

DISCUSSION OF INVITED ADDRESS BY R. D. NORTHEY

Dr M.J. Pender commented on Dr Northey's suggestion that statements of future probabilities should always be related to a time scale. He felt that this posed considerable difficulties in geotechnical engineering. It is clearly possible to reduce data on say road deaths to a probability of meeting with an accident per year. However, data on soil failures are relatively few and well documented case histories very rare. Thus, it is hard to see how one can talk of slope failure probabilities in terms of events per year. However, one aspect of the probability approach that is very useful is the background it provides to the probability of failure concept. Relatively simple calculations in terms of failure probabilities illustrate very clearly the significance of variability of soil strength parameters for various factors of safety. Dr Northey replied the time aspect could not be completely neglected as eventually all slopes must fail.

Mr J.D. Hodgson described recent experience in the Sydney Division of the Institution of Engineers in Australia on listing structural engineers which is relevant to this paper. The object was to list those capable of designing structures in terms of the local government ordinances. After a lengthy and wide-ranging discussion within the profession, two meetings of members rejected the proposal, and it is now probable that a system of compulsory checking will be suggested as an alternative to protect the public interest. The legal aspects of building regulation need to be considered as recent rulings have put at risk the inspector and the authority and have caused some authorities to effectively cease inspection work.

With regard to dam safety it is considered excellent that each dam authority in NSW now has a dam surveillance unit but he would feel happier if each authority checked another authority's dams rather than their own. In all cases, it seems better to use checking rather than other forms of regulation. The profession must look too at the image of itself that it projects. Generally, this is one of infallibility, and if we are now to change to probability of failure, with its acceptance of fallibility, then we should think through carefully how we are to change this image and the public acceptance of it and the new risk of something less than 100% attainment

of the design objectives. Dr Northey agreed and repeated his earlier comment that human behaviour was the greatest source of uncertainty.

Mr P.C. Stevenson suggested that the risk should be standardised to the risk in one year, and that the design life should be eliminated. If risk was considered in terms of the risk per year, one of the variables was removed. However accurate an estimate was, it must be measured in relation to a fixed period of time. Dr Northey agreed.

Dr R.H.G. Parry commented that there was an interesting cycle of events when new techniques were introduced, which could be seen in bridge design. There seemed to be a cycle of bridge failures every thirty years or so. First of all there was a period of introduction of a new material which was safe due to the thought behind its introduction. Then there was a period of development which was also safe. Finally, a period of great risk due to complacency and the reduced number of people involved in the design. He was involved in the design of structures in the North Sea and was in the early stages of using new techniques. They were driving very large piles, 2.5m in diameter and 30m in length into soils which were not found on land. How did one even start to assess their properties? There was no way in which statistics could be applied with confidence at this early stage. Dr Northey agreed that new processes were handled carefully until they became familiar and then they were pushed too far. Also there tended to be a generation gap between engineers - maybe each generation had to relearn.

Dr J.A. Webster commented that the generation gap in engineering became apparent when a pattern was well established, due to incremental refinements in the methods of construction, rather than to any sudden changes. He suggested that the profession should consciously take stock every ten years and look at building in a new light. Dr Northey agreed, and added that maintenance methods need to be updated in a similar manner. As an example, he recalled that in 1976 Wellington had a quarter of the annual rainfall in 24 hours. This showed up weaknesses in the design procedures, forcing people to look at the causes of failure - roads should have been designed as overflow channels, the designer reminding himself that the question was not 'if' but 'when'.

Mr J.N. Kay submitted the following written discussion.

Dr Northey indicated that he did not wish to discuss the more esoteric aspects of probability theory and one that he cited was the Bayesian approach. Dr Parry in his discussion indicated that a probabilistic approach was not viable for cases where few, if any, statistics had been gathered relating to the type of structure and to the site. The case of the oil rig design in the North Sea was used as an illustration. He suggested that, particularly for these cases, the philosophy implied by the Bayesian approach should be given serious consideration if progress was to be made in the rationalisation of uncertainty. A large proportion of

structures were one-of-a-kind types and we were frequently confronted with the difficulty to a greater or lesser extent, that few past performance data were available. Whereas the lack of data tended to deter us from taking a probabilistic approach, the greater uncertainty level really indicated a greater need for a systematic evaluation along these lines. This meant that we may need to develop probability distributions, for individual aspects such as material properties, human error, applied loads etc based (at least in part) on subjective judgement. Relatively simple methods have been proposed by Cornell and others (American Concrete Institute Proc. 1969) for carrying through the evaluation in conjunction with estimates of the consequences of failure.