Geological assessment of the cut slope failures in highly weathered igneous rocks at the Senai Toll Plaza of the Malaysia-Singapore Second Crossing Expressway, Johor, Malaysia

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During the wet season in mid April 1997, a major slope failure has occurred in a slope cut near the Senai Toll Plaza of the Malaysia-Singapore Second Crossing Expressway. The failure can be described as a deep sliding (Varnes, 1978; Ibrahim Komoo, 1986) in a zone of highly weathered rocks (grade IV) to residual soil (Grade VI), although the failure mechanism took place in the form of double wedge controlled by relict structural discontinuities.

Detailed geological mapping was carried out to identify the geological factors that might cause the failure. Field evidences indicate that the failure is structural-controlled, and thus discontinuity survey was thoroughly carried out on every berm slopes including the failure scarps to identify the attitude and influence of discontinuities towards the slope instability. The conventional discontinuity survey (e.g. Geotechnical Control Office Hong Kong, 1984; Ibrahim Komoo & Ibrahim Abdullah, 1983) could not be conducted because the slope surface is almost entirely turfed and the outcrops are too limited as well as intensely weathered. Thus, the study has to be carefully done in a "walk-over" survey over almost the entire slope surface to detect the presence of any form of relict discontinuities. The mapping was also extended to the areas around the failed section to identify environmental factors that might contribute towards the slope failure.

Results of the kinematics stability analysis on the discontinuity data clearly indicate that the elements of instability already existed in the slope mass due to the presence of unfavourably daylighting intersecting sets of discontinuity. The sliding planes were developed along the relict fault zone, relict joints and also along a highly weathered aplite (kaolinite) dyke. There are signs that surface runoff flow towards the failed sections. Man-made topographic depressions found in the oil palm estate above the slope were responsible for temporary water ponding, which encourage water infiltration. Infiltration rate was also accelerated by the widespread occurrences of shrinkage cracks in the clayey soil surfaces, which are interconnecting with the relict discontinuities within the slope. Water also infiltrated into the slope through the cracks on the concrete berm drains and water spillage from the clogged up drains.

In conclusion, the slope failure is primarily caused by the presence of relict structural discontinuities. Water was identified as the main triggering factor. An almost continuous daily rainfall prior to failure has led to increasing flow of surface runoff and rate of infiltration. This subsequently led to saturation and drastic decrease of shear strength parameters of the materials and discontinuity planes. It is suggested that stability assessments of slope cuts in highly weathered rocks need to take into consideration not only the material strength parameters, but also most importantly relict discontinuities and local climatic conditions and other surrounding factors. The constructed slope should also be constantly and continuously monitored, especially during the rainy seasons.

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