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Research Paper

TO STUDY THE PROPERTIES OF GEOPOLYMER CONCRETE USING GGBS

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ABSTRACT

In this project the experimental investigation is done on geopolymer concrete. The project aim is to use GGBS in place of OPC and compare its properties with the normal concrete. In this project GGBS, sodium hydroxide, sodium silicate, coarse sand and coarse aggregate are used as the ingredient. The GGBS react with sodium hydroxide and sodium silicate to form calcium silicate. Thus calcium silicate act as binder and bind the coarse sand and coarse aggregate. When calcium silicate is formed the heat is evolved as the reaction is exothermic. So initial heat is not required to start the polymerization process.

INTRODUCTION

In the production of cement the limestone and clay is heated to a high temperature of 1500 ˚C in a kiln then these material fused and form clinker which further crushed to form cement. Thus this process is very costly and emit large amount of fly ash and carbon dioxide to the environment. Thus in geopolymer concrete the use of GGBS as the binder replaces the cement thus it is a key for the sustainable development.

In the manufacture of pig iron the haematite and limestone are heated then limestone break and form quick lime with the liberation of carbon dioxide .Thus this quick lime react with impurities sand form slag which is known as GGBS.

Geopolymer concretes which are ideal for building and repairing infrastructures and for casting units, because they attain high early strength and their setting times can be controlled by adding superplasticizer.

The geopolymer can attain high early strength, and have low shrinkage, freeze-thaw resistance, sulphate resistance and corrosion resistance.

EXPERIMENT PROGRAMME

In this experiment the GGBS is used as the binder in place of cement in concrete. The GGBS react with the bases and form calcium silicate which act as the binder to the coarse sand and coarse aggregate.

The variation in the amount of sodium hydroxide and sodium silicate is done in concrete and their effect on compressive strength and tensile strength is noted down.

The manufacture of geopolymer concrete is carried out using the usual concrete technology methods as in the case of OPC concrete in Concrete laboratory of Integral University, Lucknow.

MATERIAL USED

Ground-granulated blast-furnace slag is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Ground Granulated Blastfurnace slag (GGBS) is a by-product for manufacture of pigiron and obtained through rapid cooling by water or quenching molten slag. Here the molten slag is produced which is instantaneously tapped and quenched by water. This rapid quenching of molten slag facilitates formation of "Granulated slag".

If slag is properly processed then it develops hydraulic property and it can effectively be used as a pozzolanic material. However, if slag is slowly air cooled then it is hydraulically inert and such crystallized slag cannot be used as pozzolanic material. GGBS essentially consists of silicates and alumino silicates of calcium and other bases that is developed in a molten condition simultaneously with iron in a blast furnace. The chemical composition of oxides in GGBS is similar to that of Portland cement but the proportion varies.

Coarse sand

The most common constituent of sand is silica, usually in the form of quartz, which is chemical inert and hard. Hence used as a coarse sand in concrete.

Coarse aggregate

The coarse aggregate are used are crushed stone ranging from 10mm to 20mm.Thus it is necessary to do the sieve analysis. Sodium hydroxide and Sodium silicate are commercially available in market in pellets form.

Mixture proportion

The volume of concrete is given in tabular form for 3 cubes= .0101 cubic meter.

Geopolymer concrete using G.G.B.S

NaOH	Sodium Silicate	G.G.B.S	coarse sand	Agg 10 mm	Agg 20 mm	molarity
337 gm	1 kg	6.5kg	7.76	6.68kg	10kg	8M
405gm	1 kg	6.5kg	7.76	6.68kg	10kg	10 M
480gm	1 kg	6.5kg	7.76	6.68kg	10kg	12M
560gm	1 kg	6.5kg	7.76	6.68kg	10kg	14 M

Casting of concrete

In the laboratory GGBS, coarse sand and coarse are mixed in a concrete mixer and then dry mixing is done for three minutes and then sodium hydroxide and sodium silicate are added to the mixture. The mixing is done till homogenous slurry is formed. Then mixture is taken to a pan where slump is measured.

OBSERVATION AND RESULT

Slump

The results indicate that the value of slump will remain constant on varying the molarity of geopolymer concrete and thus collapse slump is formed.

Slump = 19.4 cm

Compressive Strength

Compressive strength test was performed according to ASTM C 39.Cubes of specimen of size 150 mm x 150 mm x 150 mm were prepared for each mix. After 24 hours the specimens were de molded and cured in water for 28 days until testing. For specimens with uneven surfaces, capping was used to minimize the effect of stress concentration. The compressive strength reported is the average of three results obtained from three identical cube.

Variation in the molarity of NaOH				
	8M	**10M**	**12M**	**14M**
Comp. Strength (Mpa)	22.68	29.47	31.64	50.06
	20.03	29.57	33.92	46.69
	25.15	30.22	34.6	53.94
Mean value (Mpa)	22.62	29.75	33.38	50.23

Split Tensile Test

PROCEDURE

- Take the wet specimen from water after 7 days of curing
- Wipe out water from the surface of specimen
- Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
- Note the weight and dimension of the specimen.
- Set the compression testing machine for the required range.
- Keep are plywood strip on the lower plate and place the specimen.
- Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate.
- Place the other plywood strip above the specimen.
- Bring down the upper plate to touch the plywood strip.
- Apply the load continuously without shock at a rate of approximately 14-21kg/cm2/minute (Which corresponds to a total load of 9900kg/minute to 14850kg/minute)
- Note down the breaking load(P)

SPLIT TENSILE STRENGTH

T = 2P/ pi DL

Tensile strength of geopolymer concrete with G.G.B.S

There is variation in tensile strength of geopolymer concrete on varying the molarity of sodium hydroxide and sodium silicate solution. The variation in tensile strength are given in a tabular form

Variation in the molarity of NaOH				
	8M	**10M**	**12M**	**14M**
Tensile Strength (Mpa)	1.92	2.54	2.93	3.68
	1.79	2.65	3.08	3.32
	2.34	2.44	3.15	3.47
Mean value (Mpa)	2.01	2.54	3.05	3.49

SUMMARY

1. The increase in the content of bases increase both compressive as well as tensile strength.
2. The setting time is very short so it is necessary to add superplasticizer to delay the setting time.
3. The bases are very harmful they can cause blindness.

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