Stormwater Runoff & Design Flow of Storm sewer

- Sewer
- Storm Sewer

Generally there are two types for stormwater runoff

1. Hydrograph method
2. Rational method

Hydrograph Method

Hydrograph method for stormwater runoff is used for longer water sheds generally greater than $3km^2$.

Rational Method

Rational method for stormwater runoff is very handy method for the calculation of storm water in urban areas.

Rational formula

This basic formula for this approach is

$$Q = CiA$$

Where

Q = total amount of storm sewage (peak discharge)

i = rainfall intensity (mm/hr)

A = catchment area i.e. area of drainage for which the sewerage system is to be designed. Planimeter is mostly used for the determination of area

C = runoff co-efficient representing the combine effect of percolation and evaporation.

The value of C for various soils is given in tables. Value C is not constant but changes (increases) with increase in duration of rainfall as the infiltration decreases.

For impervious soil $C = t/(8+t)$

For pervious soil $C = 0.3t/(20+t)$

Where

t = duration of rainfall in minutes

for composite area, average value of C is

$$C = (C_1A_1 + C_2A_2 + \ldots\ldots\ldots\ldots\ldots C_nA_n)/\sum A$$

Where A_1,A_2…….An are the **catchment areas** with **runoff co-efficient** C_1,C_2……Cn respectively and

∑A is the total area

Intensity of Rainfall (*i*)

- Intensity of rainfall is defined as the amount of ppt per unit time expressed as depth of water per unit time (mm/hr, inch/hr).
- It has been observed that intensity of rainfall for a short period rain fall is greater than that of long duration rainfall. Maximum flows are produced by short duration rain.
- Curves and equation are available showing relation of duration and intensity of rainfall.

The equations for intensity of rainfall is

$$i = A/(t+B)$$

where

A and **B** are constants depending upon frequency of occurrence and area under consideration

Runoff according to the Kuitchling formula

$$i = 2667/(t+20)$$ (for storm once in 10 years)

$$i = 3048/(t+20)$$ (for storm once in 15 years)

Where **t** is in minutes and *i* is in mm/hr. The above formulas are derived for a specific area and specific frequency of rainfall. Actually the values of A and B are different for different areas and intensity of rainfall.

Time of Concentration

Time of concentration is the time required for maximum runoff rate to develop at a point in sewerage line. It is the time required for storm water to run from the farthest point of the area to reach the point for which the maximum runoff is to be estimated.

Time of cone = time of inlet + time of flow

Time of Inlet

Time of inlet is the time required for water to flow over the surface of the ground to the sewer inlet. It depends upon the size, shape and slope of area. Its value is generally 3-20 minutes.

Time of Flow

It is the time taken by storm water to flow from one inlet to the other. It depends upon the length, size, slope and smoothness of sewer and is found as

$$t = L/V$$

Where

t = time of flow

L = Length of sewer (pipe)

V = Velocity of flow

The importance lies in the fact that out of all storms of equal frequency of occurrence the storm, which has duration equal to the time of concentration produces maximum flow in sewers. Duration less than concentration time produces less then maximum discharge.

Design of Storm Sewer on basis of Design flow

1. Computer the intensity of rainfall and runoff coefficient (C)
2. Calculate the design flow using rational formula $Q = CiA$
3. Design the sewer with self cleansing velocity of 1 m/sec