AN INVESTIGATION ON GEOPOLYMER CONCRETE WITH GGBFS AND FLY ASH

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Abstract

The conventional concrete used for construction of large structures releases greenhouse gases leading to ozone layer depletion and global warming. An alternative solution to conventional concrete has been sought by many researchers. Geopolymer concrete is the one in which cement in conventional concrete is replaced by mineral admixtures such as fly ash, GGBFS, metakaolin, silica fumes etc. and chemical solution acting together as a binder. In this paper, geopolymer concrete made using ground granulated blast furnace slag(GGBFS) and fly ash in alkaline solution (sodium silicate and sodium hydroxide) is compared with conventional concrete. The strength parameters investigated are (i) 7 day compressive strength (ii) 28 day compressive strength (iii) 28 day Split tensile strength (iv) 28 day flexural strength. Workability and cost of geopolymer concrete with GGBFS and Fly ash is also investigated. Specific gravity of different materials was found using specific gravity bottle and obtained as;

Table 1 Specific gravity of materials

Material	Specific gravity
Cement	3.15
GGBFS	2.92
Fly Ash	2.45

Workability was examined using slump test and obtained the following result;

Table 2 Slump value and workability of various cases

Cases	Slump value (mm)	Inference
Conventional concrete	30	Medium workability suitablefor RCC work with less reinforcement
100% Fly Ash	70	Medium workability suitablefor RCC work with less reinforcement
100% GGBFS	45	Medium workability suitable for RCC work with less reinforcement

Geopolymer concrete and conventional concrete were cast in the mix ratio 1:1.3:3.1. 7 and 28 days compressive strength, 28 days split tensile strength and 28 days flexural strength were conducted for all the cases.

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Therefore 3 cubes for 7 days and 28 days compressive strength test, 2 cylinders for 28 days split tensile and 1 beam for 28 days are required. There are 9 specimens to be cast for each case. Results were obtained as given below;

Table 3 Compressive, split tensile and flexural strength of various cases

Cases	7 days compressive strength (MPa)	28 days compressive strength (MPa)	28 days split Tensile strength (MPa)	28 days flexural strength (MPa)
Conventional concrete	16.14	16.96	6.47	7.5
100% Fly Ash	13.77	20.22	3.04	3.75
100% GGBFS	37.63	42.81	10.68	11.25

Cost analysis was carried out by obtaining cost of cement, fine aggregate and coarse aggregate (12mm and 20mm) from the Schedule of Rates 2012: Volume 1. The rates of the materials like NaOH, Na_2SiO_3, GGBFS and fly ash etc are obtained from the commercial market. Cost of 1 m^3 of different cases of concrete were obtained as follows;

Table 4 Cost per m^3 of concrete for various cases

Cases	Amount
Conventional concrete	₹ 3453.50
100% Fly Ash	₹ 2991.90
100% GGBFS	₹ 3094.40

Graphical representation of results obtained from specific gravity test, slump test, 7 and 28 days compressive strength test, 28 days split tensile test, 28 days flexural strength and cost analysis are given below;

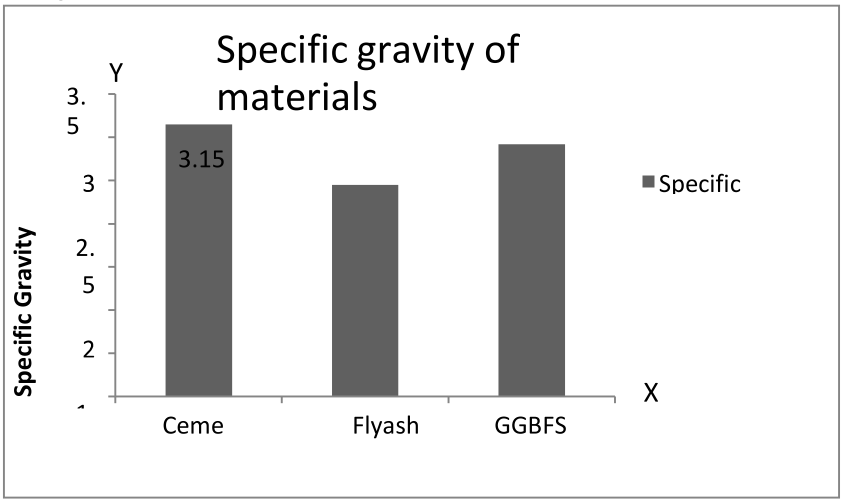

Fig 1 Graph Showing Specific Gravity

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The highest specific gravity was obtained for cement i.e. 3.15 and lowest for fly ash i.e. 2.45.

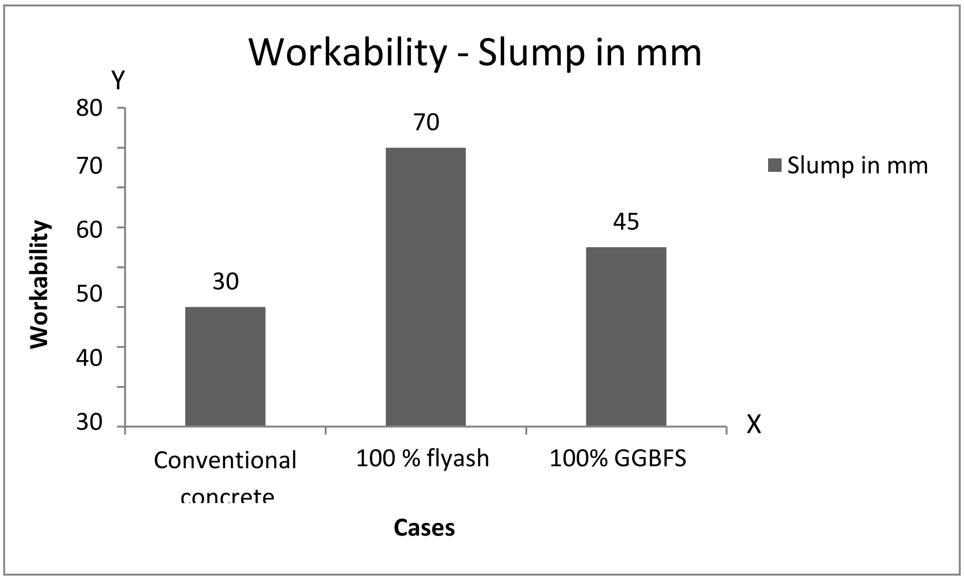

Fig 2 Graph Showing Slump Value

The highest slump value was obtained for 100% fly ash geopolymer concrete i.e. 70 mm and lowestfor conventional concrete i.e. 30 mm.

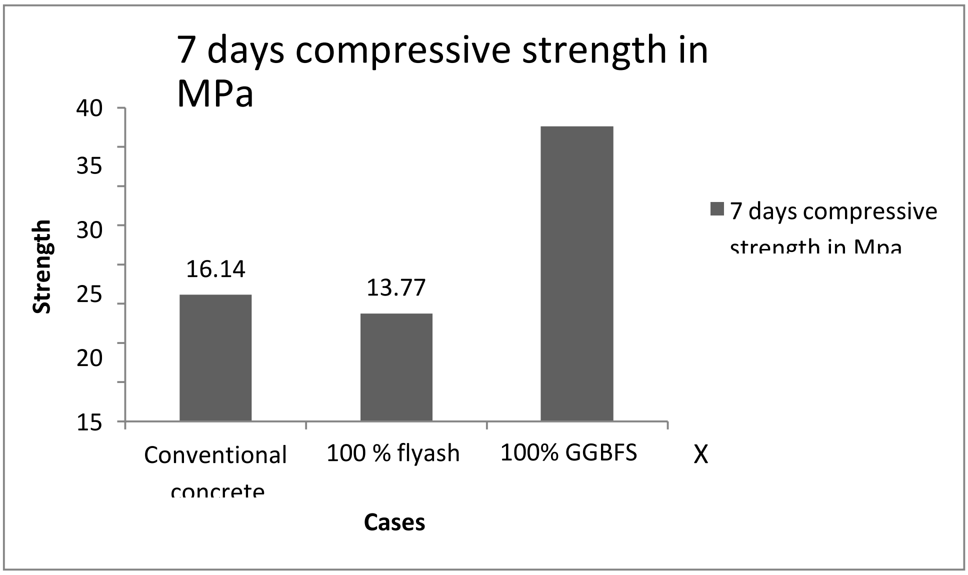

Fig 3 Graph showing 7 days compressive strength in MPa

The highest 7 days compressive strength was obtained for 100% GGBFS geopolymer concrete i.e. 37.63 MPa and lowest for 100% fly ash geopolymer concrete i.e. 13.77 MPa.

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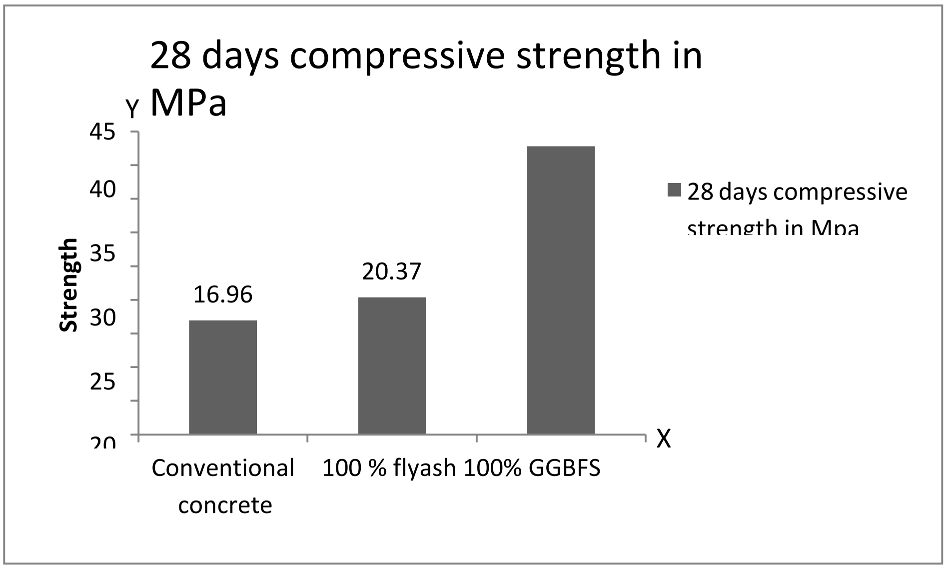

Fig 4 Graph showing 28 days compressive strength in MPa

The highest 28 days compressive strength was obtained for 100% GGBFS geopolymer concrete i.e. 42.81 MPa and lowest for 100% conventional concrete i.e. 16.96 MPa.

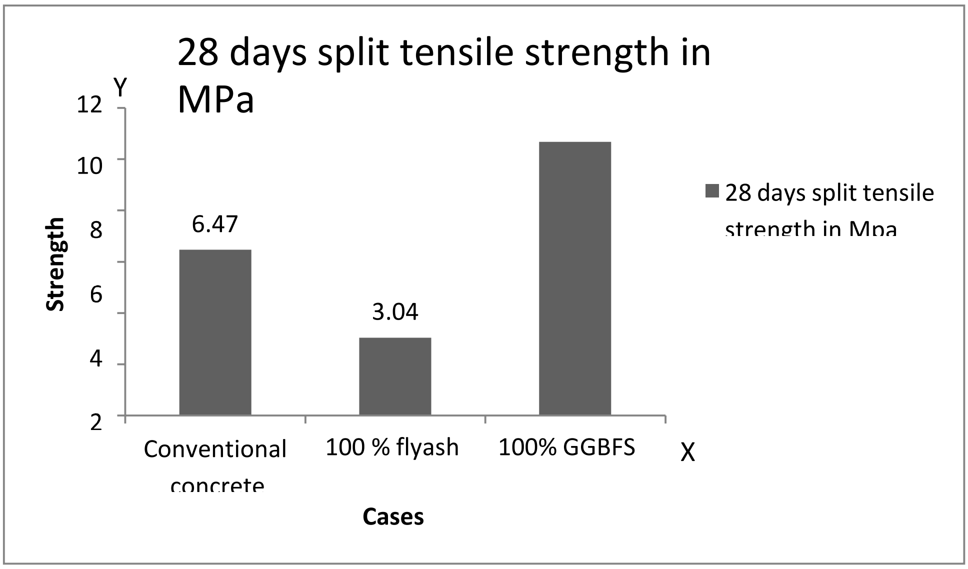

Fig 5 Graph showing 28 days split tensile strength in MPa

The highest 28 days split tensile strength was obtained for 100% GGBFS geopolymer concrete i.e. 10.68 MPa and lowest for 100% fly ash geopolymer concrete i.e. 3.04 MPa.

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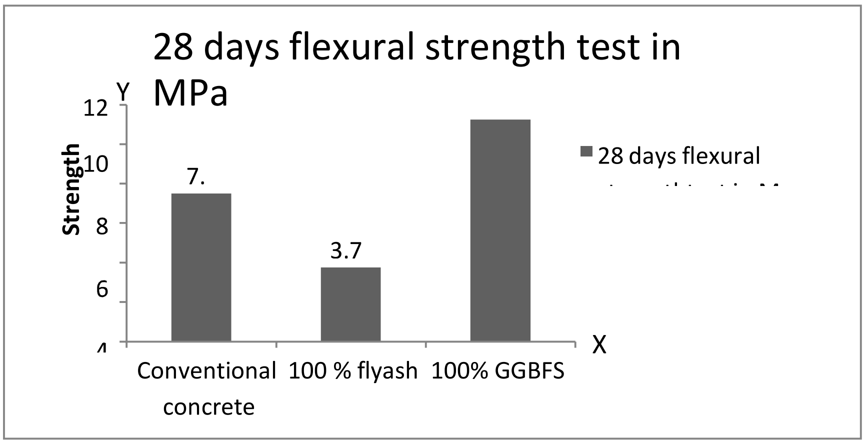

Fig 6 Graph showing 28 days flexural strength in MPa

The highest 28 days flexural strength was obtained for 100% GGBFS geopolymer concrete i.e. 11.25MPa and lowest for 100% fly ash geopolymer concrete i.e. 3.75 MPa

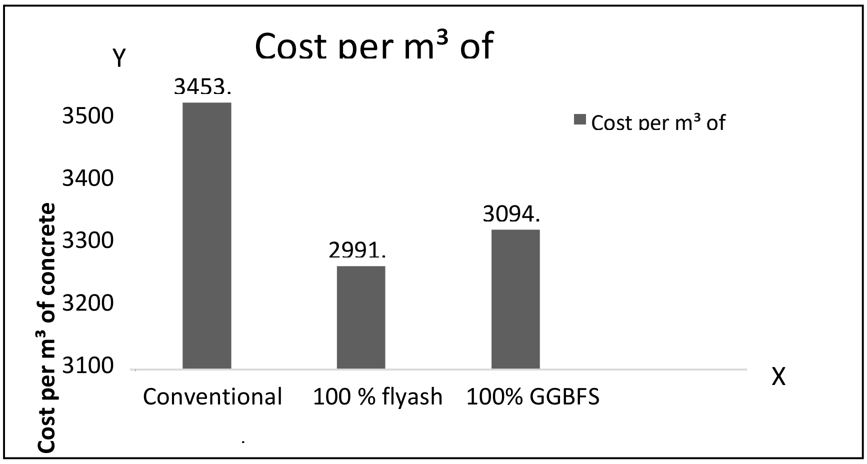

Fig 7 Graph showing cost of concrete per m^3 in rupees

The highest cost per m^3 of concrete was obtained for conventional concrete i.e. ₹ 3453.5 and the lowest for case 2 (100% fly ash) .i.e. ₹ 2991.90.The overall study shows that GGBFS based geopolymer concrete has the highest strength and is more economical than conventional cement concrete. It has medium workability and can be used for many practical applications. This reduces the harmful industrial solid waste released into the environment and promotes sustainable development.

Keywords: Geopolymer Concrete, Ground Granulated Blast Furnace Slag, Fly Ash, Alkaline Solution

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STUDY ON USE OF WASTE GLASS IN PAVEMENT AS AN AGENT FOR SOIL STABILIZATION

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Abstract

The weak soil is largely distributed worldwide and creates problems in constructing pavements, roadways due to low shear strength and bearing capacity. Stabilization is a technique introduced many years ago with the main purpose to render the soils capable of meeting the requirements of the specific engineering projects. Stabilized materials may be used as improved subgrades or capping layers or subbases for Highway or airfield pavements. Various soil stabilization techniques are using but none of them are cost effective and environmentally friendly way. The present study aims to effect of soil stabilization with waste glass powder which will reduce the cost and is environmentally friendly. The main objective of the investigation is to determine the CBR value and compare it with the virgin soil and the optimum percentage of glass was also determined. The California bearing ratio test (CBR), is penetration test which plays a major value for the evaluation of subgrade strength of roads and pavements.

Powdered glass are mixed in the selected soil in varying proportion by dry weight of soils. Glass powder was mixed with the soil samples by 0%, 8% and 12% of dry weight of soil to conduct the tests and to determine the optimum percentage of glass powder. For different combinations of glass and soil the Proctor and CBR tests are conducted and the results are represented in tabular form (Table.1.and Table.2.) and graphical form (Fig.1. and Fig.2.). The Standard Proctor tests were conducted on unstabilized and glass stabilized subgrade soils as per IS 2720 to determine the maximum dry density and optimum moisture content.

Table.1. Effects of glass stabilization on MDD and OMC of subgrade soil

Glass Content (%)	MDD (g/cc)	OMC (%)
0	1.89	12.9
8	1.95	8
12	1.783	4

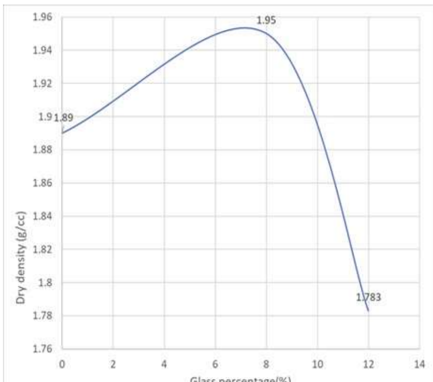

Fig.1.Variation graph between MDD with different percentage of glass powder.

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