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LABORATORY TESTS OF DOWEL JOINTS TYPE IN CEMENT-SPLINTER BOARDS

LABORATORNÍ TESTOVÁNÍ SPOJŮ KOLÍKOVÉHO TYPU V CEMENTOŠTĚPKOVÝCH DESKÁCH VELOX

Abstract

The aim of this paper is determination of selected strength and deformation characteristics (hole wall tensile deformation, modulus of flexuous compressibility) dowel joints in cement-splinter boards VELOX on the basis of destructive testing.

Keywords

Cement-splinter board, dowel joint, hole wall tensile deformation.

Abstrakt

Cílem tohoto příspěvku je stanovení vybraných pevnostních a přetvárných charakteristik (pevnost v otlačení stěny otvoru, pružný modul stlačitelnosti) kolíkových spojů v cementoštěpkových deskách VELOX na základě destruktivního testování.

Klíčová slova

Cementoštěpková deska, kolíkový spoj, pevnost v otlačení.

1 ÚVOD

Nowadays, huge development in using of new wood-based materials is happening, mainly in the timber structures. One of these materials is timber-cement boards VELOX, which are made from coniferous wood chips (89%), cement and water glass solution. Timber-cement boards are mainly used in the area of construction of houses and apartment buildings (as surface fastening elements) and for construction of anti-noise screens.

In addition to basic physical and mechanical properties of these boards, it is necessary to pay attention even to bearing capacity and characteristics of connections of these boards to their bearing wood frames.

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2 MEASUREMENT DESCRIPTION

Non-destructive testing of cement-splinter boards VELOX WS and the subsequent destructive testing of the board fastener and the dowel type fastener was carried out with a set of 40 samples.

Tested Material

Cement-splinter boards VELOX WS with a thickness of 35 mm and basis weight of 25 kg.m^{-2} (see fig. 1, 2).

Fig. 1, 2: Detailed View of the board VELOX WS

Fasteners

Dowels with a diameter of 6 mm made of steel, strength class S235, with tensile strength f_u = 360 MPa were selected as fasteners for testing.

2.1 Non-Destructive Methods

Moisture Measurement

Piercing moisture meters WNT 650 and WHT 860 were used for moisture measuring of the samples from the set. Every sample underwent two measurements.

Sample Weight Determination

The weight was measured with digital scales Soehnle CWE 7745 with a measuring accuracy 5g. Two weighing procedures were carried out with the lapse of time of 6 hours. If the difference between the two values was not over 0.1% of the sample weight, both the values were recorded and the weight was determined as an average of these values.

Dimensions of the Samples

The dimensions of the test samples were measured with a minimum accuracy of 1% (the dimensions up to 150 mm by means of a calliper with an accuracy of 0.01 mm and the dimensions over 150 mm by means of a tape measure with an accuracy of 0.5 mm) after conditioning of the samples.

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2.2 Destructive Methods

Test of the Dowel Type Fastener with the Board VELOX WS

For the destructive testing, a hydraulic press EU 40, which made it possible to deduct and fluently record load with the boundary error of ± 1% of the load affecting the test piece and pushing the fastener into wood with the boundary error of ±1 % of the pushing, was used.

Test Sample

The test sample was a rectangular prism sized 35 × 90 × 150 mm (fig. 3). The thickness of the test piece, 35 mm, corresponded to the production thickness of the board.

Fig. 3: Test Samples

Before fitting of the fastener, the test pieces were conditioned to the constant weight (the results of two subsequent weighing procedures carried out in the interval of 6 hrs did not differ of more than 0.01% of the test piece weight).

For dowel type fastener, holes with the same diameter as the pin diameter had been drilled into the test pieces in advance (the same as for their using in practice).

Steel Test Preparation

The steel test preparation was made of structural (construction) steel and designed in the way, so that the friction between the steel boards and the test piece did not affect the test result (fig. 4).

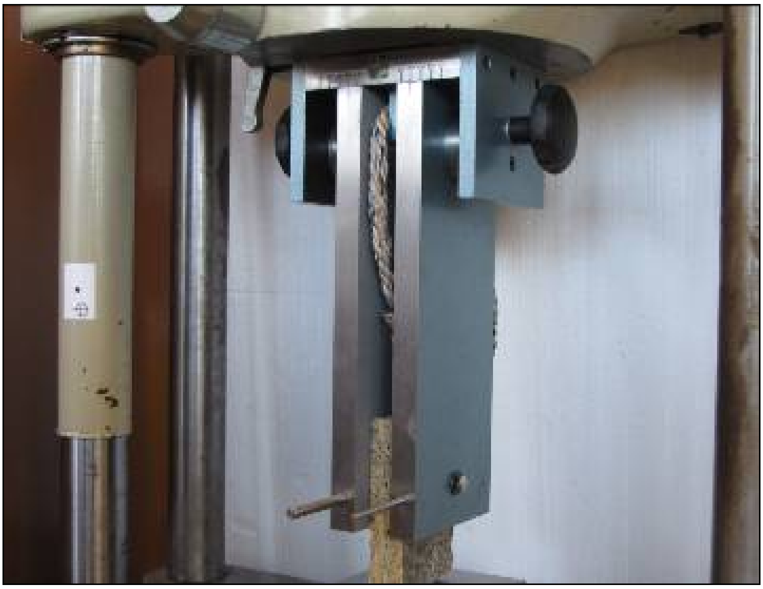

Fig. 4: Steel test preparation

Estimation of the Maximum Load

The maximum load value of the dowel type fastener was set in accordance with EC5 (joint of outer thick steel boards and central wood element – timber boards):

$$F_{ax,Rk} = 0{,}5 f_{h,2,k}\, t_2\, d = 0{,}5.34{,}74.35.6 = 3648 N = 3{,}648\text{kN}$$

$$F_{ax,Rk} = 2{,}3\sqrt{M_{y,Rk}\, f_{h,2,k}\, d} + \frac{F_{ax,Rk}}{4} = 2{,}3\sqrt{11392.\, 34{,}74.6} + 0 = 3544 N = 3{,}544\text{kN}$$

where:

d = 6 mm (diameter of the dowel);

t_2 = 35 mm (thickness of the middle element).

$$f_{h,2,k} = 50 d^{-0,6} t^{0,2} = 50.6^{-0,6} 35^{0,2} = 34{,}74\,\text{MPa}$$

$$M_{y,Rk} = 0{,}3.f_{u,k}\, d^{2,6} = 0{,}3.360.6^{2,6} = 11392\,\text{Nmm}$$

Note: In order to set the typical strength of the timber-cement boards in crushing, no exactly determined calculation figure has been set in the Czech Republic; therefore the crushing strength value for chipboards and OSB was used. The chipboards are the closest to the wood-cement chipboards VELOX WS as to their composition and their weight volumes.

Test Procedure

The load was gradually increased up to the value of 0.4 $F_{\max,est}$ and it was kept on this value for 30 sec. Then the load was decreased to 0.1 $F_{\max,est}$ and it was kept on this value for 30 sec. The load was then increased to reach the maximum load in (300 ± 120) sec (fig. 5).

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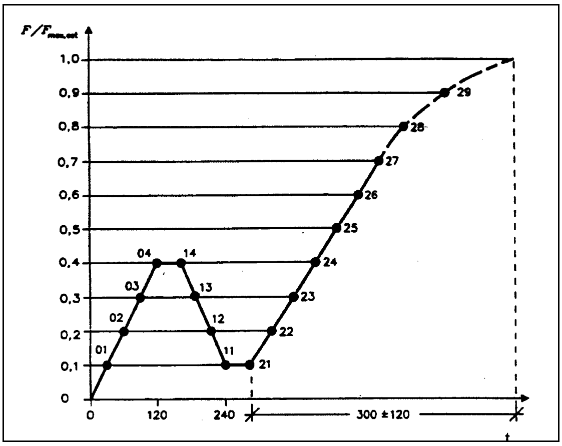

Fig. 5: Loading procedure [1]

Set Characteristics for the Joint

The following values were calculated from the recorded measuring procedures:

Hole wall tensile deformation:

$$f_h = \frac{F_{\max}}{d\,t} \tag{1}$$

Modulus of flexuous compressibility:

$$K_e = \frac{0{,}4 f_{h,est}}{w_e} \tag{2}$$

where:

d – diameter of the fastener in mm;

$F_{\max}$ – maximum load in N;

$f_{h,est}$ – estimated wall thickness in the hole in $N.mm^{-2}$;

t – board thickness in mm;

w_e – elastic deformation.

Estimated Hole wall tensile deformation:

The estimated hole wall tensile deformation, which is based on the estimated maximum load, is determined on the basis of the following formula:

$$f_{h,est} = \frac{F_{\max,est}}{d\,t} \tag{3}$$

where:

$F_{\max,est}$ – max. estimated load in N;

d – diameter of the fastener in mm;

t – board thickness in mm.

The estimated embedment strength was set by putting the values down into the formula (3). The strength is based on the estimated maximum load.

$$f_{h,est} = \frac{F_{\max,est}}{d\,t} = \frac{3544}{6.35} = 16,88\text{MPa}$$

3 MEASUREMENT RESULTS

From the results gained from the destructive testing, the attention was paid mainly to the determination of the hole wall tensile deformation in the tested timber-cement boards VELOX WS and to the module of compression for this fastener.

Hole wall tensile deformation

On the basis of putting the obtained values down into the formula (1), statistic quantities of the embedment strength were determined and the histogram of these values was created (fig. 6).

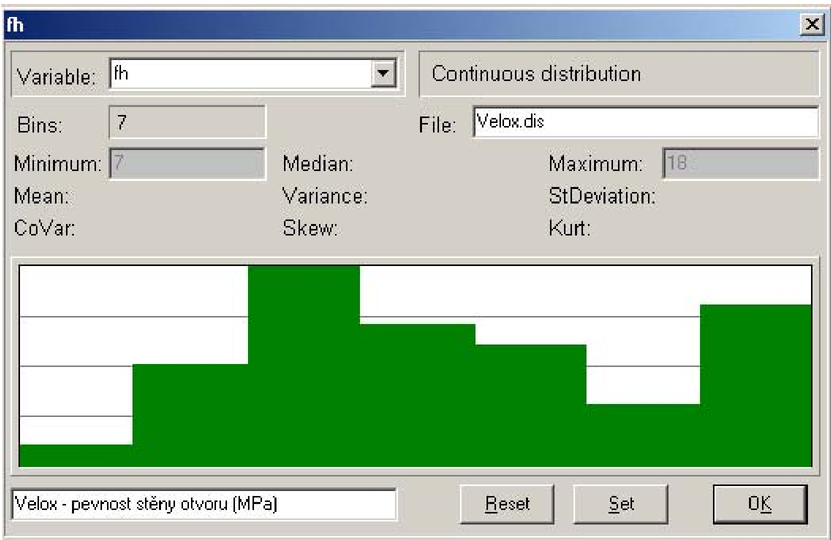

Fig. 6: Histogram of the measured values and approximation using Gauss division of the hole wall tensile deformation

Modulus of flexuous compressibility

On the basis of putting the obtained values down into the formula (2), statistic quantities of the compression module were determined and the histogram of these values was created (fig. 7).

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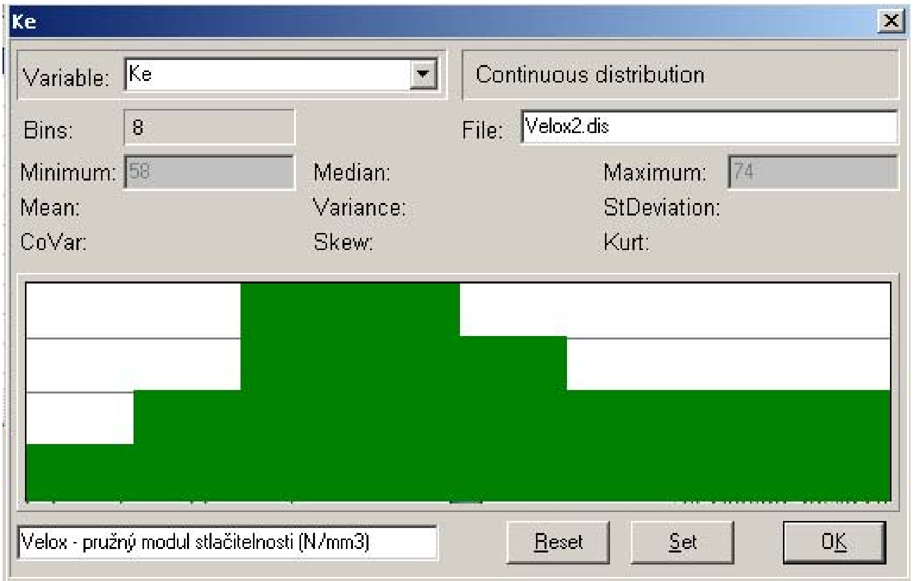

Fig. 7: Histogram of the measured values and approximation using Gauss division of the compression module

Resultant Values

Table 1 shows a brief overview of results gained during the destructive testing of the dowel type connection with the board VELOX WS.

Tab. 1: Table of the result values for the dowel type fastener with the board VELOX WS (*X* – average quantity value, *SD* – standard deviation, 5% - 5% quantile)

	Resultant values		
	X	*SD*	5%
Hole wall tensile deformation – f_h [MPa]	14,85	1,86	11,75
Modulus of flexuous compressibility – K_e [$N.mm^{-3}$]	65,70	3,90	59,27

4 CONCLUSION

It is evident from the above-mentioned data that the typical value (5% quantiles) of the hole wall tensile deformation f_h = 11.75 MPa, gained from the destructive testing, is approximately 30 % lower than the originally estimated OSB value for the boards $f_{h,est}$ = 16.88 MPa, which is apparently caused by a different structure and density of the cement-splinter board VELOX WS (see fig. 1, 2, and 3).

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