USE OF GEOPOLYMER MATRIX COMPOSITES IN THE CONSTRUCTION OF FIRE DOORS

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Abstract

Protection and safety of workers in plants with the danger of fire is always the first place. They are currently used in devices that are designed to quickly separate the fire residues from workers such as steel fire doors filled with non-combustible materials that insulate the prescribed time up to 600 ° C. As the demands for safety was the requirement for resistance to temperatures higher than 600 ° C. [1, 2]. Post relates to improvements refractory properties of steel gates based geopolymer matrix composites. They analyzed the properties of different materials such as fillers geopolymer matrix, durability and affinity to steel parts of the door structure.

Introduction

Geopolymers have been known and used for a long time. However, they are considered a modern material even today. Geopolymers got their name in 1970 when Davidovich [3] termed the alkali activated aluminosilicates. Their general formula is $M_n\{-(SiO_2)_z - AlO_2\}_n \cdot wH_2O$, where usually $M \approx 1$ and $2 \leq n \leq 6$. The letter M represents one or more alkali metals. In the industrial waste, especially in slags or fly ash, cations Ca^{2+} are to be found. Letter "n" is a degree of polycondensation, "z" is 1,2,3 or higher up to 32Geopolymers – alkali activated systems – can be prepared both from the metakaolins and from the waste.

In comparison with concretes, geopolymers have specific qualities which enable their usage in areas where the concretes fail. One of these areas is fire-resistance. While concrete is starting to break at the temperature of 300 °C, the measurable deformations in the geopolymers don't come until 600 °C. It means that the geoploymers are suitable for the procuring of the fire-resistance of wooden buildings, anti-fire doors and other applications where the fire-resistance is required [4].

Experimental

For the experiments, chipboards of usual fabrication with the geopolymer paint were used.

Parameters of the experiment:

Chipboard: size 30 x 30 x 2 cm.
Geopolymer: 37% of cement, geopolymer Baucis 160, CLUZ Nove Straseci, CZ; 21% of fly ash, 2% of the waste produced by cutting with water ray, 40% of alkali activator Lukosil L160, CLUZ

Fig. 1 Experiment arrangement

Nove Straseci, CZ. The water glass and the basalt fabric as 1. layer on chipboard was used. The layers were covered with PE foil for 28 days.

During the test of fire-resistance, the boards were put in a frame. From the side of the geopolymer sheet, they were burnt with a propane-butane burner flame (PIC 1). The temperature on the side of the flame and on the opposite side was measured by a pyrometer with a scale up to 1000 °C. The measurement took place in 2 minutes intervals and was finished after 30 minutes, more precisely after the board was burnt through.

Results

The experiments have proved the high resistance of the geopolymer layer on the chipboard and the isolation ability of this connection. On the side of the flame, the temperature achieved 700 °C. In the course of the flame test the geopolymer shrank considerably, which caused the cracking of the geopolymer layer. Due to the effect of the water glass foundation and the basalt fabric the layer did not fall off. At the high temperatures the cohesiveness was preserved and so the fire couldn't reach the board. The structure of the geopolymer before and after the burning through is shown in picture 2 and 3. The graphs in pictures 4 and 5 represent the course of the temperatures on both sides of the board.

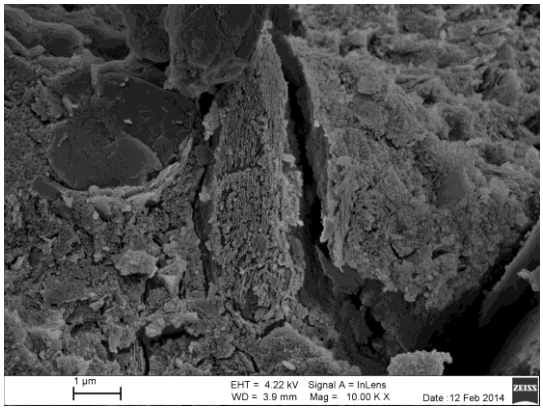

Fig. 2 Structure of the geopolymer before the burning through

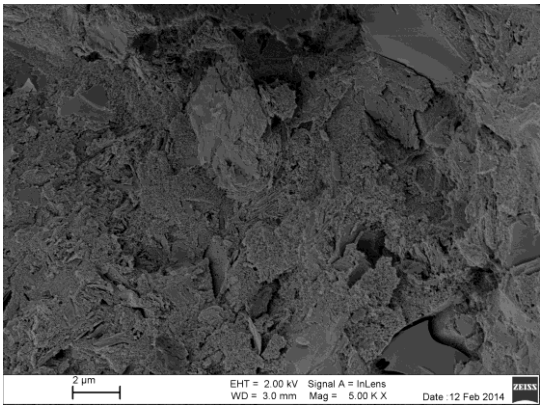

Fig. 3 Structure of the geopolymer after the burning through

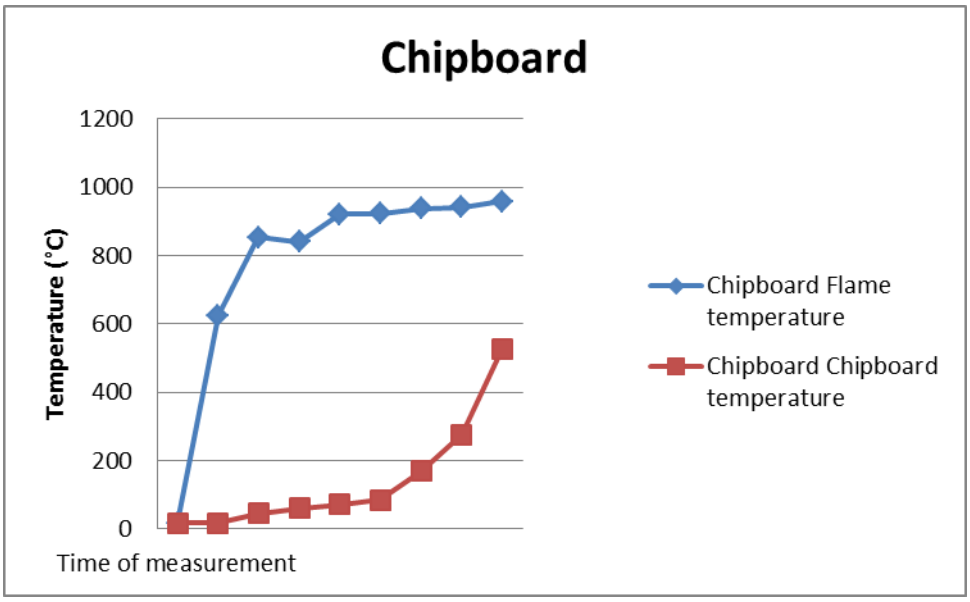

Fig. 4 Curve of the course of the temperatures during the test of the chipboard without the geopolymer

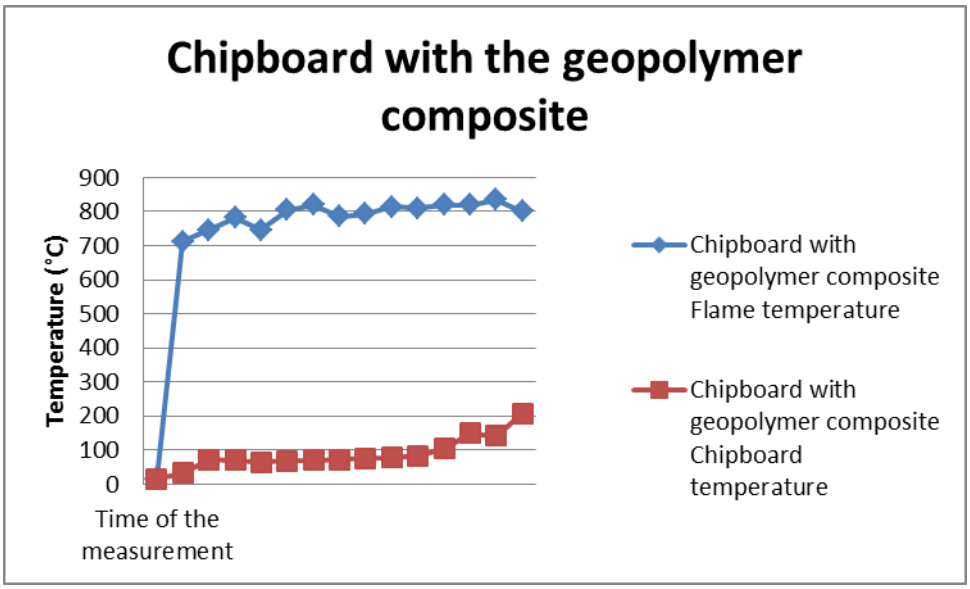

Fig. 4 Curve of the course of the temperatures during the test of the chipboard with the geopolymer

Conclusion

It has been proved that the layer of geopolymer applied on chipboard prevents the burning through for more than 30 minutes. The coat made from water glass and the installation of basalt fabric forestalls the falling off of the geopolymer layer. At the same time, the geopolymer Baucis with the fly ash and with the waste produced by cutting with water ray has proved to be useful.

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References:

[1] H. Rahier, J.Wastiels, M. Biesemans, R. Willlem, G. Van Assche, B. Van Mele. Reaction mechanisc, kinetics and high temperature transformations of geopolymers. J Mater Sci (2007) 42:2982–2996

[2] R.E. Lyon et al.: Fire resistant aluninosilicate composites. Fire and materials, Vol. 21, 67 – 73 (1997)

[3] Davidovitch, J.: Geopolymers. Inorganic polymeric new materials *J. Therm. Anal.* **1991**, *37*, 1633.

[4] Pawlasová, S., Skavara, F. High-temperature properties of geopolymer materials. In *Alkali activated materials-research, production and utilization 3rd conference, Prague, Czech Republic* (2007). (pp. 523-524).