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DEVELOPMENT OF GEOPOLYMER MORTAR WITH ALKALINE SOLUTION

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Abstract- Geopolymer is the new technique which is produced from the alkali activated alumino silicate material. This type of technique is an eco-friendly technique which contributes in the sustainable development. In the geopolymer construction the waste product like fly ash, glass furnace slag etc. is utilized to develop mortar for use in civil engineering applications. It provides an alternate to the conventional concrete and mortar which is produced by using cement. This technology completely replaces the cement as binding material. So the geopolymer reduces the emission of greenhouse gases, which is emitted during the manufacturing of cement and also the cost of the disposal of fly ash. In this research paper, the compressive strength of the geopolymer mortar has been studied with different ratio of alkaline solution. The variation in Sodium Silicate to Sodium Hydroxide used in this study was 1.5,2 and 2.5. The result of this research paper highlights that the compressive strength of geopolymer mortar was maximum using alkaline solution with ratio 2.

Keywords- geopolymer, alkaline liquid, compressive strength, low calcium fly ash.

I. INTRODUCTION

In the conventional construction system, cement is widely used as a binding material in concrete and mortar. Mortar is made up of cement, fine aggregate and water in fixed proportions. Cement is the main active ingredient which reacts with water to produce mortar using sand. In the manufacturing of cement, huge amount of CO_2 is released during the calcination of limestone and this CO_2 is responsible for the greenhouse effect. Due to rapid increase in civil construction, the demand for the ordinary Portland cement increased day by day resulting in the need for establishing of new cement manufacturing plant. In order to reduce the demand of cement an alternative solution is required which could reduce the degradation of the environment.

Geopolymer technology invented by Prof. Davidovits provides an alternative to the conventional civil construction. In this special type of aluminosilicate polymer called as geopolymer are used. There are two main constituents of geopolymer, fly ash and alkaline solution. The alkaline solution consists of the hydroxides and silicates of Sodium or Potassium. In geopolymer mortar the alumina and silica present in the fly ash reacts with the alkaline solution to form a gel , which gel is further used to bind the ingredients of the mortar.

Low calcium fly ash is the by-product of the thermal power industries, used in geopolymer based concrete and mortar. By using such type of material in construction we intend to recycle the waste material and reduce the cost of its disposal ultimately reducing the environmental degradation . Generally, fly ash is used as a partial replacement of the Portland cement in the conventional method of construction. Low calcium fly ash mortar has good durability, excellent compressive strength and good resistance to sulphate attack. Low calcium fly ash based mortar and concrete are economical than cement based concrete and mortar. So the fly ash is like a substitute to cement in producing geopolymer concrete and reduces the carbon footprints on the environment. This geopolymer technology can reduces upto 80% CO_2 emission in the environment produced by cement industries, if implemented in civil construction.

II. EXPERIMENTAL WORK

The preparation of geopolymer mortar is similar to cement mortar. The process involved in the manufacturing of geopolymer mortar are preparation of activator solution, dry and wet mixing of the ingredients of the mortar, casting of samples, curing and after that testing of samples at specified time period. Firstly, solution of sodium hydroxide, of 14M (molarity) is prepared by mixing, 560g (14×40) i.e (molarity ×molecular weight) of sodium hydroxide with1 litre of RO water or distilled water. The mass of sodium hydroxide depends on its molarity. The fly ash sample need in this study was collected from the Rajpura Thermal Power Plant. In this research the sand used conforms to Zone-II of IS 383-2016. In Geopolmer mix the sand with a specific gravity 2.62 which was saturated surface dry to avoid water absorption from activator solution. The ratio of flyash to sand was 1:1.5, whereas the activator to fly ash ratio was 0.45. The prepared solution of sodium hydroxide was mixed to sodium silicate water glass in the ratio of 1.5, 2 and 2.5. After that the prepared solutions of SS/SH of different ratios were

gradually added into the dry mix of the ingredients in different proportion as per planned study. The mixing was done until the mixture became homogeneous and uniform in colour. Immediately after mixing, samples of size 70.6×70.6 mm were cast in vibrating machine. The specimen were kept in the oven along with the mould at 90ºC curing temperature for 24 hours and thereafter the samples were at room temperature for 7,14 and 28 days .

Compressive Strength of Geopolymer Mortar

The compressive strength of geopolymer mortar samples after curing were tested in the Compressive Testing Machine of 3000KN capacity as per IS code 4031(part 6): 1988 which is for cement mortar. For each mix, set of three samples were tested for the specified time period and the average of three samples was taken for final result.

The results of the tests at 7days, 14 days and 28 days were observed for further analysis.

III. **RESULTS**

TABLE I
Average Compressive Strength with Different Alkaline Solution Ratios

S.N	**SS/SH**	**Compressive Strength in N/mm^2**		
		7 days	**14 days**	**28 days**
a)	1.5	18.05	21.32	27.34
b)	2	21.42	25.10	29.85
c)	2.5	16.83	23.77	27.34

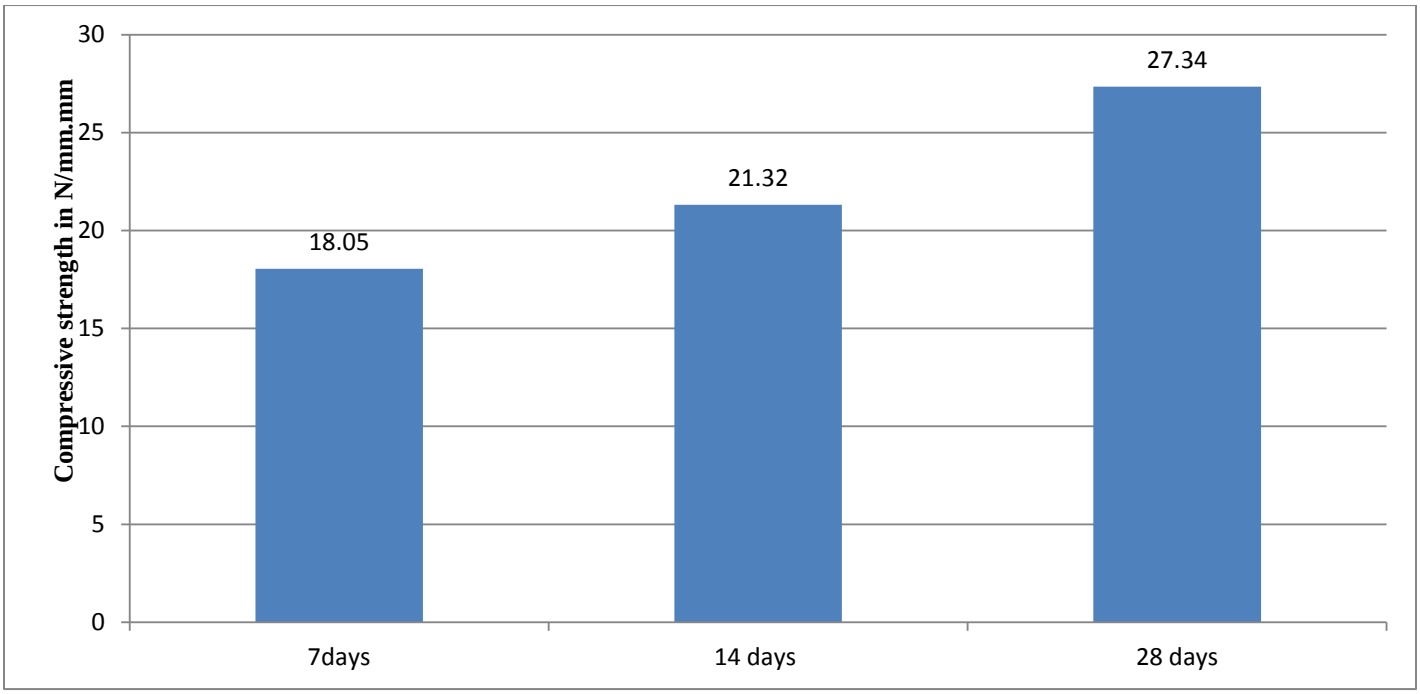

Fig.1 The Compressive Strength of Geopolymer Mortar with SS/SH Ratio 1.5 at 90º C

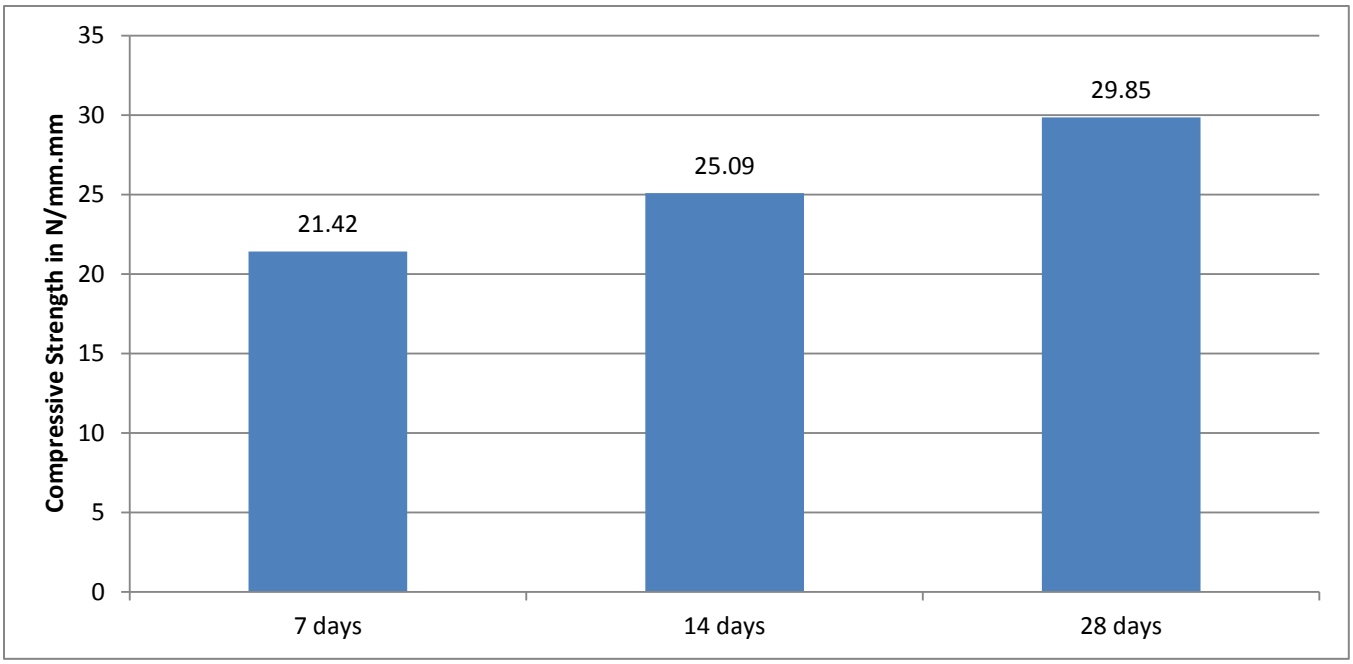

Fig.2 The Compressive Strength of Geopolymer Mortar with SS/SH ratio 2 at 90º C

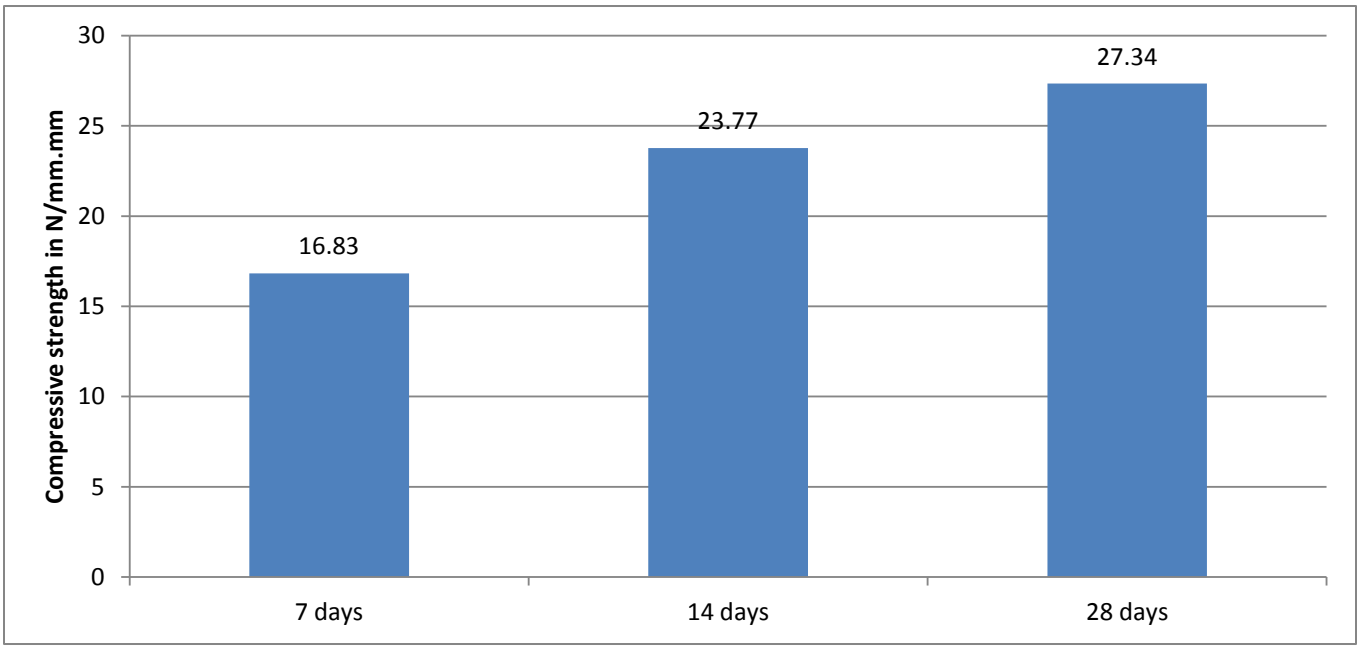

Fig.3. The Compressive Strength of Geopolymer Mortar with SS/SH ratio 2.5 at 90ºC

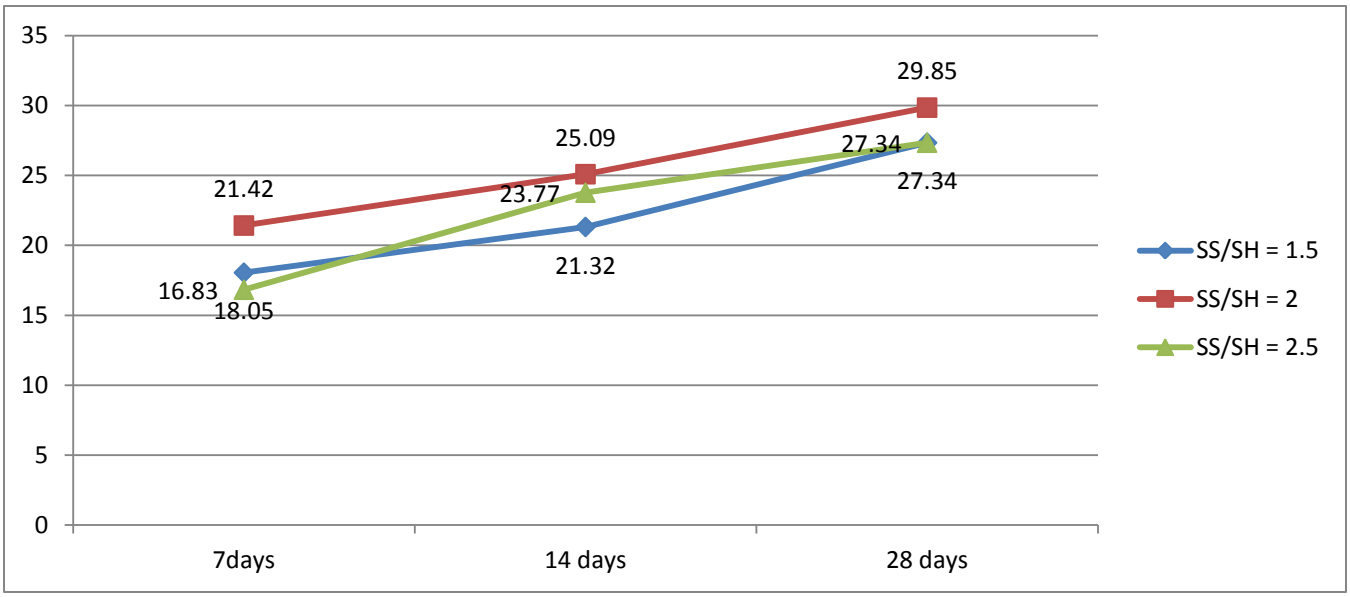

Fig. 4 Comparison of Compressive Strength with Variation in SS/SH Ratios.

IV. DISCUSSION AND CONCLUSIONS

- From the results it was observed that the compressive strength with different ratios of alkaline solutions at 7, 14 and 28 days.
- From the fig.1, the compressive strength increases with the SS/SH ratio 1.5 at the specified curing period .
- And when the ratio of alkaline solution increases from 1.5 to 2 there was also increase in the compressive strength of the geopolymer mortar.
- The further increment in the ratio of alkaline solution from 2 to 2.5 there was a decrease in the compressive strength of geopolymer mortar.

V. RECOMMENDATIONS

- So from the result we concluded the compressive strength at the ratio 2 of alkaline solution gave the maximum compressive strength at 7, 14 and 28 days and it corresponded to the equivalent strength of cement mortar.
- Geopolymer mortar is recommended as an innovative construction material which replace the cement as a binding material in the conventional cement mortar.
- Gepolymper technology utilizes the waste material of Thermal Power industries.

VI. LIMITATIONS

- High cost of activator solutions
- If compaction is not proper it will decrease the strength of the mortar.
- It is very difficult to deal with the sodium hydroxide solution because it release the huge amount of heat when dissolved into the water.
- It is a new concept of construction and since no Indian Standards are available.

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