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PERFORMANCES OF CONCRETE MASONRY WITH RECYCLED WOOD CHIPS (II)

BY

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Abstract. The purpose of this study is to obtain an environmentally friendly building material based on recycled wood chips resulted from different industries as wood waste. The wood waste management of any field and its recycling in obtaining other resources further used to develop useful products for masonry structures is a way to mitigate the environmental effects of pollution.

The usage and application of these materials or construction products is encouraged by their mechanical and physical performances according to the variation of 50 and 25 wood chips percentage reported to the aggregates' volume. Compressive strength and density were established by experimental test and added to bending strength from a previous study. This research shows the influence of wood chips as a light aggregate and recycled material included in the cement mass on the mechanical properties and density of the material.

Keywords: light aggregate; wood waste; compressive strength; bending strength; lightweight blocks.

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1. Introduction

Due to rapid world population growth, there is an increasing demand in the civil engineering area for concrete or performant building materials with improved mechanical and thermal performances. In addition, in the context of sustainable design and technology, civil engineers aim to develop and build lightweight structures and buildings with low cost and energy consumptions. Adding wood waste in conventional concrete as a partial or integral replacement of the fine and coarse aggregate improves thermal properties as well as reduces density, resulting in an eco-friendly material. On the other hand, nowadays, the increasing of the waste volume generated from the development of industries is a serious problem (Ahmed *et al.*, 2018). The wood waste management of any field and its recycling in obtaining other resources further used to develop useful products such as lightweight-concrete for masonry structures is a way to mitigate the environmental effects of pollution.

Recent studies show the concern of incorporating different types of wood waste as sawdust or chipped wood in concrete. Lightweight and sustainable concrete or precast blocks for wall blocks or other building wall elements with high thermal requirements and low density can be produced using this technique (Aigbomian & Fan, 2013). Mechanical performances such as compressive or bending strength were observed regarding the influence of light aggregate percentage.

However, in other studies, wood waste is used as partial replacement of different material constituents of concrete (Fapohunda *et al.*, 2018), as cement (Chowdhury *et al.*, 2015), or coarse aggregate (Thandavamoorthy, 2016), mortar (Sasah & Kankam, 2017) or clay bricks (Ganga *et al.*, 2014), and the results show the workability and performances variation due to the modification of the quantity and quality of wood ash or chips.

Construction products based on wood chip size up to 20 mm and cement can be obtained in the form of prefabricated elements, blocks with different shapes and sizes with many advantages compared with conventional building elements. In this study, a new and sustainable building material has been developed by using recycled wood waste in order to achieve an environmentally friendly material with convenient properties.

2. Experimental Test

Within this experimental study, the mechanical and physical performances according to content and percentages of wood chips and other

constituent materials of the final product will be noted. The mechanical characteristics of the material are important in the design process and in establishing their applicability in structural or non-structural elements.

The compressive strength and density of lightweight concrete were determined by the experimental programme in Composite Materials Laboratory of the Civil Engineering Faculty depending on the two proposed mixtures based on the C20/25 standard concrete, realised in our faculty. The contents of the two mixtures are based on 50% for A and 25% for B wood chips reported to the total volume of aggregate, included in the mixture with cement and water (Ențuc *et al.*, 2018). The samples were weighed and the values are shown in Table 1.

Table 1
Compressive Strengths and Weights of the A and B Specimens at 28 Days

Mixture	Compressive strength, [MPa]			Weight [kg/m ³]
	a	b	c	
A1	3.064	2.636	2.906	1,188.37
A2	2.984	2.92	2.718	1,203.15
A3	2.634	2.738	2.666	1,154.59
Average value	2.81			1,182
B1	9.565	8.705	8.235	1,716.75
B2	9.05	8.78	7.445	1,752.53
B3	8.865	8.53	7.35	1,747.71
Average value	8.50			1,739

Compressive strengths for the two mixtures were performed at 28 days in accordance with the standard's requirements (SR EN 12390-5:2002), using a universal testing machine with 600 kN compressive capacity. The test duration did not exceed 90 s and the test speed was 0.05 kN/s for A, respectively 0.08 kN/s for B (Figs. 1 and 2). The compressive strength was performed on the prisms resulted after performing the bending test, with nine specimens of each mixture, A and B.

In Fig. 3 and Table 2 are presented the average values of the strengths and weights for both A and B specimens related to the wood chips percentage.



Fig. 1 – The placing of the A (left), respective B (right) prisms on the machine steel plates for the compressive test.



Fig. 2 – The failure of the A (left) and B (right) specimens under compressive

Table 2

The Average Values of Bending and Compressive Strengths and Weights of the A and B Specimens at 28 days

Mixture	Bending strength, [MPa]	Compressive strength, [MPa]	Weight [kg/m ³]
A	1.34	2.81	1,182
B	2.17	8.50	1,739

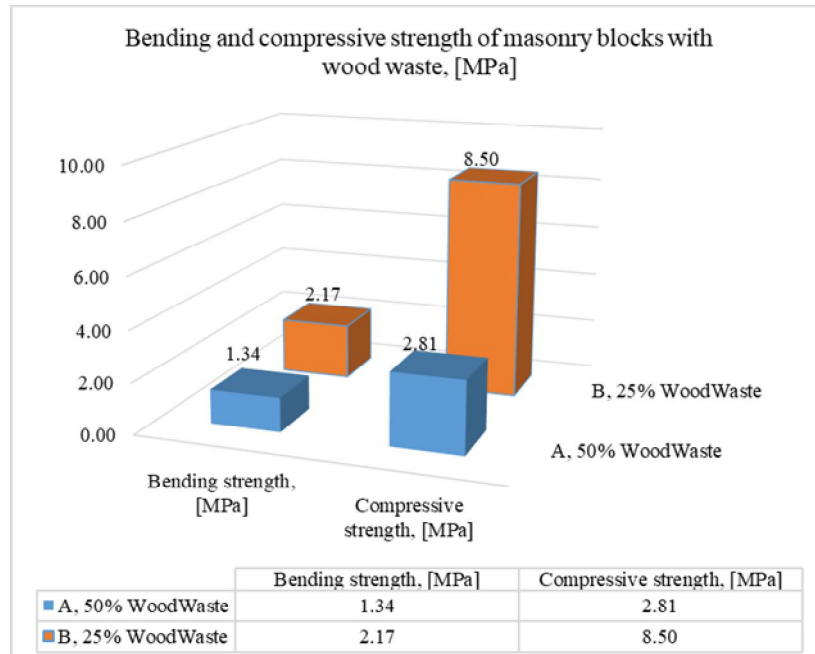


Fig. 3 – The bending strength of the A and B specimens due to wood chips percentage.

3. Conclusions

This experimental study notifies the influence of light aggregates due to wood waste replacement in the concrete for the two mixes A and B, based on 50%, respectively 25% wood chips from total volume of aggregates. The experimental study analyses the behaviour of a new building material made of concrete with cement, fine aggregate and wood chips as a total replacement of course aggregate. The increasing percentage of wood chips as a light aggregate in concrete leads to lower values of compressive strength and weight. In consequence, raising the percentage of wood chips from 25 to 50 for B and A materials lead to a decreasing of compressive strength, from 8.5 MPa for B material to 2.81 for A material. In the same manner, lower weight values due to the increase of light aggregate volume, 1739 kg/m³ for 25% wood chips respectively 1182 kg/m³ for 50% wood chips were highlighted.

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REFERENCES

- Ahmed W., Khushnood R.A, Memon S.A., Ahmad S., Baloch W.L., Usman M., *Effective Use of Sawdust for the Production of Eco-Friendly and Thermal-Energy Efficient Normal Weight and Lightweight Concretes with Tailored Fracture Properties*, Journal of Cleaner Production, **184**, 1016-1027 (2018).
- Aigbomian E.P., Fan M., *Development of Wood-Crete from Treated Wood*, Construction and Building Materials, **52**, 353-360 (2014).
- Chowdhury S., Mishra M., Suganya O., *The Incorporation of Wood Waste Ash as a Partial Cement Replacement Material for Making Structural Grade Concrete: An Overview*, Ain Shams Engineering Journal, **6**, 429-437 (2015).
- Entuț I.S., Isopescu D.N., Bagdasar L.C., Opreșan G., Zapodeanu I., Maxineasa S.G., *Performances of the Concrete Masonry with Recycled Wood Chips (I)*, The Bul. Inst. Politehnic, Iași, **64 (68)**, 3, s. Construction. Architecture Section, 103-108 (2018).
- Fapohunda C., Akinbile B., Oyelade A, *A Review of the Properties, Structural Characteristics and Application Potentials of Concrete Containing Wood Waste as Partial Replacement of one of its Constituents Material*, YBL Journal of Built Environment, **6**, 1 (2018).
- Ganga G., Nsongo T., Elenga H., Mabilia B., Tatsiete T.T., Nzonzolo, *Effect of Incorporation of Chips and Wood Dust Mahogany on Mechanical and Acoustic Behavior of Brick Clay*, Journal of Building Construction and Planning Research, **2**, 198-208 (2014), <http://dx.doi.org/10.4236/jbcpr.2014.23018>.
- Sasah J., Kankam C.K., *Study of Brick Mortar Using Sawdust as Partial Replacement for Sand*, Journal of Civil Engineering and Construction Technology, **6**, 59-66 (2017), DOI: 10.5897/JCECT2017.0450.
- Thandavamoorthy T.S., *Wood Waste as Coarse Aggregate in the Production of Concrete*, European Journal of Environmental and Civil Engineering, **20:2**, 125-141 (2016), DOI: 10.1080/19648189.2015.1016631.
- * * *Încercare pe beton întărit, Partea 3. Rezistența la compresiune a epruvetelor*, SR EN 12390-3, 2005, ASRO.

PERFORMANȚELE BLOCURILOR DIN BETON PENTRU ZIDĂRIE REALIZATE CU AGREGATE UȘOARE PROVENITE DIN DEȘEU LEMNOS (II)

(Rezumat)

Scopul acestui studiu de cercetare este de a obține un material de construcții prietenos cu mediul prin reciclarea deșeurilor lemnoase provenite din diferite industrii.

Managementul și reciclarea deșeurilor din lemn în obținerea de resurse folosite mai departe în producerea unor materiale și produse pentru construcții la realizarea pereților constituie o strategie de reducere a efectelor poluării asupra mediului. Stabilirea domeniului de aplicare a materialelor și produselor nou dezvoltate se efectuează în funcție de performanțele mecanice și fizice ale materialului lând în considerare modificarea conținutului de agregate ușoare din aşchii din lemn, 50% și 25%, raportat la volumul agregatelor pentru o unitate de volum de beton.

Rezistențele la compresiune și densitățile materialului au fost determinate experimental și completate la studiile făcute anterior în vederea cunoașterii comportării materialului la diferite solicitări. Acest studiu arată influența cantității de aşchii din lemn reciclat folosite ca agregate ușoare incluse în masa de ciment asupra performanțelor materialului analizat.

