WATER SUPPLY ENGINEERING

(CONVEYANCE OF WATER)

Compiled and Prepared By:

Abhash Acharya

070-BCE-004

Central Campus, Pulchowk

Gravity Conduits and pressure conduits:

Gravity conduits are those conduits in which water flows under the action of gravity where water surface will be at atmospheric pressure. Pressure conduits are those conduits where water flows under pressure above atmospheric pressure.

8.1 Pipe Materials

Water is supplied to the consumers through the pipe under pressure. The pipe materials should be corrosion resistant and resistant to chemical reactions. Pipe material should not release harmful substances into the water they carry.

8.1.1 Requirement of good pipe material

1. **Structural Strength:**

The pipe material should be able to withstand internal as well as external pressures. Internal pressures generate due to static and dynamic water pressures as well as water hammer effects. The external pressures are due to the pressure due to vehicles and overburden pressure by soils.

2. **Durability:**

The durability of the pipe material must be more than the design period of the water supply scheme.

3. **Resistance to corrosion:**

Water contains gases as carbon dioxide and hydrogen sulphide which are corrosive in nature. The pipe material should resist such corrosions and the corrosion caused due to chemical reactions.

4. **Resistance to abrasion:**

Suspended solids present in the water may cause the erosion of the pipe as high-velocity flow leads to abrasion. The pipe material must resist such abrasion.

5. **Imperviousness:**

The groundwater and waste water may enter the pipe line carrying water to be supplied to the consumers if the pipe is not impervious. So, to prevent such movement of groundwater and waste water into the pipe, the pipe material must be impervious.

6. **Smoothness:**

Smoothness determines the carrying capacity of the pipe. The smoother is the pipe, the more will be the carrying capacity and vice versa. When the pipe is smooth, the resistance to the flow of water decreases.

7. **Weight:**

The pipe material should be light in weight which contributes to easier transportation and reduced transportation cost.

8. **Easy to join:**

The pipe materials must be easy to join. It should be easier to make service connections.

9. **Cost:**

The cost of the pipe including handling, transportation and installation must be within the affordable limit (less) so to make the water supply scheme economical.

8.1.2 Types of Pipe Material

- Cast Iron (CI) Pipe
- Steel Pipe
- Wrought Iron (WI) Pipe
- GI Pipe
- Ductile Iron
- Concrete Pipe
- Asbestos Pipe
- Plastic Pipe

8.1.2.1 Cast Iron (CI) Pipes

CI pipe contains 4 – 5 % of carbon and other impurities such as Sulphur, phosphorous, silicon, e.t.c. They are used for making the casting of various shapes.

Advantages:

- Moderate cost
- High durability
- Strong and resistance to corrosion
- Withstand high internal and external pressure
- Easy to cut and join

Disadvantages:

- They are heavy and are difficult to transport and handle.
- They are brittle in nature.
- The carrying capacity of pipe decreases with time.

Remarks:

- Joined by socket, spigot, and flanged joints.
- Provision of expansion joints.

8.1.2.2 Ductile Iron (DI) Pipes

Material: Ductile Iron

Weight: 0.1 – 8 kg

Type: 0.5” – 6”

Casting dimension tolerance: 0.2 – 0.39mm

Advantages:

- Greater strength than CI pipes.
- Greater impact resistance than CI pipes.
- Greater durability than CI pipes.
- They are lighter in weight than CI pipes.
- They can easily be joined.

Disadvantages:

- These pipes are prone to internal and external protection systems. So internal as well as external protection systems are required.
- Corrosion can occur.

8.1.2.3 Steel Pipes

Material: Mild Steel. An alloy of iron containing 0.5 to 1.5% carbon.

Advantages:

- Moderate cost
- Resist very high internal pressure
- Light in weight
- Easy to handle
- Perfectly impervious
- Flexible and can be used in curves

Disadvantages:

- Easily corroded
- Cannot be used for vacuum creating locations

- Maintenance cost is high
- Cannot withstand external pressure

8.1.2.4 Cement Concrete Pipes

Advantages:

- Less corrosion
- Requires less maintenance
- Durable (Life span of about 75 years)
- Resist external loads
- Transportation cost is reduced when cast in situ pipes are used

Disadvantages:

- Difficult to repair
- Cannot withstand high internal pressure
- Difficult to make service connections
- Acidic and alkaline water corrodes the pipe
- Cannot be used for small diameter pipes

Remarks:

- Used in main pipe diameter greater than 50 – 250 cm.
- Cast in-situ or precast Plain cement concrete pipes are used for heads up to 15m.
- RCC pipes are used for heads up to 100m.
- Prestressed pipes are used for heads up to 100-150m.

8.1.2.5 Galvanized Iron (GI) Pipes

These are zinc coated wrought iron pipes which are widely used for inside building and service connections.

Advantages:

- Moderate cost
- Easy to handle
- Easy to join by threading

Disadvantages:

- Corrosion occurs with acidic and alkaline water flow
- Less durable
- Roughness increases with time

8.1.2.6 Wrought Iron (WI) Pipes

Wrought iron is the purest form of iron-containing about 0.2% carbon.

Advantages:

- Light in weight
- Easy to transport
- Easy to cut and thread
- Malleable and ductile

Disadvantages:

- Costly
- Less durable
- Easily corroded
- Weak

8.1.2.7 Asbestos Cement Pipes

These pipes are outdated as they were supposed to cause the carcinogenic effect. They are light in weight, brittle and very smooth.

8.1.2.8 Plastic Pipes

Advantages:

- Cheap
- Flexible
- Light in weight
- Easy to join
- High impact strength
- Chemical resistant
- Durable (Life span up to 50 years)

Disadvantages:

- Cannot be used for high temperature
- Inflammable
- Less resistant to weathering.

8.1.2.9 PVC Pipes

Advantages:

- Cheap
- Corrosion resistant
- Easy to join
- Durable (Life span up to 50 years)
- Rust proof
- Smooth which reduces loss of head due to friction

Disadvantages:

- Brittle
- Cannot be used to carry hot water
- Less resistant to weathering

8.1.2.10 Poly Propylene Random (PPR) Pipes

Advantages:

- Environment friendly
- Light in weight : Density 0.89 – 0.92 g/cm^3
- Long service life
- Good anti-corrosion property
- Low pipe resistance i.e. inner wall of pipe is smooth
- Firm pipe fittings connection
- Recycling property
- Reasonable price

Disadvantages:

- Not suitable for outdoor installation
- Addition or repairs can only be done by making use of a fusion-welding tool

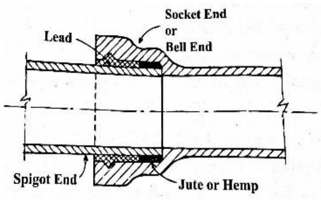
8.2 Pipe Joints

The selection of pipe joints depend upon:

- Pipe materials
- Pressure
- Durability
- Site conditions, etc.

Types of pipe joints

8.2.1 Socket and Spigot Joint/Bell and spigot joint/Run lead joint:

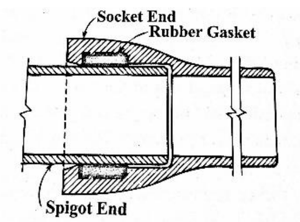


Socket and Spigot Joint

Used for: Cast iron, ductile iron and cement concrete pipes.

One end of the pipe is normal which is called spigot end whereas another end is enlarged to form a socket-like structure which is called the socket end. Few strands of jute are wrapped around the spigot end and a rubber gasket is placed over the jute. The spigot end is inserted into socket end of preceding pipe. The inserted pipe is aligned and centered and the annular space between socket and spigot is filled with molten lead which on cooling and provides the water tight joint.

8.2.2 Tyton Joint/Push on joint/Push on flexible joint:

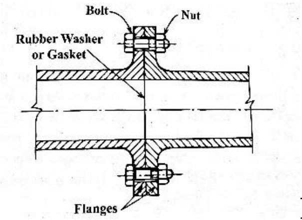


Tyton Joint

Used for: Cast iron and ductile iron pipes.

The rubber gasket is placed in the socket end of the preceding pipe and spigot end is inserted through the rubber gasket into the socket. The socket on 50% compression makes the joint watertight. Spigot end is chamfered and lubricated for smooth entry of the pipe in the socket.

8.2.3 Flanged Joint:



Flanged Joint

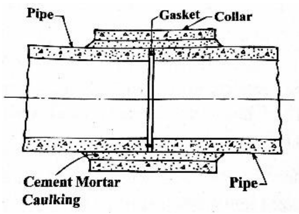
Used for: Cast iron, ductile iron, steel and galvanized iron pipes.

Uses: Used for temporary pipelines, treatment plants, hydraulic laboratories, boiler houses, etc.

Not used where deflections and vibrations are expected.

The pipe consists of flanges on both ends which are cast during manufacturing of the pipe. The two ends of the pipe are brought closer making the holes of flanges in line with each other. After that for making the joint water tight the rubber gasket is placed between two flanges and is bolted by nuts and bolts.

8.2.4 Collar joint:

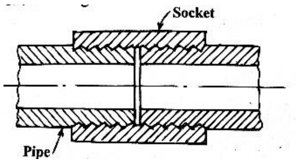


Collar Joint

Used for: Cement concrete pipes.

The pipe has the groove along the cross section at both ends. The ends of the two pipes to be jointed are brought in contact and a rubber gasket between steel rings soaked in cement paste is placed in the groove. The collar made up of reinforced cement is slipped over the pipes. The annular space between the inside of the collar and outside of the pipe is filled with 1:1 cement mortar.

8.2.5 Screwed Socket Joint:

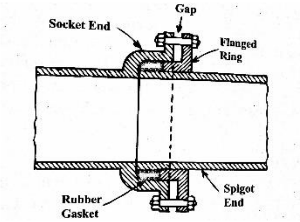


Screwed Socket Joint

Used for: Galvanized iron pipes.

The pipe ends consist of screw threads on the outer surface. For the joint to be possible a socket with threads on the inner surface is screwed and tighten on the pipe ends on which jute are placed. So the joint becomes water tight and is held firmly.

8.2.6 Expansion Joint:



Expansion Joint

It consists of a socket end and a spigot end. The socket end of the pipe is cast flanged. A cast iron follower ring is introduced at the spigot end of the pipe and is held away from the pipe end. On the spigot end of the pipe, a rubber gasket is introduced and is inserted into the socket end. The cast iron follower ring is moved and is fixed to the socket by nuts and bolts. The rubber gasket will absorb the variation in length due to movement of socket end in forward or backward direction. The follower ring keeps the rubber gasket in the position which makes the joint water tight.

Uses: Used when the elongation and shortening of pipe may occur due to change in temperature.

8.3 Laying of Pipes

Steps in the laying of pipes are listed below:

1. Setting out:

It includes the transferring of points of pipe alignment from the drawing to the ground. Centre line of alignment is marked on the ground by driving the stakes. Stakes are driven 30m apart on straight stretches and 7.5m to 15m apart on curves.

2. Excavation of trench:

The trench is excavated along the alignment to place the pipes. The width of the trench should be 30cm more than the external diameter of the pipe. The depth of trench should be equal to or more than 90cm from the top to protect the pipe from external pressure (vehicular pressures) and the depth at joints should be 15cm more than normal depth.

3. Timbering of trench:

After excavation, the excavation needs to be supported by timbering which prevents the soil from caving in. The timbering is not required for hard soil where the soil does not cave in.

4. Preparation of subgrade:

Subgrade is prepared by ramming the layer of soil to the thickness of 15-30cm. A single layer brick flat soling is provided above the compacted soil. In those sites where settlement is likely to occur the subgrade is prepared with a cement concrete bed of 15cm thick over a brick flat soling.

5. Laying and jointing of pipes:

After the preparation of subgrade, pipes are lowered for laying. Small diameter pipes are lowered manually whereas large diameter pipes are lowered using mechanical devices. The pipes are then jointed including the use of various appurtenances as valves, fittings.

6. Testing of pipeline:

The pipeline is tested in pressure and leakage.

- **Pressure Test:**

Among the pressure of about $0.5N/mm^2$ or the maximum pressure plus 50% more whichever is greater is supplied to the pipeline. The fall of pressure in the pipeline is then observed and recorded. If the test pressure is maintained without any measurable head loss for at least half an hour, the pipeline is considered ok.

- **Leakage Test:**

$Q = NDP^{1/2}/3.3$

Where,

Q is the allowable leakage in cm^3/hr

N is the number of pipe joints in the test section

D is the diameter of the pipe in mm

P is the applied test pressure in kg/cm^2

7. Backfilling of the trench:

After laying and testing of the pipeline the back filling of the trench is carried in layers of 15-30cm thickness and is well rammed to resist the movement of pipes.

8. Disinfection of pipeline:

The disinfection of the pipeline needs to be done. For the disinfection of the pipeline, the pipeline is filled with chlorinated water so that the residual chlorine after 12 hours is maintained to be 50mg/l. The pipe is then emptied, flushed with fresh water and put into service.

Bibliography:

Kansakar B.R. (2015), Water Supply Engineering, Divine Print Support, Lagan Tole, Kathmandu.

Punmia B.C., Jain A. and JainA. (1998), Water Supply Engineering, Laxmi Publications (P) Ltd., New Delhi, India.