

SESSION 17: SOIL SLOPE STABILITY

Papers:

STABILITY CHARTS FOR SIMPLE EARTH SLOPES ALLOWING FOR TENSION CRACKS
B.F. Cousins, Vol 2, 101-105

STABILISATION OF A MUDSTONE DERIVED COLLUVIUM SLOPE
G. Ramsay, Vol 2, 107-114

STABILITY OF CUT SLOPES IN A PUMICE SOIL DEPOSIT WITH PARTICULAR REFERENCE
TO TENSILE FAILURE
T. Yamanouchi, K. Gotohi and H. Murata, Vol 1, 115-120

Paper by B.F. Cousins

Mr J.P. Blakeley asked Dr Cousins to comment on the relative reductions in the stability associated with the reduction in length of the shearing surface caused by the tension crack and the effect of water pressure in the crack. Dr Cousins replied that in his study he had allowed the tension crack to completely fill up with water and found that it did alter the position of the critical point of the slope.

Dr G.L. Boyd asked the author whether his approach differed from Hoek's stability charts, in what type of material, and in what type of slope he would confidently use the design charts, and which particular features of slope materials, or slope conditions would lead him to suggest caution in using the tables? Dr Cousins replied that charts were tools and a lot more knowledge and research was required to determine their usefulness. There were no uniform soils and this caused problems. The charts used the same techniques as slip surface analysis, their value depended on the user. The charts were similar to Hoek's apart from the use of pore pressure ratios; the charts were more suitable for low slope angles rather than high angle slopes where pore pressures were more influential.

Dr R. Sancio stated that by using the most unfavourable tension cracks, two drawbacks arose:

- i) Where the slope was very steep, say 60° the height of the tension crack became unreasonably large.
- ii) Large values of Z_c/H resulted, particularly when water was allowed to fill the crack near or at the crest of the slope.

Point (i) had been clearly taken into account by limiting Z_c/H to 0.5 as suggested by Terzaghi. So far as point (ii) was concerned, it had been shown by finite element methods (Duncan and Dunlop 1961) and finite difference methods, or limit equilibrium methods (Sancio and Goodman 1979) that tensile strength decreased in the upper slope towards the crest and became practically zero there. He asked whether Dr Cousins would agree that in the case of water filled cracks the approach gave quite conservative factors of safety in steep slopes and suggested that he should restrict his tables to a maximum

slope angle of 60° . To the first question, Dr Cousins agreed that the 0.5 factor seemed a reasonable cut off point, and that the restriction of the tables to 60° was a good suggestion.

Paper by G. Ramsay

Mr J.P. Blakeley asked how much was the drainage system designed on the basis of investigation and how much was it modified as construction of the drainage system proceeded. Was the amount of investigation carried out prior to construction works considered to be sufficient in the light of experience gained during drainage construction?

Mr P. Wilcox, who was associated with the initial design, replied to the first question that the drainage system was designed at the same time as the initial portal structure, and the only modifications were to reduce the amount of excavation by extending the portal system and to include inclined drains within the portal structure.

Dr I.M. Parton, also associated with the design work, replied to the second part of the question that a variety of investigation tools were used at the Poro-o-tarao site, ranging from core penetrometers and standard penetration tests, small diameter drill holes and 1m diameter shafts, and seismic refraction methods. The seismic refraction studies did not provide useful information due to the nature of the colluvium. The 1m diameter shafts proved cheap to install and provided an opportunity to study the mudstone-colluvium interface in situ.

B. Tait asked if a permanent inspection system has been provided. This was of vital importance in this type of stabilisation. Mr P. Wilcox commented that a continuous monitoring system to monitor slope stability and to give an indication of any change in stability is operated by the Railways.

Mr R.L. Couch stated that as one who had been involved in the pre-construction phase of the investigations, he would like to support Dr Ramsay's conclusions that in this type of material large diameter shafts were a much more effective means of investigation on unstable slopes than small diameter boreholes. Furthermore, they could be put down much more quickly and at similar cost to the small

diameter holes. As an extra bonus, the shafts were a more suitable means of installing piezometers. The points demonstrated so clearly at Poro-o-tarao have since been successfully applied in similar materials at other sites.

Paper by T. Yamanouchi, K. Gotohi and H. Murata

Mr M. Mitchell noted that Fig.7 of the paper showed maximum stress contours, and asked whether the case of a concave lower slope was analysed in order to reduce some of the more critical stress. Dr Yamanouchi showed that the protection of the

slope meant that it was difficult for a concave lower slope to be obtained.

Mr G.L. Evans commented that Table 7 showing index properties indicated a wide range of natural moisture content from 7.7 percent to 30 percent. He asked what influence moisture content had on strength; what was the moisture content ratio; and how much was the moisture content likely to change with rainfall? Dr Yamanouchi replied that strength changed with moisture content and the most damage occurred after heavy rain. The moisture content ratio was equal to the moisture content as a percentage.