AMORPHOUS, SELF-HEALED (ASH-G) GEOPOLYMER AND (ASH-C) CERAMIC COMPOSITES

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Basalt is a common volcanic rock found all around the world and on Mars. The abundance of basalt has attracted attention from construction firms and material researchers as an alternative reinforcement source. Potassium geopolymer in the stoichiometric composition $K_2O \cdot Al_2O_3 \cdot 4SiO_2 \cdot 11H_2O$ was produced from fumed silica, deionized water, potassium hydroxide, (i.e. water glass) and metakaolin. The geopolymer matrix was fabricated in an IKA® high shear mixer. ½" chopped basalt fibers from Kameny Vek in Moscow were added to potassium geopolymer in amounts of 7.5 wt %. The basalt fibers and 7.5 wt % glass frit (900°C) were then dispersed in KGP using a planetary high shear Thinky mixer and the samples were allowed to set under applied pressure at ambient temperatures for 1 day followed by 1 day at 50°C to complete the reaction. A low melting temperature fine glass frit (Tm = 900°C) was added to produce self-sealing/crack filling in a dehydrated but un-crystallized geopolymer composite (900-1000 °C). Sample geometries were 1" x 1" x 6" in dimensions. Six samples from each basalt weight class were heated to 400, 800, 900, 1000, 1100, and 1200 °C. The ramp up and down rates were 7 °C/min with a 1 hour soak time at each set temperature. SEM/EDS data indicated that melting and bonding of the glass phase dispersed into the surrounding KGP matrix, produced a self-sealing effect on the dehydrated and cracked matrix. The chopped basalt fibers melted after the KGP matrix crystallized into leucite, providing a network/glass filling system in a ceramic (1200 °C). At intermediate temperatures the geopolymer was converted to a ceramic, but the basalt fibers remained intact. The amorphous self-healing effect of the glass frit significantly improved to the flexure strength of the geopolymer and ceramic composite.