

IMPLICATIONS OF SURFACE FINISH AND SUB-SURFACE POROSITY ON COMPONENT LIFE PREDICTION

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May 5, 2020

Abstract

High duty engineering component life is usually demonstrated through extensive testing and statistical analysis applied to empirical curve-fit equations. Because of this, the extent of the testing required is huge and costly: it must consider the load cycle range and test to high numbers of cycles. Furthermore, this testing must be repeated for every material, method of manufacture, and subsequent post-processing. Additive Manufacturing (AM) for high duty components has brought to the fore the question of the effect of porosity and surface roughness on fatigue life. Because there is relatively little service life experience, it is possible that the testing approach could also fail to represent conservatively the true life of a critical component. The authors propose the development of a fatigue model based on well-established engineering physics principles, by creating computational specimens with modelled surface roughness and porosity, and subjected to cyclic loading using Finite Element Analysis. They show that the combination of roughness features and sub-surface pores leads to an equivalent plastic strain distribution pattern that suggests an emergent physical process. Such a phenomenological understanding of the fatigue failure process should lead to improved life prediction techniques, more cost effective test procedures, and the development of better AM methods.

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