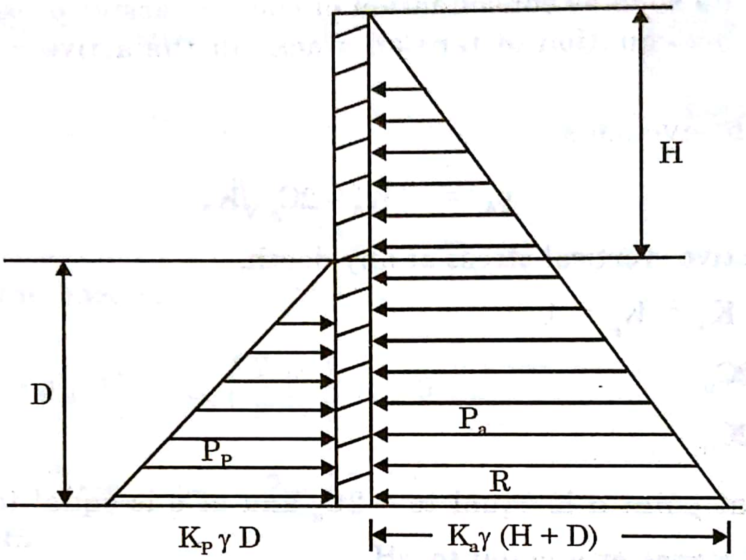
With suitable illustrations describe the simplified analysis method for designing the depth of embedment of a cantilever sheet pile for a 6 m deep excavation in a sandy soil layer for γ = 18 kN/m^3 and ϕ = 35° for a factor of safety of 20°

Sol.



Let D be the depth of the embedment and H be the height of the cantilever sheet pile above the dredge level.

Assuming a concentrated force R acting at the foot of the pile. For equilbrium the moment of active pressure on the right and passive resistance on the left about the point of reaction R must be balanced.

$$\Sigma M = 0 \quad \Rightarrow \quad P_p \times \frac{D}{3} - P_a \times \frac{(H+D)}{3} = 0$$

We will provide F.O.S = 2, against passive force which is providing stability.

$$\therefore \quad \frac{P_P}{2}\frac{D}{3} - \frac{P_a(H+D)}{3} = 0 \qquad \text{... (i)}$$

$$\because \quad P_P = \frac{1}{2}K_p\gamma D^2$$

$$P_a = \frac{1}{2}K_a\gamma(H+D)^2$$

Put the value of P_P and Pa in (i)

$$\Rightarrow \frac{1}{6}\times\frac{1}{2}K_p\gamma D^2 \times D - \left(\frac{H+D}{3}\right)\times\frac{1}{2}Ka\gamma(H+D)^2 = 0$$

$$\Rightarrow \frac{\gamma}{6}\left[\frac{K_pD^3}{2} - K_a(H+D)^3\right] = 0$$

$$\Rightarrow K_pD^3 - 2\,K_a\,(H+D)^3 = 0 \qquad \text{... (ii)}$$

Data given

$$\phi = 35° \quad H = 6\text{ m}$$

$$\gamma = 18\text{ kN/m}^3$$

$$\text{F.O.S} = 2.0$$

$$\therefore \quad K_a = \frac{1-\sin\phi}{(1+\sin\phi)} = \frac{1-\sin 35°}{(1+\sin 35°)} = 0.271$$

$$K_P = \left(\frac{1}{Ka}\right) = \mathbf{3.69}$$

$$\therefore \quad 3.69D^3 - 2\times 0.271(6+D)^3 = 0$$

$$\Rightarrow \quad 3.69D^3 - 0.542\,[(6)^3 + D^3 + 3\times 6D\,(D+6)] = 0$$

$$\Rightarrow \quad 3.69\,D^3 - 0.542\,[216 + D^3 + 108\,D] = 0$$

$$\Rightarrow \quad 3.148D^3 - 9.756\,D^2 - 58.536\,D - 117.072 = 0 \qquad \text{... (iii)}$$

Solving above equation. for D.

$$\boxed{D = 6.71\text{ m}}$$

∴ Therefore depth of embedment for sheet pile $D = 6.71$ m

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