A Comparison of 2D and 3D Slope Stability Analyses of Road Embankments

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In current practice, the slope stability of a road embankment is usually investigated using two-dimensional limit equilibrium (LE) methods which assume plane strain conditions. In many cases, however, the critical loading condition on top of the road is derived during the construction phase wherein heavy equipment transmit high base pressures over a limited area, thereby rendering the plane strain assumption unrealistic. Despite the availability of software that are capable of modeling slopes in three dimensions, geotechnical professionals usually perform two-dimensional analyses because of the relative ease of model construction and relatively faster simulation times.

This paper investigates the discrepancy between the critical Factors of Safety (FoS) that are obtained from two- and three-dimensional LE techniques by considering variations in surcharge load configuration, slope gradient, embankment height, and material strength parameters. The results of this parametric study show that for the same slope, three-dimensional analyses would produce higher FoS than two-dimensional LE calculations, with variations reaching as high as 40%. The results of this study assert the significance of performing three-dimensional slope stability analyses on road embankments to achieve potential cost savings on projects.

Keywords: slope stability, limit equilibrium method, two-dimensional, three-dimensional