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Green Concrete Using GGBS

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Abstract: **-- A mixture of cement, fine aggregate, coarse aggregate and water is term as Concrete. Concrete is key in the development of infrastructure viz. Buildings, industrial structures, bridges and highways etc. Concrete is most commonly used in all types of construction with an annual production exceeding 2 billion metric tons per year. But the production of raw material of concrete has certain detrimental effects on the environment. Worlds 8% to 10% of total CO2 emission come from the manufacture of cement. Therefore, the main aim of project is to reduced amount of cement by replacing it with GGBS to the optimum level so that energy required for cement production can be saved and during production of cement emission of greenhouse gases like CO2 takes place which leads to air pollution will be minimized with use of GGBS (Ground Granular Blast Furnace Slag). Also, to check compressive strength, Tensile strength and Flexural strength of concrete by replacing cement with different percentage of GGBS.**

***Key words*: Compressive strength, Concrete, CO2, Environment, Flexural strength, GGBS, Tensile strength.**

I. INTRODUCTION

Concrete is closely related to every human being and their day-to-day life. It is widely used as construction material in world, and it is very difficult to find another material of construction as versatile as concrete. Concrete is nothing but artificial stone resulting from the hardening of mixture of cement, sand, coarse aggregates, water and sometimes mineral and chemical admixtures are also added to enhance properties of concrete in fresh and hardened state. For making good or bad concrete it required some materials, hence controlling the properties at every stage of concreting play an important role in its quality of strength. Most of the people associate GREEN CONCRETE with concrete that is colored with pigment. However, it is also referred which has not yet hardened. But in the contexts of this topic, green concrete is taken to mean environmentally friendly concrete. This means concrete that uses less energy in its production and produces less carbon dioxide then normal concrete is green concrete. Green concrete is a revolutionary topic in the history of concrete industry, this was first invented in Denmark in year 1998. Green concrete is the type of concrete which is much like the conventional concrete but the production of such concrete requires minimum amount of energy and causes least harm to environment. This is called as eco–friendly concrete and reduced environmental impact for e.g. energy saving CO2 emission waste water. The materials used for producing green concrete are cementitious materials i.e. Ground granulated blast furnace slag, fly ash, silica fume, geopolymer etc. [1]

CementitiousMaterials:Cementitious products compromise the glue that holds concrete together. These materials include traditional Portland cement and other cementitious materials, such as ground granulated blast furnace slag (GGBS), a fly ash, silica fume and geopolymer. These materials are either combined at the cement works (to produce composite cement) or at the concrete mixer when the concrete is being produced. GGBS and fly ash are most commonly used of these materials in the UK. These secondary materials are useful by products of other industrial processes, which would potentially otherwise be sent to landfill. Using GGBS or fly ash in concrete, either as a mixer addition or through a factory-made cement, significantly reduces the overall greenhouse gas emissions associated with the production of concrete.

Ground granulated blast furnaces slag (GGBS) is by product from the blast furnaces used to make iron. These operated at about 1500 centigrade and are fed with a carefully controlled mixture of iron ore, coke and limestone. The iron ore is reduced to iron remaining materials iron a slag that floats on the top of the iron

Objectives:

- To study and compare compressive strength of concrete by replacing cement with different percentage of GGBS
- To study and compare the tensile strength of concrete by replacing cement with different percentage of GGBS.
- To study and compare flexural strength.

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• To calculate optimum percentage of GGBS in the fresh and hardened concrete.

Materials:

Following materials are used and testing has been done as per Indian Standard specification. Mix design is done as per IS 10262:2009 for M25 grade concrete [2] (Table 1–2).

Cement

BIRLA GOLD 43 Grade Ordinary P.C.C. IS-12269
GGBS 10% to 50% replacing by cement.

Table1: Quantities for Per Cubic Meter of Concrete.

Material	Proportion by weight	Weight in kg/m^3
Cement	1	384
Fine aggregate	1.661	637.72
Coarse aggregate 10 mm	1.303	500.40
Coarse aggregate 20 mm	1.955	751
Water	0.43	166

Table2: Schedule of Specimen Preparation

Sr. No	Code	Cement %	GGBS %	W/C ratio
1	M0	100	00	0.43
2	M1	90	10	
3	M2	80	20	
4	M3	70	30	
5	M4	60	40	
6	M5	50	50	

II. RESULTS AND GRAPHICAL PRESENTATION

Table3: Compressive Strength for Various % Replacement of GGBS.

Sr. No	% GGBS	Compressive Strength N/mm^2	
		7 Days	28 Days
1	00	24.45	30.35
2	10	19.04	24.46
3	20	20.09	26.00
4	30	26.12	32.00
5	40	22.61	29.10
6	50	21.80	27.94

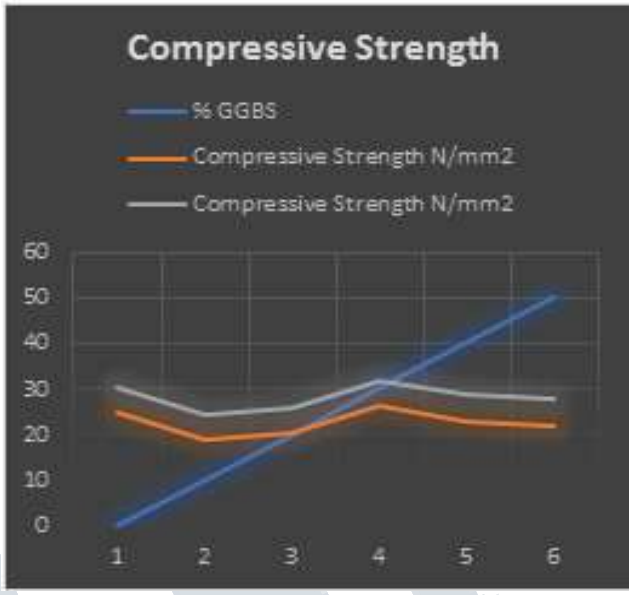

Fig. 1: Graphical representation of Compressive Strength

Sr. No	% GGBS	Flexural Strength N/mm^2	
		7 Days	28 Days
1	00	3.88	4.96
2	10	2.495	5.05
3	20	3.475	5.46
4	30	4.10	5.63
5	40	3.77	4.78

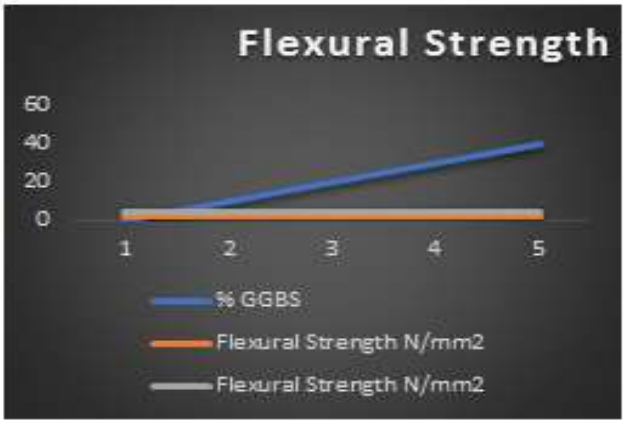

Fig. 2: Graphical representation of Flexural strength

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Table5: Split Tensile Strength for Various % Replacement of GGBS.

Sr. No	% GGBS	Split Tensile Strength N/mm^2	
		7 Days	28 Days
1	00	1.749	3.017
2	10	1.664	2.919
3	20	1.664	2.929
4	30	1.770	3.041

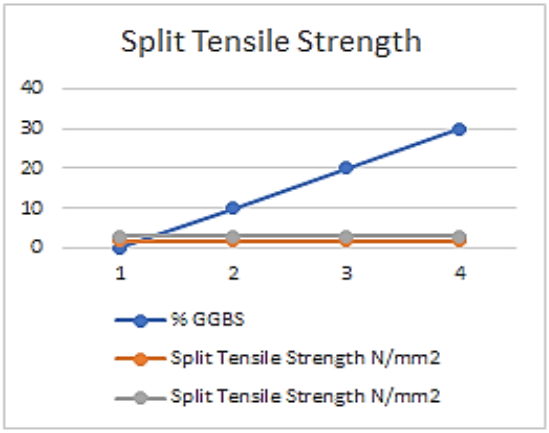

Fig.3: Graphical representation of Split Tensile strength

Table6: Optimum GGBS Content

Strength	GGBS %	Strength Value N/mm^2	
		7 Days	28 Days
Compressive	30	26.12	32.00
Flexural	30	4.10	5.63
Split Tensile	30	1.77	3.041

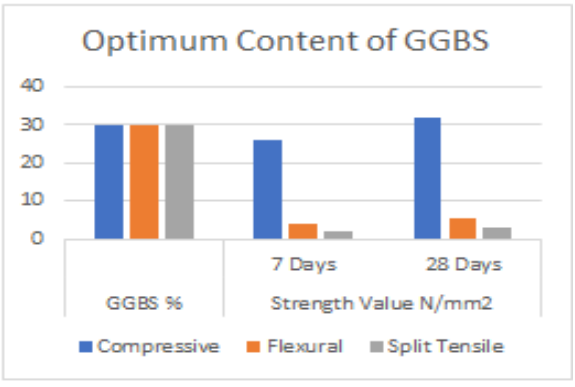

Fig.4: Graphical representation of Optimum Content of GGBS

II. CONCLUSION

- We can replace cement by GGBS with 30%.
- The compressive strength of GGBS concrete increases as GGBS content in increased up to an optimum point, after which compressive strength decreases.
- The optimum level of GGBS content for maximizing the strength is 30%.
- The optimum GGBS content for compressive strength, flexural strength and for Split tensile test is 30%.

III. APPLICATION

- GGBS can be used in concrete used for dam as heat of hydration is less.
- It can be used in the construction of bridges.
- It can be used in the construction of columns.
- It can be used in road construction.

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Cost Analysis

Material	0 % GGBS Content			30 % GGBS Content				
	Volume/m^3	Rate/ m^3	Total Cost	Volume/m^3	Rate/ m^3	Cost per m^3	Volume of GGBS replacing Cement	Total Cost
	m^3	INR	INR	m^3	INR	INR	m^3	INR
Cement	384	7	2688	268.8	7	1881.6	188.6	1881.6
Coarse Aggregate	1251.4	700	310.8	1251.4	700	310.8	188.6	310.8
Fine Aggregate	637.72	800	192.8	637.72	800	192.8	188.6	192.8
Total cost per m^3 of Concrete			3191.6/m^3					2385.2/m^3