

The efficiency of a cut-off with an overall permeability k_2 , where k_2 is less than the permeability k_1 of the alluvium has also been determined, and it is hoped to publish this, together with a full analysis of the cut-off with slits, in due course.

Yours faithfully,

Department of Civil Engineering,
Imperial College,
27 October, 1961.

N. AMBRASEYS, D.I.C., Ph.D.

The Secretary,
The Institution of Civil Engineers.

DEAR SIR,

The Paper "A contribution to the analysis of stress in a circular tunnel" by Mr H. D. Morgan (*Géotechnique*, 11 : 1 : 37-46) is of great interest.

It is felt that there are a number of points which deserve further investigation; the most important being as follows:—

- (1) On p. 41 of the Paper the conclusion that " $d_2=0$ (and consequently $p_r+p_\theta=0$) for the case where the ground is continuous for a long distance in the direction of the y -axis along the line of the tunnel and no strain occurs in this direction" is not acceptable. This is a case of plane deformation. The condition that $\epsilon_y=0$ leads to the well-known relation:

$$p_y = \nu(p_r + p_\theta)$$

and p_y is not zero as in the case of plane stress problems.

The problem can only be solved by taking into consideration the circumferential displacements of the tunnel and the lining. The Author appears to have ignored this aspect completely and, therefore, his results need modifications accordingly.

- (2) On p. 45 of the Paper, the conclusion that "the critical pressure before collapse, is of the same order as the elastic modulus of the ground" is not generally true and must be qualified. The Author arrived at the expression $p = \frac{3EI}{a^3} + \frac{Ec}{(1+\nu)}$, by assuming that the buckled shape of the lining is $z = \delta \cos 2\theta$. When the elastic modulus of the ground is high, deformation with a larger number of waves gives a lower buckling value. This can be compared with the case of a bar embedded in an elastic foundation, and this problem may be solved along similar lines.

To cover these points fully would require a paper of equal length. (This, the Writer hopes to prepare at a later date.)

The stresses in tunnel linings depend, to a very large extent upon the method of construction. For example, the deformation of the ground around the tunnel before the lining is constructed, the treatment at the interface between the ground and the lining are important factors in influencing the stresses in the lining. It is from this consideration that the Writer feels that field measurements and observations should provide important and valuable information which will increase our understanding of the problem. The Writer therefore gladly endorses the Author's appeal for more co-operation from others working in the same field.

Yours faithfully,

T. K. HSIEH, B.S., Ph.D., A.M.I.C.E.

Chief Designer, Planning Department.

George Wimpey & Co. Ltd,
London, W.6.
10 November, 1961.