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Fretting-fatigue of lug-bush shrink-fitted assemblies: interference-fit and lug bore size effects

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The fatigue behaviour of shrink fitted lug-bush assemblies is studied for different interference-fit levels and lug bore sizes. Experiments and numerical simulations are compared through two types of analysis: a fatigue stress and a surface damage analysis. The influence of surface damage on crack initiation is investigated. Increasing interference-fit level is expected to increase lug-bush fatigue life and surface damage is expected to be more important increasing lug bore size.

Keywords: Fretting-Fatigue; crack initiation; interference-fit

1. Introduction:

When assemblies are submitted to fatigue loads, microscopic relative movements of fretting may occur between the mating surfaces. Some failure cases of shrink-fitted assemblies have been reported in literature such as connecting rods[1] and aircraft attachment lugs [2]. In those cases, wear debris and surface damage are sometimes suspected of promoting crack initiation. In 1984, Ruiz[3] proposed a new design parameter, suitable for fretting-fatigue contacts, which assumes the location of crack initiation to be the zone that maximises stress and surface damage. We may then wonder, as for lug-bush assemblies, whether surface damage has an influence on the fretting-fatigue crack initiation.

2. Methods:

Lug-bush assemblies (Figure 1, a) with different interference-fit levels and lug bore sizes are tested with a uniaxial fatigue test bench. Experiments and numerical simulations are conducted to compare the fatigue crack initiation life, crack localization and surface damage of lug-bush connections with the prediction given by a classical multiaxial fatigue criteria, SWT (Figure 1, b), and a surface criteria, the density of friction energy dissipated in the interface per cycle, dEd (Figure 1, c).

3. Results:

On the one hand, it is expected that interference fit has a beneficial effect on fatigue life of lug-bush assemblies for the range of shrink-fit levels considered On the other hand, numerical simulations show that dEd values increase with lug bore size considering same critical SWT maximum value along the bore lug. As a consequence, the surface damage is expected to be more severe for larger lug bores and play potentially a bigger part in crack initiation.

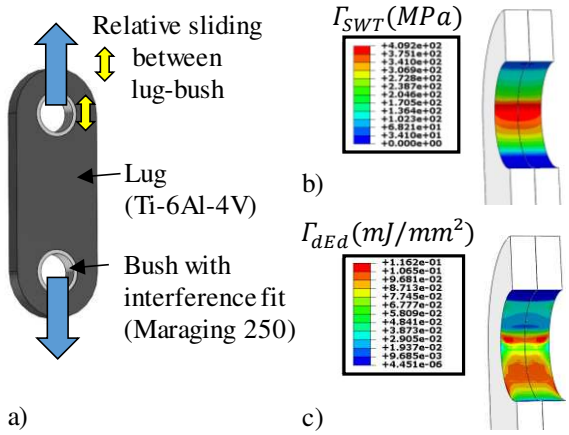

Figure 1 : Lug-bush assembly (a), distribution of SWT (b) and dEd (c) along a lug bore

These results will give critical information about the need to take into account size effect not only for stress gradient but also for tribological issues, as laboratory specimens are most often small-scale test specimens.

4. References:

[1] J. Chao, "Fretting-fatigue induced failure of a connecting rod," Engineering Failure Analysis, 96, 2018, 186–201

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[3]C. Ruiz, P. Boddington, and K. C. Chen, "An investigation of fatigue and fretting in a dovetail joint," Experimental Mechanics, 24, 3, 1984, 208–217