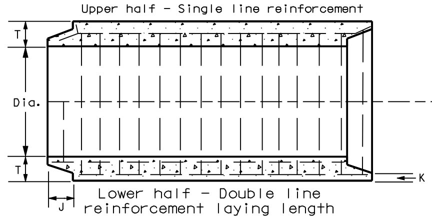
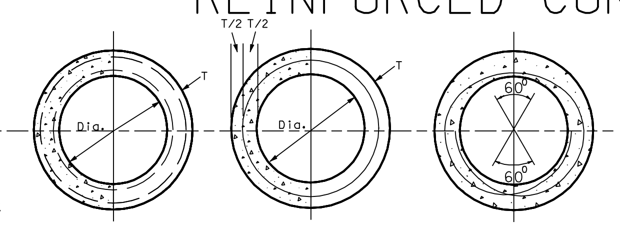
REINFORCED CONCRETE PIPE CULVERT AND END SECTIONS

D-714-1



REINFORCED CONCRETE PIPE
TYPICAL LONGITUDINAL SECTION

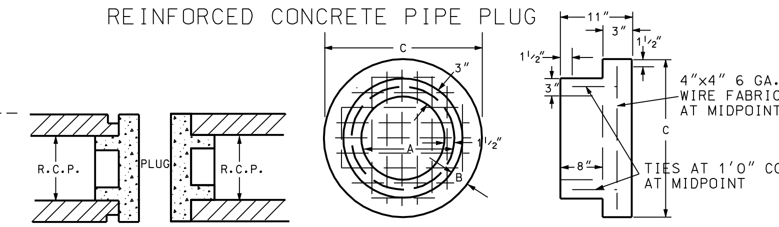


END VIEW
Double line reinforcement

END VIEW
Single line reinforcement

END VIEW
Top half showing Elliptical reinforcement. Bottom half showing Elliptical & Inner Cage reinforcement

REINFORCED CONCRETE PIPE PLUG

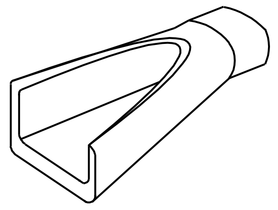


CONCRETE SHALL CONFORM TO STRENGTH REQUIREMENTS FOR REINFORCED CONCRETE PIPE CULVERTS, CL. II.

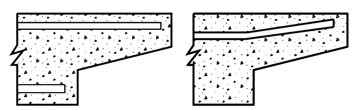
CONCRETE PIPE PLUG DIMENSIONS (in inches)			
PIPE DIAMETER	A	B	C
15	8	2.25	19.5
18	11	3.0	23.0
21	14	3.25	26.5
24	17	3.50	30.0
27	20	3.75	33.5
30	23	4.0	37.0
33	26	4.25	40.5
36	29	4.50	44.0
42	35	5.0	51.0
48	41	5.50	58.0

SEE STANDARD D-714-22 FOR DETAILS OF CONCRETE PIPE TIES (TIE BOLTS).

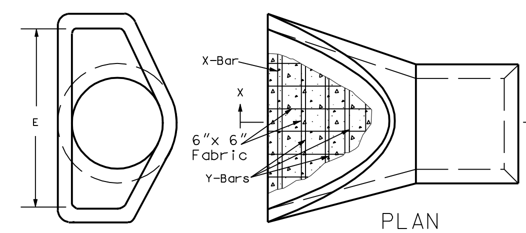
END SECTION										
	TERMINAL DIMENSIONS							REINFORCING STEEL		
DIA	A	B	C	D	E	F	G	X	Y	Z
12	0'-4"	2'-0"	4'-0 7/8"	6'-0 7/8"	2'-0"	2"	2"	2-1/4" x 2'	6-1/4"x 2' @ 6"c.c.	2-1/4"x 4'
15	0'-6"	2'-3"	3'-10"	6'-1"	2'-6"	2 1/4"	2 1/4"	2-1/4" x 2 1/2'	6-1/4"x 2 1/2' @ 6"c.c.	2-3/8"x 4'
18	0'-9"	2'-3"	3'-10"	6'-1"	3'-0"	2 1/2"	2 1/2"	2-3/8" x 3'	6-1/4"x 3' @ 6"c.c.	2-3/8"x 4'
21	0'-9"	3'-0"	3'-1 1/2"	6'-1 1/2"	3'-6"	2 3/4"	2 3/4"	2-3/8" x 3 1/2'	8-1/4"x 3 1/2' @ 6"c.c.	2-3/8"x 5'
24	0'-9 1/2"	3'-7 1/2"	2'-6"	6'-1 1/2"	4'-0"	3"	3"	2-1/2" x 4'	8-3/8"x 4' @ 8"c.c.	2-3/8"x 6'
27	0'-10 1/2"	4'-1 1/2"	2'-0"	6'-1 1/2"	4'-6"	3 1/4"	3 1/4"	2-1/2 " x 5'	8-3/8"x 5' @ 9"c.c.	2-3/8"x 6'
30	1'-0"	4'-6"	1'-7 3/4"	6'-1 3/4"	5'-0"	3 1/2"	3 1/2"	2-1/2 " x 5'	12-3/8"x 5' @ 8"c.c.	2-1/2"x 6'
36	1'-3"	5'-3"	2'-10 3/4"	8'-1 3/4"	6'-0"	4"	4"	2-1/2 " x 6'	12-3/8"x 6' @ 6"c.c.	2-1/2"x 8'
42	1'-9"	5'-3"	2'-11"	8'-2"	6'-6"	4 1/2"	4 1/2"	2-1/2" x 7'	12-1/2"x 7' @9"c.c.	2-1/2"x 8'
48	2'-0"	6'-0"	2'-2"	8'-2"	7'-0"	5"	5"	2-1/2" x 8'	16-1/2"x 8' @ 8"c.c.	2-1/2"x 8'
54	2'-3"	5'-5"	2'-9 1/4"	8'-2 1/4"	7'-6"	5 1/2"	5 1/2"	2-1/2" x 8'	16-1/2"x 8' @ 7"c.c.	2-1/2"x 8'
60	2'-11"	5'-0"	3'-3"	8'-3"	8'-0"	6"	5"	2-1/2" x 9'	16-1/2"x 9' @ 6"c.c.	2-1/2"x 9'
66	2'-6"	6'-0"	2'-3"	8'-3"	8'-6"	6 1/2"	5 1/2"	2-1/2" x 9'	22-1/2"x 9' @ 6"c.c.	2-1/2"x 9'
72	3'-0"	6'-6"	1'-9"	8'-3"	9'-0"	7"	6"	2-1/2" x 10'	24-1/2"x 10' @ 6"c.c.	2-1/2"x 9'
78	3'-0"	7'-6"	1'-9"	9'-3"	9'-6"	7 1/2"	6 1/2"	2-1/2" x 10'	28-1/2"x 10' @ 6"c.c.	2-1/2"x 10'
84	3'-0"	7'-6 1/2"	1'-9"	9'-3 1/2"	10'-0"	8"	6 1/2"	4-1/2" x 10'	28-1/2"x 10' @ 6"c.c.	4-1/2"x 10'
90	3'-5"	7'-3 1/2"	2'-0"	9'-3 1/2"	11'-0"	8 1/2"	6 1/2"	4-1/2" x 11'	28-1/2"x 11' @ 6"c.c.	4-1/2"x 10'



PERSPECTIVE

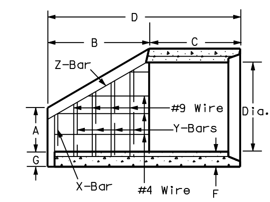


ARRANGEMENT FOR REINFORCEMENT
At end of 36" to 106" pipe.
At end of 12" to 33" pipe.



END VIEW

PLAN



SECTION X-X
END SECTION
Equivalent to Class III Pipe

Permissible Fill Heights
RCP Sewer Trench Conditions
Other than Class I

PIPE SIZE	Class II	Class III	Class IV	Class V
	FT.	FT.	FT.	FT.
2" thru 54"	3-9	1-3 9-13	13-23	23+
60" thru 108"	1-9	9-13	13-23	23+

REINFORCED CONCRETE PIPE

Classes I, II and III:

Internal Dia. of pipe in Inches	Cross-Sectional Water Area	Weight per lin. foot of Pipe Std. Wall	Joint J Groove End Min./Max.	Joint K Tongue End Min.	CLASS I (D-load to produce a 0.01 inch crack 800; ultimate load 1200): Minimum Wall Thickness	CLASS I 4000 P.S.I. Circular rein. in circular pipe: Inner Cage	CLASS I 4000 P.S.I. Circular rein. in circular pipe: Outer Cage	CLASS I Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS I Height of Fill Trench Conditions		CLASS II (1000; 1500): Minimum Wall Thickness	CLASS II 4000 P.S.I.: Inner Cage	CLASS II 4000 P.S.I.: Outer Cage	CLASS II Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS II Height of Fill Normal Backfill	CLASS II Height of Fill Imperfect Trench	CLASS III (1350; 2000): Minimum Wall Thickness	CLASS III 4000 P.S.I.: Inner Cage	CLASS III 4000 P.S.I.: Outer Cage	CLASS III Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS III Minimum Wall Thickness	CLASS III 4000 P.S.I.: Inner Cage	CLASS III 4000 P.S.I.: Outer Cage	CLASS III Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS III Height of Fill Normal Backfill	CLASS III Height of Fill Imperfect Trench
Dia	Sq. ft.	Lbs.	In.	In.	In.	Sq. in.	Sq. in.	Sq. in.	Ft.		In.	Sq. in.	Sq. in.	Sq. in.	Ft.	Ft.	In.	Sq. in.	Sq. in.	Sq. in.	In.	Sq. in.	Sq. in.	Sq. in.	Ft.	Ft.
12	0.79	92	1 5/8-2 3/8	3/4								.07					2	.07				.07			1-16	16-31
15	1.23	127	1 3/4-2 3/4	7/8		TO BE USED FOR						.07					2 1/4	.07				.07			1-16	16-31
18	1.77	168	1 7/8-2 7/8	1		R.C.P. SEWER ONLY						.07		.07			2 1/2	.07		.07		.07			1-16	16-31
21	2.40	214	1 7/8-3 1/8	1 1/8								.07		.07			2 3/4	.07		.07		.07			1-16	16-31
24	3.14	265	2 3/4-3 3/4	1 1/8								.07		.07			3	.07		.07	3 3/4	.07			1-16	16-31
27	3.98	322	2 3/4-4	1 1/4		** Special conditions only					3 1/4	.13		.11	3-11	11-18	3 1/4	.16		.14	4	.08			1-3 11-16	16-31
30	4.91	384	3 1/4-4 1/4	1 1/4							3 1/2	.14		.12	3-11	11-18	3 1/2	.18		.15	4 1/4	.10			1-3 11-16	16-31
33	5.94	452	3 1/4-4 1/4	1 1/2							3 3/4	.15		.13	3-11	11-18	3 3/4	.20		.17	4 1/2	.12			1-3 11-16	16-31
36	7.07	524	3 1/4-4 1/4	1 1/2							4	.12	.07	.13	3-11	11-18	4	.17	.10	.19	4 3/4	.06	.07	.09	1-3 11-16	16-31
42	9.62	685	3 3/4-4 3/4	1 3/4							4 1/2	.15	.09	.17	3-11	11-18	4 1/2	.21	.13	.23	5 1/4	.12	.07	.13	1-3 11-16	16-31
48	12.57	867	3 5/8-4 3/4	1 7/8							5	.18	.11	.20	3-11	11-18	5	.24	.14	.27	5 3/4	.16	.10	.18	1-3 11-16	16-31
54	15.90	1070	4 1/8-5 1/4	2							5 1/2	.22	.13	.24	3-11	11-18	5 1/2	.29	.17	.32	6 1/4	.21	.13	.23	1-3 11-16	16-31
									**																	
60	19.63	1296	4 1/2-5 1/2	2 1/4	6	.21	.13	.23	6-9		6	.25	.15	.28	3-11	11-18	6	.34	.20	.38	6 3/4	.25	.15	.28	1-3 11-16	16-31
66	23.76	1542	5-6	2 5/8	6 1/2	.25	.15	.28	6-9		6 1/2	.31	.19	.34	3-11	11-18	6 1/2	.41	.25	.46	7 1/4	.31	.19	.34	1-3 11-16	16-31
72	28.27	1810	5 5/8-6 3/4	2 7/8	7	.29	.17	.32	6-9		7	.35	.21	.39	3-11	11-18	7	.49	.29	.54	7 3/4	.36	.22	.40	1-3 11-16	16-31
78	33.18	2098	6 1/4-7 1/4	2 7/8	7 1/2	.32	.19	.36	6-9		7 1/2	.40	.24	.44	3-11	11-18	7 1/2	.57	.34	.63	8 1/4	.42	.25	.47	1-3 11-16	16-31
84	38.48	2410	5 5/8-7 3/4	3 3/8	8	.37	.25	.41	6-9		8	.46	.28	.51	3-11	11-18	8	.64	.38	.71	8 3/4	.50	.30	.56	1-3 11-16	16-31
																		5000 P.S.I.								
90	44.18	2793	6 3/4-8 1/4	3 1/8	8 1/2	.41	.25	.46	6-9		8 1/2	.51	.31	.57	3-11	11-18	8 1/2	.69	.41	.77	9 1/4	.59	.35	.66	1-3 11-16	16-31
96	50.27	3092	7-8 1/4	3 1/2	9	.46	.28	.51	6-9		9	.57	.34	.63	3-11	11-18	9	.76	.46	.84	9 3/4	.70	.42	.17 .53	1-3 11-16	16-31
							5000 P.S.I.					5000 P.S.I.														
102	56.75	3466	7-8 1/4	3 1/2	9 1/2	.54	.32	.13 .41	6-9		9 1/2	.68	.41	.27 .41	3-11	11-18	9 1/2	.90	.54	.36 .54	10 1/4	.83	.50	.33 .50	1-3 11-16	16-31
108	63.62	3864	7 1/4-8 1/2	3 3/4	10	.61	.32	.15 .46	6-9		10	.74	.46	.30 .46	3-11	11-18	10	1.08	.65	.43 .65	10 3/4	.99	.59	.40 .59	1-3 11-16	16-31

Class IV and Class IV Alternate (D-load to produce a 0.01 inch crack 2000; D-load to produce ultimate load 3000):

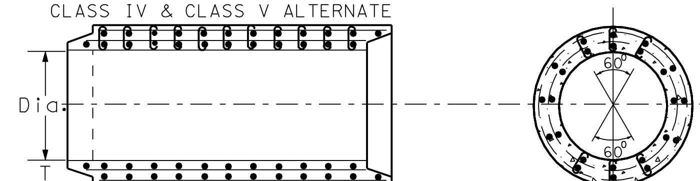
Dia	CLASS IV Minimum Wall Thickness	CLASS IV 4000 P.S.I. Circular rein. in circular pipe: Inner Cage	CLASS IV 4000 P.S.I.: Outer Cage	CLASS IV Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS IV Minimum Wall Thickness	CLASS IV 4000 P.S.I.: Inner Cage	CLASS IV 4000 P.S.I.: Outer Cage	CLASS IV Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS IV ALTERNATE Minimum Wall Thickness	5000 P.S.I. Inner Cage Ai	5000 P.S.I. Ellip Cage Ae	5000 P.S.I. Outer Cage Ao	Shear Steel N	Shear Steel S	Shear Steel Ar	Height of Fill Normal Backfill	Height of Fill Imperfect Trench
	In.	Sq. in.	Sq. in.	Sq. in.	In.	Sq. in.	Sq. in.	Sq. in.	In.	Sq. in	Sq. in	Sq. in	No.	In.	Sq. in	Ft.	Ft.
12	2	.07														16-24	24-43
15	2 1/4	.10														16-24	24-43
18	2 1/2	.14		.11												16-24	24-43
21	2 3/4	.20		.17												16-24	24-43
24	3	.27		.23	3 3/4	.07	.07	.08								16-24	24-43
27	3 1/4	.31		.25	4	.08	.07	.09								16-24	24-43
30	3 1/2	.35		.28	4 1/4	.09	.07	.10								16-24	24-43
33	3 3/4	.27	.16	.30	4 1/2	.11	.07	.12								16-24	24-43
36	4	.30	.21	.33	4 3/4	.14	.08	.15								16-24	24-43
42	4 1/2	.35	.21	.39	5 1/4	.20	.12	.22								16-24	24-43
48	5	.42	.25	.47	5 3/4	.26	.16	.29								16-24	24-43
54	5 1/2	.50	.30	.55	6 1/4	.34	.25	.38								16-24	24-43
		5000 P.S.I.															
60	6	.59	.35	.66	6 3/4	.41	.25	.46	6	.54	.27	.41	7	6	.22	16-24	24-43
66	6 1/2	.69	.41	.77	7 1/4	.51	.31	.57	6 1/2	.60	.30	.45	8	6	.22	16-24	24-43
						5000 P.S.I.											
72	7	.79	.47	.88	7 3/4	.61	.37	.68	7	.64	.32	.48	8	6	.23	16-24	24-43
78					8 1/4	.71	.43	.79	7 1/2	.70	.35	.53	9	6	.25	16-24	24-43
84					8 3/4	.85	.51	.94	8	.76	.38	.57	10	6	.28	16-24	24-43
90									8 1/2	.82	.43	.62	11	6	.31	16-24	24-43
96									9	.88	.46	.66	11	6	.34	16-24	24-43
102									9 1/2	.94	.52	.71	12	6	.37	16-24	24-43
108									10	1.02	.57	.76	12	6	.40	16-24	24-43

Class V and Class V Alternate (D-load to produce a 0.01 inch crack 3000; D-load to produce ultimate load 3750):

Dia	CLASS V Minimum Wall Thickness	CLASS V 6000 P.S.I. Circular rein. in circular pipe: Inner Cage	CLASS V 6000 P.S.I.: Outer Cage	CLASS V Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS V Minimum Wall Thickness	CLASS V 6000 P.S.I.: Inner Cage	CLASS V 6000 P.S.I.: Outer Cage	CLASS V Ellip. rein. in Cir. pipe & Cir. rein. in Ellip. pipe	CLASS V ALTERNATE Minimum Wall Thickness	5000 P.S.I. Inner Cage Ai	5000 P.S.I. Ellip Cage Ae	5000 P.S.I. Outer Cage Ao	Shear Steel N	Shear Steel S	Shear Steel Ar	Height of Fill Normal Backfill	Height of Fill Imperfect Trench
	In.	Sq. in	Sq. in	Sq. in	In.	Sq. in	Sq. in	Sq. in	In.	Sq. in	Sq. in	Sq. in	No.	In.	Sq. in	Ft.	Ft.
12	2	.10														24-35	35-69
15	2 1/4	.14														24-35	35-69
18	2 1/2	.19		.16												24-35	35-69
21	2 3/4	.24		.21												24-35	35-69
24	3	.30		.24	3 3/4	.12	.07	.13								24-35	35-69
27	3 1/4	.38	.23	.42	4	.14	.08	.16								24-35	35-69
30	3 1/2	.41	.23	.46	4 1/4	.18	.11	.20								24-35	35-69
33	3 3/4	.46	.28	.51	4 1/2	.23	.14	.25								24-35	35-69
36	4	.50	.30	.56	4 3/4	.27	.16	.30								24-35	35-69
42	4 1/2	.60	.36	.67	5 1/4	.36	.28	.40								24-35	35-69
48	5	.73	.44	.81	5 3/4	.47	.28	.52	5	.66	.33	.50	8	4	.22	24-35	35-69
54					6 1/4	.58	.35	.64	5 1/2	.74	.37	.56	9	4	.22	24-35	35-69
60					6 3/4	.70	.42	.78	6	.82	.41	.62	7	6	.22	24-35	35-69
66					7 1/4	.84	.50	.93	6 1/2	.88	.44	.66	8	6	.22	24-35	35-69
72					7 3/4	.99	.57	1.10	7	.96	.48	.72	8	6	.23	24-35	35-69
78									7 1/2	1.04	.52	.78	9	6	.25	24-35	35-69
84									8	1.12	.56	.84	10	6	.28	24-35	35-69
90									8 1/2	1.20	.65	.90	11	6	.31	24-35	35-69
96									9	1.32		.99	11	8	.34	24-35	35-69
102									9 1/2	1.42		1.07	12	8	.37	24-35	35-69
108																	

NOTES:
1. All reinforcement shall be electrically welded cold drawn steel wire fabric.
2. Circular reinforcement shall lap in accordance to A.A.S.H.T.O. M170.
3. All circular, longitudinal, and elliptical reinforcement shall be assembled and securely fastened in cage fashion so as to maintain reinforcement in exact shape and correct positions within the forms.
4. Laying length of pipe: 12" to 66" (incl.) = not less than 4 feet
   66" to 108" (incl.) = not less than 6 feet
5. Joints shall be sealed with rubber gaskets or with sealer approved by the engineer whenever pipe are specified for storm drain or sanitary sewers.
6. Welded steel wire fabric may be substituted for the reinforcing steel bars but must match the area of steel provided by the bars and the lap of the fabric must be in accordance with AASHTO specifications

CLASS IV & CLASS V ALTERNATE



LONGITUDINAL SECTION

Ai, Ae, Ao = Minimum circumferential reinforcement required in square inches per lineal foot of pipe.
Ar = Minimum radial reinforcement required in square inches per square foot of pipe.
N = Minimum number of rows of radial reinforcement at top and bottom of pipe.
S = Maximum circumferential spacing of rows of radial reinforcing.

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

10-1-86

REVISIONS	
DATE	CHANGE
11-05-86	Note added
07-17-87	Addded pipe plug detail
09-01-88	Reinforcement cage
03-10-95	General revisions
12-23-98	Note # 6, 30" FES
12-01-04	PE stamp added

This document was originally issued and sealed by MARK S GAYDOS, Registration Number PE-4518, on 12/01/04 and the original document is stored at the North Dakota Department of Transportation