8	N.D.	F-1-094(03)	89

D-630-2

REINFORCED CONCRETE PIPE ARCH CULVERTS AND END SECTIONS

SPAN-RISE (IN)	SIZE (IN)	T (IN)	RISE (IN)	SPAN (IN)	WATER AREA (S.F.)	Min. and Max. Cover in Feet: CLASS II Normal Backfill	CLASS II Sewer Trench	CLASS III Normal Backfill	CLASS III Sewer Trench	CLASS IV Normal Backfill	CLASS IV Sewer Trench
22x13	18	2 1/2	13 1/2	22	1.65	3-10		2-3 10-14	2-13	1-2 14-21	1-2 13-50
29x18	24	3	18	28 1/2	2.8	3-10	4-6	2-3 10-14	2-4 6-12	1-2 14-22	1-2 12-26
36x23	30	3 1/2	22 1/2	36 1/4	4.4	3-10	3-7	1-3 10-14	1-3 7-13	14-22	13-25
44x27	36	4	26 5/8	43 3/4	6.4	2-10	2-8	1-2 10-14	1-2 8-13	14-22	13-25
51x31	42	4 1/2	31 5/16	51 1/8	8.8	1-10	2-8	10-15	8-14	15-22	14-25
58x36	48	5	36	58 1/2	11.4	1-10	1-8	10-15	8-14	15-22	14-25
65x40	54	5 1/2	40	65	14.3	1-11	1-8	11-15	8-12	15-22	12-21
73x45	60	6	45	73 1/2	17.7	1-11	1-8	11-15	8-12	15-22	12-21
88x54	72	7	54	88	25.6	1-12	1-9	12-15	9-13	15-23	13-22
102x62	84	8	62	102	34.6	1-12	1-9	12-16	9-14	16-23	14-22
115x72	90	8 1/2	72	115 1/2	44.5	1-14	1-13	14-17	13-16	17-24	16-24
122x78	96	9	78	122 3/8	51.7	1-14	1-13	14-17	13-16	17-24	16-24
138x88	108	10	88	138 1/2	66.0	1-14	1-14	14-18	14-17	18-25	17-25
154x97	120	11	96 7/8	154	81.8	1-15	1-14	15-19	14-17	19-25	17-25

SPAN-RISE	Dimensions of End Sections: D (IN)	E (IN)	I (IN)	J (IN)	K (IN)	L (IN)	N (IN)	R (IN)	SLOPE	WEIGHT IN LBS. SEC.1	SEC.2
22x13	72	36	45	7			27	2	3:1		
29x18	72	48	30	8 9/16			42	3	3:1		
36x23	96	60	46	9 1/2			50	3	3:1		
44x27	96	72	36	11 1/8			60	6	3:1		
51x31	96	78	36	15 13/16			60	6	3:1		
58x36	96	84	36	21			60	6	3:1		
65x40	96	90	36	25 1/2			60	6	3:1		
73x45	96	96	36	31			60	6	3:1		
88x54	99	120	39	31			60	6	2:1		
102x62	102	144	19	28 1/2			83	6	2:1		
115x72	133 1/4			29 1/4	30 1/4	48			2:1	19100	3930
122x78	143 1/4			30 1/4	40 1/2	54			2:1	22000	6060
138x88	160 1/2			32 1/4	57 1/2	66			2:1	27940	10920
154x97	175			35 3/4	72	78			2:1	34600	17010

SPAN-RISE	Dimensions of Intermediate Sections: A (IN)	B (IN)	C (IN)	F (IN)	G (IN)	H (IN)	M (IN)	R1 (IN)	R2 (IN)	R3 (IN)	S (IN)	U (IN)	V (IN)
22x13	1 3/8	3/8	3/4	1 1/8	1	2	1	27 1/2	13 3/4	5 1/4	7 1/8		
29x18	1 5/8	1/2	1 3/8	1 3/8	1 5/8	3	3	40 3/4	15	4 7/8	10 7/8		
36x23	1 13/16	5/8	1 9/16	1 9/16	1 13/16	3 1/2	3 13/16	51	18 3/4	6 1/8	13 5/8	26	29
44x27	2	3/4	1 3/4	1 3/4	2	4	4 1/8	62	22 1/2	6 1/2	17 1/8	30	34
51x31	2	3/4	1 3/4	1 3/4	2	4	5 1/16	73	26 1/4	7 3/4	20	34	39
58x36	2 1/4	3/4	2	2	2 1/4	5	6	84	30	8 7/8	22 3/4	42	43
65x40	3	3/4	1 3/4	2 1/2	2 1/4	5	6 1/2	92 1/2	33 1/2	10	25 1/4	48	49
73x45	3 5/16	3/4	1 15/16	2 3/4	2 1/2	5	7 1/2	105	37 1/2	11 1/16	28 1/2	52	55
88x54	3 13/16	1	2 3/16	3 1/4	2 3/4	6	9	126	45	13 5/16	34 3/16	60	67
102x62	4 1/8	1	2 7/8	3 1/2	3 1/2	6	10 5/8	162 1/2	52	14 1/2	38	68	77
115x72	4 1/4	1	3 1/4	3 3/4	3 3/4	7	13	183	59	18	39 13/16	40	87
122x78	4 1/2	1	3 1/2	4	4	7	15 1/4	218	62	20	41	41	96
138x88	5	1	4	4 1/2	4 1/2	7	17 1/8	269	70	22	47 1/16	48	105
154x97	5 1/2	1	4 1/2	5	5	7	18 7/8	301 3/8	78	24	53	70	125

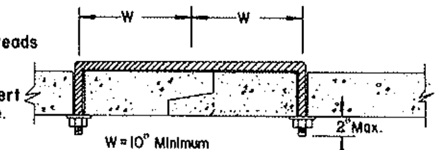
SPAN-RISE	Stirrup Requirements: CLASS III Y (IN)	CLASS III Asy	CLASS IV X (IN)	CLASS IV Y (IN)	CLASS IV Asx	CLASS IV Asy	fc (KSI) CLASS II	CLASS III	CLASS IV	WT. PER FOOT (LBS.)
22x13							4	4	4	165
29x18							4	4	4	314
36x23							4	4	4	445
44x27							4	4	4	597
51x31							4	4	4	739
58x36							4	4	4	882
65x40							4	4	4	1067
73x45	48	0.55	36	48	0.44	0.98	4	4	5	1320
88x54	60	0.66	48	60	0.55	1.18	4	5	5	1840
102x62	72	0.77	60	72	0.66	1.37	4	5	5	2412
115x72	84	0.88	72	84	0.77	1.57	4	5	5	2894
122x78	84	0.88	72	84	0.77	1.57	4	5	5	3285
138x88	96	0.99	84	96	0.88	1.77	5	5	5	4126
154x97	108	1.10	96	108	0.99	1.96	5	5	5	5048

SPAN-RISE	Double Line Reinforcement, As Continuous Basic Reinforcement: Inner Cage CL. II	Inner CL. III	Inner CL. IV	Outer Cage CL. II	Outer CL. III	Outer CL. IV	As Additional Reinforcement: "U" Inner Cage CL. II	"U" CL. III	"U" CL. IV	"V" Outer Cage CL. II	"V" CL. III	"V" CL. IV	Single Line Reinforcement CL. II	CL. III	CL. IV
22x13													0.11	0.14	0.26
29x18													0.16	0.22	0.32
36x23	0.09	0.12	0.18	0.07	0.09	0.14	0.09	0.12	0.18	0.07	0.09	0.13	0.18	0.24	0.36
44x27	0.11	0.15	0.22	0.09	0.12	0.17	0.11	0.15	0.22	0.09	0.12	0.16	0.22	0.30	0.44
51x31	0.13	0.18	0.27	0.10	0.14	0.21	0.13	0.18	0.27	0.10	0.14	0.22	0.26	0.36	0.54
58x36	0.15	0.22	0.33	0.12	0.17	0.25	0.15	0.22	0.33	0.12	0.17	0.25	0.30	0.44	
65x40	0.18	0.24	0.38	0.14	0.19	0.29	0.18	0.24	0.38	0.14	0.19	0.29	0.36	0.48	
73x45	0.21	0.28	0.41	0.17	0.22	0.31	0.21	0.28	0.41	0.17	0.22	0.31	0.42	0.56	
88x54	0.26	0.36	0.50	0.20	0.28	0.38	0.26	0.36	0.50	0.20	0.28	0.38	0.52	0.72	
102x62	0.32	0.44	0.58	0.24	0.34	0.44	0.32	0.44	0.58	0.24	0.34	0.44	0.64	0.88	
115x72	0.40	0.53	0.75	0.28	0.36	0.51	0.40	0.53	0.75	0.28	0.36	0.51			
122x78	0.42	0.54	0.77	0.30	0.39	0.56	0.42	0.54	0.77	0.30	0.39	0.56			
138x88	0.50	0.64	0.91	0.34	0.45	0.63	0.50	0.64	0.91	0.34	0.45	0.63			
154x97	0.59	0.76	1.07	0.41	0.53	0.76	0.59	0.76	1.07	0.41	0.53	0.76			

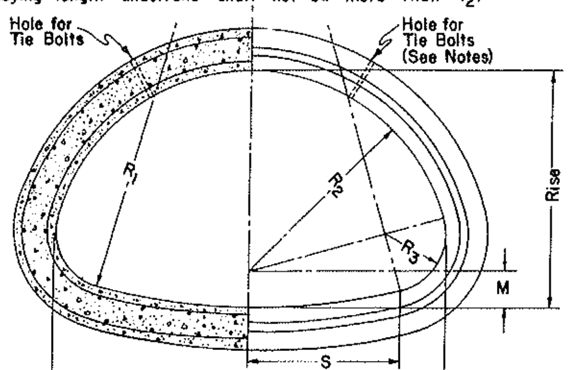
Size = Dia. of Circular Pipe with approximately equivalent cross section area.
As = Minimum Circumferential Steel Area (in square inches) per lineal foot of pipe barrel in each continuous basic cage and additional cages in area denoted "U" and "V."
Asy and Asx = Minimum Stirrup Reinforcement Steel Area in square inches per lineal feet of Pipe Arch.
Maximum spacing of Stirrups = 12"
Tolerance in radial dimensions at Joints = ± 1/8 for 54" or smaller & ± 1/4" for 60" or larger.
Tolerance in length of Joints (H) ± 1/4".
Laying length underruns shall not be more than 1/2".

fc(KSI) = Minimum compressive strength of concrete in thousands of lbs. per square inch.
Laying length of pipe shall not be less than 6 feet for size 84" and larger.
3/4" Minimum Reinforcement cover.
Reinforced Concrete Pipe Arch & End Sections shall conform to Sec. 630 of the St'd. Spec's.
Design of End Sections shall confirm to Class II Reinforced Concrete Pipe Arch.
Tolerance in Rise and Span = ± 2% of Tabular values.
Tolerance in Wall thickness (T) = Not less than Design T by more than 7% or 1/4".
Dimension "U" and "V" is measured on the ℄ of the Culvert wall.
All reinforcement shall be electrically welded cold drawn steel wire fabric.

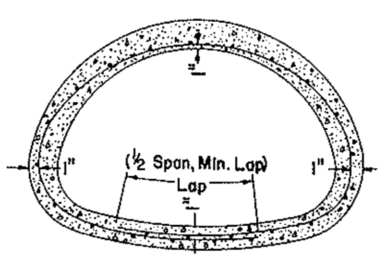
U-Bolts shall be 1" nominal dia. with threads on each end.
Galvanizing of U-Bolts is not required.
The two end joints of each end of culvert shall be tied on sizes 42" to 84" inclusive.
On culverts larger than 84", all joints shall be tied.
The holes in the pipe may be cast or drilled and shall be no larger than necessary to accomodate the threaded portion of the U-Bolts.
Joints may also be tied as shown on Std. Drwg. No. D-630-1.
Tie Bolts and fasteners or U-Bolts shall be incidental to the price bid for R.C.P. Arch or End Sections.



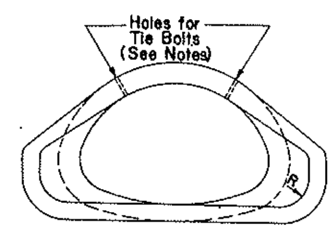
U-BOLT DETAIL



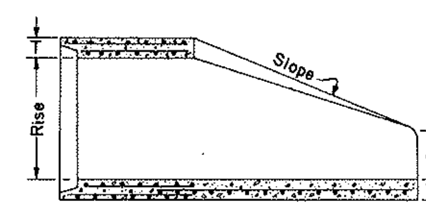
TRANSVERSE SEC. END VIEW



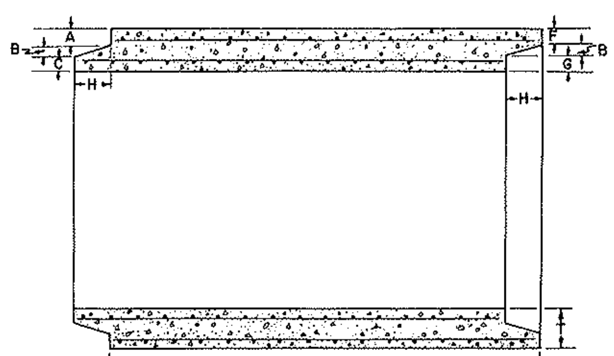
SINGLE-LINE REINFORCEMENT



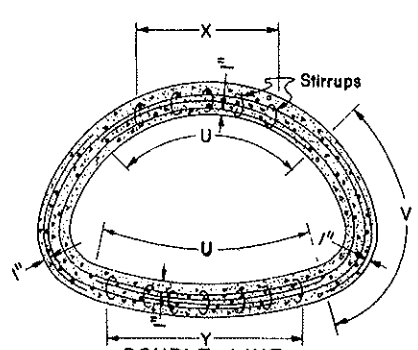
END VIEW



A-A



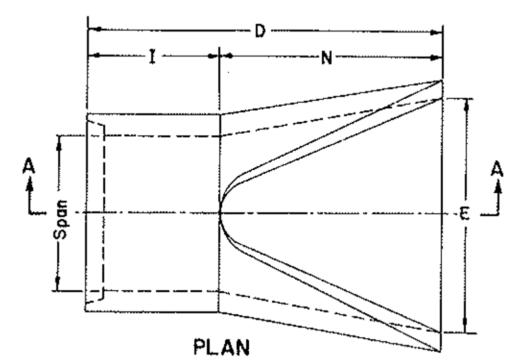
LONGITUDINAL SECTION



DOUBLE-LINE REINFORCEMENT

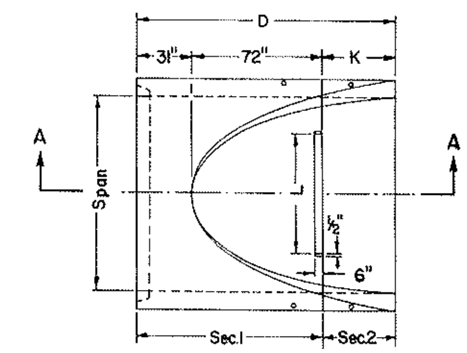
REINFORCED CONCRETE PIPE ARCH CULVERT


PERSPECTIVE

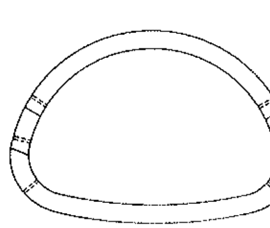


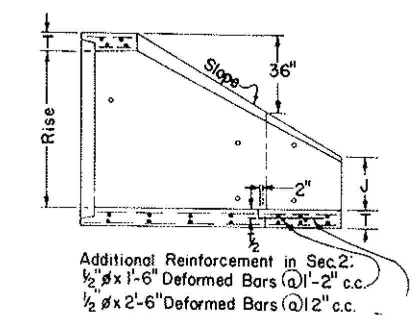
PLAN

END SECTION FOR ARCHES SMALLER THAN 90"



PLAN
TWO-PIECE END SECTION


END VIEW



Additional Reinforcement in Sec. 2:
1/2" ø x 1'-6" Deformed Bars @ 1'-2" c.c.
1/2" ø x 2'-6" Deformed Bars @ 12" c.c.
A-A

END SECTION FOR ARCHES 90" AND LARGER

1-1-75	
REVISIONS	
DATE	CHANGE

NORTH DAKOTA STATE HIGHWAY DEPARTMENT
Submitted: [signature] Design Engineer
Recommended: Asst. Chief Engineer Pre-Construction
Approved: [signature] Chief Engineer

4 17A

CORRUGATED STEEL PIPE CULVERTS AND END SECTIONS

(ROUND PIPE)

NOTES

Pipe and Connecting Bands shall conform to applicable sections of NDSHD Standard Specifications and to AASHO M-36.

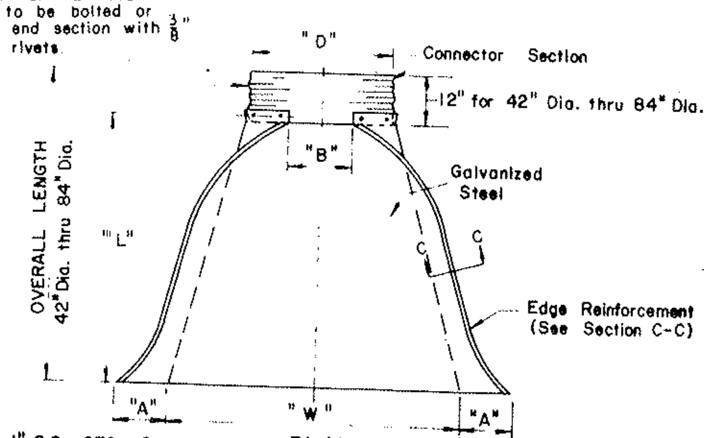
Top edge of all End Sections to have tubing reinforcement or rolled tubed reinforcement (See Section A-A). The tubing is to be supplemented with 2"x2"x¼" Galv. Angle for 60" thru 72" Dia. and 2½"x2½"x¼" Galv. Angle for 78" and 84" Dia. Angles to be attached by Gal. ⅜" Ø bolts and nuts. Angles are to extend from Pipe to the corner wing bend.

Elongated pipe shall be factory preformed so that the vertical diameter shall be 5% greater and the horizontal diameter 5% less than a circular pipe.

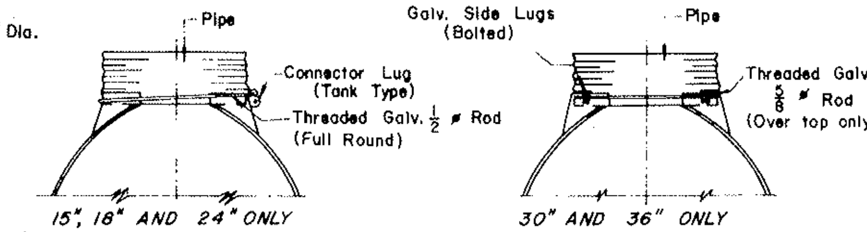
Fill Height Tables are based on the following criteria:

1. Embankment weight = 120 lb/ft³
2. Max. pipe deflection = 5%
3. Bedding - Class C
4. Compaction = 95% Proctor Density
5. Modulus of passive soil resistance (E') = 1400 psi
6. H-20 Live Load

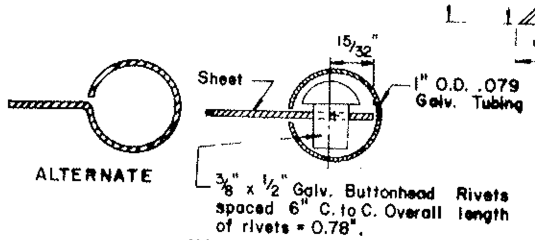
This connection for 42" thru 84" diameter pipe to be bolted or riveted to the end section with ⅜" Galv. bolts or rivets.



PLAN



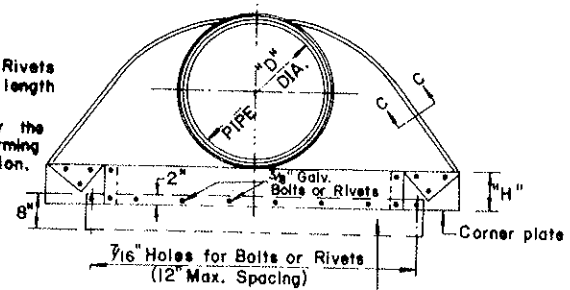
ROD CONNECTION DETAILS



⅜" x ½" Galv. Buttonhead Rivets spaced 6" C. to C. Overall length of rivets = 0.78".

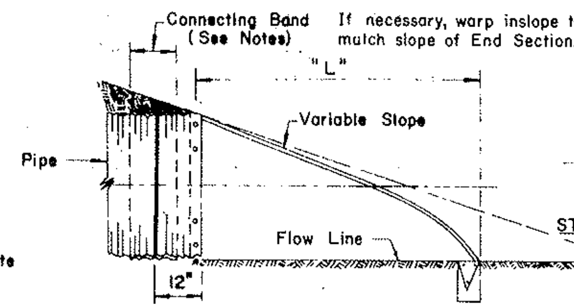
NOTE: Tubing is slipped over the sheet and rivets prior to forming operations of the End Section.

SECTION C-C



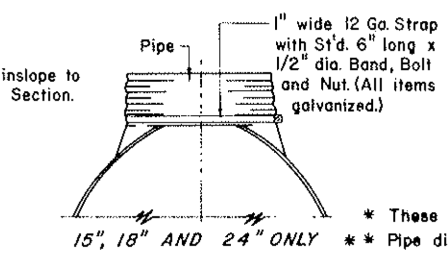
ELEVATION

Galv. Toe Plate required on End Sections for pipe of 30" dia. or larger. Plate to be fastened to End Section in field. Thickness of Toe Plate to be same as End Section. Where Toe Plate is needed the Toe Plate, Bolts and Nuts are to be included in price bid for End Sections.



TYPICAL CROSS-SECTION

(Showing Connector Section)



STRAP CONNECTION DETAILS

END SECTIONS

** PIPE DIA (In)	GALV THICK.	DIMENSIONS A In	B In	H In	L In	W In	Approx Slope Rate	Body Piece
15	.064	7	8	6	26	30	2-1/2:1	1
18	.064	8	10	6	31	36	2-1/2:1	1
24	.064	10	13	6	41	48	2-1/2:1	1
30	.079	12	16	8	51	60	2-1/2:1	1
36	.079	14	19	9	60	72	2-1/2:1	2
42	.109	16	22	11	69	84	2-1/2:1	2
48	.109	18	27	12	78	90	2-1/4:1	2
54	.109	18	30	12	84	102	2:1	2
*60	.109	18	33	12	87	114	1-3/4:1	3
*66	.109	18	36	12	87	120	1-1/2:1	3
*72	.109	18	39	12	87	126	1-1/3:1	3
*78	.109	18	42	12	87	132	1-1/4:1	3
*84	.109	18	45	12	87	138	1-1/6:1	3

* These sizes have 0.138 in. center panels.
** Pipe diameter is equal to dimension "D" of end section.
Manufacturers tolerances of above dimensions will be allowed.
Splices to be the lap riveted type.
Multiple panel bodies shall have lap seams which are to be tightly joined with ⅜" Ø galv. bolts or rivets. Nuts to be torqued to 25 lbs. ±.

FILL HEIGHT TABLES

RIVETED, WELDED OR HELICAL FABRICATION

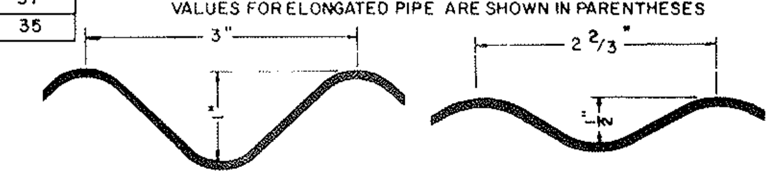
3" BY 1" CORRUGATIONS

WATERWAY AREA SQ. FT.	PIPE DIA (IN.)	MIN. COVER (IN.)	MAX. FILL HEIGHTS OVER TOP OF PIPE — GALV METAL THICKNESS (IN.) .064	.079	.109	.138	.168
7.1	36	12	48	60	78 (88)	89 (106)	101 (118)
9.6	42	12	41	51	64 (76)	71 (91)	79 (101)
12.6	48	12	36	45	57 (66)	61 (80)	66 (88)
15.9	54	12	32	40	52 (59)	55 (71)	59 (79)
19.6	60	12	29	36	49 (53)	51 (64)	54 (71)
23.8	66	12	26	33	47	49 (58)	51 (64)
28.3	72	12	24	30	44	47 (53)	49 (59)
33.2	78	12	22	28	41	46 (49)	47 (54)
38.5	84	12	21	26	38	45	46 (51)
44.2	90	12	19	24	35	43	45
50.3	96	12	18	22	33	40	44
56.7	102	24	17	21	31	38	42
63.6	108	24		20	30	35	39
70.9	114	24		19	28	34	37
78.5	120	24			27	32	35

2⅔" BY ½" CORRUGATIONS

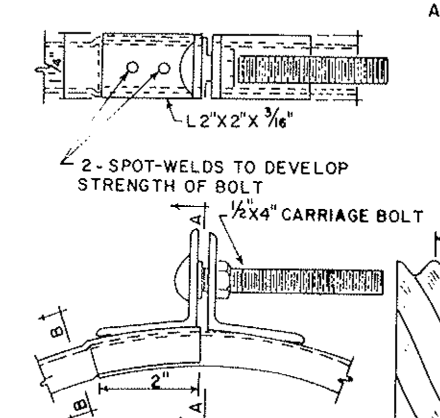
WATERWAY AREA SQ. FT.	PIPE DIA. (IN.)	MIN. COVER (IN.)	MAX. FILL HEIGHTS OVER TOP OF PIPE — GALV. METAL THICKNESS (IN.) .064	.079	.109	.138	.168
1.2	15	12	67	73			
1.8	18	12	56	61			
3.1	24	12	42	46	59		
4.9	30	12	34	36	47		
7.1	36	12	28	30	39	41	
9.6	42	12	31	43	46 (67)	48 (70)	50 (73)
12.6	48	12	27	37	45 (58)	46 (61)	47 (64)
15.9	54	12		33	43 (52)	44 (54)	45 (57)
19.6	60	12			43 (47)	43 (49)	44 (51)
23.8	66	12			42	43	43 (47)
28.3	72	12				41	43
33.2	78	12					39
38.5	84	12					35

VALUES FOR ELONGATED PIPE ARE SHOWN IN PARENTHESES

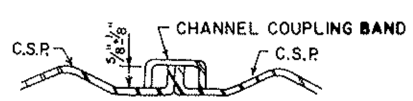


3" BY 1" CORRUGATIONS

2⅔" BY ½" CORRUGATIONS

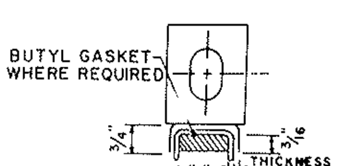


2-SPOT-WELDS TO DEVELOP STRENGTH OF BOLT



SECTION "B-B"

CHANNEL COUPLING BAND FOR USE ON FLANGED END C.S.P.
(CHANNEL COUPLING BANDS SHALL BE TWO PIECE)

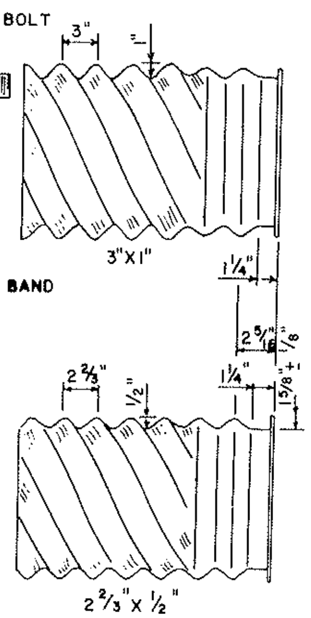


NOMINAL DIMENSIONS

THICKNESS	"A"	FOR USE WITH C.S.P.
0.079"	¾	0.09" THICK OR LIGHTER
0.109"	1"	0.138" THICK OR HEAVIER

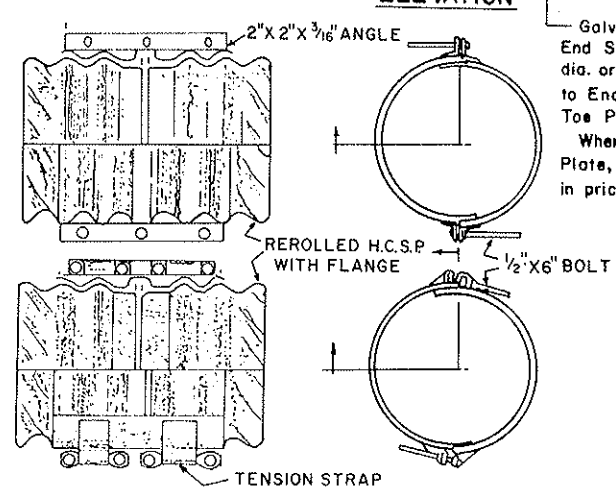
SECTION "AA"

CORRUGATED STEEL PIPE FLANGE BAND DETAILS

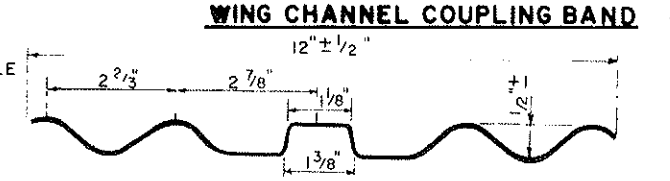


SPIRAL C.S.P.

REFORMED TO ACCEPT FLANGE, ANNULAR, DIMPLE AND HUGGER COUPLERS

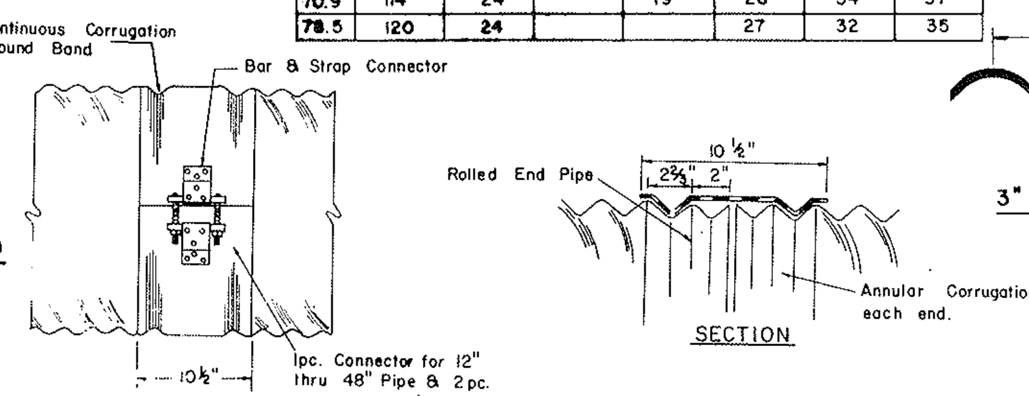


WING CHANNEL COUPLING BAND



CROSS SECTION OF WING CHANNEL COUPLING BAND

WING CHANNEL COUPLING BAND FOR ANNULAR C.S.P. OR REFORMED H.C.S.P.



1pc. Connector for 12" thru 48" Pipe & 2pc. above.

CONNECTING BAND DETAILS FOR HELICAL, WELDED - SEAM CULVERT

6-1-74 REVISIONS	
DATE	CHANGE
1-1-75	Connecting Band
3-16-77	Connecting Strap
5-1-78	Flange Band Details

NORTH DAKOTA STATE HIGHWAY DEPARTMENT

Submitted: [signature] Design Engineer

Recommended: Asst. Chief Engineer Pre-Construction

Approved: [signature] Chief Engineer