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THE EMBEDMENT STRENGTH OF DOWEL JOINTS IN CEMENT-SPLINTER BOARDS VELOX

PEVNOST STĚNY OTVORU KOLÍKOVÝCH SPOJŮ V CEMENTOŠTĚPKOVÝCH DESKÁCH VELOX

Abstract

The aim of this paper is determination of embedment strength of cement-splinter board VELOX WS in dowel dual-shear joint on the base of laboratory measurement of these joints with selected diameters. Reliance of embedment strength on diameter of connecting element (dowel) is determined.

Keywords

Cement-splinter board, dowel joint, embedment strength.

Abstrakt

Obsahem příspěvku je stanovení pevnosti stěny otvoru cementoštěpkové desky VELOX WS v kolíkovém dvojstřižném spoji na základě laboratorních testů těchto spojů, prováděných s kolíky různých průměrů. Je určena závislost této pevnosti na průměru ocelového kolíku.

Klíčová slova

Cementoštěpková deska, kolíkový spoj, pevnost stěny otvoru.

1 INTRODUCTION

Cement-splinter boards VELOX are among others used in civil engineering also as a bearing and stiffening wall-cladding of wooden structures with the wooden frame (fig. 1, 2). Material properties (physical and mechanical) of these boards are already relatively detail laboratory determined and known. But in Czech standards for design of timber structures there are no specifications of embedment strength of these boards, which is necessary for correct design of nail joints of these boards with wooden frame.

The aim of this paper is determination of embedment strength of cement-splinter boards in dowel eventually nail joints and assessment of dependence of embedment strength on the dowel diameter. There were selected 3 dowel diameters for testing: 6 mm, 8 mm and 12 mm.

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These dowel diameters were selected purposely regarding to thickness of tested board (35 mm) to guarantee primarily deformation of hole embedment and not the dowel deformation.

Fig. 1, 2: The usage of VELOX boards as a wall-cladding of wooden structures with the wooden frame

2 MEASUREMENT DESCRIPTION

Laboratory testing of dowel joints in cement-splinter boards VELOX WS with thickness of 35 mm, was performed on dowels with diameter of 6, 8 and 12 mm, 56 samples for each dowel diameter.

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 0.1% of the test piece weight).

The value of samples moisture during the laboratory testing was 12% (measured with piercing moisture meter WHT 860).

Destructive testing

Destructive laboratory testing, which has already been detail described in [1] was performed on hydraulic press EU 40 in laboratories of Faculty of Civil Engineering, according to normative requirements specified in [2].

Fasteners

Dowels with a diameter of 6, 8 and 12 mm made of steel, strength class S235, with tensile strength f_u = 360 MPa were selected as fasteners for testing.

Embedment strength

The embedment strength is determined on the basis of following formula according to [2]:

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

where:

d – is diameter of the fastener in mm;

$F_{\max}$ – maximum load in N;

t – board thickness in mm.

For the compare possibility of embedment strength resultant values gained on the basis of destructive testing also estimated embedment strength from normative formulas (detail described in [1]) was established.

Estimated embedment strength:

$$f_{h,est} = \frac{F_{\max,est}}{d\,t} \tag{2}$$

where:

$F_{\max,est}$ - maximum estimated load in N;

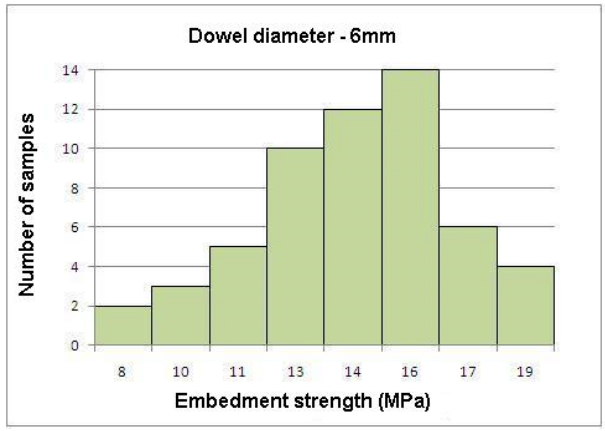
3 MEASUREMENT RESULTS

Table 1 shows a brief overview of embedment strength results of dowel joints with selected diameters in VELOX WS boards.

Tab. 1: of the result values of dowel joints embedment strength (f_h) of selected diameters in boards VELOX WS (f_h – average quantity value, SD – standard deviation, 5% - 5% quantile)

Dowel diameter [mm]	Estimated embedment strength [MPa]	Resultant statistic values [MPa]		
	$f_{h,est}$	f_h	SD	5%
6	16,87	14,76	2,65	10,41
8	14,61	12,63	2,64	8,30
12	11,93	9,41	1,57	6,82

On the basis of destructive testing results were created histograms of embedment strength in cement-splinter board VELOX WS for individual dowel diameters – 6 mm, 8 mm and 12 mm (fig. 3, 4 and 5).



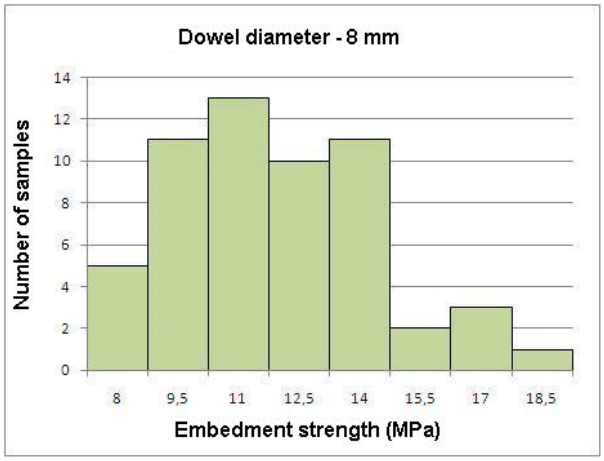


Fig. 3, 4: Histogram of the measured values and approximation using Gauss division of the embedment strength of dowel joint (f_h) with diameter 6 and 8 mm

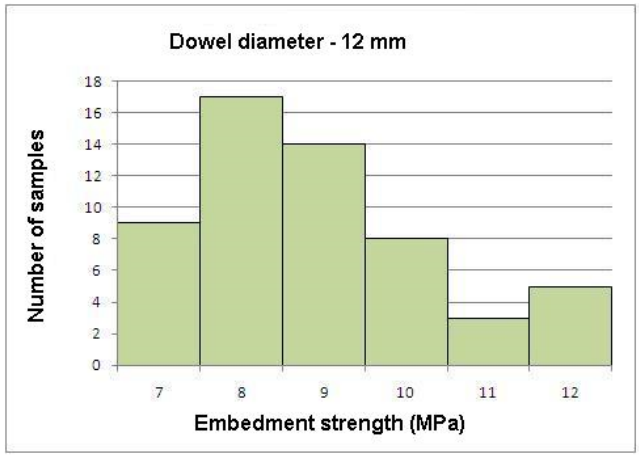


Fig. 5: Histogram of the measured values and approximation using Gauss division of the embedment strength of dowel joint (f_h) with diameter 12 mm

Figures 6 to 8 display typical hole deformation of VELOX WS boards in dowel joints at destructive testing.

Fig. 6, 7: Hole deformation after destructive testing for dowel with diameter 6 and 8 mm

Fig. 8: Hole deformation after destructive testing for dowel with diameter 12 mm

From resultant values of destructive laboratory testing was created graph of embedment strength $f_{h,05}$ dependence on dowel diameter d (fig. 9) and mathematical functions describing this dependence:

polynomial function:

$$f_{h,05} = 0{,}1144\,d^2 - 2{,}6567\,d + 22{,}229 \tag{3}$$

power function:

$$f_{h,05} = 29{,}956\,d^{-0{,}601} \tag{4}$$

Reliability values of created mathematical functions are following: polynomial function: $R^2 = 1$, power function $R^2 = 0{,}98$.

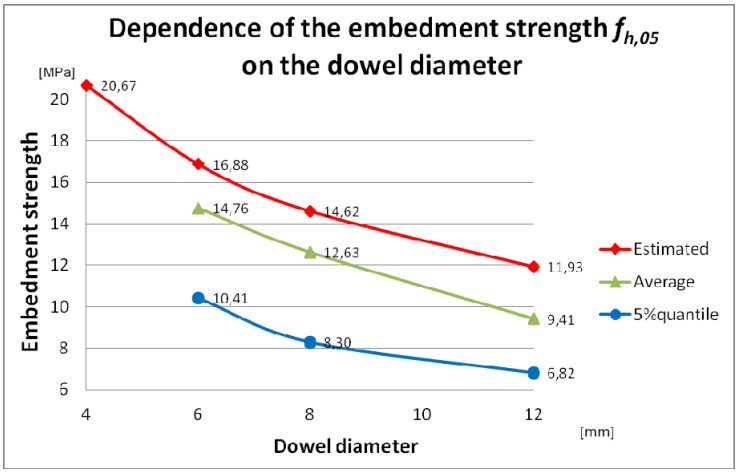


Fig. 9: Graph of embedment strength $f_{h,05}$ dependence on dowel diameter

4 CONCLUSION

It is noticeable from mentioned results, that 5% quantile of embedment strength $f_{h,05}$ for selected dowel diameters range 6,8 and 10,4 MPa and drops non-linear with increasing dowel diameter. The increase of embedment strength is described with mathematical functions (3) and (4).

Comparisons of values of estimated embedment strength $\boldsymbol{f_{h,est}}$ and 5% quantile embedment strength from results of destructive testing $f_{h,05}$ mentioned in the table 1 shows, that drop of embedment strength with increasing dowel diameter is by both compared strengths non-linear, but values of embedment strength $f_{h,05}$ are approximately 40% lower than values of estimated embedment strength $\boldsymbol{f_{h,est}}$.

The difference of these values is obviously caused with inaccurate estimation of embedment strength, which came out from formulas for particle boards. These boards are with its structure and properties most similar to cement-splinter boards VELOX WS, for which there are no values of embedment strength in dowels joints so far.

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