9th Dec,
WEDNESDAY

08. MAXIMUM FLOOD ESTIMATION

Flood is a usual stage (depth of flow) in a river, water accumulate to such a level that it overtop the banks and inundate (submerge) large area and cause loss of life and economic loss.

- Floods occur due to :
  (i) Heavy rainfall in a catchment.
  (ii) Sudden melting
  (iii) Obstruction to the flow.

- Floods are estimated and data is used :
  (i) in the design of hydraulic structures
  (ii) in the design of 'levee' (flood protection wall)
  (iii) flood management

→ Methods to estimate flood Discharge:

1. Using past flood marks.

Wetted area, wetted perimeter, hydraulic mean radius 'R' are calculated and $Q = A \cdot V$.

2. Using emperical formula.

(i) Dicken's formula (North Indian Catchment)

$$Q = C_D A^{3/4}$$

(ii) Ryve's formula (South Indian Catchment)

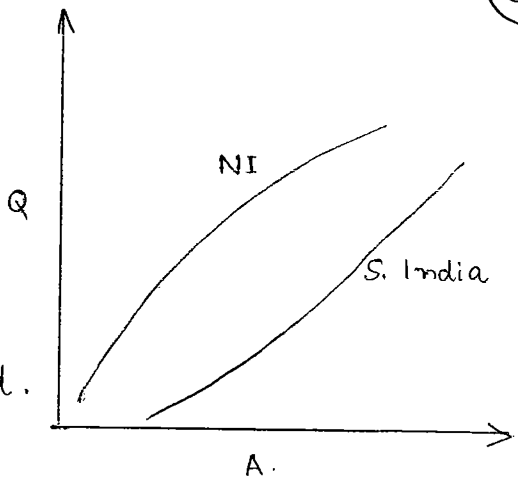
$$Q = C_R A^{2/3}$$

(iii) Inglis Formula

$$Q = \frac{124 A}{\sqrt{A + 10.4}}$$

3. Flood envelope curves

Q vs A plots are made for different parts of India by Central Water Commission (CWC). Knowing the area of catchment (A), max. flood discharge can be calculated (Q).



4. Unit Hydrograph method.

UHG ⟶ DRH ⟶ FHG.

For short term flood forecasting, this method is used.

5. Flood Frequency Analysis.

Probable max. flood, PMF = X_T

$$X_T = \bar{X} + K\sigma$$

This method is used for long range (term) flood forecasting.

$\bar{X}$ → mean of flood data.

σ → standard deviation of flood data.

k → frequency factor.

$$k = \frac{y_t - y'}{s'}$$

y' & s' depends on sample size 'N', they are obtained from Gumbell's tables.

$$K = \frac{y_t - 0.577}{1.2825} \quad \text{(when sample size, } N = \infty)$$

$$y_t = -\ln(-\ln(1-p)) \; ; \text{ where } P = \frac{1}{T}$$

6. Rational Formula.

- It is an emporical formula but universal.
- best suitable for urban catchments whose catchment area < 5000 ha (50 km²).

$$\text{Max. flood discharge, } Q_{max} = \frac{AIR}{360}$$

where A → area of catchment (ha)

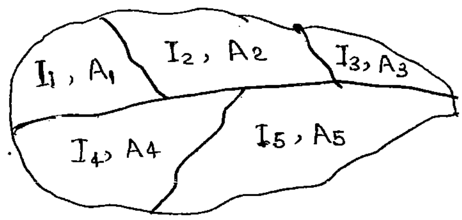
I → impermeability factor (or) runoff factor $\left(= \frac{\text{Runoff}}{\text{Rainfall}}\right)$

R → rainfall intensity (mm/hr) $\left\{= \frac{\text{depth of rainfall}}{\text{duration of rainfall}}\right\}$

$$R = \frac{P}{t}$$

when duration of rainfall, 't', is not given, it is taken as time of concentration, 't_c'

$$I = \frac{\Sigma A_i I_i}{A}$$



NOTE :

- Rational formula is applicable only for such storms whose duration is $\geq t_c$. ie minimum time storm has to occur to produce max discharge is time of concentration, t_c.

$$Q \propto A, \quad Q \propto R, \quad Q \propto \frac{1}{t}$$

$$R \propto \frac{1}{t}$$

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01 Run off coeffecient, I = 0.4   P = 45 mm/hr.

Area of catchment, A = 90 ha.

$$Q_{max} = \frac{AIR}{360} = \frac{90 * 0.4 \times 45}{360} = \underline{4.5 \text{ m}^3/\text{s}}$$

02 $Q_{max} = \frac{AIR}{360} = \frac{60 \times 0.4 \times 30}{360} = \underline{2\ m^3/s}$

03. $A_1 = 30\%\ A$, $A_2 = 70\%\ A$.

$I_1 = 0.4$ $I_2 = 0.6$.

$$I = \frac{\Sigma A_i I_i}{A} = 0.4 \times 0.3 + 0.6 \times 0.7 = \underline{0.54}$$

04 $A = 1.5\ km^2 = 150\ ha$ $\{1\ km^2 = 100\ ha\}$

$I = 0.42$, $t_c = 28$ min.

$P = 48$ mm.

$$R = \frac{48\ mm}{28/60} = 102.86$$ (duration of rainfall t not given ⇒ $t = t_c$).

$$Q_{max} = \frac{150 \times 0.42 \times 102.86}{360} = \underline{18\ m^3/s}$$

05. Equivalent runoff coeffecient $= \frac{10 \times 0.7 + 20 \times 0.1 + 50 \times 0.3 + 20 \times 0.8}{10 + 20 + 50 + 20}$

$= \underline{0.4}$

06. $I = 0.3$, $A = 0.85\ km^2 = 85\ ha$. {Entire catchment starts contributing when $t \geq t_c$}

$t_c = 30$ min., $P = 50$ mm

$$R = \frac{50}{30/60} = 100\ mm/hr.$$

$$Q_{max} = \frac{85 \times 0.3 \times 100}{360} = \underline{7.0833}\ m^3/s$$

08. $Q_{max} = \frac{150 \times 0.4 \times 100/10}{360} = 1.667\ m^3/s$

$= \underline{100}\ m^3/min$