Determination of pressure on Retaining wall due to Uniform Surcharge*

by

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N. Babu Shanker M. Ramakrishna Reddy*****

The discussers read with interest this paper on earth pressures due to uniform surcharge loads. They have the following comments on the paper.

The variable, ρ, introduced in Equation 5 is same as the variable, r, of Equation 3.

Vertical stress mentioned in line 12 on page 387 is not γz but $(\gamma z+q)$ and similarly the lateral stress is ka $(\gamma z+q)$ and not $k_a\,\gamma z$

Authors contention that $\mu = \dfrac{k_a}{1+k_a}$ is not correct; on the other hand from the theory of elasticity one can easily derive that $\mu = \dfrac{k_o}{1+k_o}$, where k_o is the coefficient of earth pressure at rest, which is roughly equal to (1—sin ϕ) as per Jaky (1944). Thus Equation 10 may be modified as

$$p = \frac{q}{4}\,\frac{(4-3\sin\phi)}{(2-\sin\phi)} = q\,f(\phi)$$

This modified $f(\phi)$ curve in Figure 3 will be slightly above the author's curve. It will be almost a straight line with equation.

$f(\phi) \simeq 0.5-0.003\phi. \simeq 0.45$ an average value for usual range of ϕ.

R. Nagamanikkam****

The author tries to combine the results through the double integration of Boussinesq's equation, which is based on the theory of elastic equilibrium of soil mass, homogeneous and isotropic in characteristics, with that of conventional method wherein the use of Ka is involved. In the elastic solutions, the use of μ and E alone find a place and no where the values of soil properties C and ϕ are used. Moreover the value of μ is

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approximately equal to $\frac{K_o}{1+K_o}$ only whereas it is noted to be equal to $\frac{K_a}{1+K_a}$ in the paper. K_o condition prevails only when there is elastic equilibrium. Lateral pressure due to uniform surcharge load have already been worked out using elastic equilibrium concept and solutions are available in standard text books. The computation of Earth pressure using K_a, belongs to the limit equilibrium concept where moment of earth retaining structure, thus mobilishing the shear strength is contemplated. The writer feels that the equation obtained through elastic equilibrium concept cannot be converted into that obtained through limit equilibrium theory. The author says that the conventional method shows for $p = 0$ the lateral stress is equal to vertical stress which is difficult to conceive. It is not known how the author arrives at such conclusions.

The application of the theoretical solutions to design problems implies that the materials behave elastically. The elasticity solutions are good approximation at small displacements. At large displacements the stresses in certain regions reach the yield stress and stress distribution may be quite different from the elastic distribution. For example the elastic solution given a stress equal to infinity at the bottom of the yielding wall. This is obviously untenable in a real material. Plastic yielding would occur at these points as soon as the stress reaches the yield point. Hence the theoretical stress distribution from elastic theory is not valid in this zone even at small deflections. The difference between the actual and the computed stress distribution can be expected to increase as the deflection increases owing to the spead of plastic zone. The practical solutions of earth pressure distribution problems often falls in between the theories of elasticity and plasticity. In the light of the above. the writer feels that the mathematical solutions presented by the author is not acceptable both in theoretical and practical grounds. The writer still prefers the use of equation $p = K_{a,q}$ or alternatively elasticity solutions [equation (7)] as derived by the author in paper is $p = \frac{q}{4}(1+2\mu)$. It appears, in trying to combine both these equations with an assumption $\mu = \frac{K_o}{1+K_o}$ the author has committed an error as pointed out earlier and hence the solutions $p = \frac{q}{4}(2—\sin\phi)$ is not justifiable.

Author's Reply

The author thanks Shree N. Bubushankar, M.R. Reddy and R. Naga-manikkam for their comments and for the printing errors pointed out by them. It might be a good idea for Indian Geotechnical Society to send proofs to the Author, prior to the publication of material, since most of the errors specially in mathematical paper take place during transference from manuscript level to printing level. Fortunately, in this work, the printing errors would not vitiate the final results.

(1) Apart the printing errors, the main objection of Shri N. Babushankar and M.R. Reddy is regarding the equation $\mu = \frac{K_a}{1+K_a}$. The author is aware of the postulations regarding μ and K_o. Even then, he has used the

equation $\mu = \frac{K_a}{1+K_a}$, since more published data is available regarding relation between K_a and ϕ in prototype earth pressure tests than in K_o and ϕ. The author of the paper is not alone in making this postulation and Bowles, as quoted in reference 2 of the original paper has freely used this hypothecation.

(2) As far as the comments of Shree. R. Nagamanikkam are concerned, his main objection regarding $\mu = \frac{K_a}{1+C_a}$ is already dealt with in (1) above The standard text book literature giving lateral pressure due to uniform surcharge using elastic analysis incorporates μ value, and experiments on soils on quantitative estimate of μ are really very little. There is a small printing error, the author's contention is that for $\phi = o$ and not for $P = 0$, conventional method would yield equal values of lateral and vertical stress. That this is difficult to conceive for soils from practical point of view is clear, since even for soils having very small values of ϕ, the possibilty of the soil, obeying Pascal's Law thus making lateral and vertical stress equal is rather remote. The author must say that the equation $P = K_a\, q$, which involves conversion of actual load into fictitions earth should be put in the back. The relation $p = \frac{q}{4}(1+2\mu)$ is much better than that. Regarding exact relation between μ and soil properties, much is needed to be done. Till then reasonale postulation such as the one propounded by author will do. In fact, very little experimentation has been done for the case of uniform surcharge occuping complete backfill. And as has been pointed out in the last para of conclusions in the original paper, the author looks forward to such trials.