Laboratory investigation on the strength characteristics of Geopolymer concrete

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Abstract: - *In the present situation of construction sector and society, there is a need to find the alternative method to manufacture the concrete because the production of concrete becoming expensive due to the scarcity of naturally available ingredients of Concrete and raw materials of cement. Utilizing industrial waste and by-product as an ingredient in a production of concrete can be a solution to overcome this problem and also will help to decrease the impact of these waste materials on the environment. In this investigation durability and strength characteristics of geopolymer concrete are studied by using the major industrial waste. In this work, fly ash is replaced with 0% 5%, 10%, 15% and 20% Glass powder in producing Geopolymer concrete. Compressive strength test of geopolymer concrete is carried out for 7 and 28 days period. The materials to be used for this study are fly ash, glass powder; fine aggregate, coarse aggregate, Sodium Hydroxide solution (as an alkaline activator).*

Key Words: Fly ash, Glass powder; Fine aggregate, Coarse aggregate, Sodium Hydroxide solution, Compressive strength test, Split tensile strength test, flexural strength test.

INTRODUCTION

In the last ten years construction activities in India took a huge boost due to improving the economy and rising population. We are a second largest populated country in the world and it is estimated to become a largest around 2050.

To satisfy the need of the ever-increasing population and to compete with other emerging economies in the world it is very important to improve our infrastructure. Infrastructures like roads, bridges, dams etc require a huge amount of concrete to build, and this requirement for concrete created a scarcity of natural resources which are used as ingredients in the manufacture of concrete and this scarcity of ingredients making concrete expensive day by day.

One of the main ingredients of concrete is cement and these cement manufacturing factories are playing a significant role in emitting CO2 into the atmosphere

GEOPOLYMER CONCRETE

Geopolymer is an inorganic polymer with a structural backbone of poly-silicate or polysilicon-oxoaluminates. Different properties of alumina silicate solids and alkali activating solutions have been used which were cured at a temperature higher than 50 degree Celsius to produce geopolymer products. Studies on materials containing alumina silicate such as blast furnace slag, fly ash, clay materials etc. proved that geopolymers possess excellent mechanical properties.

OBJECTIVE OF THE STUDY

1. To find out the properties of the materials and the suitability of non-conventional method of producing concrete without using conventional Ordinary Portland cement
2. To investigate the outcome of varying glass powder on the compression strength of geopolymer concrete prepared using trial mix design and obtaining the optimum mix of glass powder
3. To study the characteristics of variation of GGBS in the GPC produced using obtained optimum mix design.
4. To determine the strength properties of concrete for seven and twenty-eight days after curing under room temperature.
5. To find out the water absorption of geopolymer concrete

1. MIX DESIGN

Table-1 Mix proportion

Mix	Fly ash (kg/m^3)	F.A (kg/m^3)	C.A (kg/m^3)	Water ($lit./m^3$)
480.33	720.49	1104.76	144.09	480.33

Weight of **12 Molar NaOH Solution** 69.16Kg per cubic meter

Table-2 Types of Mixes

Type of Mixes	Description
GP_0	Glass powder replacement 0%
GP_5	Glass powder replacement 5%
GP_{10}	Glass powder replacement 10%
GP_{15}	Glass powder replacement 15%
GP_{20}	Glass powder replacement 20%

TESTING OF CONCRETE CUBES

Compressive strength test

- Test was carried on a cubical specimen having size 150 ×150 ×150 mm.
- The compressive test is conducted on cubes of curing period 7 and 28 days.

Split tensile strength test

- Test was carried on a cylindrical specimen of size 150 mm long and 300 mm dia.
- The compressive test is conducted on cubes of curing period 7 and 28 days.

Flexural strength test

- Test was carried on a beam specimen of size 150 ×150 ×750 mm.
- The flexural strength test is conducted on beams of curing period 7 and 28 days.

Water absorption test

- Test was carried on a cube specimen of size 150 ×150 ×150 mm.
- The test specimens were oven dried at 100 ^{0}C to evaluate the water absorption.

RESULT

Following results are obtained for compressive strength of Concrete cubes.

Table-3 7 and 28 days Compression Strength of Geopolymer concrete using a Glass

Type of mix	7 Days strength (N/mm²)	28 Days strength (N/mm²)
GP_0	5.33	21.55
GP_5	7.77	23.33
GP_{10}	5.33	16.00
GP_{15}	4.0	15.55
GP_{20}	4.0	14.89

Table-4 7 and 28 days Compression Strength of Geopolymer concrete using a GGBS

Type of mix	7 Days Strength (N/mm²)	28 Days Strength (N/mm²)
GB_5	6.45	18.22
GB_{10}	11.34	22.00
GB_{15}	10.00	28.00
GB_{20}	11.55	18.67

Following results are obtained for Split tensile strength of Concrete cylinder.

Table-5 7 and 28 days split tensile Strength of Geopolymer concrete

Mix types	7 Days Strength (N/mm²)	28 Days Strength (N/mm²)
GB_5	1.41	2.26
GB_{10}	1.34	2.89
GB_{15}	1.62	3.11
GB_{20}	2.26	2.55

Following results are obtained for flexural strength of Concrete beam specimen.

Table-6 7 and 28 days split tensile Strength of Geopolymer concrete

Type of mix	7 Days Strength (N/mm²)	28 Days Strength (N/mm²)
GB_0	2.66	3.54
GB_5	2.51	3.73
GB_{10}	2.82	3.79
GB_{15}	2.95	3.88
GB_{20}	3.08	3.66

Following results are obtained for Water absorption test.

Table-6 Water absorption of geopolymer concrete after 28 days

Type of mix	Water Absorption (%)	Density (KN/m³)
GP_0	11.56	23.13
GP_5	12.50	24.27
GP_{10}	12.17	23.91
GP_{15}	12.03	22.92
GP_{20}	11.89	22.59
GB_5	12.57	24.43
GB_{10}	12.31	23.78
GB_{15}	11.97	24.05
GB_{20}	12.46	24.17

CONCLUSIONS

1. This investigation showed that GP_5 has attained the maximum compressive strength for both 7 and 28 days. Hence up to 5% replacement of glass powder with fly ash is acceptable.

2. The compression test results showed increase in compression strength of the concrete sample as the curing period increases as the glass powder is added to geopolymer concrete sample up to 5 percentage glass powder only.

3. From the investigation, it is found that 15% GGBS has attained the maximum compressive strength for 28.

4. From the investigation, it is found that $GGBS_{15}$ has attained the maximum Split tensile strength for 28 days. Hence up to 15% replacement of GGBS with fly ash is acceptable.

5. From the investigation, it is found that $GGBS_{15}$ has attained the maximum bending strength for 28 days. Hence up to 15% replacement of GGBS with fly ash is acceptable.

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