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RESEARCH ARTICLE OPEN ACCESS

Partial Replacement of Quarry Dust and Cement with Ground Granulated Blast Furnace Slag

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Abstract:

Concrete is an essential part in the development of infrastructure Viz., buildings, industrial structures, bridges and highways etc., preeminent to usage of great quantity of concrete. The construction industry in today's date is growing expeditiously. Cement is a prime material in the concrete mixture which manufactured by the materials like lime and silica. The value of concrete is attributed to value of its ingredients are high cost. Thus this study is carried out to find the alterative option in ingredients of concrete, like GGBS (Ground Granulated Blast furnace Slag) can be used as a replacement of cement in the concrete. This replacement will lower the cost and will make less use of cement in concrete. In this experimental study the compressive strength of concrete with GGBS as ingredient will be understand. Along with that the cost analysis is also done to suggest the most optimized percentage of GGBS to be used in various condition.

Keyword: GGBS; Compressive Strength; Cement; Concrete

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I. INTRODUCTION

Concrete is now-a-days no longer a material consisting of cement, aggregates, water and admixtures, but it's manufactured by different types of ingredients performed in different conditions exposures. Engineers are tailoring concrete with different specific applications and it contain different materials like micro silica, colloidal silica, binders, fillers and pozzolanic materials. One of the main reasons for the deterioration of concrete in the past is that too much emphasis is laid on concrete compressive strength rather than on the performance of concrete. Concrete has tendency to harden and attain strength for few more years. Concrete withstands compression (crushing), but is extremely poor in tension (stretching). After the water cement is the prime ingredient of concrete. But the productions of cement is more costly and expensive and major problem for environment and civil engineer is resolution to find out the need.

Many researchers have resolved the path of reducing the cement as ingredient to avoid the CO2 emissions. Several by-products are replaced with cement like Fly ash, Silica Fume, GGBS. River

sand is also a most expensive ingredient in the concrete and due to high usage of river sand its environmental danger and its results into high price. That's why we have to find the alternative material to replace the sand. Quarry dust the option to replace the sand. Thus, we have studied the replacement of cement with GGBS and sand with Quarry dust. Ground-granulated blast- furnace slag (GGBS or GGBFS) is a 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 in fine powder. Ground-granulated blast furnace is highly cementetious and high in CSH (calcium silicate hydrates) which is a strength, durability and appearance of the concrete.

Quarry dust is the residue from the granite quarry. Quarry rock dust can be economical alternative to the sand. It's largely used in the highways and finishing material and used to manufactured hollow blocks and light weight concrete. After processing fine particle of size less than 4.75mm is used in this work. In New York, construction of the World Trade Centre has about 40% GGBS as replacement of cement in the concrete (Slag Cement Association, 2005).

II. LITERATURE REVIEW

1. Geological study is carried out on the behavior of fly ash based bricks by saravana Raja Mohan et a1 (20l3),Fly ash bricks shows better result against sulphate attack for which experiment is conducted of cycles of salt exposure. It means nil Efflorescence. When compare to clay bricks, fly ash brick is 10.609a lighter.

2. A Sumathi (2014), conducted experimental study to find the optimum mix percentage of fly ash brick. From the result it was found that among the seven proportions the maximum optimized compressive strength is obtained for optimal mix percentage of Flyash-15'to, Lime-30' o, Gypsum-2' quarry dust-53' o.

3. Experimental study find out on fly ash bricks and differentiating with clay brick by Aakash Suresh Pawar (2014).Manufactured fly ash brick having high load carrying capacity and it is superior than commercially available clay bricks. The characteristics values of fly ash bricks are exceptional.

4. Krishnamoorthy et al (1994) researched the quantum of fly ash when added to soil for making good bricks. Fly ash are obtained from Vijaywada thermal power station was mixed with soil in varying ratios such as 0' o, 10' o, 20' o, 30' o, 40' o, 50' o are described that the bricks cannot be produced with large swelling soils without additives. The property of strength and water absorption of bricks made with replacement of soil by 50' o of fly ash was suitable and strength were ranging from 9.8 to11.5 N/mm2 but for the country brick, it was about 3.5N/mm2.

5. Pathan V.G, Ghutke V.S and Pathan G have resusltant in their project that ground granulated blast furnace slag is good replacement of cement than various other alternatives. The rate of strength gain in slag replaced concrete is less in speed in

early stages but with proper curing the strength goes on increasing enormously. The compressive strength decreases when the cement replacement is greater than 50%. Use of slag or slag cements usually improves workability and decreases the water demand due to the increase in paste volume caused by the lower relative density of slag. From their results they concluded that 45% replacement of cement by GGBS gives the highest amount of compressive strength. They suggested that the replacement of cement with slag should be limited to 40% in India.

III. METHODOLOGY

1. Collection of raw materials

1) Fly Ash: Fly ash is a by-product of burning pulverized coal in an electrical generating station
2) Quarry Dust: It is residue taken from granite quarry
3) Cement: The cement of grade 53 was used. 53 Grade OPC is a higher strength concrete.
4) GGBS: Ground-granulated blast- furnace slag (GGBS or GGBFS) is a 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 in fine powder.

It is evident that about 85-100%of total raw materials are either waste materials or byproduct barring sand. Hence there is a lot of saving of natural resources like fertile soil and coal, if compared with red bricks activity.

2. Testing on Cement

1) Fineness Test
2) Standard Consistency Test
3) Initial and Final Setting time
4) Physical properties of cement

S.NO	CHARACTERISTICS	VALUES
1	FINENESS	3.12
2	NORMAL CONSISTENCY	36%
3	INITIAL SETTING TIME	48 MIN
4	FINAL SETTING TIME	240MIN
5	SPECIFIC GRAVITY	4.8%

3. Characteristics of Fly Ash Bricks

1. The standard size of the brick is 230 x110x70 mm.

2. The bricks are manufactured and tested as per IS 12894-2002.

3. Fly ash bricks are sound, compact and uniform in size, shape and colour. Smooth rectangular faces of the bricks are accompanied with sharp and square corners.

4. They are free from visible cracks, warpage, flaws, and organic matter.

5. Economical and environment friendly.

6. 28 % lighter than ordinary clay bricks.

7. Compressive strength: - 7.5 N/mm2 on an average.

IV. TEST RESULT AND OBSERVARTION

1. Water Absorption Test After 21 Days

Sr No.	Ratio	Average Water Absorption (%)
1	N	1.88

2	S1	1.59
3	S2	1.31
4	S3	0.63
5	C1	0.98
6	C2	0.67
7	C3	1.26

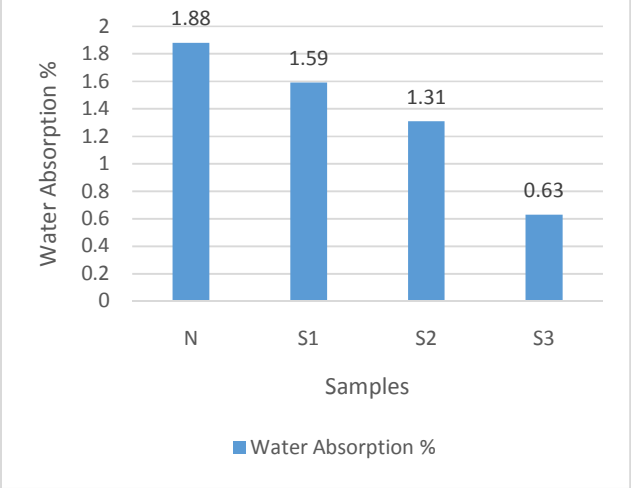
2. Compressive Strength of 7 Days

Sr No.	Ratio	Avg Compressive Strength (N/mm^2)
1	N	9.32
2	S1	11.24
3	S2	8.17
4	S3	13.23
5	C1	10.43
6	C2	8.13
7	C3	7.80

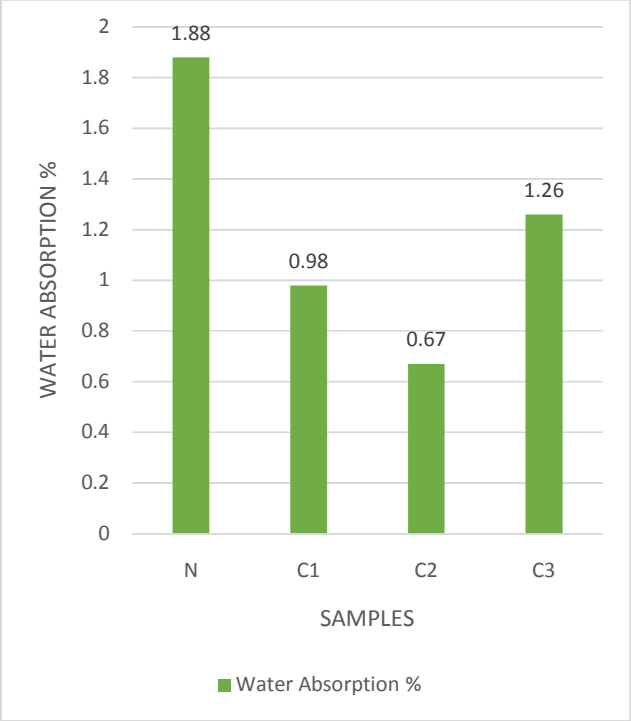
3. Compressive Strength of 21 Days

Sr No.	Ratio	Avg Compressive Strength (N/mm2)
1	N	15.34
2	S1	18.78
3	S2	13.56
4	S3	22.31
5	C1	17.28
6	C2	13.59
7	C3	11.35

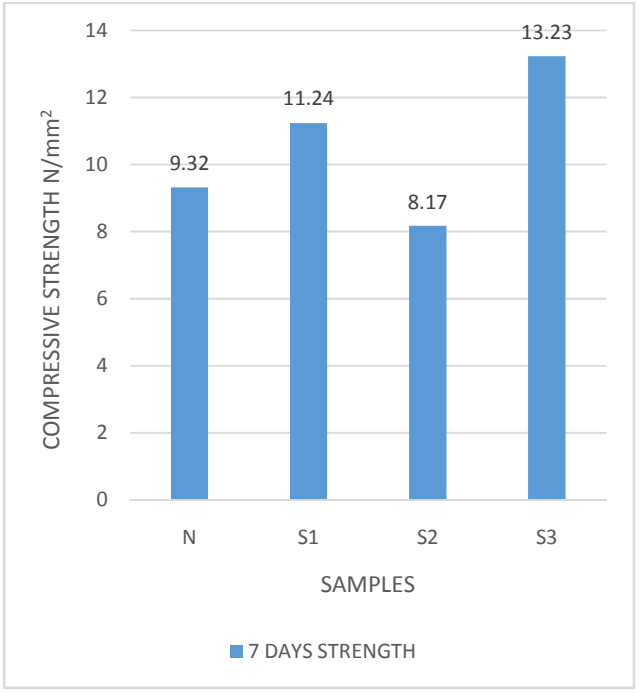
4. Graphs



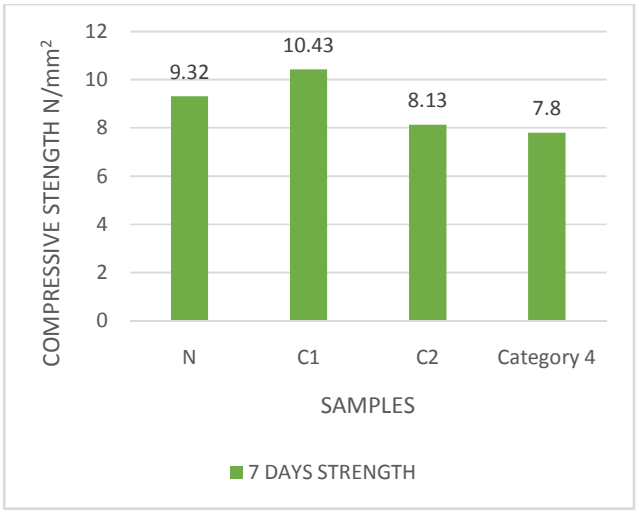
Graph 1: Water Absorption % in partial replacement of Quarry dust with ggbs



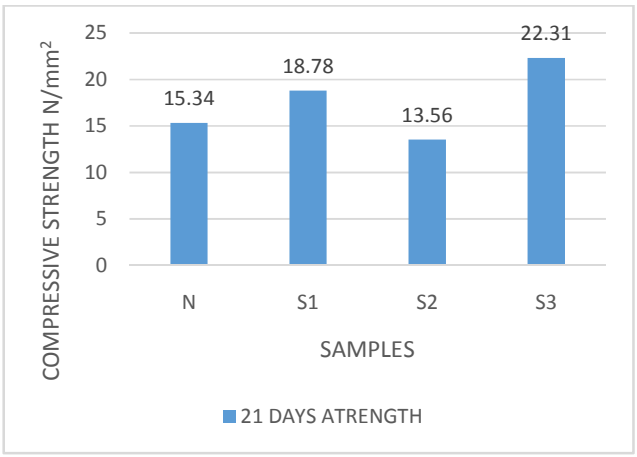
Graph 2: Water absorption % in partial of cement with ggbs



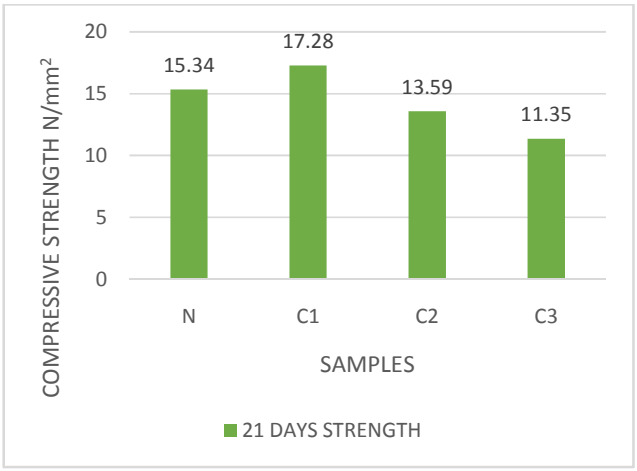
Graph 3:- Graph showing compressive strength of brick after 7 days of curing in partial replacement of quarry dust withggbs



Graph 4: Graph showing compressive strength of brick after 7 days of curing in partial replacement of cement with ggbs



Graph 5:- Graph showing compressive strength of brick after 21days of curing in partial replacement of quarry dust with GGBS



Graph 6:- Graph showing compressive strength of brick after 21days of curing in partial replacement of cement with ggbs

V. CONCLUSION

During the experiment and investigation on fly ash bricks in partial replacement of cement and quarry dust with ground-granulated blast- furnace slag following results were found and recorded.

1. In partial replacement of quarry dust with ggbs, the % of water absorption decreases with increase in the % of ggbs.

2. In partial replacement of cement with ggbs, the % water absorption increases with increase in the % ggbs.

3. From the results it was found that, among the seven proportions the maximum optimized compressive strength is obtained for optimum mix percentage of Flyash-50%, cement-10%, Quarry dust-10% and ggbs-30% as 22.31N/mm².

4. The weight of brick is lighter than the normal fly ash brick and its saves cement and also have environmental benefits.

5. The cost comparison between "N" sample and "C3" sample, the cost of brick are quite similar i.e. N=3.08 Rs and C3=3.02 Rs and it also satisfies specification of I.S. 3495(P-I)-1976, Determination of Compressive Strength (Second Revision).

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