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Comparative Study of Fly Ash with Waste Paper Sludge Ash (Geopolymer) and Clay Bricks

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Abstract: *This paper presents Fly Ash with Waste paper Sludge Ash brick properties, manufacturing process material required for preparing the Geopolymer bricks with fly ash and waste paper sludge ash as per Indian standard code provisions, inspection and quality control. The textures of the bricks with waste Paper Sludge Ash and Fly Ash Bricks were very similar to that of clay bricks; the sample with the additive contains spherical Fly Ash particles. These particles of geopolymer led to a reduction in the density of the bricks and a substantial improvement in their durability. Use of this additive could have practical implications as a means of recycling and for achieving cost savings in brick production. The Literature on Clay Bricks and Fly ash with Waste Paper Sludge Ash(Geopolymer) Bricks has been presented under the classifications based on absorption coefficient, shape and size, density, weight, porosity, thermal conductivity and compressive strength of geopolymer bricks. Background: A lot of pressure on a generate more energy and the amount of fly ash problem to our environment because geopolymer etc. Results: The absorption coefficient, shape and size, density, weight, porosity, thermal conductivity and compressive strength of geopolymer bricks compare with normal clay bricks that delivers good results. (1) Geopolymer used as waste from industrial by product and environment is directly protected by reducing solid waste disposal. (2)The average compressive strength of geopolymer brick is 9 N/mm^2 (3)Geopolymer used as raw material replacing of clay to make fired bricks is an effective measure of saving land and decreasing pollution. The properties of the bricks improved with the firing temperature (4) Geopolymer bricks show less damage than conventional bricks when exposed to salt crystallization cycles. This improvement is due to the reduction of the surface area of the bricks. Conclusion: From the present study, it can be concluded that geopolymer bricks can be used as an alternative to clay bricks.*

Keywords: *Geopolymer Brick, Compressive Strength, Clay Bricks, Fly ash, Waste paper sludge ash.*

I. INTRODUCTION

Geopolymers are synthetic inorganic polymers produced by alkaline activation of aluminosilicate raw materials, which can exhibit excellent physical and chemical properties. Typical precursors for geopolymers are derived from various naturally occurring kaolin sources as well as industrial by-products such as fly ash and ground granulated blast furnace slag (GGBFS). Fly ash is the fine portion of coal combustion by-products produced from electric power generation. Fly ash materials are generally classified into two classes (i)class F and (ii)class C fly ash according to ASTM C618. Thus far, the majority of work on fly ash geopolymer systems has focussed on class F fly ash, due mainly to rapid setting behavior characteristic of class C fly ashes during geopolymer synthesis. Correspondingly, early strength gain of class F fly ash-based geopolymer products cured at ambient temperature tends to be extremely slow, and heat curing is generally required for such binder systems to achieve early age strength development. Thus, the need for heat curing partly explains the general emphasis on pre-cast geopolymer products compared to ambient curing in situ construction due to the relatively slow strength gain of the latter. Several studies have been published addressing early setting and strength development of ambient-cured fly ash geopolymer involving the addition of supplementary pozzolanic materials such as GGBFS and kaolinite.

Wastepaper sludge is an end product derived from paper-recycling industries and is largely disposed of at landfills. An estimated six million tonnes per annum of paper sludge was reportedly generated in Europe and 4.5 million tonnes per annum in the USA. Dry wastepaper sludge contains about 52% organic matter (cellulose fibers) with the remainder comprising of mineral phases, including calcite, rutile and filler clays. It has been proposed that the high organic content in this type of waste residue can be used as biomass resource through combustion of wastepaper sludge in fluidized bed to generate steam for onsite utilization.

As an alternative disposal route for this material, calcination of 30% of wastepaper sludge generated in Japan was reported. Frias et al. [9]recently carried out a thorough review on the application of calcined wastepaper sludge as a supplementary cementitious material in manufacturing of future eco-efficient cement and concluded that the ash generated after calcination posses highly pozzolanic property. Enhancement of concrete mechanical properties, durability on freeze/thaw exposure and resistance to acid attack with the addition of calcined paper sludge, was widely reported. Other recent uses of calcined sludge which has attracted research interest is its inclusion in geopolymer binder systems as supplementary material. Boca Santa et al.[8] fabricated geopolymer paste samples using bottom ash and calcined paper sludge in the ratio of 2:1 to achieve the compressive strengths of 23MPa at 90days. Geopolymer mortars fabricated with 100%calcined wastepaper sludge were also reported, but the optimum compressive strength was only 8.0Mpa at 28days when 12M NaOH was used.

A.Clay Brick Unit

Building bricks are usually made with mixture of clay and sand, which are mixed and moulded in various ways and are dried and burnt. the clay for brick making must develop proper plasticity and be capable of drying rapidly without excessive shrinkage, warping or cracking and of being burnt to desired texture and strength. This process for making clay bricks, require heating of the bricks in kilns to more than 2000ºF, which consumes much fossil fuel and generates air pollutants and carbon dioxides due to the combustion of the fossil fuel.

B. Clay bricks

Bricks are made from soil and hence the property of bricks depends on the properties of soil. Raw materials required for manufacturing of clay bricks are clay, silt and sand. The four distinct stages of manufacturing the hand mould clay bricks are: (i) preparing the brick earth (ii) moulding clay in rectangular blocks of uniform size (iii) drying in sun and air and (iv) burning them in brick kilns.

Fig. 1 Clay bricks

Burning of the brick during manufacture governs the quality and properties of brick and uses more fossil fuels.

C. Geopolymer Bricks

Geopolymer bricks manufacturing units can be set up near thermal power stations. Raw materials required for manufacturing of Geopolymer bricks are fly ash, waste paper sludge ash and sand (optional). In the presence of alkali solution (10-Molarity) like sodium hydroxide and sodium silicate, Geopolymeric reaction takes place between alkali solution, fly ash and waste paper sludge ash at ordinary temperature and forms a compound possessing cementitious properties.

Fig. 2 Geopolymer bricks

After reactions between lime and fly ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound.

D. Tests on Brick

The clay bricks of size 230 x 110 x 70mm were procured from Villianur, near Pudhucherry and the mixer of fly ash and waste paper sludge ash bricks of size 230 x 110 x70mm from our research lab(Fig. 1 and 2). These bricks were used in this study. The bricks were tested for their strength and other properties and their results are discussed below:

II. MASS OF BRICK

The tendency of an object to resist changes in its state of motion varies with the mass as it is solely dependent upon the inertia of an object. The more inertia which an object has, the more mass it has. More massive object in a structure has a greater inertia force on the structure when acceleration is applied on the structure. The mass comparison of clay brick and geopolymer brick is shown in Fig. 4.

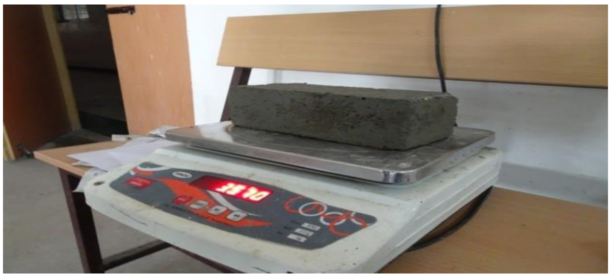
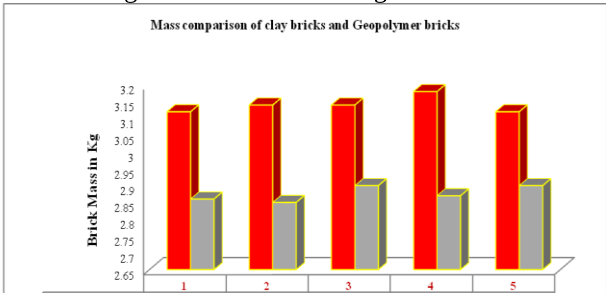


Fig.3 To measure the weight in the Machine



	1	2	3	4	5
Clay Brick	3.12	3.14	3.14	3.18	3.12
Geopolymer Brick	2.86	2.85	2.9	2.87	2.9

Fig. 4 Mass comparison of clay bricks and geopolymer bricks

From the results, it is found that, generally Geopolymer bricks are 8.58% lighter than the clay bricks used in this study. As the mass of the brick reduces, the loads on the structural elements also reduce which may offer better strength to weight ratio. Due to this reason, the construction of buildings using fly ash bricks can be done quickly and easily, in turn saves time and labour costs.

III.WATER ABSORPTION TEST

A high absorption results in vulnerability to volume changes that would result in cracking of the bricks and structural damage in buildings. The absorption is the amount of water which is taken up from the mortar to fill pores in the clay brick. Water absorption tests were performed on fly ash bricks and clay bricks as per IS 3495 [1992].

The specimens were immersed in water at room temperature (22°C) for 24h and the weight recorded as ws (saturated weight). All the specimens were dried and the weight of dried specimens were recorded as wd (dry weight), where ws and wd are in kg. The water absorption by the brick is calculated as,

Fig 5: Water Absorption Test on Clay Bricks

Water absorption of brick (%) = [(ws-wd)/wd)] ×100 --------- (1)

The average comparison of water absorption in the clay bricks and the Geopolymer bricks is shown in Fig. 6.

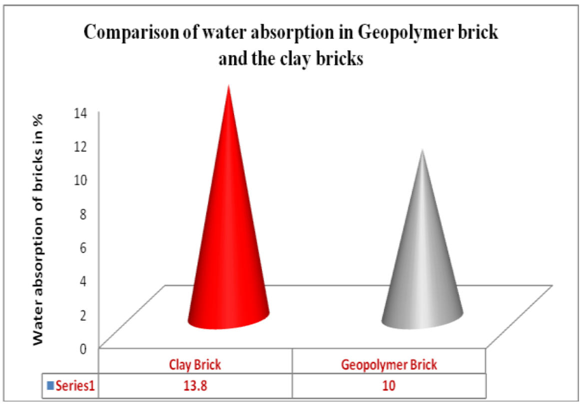


Fig. 6 Comparison of water absorption in fly ash bricks and the clay bricks

The water absorption of both clay brick and the Geopolymer brick were within the limit of 20% of its weight. The water absorption of the clay brick was observed as 13.7% higher than the Geopolymer brick. From the results, it was understood that fly ash brick has moderate level of water absorption behaviour and hence fly ash based construction may yield good structure performance.

IV. COMPRESSIVE STRENGTH OF THE BRICKS

The average compressive strength of the Geopolymer bricks was 55.3% higher than the clay bricks as shown in Fig. 7.

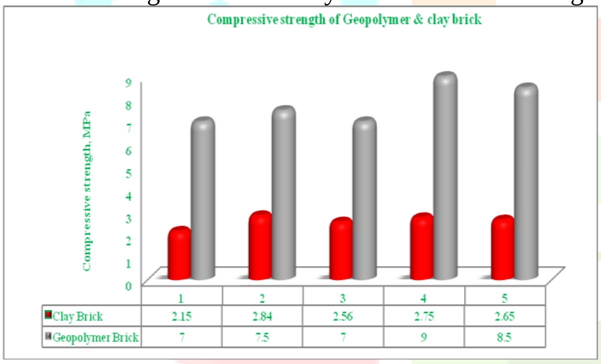


Fig. 7 Compressive strength of clay bricks and the Geopolymer bricks with upward orientation

The tested specimen is given below: Compressive strength = P / A Where, P - Failure load (N); A - Area of the specimen (mm^2)

V. FLEXURAL STRENGTH OF THE BRICK

The flexural strength of the bricks was performed by single point tests as per IS 3495 (Part – III – 1976). The test specimen was placed centrally on self aligning bearers with two steel rollers of 40mm diameters as reported by Dayaratnam [1987][10]. The Flexural strength of clay brick, Geopolymer brick in Fig 8.

The rollers were mounted in such a manner that the load was applied axially and equally divided between the two rollers. The load was applied at a uniform rate increasing continuously till the specimen cracked and the maximum load applied to the specimen during the test was recorded and the flexural strength was calculated as, $F = 3PL/2BD^2$.

where, F = Flexural strength of the brick in MPa

P = Load in Newtons

L = Span between the bearers in mm

B = Width of the brick in mm

D = Depth of the brick in mm

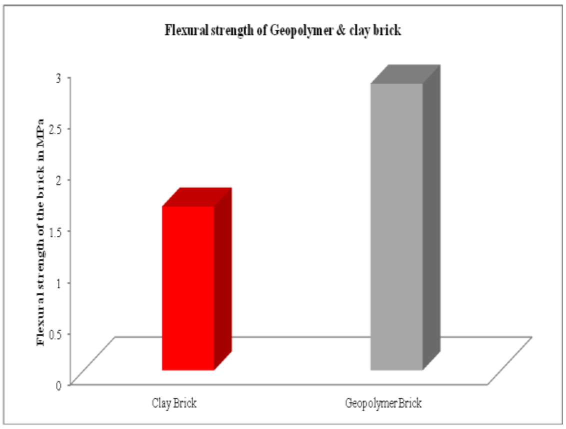


Fig.8 Flexural strength of clay brick and fly ash& Paper Sludge Ash brick

The geopolymer bricks had 56% higher flexural strength than the clay bricks on an average. The tensile strength expressed in the form of the modulus of rupture value and is nearly 2.27 times the value for normal clay bricks.

VI. COST OF PRODUCTION OF 1m³ (500 BRICKS) OF GEOPLOYMER BRICKS

Cost per cubic metre of brick masonry comes out to be Rs.7200 and Cost per cubic metre of geopolymer masonry comes out to be Rs.6000. The cost of block walls per metre^3 of geopolymer masonry comes out to be 17% less than that of clay brick walls(There is no plastering work and painting in the geopolymer brick masonry work).So, Geopolymer brick masonry is economical than clay brick masonry.

VII. COMPARISON BETWEEN CLAY BRICK AND GEOPOLYMER BRICK

1) Normal clay bricks have varying colour as per soil whereas Geopolymer bricks have a uniform pleasing colour like cement.
2) As normal clay bricks are handmade they have an uneven shape, on the other hand, Geopolymer bricks are uniform in shape and smooth in the finish.
3) Normal clay bricks are lightly bonded, whereas there is a dense composition in the case of Geopolymer bricks.
4) Plastering is required in case of normal clay bricks whereas no plastering is required in case of Geopolymer bricks.
5) Geopolymer bricks are lighter than clay bricks.
6) The compressive strength of Geopolymer bricks is more than that of clay bricks.
7) Geopolymer bricks are less porous than that of clay bricks.

VIII.CONCLUSIONS

1) Geopolymer used as wasted product and environment is directly protected by reducing solid waste disposal.
2) The average compressive strength of Geopolymer brick is 9N/mm^2.
3) Geopolymer used as raw material replacing of clay to make fired bricks is an effective measure of saving land and decreasing pollution. The properties of the bricks improved with the firing temperature.
4) Geopolymer does not modify the hydric properties of the bricks but it does make them lighter. In fact, all the bricks with Geopolymer have a lower density.
5) Geopolymer bricks are 17% less than normal clay bricks in costwise.

REFERENCE

[1] Ujjwal Bhattacharjee, Tara Chandra Kandpal, “Potential of fly ash utilization in India” Energy 27,2002, pp.151-166.

[2] Samitinjay Sadashivrao Bansode, “Comparative Analysis between Properties of Steel Slag, Fly Ash, and Clay Bricks” Geo-Congress(ASCE)2012 pp. 3816-3825.

[3] M. B. Varma and P. P. Gadling, “Additive to Cement –A Pozzolanic Material-Fly Ash” International Journal of Engineering Research ISSN:2319-6890(online),2347-5013(print) Volume No.5 Issue: Special 3,27-28 Feb.2016 pp.558-564.

[4] Sunil Kumar, “A perspective study on fly ash–lime–gypsum bricks and hollow blocks

[5] For low-cost housing development” Construction and Building Materials 16, 2002 pp. 519–525.

[6] K. Wesche, “Fly Ash in Concrete”, edition published in the Taylor & Francis e-Library, ISBN 0-203-62641-9 Master e-book ISBN, 2005. pp.168.

[7] Giuseppe Cultrone, et al., “Fly ash addition in clayey materials to improve the quality of solid bricks”, published in Journal of Construction and Building Material 23, (2009) pp.1178-1184.

[8] Boca Santa et al. Geopolymer synthetized from bottom coal ash and calcined paper sludge. J. Clean. Prod. 2013;57:302–307.

[9] Frias, M., Garcia, R., Vigil, R., & Ferreiro, S. (2008). Calcination of art paper sludge waste for the use as a supplementary cementing mater ial. Applied Clay Science, 42(1), 189-193.

[10] Dayaratnam,P., Design of Concrete Structures, Oxford and I.B.H.,1987,pp.137-146.

[11] A.R. Aguilar, O.B. Diaz, J.I. Escalante-Garcia, Lightweight concretes of activated metakaolin-fly ash binders, with blast furnace slag aggregates, Constr. Build. Mater. 24 (2010) 1166–1175.

[12] A. S. Muntohar, “Engineering characteristics of the compressed-stabilized earth brick,” Constr. Build. Mater., vol. 25, no. 11, pp. 4215–4220, 2011.

[13] IS 3495 (Parts 1 to 4) : 1992 Methods of Tests of Burnt Clay Building Bricks.