Elaboration and characterization of geopolymers composite based on phosphate glass fibers

Y. HADDAJI[1], N. SALOUMI[1,2], H.MAJDOUBI[1], M. EL BOUCHTI[1,2], M. OUMAM[1], H. HANNACHE[1,3]

(1) Laboratory LIMAT, Faculty of science Ben M'Sik, Hassan II University, Casablanca, Morocco,

(2) Laboratory REMTEX, ESITH (Higher School of textile and clothing industries), Casablanca, Morocco,

(3) Materials Science and Nanoengineering Department, Mohamed VI Polytechnic University, Benguerir, Morocco

ys,haddaji@gmail.com

Abstract

Geopolymers are inorganic polymers, they have high compressive strength, low drying shrinkage, good fire resistance and superior durability in the aggressive environment compared to Portland cement concrete. Geopolymers can be used as a binder of lightweight aggregate and as reinforcement material and composite materials, especially for organic compounds to improve its flame resistance [1-2].

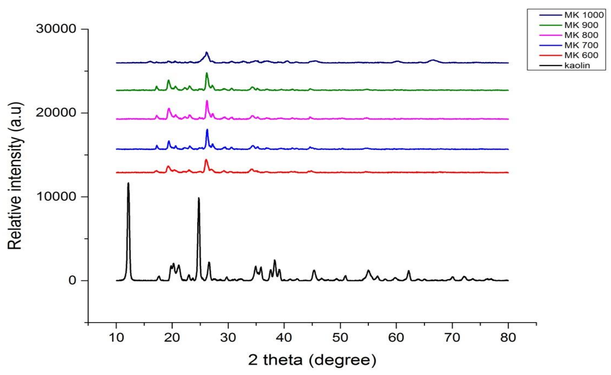
In this study we aim to develop new geopolymers based on natural phosphate enhanced by phosphate glass fibers (PGF). The fibers were added to the geopolymers materials as a reinforcement agent in order to improve their properties. The main objective of this present work is to examine the effect of addition of various amounts of phosphate glass fibers (up to 0,03 wt%) with different compositions on the inorganic polymer microstructure, apparent density, and compressive and tensile strength. The performance of the elaborated geopolymers composites are compared in terms of fresh and hardened state properties, such as workability, compressive strength, modulus of elasticity, flexural tensile strength, durability in Aggressive environment (acidic or basic environment) as well as on the structure of geopolymers. X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), also characterized the elaborated geopolymers composites.

Experimental procedure

Materials

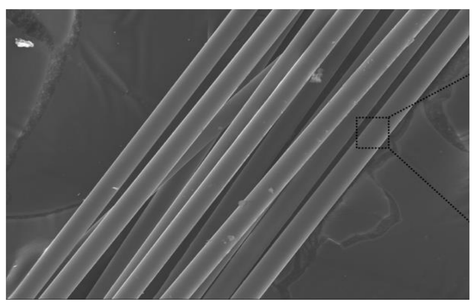
- **Metakaolin**

For the preparation of the geopolymer matrix a pure ultrafine metakaolin powder was used.



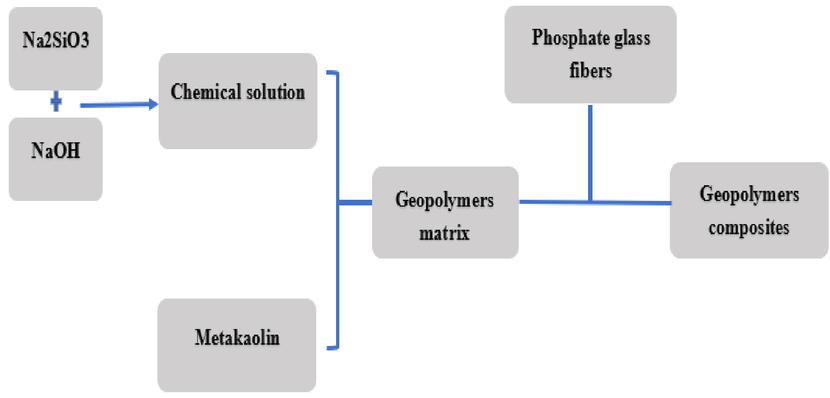
- **Phosphate glass fibers (PGF)**

Phosphate Glass fiber was used as reinforcements for the geopolymer-matrix composites. SEM image is shown in Figure below.



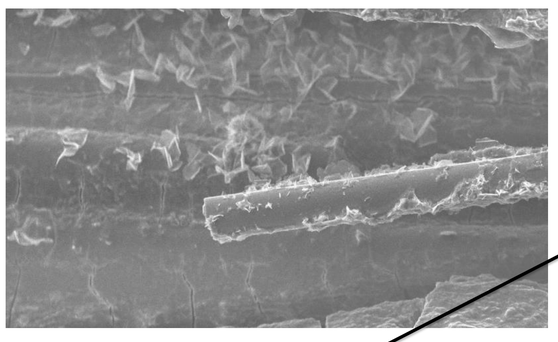
Mixing procedure

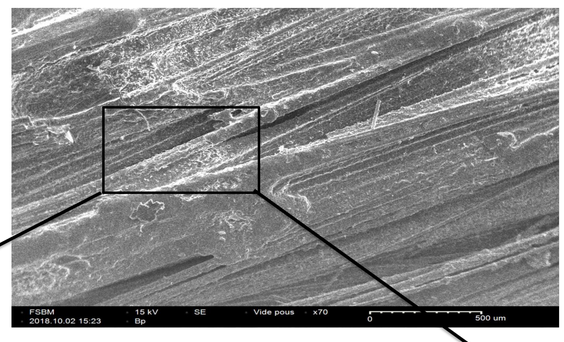
Geopolymer matrix were prepared according to the mixing procedure shown in Figure below, and PGF were added as a volume fraction ratio of 0.01%, 0.02% 0.03%, and 0.04.



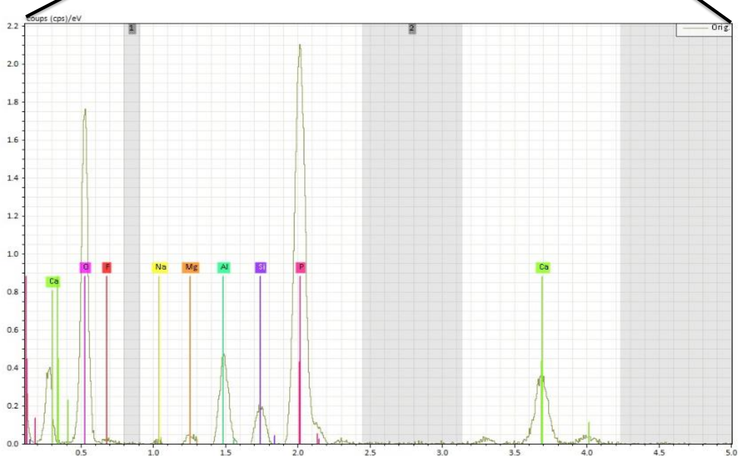
Experimental results and discussion

- **SEM images of phosphate glass fibers geopolymers composites**

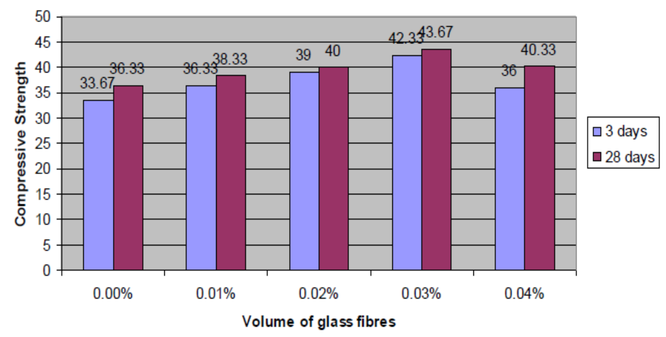




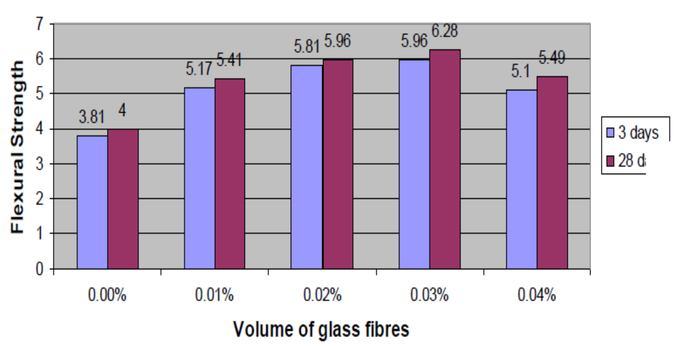
- **EDS spectrum of PGFG**



- **Mechanical properties**



Compressive strength of PGFC



Flexural strength of PGFC

Conclusion

- ✓ Geopolymer concrete is an excellent alternative to Portland cement concrete.
- ✓ Metakaolin based Geopolymer concrete has an excellent compressive strength within short period (3 days) and suitable for structural applications. Inclusion of phosphate glass fibers in Geopolymer concrete shows a considerable increase in compressive and flexural strength of PGFGC with respect to geopolymers without fibers.
- ✓ Compressive strength & Flexural strength of phosphate glass fibres reinforced geopolymer concrete increases with respect to increase in percentage volume fraction of glass fibres from 0.01%,0.02%,0.03% and 0.04%.

Références

- ✓ [1]R. Pouhet, Formulation and durability of metakaolin-based geopolymers, (n.d.) 264.
- ✓ [2]P. Sukontasukkul, P. Pongsopha, P. Chindaprasirt, S. Songpiriyakij, Flexural performance and toughness of hybrid steel and polypropylene fibre reinforced geopolymer, Construction and Building Materials. 161 (2018) 37–44.