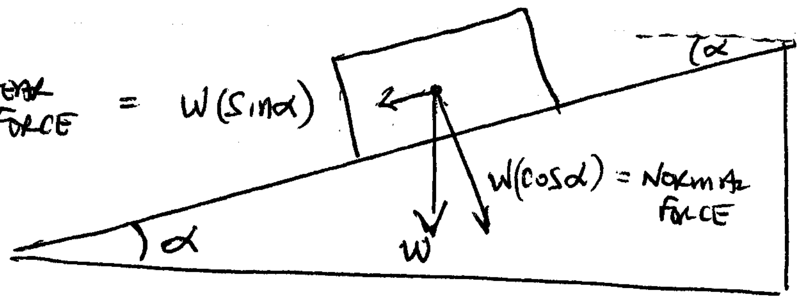
Environmental Geology – Slope Stability Equations

(1) Block of mass on slope



W = Weight of Block (Newtons = $\frac{kg\text{-}m}{sec^2}$) = mg = ρgV = γV

m = mass, g = 9.8 m/sec², ρ = density, V = volume, γ = unit wt.

α = Slope Angle

Shear Force $\tau_s = W(\sin\alpha)$ Downslope force

Normal force $\sigma_n = W(\cos\alpha)$ Perpendicular force

Key ENV. GEOLOGY HW #2

MASS WASTING / SLOPE STABILITY PROBLEM SET

(1) $E_p = mgh$

$h = 200\text{ft}\left(1\text{ m}/3.28\text{ft}\right) = 61.0\text{ m}$

$E_p = 5000\text{ J} = 5000\ \frac{\text{Kg m}^2}{\text{sec}^2}$

$m = \frac{E_p}{gh} = \frac{5000\ \text{Kg m}^2/\text{sec}^2}{(9.8\text{ m/sec}^2)(61.0\text{ m})}$ $g = 9.82\text{ m/sec}^2$

$m = \frac{5000\ \text{Kg m}^2/\text{sec}^2}{597.8\ \text{m}^2/\text{sec}^2} = \boxed{8.4\text{ Kg}}$

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(2) $E_p = mgh$

$h = 500\text{ ft}\left(\frac{1\text{m}}{3.28\text{ft}}\right) = ~~1524.4~~\ 152.4\text{ m}$

$g = 9.82\text{ m/sec}^2$

$E_p = (2272.2\text{ Kg})\left(9.8\frac{\text{m}}{\text{sec}}\right)(~~1524.4~~\ 152.4\text{ m}) =$

~~m~~ $F = mg = 5000\text{ lbs}\left(\frac{1\text{ kg}}{2.2\text{ lb}}\right) =$

$m = 2272.7\text{ Kg}$

$3.4 \times 10^6\text{ J} =$

$3.4 \times 10^6\text{ KJ}$

11808

(3) $E_K = \frac{1}{2} m v^2$

$E_K = 10{,}000\,J$

$m = \frac{2 E_K}{V^2}$

$V = \left(\frac{2\,mi}{hr}\right)\left(\frac{5280\,ft}{mi}\right)\left(\frac{1\,m}{3.28\,ft}\right)\left(\frac{1\,hr}{3600\,sec}\right) = 0.89\,\frac{m}{sec}$

$m = \frac{2\left(10{,}000\,Kg\,m^2/sec^2\right)}{\left(0.89\,m/sec\right)^2} = \frac{20{,}000\,Kg\,m^2/sec^2}{0.79\,m^2/sec^2} = 25{,}316.4\,Kg$

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(4) $WT = 5\,ton\left(\frac{2000\,lb}{ton}\right) = 10{,}000\,lb\left(\frac{1\,kg}{2.2\,lb}\right) = 4545.5\,Kg$

$L = 200\,ft\left(\frac{1\,m}{3.28\,ft}\right) = 61\,m$ $\quad w = 50\,ft\left(\frac{1\,m}{3.28\,ft}\right) = 15.2$

Area $= 927.2\,m^2$

$\text{Stress} = \frac{F}{A} = \frac{mg}{A} = \frac{(9.8\,m/sec^2)(4545.5\,kg)}{927.2\,m^2} =$

$48.04\,N/m^2$

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(5) $W = Fd = wt \cdot d = m \cdot g \cdot h$

$V_{ol} = 5\,m \times 6.2\,m \times 3.2\,m = 500\,cm \times 620\,cm \times 320\,cm = 9.92 \times 10^7\,cm^3$

$D = \frac{m}{V} \Rightarrow m = DV = \left(\frac{3.0\,gm}{cm^3}\right)\left(9.92 \times 10^7\,cm^3\right) = 2.976 \times 10^8\,gm\left(\frac{1\,kg}{10^3\,g}\right) = 297600\,Kg$

$h = 300\,ft\left(\frac{1\,m}{3.28\,ft}\right) = 91.5\,m$

$W = (297600\,Kg)(9.8\,m/sec^2)(91.5\,m) = 2.7 \times 10^8\,J$ *

$\theta = 35°$

(6) $D = \frac{M}{V}$

$Vol = 5m \cdot 6.2m \cdot 3.2m =$

$500\,cm \cdot 620\,cm \cdot 320\,cm = 9.92 \times 10^7\,cm^3$

$M = D \cdot V = \left(\frac{4.0\,gm}{cm^3}\right)(9.92 \times 10^7\,cm^3) = 3.97 \times 10^8\,gm \; \frac{1\,Kg}{1000\,gm} =$

MASS = $396{,}800\,Kg$

$W_T = mg = 396800\,Kg \; 9.8\,\frac{m}{sec^2} =$

$3.9 \times 10^6\,N$

NORMAL FORCE $= Wt\,(\cos\theta) = (3.9 \times 10^6\,N)(\cos 35°) =$
$3.2 \times 10^6\,N$

SHEAR FORCE $= Wt\,(\sin\theta) = (3.9 \times 10^6\,N)(\sin 35°) =$
$2.2 \times 10^6\,N$

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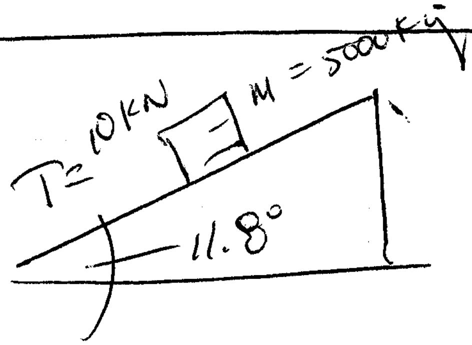
(7)



$T = Wt \sin\theta$

$10{,}000\,N = (5000\,Kg)\left(9.8\,\frac{m}{sec^2}\right)(\sin\theta)$

$0.20 = \frac{10{,}000\,N}{49{,}000\,N} = \sin\theta$

$0.20 = \sin\theta \longrightarrow$ INV $\sin(0.20) =$ $11.8°$

$11.8° = \theta$

(8) Coluvium volume = $\overset{w}{0.4\,Km} \times \overset{L}{0.2\,Km} \times \overset{t}{0.15\,Km}$

$400\,m \times 200\,m \times 150\,m =$

ASSUME $\theta = 12°$

$3.6 \times 10^7\,m^3$

$$D = \left(2.1 \frac{Mg}{m^3}\right)\left(\frac{1\times10^6 g}{1\,Mg}\right)\left(\frac{1\,Kg}{1\times10^3 g}\right) = 2100\,Kg/m^3$$

(a) Specific WT = $\frac{mg}{V} = \frac{2100\,Kg \cdot 9.8\,m/sec^2}{1\,m^3} = 20{,}580 \frac{N}{m^3}$

(b) Normal Stress $\sigma = \gamma h \cos^2\theta = \left(20{,}580 \frac{N}{m^3}\right)(150\,m)(\cos^2 12°) =$

$\sigma = 2.95 \times 10^6 \frac{N}{m^2} \cdot \frac{1\,KN}{1000\,N} = 2954 \frac{KN}{m^2}$

(c) $\tau = \gamma h (\cos\theta)(\sin\theta) =$

$$\left(20{,}580 \frac{N}{m^3}\right)(150\,m)(\cos 12°)(\sin 12°)\left(\frac{1\,KN}{1000\,N}\right) =$$

629 KN

0.98

(9) $h = 3.6\,m$

$\theta = 12°$ $F = 1.2 = \frac{\sigma}{\tau}$ = $\frac{\text{normal stress}}{\text{shear stress}}$

Coulomb's Equation

$$S = c + \sigma' \tan\phi$$

$$\frac{S - c}{\sigma'} = \tan\phi$$

NOT ENOUGH INFORMATION GIVEN —

NEED A VOLUME

NEED SHEAR STRENGTH