Circular Pipe: Manning’s n

Caltrans HDM Table 851.2

Suggested values for Manning’s Roughness coefficient (n) for design purposes are given in the tabe below.

Manning “n” Value for Alternative Pipe Materials[1]

Type of Conduit		**Recommended Design Value**	**“n” Value Range**
Corrugated Metal Pipe[2]			
(Annular and Helical)[3]			
2⅔” x ½”	corrugation	0.025	0.022 – 0.027
3″ x 1″	“	0.028	0.027 – 0.028
5″ x 1″	“	0.026	0.025 – 0.026
6″ x 2″	“	0.035	0.033 – 0.035
9″ x 2½”	“	0.035	0.033 – 0.037
Concrete Pipe			
Pre-cast		0.012	0.011 – 0.017
Cast-in-place		0.013	0.012 – 0.017
Concrete Box		0.013	0.012 – 0.018
Plastic Pipe (HDPE and PVC)			
Smooth Interior		0.012	0.010 – 0.013
Corrugated Interior		0.022	0.020 – 0.025

Spiral Rib Metal Pipe		
¾” (W) x 1″ (D) @ 11½” o/c	0.013	0.011 – 0.015
¾” (W) x Ÿ” (D) @ 7½” o/c	0.013	0.012 – 0.015
¾” (W) x 1″ (D) @ 8½” o/c	0.013	0.012 – 0.015
Composite Steel Spiral Rib Pipe	0.012	0.011 – 0.015
Steel Pipe, Ungalvanized	0.015	–
Cast Iron Pipe	0.015	–
Clay Sewer Pipe	0.013	–
Polymer Concrete Grated Line Drain	0.011	0.010 – 0.013

Notes:	
(1)	Tabulated n-values apply to circular pipes flowing full except for the grated line drain. See Note 5.
(2)	For lined corrugated metal pipe, a composite roughness coefficient may be computed using the procedures outlined in the HDS No. 5, Hydraulic Design of Highway Culverts.
(3)	Lower n-values may be possible for helical pipe under specific flow conditions (refer to FHWA’s publication Hydraulic Flow Resistance Factors for Corrugated Metal Conduits), but in general, it is recommended that the tabulated n-value be used for both annular and helical corrugated pipes.
(4)	For culverts operating under inlet control, barrel roughness does not impact the headwater. For culverts operating under outlet control barrel roughness is a significant factor. See Index 825.2 Culvert Flow.
(5)	Grated Line Drain details are shown in Standard Plan D98C and described under Index 837.2(6) Grated Line Drains. This type of inlet can be used as an alternative at the locations described under Index 837.2(5) Slotted Drains. The carrying capacity is less than 18-inch slotted (pipe) drains.

HDS-4 Table B-3

Manning’s n Values for Closed Conduits

Description		Manning’s n Range
Concrete pipe		0.011 – 0.013
Corrugated metal pipe or pipe-arch:		
Corrugated Metal Pipes and Boxes, Annular or Helical Pipe (Manning’s n varies with barrel size)	68 by 13 mm (2⅔ x ½ in.) corrugations	0.022 – 0.027
	150 by 25 mm (6 x 1 in.) corrugations	0.022 – 0.025
	125 by 25 mm (5 x 1in.) corrugations	0.025 – 0.026
	75 by 25 mm (3 x 1 in) corrugations	0.027 – 0.028
	150 by 50 mm (6 x 2 in.) structural plate corrugations	0.033 – 0.035
	230 by 64 mm (9 x 2-1/2 in.) structural plate corrugations	0.033 – 0.037
Corrugated Metal Pipes Helical Corrugations, Full Circular Flow	68 by 13 mm (2⅔ x ½ in.) corrugations	0.012 – 0.024
Spiral Rib Metal Pipe	Smooth walls	0.012 – 0.013
Vitrified clay pipe		0.012 – 0.014
Cast-iron pipe, uncoated		0.013
Steel pipe		0.009 – 0.013
Brick		0.014 – 0.017
Monolithic concrete:		
1. Wood forms, rough		0.015 – 0.017
2. Wood forms, smooth		0.012 – 0.014
3. Steel forms		0.012 – 0.013
Cemented rubble masonry walls:		
1. Concrete floor and top		0.017 – 0.022

2. Natural floor	0.019 – 0.025
Laminated treated wood	0.015 – 0.017
Vitrified clay liner plates	0.015
NOTE: The values indicated in this table are recommended Manning's n design values. Actual field values for older existing pipelines may vary depending on the effects of abrasion, corrosion, deflection, and joint conditions. Concrete pipe with poor joints and deteriorated walls may have n values of 0.014 to 0.018. Corrugated metal pipe with joint and wall problems may also have higher n values, and in addition, may experience shape changes which could adversely effect the general hydraulic characteristics of the pipeline.	

Other: Variation of n with Flow Depth in Pipe

From "Scattergraph's Principles and Practice, by Kevin L Enfinger, P.E. and James S Schutsbach, ADS Environmental Services, 2003.

A fourth order polynomial approximation of Camp's varying roughness coefficient:

$f(d)=1.04+2.30*(d/D)-6.86*(d/D)^2+7.79*(d/D)^3-3.27*(d/D)^4$

From http://www.engineeringexceltemplates.com, Manning Equation Partially Filled Circular Pipes:

The Manning equation was developed for flow in open channels with rectangular, trapezoidal, and similar cross-sections. It works very well for those applications using a constant value for the Manning roughness coefficient, n. Better agreement with experimental measurements is obtained for partially full pipe flow, however, by using the variation in Manning roughness coefficient developed by Camp …

The equations to calculate $n/_{nfull}$, in terms of (y/D) for y < (D/2) are as follows:>/p>

- n/n_{full} = 1 + (y/D)*(1/3) for 0 < (y/D) < 0.03
- n/n_{full} = 1.1 + ((y/D) – 0.03)*(12/7) for 0.03 < y/D < 0.1
- n/n_{full} = 1.22 + ((y/D) – 0.1)*(0.6) for 0.1 < (y/D) < 0.2
- n/n_{full} = 1.29 for 0.2 < (y/D) < 0.3
- n/n_{full} = 1.29 – ((y/D) – 0.3)*(0.2) for 0.3 < (y/D) < 0.5

The equation used for n/n_{full} for 0.5 < (y/D) < 1 is:

- $n/n_{full} = 1.25 - [((y/D) - 0.5)/2]$