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Dynamic Earth Pressure Distribution Behind Retaining Walls

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SYPNOSIS: The point of application of dynamic active thrust and its distribution are computed using the method of slices and criterion of maximization of overturning moment of the active thrust. The computations show that point of application of the dynamic thrust is significantly influenced by such factors as wall friction and acceleration coefficients. Horizontal accelerations coupled with positive vertical accelerations (acting downwards) have the effect of moving the point of application closer to the wall base. The combination of horizontal acceleration with negative vertical acceleration produces exactly the reverse effect and generates more overturning moments even though the magnitude of corresponding active thrust is less. The resulting earth pressure distribution shows a nonlinear trend.

INTRODUCTION

The point of application of active thrust (P_{ae}) and its distribution under dynamic conditions has been the topic of interest of research workers for quite some time. Notable among them are Basavanna (1970), Seed and Whitman (1970), and Joshi and Panigrahy (1985), who attempted to make predictions on the basis of certain simplifying assumptions.

The author used method of slices for predicting the point of application and distribution of the dynamic active thrust, in which, the analysis was made both statically determinate and unique by introducing the criterion of maximization of overturning moment of the active thrust. The details of these computations are presented and discussed in this paper.

METHOD OF ANALYSIS

A vertical wall(height H= 10m) with horizontal conhensionless backfill material (angle of internal friction, ϕ=30°, unit weight, γ =18KN/m^3) is considered in the analysis. Plane failure surface as per the Mononobe-Okabe analysis (1929, 1926) is assumed as shown in Fig. 1 and the failure wedge is divided into a number (50) of vertical slices of equal width. On a typical slice r, the forces acting are its own weight (W_r) dynamic forces K_hW_r and K_vW_r in horizontal and vertical directions (K_h and K_v are corresponding acceleration coefficients), interslice forces F_{rr} and F_{rl} and soil reaction R_r at its base. The analysis of forces is indeterminate because the directions of interslice forces (θ_{rr} and θ_{rl}) are unknown.

On the n th slice near the face of wall (Fig. 1), one of the interslice forces is P_{ae}, acting on its left side with known direction δ where δ is the angle of wall friction. However the direction of other interslice force on its right side is unknown. Similarly for the first slice of triangular shape, the direction of interslice force on its left side is unknown and on its right side, for any vertical plane passing through C, the direction of interslice force would be horizontal, since point C being a part of undisturbed semiinfinite medium. Thus the directions of interslice forces vary from 0 to δ, but the nature of variation being unknown. This may be expressed by the following relation.

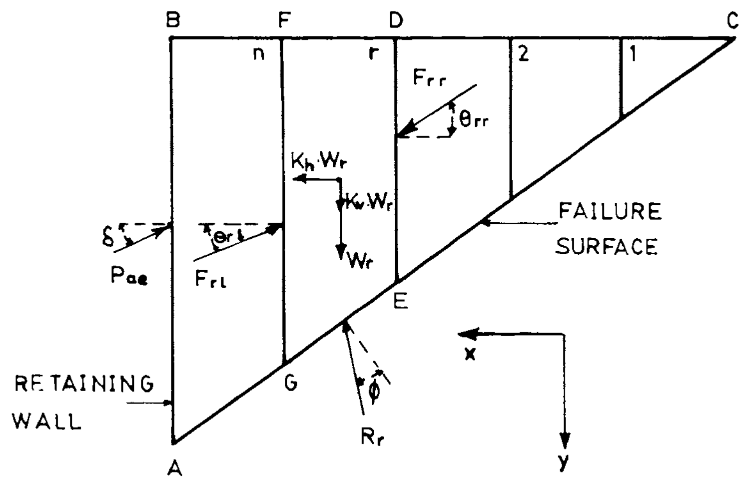

Fig. 1 Forces on a Typical Slice

$$\theta_{rl} = \left(\frac{CF}{CB}\right)^p \cdot \delta \qquad (1)$$

Where : θ_{rl} = inclination of interslice force on r th slice

CF,CB = distances as shown in Fig. 1.

The parameter p in Eq. 1 is unknown and by giving different values to p, different directions of interslice forces and hence different points of application of P_{ae} are obtained, thus making the analysis determinate but nonunique.

However the computations show that with increasing value of p, the height of point of application of P_{ae} from the base increases, in turn increasing its overturning moment and it reaches its maximum value when the directions of all interslice forces (except P_{ae}) become horizontal as seen from Eq. 1. This situation gives maximum possible value of overturning moment of P_{ae} and also makes the analysis unique. Since overturning moment is one of the principal parameters in the design of retaining walls, it would be quite appropriate if its maximum possible value is considered in the analysis.

On the basis of above criterion, a parameteric study was carried out and the resulted are discussed below.

DISCUSSION

The ratio of height of point of application of P_{ae} (h) to the height of the wall is designated

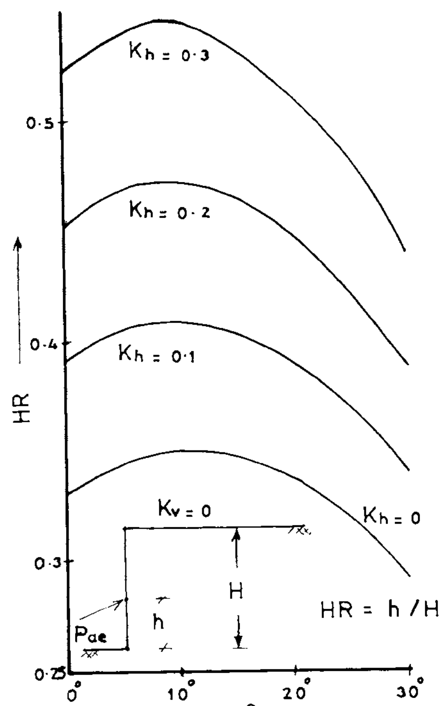

Fig.2 Variation of HR with K_h and δ

as HR and in Fig.2, the influence of δ and K_h (with K_v = 0) on HR is shown. It is seen that for any specified value of wall friction angle, the point of application of P_{ae} moves away from wall base with increasing K_h. For specified values of K_h and K_v, HR initially increases with increasing wall friction angle, attaining a peak and later showing a decreasing trend. Similar behaviour is indicated with other values of K_v (vertically downward positive) as shown in Fig.3

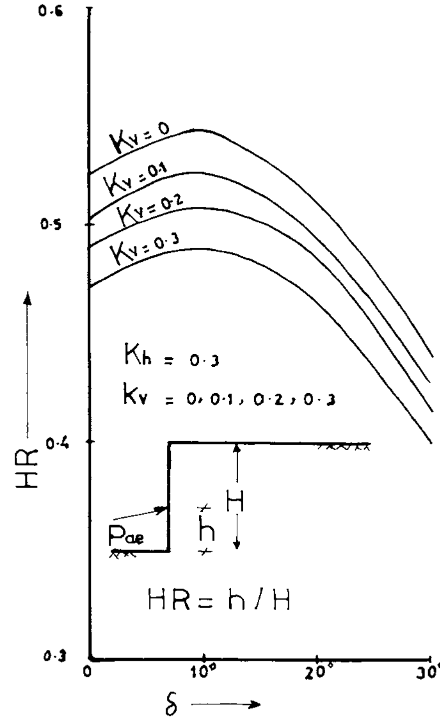

Fig. 3 Variation of HR with $+K_v$ and δ

and Fig.4.

Fig. 3 and Fig. 4 also show the influence of positive and negative values of K_v on HR. It is interesting to note that for a specified value of K_h, with increasing positive value of K_v, the point of application of P_{ae} moves closer to the wall base; whereas with increasing negative values of K_v(-0.1 to -0.3), exactly reverse effect is obtained. Thus the computations indicate that the combination of increasing horizontal and negative vertical accelerations is more effective in generating higher overturning moments even though the magnitude of the corresponding active thrust is less as compared to the combination of horizontal accelerations and positive vertical accelerations.

In Fig. 5, the results obtained by the author are with those obtained by the method proposed by Seed and Whitman (1970), for the case of a smooth wall with K_v=0. It is seen that the HR values as computed by the author are more, thus generating more overturning moments, with a marked divergence at higher values of K_h.

Finally, the distribution of earth pressure is shown in Fig. 6 for the case K_v= δ = 0. on which, pressure p_x along the retaining wall is expressed in dimensionless from($p_x/\gamma H$). Nonlinear trends in the distribution with increasing values of K_h are clearly noticable in the figure.

CONCLUSIONS

On the basis of above computations, the following conclusions are drawn.

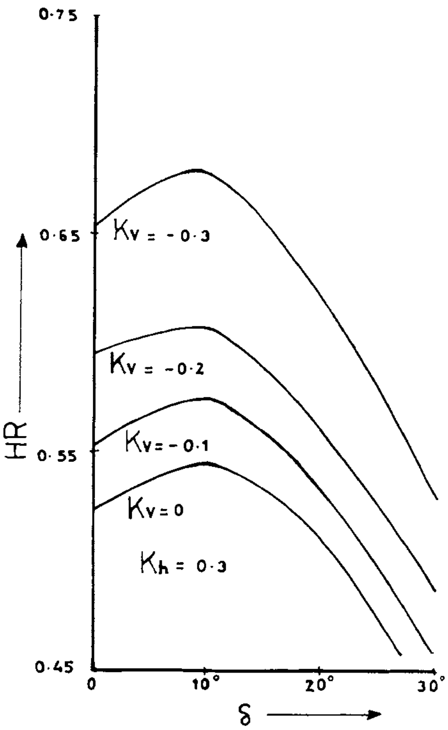

Fig. 4 Variation of HR with $-K_v$ and δ

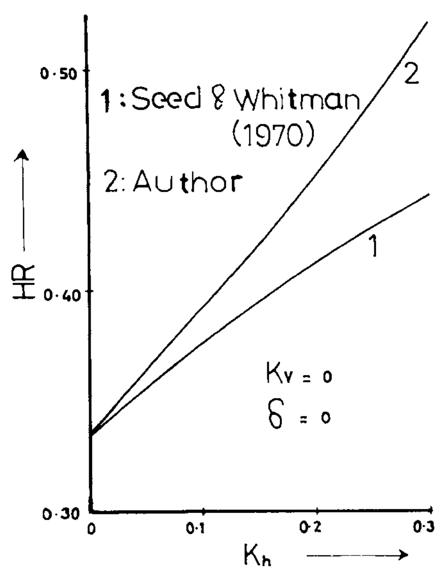

Fig. 5 Comparision of Author's and Seed and Whitman's results

1. For the backfill material of specified properties, the point of application of dynamic active thrust is significantly influenced by such factors as angle of wall friction and acceleration ceofficients.

2. The combination of horizontal acceleration and negative vertical acceleration (acting upward) generates more overturning moments.

3. The resulting distribution of earth pressure is nonlinear.

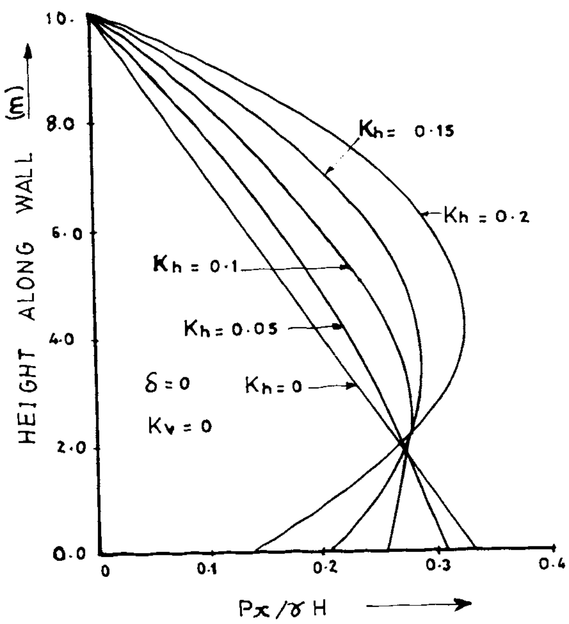

Fig. 6 Effect of K_h on Earth Pressure Distribution.

REFERENCES

Basavanna, B.M. (1970), "Dynamic Earth Pressure Distribution Behind Retaining Walls", Proc., 4th Symposium on Earthquake Engineering Roorkee, 311-320.

Joshi, V.H., and Panigrahy, G.K. (1985), "Active Earth Pressure Distribution for Design of Retaining Walls", Proc. 2nd International Conference on Computer Aided Analysis and Design in Civil Engineering, Roorkee, VI-92-VI-101.

Mononobe, N. (1929), "On the Determination of Active Earth Pressure During Earthquakes", Proc., World Engineering Conference, vol.9, 274-280.

Okabe, S. (1926), "General Theory of Earth Pressure", Journal of the Japanese Society of Civil Engineering, Tokyo, vol. 12, No. 1.

Seed, H.B., and Whitman,R.V. (1970), "Design of Earth Retaining Structures For Dynamic Loads", Proc., Speciality Conference on Lateral Stresses in the Ground and Design of Earth Retaining Structures, ASCE, 103-147.