GEOPOLYMER NANOCOMPOSITES

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Abstract

Nanocomposites are characterized by specific properties. These properties also satisfy the geopolymer composite systems that are produced by activation of alkaline alumino-silicates. The work concerns nanocomposite systems using carbon nanoparticles and nanotubes SiO2. Their structure is presented first,followed by adhesion of nanoparticles due to the geopolymer matrix and the mechanical properties of these composites.

The nanocomposite materials were made from commercial materials - cement and an activator based on sodium silicate Baucis 160 L. The preparation of geopolymeric matrix was done by a standard method. However, mixing the geopolymer was different being extended to 20 minutes. The amount of nanoparticles was varied in the amount of 0.5, 1.0, 1.5, 2.0, 2.5 weight percent relating to the weight of cement. The structuied characteristics were analyzed by scanning electron microscope, then the mechanical properties such as compressive strength, by dynamometer.

Keywords: Geopolymer, Carbon nanoparticles, Nanotubes SiO2, Baucis 160 L, Electron microscope

1. INTRODUCTION

Geopolymers are a type of material which is produced by alcaliactivation of solid alumino-silicates with hardening at low temperature for about 21 days. However, ripening time can be reduced by increasing temperature [1]. Compared to portland cement geopolymer concrete has better mechanical and thermal properties. They are about 30% stronger, and constant ground 1000 ° C. In their synthesis an exothermic reaction of polycondensation type occurs at which the releasing low molecular substance, in this case water. In this way it is also possible to evaluate waste such as slag or fly ash from thermal power stations. Their industrial use has developed since the 1970' s although some evidence of its use can be seen already in the early history lof our civilisation [2,3]. The resulting polymer chemical bond of Si-O-Al-O can be described:

$$Mn\ [\ -\ (Si\ -\ O_2)z\ –\ Al\ –\ O\ ]n\ .\ wH_2O$$

where M is an alkaline component (K, Na, Ca), the symbol - represents a bond, z is 1, 2 or 3, and n is the number of units in the chain or

$$M_2O(mAl_2O_3\ nSiO_2$$

usually with $m \approx 1$ and $2 \leq n \leq 6$, and where M represents one or more alkali metals.

Pure geopolymer can be used as the matrix of geopolymer compositeS of the particle, fiber or plate type. Currently there are increasingly used in the materials of nanometric dimensions, such as nanodots, nanotubes, nanofibers, etc., which may also be used into thse composites. The question is how the presence of nanoparticles affects the characteristics of the composite. The temperature at which the

nanogeopolymer hardening is important,too [1]. This work deals with the influence of the quantity of nanoparticles in nanogeopolymer matrix and its compressive strength.

2. EXPERIMENTAL

For the experiment a commercial geopolymer Baucis L160 with the activator of waterglass and NaOH with Si / Al ratio of 3.2 was used. At first geopolymer material was mixed in low speed for 5 minutes and after this time the speed was increased to 200 rev / min At this speed, the material was mixed until it began togrow thicker. It occurred at 15 minuts.This mixing time was observed for all thesamples. Afterwards SiO2 nanotubes into were added the matrix (Fig. 1) and the carbon nanoparticles in weight%: 0.5; 1; 3; 5; and 8. SiO2 nanotubes of Russian origin and recycled milled carbon fibers were used.Then SiO2 nanotubes were added into the matrix of (Fig. 1) and the carbon nanoparticles in weight%: 0.5; 1; 3; 5; and 8. SiO2 nanotubes of Russian-made and recycled milled carbon fibers were used.

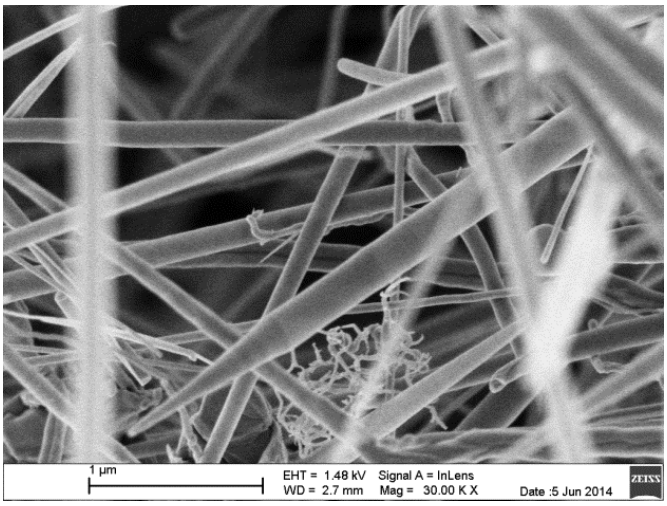


Fig. 1 Nanotubes SiO2

After addition the of fibers to the mass of the geopolymer there was further mixing for about 5 minutes. The mixture was further shaken on a frequency vibrating table for a reduction of bubbles from the material. Samples were made by pouring the mass into cylindrical containers with an inside diameter of 27 mm and a height of 70 mm. Geopolymer composite in the forms held at an elevated temperature of 65 ° C for 24 hours. Then the temperature was raised to 82 ° C and the samples were left in the forms again in an oven for 24 hours. The samples were left for 24 hours in a laboratory atmosphere after removing out of the form.

Determination of compressive strength was carried out after grinding the base to a plane-parallel level on the dynamometer with the range of up to 10 kN. For each of the mixtures three trials were performed.

3. RESULT AND DISCUSSION

The values of compressive strength of samples do not show any trend and their statistical deviations are within the statistical uncertainty (Fig. 3, 4.). The reason is the poor adhesion of the fibers to the geopolymer matrix. Expected increase in compressive strength by SiO2 nanotubes by engaged into the geopolymer chain (Fig. 2) has not been confirmed.

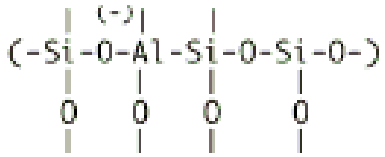


Fig. 2 Poly(sialate-disiloxo)

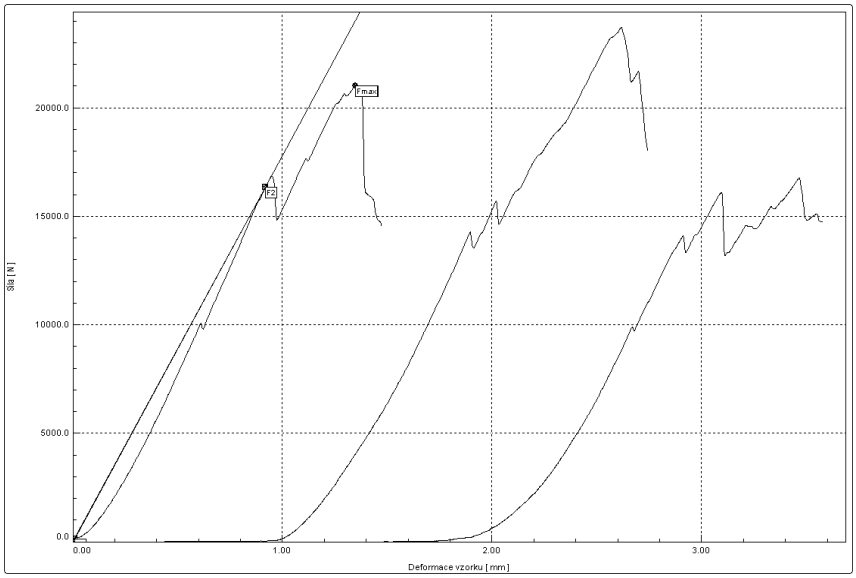


Fig. 3 Typical curves – strength [N]/deformation [mm] of composite, 8% C-nanoparticles

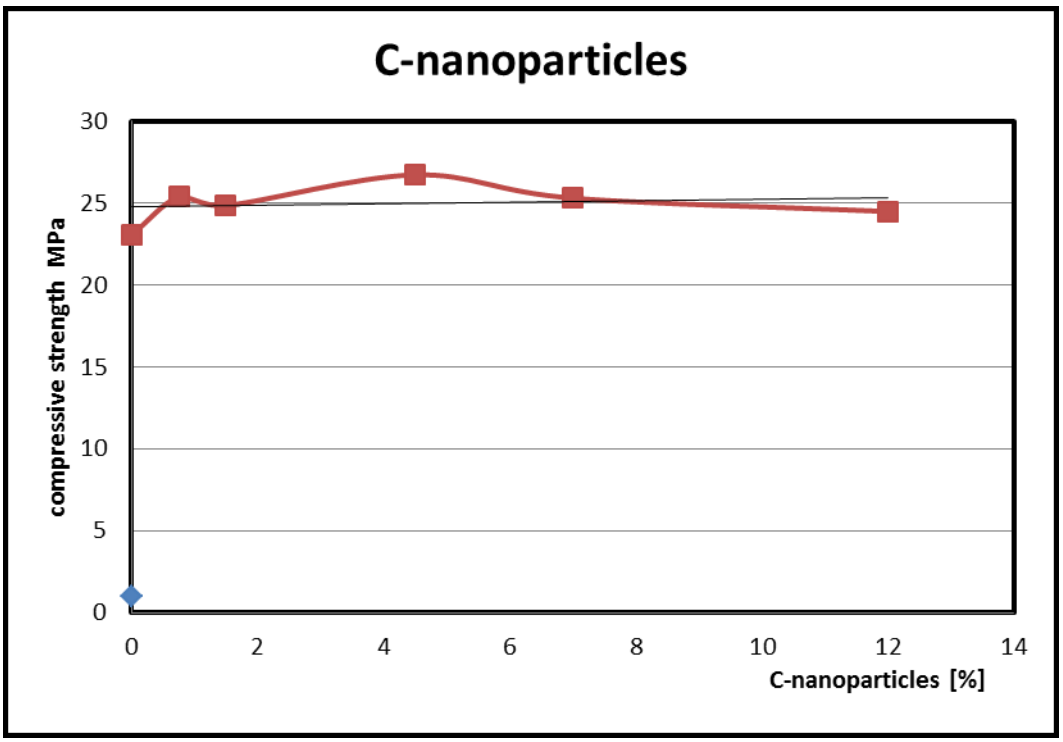


Fig. 4: Compressive strenght - C-nanoparticles

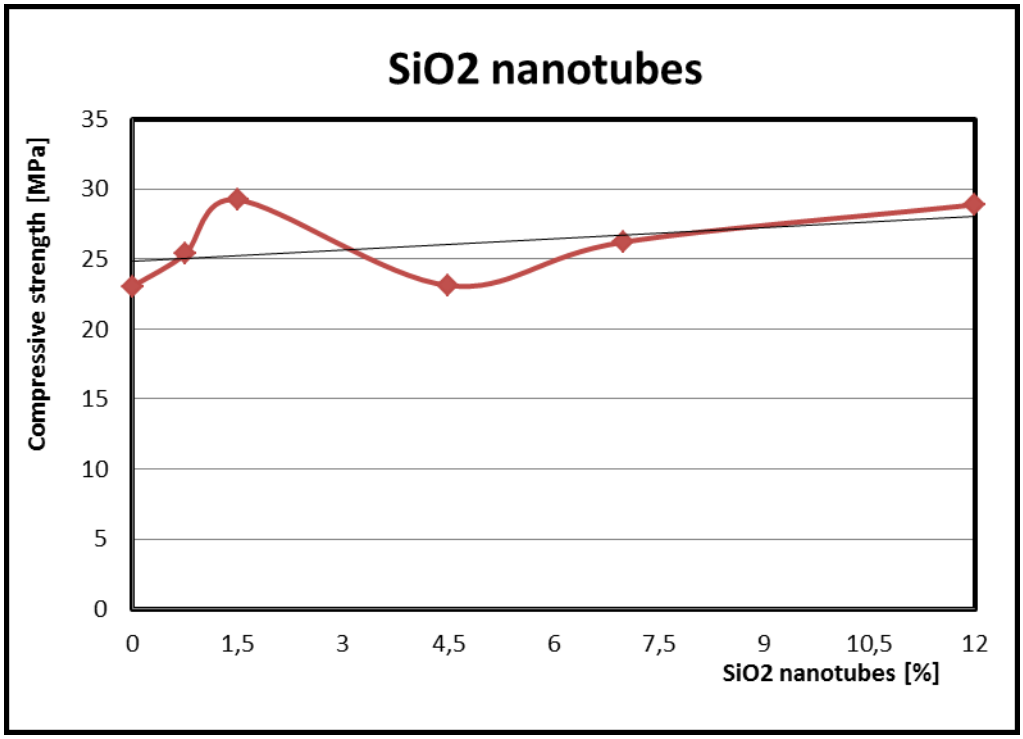
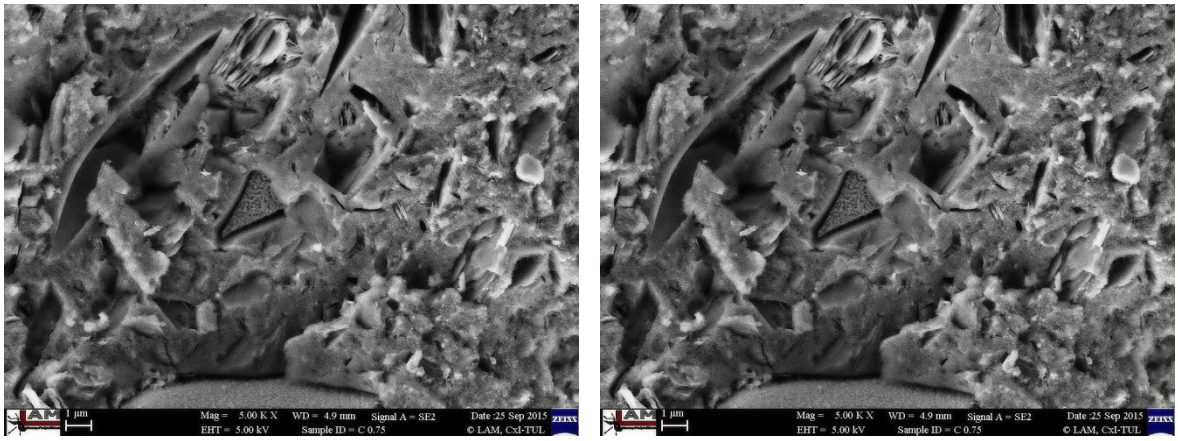


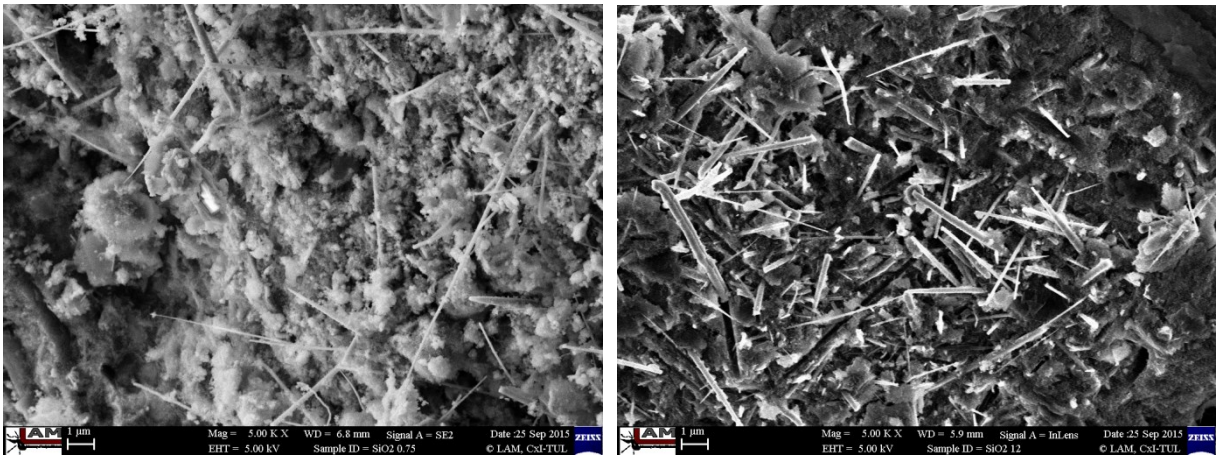
Fig. 5: Compressive strenght - SiO2 nanotubes

The conclusions support from SEM images (Fig. 6 -7)



A B

Fig. 6 SEM images of nanocomposite 0,5 % C-nanoparticles (A) and 8 % C-nanoparticles (B)



A B

Fig. 7 SEM images of nanocomposite 0,5 % C-nanoparticles (A) and 8 % C-nanoparticles (B)

4. CONCLUSION

The influence of carbon nanotubes and of the content of SiO2 nanoparticles on the strength characteristics of nanocomposites on the base of geopolymers was studied. It was found that thenanoparticles and nanotubes are in the geopolymeric nanocomposite do not apply appropriately. Poor adhesion of the nanoparticles to the geopolymer was determined as the cause. Increase of adhesion will be the subject of further research

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