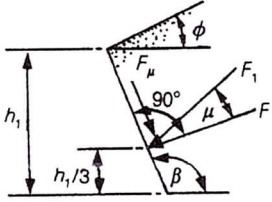
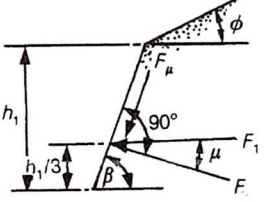
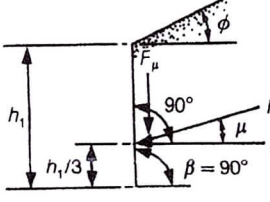


Horizontal pressures due to retained materials

Dry granular materials	Intensity of pressure normal to back of wall at depth h: $q = kDh \sin^2 \beta$ Total pressure normal to back of wall of height h_1: $F = \frac{1}{2}kDh_1^2 \sin \beta$ Values of k for various conditions are given below. Total pressure on back of wall: $F_1 = F \sec \mu$ Angle between line of action of F_1 and back of wall = $(90 - \mu)^\circ$ Force parallel to back of wall: $F_\mu = F \tan \mu = F_1 \sin \mu$ When friction on back of wall is neglected ($\mu = 0$): $F_1 = F$; $F_\mu = 0$; F_1 acts at right angles to back of wall			Notation D weight of retained material ϕ angle of slope of bank of retained material (in degrees) θ angle of internal friction of material retained (in degrees) μ angle of friction between material and concrete wall (in degrees)
	Friction on back of wall	Inclined outwards  Inclined inwards  Vertical 		
	Active pressures	Any slope ϕ $k = \left[\frac{\sin(\beta - \theta)}{(\alpha + 1) \sin \beta} \right]^2 \frac{1}{\sin^2 \beta} \quad \alpha = \sqrt{\left[\frac{\sin \theta \sin(\theta - \phi)}{\sin \beta \sin(\beta - \phi)} \right]}$	$k = \left(\frac{\cos \theta}{\alpha + 1} \right)^2$ $\alpha = \sqrt{[\sin^2 \theta - \frac{1}{2} \tan \phi \sin 2\theta]}$	
	$\mu = 0$	$\phi = \theta$ (max.) $k_1 = \left[\frac{\sin(\beta - \theta)}{\sin \beta} \right]^2 \frac{1}{\sin^2 \beta}$ $\phi = 0$ (level) $k_2 = \left[\frac{\sin(\beta - \theta)}{\sin \theta + \sin \beta} \right]^2 \frac{1}{\sin^2 \beta}$ $\phi = -\theta$ (min.) $k_3 = \left[\frac{\sin(\beta - \theta)}{(\alpha + 1) \sin \beta} \right]^2 \frac{1}{\sin^2 \beta} \quad \alpha = \sqrt{\left[\frac{2 \sin^2 \theta \cos \theta}{\sin \beta \sin(\beta + \theta)} \right]}$	$k_1 = \cos^2 \theta$ $k_2 = \frac{1 - \sin \theta}{1 + \sin \theta}$ $k_3 = \left[\frac{\cos \theta}{1 + \sqrt{(2) \sin \theta}} \right]^2$	
	μ taken into account	Any slope ϕ $k = \left[\frac{\sin(\beta - \theta)}{(\alpha + 1) \sin \beta} \right]^2 \frac{\cos \mu}{\sin(\mu + \beta) \sin \beta}$ $\alpha = \sqrt{\left[\frac{\sin(\theta + \mu) \sin(\theta - \phi)}{\sin(\mu + \beta) \sin(\beta - \phi)} \right]}$	$k = \left(\frac{\cos \theta}{\alpha + 1} \right)^2$ $\alpha = \sqrt{\left[\frac{\sin(\theta + \mu) \sin(\theta - \phi)}{\cos \mu \cos \phi} \right]}$	
	$\phi = \theta$ (max.) $k_1 = k \quad \alpha = 0$ $\phi = 0$ (level) $k_2 = k \quad \alpha = \sqrt{\left[\frac{\sin(\theta + \mu) \sin \theta}{\sin(\mu + \beta) \sin \beta} \right]}$ $\phi = -\theta$ (min.) $k_3 = k \quad \alpha = \sqrt{\left[\frac{\sin(\theta + \mu) \sin 2\theta}{\sin(\mu + \beta) \sin(\beta + \theta)} \right]}$	$k_1 = \cos^2 \theta$ $k_2 = k$ $\alpha = \sqrt{[\sin \theta (\sin \theta + \cos \theta \tan \mu)]}$ $k_3 = k$ $\alpha = \sqrt{[2 \sin \theta (\sin \theta + \cos \theta \tan \mu)]}$		
Passive resistance	Intensity of horizontal passive resistance against vertical wall at depth h ($\phi = 0$): $q_p = \frac{Dh}{k_2} = \left(\frac{1 + \sin \theta}{1 - \sin \theta} \right) Dh$			
Cohesive soils	Active pressures	Intensity of horizontal pressure at depth h on vertical wall ($\phi = 0$): $q_2 = \left(\frac{1 - \sin \theta}{1 + \sin \theta} \right) Dh - 2C \sqrt{\left(\frac{1 - \sin \theta}{1 + \sin \theta} \right)} = k_2 Dh - 2C \sqrt{k_2}$		C is a cohesion factor, equal to the shearing strength of unloaded soil Other notation as for granular materials
	Passive resistance	Intensity of horizontal passive resistance against vertical wall at depth h ($\phi = 0$) retaining ordinary saturated clay: $q_p = \frac{Dh}{k_2} + \frac{2C}{k_2}$		
Units	The foregoing formulae are applicable to any consistent set of units.			