TABLE 10—SUPPORTING STRENGTHS (LB PER LIN FT) OF SEWER PIPE FOR DIFFERENT BEDDING CONDITIONS

Three edge bearing strengths	Impermissible bedding (load factor 1.1)	Ordinary bedding (load factor 1.5)	First class bedding (load factor 1.9)	Concrete cradle bedding (load factor 2.25–3.4)
1100	1210	1650	2090	2475–3740
1300	1430	1950	2470	2925–4420
1400	1540	2100	2660	3150–4760
1500	1650	2250	2850	3375–5100
1750	1925	2625	3325	3938–5950
2000	2200	3000	3800	4500–6800
2200	2420	3300	4180	4950–7480
2400	2640	3600	4560	5400–8160
2750	3025	4125	5225	6190–9350
3200	3520	4800	6080	7200–10880
3500	3850	5250	6650	7875–11900
3900	4290	5850	7410	8775–13260
4000	4400	6000	7600	8800–13600
5000	5500	7500	9500	11,000–17,000

safety factor of 1.2 to 1.5 is recommended. That is, once the safe supporting strength is determined, it is multiplied by a factor of 1.2 to 1.5 to obtain the "field supporting strength," which serves as the basis for specifying the pipe class to be installed.

For reinforced concrete sewer and culvert pipes, it is customary to design on the basis of 80 percent of the ultimate load, or 100 percent of the load necessary to produce a 0.01-in. crack, whichever is less.

APPLICABILITY OF DATA

These data and comments on sewer pipe design are generally applicable to most types of manufactured pipe. Where differences from these design practices apply for specific pipe materials, the matter will be covered in the discussion of the particular material. Sewers constructed in place also have different design considerations, depending on size, shape, and material.

Section 3—Asbestos-Cement Pipe

The same materials, processes, and testing procedures are used in the manufacture of asbestos-cement nonpressure sewer pipe and building sewer pipe as in the manufacture of pressure pipe for water supply systems. The subject of manufacture is covered in Manual of Practice No. 2 (pages M10 to M13).[24]

Pipe characteristics

There are three types of asbestos-cement pipe: building sewer pipe, gravity sewer pipe, and pressure sewer pipe. In the selection of pipe, the design engineer must consider, in addition to application, characteristics of the pipe material.

PHYSICAL CHARACTERISTICS

Asbestos-cement building sewer pipe is supplied in Class 1500. Nonpressure sewer pipe is generally available in Classes 1500, 2400, and 3300, and sometimes in Classes 4000 and 5000. These class designations are based on supporting strengths as determined by the three-edge bearing test. Pressure sewer pipe is available in Class 100, Class 150, and Class 200, based on the combined internal and external loading theory.[24]

Table 11 shows data on the available pipe diameters and lengths and the weight per foot in the different classes. These weights per foot are approximate and include the weight of one coupling attached to the pipe length. The weights given in Table 11 are approximate and may vary slightly from one manufacturer to another.

Well-point dewatering system along fully-sheeted trench for 24-in. asbestos-cement sewer pipe.

SURFACE CHARACTERISTICS

The need for a smooth bore in sewer pipe has been pointed out previously. Manufacturers of asbestos-cement sewer pipe meet this criterion through the method of manufacture, which utilizes a polished steel mandrel around which the pipe is formed. The resulting product has a Kutter or Manning n value of 0.010. After curing, the material has a low content of uncombined calcium hydroxide. The flow characteristics are relatively unaffected by continued use.

Linings

Asbestos-cement sewer pipe is normally unlined. An epoxy-lined pipe is available for use in special applications. This epoxy material is applied free of solvents, and the lining, therefore, has no holidays attributable to solvent evaporation. Pipe joints and fittings are also available with epoxy linings. The surface of epoxy-lined pipe has a roughness coefficient equal to or better than that of unlined pipe.

Joints and fittings

Nonpressure asbestos-cement sewer pipe and house and building sewer pipe use the same type of couplings, with flexible rubber rings, as does water pipe. These couplings provide a joint that is both leakproof and rootproof.

Fittings of all types and for all uses are available for joining asbestos-cement pipe to other sewers constructed of any material.

Specifications

In the preparation of specifications for asbestos-cement nonpressure sewer pipe, the design engineer should specify that the manufacture and material meet the requirements of the latest revision of the Federal Specification SS-P-331 and ASTM Specification C-428. Asbestos-cement pressure sewer pipe is specified by Federal Specification SSP351a, AWWA C-400-65, and ASTM Des. C-296-65T.

Manufacturers

Asbestos-cement sewer pipe is manufactured by the following companies:

Cement-Asbestos Product Co., Woodward, Ala.
Certain-teed Products Co., Ambler, Pa.
Flintkote Co. (Orangeburg Mfg. Div.), Orangeburg, N. Y.
Johns-Manville Corp., New York, N. Y.

TABLE 11—CHARACTERISTICS OF ASBESTOS-CEMENT PIPE

Size (in.)	Available lengths (ft)	Approximate weight per foot (lb)* (with coupling attached)						
		Class 1500	Class 2400	Class 3300	Class 4000	Class 5000	Class 6000	Class 7000
		BUILDING AND HOUSE SEWERS						
4	5, 6-1/2, 10, 13	4.6–5.0	5.0–5.6	6.7				
5	5, 6-1/2, 10, 13	6.4–6.7	6.9–7.7	8.9–9.4				
6	5, 6-1/2, 10, 13	7.7–8.7	8.8–9.2	10.3–11.1				
		GRAVITY SEWERS						
6	5, 6-1/2, 10, 13	8.1	8.8	10.4				
8	5, 6-1/2, 10, 13	12.8–13.1	12.8–14.0	14.5–15.8				
10	6-1/2, 13	16.1–17.1	16.1–17.7	17.8–20.5	20.0–22.7	21.9–25.8		
12	6-1/2, 13	22.2–29.9	23.0–24.0	24.9–27.0	26.6–29.6	29.6–33.6		
14	6-1/2, 13	25.9–27.7	25.9–28.9	29.7–34.0	31.1–37.3	34.1–42.0		
15	6-1/2, 13	28.4	28.4	33.1	35.2	39.3		
16	6-1/2, 13	31.5–33.3	31.5–35.3	34.5–41.1	37.1–45.4	40.9–51.0		
18	6-1/2, 13		40.3–42.0	45.6–48.9	50.7–54.2	53.4–60.6		
20	6-1/2, 13		46.3–48.9	52.2–57.1	59.0–63.0	61.7–70.6		
21	6-1/2, 13		50.1	58.7	66.3	72.5		
24	13		56.1–64.3	70.8–74.5	78.9–82.3	81.4–92.2		
27	13			89.3	96.6	110.4		
30	13			104.8	115.9	128.9		
33	13				133.5	148.7		
36	13				152.2	169.8		
39	13					198.0	219.0	238
42	13					216.0	290.0	260

*Weight per foot will vary with pipe length because total weight includes attached coupling. Weight per foot also varies from one manufacturer to another; above ranges are from two manufacturers.

Section 4—Bituminized Fiber Pipe

Laminated-wall, bituminized-fiber drain and sewer pipe is designed to have a resistance to external loads, chemicals, heat, and water. It is manufactured in accordance with Federal Specifications SS-P345a and Commercial Standard CS 226-59. Homogeneous bituminized-fiber pipe is also manufactured in accordance with Commercial Standards CS116-54, but this type of pipe is not covered in this section.

Manufacture

The process of manufacturing laminated-wall bituminized fiber pipe consists of two major steps. The first step is the forming of the pipe as a multiple laminated or spiral fibrous structure of tough uniform fibers bonded with a special water resistant adhesive. The second step is impregnation of the formed pipe, under high pressure, with an especially compounded liquefied pitch. The result is a pipe with a dense wall and smooth interior surface, free from obstructions or rough flaky areas.

Testing

To ensure that the pipe as produced by the manufacturing process meets specifications, samples are tested to determine their strength with respect to crushing, axial-compression crushing, surge pressure, and hydrostatic pressure, and to determine their resistance to flattening pressures, chemicals, kerosene, hot water, and heat. Tests are also made to determine resistance to the absorption of water and to longitudinal permeability seepage. All tests are conducted with standardized equipment and controlled procedures.

MINIMUM TEST CRITERIA

Table 12 lists the minimum acceptable test criteria for physical strength characteristics.

In addition to the criteria in Table 12, laminated-wall, bituminized fiber pipe must have the following characteristics.

Chemical and kerosene resistance. Both pipe and fittings must be highly resistant to corrosive soils, acids, alkalies, salts, and petroleum wastes. After being subjected to the chemicals under test conditions, the crushing strength of the samples must not be less than the values indicated in Table 12. Tests are made by subjecting separate samples, for periods of 10 days at 70 to 80° F, to 0.1 *N* sulfuric acid, 0.1 *N* sodium carbonate, 0.1 *N* sodium sulfate, and kerosene. Then the test specimens are emptied, rinsed, wiped dry, and tested for crushing strength.

Flattening resistance. Both pipe and fittings must resist the combined flattening effects of earth loads and heat.

TABLE 12—MINIMUM REQUIRED PHYSICAL CHARACTERISTICS FOR BITUMINIZED-FIBER PIPE

Federal Specifications SS-P-345a

Pipe size* (in.)	Wall thickness (in.)	Physical strength tests				
		Axial crushing (lb/lin ft)	Beam (lb/lin ft)	Crushing (lb/lin ft)	Hydrostatic pressure (psi)	Surge pressure (psi)
2	0.25	6,000	1,000	1,500	350	600
3	0.28	10,000	1,000	1,500	350	600
4	0.32	13,000	2,200	1,500	350	600
5	0.41	20,000	4,200	1,500	350	600
6	0.46	30,000	4,400	1,500	300	500
8	0.57	39,000	7,000	1,800	300	500
10	0.61	60,000	7,500	1,800	200	350
12	0.61	72,000	8,500	1,800	150	350
15	0.67	98,000	10,000	1,800	150	250
18	0.71	125,000	11,500	1,800	100	250

*Nominal inside pipe diameter.