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Title:

Numerical modelling of the effects of shot peening on crack shape evolution under low-cycle fatigue

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1. The title should be as brief as possible but long enough to indicate clearly the nature of the study. Capitalise the first letter of the first word ONLY (place names excluded). No full stop at the end.
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Shot peening is an important fatigue amelioration strategy. The current paper presents a finite element (FE) analysis of the effects of shot peening on crack aspect ratio (*a*/*c*) evolution in the early stages of crack growth in a low pressure (LP) steam turbine material, FV448. The fatigue behaviour of this material has been experimentally evaluated using a U-notched specimen (representing the fir tree root geometry of the turbine blade) under 3-point bend tests. Two different shot peening intensities were considered in this study: an industrially applied shot peening process and a less intense shot peening process. The un-peened (polished) condition was also considered as a baseline comparison.

FE models have been developed, incorporating both compressive residual stress and strain hardening effects caused by shot peening. Static cracks with varying surface lengths (2*c*) and depths (*a*) were also introduced into the model. The *J*-integral and stress intensity factors of these cracks were then calculated at both the surface point and the deepest point along the crack front for the shot-peened and un-peened conditions. The obtained results were used to explain and predict the experimental observation that crack aspect ratio evolution in the early stages of crack growth in un-peened and shot-peened conditions is quite different: shallower *a*/*c* values are typically observed in the shot-peened condition. The relative contributions of compressive residual stresses and strain hardening to this effect were concluded by separately assessing their effects on crack growth. In addition, incorporation of the effects of the aspect ratio evolution into fatigue life assessment methods has been adopted in order to improve the current overly-conservative fatigue life predictions of shot-peened components.