

SESSION 22: MATHEMATICAL ANALYSES

Papers:

Foundation Design

THE BEHAVIOUR OF CIRCULAR TANKS ON DEEP ELASTIC FOUNDATIONS
J.C. Small, J.R. Booker and P.G. Redman, Vol 2, 215-219

ULTIMATE LOAD FOUNDATION DESIGN USING STATISTICALLY BASED FACTORS
P.A. McAnally, Vol 2, 227-232

Finite element analysis

AUTOMATIC JOINT ELEMENTS GENERATION TO SIMULATE STRAIN SOFTENING YIELD BEHAVIOUR IN EARTHEN MATERIALS
B.G. Richards, Vol 2, 233-239

THE ANALYSIS OF MULTIPLE UNDERREAM ANCHORS
R.K. Rowe and J.R. Booker, Vol 2, 247-252

Paper by J.C. Small, J.R. Booker and P.G. Redman

Prof P.W. Taylor asked if the wall was free to move both at the top and base, should there not be a linear tension distribution. Mr Small replied that the wall was still connected to the base but was free to move horizontally with it. There was no differential movement between the base and the wall. The practical implications were greater tensions in the base of the wall but lower moments.

Dr P.T. Brown commented that it was also important to consider whether the roof was fixed at the top of the sides, or floating. In the latter case wall deflections might cause the roof to jam. Mr Small replied that both floating and fixed roofs could be accommodated in this analysis.

Mr L.C. Douglas noted that Mr Small had mentioned in his presentation of the paper the idea of stepping the walls of concrete tanks for the economical use of materials. This idea might not be well received by those involved in constructing concrete tanks because temperature effects in concrete tanks could cause movement of the walls during the early curing stages, which could disturb the concrete to concrete junction. Mr Small replied that concrete tank constructors tended to use a tapered wall because of formwork effects. Temperature effects also needed to be considered.

Paper by R.K. Rowe and J.R. Booker

Prof Ladanyi asked what the practical applications of this analysis were. Dr Rowe replied that the presentation was of an analytical model which must be used with engineering judgement. One example of its use was for helix pipe anchors.

Prof H. Ohta asked whether Swain's results had been used to compare experimental results with the theory. Dr Rowe replied that this was now being carried out. The comparison did not appear to be very close near the surface, probably due to tension effects. Good estimates could be obtained

below depths of 2D when using the modulus found from one test to predict other results.

Prof P.W. Taylor suggested that, in practical applications, there would be elastic extension of the anchor rods between the anchor points. He asked whether the author had considered this point, and whether he thought it would be significant. Dr Rowe replied that this had not been considered in this paper but that a more generalised study will be published shortly.

Paper by B.G. Richards

Prof I.B. Donald said that three points were not clear:

- i) The strain softening appeared to be instantaneous for any one element and the model predicted nicely the gradual strain softening of the mass, but it was possible for strain softening to be gradual for one element and it would be interesting to know if the programme could handle this. Fig 7 showed elements in the process of strain softening which seemed to imply a gradual rather than an instantaneous process.
- ii) Although the plane strain problem solved was a symmetrical one, the predicted failure was asymmetrical; how did that happen?
- iii) Fig 20 showed a considerable difference between the slope of the line of failed elements and the observed failure plane. How could this be explained and how did the result compare with a critical wedge analysis?

Dr B.G. Richards replied as follows:

- i) The combination of elements at different stages of softening resulted in an overall gradual strain softening.
- ii) The τ_{max} failure planes in a triaxial test were symmetrical but due to the mathematical model failure became oriented in the direction of the

element which failed first.

- iii) The position of the failure plane was only known at the top of the escarpment and at the toe. Hence a straight line was drawn. Two wedge analysis resulted in a line of lower slope than that generated by the model.

Dr M.J. Pender commented that the author had mentioned the inclusion of dilatancy in his programme and asked whether he had any comments on the effect of dilatancy on the results of the analysis. Dr B.G. Richards said that the dilatancy part of the model had not been verified. Dilatancy could be incorporated in the diagonal terms of the stress matrix, or through the non-associated flow rule, or instead of setting the angle of maximum shear strain, by setting the velocity gradient at one place.

Dr J.A. Webster asked what material data the model had been based on and Dr G.B.

Richards replied that 400-500 cores had been taken from the spoil pile and hundreds of shear box and triaxial tests performed. Extensive field instrumentation was also undertaken.

Mr J. Eckersley briefly described the general geometry of observed spoil pile failures modelled by Dr Richards in this paper. The general deformation pattern included a steeply dipping, well-defined shear plane (58° to 70°) near the spoil crest, with up to 20m of shear displacement; the displacement of the spoil block from toe to mid-height into the pit as a virtually intact block, with 5 to 20m of movement, and the formation of a mid-height deformation zone of tension cracks and/or well-defined steeply angled shears. The third feature was more clearly defined in some cases than others. The conclusion drawn was that the mechanism could be represented by a simple system of two sliding wedges.