Design Red Lights (Project Check List)

1. When specifying floor and invert elevations of a structure, check for sufficient wall height to take the required holes. Thus one must subtract brick & casting allowance, top slab thickness, and hole raise, if applicable.

2. Look out for too much pipe into too small a structure. There may be very little support for the top section when all the blank outs are removed . This is particularly critical when transporting the structure and when CMP or HDPE is used.

3. Try to put pipes into flat wall structures at as near 90 degrees to the wall as possible. Shallow angles require large elliptical holes and weaken the wall.

4. Try to maintain at least 2' of cover over your pipes. Less than this may put you into the throat area, cause conflicts with castings, or cost your client more for high strength pipe. (Note that these are only some of the problems.)

5. Specify pipe material on your drawing. Hole sizes differ for the same pipe in different materials.

6. Use standard structures wherever possible. They are far more economical.

7. Where possible, use locally manufactured castings. They do not have high transportation costs and long delivery times.

Standard Hole Diameters

Notes: (1) A dash (-) in the table signifies that the pipe is not manufactured or else not readily available in a particular material.

(2) Values given in the table are those that would normally be used in our plant. However, the blank out diameter can be varied as required by a given situation.

Pipe Size	Pipe Types				
(Nominal I.D.)	D.I.P.	Clay	P.V.C.	R.C.P.	C.M.P.
4"	7"	7"	7"	-	-
6"	12"	12"	12"	-	12"
8"	12"	12"	12"	-	12"
10"	16"	16"	16"	-	16"
12"	16"	16"	16"	21"	18"
14"	20"	-	-	-	-
15"	-	-	20"	24"	21"
16"	20"	26"	-	-	-
18"	24"	27"	24"	30"	24"
20"	24"	29"	-	-	-
21"	-	-	26"	-	28"
24"	28"	34"	28"	36"	30"
30"	36"	40"	36"	42"	36"
36"	42"	47"	42"	48"	42"
42"	-	56"	49"	60"	48'
48"	-	61"	55"	66"	54"
54"	-	-	-	72"	60"
60"	-	-	-	78"	66"
66"	-	-	-	84"	72"
72"	-	-	-	92"	78"
78"	-	-	-	96"	84"
84"	-	-	-	108"	92"
90"	-	-	-	113"	-
96"	-	-	-	120"	108"

Instructions & Examples for Pipe Half Angle Table

(Used with circular structures - see "Half Angle Diagram" for illustration)

Example No. 1:

To find if a given structure will accomodate two pipes on approximately the same level, whose size and centerline included angle is specified.

Given: 48" Dia manhole, 12" dia. RCP pipe, 18" dia. RCP pipe, 76 degree included angle between pipe centerlines.

Procedure:

(1.) Turn to "Standard Hole Diameter Table" and find: 12" RCP hole is 21" dia., and 18" RCP hole is 30" dia.

(2.) Turn to "Pipe Half Angle Table" and find:
- (a.) Structure dia. on bottom row. (48")
- (b.) Hole dia. of 30" at right side of table.
- (c.) Read up and left to intersection finding half angle of 38.68 degrees.
- (d.) Repeat procedure for 48" dia. structure & 21" dia. hole, finding half angle of 25.94 degrees.
- (e.) In bottom row below structure dia. find separation angle of 9.53 degrees.
- (f.) Add angle found in steps - (c.), (d.) & (e.) giving result of 74.15 degrees.

Result: 74.15 degrees is the normal minimum angle between these pipes in this structure. Since this angle is less than the 76 degrees specified; the structure will readily accommodate the pipes in question.

(See next page for example no. 2)

Instructions & Examples for Pipe Half Angle Table *(cont.)*

(Used with circular structures - see "Half Angle Diagram" for illustration)

Example No. 2:

Find the minimum structure for the pipes of Example 1 on the previous page.

Given: Round Structure desired for reasons of economy: Find minimum diameter structure for 12" dia. RCP pipe, 18" dia. RCP pipe; 76 degree included angle between pipe centerlines.

Procedure:

(1.) Hole Diameters are once again 21" & 30".

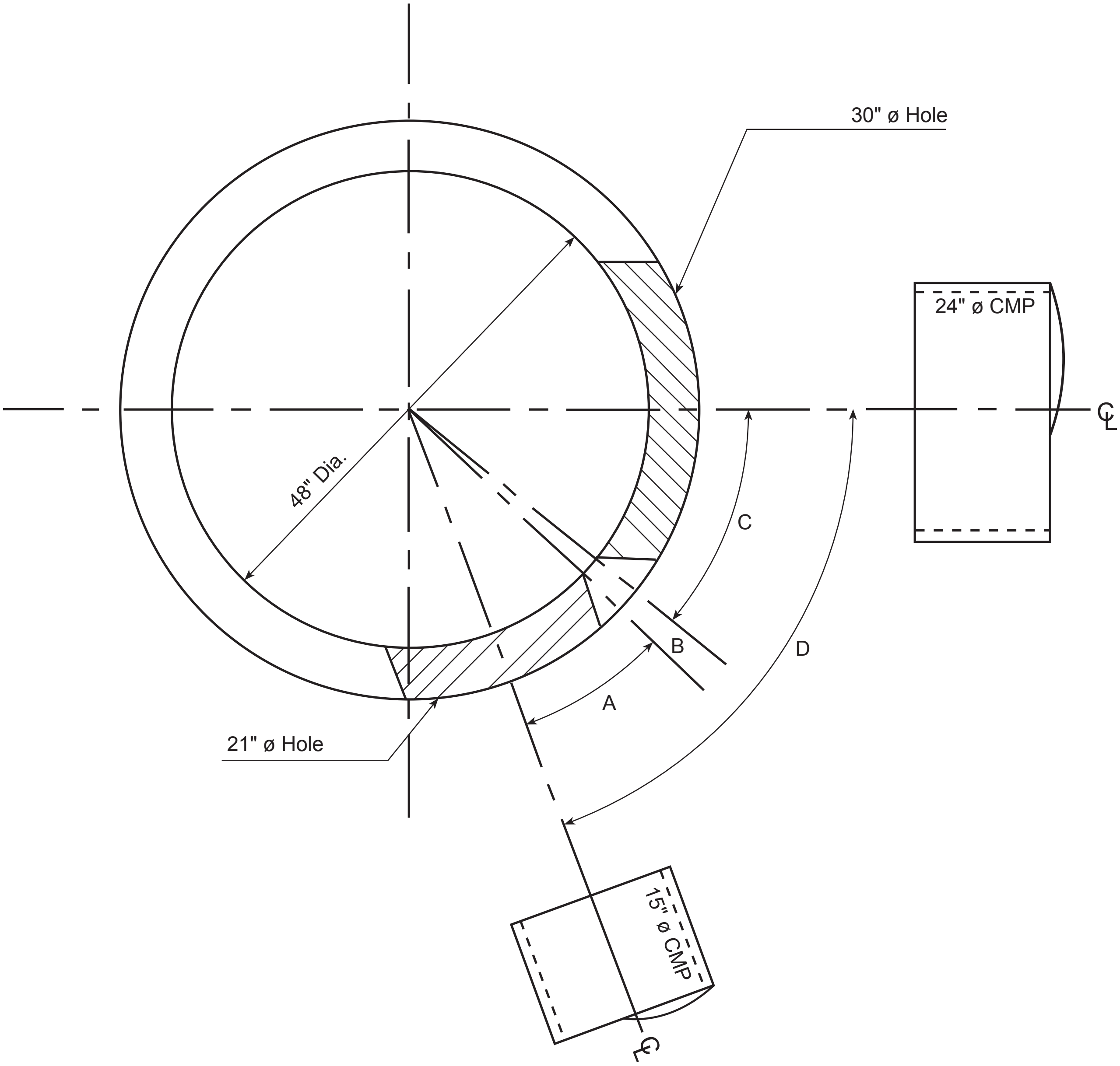
(2.) Try 42" dia. structure in "Pipe Half Angle Table".

(3.) Find half angles of:
45.58 deg. for 30" hole, 30.00 deg. for 21" hole, and
10.88 deg. for 42" dia. structure separation angle.

(4.) Total angle is 86.46 deg., which is too large, however, pipe separation angle of 10.88 deg. can be reduced to 0 deg., and the holes butted together at the inside wall. This is not recommended practice, but is a design option, thus the total included angle is 75.58 deg. This is less than the 76 deg. specified, and the 42" round will just accommodate the pipes in question.

Note: Structure sizes can also be reduced by decreasing hole diameters. However, the designer should be aware such procedures increase construction difficulties, may violate local standards, and should be avoided if at all possible.

For sanitary sewer structures, the hole diameter is determined by the flexible connector required and the 4" spacing between holes is required.



NOTE:

A = Half angle for 21" dia. hole in a 48" dia. structure.

B = Separation angle for a 48" dia. structure.

C = Half angle for 30" dia. hole in a 48" dia. structure.

D = Min. angle between pipe CL's.
(Where hole separation is required.)

-No Scale-
All dimensions subject to allowable specification tolerances.

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DATE	SECT.PAGE
2018	16.1.5

PIPE HALF ANGLE DIAGRAM

Half Angle
(Degrees)

					90.00	**96"**
					69.64	**90"**
				90.00	61.04	**84"**
				68.21	54.34	**78"**
			90.00	59.00	48.59	**72"**
			66.44	51.79	43.43	**66"**
		90.00	56.44	45.58	38.68	**60"**
		64.16	48.59	40.01	34.23	**54"**
	90.00	53.13	41.81	34.85	30.00	**48"**
90.00	61.04	44.43	35.69	30.00	25.94	**42"**
59.00	48.59	36.87	30.00	25.38	22.02	**36"**
45.58	38.68	30.00	24.62	20.92	18.21	**30"**
41.81	35.69	27.82	22.89	19.47	16.96	**28"**
34.85	30.00	23.58	19.47	16.60	14.48	**24"**
30.00	25.94	20.49	16.96	14.48	12.64	**21"**
25.38	22.02	17.46	14.48	12.37	10.81	**18"**
22.39	19.47	15.47	12.84	10.98	9.59	**16"**
19.47	16.96	13.49	11.21	9.59	8.39	**14"**
16.60	14.48	11.54	9.59	8.21	7.18	**12"**
13.77	12.02	9.59	7.98	6.84	5.98	**10"**
42" / **10.88**	**48"** / **9.53**	**60"** / **7.63**	**72"** / **6.36**	**84"** / **5.45**	**96"** / **4.77**	

Hole Diameters
(Inches)

Structure Diameter
(Inches)
/
Separation Angle
(Degrees)

Note: Separation angle is based on a 4" (Min.) space between openings, measured on the I.D. of the pipe.

Maximum Pipe Angle Tables
Use with Square or Rectangular Structures
Instructions / Examples

The following pages give the maximum angle at which a hole of given diameter may enter the wall of a square or rectangular structure without cutting into the corner area of the box. In the following discussion, refer to the "Pipe Angle Diagram, Flat Wall Structures".

The table on page 7.16 gives angle values for situations where the pipe centerline meets a wall centerline at the inside face of the wall. See the lower diagram on page 7.15. Application is restricted to walls whose inside width and thickness are given at the bottom of the table. For structures with other dimensions, use the formula for ø found at the bottom of the "Pipe Angle Diagram" page. Note that dimension "L" has no effect in this instance so table values can be used for non-standard box lengths.

Example No. 1: **Ref: Table on page 7.16**

Given: It is desired to put an 15" RCP pipe through the wide side of a 24" x 36" box at an angle of 30 degrees with the box centerline and with the pipe centerline passing through the center of the wall. Can this be done without cutting into the box corner?

Procedure:

(1.) Turn to "Standard Hole Diameter Table" and find: 15" RCP hole is 24" dia.

(2.) Wall thickness for a 24" x 36" box is 6", so inside wall dimension over wall thickness is 36" / 6".

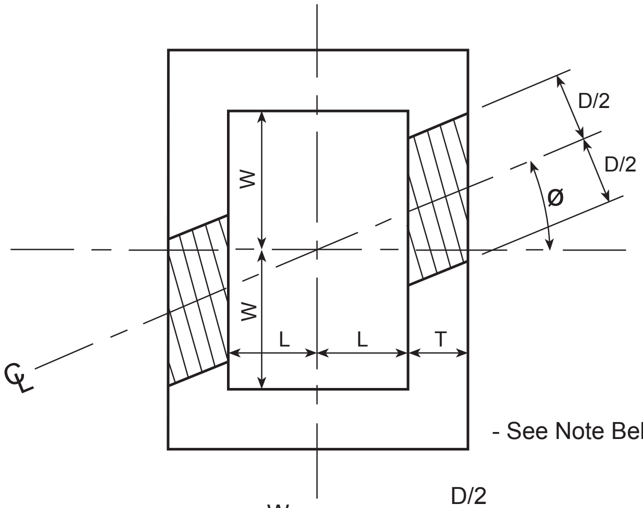
(3.) Find 36" / 6" column in the table and 24" hole diameter row at the right side of table.

Result: Read up and over to intersection; finding max. angle of 32.33 degrees. Max. angle is greater than proposed angle, so we are OK.

Note that a jog is formed in the line when using this system. As a practical matter, given sufficient distance between structures, this jog can be eliminated by slightly angling the pipe in the hole. However, the designer should consider this problem.

The diagram and equation found at he top of "Pipe Angle Diagram", page 7.15, is for those situations where the pipe and hole centerline pass through the center of the structure. No table values are recommended here due to the large number of possible "W" and "L" combinations.

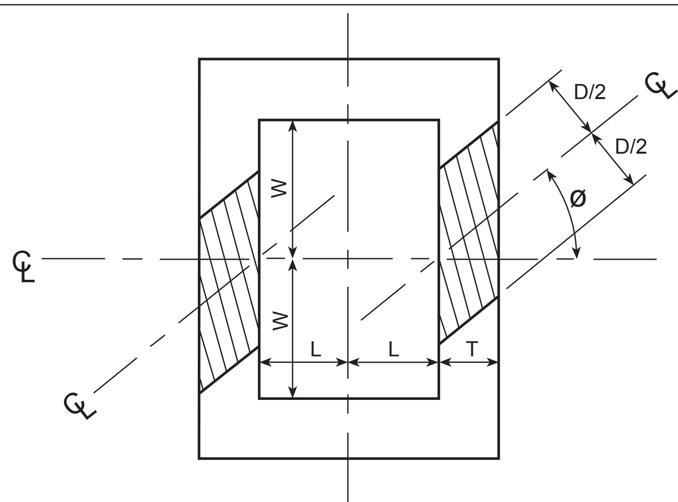
Engineering



- See Note Below -

$$Ø = Tan^{-1}\frac{W}{L + T} - Sin^{-1}\frac{D/2}{\sqrt{w^2 + (L + T)^2}}$$

Pipe ℄ Through Center of Structure



$$Ø = Tan^{-1}\frac{W}{T} - Sin^{-1}\frac{D/2}{\sqrt{w^2 + T^2}}$$

Pipe ℄ Meets Structure ℄ @ Inside Wall - See Table

-No Scale-
All dimensions subject to allowable specification tolerances.

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DATE	SECT.PAGE
2018	16.1.8

PIPE HALF ANGLE DIAGRAM -
FLAT WALL STRUCTURES

Table

Pipe ℄ meets structure ℄ @ inside wall.

Maximum Angle (Degrees)

72" / 8"	60" / 6"	48" / 6"	42" / 6"	36" / 6"	30" / 6"	24" / 4"	18" / 4"	Hole Diameters (Inches)
0.00								72"
13.98								66"
23.03	0.00							60"
30.41	16.74							54"
36.87	27.02	0.00						48"
42.76	35.34	17.87	0.00					42"
48.26	42.65	29.28	18.55	0.00				36"
53.47	49.33	38.64	30.68	19.33	0.00			30"
55.16	51.46	41.50	34.19	24.02	8.14			28"
58.48	55.60	46.95	40.73	32.33	20.23	0.00		24"
60.93	58.62	50.85	45.32	37.96	27.66	15.46		21"
63.35	61.58	54.63	49.72	43.25	34.34	26.21	0.00	18"
64.94	63.53	57.10	52.57	46.63	38.52	32.33	11.72	16"
66.53	65.46	59.53	55.36	49.92	42.52	37.96	20.74	14"
68.11	67.38	61.93	58.11	53.13	46.40	43.25	28.51	12"
69.68	69.28	64.30	60.82	56.29	50.17	48.28	35.53	10"

Inside Wall Dimension / Wall Thickness

Cast Iron Products

Load Designations***		
Classification	**Application**	**Proof Load Test**
Heavy Duty	Suitable for highway traffic loads, or 16,000 lb. wheel loads.	25,000 lbs.* (Ref: Fed. Spec. RR-F-621C)
Medium Duty	Suitable for driveways, parking lots, ramps and other similar applications where wheel loads do not exceed 12,000 lbs.	18,000 lbs.*
Light Duty	Suitable for pedestrian areas such as sidewalks, terraces and other areas which do not receive vehicular traffic.	

* Proof load is applied over a 9" x 9" area in center of the casting and held for one minute without failure or permanent deflection.

Steel Grating and Covers

Load Designations***		
Classification		**Application**
Traffic	H-20	AASHTO H20: 16,000 lbs over 10" x 20" area.**
	H-15	AASHTO H15: 12,000 lbs over 6.9" x 17.30" area.**
	H-10	AASHTO H10: 8,000 lbs over 5.6" x 14.1" area.**
Non-Traffic		These grates and covers are not intended for traffic applications. All our standard products exceed 300 PSF.

** Design includes 30% for impact. Load area is increased by twice the distance center to center of the bearing bars in the direction perpendicular to the bearing bars.

*** Load designation and classifications are per U.S. Foundry & Mfg. Corp. Products as shown in their 3rd addition catalog, copyright 1986.

Engineering

Radius Pipe

Radius pipe, also referred to as bevelled or mitered pipe, incorporates the deflection angle into the pipe joint. The pipe is manufactured by shortening one side of the pipe and the amount of shortening or drop for any given pipe is dependent on manufacturing feasibility. Because of the possibility of greater deflection angles per joint, sharper curvature with correspondingly shorter radi can be obtained with radius pipe than with deflected straight pipe. As in the case of deflected straight pipe, the radius of curvature which may be obtained by radius pipe is a function of the deflection angle per joint, diameter of the pipe, length of pipe sections and wall thickness.

The radius of curvature is computed with the equation:

$$R = \frac{L}{\mathrm{TAN}\,\frac{\Delta}{N}} - \left(\frac{D}{2} + t\right) \qquad (3)$$

where:

- Δ = Total deflection angle of curve, degrees
- N = number of radius pipe
- L = standard pipe length being used, feet
- R = radius of curvature, feet
- D = inside diameter of the pipe, feet
- t = wall thickness of the pipe, feet

From Figure 3, the radius of curvature can be expressed in terms of the drop and is given by the equation:

$$R = \frac{L(D + 2t)}{DROP} - \left(\frac{D}{2} + t\right) \text{or} \left(\frac{L}{DROP} - \frac{1}{2}\right) B_C \qquad (4)$$

where:

- B_C = outside diameter of the pipe, feet

Since the maximum permissible drop for any given pipe is dependent on manufacturing feasibility, it is essential to coordinate the design of radius pipe with the pipe manufacturer, Many manufacturers have standardardized joint configurations and deflections for specific radi and economics may be realized by utilizing standard radius pipe.

As illustrated in Figure 4, when concrete pipe is installed on curved alignment using radius pipe. the pipe sections are oriented such that the plane of the dropped joint is at right angles to the theoretical circular curve. Projection of the joints do not converge at a common point, but are tangents to a common circle of diameter equal to the length of pipe sections. The point of curve (P.C.) is at the midpoint of the last straight pipe and the point of tangent (P.T.) is one half of the standard pipe length back from the straight end of the last radius pipe. The required number of pieces of radius pipe is equal to the length of the circular curve in feet divided by the centerline length of the radius pipe (L - 1/2 DROP). Where possible, minor modifications in the radius are normally made so this quotient will be a whole number.

Minimum radius of curvature obtained from equations (3) and (4) are approximate, but are within a range of accuracy that will enable the pipe to be readily installed to fit the required alignment. A reasonable amount of field adjustment is possible for radius pipe by pulling the joints in the same manner as with deflected straight pipe.