Examples on Spillways:

1) The crest of dam spillway has been kept at 723.70m while the maximum level in the reservoir is to be 734.50m. Calculate the maximum discharge through the overflow spillway when the flow takes place through 5 units of 12.2m widths each of the crest of the spillway.

Solutions:

Assume pointed nose piers and rounded abutments

Effective length of spillway crest:

Le= L-2 (Nkp+Ka) He

L = 5*12.2 = 61m

Max. flood rise over the crest, H = 734.5-723.70

= 10.8m

Neglecting velocity of approach and taking C = 2.2

Le = 61.2 4*0+0 10.8 = 61m

Q = CLe $H^{3/2}$

2.2*61*$10.8^{3/2}$ = 4763 m^3/s

If square nosed piers and square abutments are assumed:

Le = 61-2(4*0.02+0.2) 10.8 = 54.952m

Q = 2.2*54.952*$10.8^{3/2}$ = **$4291 m^3/s$**

2) Compute the discharge over an ogee shaped spillway whose coefficient of discharge is 2.2 at a head of 6m on the crest. The flow takes place through 4 units of 12.5m width each at the crest of the spillway. The spillway crest is 10m above the bottom of the approach channel which has the same width that of the spillway, (Take Ka = 0.10 and K_p = 0.015).

Solution:

L= 12.5*4=50m

Le=L-2 (NKp+ka)He

He= H_d+H_a

Ha ≈ Hd

As a first trial, neglect velocity of approach:

Le= 50-2(3*0.015+0.10)*6=48.26m

Q=2.2*48.26*$6^{3/2}$=1560.4m^3/s

Calculate V_a (velocity of approach)

$$Va = \frac{Q}{A} = \frac{Q}{L(p + Hd)} = \frac{1560.4}{50(10+6)} = 1.95m/s$$

$$Ha = \frac{va^2}{2g} = \frac{1.95^2}{19.62} = 0.194m$$

$$He = Hd + Ha = 6 + \frac{1.95^2}{19.62} = 6.194 \approx 6.2m$$

$$\rightarrow \quad Q = 2.2 * 48.26 * 6.2^{3/2} = 1639m^3/s$$

$$Va = \frac{Q}{A} = \frac{1639}{50(16)} = 2.05m/s \rightarrow He = 6.21m.$$

$$\rightarrow Q = 1643m^3/s \rightarrow Va = 2.05m/s \Rightarrow He = 6.21m$$

$$\therefore Q = 1643m^3/s \text{ and } He = 6.21m$$

3) Design a suitable section for the overflow portion of a concrete gravity dam having the d/s face sloping at 0.7H:1V. The design discharge for the spillway is $8000m^3/s$. The height of the spillway crest is kept at 204m. The average riverbed level at the site is 100.00m. The spillway crest length consists of 6 spans having a clear width of 10m each. Thickness of each pier may be taken as 2.5m.

Solution:

The given spillway looks like high weir. Assume C = 2.2

Le=L = net length of crest → first approximation = 6*10 = 60m

$Q = CLeHe^{3/2}$

$8000 = 2.2*60*He^{3/2}$

$\Rightarrow$ He = 15.5m $\approx H_d$ (neglecting H_d)

Height of spillway crest a bone river bed:

P = 204-100 =1 04m

$$\frac{p}{H_d} = \frac{104}{15.5} = 6.71 > 1.33 \rightarrow High spillway$$

$\therefore$ Effect of velocity of approach is negligible.

Also $$\frac{Hd + d}{He} = \frac{He + p}{He}$$

$$\frac{15.5 + 104}{15.5} = 7.71 > 1.7$$

$\therefore$ The discharge coefficient is not affected by tail water conditions and hence the spillway remains as high spillway $\Rightarrow$ effect of velocity of approach is negligible

Effective crest length of spillway, Le:

By assuming, rounded-nose piers, $K_p = 0.01$

Round abutments, Ka = 0.1

N = 6-1 = 5

Assume that the actual value of H_e is slightly more than the approximate value worked out, Let it be 16.30m

Le= L-2 (Nkp+Ka)He = 60-2 (5*0.01+0.1) 16.3 = 55.11m

$\Rightarrow$ Q= 2.2*55.11*$He^{3/2}$ **($Q=8000m^3/s$)**

$\Rightarrow$He= 16.4 m ≈ **16.3m**

Hence, assumed value of He is all right. Thus, the crest profile will be designed for **H_d ≈ He = 16.4m**

(As velocity of approach is negligible)

Check

$$V_a = \frac{Q}{A} = \frac{8000}{[60+5*2.5][104+16.4} = 0.916 m/s$$

$$Ha = \frac{Va^2}{2g} = \frac{(0.916)^2}{2*9.81} = 0.043m$$

$\therefore$ This is very small and could be neglected.

For D/S profile:

D/s profile of the ogee crest for **WES standard** for a vertical water surface is given by:

$X^{1.85}=2Hd^{0.85}y$

$$\Rightarrow Y = \frac{X^{1.85}}{2Hd^{0.85}} = \frac{X^{1.85}}{2*(16.4)^{0.85}}$$

$$\Rightarrow Y = \frac{X^{1.85}}{21.6}$$

Point of Tangency (PT) is determined as follows:

D/s slope of the dam is 0.7H:1V

$$\therefore \frac{dy}{dx} = \tan\theta = \frac{1}{0.7}$$

Differentiating the equation of the d/s profile with respect to x:

$$\frac{dy}{dx} = \frac{1.85X^{0.85}}{21.6} = \frac{1}{0.7}$$

$$\Rightarrow X^{0.85} = 16.8$$

$$\Rightarrow X = 27.4m$$

$$Y = \frac{X^{1.85}}{21.6} = \frac{(27.4)^{1.85}}{21.6}$$

$$= 21.6$$

Co-ordinates of point of tangency (PT) is given by ***(27.4, 21.2)***

The coordinates of the d/s spillway profile from x = 0, to x = 27.4m will be worked out as follows.

X(m)	Y= $\frac{X^{1.85}}{21.6}$
0	0.00
1	0.046
2	0.166
3	0.353
:	:
:	:
(PT)27.4	**21.2**

∴From this d/s profile can be sketched

For U/S profile:

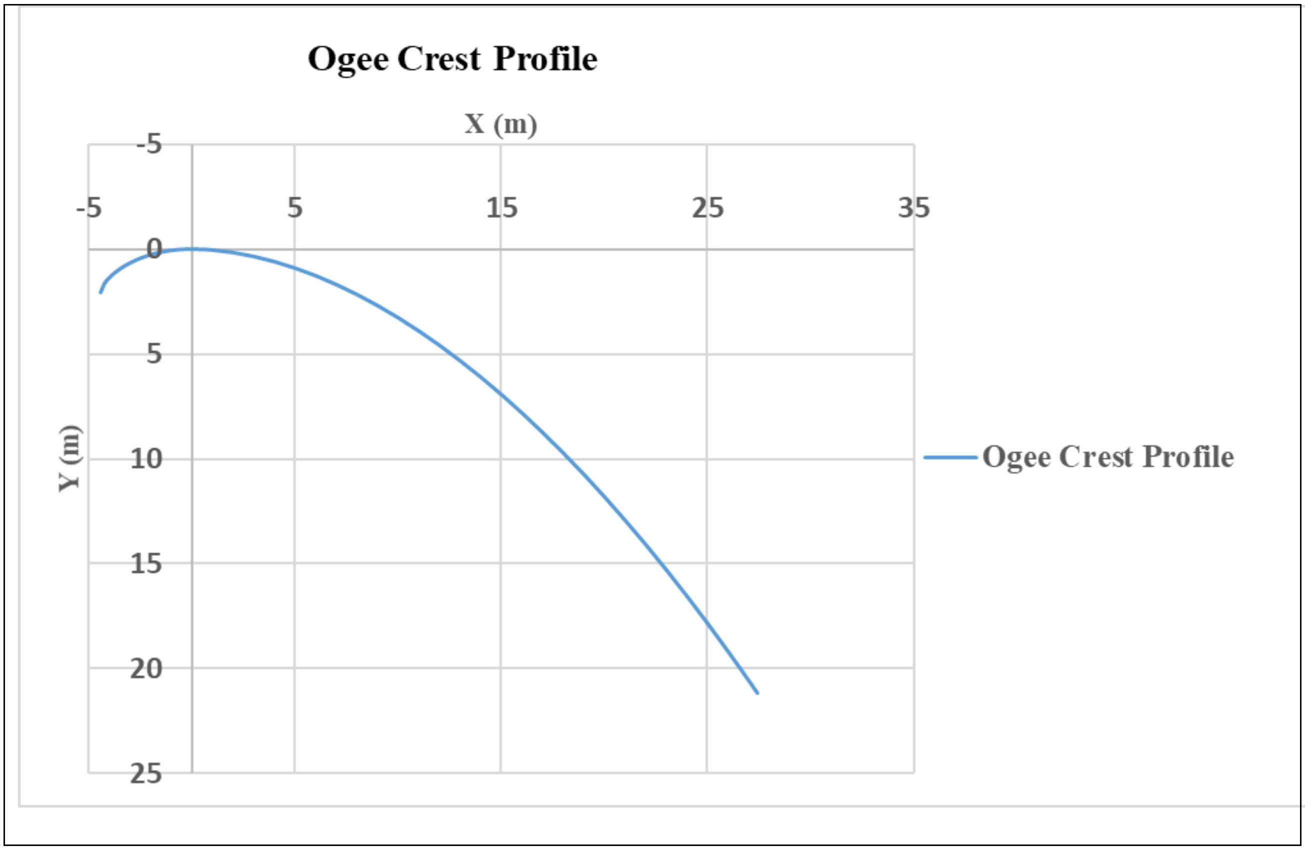
R_1= 0.2H_d = 3.28 m
R_2 = 0.5H_d = 8.20 m
a = 0.175H_a = 2.82 m
b = 0.282H_d = 4.625 m

y = {0.724 (x+ 0.270 Hd)1.85/(Hd)0.85 }+ 0.126 Hd - 0.4315(Hd)0.375(x + 0.270 Hd)0.625

This curve should go to x=-0.27Hd,
For Y=H_d =16.4, x=-0.27Hd= **-4.428**

X(m)	Y(m)
-0.1	-0.0014631
-0.15	-0.0006692
-0.2	0.0004349
:	:
:	:
:	:
-4.428	**2.0664000**

∴This values are used and u/s profile can be sketched.



<u>Figure</u>: The Profile of the Required Ogee Crest Spillway