Irrigation Engg. - II

[SEC → C]

[Sarda type fall] (Num.)

Q1 Design a 1.5 m Sarda type fall for a Canal having a Discharge of 12 Cumecs.

Given → Bed level U/S = 103 m
Side slopes of channel = 1:1 m
Bed level D/S = 101.5 m
Bed width (U/S & D/S) = 10 m
FSL upstream = 104.5 m
where U/S ⇒ Upstream and C = 8
D/S ⇒ Downstream
FSL ⇒ Full supply level

Sol. ① [Length of crest] :-

Length of crest is same as the Bed width = 10 m

② [Crest level] :-

$Q = 1.7 L H^{3/2}$ (Broad Crest)
$Q = 1.84 L H^{3/2}$ (Narrow Crest)

Main formula :-

$$Q = C_d \sqrt{2g} \cdot L \cdot H^{3/2} \left(\frac{H}{B_t}\right)^{1/6}$$

Here, $Q = 12\ m^3/s$

C_d = Coff. of Discharge

= 0.415 (Rectangular crest)

= 0.45 (Trapezodial crest)

If $Q < 14$ → Rectangular crest

$Q \geq 14$ → Trapezodial crest

Here $Q = 12$ i.e < 14, Rect. crest and $C_d = 0.415$

$g = 9.81$

$L = 10\ m$

$H = ?$

B_t = Top width of crest

and, $B_t = 0.55 \sqrt{d}$ (Rectangular)

$B_t = 0.55 \sqrt{H+d}$ (Trapezodial)

Always Assume $B_t = 0.8\ m$ [Rectangular]

$B_t = 1.0\ m$ [Trapezodial]

$$\therefore Q = C_d \sqrt{2g} \cdot L \cdot H^{3/2} \left(\frac{H}{B_t}\right)^{1/6}$$

$$12 = 0.415 \sqrt{2 \times 9.81} \times 10 \times H^{3/2} \times \left(\frac{H}{0.8}\right)^{1/6}$$

$$\therefore H^{5/3} = 0.628$$

$$\therefore [H = 0.755\ m]$$

Take $\boxed{H = 0.76\,m}$

Velocity of approach = $\frac{\text{Discharge}}{\text{Area}}$ $\left(\frac{Q}{A}\right)$

$Q = 12$, $A = (b + d)\cdot d$

$b = 10\,m$

Take $d = 1.5\,m$ [Rectangular]

$d = 1.8\,m$ [Trapezoidal]

$V = \frac{12}{(10 + 1.5)\,1.5} = 0.696\,m/s$

Velocity head = $\frac{V^2}{2g} = \frac{(0.696)^2}{2(9.81)} = 0.025\,m$

[U/S TEL = U/S FSL + vel. Head]

$= 104.5 + 0.025$

$= 104.525\,m$

R.L of crest = U/S TEL − H

(Crest level) $= 104.525 - 0.76$

$= [103.77\,m]$

Use crest level of 103.77 m

and Height of crest ⇒ crest level − Bed level d/s above D/s floor

$= 103.77 - 103$

$= 0.77\,m$

③ [Shape of crest] :-

Here, shape of the crest is "Rectangular" as $Q < 14\ m^3/s$.

Bt (Top width of crest)

$$B_t = 0.55\sqrt{d}$$

d = height of crest above d/s Bed

[d = R.L of crest − Bed level d/s]

$d = 103.77 - 101.5$

$(d = 2.27\ m)$

$$B_t = 0.55\sqrt{2.27}$$

$$= [0.825\ m]$$

$$\text{Min. thickness of Base width} = \frac{h+d}{G}$$

Here, $h = H - \text{vel. head}$

$= 0.755 - 0.025$

$= 0.73\ m$

and, $G = 2$ (for Masonry)

$$\text{Thickness} = \frac{0.73 + 2.27}{2}$$

$$= 1.5\ m$$

Provide C:C, 1:2:4

(4) [Cistern Element] :-

We have to Design the Length & Depth of Cistern element.

Length, $L_c = 5\sqrt{H \cdot H_L}$

Here, $H = 0.76\,m$

H_L = 1.5m always for both Rectangular & Trapezoidal crest

$$L_c = 5\sqrt{0.76 \times 1.5}$$

$$= \boxed{5.5\,m}$$

Depth, $X = \frac{1}{4}(H \cdot H_L)^{2/3}$

$$X = \frac{1}{4}(0.76 \times 1.5)^{2/3}$$

$$= 0.273\,m$$

$$X \simeq \boxed{0.3m}$$

R.L of Cistern = D/s of Bed - X

= 101.5 - 0.3

= 101.2m

(5) [Design of Impervious floor] :-

Seepage head : $H_s = d = 2.27\ m$

Bligh's coff. = 8 (C)

Length of impervious floor on creep length $= C \times H_s$

$= 8 \times 2.27$

$= 18.16\ m$

Fixed
- Provide u/s cutoff = $d_1 = 1.0\ m$
- Provide D/s cutoff = $d_2 = 1.6\ m$
- The vertical length of creep = $2(d_1 + d_2)$

$= 2(1 + 1.6)$

$= 5.2\ m$

Length of Horizontal impervious floor

$= 18.16 - 5.2$

$= 12.96\ m$

Provide 13 m length of impervious floor.

Fixed
- Min. Length of impervious floor $= l_d = 2(D + 1.2) + H_L$
- $D = 1.5\ m$ for Rectangular
- $D = 1.8\ m$ for Trapezodial
- $H_L = 1.5\ m$ for Both.

$l_d = 2(1.5 + 1.2) + 1.5$

$[l_d = 6.9\ m]$

Take it as 7m

∴ Balance of length = 13 − 7
= 6m is to be provided under and u/s of the crest.

(6) [Upstream & Downstream Curtain wall] :-

Max. depth of u/s curtain wall = $\frac{Y_u}{3}$

= $\frac{1.5}{3}$ = 0.5m

Max. depth of d/s curtain wall = $\frac{Y_u}{2}$

= $\frac{1.5}{2}$ = 0.75m

Y_u = water Depth = 1.5 m

Side Protection → side pitching, consisting of one brick on edge, is provided after the warped Rings. The side pitching may be curtailed at any angle of 45° from the end pitching in plan.
Slope of side pitching → 1:1 to 1½:1

(Diagram from Book) ←

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