Geopolymer Concrete By Using Flyash GGBS As A Replacement of Cement

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Abstract- *Concrete has occupied an important place in construction industry in the past few decades and it is used widely in all types of constructions ranging from small buildings to large infrastructural dams or reservoirs. Cement is major ingredient of concrete. The cost of cement is increasing day by day due to its limited availability and large demand. At the same time the global warming is increasing day by day. Manufacturing of cement also releases carbon dioxide. In the present study an attempt been made on concrete and also an experimental investigation on the concrete using by replacing cement with FLYASH and GGBS to decrease the usage of cement as well as emission of concrete.*

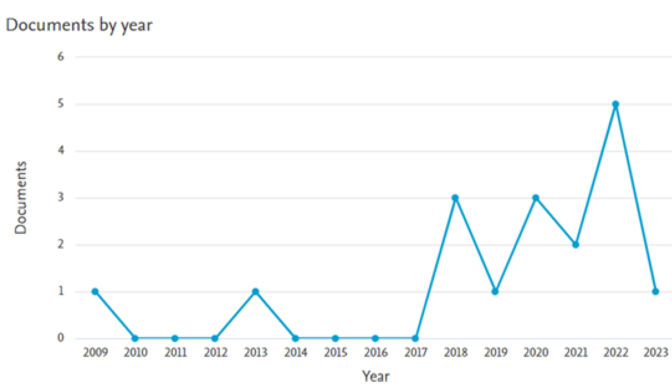
Experimental studies were performed on plain cement concrete and replacement of cement with Fly ash is done. In this study the concrete mix were prepared by using fly ash, sodium silicate, sodium hydroxide. A comparative analysis has been carried out for concrete to the Geopolymer concrete in relation to their compressive strength, split tension strength, acid resistance and water absorption. The concrete made with fly ash performed well in terms of compressive strength, split tension strength acid resistance and water absorption showed higher performance at the age of 7,14,28 days than conventional concrete. And also two different types of acid attack is done to determine the and compressive strength both on conventional concrete and geo polymeric concrete.

Keywords- Geopolymer, Compressive strength, Flexural strength, Split Tensile strength, Acid Attack, alkaline.

I. SELF-COMPACTING GEO POLYMER CONCRETE

Rangan*et al.* (2008) conducted various studies on silent features that effects workability, durability and compressive strength of fly ash-based geopolymer concrete. The addition of naphthalene based super plasticizer byup to 4% of fly ash by mass increases the workability and a slight degradation of compressive strength can be seen after an increase in SP dosage by 2%. Slump value also increases as the water content increase. The study also concludes that higher compressive strengths can be achieved by higher concentration of sodium hydroxide solution in terms of molar concentration and also by higher ratio of sodium hydroxide to sodium silicate by mass and also they stressed on the curing temperature that as the curing temperature increases from 300C to 900C the strength also increases but the strength increase from 700C is not that significant and also curing hours place a very important role, as the curing hours increases from 4hours to 96hours the strength also increases but after 48hours the strength increase is not that significant. An increase in water to Na2O ratio and water to geopolymer solid ratio decreases the compressive strength. However, thermally cured geopolymer concrete showed very little gain in strength with time. As nippetof the key literature discussing the properties influencing the development of geopolymer is given as follows:

Figure2.4,2.5 and 2.6 shows the number of documents and their respective types and subject area which were published under the umbrella term of self-compacting geo polymer concrete.



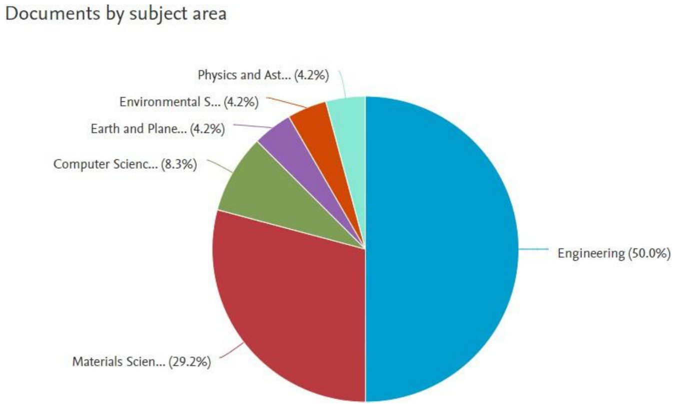


Figure2.6 Documents by subjectarea–Self compacting geopolymerconcrete

Douglas E., *et al.* (1990) experimentally examined the creationof compressive strength of alkali-activated soil-activated blast furnace slag concrete. We used sodium silicate as an activator and removed OPC entirely. The mixture's fluid-to-binding ratio was 0.34 to 0.50. Concrete compressive strengths ranged from 20.4 to 38.9 MPa and from 45.5 to 59.6 MPa for 1 and 28 days, respectively. The bending strengths of 7 and 14 days were in the range of 5 MPa.

In the development of geopolymer concrete, alkaline activators are important to Wang, *et al.*., (1994) to identify the most important factors that affect the strength production of alkali-activated slag, including form of alkaline activator, method to add an activator, dosage of alkaline, type and fineness of slag,ratio of SiO2 to Na2O (Modulus, MS) when using water.

Fig4.1,4.2 working pic so fgpc

Curing of GPC

Normally there were three types of curing are available for manufacture of GPC .they are HEAT, WAPOUR,AMBENT curing. But as per the availability and local conditions I have used HEAT curing for the manufacturing ofGPC.

In the heat curing the specimen was put into a woven and left it for 24 hoursat a temperature of 60 degree C After 24 hours the mould was taken out and the cube was made separated from mould. From now onwards up to the testing day it will not need any type of curing.

II. EXPERIMENTAL TESTS

SLUMP CONE TEST:

This test is used extensively in site all over the world. The slump test does not measure the workability of concrete, but the test is very useful in detecting variations in the uniformity of a mix of given nominal proportions.
The slump test is done as prescribed by IS:516.
The apparatus for conducting the slump test essential consists of a metallic mould in the form of a cone having the internal dimensions as under

Bottom diameter: 200mm
Top diameter :100mm

The mould for slump is a frustum of a cone, 300 mm high. It is placed on a smooth surface with the smaller opening at the top, and filled with concrete in three layers. Each layer is tamped twenty five times with a standard 16 mm diameter steel rod, rounded at the end, and the top surface is strucked off by means of sawing and rolling motion of the tamping rod. The mould must be firmly fixed against its base during the entire operation; this is facilitated by handles or foot-rests brazed to the mould. Immediately after filling, the cone is slowly lifted vertically up, and the un supported concrete will now slump–hence the name of the test. The difference in level between the height of the mould and that of highest point of subsided concrete is measured. This difference in height in mm is taken as slump of concrete.

COMPRESSION TEST:

Compression test was conducted on 150mm×150mm×150mm cubes. Concrete specimens were removed from curing tank and cleaned. In the testing machine, the cube is placed with the cast faces at right angles to that of compressive faces, then load is applied at a constant rate of 1.4 kg/cm2/minute up to failure and the ultimate load is noted. The load is increased until the specimen fails and the maximum load is recorded. The compression tests were carried out at 7,14, 28, days. For strength computation, the average load of three specimens is considered for each mix. The average of three specimens was reported as the cube compressive of strength.

$$\text{Cube compressive strength} = \frac{\text{Load}}{\text{Area of cross section}}$$

Fig4.3 Compressivetest

SPLIT TENSILE STRENGTH

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and iscontinued until failure of the specimen occurs.

Splitting Tensile Strength shall be calculated by using the formula:
P = maximum load in Newtons applied to the specimen,
L=length of the specimen in mm,
D=cross sectional dimension of the specimen in mm.

FLEXURAL STRENGTH

The flexural strength may be expressed as the modulus of rupture fb, which, if "a" equals the distance between the line of fracture and the nearer support, measured on the centre line of tensile side of the specimen, shall be calculated to the nearest 0.5kg/sq.cm as follows:

Where
b=measured width in cm of the specimen d=measured depth in cm of the specimen.
l=length in cm of the span in which the specimen was supported and p=maximum load in kg applied to the specimen.

Fig4.4 Testing of Prism Specimens

DURABILITY TESTS

Acid Exposure

Hydrochloric acid (HCL) of 1% concentration was considered to be representative of aggressive sewer environments and 1% Hydrochloric acid (HCL) solution has been used in many laboratory tests to investigate the acid resistance of concretes for sewer structures. Concrete cube 15 × 15 × 15 cm samples were immersed in 1% Hydrochloric acid solution over 28, 60 and 90 days and the samples were regularly investigated by visual inspection of surface deterioration, measuring mass change and testing load bearing capacity in compression.

Fig4.5 SpecimensofAcidExposure

Sulphate Exposure

In this study, Sodiumsulphate,H_2SO_4 1% by mass of water solution is prepared .The compressive strength of cube specimens with dimensions of 15 × 15 × 15 cm which were prepared by the substitution of quartzite by coarse aggregate by weight were determined after the specimens were kept in 1% H_2SO_4 Sulphate solution. Then, the specimens were placed into sulphate solution and kept there for 28, 60 and 90 days. The specimens were removed from sulphate solution after 28, 60 and 90 days, and then, the compressive strength and mass losses of the specimens were determined.

III. CONCLUSION

1. It is observed that the concrete slump values are equal to the values of cc of M20 grade
2. It is observed that the compressive strength of the GPC was 5 N/mm^2more when it is compared with conventional concrete at 7 days .which was 33% more then cc
3. It is observed that the compressive strength of the GPC was 14N/mm^2more when it is compared with conventional concrete at 28 days. Which was 50% more than ordinary cc
4. It is observed that split tensile strength of GPC was 1.72N more when it is compared with conventional concrete at 7 days.
5. It is observed that the Split tensile strength of GPC 1.12N more when it is compared with conventional concrete at 28 days.

6. It is observed that flexural strength of the GPC was 0.6% more when it is compared with conventional concrete at 28days.
7. It is observed that the flexural strength of GPC was 0.7% when it is compared with conventional concrete at 90 days.
8. During 1%HCL acid attack on GPC the compressive strength was 1.27% when it is compared with conventional concrete at 28 days.
9. During 3%HCL acid attack on GPC the compressive strength was 3.1% when it is compared with conventional concrete at 28 days.
10. During 1%H2SO4acid attack on GPC the compressive strength was 0.7% more when it is compared with conventional concrete at 28 days.
11. During 3%H2SO4acid attack on GPC the compressive strength was 3.5% more when it is compared with conventional concrete at 28 days.
12. It is observed that the WATER absorption of GPC cylindrical specimen was 5% less when compared with conventional concrete at 28 days.