EXPERIMENTAL STUDIES ON PROPERTIES OF GEO-POLYMER CONCRETE WITH GGBS AS A BINDER

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Abstract

This paper elucidates an alternative to conventional concrete we introduced Geopolymer concrete ie replacing cement with pozzolanic materials like GGBS and fly ash. In our study we incorporated GGBS with cement at cent percent and alkali solutions like Sodium hydroxide and Sodium silicate are used in ratio 1:2 as binders. We designed for 8 &10 molarity of sodium hydroxide. Compressive strength and flexural strength are found for Geopolymer concrete for 7 and 28 days of curing. The overall aim is to reduce usage of cement as well as to reduce pollution because one ton of cement produce one ton of carbon dioxide. This type of concrete improves use of waste products of industry in our construction industry.

Keywords:- *GGBS , Fly Ash, Cement, Geopolymer Concrete, Compression Strength, Flexural strength.*

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1. INTRODUCTION

Romans used geopolymer concrete in ancient days but it was invented by Davidovits in 1978. Concrete that is produced using aluminate and silica as binding materials is called Geopolymer concrete. Metal Slag, ash products are mainly used because they are waste products and they are not useful for environment . These waste materials are directly mixed within the concrete and have a similar binding properties to that of cement. Usage of activators like Sodium hydroxide and Sodium silicate increases binding property to that of cement. This concrete has more additional advantages than conventional concrete. It has more life and minimizes money spent on repairs and maintenance.. Properties like high compressive, flexural, split tensile strength are noted for geopolymer concrete. Curing of geopolymer concrete is fast than nominal concrete.Geopolymer concrete gains its maximum strength with in 7 days. In geopolymer concrete polymerization takes place between alkaline liquid and earth materials like flyash or GGBS. These are formed in chain like structures during polymerization and they are linked by covalent type of bond. Geopolymers have a similar chemical composition like Zeolite. Chemicals like Sodium hydroxide/ Potassium hydroxide/Sodium silicate/ Potassium silicate are commonly used alkaline liquids to enhance reaction rate in concrete. Sodium hydroxide and Sodium silicate are preferred because they are affordable and commonly available in market. Ground granulated blast furnace slag (GGBS) is a by-product from the blast-furnaces during manufacture of iron products. During the process, slag was formed and it is then dried and ground to a fine powder.

2. RAW MATERIALS

GGBS:-

GGBS we opted is taken from JSW(Jindal Steel works) and its chemical composition are:-

Table 1 Properties of GGBS Aggregates:- Coarse aggregate:- 10 mm size aggregate are used

CaO	37.34%
Al_2O_3	14.42%
Fe_2O_3	1.11%
SiO_2	37.73%
MgO	8.71%
MnO	0.02%

Table 2 Properties of Coarse aggregate

Specifikc gravity	3.10
Bulk Density (kg/m^3)	1.77
Flakiness	35.51%
Elongation	20.28%

Table 3 Properties of Fine aggregate Fine aggregate:-

I.S. Sieve (mm)	Percentage Passing through I.S. Sieve	Percentage Passing I.S. Sieve as per IS 383-1970
10		
4.75	98.8	90-100
2.36	97.6	85-100
1.18	92.2	75-100
600 micron	60.8	60-79
300 micron	17.2	12-40
150 micron	1.8	0-10
Zone	3	
Fineness modulus	2.31	
Specific Gravity	2.735	
Bulk Density Kg/m^3	1.72	

Alkaline solutions:-
Sodium hydroxide & Sodium Silicate are preferred as Alkaline liquids at ratio 1:2. Sodium hydroxide flakes(97%) purity and Sodium Silicate(8.5%) of sodium oxide are used in present study.

Methodology:-
Preparation of Alkaline solution:-
8 and 10 molarity of Sodium Hydroxide are prepared.Sodium hydroxide has a molecular weight of 40.To prepare 8 and 10 molar of Sodium Hydroxide solution 320 gms and 400gms of flakes are dissolved in distilled water to form 1 liter solution. To prepare solution a conical flask is taken and sodium hydroxide flakes are mixed within the water to prepare 1 liter of sodium hydroxide solution
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Mix design:-
We adopted a trail mix design for this experiment. Assume unit weight of Geopolymer concrete is 2400 kg/m^3.75 % of its composition is comprised with aggregates. In that 75% only 70% is comprised with coarse aggregate and 30% with fine aggregate. Liquid to GGBS ratio is 0.45. Sodium hydroxide & Sodium Silicate solutions are taken in ratio 1:2. Below table illustrates composition for 1m^3 of Geopolymer concrete.

Table 4 Proportions of mix for 1 m^3

Coarse aggregate	1260 kg/m^3
Fine aggregate	540 kg/m^3
GGBS	413.8 kg/m^3
Sodium hydroxide	62.1 kg/m^3
Sodium Silicate	124.2 kg/m^3

Mixing, Casting, Curing:-
Cubes of size 150x150x150 mm and Beams of size 500x100x100 mm are used for this study. Geopolymer Concrete was prepared in a tray and its raw materials are weighed. First coarse and fine aggregates, GGBS are mixed for 5 to 10 minutes in dry condition later alkaline solution is added and fused for 6 minutes. After compaction on vibrating table entire mould is left for 2 days and then it is demould. Ambient curing technique is followed and cured for 7 and 28 days. After curing Compression and Flexural strength are found out.

3. RESULT

8 Molarity of Sodium hydroxide:-

Compressive strength for 7 and 28 days curing

Sample No	7 days(N/mm^2)	28 days(N/mm^2)
1	23.11	25.28
2	21.77	24.85
3	20.88	24.85
Average	21.92	25

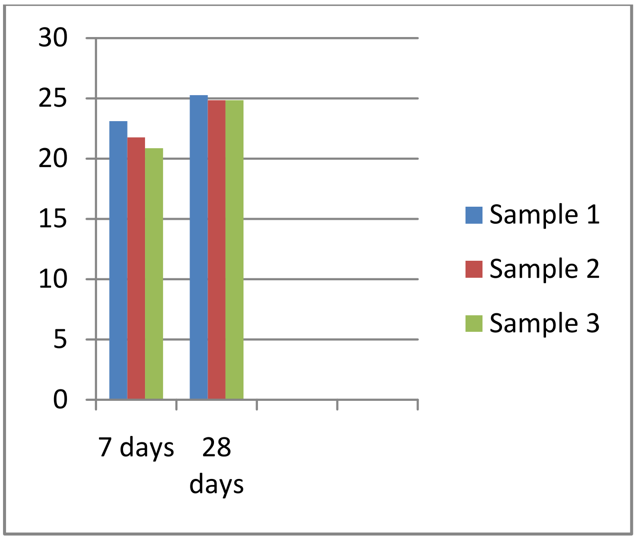

Fig 1: Compressive strength comparison for three samples of 7days and 28 days cured cubes

Flexural strength for 7 and 28 days curing

Sample No	7 days(N/mm^2)	28 days(N/mm^2)
1	5.395	6.687
2	4.905	7.848
3	4.905	7.35
Average	5.06	7.29

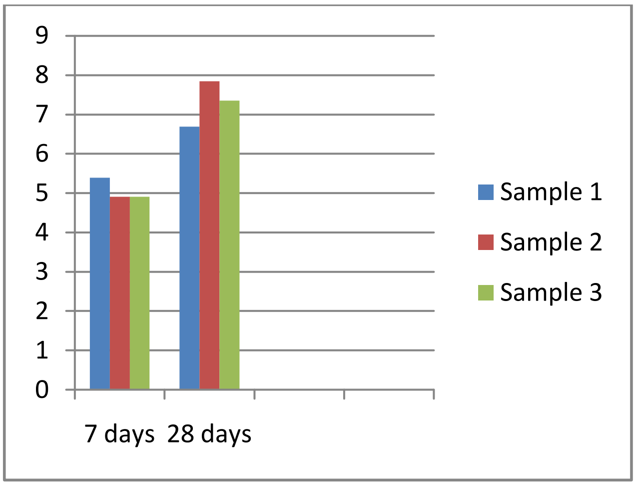

Fig 2: Flexural strength comparison for three samples of 7days and 28 days cured cubes

10 Molarity of Sodium hydroxide:-

Compressive strength for 7 and 28 days curing

Sample No	7 days(N/mm^2)	28 days(N/mm^2)
1	28.77	33.13
2	29.21	35.31
3	28.34	36.62
Average	28.77	35.02

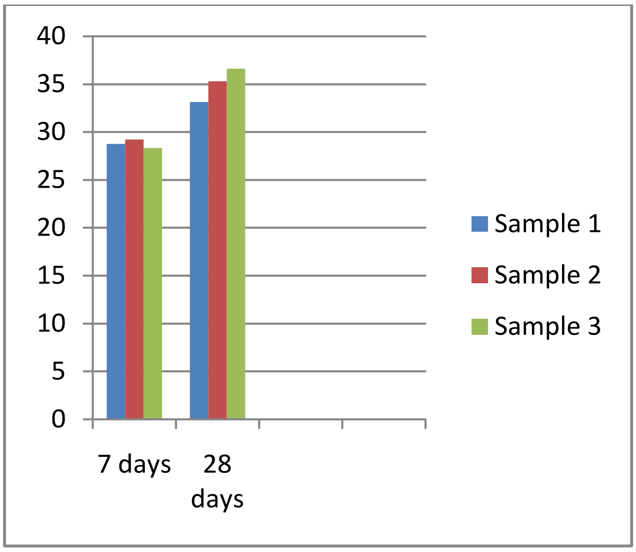

Fig 3: Compressive strength comparison for three samples of 7days and 28 days cured cubes

Flexural strength for 7 and 28 days curing

Sample no	7days(N/mm^2)	28days(N/mm^2)
1	10.79	12.75
2	10.79	10.79
3	9.81	9.81
AVG	10.46	11.11

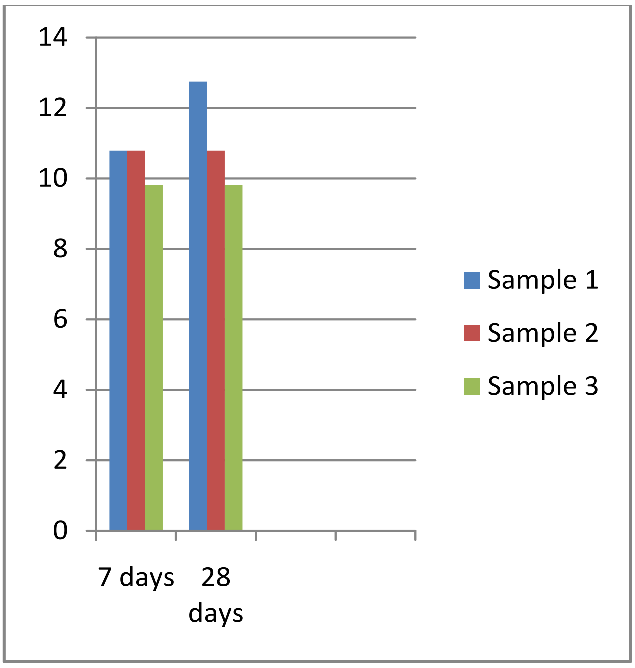

Fig 4: Flexural strength comparison for three samples of 7days and 28 days cured cubes

CONCLUSION

From the above results compressive strength and flexural strength are increased when molarity of sodium hydroxide is increased in solution.

Curing for 7 days compressive strength reaches to 80 % of its strength.

For 7days and 28 days of curing flexural strength values looked alike in some cases.

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