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HIGH PERFORMANCE CONCRETE M50 WITH GGBS AND ROBO SAND

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ABSTRACT

The use of high performance concrete offers advantages in durability, ease of placement, and reduced creep and shrinkage, as well as increased compressive, shear and tensile strength. Offsetting these advantages are potentially reduced ductility and fire resistance, and increased unit cost. The present paper focuses on the investigating characteristics of M50 grade concrete with partial replacement of cement with Ground Granulated Blast Furnace Slag (GGBS) and sand with the ROBO sand (crusher dust). The cubes and cylinders are tested for compressive strengths and split tensile strength. It is found that by the partial replacements of cement with GGBS and the sand with ROBO sand helped in improving the strength of the concrete substantially compared to nominal mix concrete. The compressive strength is studied at 7days, 28 days. Water reducing admixtures are used to increase the workability characteristics. For all levels of cement replacement concrete achieved superior performance in the fresh and mechanical tests should be compared with the reference mixture.

Key words: Hpc, Ggbs, Robo sand, Compressive strength, Split tensile strength.

1. INTRODUCTION

Concrete is the most widely used construction material in India with annual consumption exceeding 100 million cubic metres. It is well known that conventional concrete designed on the basis of compressive strength does not meet many functional requirements such as impermeability, resistance to frost, thermal cracking adequately. Conventional Portland cement concrete is found deficient in respect of:

- Durability in severe environs (Shorter service life and requiremaintenance)
- Time of construction (longer release time of forms and slower gain ofstrength)
- Energy absorption capacity (for earthquake-resistant structures)
- Repair and retrofittingjobs

In the engineering industry, the improvement of existing materials allow for technological advancement and the construction of more reliable structures without over design. A High performance concrete is something which demands much higher performance from concrete as compared to performance expected from routing concrete. Use of chemical admixtures reduces the water content, thereby reducing the porosity within the hydrated cement paste. Mineral admixtures also called as cement replacement material (CRM) such as fly ash, rice husk ash, ground granulated blast furnace slag ,Met kaolin, silica fume are more commonly used in the development of High performance mixes, act as pozzolanic materials as well as fine fillers, thereby the microstructure of hardened cement matrix becomes denser andstrong.

2. OBJECTIVES

- To determine the most optimized mix of GGBS- basedconcrete.
- To optimize strength characteristics of concrete by partially replacement of cement by GGBS and sand by Quarrysand
- To determine the variation of workability of concrete by partially replacing the cement by GGB and Robosand.
- To study the fresh properties ofconcrete
- To understand the mechanical properties ofconcrete

3. LITERATUREREVIEW

Wang Ling et al. (2004) analyzed the performance of GGBS and the effect of GGBS on fresh concrete and hardened concrete. GGBS concrete is characterized by high strength, lower heat of hydration and resistance to chemical corrosion.

Peter et al. (2010) studied the BS 15167-1 which requires that the minimum specific surface area of GGBS shall be 2750 cm2/g (BS 15167-1:2006). In China, GGBS is classified into three grades; namely S75, S95 and S105. The GB/T18046 requires a minimum surface area of 3000 cm2/g for grade S75 GGBS, 4000 cm2/g for grade S95 and 5000 cm2/g for grade S105, which are higher than the BS EN's requirements (GB/T18046-2008). It was reported that slag with a specific surface area between 4000 cm2/g and 6000 cm2/g would significantly improve the performance of GGBS concretes.

AvelineDarquennes 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).

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.

AmitRana (2012) found out the optimum quantity of steel fibres required to achieve the maximum flexural strength for M25 grade concrete was found out. From the exhaustive and extensive experimental work it was found that with increase in steel fibre content in concrete there was a tremendous increase in Flexural strength. Even at 1 % steel fibre content flexural strength of 6.46 N/mm² was observed against flexural strength 5.36 N/mm² at 0% hence increase of 1.1% flexural strength.

Eva Vejmelkova, et al., (2013). "High performance concrete with Czech meta kaolin: Experimental analysis of strength, toughness and durability characteristics" Construction and Building Materials.

MojtabaValinejadShoubi et al. (2013) reviewed in their research the specifications, production method and degree of effectiveness of some industrial byproducts such as GGBS, Silica Fume and PFA as cement replacement to achieve high performance and sustainable concrete which can lead not only to improving the performance of the concrete but also to the reduction of ECO2 by reducing the amount of PC showing how they affect economical, environmental and social aspects positively.

Marta Kasior -Kazberuk and MalgorzataLelusz (2014) " Strength of concrete with different types of cement have been analyzed to evaluate the effect of addition content, the time of curing and the type of cement on the compressive strength changes. The pozzolanic and hydraulic activity of fly ash has mainly been pointed out as well as the possibility to use this addition as a concrete component.

Shreeti S. Mavinkurve, et al., (2015) "Present paper discusses the approach adopted to develop HPC mix by means of laboratory trials using HRM. The various properties of concrete, both in the fresh and hardened states are also highlighted .It can be concluded the high strength concrete up to compressive strength of 82.75 M pa, having quite low permeability and with reasonably high slump can be developed using Indian HRM and cement".

4. MATERIALS AND TESTINGMETHODS

M-50 GRADE

Concrete mix design – M50 grade of concrete provided here is Actual site conditions vary and thus this should be adjusted as per the location and other factors.

Design Stipulation

Characteristics comprehensive Strength @ 28 days = 60 N/mm^2

Maximum size of aggregate = 20 mm\

Degree of workability = Collapsible

Degree of quality control = Good

Type of exposure = Severe

Minimum cement content as per is 456-2000

Test data for concrete ingredients

Specific gravity of cement = 3.15

Specific gravity of fly ash = 2.24

Specific gravity of microsilica = 2.21

Setting time of cement initial = 120 min, final = 185 min

Cement compressive strength =45.21 N/mm^2 @ 3 days

54.82 N/mm^2 @ 7 days

69.32 N/mm^2 @ 28 days

Specific gravity of coarse aggregates (ca) and fine aggregates (fa) 20 mm 2.729

10 mm 2.747

R/sand 2.751C/sand 2.697

Basic Properties of GGBS

Robo Sand

PROPERTITES	ROBO SAND
SPECIFIC GRAVITY	2.61

Mixing

The concrete using grade Ultratech 50 grade OPC with water cement ratio 0.37 were used. Concrete is mixed in roller type of mixing machine.

Figure shows the concrete mix

Curing

The specimen is striped after 24 hours. The test cubes were cured for duration of 28 days in a curing tank with chloride content.

Figure shows the testing samples for curing purpose after 24 hours to dip in

Compression Test

Figure shows the compression test of specimen of 150mm cube

The cubes of size 150 x 150 x 150 mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks.

Split Tensile Test

The test is carried out by placing cylinder specimen of dimension 150 mm diameter and 300 mm length, horizontally between the loading surface of compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted.

The failure load of tensile strength of cylinder is calculated by using the formula

Tensile strength = 2P/3.14 DL6.2.2

where,

P – Failure of thespecimen

D – Diameter of the specimen

L – Length of thespecimen

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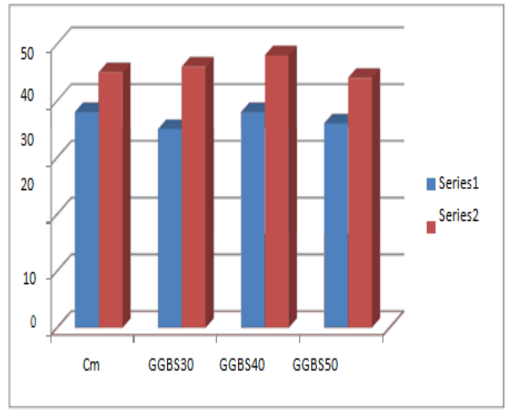
Figure shows the split tensile test

5. RESULTS ANDDISCUSSIONS

Mix Proportion Per Cubic Meter

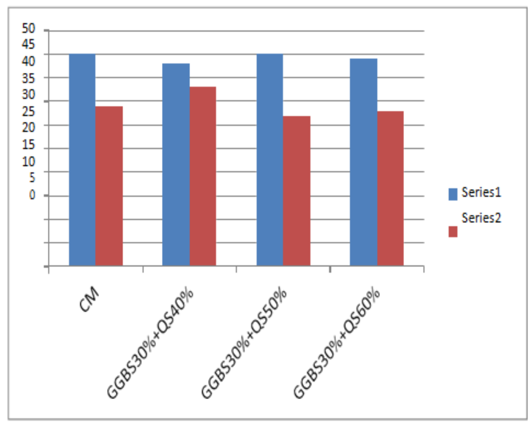
Mixes Name	GGBS (Kg)	Ceme70t (Kg)	FA (Kg)	CA(Kg)	QS (Kg)	Water (w/c 0.4) (liters)	0.75% SP (liters)
M	-	425	684.24	1121.25	-	170	3.187
M1	127.5	297.5	684.25	1121.25	-	170	3.187
M2	170	255	684.25	1121.25	-	170	3.187
M3	212.5	212.5	684.25	1121.25	-	170	3.187
M4	127.5	297.5	684.25	1121.25	273.7	170	3.187
M5	127.5	255	410.25	1121.25	342.12	170	3.187
M6	127.5	212.5	342.12	1121.25	410.55	170	3.187
M7	170	297.5	410.55	1121.25	273.7	170	3.187
M8	170	255	342.12	1121.25	342.12	170	3.187
M9	170	212.5	237.7	1121.25	410.55	170	3.187
M10	212.5	297.5	410.55	1121.25	273.7	170	3.187
M11	212.5	255	342.12	1121.25	342.12	170	3.187
M12	212.5	212.5	273.7	1121.21	410.55	170	3.187



Compressive Strength of GGBS

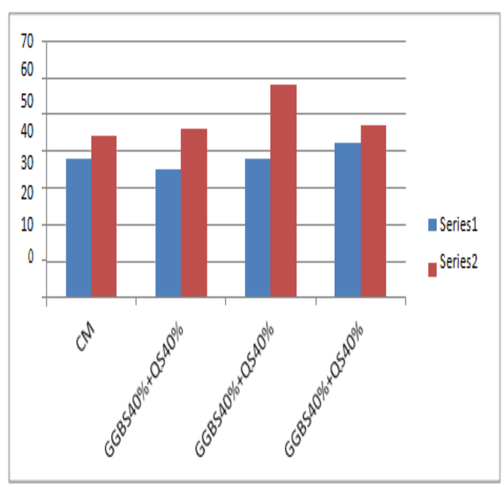
7 and 28 Days Compressive Strength of GGBS

Compressive Strength of GGBS and QS



7 and 28 Days Compressive Strength of GGBS with the variation of QS

Compressive Strength of GGBS andQS



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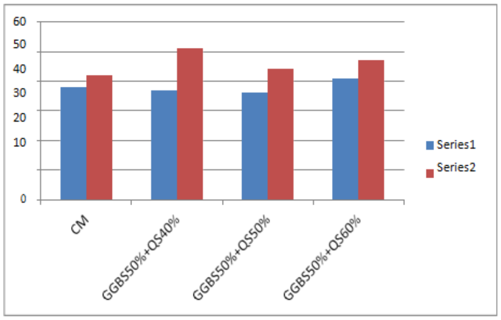
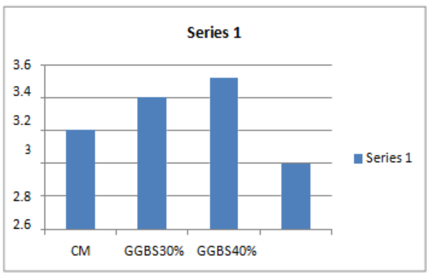
Compressive Strength of GGBS andQS



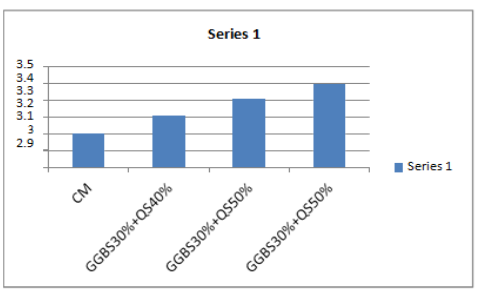
7 and 28 Days Compressive Strength of GGBS with the variation of QS

28 Days Split Tensile Strength (Mpa)



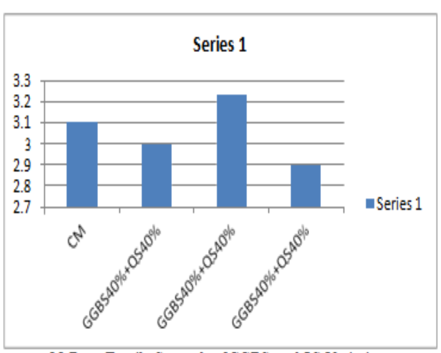
28 Days Flexural Strength of GGBS variations

28 Days Split Tensile Strength of GGBS with the Variation of QS



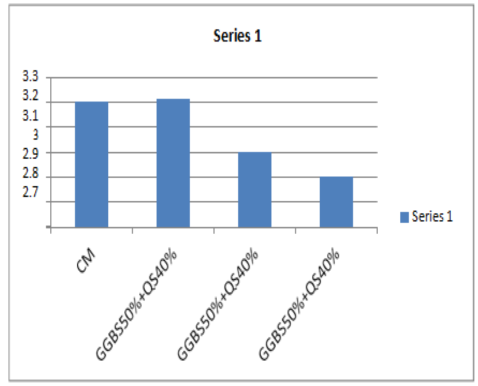
28 Days Tensile Strength of GGBS and QS Variation

28 Days Split Tensile Strength of GGBS with the Variation of QS



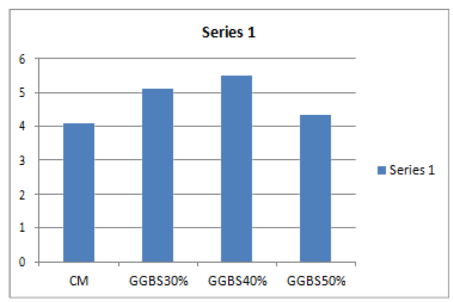
28 Days Tensile Strength of GGBS and QS Variation

28 Days Split Tensile Strength of GGBS with the Variation of QS



28 Days Tensile Strength of GGBS and QS Variation

28 Days Flexural Strength of GGBS



Days Flexural Strength of GGBS

6.CONCLUSIONS

As percentage of Robo sand replacing River Sand is increased, the workability of the mix decreases irrespective of percentage of GGBS replacing the cement. At constant percentage replacement of River Sand with Robo sand, the workability of the concrete does not get effected as percentage GGBS replacing the cement is varied. Robosand can replace River Sand 100% without effecting Compressive Strength. The optimum percentage of GGBS replacing cement is 50% for getting maximum compressive strength and the maximum Compressive Strength obtained is 52.76 N/mm2.The Split Tensile Strength increases with the increase in percentage of GGBS as well as with the increase in percentage of Robo sand and the maximum Tensile

Strength obtained is 4.56 N/mm2. The Flexural Strength also increases with the increase in percentage of GGBS as well as with the increase in percentage of Robo sand and the maximum Flexural Strength obtained is 6.85 N/mm2.The maximum increase in Compressive Strength is about 17.22% as compared to that of the conventional mix at the age of 28 days. The average increase in Split Tensile Strength is about 26.6 % as compared to that of the conventional mix at the age of 28 days. The average increase in Flexural Strength is about 12% as compared to that of the conventional mix at the age of 28days.

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