MECHANICAL AND FRACTURE PERFORMANCE OF CELLULOSE FIBERS BASED GEOPOLYMERIC COMPOSITE INCORPORATING WASTES

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Geopolymers drew a lot of attention among scientific communities in the last decades for being a cement-like material, sustainable and eco-friendly. Its mechanical properties are well comparable to those of Portland cement and it has been demonstrated that these materials are so chemically stable that they can yield almost infinite durability compared to concrete [1]. While showing these attractive features, geopolymer nonetheless involves high cost due to refined primary materials utilization and low resistance to crack propagation (fracture toughness). On one hand, cost of production can be sensitively reduced by using wastes as source materials, among all fly-ash, a power plant by-product, and borosilicate glass, recycled glass from pharmaceutical vials. On the other, fracture toughness can be improved by producing composites from geopolymeric matrix.
In this work we present a study on mechanical and fracture behavior of composite materials based on geopolymer compound made through alkali activation of fly-ash and borosilicate glass, following the formulation presented in previous studies [2], and then dispersing cellulose fibers in the matrix. Dispersion of fibers was carried out by means of ultra-sonication of the powders and fibers mixture prior to chemically activation in sodium hydroxide (12M NaOH). 4x3x16 mm samples for three-point bending (3PO) tests and chevron notch (CVN) tests were produced in a set of at least 10 samples per test. SEM observations were carried out to examine the grain size of the raw materials (both powders and fibers) and to inspect the fracture surface of the broken samples (Figure 1), and measure CVN depth. Then the critical stress intensity factor was calculated from CVN results. Grain size evaluation of the raw powders was also performed by laser diffraction particle sizing technique. In figure 1 it is evidenced a well-defined dispersion of fibers, and no fiber bundles and/or agglomerates were observed. After testing, it was recorded an improvement of up to 162% and 54 % in bending strength as compared to geopolymeric compound made of the same formula of previous studies and Portland cement respectively [2]. Still, as compared to the same materials, improvement of fracture toughness was up to 50% [2,3]. These results are in line with late developments in geopolymeric composites [4]. Image analyses of 10 captured SEM pictures of the fracture surface were also instrumental to evaluate the porosity of the geopolymeric components, giving an average value of the relative density of 91%.

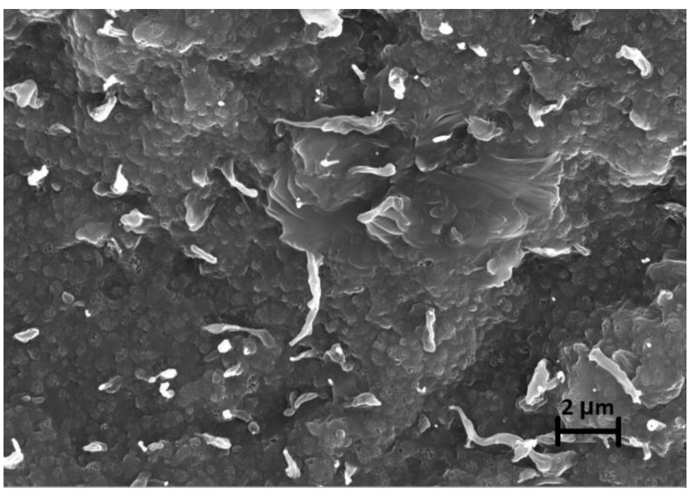

Figure 1 – SEM fracture surface image of 3PO bending sample

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