Performance assessment of repaired composite sandwich beams

RJC Carbas (University of Porto, Portugal) | DS Correia | EAS Marques | LFM da Silva

1. Introduction

In many industries where weight savings are important, composite sandwich structures are used extensively, including wind turbine blades, aerospace components, and marine vessels. These structures are subjected to complex loading and can be prone to fatigue damage throughout their life cycle. This paper examines the fatigue performance of repaired composite sandwich beams, which will be necessary to extend their service life and maintain their structural integrity. The focus of this research is to evaluate the effectiveness of the methods used to repair composite sandwich beams under four-point bending fatigue testing. A comprehensive experimental test series was performed to evaluate both the initiation and progression of damage in repaired beams subjected to cyclic loading. The results of this research will aid in obtaining a greater understanding of the long-term behavior of repaired composite sandwich beams and will provide data that can be applied towards design optimization, maintenance practices, and the reliability of structures in weight-critical applications.

2. Methodology

The four-point bending test configuration was used to investigate the mechanical behaviour and evaluate the effects of pure bending moments on sandwich beams. Each beam had 10 mm core thickness and 2 mm outer skin thickness, with a total length of 300 mm and a width of 25 mm. Schematic representation of the setup is presented in Figure 1.

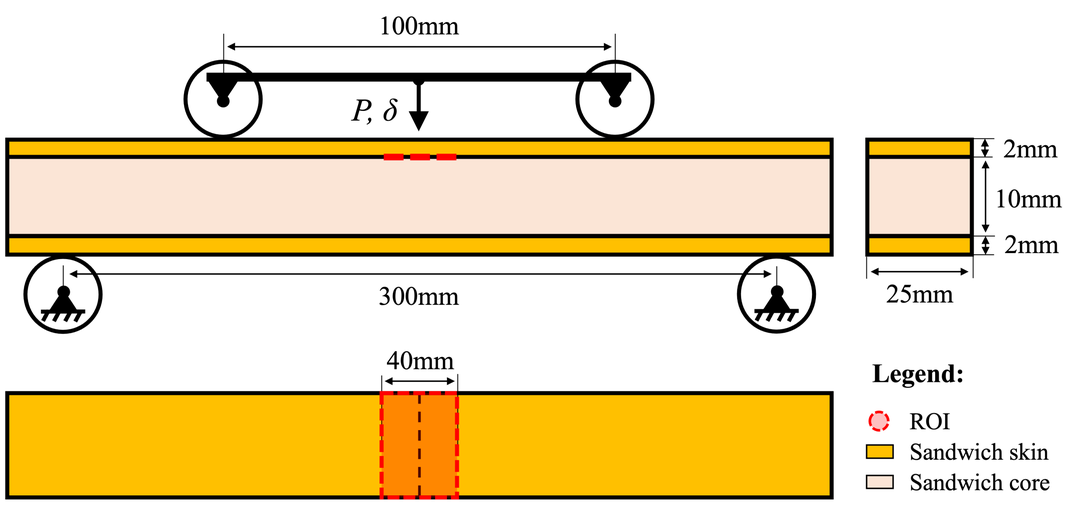

Figure 1. 4PB specimen dimensions and test scheme. Region of interest (ROI), highlighted in red.

The sandwich structure uses a **Balsa wood** core that has an end grain and has been selected because it has high specific strength and excellent compressive strength. Enveloping both sides of the core are two external skins made from a composite material created by impregnating a fiberglass **fabric laminate** with **Lapox K-6 (AH-312)**. To repair the compromised portion of the sandwich structure, a high-performance structural methacrylate adhesive (**Plexus MA560**) was used as a filling material because of its toughness and superior bonding characteristics when used in restoring structural integrity to materials.

3. Experimental results

This project compares two repair methods, analysing the performance of matrix resins versus high-performance methacrylate adhesives. The evaluation focuses on the deformation capacity under load at a defined specific strength level.

Four different samples were tested: reference (**Ref**); damaged (**Dmg**); epoxy resin **(Res),** which is the resin used in the GFRP skin**, methacrylate adhesive** (**Adh**), as shown in Figure 2.

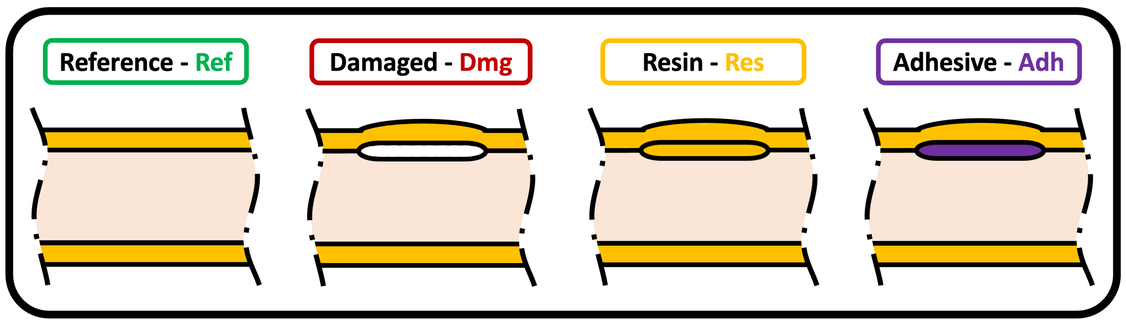

Figure 2. Regions of interest (ROI) of the tested samples: reference (**Ref**), damaged (**Dmg**), epoxy resin (**Res**) and methacrylate adhesive (**Adh**).

The load-displacement behavior for each joint is shown in Figure 3, with the test termination set at a stopping criterion of 500 N.

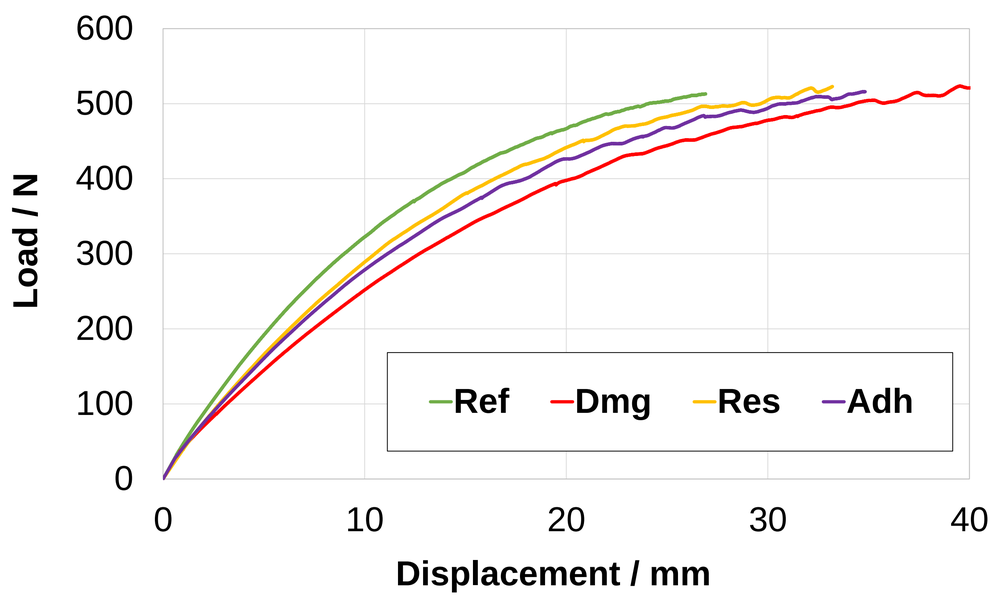

Figure 3. Load-displacement curves of the tested samples: reference (**Ref**), damaged (**Dmg**), epoxy resin (**Res**) and methacrylate adhesive (**Adh**).

4. Conclusion

The main findings can be summarized:

- At 500 N load, the damaged specimen showed evidence of propagation;
- Methacrylate adhesive was effective at repairing because of its ductility and good adhesion;
- Stiffness of repairs was higher when done with resin compared to repairs performed with methacrylate adhesive;
- Resin's higher fluidity allowed for more effective filling/penetration of the damaged area.

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