Materials Science and Engineering, Volume 45, No. 1 (2020), pp. 316–322.
DOI: 10.32974.mse.2020.032

POSSIBILITIES OF UTILIZATION GROUND REED IN CEMENT FOAM

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Abstract: Nowadays, due to overpopulation heating energy consumptions constantly increasing, however this could be reduced by suitable insulation materials. Thermal insulation products play a significant role in building materials. In the construction and building industry reed is known as an ecological insulation material. Using reed energy-saving production process can be created and with this natural material, environmentally friendly material use can be achieved. For this reason the present study has a dual goal: partly integration of ground reed into cement foam as a space filler and insulation material, on the other part making an insulating panel using reed particles. During the experiment, the reed fibres were cut and then mixed with cement paste. In this research work the compressive strength of the samples (at 7, 17 and 28 days), density and finally the thermal conductivity of the samples were measured.

Keywords: reed, cement foam, insulting materials

INTRODUCTION

Today, there is a rapid growth in the construction industry worldwide. Due to rapid urbanization, total energy consumption and a significant portion of greenhouse gas emissions is attributed to construction industry. All over the world one third of the total energy is used to heat or cool buildings. In order to save the energy consumption of concrete buildings, there is a large demand for the development of structural cement based materials with low thermal conductivity and eligible compressive strength [1, 2].

Several agricultural waste materials have already been used as alternatives to cement-based products [3, 4].

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Benmansour et al. [5] had main goal is to assess the potential of a new natural material (palm fibres, DPF) as a building materials. In their experiment, several mixtures were made with palm fibres added in different amounts (0 to 30 wt%). According to their measurement results that the incorporation of palm fibres into the mortar along with the weight of sample reduces the thermal conductivity and compressive strength of composite. By their study, the use of palm wood fibres in 5–15 wt% suits the thermal and mechanical requirements of building materials.

Remesar et al. [6] investigated the effect of a combination of three different materials, namely coarse expanded clay (CEC), fine expanded clay (FEC) and fly ash. Experimental results show that the use of FEC results in lower thermal conductivity and lower compressive strength than the use of CEC. The reason for this was explained by the finer pore size distribution and the smaller pore size. Of the three materials, fly ash has the least effect on thermal and mechanical properties, while combination of the three materials shows that the thermal conductivity decreases, as well as the compressive strength is within acceptable limits.

Bołtryk and Pawluczuk [7] aimed to establish the properties of lightweight cement composites with natural fillers, such as reed and conifer sawdust. The compressive strength, density and porosity of the samples were measured.

These research works inspired us to add ground reed in to the cement paste. The aim of research was to reduce the amount of primary materials used in the production of cement foams. As the reed has a thermal conductivity of 0.05 W/mK, so it has excellent thermal insulation properties, which can further improve the energy performance of cement-based lightweight concrete products. In addition to these properties, it is important to know the effect of the additive on the strength values. Therefore, in this research work compressive strength tests were measured.

1. MATERIALS AND METHODS

In the research work the first step was the grinding of 2 m long reeds, which was done by an AL-KO, Power Slider 2500 R type blade shredder. In the shredder the knives make a rotating motion as a result of which the reed fibres are cut. As a result of this shredding mechanism, ground reeds of different fractions were obtained, which were used in different ways.

Figure 1
Ground reed

After grinding, cement foams were made using these reeds in the range of 5–40 mm. In this case, the reed particles were used as filler. During the research work DDC CEM II/ B-M (V-LL) 32,5 R type cement was applied to prepare the cement foam to which 30 wt% concentration H_2O_2 solution in amount of 4 wt%, proportionally to the weight of the cement, as a foaming additive and 10 wt% ground reed were added at a factor of 0.488 w/c.

During the experiment the ground reed was added to the cement paste then the cement mass was cast into 75 × 75 × 75 mm moulds. Specimens were removed from the moulds at one day of age and those were stored in a steam chamber until the day of compressive strength test. The temperature of the steam chamber was 22 °C and the relative humidity was ~ 90%. A total of 27 specimens were prepared on which compressive strength of 7, 14 and 28 days were measured.

Figure 2
Cement foams made from ground reeds

During the experiments it was found that after mixing the ground reed with cement paste the water was absorbed from the cement paste and as a result the samples had a hard time to dry. The next step is the mineralization, known from the production of wood wool boards, i.e. utilizing the hygroscopic capacity of reeds, so a mineral was injected into its structure. In the production of wood wool boards the mineralization of wood raw materials is carried out with an aqueous solution of calcium chloride ($CaCl_2$), occasionally using magnesium chloride ($MgCl_2$) or water glass (Na_2SiO_3).

For all these reasons the ground reeds were fractionated using a sieve with 5 mm opening size, then cylindrical seeds were prepared from the sieved reeds. During the reed seed preparation, 100 g of reeds were mixed with 160 g of water glass, (Na_2SiO_3) and then it was compressed into a PVC pipe with 25 mm in diameter and 150 mm in length. As a result of compression, the water glass glued the reeds particles together. After one day it could be easily removed from the pipe, without being fractured. The reed seeds were made to size proportionally to the mould and fixed in the 150 × 150 × 150 mm mould. The 6 reed seeds were fixed by the clamping force of the mould *(Figure 3)*, and foamed around with cement paste.

Figure 3
The reed seeds in the mould

During the foaming of the reed seeds, CRH CEM II/B-S 42.5 N type Portland cement was used. In this case, too H_2O_2 was used in an amount of 4 wt% as foaming agent with w/c factor of 0.553.

After that, a pressed insulating panel was made using ground reeds in the range of 5–40 mm. For this DDC CEM I 52.5 N type cement and 16 wt% reed were used to obtain a more stable panel as a final product. The insulating panel made using ground reed is based on similar concept for commercially available Heraklith® wood wool insulation boards [8]. During the production of the insulating panel, ground reeds were added to a relatively dilute (0.46 w/c) cement paste with gradual mixing. After mixing, the cement-reed paste was casted into the 300 × 300 × 50 mm mould of size, and then the top was located on crest of the mould. Following this the sample was pressed by a pneumatic cylinder, where a pressure load of 2 bar was applied to the sample for one hour. Affected by this the cemented reed mixture was compressed, resulting in a pressed reed panel which is similar to wood wool insulation boards.

Figure 4
The process of pressing a reed panel

2. RESULTS AND DISCUSSION

Compressive strength testing was performed on cement foams at 7, 14 and 28 days of age. The test was made with an INSTRON electromechanical tensile and compression testing apparatus. The measurement results of the compressive strength of cement foam can be seen in *Figure 5*. The mean of the compressive strength results measured at 7 and 28 days of age was 0.85 MPa, while the mean values for the 14 day results were 0.64 MPa.

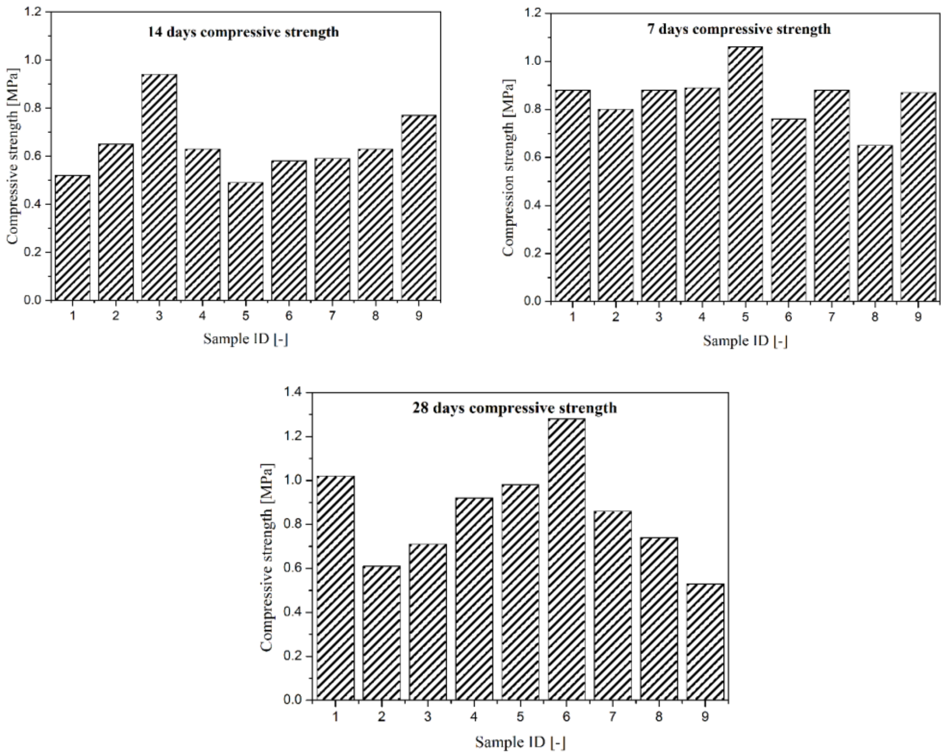

Figure 5

Compressive strength of cement foams

The specimen density of the cement foams was determined from their geometric data. The highest density was in the 7 days samples, this values was 643 kg/m^3. The lowest density was shown by dried and measured cement foams after 14 day of age with average values of 623 kg/m^3. The average densities of the samples aged for 28 days were 640 kg/m^3.

It can be stated that the reeds do not absorb water from the cement paste when the reeds are treated with the mineralizing material. It is important that the reeds treated with water glass glued together. Due to foaming of the sample, its volume increases and this is the reason why some reed seeds broke or moved out of place.

After curing time the pressed reed panel was dried to constant weight and then its thermal conductivity was measured. The test was carried out with the RAPID K type instrument, which work on the principle of heat flux measurement. According to the examination a favourable thermal conductivity value (0.0738 W/mK) was measured, as it is in the set value range (0.07–0.08 W/mK).

Figure 6
Thermal insulation reed panel

It can be seen in *Figure 6* that the insulating panel was very stable and solid after it was removed from the mould. In the research work only the thermal conductivity was determined as a qualifying test, because it was the primary aim. Further qualification tests are also planned for the future.

CONCLUSION

Based on the experiments, it can be stated that reed particles can be used in different forms to produce cement foams. During the mixing of the reed particles into the cement foam by the reed gradually adding, a sufficiently homogeneous cement paste can be prepared, which is suitable for foaming with hydrogen peroxide. By this method some of primary materials applied can be replaced, thus a more environmentally friendly product can be produced. Using a combination of 4 wt% hydrogen peroxide and 10 wt% reed particles proportionally to the weight of cement, test specimens with a specimen density of 620–650 kg/m^3 were prepared. It is 28 days compressive strength showed a value of around 1 MPa.

It was proved to be possible to prepare reed seeds with fine reed particles (d < 5 mm) and water glass, however the foaming cement damaged the reed seeds fixed into the mould. Thus, further investigation are needed for such apply.

During the production of the thermal insulation panel, the DDC CEM I 52.5 N type cement is suitable, so a stable thermal insulation board can be prepared.

ACKNOWLEDGEMENTS

This research was supported by the European Union ant the Hungarian State, co-financed by the European Regional Development Fund in the framework of the GINOP – 2.3.4.-15-2016-00004 project, aimed to promote the cooperation between the higher education and the industry.

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