Design of a Barrage :-

Q1 Following particulars were recorded from a Barrage :-

(i) Max. Reservioun level = 212 m
(ii) Pond level = 211 m
(iii) D/S HFL = 210 m
(iv) Max. Design flood discharge = 3500 m^3/s
(v) Crest level of Barrage = 207 m
(vi) Crest level of H.Regulator = 208 m
(vii) Coff. of Discharge = 2.1 For Barrage
(viii) Coff. of Discharge = 1.5 for H. Regulator
(ix) River Bed level = 205 m
(x) Design discharge of main Canal = 500 m^3/s

Determine the No: of gates for a Barrage and the head Regulator if each gate has 10 m clear span.

If the stilling Basin is provided downstream of the Barrage for energy dissipation, find the Length and R.L of Basin floor.

Assume that length of Basin is 5 times the Conjugate depth required for hydraulic jump.

Sol. (I) Design of water way for Barrage during flood :-

High Flood Discharge = 3500 m^3/s

HFL = 212 m (Given)

Crest level of Barrage = 207 m

∴ Head Causing flow = 212 - 207

= 5m

Coff. of Discharge for Barrage = 2.1 = C

Hence, Length of waterway (L) :-

$Q = C L_e H_e^{3/2}$

$\therefore L = L_e = \frac{Q}{C H^{3/2}} = \frac{3500}{(2.1)(5)^{3/2}}$

$L = 149.07\ m = 150\ m$

Length = 150 m

Provide 15 bays each of 10 m span

Hence, no. of gates for Barrage = (15)

(II) Design of waterway for Canal Head Regulator :-

Design Discharge of Canal = 500 m^3/s

Pond level = 211 m

Crest level of H. Regulator = 208 m

∴ Head Causing flow = 211 - 208

= 3m

Coff. of Discharge = C = 1.5

(for H. Regulator)

Hence, Length of waterway :-

$$Q = C L_e H_e^{3/2}$$

$$L = L_e = \frac{Q}{C H^{3/2}} = \frac{500}{1.5 (3)^{3/2}}$$

$$L = 64.2 \text{ m}$$

Provide length = 70 m

∴ 7 bays of 10m span each.

∴ No: of gates for Head regulator = (7)

(III) Design of Stilling Basin :- [D/S of Barrage]

U/S TEL ≈ U/S HFL = 212 m
(neglecting vel. of approach)

D/S TEL ≈ D/S HFL = 210 m
(neglecting vel. of flow)

H_L = 212 - 210
= 2 m (Head loss)

Linear Discharge = $q = \frac{Q}{L} = \frac{3500}{150}$

$= 23.33 \text{ m}^3/\text{s}$

We have to compute value of E_{f_2}
For $H_L = 2$m, $q = 23.33$ cumec

Analytically,

$$Y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(23.33)^2}{9.81}\right)^{1/3}$$

$[Y_c = 3.81m]$

$Y = \frac{Y_2}{Y_c}$, $Z = \frac{H_L}{Y_c} = \frac{2}{3.81} = 0.5249$

Since $Z<1$, value of Y will be :-

$Y = 1 + 0.93556(Z)^{0.368}$

$= 1 + 0.93556\ (0.5249)^{0.368}$

$= 1.738$

$\therefore Y_2 = Y \cdot Y_c$

$= (1.738)(3.81)$

$[Y_2 = 6.62m]$

HTQ, Length of system $= 5\,Y_2$

$= 5\ (6.62)$

$= \boxed{33.1m}$

And, $\frac{E_{f2}}{Y_c} = Y + \frac{1}{2Y^2}$

$= 1.738 + \frac{1}{2(1.738)^2}$

$E_{f2} = 1.9035\,Y_c$

$= 1.9035\ (3.81)$

$= 7.25m$ ✓

R.L of Basin = d/s T.E.L − E_{f2}

$= 210 - 7.25$

$= 202.75m$ ✓

Barrage :-

The function of Barrage is similar to that of weir., but the heading up of water is effected by gates alone. No solid obstruction is put across the River. The crest level of barrage is at low level.

During the floods, gates are Raised to clear off the high flood level, enabling the high flood to pass downstream with minimum afflux.

When the flood recedes, the gates are lowered and the flow is obstructed.

Barrages are much costlier than weirs.