THE APPLICATION OF ADHESIVES FOR CONNECTING STRUCTURAL GLASS STRIPS TO EXISTING TIMBER JOISTS

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Introduction

Strengthening procedures often impair the original appearance of timber floors. An example of such a procedure is applying tensile strengthening elements made of steel or various polymers. This study proposes using structural glass strips as a transparent tensile reinforcement.

Materials and methods

Two methods of connecting the structural glass strips to the timber joists were considered. The first method was direct adhesive bonding, whereas the second method employed a newly developed timber–glass point joint, consisting of self-tapping screws, an aluminium insertion, and an epoxy resin-based adhesive. First, the two connection methods were tested on a small scale regarding their shear load-bearing capacity and load-slip behaviour. Finally, the two connection methods were tested on old timber joists strengthened with CLT panels and structural glass strips under four-point bending conditions over a span of 4.5 m.

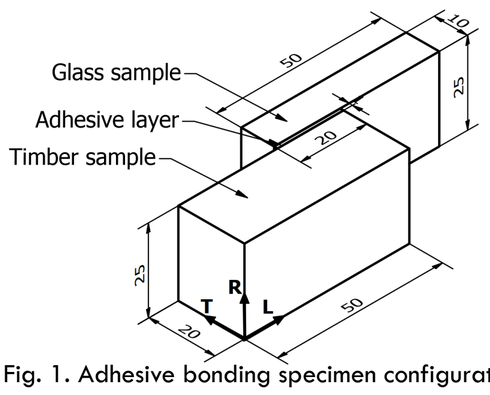


Fig. 1. Adhesive bonding specimen configuration

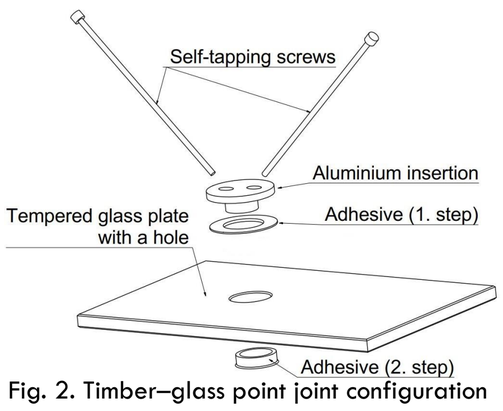


Fig. 2. Timber–glass point joint configuration

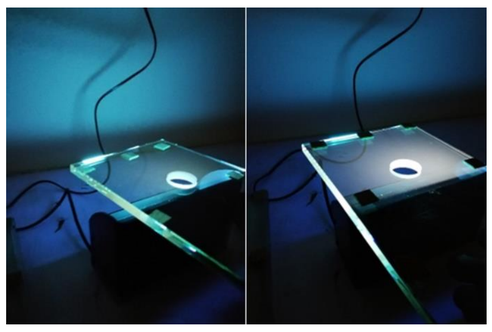


Fig. 3. Ultraviolet light shining on the air (left) and tin side (right) of the glass strips

Results

The results comprise small scale shear loading test results and four-point bending test results.

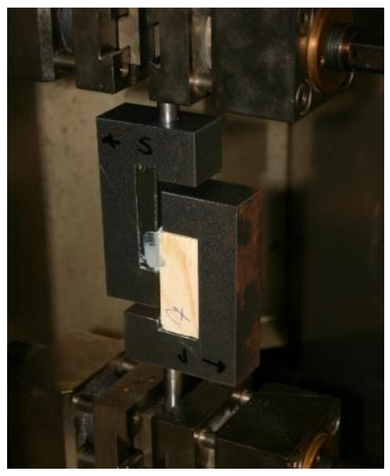


Fig. 4. Bonded specimen shear test

Fig. 5. Bonded specimen failure types

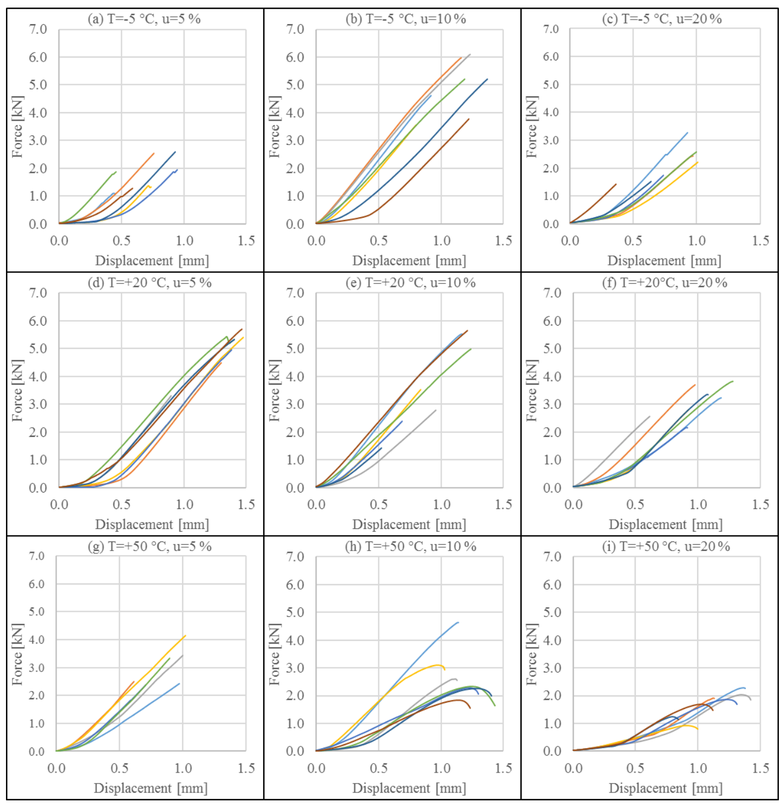


Fig. 6. Load-displacement curves for the shear specimens and for different environmental conditions

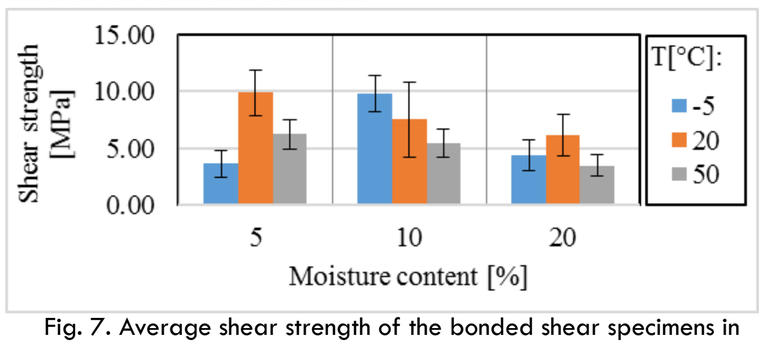


Fig. 7. Average shear strength of the bonded shear specimens in relation to different test temperatures and timber moisture contents (with error bars representing standard deviation)

Fig. 8. Timber–glass point joint

Fig. 9. Timber–glass point joint shear test

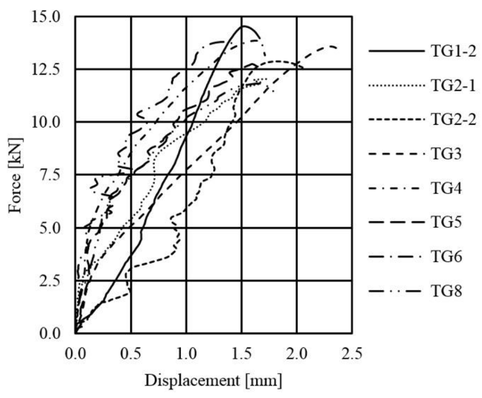
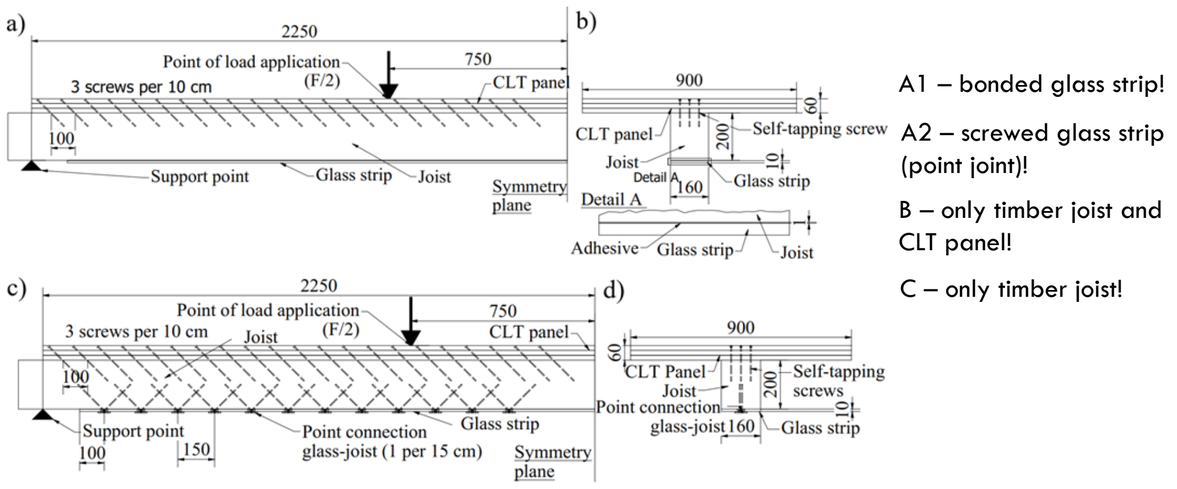


Fig. 10. Timber–glass point joint shear test Load-displacement curves



A1 – bonded glass strip!

A2 – screwed glass strip (point joint)!

B – only timber joist and CLT panel!

C – only timber joist!

Fig. 11. a) Configuration A1 – longitudinal section; b) configuration A1 – cross-section; c) configuration A2 – longitudinal section; d) configuration A2 – cross-section

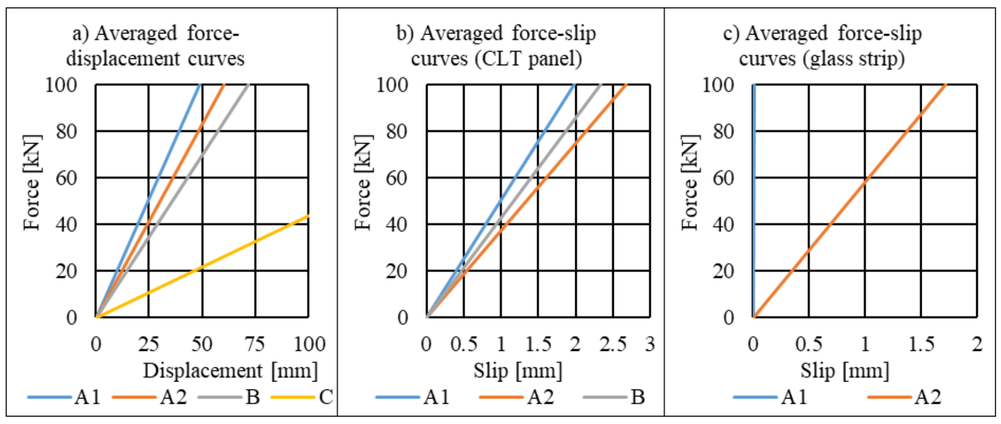


Fig. 12. Four-point bending test averaged force-displacement (a), force-slip (CLT – b , glass strip – c) curves for different joist configurations

Conclusions

The performed experiments on small shear specimen under different environmental conditions indicate the suitability of the chosen rapid-setting thixotropic epoxy adhesive for bonding glass to timber.

The point joint represents an alternative to classic adhesive bonding, when reversibility is an important factor.

The results of the four-point bending experiments show that the structural glass strips significantly increased the bending stiffness of the tested timber joist configurations and, in some cases, also resulted in higher load-bearing capacities.

The screwed glass strip is structurally less efficient than the bonded glass strip, but it is superior in terms of non-invasiveness and reversibility, which is essential for applications on the wooden built heritage.

Additional information:

- Unuk, Žiga, et al. "Evaluation of a structural epoxy adhesive for timber-glass bonds under shear loading and different environmental conditions." International Journal of Adhesion and Adhesives 95 (2019): 102425.
- Unuk, Žiga, et al. "Novel composite connection for timber–glass composite structures." Archives of Civil and Mechanical Engineering 20.1 (2020): 1-16.
- Unuk, Žiga, et al. "Strengthening of old timber floor joists with cross-laminated timber panels and tempered glass strips." Construction and Building Materials 298 (2021): 123841.

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