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Internal Assessment Test 5– Feb 2022

Sub:	Municipal and Industrial Waste Water Engineering				Sub Code:	17CV71	Branch:	CIVIL
Date:	05.02.2021	Duration:	90 min’s	Max marks:	50	Sem / sec:	Vll/ C	OBE

Answer all questions. Assume any missing data suitably.
Provide neat sketches wherever necessary

	MARKS	CO	RBT
1. Explain the different types of sewerage system with their advantages and disadvantages	[10]	CO1	L1
2. What are sewer appurtenances? Explain with neat sketch the manhole.	[10]	CO1	L2
3. A certain district of a city has a projected population of 50000 residing over an area of 40 hectares. Find the desired discharged for the sewer line for the following data: Rate of water supply= 200 lit per capita per day Average impermeability coefficient for the entire area = 0.3 Time of concentration = 50 minutes. A sewer line is to be designed for a flow equivalent to the wet weather flow plus twice the DWF. Use U.S ministry of health formulae. Assume that 75% of water supply reaches in sewer as wastewater.	[10]	CO1	L3
4. Explain self cleansing and no scouring velocities in sewer. List the factors on which it depends	[10]	CO1	L2

1. Explain the different types of sewerage system with their advantages and disadvantages

Classification of Sewerage System
1. Combined system
2. Separate System
3. Partially separate system
Combined System
When only one set of sewer is laid carrying both the sanitary sewage and the storm water is called as combined system. Sewage and storm water both are carried to the treatment plant through combined sewers.

Merits
1. Size of the sewers being large, chocking problems are less and easy to clean.
2. House plumbing can be done easily and it proves economical as one set of sewers are laid.
3. Because of dilution of sanitary sewage with storm water nuisance potential is reduced and can be easily and economically treated.

Demerits
1. Size of the sewers being large, difficulty in handling and transportation.
2. Load on treatment plant is unnecessarily increased.
3. It is uneconomical if pumping is needed because of large amount of combined flow.
4. Unnecessarily storm water is polluted.
Suitable conditions for combined system
1. Rainfall in even throughout the year.
2. Both the sanitary sewage and the storm water have to be pumped.
3. The area to be sewered is heavily built up and space for laying two sets of pipes is not available.
4. Where Effective or quicker flows have to be provided.

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

Merits
1. Size of the sewers is small.
2. Sewage load on treatment unit is less.
3. Rivers or streams are not polluted.
4. Storm water can be discharged into rivers without any treatment.
Demerits
1. Sewers being small, cleaning is difficult.
2. Frequent choking problem will be there.
3. System proves costly as it involves two sets of sewers.
4. The use of storm sewer is only partial because during non-monsoon seasons, they will be idle and forms the dumping places for garbage and rubbish and may get clogged.

Suitable conditions for separate sewerage systems
1. Where rainfall is uneven.
2. Where sanitary sewage is to be pumped.
3. The drainage area is steep, allowing to runoff quickly.
4. Sewers are to be constructed in rocky strata. The large combined sewers would be more expensive.

Partially Combined or Partially Separate System

Sometimes a part of storm waters especially that originating from the roofs or paved courtyards of buildings, is allowed to be admitted into the sewers and similarly, the domestic sewage is allowed to be admitted into the drainage. The resulting system is called as partially separate or partially combined system.

Merit
1. The sizes of sewers are not very large as some portion of storm water is carried through open drains.
2. Combines the advantages of both the previous systems.
3. Silting problem is completely eliminated.
Demerit
1. The cost of pumping is increased at the disposal point than separate system because a portion of storm water is mixed with sanitary sewage.
2. During dry weather, the velocity of flow may be low.
3. The storm water is unnecessary put load on to the treatment plants.
4. Pumping of storm water in unnecessary over-load on the pumps.

2. A certain district of a city has a projected population of 50000 residing over an area of 40 hectares. Find the desired discharged for the sewer line for the following data:
   Rate of water supply= 200 lit per capita per day
   Average impermeability coefficient for the entire area = 0.3
   Time of concentration = 50 minutes.

A sewer line is to be designed for a flow equivalent to the wet weather flow plus twice the DWF. Use U.S ministry of health formulae. Assume that 75% of water supply reaches in sewer as wastewater.

Solution :

The sewage flow is equal to 75% of rate of water supply. Hence sewage flow will be equal to $0.75 \times 200 = 150$ litres/capita/day.

$$\therefore \text{ Sewage flow (D.W.F.)} = \frac{50000 \times 150}{24 \times 60 \times 60} = 86.8 \text{ litres/seconds.}$$

The rainfall intensity is given by

$$R_i = \frac{25.4\,a}{t + b} \text{ mm/hour} \quad ...(3.7)$$

Here $t = 50$ minutes ; $a = 40$; $b = 20$

$$\therefore \quad R_i = \frac{25.4 \times 40}{50 + 20} = 14.5 \text{ mm/hour} = 1.45 \text{ cm/hour}$$

The W.W.F. is given by

$$Q = 28\,A.I.R_i$$

$$= 28 \times 40 \times 0.3\,(1.45) = 487.2 \text{ litres/sec.}$$

Hence the design discharge is given by

$$Q = 2\,(\text{D.W.F.}) + \text{W.W.F.}$$

$$= 2\,(86.8) + 487.2 = \mathbf{661} \textbf{ litres/second}$$

Comment : Ratio of D.W.F. and W.W.F. $= \frac{86.8}{487.2} = \frac{1}{5.6}$.

Since this ratio is not very large, it is preferable to use a combined sewer system.

3. What are sewer appurtenances? Explain with neat sketch, construction and working of a drop manhole

Sewage flowing in the sewer line contains a large number of impurities in the form of silt, fats, oils, rags etc. Under normal flows they are not likely to settle and choke the sewers, but during small flows self-cleansing velocity is not likely to develop and the chances of choking of the sewers are increased. Choking have to be removed time to time and facilities should be provided on the sewer lines for this purpose. Therefore, for proper functioning and to facilitate maintenance of the sewage system, various additional structures have to be constructed on the sewer lines. These structures are known as sewer appurtenances

Following are the important appurtenances, 1. Manholes 2. Inlets 3. Catch basins 4. Flushing devices 5. Regulators 6. Inverted siphons 7. Grease and oil traps 8. Lamp holes 9.Leaping weirs 10. Junction chambers

Manholes: The manholes are R.C.C or masonry chambers constructed on the sewer line to facilitate a man to enter the sewer line and make the necessary inspection and repairs. These are fitted with suitable cast iron covers. The manholes should be installed at every point where there is a change in direction, change in pipe size, or considerable change in gradient. As far as possible sewer line between two subsequent man holes should be straight. The centre distance between manholes is less for sewers of smaller size while it may behave such a size that man can easily enter in the working chamber. The minimum size is 50cm diameter.

Size of Sewer Recommended spacing of Manhole

Dia up to 0.3 m 45 m
Dia up to 0.6 m 75 m
Dia up to0.9 m 90 m
Dia up to1.2 m 120 m
Dia up to1.5 m 250 m
Dia greater than 1.5 m 300 m

Classification of Manhole:

Shallow Manholes (Inspection Manholes) are the one which are about 0.75 to 0.9 m in depth. They are constructed at the start of a branch sewer.

Normal Manholes are those which are about 1.5 m in depth. They are constructed either in square (1 m * 1m) or rectangular (0.8 m * 1.2 m) in cross section.

Deep Manholes are those which are deeper than 1.5 m. The size of such a manhole is larger at the bottom, which is reduced at the top to reduce the size of manhole cover.

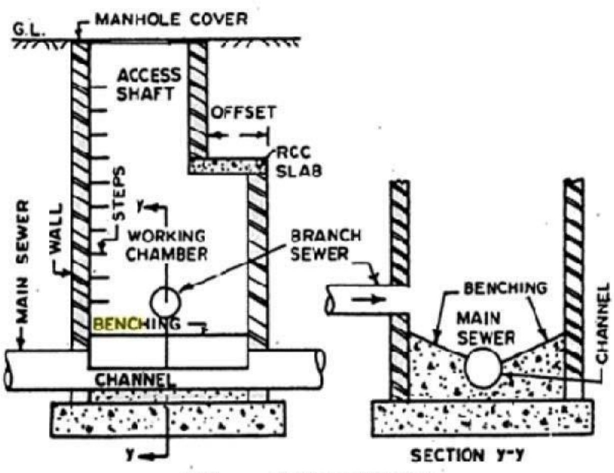

FIG. DEEP MANHOLE

4. Explain self cleansing and no scouring velocities in sewer. List the factors on which it depends

Self-cleansing velocity: It is necessary to maintain a minimum velocity in a sewer line to ensure that suspended solids do not deposit and cause choking troubles. Such a minimum velocity is called as self-cleansing velocity. Self-cleansing velocity is determined by considering the particle size and specific weight of the suspended solids in sewage. The velocity which can cause automatic selfcleansing can be found out by the following formula given by Shield:

$$Vs = \sqrt{\frac{8K}{f'}(Ss - 1)g.d'}$$

Where:
f = Darcy‘s co-efficient of friction, 0.03
K = characteristics of solid particles
= 0.06 for organic and
= 0.04 for inorganic solids
Ss = specific gravity of particles
= 2.65 for inorganic and
= 1.2 for organic solids
S = specific gravity of sewage, 1.0
G = acceleration due to gravity
D = diameter of particle as per

Maximum Velocity or Non-scouring Velocity

The interior surface of the sewer pipe gets scored due to the continuous abrasion caused by suspended solids present in sewage. The scoring is pronounced at higher velocity than what can be tolerated by the pipe materials. This wear and tear of the sewer pipes will reduce the life span of the pipe and their carrying capacity. In order to avoid this, it is necessary to limit the maximum velocity that will be produced in sewer pipe at any time. This limiting or non-scouring velocity mainly depends upon the
material of sewer.

Sewer Material Limiting velocity, m/sec

Vitrified tiles 4.5 – 5.5
Cast iron sewer 3.5 – 4.5
Cement concrete 2.5 – 3.0
Stone ware sewer 3.0 – 4.5
Brick lined sewer 1.5 – 2.5

Effect of Flow Variations on Velocities in a Sewer:

The discharge flowing through sewers varies considerably from time to time. Hence, there occur variation in depth of flow and thus, variation in Hydraulic Mean Depth (H.M.D.). Due to change in H.M.D. there occur changes in flow velocity, because it is proportional to (H.M.D.). Therefore, it is necessary to check the sewer for minimum velocity of about 0.45 m/sec at the time of minimum flow (1/3 of average flow) and the velocity of about 0.9 to 1.2 m/sec should be developed at a time of average flow. The velocity should also be checked for limiting velocity i.e. non-scouring velocity at the maximum discharge. For flat ground sewers are designed for self-cleansing velocity at maximum discharge. This will permit flatter gradient for sewers. For mild slopping ground, the condition of developing self-cleansing velocity at average flow may be economical. Whereas, in hilly areas, sewers can be designed for self-cleansing velocity at minimum discharge, but the design must be checked for non-scouring velocity at maximum discharge.

5. The catchment area is of 300 hectares. The surface covers in the catchment classify as given below

Type of the area	% of area	Coefficient
Roofs	15	0.90
Pavements and yards	15	0.80
Lawns and gardens	25	0.15
Roads	20	0.40
Open grounds	15	0.10
Single family dwelling	10	0.50

Calculate the runoff coefficient and quantity of storm water runoff. If the intensity of rainfall is 30 mm/h for rain with duration equal to time of concentration. If the population density in the area is 350 person per hectare and rate of water supply is 200 lpcd. Calculate design discharge for combined system. Take Q peak =2

Solution

Estimation of storm water discharge for storm water drain of separate system

Overall runoff coefficient $C = [A_1.C_1 + A_2.C_2 + \ldots + A_n.C_n] / [A_1 + A_2 + \ldots + A_n]$

$$= \frac{(0.15 \times 0.90 + 0.15 \times 0.80 + 0.25 \times 0.15 + 0.20 \times 0.4 + 0.15 \times 0.1 + 0.10 \times 0.5)}{0.15 + 0.15 + 0.25 + 0.20 + 0.15 + 0.10}$$

$= 0.44$

Therefore quantity of storm water, $Q = C.I.A/360$

$= 0.44 \times 30 \times 300/360$

$= 11\ m^3/sec$

Estimation of sewage discharge for separate system sanitary sewer

Quantity of sanitary sewage = 300 x 350 x 200 x 0.80 = 16800 m^3/day = 0.194 m^3/sec

Considering peak factor of 2, the design discharge for sanitary sewers = 0.194 x 2

= 0.389 m^3/sec

Estimation of discharge for partially separate system

Storm water discharge falling on roofs and paved courtyards will be added to the sanitary sewer. This quantity can be estimated as:

Average coefficient of runoff = (0.90 x 45 + 0.80 x 45) / 90 = 0.85

Discharge = 0.85 x 30 x 90 / 360 = 6.375 m^3/sec

Therefore total discharge in the sanitary sewer of partially separate system = 6.375 + 0.389 = 6.764 m^3/sec and the discharge in storm water drains = 11 – 6.375 = 4.625 m^3/sec