AN EXPERIMENTAL STUDY ON BRICKS USING DEMOLITION WASTES AS SUSTAINABLE SOLUTION

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Abstract: **India is a fast-developing country, due to increasing urbanization there is huge demand for construction of structures and also the demolition old ones. Large quantities of demolished waste are generated from construction industry every year. Re-use of this demolished waste reduces the carbon footprint and results in a sustainable construction. An effort has been made in this project work to utilize the demolished waste in manufacturing solid bricks. Demolished brick powder and clayey soil are used as fine aggregates whereas fly ash is used as binder. The amount of C & D waste generated in the country has increased considerably in recent years due to rapid pace of development. There is no uniform and systematic process followed in determining the total quantity of C & D waste generated or in collection, transportation and disposal of C & D waste anywhere in India. This study investigates the bricks characteristics, both strength and aesthetic tests such as water absorption test, compressive test are to be conducted on bricks using construction waste and normal bricks which are to be compared. This project is very useful as it is eco-friendly to the environment.**

1. INTRODUCTION

The brick is one of the most widely used masonry units for building construction. Common building materials, such as bricks and cement, are responsible for a number of sensitive issues linked to the social and environmental impacts. Conventional bricks are made from raw materials, clay, sand, plastic [high-density polyethylene (HDPE) and polyethylene (PE)] and nonplastic materials, then fired in a kiln at a temperature ranging from 850 to 950 °C. The use of fossil fuels induces large energy consumptions that are responsible for economic, energy, environmental and ecological issues. As an example, the production of one tonne of cement requires the consumption of 1.7 tons of raw materials and involves the emission of 0.8 tons of CO_2 into the atmosphere. The Reuse of this industrial waste by recycling it into new building materials is considered a practical solution for reducing many environmental problems related to pollution. However, this waste can only be recycled if its environmental properties and behaviors complies with specific requirements and respond to a relevant environmental standards. Many studies have been done to incorporate fired clay waste bricks into the production process of different building materials, one of these techniques is the geopolymerization.

Geopolymerization is one of the best techniques of recycling waste in the production of a new construction material that meets both standards and practice-oriented applications. Geopolymerization is the processing technique used to produce new geopolymer based materials. Geopolymers are alkaline alumino-silicate binders, which can be a substitute for building materials. The term Geopolymer is used to characterize a classification of alumino-silicate materials manufactured mainly for the substitution purpose of ordinary Portland cement (OPC) in concrete. The term was first introduced by Joseph Davidovits in the 1970s, although comparable materials were created in the previous Soviet Union since the 1950s, but were called soil cements. The geopolymers are generally made of pozzolanic materials such as kaolin, metakaolin, GGBFS, fly ash and ceramic waste. These materials are activated by an alkaline solution generally containing varying amounts of dissolved silicium. They have a wide range of applications thanks to their properties such as resistance to acid attack, fire and high temperatures. The main characteristic of geopolymers is their ability to provide an important reduction in CO_2 emissions and less energy requirements for production compared with Ordinary Portland Cement products thanks to the low curing temperature used. Geopolymers can be considered a green concrete.

Geopolymerization is a geosynthesis which is a reaction that chemically integrates minerals . The exposure of aluminosilicate materials such as fly ash, blast furnace slag, or thermally activated substances to high-alkaline environments (hydroxides, silicates) gives rise to the formation of a geopolymer. Geopolymers are characterized by a two- to three-dimensional Si-O-Al structure. The most important advantage of geopolymer binders is their low manufacturing energy consumption and low CO_2 emission, which make them to be a ‘‘Green Materia. Many work through the literature, presented different technique of optimizing different aspect of the geopolymer formulation, from material composition to uses of recycled waste have shown that optimizing the type and concentration of the alkaline activator can produce mortar samples with a compressive strength up to 50 MPa after 7 days of curing at 65 °C. The combination of fly ash and waste bricks was presented by Rovanik et al.

2. MATERIALS

2.1 DEMOLISHED BRICK WASTE & CLAYEY SOIL

The Brick material was first crushed into small coarser particles using a tamping rod. The crushed brick waste was then powdered to finer particles by an Impact crusher. These powdered brick wastes are then sieved through 75mm to get the required particle size. The procured clayey soil is sieved through 12 mm sieve and these two materials are then mixed together according to the required proportion required for the casting of bricks.

2.2 BINDING MATERIALS

A.SODIUM HYDROXIDE

Sodium hydroxide is an inorganic compound and a white solid ionic compound which is a highly caustic base and alkali. Sodium hydroxide is used in some cement mix plasticizers. This helps homogenize cement mixes, preventing segregation of sands and cement, decreases the amount of water required in a mix and increases workability of the cement product, be it mortar, render or concrete.

B.SODIUM SILICATE

Sodium silicate is a colorless transparent solids or white powders, which is soluble in water in various amounts, producing alkaline solutions. By adding Sodium silicate, silicon-oxygen anions found in fly-ash go into solution and form polymers which begin to coagulate in the liquid during curing. The alkali of the sodium silicate then reacts with silica present in fly-ash in the glass phase, strengthening this process of polymerization and coagulation, ending with the generation of a water-stable silica gel. Dehydration of the silica gel and consolidation of the structure subsequently produces an increase in the strength of the bonds, resulting in the creation of a hard, solid material.

2.3 FLY ASH

Fly ash is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. fly ash has been used as a component in geopolymers, where the reactivity of the fly ash can be used to create a binder similar to a hydrated Portland cement in appearance, but with potentially superior properties, including reduced CO2 emissions and also reduces the amount of clay soil used.

2.4 ALKALINE ACTIVATORS

The combination of silicate and sodium hydroxide was used as an alkaline activator for the preparation of geopolymer bricks. Sodium silicate is composed of 27% SiO2, 8% Na2O, and 65% H2O (by mass). NaOH with a purity of 98% was supplied in solid capsules forms. Sodium hydroxide is prepared in different concentrations of 6 M, 8 M, 10 M, 12 M and 14 M. The two solutions of NaOH and Na2SiO3 were mixed 24 h before the geopolymer bricks samples were prepared to obtain the homogeneity of the total solution.

Fly ash, Sodium hydroxide and Sodium silicate are commercially available in the market and were procured from the same. For fine aggregates about 50 kilograms of brick waste was collected from a demolished building site near Padmanabhanagar, Bengaluru, India. These segregation of brick from other waste such as concrete, rubbles etc. was performed at the site itself. About 50 kilograms of Clayey soil was procured from excavation site near Mallasandra, Bengaluru, India.

3. METHODOLGY

Geopolymer bricks were prepared by mixing the solid precursors: 48% clayey soil and 32% brick waste and 20% fly ash with an alkaline solution of silicate and sodium hydroxide. All the formulations prepared in our study contain 48% of clayey soil by weight. The variation is reflected only in different molar of an alkaline solution of silicate and sodium hydroxide. Various studies have shown that the order of preparation and the method of mixing materials have a very important role to play in achieving good results. To obtain a homogeneous geopolymer binder, dry solid materials were mixed for 3 min, then the alkaline solution were added, and the mixing remained for 6 min in order to get an homogenous binder. The liquid/solid ratio used is 0.4 by weight, using a mixer with a capacity of 5 l. After mixing, five prismatic samples of 20 × 10 × 10 cm3 were molded for each formulation to measure flexural and compressive strengths. These numbers of samples were used to ensure the reproducibility of the strength testings. Hence, the means of the prepared samples are calculated. In this study, geopolymer bricks are formulated according to the following property.

3.1The molarity of NaOH

The presence of a sufficient quantity of NaOH in the liquid phase have an essential role in the geopolymerization reaction. NaOH reacts as a dissolving agent for aluminium and silicium. Based on the literature, the range of molarity from 6 to 14 M are used to optimize the maximum dissolution of the aluminosilicate material. To evaluate the effect of NaOH molarity on the compressive and flexural strengths, a series of 40 × 40 × 160 mm3 samples of geopolymer bricks were prepared with a Na2SiO3/ NaOH mass ratio of 2.5, a GGBFS/WB mass ratio = 80/20, and with different molarities of NaOH.

A.To prepare **8M** NaOH solution (8*40=320g), 320g sodium hydroxide pellets in 250 ml distilled water and then make up the solution to 1 litre.

B.To prepare **10M** NaOH solution (10*40=400g), 400g sodium hydroxide pellets in 250 ml distilled water and then make up the solution to 1 litre.

C.To prepare **12M** NaOH solution (12*40=480g), 480g sodium hydroxide pellets in 250 ml distilled water and then make up the solution to 1 litre.

4. CONCLUSION

This research focuses on the potential for reuse of industrial waste for the production of geopolymer-based building materials. This presents an experimental study of waste brick recycling with the association of another industrial waste Flyash to produce a new geopolymer brick. The process of preparing the geopolymer bricks was carried out using a combination of hydroxide and sodium silicate as an alkaline solution. The quantity of Flyash incorporated, the molarity of NaOH and the silicate/hydroxide ratio are the three parameters that each been optimised according to the mechanical strength of the final product. The results of this study highlight and demonstrate a new and advantageous application in the construction of a major waste with the geopolymerization process. These results show that the inclusion of ground granulated blast furnace slag (GGBFS) in the geopolymer matrix based on brick waste (WB) improves the physical and mechanical properties of the geopolymer brick. The best compressive strength of 89.91 MPa was obtained for a molarity of 8 M NaOH. The highest bending strength obtained in this study is 10.97 MPa for a a molarity of 8 M NaOH. This research therefore concludes that geopolymer bricks are an environmentally friendly alternative to conventional fired bricks.

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