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Guest editorial : Characterisation of crack tip fields

Joint special issues of the International Journal of Fatigue (Elsevier) and Fatigue & Fracture of Engineering Materials & Structures (Wiley) containing selected and fully peer reviewed papers from the 4th international workshop on Characterisation of Crack Tip Fields held in Bonifacio, France over April 10 – 12, 2017.

Single parameter characterisation of the crack/notch tip field using fracture mechanics parameters like K, J or CTOD has been extremely powerful in advancing predictive technologies for critical or sub-critical crack growth. It has also become clear over the last 40 years that single parameter approaches have limitations particularly in dealing with crack growth phenomena arising from crack tip shielding, often resulting from the plastic enclave surrounding a crack. Influences of this enclave on the crack tip stress field ahead of the crack are maximised during cyclic loading. In the case of a parameter like the stress intensity factor which characterises the crack tip field via an elastic approximation, it is not surprising that any set of plasticity-induced circumstances which perturb the size of the plastic enclave and its associated strain field lead to predictive difficulties.

Over the last 30 years, notable researches related to such difficulties include short cracks, plasticity-induced closure, variable amplitude, mixed mode and notch effects. Thus using more than one fracture mechanics parameter has been more and more studied. Attention has been directed, for example, towards incorporating the T-stress (second term in a Williams-type expansion of the crack tip stresses) into life prediction methods. The T-stress affects the extent and shape of crack tip plasticity. It would therefore be expected to be influential in plasticity-related crack growth phenomena. The situation is further complicated where a crack experiences multiaxial loading and Mode II and III fracture mechanics parameters are also necessary. Alongside this, new analytical models have been proposed and advanced experimental techniques allow greatly improved measurement of 2D and 3D fields associated with the crack tip zone.

The fourth international workshop on Characterisation of Crack Tip Fields was organized by both French Society for Metallurgy and Materials, SF2M (www.sf2m.fr) and the Italian Group of Fracture (www.gruppofratura.it). Like previous editions, this one followed the successful format of the first three workshops¹, based on largely invited groups of delegates and allowing enough time for discussion after each paper and a large discussion at the end for a common synthesis. The following main points have to be noted from the discussions as being important:

- small cracks require other parameter than long cracks for crack tip field characterisation;
- environment for small crack growth is important;
- interpretation of very small crack growth rate (gigacycle regime) is an open question;
- shielding effects (including crack closure mechanisms) have still to be studied;
- ensuring accuracy, compatibility and correlation between various experimental techniques is a key of progress;
- the use of full field experimental measuring techniques (not only surface but volume too) have to be promoted;
- engineering applications and academic researches have to exchange more frequently.

The papers selected for these joint Special Issues of the International of Fatigue and Fracture & Fracture Engineering Materials & Structures show a range of research that is already giving detailed consideration to a number of the above aspects.

The next edition of the international workshop Characterisation of Crack Tip Fields series is proposed to take place in Heidelberg, Germany, 8-10 April 2019.

The Guest Editors of this special issue warmly thank all the authors for their contributions and hope this overview of current thinking in the area of crack tip fields in relation to fatigue and fracture is of use for the research community.

1 Forni di Sopra, Italy, 7 – 9 March 2011 ; Malaga, Spain, 15–17 April 2013 ; Urbino, Italy, 20–22 April 2015

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