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HANDBOOK**

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PIPING HANDBOOK

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PIPING HANDBOOK

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Fifth Edition

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PIPING HANDBOOK

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PREFACE

Since its First Edition in 1930, the purpose of the Piping Handbook has been to provide authoritative and accessible data for the engineer interested in piping design. This present edition, the Fifth, has been prepared with the same aim in mind: its scope, contents and arrangement reflect the tremendous advances which have been made in piping design in the twenty-odd years that have elapsed since the original publication of the Fourth Edition.

The first nine chapters deal with aspects of piping that are generally common to all piping systems. The remaining fourteen chapters treat the design considerations which are unique to specific applications. Much of the material is entirely new, some has been completely rewritten, and a good deal of the excellent material of former editions has been retained.

The twenty-three chapters have been prepared by eighteen authors, each of whom is an authority in his area of specialty. Many sources have been drawn upon and, throughout, credit is given to the original source of material. In some cases, material from an original source is condensed and a reference is given in the text or in the bibliography at the chapter end. In other cases, material may be quoted directly. If the quote is lengthy, the material is set in smaller type.

In this Fifth Edition of the Piping Handbook, the scope has been extended to cover relatively new fields such as those of nuclear and cryogenic piping systems. The flow of non-Newtonian fluids, the one-dimensional flow of compressible fluids and the design of sewerage systems are dealt with. The sections on manufacture, fabrication, specification and inspection of piping have been greatly enlarged and are well illustrated.

In recognition of the advantages in speed and accuracy afforded by the digital computer, an entirely new chapter on expansion and flexibility has been written. The fundamentals of matrix manipulation are introduced,

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tables of compliances of piping system components are presented, examples are given of analytical solutions of expansion problems, and the economies in time and money of computer solutions are discussed. Simplified flexibility charts and graphs of the previous edition are partially retained in order that approximate, rapid solutions may be obtained.

Throughout the chapters which deal with design of specific piping systems, reference has been made to the latest edition of the governing code which was available at the time of writing. In instances in which no final code has been approved, test cases are often cited.

The names and affiliations of the several authors appear in the List of Contributors and, further, the name of each author appears at the heading of each chapter. To all of them, grateful acknowledgment is made for their having performed a most notable contribution to the art of piping design. Credit is due them for their achievement. For errors in form and typography, and for errors of omission, I accept full responsibility.

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* This chapter was written by a subcommittee of the Manufacturers Standardization Society of the Valve and Fittings Industry. The membership of that committee appears in the List of Contributors.

Vitrified-clay Sewer Pipe. Vitrified-clay pipe is manufactured in standard sizes from 4 to 36 in. in diameter and in two strength classifications. ASTM Specifications C13 and C200 cover "standard-strength" and "extra-strength" clay pipe.

The crushing strengths and dimensions are given in Tables 6 to 8. A wide variety of vitrified clay fittings is available as shown by Fig. 15. Detailed dimensions of tee branches are given in Tables 9 to 12. Dimensions of the other types of fittings are given in the "Clay Pipe Engineering Manual."²¹

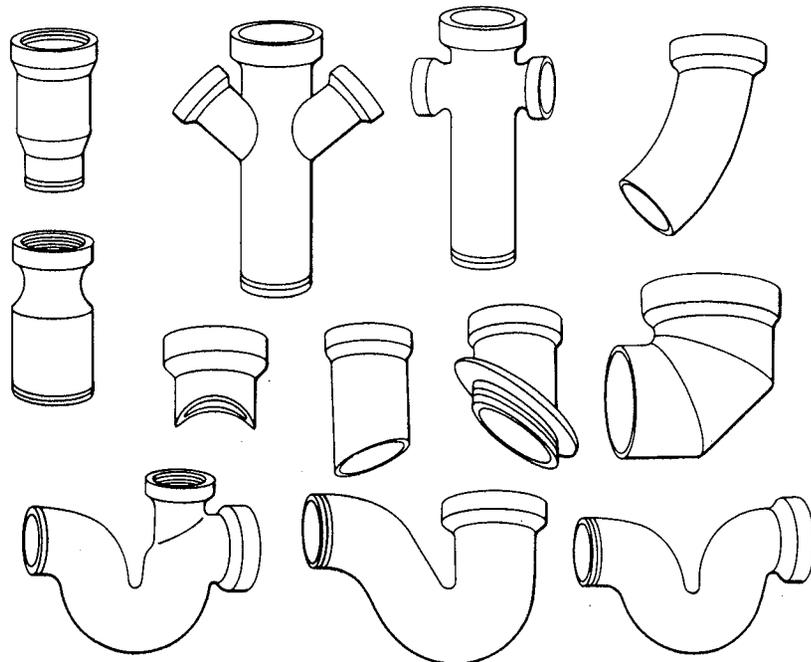


FIG. 15. Clay sewer pipe special fittings.

Vitrified-clay pipe is resistant to corrosion from most acids, making it advantageous when handling septic sewage or wastes with high acid content. Joints are commonly made up with bituminous compounds, of which there are many different types available. Recent developmental work by clay-pipe manufacturers has resulted in the marketing of joints employing resilient plastic materials which limit joint leakage under deflection and high ground-water conditions. Three types of these joints are covered under ASTM Specification C425, Vitrified Clay Pipe Joints Using Materials Having Resilient Properties.

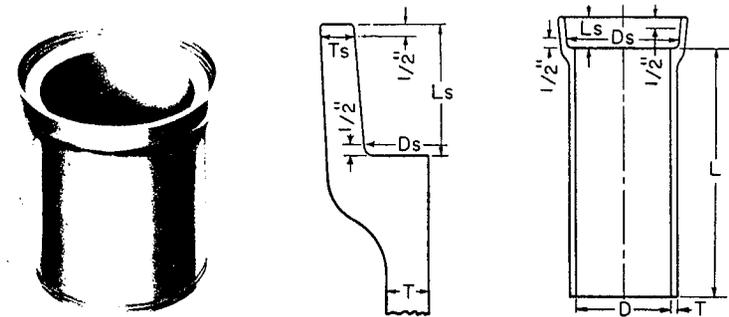
APPURTENANCES AND SPECIAL STRUCTURES

Essential to all sewerage systems are the appurtenant structures such as service connections, manholes, junction chambers, storm-water inlets, diversion chambers, etc. The design of such structures is not covered in detail in this chapter, but typical designs for the most commonly used appurtenances will be presented briefly.

Table 6. Crushing Strengths for Clay Sewer Pipe

Size, in.	Crushing strength, min, lb/lin ft			
	Standard-strength		Extra-strength	
	Three-edge bearing	Sand bearing	Three-edge bearing	Sand bearing
4	1,000	1,500		
6	1,100	1,650	2,000	3,000
8	1,300	1,950	2,000	3,000
10	1,400	2,100	2,000	3,000
12	1,500	2,250	2,250	3,375
15	1,750	2,625	2,750	4,125
18	2,000	3,000	3,300	4,950
21	2,200	3,300	3,850	5,775
24	2,400	3,600	4,400	6,600
27	2,750	4,125	4,700	7,050
30	3,200	4,800	5,000	7,500
33	3,500	5,250	5,500	8,250
36	3,900	5,850	6,000	9,000

Table 7. Standard-strength Vitrified-clay Pipe Conforming to ASTM Specifications C13



Size, in.	Laying length L		Max difference in length of two opposite sides, in.	Outside diameter of barrel, in.		Inside diameter of socket at 1/2 in. above base, in. DS
	Min*	Limit of minus variation, in. per ft of length†		Min	Max	
4	2	1/8	5/16	4 7/8	5 1/8	5 3/4
6	2	1/8	5/8	7 1/16	7 7/16	8 3/8
8	2	1/8	7/16	9 1/4	9 3/4	10 1/4
10	2	1/8	7/16	11 1/2	12	12 3/4
12	2	1/8	7/16	13 3/4	14 5/16	15 1/8
15	3	1/8	1/2	17 3/16	17 13/16	18 5/8
18	3	1/8	1/2	20 5/8	21 1/16	22 1/4
21	3	1/8	9/16	24 1/8	25	25 3/8
24	3	3/8	9/16	27 1/2	28 1/2	29 3/8
27	3	3/8	9/16	31	32 1/8	33
30	3	3/8	5/8	34 3/8	35 5/8	36 1/4
33	3	3/8	5/8	37 5/8	38 13/16	39 7/8
36	3	3/8	1 1/16	40 3/4	42 1/4	43 1/4

Table 7. (Continued)

Size, in.	Depth of socket, in. <i>LS</i>		Thickness of barrel, in. <i>T</i>		Thickness of socket at 1/4 in. from outer end, in. <i>TS</i>	
	Nominal	Min	Nominal	Min	Nominal	Min
	4	1 3/4	1 1/2	1/2	7/16	7/16
6	2 1/4	2	5/8	9/16	1/2	7/16
8	2 1/2	2 1/4	3/4	1 1/16	9/16	1/2
10	2 5/8	2 3/8	7/8	1 3/16	5/8	9/16
12	2 3/4	2 1/2	1	1 5/16	3/4	1 1/16
15	2 7/8	2 5/8	1 1/4	1 1/2	1 5/16	7/8
18	3	2 3/4	1 1/2	1 3/8	1 1/2	1 1/16
21	3 1/4	3	1 3/4	1 5/8	1 5/16	1 3/16
24	3 3/8	3 1/8	2	1 7/8	1 1/2	1 3/8
27	3 1/2	3 1/4	2 1/4	2 1/8	1 11/16	1 9/16
30	3 5/8	3 3/8	2 1/2	2 3/8	1 7/8	1 3/4
33	3 3/4	3 1/2	2 5/8	2 1/2	2	1 13/16
36	4	3 3/4	2 3/4	2 5/8	2 1/16	1 7/8

* There shall be no maximum length. Shorter lengths may be used for closures and specials.
† There is no limit for plus variation.

Building Service Connections. Figure 16 shows typical details of service connections to a sanitary sewer laid in a relatively shallow trench; Fig. 17 shows a typical connection to a deep sewer. It is noted that the connection shown in Fig. 16 makes use of either a wye branch or a tee branch in the main sewer line.

Junction Chambers and Manholes. Figure 18 shows a typical design for a junction chamber and manhole for relatively small sewers. For junctions of large sewers, a special underground structure will ordinarily be required, and the entrance to it will be provided for by a manhole located at one side. Such chambers and manholes are required at every sewer junction and at every point where the sewer

Table 8. Dimensions of Extra-strength Clay Pipe†

Nominal size, in.	Laying length <i>L</i>		Max difference in length of two opposite sides, in.	Outside diameter of barrel, in. †, §		Inside diameter of socket at 1/2 in. above base, in. <i>DS</i>
	Min, ft*	Limit of minus variation, in. per ft of length†		Min	Max	
8	2	1/4	7/16	9 1/4	9 3/4	10 1/2
10	2	1/4	7/16	11 1/2	12	12 3/4
12	2	1/4	7/16	13 3/4	14 5/16	15 1/2
15	3	1/4	1/2	17 3/16	17 13/16	18 5/8
18	3	1/4	1/2	20 5/8	21 7/16	22 1/4
21	3	1/4	9/16	24 1/8	25	25 7/8
24	3	3/8	9/16	27 1/2	28 1/2	29 3/8
27	3	3/8	5/8	31	32 1/8	33
30	3	3/8	5/8	34 3/8	35 5/8	36 1/2
33	3	3/8	5/8	37 5/8	38 15/16	39 7/8
36	3	3/8	1 1/16	40 3/4	42 1/4	43 1/4

Table 8. (Continued)

Nominal size, in.	Depth of socket, in. <i>LS</i>		Thickness of barrel, in. <i>T</i>		Thickness of socket at 1/2 in. from outer end, in. <i>TS</i>	
	Nominal	Min	Nominal	Min	Nominal	Min
	6	2 1/4	2	1 1/16	9/16	1/2
8	2 1/2	2 1/4	7/8	3/4	9/16	1/2
10	2 5/8	2 3/8	1	7/8	5/8	9/16
12	2 3/4	2 1/2	1 3/16	1 1/16	3/4	1 1/16
15	2 7/8	2 5/8	1 1/2	1 3/8	1 5/16	7/8
18	3	2 3/4	1 7/8	1 3/4	1 1/8	1 1/16
21	3 1/4	3	2 1/4	2	1 5/16	1 3/16
24	3 3/8	3 1/8	2 1/2	2 1/4	1 1/2	1 3/8
27	3 1/2	3 1/4	2 3/4	2 1/2	1 11/16	1 9/16
30	3 5/8	3 3/8	3	2 3/4	1 7/8	1 3/4
33	3 3/4	3 1/2	3 1/4	3	2	1 3/4
36	4	3 3/4	3 1/2	3 1/4	2 1/16	1 7/8

* There shall be no maximum length. Shorter lengths may be used for closures and specials.
† There is no limit for plus variation.
‡ The average actual inside diameters of pipe having the nominal thickness of barrel shown in Table 8 may be smaller than the nominal sizes.
§ The outside diameter of the barrel may be greater than the maximum figures stated in Table 8 provided the other dimensions are varied accordingly within the specification tolerances.
¶ Dimensions *L*, *DS*, *LS*, *T*, and *TS* refer to the sketch of Table 7.

changes in size, slope, direction, or elevation. It is general practice to install sewers in straight lines between manholes, except that for the larger sizes (36 in. and above) they may be laid on curves. Manholes are usually installed at the upper end of every lateral sewer and in straight-line sewers so that the spacing will not exceed

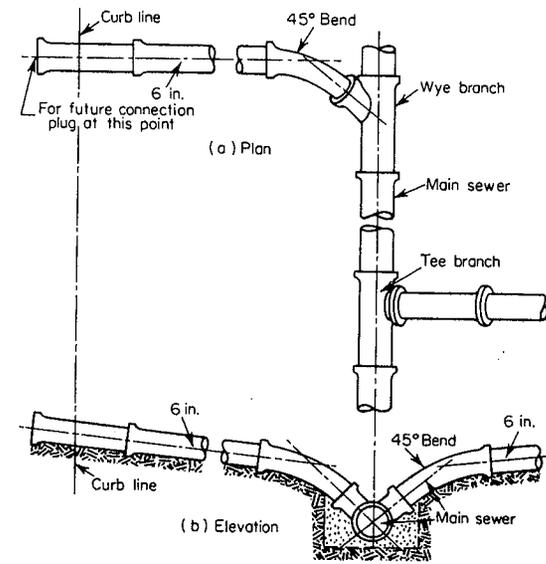


Fig. 16. Typical service connections to a shallow sewer.