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PROPERTIES OF HEMP FLY ASH CONCRETE AND BLOCKS

BY

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Abstract. In the paper are analysed the results of experimental test effectuated on concrete prepared with fly ash and hemp fibers as disperse reinforcement. The density and compressive strength of fly ash concrete were determined and analysed. As practical application the fly ash concrete was used to manufacture hollow concrete blocks which were tested in compression. The compressive strength and type of failure of blocks under compression were presented.

Keywords: fly ash; hemp fibers; density; compressive strength; hollow concrete block.

1. Introduction

Concrete is the most used material in construction and one of the great product which pollutes the environment because its high consumption of cement and natural aggregates. For cement production important quantities of CO2 are eliminated in the atmosphere. The natural resources are affected in time by the huge consumption of aggregates, an important component of concrete (Huang *et al.*, 2016). Researches in the building industry tried to reduce the CO_2 emission by replacing the cement in concrete mix with other materials such as: silica fume,

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fly ash, glass powder, rice husk, banana leaves ashes, etc. (Soo Zoum *et al.*, 2016; Gholampour & Ozabakkaloglu, 2017; Lee *et al.*, 2018; Khan *et al.*, 2018; Kanning *et al.*, 2014). For replacing the natural aggregates, a lot of other materials can be used, such as: ground granulated blust furnace slag, steel slag, chopped plastic bottles, polystyrene granules, recycled aggregates, agro-wastes, etc. (Erdogan Özbay *et al.*, 2016; Garg & Khadwal, 2014; Rahmani *et al.*, 2013; Yi Xu *et al.*, 2012; Soares *et al.*, 2014; Jnyanendra Kumar Prusty *et al.*, 2016).

In the article are analysed the characteristics of fly ash concrete with hemp fibers and the behaviour of hollow blocks under compression.

2. Experimental Program

2.1. Materials

For preparing the experimental concrete (FAHC), the following dosages of components were used: cement 324 kg/m^3 (SR EN 197-1:2011), fly ash, 36 kg/m^3, river sand with sizes 0-4 mm in a quantity of 803 kg/m^3; aggregate of sizes 4,...,8 mm in a quantity of 384 kg/m^3; aggregate of sizes 8,...,16 mm in a quantity of 559 kg/m^3; water was in a dosage of 172 l/m^3 and superplasticiser type MasterGlenium SKY 617 from BASF was in a dosage of 1% from cement dosage. The characteristics of fly ash used in the present research are given in previous article (Bărbuță *et al.*, 2015). The waste of hemp was cut at 30 mm length for obtaining fibers. The hemp fibers were used in a percentage of 0.25% from the mix weight.

2.2. Samples

For determining the density and the compressive strength of concrete with fly ash and hemp fibers, the cubes of 150 mm sizes were poured (SR EN

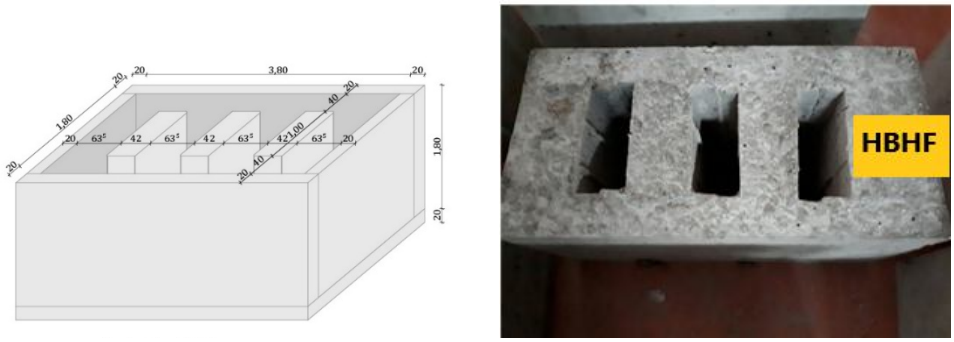

Fig. 1 – The hollow block.

12390-3:2011). The split tensile strength was determined on prism of 100 × × 100 × 500 mm sizes (SR EN 12390-4:2010). The hollow blocks (HBHF) of sizes 380 × 180 × 180 mm were manufactured, Fig. 1 (Timu, 2018).

3. Test Results and Discussions

3.1. Density of Fly Ash Concrete with Hemp Fibers

The density of hardened concrete was determined according to standard. The experimental value is given in Table 1.

Table 1
Physical-Mechanical Characteristics of Fly Ash Concrete with Fibers

Concrete sample	Density kg/m^3	f_c N/mm^2	f_{td} N/mm^2
FAHC	2,244	34.8	2.90

3.2. Compressive Strength of Concrete

The values of compressive strength and split tensile strength for the concrete with wastes were determined at 28 days on 3 cubes, according to SR EN 12390-3:2011, SR EN 12390-4:2010. The values are given in Table 1.

3.3. Tests on Hollow Blocks

The hollow blocks of fly ash concrete were subjected to axial compression. The maximum value of the compression load was divided by the gross contact area of the block, including holes and was noted f_{cbl1}, and by the net area, noted f_{cbl2}.

The experimental results on blocks are given in Table 2.

Table 2
Experimental Results of Hollow Blocks Subjected to Compression

No.	Sample	Sizes of Block mm	Maximum compression force kN	f_{cbl1} N/mm^2	f_{cbl2} N/mm^2
1	HBF	380 × 180 × 180	398.70	5.82	7.15

The compressive strengths fcbl of the hollow block had small values compared with the compressive strength of concrete. Blocks with fly ash and hemp fibers can be used as self-weight masonry (SR EN 771-4:2004).

3.5. Failure Mode

The block was loaded gradually. Vertical cracks near holes occurred which had developed until failure, produced by concrete degradation especially at the block ends (Fig. 2).

Fig. 2 – The hollow block.

4. Conclusions

The concrete used for manufacturing the hollow blocks was prepared with fly ash as cementitious addition and hemp fibers as disperse reinforcement. The compressive strength of the concrete presented high value, that can classify the concrete as C20/25. The concrete was used for manufacturing hollow blocks that were subjected to axial compression. The failure of hollow blocks was gradually, ductile, that recommend to be use as prefabricated elements for self weight masonry.

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PROPRIETĂȚILE BETONULUI CU CENUŞĂ DE TERMOCENTRALĂ ŞI CÂNEPĂ ŞI A BLOCURILOR

(Rezumat)

În lucrare sunt analizate rezultatele ale testelor experimentale efectuate pe beton preparat cu cenuşă de termocentrală şi fibre de cânepă ca armătură dispersă. Densitatea şi rezistența la compresiune a betonului cu cenuşă de termocentrală au fost determinate şi analizate. Ca aplicație practică betonul a fost utilizat pentru realizare blocurilor cu goluri, care au fost încercate la compresiune. Rezistența la compresiune axială şi modul de rupere al blocurilor au fost analizate.