8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

SEISMIC DISPLACEMENT OF COHESIVE-FRICTIONAL SLOPES USING NEWMARK'S METHOD

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Keywords: Newmark's method, Upper bound limit analysis, Displacement of soil slopes, Pseudo static method

The upper bound theorem of limit analysis together with Newmark's method is employed to evaluate the displacement of soil slopes subject to cracks. The pseudo static approach has been routinely used in the literature to estimate the seismic displacement of soil slopes. However, the effect of cracks on the slope displacement has yet to be tackled. In this paper, a new technique is proposed to estimate the horizontal displacement at the slope toe due to a given earthquake postulating rough estimation of real time crack formation. Rotational failure mechanisms for intact slopes exhibiting the formation of cracks as part of the failure process and the case of cracks, which are pre-existing in the slope, were considered. On the basis of Newmark's method, the seismic-induced displacement is calculated by incorporating a stepwise yield acceleration corresponding to the cracks occurring in the slope.

In order to calculate the slope displacements generated by the earthquake, a new yield acceleration, accounting for the presence of the cracks formed the first time the yield acceleration of the intact slope was exceeded, needs to be calculated for all the subsequent steps. Four cases are considered in this paper:

I. Slopes made of rocks / cohesive soils of unlimited tensile strength, hence not subject to tension cracks.

II. Slopes made of rocks / cohesive soils of limited tensile strength.

III. Slopes made of rocks / cohesive soils of zero tensile strength.

IV. Slopes subject to the most unfavourable crack from a stability point of view pre-existing the onset of the earthquake.

The analytical solution is derived here for the case of a horizontal upper slope surface and vertical pre-existing cracks from the upper slope (see Figure 1). However, the solution can be straightforwardly extended to the case of a non-horizontal

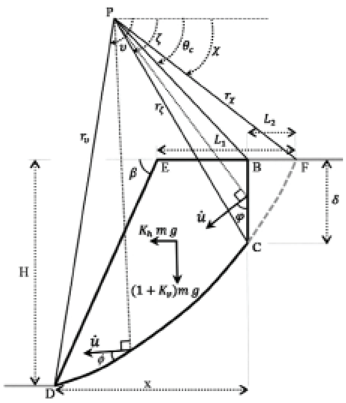

Figure 1. Failure mechanism. Note that φ φ. The wedge of soil enclosed by black lines D-C (Logarithmic spiral failure line), B-C (pre-existing crack), B-E (upper surface of the slope) and E-D (slope face) rotates around point P.

upper slope and that of cracks departing from the slope face.

Results of the proposed technique can reasonably bridge the gap between the conservatism of assuming the slopes subject to the most detrimental cracks, and the overestimation of slope stability resulted from the neglect of crack formation.

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