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EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE BY USING PORTLAND SLAG CEMENT

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ABSTRACT

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water, which is used for the construction. The cement used here is Portland Slag Cement which is the mixture of the Portland cement clinker, Gypsum & Granulated Slag or mixing the Ground Granulated Blast furnace Slag (GGBS) with ordinary Portland cement by means of mechanical blenders. Portland Slag cement is much stronger than the ordinary cement when used in concrete. The grade of concrete selected for our work is M30.

Keywords: *Portland Slag Cement, Fine aggregate, Coarse aggregate, Water, Clinker, Gypsum and Ground*

Granulated Blast furnace Slag.

1. INTRODUCTION

For the building industry to advance, concrete's performance as a construction material must be improved. Several improvements to the inert qualities of traditional concrete have been made during the past few decades. The present invention relates to an improved process for the production of Portland slag cement using granulated blast furnace slag. The invention particularly relates to a process for the production of Portland slag cement using cement clinker and higher proportion of ground granulated blast furnace slag, which is a waste material from Steel plants. The Portland slag cement of the present invention shall be useful in buildings and other large structure such as dams, bridges, roads etc. The main raw material for the Portland slag cement is the cement clinker (55 to 85% by weight). Granulated blast furnace slag can be used only in the range of 15 to 40% by weight. The formation of cement clinker is an energy intensive process due to crushing, grinding and high temperature. The production cost of Portland slag cement is relatively high as it uses more cement clinker.

2. LITERATURE REVIEW

Wang Ling et al. (2004) analysed the performance of Slag and the effect of portland slag cement on fresh concrete and hardened concrete. Portland slag cement concrete is characterized by high strength, lower heat of hydration and resistance to chemical corrosion.

Elsayed (2011) investigated experimentally in his study the effects of mineral admixtures on water permeability and compressive strength of concretes containing silica fume (SF) and fly ash (FA). The results were compared

to the control concrete, ordinary Portland cement concrete without admixtures. The optimum cement replacement by FA and SF in this experiment was 10%. The strength and permeability of concrete containing silica fume, fly ash and high slag cement could be beneficial in the utilization of these waste materials in concrete work, especially in terms of durability.

Luo et al. experimentally studied the chloride diffusion coefficient and the chloride binding capacity of Portland cement or blended cement made of Portland cement and 70 % GGBS replacement with or without 5 % sulphate. They found that (i) chloride diffusion coefficient decreased; (ii) chloride ion binding capacity improved in samples of blended cement.

Oner and Akyuz studied on optimum level of Slag on compressive strength of concrete and concluded that the optimum level of Slag content for maximizing strength is at about 55–59% of the total binder content.

Qian Jueshi and Shi Caijun [5] studied on high performance cementing materials from industrial slag and reviewed the recent progresses in the activation of latent cementitious properties of different slag. They opined that Alkali-activated slag, such as blast furnace slag, steel slag, copper slag and phosphorus slag should be a prime topic for construction materials researchers.

Aveline Darquennes et al. (2011) determined the slag effect on cracking. Their study focuses on the autogenous deformation evolution of concretes characterized by different percentages of slag (0 and 42% of the binder mass) under free and restraint conditions by means of the TSTM device (Temperature Stress Testing Machine).

Shariq et al.(2008) studied the effect of curing procedure on the compressive strength development of cement mortar and concrete incorporating ground granulated blast furnace slag. The compressive strength development of cement mortar incorporating 20, 40 and 60 percent replacement of GGBFS for different types of sand and strength development of concrete with 20, 40 and 60 percent replacement of GGBFS on two grades of concrete are investigated. Tests results show that the incorporating 20% and 40% GGBFS is highly significant to increase the compressive strength of mortar after 28 days and 150 days, respectively.

3. MATERIAL PROPERTIES Cement

Portland Slag Cement (PSC) is manufactured by either inter-grinding in the Portland cement clinker, Gypsum & Granulated Slag or mixing the Ground Granulated Blast furnace Slag (GGBS) with ordinary Portland cement by means of mechanical blenders. It is created with a blend of 45-50% slag, 45-50% clinker and 3-5% gypsum. Portland slag cement is the most suitable cement for concrete paths, mass concrete uses, structures and bases, precast concrete, concrete open to sea water and oceanic use. The various properties of Cement are shown

in table below.

Table 1: Properties of Cement

Parameters	Values
Specific Gravity	2.87
Standard consistency	32.5%
Initial Setting time	70 min
Final setting time	480 min

Fine Aggregate:

Fine aggregates are defined as those that pass through an IS sieve with a mesh size of 4.75mm. Under grading zone II, M-Sand is utilized as a fine aggregate in accordance with IS 383 - 2016. The table below displays the test results for the fine aggregate qualities.

Table 2: Properties of Fine Aggregate (M – Sand)

Parameters	Values
Specific Gravity	2.7
Sieve analysis	Zone II
Fineness modulus	0.982
Water absorption	1%

Coarse Aggregate:

The majority of the aggregate that passes through a 4.75mm IS sieve is referred to be coarse aggregate. The strength of concrete is determined by the characteristics of coarse particles. Therefore, the aggregate should be devoid of contaminants such as minerals and chemicals. Crushed angular metal from a local source was used as coarse aggregate. The choice of coarse aggregate must take into account a number of factors. The characteristics are described below.

Table 3: Properties of Coarse Aggregate

Parameters	Values
Specific Gravity	2.8
Size of aggregate	20mm
Water absorption	0.45%

4. MIX DESIGN FOR PORTLAND SLAG CEMENT CONCRETE

The desired the properties of Concrete can be obtained by using the ingredients in a certain proportion. Thus determining the relative amount of material is known as mix design. That it can be defined as the process of selecting suitable ingredient of Concrete and determining Their relative quantities for producing the Concrete of desired properties strength, durability and consistency, etc., as economical as possible. The object of mix design is to decide the properties of material, which will produce the concrete having the required properties. The mix proportion should be selected in such a way that the resulting concrete is desired workability while fresh and it could be placed and compacted easily for the indented purpose.

Table 4: Mix Proportioning for Portland Slag Cement

Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	W/C Ratio (Lit.)
413	695	1175	186
1	1.7	2.85	0.45

5. TESTS AND RESULTS

In this testing investigation, specimens are cast and tested to measure the compressive strength, split tensile strength, and flexural strength of conventional concrete and Portland Slag Cement Concrete For compressive strength, split tensile strength, and flexural strength, the specimen sizes are 150 mm x 150 mm x 150 mm, 150 mm x 300 mm, and 100 mm x 100 mm, 500 mm, respectively.

Table 5: Test Results

Mix	Compressive Strength (N/mm^2)		Split tensile strength (N/mm^2)		Flexural strength (N/mm^2)
	7 days	28 days	7 days	28 days	28 days
M1	21.64	31.93	1.56	2.83	3.4
M1	22.63	33.42	1.83	2.97	3.46
M1	21.49	32.24	1.78	2.74	3.39
Average	**21.92**	**32.53**	**1.72**	**2.84**	**3.42**
M2	31.5	49.5	3.1	6.3	5.73
M2	33	51	3.4	6.6	5.74
M2	32.5	50.5	3.3	6.4	5.67
Average	**32.3**	**50.3**	**3.3**	**6.4**	**5.71**

M1 – Conventional concrete

M2 – Portland Slag Cement Concrete

COMPARISON OF COMPRESSIVE STRENGTH OF CONCRETE

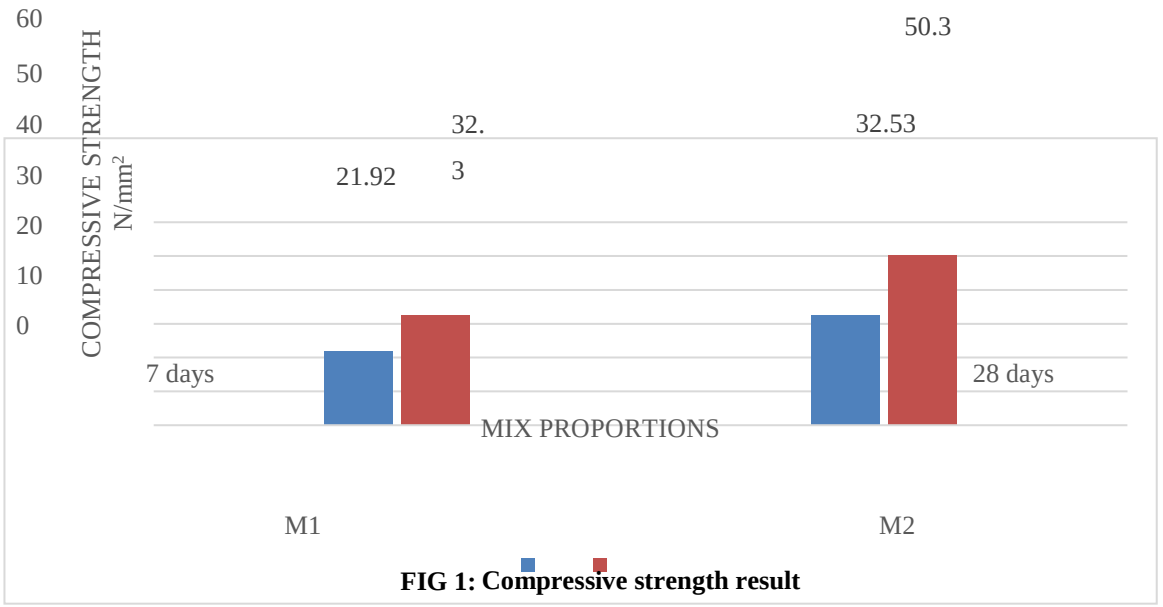

FIG 1: Compressive strength result

COMPARISON OF SPLIT TENSILE STRENGTH

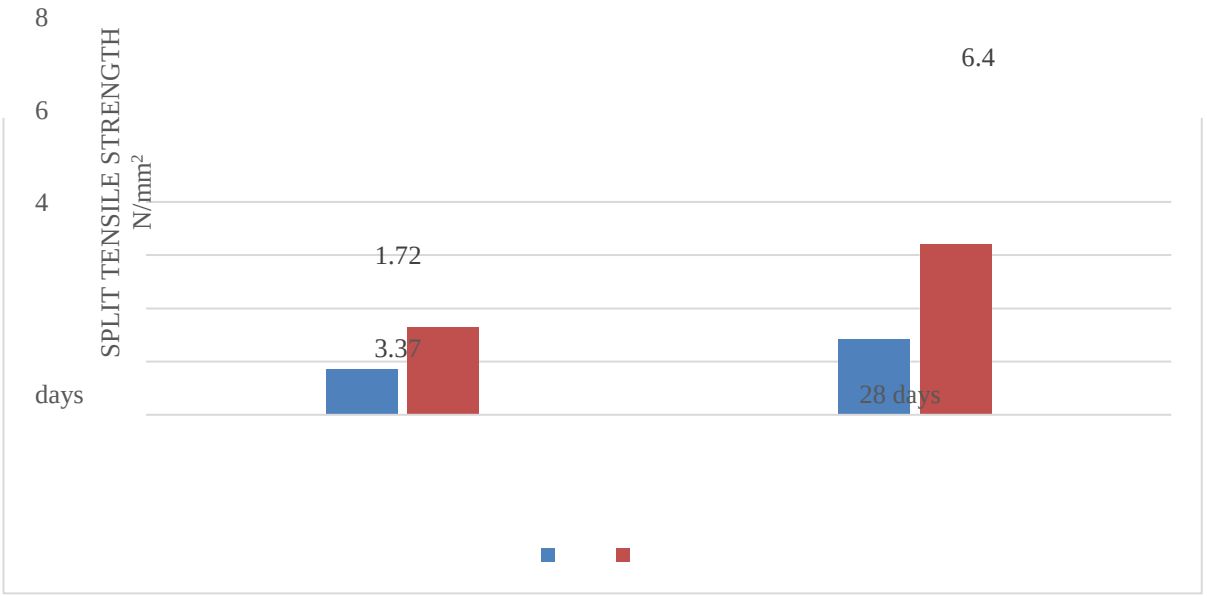

FIG 2: SPLIT TENSILE STRENGTH RESULT

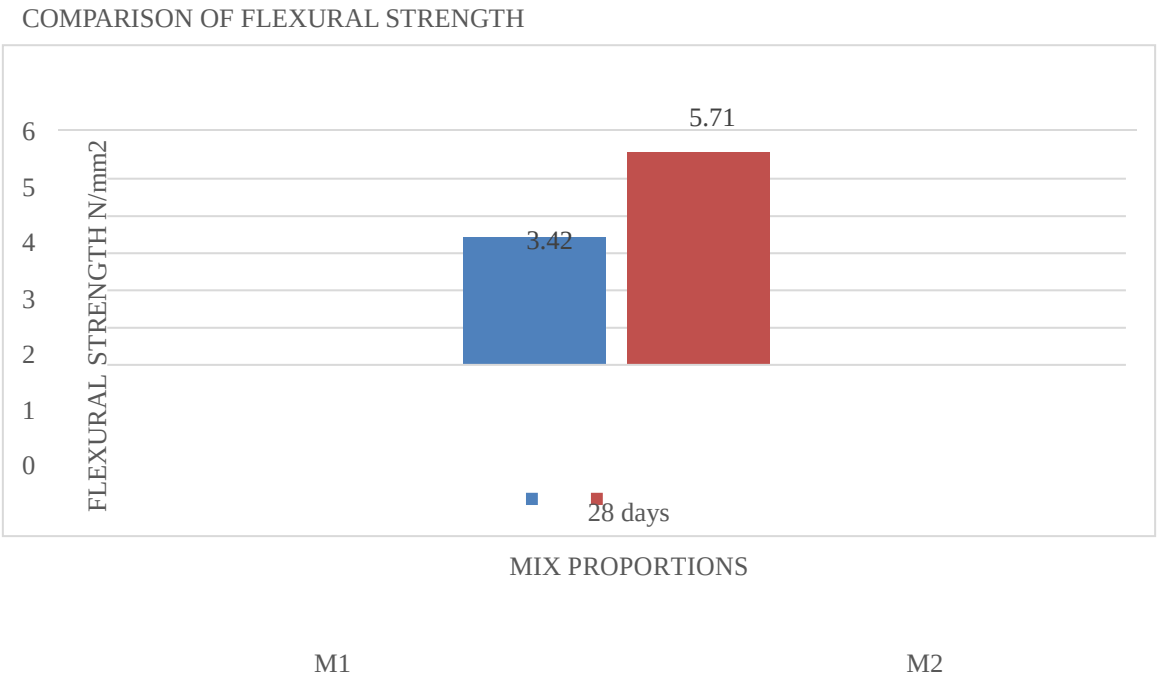

FIG 3: FLEXURAL STRENGTH RESULT

. CONCLUSION

By comparing the strength of compressive strength, split tensile strength, flexural strength of conventional concrete and Portland Slag Cement Concrete we come to know that Portland Slag Cement Concrete is much stronger than the conventional concrete. Thus the Portland slag cement of the present invention shall be useful in buildings and other large structure such as dams, bridges, roads etc.

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