LOW TEMPERATURE FIRED PHOSPHATE BONDED CLAY BRICKS

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The broad aim of this project was to investigate the feasibility of fabricating low temperature fired clay bricks using suitable minerals commonly available in Sri Lanka. Conventional clay bricks are fired at temperatures around 800 ^{0}C -1000 ^{0}C, depending on the composition of the clay. The major cost is due to the use of firewood and the cost can be bought down by reducing the firing temperature. Manufacturing of clay bodies using suitable chemicals for strong bonding at low temperatures is a promising approach in reducing the high demand for firewood in the brick industry. This will also help prevent deforestation. Although the fabrication of clay bodies using phosphoric acid has been known for many years, they were not commonly used due to the high production cost.

It is expected that the Fe^{3+} ions present in soil as an impurity would form a self-reinforced microstructure upon the addition of phosphoric acid. Since red soil (RS) has relatively high amount of Fe^{3+} ions, commonly available red soil was used as the starting material in the present study. Phosphoric acid (3 M and 1 M solutions), Eppawala apatite mineral (EAM) and red earth mineral (REM) were used as additives. Small-sized brick samples were prepared and fired at 300 ^{0}C for one hour. Subsequently some important properties such as compressive strength, modulus of rupture and water absorption of these brick samples were investigated. These values were also compared with those of conventional bricks made with the same soil without any additives fired at 800 ^{0}C. It was observed that the properties of phosphoric acid added bricks, phosphoric acid with EAM added bricks and also phosphoric acid with REM added bricks were superior to those of conventional bricks. A significant variation of these properties was also observed with varying concentration of phosphoric acid. The iron oxide (Fe_2O_3) present in the soil was identified using X-Ray Diffraction (XRD) analysis. Scanning Electron Microscopic (SEM) analysis of brick samples fired at 300 ^{0}C for one hour which were prepared using only phosphoric acid as an additive revealed that there were needle type elongated grains formed in the microstructure. However, the SEM micrographs of conventional brick samples did not show the formation of such elongated grains. Subsequent Energy Dispersive X-Ray analysis (EDX) confirmed that these needle type of grains were mainly composed of iron rich phosphate compositions. Moreover, an increase in the formation of these elongated grains could be observed with increasing concentration of phosphoric acid used in the fabrication process. Since the phosphate bonded ceramic formation is known to be favorable in the acidic pH range, there is a high possibility of occurrence of phosphate bonds in these samples. The formation of needle type elongated grains of iron phosphates may act as a self reinforcement and this would increase the strength of brick samples by crack branching, crack bridging and fiber pullout.

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