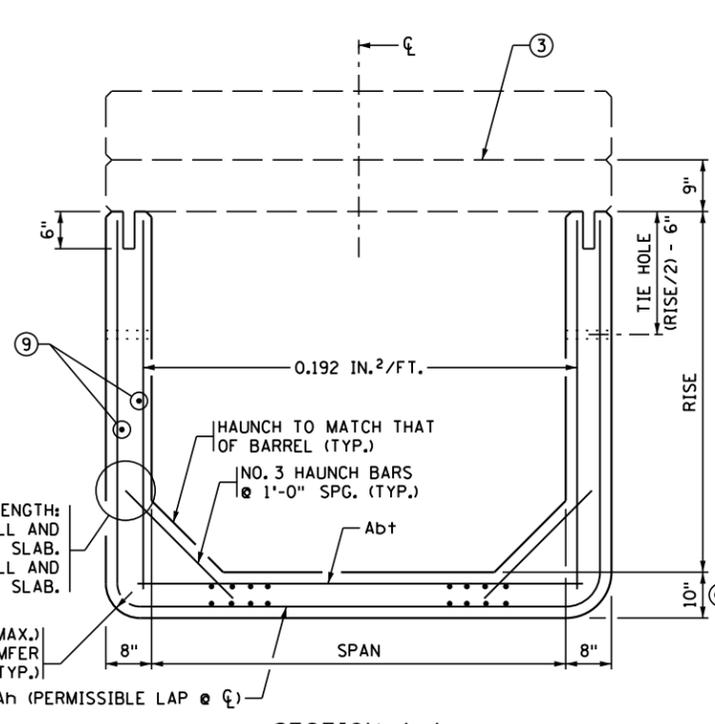
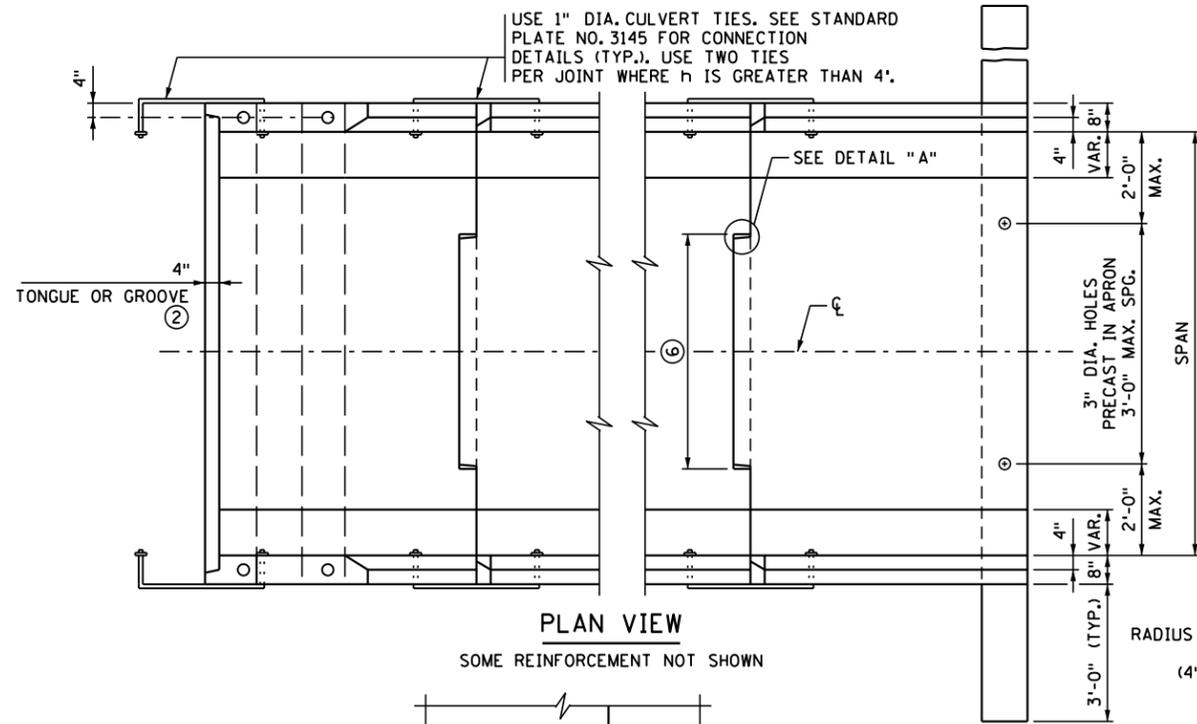
STATE PROJ. NO. - (T.H.) STA. + .

FIG. 5-395.102

CERTIFIED BY _____ DATE _____ TITLE: PRECAST CONCRETE END SECTION TYPE I - SINGLE OR DOUBLE BARREL FOR SKEWS UP TO 7 1/2'

DES: _____ DR: _____ APPROVED: _____
 CHK: _____ CHK: _____ SHEET NO. OF SHEETS

BRIDGE NO. _____

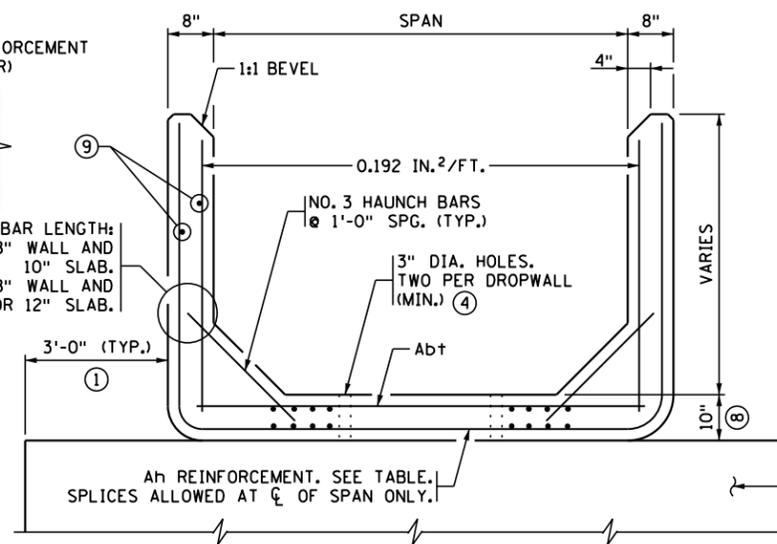
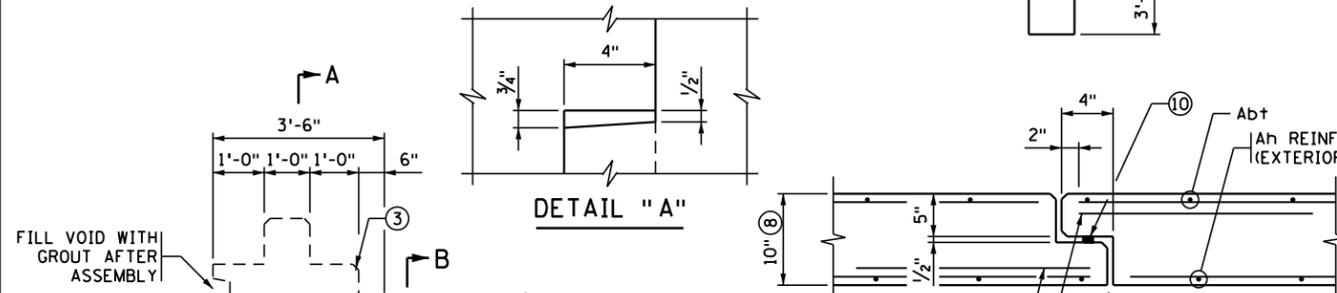


CONSTRUCTION NOTES

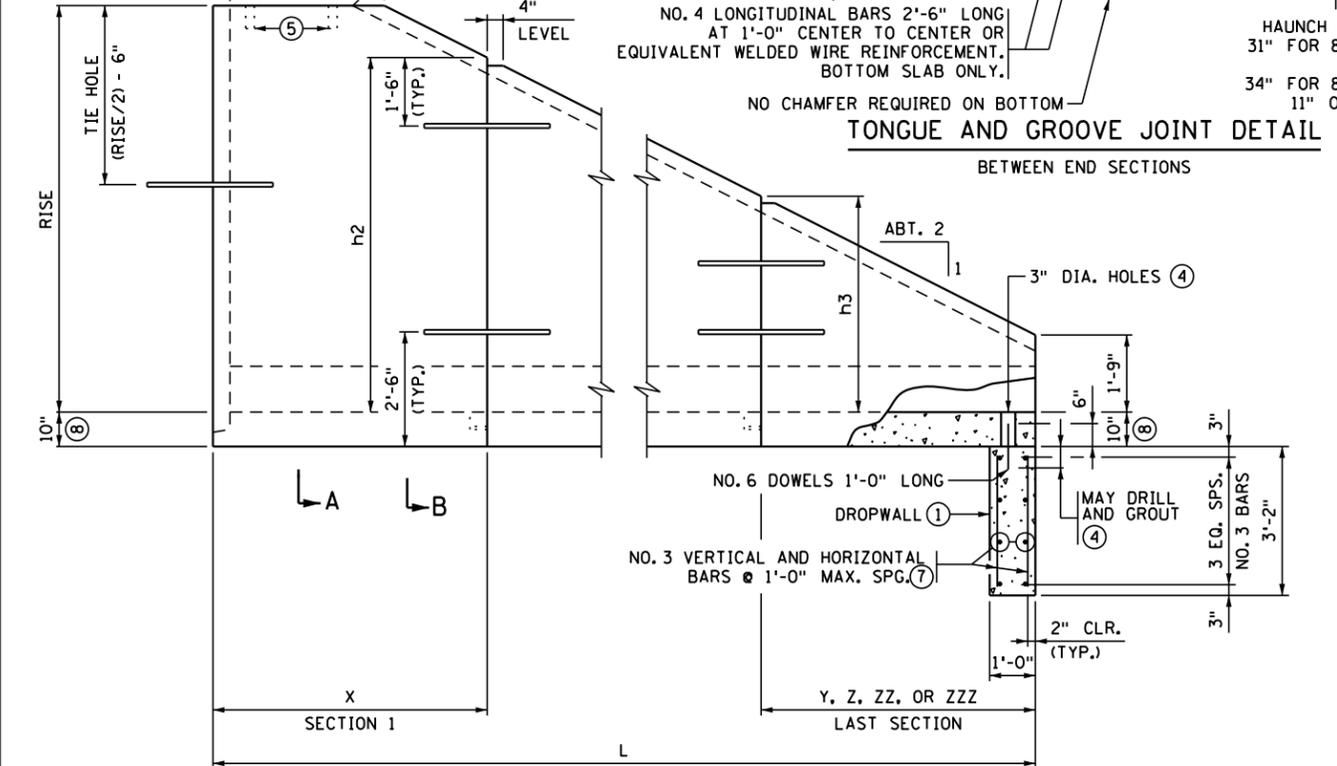
- SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.
- USE CONCRETE MIX NO. 3W82 WITH NO CALCIUM CHLORIDE ALLOWED.
- ON ALL END SECTIONS FOR WATERWAYS, USE DROPWALLS ON INLET AND OUTLET ENDS.
- SEE STANDARD FIG. 5-395.115 FOR EMBANKMENT PROTECTION.
- FINISH ALL EXPOSED EDGES OF CONCRETE WITH 1/2" OR 3/4" CHAMFER OR RADIUS UNLESS OTHERWISE NOTED.
- WITH DOUBLE BOXES LOCATE DROPWALL JOINTS BETWEEN END SECTIONS. SEE STANDARD FIG. 5-395.111 FOR ALTERNATE DROPWALLS. LIMITS OF EXCAVATION FOR DROPWALL ARE APPROXIMATELY THE SAME AS DROPWALL DIMENSIONS. DROPWALL CONCRETE MIX IS 3S52, OR 3Y82 IF PRECAST. FURNISHING AND INSTALLATION OF DROPWALL TO BE INCLUDED IN PRICE BID FOR END SECTIONS. DROPWALL NOT REQUIRED FOR NON-WATERWAY USE.
 - CHECK LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED.
 - SEE STANDARD FIG. 5-395.104(B) FOR LINTEL BEAM DETAILS.
 - FILL HOLE WITH GROUT. GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".
 - 2" DIAMETER HOLE, 6" DEEP IN TOP OF THE SECTION WALL.
 - 3'-6" MIN. TONGUE AND 3'-7" MIN. GROOVE FOR CULVERTS WITH 6'-0" SPANS. 5'-0" MIN. TONGUE AND 5'-1" MIN. GROOVE FOR CULVERTS WITH SPANS GREATER THAN 6'-0". CENTER TONGUE AND GROOVE ON C OF EACH APRON JOINT. TONGUE AND GROOVE JOINT ON ALL THREE SIDES OF APRON IS PERMISSIBLE.
 - WELDED WIRE REINFORCEMENT OF EQUAL AREA MAY BE SUBSTITUTED FOR REBAR.
 - APRON TOP AND BOTTOM SLAB THICKNESS MAY BE 8" FOR CULVERTS WITH 6" SPANS ONLY. BOTTOM SLAB THICKNESS MAY BE INCREASED UP TO 2" MAX. PROVIDED CONCRETE COVER IS 1/2" MIN., 2" MAX.
 - PLACE LONGITUDINAL REINFORCEMENT PERPENDICULAR TO THE CULVERT SPAN WITH A MINIMUM OF 0.06 SQUARE INCHES PER PERIPHERAL FOOT ON ALL FACES OF THE BARREL.
 - REFER TO SPEC. 2412 FOR SEALANT REQUIREMENTS.

PLAN VIEW
SOME REINFORCEMENT NOT SHOWN

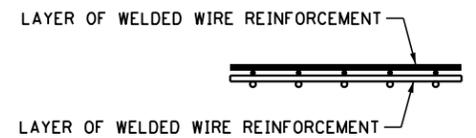
SECTION A-A



SECTION B-B



SIDE ELEVATION



REINFORCEMENT LAYER DETAIL

WHEN MORE THAN ONE LAYER OF WELDED WIRE REINFORCEMENT IS USED TO OBTAIN THE REQUIRED REINFORCEMENT AREAS, PLACE THE WIRES OF THE WELDED WIRE REINFORCEMENT AS SHOWN.

Abt REINFORCEMENT

SPAN (FT.)	Abt (IN ² /FT.)
6-10	0.20
12	0.30
14	0.39
16	0.39

APRON DIMENSIONS & Ah REINFORCEMENT

RISE FT.	L FT.	SECTION 1		h2	SECTION 2		h3	SECTION 3		h4	SECTION 4		h5	SECTION 5		h6
		X	Ah		Y	Ah		Z	Ah		ZZ	Ah		ZZZ	Ah	
4	8	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")									
5	10	6'	0.192	3'-9"	4'	0.192	1'-9"									
6	12	6'	0.192	4'-9"	6'	0.192	1'-9"									
7	14	6'	0.192	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)							
8	16	6'	0.20	6'-9"	6'	0.192	3'-9"	4'	0.192							
9	18	6'	0.29	7'-9"	6'	0.20	4'-9"	6'	0.192							
10	20	6'	0.42	8'-9"	6'	0.29	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)				
11	22	6'	0.60	9'-9"	6'	0.42	6'-9"	6'	0.192	3'-9"	4'	0.192				
12	24	6'	0.78	10'-9"	6'	0.60	7'-9"	6'	0.20	4'-9"	6'	0.192				
13	26	6'	1.03	11'-9"	6'	0.78	8'-9"	6'	0.28	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")
14	28	6'	1.38	12'-9"	6'	1.03	9'-9"	6'	0.40	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"

NOTE: Ah IS AREA OF REINFORCEMENT PER FOOT OF LENGTH (IN²/FT.)
VALUES IN () MAY BE USED FOR END SECTIONS WITH SPANS OF 14' AND 16' ONLY.

REVISION: FEBRUARY 22, 2018
APPROVED: MARCH 24, 2011
Nancy Dubenberger
STATE BRIDGE ENGINEER

STATE PROJ. NO. - (T.H.) STA. + . FIG. 5-395.104(A)

CERTIFIED BY _____ DATE _____ TITLE: PRECAST CONCRETE END SECTION TYPE III - SINGLE OR DOUBLE BARREL FOR SKEWS UP TO 7/2"

DES: _____ DR: _____ APPROVED: _____
CHK: _____ CHK: _____ SHEET NO. OF SHEETS

NAME: _____ LIC. NO. _____ BRIDGE NO. _____

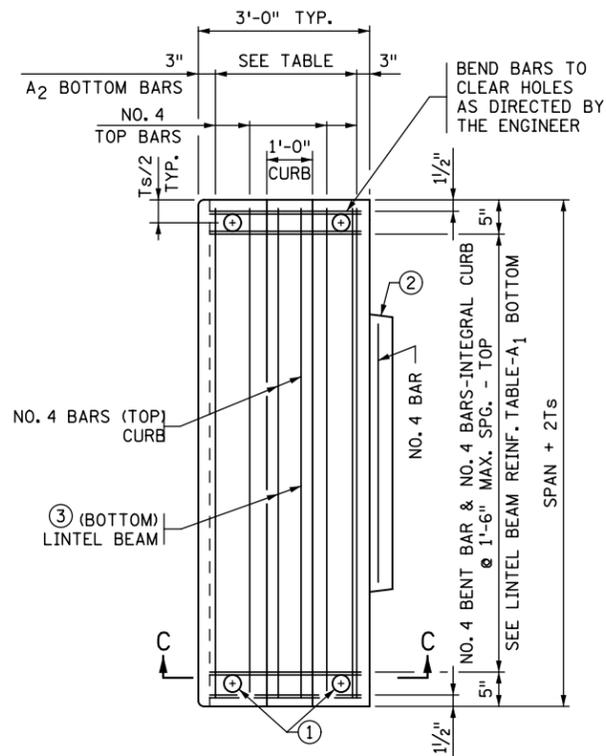
CONSTRUCTION NOTES

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.

ALL END SECTIONS REQUIRE CURB ON LINTEL BEAM.

GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".

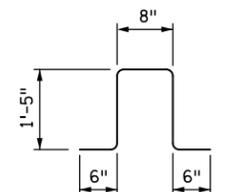
- ① 3" DIA. HOLE THROUGH LINTEL BEAM AND 2" DIA. HOLE IN TOP OF WALL SECTION. PLACE NO. 8 DOWEL, 1'-0" LONG, IN HOLE AND FILL HOLE WITH GROUT.
- ② CHECK THE LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED. TONGUE AND GROOVE TO TERMINATE AT HAUNCH.
- ③ FOR SPANS UNDER 10'-0" USE NO. 8 BARS. FOR SPANS OF 10'-0" TO 12'-0" USE NO. 9 BARS. FOR 14'-0" AND 16'-0" SPAN, USE NO. 10 BARS.
- ④ ALTERNATE BAR BEND MAY BE USED FOR NO. 4 BENT BAR.



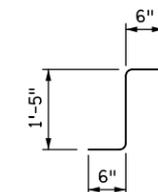
PLAN VIEW OF SQUARE LINTEL BEAM

LINTEL BEAM BOTTOM REINFORCEMENT		
SPAN (FT.)	A ₁	A ₂
6	NO. 4 @ 1'-2"	NO. 4 @ 9/2"
8	NO. 4 @ 8"	NO. 5 @ 8"
10	NO. 5 @ 8"	NO. 6 @ 7 1/2"
12	NO. 5 @ 6"	NO. 6 @ 6"
14	NO. 6 @ 6"	NO. 7 @ 6"
16	NO. 6 @ 6"	NO. 7 @ 6"

NOTE: MAXIMUM BAR SPACING GIVEN, REDUCE AS NECESSARY

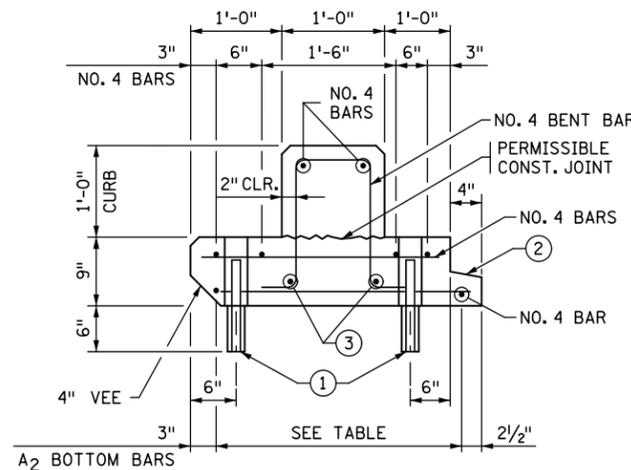


NO. 4 BENT BAR



**NO. 4 BENT BAR
ALTERNATE**

④
2 REQUIRED



SECTION C-C

INTEGRAL CURB WITH TONGUE.
ADDITIONAL REINFORCEMENT IN TONGUE NOT SHOWN.

REVISION: 10-09-2015

APPROVED: MARCH 24, 2011

Nancy Subenberger
STATE BRIDGE ENGINEER

STATE PROJ. NO - (T.H.) STA. + .

FIG. 5-395.104(B)

CERTIFIED BY _____
LICENSED PROFESSIONAL ENGINEER DATE _____
NAME: _____ LIC. NO. _____

TITLE: PRECAST CONCRETE END SECTION
TYPE III - SINGLE OR DOUBLE BARREL
FOR SKEWS UP TO 7 1/2°

DES: _____ DR: _____ APPROVED: _____
CHK: _____ CHK: _____
SHEET NO. OF SHEETS

BRIDGE NO.

Ah REINFORCEMENT		
HEIGHT h (FT.)	Ah (IN ² /FT.)	
	15° & 30° SKEW	45° SKEW
7 OR LESS	0.192	0.192
8	0.20	0.24
9	0.29	0.36
10	0.42	0.53
11	0.60	0.75
12	0.78	0.98
13	1.03	1.36
14	1.38	1.85

Ab† REINFORCEMENT	
SPAN (FT.)	Ab† (IN ² /FT.)
6-10	0.20
12	0.30
14	0.39
16	0.39

LINTEL BEAM REINFORCEMENT		
SPAN (FT.)	BOTTOM REINFORCEMENT	
	A1	A2
6	NO. 4 @ 1'-0"	NO. 4 @ 9"
8	NO. 4 @ 1'-1"	NO. 4 @ 6"
10	NO. 4 @ 9"	NO. 5 @ 6"
12	NO. 5 @ 9"	NO. 6 @ 6"
14	NO. 6 @ 9"	NO. 8 @ 6"
16	NO. 6 @ 9"	NO. 8 @ 6"

LENGTH N			
SPAN (FT.)	15° SKEW	30° SKEW	45° SKEW
6	4'-3 ³ / ₈ "	6'-4 ¹ / ₄ "	9'-2"
8	4'-9 ⁷ / ₈ "	7'-6"	11'-2"
10	5'-4 ¹ / ₄ "	8'-7 ⁷ / ₈ "	13'-2"
12	5'-10 ³ / ₄ "	9'-9 ³ / ₄ "	15'-2"
14	6'-5 ¹ / ₈ "	10'-11 ⁵ / ₈ "	17'-2"
16	6'-11 ⁵ / ₈ "	12'-1 ¹ / ₂ "	NA (7)

LINTEL BEAM THICKNESS			
SPAN (FT.)	15° SKEW	30° SKEW	45° SKEW
≤ 12	9"	9"	9"
14	10" (8)	10" (8)	10" (8)
16	10" (8)	10" (8)	NA (7)

CONSTRUCTION NOTES

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.

ALL END SECTIONS REQUIRE CURB ON LINTEL BEAM.

GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".

STRUCTURAL STEEL PER SPEC. 3306.

WELDING PER SPEC. 2471.

GALVANIZE STRUCTURAL STEEL PER SPEC. 3394.

GALVANIZE BOLTS, NUTS AND WASHERS PER SPEC. 3392.

(1) NO. 8 DOWEL, 1'-0" LONG, 2" DIA. HOLE IN THE TOP OF THE WALL SECTION AND 3" DIA. HOLE IN THE LINTEL. FILL HOLE WITH GROUT.

(2) PROVIDE ADDITIONAL 3" HOLES AT 4'-0" MAXIMUM SPACING WHEN SIDE OF LINTEL BEAM IS OVER 6 FT.

(3) CHECK THE LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED. TONGUE AND GROOVE TO TERMINATE AT CULVERT RADIUS.

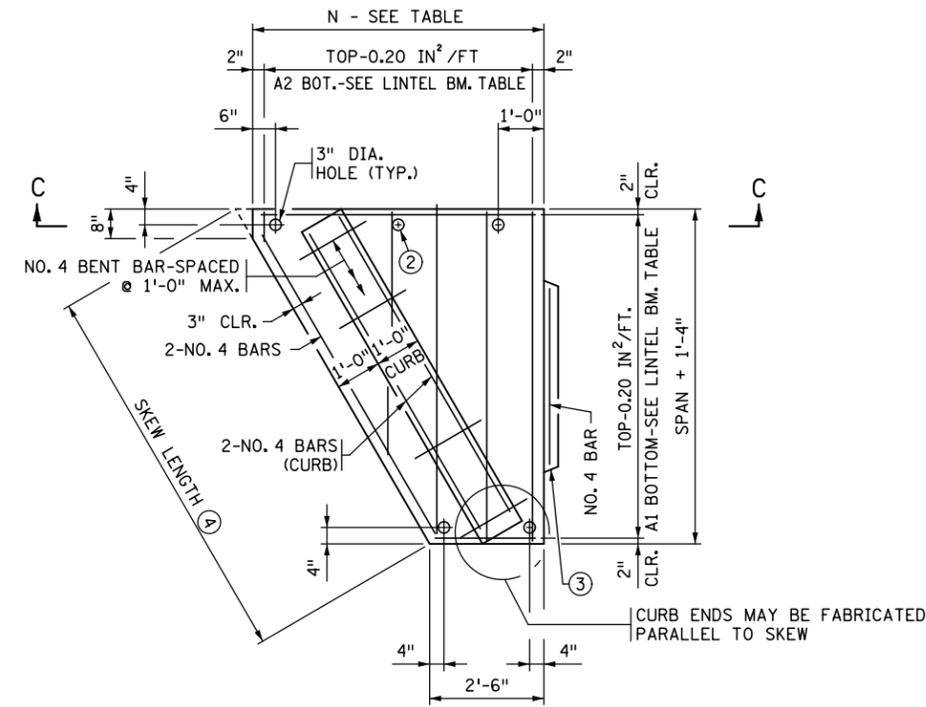
(4) FOR SKEW LENGTH UNDER 10' USE NO. 8 BARS. FOR SKEW LENGTH OF 10' TO 14' USE NO. 9 BARS. FOR SKEW LENGTH OVER 14' TO 18' USE NO. 10 BARS. FOR SKEW LENGTH OVER 18' TO 22' USE NO. 11 BARS OR EQUAL. SKEW LENGTH IS DISTANCE BETWEEN OUTSIDE FACES OF END SECTION ALONG LINTEL BEAM.

(5) SEE LINTEL BEAM THICKNESS TABLE ON THIS SHEET. USE LINTEL BEAMS WITH 5000 PSI 3W82 CONCRETE UNLESS OTHERWISE SPECIFIED.

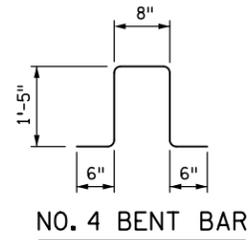
(6) ALTERNATE BAR BEND MAY BE USED FOR NO. 4 BENT BARS.

(7) FOR CULVERTS WITH SPANS OF 16' THE MAXIMUM SKEW IS 30°.

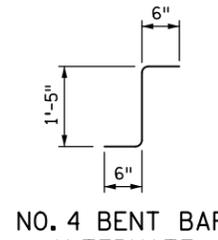
(8) ALTERNATIVELY A 9" THICKNESS MAY BE USED WITH 6500 PSI 3W82 CONCRETE.



PLAN VIEW
LINTEL BEAM WITH INTEGRAL CURB

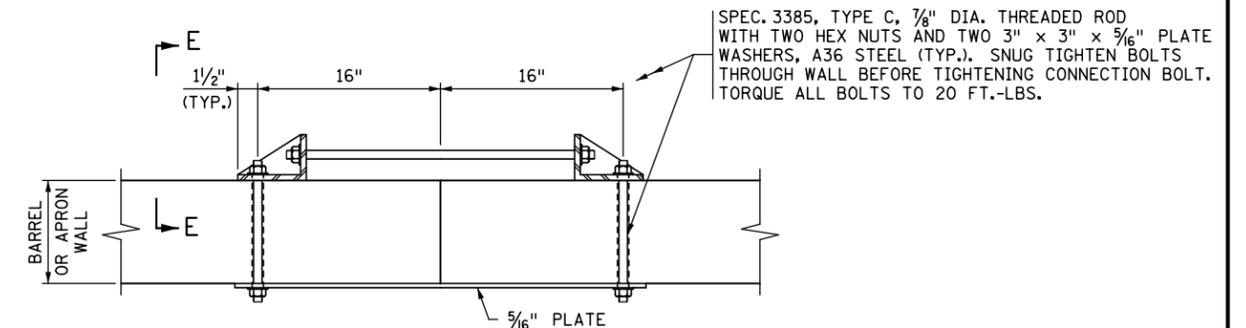


NO. 4 BENT BAR

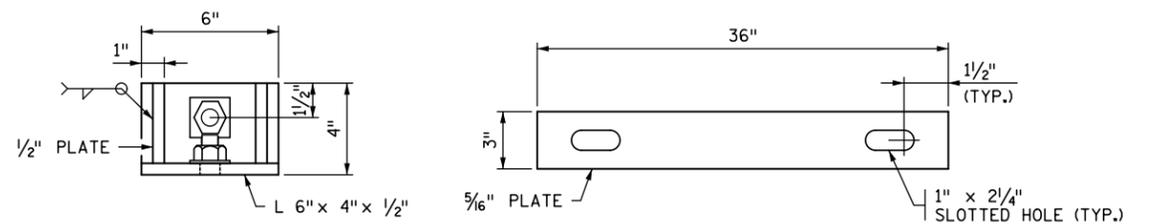


NO. 4 BENT BAR ALTERNATE

(6)
2 REQUIRED



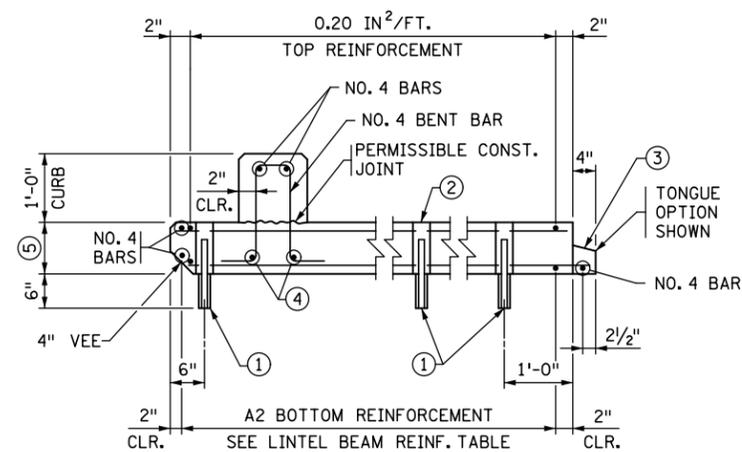
PLAN VIEW



SECTION E-E

PLATE DETAIL

EXTRA STRONG CONNECTION DETAILS



SECTION C-C

LINTEL BEAM WITH INTEGRAL CURB

REVISION: 10-09-2015

APPROVED: MARCH 24, 2011

Nancy Subenberger
STATE BRIDGE ENGINEER

STATE PROJ. NO

(T.H.) STA. +

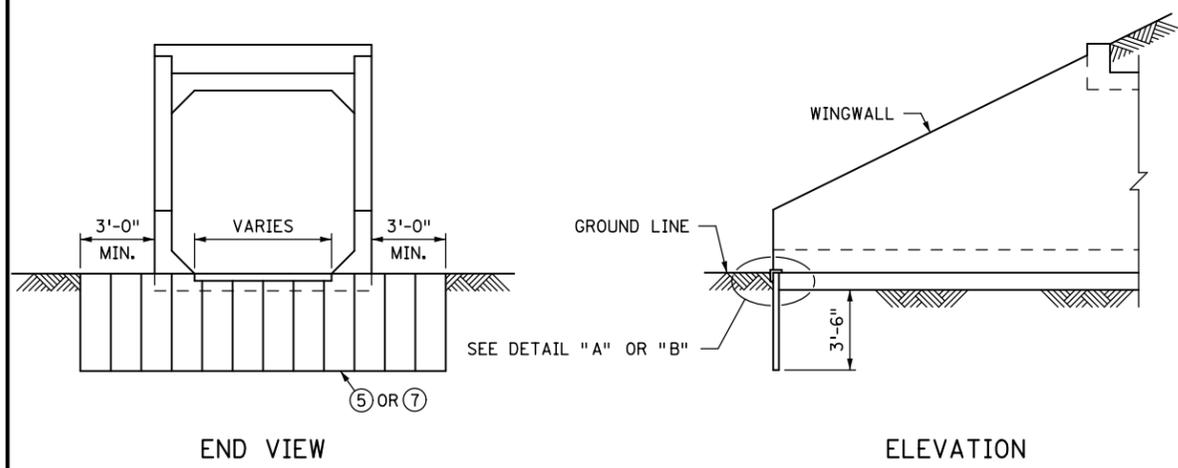
FIG. 5-395.110(B)

CERTIFIED BY _____
LICENSED PROFESSIONAL ENGINEER DATE _____
NAME: _____ LIC. NO. _____

TITLE: PRECAST CONCRETE END SECTION
TYPE III - SINGLE OR DOUBLE BARREL
FOR SKEWS 7¹/₂' TO 45'

DES: _____ DR: _____ APPROVED: _____
CHK: _____ CHK: _____ SHEET NO. OF SHEETS

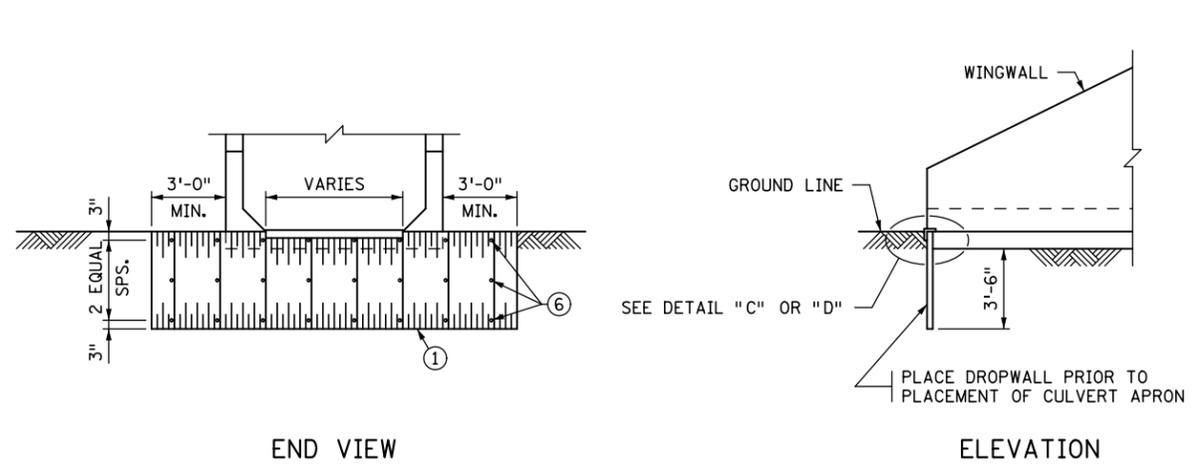
BRIDGE NO.



END VIEW

ELEVATION

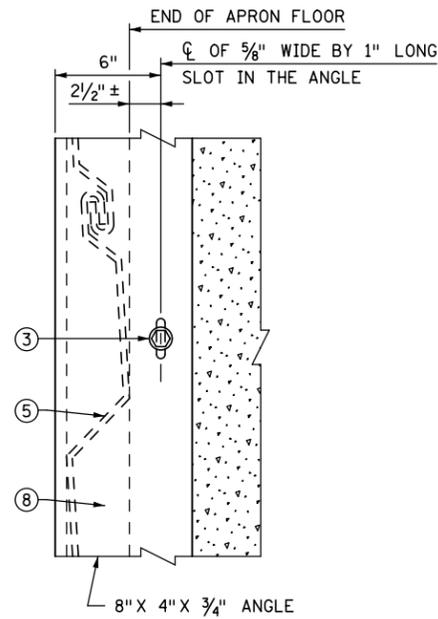
ALTERNATES 1 & 2 (STEEL SHEET PILING)



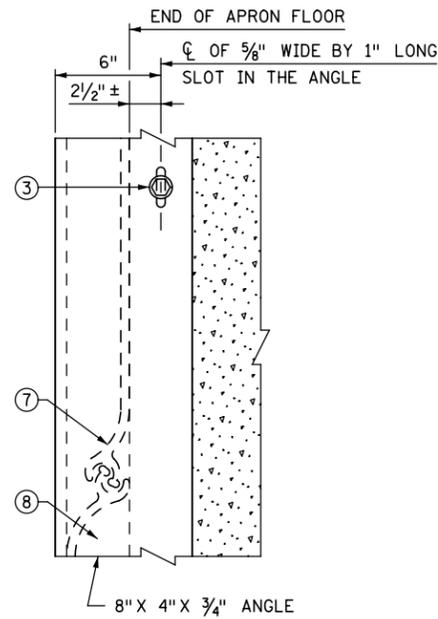
END VIEW

ELEVATION

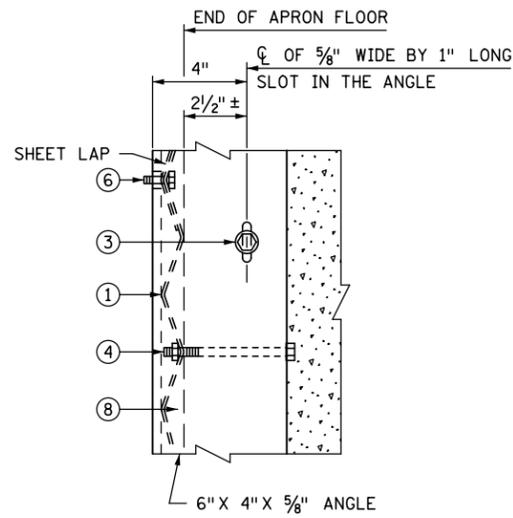
ALTERNATES 3 & 4 (GALVANIZED STEEL SHEETS)



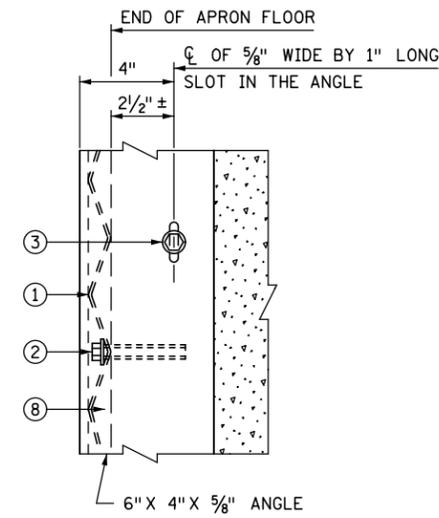
PLAN



PLAN

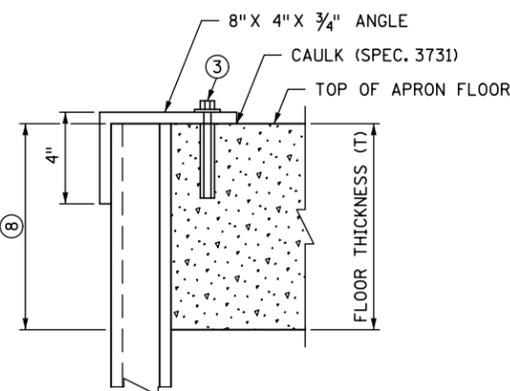


PLAN



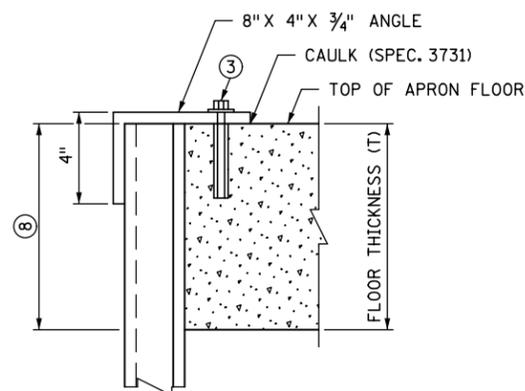
PLAN

DESIGNER NOTE
 (REMOVE PRIOR TO PLOTTING FINAL PLAN):
 BEFORE CULVERT PLANS ARE PREPARED, TAKE
 SAMPLES FROM THE DRAINAGE AREA
 FOR PH DETERMINATION. THE SOIL AND WATER SHOULD
 HAVE A PH OF 6.5 OR MORE IF SHEET STEEL IS USED.



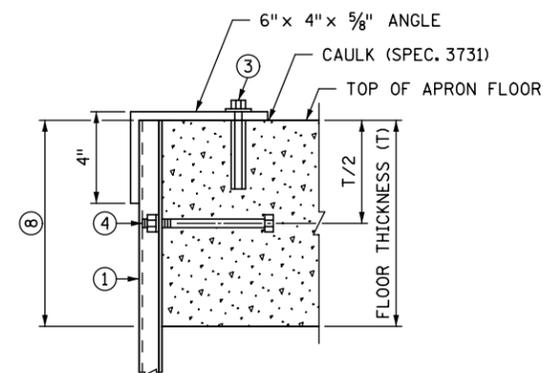
ELEVATION

DETAIL "A" - ALTERNATE 1
 STEEL SHEET PILING SHOWN



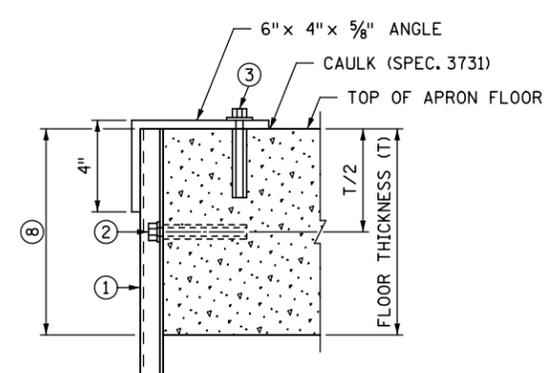
ELEVATION

DETAIL "B" - ALTERNATE 2
 STEEL SHEET PILING SHOWN



ELEVATION

DETAIL "C" - ALTERNATE 3
 ON NEW CONSTRUCTION ONLY



ELEVATION

DETAIL "D" - ALTERNATE 4
 ON NEW OR OLD CONSTRUCTION

CONSTRUCTION NOTES

GALVANIZE ALL FASTENERS AND ANCHORS PER SPEC. 3392.

GALVANIZE STEEL ANGLES PER 3394.

- ① 2 1/2" x 1/2" OR 2 2/3" x 1/2" CORRUGATED (12 GAGE) OR HEAVIER GALVANIZED STEEL SHEETS.
- ② FASTEN THE STEEL SHEETS TO THE FRONT EDGE OF THE APRON WITH 3/8" DIAMETER BY 4" LONG BOLTS AND APPROVED ANCHORAGES (10" ± CENTER TO CENTER, TO THE NEAREST VALLEY).
- ③ FASTEN THE 8" x 4" x 3/4" OR 6" x 4" x 5/8" ANGLE WITH 3/8" DIAMETER 4" LONG BOLTS, 1" O.D. WASHER AND AN APPROVED ANCHORAGE (2'-0" SPACING).
- ④ FASTEN THE STEEL SHEETS TO THE FRONT EDGE OF THE APRON WITH 3/8" DIAMETER 5" LONG BOLTS, NUT AND LOCK WASHER (10" ± CENTER TO CENTER, TO THE NEAREST VALLEY).
- ⑤ (12 GAGE) GALVANIZED CORRUGATED STEEL SHEET PILING, INTERLOCKING TYPE A.
- ⑥ 3/8" DIA. x 1" LONG BOLT WITH NUT, TO LAP STEEL SHEETS.
- ⑦ STEEL SHEET PILING, SECTION NO. MP-112 OR EQUAL.
- ⑧ FILL THE VOIDS AS SHOWN, WITH CONCRETE OR CONCRETE GROUT, AS APPROVED BY THE ENGINEER.

REVISION: 10-09-2015
 APPROVED: MARCH 24, 2011
 Nancy Subenberger
 STATE BRIDGE ENGINEER

STATE PROJ. NO		- (T.H.) STA. +		FIG. 5-395.111	
CERTIFIED BY	DATE	TITLE:	DES:	DR:	APPROVED:
NAME:	LIC. NO.	ALTERNATE DROPWALLS FOR BOX CULVERTS	CHK:	CHK:	BRIDGE NO.
			SHEET NO. OF SHEETS		

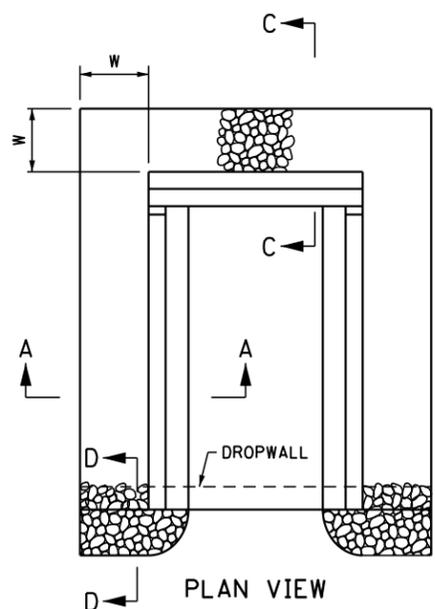
CONSTRUCTION NOTES

THIS PLAN SHEET IS FOR CULVERT EMBANKMENT PROTECTION ONLY. REFER TO THE GRADING PLANS FOR ADDITIONAL RIPRAP OR OTHER SCOUR PROTECTION MEASURES.

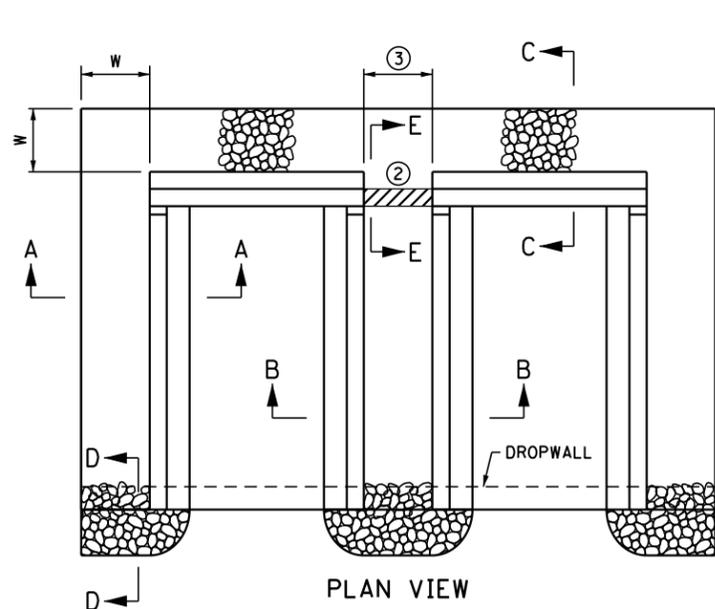
PROVIDE RIPRAP PER SPECS. 2511 AND 3601.

EMBANKMENT PROTECTION, INCLUDING MATERIAL PLACED BETWEEN BARRELS THAT ARE LESS THAN 2'-0" APART, IS INCIDENTAL.

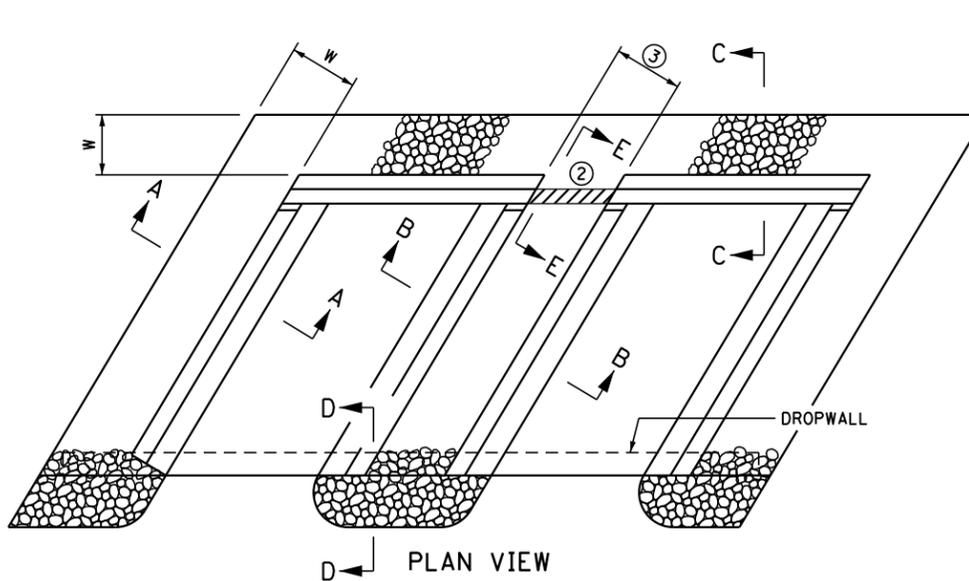
- ① FOR TYPE OF GEOTEXTILE FILTER MATERIAL REQUIRED, SEE SPEC. 3733. PROVIDE GEOTEXTILE STRIPS CONTINUOUS WITHOUT OVERLAPS, EXCEPT FOR THE TOP STRIP, WHICH SHOULD SHINGLE VERTICAL STRIPS. BURY THE TOP EDGE TO PREVENT UNDERMINING.
- ② IF THE DISTANCE BETWEEN DOUBLE BARRELS IS LESS THAN 2'-0" USE EITHER PEA ROCK OR LEAN MIX BACKFILL (SPEC. 2520) BETWEEN THE CULVERTS AS APPROVED BY THE ENGINEER. IF PEA ROCK IS USED PROVIDE APPROVED GROUT SEEPAGE CUTOFF CORE, MINIMUM 12" THICK BETWEEN THE CULVERT'S TWO ENDS AND PROVIDE CLASS I GROUTED RIPRAP IN LIEU OF CLASS III RIPRAP.
- ③ REFER TO THE GENERAL PLAN AND ELEVATION SHEET FOR THE DISTANCE BETWEEN BARRELS OF ADJACENT BOXES.



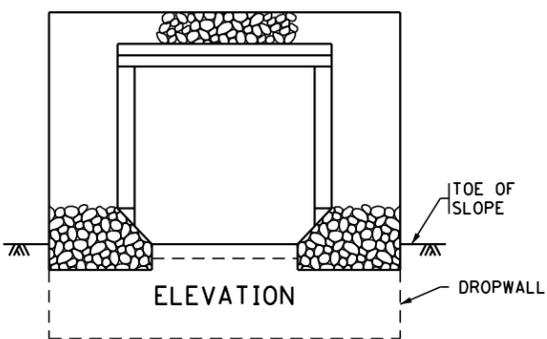
PLAN VIEW



PLAN VIEW

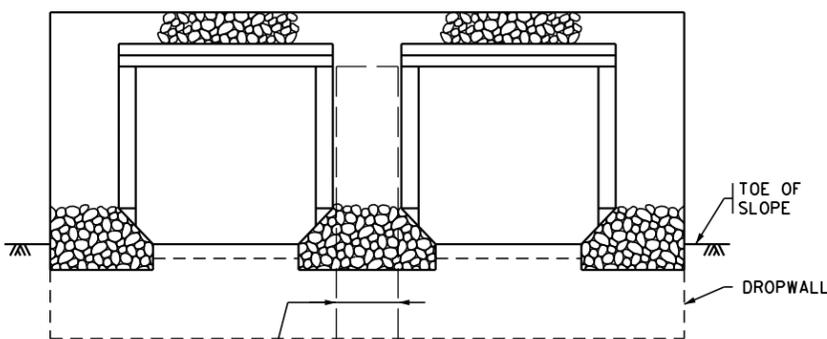


PLAN VIEW



ELEVATION

SINGLE BARREL
CLASS III OR IV SHOWN FOR SKEWS UP TO 7 1/2°

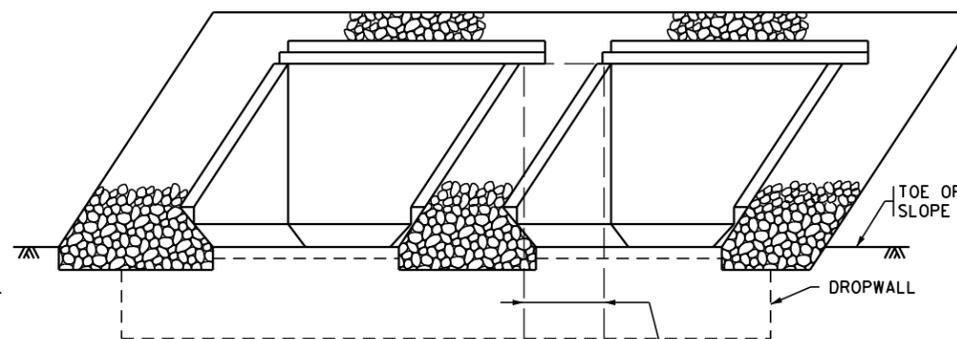


ELEVATION

APPROVED GROUT SEEPAGE CUTOFF CORE ②

MULTIPLE BARREL

FOR SKEWS UP TO 7 1/2° CLASS III OR IV SHOWN DOUBLE BARREL SHOWN

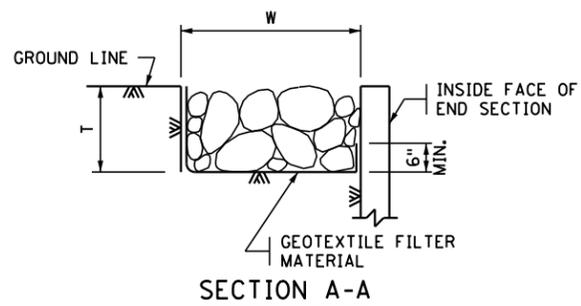


ELEVATION

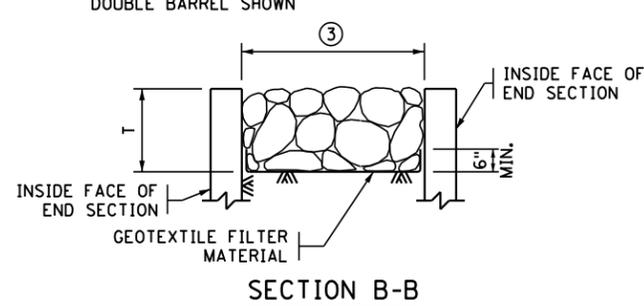
MULTIPLE BARREL

FOR SKEWS OVER 7 1/2° CLASS III OR IV SHOWN DOUBLE BARREL SHOWN, OTHER BARREL CONFIGURATIONS SIMILAR.

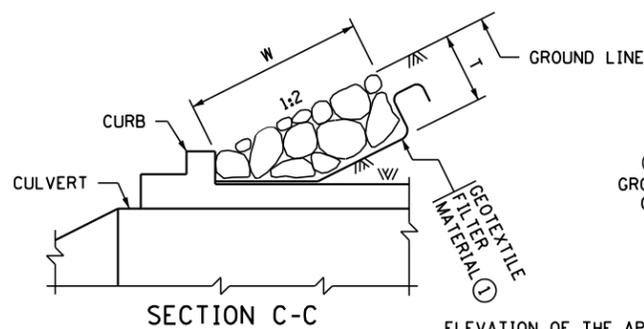
APPROVED GROUT SEEPAGE CUTOFF CORE ②



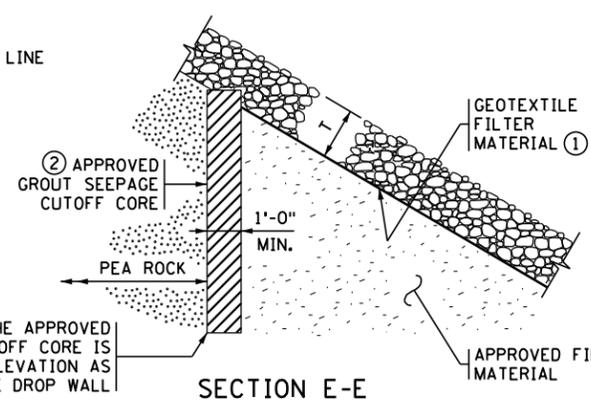
SECTION A-A



SECTION B-B

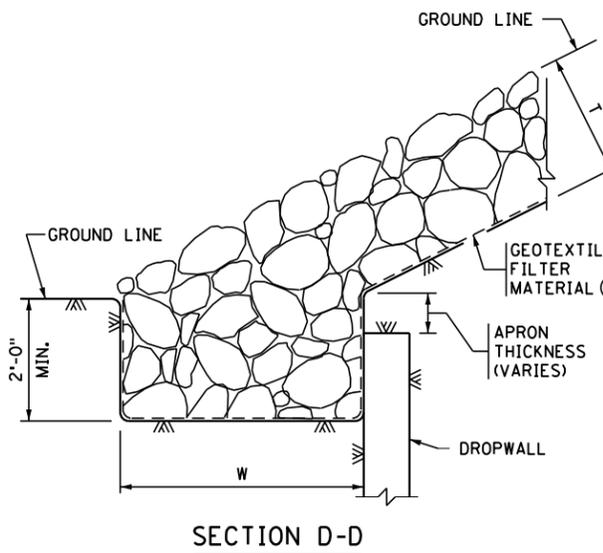


SECTION C-C



SECTION E-E

ELEVATION OF THE APPROVED GROUT SEEPAGE CUTOFF CORE IS TO BE THE SAME ELEVATION AS THE BOTTOM OF THE DROP WALL



SECTION D-D

RIPRAP CLASS

RIPRAP CLASS	RIPRAP CLASS	T	W
<input type="checkbox"/>	III	1'-6"	3'-0"
<input type="checkbox"/>	IV	2'-0"	4'-0"

DESIGNER NOTE: REMOVE PRIOR TO PLOTTING FINAL PLAN
DESIGNER TO SELECT EITHER CLASS III OR IV RIPRAP USING CHECK BOX ABOVE.

REVISION: 10-22-2019

APPROVED: SEPTEMBER 11, 2014

Nancy M. Beninger
STATE BRIDGE ENGINEER

STATE PROJ. NO. - (T.H.) STA. + .

FIG. 5-395.115

CERTIFIED BY _____ DATE _____
LICENSED PROFESSIONAL ENGINEER
NAME: _____ LIC. NO. _____

TITLE: **EMBANKMENT PROTECTION FOR BOX CULVERTS**

DES: _____ DR: _____ APPROVED: _____
CHK: _____ CHK: _____
SHEET NO. OF SHEETS

BRIDGE NO.