IAT-5 18CV55

1. Define dry weather flow and wet weather flow. Explain factors affecting DWF and WWF

Dry Weather Flow (DWF): Domestic sewage and industrial sewage collectively called as DWF. It does not contain storm water. It indicates the normal flow during dry season of the year. Sanitary sewage is mostly the spent water of the community into sewer system with some groundwater and a fraction of the storm runoff from the area, draining into it. Sanitary sewage is also called as the Dry Weather Flow (D.W.F), which includes the domestic sewage obtained from residences and industries etc., and the industrial sewage or trade waste coming from manufacturing units and other concerns. Dry Weather Flow (D.W.F) is the quantity of water that flows through sewer in dry weather when no storm water is in the sewer.
Practically the average sewer never flows in the sewers; it continuously varies from hour to hour of the day and season to season. The design of the sewers should be done for the maximum possible flow which would ever pass through in worst possible case.
(i)The seasonal maximum rate of flow may be taken as the 1.3 times of average daily rate of flow
(ii) The monthly maximum rate of flow may be taken as the 1.4 times the average rate of flow.
(iii) The daily maximum rate of flow may be taken as the 1.8 times or so the average daily rate of flow.

DRY WEATHER FLOW (DWF):
It is that quantity of wastewater that flows through as sewer in dry weather when no storm water is in the sewer. The dry weather flow is also sometimes called as 'sanitary sewage', and is obtained from the following sources:

Factors Affecting sanitary sewage
1) Population
2) Rate of water supply.
3) Type of area served (Industrial, Commercial, Etc…)
4) Ground water infiltration and exfiltration

1.Population: The quantity of sanitary sewage or DWF directly depends on the population at the end of the design period. As the population increases, the quantity of sanitary sewage also increases. The quantity of water supply 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.Rate of water supply: The quantity of wastewater discharged into a sewer system is less than the amount of water supplied to the community. This is because of losses due to leakage from pipes, lawn sprinkling and manufacturing process etc. hence the rate of consumption of both public as well as private supplies must be taken into account. In estimation of quantity of sewage, the anticipated rate of water consumption at the end of the design period must also be studied
3.Type of area to be served: Quantity of sanitary sewage depends upon the type of area such as Residential, industrial or Commercial. The quantity of sewage produced in residential area directly depends on the quantity of water supply to that area. This type of sewage is generally expressed as litres per capita per day.

4. Groundwater infiltration and exfiltration:
i. Infiltration: In case of sewers which are laid below ground water table and in water clogged areas, an allowance should be made for the water entering the sewers through leaky joints. Infiltration represents a slow response process resulting in increased flows mainly due to seasonally-elevated groundwater entering the drainage system, and primarily occurring through defects in the pipe network.

Exfiltration: represents losses from the sewer pipe, resulting in reduced conveyance flows and is due to leaks from defects in the sewer pipe walls as well as overflow discharge into manholes, chambers and connecting surface water pipes. The physical defects are due to a combination of factors including poor construction and pipe joint fittings, root penetration, illicit connections, biochemical corrosion, soil conditions and traffic loadings as well as aggressive groundwater

Wet Weather Flow (WWF): Domestic sewage, industrial sewage and storm water collectively called as WWF. It indicates the maximum flow of sewage during wet season.

Runoff coefficient:-
In rational method, the value of runoff coefficient, C is required. The whole quantity of rain water that fall over the ground does not reach the sewer line. A portion of it percolates in the ground, a portion evaporates, a portion is stored in ponds and ditches and only remaining portion of rainwater reaches the sewer line. The runoff coefficient depends mainly on characteristics of ground surface as porosity, wetness, ground cover etc., which varies from 0.01 for forest or wooded area to 0.95 for a water tight roof surfaces.

Run of Coefficient: Impermeability factor

- The storm water flow depends upon the imperviousness of the surface over which rainfall takes place.
- If the ground is relatively impervious, more runoff takes place .
- The percentage of rain water that is available in the form of runoff is known as *impermeability factor* or runoff coefficient.

Intensity of Rainfall
The rainfall intensity is expressed in mm/hr. The intensity of rainfall can be determined with the help of automatic rain gauges.

Time of concentration of flow:
The time taken for the maximum runoff rate to develop, is known as the time of concentration, and is equal to the time required for a drop of water to run from the farthest point of the watershed to the point for which the runoff is to be calculated.

2. 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.

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.

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

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

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

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

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

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.

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

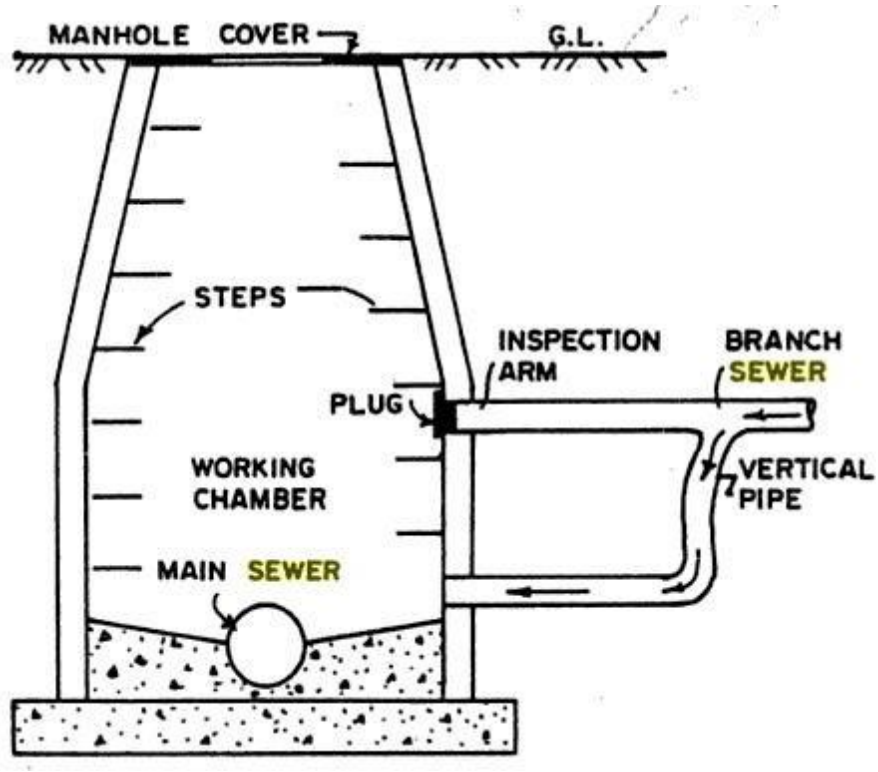
Sewage flowing in the sewer line contains a large number of impurities in the form of silt, fats, oils, rags etc. Under normal flows they are not likely to settle and choke the sewers, but during small flows self-cleansing velocity is not likely to develop and the chances of choking of the sewers are 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

Drop Manhole: It is a measure of connecting high level branch sewer to low level main sewer. They are connected through a vertical pipe. The installation of a drop manhole becomes necessary when there is difference in levels is more than 60cm between branch sewer and the main sewer, which can be avoided by increasing the sewer grade.

Components parts of a Deep Manhole are:

i) Access shaft ii) Working chamber iii) Bottom or Invert iv) Side walls v) Steps or ladder vi) Top cover



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 = $300 \times 350 \times 200 \times 0.80 = 16800\ m^3/day = 0.194\ m^3/sec$

Considering peak factor of 2, the design discharge for sanitary sewers $= 0.194 \times 2$

$= 0.389\ m^3/sec$

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 = $(0.90 \times 45 + 0.80 \times 45) / 90 = 0.85$

Discharge $= 0.85 \times 30 \times 90 / 360 = 6.375\ m^3/sec$

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 = $11 - 6.375 = 4.625\ m^3/sec$