# **NEC license Exam Preparation**

## Chapter 6: Water Supply, Sanitation and Environment



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- Types of intakes,
- Factor affecting selection of location of intake;
- Types and purposes of pipe materials,
- Joints, valves and fittings;
- Break pressure tanks;
- Service reservoirs and their capacity determination;
- Design of branch and looped water distribution systems.

## **Definition of intake**

- A structure placed in a water source to withdraw water and convey it to a pipe through which it flows to the treatment plant.
- Intake consist of two sections:
  - First, intake pipe with the screen at the inlet end and valve to control the flow of water.
  - Second, intake structure.
- The structure may be of stone masonry, brick masonry, R.C.C, or concrete blocks.



- Purer zone of the source must be selected for intake construction.
- Sufficient quantity of water available.
- For the reduction in system cost, the intake site is selected near the treatment plant.
- Should be constructed on the upstream side of sewage disposal point.
- Should never be located in the curves in meandering rivers. If is to be located concave or outer side is preferred as it always have water.
- Should never be constructed near the navigation channel.



**Classification of Intakes** 

Category 1:

## 1. Submerged Intake:

- Submerged intakes are constructed entirely under water.
- commonly used to obtain water from lakes.

## 2. Exposed Intake:

- Exposed intakes are in the form of tower constructed near the bank of the river, or in some cases even away from the bank of the river.
- It is common due to ease of its operation.



#### Category 2:

#### 1. Wet Intake:

 In wet intake the water level of intake tower is practically the same as the water level of sources of supply.

#### 2. Dry Intake:

- In dry intake there is no water in the water tower.
- Water enters through the port directly into the conveying pipes.
- The dry tower is simply used for the operation of valves
- They are useful since they can get water from any level by opening the port at that level.



## Category 3: 1. River Intake

- Constructed at the bank of the river.
- Penstocks are positioned at different levels to permit the river water for minimum flow, average flow, and maximum flow.
- In the entry, a port screen is provided to prevent the entry of debris
- Wet intake used.



# 2. Reservoir Intake

These are similar to river intake, these are located near the upstream face of the dam where maximum depth of water is available.

Dry intake used,



# 3. Spring Intake

- It consists of two chambers as collection chamber and valve chamber.
- The collection chamber is provided with the wing walls on both sides which divert the water from the source to the collection chamber.
- The base of the collection chamber is made of plain cement concrete to avoid leakage.



- The collection chamber acts as sedimentation tank, which removes suspended particles and turbidity.
- The outlet pipe is kept at 10 to 15 cm above the floor to screen out the suspended particles to enter into the transmission main of water supply system.
- <u>Note: Springs having yield less than 0.05</u> <u>Ips should not be used for gravity flow</u> <u>system.</u>



# Protection of spring intake

- Tress are planted above the spring sources.
- Surface water drain should be 8m above and around the spring to drain the surface water run off during monsoon.
- There should be no habitant and easy access to animals around springs up to a distance of 30 m to 90 m to avoid contamination.
- Barbed wire fencing at a distance of 5m from spring intake.



- Q. Submerged intakes are mainly suitable for
- a) Large river
- b) Small river
- c) Pond
- d) Lake

Q.The type of intake in which the water enters into the conduits directly form the source is called

- a. Dry intake
- b. Wet intake
- c. Both
- d. None

## **Types of Pipe Material**

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



## Cast Iron (CI) Pipes

- Cl pipe contains 4 5 % of carbon and other impurities such as Sulphur, phosphorous, silicon, e.t.c.
- Manufactured from pig iron.
- Cast iron are highly durable and have lifespan of about 100 years.
- Extensively used for conveyance of water in w/s system.



## Advantages:

- 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.



## **Ductile Iron (DI) Pipes**

- Material: Ductile Iron
- Developed form of cast iron pipe.
- Manufactured from ductile iron, also called nodular iron or spheroidal graphite iron.
- Manufactured using centrifugal casting in metal or resin lined molds.
- Internal lining of cement mortar and external coating are of zinc/asphalt/paints.
- Lifespan> 100 yrs.



#### 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:**

- Internal as well as external protection systems are required.
- Corrosion can occur.

## **Steel Pipes**

- Material: Mild Steel
- Fabricated by rolling the flat steel plates to proper diameter and riveting or wielding the edges.
- Joints may be transverse and longitudinal or transverse and spiral.
- Welded pipes are more commonly used as it is stronger and smoother than riveted pipes.



• 40 years life

## Advantages:

- 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



#### **Cement Concrete Pipes**

- Concrete pipes are made up of either PCC or RCC.
- Plain concrete are normally used for heads up to 15 m and reinforced concrete are normally used for heads up to 60m.
- Note: Rcc pipes upto 100 m in some book.
- Prestressed pipes are used for heads up to 100-150m.



• Although they are resistant to corrosion but not used much due to their heavy weight and difficulty in making connections.

## **Advantages:**

- Less corrosion Requires less maintenance.
- Durable (Life span of about 75 years)
- Highly Resists external loading
- Transportation cost is reduced when casted in field.

## **Disadvantages:**

- Difficult to repair
- Cannot withstand high internal

5 pressure

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

## Galvanized Iron (GI) Pipes

- These are zinc coated wrought iron pipes which are widely used for inside building and service connections.
- Water with presence of free chlorine can corrode pipe.
- Mostly available in 6 m length 20 yrs life span.
- Can withstand internal pressure up to 180 m.



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



- 1. PVC Pipes
- Life span up to 50 years
- Maximum service temperature: 60 degree celcius.

2. PPR pipes

• Temperature resistant upto 80 degree celcius.

- 3. Polyethylene pipe
- HDPE,LDPE,MDPE
- HDPE are widely used in gravity flow rural supply in Nepal.
- 50 yrs life span





## • HDPE pressure ratings

- I. 2
- II. 2.5
- III. 4
- IV. 6
- V. 10
- VI. 12.5
- VII. 16 kg/cm2

Note: 1kg/cm2 = 10 m.

• If pressure exceeds 10kg/cm2 i.e 160 m, GI used.

# Types of Distribution system

a. Dead End System

b.Grid iron system

c. Ring system

d.Radial system

#### Dead-end System:

- It is also called a tree system, it consists of one main supply line, from which originates (generally at right angles) a number of sub-main pipes; Each sub-main is then divided into several branch pipes, called laterals
- This type of distribution system is suitable for older towns which have developed in a haphazard manner, without properly planned road e.g. old city, irregularly grown city, etc; It is economical and simple

#### Gridiron System:

- It is also known as an interlaced system or reticulation system, the mains, sub-mains, and branches are all connected with each other
- There is no dead-end in the system as looping is provided and is most suitable for well-planned cities; There is equal pressure in all pipe and multiple flow path





## Radial system:

- If a city or town is having a system of radial roads emerging from different centers, the pipeline can be best laid in a radial method by placing the distribution reservoir at these centers
- The water from the distribution reservoir is then supplied radially to distribution pipes and thus also known as zonal distribution

## **Ring System:**

- It is also called a circular system; In this system, a closed ring, either circular or rectangular, of the main pipes, is formed around the area to be served; The distribution area is divided into rectangular or circular blocks, and the main water pipes are laid on the periphery of the blocks
- This system is very suitable for towns and cities having well-planned roads; It is economical and pressure at the ends are reasonably equal





# MCQ.

- The layout which conveys water flow toward the outer periphery?
- a) Grid iron pattern
- b) Ring system
- c) Radial pattern
- d) Dead end system

## Reservoir

• Reservoir is a tank used to store the water.

Types of reservoir :

- a. Clear water reservoir : Reservoir provided at the end of water treatment process.
- b. Service reservoir: To provide storage to meet the fluctuation in demand of water, to stabilize the pressure, to provide storage for fighting and other emergencies.
- Also called distribution reservoir.

#### **Capacity determination of service reservoir:**

The storage capacity of the service reservoir is based on the following three requirements:

- **Balancing reserve :** Reserve to meet the fluctuation in demand of water from one part of day to another.
- Breakdown reserve: Reserve of water during the breakdown period. It is generally not more than 25 % of total storage.
- Fire reserve: Water stored in distribution reservoir for firefighting purpose.
- capacity = Maximum cumulative surplus + Maximum cumulative deficit total inflow + total demand.

Q. HDPE pipes have maximum pressure rating of ...... Kg/sq. cm

- a. 4
- b. 6
- c. 10
- d. 16
- Q. HDPE in HDPE pipe stands for
- a. Heavy duty plastic exterior
- b. High diameter polyethylene
- c. High density polyethene
- d. High density polyethylene

Q. The tanks used in the distribution systems to release the excessive hydrostatic pressure are called

- a. Clear water reservoir
- b. Service reservoir
- c. Break pressure tanks
- d. All of the above

# Design criteria of pipes

## Velocity:

- Minimum velocity = 0.3m/s
- Maximum velocity = 3 m/s
- Minimum velocity for untreated water = 0.6m/s

## Pipe Size:

Commercially available pipe sizes in mm are : 15, 20, 25, 32, 40, 50, 65, 80, 100,...... Upto 3 m.

#### **Pressure**

#### Recommended pressure:

- For Private connection: Maximum Pressure = 15m & Minimum Pressure = 5m
- For Public stand post: Desirable Pressure = 15m, Minimum Pressure = 5m Maximum Pressure = 55m

## **Design of branched system:**

- Dead end system falls in this type.
- Designed by: Darcy weisbach equation :

• 
$$h_f = \frac{f l V^2}{2g d}$$
 or  $h_f = \frac{f l Q^2}{12.1 d^5}$  OR,

• by Hazen-William's equation.

• 
$$h_f = \frac{10.68 \, l}{d^{4.87}} \left(\frac{Q}{C}\right)^{1.852}$$
 and  $V = 0.849 \, C \, R^{0.63} S^{0.54}$ 

## Looped system

- Designed by Hardy Cross method
- Grid iron, ring and radial system are examples.



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

- Spigot: normal end
- Socket: enlarged end
- The spigot end is inserted into socket end of preceding pipe.
- Few strands of jute or a rubber gasket is placed around the spigot end.
- Used for CI pipes.



#### **SPIGOT & SOCKET JOINT**

Socket End



## **Flanged Joint**

- 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.
- Used in temporary works and maintenance works.





## **Collar Joint**

- The ends of the two pipes to be jointed are brought in contact and a rubber gasket 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.
- Used for: Cement concrete pipes.



## Screwed Socket Joint/threaded joint:

• Screwed Socket Joint Used for: Galvanized iron pipes.



#### **Expansion Joint:**

- It consists of a socket end and a spigot end.
- Used when the elongation and shortening of pipe may occur due to change in temperature.





Q. Which of the following pipe joints would be suitable for pipes carrying steam?

- a) Flanged
- b) Threaded
- c) Bell and spigot
- d) Expansion

Q. ..... joint is usually used for joining cast iron pipes mostly used for temporary pipelines, where it may be necessary to dismantle & reassemble the pipeline very frequently.

- A. Collar
- B. Flanged
- C. Bell and Spigot
- D. Expansion



#### Q. High pH value of water does not produce

- a) Incrustation
- b) Sediment deposits
- c) Tuberculation
- d) None of these

Q. Higher yield may be expected from

- a) Gravity springs
- b) Surface springs
- c) Artesian springs
- d) All the above



• A **valve** is a device that regulates or controls the flow of a fluid by opening, closing, or partially obstructing it.

□ What are valves used for?

- To regulate the flow of water.
- To prevent the flow in opposite direction.
- To release excessive pressure.
- To remove or admit the air.
- To drain or washout the pipeline.

## 1. Sluice Valves:

- Sluice valves are also known as gate valves, cut off valves or shut off valves.
- They are required to shut off the supplies whenever desired in the water supply system.



- 2. Reflux Valves:
- Reflux valves are also known as check valves or non-return valves.
- It is used to make the water flow in a single direction.



- 3. Pressure Relief Valves:
- Pressure relief valves are also known as automatic cutoff valves or safety valves.
- When the pressure exceeds the predetermine value there exist the chance of bursting of the pipes, so pressure relief values are used.

4. Drain Valves:

- Drain valves are also known as scour valves or washout valves or blow off valves.
- They are used to wash out the deposited sediments from the pipeline.

# **Fittings**

Fittings are used in the pipeline during its laying for various purposes such as:-

- Connecting different pipes
- Changing the direction of flow
- Connecting different appurtenances
- Closing and sealing of pipe etc.

# **Types of Fitting**



## 1. Bend:

• Bend is a fitting used to change the direction of a pipeline.

## 2. Tee:

- Tee is a fitting with one inlet and two outlets.
- It is used to for connecting pipes of different diameters or for changing the direction of pipelines.

## 3. Cross:

- Cross is a fitting to connect four pipe sections.
- It has one outlet and three inlets or vice versa.

## 4. Wye:

- Wye is a fitting with two inlets or one outlet or vice versa.
- It is used to create a branch.



## 5. Reducer:

• To join two pipes of different diameters.

## 6. Socket:

- Socket is a fitting that fits over the pipe.
- It is classified as the plain and reducing socket.
- Plain socket connects two pipes of same diameters
- Reducing sockets is used to connect two pipes of different diameters.

## 7. Plug:

• A plug is used to close a pipe with threads.





## 8. Nipple:

Nipple is a fitting (short stub of pipe) which is used for connecting two other fittings.

## 9. Union:

Union is a fitting to connect two pipes of the same diameter for quick and convenient disconnection.

## 10.Stopcock:

Stopcocks are fittings which are cut off valves of small size.



Q. To prevent the water flow in the wrong direction which of the following valve is used?

a) Safety valveb) Drain valvec)Bothd) Check valve

Q. Which accommodates four pipes?

- a) Socket
- b) elbow
- c) Tee
- d) cross

- Which is used for separation of joint connection that allows the assembly to be dismantled for repair operations?
- a) Union
- b) Tee
- c) Cross
- d) Elbow

Q. Air relief valves are provided in water supply mains at ....

- a) Low point
- b) Summits
- c) Junction
- d) Any of the above.

## Q. Two pipes of different diameters can be joined by.....

- a. Elbow
- b. Reducer
- c. Union
- d. Nipple

• PE 63, PE 80 and PE 100

# THANK YOU