Biopolymers-2016: Radiation Processed Textile Sludge for Preparing Eco-friendly Bricks - Mubarak Ahmad Khan - Bangladesh Atomic Energy Commission

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The research project will allow to understand the operation of physical mechanism of clay adherence to sand during the process of slapping , drying and burning in manufacturing ceramics, in order to lead to a contribution to the theory that explains the interactions of both phases and how they work to achieve mechanical properties and little absorption, important requirements for the quality of these products, some of them structural. Raw material is obtained from deposits that are used to manufacture ceramics in the Western (Paraguayan Chaco) and Eastern Regions of Paraguay and with these materials half brick test tubes both of solid and hollow ceramic bricks submitted to drying and cooking temperature processes interrupting said process according to proposed temperature each 150° C up to 750and from then on each 50° up to 900° or 1200°C according to the mineralogic composition of raw material, in order to continue studying macroscopically and microscopically and validate the theoretical contribution that we seek to verify in the aforementioned theory. Using techniques such as XRD, spectrophotometry, among others. Besides physical density tests will be done , unit weight, bending and compression in semi-pressed solid bricks of small scale sizes in order to facilitate investigation. In this study at least three different types of clays will be chosen, some will be combined to form other ceramic products and take advantage of this variation for the conclusions of this theoretical study.

In the construction industry, nanotechnology could potentially improve many building systems and explain some materials properties. Cement based materials are built up from the complex and complicated nanoscale structure of cement and its hydrates and, in several systems these "nano-effects" determine all the "macro-scale" properties that are usually measured1. On the idea of recent molecular simulation and experimental studies, possible strategies for tuning the mechanical properties of cementitious materials by modifying the bonding scheme within the hydrates at molecular level are being discussed2. On ceramic tile systems it is not different. The overall results of adherence between ceramic tiles and polymer modified mortars might be explained considering the nano-order structure that's developed at the interface tile/mortar3.

Latex modified Portland cement mortars based on poly(ethylene-co-vinyl acetate), EVA, is the standard product in the market for ceramic tile installation4. However, based on chemical features of EVA and ceramic tiles, predominantly the weak van der Waals forces are expected to be developed at the tile-polymer modified mortar interface. On the other hand, surface modification is generally performed to modify its properties such as enhancing the interface adhesion between inorganic and organic materials. In this sense, silane coupling agents have been used for generating a hybrid (organic-inorganic) layer onto substrates5.

Until now, just few studies have been published in the literature that used silanes in systems based on Portland cement without polymer modification6-11. These studies reported surfaces of fibers, silica fumed, and cenospheres being modified with silanes or organosilanes which were added in mortars and concretes during mixing. In all cases, it was observed an increase on mechanical properties, but the mechanism of interaction was not deeply investigated. More recently, it was identified the possibility of developing strong bonds between some organosilanes and cement through covalent bonds12-14. Moreover, when considering EVA interaction with organosilanes, limited content of researches have been published and minor improvement on adherence was actually achieved15,16.

The possibility of bonding improvement at the interface between ceramic tiles and polymer modified mortars (PMM) is decisive for assuring stability to the adhered method as a reliable choice in ceramic tile installation. For this reason, in the last years, around the world, the lack of confidence has raised the concern from ceramic tiles and mortar industries with an overall result of reduction on the industrial growth and, indirectly, it has an adverse impact upon all manufactures, merchants and installers17-19. Besides that, when evaluating ceramic tile systems failures, adhesive rupture between cladding and modified mortar was observed in 84% of the buildings20. This value is not totally surprising when considering that the modeling of ceramic tile coverings behavior reveals the highest shear stresses in tile/tile bed interface, mostly related to stresses caused by moisture expansion or thermal movements21.

Hence, the main goal of this work was to promote a novel chemical functionalization of ceramic tiles surfaces by modifying with trialkoxysilanes coupling agents to generate an organic layer onto inorganic tile so as to reinforce the interface adhesion between tile and polymer modified mortar.

Soda-lime glass tiles ($SiO_2 \approx 70$ wt. (%); $Na_2O \approx 15$ wt. (%); $CaO \approx 10$ wt. (%)) with dimensions of fifty x 50 mm were selected to be used as template for modeling the effect of silane modification within the adherence between EVA modified mortar and silane modified tile. This choice was supported the chemical similarity of glass tile compared to ceramic tile related to the vitreous phase and composition for mimetizing inorganic substrate properties.

Glass tile surfaces were prepared with five silane derivatives bearing specific functionalities. Amino ($-NH_2$), mercapto (-SH), vinyl ($-CH = CH_2$), methacrylic ($CH_2 = C(CH_3)COO-$), and isocyanate (-N = C = O) groups were chosen as reactive groups of coupling agents (Table 1) for evaluating their relative compatibility with the EVA mortar. The silanes were supplied by Sigma-Aldrich. Glass tile without any chemical modification (as supplied) was used as reference.

Prior to silane reaction, glass tile surface impurities were fully removed by immersion in 20% nitric acid for 2 hours, followed by deionized water (DI) rinse. After that, tiles were overnight dipped in DI water and air dried.

Hydroxylation (-OH) was conducted by soaking tile samples in a 70:30 mixture of deionized water: 30% hydrogen peroxide (H_2O_2) for 45 minutes at about 70 °C. Then, 5 mL of NH_4OH (conc.) were dropped for each 100 mL of the H_2O:H_2O_2 solution. After cooling, glass tile was rinsed in DI water and then dried in methanol. This increase of hydroxyl concentration is usually recommended and performed before silane application. This process enhances the density of available sites for silane reaction, improving surface modification process. Hydroxyl functionalization of glass results in the increase of silanol groups (Si-OH) at tile surface related to the reaction of silicon incomplete bonds minimizing free energy. The effect of this hydrophilic chemical functionalization with silanol groups within the adherence between EVA modified mortar and glass tile was also evaluated.

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