EXPERIMENTAL INVESTIGATION ON FLYASH BASED GEOPOLYMER BRICKS

Dr. Manoj Kumar Nayak[1], Sushree Sefali Mishra[2]
[1] *Mechanical Engineering, Gandhi Engineering College(GEC, Bhubaneswar)*
[2] *Mechanical Engineering, Gandhi Engineering College(GEC, Bhubaneswar)*

ABSTRACT

The purpose of the present study is to investigate the behaviour of Fly ash based Geopolymer eco Bricks and its Durability, the size of the bricks were adopted was 190mmx90mmx90mm. The brick were cast with fly ash to river sand and eco-sand (silica sand) with the Different ratio's of 1:1.6, 1:1.8, 1:2 by weight. The optimum water/ binder ratio of 0.416 was selected as per available literature. The water/binder ratio is the ratio of solution (NaOH and water) to fly ash. Bricks will be casted in this study under ambient curing. Visual inspection of Geopolymer mortar samples did not reveal any recognizable change in colour and remained structurally intact though the exposed surface turned slightly softer. Through Optical microscope, corroded surface could be seen which increased with time of exposure. After exposure in the acid solution for 18 weeks, the Geopolymer samples almost lost its alkalinity and showed very low weight loss in the range from 0.54% to 0.28% of initial weight. Loss of weight was found higher for specimen with higher percent of Na SIO3. Results obtained in the present study indicate that
Geopolymers are highly resistant to sulfuric acid.

Keywords: Experimental, Investigation, Flyash, Geopolymer Bricks

1. INTRODUCTION

1.1 Geopolymer

Geo polymers are new materials for fire- and heat-resistant coatings and adhesives, medicinal applications, high- temperature ceramics, new binders for fire-resistant fiber composites, toxic and radioactive waste encapsulation and new cements for brick. The properties and uses of geo polymers are being explored in many scientific and industrial disciplines: modern inorganic chemistry, physical chemistry, colloid chemistry, mineralogy, geology, and in other types of engineering process technologies. Geo polymers are part of polymer science, chemistry and technology that forms one of the major areas of materials science. Polymers are either organic material, i.e. carbon-based, or inorganic polymer, for example silicon-based. The organic polymers comprise the classes of natural polymers (rubber, cellulose), synthetic organic polymers (textile fibers, plastics, films, elastomers, etc.) and natural biopolymers (biology, medicine, pharmacy). Raw materials used in the synthesis of silicon-based polymers are mainly rock-forming minerals of geological origin, hence the name: geo polymer.

1.2 Geopolymer Resins And Binders

- Fire-resistant materials, thermal insulation, foams;
- Low-energy ceramic tiles, refractory items, thermal shock refractories;
- High-tech resin systems, paints, binders and grouts;
- Bio-technologies (materials for medicinal applications);
- Foundry industry (resins), tooling for the manufacture of organic fiber composites;

- Composites for infrastructures repair and strengthening, fire-resistant and heat-resistant high-tech carbon-fiber composites for aircraft interior and automobile;
- Radioactive and toxic waste containment;

1.3 Geopolymer Cements And Bricks

1.3.1 Low-tech building materials (clay bricks),

1.3.2 Low-CO_2 cements and bricks.

2.METHODOLOGY

Figure.1. shows the methodology adopted in this study

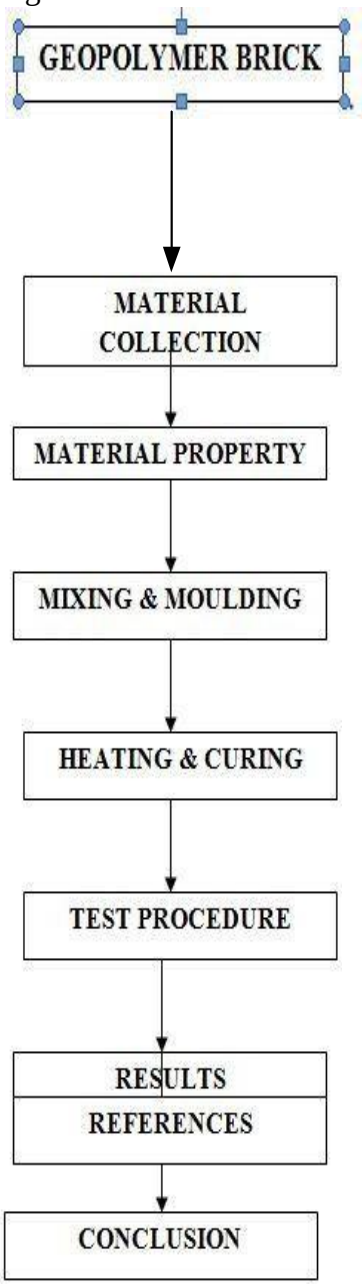

Figure.1. Methodology

3. MATERIAL COLLECTION

3.1 Fly Ash

Fly Ash is a by-product of the combustion of pulverized coal in electric power generation plants. When the pulverized coal is ignited in the combustion chamber, the carbon and volatile materials are burned off. However, some of the mineral impurities of clay, shale, feldspars, etc., are fused in suspension and carried out of the combustion chamber in the exhaust gases. As the exhaust gases cool, the fused materials solidify into spherical glassy particles called Fly Ash. Due to the fusion-in-suspension these Fly Ash particles are mostly minute solid spheres and hollow ecospheres with some particles even being plerospheres, which are spheres containing smaller spheres.

3.1.1 Advantages Of Fly Ash In Brick

Fly Ash is a pozzolan.

A pozzolan is a siliceous or alumino siliceous material that, in finely divided form and in the presence of moisture, chemically reacts with the calcium hydroxide released by the hydration of Portland Cement to form additional calcium silicate hydrate and other cementious compounds. The hydration reactions are similar to the reactions occurring during the hydration of Portland cement. Thus, brick containing Fly Ash pozzolan becomes denser, stronger and generally more durable long term as compared to straight Portland cement brick mixtures.

3.2 Fine Aggregate

Generally River Sand is used in the Geo polymer brick. Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days good sand is not readily available, it is transported from a long distance. Those resources are also exhausting very rapidly. So it is a need of the time to find some substitute to natural river sand. The artificial sand produced by proper machines can be a better substitute to river sand. When fine particles are in proper proportion, the sand will have fewer voids. The cement quantity required will be less. Such sand will be more economical. Demand for manufactured fine aggregates for making brick is increasing day by day as river sand cannot meet the rising demand of construction sector. Because of its limited supply, the cost of Natural River sand has sky rocketed and its consistent supply cannot be guaranteed. Under this circumstances use of manufactured sand becomes inevitable. River sand in many parts of the country is not graded properly and has excessive silt and organic impurities and these can be detrimental to durability of steel in brick whereas manufactured sand has no silt or organic impurities

3.3 Sodium Hydroxide

Generally the sodium hydroxides are available in solid state by means of pellets and flakes. The cost of the sodium hydroxide is mainly varied according to the purity of the substance. Since our geopolymer brick is homogenous material and its main process to activate the sodium silicate, so it is recommended to use the lowest cost i.e. up to 94% to 96% purity. In this investigation the sodium hydroxide f lakes were used. Whose physical and chemical properties are given by the manufacturer is shown in Table 1.Sodium hydroxide is industrially produced as a 50% solution by variations of the electrolytic chloralkali process. Chlorine gas is also produced in this process. Solid sodium hydroxide is obtained from this solution by the evaporation of water. Solid sodium hydroxide is most commonly sold as flakes, prills, and cast blocks.(Figure.2 and Figure.3))

PERCENTAGE	SPECIFIC GRAVITY
20%	1.22
30%	1.33
40%	1.43
50%	1.53

Table 1: Physical

Properties Sodium hydroxide

Figure. 2 NaoH – Flakes

Figure.3 NaoH – Pellets

3.4 Eco Sand

Getting good Quarry dust free from organic impurities and salts is very difficult in now a day. While adding the Quarry dustto the mix. And the Quarry dust should be in uniform size i.e., all the Quarry dust particles should be fine. The Quarry Dust obtained from local resource was used in brick to cast test bricks. The physical and chemical properties of Quarry Dust obtained by testing the samples as per Indian Standards.Table.2 and Figure.4)

Table 2 Properties of Quarry dust

PROPERTY	QUARRY DUST	NATURAL SAND
Specific gravity	2.54-2.60	2.60
Bulk relative density (kg/m^3)	1720-1810	1460
Absorption (%)	1.20-1.50	Nil
Moisture content (%)	Nil	1.50
Fine particles less than 0.075mm (%)	12-15	06
Sieve analysis	Zone II	Zone II

Figure. 4 Eco sand

3.5 Sodium Silicate (Na_2sio_3)

Soluble silicates are one of the oldest and most benign industrial chemicals. The industrial beginnings of sodium silicate start in 1818 but references to making sodium silicate like products can be traced back as far as the ancient Phoenicians 2. One reason for the early development of soluble silicate was the relatively simple process for manufacturing it. Sodium (or potassium) silicates are manufactured by fusing sand (SiO2) with sodium or potassium carbonate (Na2CO3 or K2CO3) at 1100-1200°C. The resulting glass can be dissolved with high pressure steam to form a clear, slightly viscous liquid known as "water glass." Sodium silicate is a white powder that is readily soluble in water, producing an alkaline solution.It is one of a number of related compounds like, sodium ortho silicate, sodium pyro silicate, etc. All are glassy, colorless and dissolve in water. Sodium silicate is stable in neutral and alkaline. In acidic solutions, the silicate ion reacts with hydrogen ions to form silicic acid, which when heated and roasted forms silica gel, a hard, glassy substance. Liquids and solids based on sodium silicate and produced by PQ Corporation have a density from 1.6g/cubic cm. to about 1.4 g/cubic cm.

3.5.1 Chemical Reactions Of Silicate

Sodium silicate is unique in that it can undergo four very distinct chemical reactions. These reactions have been defined as:

- 3.5.1.1 Hydration/Dehydration
- 3.5.1.2 Gelation
- 3.5.1.3 Precipitation
- 3.5.1.4 Surface Charge Modification.

These reactions allow silicate to act as a:

- 3.5.1.5 Film Binder
- 3.5.1.6 Matrix Binder
- 3.5.1.7 Chemical Binder

Silicate can adhere an agglomerated material by one or more of its chemical reactions. Sometimes silicate-based formulations achieve their best performance by taking advantage of more than one of these adhesion mechanisms.

3.6 Hydration

As water is removed from liquid silicate, the silicate progressively becomes tackier and more viscous. The removal of a relatively small amount of water will render the liquid silicate a glassy film. Liquid silicates with a high 3.2 ratio are best suited for acting as a film binder. The lower alkali content of a 3.2 ratio silicate has less affinity for water and can therefore dry quicker. Upon drying the bond is less susceptible to moisture pick-up, but to achieve more complete water resistance, some degree of either heat or chemical setting needs to occur.

4. MATERIAL CHARACTERISTICS

4.1 Bricks

The bricks are obtained by moulding clay in a rectangular block of uniform size and then by drying and burning the blocks. As the bricks are of uniform size, they can be properly arranged and further, as they are in lightweight, no lifting appliance is required for them. The common brick is one of the oldest building materials and it is extensively used at present as a leading material in construction. In India, process of brick making has not changed since many centuries except some

minor refinements. There has been hardly any effort in our country to improve the brick-making process for enhancing the quality of bricks. A brick is generally subjected to the following tests to find out its suitability for the construction work.

4.2 Mechanical Properties Of Geopolymer Brick

This geo polymer has been used on a number of different projects in Australia and a total volume of over 3000 m³ has been poured to date. It is not "labcrete"! Test specimens have been taken during actual production and a summary of the average mechanical properties are given in Table.While the most common concrete grades used are 32 and 40 MPa (equivalent to f'cu of 40 and 50 MPa), cylinder strengths up to 70 MPa have been measured. Since the geo polymer binder consists entirely of fly ash and GGBS, there has been a common perception that geo polymer concrete would develop its strength very slowly or require heat curing. Portland cement systems containing high volume replacement of fly ash or GGBS and many geo polymer binders do develop compressive strength slowly. However, this particular geo polymer concrete develops its strength quite rapidly with design strength typically achieved after 7 days under laboratory conditions as seen in Figure. Strength development at early age (up to 3 days) is sensitive to ambient temperature but adequate early strength would be expected if the concrete temperature is above approximately 20°C.

The drying shrinkage of this geo polymer concrete is much lower than for Portland cement based concrete with typical 56 day values of approximately 300 microstrain or less. The drying shrinkage will normally be less than that achieved for a Portland cement based concrete even incorporating a shrinkage reducing admixture as shown in Figure. The product also has a very low heat of hydration as seen in Figure. The limited thermal and drying shrinkage makes it well suited for thick and heavily restrained concrete elements and should enable a significant reduction in the quantity of crack control reinforcement.

4.3. Properties Of Fine Agreggate

Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.(Table.3).

4.4. Properties Of Fly Ash

Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal fired power plants and together with bottom ash removed from the bottom of the furnace. It is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO), both being endemic ingredients in many coal-bearing rock strata. Its mineralogical composition, fine particle size and amorphous character is generally pozzolanic and in some cases also self cementious. In the past, fly ash was generally released into the atmosphere, but pollution control equipment mandated in recent decades now requires that it be captured prior to release. In US, flyash is generally stored at coal power plants or placed in landfills. About 43 percent is recycled, which is often used to supplement Portland cement in brick production. Two classes of flyash are defined by ASTM C618: Class F flyash and Class C flyash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the flyash is influenced by the chemical content of the coal burned i.e. anthracite, bituminous, and lignite (ASTM C618 – 08). In this study, flyash was collected from

Mettur thermal power plant. It is a Class C flyash.

4.5 Properties Of Fly Ash

Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coalfired power plants and together with bottom ash removed from the bottom of the furnace. It is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO2) (both amorphous and crystalline) and calcium oxide (CaO), both being endemic ingredients in many coal-bearing rock strata. Its mineralogical composition, fine particle size and amorphous character is generally pozzolanic and in some cases also self cementious. In the past, fly ash was generally released into the atmosphere, but pollution control equipment mandated in recent decades now requires that it be captured prior to release. In US, flyash is generally stored at coal power plants or placed in landfills. About 43 percent is recycled, which is often used to supplement Portland cement in brick production. Two classes of flyash are defined by ASTM C618: Class F flyash and Class C flyash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the flyash is influenced by the chemical content of the coal burned i.e. anthracite, bituminous, and lignite (ASTM C618 – 08). In this study, flyash was collected from Mettur thermal power plant. It is a Class C flyash. The chemical and physical properties of flyash are described in Table.4

S.NO	PROPERTIES	VALUE
1	Specific Gravity	2.65
2	Fineness Modulus	2.25
3	Water absorption	1.5%

Table 3. Property Of Fine Aggregate

Components	Percentage (%)by Weight
Silica as SiO_2	61.65
Iron as Fe_2O_3	9.56
Alumina as Al_2O_3	25.86
Calcium as CaO	13.78
Magnesium as MgO	2.33
Titanium as TiO_2	1.09
Sodium Na_2O	1.46
Pottasium K_2O	1.57
Sulphate as SO_3	0.62
Loss on ignition	2.38

Table.4 Properties Of Fly Ash

4.6 Properties of Eco Sand

- Higher Strength Of Brick
- Durability Of Brick
- Worka

- Less Construction Defects
- Economy
- Eco-Friendly
- Bility Of Brick

4.7Physical Properties Of NaOH

Caustic soda is also known as sodium hydroxide, caustic, and lye. Anhydrous (100%, solid) sodium hydroxide has a chemical formula of NaOH and a molecular weight of 40.00. Caustic soda, as a 50% solution, is an odorless and colorless liquid. In all forms, caustic soda is highly corrosive and reactive. Caustic soda solution reacts readily with metals such as aluminum, magnesium, zinc, tin, chromium, bronze, brass, copper, and tantalum. Galvanized (zinc coated) materials should be avoided. Contact with acids, halogenated organics, organic nitro compounds, and glycol should be avoided. It reacts with most animal tissue, including leather, human skin, and eyes. It also reacts readily with various reducing sugars (i.e., fructose, galactose, maltose, dry whey solids) to produce carbon monoxide. Upon cooling, the viscosity of the solution increases rapidly as the temperature falls below 65°F (18°C). (Table.5)

Table 5 Basic Properties of Caustic Soda

Basic Properties of Caustic Soda Solution 50%	
Vapor pressure	1.5 mmHg @ 68°F (0.20 kPa @ 20°C)
Boiling point	Approximately 293°F (145°C)
Freezing point	Approximately 58°F (14°C)
pH	14
Specific gravity	1.52 g/ml @ 68°F (20°C)*

Caustic soda, as a 50% solution, is an odorless and colorless liquid. In all forms, caustic soda is highly corrosive and reactive. Caustic soda solution reacts readily with metals such as aluminum, magnesium, zinc, tin, chromium, bronze, brass, copper, and tantalum. Galvanized (zinc coated) materials should be avoided. Contact with acids, halogenated organics, organic nitro compounds, and glycol should be avoided. It reacts with most animal tissue, including leather, human skin, and eyes. It also reacts readily with various reducing sugars (i.e., fructose, galactose, maltose, dry whey solids) to produce carbon monoxide. Upon cooling, the viscosity of the solution increases rapidly as the temperature falls below 65°F (18°C). (Table.5)

4.8 Chemical Information And Properties

Table 6 The chemical formula for Sodium Hydroxide is NaOH

Molar mass of 39.9971 g/mol
Melting Point: 318'C, 604'F
Boiling Point: 1388'C, 2530'F
Density in Natural State: 2.13 g/cm^3
Very soluble in water, alcohol, glycerin and

methynol
Has an Acidity of 13
Reacts with Carbon Dioxide to form Sodium Carbonate
Also reacts with other Acids to form pure water and salts
Type of Bond: Ionic
Percentage composition by mass: Sodium:57.48% Oxygen:40.00% Hydrogen: 2.52%**7**

5 TEST FOR MATERIAL

5.1 Sieve Analysis Test Of Sand

Sieve analysis test aims at grading or separating sand particles into different ranges of size. In practice this is done by passing the materials through a set of sieves with openings of different diameter. Separating larger particles from smaller particles, then calculating the percentage passing each sieve.

5.2Acid Test

Here, a sample of stone weighing about 50 to 100 gm is taken. It is placed in a solution of hydrophobic acid having strength of one percent and is kept there for seven days. Solution is agitated at intervals. A good building stone maintains its sharp edges and keeps its surface free from powder at the end of this period. If the edges are broken and powder is formed on the surface, it indicates the presence of calcium carbonate and such a stone will have poor weathering quality. This test is usually carried out on sandstones.(Figure.6)

Figure.6 Acid Testing

5.3 Test On Sulfuric Acid Resistance

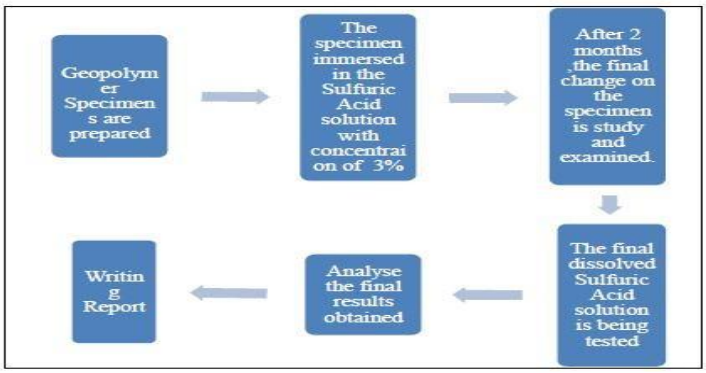

Figure.7. Test On Sulfuric Acid Resistance

5.4Hardness Test

In this test a scratch is made on brick surface with a hard thing. If that doesn't left any impression on brick then that is good quality brick.

5.5 Water Absorption On Geopolymer

Water penetrability, namely water absorption is important measurement to control geo polymer durability. Regarding to this, pores in the geopolymer have an important role to allow the liquid/fluid move through the geopolymer. However the tendency of geo polymer to absorption and transmission of water by capillary action not only depends on the porosity but also on its pore diameter, distribution, continuity and tortuosity.

5.6 Preparation Of Geo Polymer Sample

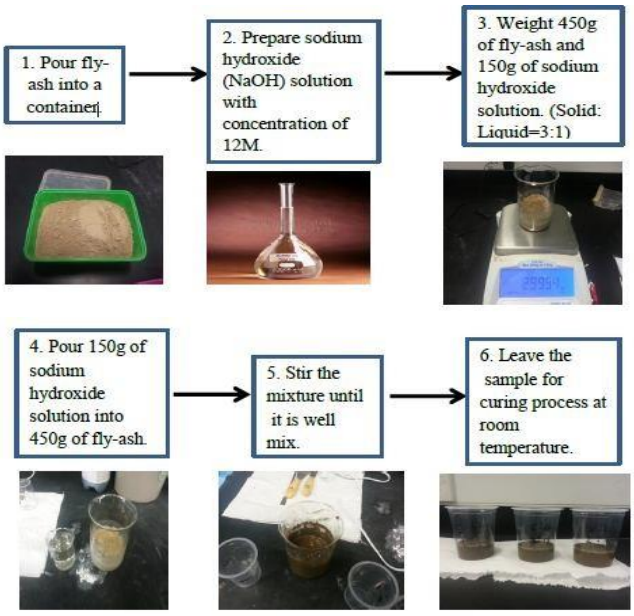

Figure. 8 Preparation Of Geo Polymer Sample

5.7Efflorescence Test

The liability to efflorescence shall be reported as 'Nil', 'Slight', 'Moderate', 'Heavy' or 'Serious' in accordance with the following definitions.

(a) Nil : When there is no perceptible deposit of efflorescence

(b) Slight : When not more than 10 percent of the exposed area of brick is covered with a thin deposit of salts

(c) Moderate : When there is a heavier deposit than under 'Slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

(d) Heavy : When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

(e) Serious : When there is a heavy deposit of salts accompanied by powdering and / or flaking of the exposed surfaces.

5.8Dimension Test

Twenty bricks are selected at random to check measurement of length, width and height. These dimensions are to be measured in one or two lots of ten each as shown in figure. Variation in

dimensions are allowed only within narrow limits, ±3% for class one and ±8% for other classes.

5.9 Color Test

Bricks are closely viewed to check if its edges are sharp and straight and uniform in shape. A good quality brick should have bright and uniform color throughout. A good brick should be of proper shape and standard specified size, the edges of it should be sharp, there should not be any cracks and fissures on the brick. The colour of a good brick should be copper red colour. A yellowish tint on brick indicates that it is under burnt and hence possessing of lower strength, and if a brick is of dark blackish blue colour then it indicates the brick is over burnt and is brittle in nature. When a brick is struck by a hammer or against another brick, it should emit a clear metallic ringing sound, it should not be dull. A freshly fractured brick should show a homogeneous compact structure without any lumps. If a brick is dropped from about a height of 1m on a hard ground or on another brick, it should not break. When a brick is scratched with finger nail it should not leave any impression on the brick. A good brick (1st Class) should not absorb water by not more than 20% of its own Dry weight when immersed in water for a period of 24 Hours.

6 EXPERIMENTAL PROCEDURE

6.1Manufacturing Of Bricks

There was no clear past details about the project. And there is no hard procedure for casting the bricks. So the procedure that is given below was followed by our own. And the equipments which were used in this project are for our convenience only.

6.2Mould Preparation

After collecting all the materials, a mould was prepared. This mould was non-water absorbing in the size of 230mm length, 110mm wide and 80mm deep. The shorter sides of the mould are slightly projecting to serve as handle. And joints were made without any hole or gap to avoid leakage.

6.3Mixing

After all the ingredients were ready, the mixing was done. In this project, mixing was done manually. The mixing process of fibrous concrete bricks and adobe bricks are different, and that processes are given below. The exact mix proportion was not known. So, trial proportions were used in this project.

6.4Casting Of Bricks

After mixing, it should be placed in the mould within 30 minutes. So, two moulds were used at the time to make the process very fast. The bricks were moulded manually by hand and on the table. The following are the steps involved in molding,

- The mould was over a table
- The lump of mix was taken and it was placed in the mould.
- The extra or surplus mix was removed either by wooden strike or the metal strike or frame with wire. The casted geopolymer bricks dried for 14 days.

6.5Quality Of Comfort

All materials manufactured with LTGS geopolymeric cross-linking preserve the quality of comfort specific to earth materials. This quality remains and is neither disturbed by the medium temperature treatments (85-450°C), nor by the quantities of added GEOPOLY ® reagent.This

quality of "interior comfort", like the one obtained from pisé or rammed earth, is due to the "air-conditioning" property provided by the physical and chemical characteristics of geopolymers obtained with LTGS. These geopolymers, which constitute the matrix of the brick, have properties known as zeolithic,

i.e. the property "to breathe", to be in constant hygrometrical balance with the interior of a house and constitute therefore an excellent insulation material against heat. Indeed, contrary to the generally propagated idea, the heat insulation of buildings against warm climate does not follow the same rules and laws as the heat insulation against cold climate. It is known that, in hot and dry areas, the traditional earth material is providing a comfort much higher than modern insulating material used in northern industrialized countries. Bricks manufactured by LTGS geopolymeric cross-linking absorb water vapour. At night, they store condensation moisture from the surrounding air. During the day, they release this moisture, either inside, if the relative humidity should be compensated for, or outside. There is evaporation, therefore a drop in the temperature of the material, therefore a cooling of the house, and insulation against heat.

Project Photos

Figure. 9 At The Stage Of Chemicals Addition (NAOH&Na_2SIO_3)

Figure. 10 Brick Mould

Figure.11 At The Stage Of Placing

Figure. 12 Geopolymer Bricks

6.6Resistant Of Geopolymer To Chemical

Tests were performed to study the sulfate resistance of the low-calcium fly ash-based polymer and the normal commercialize concrete. The test specimens were immersed in 5% sodium sulfate up to one year. The result showed that there was no sign of surface erosion, cracking or spalling and there was also no significant changes in mass and length of the geo polymer concrete. In term of sulfuric acid resistance, the specimens are placed in three different concentration of sulfuric acid solution which are 2%, 1% and 0.5%. Similar to sulfate resistance test, the specimens are placed in the sulfuric acid solution for up to one year. The finding from this test is that the maximum loss of the test. specimens of about 3% after one year.The damage to the surface of the specimens

increased as the concentration of the acid solution increased. In other study conducted, the commercialize concrete is immersed in the same set of sulfuric acid solution. The result show staggering different compare to geo polymer concrete. For an instance, if both sample test with the 5% concentration of sulfuric acid solution, the acid had destroyed almost 65% of the commercialize concrete compare to geo polymer concrete which is only 10%.

7 TEST RESULTS

After casting the bricks, they were analyzed for using as a brick. Various tests were carried out to check the properties of the bricks. And the results of the test were analyzed with the existing and standard results. The following tests were carried out to check the strength of the brick.

7.1 Water Absorption Test

Dry the specimen in ventilated oven at a temperature of 105□C to 115□C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (M_1) specimen too warm to touch shall not be used for this purpose. Immerse completely dried specimen in clean water at a temperature of 27+2□C for 24 hours. Remove the specimen and swipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water .

Table 6 Water Absorbtion Test Result Results

MIX COMPOSITION	WEIGHT (gm)		WATER ABSORPTION (%)
	DRY	WET	
1: 1.6	4.579	5.302	15.78
1: 1.8	4.452	5.151	15.70
1: 2	4.502	5.356	18.96

Table 7 Compressive Strength Test

MIX COMPOSITION	COMPRESSIVE STRENGTH N/mm^2
1: 1.6	6.5
1: 1.8	8.73
1: 2	11.28

7.2 Compressive Strength Test

Sample A – Standard Size Of Brick (190mmx90mmx90mm)

7.3 Efflorescence Test

The Efflorescence test for clay bricks and fly ash bricks was conducted and the results were compared in which Grey or white deposits are slight to moderate in normal bricks and less than 10% on the surface area in fly ash bricks.(Table.8)

Table 8 Efflorescence Test Results

NORMAL BRICKS	FLY ASH GEO POLYMER BRICKS
Slight to moderate	The grey deposit is less than 10 %.

Table 9 Acid Attack Test Results

MIX COMPOSITION	WEIGHT BEFORE IMMERSED IN ACID	WEIGHT AFTER IMMERSED IN ACID	% OF WEIGHT LOSS
1: 1.6	4.579	4.554	0.54%
1: 1.8	4.452	4.432	0.44%
1: 2	4.502	4.489	0.28%

7.4 Acid Attack Test

Table 9 shows the Acid Attack Test Results

8 CONCLUSIONS

From the above experimental studies we can conclude that,

- Geopolymer bricks are suitable for non-load bearing walls only.
- Since, these bricks are relatively light weight and more flexible compared to normal brick, these bricks are potentially ideal material for earthquake prone areas.
- Geopolymer brick does not expand or contract, so sheets of glass or glass block can be embedded in and trimmed with geopolymer.
- The geopolymer bricks are good sound absorbent, hence geopolymer is used in these bricks. So, these bricks can be used in auditoriums.
- The strength of the brick higher than the normal brick
- This has tremendously increased the compressive strength of the block. but still the density of the block is lower than conventional bricks made using clay.

References

[1]. T.Subramani, C.Sumathi , " Experimental Investigation Of Partial Replacement Of Cement With Fly Ash And Sand With Bottom Ash And Glass Used In Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 245-253 , 2015

[2]. T.Subramani, A.Mumtaj , " Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 254-263 , 2015

[3]. T.Subramani, S.B.Sankar Ram **Experimental Study on Concrete Using Cement With Glass Powder, IOSR Journal of Engineering,**Volume 5 , Issue 5, Version 3, pp43-53, 2015

[4]. T.Subramani, S.Kumaran , " Experimental Investigation Of Using Concrete Waste And Brick Waste As A Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) ,
Volume 4, Issue 5, pp. 294-303 , 2015

[5]. T.Subramani, G.Ravi, **"Experimental Investigation Of Coarse Aggregate With Steel Slag In Concrete", IOSR Journal of Engineering,** Volume 5,Issue 5, Version 3, pp64-73, 2015

[6]. T.Subramani, K.S.Ramesh , " Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement Of Sand With M sand" , International Journal of

Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5 , pp. 313-322 , 2015

[7]. T.Subramani, G.Shanmugam , " Experimental Investigation Of Using Papercrete And Recycled Aggregate As A Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) ,
Volume 4, Issue 5, pp. 323-332 , May 2015

[8]. T.Subramani, "Experimental Investigations on Coir Fibre Reinforced Bituminous Mixes" International Journal of Engineering Research and Applications, Vol.2, Issue.3, pp 1794-1804, 2012.