Evaluation of SSY boundary using DIC results

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Abstract

In this work the boundaries of small-scale yielding (SSY) and large-scale yielding (LSY) have been experimentally evaluated from the analysis of crack tip opening displacement (CTOD) measured by Digital Image Correlation (DIC). The approach published in a previous numerical work [18] has been used to define the boundaries of SSY and LSY. According to this approach, CTOD must be resolved into its elastic and plastic components, analysing the ratio between the elastic CTOD range and the total CTOD range ($\Delta\delta_\epsilon/\ \Delta\delta_\tau$) to define the boundary where SSY conditions can be established. Three materials have been studied, commercially pure titanium and 2024-T3 and 7050-T6 aluminium alloys, tested at different stress ratio values (0.1 and 0.6 for titanium, and 0.1, 0.3 and 0.5 for the aluminium alloys). SSY conditions are shown to dominate when $\Delta\delta_\epsilon/\ \Delta\delta_\tau$[?]79% and [?]78% for titanium and the two aluminium alloys, respectively. In addition, LSY can be established when $\Delta\delta_\epsilon/\ \Delta\delta_\tau$[?]66.3% and [?]67.2% for titanium and for 2024-T3 and 7050-T6 aluminum alloys, respectively. Transition or LSY conditions are more probable in fatigue tests conducted at low R-ratio than in tests at high R-ratio. In addition, crack lengths above 40% with respect to the width of the specimen promote transition or LSY conditions. The results obtained in this work can assist to a better understanding of the mechanisms driving fatigue crack growth.

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