Rate of settlement under two- and three-dimensional consolidation

DAVIS, E. H. and POULOS, H. G. (1972). *Géotechnqiue* **22**, No. 1, 95–114.

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The Authors note that the Writer applied the simple diffusion theory to sand drain consolidation theory (Barron, 1948) and that a method including the use of soil stress–strain properties would be a closer approximation. The Writer strongly agrees. When the Writer developed his ideas the diffusion theory was the only one known to him. The influence of stress–strain properties was recognized but not included.

The Writer has suggested that such conditions be included in sand drain theory and has indicated that this should be done (Barron, 1970). Radial seepage forces will tend to strain the soil which might result in a non-uniform water content in the soil mass at the completion of consolidation.

The mathematics of this more realistic approach may be difficult to accomplish and it may be necessary to resort to the finite element method.

REFERENCES

Barron, R. A. (1948). Consolidation of fine-grained soils by drain wells. *Trans. Am. Soc. Civ. Engrs* **113**, 718.

Barron, R. A. (1970). Discussion on Foundation precompression with vertical sand drains. *Jnl Soil Mech. Fdns Div. Am. Soc. Civ. Engrs* **96**, SM5, 1831.

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The Authors agree that a Biot type solution to the sand drain problem is desirable. A colleague of the Authors', Dr J. R. Booker, has developed numerical or semi-numerical methods of solving the Biot theory and it is hoped to use these methods for the sand drain and other problems shortly. There is a possibility that such an investigation may offer at least a partially alternative explanation to the effects previously attributed to smear with sand drains.

Anisotropic elastic parameters for soil

PICKERING, D. J. (1970). *Géotechnique* **20**, No. 3, 271–276. Discussion (1971) **21**, No. 2, 181–183; (1972) **22**, No. 1, 183–185.

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In the discussion by Chowdhury and King (1971), they stated that the necessary conditions for the volumetric strain having the same sign as the mean applied stress are

$$\mu_{yx} < 0{\cdot}5 \qquad \mu_{xx} < 1-\frac{E_x}{E_y}\mu_{yx} \qquad \ldots\ldots (1)$$

In Pickering's (1971) reply, he proved that these conditions are neither necessary nor sufficient for soils falling within the range of possible cross-anisotropic elastic materials. Further, in Chowdhury and King's (1972) discussion, they explained that their conditions were valid on the assumption that all stress components are of the same sign. In the technical note by

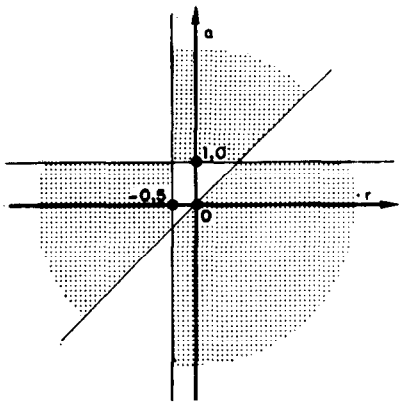

Fig. 1

Uriel and Cañizo (1971), presented as an extension to the Paper, the general expression for the volumetric strain of a soil under the stresses σ_x, σ_y, σ_z, τ_{yz}, τ_{zx} and τ_{xy} was given

$$3\epsilon_{oct} = \frac{(n-2\mu_{xy})(r-a)}{1-a}\frac{3\sigma_{oct}}{E_x}$$

where

$$r = \frac{1-\mu_{xx}-\mu_{xy}}{n-2\mu_{xy}}$$

and

$$a = -\frac{\sigma_y}{\sigma_x/\sigma_z}$$

Hence, the necessary and sufficient condition for ϵ_{oct} having the same sign as σ_{oct} is

$$\frac{(n-2\mu_{xy})(r-a)}{(1-a)} > 0 \qquad . \; . \; . \; . \; . \; . \; . \; . \; . \; (2)$$

It can be seen that this condition depends not only on the elastic parameters of the soil, but also on the applied stresses. For the inequality in equation (2) to be satisfied, two or none of the terms in brackets must be simultaneously negative. The equation $n-2\mu_{xy}=0$ represents a plane in the n, μ_{xx}, μ_{xy} space, defined by the line AB and the axis μ_{xx} (Fig. 2 of the Paper). This plane is represented by the line (AB)F in Fig. 2 of Uriel and Cañizo (1971). For every point lying on the right side of the line (AB)F, $n-2\mu_{xy}<0$ and, therefore, this condition is equivalent to $-\infty<r<-0{\cdot}5$.

Given this equivalence, the full discussion of equation (2) is easy. It can be transformed into

$$(r/0{\cdot}5)(r-a)(1-a) > 0$$

The shaded areas in Fig. 1 represent the only possible points for which the volumetric strain has the same sign as the mean applied stress. Conditions (1) coincide with $0<r<\infty$ and, in general, do not represent any limitation to the sign of $\sigma_{oct}\,\epsilon_{oct}$. If all stress components are of the same sign, then $a<0$ and it follows from Fig. 1 that these conditions are sufficient but not necessary for $\sigma_{oct}\,\epsilon_{oct}>0$.

REFERENCE

Uriel, A. O. & Cañizo, L. (1971). On the elastic anisotropy of soil. *Géotechnique* **21**, No. 3, 262–267.