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CARYING CAPACITY ASSESSMENT OF ONE-SHEAR NAIL JOINT OF CEMENT-SPLINTER BOARDS

OVĚŘENÍ ÚNOSNOSTI JEDNOSTŘIŽNÉHO HŘEBÍKOVÉHO SPOJE CEMENTOŠTĚPKOVÝCH DESEK

Abstract

The aim of this article is in description of behavior and bearing capacity of one-shear nail joint of cement-splinter boards with middle solid wood element. This is made on the base of destructive laboratory testing according to valid European standards [1]. In the second part of this paper there is described typical damage of these joints and comparison of these results with bearing capacity of the same way arranged and loaded joints, where however instead of cement-splinter boards solid wood boards were used.

Keywords

Cement-splinter boards, solid wood, nail joint, shear, carrying capacity, embedment strength.

Abstrakt

Obsahem tohoto příspěvku je popis chování a únosnost jednostřižných hřebíkových spojů ve spojích cementoštěpkových desek s prostředním prvkem z rostlého dřeva. Toto je provedeno na základě destruktivního laboratorního testování podle platných evropských norem [1]. V druhé části tohoto příspěvku je popsáno typické porušení těchto spojů a srovnání s výsledky spojů, kde cemetoštěpkové desky jsou nahrazeny rostlým dřevem.

Klíčová slova

Cementoštěpkové desky, rostlé dřevo, hřebíkový spoj, střih, únosnost, pevnost v otlačení.

1 INTRODUCTION

Cement splinter boards are among others [2, 3] used in civil engineering also as a bearing and stiffening wall-cladding of timber structures with the timber wall frame [4]. Material properties (physical and mechanical) of these boards are already relatively detail laboratory determined and known. But in standards for design of timber structures there are no specifications of behaviour of these joint types, which is necessary for correct design of nail joints of these boards with timber frame.

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Test samples are selected to correspond with values usually used in praxis (cement-splinter board and middle solid wood element thickness, diameter and arrangement of dowel type elements – nails) and results of this research are applicable into praxis.

2 MEASUREMENT DESCRIPTION

Tested material

There were selected cement-splinter boards with thickness of 25 mm (ρ_k = 700 kg.m^{-3}) and 35 mm (ρ_k = 650 kg.m^{-3}) and squared timber (spruce with the strength class C24 – standard characteristic value of density ρ_k = 350 kg.m^{-3} which laboratory measured average density was 470 kg.m^{-3} [5].

Fasteners

Nails with a diameter of 2.8 mm and length of 70 mm made of steel with minimal ultimate tensile strength f_u = 600 MPa were selected as fasteners for testing.

Test samples

There were created two sets of one-shear nail joints of cement-splinter boards with middle element made of solid wood (40 samples in each set). Thickness of middle solid wood element is 60 mm. Thickness of outer cement-splinter and solid wood boards were selected in praxis most used values 25 and 35 mm (obr. 1, 2 a 3).

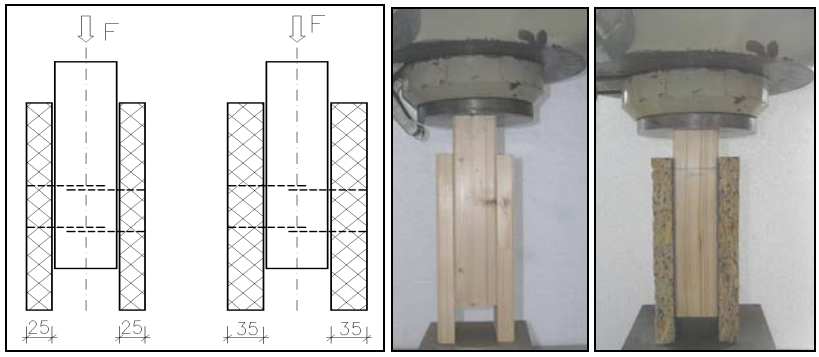

Fig. 1, 2, and 3: Test samples with selected outer boards thicknesses (25 and 35 mm)

Test procedure

The measurement took place on hydraulic press EU40 in VŠB-TUO Faculty of Civil Engineering laboratories [5, 6, and 7].

3 LABORATORY MEASUREMENT RESULTS

3.1 Statistic evaluation of tests results

Table 1 shows a brief overview of fasteners bearing capacity statistic results of nails in joints of middle solid wood element and outer cement-splinter boards with selected thicknesses. In table 1 there are also mentioned values of nails bearing capacity determined by calculation according to [1] (one-shear joints board-timber) k_{mod} = 1.0 and γ_M = 1.3.

Table 1: Contains the result values of one-shear nail joints bearing capacity ($F_{v,Rk}$) in joints of middle solid wood element and cement-splinter boards with selected thicknesses ($F_{v,Rk,\ mean}$ – mean value, SD – standard deviation, $F_{v,Rk,l}$ - 5% quantile – characteristic value of laboratory determined bearing capacity, $F_{v,Rk}$ - 5% quantile – characteristic value determined by the calculation according to [1])

Outer board thickness [mm]	Laboratory determined nails bearing capacity [kN]			Bearing capacity determined by the calculation according to [1]
t [mm]	$F_{v,Rk,\ mean}$	***SD***	$F_{v,Rk.l}$	$F_{v,Rk}$
25	1.275	0.146	1.034	0.857
35	1.080	0.129	0.868	0.854

On the basis of destructive testing results were created histograms (fig. 4 and 5) of nails bearing capacity in joints of cement-splinter boards of selected thicknesses (which can be used e.g. in fully probabilistic method SBRA [8, 9]).

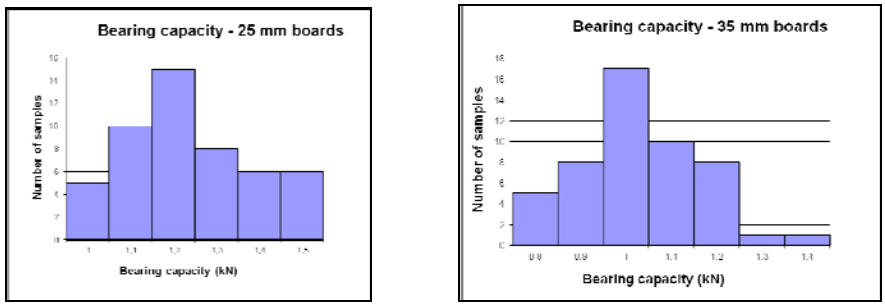

Fig. 4, 5: Histograms of the measured values of the bearing capacity of fasteners in 4-nail joints ($F_{v,Rk}$) with board thicknesses 25 a 35 mm

3.2 Test samples damage

The test samples were loaded till the reach of maximum load or limit shift of 15 mm (fig. 6). Mostly was reached maximum load if the joint before the limit shift of 15 mm. In the picture 6 is shown the test sample before and after test procedure with visible shift of boards after test procedure. By the test samples after the destructive testing is visible shift of cement-splinter boards. In the picture 7 is shown typical damage (plastic bend) of fasteners – nails.

Fig. 6, 7: Test samples before and after destructive test procedure; typical damage of joint fasteners - nails

3.3 Comparison with samples with solid wood boards

For comparison possibility of one-shear nails bearing capacity in joints with cement-splinter and solid wood boards was performed another set of 40 samples, where the cement-splinter boards were replaced with solid wood boards. Statistic evaluated tests results are mentioned in table 2.

Table 2: Contains the result values of one-shear nail joints bearing capacity ($F_{v,Rk}$) in joints of middle solid wood element and solid wood boards with selected thicknesses ($F_{v,Rk,\ mean}$ – mean value, SD – standard deviation, $F_{v,Rk,l}$ - 5% quantile – characteristic value of laboratory determined bearing capacity, $F_{v,Rk}$ - 5% quantile – characteristic value determined by the calculation according to [1])

Outer board thickness [mm]	Laboratory determined nails bearing capacity [kN]			Bearing capacity determined by the calculation according to [1]
t [mm]	$F_{v,Rk,\ mean}$	SD	$F_{v,Rk}$	$F_{v,Rk}$
25	0.915	0.050	0.816	0.734
35	0.863	0.021	0.828	0.734

4 CONCLUSION

According to [1] calculated characteristic bearing capacity $F_{v,Rk}$ for one-shear joints of cement-splinter boards and middle element of solid wood is 0.857 kN for board thickness of 25 mm and 0.854 kN for board thickness of 35 mm.

The characteristic values gain from destructive laboratory testing are 1.034 kN for board of thickness 25 mm and 0.868 kN for board thickness of 35 mm. These values are established for shift of the joint 1mm.

From tables 1 and 2 is evident, that bearing capacity of one-shear nail joints with cement-splinter boards is higher than in joints with solid wood boards. For board thickness of 25 mm the difference is approximately 22% and for board thickness of 35 mm approximately 5%.

The difference in bearing capacity is possibly due to greater density of cement-splinter boards in opposite to solid timbers, which were used as outer joints elements.

It is possible to say, that cement-splinter boards in nail joints act similar as solid wood. However in calculations of bearing capacity of these joints is necessary to use actual cement-splinter boards' density.

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