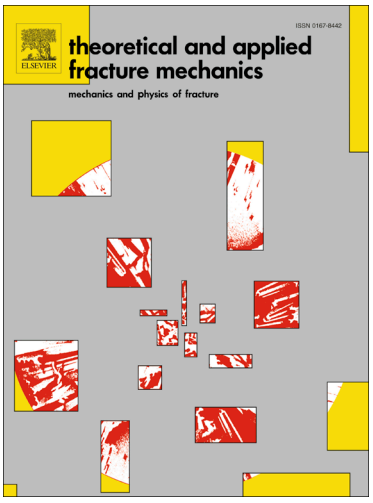

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Experimental and Numerical Studies to Estimate Fatigue Crack Growth Behavior of Ni-Based Super Alloy

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ABSTRACT

In this work, the fatigue crack growth behavior of the Nickel based super alloy is investigated at room (26 °C) and elevated temperature (650 °C). The fatigue crack growth experiments are performed to understand the effect of temperature and loading rate. The elasto plastic fracture toughness tests are performed to evaluate J_{IC}. Paris law is used in conjunction with extended finite element method (XFEM) to numerically predict the fatigue life. The stress intensity factors of individual mode (K_I and K_{II}) are computed from *J*-integral by decomposing the stress, strain and strain derivatives into symmetric and antisymmetric parts. Few parametric studies are performed to show the mesh convergence and path independency of *J*-integral. Fatigue crack growth in aero-engine turbine disc is predicted. The numerically predicted fatigue life is found in good match with the experimental results.

Keywords: Fatigue crack growth; Fracture toughness; XFEM; *J*-decomposition

1. INTRODUCTION

These days, industries demand the materials, which can remain unaffected at high temperature i.e. above 1000 °C under peak loads. This requirement can be fulfilled by developing materials with high recrystallization temperature such as nickel, titanium and iron intermediate alloys (Nickel based super alloys). Along with the development of high quality material, damage tolerance study is also required to predict the safe life of the structures or components. The fatigue life evaluation of any component or structure becomes very important from the safety and design point of view.

In general, the fatigue crack growth behavior of metals and alloys is described in three stages as demonstrated in Figure 1. In stage I (known as the threshold stage), the crack growth rate is negligible, and a threshold stress intensity factor is required for crack growth which is highly affected by the environment and microstructure. In stage II, the fatigue crack growth remains stable and varies linearly with the stress intensity factor on log-log scale. In