International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Experimental Study of Concrete Made With GGBS and Granite Powder

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Abstract: ***Cement industry may be one amongst the key sources of environmental pollution so the reduction of cement demand should be improved. Granite powder and Ground granulated blast furnace slag (GGBS) are the by-products of industries and it ought to be reused to scale back the waste pollution. Therefore the present study is directed towards developing a better understanding of the combined performance of Granite powder and GGBS on the strength properties of Ternary concrete over an Ordinary concrete. This work primarily deals with the strength characteristics such as Compressive, Split Tensile strength. Total 4 Different concrete mixtures were cast and tested with same cement replacement levels (40%) of Granite powder and GGBS as an addition (15,20 and 25%). Compressive, Split Tensile. Concrete made with granite powder and GGBS At the ages of 7, 14 and 28 days for various combinations of Granite powder and GGBS. All Mixes were studied at a water-cement ratio of 0.4. The experimental results show that the strength properties of Concrete made with granite powder and GGBS increase with an increase in cement replacement levels of up to the certain limit (20%)***
Keywords: Cement, fine aggregate, coarse aggregate, water, GGBS, granite powder

I. INTRODUCTION

Concrete is one of the key construction materials having good compressive &, flexural strengths and durable properties among others. With comparative low cost made from some of the most widely available elements, it has found wide usage. It is mouldable, adaptable and relatively fire resistant. The fact that it is an engineered material which satisfies almost any reasonable set of performance specifications, more than any other material currently available has made it immensely popular construction material. In fact, every year more than 1 m3 of concrete is produced per person (more than 10 billion tonnes) worldwide. Strength (load-bearing capacity) and durability (its resistance to deteriorating agencies) of concrete structures are the most important parameters to be considered while discussing concrete. The deteriorating agencies may be chemical – sulphates, chlorides, CO2, acids etc. or mechanical causes like abrasion, impact, temperature etc. Triple-blended concretes belong to that stratum of concretes where the strength and durability characteristics are maximized to the highest extent possible, in comparison to various other types of concretes, by subtle tailoring of its chemical composition, fineness and particle size distribution. Greater varieties are introduced by the incorporation of additives like pozzolana, granulated slag or inert fillers. These lead to different „specification‟ of cement in national and international standards. In simple words, triple blended cement is characterised by part replacement of cement with mineral admixtures/additives such as pozzolanic admixtures (fly ash, silica fume, granulated slag etc.) or inert fillers. The corresponding concrete is termed as triple blended ‘concrete. These admixtures are found to enhance the physical, chemical and mechanical properties of the concrete i.e. in terms of its strength parameters (compressive and flexural) as well as durability parameters.

II. LITERATURE REVIEW

Triple Blending Of Cement Concrete”, Balkrishn Y & V Lavanya. International Research Journal Of Engineering and technology 2016- was investigated the optimization of a Ternary Blended Cementitious system based on Ordinary Portland Cement (OPC)/ GGBS / Micro Silica for the development of Ternary Concrete.

Compressive Strength of Ternary Blended Concrete at the ages of 7, 28, 60, 90 days for various combinations of Micro Silica and GGBS mixes. Micro Silica of 0%, 5%, and 10% and15% along with GGBS was replaced by 20%, 30% 40% and 50%.

All the mixes were studied at water-cement ratio of 0.45. “Sustainable Studies on Concrete with GGBS As a Replacement Material in Cement”, S. Arivalagan, Jordan Journal of civil engineering(2014) - 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

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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. "Experimental Study on Concrete with Waste Granite Powder as an Admixture", K Chiranjivi Reddy, K. Chiranjeevi reddy Int. Journal of Engineering Research and Applications- it examined the possibility of using stone waste as replacement of Pozzolana Portland Cement in the range of 5%, 10%, 30%, 40% and 50% by weight of M 25 grade concrete. They reported that stone waste of marginal quantity as a partial replacement to the cement had a beneficial effect on the mechanical properties such as compressive strength values for 7, 14, 28 days were less than the PPC cement. They investigated the effect of using quarry dust as a possible substitute for cement in concrete. Partial replacement of cement with varying percentage of quarry dust (0%, 10%, 15%, 20%, 25%, 30%, 35%, 40%) by weight of M 20, M 30 and M 40 grade of concrete cubes were made for conducting compressive strength. From the experimental studies, 25% partial replacement of cement with quarry dust showed improvement in hardened of concrete.

III. OBJECTIVES

A. To determine the combined effect on the Granite powder and GGBS on compressive and flexural strengths of ternary concrete.
B. To use a pozzolanic material such as Granite powder and GGBS in concrete by partial replacement of cement.
C. To utilize industrial by-product and find out the economical and performance evaluation of concrete mix.
D. To create healthy environment worldwide by using industrial by-products wisely.
E. To provide economical construction material.

IV. EXPERIMENTAL PROGRAMME

The experimental programme was planned to produce a Blended Concrete with reduced cement content by adding different percentages of granite powder and GGBS. The material used and the experimental procedure for mixing, casting and testing of specimens are described in the following section. Total 72 specimens (36 cubes and 36 cylinders) were cast to determine compressively, split tensile and of ordinary Portland cement and Blended Concrete at the age of 7, 14 and 28days.

A. Material

1) *Cement:* Ordinary Portland cement of 53 gra de having a specific gravity of 3.15 was used. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of 12269-1987
2) *Fine Aggregate:* Locally available river sand confirming to zone II of table 4 of BIS: 383-1970 (specific gravity: 2.6 and fineness modulus 3.17 and bulk density 1793 kg/m3) was used as fine aggregate
3) *Coarse Aggregate:* Locally available quarried and crushed granite stones confirming to a graded aggregate of nominal size between 20mm and 4.75mm as per table 2 of BIS:383-1970 (specific gravity: 2.9, fineness modulus:6.87, bulk density:1603kg/m3
4) *GGBS:* GGBS was collected from Pune. Confirming to IS 12089 – 1987. (Specific gravity: 2.87 F.)Water: Clean drinking water available on the college campus was used for mixing and curing of concrete confirming to IS 456-2000.
5) *Granite powder* – This powder is collected from locally available granite cutting store.
6) *Water:* Clean drinking water available on the college campus was used for mixing and curing of concrete confirming to IS 456-2000.

B. Mix proportions

1) *Control concrete:* Mix design is carried out as per guide line given in IS: 10262-2009 for M40 which yielded a proportion of 1:1.33:2.21 with water cement ratio of 0.4. is used as the reference mix. Control mixtures were prepared for medium workability with using superplasticizer. The mix proportioning control concrete is given in

Table 1: Mix proportion (kg/m3) for controlled concrete

INGREDIENT	CEMENT	FA	CA	WATER
QTY IN KG/M^3	475	634	1052	189
RATIO	1	1.33	2.21	0.4

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TABLE 2: TRIAL MIXES

MIX	CEMENT (%)	GGBS (%)	GRANITE POWDER (%)
A	100	0	0
B	60	20	20
C	60	25	15
D	60	15	25

C. Mixing, casting, and curing of specimens

1) *Mixing:* A Designed mix ratio of 1:1.33:2.21 was used for the concrete. Batching was by weight and a constant water/cement ratio of 0.4 used. Mixing was done manually on the smooth concrete pavement
2) *Casting:* For casting the cubes & cylinders standard cast iron metal moulds were used. Whole casting procedure is confirmed to Indian Standard: 10262-2009. The following specimens were prepared for both controlled concrete (CC) and blended concrete to perform tests at 7, 14 and 28 days.150x150x150 mm cubes for compressive strength & 150 x300mm. cylinders for split tensile
3) *Curing:* After casting, the moulded specimens are stored in the laboratory free from vibration, in moist air and at room temperature for 24 hours. After this period, the specimens are removed from the moulds and immediately submerged in the clean fresh water of curing tank. The curing water is removed after every 3 days. The specimens are cured for 7, 14 and 28days.

C. Testing of Specimens

At the age of 7, 14 and28 days, the specimens were taken out of water and allowed to dry under shade and then tested for strengths at room temperature. Cube compression tests were performed on standard cubes of size 150 x 150 x 150 mm after 7, 14 & 28 days curing. As shown in Fig.3 and the test results are presented in Table 3. The compressive strength of specimen was calculated by the expression:

$$_{CU}= P_C /A$$

Where, Pc= Failure load in compression in kN

A = Loaded area of a cube, mm2 load to opposite edges. Test results are shown in Table 4. The split tensile strength of cylinder was determined by the expression:

$$FT=2P /\Pi LD$$

Where, FT = Tensile strength, MPa

P = Load at failure,

L = length of cylinder, mm D = Diameter of cylinder, mm

V. RESULT AND DISSCUSION

A. Compressive strength

MIX	7 DAYS (KN/M^2)	14 DAYS (KN/M^2)	28 DAYS (KN/M^2)
A	30.44	38.44	47
B	21.68	26.66	42.87
C	18.53	24.44	37
D	18.4	21.33	31.15

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B. Split Tensile Strength

MIX	7 DAYS (KN/M^2)	14 DAYS (KN/M^2)	28 DAYS (KN/M^2)
A	2.00	2.22	2.55
B	1.81	2.14	2.80
C	1.57	2.00	2.57
D	1.48	1.75	2.19

6.2 Graphical Analysis

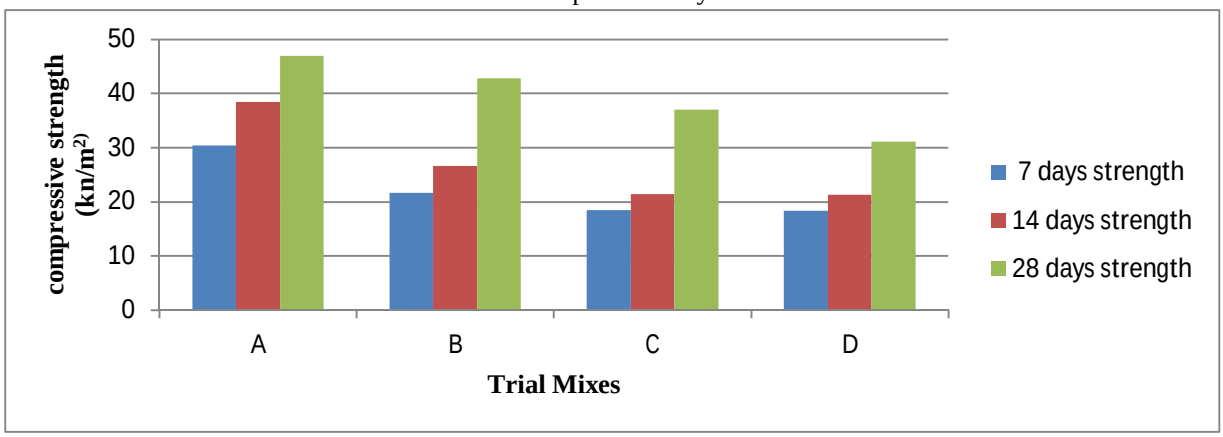

Fig.1. Compressive Strength of normal concrete w.r.t Normal Concrete with granite powder and with different percentage

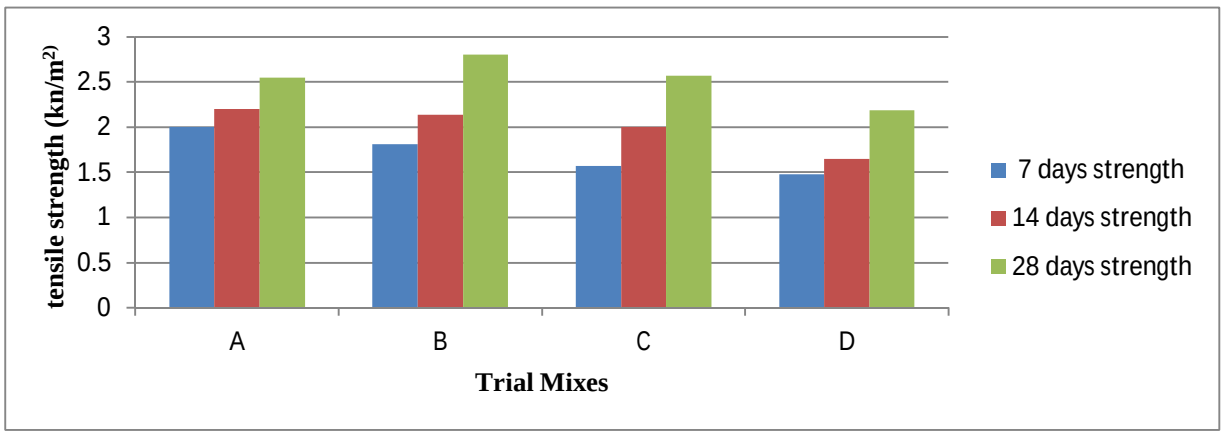

Fig.2 Tensile Strength of normal concrete w.r.t Normal Concrete with granite powder and with different percentage

V. CONCLUSION

A. The early age strength of concrete with GGBS and Granite powder with same proportion was lower than the plain concrete. However, as the curing period is extended, the strength increases. The reason is that the pozzolanic reaction is slow and the formation of calcium hydroxide requires time.

B. The strength properties of concrete increases as the GGBS content increased up to an optimum point. Therefore it can be concluded that there is an optimum level for the efficient use of GGBS content, which yields the highest strength. The optimum level of GGBS content for maximizing strengths is at about 20% of total binder content.

C. The compressive strength of concrete with 20% GGBS and 20% granite powder is nearly same as the compressive strength of plain concrete.

D. Early age Tensile strength of concrete with GGBS and granite powder is low as compared to plain concrete

E. But after 28 days strength of concrete with GGBS and granite powder is more than plain concrete.

F. The tensile strength of concrete with GGBS and granite powder is more at 28 days than plain concrete hence it is used for pavement concrete and runways. It is also used for water retaining structure.

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G. The dimensions of the granite fine particles are compatible with the purpose of filling up the transition zone and capillary pores, thus acting as micro filler.

H. Thus Waste was utilized and makes more environmentally friendly. Thus granite powder aggregate is the best choice where there are available.

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