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GEO-POLYMER OF BRICK BY USING RICE HUSK OF FLY ASH

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Abstract - As a result of booming infrastructural development around the world, the demand for cement production is increased. Ordinary Portland Cement (OPC) is mainly used as a cementations material for the concrete production. Nowadays, concrete industry is known to be the major consumer of natural resources, such as water, sand and aggregates, and manufacturing Portland cement also requires large amounts of each of them. The energy consumption for OPC production is high. It is estimated that the production of cement will increase from 1.5 billion tons in 1995 to 2.2 billion tons in 2010 (Malhotra, 1999). For manufacturing each tone (t) of the OPC about 1.5t of raw materials is needed (Mccaffery, 2002). The production of 1t of OPC consumes 4GJ energy and produces about 1t of carbon dioxide (CO2) to the atmosphere which leads to environmental pollution (Mehta, 2001). To reduce the environmental pollution and excess embodied energy utilization, one method of alternative solution can be Geo-polymer concrete.

***Key Words*:** infrastructural development, cement production, Geo-polymer concrete

1. INTRODUCTION

The term ‘Geo-polymer’ was first introduced by Davidovits in 1978 to describe a family of mineral binders with chemical composition similar to zeolites but with an amorphous microstructure. He also suggested the use of the term ‘Poly (sialate)’ for the chemical designation of geo-polymers based on silico-aluminate (Davidovits et al. 2002), Sialate is an abbreviation for silicon-oxo-aluminate. (Davidovits et al. 2002), Sialate is an abbreviation for silicon-oxo-aluminate. Poly(sialates) are chain and ring polymers with Si4+ and AL3+ in IV-fold coordination with oxygen and range from amorphous to semi crystalline with the empirical formula: Mn (-(SiO2) z–AlO2) n. wH2OUnlike ordinary Portland/ pozzolanic cements, Geo-polymers do not form calcium silicate-hydrates (CSH) for matrix formation and strength, but utilize the polycondensation of silica and alumina precursors and a high alkali content to attain structural strength. Therefore, geo-polymers are sometimes referred to as alkali activated alumino silicate binders (Davidovits 1994). The term ‘alkali-activated’ could create significant confusion and generate false granted ideas about Geo-polymer concreteBuilding materials are in high demand as the country reaches the height of its growth. The demand for these resources is expanding at a startling rate. The demand for brick is highly unpredictable, despite the fact that it is one of the most commonly used building materials. But because all brick kilns in India rely on high-quality clay that is gathered from agricultural fields, the unrestricted use of clay is harmful to society as a whole.It is also a time-consuming and energy-intensive technique to manufacture bricks at high temperatures, which is a problem that the brick industry is coping with. Massive quantities of fossil fuels are consumed during the manufacturing process of burned bricks, resulting in enormous carbon dioxide emissions into the environment.Because of the significant energy consumption and depletion of natural resources associated with the production of burnt bricks from clay resources, the manufacture of burnt bricks from clay resources is not currently regarded to be environmentally advantageous. Making bricks out of industrial waste products such as fly ash and rice husk ash, among other things, is both environmentally and economically beneficial because, in addition to saving valuable top agricultural soil, it also achieves the social goal of removing waste from the environment, which is a win-win situation. As previously stated, the biggest disadvantage of using burned

bricks is the substantial amount of energy required during the firing process to get the desired result. During the recent past, humans have been experimenting with several different techniques of producing bricks. Geopolymerization is one of the most effective methods that could be considered in this case. It is also quite inexpensive. When raw materials such as silica's and alumina dissolve in the presence of extremely concentrated alkaline solutions, the result is the formation of aluminosilicate gel. This gel is then condensed with silica and alumina polymerization to generate three-dimensional polymeric structures, which is referred to as geopolymeric structure formation in the scientific community. This research will look into the application of Geopolymerization to the production of bricks manufactured from fly ash

1.1Fly Ash Brick

Fly ash bricks are a building material, especially masonry units that are utilized in the construction of buildings. They are supposed to be a part of good and affordable building materials. Fly ash is a waste product of a power generating plant and that is reused in concrete by partial replacement of cement. It is also used for making bricks is called Fly Ash Brick.Fly Ash Bricks are used as the alternative material for burnt clay bricks for masonry works. The raw material used in the fly ash brick such as fly ash, sand/stone, and ordinary Portland cement. The test conducted to test fly ash brick includes a compressive strength test, Water Absorption Test, and Efflorescence Test. The containing class C or class F fly ash and water. Fly ash brick is generally compressed at 28 MPa and cured for 24 hours in a 66°C steam bath, then stiffened with an air-entrainment agent, the bricks can last for more than 100 freeze-thaw cycles

2. DEVELOPMENT OF BRICKS

A mould of standard brick dimension was used to prepare the bricks.

2.1. Procurement of Raw Materials

All raw materials say rice husk ash, soil will be collected from the respective sources and will be batched according to the given proportion.

2.2. Addition of waste Material

First rice husk is collected from the rice milling industry and then the rice husk is dried. Then this rice husk burnt and obtain a uniform fine Powder.

2.3. Mixing

The rice husk and clay is mixed thoroughly until a uniform color homogeneous mixture is obtained. The mixing can be done by hand or by a blender.

2.4. Moulding

A mould of standard size 190mm x 90mm x 90mm is prepared. The clay is pressed into the mould with hands and excess is removed from the top of mould with strike.

2.5. Drying

The moulded brick is left to dry for two days to facilitate uniform drying and prevent warping. After drying of bricks they are sufficiently hard to allow them to stack then bricks are ready to be tested

3. FLY ASH BRICKS PROPERTIES

1. Appearance: The bricks have a satisfactory cement color, which is uniform in shade and smooth, but does not need plastering for building works
2. Thermal Conductivity: They do not absorb heat and give extreme light reflection.
3. Sound Insulation: It gives an adequate degree of sound insulation.
4. Fire and Vermin Resistance: They have adequate fire resistance; it has no difficulty with vermin attacks.
5. Durability and Moisture Content: These blocks are highly durable, the absorption of moisture is 6–12%, which decreases the humidity of the walls.
6. Toxicity and Stability: When mixed with lime, fly ash turns into a non-toxic commodity thus has potential as a good building material.

3.1. GEOPOLYMER BRICKS DESIGN

The concentration of NaOH used in the experiment is based on the research of previous researches. All the mortars are designed similar to the normal mortar. Accordingly, the performances of geopolymer bricks specimens made with 3M and 4M of NaOH are evaluated.

3.2. TESTING OF GEOPOLYMER BRICKS

All three brick specimens are tested one by one and average result is taken as brick's compressive/crushing strength. The tests on bricks carried out as per IS 3495: 1992 (Part 1) Determination of compressive strength

4. METHODOLOGY

4.1. Black rice husk ash (BRHA)

Black rice husk ash (BRHA) is a by-product from the burning of rice husk. The husk of the rice is removed in the farming process before it is sold and consumed. It has been found to burn this rice husk in kilns to make various things. The rice husk ash is then used as a substitute or admixture in cement. One effective method used today to rid the plant of rice husk is to use it to fuel kilns. These kilns help to produce bricks and other clay products that are used in daily life. After the kilns have been fired using rice husk, the ash still remains. As the production rate of rice husk ash is about 20% of the dried rice husk, the amount of RHA generated yearly is about 20 million tons worldwide. The process of producing rice husk ash from rice husk is shown in Figure

Rice husk Burning rice husk Black rice husk ash

Fig: Black rice husk ash obtained from rice husk

Low-calcium (ASTM Class F) fly ash is preferred as a source material than high calcium (ASTM Class C) fly ash. The presence of calcium in high amount may interfere with the polymerisation process and alter the microstructure The fly ash used in the production of geopolymer concrete at Curtin University is Class F fly ash sourced from the coal fired power station. The class F fly ash is characterized by high silicon and aluminum contents and low calcium content, and a loss on ignition of 0.46. The colour of fly ash can be tan to dark grey, depending upon the chemical and mineral constituents. In order to develop the fly ash-based geopolymer concrete technology, therefore, a rigorous trail-and-error process was used. The focus of the study was to identify the salient parameters that influence the mixture proportions and the properties of low calcium fly ash-and rise husk ash based geopolymer concrete. Fineness of fly ash mostly depends on the operating conditions of coal crushers and the grinding process of coal itself. Finer gradation generally results in a more reactive ash and contains less carbon. The chemical composition is mainly composed of the oxides of silicon(SiO_2), aluminium (Al_2O_3), iron (Fe_2O_3), and calcium (CaO), whereas magnesium, potassium, sodium, titanium, and sulphur are also present in a lesser amount. The major influence on the fly ash chemical composition comes from the type of coal. The combustion of sub-bituminous coal contains more calcium and less iron than fly ash from bituminous coal. The physical and chemical characteristics depend on the combustion methods, coal source and particle shape. The chemical compositions of various fly ashes show a wide range, indicating that there is a wide variation in the coal used in power plants all over

5. OBJECTIVES

1. To study the properties of various types of bricks available in market.

2. To develop a method to manufacture of Geopolymer bricks.

3. To carry out the tests on various types of bricks including Geopolymer bricks.

4. Analyzes the various approaches on production of Geopolymer Brick

6. ADVANTAGES

1. Appearance
2. Strength
3. Durability
4. Sound Insulation
5. Sustainability
6. Availability
7. Cost.
8. Applicability

7. DISADVANTAGES

1. Slow Strength Gain.
2. Longer setting Times.
3. Poor Air Content Control
4. Seasonal Restrictions
5. Size Limitations
6. With concrete is less due to the smooth finish.

8. LITERATURE REVIEW

8.1. Manufacturing of bricks using rice husk ash

Sudarshan S. Shankare et.al (2019) have published a paper "Manufacturing of Bricks Using Rice Husk Ash". In their research rice

Husk ash was varied by 4, 8, 12, 16 and 20 percentages by weight and Engineering properties like compressive strength, water

Absorption, soundness, shape and size have been studied according to Indian Standard Specifications and compared to all other

Proportions. The test outcomes discussed that increasing rice husk in product decline the compressive strength because the combusted

Rice husk replace with the space in the product which effect the density and compressive strength.

8.2. Use of Rice Husk Ash as Substitute to Make Clay Bricks

Rafid Shams Huq et.al (2018) studied the usage of rice husk ash as supplementary material in production of bricks. The focus of

Their paper is not identifying the best production process but to explore the effectiveness of one of the possible uses of RHA in the

Construction industry. Bricks of different percentage of RHA (15%, 25%, 35%) were made and tested for Water Absorption,

Crushing Strength, Los Angles Abrasion Value & Aggregate Impact Value. It was observed that although porosity increases due

RHA, it is still acceptable to use RHA in brick.

8.3. Recycling of bagasse ash and rice husk ash in the production of bricks

Mrs.K. Saranya et.al (2016) examined the usage of sugarcane bagasse ash and rice husk in manufacturing of bricks. In this study

SCBA & RHA are mixed in particular proportion (2.5%, 5%, 10%, 15%, 20%) is provided as the replacement of clay in the production

Of bricks. The experimental results showed that the use of SCBA-RHA-CLAY combination bricks is lighter in weight, durable, non

Hazardous energy efficient, additional strength gains due to pozzolanic properties and reduction in permeability because of pore

Refinement.

8.4. Effect of Rice Husk and Rice Husk Ash to Properties of Bricks

J. Sutas et.al (2011) There research has aims to study effect between rice husk and rice husk ash on properties of bricks.Comparative adding between rice husk and rice husk ash were varied by 0 -10% by weight. The results showed that more adding rice husk less compressive strength and density of specimens.)

8. **5. Compared Chamber Clay bricks, Fly ash bricks**

K. Mahendran (1) compared Chamber Clay bricks, Fly ash bricks, AAC blocks, CLC blocks

And Porotherm blocks based on their engineering properties and economic aspects. Various

Tests were carried out to determine the engineering properties. Cost benefit analysis made for

Each building blocks from the obtained results.

8.6. The Fly Ash brick properties, manufacturing process material required for preparing the clay bricks and fly ash bricks

P.P. Gadling (2) presented the Fly Ash brick properties, manufacturing process material

Required for preparing the clay bricks and fly ash bricks as per Indian standard code

Provisions, inspection and quality control. Use of this additive could have practical

Implications as a means of recycling and for achieving cost savings in brick production.

8.7. Strength and Durability Studies on Fly ash based Geopolymer Bricks

C. Antony Jeyasehar (3) conducted research work on "Strength and Durability Studies on Fly

Ash based Geopolymer Bricks" to improve the quality of geopolymer mortar through special

Treatments and study the property, particularly the acid resistance. The durability tests such

As water absorption test and acid resistance test (HCl and H2SO4) are also conducted.

8.8. Investigated brick production using Fly Ash

Safeer Abbas et al. (4) investigated brick production using Fly Ash (FA). Mechanical and

Durability properties of bricks were studied. Utilization of Fly Ash in brick production can

Lead towards economical and sustainable construction.

8.9. Compared the environmental impacts of three wall types commonly built in Brazil.

Danielle et al. (5) compared the environmental impacts of three wall types commonly built in

Brazil. Differences in impacts mainly result from the use of distinct natural resources and

Processes. It has run different sensitivity analyses to test the final results. The Brick

Manufacturing process has a great impact on Climate Change and Resource Depletion.

8.10. Effect of concentration of alkaline liquid and curing time on strength and water absorption of Geo-polymer Bricks.

Anurag Mishra et al., (2008), effect of concentration of alkaline liquid and curing time on strength and water absorption of Geo-polymer Bricks. Compressive strength increases with increase in concentration of NaOH from 8M to 16M. Increase in compressive strength was also observed with increase in curing time. However when curing time was increased from 48 hrs to 72 hrs, there was not much variation in compressive strength. The test results show that the compressive strength increases with increase in air curing time from 7 days to 28 days.

8.11. The curing temperature in the range of 60°C to 90°C increases, the compressive strength of fly ash-based Geo-polymer Brick

Nguyen Van Chanh.,(2008), as the curing temperature in the range of 60°C to 90°C increases, the compressive strength of fly ash-based Geo-polymer Brick also increases. Longer curing time, in the range of 24 to 72 hours (4 days), produces higher compressive strength of fly ash-based Geo-polymer concrete. However, the increase in strength beyond 48 hours is not significant. The slump value of the fresh fly-ash-based Geo-polymer Brick increases with the increase of extra water added to the mixture. The compressive strength of heat-cured fly ash-based Geo-polymer Brick does not depend on age. Geo-polymer Brick has excellent properties within both acid and salt environments. The production of Geo-polymers have a relative higher strength, excellent volume stability, better durability.

8.12. Fly ash was used as raw material for making Geo-polymer.

S.wada et al., (2006), fly ash was used as raw material for making Geo-polymer. The samples were prepared by mixing fly ash and activator, sodium hydroxide (NaOH) with varying the proportion of H2O and Na2O. In addition, the possibility of using rice husk ash (RHA) as a partial replacement for fly ash raw material was studied. After mixing, the mixtures were casted in a plastic mold and left to harden for 48 hr at room temperature and 60°C and further cured for 7 days. The existing phases were investigated by using XRD.

Bending strength and density of the Geo-polymers were also examined. Results showed that the amount of H2O and Na2O in the mixtures had an effect on the properties of Geo-polymer. The strength decreased with an increase in H2O mol ratio and the appropriate mol ratio of Na2O was 1.0. The addition of RHA as a silica source also had an effect on the strength of Geo-polymer. The strength increased with an increase in silica content. The average compressive strength increased approximately 10 to 12% when there is increase in molar concentration of NaOH solution.

8.13. The strength properties of rice husk ash Brick

Kartini, K. et al., (2006), the strength properties of rice husk ash Brick of grade 30 with or without super plasticizer (Sp). Adding the optimum amount of RHA is important for achieving high strength, however, being cellular in nature, the use of RHA tends to increase the water requirement. Super plasticizer (Sp) needs to be incorporated with proper dosage. The results reveal the influence of RHA on the workability of concrete and its strength performance (compressive strength, flexural strength and tensile splitting) by replacing ordinary Portland cement (OPC) with different replacement levels of RHA

9. SCOPE

1. Improved strength, consistency, and homogeneity.

2. These bricks are free from cracks, wrap age, organic matter, pebbles, and nodules of free lime.

3. It improves the strength over time and offers greater strength to the building.

4. These bricks do not cause any extra load for the design of structures and provide better earthquake resistance.

5. Due to high strength, no breakages/wastages during transport and handling

6. The pozzolanic reaction between fly ash and lime produces less heat.

7. It keeps your building cooler in summer, hence most suitable for Indian climates.

8. These bricks are highly durable and less permeable

9. These bricks are less porous, absorb less water, and reduce dampness on the walls it is also highly resistant to attack by mild acid, water, and sulfate.

10.Construction with these bricks provides decent sound insulation to the building.

11. These bricks are highly fire-resistant compared to normal clay bricks.

12. These bricks have easy Workability and absorb less water

13. The same number of fly ash bricks will cover more areas than clay bricks Consumption of mortar is also low

14. These bricks are suitable for multi storey structures
15. The cost is 30% lower than clay bricks.
16. More environment-friendly as they are made up of waste materials.
17. Construction of pavements, dams, tanks, under water works, canal lining and irrigation work
18. The demand for fly ash bricks in India is increasing
19. As the cost and environmental benefits, people prefer more and more fly ash bricks over common burnt bricks.
20. Fly ash bricks are structurally stronger, more durable, better insulators, water-resistant
21. Utilization of geopolymer Bricks brings economy in construction

10. RESULTS

1 Testing of Bricks

1. Water absorption test of brick

2. Compressive strength test of brick/ crushing strength test on bricks
3. Hardness test of brick
4. Shape and size test of bricks
5. Color test of bricks
6. Soundness test of brick
7. Structure of brick test
8. Efflorescence test of brick

2. **Water absorption testing of bricks**

A water absorption test of the brick is performed to determine the amount of moisture absorbed by the brick under extreme conditions. The purpose of the water absorption test of bricks is to determine their durability of the bricks. The water absorption test necessitates the use of a weighing machine and a drying oven.

Procedure:

1. Firstly, the brick specimen is dried in a drying oven
2. After that, weigh the dry specimen using the weighing machine and mark it as W1.
3. Secondly, immerse the brick in water for 24 hours.
4. Then take the brick out and drain the water.
5. Similarly, measure the weight and mark it as W2.
6. Finally using the formula determine the water absorption. Water absorption = (W1 -W2) / W1 x 100

The moisture content of the brick is thus determined by the difference between the dry weight and the wet weight. Water absorption for high-quality bricks should be less than 20% of thedryweight.This brick test ensures that the brick is longlasti ng and can withstand extreme weather conditions.

Figure: Water absorption test

3. Compressive strength Test of brick/Crushing strength of brick

The ability of the brick to withstand a particular load without failure is the compressive strength of the brick. A compressive strength testing machine is the apparatus for determining the compressive strength of brick.

1. First, take three sample specimens and submerge them in water.

2. After 24 hours, drain the water. Fill the frog and void with mortar in a ratio of 1: 3.

3. Subsequently, store the brick in jute bags for 3 days.

4. Place the brick in the compression testing machine with the brick frog area facing upwards. After that apply the load slowly.
5. Note down the load at which the bricks break.

Finally, using the formula to determine the compressive strength of brick. Compressive strength (N/mm^2) = Maximum load at bricks fail/ Loaded area of brick for good quality bricks, the compressive strength should not be less than 3.5 N/mm^2

Figure: Compressive strength Test

4. **Compressive strength Test**

A good quality brick should be free of soluble salts. However, if soluble salts are present, they form a white substance on the brick surface. Generally, efflorescence on brick is the name given to this white formation. The test procedure for performing the Efflorescence test on brick is as follows.

1. First, take a brick specimen and submerge it in water for 24 hours.
2. After 24 hours, drain the brick and allow them to dry.
3. Keenly observe the brick surface.

5. **Hardness test on bricks**

The hardness test on bricks is a field verification test. Hence they are performed on-site. A good brick should resist scratches against sharp things. The following is the test

At first, choose a brick randomly from the stack.

1. Using a nail or finger make a mark on its surface.
2. If there is no scratch, then it is a good quality brick.

Figure:Hardness test

11. CONCLUSION

From the above experimental work and based on our result. we can conclude that,

1. The strength of the brick higher than the normal brick Rice Husk Fly ash is directly protected the environment by reducing solid waste disposal.

2. The water absorption percentage is increase with increase the mole ratio of geo-polymer solution.

3. To increase the mole ratio to achieve the high strength.

4. Efflorescence is obtained in our project because we are using alkaline material in this project.

5. Water absorption property is less compare to conventional mix.

6. The cost of our brick is low compare to fly ash brick.

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