

ABSTRACT

The increasing emphasis on energy conservation and environmental protection has led to investigation of alternatives to customary building material. Effort are urgently underway all over the world to develop environment friendly construction materials which makes minimum utility of natural resources and helps to reduce green house gas emission. The contribution of green house gas emission due to ordinary Portland cement production worldwide is approximately 7%. For each ton of Portland cement manufactures, it is estimated that one ton of CO₂ is released into the environment. Compared to Portland cement, fly ash based geopolymer concrete can reduce carbon emissions by 80% which has the potential to reduce global emissions by approximately 2.1 billion tons a year. In this connection, Geopolymers are showing great potential and does not need the presence of Portland cement as a binder.

Geopolymer Concrete (GPC) is the name given to concrete where the binder is entirely replaced by an inorganic polymer formed between a strong alkaline solution and an aluminosilicate source. The source material such as fly ash that are rich in silicon (Si) and aluminium (Al) are activated by alkaline liquid to produce the binder. On the other hand the abundant availability of fly ash worldwide creates opportunity to utilise as substitute for OPC to manufacture concrete.

This research report presents the study on the development of strength for various grades of geopolymer concrete for different curing conditions (ambient and oven curing). Trial mix was chosen for low calcium fly ash based geopolymer concrete using mix design reported in the research report by Hardjito (2005). The concentration of the sodium hydroxide solution was varied as 8 Molar, 10 Molar, 12 Molar and 14 Molar. The alkaline solution

used in the study is a combination of sodium silicate and sodium hydroxide solution with the ratio of 2.5. The effect of change in concentration and curing condition on mechanical property such as compressive strength, tensile strength, flexural strength for GPC solid block and GPC hollow block are studied. Result indicates that heat cured GPC block performed better than specimen cured at room temperature. The result also shows that as the molarity increases the strength of GPC also increases.

An experimental study was conducted to assess the acid resistance of fly ash based geopolymer concrete block. Durability of specimens was assessed by immersing the GPC specimen in 3% of sulphuric acid for a period of 7, 14 and 28 days. Evaluation of chemical resistance in terms of change in weight, residual compressive strength, residual tensile strength, pH of solution at regular interval was carried out. After exposure in the acid solution the samples showed very low weight loss. The weight loss on exposure to sulphuric acid in GPC solid block specimen cured at room temperature and at 60°C was about 0.53% to 2.01% and 0.2% to 1.02% for 28 days exposure.

The residual compressive strength for GPC block after immersion for both curing condition was found to vary between 15.09 MPa to 20.14 MPa and 20.09 MPa to 28.1 MPa. The reduction in compressive strength observed for the specimens cured at room temperature and 60°C were 7%, 14%, 22% and 6%, 12%, 20% respectively. The reduction in split tensile strength observed for specimens cured at room temperature and at 60°C were 4%, 11%, 19% and 3%, 10%, 18% respectively.

Study on water absorption was also carried out for geopolymer specimens. The percentage of water absorption varied in the range 2% to 4.33% and 1.33% to 3.42% for specimen cured at room temperature and at

60°C. The percentage of water absorption is found to be less in case of specimen cured at 60°C temperature than specimen cured at room temperature.

Further an experimental study was conducted to evaluate the behaviour of unreinforced geopolymer brick masonry prism. Clay bricks and geopolymer brick were used in constructing masonry prisms. English bond unreinforced Clay Brick Prism (CBP) and Geopolymer Brick Prism GBP (M1) and GBP (M2) were cast using 10M and 12M NaOH concentration with prism dimension of 609 x 220 x 609 mm ($h/t = 2.77$) and 609 x 220 x 914 mm ($h/t = 4.3$). The stress strain characteristics under uniaxial compression have been studied. Based on the results and observations of the comprehensive experimental study nonlinear stress-strain curves have been obtained. The stress strain behavior of geopolymer brick prism was found to be better when compared to clay brick prism. The analytical values obtained using regression analysis and chi square test is substantially conservative when compared to the experiment values. Results also show that increase in masonry strength was more prominent in the case of prism constructed using GPC brick.

From the experimental investigation conducted in this research programme and based on the overall performance of the new concrete mixture, it is concluded that various characteristic of GPC block and GPC bricks point out high potential to be an alternative structural material because they are not only environmental friendly but also possess adequate mechanical and durability properties .