

INVESTIGATION ON MECHANICAL AND DURABILITY PROPERTIES OF HIGH PERFORMANCE CONCRETE WITH GGBS AND ROBO SAND

GARIDIGALLA BALA RAJU¹, G RAJESH²

¹M. Tech Student, Department of Civil Engineering, P.V.K.K Institute of Technology, Alamuru Road, Anantapur, Andhra Pradesh 515002

²Assistant Professor, Department of Civil Engineering, P.V.K.K Institute of

ABSTRACT- Increased compressive, shear, and tensile strength, less creep and shrinkage, and ease of placing are just a few of the benefits of using high performance concrete. Potentially lower ductility and fire resistance as well as higher unit cost mitigate these benefits. This research delves into the properties of M40 grade concrete that has had some of its cement and sand replaced with ROBO sand (crushing dust) and Ground Granulated Blast Furnace Slag (GGBS). Cylinders and cubes undergo compressive and split tensile strength tests. There was a noticeable increase in concrete strength when GGBS and ROBO sand were partially substituted for cement and sand, respectively, in comparison to nominal mix concrete. At 7, 28 days and 900 days, the compressive strength is measured. The workability is improved by adding admixtures that reduce water content. It is important to compare the results of the mechanical and fresh tests that concrete with different amounts of cement substitution produced with the reference mixture.

1. INTRODUCTION

Concrete is considered as durable and strong material. Reinforced concrete is one of the most popular materials used for construction around the world. Reinforced concrete is exposed to deterioration in some regions especially in coastal regions. Therefore researchers around the world are directing their efforts towards developing a new material to overcome this problem. Invention of large construction plants and equipments around the world added to the increased of material. This scenario leads to the use of additive materials to improve the

quality of concrete. As an outcome of the experiments and researches, cement based concrete which meets special performance with respect to workability, strength and durability known as "HIGH PERFORMANCE CONCRETE" was developed.

Concrete has been the major instrument for providing stable and reliable infrastructure since the days of Greek and romancivilization. The most important part of concrete is the cement. Use of cement alone as a binder material produces large heat of hydration. Since the production of this raw material produces lot of CO₂ emission. The carbon dioxide emission from the cement raw material is very harmful to the environmental changes. Nowadays many researchers have been carried out to reduce the CO₂. The effective way of reducing CO₂ emission from the cement industry is to use the industrial by products or use of supplementary cementing material such as Ground Granulated Blast Furnace Slag (GGBS), Fly Ash(FA), Silica Fume (SF) and Metakaolin (MK). In this present experimental work an attempt is made to replace cement by GGBS to overcome these problems. River sand has been used as a major building material component. Its well- graded and that all sizes grains are well distributed in a given sample. River sand is mainly used for all kinds of civil engineering construction. River sand has been the most important choice for the fine aggregate River sand has been used as a major building material component. Its well-graded and that all sizes grains are well distributed in a given sample. River sand is mainly used for all kinds of civil engineering construction. River sand has been the most important choice for the fine aggregate component of concrete

in the early periods. Overuse of the material have been led to environmental concerns, the depleting of securable river sand due to this the material cost also increases. Nowadays the natural river sand becomes scarce and very costly. To overcome from this crisis, partial replacement of natural sand with robo sand is economic alternative. Use of robo sand in concrete increases the strength characteristics component of concrete in the early periods. Overuse of thematerial have been led to environmental concerns, thedepleting of securable river sand due to this the material costalso increases. Nowadays the natural river sand becomesscarce and very costly. To overcome from this crisis, partialreplacement of natural sand with quarry sand is economicalalternative. Use of robo sand in concrete increases the strength.

2. LITERATURE REVIEW

P.L.Domone, and M.N.Soutsos, (1995) “The results showbroadly similar effects to those in lower strength concrete,although of differing magnitude in some cases. Some potential advantages of ternary blends for optimization ofproperties have been demonstrated. Long- term strength of PFA and GGBS mixes may not reach those of 100% Portland cement mixes when the water-binder ratio is reduced to 0-26 and below, but micro silica can increase the strength of all mixes”.

R.Duval and E.H.Kadri (1998) “The results show that partial cement replacement up to10% silica fume does not reduce the concrete workability and propose a model to evaluate the compressive strength of silica fume concrete at any time. The increase of the compressive strength of SF concretes depends much more on the decrease of the water/cementitious materials ratio than on the replacement of silica fume with cement’.

ShreetiS.Mavinkurve, et al., (2003) “Presentpaper 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”.

3. MATERIALS AND MIX PROPORTIONING

Coarse aggregates

Locally accessible pulverized rock stone total of 10mm size was utilized ascoarse total. The coarse total going through 10mm and holding 4.75mm was utilized for exploratory work. The properties of coarse totals were resolved as perIS: 2386-1963.

Fine aggregates

The locally accessible stream sand, going through 4.75 mm was utilized in this test work. The properties of fine totals were resolved according to May be: 2386-1963.

GGBS

Ground Granulated Blast Furnace is a byproduct from the Blast furnace slag is a solid waste discharged in large quantities by the iron and steel industry in India. These operate at a temperature of about 1500 degree centigrade and fed with a carefully controlled mixture of iron – ore, coke and limestone. The iron ore is reduced to iron and remaining materials from slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has been rapidly quenched in large volumes of water. The quenching optimizes the cementitious properties and produces granules similar to coarse sand. This granulated slag is then dried and to a fine powder.

Manufactured sand

Fabricated sand (M-Sand) is a substitute of waterway sand for solid development. Made sand is delivered from hard rock stone by pounding. The pulverized sand is of cubical shape with grounded edges, washed and evaluated to as a development material. The extent of produced sand (M-Sand) is under 4.75mm.



GGBS

MIX DESIGN

Mix Proportion for M₄₀

Cement(binder)	Fine aggregate	Coarse aggregate	Water
385 kg/m ³	820.43 kg/m ³	1140.11 kg/m ³	140 kg/m ³
1	2.13	2.96	0.36

Mixing Casting and Curing

Mixing of concrete is done by using hand. All the ingredients of concrete were weighed and batched according to the mix proportions. The order of mixing the ingredients of concrete was first fine aggregates, cement, coarse aggregate and finally water with admixture. The materials must be thoroughly mixed to obtain a good mix. After getting a mix, the moulds must be taken and apply grease to the inner surface of the mould for getting cubes easily. Concrete is poured in each mould by three layers. Each layer is to be tampered 25 times by using tamping rod. After casting the moulds they have to be removed after 24 hours. The curing must be done; immediately after removing the moulds.

Tests to be conducted on concrete

Fresh concrete tests

Slump cone test

Hardened concrete tests

Compressive strength

Split tensile strength

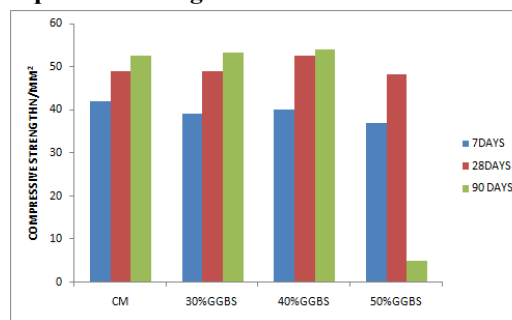
4. RESULTS AND ANALYSIS

Workability of concrete

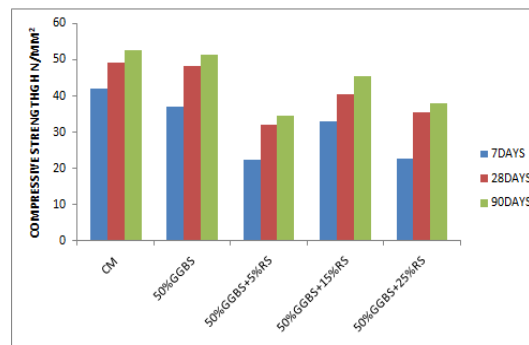
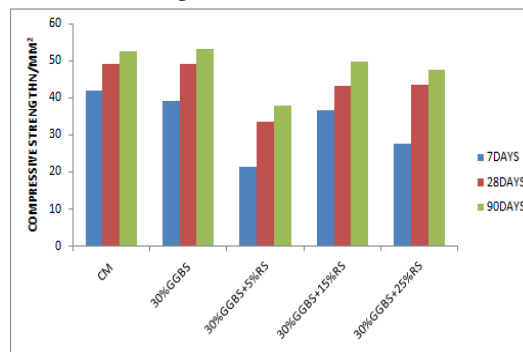
Slump cone test

MIX PROPORTION	SLUMP
CM	100
30%GGBS	85
40%GGBS	110
50%GGBS	120
30%GGBS+5%RS	97
30%GGBS+15%RS	63
30%GGBS+25%RS	52
40%GGBS+5%RS	96
40%GGBS+15%RS	64
40%GGBS+25%RS	54
50%GGBS+5%RS	97
50%GGBS+15%RS	62
50%GGBS+25%RS	51

Compressive strength of concrete

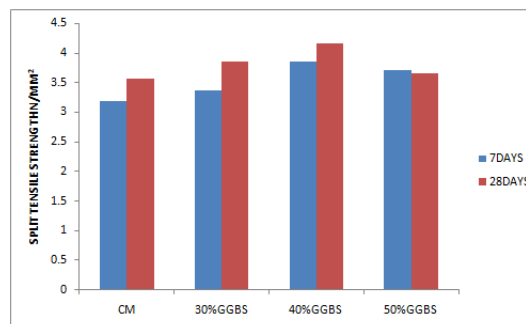


Variation of compressive strength for Compressive strength of GGBS Concrete

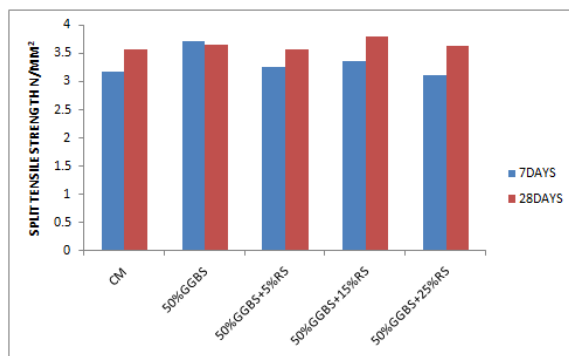
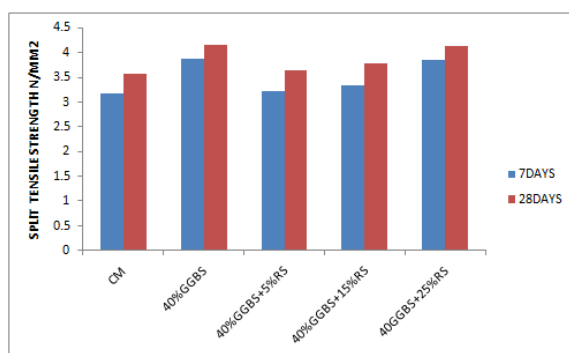
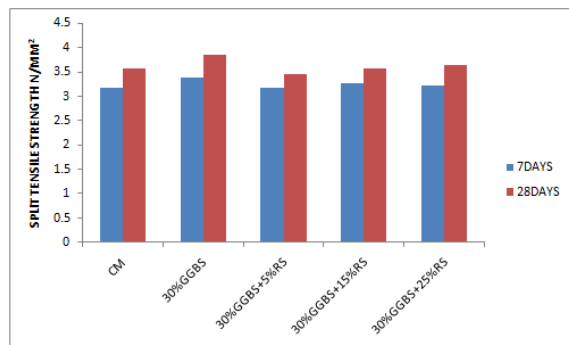


Compressive strength of GGBS with variations of Robo sand

Split tensile strength of GGBS mixes



Split tensile strength of GGBS with variations of ROBO sand



5. CONCLUSIONS

From the above trial think about the accompanying ends were made

1. In high performance concrete mix design as water cement ratio adopted is low, super plasticizers are necessary to maintain required workability. As the percentage of mineral admixture is increased for through mixing and for obtaining the desired strength.

2. The workability of concrete was found to be increases with the increase in GGBS in concrete. It further decreases as the percentage of Quarry Sand increases
3. In M₄₀ grade of concrete as the water-cement ratio of 0.36 is insufficient to provide the good workability, hence super plasticizer are necessary for those grades of concrete.
4. Maximum compressive and flexural strength has been obtained for replacement of cement by 40% GGBS.
5. Compressive strength of concrete can be improved by using admixtures.
6. From the graph it is proved that ROBO sand can be used as an alternative material for the fine aggregate.
7. The compressive strength is increased as the percentage of ROBO sand is increased and further decreases.
8. We observed that better results obtained when GGBS is replaced up to 40% and ROBO sand up to 15%.
9. Maximum compressive strength obtained for replacement of cement by 40% GGBS and sand by 15% of robo sand
10. Maximum split tensile strength obtained for replacement of cement by 40% GGBS and sand by 15% of robo sand,
11. The scope of using high performance concrete in our constructional activities lies large, viz., precast, prestressed bridges, multi-storied buildings, bridges and structures on coastal areas and like. To affect this change, we will have to review the designing to structures by encouraging use of high performance concrete.

REFERENCES

- [1]. Indian standard recommended method of concrete mix design (IS: 10262-2009).
- [2]. Concrete technology by M.S. Shetty.
- [3]. High performance concrete by V.M. Malhotra.
- [4]. Design of concrete mixes by N. Krishna raju.
- [5]. Bureau of Indian standards, specification for casting of specimen IS: 10262-1962..

- [6]. Domone, and M.N.Soutsos, (1995). "Properties of high strength concrete mixes containing PFA and GGBS" magazine of Concrete research, Vol.47, pp 355-367
- [7]. Duval and E.H.Kadri (1998) "Influence of silica fume on the workability and the compressive strength of high performance concretes" Cement and concrete research, Vol.28, pp 533-547
- [8]. Shreeti S. Mavinkurve, et al., (2003). "High performance concrete using high reactivity metakaolin" The Indian concrete Journal, pp 1077-1085
- [9]. Marta Kasior-Kazberuk, and Malgorzata Lelusz. (2007) "Strength development of concrete with fly ash addition" Journal of civil engg. And management, Vol.8, pp 115-125
- [10]. Forster (1994) as "a concrete made with appropriate materials combined according to a selected mix design and properly mixed, transported, placed, consolidated."
- [11]. Bache reported that using a "very high dosage of superplasticizers and silica fume, water binder ratio can be reduced to 0.16 to reach a compressive strength of 280 MPa" (Bache, 1981).
- [12]. Ozkul and Dogan (1999) studied the "effect of an N-vinyl copolymer superplasticizer on the properties of fresh and hardened concretes".
- [13]. Wang (2008) investigated the "effects of elevated temperature on cement pastes by conducting experimental test on concrete by replacing cement with GGBS"
- [14]. Maiti & Raj (2010) did an experimental study on concrete mix design on Portland cement replacements by GGBS from 50 to 65% for M20 grade concrete
- [15]. Ramesh et al. (2013) conducted an experimental investigation on durability characteristics of high performance concrete using mineral admixtures on M75 grade concrete with replacement levels of 0, 5%, 7.5% and 10% of silica fume and ground granulated blast furnace slag
- [16]. Mohamed et al. (2012) conducted an investigation on the locally available ground granulated blast furnace slag to protect the environment against waste dumping