

Development of Eco-Friendly Geopolymer Brick- A Review

Preetinder Singh¹, Dr. Sanjay K. Sharma²,

¹ME Student, Department of Civil Engineering (NITTTR) Chandigarh,

² Professor, Department of Civil Engineering (NITTTR) Chandigarh,

National Institute of Technical Teachers Training and Research, Chandigarh (U.T) India

(E-mail:preetchahal88@gmail.com)

Abstract-This paper offers a review on production of fly ash based geopolymer bricks using foundry sand. Brick belongs to the extensive family of construction materials since it is mainly used in the erection of outer and inner walls. Bricks are world's most adaptable, reliable and durable material for construction. For making an eco-friendly building it is important that the material using in such construction should be environment friendly. In Geopolymer bricks main ingredients of brick will be totally replace by the waste coming out from Thermal power plant, waste of burnt coal known fly ash, waste coming from metal casting industry foundry sand. Materials rich in (Si) silica and (Al) alumina are the requirements for the geopolymer synthesis. The activator use is sodium hydroxide (Na OH) with Sodium silicate (Na₂ SiO₃) solution. The main advantages are good compressive strength, use of top most fertile soil will eliminate and effective utilization of industry waste and environment eco-friendly. The study will be carried out on (230×110×75)mm size of geopolymer brick with 100% replacement cement in geopolymer concrete bricks using fly ash , waste foundry sand and mineral material.

Keywords: Geopolymer, Flyash, Waste, Foundry sand , Alkaline Activator.

I. INTRODUCTION

An increasing environmental issues has force industries to develop materials that are more environment friendly and leads to zero impact environment eco-friendly construction. The material from a natural resources and industrial waste by-products are very important. This review focuses more on bricks one of the most required material for construction. Current demand is over 1000 billion bricks a year. The common practice of firing clay bricks in kilns large quantities of coal and fuels were consumed. The Indian brick industry, which is the second largest producer in the world consumes more than 150 million tonnes of coal annually without counting the electricity used in brick production, the diesel for transporting the bricks alone produce roughly one-third of the total CO₂ emissions of the global airline industry (550 million tons of CO₂). In 1970s, Davidovits start the discovery and show of the research in geopolymer binders. Geopolymers are a type of materials that formed by the polymer synthesis of silicon (Si) and aluminum (Al) which are ingredients of coal waste known as fly ash. Geopolymers are a chain structures formed on a keystone of Al and Si ions. This technology is considered as new technology, but it has ancient roots and has

been used as the building material in erection of pyramids at ancient times. Geopolymer binder can be used in applications to fully or partially replace OPC in cement based fly ash bricks with environmental and technical benefits, including an 80 - 90% reduction in CO₂ emissions.

II. VARIOUS STUDIES

A. Palomo et al.[1] studies the mechanism of activation of a fly ash (no other solid material was used) with highly alkaline solutions. The solutions, made with NaOH, KOH, water glass, etc., have the usual characteristic of very high OH⁻ concentration. The reaction results amorphous aluminosilicate gel type having a structure similar to zeolitic precursors. The other variables studied were, temperature and time of curing of sample together with solution/fly ash ratio. P. Duxson et al. [2] A brief study on history and review of geopolymer technology was presented with the aim of introducing the technology and the vast categories of materials that get synthesized by alkali-activation of aluminosilicates. The chemical and structural characteristics of geopolymers derived from, fly ash and slag are examined in terms of effects of raw material selection on the properties of geo-polymer combined mix. A. Allahverdi et al. [3] in this research main focus was on, geo-polymerization of construction waste materials with alkali-activators based on solution formed by mixing Na₂SiO₃ and Na OH has been investigated. The sodium hydroxide concentration was adjusted for various samples and setting time and 28-day compressive strength were studied. Konstantinos et al. [4] author focused on geopolymer technology, green buildings and sustainable cities. The cities of the future apart from having low energy consumption and greenhouse gas emissions should also adopt the "zero waste" principle. The geopolymer concrete made from fly ash and ground granulated blast furnace slag results in low emissions of CO₂ than OPC concrete. C. Antony Jeyasehar et al. [5] The main objective was to improve the quality of geopolymer mortar. The main focus of the investigation was on optimum use of the available fly ash and minimize water absorption and achieve high compressive strength. The compressive strength of bricks is worked out by using 10M and 12M NaOH solution, it is very high as compare to that of concrete. The Steam curing increases compressive strength of brick and strength of steam cured was more when compared to air curing.

III. MATERIALS TO USE

Fly Ash: Fly Ash is stuff which is composition of silica and aluminosilicate material. The major constituents of fly ashes are

Silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), ferric oxide (Fe_2O_3) and calcium oxide (CaO). Other minor constituents are MgO , Na_2O , K_2O , SO_3 , MnO , TiO_2 and un-burnt carbon. The variation in main constituents - Silica (25- 60%) and Alumina (10-30%). When the sum of these principal constituents is 70% or more and reactive calcium oxide is less than 10% technically the fly ash is named as class F fly ash.

Alkaline solutions: The alkaline solution is mix of sodium hydroxide (Na OH) and sodium silicate (Na_2SiO_3) solution or potassium hydroxide (KOH) and sodium silicate (Na_2SiO_3) solution. The sodium silicate solution can buy from a local supplier. The sodium hydroxide solution can be prepared by dissolving the solid flakes or pellets in water. Both the solutions should be premixed 24 hours before use.

Foundry sand: Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used for molding material because of its thermal conductivity. It is a by-product from metal castings industries. 100 million tonnes of sand is used for annually production of that 10-15 million tonnes is no longer useful.

IV. ADVANTAGES OF GEOPOLYMER BRICKS

- No any inflammable and harmful geopolymer resins and binders in use.
- Geopolymer is being studied broadly and act as a Greener material second to Ordinary Portland cement which acts as a binder in cement based fly ash bricks.
- It has been found that geopolymer brick has good engineering properties as compare to fired clay bricks.
- The use of fly ash is good for environment safety.
- The harmful impact on the surroundings suggests the need for full utilization of fly ash when it's feasible to use in brick production.
- No kiln burning is required.
- Bricks are uniform in shape and size in comparison to burnt clay brick, therefore, require less mortar in brick work and finishing work resulting in saving of cement mortar.
- Bricks are environment friendly as:
 - It is a green building product and recommended in LEED & TERI-GRIHA systems.
 - It uses fly ash, which is a waste – product of thermal power plants having no value itself.
 - Save fertile agriculture land which is used for manufacturing clay bricks.
 - Less energy consumption in manufacturing and act as more insulating material compared to clay bricks and help in keeping clean environment.
- Utilization of by-products hence good solution to the disposal problem.
- Economical product.

V. EXPECTED RESULTS

The expected results by study of the use of foundry sand and fly ash with alkaline solution in Geopolymer brick, the high compressive strength & less water absorption with comparative to burnt clay bricks, less chances of efflorescence. It is expected that the present study will help out in developing the economical and environment friendly brick. This study will be help in use of waste by products in case dumping on open land is harmful to health and cut down the cost of bricks in construction. It will be beneficial in production of Green environment eco-friendly brick.

VI. REFERENCES

- [1] Palomo, M.W. Grutzeck, M.T. Blanco, "ALKALI-ACTIVATED FLY ASHES A CEMENT FOR THE FUTURE", Cement and Concrete Research, Volume- 29, 1999, Page no. 1323-1329.
- [2] P. Duxson, A. Fernandez-Jimenez, J. L. Provis, G. C. Lukey, A. Palomo, J. S. J. van Deventer, "GEOPOLYMER TECHNOLOGY: THE CURRENT STATE OF THE ART", J Material Science (2007) Volume 42, Page no. 2917–2933.
- [3] A. Allahverdi, E. Najafi Kani, "CONSTRUCTION WASTES AS RAW MATERIALS FOR GEOPOLYMER BINDERS", International Journal of Civil Engineering, Volume-7, Issue 3, September 2009.
- [4] Michael J. Howie, "CEMENT FREE CONCRETE USING ALKALI-ACTIVATED HIGH-CARBON FLY ASH AS BINDER", Clarkson University, Thesis Proposal, March 2009
- [5] Konstantinos, A. Komnitsas, "POTENTIAL OF GEOPOLYMER TECHNOLOGY TOWARDS GREEN BUILDINGS AND SUSTAINABLE CITIES", Procedia Engineering Volume-21, 2011, Page No.1023 – 1032.
- [6] Ammar Motorwala, Vineet Shah, Ravishankar Kammula, Praveena Nannapaneni, Prof. D. B. Raijiwala, "ALKALI ACTIVATED FLY-ASH BASED GEOPOLYMER CONCRETE", International Journal of Emerging Technology and Advanced Engineering ,Page No.2250-2459, Volume 3, Issue 1, January 2013.
- [7] Bennet Jose Mathew1, Sudhakar M, Dr. C Natarajan, "DEVELOPMENT OF COAL ASH-GGBS BASED GEOPOLYMER BRICKS", European International Journal of Science and Technology, Volume-2, 2013.
- [8] C.Antony Jeyasehar , G. Saravanan A.K. Ramakrishnan and S. Kandasamy, "STRENGTH AND DURABILITY STUDIES ON FLY ASH BASED GEOPOLYMER BRICKS", ASIAN JOURNAL OF CIVIL ENGINEERING , VOL. 14, Issue. 6 ,2013, Page No. 797-808.
- [9] S.D. Muduli, J.K. Sadangi, B.D. Nayak, B.K. Mishra, "EFFECT OF NAOH CONCENTRATION IN MANUFACTURE OF GEOPOLYMER FLY ASH BUILDING BRICK", Greener Journal of Physical Sciences, Volume-3 , Page No. 204-211, October 2013.



Preetinder Singh, pursuing Master's Degree in Construction Technology and Management. Eco-friendly materials, Green building & sustainable development are the interested research areas.



Dr. Sanjay Sharma, more than 25 years of industry and teaching experience. Developed many instructional material. Repair and Rehabilitation of Structures, Environmental engineering, Sustainable Development are interest areas.