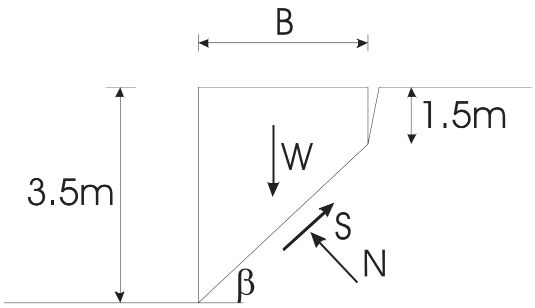
Tutorial 1 Solution

Q1

(a)



$B = \dfrac{2}{\tan\beta}$, length of slip surface: $L = \dfrac{2}{\sin\beta}$, $W = \dfrac{1.5+3.5}{2} B19 = \dfrac{95}{\tan\beta}$

Resolving *parallel* to the slip surface:

$$W \sin\beta = S$$

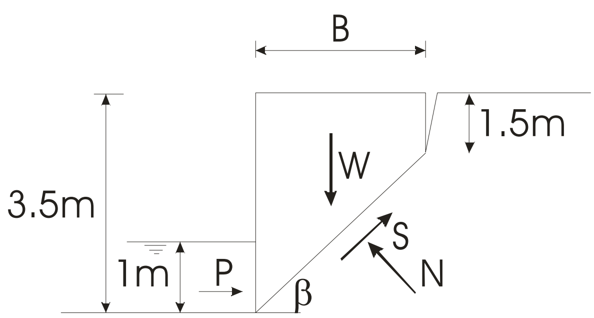
$$\frac{95}{\tan\beta}\sin\beta = \frac{S_u L}{F} = \frac{28 \text{ x } 2}{F \text{ x } \sin\beta}, \text{ Hence } F = \frac{0.589}{\sin\beta \text{ x } \cos\beta} = \frac{1.178}{\sin 2\beta} \quad (1)$$

Critical value of β is for $\dfrac{\partial F}{\partial \beta} = 0$

$$\frac{\partial F}{\partial \beta} = \frac{-2 * 1.178 * \cos 2\beta}{\sin^2 2\beta} = 0 \text{ which is zero when } \cos 2\beta = 0,\ 2\beta = \frac{\pi}{2},\ \beta = 45°$$

Substituting $\beta = 45°$ in Equation 1: F=1.178

(b)



$P = \dfrac{1}{2} \text{ x } 1 \text{ x } 1 \text{ x } \gamma_w$

Resolving *parallel* to the slip surface

$$W \sin\beta = S + P\cos\beta$$

$$\frac{95}{\tan\beta}\sin\beta = \frac{28 \text{ x } 2}{F \text{ x } \sin\beta} + 0.5 \text{ x } 9.8 \text{ x } \cos\beta$$

Hence $F = \dfrac{1.24}{\sin 2\beta}$ (2) and minimum F for $\dfrac{\partial F}{\partial \beta} = 0$

$\dfrac{\partial F}{\partial \beta} = \dfrac{-2 \times 1.24 \times \cos 2\beta}{\sin^2 2\beta} = 0$ which is zero when $\cos 2\beta = 0$, $2\beta = \dfrac{\pi}{2}$, $\beta = 45°$

Substituting $\beta = 45°$ in Equation 2: F=1.24

Q2

(a)

W = (10 x 20)18 + (5 x 20)20 = 5600 kN

l = 20.sec5° = 20.08 m.

V_1 = water force in tension crack = ½ x 15^2 x 9.81 = 1103.6 kN

V_2 = water force from river = ½ x 10^2 x 9.81 = 490.5 kN

U =water force acting on the slip surface (15 + 10)/2 x 20.08 x 9.81= 2462.3 kN

S=shear force acting on the slip surface= $N'\dfrac{\tan\phi'}{F}$ where N' is the normal effective force acting on the slip surface

F= 1.0 as it is back analysis of failure of the mass ABCD

Resolving *parallel* to the slip surface:

$$V_1 \cos 5^\circ - V_2 \cos 5^\circ + W \sin 5^\circ - N'\frac{\tan\phi'}{F} = 0$$

$N' \tan\phi' = 1098.86 \text{kN}$ (1)

Resolving *perpendicularly* to the slip surface

$$-V_1 \sin 5^\circ - U + W\cos 5^\circ + V_2 \sin 5^\circ - N' = 0$$

$N' = 3063.38\,kN$ (2)

Hence from (1) and (2) $\phi' = 19.7^\circ$

(b)

Undrained conditions

Resolving *parallel* to the slip surface:

$$V_1 \cos 5^\circ - V_2 \cos 5^\circ + W \sin 5^\circ - \frac{S_u}{F}\frac{20}{\cos 5^\circ} = 0$$

F=1

Thus $S_u = 54.7\,kPa$

(c)

Again we are considering drained conditions:

U = (10 + 9)/2 x 20.08 x 9.81 = 1871 kN;

V_1 = ½ x 10^2 x 9.81 = 490.5 kN;

V_2 = ½ x 9^2 x 9.81 = 397.3 kN.

Resolving *parallel* to the slip surface:

$$V_1 \cos 5^\circ - V_2 \cos 5^\circ + W \sin 5^\circ - N'\frac{\tan \phi'}{F} - \frac{c' x 20}{Fx \cos 5^\circ} = 0$$

$$580.91 - N'\frac{\tan 16^\circ}{F} - \frac{200.76}{F} = 0 \qquad (3)$$

Resolving *perpendicularly* to the slip surface

$$-V_1 \sin 5^\circ - U + W \cos 5^\circ + V_2 \sin 5^\circ - N' = 0$$

$N' = 3699.55\,kN$ (4)

Hence from (3) and (4) $F = 2.15$
