

Internal Assessment Test 1 - Sept 2017

Environmental Engineering II

- 1) Explain the different systems of Sewerage with their merits and demerits.

The Sewerage systems are classified as.

1. Separate system.
2. Combined system.
3. Partially combined or Partially Separate system.

① Separate System: In this system 2 sets of Sewer are laid. The Sanitary Sewage is carried through one set of Sewer called Sanitary Sewer. While the storm water is carried through another set of conduits called drains. The sewage is carried to the treatment plant & the storm water is directly discharged into the natural rivers or stream for disposal.

Merits

1. The sizes of Sewer are small.
2. Sewage load on treatment unit is less.
3. River or stream are not polluted.

Demerits

1. Sewer being small cleaning is difficult.
2. Frequent choking problem will be there.
3. The system proves costly as it involves 2 sets of Sewer.

② Combined System: When only one set of Sewer are used to carry both sanitary w/w and storm water. The system is called combined system. The Sewage & storm water both are carried to the treatment plant. The Sewer used are called as combined Sewer.

Merits

1. The sizes of Sewer being large choking problems are less & easy to clean.
2. It proves economical as only one set of Sewer are laid.
3. Because of dilution of w/w with storm water, nuisance potential is greatly reduced.

Demerits:

1. Sizes being large, difficulty in handling & transportation.
2. The load on treatment plant is unnecessarily increased.
3. Unnecessarily storm water is polluted.

③ Partially combined / Partially Separate System:-

Sometimes a part of storm water especially that originating from the roofs or paved courtyards of buildings is allowed to be admitted into the sewers & similarly the domestic w/c is allowed to admit into the drains, the resulting system is called as partially separate or partially combined.

Merits:

1. The size of sewers are not very large as some portion of storm water is carried through open drains.
2. Combines the advantages of both previous system.
3. Silt problem is completely eliminated.

Demerits:-

1. During dry weather, the velocity of flow may be low.
2. The storm water is unnecessary put load on to the treatment plants to extend.
3. Pumping of storm water is unnecessary over-load on the pumps.

2) Explain the factors affecting quantity of dry weather flow.

1. Population: The quantity of sanitary w/w directly depends on the population. As the population increases, the quantity of w/w also increases. The quantity of water is equal to the rate of water supply multiplied by the population. There are several methods used for forecasting the population of a community.

2. Type of area: The quantity of sanitary w/w also depends on the type of area as residential, industrial or commercial. The quantity of w/w developed from residential area depends on the rate of water supply to that area.

The quantity of w/w produced by various industrial processes which is different for each industry. Similarly, the quantity of w/w obtained from commercial & public places can be determined by studying the development of other such places.

3. 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 of the fact that all the water supplied does not reach sewer owing to such losses as leakages in pipes or such deduction as lawn sprinkling, manufacturing processes, automobile washing, etc. However, these losses may be largely made up by such additions as surface drainage, ground water infiltration, water supply from private wells etc.

4. Ground water infiltration: - The quantity of w/w is also affected by ground water infiltration through joints. The quantity will depend on the nature of soil, materials of sewers, type of joints in a sewer line, workmanship in laying area sewers & position of the underground water table.

3). Explain the tests to be conducted for the sewers before putting them under service.

1. Smoke test: This test is performed for soil pipes, vent pipes laid above ground. The test is conducted under a pressure of 2.5 m of water and maintained for 15 minutes. After all trap seals have been filled with water, the smoke is produced by burning tar paper or oil waste in combustion chamber of a smoke machine. If the pipes leak smoke then it has to be repaired or replaced.

2. Water test or test for leakage: - Test for leakage is performed for underground sewer pipes before backfilling is done. The test should be carried out by suitably plugging the lower end of the drain & filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe is jointed so as to provide

The required test head, 1.5 m of water. Subsidence of water in the knuckle bend may be due to.

- i. absorption of water by pipe & joints.
- ii. leakage of joints. etc

The joints which leak or sweat are repaired & the leakage pipes if any will also be replaced.

3. Test for straightness of alignment and obstruction:-

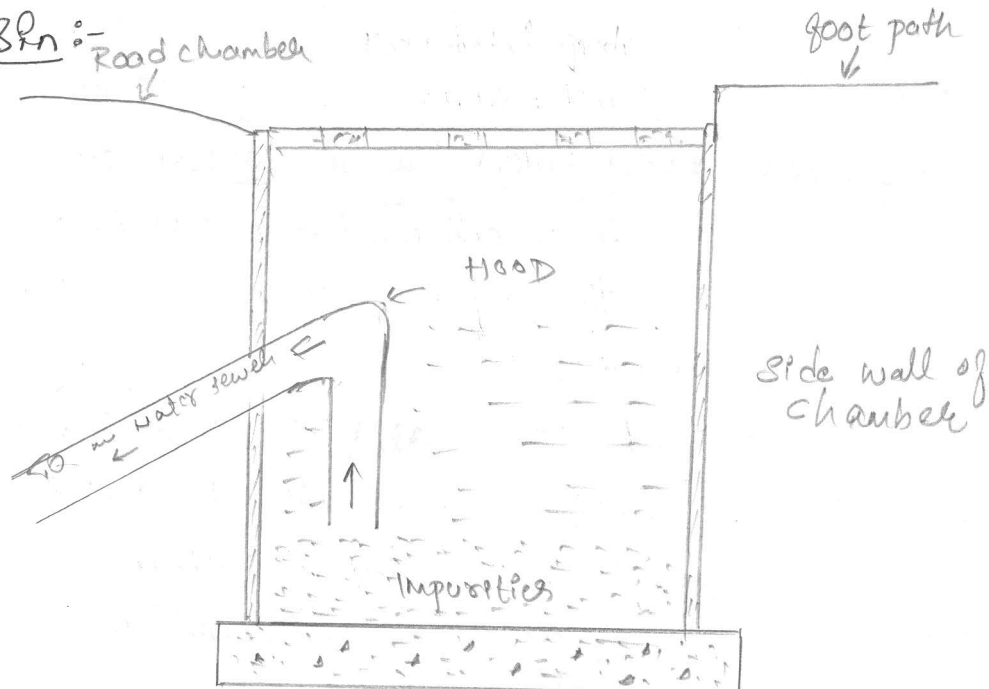
For this test a mirror is placed in front of one end of the sewer & image of the section is observed. If the sewer line is straight the image should be circular. If it is not a complete circle then it is not straight.

For testing - obstruction. by inserting a smooth steel ball at upper end & if there is no obstruction in the sewer line the ball will emerge out from the lower end.

4) What are sewer appurtenances? Explain the following with neat sketch.

For proper functioning and to facilitate maintenance of the sewerage system, various additional structures have to be constructed on the sewer lines. These structures are known as sewer appurtenances.

1) Catch Basin:-



5) The main sewer was designed for an area of 50 km^2 . Density of population of the town is 200 person/hectare. The average flow is 250 lpd . The peak discharge is 1.5 times more than the average flow. Rainfall equivalent of 8 mm in 24 hrs all of which are runoff.

- What should be the capacity of the sewer in m^3/sec .
- Find the minimum velocity and gradient required to transport wastewater containing particles of 1 mm dia through a sewer of 35 cm dia. Specific gravity of particles is 2.65 and the values of $K=0.06$ and $f=0.03$.

Density of population = 200 persons/hectare.

$$\begin{aligned} \text{Area} &= 50 \text{ km}^2 \\ &= 50 \times 100 \\ &= 5000 \text{ hectares.} \end{aligned}$$

$$\begin{aligned} \therefore \text{Total population of area} &= 200 \text{ person/hect} \times 5000 \text{ hec} \\ &= 1 \times 10^6 \text{ persons.} \end{aligned}$$

Wastewater flow calculations

$$\begin{aligned} \text{Avg flow of w/w} &= 250 \times 1 \times 10^6 = 25 \times 10^7 \text{ l/day} \\ &= \frac{25 \times 10^7}{1000 \times 24 \times 60 \times 60} \text{ m}^3/\text{sec} \\ &= 2.893 \text{ m}^3/\text{sec} \end{aligned}$$

$$\begin{aligned} \text{Maximum w/w flow} &= 1.5 \times 2.893 \\ &= 4.34 \text{ m}^3/\text{sec} \end{aligned}$$

$$\therefore \text{peak flow of w/w} = Q = 4.34 \text{ m}^3/\text{sec.}$$

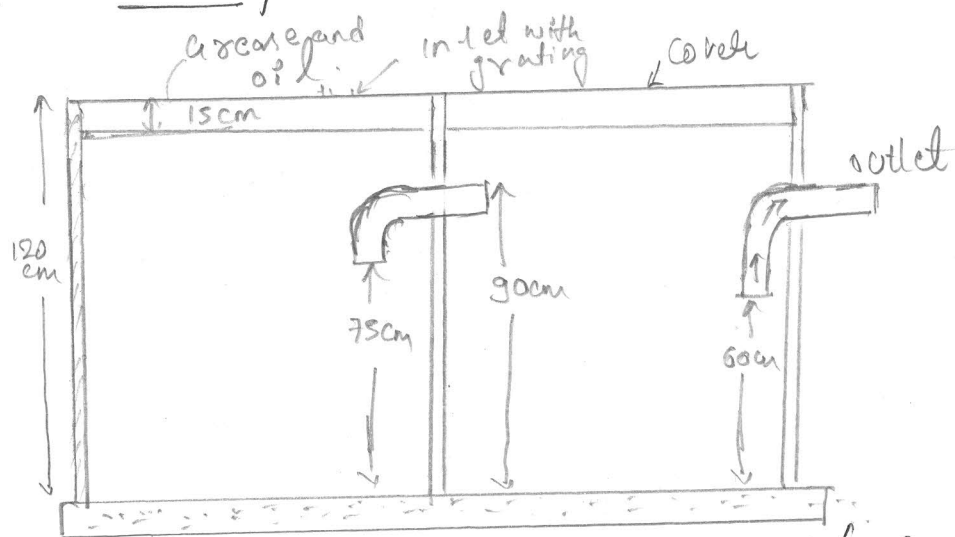
Storm water calculations

$$\begin{aligned} &= \frac{50 \times 10^3 \times 10^3 \times (8/1000)}{24 \times 60 \times 60} \\ &= 4.629 \text{ m}^3/\text{sec} \end{aligned}$$

$$\begin{aligned} \text{Capacity of sewer} &= \text{peak flow} + \text{storm water flow} \\ &= 4.34 + 4.629 \\ &= 8.969 \text{ m}^3/\text{sec} \end{aligned}$$

Catch basins are nothing but street inlets provided with additional small settling basins. They are meant for the detention of suspended material, sludge, sand, heavy debris and rubbish 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 nuisance & a source of mosquito breeding apart from posing substantial maintenance problems.

ii) Grease and oil traps:-



The w/w from kitchen or hotel, restaurants, industries - consists of oil, grease & fat. If these are not removed they will stick to the interior surface of the sewer and sewer gets clogged. Some from garages particularly from the floor drains & wash racks contain oils, mud & sand.

The principle on which oil & grease trap work are simple. The grease & oil being lighter in weight float on the surface of w/w. Hence the outlet is provided well below the surface of the surface to exclude oil, grease & fat.

b) Calculation of storm water flow

using rotational formula $Q = \frac{C_i A}{360}$

$$= \frac{0.5 \times 50 \times 120}{360}$$

$$= 8.33 \text{ m}^3/\text{sec}$$

Capacity of combined flow = $Q_1 + Q_2$

$$= 8.75 \text{ m}^3/\text{sec}$$

Minimum velocity or self cleaning velocity is given by Shields formula

$$K = 0.06$$

$$f = 0.03$$

$$S_s = 2.65$$

$$S = 1.0$$

$$g = 9.8 \text{ m/sec}^2$$

$$d_s = 1 \text{ mm} = 0.001 \text{ m}$$

$$V_s = \sqrt{\frac{8K}{f} \left(\frac{S_s - S}{S} \right) g d_s}$$

$$= \sqrt{\frac{8(0.06)}{0.03} \left(\frac{2.65 - 1}{1} \right) 9.8 \times 0.001}$$

$$= 0.508$$

$$\approx 0.5 \text{ cm/sec}$$

Calculation of gradient

From Manning's formula $V = \frac{1}{n} R^{2/3} S^{1/2}$

$$R = \text{hydraulic mean depth} = \frac{d}{4} = \frac{0.035}{4} = 0.00875 \text{ m}$$

Assuming Manning's $n = 0.012$

$$0.51 = \frac{1}{0.012} (0.00875)^{2/3} S^{1/2}$$

$$S = 9.6418 \times 10^{-4}$$

$$S = 1 \text{ in } 1037.15$$

6) Design a combined circular sewer to serve a particular area of 120 hectares with the population of 120000. The rate of water supply is 135 lpcd and peak factor is 2.25. Design intensity of rainfall is 50 mm/hr and co-efficient of runoff is 0.5. The value of $n = 0.013$ and slope may be taken as 1 in 750

a) calculation of waste water flow

$$Q = \frac{1.20000 \times 135 \times 2.25}{1000 \times 24 \times 60 \times 60}$$

$$Q = 0.421 \text{ m}^3/\text{sec}$$