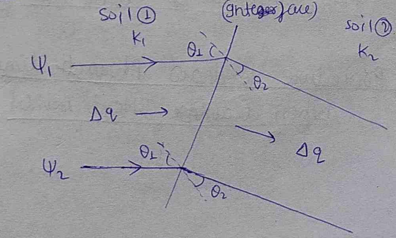
lecture
11/11/19

Note : Flow through non- homogeneous medium.

1) When medium pass from one medium to another medium then flow lines get deflected ~~and~~ at interface such that

(normal to interface)

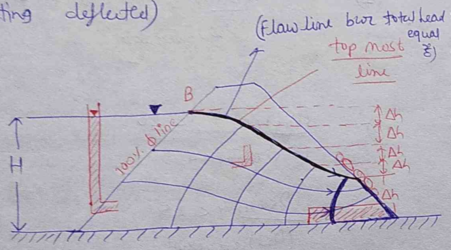


$$\boxed{\frac{K_1}{K_2} = \frac{\tan\theta_1}{\tan\theta_2}}$$ ★☆

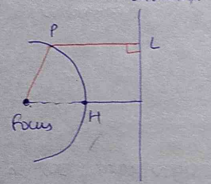
$K_2 > K_1$ $(\theta_2 > \theta_1)$
(away)

$K_2 < K_1$ $(\theta_2 < \theta_1)$
toward

θ_1 and θ_2 (angle made by flow lines with the normal to interface before and after getting deflected)



Phreatic line



PF = PL

(Properties of Parabola)

① Phreatic line is the top most flow line below which seepage takes place (boundary cond)

② Pressure below the Phreatic line is hydrostatic and Pressure on and above Phreatic line is atmospheric

③ Phreatic line follow the path of base parabola for which any Point lying on it is equidistant from focus and directrix.

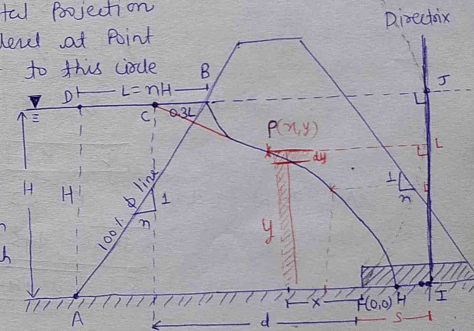
④ The flow takes place through downstream Phase of dam, Hence it always remains Wet. To Prevent it's damage either stone piching is carried out on it or drainage filter is Provided

Procedure to draw Phreatic line when drainage filter is Provided

Step ① Focus (F) is the intersecn of Permeable and impermeable medium.

Step ② let BD (L = nH) is the Horizontal projection of upstream face AB of Dam on water Surface level. Phreatic line start from point C, distance (0.3L) from Point B.

Step ③ Draw a circle with Point 'C' as center and CF is radius to meet the Horizontal Projection of water surface level at Point J. vertical tangent to this circle at Point J represent the directrix of Parabola.



Step ④ The vertex H of Parabola lies in between focus and directrix such that $\left(FH = HI = \frac{S}{2}\right)$

where S → focal length

Step ⑤ To locate the intermediate point P (x,y) on Phreatic line Draw a circle with focus F as center and Radius of (x + S) which need the vertical line drawn at a distance of x from focus (F) which represent the required Point (P) such that PF = PL = (x + S).

Step ⑥ Join all the intermediate points 'P' (x,y) to obtain the Phreatic line. as Phreatic line is the top most flow line it must start from Point (B) and Should be ⊥ar to equipotential line (A, B) Hence an anticorrection is made to obtain Phreatic line

Determination of discharge through drainage filter

let in distance dx head loss is dy $\therefore$ $i = \frac{dy}{dx}$

As per darcy's law $q = KiA = K \frac{dy}{dx} \cdot (y * 1)$

At Point P (x, y) PF = PL

$$\sqrt{\cancel{x^2} + y^2} = x + s$$

$$\cancel{x^2} + y^2 = \cancel{x^2} + s^2 + 2xs$$

$$y^2 = s^2 + 2xs$$

$$\cancel{2}y \frac{dy}{dx} = \cancel{2}s \qquad \left(\frac{dy}{dx}\right) = \frac{s}{y}$$

$\therefore$ Discharge $q = K \cdot \left(\frac{dy}{dx}\right) \cdot (y \cdot 1) = K \cdot \frac{S}{\cancel{y}} \cdot \cancel{y} \times 1$

$\boxed{q = K.S}$ ** $m^3/s/m$ length

At Point C (d, H) CF = CJ

$$\sqrt{d^2 + H^2} = d + s$$

$\boxed{S = \sqrt{d^2 + H^2} - d}$ **

$\boxed{d = \text{Base length} - \cancel{\text{focal}} \text{ filter length} - 0.7L}$

If Non-isotropic medium

$q = K's \qquad K' = \sqrt{K_x K_y}$

$\left[S = \sqrt{d_T^2 + H^2} - d_T\right] \qquad d_T = d\sqrt{\frac{K_y}{K_x}}$

('H' change नहीं होगा transform मे क्योंकि vertical change नहीं होता Horizontal change होगा) $\therefore$ $X = X_T\sqrt{\frac{K_x}{K_y}}$

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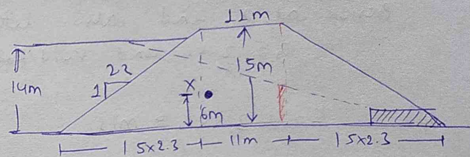
$K_x = 8 \times 10^{-7}$ cm/s

$K_z = 3.6 \times 10^{-7}$ cm/s

$N_d = 18$



(a) seepage

$P_s = (H - n\Delta h)\gamma_w$

$\Delta h = \frac{H}{N_d} = \frac{14}{18}$

$\Delta h = 0.77$

$n = ?$

$q = K.H. \frac{N_f}{N_d}$

$\left[K' = \sqrt{K_x K_y} = \sqrt{8 \times 10^{-7} \times 3.6 \times 10^{-7}} = 10^{-7} \times 5.36\right.$

$q = K'S = 5.36 \times 10^{-7} \times S$

$S = \sqrt{d_T^2 + H^2} - d_T$

d = Base width − filter medium − 0.7L

$= (15 \times 2.3 + 11 + 15 \times 2.3) = 80m$

$L = 2.3 \times 14$

$d = 80 - 12 - 0.7 \times 2.3 \times 14 = 45.46m$

$d_T = d\sqrt{\frac{K_{\cancel{x}}}{K_x}} = 45.46\sqrt{\frac{3.6 \times 10^{-7}}{8 \times 10^{-7}}} = 30.45m$

$S = \sqrt{d_T^2 + H^2} - d_T = \sqrt{30.45^2 + 14^2} - 30.45$

$= 3.06m$

$q = K'S = 5.36 \times 10^{-7} \frac{cm}{sec} \cdot 10^{-2} m \times 3.06$

$= 1.64 \times 10^{-8}$ $m^3/s/m$ length

doubt

$P.H = (T.H) - DH = (H - n\Delta h) - DH = \cancel{(...)}$

$= (14 - 3 \times \left(\frac{14}{18}\right)) - 6$

5.67 m

$U = (P.H)\gamma_w = 5.67 \times 9.81 = 55.59$

Ques- (25) Also Determine seepage Pressure pore water Pressure at X and also determine F.o.S if $G = 2.65$ and void Ratio = 7

I) $K = 3.8 \times 10^{-6}$ m/s

$q = K.H \frac{N_f}{N_d} = 3.8 \times 10^{-6} \times 6.3 \times \frac{3}{10}$

$q = \quad = 7.182 \times 10^{-6} \frac{m^3}{s}$

$= 7.182 \times 10^{-6} \times 10^{6}$ cm³/s

$\boxed{q = 7.182 \text{ cm}^3/\text{s}}$ Ans

(II) (T.H) / seepage Head (h) $= H - (5\Delta h) \overset{\text{doubt}}{=} 6.3 - 5 \times \left(\frac{6.3}{10}\right)$

$= 3.15$ m

$P_s = h\gamma_w = 3.15 \times 9.81 = 30.9$ kN/m²

$\Delta h = \frac{H}{N_d} = \frac{6.3}{10}$

$H =$

(III) $P.H = T.H - D.H = 3.15 - (-9.4)$

$= 12.5$ m

$U = (PH)\gamma_w = 12.5 \times 9.81$

$= 123.11$ kN/m²

IV F.o.S $= \frac{i_c}{i_{exit}} = \frac{\left(\frac{G-1}{1+e}\right)}{\left(\frac{\Delta h}{l}\right)} = \frac{\left(\frac{2.65-1}{1+0.7}\right)}{\frac{\frac{6.3}{10}}{3}} = 4.62$

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Solution (13)

$d_0 = 8$m

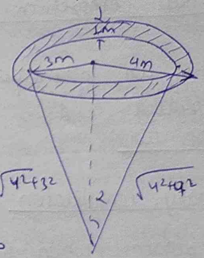
Thickness = 1m

$q = 200$ kN/m²

$\cancel{\sigma_z = \frac{qD^2}{(D+2nz)^2}}$

$\cancel{\sigma = \frac{200 \times (8)^2}{(8 + 2 \times (1) \times 4)^2}}$

$\sigma_z)_{ring} = \sigma_z)_{outer\ circle} - (\sigma_z)_{inner}$



$(1 - \cos^3\alpha_0)q - (1 - \cos^3\alpha_i)q$

$= \left\{1 - \left(\frac{4}{\sqrt{4^2+4^2}}\right)^3\right\} 200$

$- \left\{1 - \left(\frac{4}{\sqrt{4^2+3^2}}\right)^3\right\} 200$

$= 31.7$ kN/m²