Name of the Regulator :- Chumrikhali
(2V- 1.5 * 1.8m)

Purpose :- Drainage Cum Flushing

Avg. Ground level :- 2.00m PWD (6.56 ft PWD)

Highest W.L :- 3.5m PWD (11.8 ft PWD)

Lowest W.L :- (-) 1.7m PWD
(-) 4.92 ft PWD

Invert = - 1.6m
- PWD

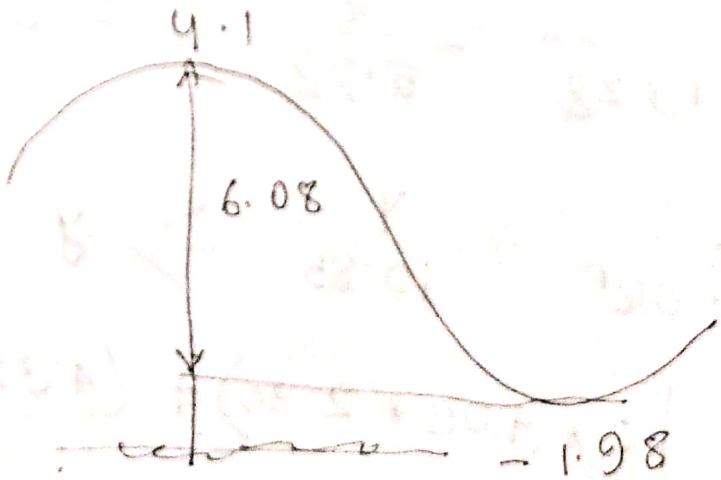
Crest Level of embankment :- 5.0m PWD (16.4 ft PWD)

Top width of embankment 6.0m (19.28 ft)

C/s slope :- 1:2

R/s " :- 1:3

Invert level :- ~~(-) 1.3m PWD~~ (-) 1.00m PWD
(-) 3.28 ft PWD



Catchment Area = 1000 Ha

Hydrologic Design :-

Highest W.L at C/S = Avg. Gr. Level + 1'

= 2·3m PWD

~~$H_w = 3·28 + 11·8 = 15·08$~~

$H_w = 3·28 + 7·56 = 10·85'$

$\frac{H_w}{D} = \frac{10·85}{6} = 1·81$

From figure 5, $\frac{Q}{B} = 80$ cfs / vent

$Q = 80 \times 5 = 400$ cfs/vent

$D_c = 0·315 \left(\frac{Q}{B}\right)^{2/3} = 0·315 \left(\frac{400}{5}\right)^{2/3} = 5·85$

$\frac{D_c + D}{2} = \frac{5·85 + 6}{2} = 5·92'$

$\frac{6}{11·8 + 3·28} = \frac{x}{5·92} = 2·36$ hrs

$\frac{6}{15·08'} = \frac{Y}{10·85} \Rightarrow y = 4·32'$

$V = \left[2 * (400 * 2·36) + (4·32 - 2·36) * 400\right] \times 3600$

$= 9619200$ cft for 12 hours

$= 222$ cfs/vent

Q No of vent = $\frac{Q_{required}}{222}$

$Q_{required} = C.I.A = 27 * 1.9 * 3.84$

$= 196$ cfs/~~vent~~

From given Area = 2100 Ha, (8.07 sq. miles)

$Q_{req} = 27 * 1.9 * 8.07 = 413$ cfs

No of vent = $\frac{413}{222} = 2$

From thumbrule 3~3.5 sq mile ⇒ 1 Vent,

So 2 vent is required.

Hydraulic Design :—

Q = 400 cfs/vent (This discharge is constant for 2.4 hours)

$q_c = \frac{400}{5} = 80$ cfs/ft

$d_c = \left(\frac{q^2}{g}\right)^{2/3} = \left(\frac{80^2}{32.2}\right)^{2/3} = 5.84'$

$V_c = \frac{q}{d_c} = \frac{80}{5.84} = 13.7$ fps

$B_c = 5' + (2 \times 6'') = 6'$

$B_1 = 5' + 2 \times 9' \tan 12^\circ = 9.83'$

$d_c + \frac{v_c^2}{2g} + z_c = d_1 + \frac{v_1^2}{2g}$

$\Rightarrow 1.5 d_c + 3'' = d_1 + \frac{v_1^2}{2g}$

At point (1) the discharge/ft width q_1 is given by

$q_1 = \frac{(80 \times 5)*}{9.83} =$

$B_c = (5' * 2) + (2 \times 6'') + 1' = 12'$

$B_1 = 12' + 2 * 9' \tan 12^\circ = 15.82'$

$d_c + \frac{v_c^2}{2g} + z_c = d_1 + \frac{v_1^2}{2g}$

$1.5 d_c + 3' = d_1 + \frac{v_1^2}{2g}$

At point (1) the discharge/ft width q_1 is given by $q_1 = \frac{80 \times 10}{15.82} = 50.5 c$

$$1.5 * 5.84 + 3' = d_1 + \frac{(50.56)^2}{d_1^2 \times 2g}$$

$$\Rightarrow 11.76' = d_1 + \frac{39.7}{d_1^2}$$

Solving this $d_1 = 2.07'$

$$V_1 = \frac{q_1}{d_1} = \frac{50.56}{2.07} = 25.15 \text{ ft/sec}$$

$$F_1 = \frac{V_1}{\sqrt{g d_1}} = \frac{25.15}{\sqrt{32.2 * 2.07}} = 3.08$$

Length of Jump

We know, $\frac{d_2}{d_1} = \frac{1}{2}\left[\sqrt{1+8F^2} - 1\right]$

$$\therefore \frac{d_2}{d_1} = \frac{1}{2}\left[\sqrt{1+8\times(3.08)^2} - 1\right]$$

$$= 3.88$$

$$d_2 = 2.07 \times 3.88 = 8.04 \text{ ft}$$

Length of Jump $= 6.9\,(8.04 - 2.07)$

$$= 41'$$

$B_2 = B_c + 2 \times 41 \tan 8°$

$= 6' + 2 \times 41 \tan 8° = 23.4'$

discharge/ft width at end

$q_2 = \frac{400 * 2}{23.4} = 34.13$ cfs/ft

$v_2 = \frac{34.13 \times 23.4}{23.4 * d_2} = \frac{34.13 \times 23.4}{23.14 * 8.92'}$

d_2 = Tail water depth $= 5.92' + 3' = 8.92'$

$= 3.82$ fps $= 1.16$ ms^{-1} (should be less than 1 ms^{-1})

Scour Depth with respect to hydraulic Jump

$R = 0.91 \left(\frac{q_2^2}{f}\right)^{1/3}$

$= 0.91 \left(\frac{34.13^2}{1.76}\right)^{1/3}$

$= 7.93'$

U/S scour Depth $= 1.25 R = 10'$

D/S " " $= 12'$

U/S Scour level = U/S W.L − 10'

= 6.56 − 10 = −3.44 ft PWD

D/S scour level = D/S W.L − 12'

= 2.64' − 12' = −9.36 ft PWD

U/S cut off required = −3.28 − (−3.44)

= 0.16'

D/S " = −6.28 − (−9.36)

= −3.08' (say 3')

Floor length and cut off by exit Gradiant

H.W.L (R/S) : 11.8ft PWD

Retention level (C/S) = 7.56 ft PWD

H = 11.8 − 7.56 = 4.24'

$$G_E = \frac{H}{d} \times \frac{1}{\pi\sqrt{\alpha}}$$

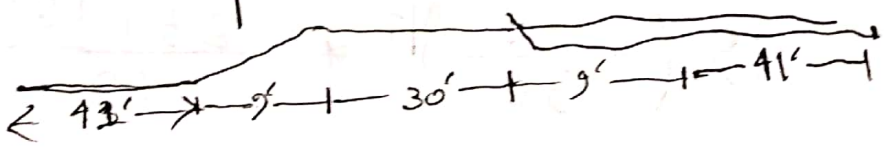
$$\frac{1}{7} = \frac{H}{d} \times \frac{1}{\pi\sqrt{\alpha}}$$

$$\sqrt{\alpha} = \frac{7 \times 4}{d \times \sqrt{\alpha}}$$

$$d = \frac{2 * H^2}{(GE)^2 \times (\pi)^2 * b^2}$$

$$= \frac{2 * (4)^2}{\left(\frac{1}{7}\right)^2 \times (3.1416)^2 * (130)^2}$$

d = 0.05'

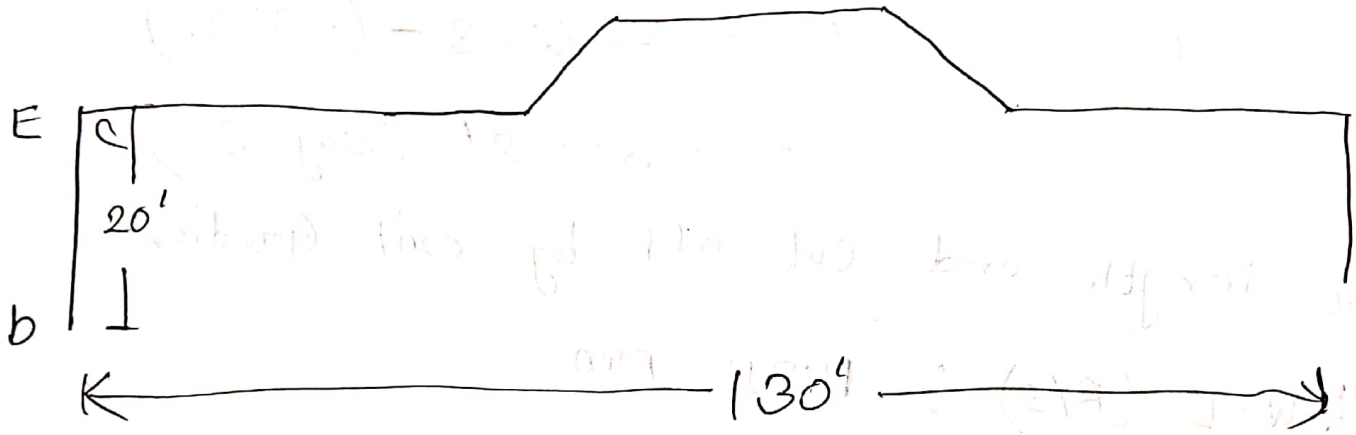


Floor Thickness

Floor length $b = 130'$

R/s depth of cutoff $d = 20'$

C/s " " " $d = 20'$



$$\frac{1}{\alpha} = \frac{d}{b} = \frac{20}{130} = 0.15$$

$P_0 = 25\%$ $P_{01} = 100 - 25 = 75$

$P_E = 38\%$ $P_{c_1} = 100 - 38 = 72\%$

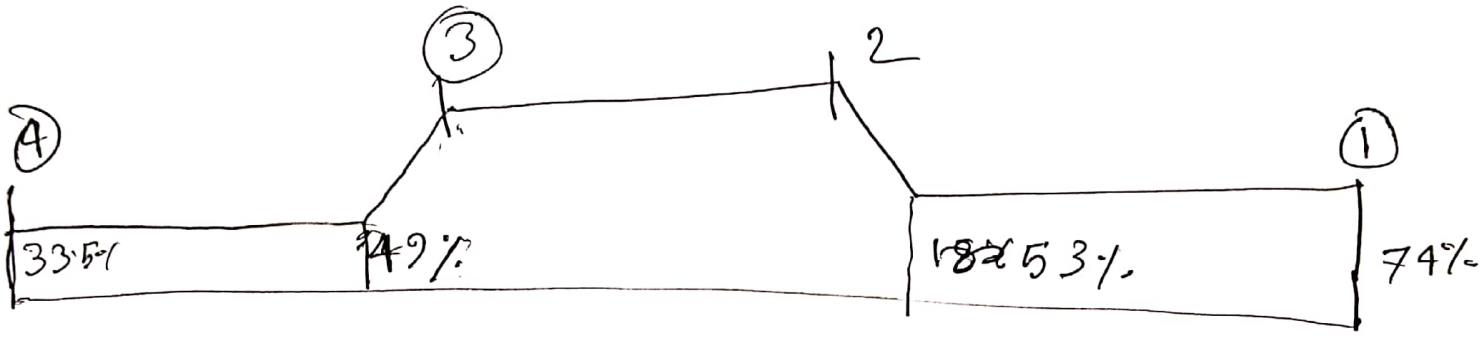
$$C = 19 \left(\frac{D}{b}\right)^{1/2} * \frac{d+D}{b}$$

$$= 19 \left(\frac{18.5}{130}\right)^{1/2} * \frac{18.5+18.5}{130} = 2\%$$

C_F = ~~1~~ 2·5%

P_{C1} = 72% + 2% = 74%

PE P_E = 38 − 2·5 − 2 = 33·5%.



$P_1 = \frac{74}{100} \times 6 = 4·44'$

$P_3 = \frac{49}{100} \times 6 = 2·94'$

$P_2 = \frac{53\%}{100} \times 6 = 3'18'$

$P_4 = \frac{33·5}{100} \times 6 = 2·01'$

At point (3) $t_3 = \frac{2·94}{1·4} = 2·1'$

" " (4) $t_4 = \frac{2·01}{1·4} = 1·43'$

Floor length = 14.0m

$F_n = 3.31$

$B_2 = 9.100$