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Subject: Environmental Engineering (CE-602)

Unit:IV

Topic: Sewerage Scheme

Quantity of sewage

example (2) If the density of population is 300 persons/hectare and the rate of water supply is 250 litres/capita/day, Calculate the quantity of sanitary sewage for (a) separate system (b) For Partially separate system.

Soln: (a) Quantity of Sanitary sewage for separate system

$= \text{Quantity of water supplied}$

$= 200 \times 300 \times 250$ litres/day (Given Catchment area = 200 hectares)

$$= \frac{200 \times 300 \times 250}{24 \times 3600}$$

$= 173.5$ litres/sec.

Peak discharge for design purpose will be twice of this

$= 173.5 \times 2 = 347$ litres/sec.

(b) Quantity of Sanitary sewage for Partially separate system

$=$ Quantity for separate system + storm water drained from roof and Pavement

$$\text{storm water} = \frac{200}{360}(0.2 \times 0.9 + 0.15 \times 0.8) \times 40$$

$$= \frac{200 \times 0.3 \times 40}{360} = 6.67\ m^2/sec$$

$= 6.67 \times 10^3$ litres/sec

Quantity of Sanitary sewage for Partially Separate system

$= 6.67 \times 10^3 + 0.173 \times 10^3$

$= 6.84 \times 10^3$ litres/sec.

Example ③: using rational formula determine the run-off from an area of 3.5 hectares for a rainfall of 12 mm lasting for 20 minutes, assuming the time of concentration to be equal to the precipitation time. If the frequency of this rainfall is 1, then also determine the runoff at a frequency of 0.3 and time of concentration 15 minutes.

Soln: Area of the load where the runoff is to be determined

$$= 3.5 \times 10^4 \text{ sq.m}$$

The intensity of rainfall $\left(i = \frac{C.R.}{T}\right)$

$$i = \frac{12}{1000} \times \frac{1}{20} \times \frac{1}{60} \text{ metre/second}$$

$$i = \frac{1}{10^5} \text{ m/sec}$$

$$\therefore R = \frac{3.5 \times 10^4}{10^5} \text{ cu.m/sec}$$

$$= 0.35 \text{ cu.m/sec}$$

At frequency 0.3, value of constant $\left[C = \frac{24}{n^{0.35}(t+9)}\right]$

$$C = \frac{24}{0.35^{0.35}(15+9)}$$

$$= 1.45$$

intensity of rainfall $i = \frac{C.R.}{T} = \frac{1.45 \times 12}{20} = 0.87 \text{ mm/minute}$

$$\text{Runoff} = \frac{3.5 \times 10^4 \times 1.45 \times 12}{10^3 \times 20 \times 60}$$

$$= \underline{0.5075 \text{ cu.m/sec}}$$

Design of Sewers

EFFECT OF VARIATIONS OF DISCHARGE ON VELOCITY IN SEWERS.

- As stated earlier, the discharge in a sewer does not remain constant at all times. It varies from time to time. Due to the variation in discharge, the hydraulic mean depth (R) also varies. Since the velocity of flow is a function of $R^{2/3}$, the velocity of flow is also varies as the sewage discharge varies. This is more prominent in the case of a combined sewer or in a partially combined sewer.
- As the flow decreases in the sewer, the velocity of flow also decreases. When the sewer becomes less than half full, (assumed at one third the average flow), it is essential to check that the velocity of flow is at least equal to 40 cm/sec, at the same time, the designer should ensure that a velocity of about 90 cm/sec is developed atleast at the time of maximum flow. While deigning the sewers, the following points should be observed in connection with the self-cleansing velocity and no-scouring velocity.

1. Before the sewer design is done, the discharge is known. Hence the velocity of flow and gradient of the sewers are to be appropriately determined and correlated, to achieve the desired results.
2. For sewers in flat country, the design of sewers should be done in such a way that self-cleansing velocity is obtained at maximum discharge. However, the section of sewer should be such that even at minimum discharge, the velocity is at least equal to 40 cm/sec.
3. For sewers in roughs country, the design of sewers should be done in such a way that self-cleansing velocity is obtained at maximum discharge. If due to steep slopes, the velocity is exceeded during maximum discharge, drop man holes should be provided to bring down the velocity within the non-scouring value.
4. In the case of combined sewer, it may be difficult to achieve self-clearing velocity during minimum flow (D.W.F). In that case, special form of sewers should be adopted.

MAXIMUM AND MINIMUM VELOCITIES TO BE GENERATED IN SEWER.

It was pointed out in the earlier paragraphs that the flow velocity in the sewer should be such that neither the suspended materials in sewage get silted up nor gets the sewage pipe material scoured out. The first limitations, limits the minimum velocity; and the second limitation, limits the maximum velocity.

MINIMUM VELOCITY OF FLOW

- The sewage flowing through a sewer contains organic as well as inorganic solid matter which remains suspended as the sewage flow. In order to keep the solid matter in suspended form, a certain minimum velocity of flow is required; otherwise the solid particles will settle in the sewer, resulting in its clogging. Such a minimum velocity is known as self-cleansing velocity.

- A self-cleansing velocity may be defined as that velocity at which the soled particles will remain in suspension, without settling at the bottom of the sewer. Also it is that velocity at which even the scour of the deposited particles of a given size will take place. It is not possible to maintain thin self-cleansing velocity throughout the day because of fluctuations in sewage flow. During minimum flow of sewage, the velocity of flow is less than the self-cleansing velocity. Hence self-cleansing velocity should be maintained at least once in a day.

MAXIMUM VELOCITY OF FLOW

- Though the minimum velocity of flow of sewage should be equal to the self- cleansing velocity so that particles do not settle and stick to the invert, there is also some upper limit of velocity of flow so that the interior surface of the sewer is not damaged due to wear.

- At higher velocity, the flow becomes turbulent, resulting in continuous abrasion of the interior surface of the sewer, by the suspended particles. Hence maximum

  velocity of flow is also limited. The maximum velocity at which no such scouring action or abrasion taken place is known as no-scouring velocity.

- Evidently such a velocity depends upon the material used for the construction of sewers. Of the ceramic materials used in sewers, vitrified tiles and glazed bricks are more resistant to wear while building bricks and concrete are less resistant to wear.

  Also, abrasion is maximum at the bottom of the sewer because the grit, sand etc. are heavy and travel along the invert. Due to this reason, the bottom of large sewers of brick or concrete is protected by lining them with with vitrified tile, glazed bricks or granite blocks.