ENVIRONMENTAL ENGINEERING-II.

INTERNAL ASSESSMENT SOLUTIONS

1) Explain the factors affecting quantity of dry feather flow.

Sol^n:

Quantity of wastewater is mainly affected by the following factors:

- Population
- Type of area.
- Rate of water supply
- Infiltration and exfiltration.

→ Population - the quantity of sanitary wastewater directly depends on the population. As the population increases the quantity of wastewater also increases. The quantity of water supply is equal to the rate of water supply multiplied by the population. The sewerage system is designed for the quantity of wastewater not only for the present population but also for future growth. There are several methods used for forecasting the population of a community such as arithmetical increase method, geometric increase method, incremental increase method, graphical comparision method, etc.

→ Type of area served - the quantity of sanitary wastewater also depends on the type of area as residential, industrial or commercial. The quantity of wastewater developed from residential areas depends on the rate of water supply

to that area. The quantity of wastewater produced by various industrial process which is different for each industry. Similarly, the quantity of wastewater obtained from commercial and public places can be determined by studying the development of other such places.

→ Rate of water supply - the quantity of used water discharged into a sewer system should be a little less than the amount of water originally supplied to the community; this is because the water supplied does not reach sewer owing to losses as leakages in pipe, lawn sprinkling, automobile washing etc

→ Ground water infiltration - the quantity of wastewater is also affected by ground water infiltration through the nature of soil, material of sewer, type of joint in a sewer line, workmanship in laying sewer and position of the underground water table.

Infiltration results in decrease in the flow and consequent increase in the pollution of ground water. But it is not more important from the point of sewer design. Since, Infiltration increases the load on the treatment plant and affects the sewer design.

2. What are sewer appurtenances? List them and explain catch basins and grease and oil traps with a

neat Sketch.

Soln

Sewer appurtenances:

Sewer appurtenances are those structures of the sewerage system which are constructed at suitable interval and other locations along a sewer line to assist in efficient operation and maintenance of the system.

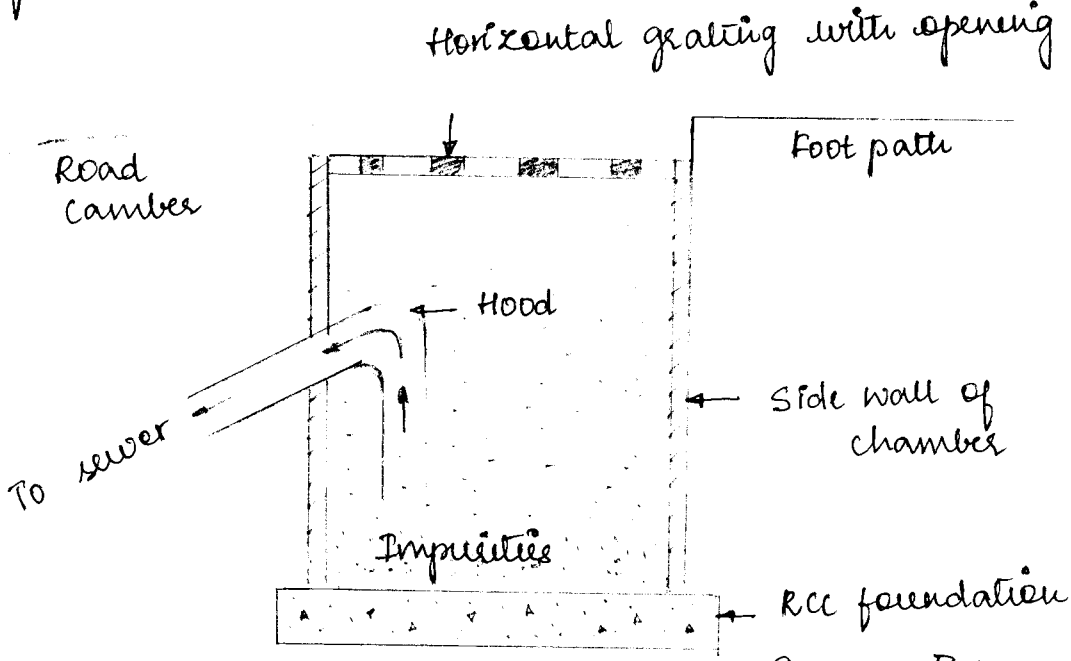
The important sewer appurtenances are:

- Street inlets
- Catch basins
- clean outs
- Man holes.
- Drop man holes
- Lamp holes
- Flushing tanks
- Grease and oil traps.
- Inverted siphons
- Storm regulators
  - → leaping weir
  - → overflow weir
  - → siphon spillway.

(i) Catch Basins:-

Catch basins are special type of street inlets provided with additional small settling basins. They are meant for the retention of suspended grit, sludge, sand, heavy debris from rainwater which otherwise might

have entered and caused choking problems. The outlet pipe from the catch basin may be submerged in order to prevent the escape of odours from the sewer. Their use is not recommended since they are more of source of mosquito breeding apart from posing substantial maintenance problems.



CATCH BASIN

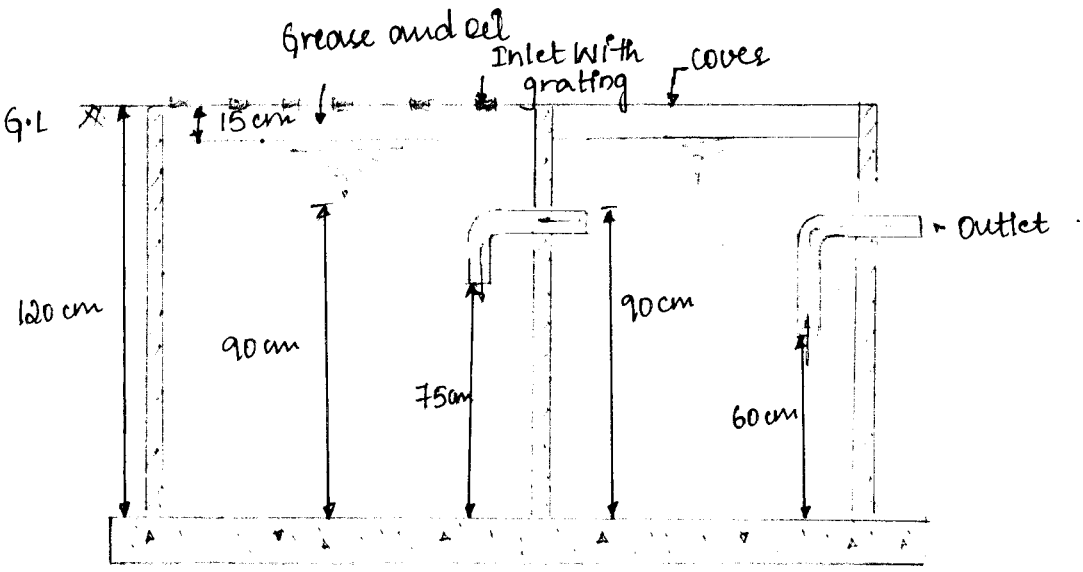
(ii) Grease and oil traps:

Grease and oil traps are specially built chambers on the sewers to exclude grease and oil from sewerage before they enter the sewer line. Such traps are located near to their sources such as automobile repair workshops, garages, kitchens of hotels, oil and grease industries, etc.

It is essential to exclude oil and grease from the sewerage due to

- Grease and oil entering into the sewer lines will stick to the interior surface.

- It increases the possibilities of explosion in the sewer lines.
- Floating materials have the tendency to stick to the walls of sewer sides.
- Causes difficulty in the treatment of waste water.



GREASE AND OIL TRAP

3. Explain the term (i) self cleansing and non silting velocity (ii) ventilation of sewer.

Soln

(i) Self cleansing velocity:

It is necessary to maintain a minimum velocity in a sewer line to ensure that suspended settleable solids do not deposit to cause choking problems, such a minimum velocity is called self-cleansing velocity. It is determined by considering the particle size and specific weight of suspended solids in waste water.

Self cleansing velocity can be determined by

Shield formula.

$$V_s = \sqrt{\frac{8k}{f}\left[\frac{S_s - S}{S}\right] g d}$$

where,

f = darcy's coefficient of friction

k = characteristics of solids

[$k = 0.04$ for inorganic solids.

$k = 0.06$ for organic solids]

S_s = Specific gravity of particles [2.65]

S = Specific gravity of sewage. [1]

d = diameter of particles in m.

g = acceleration due to gravity in m/s^2

[Or]

$$V_s = \frac{1}{n} R^{1/6} \sqrt{kd\left[\frac{S_s - S}{S}\right]}$$

where, n = coefficient of roughness

R = hydraulic mean depth.

Non-Scouring Velocity:

It is the maximum velocity at which no scouring action or abrasion of the interior surface of the sewer takes place is known as non-scouring velocity. Such a velocity depends on the materials used for the construction of sewer.

Desirable values ~~are~~ of non scouring velocity are -

Earth channel - 0.6 to 1.2 m/s

Ordinary brick lined sewer - 1.5 to 2.5 m/s.

- Cement concrete sewer - 2.5 - 3 m/s.
- Stone ware sewer - 3 to 4.5 m/s
- Cast iron sewer pipe - 3.5 to 4.5 m/s
- Vetrified tile - 4.5 to 5 m/s.

(ii) Ventilation of Sewer :-

The decomposition of organic matter present in wastewater inside the sewer result in the production of various gases such as methane, H_2S, ammonia. These gases are foul smelling, corrosive and explosive in nature, if not removed causes - serious problems and true hazardous to the workers entering the sewer lines. They may also cause air locks in sewer and affect the flow of waste water. For the disposal of these gases, ventilation of sewer line is a must.

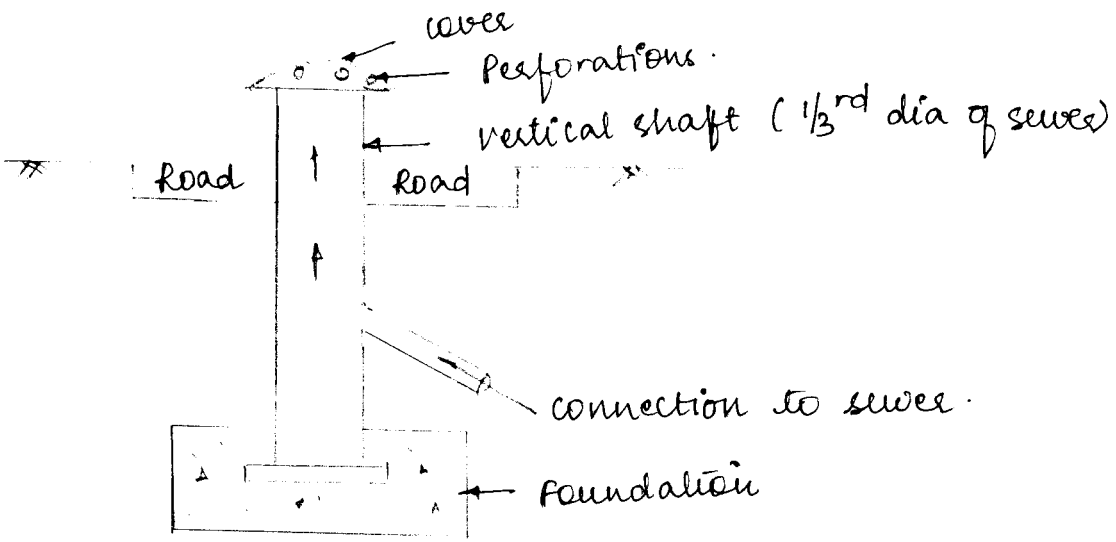
→ Methods of ventilation :

- Proper design of sewers.
- Use of perforated man hole covers.
- Use of mechanical devices like exhaust.
- Proper house drainage like house bend.
- Providing ventilating column or shaft.

D. Ventilating column or Shaft :-

In order to achieve proper ventilation, ventilating columns or shafts are generally placed at intervals of 150 to 300m along the sewer lines.

Ventilating columns are designed to serve two purposes together ; one for ventilating the sewer and the other for working as a support for street lamps, sign boards, etc. The diameter of ventilating column is preferably kept equal to $1/3^{rd}$ diameter of sewer.



VENTILALING COLUMN

4. Explain briefly how the sewers are tested for leakage after laying.

Soln. Sewers are generally tested before they are put into service. The following tests are conducted.

- Test for straightness of alignment and obstruction.
- Water test
- Smoke test
- Air test.

→ Test for straightness of alignment and obstruction :-

It is tested by two methods :

(a) At the high end of the sewer a smooth ball of

of 13mm diameter less than that of pipe is inserted. If there is no obstruction in form of yarn or mortar projecting through the joint, the ball will roll down the invert of the pipe and emerge at the lower end. Alternatively, a double disc or solid or closed cylinder 75mm less in dimension is passed to ensure that it is free from any obstruction.

(b) A mirror is placed at on end and lamp at the other end of sewer line. If the pipe line is straight, the full circle of light will be observed. The mirror will also indicate any obstruction in the pipe barrel.

→ Water test :

Water test is carried out to find out the water tightness of the joints. This is carried out after giving sufficient time to for the joints to set.

The sewers are tested by plugging the upper end with a provision for an outlet pipe with stop cock. The water is filled through a funnel connected at the lower end with a plug. After the air has been expelled, water level in the funnel is noted after 30 minutes and quantity of water required to restore the original water level is determined. The pipe line under pressure is then inspected, there shall not be any leaks in the pipe or joints, though small sweating on pipe surface is permitted.

→ Smoke test :-

Smoke is produced by burning oil waste, paper, etc.

in the combustion chamber of a smoke machine. The pipes are approved gas tight by the smoke test conducted under pressure of 25mm of water for 15 minutes after all traps seals have been filled with water.

→ Air testing :-

It is done by subjecting the stretch of pipe to an air pressure of 100mm of water by means of a hand pump. If the pressure is maintained at 75mm, the joints shall be assumed water tight. In case the drop is more than 25mm, the leaking joints shall be traced and suitably ensured for water tightness.

5. List and explain the different systems of sewerage with their merits and demerits.

Solu. The sewerage systems are classified as :

- Separate system
- Combined system
- Partially combined or partially separate system.

→ Separate system :-

In this system two sets of sewers are laid. The sanitary sewage is carried through one set of sewers while the storm water is carried through another set of conduits called drains. The sewage is carried to the treatment plant and the storm water is directly discharged into the natural rivers or streams for disposal.

Advantages:

- The size of sewers are small.
- Sewage load on treatment units is less.
- River or streams are not polluted.
- Storm water may be discharged into stream without any treatment.

Disadvantages:

- Sewers being small cleaning is difficult.
- Frequent choking problem will be there.
- The system proves costly as it involves 2 sets of sewers.
- The use of storm sewers is only partial because during non-monsoon seasons, they will be idle and forms the place for dumping garbage.

→ Combined system:

When only one set of sewers are used to carry both sanitary wastewater and storm water, the system is called combined system. The sewage and storm water both are carried to the treatment plant.

Advantages:

- The size of sewers being large choking problems are less and easy to clean.
- It proves economical as only one set of sewers are laid.
- Because of dilution of wastewater with stormwater, strength or potential is reduced.

Disadvantages:

- Size being large, difficulty in handling and transportation.
- The load on the treatment plant is unnecessarily increased.
- Storm water gets polluted unnecessarily.

→ Partially combined or partially separate system:

Sometimes a part of storm water especially originating from the roofs or paved courts of buildings is allowed to be admitted into the sewers and similarly the domestic waste water is allowed to admit into the drains, the resulting system is called partially combined or separate system.

Advantages:

- The sizes of sewers are not very large.
- Silting problem is completely eliminated.
- Combines the advantages of both the previous systems.

6. The rate of water supply to a town covering an area of 100 hectares having a population of 50000 persons is 150 lpcd, 80% of which flows out as waste water. The peak flow of waste water may be taken as 2.5 times the average flow. The area of the town is classified as :

% total area	Nature of surface	Runoff coefficient
45	Hard pavement and roof	0.8
20	unpaved	0.4
20	Garden and lawns	0.25
15	Wooden area	0.15

Design a sewer section to develop a maximum velocity of 2.5 m/s when it runs half full at peak combined flow. The time of concentration is 30 minutes.

Soln (i) Waste Water calculations :

Average flow of waste water = $0.8 \times 150 \times 50,000$

$= 600 \times 10^4$ lpcd.

$= \frac{600 \times 10^4 \times 10^{-3}}{24 \times 60 \times 60} = 0.0694$ m³/sec.

Peak flow = $2.5 \times$ Avg flow

$= 2.5 \times 0.0694$

$Q_1 = \underline{0.1736 \text{ m}^3/\text{sec}}$.

(ii) Storm Water Calculations :

$I = \frac{1016}{t + 20} = \frac{1016}{30 + 20} = 20.32$ mm/hr.

$C = \frac{\sum C_n A_n}{\sum A}$

$C = \frac{0.8 \times \frac{45}{100} \times 100 + 0.4 \times \frac{20}{100} \times 100 + 0.25 \times \frac{20}{100} \times 100 + 0.15 \times \frac{15}{100} \times 100}{45 + 20 + 20 + 15}$

$C = 0.5125$

$$Q_2 = \frac{CiA}{360}$$

$$= \frac{0.5125 \times 20.32 \times 100}{360}$$

$$Q_2 = \underline{2.89 \text{ m}^3/\text{sec}}.$$

$\therefore$ Total combined flow $= Q_1 + Q_2$

$= 0.1736 + 2.89$

$= \underline{3.0636 \text{ m}^3/\text{sec}}.$

(iii)

$Q = AV$

$$\frac{\pi/4 \times d^2}{2} = \frac{3.0636}{2.5} \quad [\because \text{Sewer runs half full}]$$

$d = 1.76 \text{ m}.$

Diameter of sewer = 2x dia of waste water flow

$D = 2 \times 1.76$

$D = 3.53 \text{ m}. \simeq 3.5 \text{m}$

$\therefore$ Diameter of the section when it is running half full for the given discharge and velocity of flow is $\underline{3.5 \text{m}}$.