2. EARTH PRESSURES. Much uncertainty exists as to methods of computation and also as to the exact weights of materials to be used in specific cases and their angles of repose. The methods and formulas which follow are those devised by Rankine based on researches of Coulomb and represent generally accepted practice.

(a) Level Bank. The earth pressure is transferred to an equivalent horizontal liquid pressure, p_e, in pounds per square foot, as follows, and p_e is the increment in pounds per square foot corresponding to p_w for water. Then,

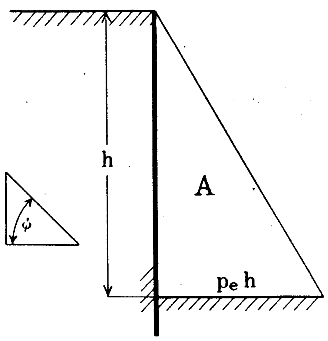

Fig. 3

$$p_e = w_e \tan^2 (45° - \tfrac{1}{2}\phi).$$

w_e = weight per cubic foot of earth, in pounds.

ϕ = angle of repose of earth, in degrees.

The fundamental laws of liquid pressures then apply which makes,

$p_e h$ = pressure, in pounds per square foot, at depth, h, in feet, and the total load on the wall, P_e, in pounds per foot of width, is,

$$P_e = \tfrac{1}{2} p_e h^2.$$

The total load is distributed or applied as illustrated in triangle A, Fig. 3 adjoining.

(b) Inclined Bank.

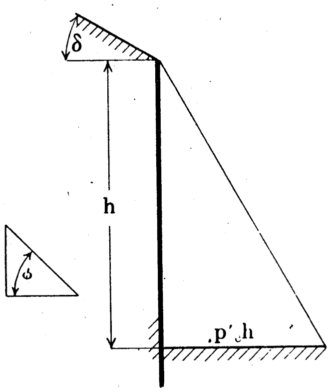

Fig. 4

$$p'_e = \frac{w_e \cos^2 \phi}{\left[1 + \sqrt{\dfrac{\sin\phi \sin(\phi - \delta)}{\cos\delta}}\right]^2}, \text{ in pounds per square foot}$$

When $\delta = \phi$, then,

$p'_e = w_e \cos^2 \phi$, in pounds per square foot.

The same laws of liquid pressures then apply, as illustrated in Fig. 4 adjoining.

(c) Surcharge Load. Fig. 5 below shows a piling wall which retains earth pressure and is loaded with a surcharge of railroad cars or piled materials which increases the lateral pressure.

The lateral pressure, p_s, in pounds per square foot due to the surcharge load, w_s, in pounds per square foot is,

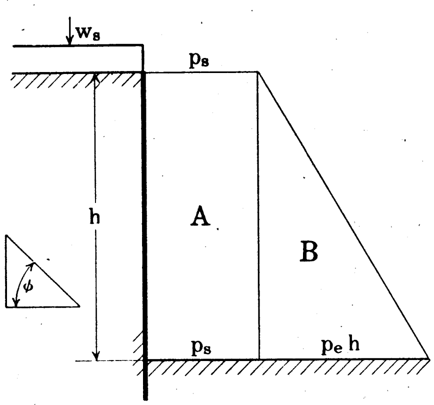

Fig. 5

$p_s = w_s \tan^2 (45° - \tfrac{1}{2}\phi)$, in pounds per square foot.

The lateral pressure, p_s, is not subject to the laws of liquid pressures but is a uniform load throughout the height h, in feet, of the piling wall and the total load, in pounds, due to the surcharge is,

Total uniform load = $p_s \times h$, in pounds per foot of width.

The total uniform load is distributed or applied as illustrated in rectangle A, Fig. 5 adjoining.

The lateral loads due to the earth loads alone are calculated as described in (a) just preceding and, since this pressure is liquid, the total load for these earth loads is illustrated in triangle B.

Thus the distribution or application of the total load, due to surcharge and earth pressures combined, is illustrated in the combination of rectangle A + triangle B, in pounds per foot of width.

$\phi = 35^\circ$ $\delta = \tan^{-1}\left(\frac{1}{1.5}\right) = 33.7^\circ$ $W_e = 110\ \mathrm{lb/ft^3}$

$$p'_e = \frac{110(\cos^2 35^\circ)}{\left[1 + \sqrt{\frac{(\sin 35^\circ)(\sin(35^\circ - 33.7^\circ))}{\cos 33.7^\circ}}\right]^2}$$

$$p'_e = \frac{73.8}{\left[1 + \sqrt{\frac{(0.574)(0.0227)}{0.832}}\right]^2} = \frac{73.8}{[1 + 0.0156]^2} = 71.6$$

$$\text{Total Force}/\text{ft length} = (6')(6')(71.6\ \mathrm{lb/ft^2}) = 2580\ \mathrm{lb/ft}$$