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Crack tip fields 4

Joint special issues of the International Journal of Fatigue (IJFatigue, Elsevier) and Fatigue & Fracture of Engineering Materials & Structures (FFEMS, Wiley) containing selected and fully peer reiewed papers from the 4th IJFatigue and FFEMS Joint Workshop on Crack tip fields 4 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, a considerable research effort has explored these areas of difficulty, including short cracks, plasticity-induced closure, variable amplitude and mixed-mode loading, as well as notch effects. Increasing attention has hence been focused on using more than one fracture mechanics parameter. Attention has been directed, for example, towards incorporating the *T*-stress (the second term in a Williams-type expansion of the crack tip stresses) into life prediction methods, as the *T*-stress affects both 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 additional Mode II and III fracture mechanics parameters are necessary. Alongside this, new analytical models have been proposed and advanced experimental techniques now allow greatly improved measurement of 2D and 3D fields associated with the crack tip zone.

These issues were discussed in the fourth international workshop on Crack tip fields 4 which was organized by both the French Society for Metallurgy and Materials, SF2M (www.sf2m.fr) and the Italian Group of Fracture (www.gruppofratura.it). This workshop retained the successful format of the first three workshops[1], based on a largely invited group of delegates and allowance of enough time for discussion after each paper with a final overall discussion on the topic in the closing session of the workshop, with the aim of obtaining an agreed summary of the current state of the area and the remaining problem areas. The following main points were recorded in these discussions as being important:

- small cracks may require different parameters to long cracks for crack tip field characterisation;
- environment for small crack growth is important;
- interpretation of very slow crack growth rate (gigacycle regime) is an open question;
- shielding effects (including crack closure mechanisms) require further study;
- ensuring accuracy, repeatability, compatibility and correlation between various experimental techniques is key to making progress;
- the use of full field experimental measurement techniques (volumetric as well as surface) has to be encouraged;
- engineering applications and academic research need to be considered concurrently.

The papers selected for these joint Special Issues of IJFatigue and FFEMS present a range of research that illustrates both the complexity of the topic and the current endeavours that are giving detailed consideration to a number of these aspects.

The next IJFatigue and FFEMS Joint Workshop on Crack tip fields 4 is proposed to take place in Heidelberg, Germany, between 8 – 10 April 2019.

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

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[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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