Stitched joints subjected to shear forces

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Abstract

In the first part of this paper, the main results from a series of experiments focused on the shear performance of stitched joints are presented. Four specimens were tested to evaluate their capacity and stiffness. Specimens showed a main failure mode, i.e., the failure of the tabs in compression. In the second part, experimental results are compared with the capacity predicted by using Eurocode 5 [1].

1 Experimental testing

Stitch joints connect two timber panels which are perpendicular to each other (Figure 1). This connection is present in all Skylark blocks, including beams and columns.

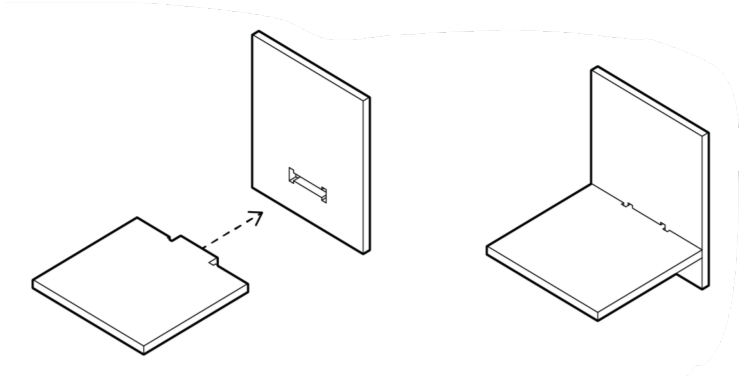

Figure 1: Stiched joint.

1.1 Experimental setup

Four specimens were tested in a shear by using an hydraulic actuator (Figure 2). Specimens were made of Metsa plywood (Metsa plywood).

The following instrumentation was installed for data acquisition:

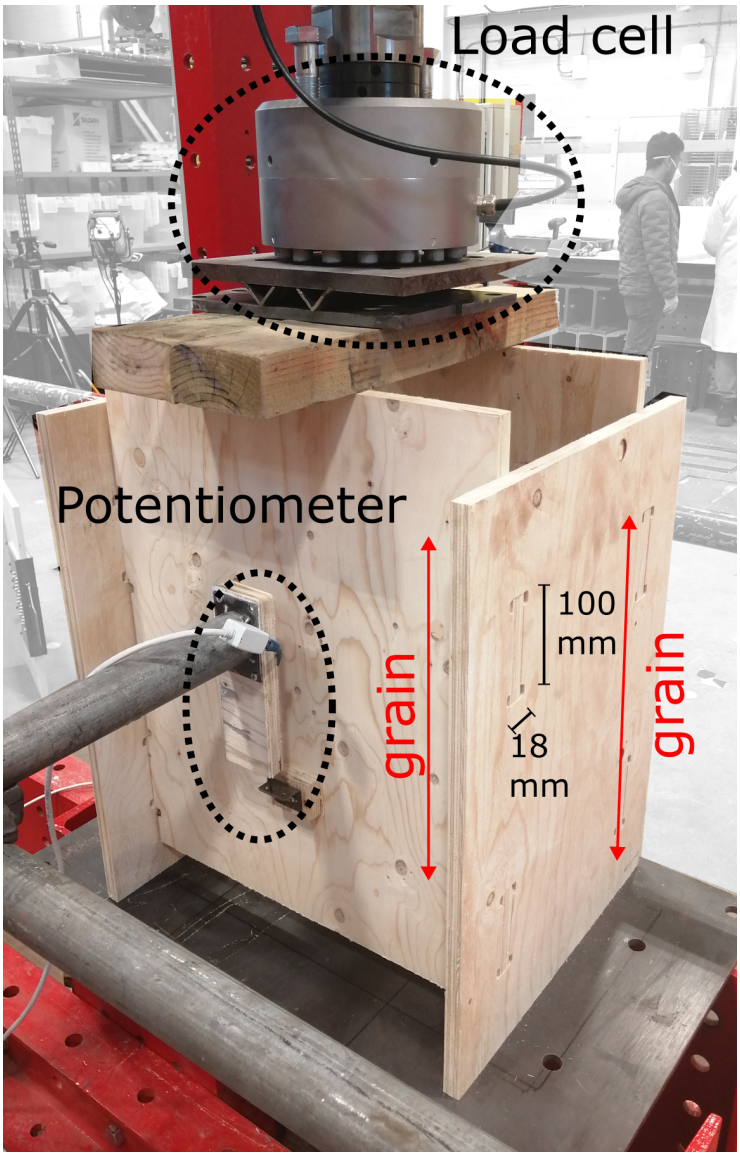

Figure 2: Experimental setup to test the shear connectors.

1. Two linear transducers (potentiometers) were used to track the panel vertical displacement. They measured the displacement with respect to an external reference.

2. A 250 kN capacity load cell was used to measure the compression force. The load cell was mounted between the actuator and the steel plate.

The loading protocol consisted of a monotonic displacement increasing until failure. The loading rate was equivalent 1 mm per minute.

1.2 Failure load

The response of the specimens in terms of force (single tab) vs vertical displacement is reported in Figure 3 Note that:

1. the actuator's force was divided by 8, because the stitch joint was made of 8 tabs resisting the load.
2. the vertical displacement was taken as the average between the measurements of the two linear transducers.

Specimens failed in between 6.99 kN and 8.02 kN. A summary of the results is reported in Table 1.

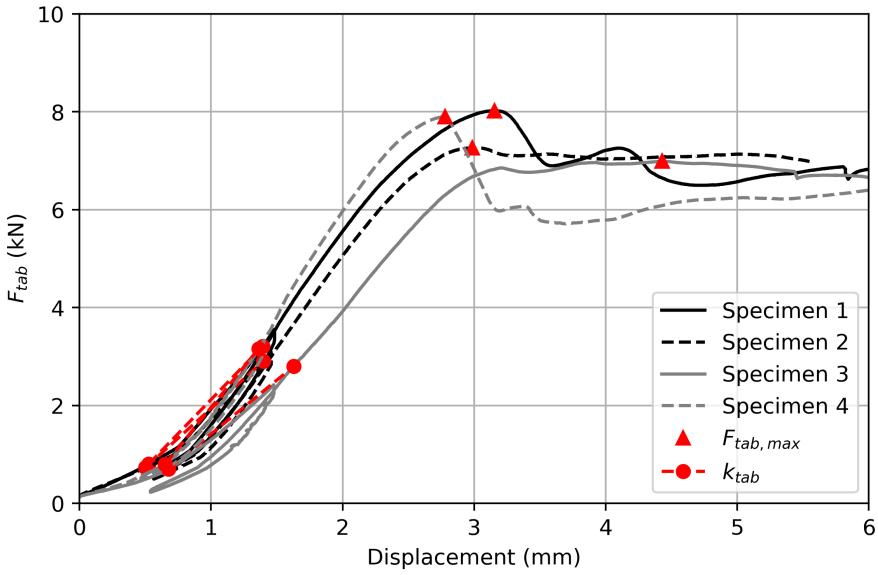

Figure 3: Force-displacement experimental results obtained for each specimen.

1.3 Failure mode

It was observed that failure happened by failing the tabs in compression. After reaching the maximum force, the specimens exhibited plastic behaviour. Pictures of the observed failure modes are reported in Figure 4.

Table 1: Test results where $F_{tab,max}$ is the maximum force and k_{tab} is the elastic stiffness.

Specimen	$F_{tab,max}(kN)$	$k_{tab}(kN/mm)$
S1	8.02	2.78
S2	7.26	2.43
S3	6.99	2.20
S4	7.90	3.33

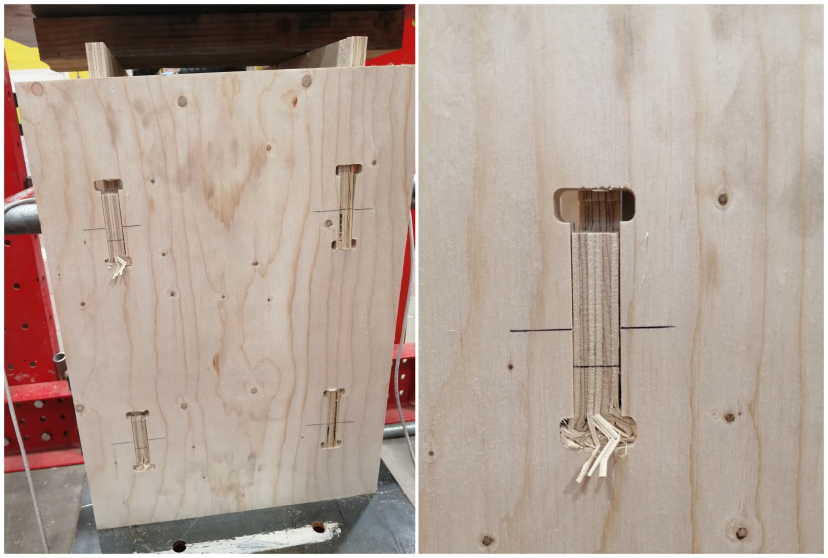

Figure 4: Observed failure modes in the stitched joints.

1.4 Elastic stiffness

The stiffness k_{tab} of the single tab is calculated using equation 1:

$$k_{tab} = \frac{F_{40\%} - F_{10\%}}{d_{40\%} - d_{10\%}} \tag{1}$$

where $F_{40\%}, F_{10\%}$ represent 40% and 10% of the maximum force (Fig. 3). $d_{40\%}, d_{10\%}$ represent the values of differential in-plane displacement where such force occurs.

The slip modulus k_{tab} ranges between 2.20 kN/mm and 3.33 kN/mm. A summary of the results is reported in Table 1.

2 Analytical model

The geometry of the specimens is reported in Figure 5. The average compression

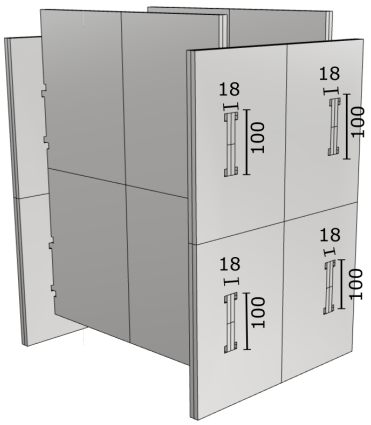

Figure 5: Geometry of the specimens.

capacity of each tab $F_{tab,max}$ can be calculated as:

$$F_{tab,max} = \overbrace{s \cdot s}^{18 \cdot 18} \cdot \overbrace{f_{c,0}}^{24.6} = 7.97\ kN$$

where s is the thickness of the panels, and $f_{c,0}$ is the compression capacity of plywood parallel to the grain It can be seen that the analytical results are consistent with the experimental data.

Acknowledgements

The series of experiments was carried out at the University of Edinburgh by Dr. Rafik Taleb and Dr. Tom Reynolds. The contribution of the technical staff in the structural engineering lab is greatly appreciated.

References

[1] Normalisation Comite Europeen de. *Eurocode 5 - Design of Timber Structures. Part1-1: General rules and rules for buildings*. Brussels, Belgium, 2004.