

# GUJARAT TECHNOLOGICAL UNIVERSITY

4<sup>th</sup> Semester Civil Engineering – PDDC

**Subject Code & Name :** X40601 - Environmental Engineering

## Assignment - 2 (Collection and Conveyance of Water)

**Date : 11-02-2015**

### **Theory :**

1. What is Intake Structure? What are the type of Intake Structure.
2. Factor governing the location of Intake Structure.
3. Explain in detail River Intake and Reservoir Intake.
4. What is conveyance of water? Classify the conveyance of water.
5. Explain Conveyance of Water through Pipe. Explain Cast Iron Pipe and Concrete Pipe in details.
6. Explain Design of Pump.
7. Explain Design of Rising Pipe.

### **Example :**

1. Design a bell mouth Canal Intake for a city of 1,00,000 Person drawing water from a canal which runs only for 12 hrs a day with depth of 1.8 M. Also calculate the head loss in the Intake conduit if the treatment plant is 0.8 KM away. Assume average consumption per person is 160 Lit/Day. Assume the velocity through the screens and bell mouth to be 0.15 m/s and 0.3 m/s respectively.
2. Find Head Loss due to friction from following data :  
Total Length of Pipe : 500 M  
Dia of Pipe : 0.20 M  
Discharge required per Pump : 1250 Lit/Min  
Friction Factor : 0.025
3. A city with 2,00,000 Population is to be supplied at 135 LPCD from a River 1 KM away. The difference in water level of Sump & Reservoir is 30 m. The Demand has to be supplied is 10 Hrs. Determine the size of Main & BHP of Pumps. Assume Maximum demand as 1.5 times of the average demand. Take coefficient of friction ( $f$ ) is 0.0075, Velocity in the pipe is 2 m/sec and efficiency of Pump as 80%.

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## Intake, 2

Q 1 What is Intake structure? What are the type of Intake structure.

Intakes are the structures used for collecting the water from the surface source.

The basic function of the intake structure is to help in safely collecting or withdrawing water from the surface source over a predetermined pool levels and then to convey this water either by gravity or pumping to the treatment plant via intake conduit.

Generally, an intake is a concrete or strainer through which the raw water from river, canal or reservoir, enters and is carried to a sump well by means of conduits. Water from the sump well is pumped through the rising main to the treatment plant.

### Type of Intake:

(1) According to the type of source

- (a) River intake
- (b) Reservoir intake
- (c) Canal intake
- (d) Lake intake

(2) According to the position of intake

- (a) Submerged intake
- (b) Exposed intake

(3) According to the presence of water in the tower

(a) Wet intake

(b) Dry intake



## 2 Factor governing the location of Intake structure.

The site for the intake should be selected carefully, keeping the following points in mind.

- (1) Site should be near treatment plant to reduce conveyance cost.
- (2) Intake must never be located in the vicinity of waste-water disposal point.
- (3) The site should be such as to permit greater withdrawal of water, if required in future.
- (4) Intake must be located at a place from where it can draw water even during the driest period of the year.
- (5) The intake site should remain easily accessible during floods, and should not get flooded.
- (6) In meandering rivers, the intakes should not be located on curves or atleast on sharp curves.
- (7) Intake must never be located near the navigation channels or roads to reduce chances of pollution due to waste discharge from ships.
- (8) Intake must be located in the ~~purer~~ zone of the source so that best quality water is withdrawn from source reduce the load on the treatment plant.



3

Explain in detail River Intake and Reservoir Intake.

### River Intake:

A river intake is located on the upstream side of the city to get comparatively better quality of water. They are either located sufficiently inside the river so that necessary demands of water can be met in all the seasons of the year or they may be located near the river bank where a sufficient depth of water is available. Sometimes, an approach channel is constructed and water is available. Sometimes, an approach channel is constructed and water is led to the intake tower. If the water level in the river is low, a weir may be constructed across it to raise the water level and direct it to the intake tower.

River intake consist of closed concrete or masonry well (or intake tower) with pumps, rising main and few entry ports (penstocks) with screens.

The intake tower permits the entry of water through several entry ports located at various levels to cope with the fluctuations in the water level during different seasons. These entry ports are also called as penstocks. The penstocks are covered with the suitably designed screens to prevent the entry of floating impurities. The entry ports contain valves which can be operated from the upper part of the well. The lowest entry is placed at the low water level of the season also.



When river carries minimum discharge, the intake well should be founded in sound footing, to a depth deeper than the scour depth. The upper part of the well serves as the pump house. The suction pipe admits water through a screen.

When river bed is soft or unstable the intake tower may be founded slightly away from the river bed as shown in fig. The intake is kept submerged under the low water level of the river. It consists of a rectangular or circular entry chamber with a strong grill at its top. The pipe conveying water from the intake to the jack well has a bell mouth entry with a screen and is supported on a concrete support. While the entry of debris and floating material is checked by the top grill, the entry of mud or coarse sand etc. is checked by the screen provided at the bell mouth entry. Water enters the jack well through the valve which can be controlled from the pump house.

## Reservoir Intake:

When the flow in the river is not guaranteed throughout the year (especially in summer) a dam is constructed across the river to store the water in the reservoir so formed.

Show a fig. Reservoir intake which is mostly used to draw the water from the reservoir formed by an earthen dam. It essentially consists of an intake tower constructed on the slope of the dam at



Such a place from where intake can draw sufficient quantity of water even in the driest period. Intake pipes are fixed at different level so as to draw water near the surface in all variations of water level. These inlet pipes are connected to one vertical pipe inside the intake well. Screens are provided at the mouth of all intake pipes to prevent the entry of floating and suspended matter. The water which enters the vertical pipe is taken to the other side of the dam by means of an outlet pipe. At the top of the intake tower valves are provided to control the flow of water. The valve tower is connected to the top of the dam by means of a foot bridge or gung way for reaching it.

In the case of earthen dams intake towers are separately constructed but in gravity dam (RC or masonry) it is constructed inside the dam itself and only entry ports or intake pipe are provided at various levels as shown in fig.



4 What is conveyance of water? Classify the conveyance of water.

Water is drawn from the sources by intakes. After its drawing the next problem is carrying it to the treatment plant which is located usually within the city limits. Therefore after collection, the water is conveyed to the city by means of conduits. If the source is at higher elevation than the treatment plant, the water can flow under gravitational force. For the conveyance of water at such places we can use open channel, aqueduct or pipeline. Mostly it has been seen that water level in the source is at lower elevation than the treatment plant, in such cases water can be conveyed by means of closed pipes under pressure.

If the source of supply is underground water; usually there is no problem as these sources are mostly in the underground of the city itself. The water is drawn from the underground sources by means of tube-wells and pumped to the overhead reservoir; from where it is distributed to the town under gravitational force. Hence at such place there is no problem of conveyance of water from source to the treatment works.

In case the source of supply of water is river or reservoir and the town is situated at higher level, the water will have to be pumped and conveyed through pressure pipes. If the source is available

at higher level than the town, it ~~is~~  
is better to construct the treatment  
plant near the source and supply the  
water to the town under gravitational  
force only. In case the water source  
is at longer distance, then cost of  
transporting water will be very high.

### Classification of conveyance of water.

- (1) Open channels
- (2) Aqueducts
- (3) Tunnels
- (h) Plumes
- (5) pipes.
  - (a) cast iron pipes
  - (b) wrought iron pipes
  - (c) steel pipes.
  - (d) Concrete pipes
  - (e) cement lined cast iron pipes
  - (f) plastic or PVC pipes
  - (g) asbestos cement pipes
  - (h) copper and lead pipes,
  - (i) wooden pipes
  - (j) vitrified clay pipes.



5 Explain Conveyance of water through pipe. Explain cast iron pipe and concrete pipe in detail.

These are circular conduits, in which water flows under pressure. Now days pressure pipes are mostly used at every place and they have eliminated the use of channels, aqueducts and tunnels to a large extent. These are made of various materials like cast iron, wrought iron, steel, cement, concrete, asbestos, cement, timber etc.

In the town pipes are also used for distribution system. In distribution system pipes of various diameters, having many connections and branches, are used. Water pipe lines follow the profile of the ground and the location which is most economical, causing less pressure in the pipes is chosen. The cost of pipeline depends on the internal pressure to bear and the length of pipe line.

The selection of material for the pipe is done based on the following points:

- (1) Carrying capacity of the pipe.
- (2) Durability and life of the pipe.
- (3) Availability of funds.
- (4) Maintenance cost, repair etc.
- (5) Type of water to be conveyed and its corrosive effect on the pipe material.

Following types of pipes are commonly used

- (1) Cast iron pipes.
- (2) Wrought iron pipes.

- (13) Steel pipes.
- (14) Concrete pipes.
- (15) Cement lined cast iron pipes.
- (16) Plastic or Pvc pipes.
- (17) Asbestos cement pipes.
- (18) Copper and lead pipes.
- (19) Wooden pipes.
- (20) Vitrified clay pipes.

### Cast - Iron Pipes:

- → Cast - iron pipes are mostly used in water supply schemes. They have higher resistance to corrosion, therefore have long life about 100 years.
- Cast iron pipes are manufactured from best grey pig iron by two methods. first method is ordinary sand moulding in which pipes are moulded in horizontal position.
- Horizontal casted pipes are also called McWane pipes.
- → Sometimes sand moulding pipes are moulded in vertical position, which are called pit cast pipes.
- In the sand moulding, after casting, the pipes are cleaned and dipped in a pot of coal tar and oil, after heating to about  $300^{\circ}\text{F}$ . This coal tar coating is done to protect it against corrosion.
- Centrifugal casting is the second method which is sometimes called as Delovund process. In this method, the molten metal is poured in water cooled cylindrical metal mould, which is rotated at high speed. Due to centrifugal force a homogeneous pipe



is cast. The pipe is taken out from the mould and sent to another process for annealing. Then it is tested under hydrostatic pressure and coated with cocet tar as in the case of sand moulding.

- Practically, it has been noted that horizontal cast pipes are 100% strong in tension and 50% stronger in rupture than vertically cast iron pipe.
- Cast-iron pipes are manufactured in lengths of 2.50 m to 5.50 m.

### Advantages of C.I. Pipes :-

- (1) Easy in jointing the pipes.
- (2) Can withstands high internal pressure.
- (3) Have a very long design life (about 100yr).
- (4) They are less prone to corrosion.

### Disadvantages of C.I. Pipes:

- (1) They are heavy and difficult to transport.
- (2) Length of pipe available is less (2.50 to 5.50m), so more joints are required for laying the pipes so chances of leakage also increases.
- (3) They are brittle so they break or crack easily.



## Concrete Pipes:

→ These pipes may be precast or cast-in-site. Plain concrete pipe may be used at such place where water does not flow under pressure.

→ These pipes are jointed with Bell and spigot joints plain concrete pipes are upto 60 cm diameter only, above it these are reinforced.

○ RCC pipes are manufactured by the following methods:

(1) Pipes having steel bar and mesh reinforcement, and by pouring concrete by usual methods,umping and curing.

(2) Pipes having fabricated reinforcement and cast by centrifugal methods and cured in tanks.

→ Precast: pipes are manufactured in factory until them transported to site. The reinforcement of RCC pipe consists of a welded steel cylinder with high tension wire wound over it. The concrete is placed around the reinforcement by centrifugal process. Something mesh reinforcement is provided, but pipes with cylinder pipe reinforcement are more water tight and strong.

→ Normally 1:2:2 concrete mix is used in the manufacture of concrete pipes.

→ Larger diameter pipes are jointed together by means of collar joint with a rubber gasket or fibre filled lead gasket placed between the two ends of the pipes.

→ In difficult areas pipes can be constructed at the site by using local materials. These are not corroded by the water, therefore have long

life, above 75 years.

→ The surface of these pipes is not affected with the time therefore, the carrying capacity does not affect with. beside The maintenance cost is low but they are very heavy and difficult to handle and transport. They cannot withstand high pressure and are difficult to repair.

→ Normally R.C.C pipe are made from 1:2:2 cement, sand and aggregate. The maximum size of the aggregate is kept as 7 mm. For carrying tension. They are provided with circumferential reinforcement. 0.25% longitudinal reinforcement is provided in the pipes. Thickness of the pipes varies from 25mm to 65mm. for pipe diameters varying from 10cm to 120 cm.

→ Various available standard size of the concrete pipes are: 80, 150, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1100 and 1200mm. These diameters are internal diameters of the pipes.

Gives specifications of ordinary R.C.C pipes as per I.S.: 158 (1971).

SR category	Diameter	Test pressure kg/cm <sup>2</sup>	Use
NB	80 - 1200	in	For use in gravity mains design pressure should not exceed 1.33 kg/cm <sup>2</sup>
1 class-P1	80 - 1200	2	For use in gravity mains design pressure should not exceed 1.33 kg/cm <sup>2</sup>
2 class P2	80 - 600	4	For use on pumping mains design pressure not to exceed 2 kg/cm <sup>2</sup>
3 class P3	80 - 400	6	- do -



## Advantages of R.C.C pipes:

- 1 Their life is more about 75 years.
- 2 They can be easily constructed in the factories or at site.
- 3 They are not affected by atmospheric actions or ordinary soil under normal conditions.
- 4 Under normal traffic load, when laid below roads, they do not collapse or fail.
- 5 They have least coefficient of thermal expansion than other type of pipes. Hence they do not require expansion joint.

## Disadvantages of R.C.C pipes:

- 1 They are affected by acids, alkalis, and salty waters.
- 2 Their repairs are very difficult.
- 3 It is difficult to make connection in them.
- 4 Porosity may cause.
- 5 Due to their heavy weight, their transportation and laying cost is more.



## E Explain Design of Pump:

→ Design of pump means to find out the capacity of the pump required (either in Brake Horse Power or Kilowatts) to deliver specific quantity of water against a specific head of water.

So design of pumps can be divided into two parts.

- (1) To find the total head against which the pump has to operate.
- (2) The total power requirement or the capacity of the pump or the size of the pump required ~~and for~~ operation as well as also deciding the number of pumps required for operation as well as stand by.

A Total head or lift against which the pump has to work:

The total head or total lift against which the pump has to work includes suction lift (or head), discharge or delivery lift (or head) and total loss of head due to friction, entrance, exit, fittings etc. in suction and delivery main.

If  $H_s$  = suction lift or head

$H_d$  = delivery or discharge head

$H_L$  = Total loss of head

The total head against which the pump has to work is given by

$$H = H_s + H_d + H_L$$

Suction lift:

It is the difference betw



the lowest water level caused by the pump.

**Discharge lift or delivery head:**

It is the difference between the point of discharge or delivery and the pump.

Generally only the friction losses is considered for the design as minor losses are very small if the length of the pipe is greater. Friction loss can be found out by Darcy Weisbach equation

$$\text{Darcy Weisbach eqn: } h_f = \frac{4f d v^2}{2 g l} = f' \frac{v^2}{2 g l}$$

Where  $l$  = length of pipe

$d$  = dia of pipe

$v$  = velocity of flow

$f$  = coefficient of friction

$f'$  = friction factor

Value of friction factor generally varies between 0.02 to 0.075.

Friction factor can be calculated by following empirical formula:

$$\text{For new pipes } f' = 0.02 \left( 1 + \frac{l}{350} \right)$$

$$\text{For old pipes } f' = 0.04 \left( 1 + \frac{l}{350} \right)$$

**B Power required by the pump or capacity of pump:**

The horse power (H.P) of the pump can be determined by calculating the work done by a pump in raising the water up to the height  $H$ .



Then the work done by the pump

$$\text{Pump} = W \times H \text{ cm.kg}$$

$$= V \cdot g \cdot H \text{ (cm.kg/sec)}$$

where  $V$  = unit weight of water

$g$  = discharge to be pumped  
in  $\text{m}^3/\text{sec}$

$H$  = Total head in metre

$$\therefore \text{Water Horse Power (W.H.P)} = \frac{V \cdot g \cdot H}{75}$$

(Since one metric H.P. = 75 kg.m/sec)

If  $n$  is the efficiency of the pump then

$$\text{Brake Horse Power (B.H.P)} = \frac{\text{W.H.P}}{n}$$

$$= \frac{V \cdot g \cdot H}{75n}$$

c Number of Pumps, size and stand by units :

Pumping units at water works are generally not operated at full capacity for all times. Since the efficiency of a pumping unit varies with the load, it is a usual practice to design such a pumping station that some of the pump units can be operated at full capacity, at all the time. Hence two, three or four pumps are installed. The sizes of these pumps can be fixed by considering the demand (Peak, average, or minimum), available storage etc. For example, if we provide 4 pumps, the two largest may supply the maximum demand; one of these or smallest may handle the normal or average demand.



and the other pump may be take care for minimum demand.

Thus, there will always exist some stand by capacity to take care of the repairs, breakdown etc. Generally, 100% stand by capacity to take care against average demand and 33.33 to 50% stand by capacity to against the peak demand is considered sufficient and may therefore be provided at the pumping station.



7 Explain Design of Rising Pipe or Design of Rising Main.

- Rising main is the pipe through which the pumped water is sent further to the next unit for treatment purpose. Water flows in this pipe under high pressure and flow is turbulent. Here the friction loss in the pipe is more due to high velocity. Pressure pipes are designed such that overall cost of the project should be lowest possible both from maintenance and constructional point of view.

Economical diameter of rising or pumping main.

- For pumping a particular fixed discharge of water, there are two options:
- (1) It can be pumped through bigger diameter pipe at low velocity or
  - (2) Through lesser diameter pipe at high velocity.

If the diameter of the pipe is increased, it will lead to higher cost of the pipe line (Initial cost) on the other hand if the pipe diameter is reduced the velocity would increase which will lead to higher frictional head loss and will require more horse power for pumping, thereby increasing the cost of pumping. Also cost of pipe fittings will increase.

For obtaining the optimum efficiency, it is necessary to design the diameter of the pumping main, which will be overall most economical in initial cost as well as maintenance cost for pumping.



the required quantity of water. The diameter which provides such optimum condition is known as "economical diameter" of the pipe.

An empirical formula given by Ley is commonly used for determining the diameter of the pumping or rising main.

$$D = 0.97 \text{ to } 2.22 \sqrt{Q}$$

Where  $D$  = Economical diameter of pipe in meter.

$Q$  = Discharge to be pumped in cumec

The above formula gives optimum velocity of water flow between 0.8 to 1.35 m/sec.

### Head loss in rising main:

The loss of head in the rising main can be found by using

- (1) Darcy Weisbach equation or
- (2) Hazen Williams equation

Darcy Weisbach ..... equation

$$h_f = \frac{4fV^2}{2gD} \text{ or } \frac{f'V^2}{2gD} \quad (f = f')$$

This equations is commonly used for design of rising main

Hazen Williams equation -

$$V = 0.85 C_n R^{0.63} S^{0.54}$$

where  $V$  = velocity of flow.

$S$  = slope of the H.C.L.

$$S = \frac{H_L}{L} \left( \frac{\text{Head loss}}{\text{Length of pipe}} \right)$$

$R$  = Hydraulic mean radius of the pipe

$$= \frac{A}{P}$$

If pipe is running full then

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

∴  $C_H$  = Hazen Williams coefficient which depends on age, quality and material of pipe.



## Examples

1

Design a bell mouth canal intake for a city of 1,00,000 person drawing water from a canal which runs only for 12 hrs a day with depth of 1.8 M. Also calculate the head loss in the Intake conduct if the treatment plant is 0.8 km away. Assume average consumption per person is 160 Lit / Day. Assume the velocity through the screens and bell mouth to be 0.15 m/s and 0.3 m/s respectively.

O. Discharge required by the city

$$= 1,00,000 \times 160$$

(Population x rate of supply)

$$= 1,60,00,000$$

= 16 MID (million liters per day)

Since canal runs only for 12 hours a day, this whole daily flow is required to be drawn in 12 hours

$$\therefore \text{Intake locf} = \frac{16}{12}$$

$$= 1.33 \text{ ML/hours}$$

$$= \frac{1.33 \times 10^6}{10^3} \text{ m}^3/\text{hr}$$

$$= \frac{1.33 \times 10^3}{60+60} \text{ m}^3/\text{sec}$$

$$= 0.333 \text{ m}^3/\text{sec}$$

Design of coarse screen:

Area of coarse screen =  $\frac{\text{Discharge}}{\text{Velocity through the screen}}$   
 Velocity through the screen =  $0.15 \text{ m/sec}$



$$\text{Area of coarse screens} = \frac{0.369}{0.15}$$

$$= 2.46 \text{ m}^2$$

Assume that minimum water level is 0.3 m below the normal water level. The bottom of the screen is kept at 0.15 m above the bed level.

The top of screen is kept at minimum water level.

$$\begin{aligned} \therefore \text{Available height of screen} \\ &= 1.8 - 0.3 - 0.15 \\ &= 1.35 \text{ m} \end{aligned}$$

$$\begin{aligned} \therefore \text{Minimum length of screen opening required} &= \frac{2.46}{1.35} \\ &= 1.82 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Assuming the clear opening between vertical bars to be } 30 \text{ mm each we have the.} \\ \text{Number of openings} &= \frac{1.82}{0.030} \\ &= 60.66 \end{aligned}$$

$$\therefore \text{Number of bars} = 59$$

$$\begin{aligned} \text{Assuming the diameter of bar is } 20 \text{ mm} \\ \text{Length occupied by the bars of } 20 \text{ mm} \end{aligned}$$

$$\begin{aligned} &= 59 \times 0.02 \\ &= 1.18 \text{ m} \end{aligned}$$

$$\therefore \text{total length of screen} = 1.82 + 1.18 = 3 \text{ m}$$

Hence provide coarse screen of length 3.0 m and height 1.35 in rectangular intake well.

### Design of Bell mouth entry:

Area of bell mouth entry =

$$= \text{discharge}$$

Velocity through the bell mouth



$$= \frac{0.369}{0.30}$$

$$= 1.23 \text{ m}^2$$

$\therefore$  Diameter  $d$  of the bell mouth entry  
is

$$\frac{\pi d^2}{4} = 1.23$$

$$d = \sqrt{\frac{4 \times 1.23}{\pi}}$$

$$d = 1.25 \text{ m}$$

If diameter of small holes in the hemispherical screen is assumed to be 15 mm ( $10 \text{ to } 20 \text{ mm}$ )

Then area of each hole  $= \frac{\pi}{4} (0.015)^2$

$$= 1.767 \times 10^{-4}$$

$\therefore$  Number of holes on the bell mouth  $=$  Area of bell mouth / Area of one hole

$$= \frac{1.23}{1.767 \times 10^{-4}}$$

$$= 6960.95$$

Say 6961 Ans

### Design of intake conduit

Assume velocity of flow in conduit as 1.5 m/sec

Area of conduit required  $=$  Discharge / Velocity

$$= \frac{0.369}{1.5}$$

$$= 0.246 \text{ m}^2$$

Diameter of pipe D will be

$$\frac{\pi}{4} D^2 = 0.2 h_6$$

$$D = \sqrt{\frac{0.2 h_6 \times 4}{\pi}}$$

$$= 0.559 \text{ m } \underline{\text{Ans}}$$

Say: 0.56 m Ans

Flow velocity through this 0.56 m dia conduit will be

$$V = \frac{Q}{A} = \frac{\pi \times (0.56)^2}{4}$$

$$= 1.49 \text{ m/sec } \underline{\text{Ans}}$$

But we will consider the assume velocity of 1.5 m/sec (as it will give design more on a safer side)

Head loss through the conduit upto the treatment plant is calculated by using Hazen Williams's equation

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

where  $C_H$  = Coefficient of the pipe material

= 130 for cast iron pipe

$R$  = hydraulic mean depth of pipe

$$= \frac{d}{4} \text{ (for pipe running full)}$$

$$= \frac{0.56}{4} = 0.14 \text{ m}$$

$V$  = velocity of flow = 1.50 m/sec

$S$  = slope

$$1.50 = 0.85 \times 130 \times (0.14)^{0.63} \times S^{0.54}$$

$$S = \frac{0.54}{1.5} = 0.36 \times 10^3 \text{ dyne/cm}^2$$

$$= 0.036 \text{ dyne/cm}^2$$

$$L = S = 0.036 \text{ dyne/cm}^2 \rightarrow 10^3$$

$$= 3.65 \times 10^3$$

Now  $S = \frac{H_L}{L}$   $\therefore$  Head loss  
 $L$ : Length of pipe

Length of pipe is equal to the distance  
 of intake from treatment plants 0.8 km  
 $0.8 \text{ km} = 800 \text{ m}$

$$H_L = 3.65 \times 10 \times 800 = 2.96 \text{ m}$$

$$\therefore \text{Ans}$$



2

Find Head Loss due to friction from following data:

Total length of pipe : 500 M

Dia of pipe : 0.20 M

Discharge required per pump : 1250 Lit/min

Friction Factor : 0.025

$$\rightarrow \text{Velocity of flow} = \frac{Q}{A}$$

$$Q = 1250 \text{ Lit/min}$$

$$= \frac{1250 \times 10^{-3}}{60} \text{ m}^3/\text{sec}$$

$$\approx 0.028 \text{ m}^3/\text{sec}$$

$$V = 0.028$$

$$\frac{2f}{D} (0.20)^2$$

$$= \frac{0.028 + 4}{2f (0.20)^2}$$

$$V = 0.891 \text{ m/sec}$$

$$h_f = \frac{\rho A V^2}{2 g f}$$

$$= \frac{0.025 \times 500 \times (0.891)^2}{2 \times 9.81 \times 0.20}$$

$$h_f = 2.528 \text{ m}$$

3 A city with 2,00,000 population is to be supplied at 135 LPcd from a River 1 km away. The difference in water level of sump & Reservoir is 30 m. The Demand has to be supplied is 10 MLD. Determine the size of Main & RHP of Pumps. Assume maximum demand as 1.5 times of the average demand. Take coefficient of friction ( $f$ ) is 0.0075, Velocity in the pipe is 2 m/sec and efficiency of pump as 80%.

O → Population of a city = 2,00,000  
 Rate of water supply = 135 LPcd (lit/capacity/day)

∴ The average demand of the town =  $2,00,000 \times 135$   
 $= 27 \times 10^6$  litres/day

Maximum daily demand =  $1.5 \times$  Avg demand  
 $= 1.5 \times 27 \times 10^6$   
 $= 40.5 \times 10^6$  litres/day  
 or  $40.5$  MLD (million litres per day)

O As the full demand is to be supplied through pumps in 10 hours

Discharge Required =  $\frac{40.5 \times 10^6}{10}$  litres/hour  
 $= \frac{40.5 \times 10^6 \times 10^3}{10 \times 3600}$   
 $= 0.1125 \text{ m}^3/\text{sec}$

The maximum velocity in the pipe is given as 2.0 m/sec.

∴ Cross sectional area of the pipe required

$$A = \frac{g}{V} = \frac{0.1125}{2}$$

$$A = 0.056 \text{ m}^2$$

If  $d$  is the diameter of the pipe then

$$\frac{\pi}{4} d^2 = 0.056$$

$$d = \sqrt{\frac{h \times 0.056}{\pi}}$$

$$d = 0.2670 \text{ m}$$

$$d = 0.27 \text{ m}$$

Provide a pipe of 0.30 m diameter Ans

Total lift is given as 30 m

Fiction loss  $h_f$  can be found by using Darcy Weisbach equation

$$h_f = \frac{hf \cdot V^2}{2gd} \quad \text{if friction factor is given use } h_f = f \cdot \left(\frac{V^2}{2g}\right)$$

$$= \frac{4 \times 0.0075 \times 1000 \times (2.0)^2}{2 \times 9.81 \times 0.30}$$

$$= 20.38 \text{ m}$$

Thus the total lift against which the pump has to work or lift the water

$$= 30 + 20.38$$

$$H = 50.38 \text{ m}$$

∴ BHP of the pump =

$$= \frac{V + gS + H}{75 \eta}$$

$$= \frac{1000 \times 0.1125 \times 50.38}{75 \times 0.80}$$



$\therefore \eta = \frac{gH}{H_f}$

(as efficiency of the pump ( $\eta$ )  
is given as  $80\%$ )

$\therefore \eta = \frac{gH}{H_f} \times 100$

$\therefore 80 = \frac{gH}{H_f} \times 100$

$\therefore gH = 80 H_f$