Water for the World

Selecting Pipe Materials
Technical Note No. RWS. 4.P.3

Several factors will influence the type of pipe material chosen for a water distribution system: corrosiveness of the water, water pressure, flow required, soil characteristics and the physical properties of the pipe material. Other considerations are whether the pipe will be used for transmission lines, distribution lines or service lines, the cost and availability of the pipe material and ease of construction and repair.

The materials most often used for water pipes in rural systems include plastic, asbestos cement, steel, and cast iron. Other materials used less often are bamboo, wood, concrete and ductile iron.

Factors in Choosing Pipe Materials

Corrosion. Some water reacts with pipe materials due to an imbalance in the chemical make-up of the water or to minerals in it. The result can be corrosion of metal pipes, leaching of cement in concrete pipes, or deposits of minerals which reduce the water flow in all types of pipe. Most likely, a judgment on the corrosiveness of the pipe will have to be based on experience in the area.

Flow. Pipe materials vary in smoothness which, in turn, affects their resistance to the flow of water. The rougher the surface, the more energy is required to move water from one point to another, thus increasing system costs. These losses are compounded as the rate of flow increases.

Water Pressure. Pipe materials vary greatly in their ability to withstand pressure without bursting so it is important that the pressure at all points in the system be known.

Soil Characteristics. Soils react with pipe materials under some conditions. Again, past experience is the best method of predicting problems. Other problems in the soil include rocks or boulders which might crush or break the pipe, swamps or bogs which do not provide adequate support, and sand which can shift and expose the pipe. Important physical properties of the pipe materials include resistance to crushing, degree of stiffness, and reaction to temperature changes, sun rays, and chemicals.

Physical Characteristics of Pipe. Impact resistance is a material's ability to absorb a blow without damage. Such a blow might occur if a rock fell on the pipe in a trench or if the pipe were dropped. The stiffness or flexibility of material indicates how it will react to impacts. Pipe materials which are inflexible include concrete, asbestos cement and cast iron. Care must be taken to prevent unintentional "bridging" of inflexible materials as shown in Figure 1. Steel pipe is moderately flexible, particularly in smaller diameters. The plastic pipes are usually very flexible.

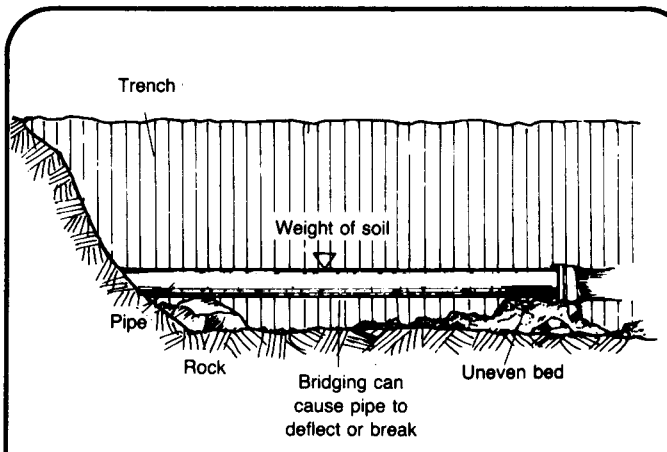


Figure 1. Bridging (Incorrect Installation)

Heat and sunlight usually affect only plastic pipe. Plastic has a relative high expansion/contraction factor when exposed to variations in temperature. For this reason, plastic pipe, particularly polyethylene, should be "snaked" in the trench. The ultraviolet rays in sunlight can cause deterioration in plastic pipe so it should not be exposed for long periods of time. The weight of the pipe is an important consideration due to the need to transport and handle the pipe. Toxicity is a potential problem if recycled plastic products are used in pipe manufacture, if toxic materials such as lead are used, or if pipe is contaminated by prior use or improper storage.

Pipes vary in length from 3-6m and longer by special order. Polyethylene coils are an exception. They come in lengths of 30 and 150m with longer lengths available. Methods used to join pipes include threaded, glued, clamped, welded, mechanical joint, rubber ring couplings and integral bell couplings. These are shown in Figures 2, 3, 4, 5, and 6. Glued joints are used for some plastics but are difficult to make properly and are not recommended for most water systems. Threaded joints are mostly used for steel pipe but occasionally are used with plastic.

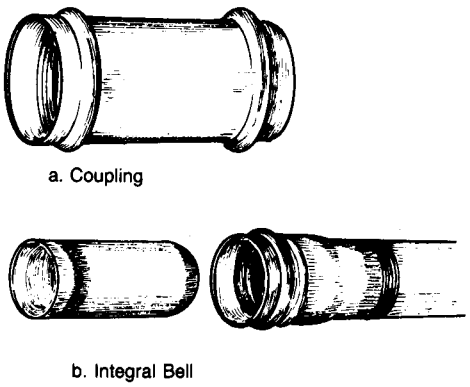


Figure 2. Gasket Joints for PVC Pipe

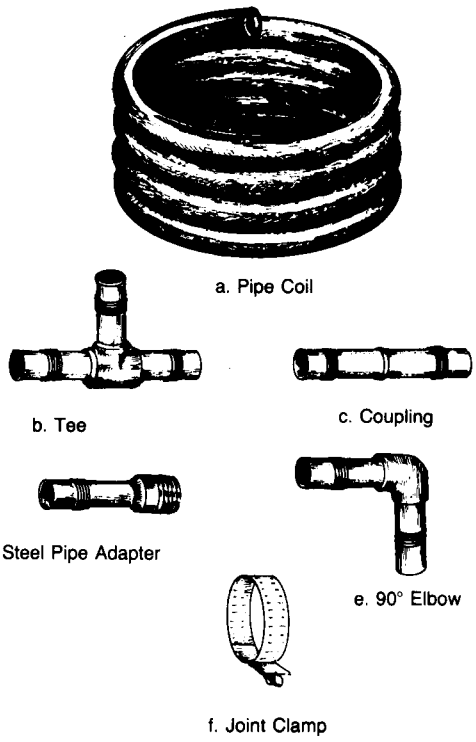


Figure 3. Polyethelene Plastic Pipe and Fittings

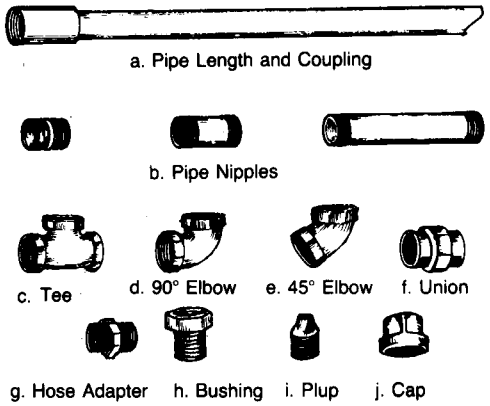


Figure 4. Galvanized Steel Pipe and Fittings

Pipe Materials

Table 1 compares common pipe materials according to several factors. While no pipe is best in all regards, plastic pipe rates high in most characteristics and is the material of choice in many small rural systems.

Bamboo is lightweight and strong. It is very inexpensive in areas where

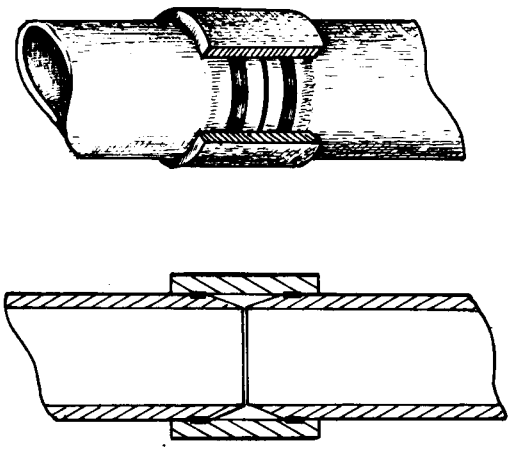
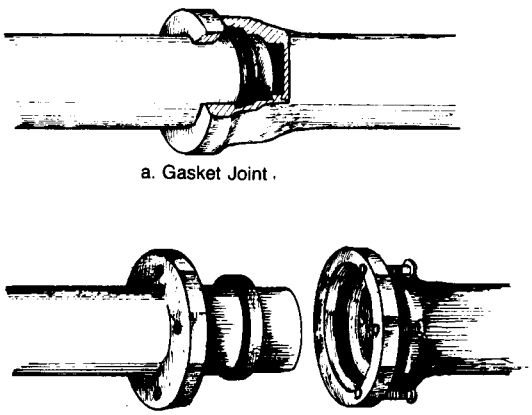


Figure 5. Typical Asbestos-Cement Pipe Joint



a. Gasket Joint

b. Mechanical (Bolted) Joint

Figure 6. Cast Iron Pipe Joints

it grows. Its primary advantages are its availability and suitability for low technology construction. Its drawbacks include a short useful life and inability to withstand pressure. Bamboo is not normally used for water systems because of the constant maintenance required and the fact that most water systems must operate under pressure.

The plastics commonly used in water systems are poly-vinyl-chloride, PVC, and high and low molecular weight polyethylene. PVC is usually available in 3 or 6m lengths and in diameters of 13-300mm. Common pressure ranges are 11 and 14 kilograms per square centimeter (kg/cm^2). While the small diameters (13-50mm) may be joined by gluing or by screwed joints, pipe diameters of 50mm and up are commonly joined by integral bell or rubber ring coupling. PVC is lightweight, flexible, resistant to breakage, highly resistant to chemicals, and easy to install. PVC is simple to repair and to tap for services and is one of the smoothest materials, which reduces friction due to flow. Its useful life should exceed 20 years.

Polyethylene is manufactured in lengths of 30 and 150m. Common diameters range from 13-50mm. It, too, is lightweight and very easy to install

Table 1. Common Pipe Materials

Material	Relative Cost	Range of Size (mm)	Common Length (m)	Pressure Rating (kg/cm^2)	Ease of Installation and Repair	Common Uses
Bamboo	Very low	Varies	Varies	Very low	Easy	Low pressure transmission
Plastic PVC	Low	13-150	6	11, 14	Very easy	All parts system
Polyethylene Low molecular High molecular	 Very low Low-moderate	 13-50 13-50	 30 & 150 30 & 150	 6 11	 Very easy Very easy	Service lines and wells
Asbestos Cement	Moderate	50-900	3 & 4	7, 11, 14	Moderately difficult	Transmission and distribution
Steel (GIP)	Moderate	13-150	6	7, 11	Moderately difficult	Wells, pump houses, tanks, wash, and stream crossing
Cast Iron	High	75-1220	3.6 & 6	4 to 25	Difficult	Large transmission mains

and repair. Service taps are simple and do not require special tools. Low molecular weight polyethylene can withstand pressures of 6 kg/cm^2 and high molecular weight, 11 kg/cm^2. Low molecular weight polyethylene is usually one of the least expensive pipe materials to purchase and install. Its useful life is over 15 years. The primary disadvantages to any type of plastic pipe are poor quality control for some locally manufactured pipe and potential damage if stored in direct sunlight.

Asbestos cement pipe is made of asbestos fibers mixed with cement and silica. The pipe is available in 3 and 4m lengths and in diameters of 50-900mm. Common pressure ratings are 7, 11, and 14 kg/cm^2 depending on wall thickness. Asbestos cement is commonly available and moderately easy to install, tap and repair in diameters of 150mm or less. The pipe walls are smooth and resistant to corrosion.

The principal disadvantage of asbestos cement is its stiffness. It must be handled with care or it will break. It also must be installed with care, often with a select backfill and bedding material as shown in Figure 7. Bridging, shown in Figure 1, must not be allowed to occur. Although asbestos cement is resistant to corrosion, highly aggressive water can leach out the cement and expose and release asbestos fibers which may then be ingested.

Steel pipe coated with zinc is known as galvanized iron pipe (GIP). It usually is manufactured in 6m lengths and in diameters of 13-150mm. Uncoated steel pipe can be obtained in longer lengths and in diameters up to 2400mm. GIP is very impact resistant and can withstand unintentional bridging. In fact, it is used when bridging is desired, such as in crossing a ravine or wash. It is moderately easy to install although special tools, including pipe wrenches and pipe threading equipment, are needed.

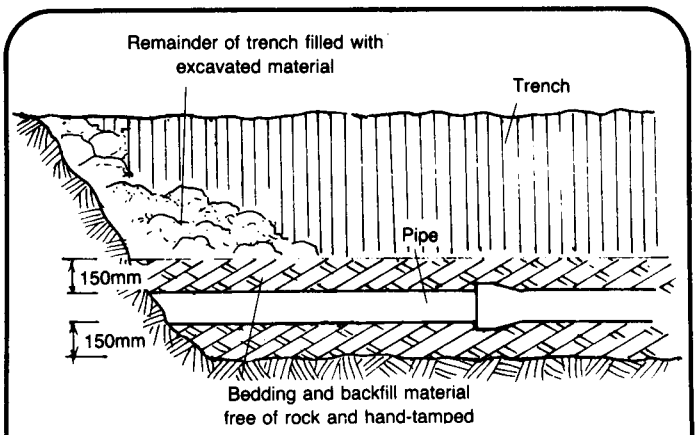


Figure 7. Installing Pipe with Select Material for Bedding

Shortcomings of GIP include its tendency to corrode in aggressive waters and soils. Repair is difficult, as is providing service taps or extensions. GIP is most commonly used for well and pump installations, for stream and wash crossings and at storage reservoirs.

Cast iron is an alloy of pig iron, carbon, manganese, phosphorous, silicon, sulphur and other materials. It is available in lengths of 3.6 and 6m. Diameters range from 75-1220mm. Pressure ratings vary between 4-25kg/cm^2. Cast iron is known for long life in water systems, often exceeding 50 years. It is expensive, moderately difficult to install due to its weight, difficult to tap or repair and is not readily available. Its primary use is for large transmission mains.

Table 1 compares the various pipe materials most often used in small rural systems. Not shown are lead, which should never be used, or copper, which is expensive and primarily used in house plumbing.

Technical Notes are part of a set of "Water for the World" materials produced under contract to the U.S. Agency for International Development by National Demonstration Water Project, Institute for Rural Water, and National Environmental Health Association. Artwork was done by Redwing Art Service. Technical Notes are intended to provide assistance to a broad range of people with field responsibility for village water supply and sanitation projects in the developing nations. For more detail on the purpose, organization and suggestions for use of Technical Notes, see the introductory Note in the series, titled "Using 'Water for the World' Technical Notes." Other parts of the "Water for the World" series include a comprehensive Program Manual and several Policy Perspectives. Further information on these materials may be obtained from the Development Information Center, Agency for International Development, Washington, D.C., 20523, U.S.A.

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