Damage in adhesive joints during Impact fatigue

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Abstract

The main aim of this research was to investigate the behaviour of adhesive joints exposed to repeated low-velocity impact i.e. *Impact fatigue* (IF), and to compare this loading regime with standard fatigue (SF), i.e. Non-impacting, constant amplitude, sinusoidal loading conditions. Two types of lap joint configuration using rubber toughened modified epoxy adhesives were used and exposed to various loading conditions in order to determine the fatigue behaviour of the joints for each load conditions. It was seen that the IF is a dramatic load conditions where fatigue can occurs faster and at drastic lower level than in SF.

Two types of techniques were used for to compare the fatigue behaviour of adhesively bonded joints, the fatigue life and the fatigue crack growth (FCG). The fatigue life was investigated using bonded aluminium alloy (7075-T6) single lap joint (SLJ) specimens. Different trends were visible in force-life plots for these two types of loading. In SF a gradual decrease in the fatigue life with increasing load was observed, whereas, in IF a significant decrease in life was seen at relatively modest levels of maximum force after relatively few cycles. Comparisons of the fatigue life show a considerably earlier failure in IF than in SF for comparable levels of force and energy. Additionally, it was demonstrated that the maximum force per cycle, loading time, stiffness and strength decreased as a result of damage generated in the sample during IF.

The fatigue crack growth texts during IF shows that crack initiation and its rapid propagation can occur at low loading levels were SF will predict high durability of joints. Differences between IF and SF were also seen with regard to the crack speed. It was found that in the initial stages of the crack propagation, the crack rate was 10 times higher in IF than in SF (Figure 1-2). In addition, It was found that the introduction of a relatively small number of in-plane impacts between blocks of SF drastically changed the dynamics of fracture in the specimen, with the IF blocks having a damage accelerating effect.

A damage shift model in conjunction with the numerical crack growth integration technique was proposed to analyse combined impact and standard fatigue (CISF). This proved to be a suitable technique to account damage for the zone ahead of the main crack tip produced by small blocks of IF.

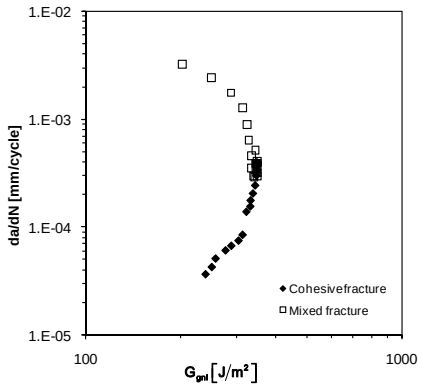

Figure 1. FCG during Standard Fatigue

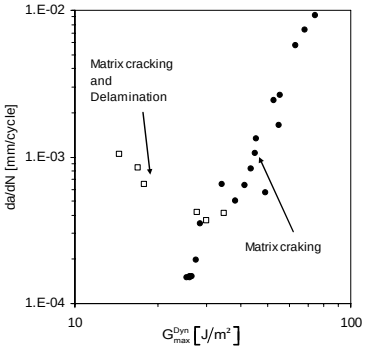

Figure 2. FCG during Impact Fatigue

References

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