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THE INFLUENCE OF WALL MOVEMENT MODES ON THE EARTH PRESSURE PARAMETERS AT ACTIVE STATE

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INTRODUCTION: The fallacy of the classical earth pressure theory enunciated by Coulomb lies in the fact that it does not consider the effect of the modes of wall movement on the earth pressure distribution and the distribution itself is assumed to be simply hydrostatic. Although abundant researches can be found in the field of earth pressure, no unified solution exists untill now encompassing the various modes of movement of the wall. This research is an attempt to put forward a solution to determine the earth pressure parameters for a rigid wall undergoing various modes of movement by numerical method.

MODEL SIMULATIONS: The finite element discretization of the backfill is shown in the Fig. 1, which is the simulation of the University of Washington's shaking table and retaining wall assembly.

The initiation of the active or passive state from the at-rest state involves the phenomena of progressive failure to capture which hardening plasticity is the best suited. In the present analyses Drucker-Prager's model of perfect plasticity has been modified to account for the strain hardening properties of the backfill. The dilatancy factor and the hardening parameter for the backfill are determined using the experimental data.

A simplified interface model explained in the Fig. 2 is used simulate the frictional behavior along the interface. The elements are assumed to have an effective length l with zero thickness (t) as shown in the figure. The mobilised value of the friction coefficient $\tan\delta$ at each incremental displacement can be evaluated by the ratio $\frac{P_t}{P_n}$, where P_n and P_t are the forces acting on the nodal points connecting the interface element as shown in the Fig. 2b.

METHOD OF ANALYSES, RESULTS AND DISCUSSION: Separate analyses have been performed by subjecting the wall to three kinds of movement, namely: translation(T), rotation about the top(RT) and rotation about the base(RB). Equal forced displacements are given to both the wall nodes as well as to the soil element nodes thus keeping the relative displacement in the normal direction between the wall and the soil always zero, which alleviates the necessity of assuming arbitrary value of normal stiffness of the interface element.

Figs. 3(a)-3(c) show the variations of the earth pressure coefficient K, the relative height h/H and the friction coefficient $\tan\delta$ with wall displacement. It can be observed that the nature of variation of the three parameters differs in each of the wall movement modes. A striking feature is the value

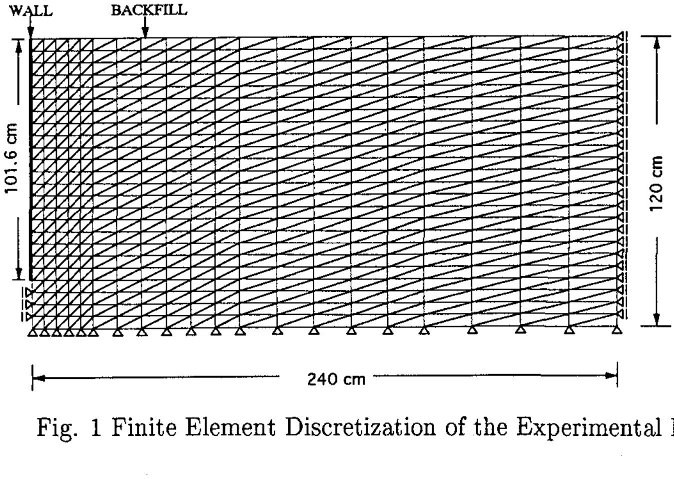

Fig. 1 Finite Element Discretization of the Experimental Model

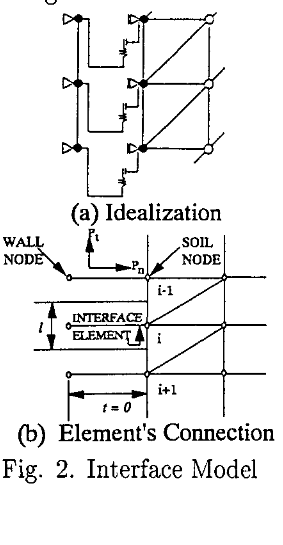

Fig. 2. Interface Model

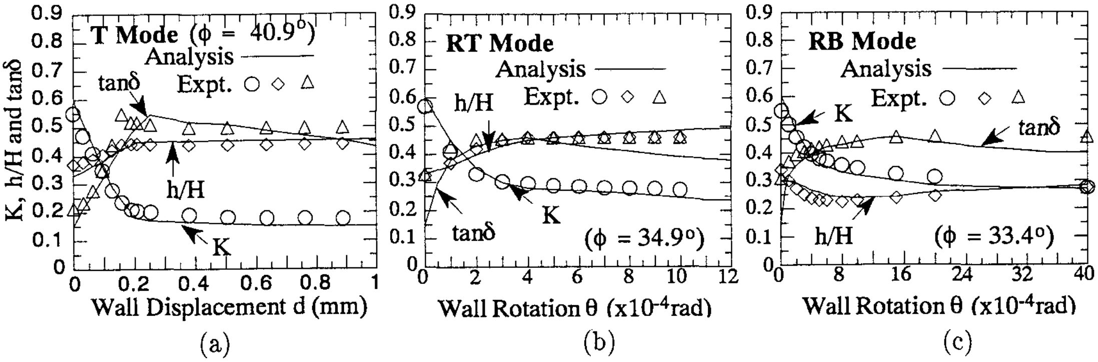

Fig. 3. Variation of K, h/H and $\tan\delta$ with Wall Displacement

of h/H which is different from Coulomb's value of 0.333. The noticeable variation of K among the three modes is in the case of the RT mode, in which it is continuing the decreasing trend. Active state has been defined based on the progressive deformation of the backfill and the parameters at the active state (i.e. K_A and $(h/H)_A$) have been calculated for various angle of internal friction ϕ. The active state coefficient K_A shows a close agreement with the coulomb values only for the T mode as seen in the Fig. 4. One important observation from the same figure is that the values calculated by using Dubrova's method of *redistribution of pressure* remain unaltered for each mode. Fig. 5 reveals that other than the RB mode, the magnitudes of $(h/H)_A$ from the analyses and Dubrova's solution agree well. Regression analyses of the results render the following two equations for K_A and $(h/H)_A$ expressing their wall movement mode dependent character for various values of ϕ.

$$K_A \cos\delta = 186203472.74M^3 + 5165156.8727M^2 + (47625.469 + \phi)M + 146.5014 \quad (1)$$

$$(h/H)_A = -5191872.4368M^3 + 43451.003M^2 + (59.1554 + \phi)M - 0.3524 \quad (2)$$

where M is the parameter which takes different values depending on the wall movement modes as shown in the Table 1.

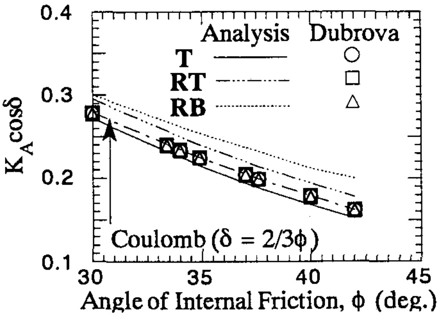

Fig. 4. Horizontal Active Coefficient K_A Vs. ϕ

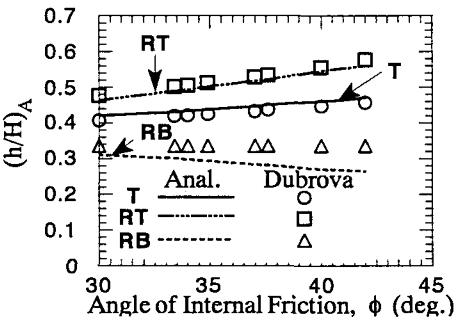

Fig. 5. Relative Height $(h/H)_A$ Vs. ϕ

CONCLUSIONS: The wall movement modes are seen to govern the failure pattern of the backfill. With increasing soil density the resultant earth pressure at active state and it's point of application behave differently depending on the wall movement modes. Dubrova's method has the limitation of giving the same value of resultant active thrust for all the wall movement modes.

Table 1: Values of Parameter M

Mode	M Value	
	K_A	$(h/H)_A$
T	−0.00996	0.00427
RT	−0.00970	0.00810
RB	−0.00836	−0.00399

REFERENCES: [1]Fang, Y.S. and Ishibashi, I. (1986):"Static Earth Pressure with Various Wall Movements", *Journal of Geotechnical Engineering Division, ASCE*, Vol.112, No. 3, pp.317-333.