Discussions

Rankine's Earth Pressure Theory for Inclined Backfills*

by

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The author is to be congratulated for deriving expressions for the co-efficient of earth pressure (K) intensity of earth pressure (p), magnitude and point of action of resultant earth pressure based on Rankine's theory, both for active and passive cases for inclined backfills in C-ϕ soils subjected to a uniform surcharge loading at the ground surface, for which no standard text books give suitable solutions. Though these expressions are lengthy, the evaluation of the quantities with the help of ordinary pocket calculators is highly appreciated. However the writer feels that following points should have been taken into account in the earth pressure computations.

Normally in most of the retaining walls which the geotechnical engineers have been asked to design, the effect of cohesion is neglected. The backfill which exhibit the property of cohesion, are subjected to tension crack and depth of tension crack is given by the formula $Z_c = \frac{2_c}{\gamma} \tan (45 \frac{+\phi}{2} \frac{-q}{\gamma}$. Hence the adhesion along the vertical face of the wall and cohesion along the plane of failure wedge get reduced to that extent thus increasing the magnitude of earth pressure on the retaining wall. It would have been better if this aspect is taken into consideration in deriving the expressions. In such cases, it appears reasonable to calculate the magnitude of earth pressure by using wedge theory. According to this a value of $P_a = 35.0$ Tonne/m for the magnitude of resultant earth pressure is arrived as against $P_a = 32.28$ t/m as given by the authors for the numerical example presented.

The backfills which exhibits cohesion behave as viscoelastic material. Under this constant strain, the shear stress would decrease with time because of stress relaxation. Consequently at sometime after the initial yielding, the shear stress in the soil is much less than its shear strength. Since active pressure is developed by virtue of shear stress along the surface of failure reduction in the shear stress increases the earth pressure. Due to increase in earth pressure the wall may again yield and the above process may get repeated. This results in necessity for continuos yielding of retaining walls. This is one of the reasons that life of the retaining structures retaining backfills which exhibit cohesive property, is likely to be of shorter duration compared to that which are designed to retain cohesionless backfills. Researchers like Tschebotarioff suggest that a

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greater wall movement is necessary for the mobilisation of active earth pressure. In cases where the yielding of wall cannot be permitted Taylor (1966) recommends that wall should be designed to withstand earth pressure at rest ($K_o=1$). This would result in highly uneconomical design and this is one of the reasons why the backfills which exhibit cohesion are not found practical use.

Reference

TAYLOR D W. (1966) FUNDAMENTALS OF SOIL MECHANICS, Asia Publishing House, New Delhi

Author's Reply

The author is thankful to Sri R. Nagamanickam for his interest and comments on the paper. The reply to his comments are as follows:

Rankine's theory does take into account the depth of tension cracks in cohesive backfills. The difference in the prediction of earth pressures this theory and the wedge theory is attributed to the fact that the back of the retaining wall is assumed to be frictionless (not mobilising the adhesion in cohesive soils) in Rankine's theory.

Backfills of cohesionless soils are normally prefered because of higher strengths and better drainability of these soils. It is true that strain-softening takes place in some soils (including stiff cohesive soils) in which case the residual shear strength value may be used in design instead of the peak strength. However, the strains needed to mobilise the active earth pressures are much smaller when compared to those necessary to mobilise complete passsive earth pressures.