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Replacement of concrete by geopolymer concrete by using fly ash and GGBS

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Abstract : Concrete is the most important aspect in present scenario. All the construction is being done with the help of this binding material. Use of cement is rising on the peak from the last few decades due to enormous demand of construction of mega structures. In addition to that cement is the only material whose demand is increasing day by day in order to meet the needs of mankind. Subsequently the price of cement is also increasing as its demand is increasing profoundly and also it available limited only. Manufacturing of cement results in emission of CO2 and other gases which contribute in global warming and which further contribute in climate change and thus it is one of the most complicated material. Its use cannot stopped but can be limited by using various materials. This paper deals with replacing of cement by fly ash and GGBS. Experiments were performed on plain concrete and then it was alter with the use of fly ash and GGBS. After that analysis were done to compare the result for the conventional concrete and geopolymer concrete . Compressive strength , acid resistance and water absorption tests were carried out after consequent 7, 14, 28 days respectively.

Index Terms: Cement, geopolymer concrete , compressive strength, GGBS, fly ash.

I. INTRODUCTION

Cement is widely used material in the construction of every small structure ranging from a timid construction of a house to a wild and enormous construction of a dam. The demand of cement is rising day by day because of globalisation and to fulfil the needs of human. This demand is resulting in the emission of CO_2 and other harmful gases in the atmosphere. The manufacturing of cement is responsible for 6-7% of all harmful gasses emission such as CO_2,etc which results in global warming and further added to climate change. Apart from greenhouse gases CO2 contributes 70-72% of global warming. The reason for such high emission is that the production of 1 tonn of cement results in production of approximately one tonn of CO2 in the atmosphere[1]. The one and only solution is to find and use other substitute of cementwhich causes less pollution and can be eqvivalent to cement. There are various substitues available in market but are used very rarely such as rice husk, metakaolin, silica fume, flyash, etc [2]. Indeed these materials cannot replace cement completely but Can be used as good alternative to some extent .The best alternate which this paper is all about is the use of geopolymer concrete. This new technology promises for less CO2 emmision , which ultimately helps in reducing global warming. The use of geopolymer concrete will also add on to the strength, durability and resistance to acid attack on concrete structures. Also the use of geopolymer concrete will be affordable and effective. For an instance, one tonn of flyash can be used to make on an average one tonn of geopolymer concrete.

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Various studies and tests were conducted and it was found that the geopolymer concrete have enormous amount of compressive strength as compared to conventional concrete[3]. This paper's objective is to determine the various other properties of geopolymer concrete with the conventional concrete.According to well knownreasercher, Jaarsveld et al. (2003), he revealed that the use of calcium plays a very crucial role in compressive strength. Higher the calcium higher will be the strength.

II.EXPERIMENTAL STUDY

2.1 Material used

1. GGBS – Ground granulated blast furnance slag is used as replacement for cement in this geopolymer concrete. The specific gravity of this material used was 2.88.

2. Flyash – This material was waste product and hence it was easily available in industries. The specific gravity of this material was 2.22.

3. Fine aggragates – The aggreagtes which passes through sieve number 4 (4.75mm) is known as fine aggregates. We have used sand and some crashed stones as fine aggregates.

- specific gravity of fine aggragates was 2.6

-water absorption for fine aggregates is 1%

-fineness modulous for fine aggregates is 2.6%

4. Coarse aggregates – The coarse aggregates are those which retain on sieve greater than 4.75mm sieve.

-specific gravity for coarse aggregate is 2.67

-average abrasion value of aggregate sample is 15.82%

- average crushing value of aggregate sample is 19.81%

5. plasticiser- In order to increase the workability naphthalene based plasticizer was used in the mixture.

2.2 Mix design

Various studies were conducted and the manufacturing of geoplymer concrete was already been published in various publications. Based on these studies only mix propotions were formulated.

The mix propostionsfor geopolymer concrete is given below:-

S No.	Material used	Weight Kg/m3
1.	20mm coarse aggregate	775
2.	10mm coarse aggregate	512
3.	Fine agrregate	560
4.	Fly ash	102.2

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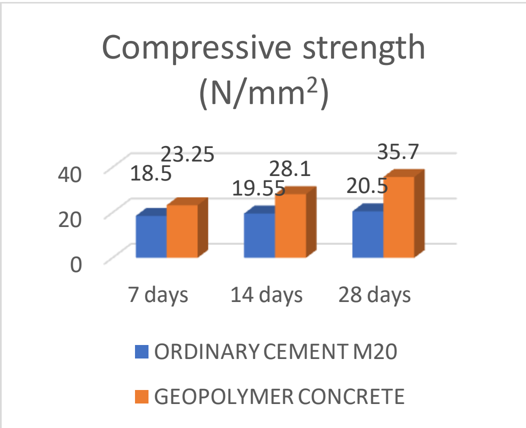
5.	GGBS	308
6.	Plasticiser	25
7.	Water	50

III.TEST RESULTS

3.1 Compressive strength

The compressive strength of any material is described as the point or the strength at which the material fails and breaks. In this analysis, the cubes were tested to determine the compressive strength of the cube specimen with the machine having capacity of 2000KN and the load is applied unless and until we get the value at which the specimen failed. The value is put up in given formula-

$$f_c = \frac{\text{failure load}}{\text{cross sectional area}}$$



3.2 Flexural strength

It is defined as the modulous of rupture f_b which is measured on the center line of tensile side of the specimen. The formula is -

$$f_b = \frac{pl}{bd^2}$$

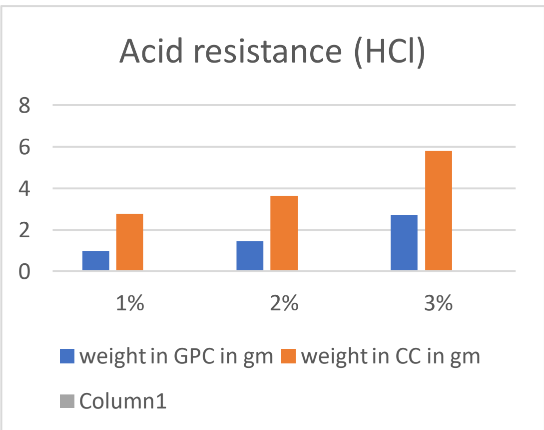
where,

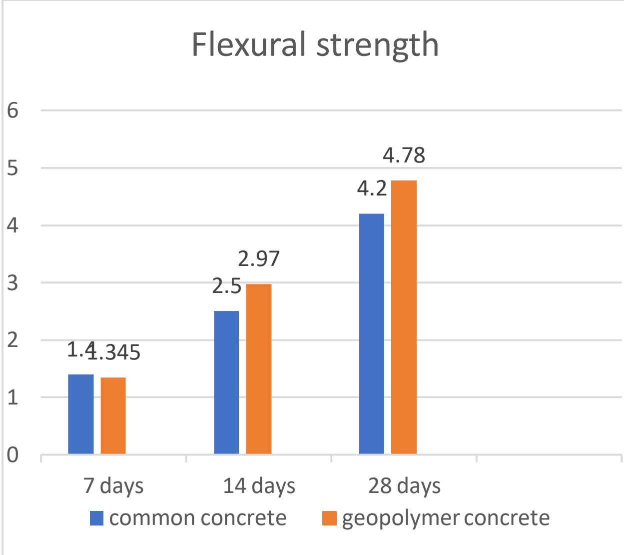
b = width of specimen in cm

d = depth of specimen in cm

l = length of span on which specimen was supported

p = maximum load in kg applied to the specimen





3.3 Acid exposure of the specimen

3.3.1 Exposure of the specimen to hydrochloric acid (HCl)

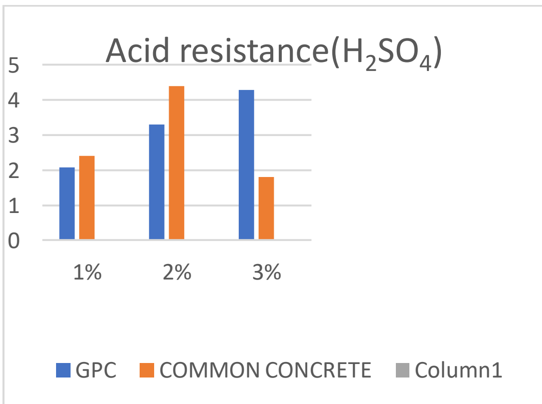
1% of HCl was used in order to measure the exposure of specimen to acids. 1% of concentration of HCl was advised to used in sewer concrete structures. Concrete cubes of 15 X 15 X 15 cm samples were immersed in 1% of HCl acid for 7, 14, 28 days and the samples were analysed in order to know about detoriation, measuring mass change and testing bearing load capacity in compression.

The given graph shows the compressive strength of geopolymer concrete and common concrete -

3.3.2Exposure of the specimen to sulphate acid (Na_2SO_4)

In this, 1% of sulphate acid was used on cubes of dimension 15 X15X15cm and they again were tested with 7, 14,28 days.

The compressive strength of cube specimen with sulphate acid given as-



IV.CONCLUSIONS

1. The slump value of geopolymer concrete is similar to that of M20 grade of concrete.
2. The compressive strength of geopolymer concrete after 7 days, 14days, 28 days are given below-

Days	Compressive strength (N/mm^2)
7 days	6
14 days	10
28 days	14

Fom table, the compressive strength after 7 days of GPC was 34% more than that of conventional concrete.

The compressive strength after 14 days of GPC was 38% more than that of conventional concrete.

The compressive strength after 28 days of GPC was 50% more than that of conventional concrete.

3. The compressive strength was 0.7% when 1% H_2SO_4 was used .
4. The compressive strength was 1.2% when 3% H_2SO4 was used.
5. The compressive strength was 2.4% when 5% H2SO4 was used.
6. The water absorption of GPC specimen was 5% less when acompared with conventional concrete.

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