Reinforcing Irish-grown Glued Laminated Beams

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Abstract

The addition of fibre reinforced polymer (FRP) in the form of rods or plates is widely accepted as an effective method of increasing the stiffness of timber elements. FRP based on glass and carbon fibres are the most common materials used when reinforcing timber. In this project, the potential use of a novel basalt FRP (BFRP) material for the flexural reinforcement of spruce glulam beams is investigated. Significant increases in flexural stiffness are achieved with modest reinforcement percentages.

1. Introduction

The performance of timber beams may be enhanced with the addition of FRP composite reinforcement. It has been seen that the addition of modest reinforcement ratios can delay tension failure in glued laminated elements [1]. The additional reinforcement utilises the extra capacity of the timber in the compression zone resulting in much more consistent behaviour as well as a significant increase in flexural stiffness. BFRP is a relatively new material and very few studies have been published in relation to its use in timber reinforcement. In this study, twenty beams were manufactured, tested in flexure and subsequently reinforced with BFRP rod reinforcement and retested in bending to examine the increase in stiffness.

2. Manufacture

The glued laminated beams were manufactured by bonding four C16 spruce laminates using a phenol resorcinol formaldehyde adhesive to give a section size of 98 mm x 125 mm. The beams were clamped in a rig applying a minimum pressure of 0.6 N/mm^2 and allowed to cure. These beams were tested in bending as discussed in Section 3.

Subsequently the beams were reinforced using two 12 mm BFRP rods inserted into two circular grooves routed the full length of the bottom tensile laminate and centered 30 mm from each edge. These two rods accumulate to a modest percentage reinforcement ratio of 1.85%. A two part thixotropic structural epoxy adhesive was chosen to bond the reinforcement to the timber as it is specially formulated for the bonding of FRP to timber.

3. Experimental Set-up and Testing

The bending test set-up is in accordance with EN 408 [2]. The beams were loaded at a constant cross head rate of 0.15 mm/s to a maximum stroke of 15 mm to ensure that the deflection did not exceed the elastic limit of the beam and that the maximum load was less than 40% of the estimated ultimate failure load. The deflections were measure locally and globally.

4. Results and Conclusions

Four matched groups were created for comparative studies and the stiffness of each group is given in Figure 1. The average increase in bending stiffness of each reinforced group is calculated relative to the stiffness in its unreinforced state. The average increase in the local bending stiffness is 16.30% with a standard deviation of 1.65% and the average increase in global bending stiffness is 8.80% with a standard deviation of 3.65%.

The elastic modulus is measured both locally and globally. Once reinforced the local elastic modulus had a mean value of 10727 N/mm^2 and the global elastic modulus had a mean value of 9307 N/mm^2.

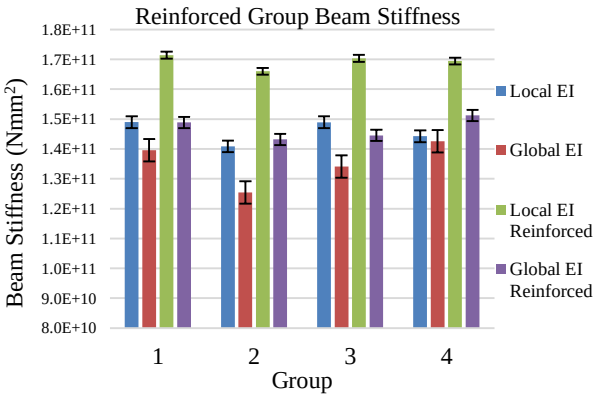

Figure 1: Group beam stiffness results

The four-point bending tests demonstrated that the addition of BFRP rod reinforcement in modest quantities can greatly increase the short-term stiffness of glued laminated beams.

5. Acknowledgments

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6. References

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