International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Study of Properties of High Strength Concrete Prepared By Partial Replacement of Cement with GGBS

Sreejith Haridas[1], Shaji M Jamal[2]
[1]P.G. Student, Department of Civil Engineering, Ilahia College of Engg & Tech., Muvattupuzha, Kerala, India
[2]Asst. Professor, Department of Civil Engineering, Ilahia College of Engg & Tech., Muvattupuzha, Kerala, India

Abstract— *Concrete is a composite construction material composed mainly of cement, fine aggregate, coarse aggregate and water. Concrete is designated as "high strength concrete" on the basis of its compressive strength measured at a given age. Concrete mix that show 40MPa or more compressive strength at 28-days are designated as high-strength concrete. Now days, 60-100 MPa concrete mixes are commercially developed. Aggregate occupy 70-75% of the total volume of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas a major contributor for green house effect and global warming. Hence it is inevitable to search either for a substitute to cement or partially replace it by some other material. Mineral admixtures such as blast furnace slag powder can be used as partial replacement to cement by 10 to 50%. In this study first the properties of a normal HSC M60 mix was evaluated. Then mixes with 30%, 40%, and 50% replacement of cement with GGBS was prepared and optimum percentage was determined by studying the fresh and Hardened state properties and comparing it with control mix. Optimum percentage was selected as 40%. Fresh properties of the HSC will be tested for slump and Compaction factor test. Hardened properties of HSC will be studied for compressive strength, flexural strength and splitting tensile strength. By studying the compressive strength of mix with partial replacement of GGBS gave high strength than Control mix. When comparing the Split tensile strength, and flexural strength also HSC with partial replacement of GGBS gave satisfactory results.*

Keywords— *High strength concrete, ground granulated blast furnace slag (GGBS), m-sand.*

I. INTRODUCTION

Concrete is a widely used construction material around the world, and its properties have been undergoing changes through technological advances. So far, numerous types of Concrete have been developed. Concrete is designated as "high-strength concrete" on the basis of its compressive strength measured at a given age. Any concrete mixtures that showed 40 MPa or more compressive strength at 28-days are designed as high-strength concrete. Now a days 60-100MPa concrete mixtures are commercially developed and used in the construction of high-rise buildings and long-span bridges in many parts of the world. With natural aggregates, it is possible to make concretes up to 120MPa compressive strength by improving the strength of the cement paste, which is controlled through the choice of cement ratio and type and dosage of admixtures. However, with the recent advancement in concrete technology and the availability of various types of mineral and chemical admixtures, and special super plasticizer, concrete with a compressive strength of up to 100MPa can now be produced commercially with an acceptable level of variability using ordinary aggregates. These developments have led to increased applications of high-strength concrete (HSC) all around the globe. HSC offers many advantages over conventional concrete. The high compressive strength can be advantageously used in compression members like columns and piles. Higher compressive strength of concrete results reduction in column size and increases available floor space. HSC can also be effectively used in structures such as domes, folded plates, shells and arches where large in-plane compressive stresses exist. The inherent techniques of producing HSC generate a dense microstructure making ingress of deleterious chemicals from the environment into the concrete core difficult, thus enhancing the long-term durability and performance of the structure.

Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas a major contributor for greenhouse effect and global warming into the atmosphere. Hence it is inevitable to search either for another material or partially replace it by some other material. The search for any such material which can be used as an alternative for cement, should lead to global sustainable development and lowest possible environmental impact. Mineral admixtures such as blast furnace slag powder can be used as partial replacement of cement by 10 to 50%. Compressive strength of blast furnace slag concrete with different dosage of slag was studied as a partial replacement of cement. From the experimental investigations, it has been observed that, the optimum replacement of Ground Granulated Blast Furnace Slag Powder to cement without much change in compressive strength is 15%.

II. SCOPE

- Determine fresh, hardened state properties of High strength concrete (M60) prepared by partial replacement of cement with GGBS.
- No previous studies were done on the properties of high strength concrete (M60) made with partial replacement of cement with GGBS, so this thesis helps to give a clear idea about its properties.

Sreejith Haridas and Shaji M Jamal, "Study of properties of high strength concrete prepared by partial replacement of cement with GGBS," *International Research Journal of Advanced Engineering and Science*, Volume 2, Issue 2, pp. 127-130, 2017.

- Comparative study of Fresh and Hardened state properties of high strength concrete using GGBS with the control mix can be made.

III. Objective

- Partially replace cement with GGBS in M60 mix.
- Develop concrete with good strength, less porosity, less capillarity, so that more durability is achieved.
- Determine optimum water/binder ratio, so that design mix having proper workability and strength is obtained.
- Find the optimum percentage of replacement of cement with GGBS.
- To study the properties of HSC M60 grade with optimum percentage of replacement of cement with GGBS.
- To compare the properties of M60 grade HSC with HSC with GGBS.

IV. Methodology

Literature Review

Selection of materials

Cement (Ordinary Portland Cement), Blast Furnace Slag, Coarse Aggregate, Super Plasticizer, Alccofine

Determination of material properties

- Cement:-Specific gravity, initial setting time, final setting time, standard consistency.
- GGBS:- Physical and chemical properties, specific gravity.
- Fine aggregate:- Specific gravity, Sieve analysis, Water absorption.
- Coarse aggregate:- Specific gravity, Sieve analysis, Water absorption, Aggregate crushing value.
- Water
- Super Plasticizer
- Alccofine

Mix proportioning

- M60 mix is adopted
- Mix proportioning is done by conducting trials and seeking experience from Neptune RMC plant, Kalamassery.
- Also using guide lines from IS 10262:2009, IS 383:1970, NMRCA and IS 456:2000

Preparation of specimen

- Preparation of M60 Mix
- Preparation of concrete with optimum percentage of coarse and fine aggregate with partial replacement of cement with blast furnace slag (30%, 40%, 50%)
- Cube of size 150×150×150mm, Beam of size 100×100×500mm, and cylinder of size 300×150mm are casted to conduct test for compressive strength, flexural strength, splitting tensile strength of the mixes. Age for compressive strength is 3,7,and 28 days and for flexural and splitting tensile strength 7 and 28 days
- Mix proportions;

Cement (Kg/m^3)	CA (Kg/m^3)	FA (Kg/m^3)	Water (Kg/m^3)	Mineral admixre (Kg/m^3)	Super plasticizer (Kg/m^3)
450	1132	786.4	165	13.5(3%)	1.39(0.3%)
450	1132	786.4	165	18 (4%)	1.87(0.4%)
450	1132	786.4	165	36 (8%)	3.88(0.8%)
450	1132	786.4	165	31.5(7%)	3.37(0.7%)
450	1132	786.4	165	27 (6%)	2.86(0.6%)
450	1132	786.4	165	22.5(5%)	2.37(0.5%)

V. Experimental Results

A. Control Mix

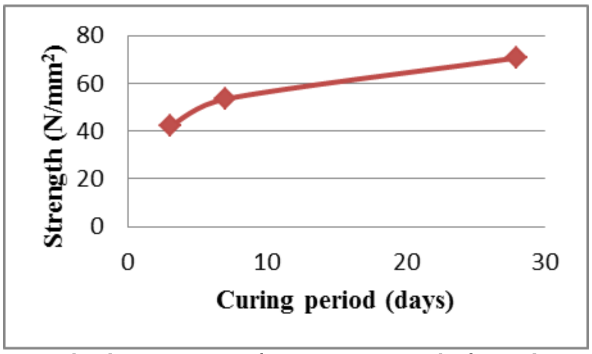

Fig. 1.Graphical representation of compressive strength of control mix.

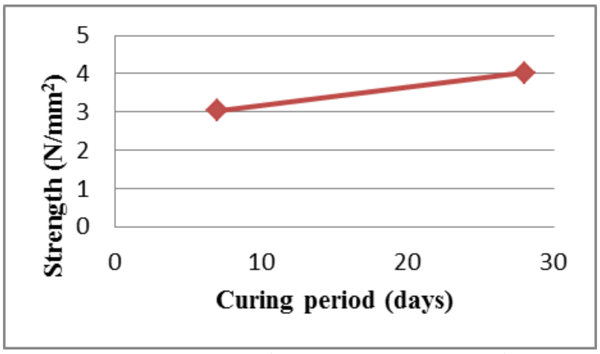

Fig. 2.Graphical representation of splitting tensile strength of control mix.

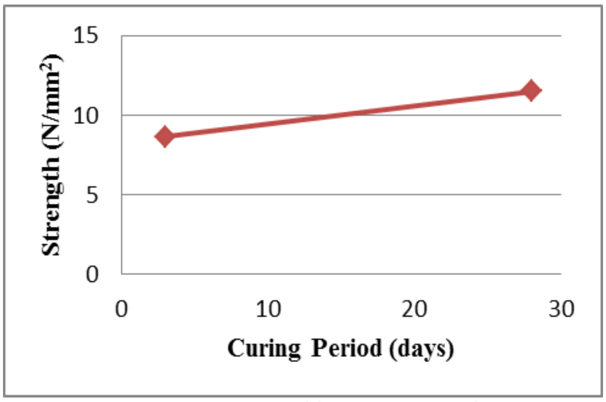

Fig. 3.Graphical representation of flexural strength of control mix.

B. Mix with Partial Replacement Of Cement With GGBS (GGBS MIX)

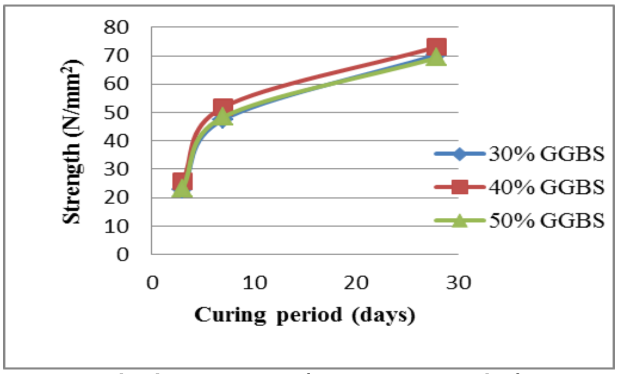

Fig. 4.Graphical representation of compressive strength of GGBS mix.

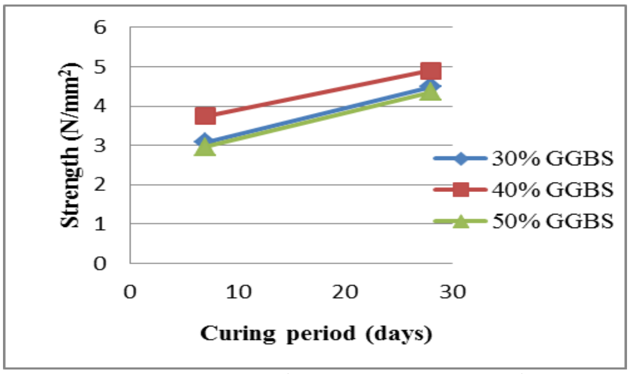

Fig. 5.Graphical representation of splitting tensile strength of GGBS mix.

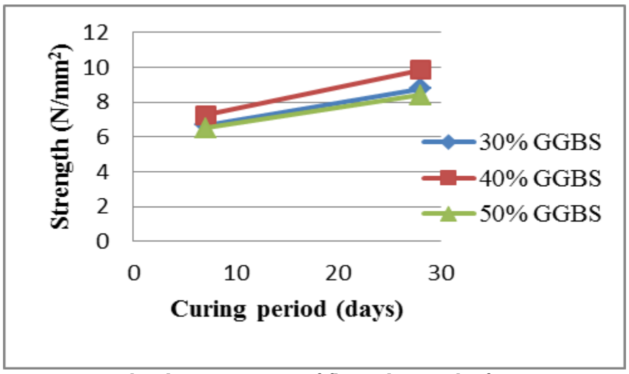

Fig. 6.Graphical representation of flexural strength of GGBS mix.

C. Comparison of Control Mix and GGBS Mix

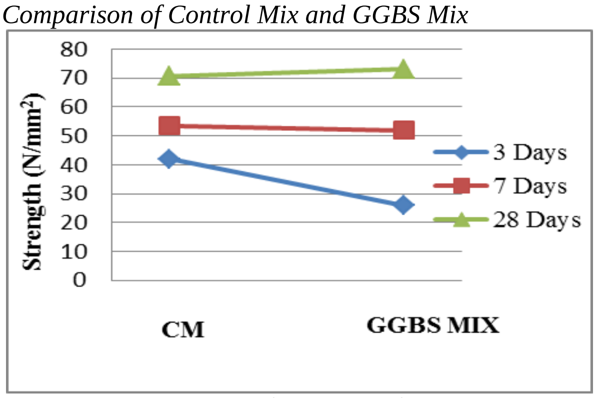

Fig. 7.Graphical representation of comparison of compressive strength of control mix and GGBS mix.

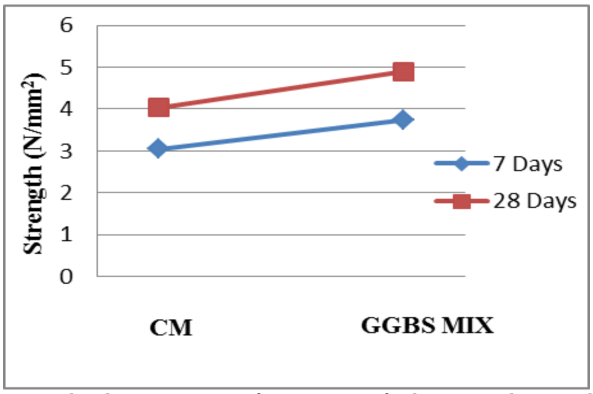

Fig. 8.Graphical representation of comparison of splitting tensile strength of control mix and GGBS mix.

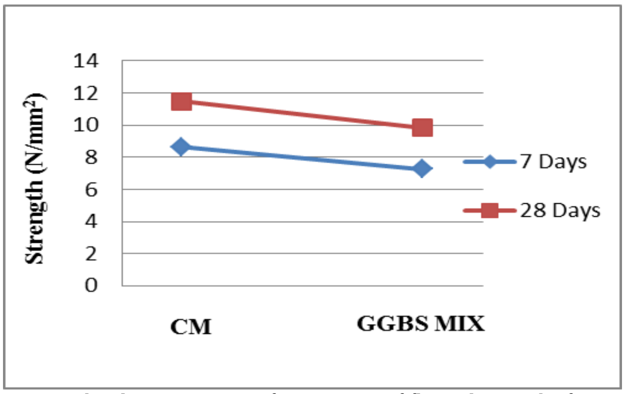

Fig. 9.Graphical representation of comparison of flexural strength of control mix and GGBS mix.

From the above results, it can be seen that comparison of 28 day strength of control mix with partial replacement of GGBS at 30%, 40% and 50%, Compressive strength of mix with 30% GGBS shows 0.45% lower strength than Control mix in 28 days. Compressive strength of mix with 40% of GGBS shows 3.53% higher strength than control mix, and Compressive strength of mix with 50% of GGBS shows 2% lower strength than Control mix. Initial development of strength is at slower rate for GGBS mix, and is attained its strength as per curing period increases. Slitting tensile strength of mix with optimum percentage GGBS shows 7.34% higher strength than Control mix and Flexural strength of mix with optimum percentage of GGBS 40% GGBS shows 16.98% lower strength than Control mix in 28 days.

VI. Conclusion

Properties of concrete were studied in present study with Ordinary Portland cement (OPC) for control mix and partial replacement of GGBS for GGBS Mix. The study was carried out on M60 grade concrete. Two different mixes was studied, the following are the conclusions obtained.

- GGBS increases the workability of concrete, as compared to control mix.
- The optimum replacement percentage of cement with GGBS is found to be 40%.

- Compressive strength of mix with optimum percentage of GGBS shows 3.53% higher strength than control mix in 28 days.
- Splitting tensile strength of mix with optimum percentage GGBS shows 7.34% higher strength than Control mix in 28 days.
- Flexural strength of mix with optimum percentage of GGBS shows 16.98% lower strength than Control mix in 28 days.
- Use of M60 mix in which cement is replaced with 40% GGBS can reduce the consumption, thus reducing production of cement and emission of carbon dioxide to atmosphere.

REFERENCES

[1] Y. O. Patil, P. N. Pattil, and A. K. Dwivedi, "GGBS as partial replacement of OPC in cement concrete-An experimental study," *International Journal of Scientific Research*, vol. 2, issue 11, 2013.
[2] A. Dubey, R. Chandak, and R. K. Yadav, "Effect of blast furnace slag powder on compressive strength of concrete," *International Journal of Scientific & Engineering Research*, vol. 3, issue 8, pp. 1-5, 2013.
[3] C. Garg and A. Khadwal, "Behavior of ground granulated blast furnace slag and limestone powder as partial cement replacement," *International Journal of Engineering and Advanced Technology (IJEAT)*, Vol. 3 Issue 6, pp. 93-96, 2013.
[4] T. Vijaya Gowri, P. Sravana, and P. Srinivasa Rao, "Studies on strength behavior of high volumes of slag concrete," *International Journal of Research in Engineering and Technology*, vol. 03, issue 04, pp. 227-238, 2014.
[5] S. K. Gadpalliwar, R. S. Deotale, and A. R. Narde, "To study the partial replacement of cement by GGBS & RHA and natural sand by quarry sand in concrete," *IOSR Journal of Mechanical and Civil Engineering*, vol. 11, issue 2 ver. II, pp. 69-77, 2014.
[6] A. Annadurai and A. Ravichandran, "Development of mix design for high strength concrete with admixtures," *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, vol. 10, issue 5, pp. 22-27, 2014.
[7] S. Arivalagan, "Sustainable studies on concrete with GGBS as a replacement material in cement," *Jordan Journal of Civil Engineering*, vol. 8, no. 3, pp. 263-270, 2014.
[8] V. Awasare and M. V. Nagendra, "Analysis of strength characteristics of GGBS concrete," *International Journal of Advanced Engineering Technology*, vol. V, issue II, pp. 82-84, 2014.
[9] A. Suvarna, P. J. Salunke, N. G. Gore, and T. N. Narkehde, "Silica fume & ground granulated blast furnace slag as cement replacement in fiber reinforced concrete," *International Research Journal of Engineering and Technology (IRJET)*, vol. 02, issue 07, pp. 438-443, 2015.