
Opening Remarks

Hugh Ford

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Opening remarks

BY SIR HUGH FORD, F.R.S.

Imperial College of Science and Technology, South Kensington, London SW7 2AZ, U.K.

This is not just another conference on recent advances in fracture mechanics. The theme is the application of the technology already available in the service of safe engineering design and operation. The aim is to review the extent to which both the technology is being applied and the engineer is learning to live with the defects that are inevitably present in his machines and structures.

This is not just another meeting on fracture. In recent years there have been plenty of these and the Discussion Meetings of the Royal Society are not so prevalent that they should be used for a specialized presentation of the latest advances or a new theory; nor are they the best vehicle for such presentations. But they do provide an admirable forum for a general review of a subject and its significance in real terms, an assessment of the state of the art and its applications.

Undoubtedly, a lot of progress has been made in the last few years in bringing together the basic concepts and mathematical models and in reconciling them with each other. Progress has been such that industry and the engineer can be expected to ask for the reduction of all this work to design methods and codes – not in the restricting sense of standards that can be blindly applied without discernment, but those that can be applied by workers who understand the underlying principles and recognize the likely dangers and limitations.

It is the contention of the organizers of this two-day Discussion Meeting that the progress that has already been made and is now being made is enough to justify responding to the designer's need for methods and numerical techniques that can be applied in real situations.

For years, the engineer has designed on the assumption that the component he is designing is made ideally and from ideal materials. He knows the first to be untrue and the metallurgist has warned him of and demonstrated the fallacy of the second. By testwork, from experience, by the use of increasingly refined analyses, he has reduced the gap between the idealized and the actual to the stage where safety factors can often be intelligently closer in the range from about 1.2 up to 2, or at most 2.5, depending upon the nature of the loading and the environment.

The major difficulties that still perplex him are the applications involving repeated dynamic loads and hostile environment, designing for which has required much discernment, judgement and experience to ensure adequate, but not excessive, provision against fatigue failure or creep rupture. The encouraging feature of recent studies of fracture has been the way in which metallurgical and fracture mechanics studies have brought a unification of concepts and techniques for the behaviour of materials under load, where defects of one sort or another are the initiators of cracks.

The Discussion Meeting therefore starts from the idea that defects of many kinds exist in every real structure, and the engineer has to learn to live with them. Certainly it is not a question

of ignoring or dispensing with continuous efforts to improve the materials of manufacture: fracture research by the metallurgist and the materials engineer has done much to reduce and limit the incidence of flagrant and catastrophic failures, and the constant endeavour to increase levels of fracture toughness of materials should not be slackened. Accepting this, however, it has to be realized that defects will always be present however good the material and its fabrication into the final component, and the recent activity in fracture studies has been to develop and render more applicable the concepts and methods of analysis for predicting the safe behaviour of machines and structures in the knowledge that the defects are there. This is the obverse of the coin to which this meeting is dedicated.

The objectives of the meeting are therefore fourfold.

1. To review briefly the progress made in recent years in the field of fracture sufficient to enable a useful focusing of the discussion on the application of the ideas and methods to real situations.

2. To assist the designer and the user of machines and structures to appreciate the nature of the defects he has to live with and design for.

3. To bring together the work of the physical metallurgist and the fracture mechanician: to reconcile the irregularities of the microstructure with the assumed continua of the computational methods and toughness assessment methods.

4. To gather together the experience of real situations of those who have been involved in applying the basic knowledge in practice. It is from detailed consideration of these experiences that proper design codes and methods will evolve and the further improvement of the science and technology will develop.

The organizers consider that it is timely to hold a Discussion Meeting with these practical objectives with the present state of knowledge. It is not only timely for engineers already in practice. It is also high time that the subject should be taught in a systematic way in undergraduate and postgraduate courses to all engineers in the making – at least to all those who are likely to bear a responsibility for safe and economic design.

The contributors to this meeting are drawn both from the ranks of those active in developing and refining the methods and from those charged with their application.

The fields of application of fracture technology are considerable and varied. For many kinds of pressure vessel, significant progress has already been made for thin-walled vessels where two-dimensional analysis can reasonably be used: thick-walled vessels, with interruptions in the rotational symmetry, changes in wall thickness, or the requirements of end closures still present formidable problems of three-dimensional analysis and of interpretation of toughness parameters. In particular, those applications involving a few cycles of high stress intensity where some degree of plastic deformation occurs require further conceptual developments and detailed confirmation.

Pipework systems have attracted considerable attention because of the importance of the safe transport of fluids where the consequences of fracture would be catastrophic. On the biggest scale, offshore structures are another fruitful field of application. Large rotors of all kinds again have had detailed and effective study, but the designer has not yet a design code or even a set of indicators that will allow him to go outside the known boundaries of size or speed of rotation.

It is not necessary, however, to invoke the important structures and components to look for the applications of fracture technology. Examples of everyday engineering abound, where

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minor redesign in the knowledge of fracture mechanics would avoid a myriad of failures not in themselves critical but time-wasting, annoying and expensive, and destructive of credibility.

It is with the aim of developing a wider appreciation of the capabilities of the present state of knowledge in intelligent application that this Discussion Meeting has been organized.