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A Review on High Performance Concrete Using Mineral Fly Ash and GGBS with M-60 Grade Concrete

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Abstract: ***The use of supplementary cementitious materials is well accepted because of the several improvements possible in the concrete mix, for the overall economy. The present work is a support to use the waste product from steel industry is helpful in cement which also helps to reduce the carbon footprint. In recent years Blast Furnace Slag when replaced with cement has emerged as a major alternative to conventional concrete and has rapidly gained the concrete industry's attention due to its cement savings, energy savings, and cost savings, socio-economic and environmental benefits. The present study reviews the results of an experimental study, conducted by various authors to evaluate the strengths and strength efficiency factors of hardened concrete, by partially replacing the cement by various percentages of ground granulated blast furnace slag and fly ash. The optimum GGBS and fly ash replacement as the cementitious material is characterized by high compressive strength, low heat of hydration, resistance to chemical attack, better workability, and good durability and cost-effective.***

Keywords: Ground Granulated Blast Furnace Slag, Cement Concrete, Workability, Compressive Strength, Flexural Strength.

1. INTRODUCTION

Concrete has basic naturally, cheaply and easily available ingredients as cement, sand, aggregate, and water. After the water, cement is second most used material in the world. But this rapid production of cement creates two big environmental problems for which we have to find out civil engineering solutions. First environmental problem is the emission of CO2 in the production process of the cement. We know that CO2 emission is very harmful which creates lots of environmental changes whatsoever. Ground Granulated Blast furnace slag (GGBS) is a by-product of the manufacture of pig iron and obtained through rapid cooling by water or quenching molten slag. Here the molten slag is produced which is instantaneously tapped and quenched by water. This rapid quenching of molten slag facilitates the formation of "Granulated slag". Ground Granulated Blast furnace Slag (GGBS) is processed from Granulated slag. Fly ash is one of the residues created during the combustion of coal in coal-fired power plants. Fine particles rise with flue gasses and are collected with finely-divided mineral admixture, available in both uncompact and compacted forms. This ultra-fine material will better fill voids between cement particles and result in a very dense concrete with higher compressive strengths and extremely low permeability.

2. LITERATURE REVIEW

Anjali Prajapati et. al. (2017) studied the effect of the performance of HPC using mineral admixture i.e. fly ash and GGBS with M-60 grade of IS cube specimen.We partially replaced Portland cement by weight of the binder. Fly ash and GGBS replacement vary from 10% to 30%. We used Conplast SP430-Sulphonated Naphthalene Polymers as a superplasticizer for better workability for high performance concrete. Dosage for superplasticizers is same for all mix proportions. Also, we have replaced fine aggregate in different proportions with foundry sand. We have investigated compressive strength, split tensile strength and flexural strength for all different cases. The HPC mix, grade M60concrete is designed as per Indian standards.

K. Nagaraj & P. Himabindu (2017) tested on concrete elements with Ground granulated blast furnace slag and Fly ash to obtain the desired strengths and properties. Finally, we used in combination of fly ash and ground granulated blast furnace slag in different percentages as replacement of cement and concrete was prepared. We casted concrete cubes and prism are kept for curing for a period of 28days. Finally, compressive test and flexural test are conducted.

To obtain such desired strength that cannot be obtained from conventional concrete and by the current method, a large number of trial mixes with different percentages of fly ash and different percentages of Ground granulated blast furnace slag are required to select the desired combination of materials that meet the required strength.

Praveen Kumar S. R et. al. (2016) prepared a high strength SCC of grade M60 by partially replacing the cement content with the untreated industrial by-products like fly ash & ground granulated blast furnace slag (GGBS) and also by replacing 100% of natural sand with manufactured sand (M. Sand). With the use of these industrial by-products, it results in an eco-friendly environment and also solves the problem at its disposal. Their work deals with the comparative study on mechanical properties like compressive strength, split tensile strength and flexural strength of SCC for various percentages of powder contents with the use of glass fibres at 0%, 0.1% & 0.2% to the total volume of the concrete mix. In this study two types, SCC mixes were prepared namely, Conventional SCC in which cement content was replaced by 30% with fly ash and Triple blended SCC in which cement content was reduced to 50% & the rest of the cement content was replaced with fly ash & GGBS by 25% each. The specimens are casted, cured & tested for the required number of days.

Muthukumar .T et. al. (2016) investigated on high performance concrete using M50 grade mix proportion. High performance concrete achieved by, 100% replace the fine aggregate by crusher wash sand and partial replacement of cement by micro silica (i.e., 5%, 10%, 15%, 20% & 25%). Glenium b233 were added to the workability of concrete mix. A result data obtained has been analysed and compared with a control specimen. A relationship between Compressive strength vs. days, Tensile strength vs. days, and Flexural strength vs. days represented graphically. Result data clearly shows the percentage increase in 7 and 28 days Compressive strength, Tensile strength and Flexural strength for M-50 Grade of Concrete. Combination of micro silica, crusher wash sand and super plasticizer in this experimental study show a great improvement in the compressive strength as well as tensile properties.Cement was replaced by micro silica by 20%, however strength increases by 16.5%. High Performance Concrete strength is achievable using micro silica.

Surekha & Chandra shekhar (2015) investigate the strength properties of GGBS (Ground Granulated Blast Furnace Slag) and Silica Fume along with Polyvinyl Chloride dust at the various replacement levels. Large scale production of cement is causing environmental problems. This has made the researchers to use the supplementary cementatious material in making concrete. Polyvinyl Chloride dust is a waste material produced in pipe industry. PVC dust is used as filler material to way towards the waste utilization. An m40 grade of concrete is used in the study and mix design was carried out according to guidelines10262 (2009). A constant 8% of Silica Fume was used as on cement replacement for all the mix. Effect of GGBS was studied by replacing cement by 30 to 50% along with PVC dust 0 to 10% as an additive. Mechanical Strengths such as compressive, Split Tensile strength and Flexural strength are investigated.

Rajith M & Amritha E K (2015) investigated the behaviour of M30 concrete by partial replacement of cement and fine aggregate by Ground granulated blast furnace slag (GGBS) and Granulated blast furnace slag (GBS). Cubes, cylinders, and beams are tested for compressive, split tensile and flexural strength after 28 days curing. Cubes are used to find the ultra-sonic pulse velocity. Replacement percentage of cement and fine aggregate by GGBS and GBS are 20, 25, 30 and 25, 50, 75 respectively. Water cement ratio used in this work is 0.45. It is found that by partial replacement of cement with GGBS and sand with GBS helped in improving the strength of concrete compared to normal mix concrete.

Rafat Siddique (2014) covers the properties of GGBS, reaction mechanism and its effect on strength and durability properties of concrete.

S. Arivalagan (2014) evaluated the strength and efficiency factors of hardened concrete, by replacing cement by various percentages of GGBS for an M35 grade of concrete. The optimum strength was obtained at 20% replacement.

Merin K Abraham et. al. (2014) studied was conducted on concrete and the results are compared and analysed. The optimum percentage replacement of cement with mineral admixtures for better strength was found out.

Reshma Rughooputh and Jaylina Rana (2013) studied the effects of partial replacement of OPC by GGBS on various properties of concrete including compressive strength, tensile strength, splitting strength, flexure strength, modulus of elasticity, drying shrinkage and initial surface absorption. Cement was partially replaced by 30 % and 50 % of GGBS by weight and test was performed at 7 and 28 days. It was found that GGBS in concrete leads to lower early compressive strength gain but higher later compressive strength gain. Flexural strength of test specimens increased by 22% and 24%, tensile strength increased by 12% and 17% to 30% and 50% replacement respectively. Drying shrinkage increased by 3% and 4%.

S. Arivalagan (2012) investigated the strength and strength efficiency factors of hardened concrete, by partially replacing cement with 20 %, 30% and 40% GGBS at different ages. The specimens when tested at 7 and 28 days, showed an increase in compressive strength for 20% replacement of cement. Split tensile strength and flexural strength of concrete also increased at 20% cement replacement. The increasing strength is due to filler effect of GGBS. It was also found that the degree of workability of concrete was normal and it increased with the addition of GGBS.

Yogendra O. Patil et. al. (2012) researched on the effects on compressive strength and flexural strength of concrete with partial replacement of cement with various percentages of GGBS. The tests were conducted at 7, 28 and 90 days with replacement ranging from 10 % to 40 %.

It was observed that the strength of concrete is inversely proportional to the percentage of replacement of cement with GGBS. The replacement of OPC by GGBS up to 20% shows the marginal reduction of 4 – 6 % in compressive and flexural strength for 90 days curing and beyond that of more than 15%. He concluded that, GGBS as replacement of OPC by 20% results in a reduction in the cost of concrete at the current market rate.

T. Vijaya Gowri et. al. (2011) investigated the effects of partial replacement of cement with GGBS on compressive strength, split tensile strength and flexural strength of concrete at 28, 90, 180 and 360 days. He used 50% GGBS as replacement material of cement for various water/binder ratios i.e. 0.55, 0.50, 0.45, 0.40, 0.36, 0.32, 0.30 and 0.27. He observed that the High Volumes of slag concrete gains an appreciable amount of strength at later ages (90 days onwards) and it increases with a decrease in water/binder ratios. He found out that the strength of high volume of slag concrete is more at later ages because of slower hydration of slag with $Ca(OH)_2$ and water. He concluded that on replacement of cement by 50% GGBS helps to reduce the cement content of concrete, thereby reducing the cost of concrete and also protecting the environment from pollution.

M. Ramalekshmi et. al. (2011) discussed the results of partial replacement of cement with 50% - 80% of GGBS on compressive strength of concrete at 7, 14 and 28 days. She concluded that slag replacement decreases the strength of concrete in short term when compared to control OPC. However, in long term, it exhibits greater final strength. Thus 50% GGBS as replacement showed maximum compressive strength at 28 days. Experiments were also conducted on beam-column with and without GGBS with 50% replacement. The specimen was tested at 28 days under constant axial load and varying lateral load which showed an increase in load carrying capacity of the specimen by 6.6 %. Thus 50% GGBS as a replacement can be used in RC specimens.

Venu Malagavelli et. al. (2010) focused on investigating characteristics of M30 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 both compressive and tensile strengths. It is found that by the partial replacement of cement with GGBS and sand with ROBO sand helped in improving the strength of the concrete substantially compared to normal mix concrete.

3. CONCLUSION

A survey of journal articles published between 2010 and 2017 yields studies that vary in scope and level of analysis, yet with consistently good results.

As our aim is to develop concrete which does not only concern on the strength of concrete, it also has many other aspects to be satisfied with workability, performance, durability and also the economy. So for this, we need to go for the addition of pozzolanic materials along with super plasticizer with having low water cement ratio. The use of silica fume is many, which is having good pozzolanic activity and is a good material for the production high performance concrete. Also now a day's one of the great applications in various structural fields is fiber reinforced concrete, which is getting popularity because of its positive effect on various properties of concrete. But silica fume and fiber reinforced materials are very costly compared with the ground granulated blast furnace slag (GGBS) and Fly ash (FA). Hence we are using ground granulated blast furnace slag (GGBS) and Fly ash (FA) in this present study.

Some of the early research works had done using different pozzolanic materials with the replacement of cement using superplasticizer for the development high strength concrete and high performance concrete. Also the development in the field of fiber reinforced concrete along with pozzolonas.

Many investigations have been done on replacement of GGBS and Fly Ash with cement in concrete and observed very enthusiastic results.

REFERENCES

1. Anjali Prajapati, Piyush Prajapati, Mohammed Qureshi (2017), "An experimental study on high performance concrete using mineral admixtures", International Journal of Engineering Development and Research, Volume 5, Issue 2, PP: 2080-2086.
2. K Nagaraj, P Himabindu (2017), "Experimental Investigations of High Strength Concrete Using GGBS & Fly ash", International Journal of Research Sciences and Advanced, Volume 2, Issue 18, PP: 170 – 181.
3. Praveen kumar S R, Manjunath K A, G. Narayana (2016), "A Comparative Study On Mechanical Properties of SCC By Partial Replacement Of Cement With Fly Ash & Ggbs With the Use of Glass Fibers", International Journal of Research in Engineering and Technology, Volume: 05 Issue: 08, PP: 161-165.
4. Muthu Kumar. T, Sirajudeen. K (2016), "Experimental Investigation on High Performance Concrete Using Alternate Materials", International Journal of Research in Engineering and Technology, Volume: 6 Issue: 14, PP: 175-181.
5. Ishwar Chandra Thakur, N. Kisku, J.P. Singh, Sheo Kumar (2016), "Properties of Concrete Incorporated with GGBS", International Journal of Research in Engineering and Technology, Volume: 05 Issue: 08, PP: 275-281.
6. V. Nagendra, C. Sashidhar, S. M. Prasanna Kumar, N. Venkata Ramana (2016), "Particle Size Effect of Ground Granulated Blast Furnace Slag (GGBS) in Cement Concrete", International Journal of Research Trends in Engineering & Research, Volume 2, Issue 8, PP: 6-10.
7. Mitilesh Sharma, Yogendra Singh, Hrishikesh Dubey (2016), "Study of Utilization of GGBS in Cement Concrete", International Journal for Scientific Research & Development Vol. 4, Issue 7, PP: 784-787.
8. Surekha T, Chandrashekhar (2015), "Experimental Investigations on Properties of Concrete with Silica Fume, GGBS and PVC Dust", International Journal for Research in Applied Science & Engineering Technology, Volume 3, Special Issue-1, PP: 144-153.
9. Rajith M, Amritha E K (2015), "Performance of Concrete with Partial Replacement of Cement and Fine Aggregate by GGBS and GBS", International Journal of Research in Advent Technology, Volume 2, Issue-5, PP: 68-72.

10. Biswadeep Bharali (2015), "Experimental Study on Self Compacting Concrete (SSC) Using Ggbs and Fly Ash", International Journal of Core Engineering & Management, Volume 2, Issue 6, PP: 1-11.
11. E.V.S. Santhosh Kumar, D. Maheswara Reddy (2015), "Innovative Study on Supplementary Cementitious Materials", International Journal of Enhanced Research in Science, Technology & Engineering, Vol. 4 Issue 12, PP: 90-97.
12. S. Murali Krishnan, T. Felix Kala (2015), "Investigation on Durability Properties of Concrete Using Manufactured Sand and Admixtures", International Journal of Mechanical Civil and Control Engineering, Vol.1, Issue.4, PP: 7-11.
13. Rafat Siddique (2014), "Utilization (recycling) of iron and steel industry By-product (GGBS), in concrete: strength and durability Properties, J mater cycles waste management, 2014, 16, PP 460-467.
14. S. Arivalagan (2014), "Sustainable studies on concrete with GGBS as a Replacement material in cement "Jordan journal of civil Engineering, Vol 8, PP: 263-270.
15. Merin K Abraham, Elson John, Bybin Paul (2014), "A Study on the Influence of Mineral Admixtures in Cementitious System Containing Chemical Admixtures", International Journal of Engineering Research and Development, Volume 10, Issue 3, PP: 76-82.
16. Jayie Shah, Ashita Sheth (2014), "Studying the effects of Fibers and Mineral Admixtures on High Strength Concrete", International Journal of Innovative Research in Advanced Engineering, Volume 1 Issue 4, and PP: 202-205.
17. Reshma Rughooputh, Jaylina Rana (2013), "Partial Replacement of Cement by Ground Granulated Blast Furnace Slag in Concrete", Journal of Emerging Trends in Engineering and Applied Sciences, Vol. 5, Issue 5, PP: 340-343.
18. S. Arivalagan (2012), "Sustainable Studies on Concrete with GGBS as a Replacement Material in Cement", Jordan Journal of Civil Engineering, Vol. 8, Issue 3, PP: 263-270.
19. Yogendra O. Patil, P.N. Patil, Arun Kumar Dwivedi, "GGBS as Partial Replacement of OPC in Cement Concrete – An Experimental Study", International Journal of Scientific Research, Vol. 2, Issue 11, PP: 189-191.
20. R. Sathish Kumar (2012), "Experimental study on the properties of concrete made with alternate construction materials", International Journal of Modern Engineering Research, Vol. 2, Issue 5, PP: 3006-3012.
21. T. Vijaya Gowri, P. Sravana, P. Srinivasa Rao (2011), "Studies on Strength Behaviour of High Volumes of Slag Concrete", International Journal of Research in Engineering and Technology, Vol. 3, Issue 4, PP: 227-238.
22. M. Ramalekshmi R. Sheeja, R. Gopinath (2014), "Experimental Behaviour of Reinforced Concrete with Partial Replacement of Cement with Ground Granulated Blast furnace Slag", International Journal of Engineering Research & Technology, Vol. 3, Issue 3, PP: 525-534.
23. Venu Malagavelli, P N Rao (2010), "High Performance Concrete with GGBS and Robo Sand", International Journal of Engineering Science and Technology, Vol. 2, Issue 10, PP: 5107-5113.
24. Indian Standard Specification for granulated slag for the manufacture of Portland Slag Cement. IS 12089:1987, Bureau of Indian Standards, New Delhi.
25. IS 456: 2000, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standard, New Delhi.
26. IS 10262: 2009 "Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standard, New Delhi
27. IS 383: 1970, "Specification for Coarse Aggregate and Fine Aggregate From Natural Sources for Concrete", Bureau of Indian Standard, New Delhi.
28. IS 9103: 1999, "Indian Standard Concrete Admixture Specification", Bureau of Indian Standard, New Delhi.
29. IS 9399: 1959, "Specification for Apparatus for Flexural Testing of Concrete", Bureau of Indian Standard, New Delhi.
30. IS 516: 1959, "Flexural Strength of Concrete", Bureau of Indian Standard, New Delhi.

