

HYDROTHERMAL STABILITY OF COMPOSITES PREPARED FROM METAKAOLIN (GEOPOLYMER) AND SLAG

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The amorphous geopolymer structures originate by the reaction of metakaolin and metasilicate of the alkaline metals. Some rise from the mixture of calcined kaolin with the hydroxides of Na or K in the furnace. Fig. 1 presents XRD pattern of the calcined metakaolin with NaOH. It is possible to recognise three mineral phases in this pattern. The first is hydroxisodalite originated from the recrystallisation of thermally alkali activated metakaolin on air and the other two are originally present minerals in kaolin, quartz and mica. The presence of hydroxisodalite or zeolites in the composite materials is an evidence of the origin of the geopolymer matrix. The composite in the form of cube was prepared from thermally activated metakaolin in the environment of NaOH and KOH, slag and an appropriate amount of water. Three sets of experiments were prepared differing in the ratio between metakaolin and slag (the system without the slag, 10:90 and 50:50) without further addition of alkaline to this mixture. The cubes were heated in an oven for 5 hours at 80°C in the plastic foil and 5 hours at the same temperature without the plastic foil. After a period of one week the cubes were either heated at the temperature 100 and 140°C with or without presence of water in the autoclaves for 24 hours and one sample from each series was left to spontaneous ageing. After autoclave treatment and spontaneous period of the ageing the cubes were subjected to the measurement of the mechanical strength, X-ray powder diffraction and selected samples were measured by ²⁷Al MAS NMR and ²⁹Si MAS NMR.

The geopolymer contained in the composite material is rigid (inactive) because sufficient strengths were not attained

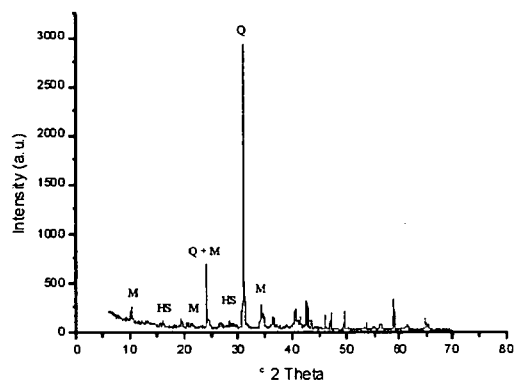


Fig. 1: XRD powder diffraction pattern of calcined kaolin with NaOH

at temperature of ageing 25°C (Fig. 2). The higher compressive strength in the composites is achieved either by the addition of the suitable binding material (slag) or by the heating of metakaolin in autoclave at 140°C. The amorphous geopolymer changes by the development of higher compressive strength of the composites on the crystalline byproducts namely phillipsite, zeolite X or hydroxisodalite. The "structure" of the geopolymer is changed by fitting silicates Na and K resulting from the dissolution of quartz at 140°C. This process is probably responsible for the development of higher compressive strength of the system. If the system contains 50% of the slag then the compressive strength is as much as 77 MPa after autoclaving cubes at 140°C in the system without H₂O. Phillipsite and hydroxisodalite were detected in both experiments carried out at 140°C. The decreasing alkalinity of the composite system (ratio 10:90) adversely influences compressive strength and as well the dissolution of quartz. At 140°C in the system with H₂O tobermorite crystallises from the CSH gel which originates by the alkaline activation of slag. In addition weak reflections of zeolite X appeared in the pattern. The system of thermally and alkali activated geopolymer with binder is a suitable means of laboratory examination of time-dependent interactions in composites.

Acknowledgements

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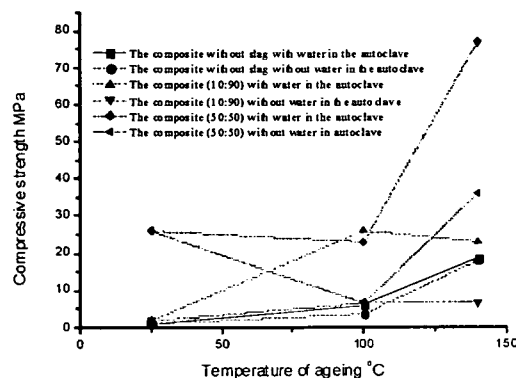


Fig. 2: Compressive strength of composites vs. temperature of ageing for various compositions and treatments of composites