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PERFORMANCES OF THE CONCRETE MASONRY WITH RECYCLED WOOD CHIPS (I)

BY

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Abstract. Nowadays, one of the most important problems is the waste produced by all industries, civil engineering, commerce or consumption of products.

In the present study, the authors aimed to obtain a new building material based on wood chips waste produced from different industries. The design material properties are influenced by the wood chips' percentage in relation to the aggregate volume, embedded in cement.

Therefore, it was proposed two mix recipes, materials A and B which contain 50 and 25 percentage of wood chips related to the aggregate volume. Tests were performed for bending (flexural tensile) strengths establishing. These mechanical performances are important properties for the design process of masonry products or structures and for proving their applicability.

Keywords: wood chips; wood waste; mechanical performances; masonry blocks.

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1. Introduction

One of society's serious problems is related to the effects of environmental pollution due to the development of industries and technologies.

Thus, the main solutions can be applied in order to:

a) adopt a system of rules and requirements that impose more responsible attitudes and behaviours on industrial, economic, administrative, educational, scientific and political levels. Nowadays, the materials and fabrication technologies must take into account the principles of sustainable development, especially for innovation;

b) reduce the waste volumes through multiple recycles and re-use. This impose the identification of new materials and technologies that allow their process, recovery and introduction into a new production cycle.

In the case of wood wastes, the most used methods of recovery and transformation is the production of wood pellets utilised as the main energy sources. On the other part, recent studies present new materials buildings and technologies (Aigbomian, 2013) which take into account different types of wood waste as sawdust or chipped wood. It can be produced lightweight sustainable blocks with good thermic properties, proper density and strengths most suitable for wall blocks or panelling or other non-structural elements with thermal requirements. However, in the other studies, wood ash is used as partial replacement of different material constituents of concrete (Fapohunda *et al*., 2018), as cement (Chowdhury, 2015), or course aggregate (Thandavamoorthy, 2016), and the results show the influence of quantity and quality of wood ash and chips on workability, mechanical characteristics and density.

Products based on wood chip sizes up to 20 mm and cement can be obtained in the form of prefabricated elements, blocks with different geometries. The content and proportions of the materials of the final product will be determined by laboratory analysis and testing using appropriate equipment for weighing, homogenizing and vibrating the products.

2. Experimental Test

The using of the new building materials which include wood chips in concrete, it is possible after their classification knowing the materials behaviour to the different type of stresses. The mechanical performances were determinate by the experimental programme in Composite Materials Laboratory of the Civil Engineering Faculty. In the experimental programme was proposed and realised two mixtures for obtaining a lightweight material based on the C20/25 standard concrete.

Thus, three prisms were realised for the A mix, and three for the B, started from the C20/25 concrete mixture with the same properties of the cement and water-cement ratio for a 1 mc. The contents for those two mix are based on the 50% and 25% wood chips reported to the total volume of aggregate, included in the mixture with cement and water (Table 1).

Table 1

The Mixture for the 1 m^3 Light Concrete Masonry with Wood Chips

Prisms, material	Cement, kg	Chips wood, kg	Fine aggregate, kg	Water, l
A, 50% wood chips	370	181.4	907	185
B, 25% wood chips	370	90.7	907+907/2	185

Wood chips (Fig. 1 *a*) have been saturated with water for 24 hours, after which they have been moved in order to remove the water's excess. These were incorporated into cement milk and then the fine aggregate was added according to the concrete mixture ratio (Fig. 1 *b*). The lightweight aggregate concrete was vibrated for the ensuring the clearance of the holes, then improving the contact between chips and cement.

a *b*

Fig. 1 – Wood chips used for the prisms obtaining:
a – the dry wood chips; *b* – the mixture of concrete with wood chips.

Bending tensile strengths for the two mixtures were performed at 28 days in accordance with standard's requirements (Fig. 2) using an universal testing machine with 600 kN compressive capacity.

The bending strength was determinate from the three-point bending test and the load was applied on the middle of the prism. The dimensions of the prisms are given in mm, 100100 × 550. The test duration did not exceed 90 s and the test speed was 0.05 kN/s for the A, respective 0.08 kN/s for B.

In the Fig. 3 are presented the prisms' specimens under loading and in Fig. 4 are shown the failure modes for the both types of prisms, A and B, and the specimens' failure to the bending was shown in the Fig. 4.

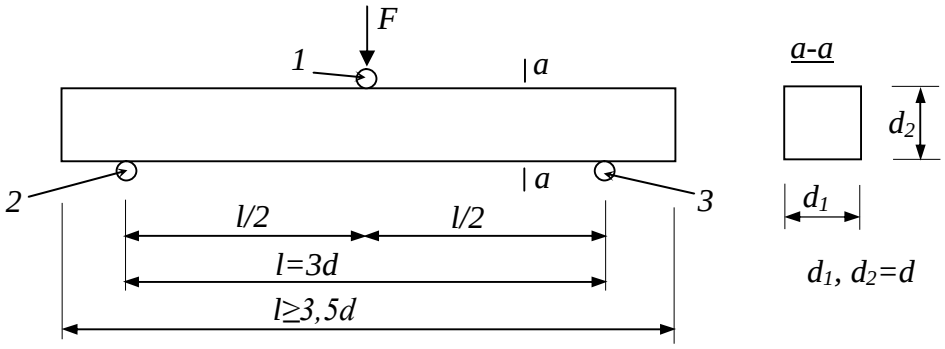

Fig. 2 – Experimental test for the three-point bending. Loading scheme (SR EN 12390-5:2002) of the specimen: *1* – loading cylinder for the force transfer; *2, 3* – Steel plates cylinder support.

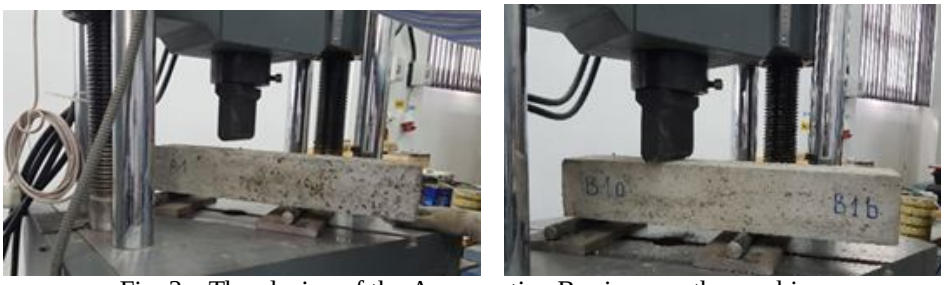

Fig. 3 – The placing of the A, respective B prisms on the machine steel plates for the bending test.

Fig. 4 – The failure of the A and B specimens under three-point bending test.

The results from the experimental test have established the average bending strengths values equal with 1.34 MPa for the A and 2.17 MPa for B, shown in Table 4 and Fig. 5.

Tabel 4.
Bending Strength of the A and B Specimens at the 28 days

Mixture	Fmax, [kN]		Bending strength, [MPa]		
	a	b	a	b	average
A1	5.41	4.46	1.65	1.36	1.34
A2	4.1	4.55	1.26	1.39	
A3	4.06	4.02	1.19	1.17	
B1	6.4	7.42	1.83	2.12	2.17
B2	8.25	7.72	2.43	2.27	
B3	7.32	7.82	2.12	2.27	

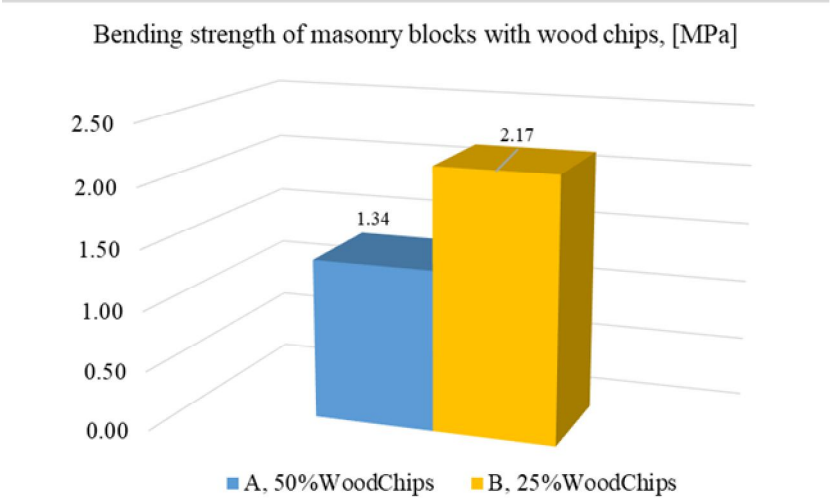

Fig. 5 – The bending strength of the A and B specimens under three-point bending test.

3. Conclusions

A building material made from concrete with cement, fine aggregate and wood chips as a replacement of course aggregate was investigated.

This study shows the influence of the wood waste replacement in the concrete for the two cases analysed. The A mix based on 50% wood chips from total volume of the aggregate and the B mix based on 25% wood chips from total volume of aggregate. It is not use coarse aggregate for the both mixes.

The bending strength for B material is equal with 2.17 MPa. The increasing of the quantity of wood waste with 50% in case of A mix induces a decrease of bending strength to 1.34 MPa.

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PERFORMANŢELE BLOCURILOR DIN BETON PENTRU ZIDĂRIE REALIZATE CU AGREGATE UŞOARE PROVENITE DIN DEŞEU LEMNOS (I)

(Rezumat)

In zilele noastre, deşeurile provenite din industria comerţului, din consumul de produse sau din producţia de materiale de construcţii sau de punere în opera a acestora constituie o problemă serioasă ce impune luarea unor măsuri pentru controlul asupra deşeurilor şi reducerea impactului asupra mediului.

Astfel, şi în cazul deşeurilor provenite din materialulul lemnos implicat în diferite domenii industriale, există astfel de preocupări care conduc la reutilizarea acestor resurse sub diferite forme şi dimensiuni şi la stabilirea unor arii de aplicare.

In acest articol se studiaza obţinerea unui material de construcţii din beton în care agregatele grosiere sunt înlocuite de agregate uşoare ce valorifica deşeul lemnos sub formă de aşchii din lemn.

Cele două reţete propuse, A şi B, cu un conţinut diferit de aşchii din lemn, de 50% respectiv 25%, raportat la volumul de agregat, au evidenţiat prin încercările experimentale realizate, valori diferite ale rezistenţei la întindere din încovoiere. Această proprietate este necesară atât în procesul de încadrare a produsului, cât şi în cel de proiectare pentru evaluarea capacităţii portante a elementului sau sistemului structural.