Comments by the author of the intodcutory report

Comments by the author of the introductory report
Remarques de l'auteur du rapport introductif
Bemerkungen des Verfassers des Einführungsberichtes

ALFRED M. FREUDENTHAL
Columbia University
New York

The discussion contributed to Theme Ia ranges from a rejection of the approximate probabilistic approach to structural safety based on the introduction of load and of carrying capacity as random variables as mathematically not rigorous enough (Misteh, Eimer, Konishi) to its rejection as being "mathematics" instead of being "common sense" (Hrennikoff), whatever this may mean. It is encouraging to those who, over the years, have attempted to promote a rational probabilistic approach to the concept of structural safety, that among the 8 contributions to Theme Ia only a single one (Hrennikoff) repeats the familiar argument of the "practical engineer" that problems of safety should be left to the "collective judgment of the profession" which will protect society from "erudite mathematical derivations" which can obviously not estimate the chances of incompetence in analysis, design and construction. Since Prof. Costa, in his discussion, has refuted this point of view by summarizing the principal arguments for the probabilistic approach in a most effective manner I shall comment only on the other extreme, namely the proposition to base the approach to structural safety on the theory of stochastic processes.

While, in principle, there can be no objection to this approach, a closer consideration of its practical applicability reveals that even an approximate solution of the problem of the estimation of the time to failure ("first exceedance" or first passage" time) presupposes the introduction of such drastic simplifying assumptions concerning the character of the random process, the response of the structure and the nature of the failure process that the physical significance of the solution becomes dubious, to say the least. Even with these simplifying assumptions not even an approximate solution can be obtained if the resistance of the structure is a statistical variable subject to time-or load history effects. It appears that under these conditions the engineering relevance of the stochastic approach to structural safety is open to serious doubts.

It is therefore more expedient to develop the approximate probabilistic approach reviewed in the Introductory Report and dealt with in the contributions by Prof. Lind and Dr. Koch. However, I should like to express some apprehension concerning the use of the Gram-Charlier expansions in fitting distribution functions. These expansions produce negative ordinates at not too large distances from the mean and are therefore unsuitable in the low probability range characteristic of safety analysis. Also selection of distribution functions on the basis of curve-fitting near the center of the distribution is an irrelevant procedure. Distribution functions that can be extrapolated towards the tails may be rationally selected only on the basis of physical argument by which a certain probability model can be justified.

In the case of structures the loads of which are of a clearly stochastic nature, such as towers subject to wind, maritime structures subject to waves and swell and flexible structures subject to earthquake accelerations, a synthesis must be attempted between the approximate probabilistic and the rigorous stochastic approach to safety analysis on the basis of which rational design criteria for such structures are developed. An illustration of such a procedure for maritime structures is presented by the author at the 22nd International Navigation Congress in Paris in 1969.

Considering the elaborate analytical methods of safety analysis in the inelastic range, as illustrated by the various contributions to Theme Ib, and the dubious physical assumptions concerning the material response underlying such analysis (linear visco-elastic, ideal elastic-plastic, steady state creep, etc.), it would seem that structural model analysis represents, so far, the only really reliable method for the establishment of the critical failure mechanism of any but the simplest structural forms on which a rational safety analysis can be based. The fact that it has not been specifically referred to in the Introductory Reports, on which Prof. Oberti comments, is simply a tacit expression of the conviction that it is so well-established a tool that it is unfailingly used whenever the results of a theoretical analysis are either physically suspect or unobtainable.

Leere Seite
Blank page
Page vide