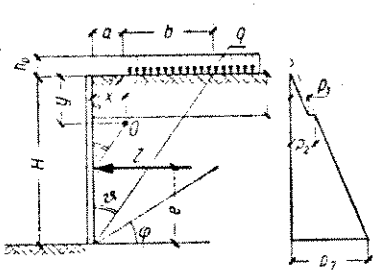
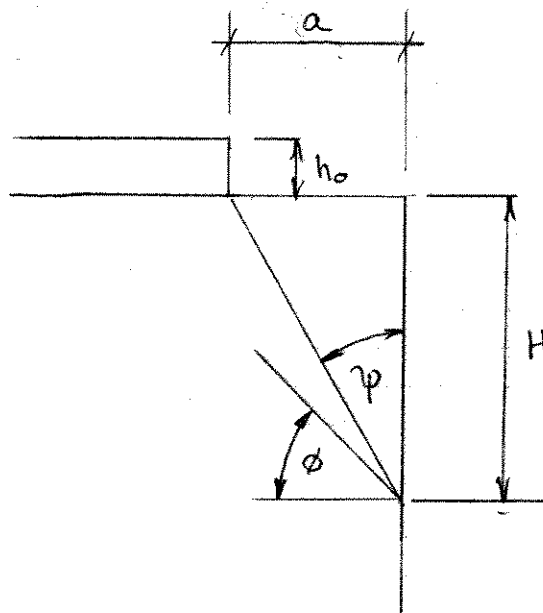


TABLICA 13-3 cd.

1	2	3
5		$\operatorname{tg} \vartheta = -\operatorname{tg} \varphi + \sqrt{(1 + \operatorname{tg}^2 \varphi) \left(1 + \frac{A}{\operatorname{tg} \varphi}\right)}$ <p>gdzie</p> $A = \frac{2ah_0}{H(H + 2h_0)}$ $k = \frac{\operatorname{tg} \varphi - A}{\operatorname{tg} (\vartheta + \varphi)}; \quad k' = \frac{\operatorname{tg} \vartheta}{\operatorname{tg} (\vartheta + \varphi)}$ $Z = \frac{1}{2} \gamma H^2 \left(1 + \frac{2h_0}{H}\right) k; \quad e = H - y - \frac{x}{\operatorname{tg} \vartheta}$ $x = \frac{2(3P_1 + P_2)a + (3P_1 + 2P_2)b}{6(P_1 + P_2)}$ $y = \frac{HP_2}{3(P_1 + P_2)}$ <p>gdzie <math>P_1 = \gamma bh_0</math> zaś <math>P_2 = \frac{1}{2}(a + b)H\gamma</math></p> $h = \frac{a}{\operatorname{tg} \vartheta}; \quad p_1 = \gamma hk'; \quad p_2 = \gamma(h + h_0)k'$ $p_3 = (H + h_0)k'; \quad h_0 = \frac{q}{\gamma}$



- 1)  $K = h_0/H$
- 2)  $R = 2K/(1+2K)$
- 3)  $B = (2-R)\tan\phi - (R/\tan\phi)$
- 4)  $\tan\psi = (\sqrt{B^2+4} - B)/2$
- 5)  $a = H \tan\psi$

where /  $a$  = clear dist to surcharge  
 $h_0$  = ht. of surcharge material  
 $\phi$  = angle of repose  
 $H$  = ht. of cantilever wall

TABLICA 13-3 cd.

CASE 5

$$\tan \psi = -\tan \phi + \sqrt{(1+\tan^2 \phi) \left(1 + \frac{A}{\tan \phi}\right)}$$

$$A = 2ah_0 / H(H+2h_0)$$

set  $a/H$  to  $\tan \psi$

$$A = 2h_0 \tan \psi / (H+2h_0)$$

Try  $h_0 \gg H$

$$A = \tan \psi$$

$$\tan \psi = -\tan \phi + \sqrt{(1+\tan^2 \phi) \left(1 + \frac{\tan \psi}{\tan \phi}\right)}$$

$$\tan \psi + \tan \phi = \sqrt{1 + \frac{\tan \psi}{\tan \phi} + \tan^2 \phi + \tan \phi \tan \psi}$$

$$\tan^2 \psi + 2 \tan \psi \tan \phi + \tan^2 \phi = 1 + \frac{\tan \psi}{\tan \phi} + \tan^2 \phi + \tan \phi \tan \psi$$

$$\tan^2 \psi + \tan \psi \tan \phi - \left(1 + \frac{\tan \psi}{\tan \phi}\right) = 0$$

$$\tan \phi \tan^2 \psi + (\tan^2 \phi - 1) \tan \psi - \tan \phi = 0$$

$$\tan \psi = \frac{-(\tan^2 \phi - 1) + \sqrt{(\tan^2 \phi - 1)^2 + 4 \tan^2 \phi}}{2 \tan \phi}$$

$$= \frac{(1 - \tan^2 \phi) + \sqrt{\tan^4 \phi + 2 \tan^2 \phi + 1}}{2 \tan \phi} =$$

$$\tan \psi = (1 - \tan^2 \phi) + \sqrt{(\tan^2 \phi + 1)^2} / 2 \tan \phi$$

$$\tan \psi = (1 - \tan^2 \phi) + (\tan^2 \phi + 1) / 2 \tan \phi$$

$$\underline{\tan \psi = 1 / \tan \phi}$$

Check: let $\phi = 32.5^\circ$	let $\phi = 25^\circ$
$\tan \phi = 0.637$	$\tan \phi = 0.466$
$\tan \psi = 1.57$	$\tan \psi = 2.14$
$\psi = 57.5^\circ$	$\psi = 65^\circ$

Try  $h_0 \ll H$

$$A = 2 h_0 \tan \psi / H$$

$$\tan \psi = -\tan \phi + \sqrt{(1 + \tan^2 \phi) \left(1 + \frac{2 h_0 \tan \psi}{H \tan \phi}\right)}$$

$$(\tan \psi + \tan \phi)^2 = (1 + \tan^2 \phi) \left(1 + \frac{2 h_0 \tan \psi}{H \tan \phi}\right)$$

since  $h_0/H \approx 0$

$$(\tan \psi + \tan \phi)^2 = 1 + \tan^2 \phi$$

$$\tan^2 \psi + 2 \tan \phi \tan \psi + \tan^2 \phi - 1 - \tan^2 \phi = 0$$

$$\tan^2 \psi + 2 \tan \phi \tan \psi - 1 = 0$$

$$\tan \psi = \frac{-2 \tan \phi + \sqrt{4 \tan^2 \phi + 4}}{2}$$

$$\tan \psi = -\tan \phi + \sqrt{\tan^2 \phi + 1}$$

$$\phi = 32.5 ; \tan \psi = 0.548 ; \psi = 28.8^\circ$$

$$\phi = 25 ; \tan \psi = 0.637 ; \psi = 32.5^\circ$$

Try  $h_0/H = 1/6$

$$A = 2aH/6H(H+H/3)$$

$$= 2a/8H = a/4H$$

$$\tan \psi = -\tan \phi + \sqrt{(1+\tan^2 \phi)(1 + \frac{a}{4H}\tan \phi)} \quad .703 \text{ } 22^\circ$$

$$(\tan \psi + \tan \phi)^2 = (1+\tan^2 \phi)(1 + \frac{\tan \psi}{4\tan \phi})$$

$$\tan^2 \psi + 2\tan \phi \tan \psi + \tan^2 \phi = 1 + \frac{\tan \psi}{4\tan \phi} + 7\tan^2 \phi + \frac{\tan \phi \tan \psi}{4}$$

$$\tan^2 \psi + (2\tan \phi - \frac{\tan \phi}{4} - \frac{1}{4\tan \phi}) \tan \psi - 1 = 0$$

$$\tan \psi = \left( -B + \sqrt{B^2 + 4} \right) / 2$$

$$B = \frac{7\tan \phi}{4} - \frac{1}{4\tan \phi} = \frac{1}{4\tan \phi} (7\tan^2 \phi - 1)$$

$$2\tan \psi = -\frac{(7\tan^2 \phi - 1)}{4\tan \phi} + \sqrt{\frac{49\tan^4 \phi - 14\tan^2 \phi + 1 + 64\tan^2 \phi}{16\tan^2 \phi}}$$

$$2\tan \psi = \frac{1 - 7\tan^2 \phi}{4\tan \phi} + \frac{\sqrt{49\tan^4 \phi + 50\tan^2 \phi + 1}}{4\tan \phi}$$

$$\tan \psi = \frac{1 - 7\tan^2 \phi + \sqrt{49\tan^4 \phi + 50\tan^2 \phi + 1}}{8\tan \phi}$$

let  $\phi = 30.5^\circ$

$\tan \psi = .702$

$\psi = 35^\circ$

let  $\phi = 25^\circ$

$\tan \psi = 0.87$

$\psi = 41^\circ$

General Solution:

$$\tan \psi = -\tan \phi + \sqrt{(1 + \tan^2 \phi) \left(1 + \frac{A}{\tan \phi}\right)}$$

$$A = 2a h_0 / H(H + 2h_0)$$

$$a/H = \tan \psi$$

$$A = 2h_0 \tan \psi / (H + 2h_0)$$

$$\text{Let } K = h_0/H \text{ or } h_0 = KH$$

$$A = 2KH \tan \psi / H(1 + 2K) = 2K \tan \psi / (1 + 2K)$$

$$\tan \psi = -\tan \phi + \sqrt{(1 + \tan^2 \phi) \left(1 + \frac{2K}{1+2K} \left(\frac{\tan \psi}{\tan \phi}\right)\right)}$$

$$\tan^2 \psi + 2 \tan \psi \tan \phi + \tan^2 \phi = (1 + \tan^2 \phi) \left(1 + \frac{2K}{1+2K} \left(\frac{\tan \psi}{\tan \phi}\right)\right)$$

$$R = 2K/(1+2K)$$

$$\tan^2 \psi + 2 \tan \psi \tan \phi + \tan^2 \phi = 1 + \frac{R \tan \psi}{\tan \phi} + \tan^2 \phi + R \tan \phi \tan \psi$$

$$\tan^2 \psi + \left(2 \tan \phi - \frac{R}{\tan \phi} - R \tan \phi\right) \tan \psi - 1 = 0$$

$$\tan \psi = (\sqrt{B^2 + 4} - B)/2$$

$$B = \tan \phi (2 - R) - (R/\tan \phi)$$

$$R = 2K/(1+2K)$$

$$K = h_0/H$$

$$a = H \tan \psi$$