

1984/55. Slope stability assessments in Tasmania - ideas for future work.

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Abstract

It is suggested that the overall objective of future work on slope stability assessments in Tasmania should be to increase confidence in stability assessments of unfailed slopes and old landslips. One approach would be to closely examine all slopes in selected areas. Detailed geological mapping and logging is the key to a better understanding of slopes. Greater confidence in stability analysis can be gained by investigation of active landslips using a combination of field monitoring, laboratory testing, and back analysis. It is important that any full-time research project is closely supervised by Departmental geologists.

INTRODUCTION

The purpose of this report is to present some ideas for future work on slope stability in Tasmania. It is emphasised that the ideas presented here should be regarded as preliminary suggestions only and they are recorded to stimulate discussion rather than as definite proposals. The completion of one research project (Moon, 1984a) and the possibility of another (funded by the Soil Conservation Programme), make it an opportune time to consider where future effort can be best directed.

Only a brief outline of a general approach is given in this report. Specific details have been discussed with P.C. Stevenson and R.C. Donaldson during a two day field trip to the North-west Coast. There is also a discussion on how confidence in stability analysis can be increased.

This report is the third in a series of four (the others are Moon, 1984b, 1984c, and 1984d) on various aspects of slope stability work in Tasmania. The Master of Science thesis (Moon, 1984a) is complementary to this series of reports. The thesis also contains general suggestions for future research.

OBJECTIVES

The overall objective of the work proposed here is to increase confidence in stability assessments of unfailed natural slopes (Tamar, Zone III) and slopes which, although currently inactive, may have failed in the past (Tamar, Zone IV). These are the areas where difficult decisions have to be made and where stability analysis has to involve many assumptions.

SUGGESTED APPROACH

There is insufficient time and resources (even with a three year full-time research project) to usefully examine all landslips and slopes in the Tamar Valley and the North-west Coast. One approach would be to select one, or at the most two, areas for detailed study. This has already been suggested by W.L. Matthews, and R.C. Donaldson has proposed the Lillico area as a type area for the North-west Coast.

Within the selected region all active landslips, old landslips, and steep unfailed slopes should be examined, and some would be selected for subsurface investigation.

IMPORTANCE OF GEOLOGY

The importance of geology to the assessment of natural slope stability cannot be over-emphasised. The principal activity within the selected region will be detailed geological mapping, including the logging and recording of all natural and man-made sections (Moon, 1980).

In the basalt areas along the North-west Coast of Tasmania the sort of questions that need to be answered include:

- (1) What is the bedrock? Entirely basalt or are there interbedded or underlying sediments?
- (2) What is the depth of weathering? A description of the weathering profile is required.
- (3) What is the depth and nature of the soil profile?
- (4) What is the thickness and nature of the colluvium?
- (5) How do all of the above vary within the selected region? How do they vary within a typical slope cross-section?
- (6) What is the role of groundwater within the slopes?

These questions should be investigated for all slopes within the selected region if there is any chance of understanding why some slopes are actively failing, others appear to have failed in the past, while other steep slopes appear stable.

In the Tamar Valley similar questions need to be asked. The lithology of the 'bedrock' Launceston Clays could be very important in understanding controls on slope stability. The distinction between unweathered 'bedrock' clay, weathered profiles including soil horizons, and colluvium and disturbed materials will be important. In many cases all these materials consist of high plasticity clays. Understanding the geology and the geomorphological evolution of such slopes will only be achieved by careful, detailed subsurface investigations. Continuous exposures provided by road cuttings and backhoe pits will be most useful for the near-surface investigations but this information will need to be supplemented in depth by drilling.

Seismic refraction surveys may be useful in determining bedrock depth along the North-west Coast but it is not likely to be very useful in the Tamar Valley because of the lack of velocity contrasts.

INCREASING CONFIDENCE IN STABILITY ANALYSIS

Methods of slope stability analysis are presented and discussed with examples by Moon (1984a, b and c) and it is assumed that readers are familiar with the uses and limitations of such techniques. Only effective stress analysis, using effective shear strength parameters, has been considered for reasons explained by Simons and Menzies (1978) and Moon (1984a).

Clearly, the major challenge in carrying out meaningful stability analyses of natural slopes will always be the determination of the geological model. Analyses based on incorrect or oversimplified geological models may be misleading.

The variability or uncertainty involved in almost every parameter affecting the stability of a slope makes probabilistic methods particularly appropriate to their analysis. One such method is discussed by Moon (1984c). Comments on the assessment of the quality and the variability of some of the input data are given by Moon (1984c) and an example of input data review is given in Moon (1984a).

The most critical input parameters in the analysis of shallow landslips are cohesion (C'), friction angle (ϕ'), and pore pressure (expressed as the pore pressure ratio r_u). In the analysis of slopes without subsurface investigation these parameters have to be guessed. Even with extensive subsurface investigation it is rarely possible to determine all three parameters accurately. Attempting to determine one unknown parameter by back analysis of an active landslip is possible *if all other parameters are known*. Otherwise assumptions need to be made and care should be taken to avoid misleading or unreliable results (Leroueil and Tavenas, 1981).

One approach to gaining greater knowledge of C' , ϕ' , and r_u , and greater confidence in assessing their variability, is to use a combination of field work, laboratory work, and back analysis of active landslips. Of the three parameters, r_u can be measured in the field by the installation and monitoring of piezometers. There is a need for more information on pore water pressures in active landslips in Tasmania and any subsurface investigation should include this activity. The type of piezometer described by Moon (1984a) is simple and cheap and should give reliable results in soils of sufficiently high permeability. In lower permeability soils more responsive piezometers (e.g. pneumatic) may need to be considered. The friction angle and residual friction angle (ϕ' and ϕ_r') can be measured in the laboratory with sufficient accuracy but the cohesion (C' and C_r') is more difficult to determine. Moon (1983, 1984a, and 1984e) discusses both of these parameters. Variations of cohesion of only one kilopascal can have considerable effects on the factor of safety or the probability of failure (see Problem B, further questions, Moon, 1984c) and determinations to this accuracy cannot be expected from laboratory testing. In active landslips where piezometer monitoring and laboratory testing have been used to determine r_u and ϕ' , back analysis can be used to determine 'field' cohesion at the time of failure. Probabilistic methods of analysis can take into account uncertainties in other parameters. If this approach is adopted for active landslips (where it is known that the factor of safety is one) confidence in assessing values of cohesion appropriate for stability analysis in other situations should develop.

The actual values of C' and C_r' applicable to the analysis of stiff fissured clays are discussed by Moon (1984a, 1984e). Chandler and Skempton (1974) and Williams and Mure (1983) adopted values of 1.5 to 2 kPa for C' when investigating the design of cuttings. Until further work is carried out in Tasmania along the lines suggested above it would seem reasonable to adopt values in the 1 to 3 kPa range for both C' and C_r' .

DISCUSSION OF POSSIBLE RESEARCH PROJECT

The ideas presented in this report can be applied whether or not the proposed soil conservation research project is carried out. If somebody is employed from outside the Department to work full-time on slope stability investigations the person will need to be closely supervised. Under the present work load it is unrealistic to expect one geologist from the Department to provide all the required initial training, field supervision and direction. One possible arrangement would be for R.C. Donaldson to

select an area along the North-west Coast and provide the close field supervision and direction for that part of the project. W.L. Matthews could select and supervise the Tamar Valley detailed study with P.C. Stevenson contributing to both areas, as well as being overall project manager. However, if time and resources are limited it may be necessary to restrict the study to one area.

Whatever approach to the research project is finally adopted, it is suggested that the prime objective should be to obtain a better regional understanding of slopes and care will have to be taken to ensure that the project does not become bogged down to the investigation of a few individual landslips.

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