Example

Design an Ogee spillway with following data.

Height of spillway crest above river bed = 100m
Design Discharge / Design Flood = 12,000 m^3/s
Number of spans = 6
Clear distance btn piers = 15m
Thickness of square nosed piers = 3m
Abutments are square nosed
Slope of d/s face of the overflow section = 0.8H:1V
U/s face is vertical
Discharge coefficient C = 2.2

Solution

- In order to design the profile of the Ogee crest, the head over the crest need to be known
- Determine Hd

L' = net length of crest = 15 × 6 = 90m

Assume first $L = L'$

$$Q = CLH_e^{3/2} \rightarrow H_e = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{12000}{2.2 \times 90}\right)^{2/3} = 15.143m$$

Check L

For square nosed pier $K_p = 0.02$
For square nosed abutment $K_a = 0.2$

$$\therefore L = L' - 2(NK_p + K_a)H_e$$
$$= 90 - 2(5 \times 0.02 + 0.2) \times 15.143 = 80.74m$$

Recalculate He

$$H_e = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{12,000}{2.2 \times 80.7}\right)^{2/3} = 16.59m$$

Check L

$$L = 90 - 2(5 \times 0.02 + 0.2) \times 16.59 = 80.05m$$

Recalculate He

$$H_e = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{12,000}{2.2 \times 80.05}\right) = 16.6m$$

Further calculation leads to the convergence of He to He = 16.7m ∴ The total head on crest He = 16.7m

Recall

$H_e = H_d + H_a$ where H_a - head due to approach velocity

calculate velocity of approach

$V = \frac{Q}{A}$; A = Area of flow Ubs of the spillway

$= (16 \times 5 + 5 \times 3) \times 1.67 =$

$= \frac{12000}{} = 0.98$ m/s

$H_a = \frac{V^2}{2g} = \frac{0.98^2}{2 \times 9.81} = 0.05$m which is very small & thus can be neglected

∴ $H_d = H_e - H_a = H_d = 16.7$m

B) Ogee Crest Downstream Profile

$X^n = K H_d^{n-1} y$

For a spillway with vertical Ubs face

$K = 2.0$ & $n = 1.85$

$X^{1.85} = 2.167^{0.85} \wedge y$

$\boxed{y = 0.0457 X^{1.85}}$

To determine the location where the dbs profile meets the straight slope tangentially,

tangent to the equation at that point = slope of the dbs face

$\frac{dy}{dx} = 1.85 \times 0.0457 X^{0.85} = \frac{1}{0.8} = 1.25$

$X = 23.8$m

The coordinates of the surface of the Ogee crest is

X	0.0	1	3	5	7	10	13	16	19	23.8
Y	0	0.05	0.35	0.9	1.67	3.24	5.26	7.72	10.61	16.09

Uls Profile

For vertical Uls face, from the table

$\frac{a}{H_d} = 0.175$ $\quad a = 2.92$ m

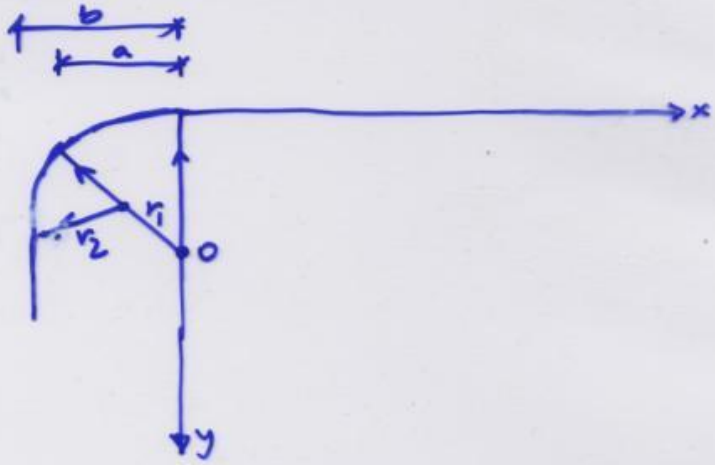
$\frac{b}{H_d} = 0.282$ $\quad b = 4.71$ m

$\frac{r_1}{H_d} = 0.5$ $\quad r_1 = 8.35$ m

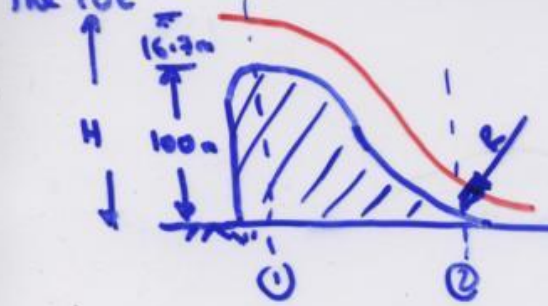
$\frac{r_2}{H_a} = 0.2$ $\quad r_2 = 3.34$ m

1) Locate O & draw arc 1 with r_1

2) locate C on the radius



The Toe



$\frac{V_1^2}{2g} + \frac{P_1}{\rho g} + z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\rho g} + z_2 + h_l$

$H = \frac{V_2^2}{2g} + y_2 + h_l$

$H = \frac{Q^2}{2gB^2y_2^2} + y_2 + (H - y_2) \cdot 0.1$

Assume rectangular x-sec

$H = \frac{Q^2}{2gB^2y_2^2} + y_2 + (H - y_2) - 0.1$

$Q = 12{,}000$ $\quad B = 15 \times 6 + 5 \times 3 = 105$ m

Trial & Error

H	y_2	B	Q	h_l	RHS	y	a	R
116.7	2.55	105	12,000	11.42	116.3	44.9	1.96	$10^5 = 92.5$