

The influence of cyclic impacts on mode II fracture energy of adhesives

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Introduction

One of the most important factors affecting the durability of adhesive joints is cyclic loads. Compared to the normal fatigue, impacts fatigue causes more weakening in adhesive properties and joint strength. However, a few studies have analyzed adhesive joints behavior under cyclic impact that the service life of adhesive joints may be significantly influenced by these kinds of loads. In the current study the influence of cyclic low energy impact loads on the residual fracture energy of adhesive joints under shear loading conditions is studied. To achieve this, ENF specimens were tested at quasi-static and impact conditions. To estimate the effects of impact fatigue loads on fracture energy of the joints a combination of repeated impact and quasi-static tests were performed.

Joint geometries and test conditions

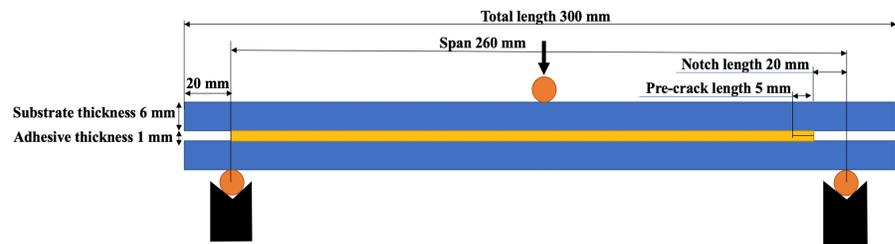


Figure 1 - ENF specimen geometry

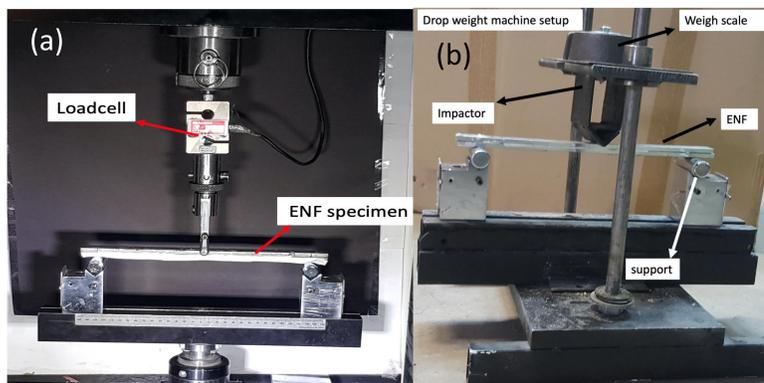


Figure 2 - (a) Static tests setup; (b) Drop weight machine setup used for impact fatigue tests

Experimental procedures

Three testing categories were considered in order to demonstrate the impact repetitions effects on pure mode II fracture energy of the adhesive.

- ENF joints in group A were tested under quasi static load in a displacement control condition by a universal testing machine. The crosshead loading rate for all quasi static conditions was fixed as 0.5 mm/min.
- Group B includes low energy impact repetition tests. To appraise the low energy impact life of the ENF joints, samples in group B were tested at different energy levels of cyclic impact loads until joints failure. The number of repetitions of impacts was counted during the tests for each specimen.
- Specimens in group C were tested under a combination of repeated impact and quasi static load to analyze the effects of low energy impacts on the residual fracture energy of the adhesive.

Discussions

As expected, the low energy impact life of the tested joints increases significantly when the impact energy level drops. In joints that endured impact cycles of less than 10% of their impact life, the fracture energy decreased by more than 15% in relation to the joints not impacted, which means that the residual fracture energy is very responsive to the impact loads. The rate of the degradation of the shear fracture energy increases with the number of impact cycles. Therefore, the influence of each impact on the failure process increases by cycles.

Due to the stress concentration at the tip of the pre-crack, the crack initiates from this point and kinks to the interface. As shown in Figure 4, several cracks kinking between the two interfaces are

Impact fatigue tests results

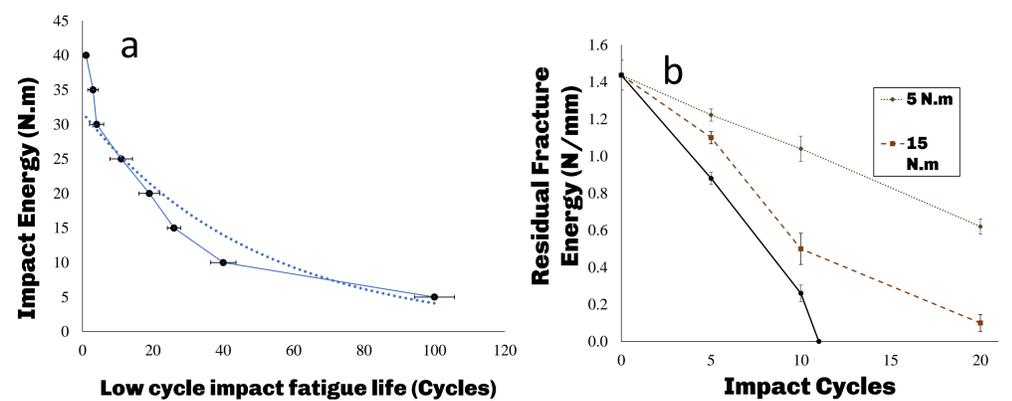


Figure 3 - (a) Impact fatigue life of the ENF joints; (b) Residual fracture energy as a function of the number of impact cycles

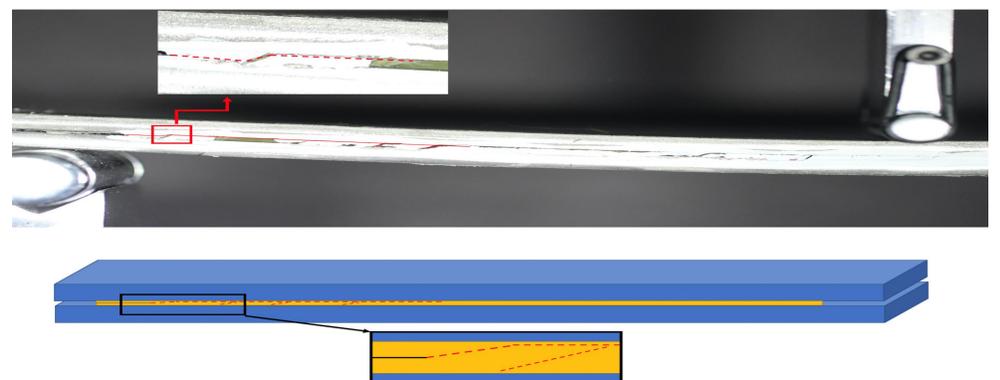


Figure 4 - Crack propagation path along the bond line

Conclusions

It was observed that the adhesive joints fracture energy is very sensitive to the cyclic impact energy level. One of the main effects of cyclic impact loads is the high potential for the creation and propagation of damage in the bonded structure. Experiments proved that no infinite impact fatigue life can be assumed for the joints as it is generally defined for normal fatigue tests.

References

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