Appendix II. - Statistical Size Effect

The decrease of observed nominal strength with the size of specimen has usually been explained statistically. The strength value is assumed to vary randomly throughout the material, and so in a specimen of a larger size the chance of encountering a smaller minimum strength is higher. The size effect law obtained in this manner then depends on the assumed statistics of strength distribution, or the statistics of the size of microscopic flaws which cause the local strength reduction. This classical, statistical approach has, however, several significant differences from the present size effect law.

One difference is due to the fact that for volumes larger than a certain characteristic volume the chance of encountering a still smaller strength (or a still larger flaw) does not increase. In such a case the statistically based size effect reaches an asymptotic value at a certain specimen size, and does not decrease any more for larger specimen sizes. On the other hand, the present size effect law continues decreasing.

Another, more significant difference is due to the fact that the amount of energy released from the uncracked part of the structure into the fracturing region is very important. Thus, the same specimen supported rigidly or elastically would have the same strength according to the statistical theory, while according to the present energy-based size effect law the elastically supported specimen can have a much smaller strength. Obviously, a similar phenomenon arises from the geometry of the structure, in the various possible manners the geometry of the uncracked regions of the structure can significantly affect the failure.

Some statistical size effect surely exists, but it may be much less significant than the present energy-based size effect. At least for concrete it seems at the present that all the known size effect can be adequately explained by the energy-based size effect law, although statistically-based theories have previously been offered to provide an explanation.

SEA ICE INDENTATION ACCOUNTING FOR STRAIN-RATE VARIATION

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ABSTRACT: Global and local indentation pressures in the creeping mode of sea ice deformation are obtained, accounting for the spatial variation of strain-rates. Two approximate methods of analysis are considered; the upper bound and strain path methods. Theoretically postulated velocity fields required in the analysis are calibrated with field measurements. Sea ice behavior is described by a multi-axial power-law creep model and by the multi-axial extension of a new uniaxial model which accounts for both hardening and softening behavior. Results are compared with previously published indentation formulas.

INTRODUCTION

Two levels of ice loading are typically considered in the design of drilling and production platforms for the Arctic. Global ice pressures govern the overall structural geometry and dimensions as well as the foundation design, while local pressures are likely to dictate wall thicknesses and local framing, and may well govern structural cost. Most of the emphasis on ice force research has been on predicting global forces. Only during recent years, as the focus changed from overall feasibility to preliminary and detailed design, has the importance of local pressures emerged. Peak local pressures may be as high as three times the average global pressure. It is widely recognized that uncertainties exist in ice load prediction models in use today and that in some cases design loads may be overestimated by an order of magnitude.

Uncertainties in existing ice load models arise primarily from four sources: (i) incomplete modeling of the thermomechanical behavior of sea ice, (ii) use of semi-empirical formulations, calibrated without adequate regard for similitude modeling and scale effects, (iii) failure to realistically model the contact forces at the ice-structure interface and the presence of macrocracks, and (iv) not accounting for the finiteness of the environmental forces driving the ice features. Both approximate analytical methods and more rigorous numerical models based on the finite and boundary element methods of analysis can be used to study ice-structure interaction at full scale with realistic models for material and interface behavior.

This paper employs two approximate methods of analysis, the upper bound and strain path methods, to study the problem of sea ice indentation in the creeping mode of deformation, accounting for the spatial variation of strain-rates. This is a problem of concern for artificial islands in the Arctic nearshore region, where "break-out" and/or steady indentation conditions occurring in the winter form a basis for select-

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