Short Communications

An Influence Chart for Vertical Stress Increase due to Uniform Normal Load over a Strip

by

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DETERMINATION of vertical stresses in a given soil mass is often required in computing the settlement due to various surface loadings. Solutions in the form of equations, tables and charts are available in literature for a wide variety of loading conditions. Building and retaining wall footings, which are the foundation elements of transferring the load to the ground pose the problem of uniform normal stress over a strip. This represents two-dimensional, plane strain case and was solved by Carothers (1920). Derivation by a different procedure is credited to Kolosov (Harr, 1966). The graphical relationships given by Kolosov are not very convenient to use in some practical problems.

Scott (1963) has presented tabular results for the following solution of Carothers :

$$\sigma_z = \frac{p}{\pi}\left[\alpha + \sin\alpha\cos(\alpha+2\delta)\right] \qquad \ldots(1)$$

The notation in the above equation is shown in Figure 1. It is, however, felt that influence values for Equation 1, would be more useful and, to this effect, an influence chart is developed here.

Denoting, $\tan\delta = b/z$ and $\tan(\alpha+\delta)=(a+b)/z$ in Figure 1, Equation (1) can be rewritten as

$$\sigma_z = \frac{p}{\pi}\left[\tan^{-1}\left(\frac{a+b}{z}\right) - \tan^{-1}\left(\frac{b}{z}\right) + \sin\left\{\tan^{-1}\left(\frac{a+b}{z}\right) - \tan^{-1}\left(\frac{b}{z}\right)\right\} \cdot \cos\left\{\tan^{-1}\left(\frac{a+b}{z}\right) + \tan^{-1}\left(\frac{b}{z}\right)\right\}\right] \qquad \ldots(2)$$

Letting $a/z=m$ and $b/z=n$

$$\sigma_z = p.I \qquad \ldots(3)$$

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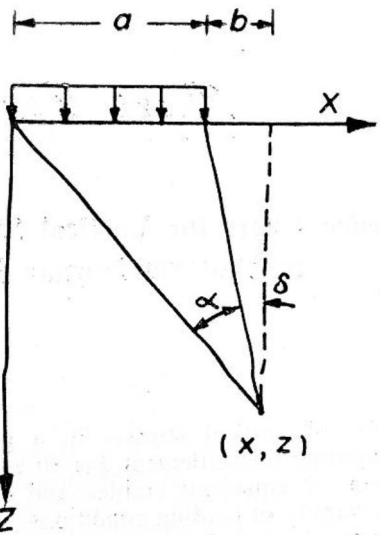

FIGURE 1: Uniform stress over strip at surface.

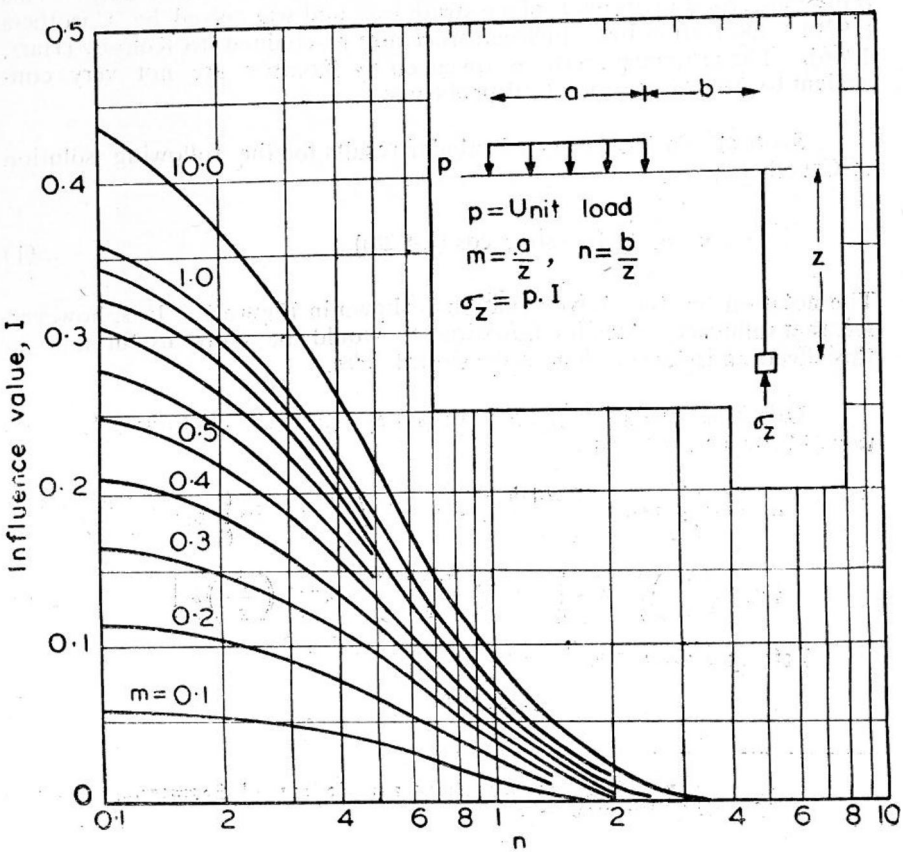

FIGURE 2 : Influence chart.

Where, the influence value, $I = f(m, n)$ and is given by

$$I = \frac{1}{\pi} [\tan^{-1}(m+n) - \tan^{-1}(n) + \sin\{\tan^{-1}(m+n) - \tan^{-1}(n)\} \cdot \cos\{\tan^{-1}(m+n) + \tan^{-1}(n)\}] \quad \ldots(4)$$

An influence chart (Figure 2) has been constructed to evaluate Equation (4). The stress computed is the vertical stress at any point inside a soil mass with normal strip load at the surface.

References

CAROTHERS, S.D. (1920) : "Plane Strain : the Direct Determination of Stress". *Proceedings*, Royal Society (London), Series A, Vol. 97, p. 110.

HARR, M.E. (1966) : "*Foundations of Theoretical Soil Mechanics*". McGraw-Hill Book Co., New York, p. 63.

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