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RACKING TESTS OF LIGHT-FRAME-TIMBER-WALL PANELS WITH CEMENT-PARTICLE-SHEATHING BOARDS

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ABSTRACT: For light-frame-timber-wall panels, cement-particle boards (CPB) are sometimes used as a sheathing material. This type of panels has several advantages, but their performance under seismic loading has not been tested in detail. In the paper, monotonic and cyclic shear tests performed on light-frame timber panels with CPB sheathing fastened to frame by staples are presented. Three types of panels which are already used in practice varying in thickness of the CPB and geometry of the staples were tested. One of the specimens was also asymmetrical with different thickness of the boards on both sides of the panel. The results of both monotonic and cyclic tests show, that the failure mechanism of the panels under lateral loading is ductile with withdrawal of the staples from the timber frame and only minor damage of the CPBs. The lateral load-bearing capacity of the panel is reduced with smaller CPB thickness, however not as much as expected according to EC5 code provisions. Higher decrease was found for ultimate lateral displacement capacity of the panel though. According to EC5 also a reduction of the load-bearing capacity for asymmetrical panels is assumed, however no decrease of the load-bearing capacity due to asymmetrical disposition of the CPB sheathing was found in the tests.

KEYWORDS: Light-frame-timber panels, cement-particle board, cyclic shear tests, load-bearing capacity, asymmetrical panel

INTRODUCTION

For timber structures, light-frame-wall panels are still dominating in the design of residential buildings, but are however sometimes used also for design of five-storey buildings and higher [1]. Their advantage is besides of their low weight also their multi-functionality with regard to thermal and sound insulation and in some cases even good fire resistance characteristics. While now days, oriented-strand boards (OSB) and gypsum-fibre boards (GFB) are the prevailing sheathing materials, especially the use of GFB is increasing due to its favourable fire characteristics. However in Slovenia, a manufacturer of prefabricated houses uses also cement-particle boards (CPB) for sheathing material, as they also offer good fire characteristics but are in comparison to GFB less brittle and sensitive to moisture. But since the use of this type of sheathing boards is not very common for light-framed panels, there aren't any experimental studies of the seismic behaviour of such panels nor of the sheathing-to-framing connections found in the literature.

Following the study of the behaviour of the CPB sheathing-to-timber connections [2], racking tests of light-frame wall panels with CPB sheathing with detail of a stapled connection already used in practice and precedingly tested, were performed. Thickness of the boards was varied, where one of the panels had asymmetrical sheathing boards to confirm, whether asymmetry influences the lateral load-bearing capacity, as it may be implied in the European code provisions EC5 [3]. The results were analysed and the obtained lateral load-bearing capacity compared to the one estimated according to EC5.

2 EXPERIMENTAL TESTS

Geometry of the tested panels is presented in Figure 1, whereas thickness of the panels differed in dependence of the CPB thickness.

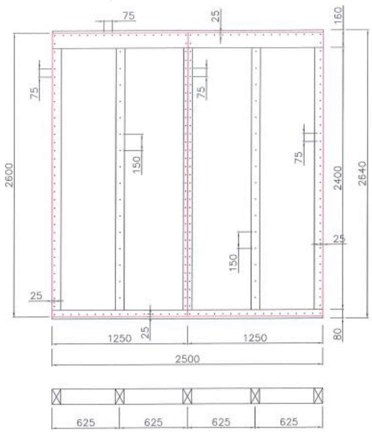

Figure 1: *Specimen B12-12 variation drawing*

Specimens labelled B12-12 had 12 mm thick CPBs on both sides, B16-16 16 mm thick ones and B12-16 a 12 mm CPB on one side and 16 mm one on the other

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side. For 12 mm CPB 1.53 x 11.25 x 45 mm staples were used, while for 16 mm CPB 2.0 x 11.76 x 50 mm staples.

For each type of the specimen, 1 monotonic and 2 cyclic racking tests were performed. The loading protocol for cyclic tests was determined according to ISO 16670: 2003 [4] on the basis of monotonic tests, which were performed according to SIST EN 594: 2011 [5]. The test setup is presented in Figure 2.

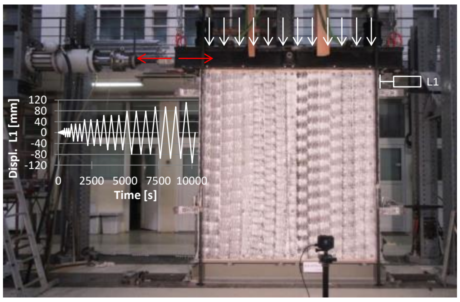

Figure 2: *Test setup*

3 RESULTS, DISCUSSION AND CONCLUSIONS

The tests have showed a ductile failure mechanism of the panels with the withdrawal of the staples from the timber. Only minor damage of CPB was obtained in the testes; already at early phase of the tests, very thin cracks in the corners occurred (Figure 3, left), which widened with increasing of the loading. With asymmetrical panel the withdrawal was more obvious in the 12 mm CPB (Figure 3, right). In Figure 4, a comparison of lateral force-lateral displacement curves obtained for monotonic tests for the three types of the panel is presented, while in Figure 5, a comparison of two hysteresis curves with envelopes for B12-12 and B16-16 panels is made.

Figure 3: *Typical damage and failure mechanism of the panel; cracks of the CPBs (left) and withdrawal of the staples (right)*

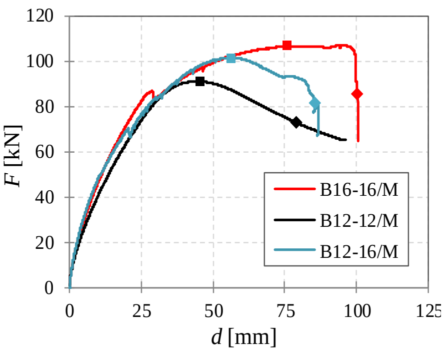

Figure 4: *Lateral force-displacement curves for the three types of panels obtained in monotonic tests*

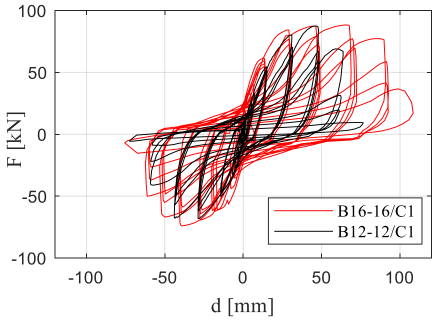

Figure 5: *Lateral force-displacement hysteresis curves for panels B12-12 and B16-16 obtained in cyclic tests*

The results show, that with reducing the board thickness and staple size (B12-12 compared to B16-16) the load-bearing capacity F_{max} is decreased for 15% in monotonic tests and only 8% for cyclic tests, while the reduction is higher for the ultimate displacement capacity; for 21% in monotonic tests and 33% for cyclic tests. Also the elastic stiffness (between 10 and 40% F_{max}) is smaller for only 7%. The decrease is smaller than expected, since the load-bearing capacity according calculated according to the EC5 code provision [3] is linearly dependent from load-bearing capacity of the connection, which is according to EC5 for B12 connection 37% lower in comparison to B16 connection. Another conclusion is that the load-bearing capacity of the asymmetrical panel is due to asymmetry not additionally decreased, as it is also recommended in EC5.

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