A comprehensive review on bi-adhesive joints

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Introduction

Over the last decades, adhesively bonded joints have been employed extensively in various industries due to their prominent advantages in comparison with other traditional fastening approaches. The remarkable capability of bi-adhesive joints in enhancing the mechanical properties of structures has attracted the attention of several researchers. This study reviews effects of the aforementioned variables of the bi-adhesive joints. Beginning with manufacturing challenges of bi-adhesive joints.

Manufacturing methods

In bi-adhesive joints adhesives have different viscosities and sometimes they should be cured for different times and at different temperatures. On the other hand, the length of the overlap covered by each adhesive is effective and it is necessary to employ techniques to prevent adhesives from mixing together. Among the methods suggested by researchers, utilizing a silicon rubber frame or tape, nylon tape, and a wire or generating a certain gap between the two adhesives are the most common considered techniques.

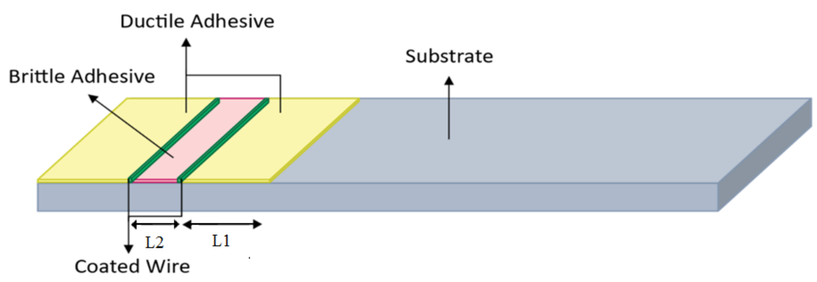

Figure 1 - Schematic of a bi-adhesive joint utilizing wire

Effect of length ratio and *E* ratio

For bi-adhesive joints, the adhesives length ratio is considered as *d*=L1/L2.

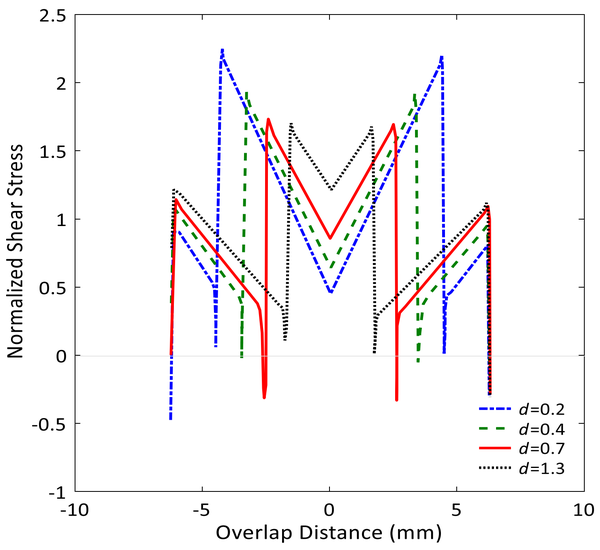

Figure 2 - Effect of *d* on the shear stress distribution [1]

E ration is defined as ratio of elasticity modulus ductile adhesive per elasticity modulus of brittle adhesive.

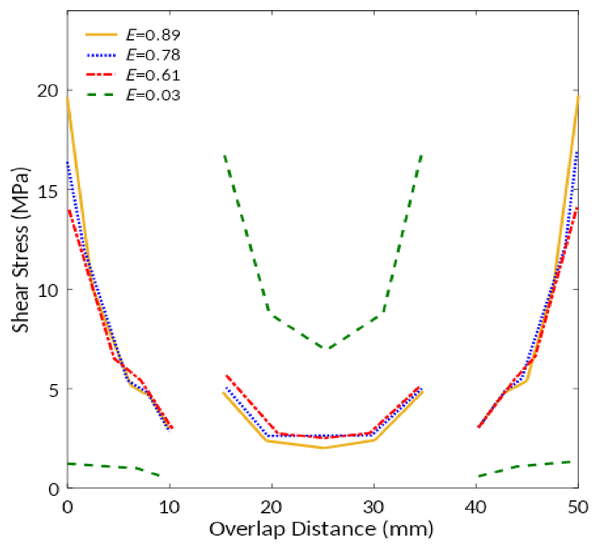

Figure 3 - Effect of the E ratio on the a) shear stress distributions [2]

Effect of the adesive thickness and overlap

Effect of the adhesive layer thickness on the failure load of bi-adhesive joints.

The failure load of joints as a function of overlap length.

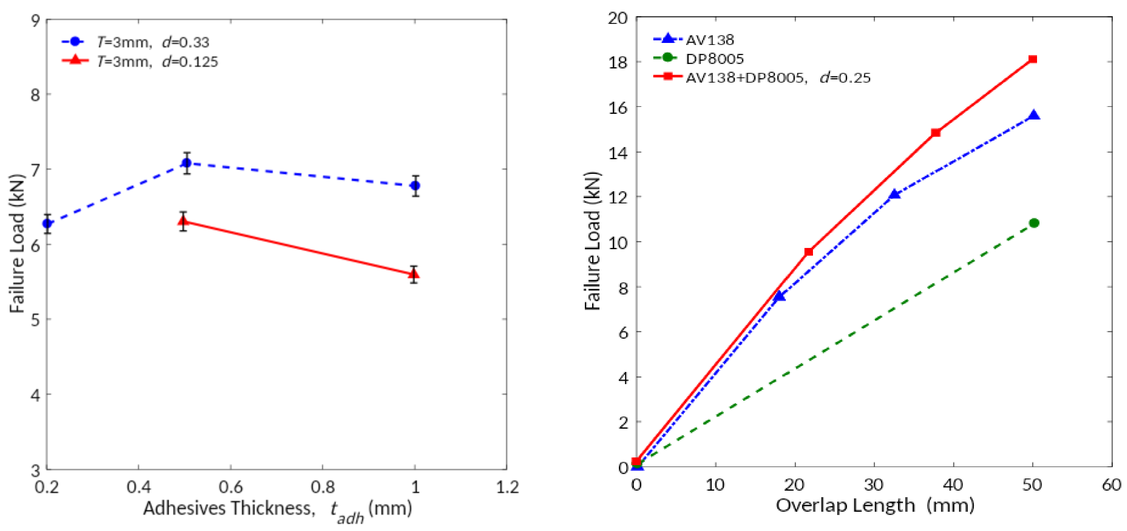

Figure 4 - Failure load as a function of adhesive thickness and overlap [3]

Impact loading

Most of the studies conducted consider the quasi-static strength of the joints. However, in a few researches, bi-adhesive joints have been analyzed in terms of the impact strength. The strength provided by the bi-adhesive joints subjected to impact loads is higher than the joints under static loads.

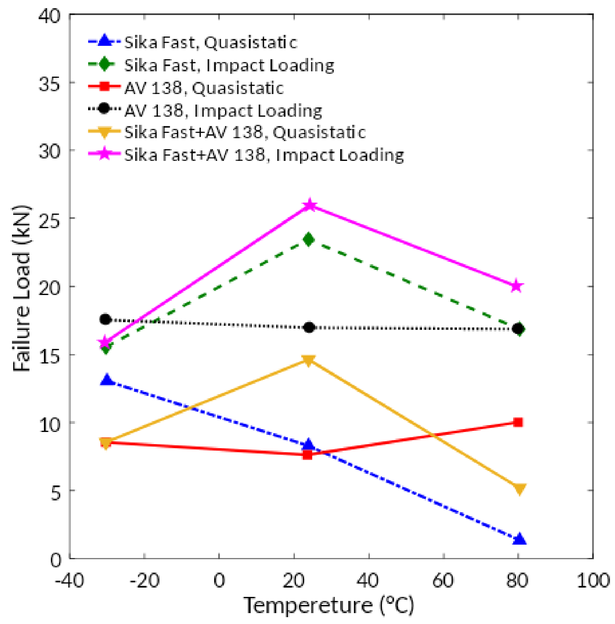

Figure 4 - Effect of temperature on the strength of the bi-adhesive joints subjected to impact and static loads [4]

Conclusions

- The use of bi-adhesive joints decreases the stress concentration at the ends of the joint and increases the stress level in the middle part where the brittle adhesive is applied. This indicates a more uniform load distribution along the joint, which increases the joint strength;
- Employing bi-adhesive single lap joints causes a secondary tensile peak along the overlap length which is due to the differences in the adhesives properties or can be due to the techniques used to prevent the adhesives mixing;
- For bi-adhesive SLJs, the lower the elasticity modulus ratio the lower the failure load. It is expected that by increasing the ratio of the modulus of elasticity, the optimum length ratio increases in single lap bi-adhesive joints.

References

[1] Özer, Halil, and Özkan Öz. Mathematical Problems in Engineering 2014 (2014).
[2] da Silva, L.F., and R. D. Adams. International Journal of Adhesion and Adhesives 27.5 (2007): 362-379.
[3] da Silva, M.R.G., E. A. S. Marques, and Lucas Silva. Latin American Journal of Solids and Structures 13.5 (2016): 835-853
[4] Machado, J.J.M., E. A. S. Marques, and Lucas FM da Silva. Composite Structures 194 (2018): 68-79.

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