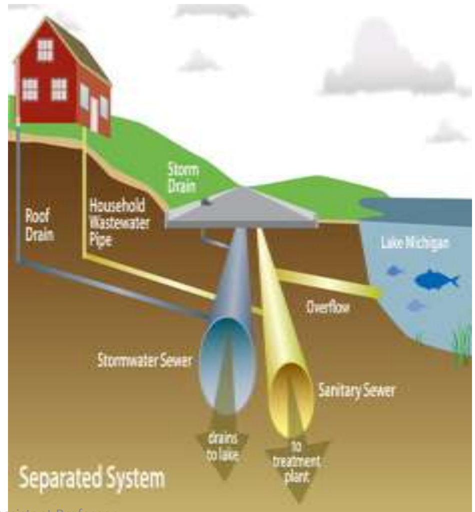
Env Engg I

Unit – 2

CONVEYANCE SYSTEM



Book: S.K. Garg

Title: Water Supply Engineering

Conveyance

There are two stages in the transportation of water:

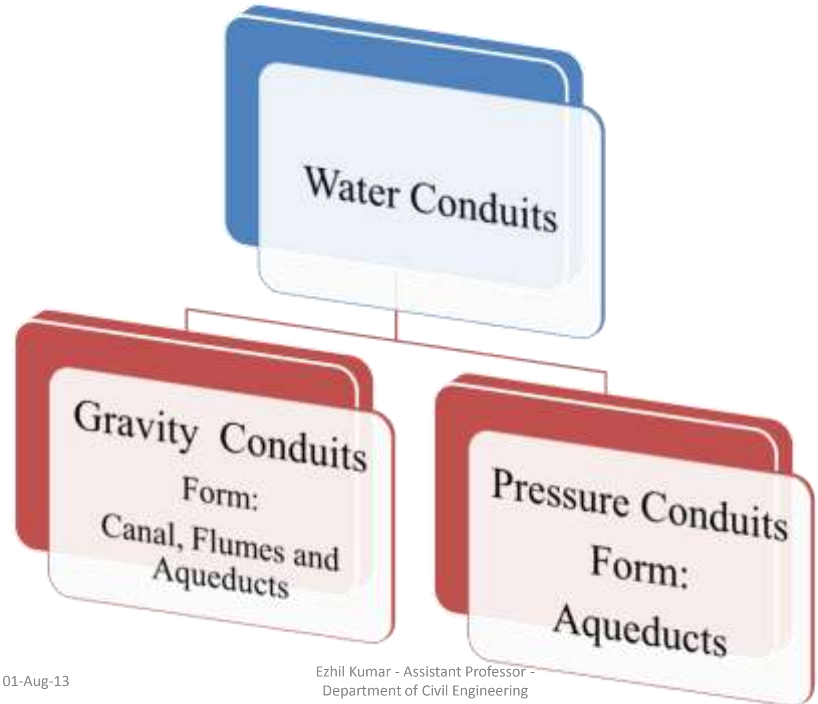
- Conveyance of water from the source to the treatment plant.
- Conveyance of treated water from treatment plant to the distribution system.

Intake Structures

1. Canal Intake
2. Reservoir or Lake Intake
3. River Intake

Water Conduit

- A channel through which anything is conveyed.
- A pipe, tube or natural channel for conveying water or other fluid.

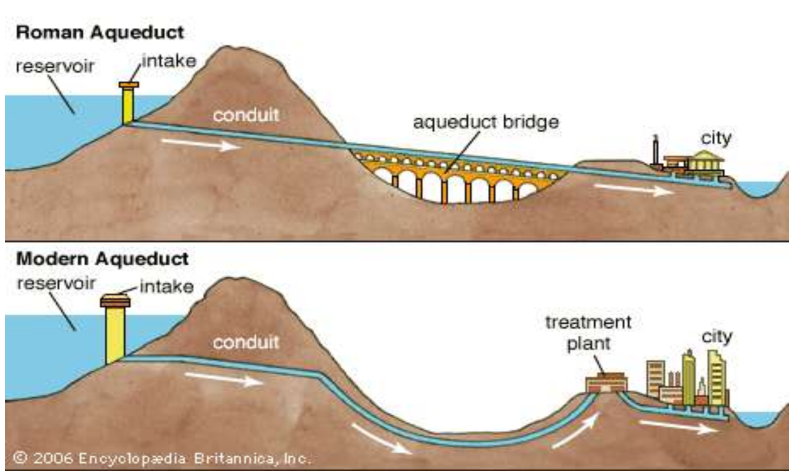

Water Conduits
Gravity Conduits
Form:
Canal, Flumes and Aqueducts
Pressure Conduits
Form:
Aqueducts

Canal

Flume

- A **flume** is man-made channel for water, in the form of an open inclined gravity chute whose walls are raised above the surrounding terrain.
- Used for the diversion of a stream of water from a river for purposes of irrigation

Aqueduct



Aqueduct

- Closed – rectangular or Circular or horse shoe section built of masonry or R.C.C.
- They are generally designed as ½ or 3/4th full.
- When designed as grade aqueducts, should not made to run full under pressure.
- Because of tension developed – open out joints of masonry work endangering structural stability – causing serious leakage.

Pressure Conduit

- Closed conduits – no air can enter into it.
- Water flows under pressure above the atmospheric pressure.
- Pressure pipes follow the natural available ground surface.
- Moves freely up and down hills or can dip beneath valleys or mountains.
- Pressure aqueducts / Pressure tunnels – closed pipes or closed aqueducts and tunnels.

• Circular in shape always – Hydraulic and structural reason.
• Due to Circular shape – pressure conduits are termed as Pressure pipe.
• Pressure pipe – drops beneath a valley, stream or some other depression – So called Sag / Depressed pipe / Inverted siphon.

Significance of Pressure Conduits

- Economical than canal or flumes
- Follow short routes
- Moving water – not exposed anywhere – no chances of getting polluted
- Invariably and universally used for water supplies – Gravity conduits – used for carrying sewage and drainage
- No percolation and evaporation takes place as in canals
- Preferably used when water is scarce

Trestles


NSL – Natural Surface Level

Hydraulics of Flow in Pipes

There are many basic principles that must be considered when preparing the hydraulic profile through the plant.

1.The hydraulic profiles are prepared at peak and average design flows and at minimum initial flow.

2.The hydraulic profile is generally prepared for all main paths of flow through the plant.

3.The head loss through the treatment plant is the sum of head losses in the treatment units and the connecting piping and appurtenances.

❖The head losses through the treatment unit include the following:

- Head losses at the influent structure.
- Head losses at the effluent structure.
- Head losses through the unit.

❖ The total loss through the connecting piping's, channels and appurtenances is the sum of following:

- Head loss due to entrance.
- Head loss due to exit.
- Head loss due to contraction and enlargement.
- Head loss due to friction.
- Head loss due to bends, fittings, gates, valves, and meters.

Hydraulic Design

The design of water supply conduits depends on the resistance to flow, available pressure or head, and allowable velocities of flow. Allowable velocity is normally between 0.9 m/sec to 1.5 m/sec but velocity of 3 m/sec to 6 m/sec can be resisted by the commonly available pipe materials.

The Head loss caused by pipe friction can be found by using either of the following formulae:

Darcy – Weisbach formula

$$H_L = \frac{f' L V^2}{d \, 2g}$$

H_L = Head loss in metres

L = Length of pipes in metres

d = Dia of pipe in metres

V = Mean velocity of flow through pipes in m/sec

g = Acceleration due to gravity

f ' = Friction factor (Dimensionless)

f ' = 0.02 (New smooth pipe); f ' = 0.075 (Old rough pipe);

R_e = Reynolds number = Vd/v,

v = Kinematic viscosity of water at 10°C from table 9.1 (Page no:448)

- R_e = 20,000 to 20,00,000

$$f' = 0.005 + \frac{0.396}{R_e^{0.3}}$$

- R_e = 20,000 to 32,40,000

$$f' = 0.0032 + \frac{0.221}{R_e^{0.237}}$$

Manning's formula

$$H_L = \frac{n^2 V^2 L}{R^{4/3}}$$

H_L = Head loss in metres

n = Manning's rugosity coefficient

L = Length of pipes in metres

V = Mean velocity of flow through pipes in m/sec

R = Hydraulic mean depth of pipe (metres)

$$R = \frac{A}{P} = \frac{\frac{\pi d^2}{4}}{\pi d} = \frac{d}{4}$$

Hazen-William's formula

$$V = 0.85 C_H . R^{0.63} . S^{0.54}$$

V = Mean velocity of flow through pipes in m/sec

R = Hydraulic mean depth of pipe (metres)

$$R = \frac{A}{P} = \frac{\frac{\pi d^2}{4}}{\pi d} = \frac{d}{4}$$

S = Slope of the energy line = H_L/L

C_H = Coefficient of hydraulic capacity given in table 6.2. (Pg No: 264)

Smoother the pipe – greater the C_H value.

Modified Hazen-William's formula

$$H_L = \frac{L.(Q/C_R)^{1.81}}{994.62\ d^{4.81}}$$

H_L = Friction head loss

L = Length of the pipe (m)

Q = Flow in pipe

C_R = Coefficient of roughness (dimensionless)

(Table 6.3 – Pg no: 266)

d = Internal dia of the pipe (m)

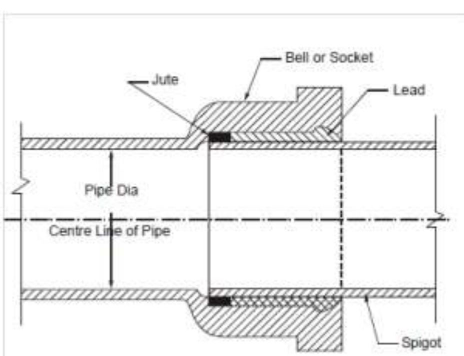
Laying of pipes

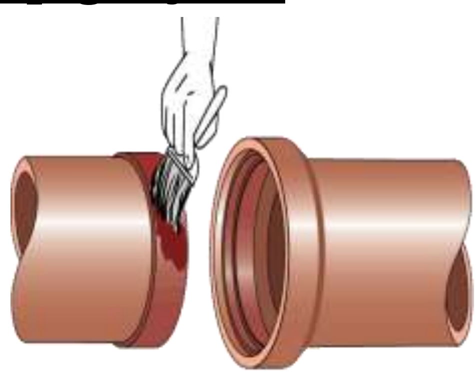
- Pipe lines are laid parallel to the Ground or road level
- Laid usually on one side of the streets – below foot paths
- Trench size – 30 to 45 cm greater than outside dia of pipe
- Make sure the soil surface is smooth
- Brush the soil accumulated inside the socket and outside the spigot
- Place Socket on the uphill side and spigot on the downhill side

Jointing of pipes

1. Socket and spigot joint
2. Flanged joint
3. Mechanical joint called dresser coupling
4. Flexible joint
5. Expansion joint

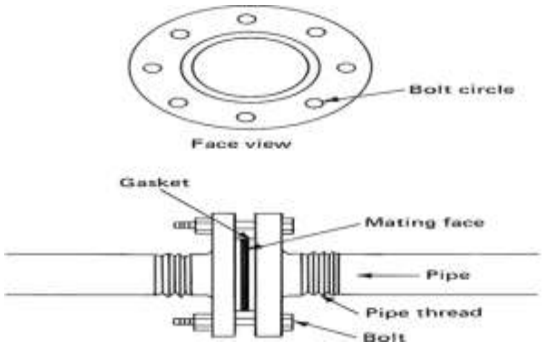
Socket and Spigot joint

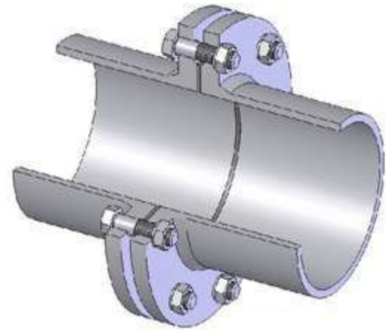




- Century old type – Used in large scale till date
- Molten lead : 3.5 to 4 kg – 15 cm dia, 45 to 50 kg – 1.2 m dia
- Skilled labours required

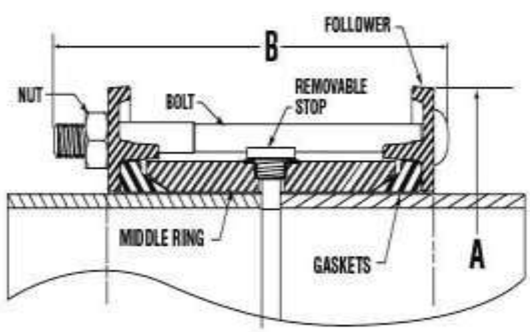
Flanged joint





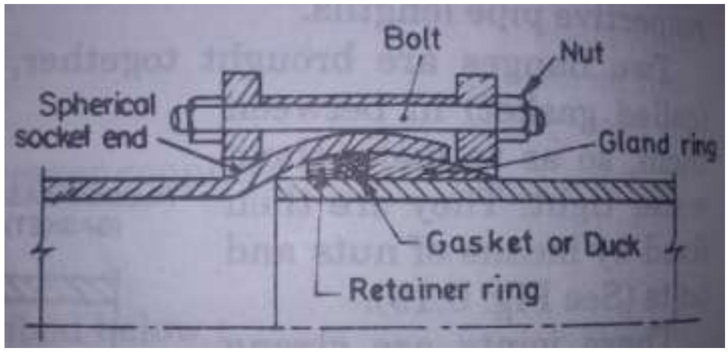
- Used in places where disjointing is done.
- Strong but rigid – cannot with stand vibrations.
- Expensive – used in indoor works (Pumping stations & filter plants)

Mechanical joint / Dresser coupling



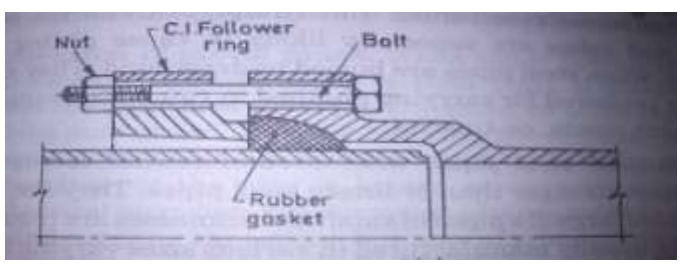
- Used in joining plain ends of the pipe
- Strong and rigid
- Withstand vibrations – carried over bridges or below bridges in hangers.

Flexible joint



- Used in places where large scale flexibility is required
- Eg: Rivers and Sea – uneven beds
- Socket is spherical – Spigot is plain

Expansion joint



- Used to counteract the thermal stresses due to temperature variations
- Socket is cast flanged – Spigot is plain
- During expansion and contraction of pipes, socket ends counteracts

Testing of pipes

- Section to Section testing
- Downstream sluice valve is closed – water is made to enter into the pipe by opening upstream sluice valve – later closed after completely filled
- Air valve is properly maintained during the filling
- Pressure gauges are then fitted along the pipes - @ 1 km interval in each section

- Pipe section is connected to pump through small by-pass valve – pump is started to develop pressure in the pipe
- After reaching certain pressure i.e. 10 to 15% above the max pressure of that pipe – assembly is removed
- Pipe is maintained in same condition for 24 hrs and inspected for possible defects , leakages at the joints there by pressure test gets over
- Finally pipes are drained out and defects are rectified
- Test is repeated until defects are completely rectified

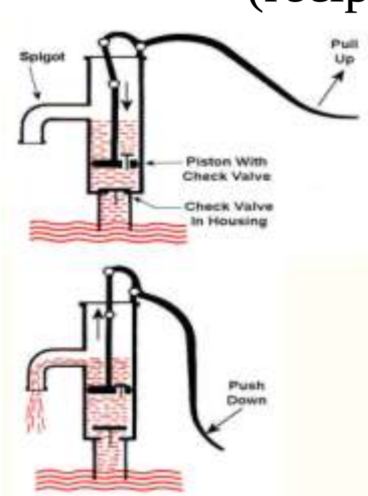
Classification of pumps

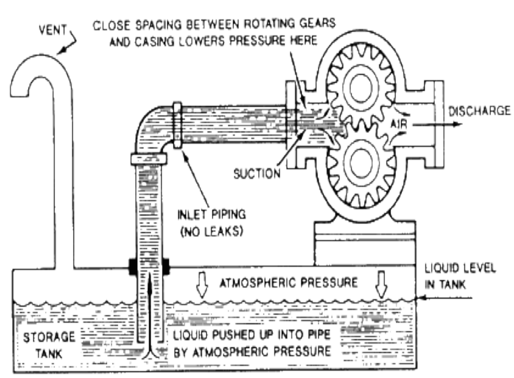
Based on principle of operation, pumps may be classified as follows:

1. Displacement pumps (reciprocating, rotary)

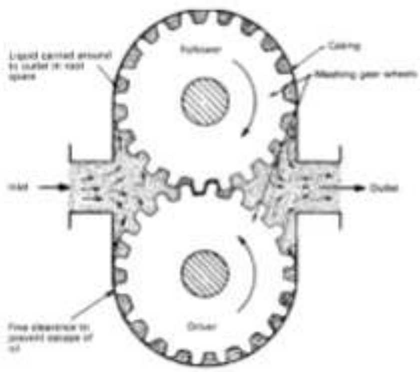
2. Roto-dynamic pumps (centrifugal, deep well and submersible pump)

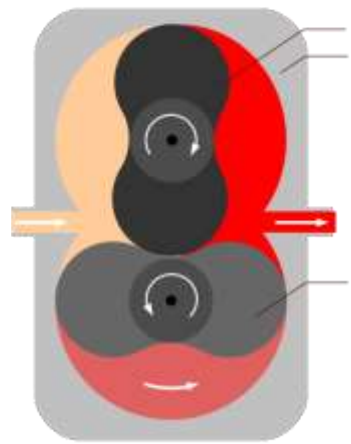
Displacement pumps (reciprocating, rotary)



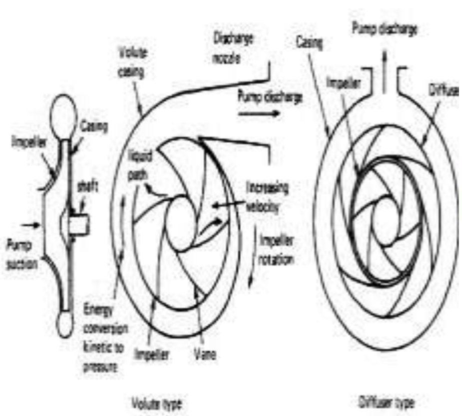


Gear pump located above the tank.

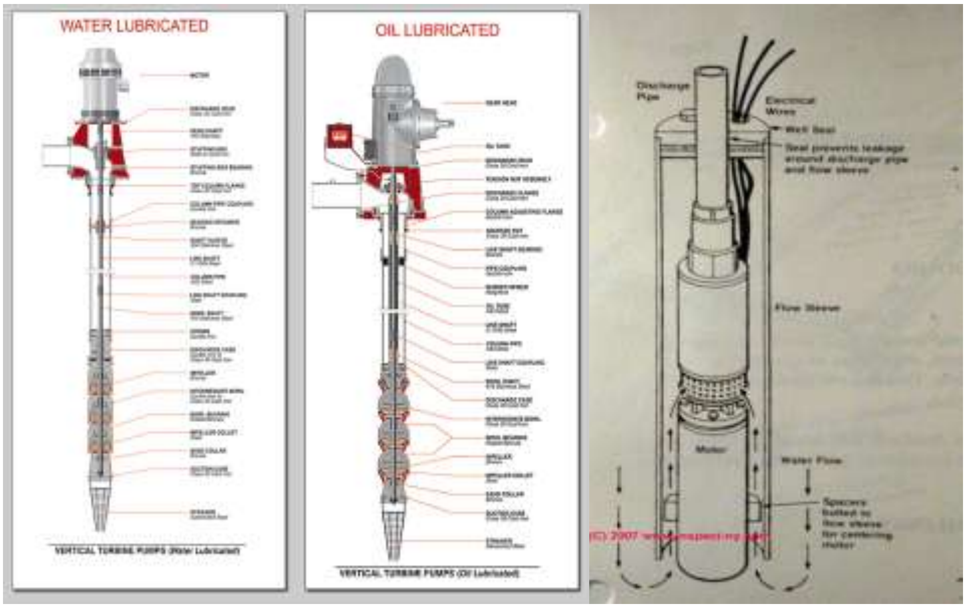




Roto-dynamic pumps (centrifugal)

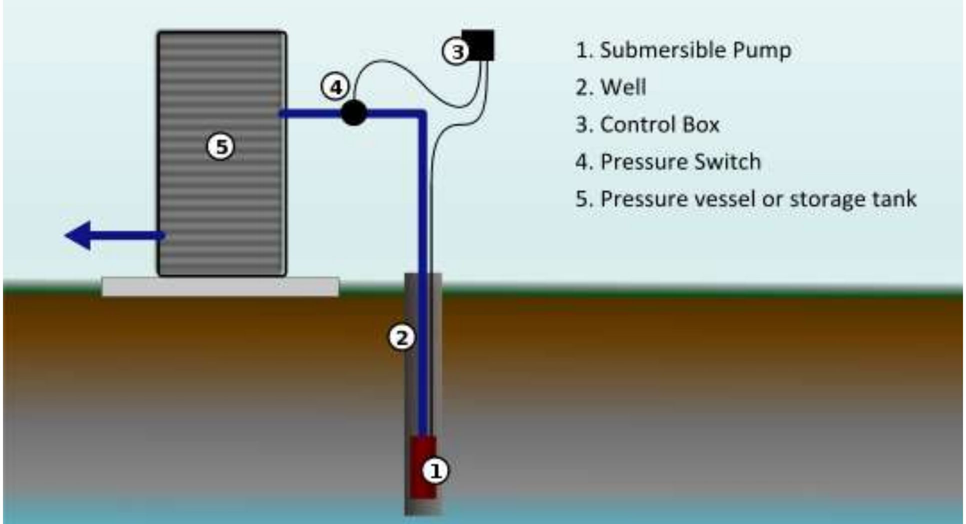


Deep well Submersible



Submersible Pump System

For wells where the ground water is at more than 8 meters depth.



Capacity of pumps

•Work done by the pump,

H.P.=gQH/75

•where, g= specific weight of water kg/m^3, Q= discharge of pump, m^3/s; and H= total head against which pump has to work.

•H= H_s + H_d + H_f + (losses due to exit, entrance, bends, valves, and so on)

•where, H_s=suction head, H_d = delivery head, and H_f = friction loss.

- Efficiency of pump (E) = gQH/Brake H.P.
- Total brake horse power required = gQH/E
- Provide even number of motors say 2,4,... with their total capacity being equal to the total BHP and provide half of the motors required as stand-by.

Factors affecting selection of pump

- Capacity of pump
- Importance of water supply schemes
- Initial cost of pumping arrangements
- Maintenance cost
- Space requirements for locating the pump
- Number of units required
- Total lift of water required
- Quantity of water to be pumped

Making of Concrete pipes

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