SLOPE STABILITY ANALYSIS USING EFFECTIVE FORCE METHOD OF SLICES

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Mass wasting in the form of slope failures, landslides and debris flows is a common way of natural degradation of soil in mountainous terrain. Heavy rainy spells are found to be the most common triggering factor which causes slope instability in most parts of the world. It is well established that heavy rains lead to change in subsurface water flow regime, which eventually initiates increase in pore water pressures in these regions. Therefore, it is of an interest to study analytical methods of slope stability under these conditions. Various approaches for solving the stability problem could be found in the literature and, they could be broadly classified as limit equilibrium analysis, limit analysis, slip line method and as combination of these. Moreover, it is well recognized that an accurate method of slices gives essentially the same factor of safety as that obtained by other approaches using numerical methods, such as finite element method.

The classical method of slices for the evaluation of the stability of slopes has been greatly improved since the first publication on the stability of earth dams by Fellenius in 1927. However, until late 1980s, serious deficiencies of the classical method of slices with respect to its application to the effective force analysis of slopes were not recognized. Numerous literature could be found even thereafter with the same misinterpretation of total and effective force analysis in the presence of seepage. Therefore, an attempt is made herein to clarify the mechanics of the solution of the method of slices with the presence of seepage within the soil mass. Limit equilibrium equations for slices with the presence of interslice forces, which satisfy the total, effective, and water forces are derived. The problem is made statically determinate using modified Spencer's (1967) approach. Computer algorithms are constructed for both the proposed approach and the classical Spencer's method in order to analyse the problem which is iterative in nature more efficiently. Case studies are carried out selecting different landslides from Japan and Sri Lanka to investigate the applicability of the proposed methods.

The difference in factor of safety obtained using the new technique and the classical Spencer's method is about ±2%. Therefore, it is concluded that due allowance must be made for the combined effects of buoyancy and seepage forces when investigating the stability of slopes in the presence of seepage.