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LOAD BEARING CAPACITY TESTS OF MECHANICAL JOINING ON TIMBER-CONCRETE BEAM

LABORATORNÍ TESTOVÁNÍ ÚNOSNSOTI MECHANICKÉHO SPŘAŽENÍ DŘEVOBETONOVÉHO NOSNÍKU

Abstract

Timber-concrete composite structures which use advantages of both materials are suitable for new works and reconstructions of civil and residential buildings.

There are described many methods of joining between timber beam and concrete slab in technical literature. Joints are more and more sophisticate which brings higher demands of work control and technology.

Main goal of this paper is in design technologically low demanding method of joining with steel plates and nails, to test its shear strength and compare it with other similar joining method.

Keywords

Timber, concrete, composite, joining, nail

Abstrakt

Dnešní dřevo-betonové kompozitní konstrukce jsou, pro spojení dobrých vlastností obou materiálů, vhodným řešením pro novostavby i rekonstrukce obytných, či občanských budov.

V odborné literatuře se objevuje mnoho způsobů jak spojení (spřažení) dřevěného trámu a betonové desky provést. Způsoby spřažení jsou stále více sofistikované, což s sebou nese i větší nároky na kontrolu provádění a technologický postup.

Cílem této práce je navrhnout technologicky nenáročný způsob spřažení, otestovat jeho únosnost a porovnat výsledky s jiným obdobným systémem spřažení.

Klíčová slova

dřevo, beton, kompozit, spřažení, hřebík

1 INTRODUCTION

Main goal of this paper is to check up possibillities of timber – concrete beam joints, using thin plates, which are nailed up to timber beam by convex nails.

Chosen joints have to fulfill two conditions. Joint elements have to be readily available and their assembly should not be difficult as other means of joining (glued thin plinth, milled gaps ect.).

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In many practical cases simple joining between timber and concrete was considered as more effective than other sophisticated methods [1] [5].

This mean of joining should be suitable for reconstructions, where it is impossible to remove timber elements for repairs in workshop. Using convex nails seems to be useful because of frequent dynamical load (celling vibrafon) [6].

Results of thin plate and nails joining tests were compared with results of similar joints. Steel thin plates and nails were compared to gangnails [2].

2 EXPERIMENTAL ATTESTATION

Six laboratory samples were made for shear load bearing capacity tests. Half of samples were made with 2 mm thick thin plate and convex nails of 4 *mm* diameter (B samples). Another three samples were made with gang-nail joints (T samples). Dimensions of laboratory samples are stated on Fig. 1.

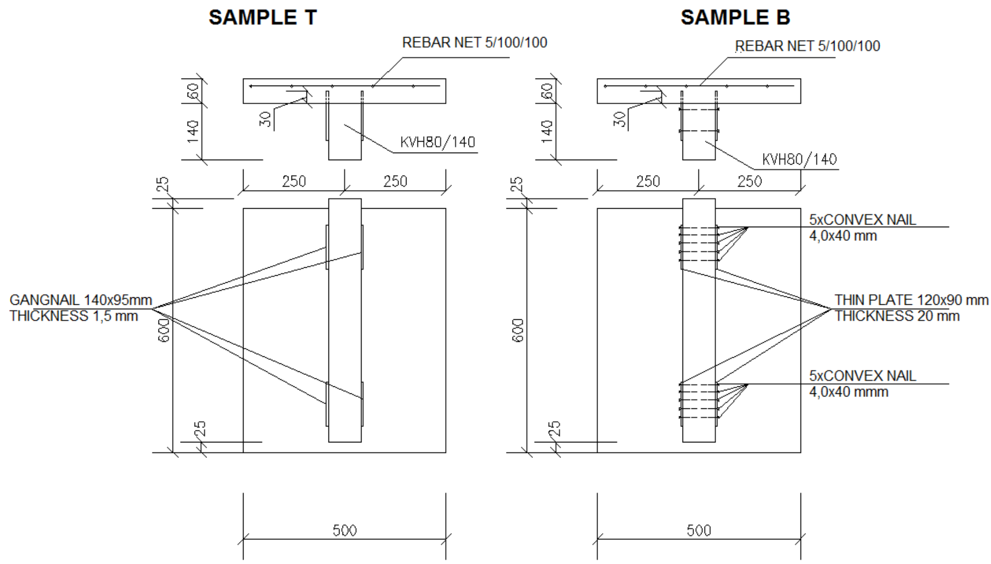

Fig. 1: Dimensions of laboratory samples

there was used concrete C20/25 and rebar net with steel grade 10505 (rebar ∅ 5 mm, raster 100/100 *mm*) for manufacuring samples. Timber beam are made of spruce planed timber type KVH of C24 class and 12% moisture.

Load bearing capacity was tested at EU 40 press in laboratory of FAST VŠB-TU Ostrava (loading proceed with constat speed of press). Shear loading was performed with help of mounting bracket, which made sample stable against turn over by excentric load action (Fig. 2)

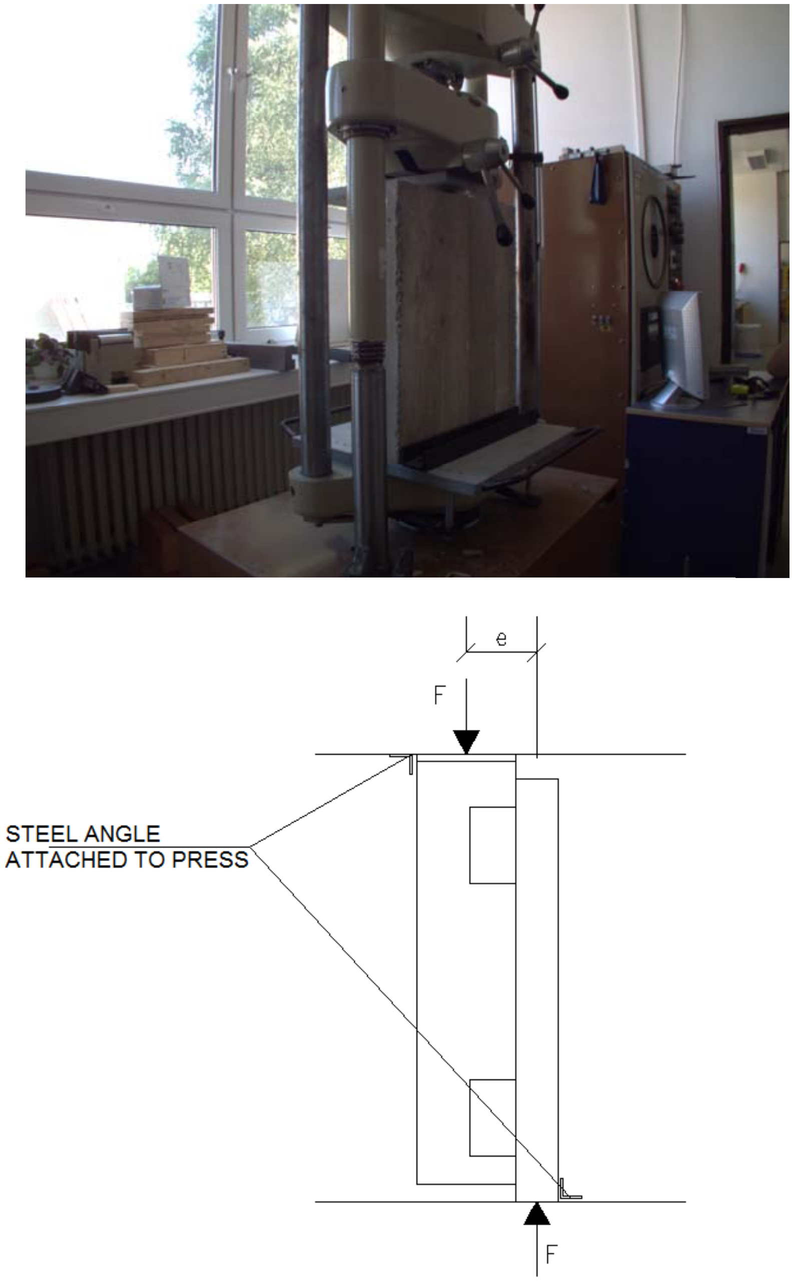

Fig. 2: Mounting bracket

3 TEST RESULTS

3.1 Joint of gangnails

T samples performed higher shear load bearing capacity than samples with thin plate and convex nails.

When the load force was 36 *kN* (60 % of maximal load bearing capacity) smal crack appeared in timber beam, right at the end of gangnail plates. Rise of the crack is also visible at the graph of force and deformation relation (Fig. 3).

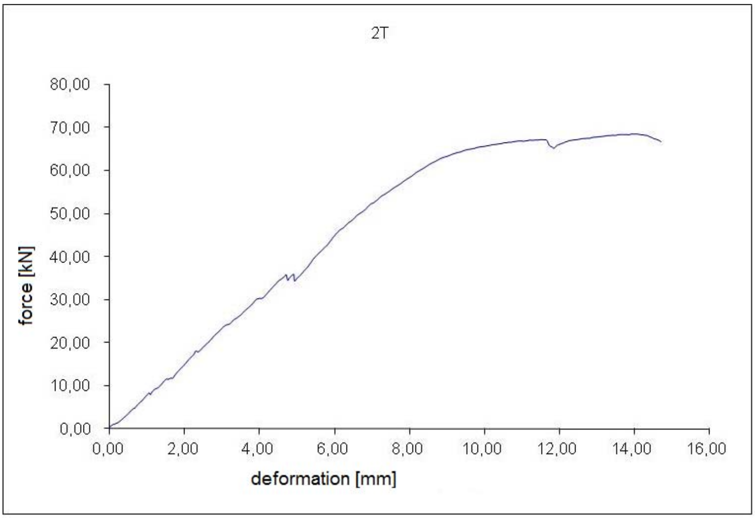

Fig. 3: Force and deformation relation

Final failure of joint appeared in gangnail plate, which showed up shear slope (Fig. 4)

Graph (Fig.3), describing loading proces has almost linear shape similar to stress diagram of steel. Failure appeared after excess of shear load bearing capacity of steel plates by load force 61,3 *kN*.

There was no sign of concrete silure. Except of first crack there was no failure in timber part too.

Fig. 4: Slope of gangnail

3.2 Joints made of thin plates and convex nails

Test proces of samples with thin plate (thickness 2 *mm*) and convex nails (4 *mm* diameter) is displayed on the graph (deformation according to loading Fig. 6)

There was examinated different type of failure than in previous case. Failure diagram has different shape.

Thin plates stayed unharmed, but nails deformation is obvious. Shift of plates to timber beam is evident even on the photo, where we can see light layer of wood, which was originaly covered by thin plate (Fig.5). Thin plates and concrete show no failure.

Fig. 5: Shape of thin plate

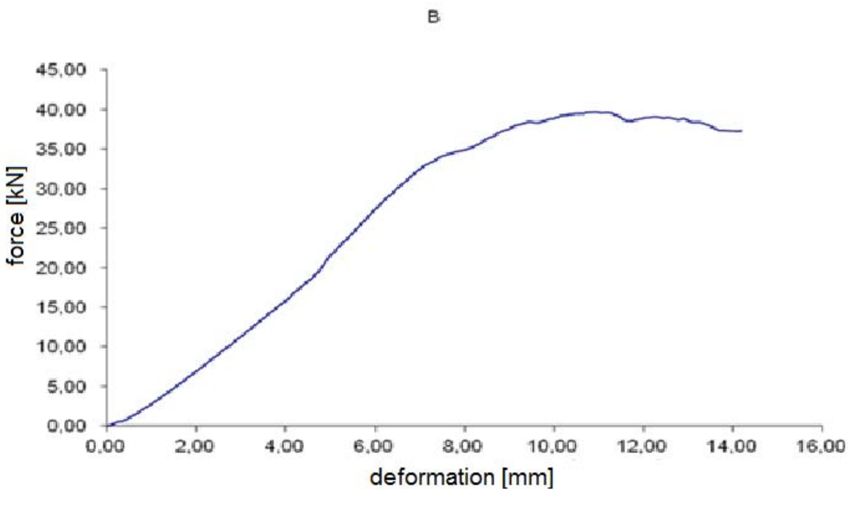

Fig. 6: Deformation graph of B sample

Load bearing capacity of four thin plates was calculated by relation below:

$$F_{v,d} = n\frac{0{,}6.f_{u,k}.t.(b-4.R)}{\gamma_{M,2}} = 4.\frac{0{,}6.500.0{,}002.(0{,}12-0{,}02)}{1{,}25} = 192{,}0kN$$

Shear load bearing capacity of joints (timber/thin plate) of serie of 20 convex nails is much lower, it is $F_{v,d}$ = 21,35 *kN* (calculation in Table n.1) [4]. Design load bearing capacity in local compresion of concrete is $F_{v,d}$ = 42,03 *kN* [3].

The weakest element of joint in this example is serie of nails, which was verified by tests.

Table n.1: Calculation of shear strength of serie of 20 nails

Input values		Calculated values		Load-bearing capacity of joint				
d(mm)	4	$f_{h,1,k}$(MPa)	22,8288			a) (kN)	Total result	
$f_{u,k}$ (MPa)	380	$M_{y,r,k}$(kNm)	0,066414			1,07		
α (deg)	0	k_{90}	1,36	$F_{v,R,k}$=	min			
α(rad)	0	n(pcs.)	20				21,35	kN
ρ (kg/m³)	290					b) (kN)		
t_1	38					6,16		

4 CONCLUSION

According to test results the calculated failure of B sample is correct. Samble B has lower shear load bearing capacity than sample T. This fact is caused by low number of nails in joint. To make joint more rigid it is possible to increase amount of nails or amount of steel plates

Variability of number of nails seems to be advantage against usage of gang-nails. It alowes us to suit joints to requirements of composite construction.

Elements of composite timber concrete beam (at least wood and concrete) and resulting composite beam have big scale of mechanical characteristics. This is the reason why the probabilistic design and analyse looks perspective. [7], [8].

Next research objective of joint with thin plate and convex nails should be bending tests of real dimesions beams. Cyclic load testing seems to be useful for theese type of composites too.

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