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Sutainable Utilization of Flyash in Paving Block

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***Abstract*—Geopolymer is a class of aluminosilicate binding materials synthesized by thermal activatio n of solid aluminosilicate base materials such as fly ash with an alkali metal hydroxide and silicate solution. The geopolymer was activated with sodium silicate. This paper presents the experimental investigation done on alkaline solution properties of geopolymer concrete. The grades chosen for the investigation were M40 the mixes were designed for 8 molarity. The alkaline solution used for present study was the combination of sodium silicate and sodium hydroxide solution with the ratio of 2.5. The test specimens were 100×100×60 mm paving block . The freshly prepared geopolymer mixes were cohesive and their workability increased with the increase in the ratio of alkaline solution .**

The strength of geopolymer concrete can be improved by decreasing the water and aggregate binding ratio . The curing period improves process resulting in higher compressive strength The geopolymer concrete do not have Portland cement, they can be considered as less energy interactive. it utilizes the industrial wastes such as fly ash for producing the binding system in concrete. The obtained compressive strength The optimum dosage for alkaline solution can be considered as 2.5, because for this ratio the GPC specimens of any grade produced maximum Strength in compression.. The replacement of recycled brick aggregate as a sand like 25%,50%,75% &100% in paver block

***Keywords*— geopolymer concrete, fly ash, molarity, sodium silicate, sodium hydroxide.**

1 INTRODUCTION

The global cement industry contributes around 1.35 billion tons of the green house gas emissions annually, or about 7% of the total man-made greenhouse gas emissions to the earth's atmosphere [1]. Due to the production of Portland cement, it is estimated that by the year 2020, the CO2 emissions will rise by about 50% from the current levels. Therefore, to preserve the global environment from the impact of cement production, it is now believed that new binders are indispensable to replace PC [2]. In this regard, the geopolymer concrete (GC) is one of the revolutionary developments related to novel materials resulting in low-cost and environmentally friendly material as alternative to PC [3].

The geopolymer technology was first introduced by Davidovits in 1978. His work considerably shows that the adoption of the geopolymer technology could reduce the CO_2

emission caused due to cement industries. Davidovits proposed that an alkaline liquid could be used to react with aluminosilicate in a source material of geological origin or in by-product materials such as fly ash to make a binder [4].

Geopolymer is synthesized by mixing aluminosilicate-reactive material with strong alkaline solutions, such as sodium hydroxide (NaOH), potassium hydroxide (KOH), sodium silicate or potassium silicate. The mixture can be cured at room temperature or temperature cured [5]. Fly ash is the most common source material for making geopolymers. Normally. good high-strength geopolymers can be made from class F fly ash [6] the recycled brick aggregate replaced as a sand like 25%,50%,75% &100%.

I. ABOUT PROJECT

MATERIAL

The following material used in experimental study[14]

a) fly ash (class F) collected from thermal power plant having specific gravity 2.00.
b) Fine aggregate: sand confirming to zone _III of IS:383-1970[18] having specific gravity 2.51 and fineness modules
c) coarse aggregate: crushed granite material confirming to of IS:383-1970 [18] having specific gravity 2.70 and fineness modules of 5.85
d) water : clean potable water for mixing
e) Alkaline liquid : specific gravity of
1) sodium hydroxide (NaOH) =1.16
2) sodium silicate ($Na2SiO_2$) =1.57
f) recycled brick aggregate : recycled brick agreegate collect from demolished structure.fineness modulus of 2.70

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II. MIX DESIGN OF GEOPOLYMER CONCERTE

In the design of geopolymer concrete mix the fine aggregate value is similar to that used in OPC concrete in which it will be in the range of 75 to 80% of the entire mixture by mass. Fine aggregate was taken as 30% of the total aggregates. The density of geopolymer concrete is taken similar to that of OPC as 2400 kg/m² [12]. The details of mix design and its proportions grade of GPC are given in Table 2.

Alkaline solution: In geopolymerization, alkaline solution plays an important role. The most common alkaline solution used geopolymerization is a combination of sodium hydroxide, (NaOH) and sodium silicate(Na_2SiO_2) In this study, a combination of sodium hydroxide and sodium silicate was choosen as the alkaline liquid. Generally sodium hydroxide and sodium silicate are readily available in market in the form of pellets and gel (liquid).

Preparation, casting and curing of geopolymer concrete :
The alkaline activator solution used in GPC mixes was combination of sodium hydroxide solution pellets and distilled water. . To prepare sodium Hydroxide solution of 8 molarity (8M). 320 gm of sodium hydroxide flakes was dissolved in water. The mass of NaOH solids in a solution will vary depending on the concentration of the solution expressed in terms of molar. M. The pellets of NaOH are dissolved in one liter of water for the required concentration. When sodium hydroxide and sodium silicate solutions mixed together polymerization will take place liberating large amount of heat, which indicates that the alkaline liquid must be used after 24 hours as binding agent.
GPC can be manufactured by adopting the conventional techniques used in the manufacture of Portland cement concrete. In the laboratory, the fly ash and the aggregates were first mixed together dry on pan for about three minutes. The liquid component of the mixture is then added to the dry materials and the mixing continued usually for another four minutes .
The addition of sodium silicate is to enhance the process of geopolymerization [12]. For the present study, concentration of NaOH solution is taken as 8M with ratio of Na_2SiO_3/NaOH as 2.5 for all the grades of GPC mixes.
In order to improve the workability ,super plasticizer calcium chloride 250ml for one litre water . (other than the water used for the preparation of alkaline solutions) and dosage of super plasticizer was added to the mix according to the mix design details. The fly ash and alkaline activator were mixed together in the mixer until homogeneous pate was obtained. This mixing process can be "handled within 5 minutes for each mixture with ratio of 2.5 alkaline solution. In paver block recycled brick aggregate replace by 25%,50%,75%&100% . After the casting demould after the 24 hour form the casting . For curing pavers covered by gunny bags and spread water once in day. After 7&28 days the compression test and three point bending load test taken. The workability of geopolymer concerte decrease with increase in the grade of concerte . This is because of decrease in ratio of water to geopolymer solids . an increase in sodium silicate concentration thus reduce the flow of GPC. How we can say that the grade of concrete increase ,the mix become stiffer decreasing the workability ,which result in strength reduction.

3.2 Effect of Ratio of Sodium Hydroxide to Sodium Silicate Solution

The effect of ratio of sodium hydroxide to sodium silicate solution by mass on the compressive strength of concrete can be seen by comparing the results. For these grades the concentration of sodium silicate solution (in terms of molarity), the water content, the fly ash content and the condition of curing were kept constant.

3.3 Compressive Strength

The compressive strength is one of the most noteworthy properties of hardened concrete and is considered as the characteristic material value for the classification of concrete. The compressive strength of the GPC specimen synthesized four different persentage of Recycled brick aggregates in table The chemecial of the geopolymer is due to substantiallyfast polymerlization processes ,the compressive strength do not vary with the edge of the concrete. This observation is in contrast to the well- known behavoir ofOPC concrete ,which undergoes hydration process and hence gains strength over the time.
The strength is increase with the increase of NaOH concentration mainly through the leaching out of silica and alumina[18].

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CONCLUSIONS

Maximizing the sustainability of coal ash utilization is essential for the future of energy production. Fly ash interlocking blocks are a practical and sustainable option for modern construction, promoting environmental responsibility while maintaining efficiency and strength. The use of fly ash in interlocking masonry blocks presents a significant advancement in sustainable construction practices. By incorporating fly ash, we can reduce the environmental impact associated with traditional building materials, decrease landfill waste, and utilize a byproduct of coal combustion effectively. This approach not only enhances the mechanical properties of the blocks such as strength and durability but also improves their thermal performance, contributing to energy efficiency in buildings. Moreover, the production of fly ash-based blocks typically requires less energy compared to conventional cement blocks, further minimizing carbon emissions. As the construction industry seeks greener alternatives, interlocking masonry blocks made with fly ash represent a viable solution that aligns with sustainability goals, promoting a circular economy and supporting the transition toward more eco-friendly building practices. Overall, embracing fly ash in this context can lead to more resilient infrastructure while fostering environmental stewardship.

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A. Figures and Tables

TABLE 1.

Grade	Coarse agreegate	Fine sand	RBA	Fly ash	NaOH	NA_2SI_3	Super plasticizer	Extra water
M40	0.388	0.166	0.16	0.22	0.027	0.062	0.00354	0.023

TABLE 2

For 50% Replacement Of RBAc

Grade	Coarse agreegate	Fine sand	RBA	Fly ash	NaOH	NA_2SI_3	Super plasticizer	Extra water
M40	0.388	0.166	0.16	0.22	0.027	0.062	0.00354	0.023

TABLE 3

For 75% Replacement of RBA

Grade	Coarse agreegate	Fine sand	RBA	Fly ash	NaOH	NA_2SI_3	Super plasticizer	Extra water
M40	0.388	0.08	0.024	0.22	0.027	0.062	0.00354	0.023

TABLE 4

For 100% Replacement of RBA

Grade	Coarse agreegate	Fine sand	RBA	Fly ash	NaOH	NA_2SI_3	Super plasticizer	Extra water
M40	0.388	0.24	0.08	0.22	0.027	0.062	0.00354	0.023

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