Twenty-Third International Conference on Composite Materials (ICCM23)

EPFL



Static and Fatigue Behavior of Basalt Composite Hybrid Joints

Dr. Lulu Liu; Yun Sun; Prof. Thomas Keller Composite Construction Laboratory (CCLab) École Polytechnique Fédérale de Lausanne (EPFL)

INTRODUCTION

- Material utilization of composites is limited by joints' efficiency.
- Ductility is required in structures composed of composite brittle members and ductile joints can provide structural ductility.
- Hybrid joints have attracted increasing interest in different fields by combining the advantages of bolted and bonded joints, however, there is no load-sharing between bolted and bonded joints and ductility is missing.

OBJECTIVE & SCOPE

- To improve joint efficiency of bonded and hybrid joints to reach 100% efficiency.
- To improve ductility of bolted, bonded and hybrid joints.
- To achieve a full summation of bolted and bonded connection resistances in hybrid joints.



- Fatigue behavior of joints is the most important concerns due to high live load-to-weight ratio in composite structures.
- To evaluate the load-fatigue life of bolted, bonded and hybrid joints.



STATIC TESTS

- The resistance of hybrid joints corresponded to the full summation of resistances of the bonded and bolted connection part.
- The maximum joint efficiency reached 95% of the laminate capacity as the overlap of the bonded joints was further increased.
- MD bolted joints, boned and hybrid joints comprising ADP adhesive exhibited high ductility indices of >90% and excellent ability to dissipate energy.



Load-displacement responses of bolted, bonded and hybrid joints.



Loading/unloading-displacement responses of bolted, bonded and hybrid joints.

 Hybrid joints could provide fail-safe and creep resistance for bonded joints.



FATIGUE TESTS

The fatigue life of the hybrid joints was significantly extended compared to that of the bonded joints, because the cyclic displacement of adhesive was delayed by the bolt, and more cycles could thus be sustained to reach the same failure

REFERENCES

L. Liu, X. Wang, Z. Wu, T. Keller, Resistance and ductility of FRP composite hybrid joints, Compos. Struct. 255 (2020) 113001. https://doi.org/10.1016/j.compstruct.2020.113001.

displacement as in the bonded joints.



F-N curves for hybrid, bonded and bolted joints.

Cyclic displacement versus fatigue life for hybrid and bonded joints.

L. Liu, X. Wang, Z. Wu, T. Keller, Tension-tension fatigue behavior of ductile adhesively-bonded FRP joints, Compos. Struct. 268 (2021) 113925. https://doi.org/10.1016/j.compstruct.2021.113925.

L. Liu, X. Wang, Z. Wu, T. Keller, Effect of fiber architecture on tension-tension fatigue behavior of bolted composite joints, Eng. Struct. (2023).

Contact Lulu Liu Postdoctoral researcher E-mail : lulu.liu@epfl.ch Office : BP2121 | CCLab EPFL École Polytechnique Fédérale de Lausanne (EPFL)