Guest editorial: fatigue design and material defects

This issue of Fatigue and Fracture of Engineering Materials and Structures contains a collection of manuscripts presented at the Second International Symposium on Fatigue Design and Material Defects (FDMD II) held in Paris, France, on June 11–13, 2014 organized by the French Society for Metallurgy and Materials (SF2M) and the German Association for Materials Research and Testing (DVM).

Building on the success of the first edition, held in Trondheim, Norway, in 2011, this second conference asked researchers and engineers to assess the state of the art concerning the fatigue design of mechanical components using materials containing defects and to determine the ways to achieve further progress in the field. The symposium was very well attended, with over 150 engineers and scientists from 30 countries who contributed in the form of oral presentations (53) and lively discussions around posters (55).

As per the first edition, the focus of this symposium was on the influence of defects on the fatigue behaviour and durability of structural materials. This is an important scientific issue with significant human and financial implications. The main objective was to understand the impact of a given defect population on the fatigue behaviour, from a material optimization point of view (i.e. the link with the material elaboration and manufacturing process) and also from a design optimization perspective.

The conference consisted of one keynote presentation, 53 oral presentations and 55 posters covering different topics: (1) probabilistic models, (2) fatigue and defects in castings, (3) evaluation of manufacturing defects with regard to structural fatigue, (4) non-destructive evaluation, (5) surface defects, (6) fatigue crack growth and thresholds at defects, (7) microstructural effects, (8) multiaxial stress effects, (9) very high cycle fatigue and (10) corrosion and welding defects.

This special topic on fatigue design and material defects is a selection of eight papers that present recent developments and trends covering most of these topics.

The role of different defect types on the fatigue strength is highlighted via the following three papers:

- Using different fatigue crack growth models, Härkegård *et al.* analyse the effect of single corrosion pits on the fatigue behaviour of steam-turbine blades made from 12% Cr steel.
- El May *et al.* propose a volumetric HCF criterion to quantify the influence of natural corrosion pits on the fatigue limit of a martensitic stainless steel, using the geometry of 'real' corrosion pits identified by means of X-ray tomography.
- Leopold *et al.* investigate the influence of both artificial and natural defects on the fatigue strength of a cast Ti-6Al-4V alloy. They show that the geometrical morphology is not the major parameter governing the reduction in fatigue life. The defect type shows the predominant influence.

The critical role played by defects and the material microstructure in determining fatigue crack initiation and growth are demonstrated by five other papers in this special issue.

- Beretta *et al.* present a probabilistic engineering approach for the structural integrity assessment of turbine discs containing defects.
- Cetin *et al.* provide a comprehensive statistical method to predict the size of the largest defect expected to occur in components.
- Zerbst *et al.* use a so-called *R*-curve analysis to determine the initial flaw size to use in fatigue crack propagation calculation. Their approach is illustrated via application to welded joints.
- Lorenzino *et al.* focus on the effect of defect orientation on the fatigue limits of two types of steels. The fatigue limits are found to be nearly independent of the tilt angle, for the same projected defect size, in terms of $area^{1/2}$.
- Finally, Guerchais *et al.* show how microstructure-sensitive finite element simulations can help to understand the crack initiation mechanisms at the surface of austenitic steel containing artificial defects.

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We hope that this special issue will serve as a reference to continually refine our understanding in the field of fatigue design using 'real' materials, containing defects, and that it will broaden the variety of real world applications.

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