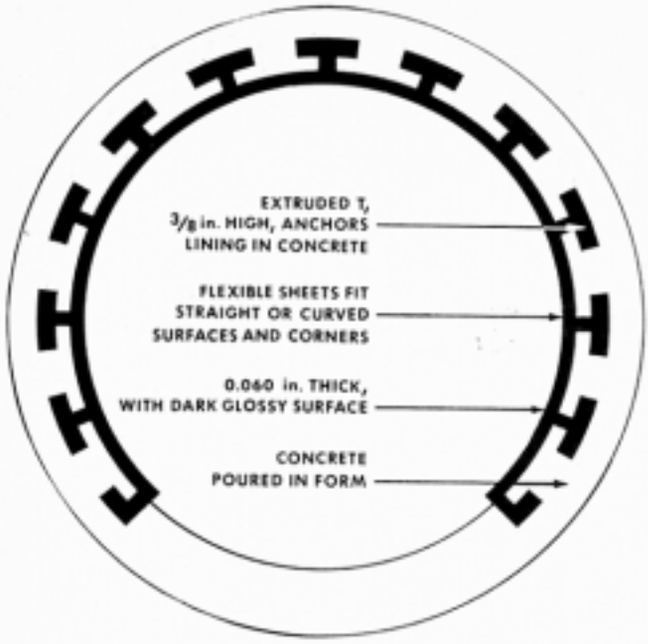

Fig. 17. Cross section, exaggerated, of plastic liner for concrete pipe.

Joints and fittings

Various types of joints are available for connecting concrete pipe sections, and the type of joint used often depends on the ground water conditions, pipe size, the manufacturer, and whether the pipe is reinforced or nonreinforced.

The principal types of joints are bell and spigot, tongue and groove, modified tongue and groove (with a reinforced modified bell), concrete collar, single rubber ring gasket, and external band. Methods of making joints will be discussed in Part 3 of this manual.

Fittings of all types, including bends, wyes, tees, connections, and specials, are available in all sizes.

Cast-in-place concrete pipe

Concrete sewers cast in-place involve engineering design formulas and calculations. Different shapes involve different engineering design approaches. Principles of design for such sewers may be found in standard reference texts[5,10,20,26] and will not be covered in this manual.

Manufacturers

Manufactured concrete pipe, joints, and fittings may be obtained from the following manufacturers; the list is not necessarily all-inclusive. For a complete list, consult the American Concrete Pipe Assn.

American Pipe & Construction Co., Monterey Park, Calif.
The Cretex Co., Inc., Elk River, Minn.
Gifford-Hill Pipe Co., Dallas, Tex.
Hydro Conduit Corp., Denver, Colo.
International Pipe & Ceramics Corp., Parsippany, N. J.
Price Brothers Co., Dayton, Ohio
United Concrete Pipe Corp., Birmingham, La.
United States Concrete Pipe Co., Cleveland, Ohio
Vulcan Materials Co., Atlanta, Ga.

Specially lined pipe, as described previously, or epoxy lining-in-place may be obtained from the following companies:

Epoxy lining-in-place; Centriline Corp., Div. of Raymond International, Inc., New York, N. Y.

Integral lining: U. S. Steel Chemicals, Div. of U. S. Steel Corp., Pittsburgh, Pa.

Plastic linings are manufactured by Amercoat Corp., Brea, Calif., but are applied by the pipe producer.

Section 9—Plastic and Plastic Lined Pipe

Until recently, the use of plastic pipe in sewer systems was limited to building sewers, house sewers, and force mains, primarily because the largest size available was 6 in. in diameter. In about 1965, a specially designed plastic pipe, termed truss pipe, was introduced in sizes of 8-, 10-, 12-, and 15-in. diam. In 1967, a British manufacturer announced the production of extruded polyvinyl chloride pipe (PVC) in diameters up to 16 in., with the future possibility of producing 20-, 24-, and 30-in. pipe. These developments undoubtedly will lead to the wider use of plastic pipe for sewers.

ABS, PE, and PVC pipe

The U. S. Department of Commerce has issued two commercial standards for plastic drain, waste, and vent pipe and fittings (CS 270-67 for ABS and 272-65 for PVC pipe) and one for sewer and drain pipe (CS 228-61 for styrene-rubber plastic). As the use of plastic pipe for sewers increases, there may be standards developed specifically for plastic sewer pipe of various compositions. Information on the design, specifications, manufacture, and testing of plastic pipe for water systems may be found in Manual of Practice No. 2.[24] Manufacture of plastic sewer pipe is similar.

In addition to the types of pipe used for water systems and/or drain, waste, and vent systems, there are two types of plastic pipe designed for wastewater use: styrene-rubber plastic pipe, and truss-type plastic pipe.

Styrene-rubber plastic pipe

This type of pipe is an extruded product and is available in 10-ft lengths. Four sizes are produced, each with a crushing strength of 1000 lb per lin ft. The dimensional characteristics of this type of pipe, as given in CS-228-61, are as follows:

Pipe size (in.)	Wall thickness (in.)	Weight (lb/ft)
2	0.073	0.25
3	0.100	0.49
4	0.125	0.78
6	0.183	0.67

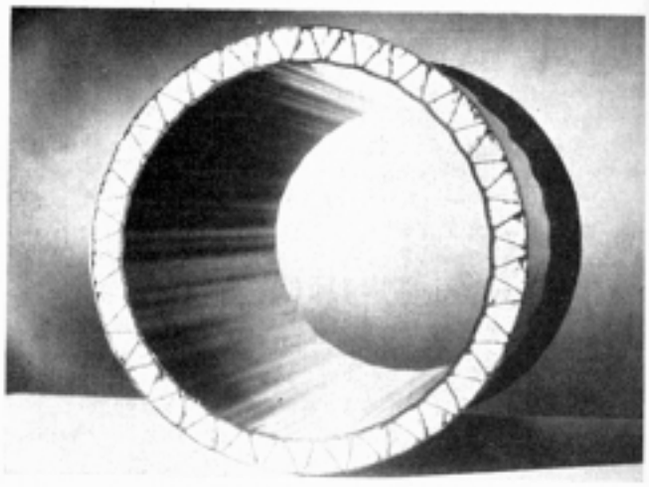

Fig. 18. Cross section of truss-type ABS plastic pipe.

TABLE 19—DATA ON TRUSS-TYPE PLASTIC PIPE

Pipe size			
Regular strength (in.)	Extra strength (in.)	Length (ft)	Weight (lb/lin ft)
...	4	6-1/4, 12-1/2	...
...	6	6-1/4, 12-1/2	...
8	...	6-1/4, 12-1/2	8
10	...	6-1/4, 12-1/2	11
12	...	6-1/4, 12-1/2	15
15	...	6-1/4, 12-1/2	26

The pipe has a tensile strength of 3100 psi, an impact strength of 3.2 ft-lb per in. notch, and an elongation of 17 percent. It is resistant to acids, detergents, caustics, and ordinary domestic wastewater.

Jointing is done by the solvent-weld method to form leakproof and rootproof joints. All types of fittings are available.

Plastic truss pipe

This type of plastic pipe (Fig. 18) consists of two interconnected walls of acrylonitrile-butadiene-styrene (ABS) resin tied together by a truss of the same material, with the voids filled with lightweight concrete.

DESIGN

The lightweight concrete in the voids of truss-type plastic pipe helps to carry the compressive load and provides lateral support for the truss members. Tensile stresses are carried by the pipe wall.

Either of two methods may be used in calculating the necessary resistance or supporting strength for backfill loading: the deflection design method or the ring compression method.[33] Tests using the latter design method indicate that the maximum backfill depth should be 48 ft, based on a given wall strength, a soil weight of 100 lb per cu ft, and a safety factor of 4.0.

The maximum recommended permissible design deflection is 5 percent in a period of 12 months. Field tests indicate that where bedding is good, the maximum deflection noted was 2 percent in 12 months.

CHARACTERISTICS

Truss-type plastic pipe is relatively light in weight and, because of its composition, is quite durable for sewer installations. It has a high resistance to abrasion, freezing, and thawing, and is not affected structurally at temperatures up to 130° F. Thermal expansion is not significant over normal installation ranges. This type of pipe is chemically resistant to hydrogen sulfide and acids in concentrations up to 5 percent.

Minimum specification (ASTM D-18617) for crushing strength is 1500 lb per lin ft, but tests on 8-in. pipe show that between 60 and 130° F, the crushing strength ranges from 2100 to 1650 lb per lin ft.

Good hydraulic flow characteristics result from the smooth surface of the interior wall of the pipe. As produced, this type of pipe is stated to have a Manning n value of 0.010.

MANUFACTURE AND TESTING

Truss-type plastic pipe is made by an extrusion process that forms both the walls and the truss arrangement simultaneously. Data on pipe sizes and weights are given in Table 19. Jointing is accomplished by chemical (solvent) welding to produce a sewer that is leakproof, and resists root penetration, and infiltration. All types of fittings are available.

Plastic pipe (15-in.) for sewer line in New York State.

Laboratory tests made on pipe after manufacture include beam tests and impact tests. By specifications of the manufacturer, truss pipe must show no leakage after sustaining a 1-in. deflection for 24 hr with a 10-ft internal water head. The required spans for the flexural test are 82, 90, 96, and 110 in. for pipe diameters of 8, 10, 12, and 15 in., respectively. Beam tests on 8-in. pipe show deflections of 1, 2, or 3 in. in a 10-ft span, with respective loads of 870, 1460, and 1900 lb.

Plastic-lined pipe

Steel pipe that has a plastic lining may be considered as plastic lined steel pipe; it also may be considered as steel armored plastic pipe. In this manual, this type of pipe is termed plastic-lined pipe.

The greatest use of plastic-lined pipe is in handling corrosive chemicals. Currently, the most important application of plastic-lined pipe in the wastewater field is in the disposal of chemical wastes into underground wells.

DESIGN AND MANUFACTURE

Plastic-lined steel pipe is produced with three types of extruded liners, namely, saran, Penton, and polypropylene. These liners are tough and stabilized; they range in thickness from 5/32 to 9/32 in. They are locked in place on the inside of the steel pipe walls by a force of several thousand pounds per square inch. The result is a thick-walled pipe with a heavy steel shell, the two layers being virtually monolithic. The pipe thus produced is suitable for use at temperatures from −20 to 200° F or higher. Pipe is available in sizes from 1 to 8 in., weighing from 2.4 to 28.6 lb per ft; it is made in 10 ft lengths.

In another manufacturing process, a special polyethylene co-polymer is bonded to both the inside and outside of steel pipe. This type of pipe is produced in approximately 30-ft lengths, with coatings of plastic 30 mils thick. Pipe sizes (diameters) available include 2, 3, 4, 6, and 8 in. The weight of this pipe ranges from 1.73 to 10.7 lb per ft. Joints are couplings or flanges.

The method for lining concrete pipe with plastic was previously described (Part 2, Section 8).

Manufacturers

Companies that produce acrylonitrile-butadiene-styrene (ABS), polyethylene (PE), polyvinyl chloride (PVC), or

styrene rubber plastic sewer pipe include the following: (All the companies listed do not necessarily produce all types of plastic pipes.)

Anesite Div., Clow Corp., Chicago, Ill.
Can-Tex Industries, Inc., Mineral Wells, Tex.
Carlon Products Corp., Aurora, Ohio
Celanese Plastics Co., Columbus, Ohio
Dan-dee Products Corp., Union City, Calif.
Ethyl Corp., Visqueen Div., Baton Rouge, La.
Evanite Plastic Co., Carrolton, Ohio
Flintkote Corp., Orangeburg, N. Y.
Gering Plastics Co., Div. of Monsanto, Kenilworth, N. J.
Haveg Industries, Inc., Amco Pipe, Wilmington, Del.
Johns-Manville Corp., New York, N. Y.
U. S. Pipe & Foundry Co., Birmingham, Ala.

Companies that produce plastic-lined pipe or plastic liners include the following:

Amercoat Corp., Brea, Calif.
Dow Chemical Corp., Midland, Mich.
International Protected Metals, Inc., South Plainfield, N. J.

Companies that produce truss-type plastic pipe include:

Armco Steel Corp., Metal Products Div., Middletown, Ohio
Robinson Clay Product Co., Akron, Ohio

TABLE 20—DATA ON GLASS-REINFORCED PIPE*

	Class 2025	Class 2530	Class 3040
Size (in.)**	2–12	2–12	2–12
Wall thickness (in.)	0.2–0.25	0.25–0.3	0.3–0.4
Weight (lb/ft)	0.83–6.70	1.25–8.0	1.4–10.4
Collapse pressure at 80°F (psi)	225–6	350–10	400–25
Axial load pressure at 80°F (psi)	3000–18,000	4000–25,000	4500–37,000
Internal pressure resistance at 200°F (psi)	200–130	300–160	400–240

* Class 2025 is suitable for use at temperatures up to 200°F, Classes 2530 and 3040 at temperatures up to 300°F.
** Nominal inside pipe diameters available are: 2, 2-1/2, 3, 4, 6, 8, 10, and 12 in.

TABLE 21—DATA ON REINFORCED PLASTIC MORTAR PIPE

Pipe size (in.)	Weight (lb/ft) Low head (125 ft)	High head (200 ft)
8	5.5	5.5
10	7.0	7.0
12	9.5	9.0
15	13.0	10.5
18	15.5	15.0
21	19.0	20.0
24	23.0	22.0
27	28.0	25.5
30	35.5	31.0
33	43.0	37.5
36	47.5	44.5
39	60.0	52.5
42	69.5	61.0
48	90.5	80.0

Section 10—Reinforced Resin Pipe

For the purposes of this manual, fiberglass reinforced pipe is not defined as plastic pipe because the composition and methods of manufacture differ from those of the plastic pipe discussed in the previous section. Commercial products on the market carry registered trade names that do not indicate the composition of the pipe. At least two major types of reinforced resin piper are available commercially.

Reinforced epoxy or polyester plastic

This type of pipe, sometimes termed simply GRP (glass-reinforced pipe), is composed of fiberglass reinforced epoxy resin or polyvinyl ester. At least one commercial product is available in three classes. When epoxy resin is used, it meets ASTM Spec. Des. 1763-63. The pipe is tested for various characteristics in accordance with several applicable ASTM specifications. Each grade of pipe has a different temperature range resistance; the thermal expansion coefficient of the pipe in diameters from 4 to 12 in. is approximately 9×10^{-6} in. per in. per degree F. The pipe has a low hydraulic-flow friction coefficient; the Hazen-Williams C-value being stated by one manufacturer as 150.

Glass-reinforced piping is available in 15 and 20 ft lengths and in diameters from 2 to 24 in., but larger diameters can be obtained for special applications. In one process of manufacture, the pipe is built up by laminations, as follows:

Inner surface—0.01 to 0.02 in. smooth resin-rich interior, reinforced with surfacing mat or veiling.

Next interior layer—0.1 in. (minimum) chemical-resistant layer, 25 to 30 percent glass by weight.

Remaining interior layers—varied thickness of glass and resin to obtain the required laminate strength.

Exterior surface—resin-rich surface, reinforced with a surfacing mat.

This type of pipe has high corrosion resistance but not necessarily abrasion resistance. The corrosion resistance is provided by the resin; the strength by the fiberglass. Best corrosion-resistance/strength characteristics are obtained with 25 to 40 percent glass and 75 to 60 percent resin. Coupling joints may be threaded, solvent-welded, or made with resin coatings.

This type of pipe has been found useful in industrial wastes systems, particularly for deep-well disposal of industrial wastes. Table 20 lists the characteristics of three classes of pipe produced by one manufacturer.

Reinforced plastic-mortar pipe

Reinforced plastic mortar pipe has a composite structure (Fig. 19) of synthetic polyester and sand mortar reinforced with continuous glass fibers.

This type of pipe is manufactured in two classes: low head (125 ft), and high head (200 ft). Because the high head pipe will be subjected to higher internal pressures, it contains a larger percentage of reinforcing glass filaments and less sand filter; consequently it weighs less per foot (Table 21). Wall thickness for the low head pipe ranges from a nominal 0.2 in. for 8-in diam. pipe to about 0.4 in. for the 48-in. pipe size. The wall thickness of high head pipe is similar to that of low-head pipe but in some cases it may be slightly less. Nominal weights per foot are shown in Table 21.

This type of pipe is manufactured in standard 10 ft laying lengths, but 20 ft lengths may be obtained. No published data are available at this time on the pipe's supporting strength for backfill loads in trenches. The material in this type of pipe will not react with the acids and chemicals normally encountered in domestic or industrial wastewaters or with corrosive soils. It is also resistant to electrolytic or galvanic corrosion and hydrogen sulfide. The internal surface of this pipe is extremely smooth and for hydraulic flow design calculations, the manufacturer recommends a Manning's n value of 0.009.