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GEO POLYMER CONCRETE

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KEYWORDS: Compressive test, Split Tensile Test, Cost Optimisation.

ABSTRACT

The objective of this research work was to produce a carbon dioxide emission free cementious material. The geopolymer concrete is such a vital and promising one. In this present study the main limitations of fly ash based geopolymer concrete are slow setting of concrete at ambient temperature and the necessity of heat curing are eliminated by addition of Ground Granulated Blast Furnace Slag (GGBS) powder which shows considerable gain in strength. The Alkaline liquids used in this study for the polymerization process are the solutions of sodium hydroxide (NaoH) and sodium silicate (Na2Sio3) solution was taken to prepare the mix.

Concrete is the world‟s most versatile, durable and reliable construction material. Next to water, concrete is the most used material, which required large quantities of Portland Cement. Ordinary Portland Cement production is the second only to the automobile as the major generator of carbon di oxide, which polluted the atmosphere. In addition to that large amount energy was also consumed for the cement production. Hence, it is inevitable to find an alternative material to the existing most expensive, most resource consuming Portland Cement. Geopolymer concrete is an innovative construction material which shall be produced by the chemical action of inorganic molecules. Fly Ash, a by- product of coal obtained from the thermal power plant is plenty available worldwide. Flyash is rich in silica and alumina reacted with alkaline solution produced aluminosilicate gel that acted as the binding material for the concrete. It is an excellent alternative construction material to the existing plain cement concrete. Geopolymer concrete shall be produced without using any amount of ordinary Portland cement.

INTRODUCTION

The concrete industry is the India's second highest payer of Central Excise and Major contributor to GDP. With infrastructure development growing and the housing sector booming, the demand for concrete is also bound to increase. However, the concrete industry is extremely energy intensive. After aluminium and steel, the manufacturing of Portland concrete is the most energy intensive process as it consumes 4GJ per tonne of energy. After thermal power plants and the iron and steel sector, the Indian concrete industry is the third largest user of coal in the country. In 2003-04, 11,400 million kWh of power was consumed by the Indian concrete industry. The concrete industry comprises 130 large concrete plants and more than 300 mini concrete plants. The industry's capacity at the beginning of the year 2008-09 was about 198 million tones. The concrete demand in India is expected to grow at 10% annually in the medium term buoyed by housing, infrastructure and corporate capital expenditures. Considering an expected production and consumption growth of 9 to 10 percent, the demand-supply position of the concrete industry is expected to improve from 2008-09 onwards.

OBJECTIVES

The following objectives are to be achieved:
(a) To collect the materials according to their specifications as per the requirement for design of concrete.
(b)To conduct physical test on the materials on the materials like cement, sand, aggregate , etc.
(c)Designing of the special mix design for the geopolymer concrete.
(d)To conduct the tests on fresh state of geopolymer concrete.
(e)Also to conduct the test on hardened state of geopolymer concrete
(f)Cost optimization for the project will also be achieved which will result in the sustainable development of the environment.

SCOPE OF WORK

The geo polymer concrete results in less emission of carbon dioxide as compared to the conventional concrete so it can be widely used for various construction processes.

MATERIAL

In the present study we used coarse aggregate, fine aggregate, cement, silica flume, polypropylene fibers are used to cast beam, cube, and cylinder. The specimen and properties of these materials are as under

(A)CEMENT

OPC of 43 grade is used for the investigation. The results for cement as obtained from various physical tests are as given. Mostly the tests were performed in procedures described inIS: 8112-2003. Cement is a adhesive in nature, a material that hardened and can be used to bind other material with each other. Cement is usually grey powder before being blended with different materials and water. It is utilized in construction can be characterized as being either hydraulic or non-hydraulic contingent on the capacity of the cement to set in nearness of water

(B) COARSE AGGREGATE

All coarse aggregate must be evaluate intimately and constantly watch and have to be taken in description into organize toward composed concrete of consistent quality. Coarse aggregates utilized during this research are crushed aggregate of range 20 mm and 10mm. Specific gravity of coarse aggregates 2.58 for 20mm and 10 mm aggregates correspondingly Coarse aggregate water absorption value at 24 hours 0.52% and fine aggregate 1.0% respectively. Coarse aggregate 20mm is 50% used and 10mm 50% used

(C) FINE AGGEGATE

Fine aggregate utilized as a part of the study is sand and ratify to zone III. Specific gravity value of fine aggregate used was 2.45

(D)Fly Ash

Fly ash, also known as “pulverized fuel ash” , It is a coal combustion product composed of fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. In modern coal- fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal- bearing rock strata. We will be using Fly ash of class C

(E)GGBS

Ground-granulated blast-furnace slag (GGBS or GGBFS) 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.The glass content of slag‟s suitable for blending with Portland cement typically varies between 90-100% and depends on the cooling method and the temperature at which cooling is initiated. The glass structure of the quenched glass largely depends on the proportions of network-forming elements such as Si and Al over network-modifiers such as Ca, Mg and to a lesser extent Al. Increased amounts of network-modifiers lead to higher degrees of network depolymerization and reactivity.

(F)Admixture

In addition to the main components of concrete like cement, sand, coarse aggregates and water, admixtures are often used to improve concrete performance.we used polycarboxylateether (PCE) as admixture. .

(G)Water

The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and watertightness, durability and weathering, drying shrinkage and potential

for cracking. For these reasons, limiting and controlling the amount of water in concrete is important for both constructability and service life.

REPLACEMENT

We replace cement with
(A)fly ash with a ratio of 35%,70% and 100%.
(B)ggbs with a ratio of 70,85 and 100%. We cast cubes and cylinder as follows:

Sr.no.	specimen	Dimension (mm)	No of specimens	Curing period
1	Cubes	150mm*150mm*150mm	42	7,14,28
2	Cylinder	200mm*100mm	7	28

Cubes150mm*150mm*150mm,Cylinder200mm*100mm, cast out of which 28 cubes each were used to determine the compressive strength and 21 cylinders each were used to determine the split tensile strength of M30 grades of Geopolymer Concrete . All geopolymer concrete were made with mix design procedure using IS 10262-2009.

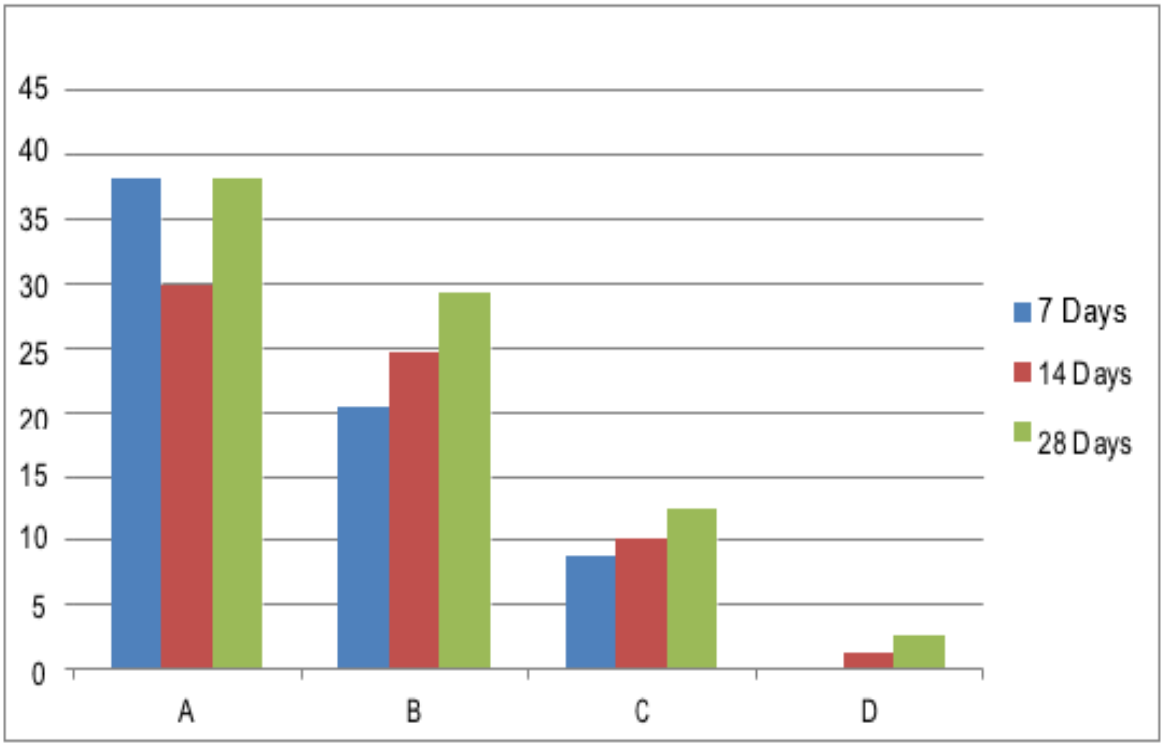
Compressive test

Compressive strength of concrete is defined as the load which causes the failure of the standard specimen. The test of compressive test should be made on 150 mm size cubes. Four specimens are used for compression test for each batch of mix. Two each for 7 days and 28 days compressive strength of concrete. Clean and surface dried specimen were placed in the testing machine the platen was lowered and touch the top surface of the specimen, the load applied gradually and maximum load was recorded.

Compressive test results

Replacemen t of fly ash and GGBS in %	Specime n Name	Mix			Compressive strength N/mm^2			
	-		7 days	Average	14 days	Averag e	28 days	Average
0%-M30	A		22.56	38.1	30.41	29.76	38.22	38.1
			21.29		29.12		37.98	
F-35%-M30	B		20.45	20.38	24.12	24.64	29.38	29.17
		M30	20.29		25.17		28.96	
F-70%-M30	C		8.64	8.65	9.57	10.03	12.68	12.32
			8.66		10.49		11.79	
F-100%-	D		0	0.15	1.36	1.18	3.36	2.54

M30			0.30		1.01		1.54	
G-70%-M30	E		11.85	12.91	18.91	19.51	22.62	22.28
			13.97		20.12		21.95	
G-85%-M30	F		8.69	9.42	10.68	11.19	14.65	15.48
			10.16		11.70		16.32	
G-100%-M30	G		14.64	15.27	22.12	21.92	25.35	26.27
			15.90		21.72		27.19	



Graph 7.3: Compressive strength of fly ash

The above bar chart shows that the standard concrete gives the more strength than geopolymer concrete.

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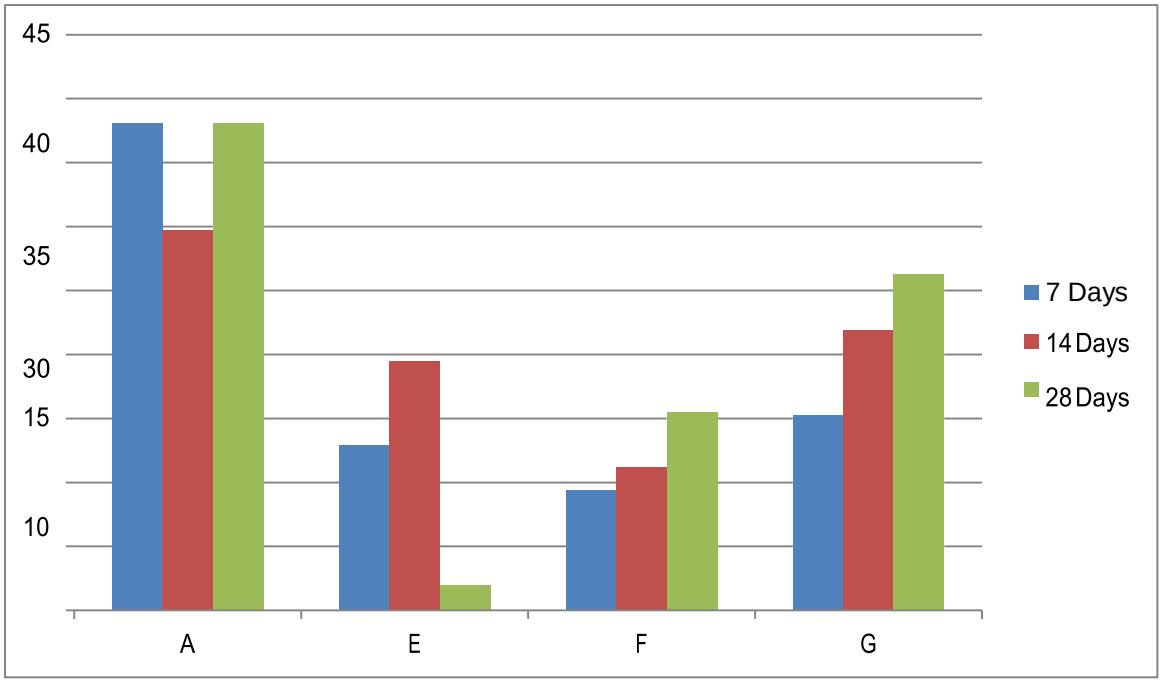


Graph 7.4 :Compressive strength for GGBS

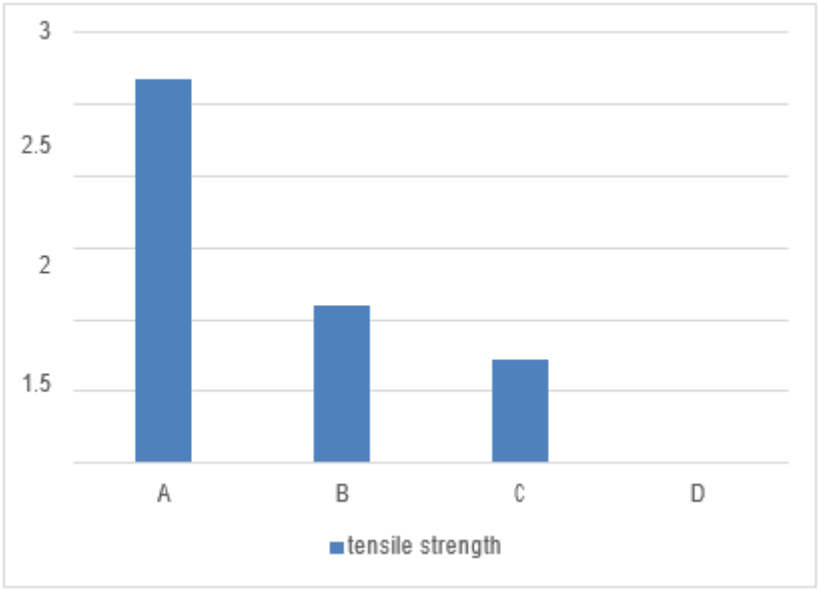
The above bar chart shows that the standard concrete gives more strength but replacement of 100% GGBS gives comparatively more strength than other replacemets specimen.

Split Tensile Test

The concrete is very week in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete member may crack.

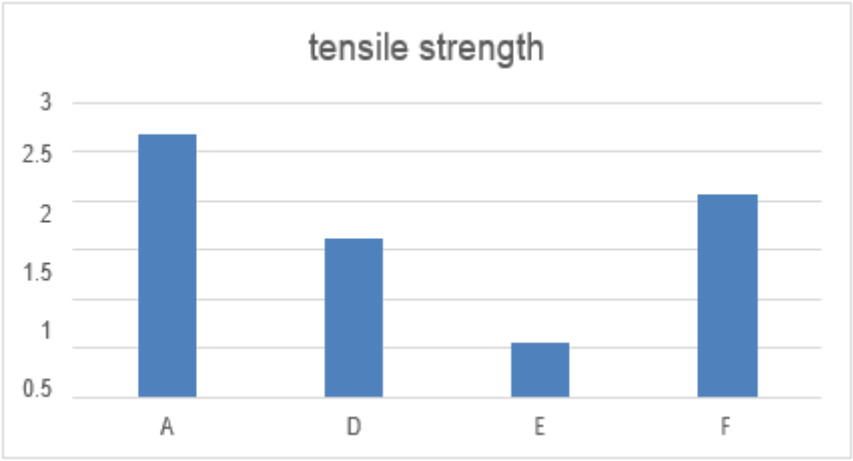
Split tensile test results

Replacement of fly ash and GGBS in %	Specimen Name.	Average load at 28 days(KN)	Split tensile strength at 28 days (N/mm^2)
0%-M30	A	47.35	2.68
F-35%-M30	B	19.43	1.10
F-70%-M30	C	12.72	0.72
F-100%-M30	D	0	0
G-70%-M30	E	28.62	1.62
G-85%-M30	F	9.89	0.56
G-100%-M30	H	36.40	2.06



Graph 7.5: tensile strength for fly ash

The above bar chart shows that the tensile strength of the standard concrete is more then the geopolmer concrete and the 100% replacement of fly ash to cement does not gives any strength



Graph 7.6: Tensile strength for GGB

The above bar chart shows that the tensile strength of the of the standard concrete is more then the geopolymer concrete.

Cost Optimisation

Cost optimization is the continous process of obtaining the best pricing/cost with no impact.Cost optimization refers to the process to optimize the cost of the project to maximize the potential of a budget allocated for the project.

Materials	Cost Evolve in Rs per Kg	
	Normal Concrete	Geopolymer concrete
Cement	7	7
Crushed Sand	2.6	2.6
Coarse Aggregate(10mm)	1.5	1.5
Coarse Aggregate(20mm)	1.8	1.8
Fly-ash(class-c)	-	1.5
GGBS	-	3
Admixtures(PCE)	70	70
Sodium silicate	-	490
Sodium Hydroxide	-	350
Water	1	1
Total	83.9	928.4

CONCLUSION

The reduced CO2 emissions of geopolymer concrete is good alteranative to ordinary Portland cement.Geopolymer concrete produces the substances that is comparable to or better than additional concrete with respect to most properties.Higher concentration of sodium hydroxide and sodium silicate results in higher compressive strength of geopolymer concrete.

1) slump cone of geopolymer concrete is comparable with normal concrete of M30 is quite decent.
2) Geopolymer concrete prepared with GGBS and fly ash of M30 grade, GGBS replacement gives higher strength than the flyash replacement at 28 day and 7 day.
3) Higher percentage replacement of flyash gives Maximum strength up to 70%.
4) GGBS gives Maximum strength at replacement of 100% compared to 70% and 80%
5) We have done the cost comparison.

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