EXPERIMENTAL STUDY ON GGBFS REPLACEMENT BY CEMENT WITH STEEL FIBRE USED IN CONCRETE

MANJU K[1], SHANMUGANATHAN A[2], SRI HARISH R[3], PRAVEEN P[4]

[1]Assistant professor, *Vels Institute of Science,Technology and Advanced Studies(VISTAS)*

[2,3,4] Undergraduate student, *Vels Institute of Science,Technology and Advanced Studies(VISTAS)*

Department of civil engineering

kmanjucivil93@gmail.com

ABSTRACT

Concrete has been major problem occur in now a days so we have to find out the solution of this problem. In this project to be focus on characteristics strength of concrete M20 grade of concrete with different proportional of replacement of cement with GGBFS and we adding 3% of steel fibres of hooked steel fibre and crimped steel fibre. To using steel fibre improve the flexural strength of concrete in different variation mix. the concrete of mix to be casted with steel fibre and without steel fibre in differ percentages. In this project to be evaluate the admixtures to improve the performance of concrete. To consider the cost of construction to be investigate to explore the replacement of materials of concrete. GGBFS to replace by cement in various percentage level of 20,40,60,80,100 %. The cubes and cylinder were tested for both compressive and spilt tensile strength of GGBFS to enhance the durability properties which is compare to conventional concrete.

Keywords: ground granulated blast furnace slag, steel fiber, steel fibre reinforced concrete slab

1. GENERAL

The main aim of the study is to obtain the suitability of GGBS as replacement of OPC in concrete. The cement in the plain concrete mixes was directly replaced by the equal weights of 20%, 40% and 60% of GGBFS to obtain corresponding GGBFS based concrete. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. It is found that by the 40% replacement of cement with GGBS and steel fibre helped in improving the strength of the concrete substantially compared to Control concrete. the effect of wet-grinding on the self-hydration performance of GGBFS without chemical admixture The compressive strength results of the hardened GGBFS. The mix proportions of the concrete incorporating GGBFS (56% GGBFS) and GGBFS with steel fibers (56% GGBFS and 0.75% steel fibers) were determined through a series laboratory tests and a life cycle assessment.

1.1 Ground Granulated Blast Furnace Slag

GGBFS is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Production and Composition

The chemical composition of a slag varies considerable depending on the composition of the raw material in the iron production process. Silicate and acuminate impurities from the ore and coke are combined in the blast furnace with a flux which lowers the viscosity of the slag in the case of pig iron production the flux consist mostly of a mixture of limestone forsterite or in some cases dolomite. In the blast furnace the slag floats on top of the iron and is decanted for separation. So cooling of slag melts results in aunreactive crystalline material consisting of an assemblage of Ca-AL-Mg silicate. To obtain a good slag reactivity or hydraulicity, the slag melt needs to be rapidly cooled or quenched below 800˚c in order to prevent the crystallization of merwinite and metltilite. To cool and fragment the slag a granulation process can be applied in which molten slag in subjected to jet streams of water or air under pressure. Alternatively, in the pelletization process the liquid slag is partially cooled with water and subsequently projected into the air by a rotating drum. In order to obtain a suitable reactivity, the obtained fragment is ground to reach the same fineness as Portland cement.

1.2 Scope of The Project

- To select a waste material this can be utilized in concrete.
- To study the various properties of the waste material.
- To identify the influence of the waste materials in concrete.
- To check the feasibility of material in the preparation in aggregate.

1.3 Objective

To discuss the strength ofggbfs replaced by cement with using steel fibre in concrete.

2. GENERAL

This chapter describes the review of literature on replacement of cement by using ground granulated blast furnace slag & briefly narrates the investigation carried by various researchers in the area of utilization of artificial aggregate in concrete.

2.1 LITERATURE REVIEW

Rafat Siddique et.al (2012) This paper deals with the mechanical properties of concrete made with ground granulated blast furnace slag (GGBFS) subjected to temperatures up to 350 C. Normal concrete having compressive strength of 34 MPa was designed using GGBFS as partial replacement of cement. Cylindrical specimens (150×300 mm) were made and subjected to temperatures of 100, 200 and 350 C. It is evident from these results that the 28-day modulus of elasticity of concrete at room temperature (27 C) decreased with increases in GGBFS content. The modulus of elasticity of concrete containing 20%, 40% and 60% GGBFS was respectively 22.5%, 39.98% and 41.7% lower than the control (15.98 GPa) at room temperature. with increases in GGBFS content. It is evident from these results that the 28-day splitting tensile strength of concrete at room temperature (27 C) decreased with increases in GGBFS content. The splitting tensile strength of concrete containing 20%, 40% and 60% GGBFS was respectively 17.4%, 8.2%, and 15.6% lower than the control (3.2 MPa) at room temperature.

Yogendra and O. Patil (2013) The main aim of the study is to obtain the suitability of GGBS as replacement of OPC in concrete. In this investigation 45 cubes and 45 beam specimen are tested. The Cubes with the dimension of 150 x 150 x 150 mm and beams with dimension of 150 x 150 x 750 mm are prepared for each batch of mixes to measure compressive strength and flexural strength of concrete respectively at the age of 7 days, 28 days and 90 days of curing. 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; however, beyond 20% replacement by GGBS the reduction in strength is substantial i.e. more than 15%. The compressive strength and flexural strength of cement concrete containing various % of GGBS at the age of 7, 28 and 90 days.

Mohd Shariq et.al (2013) The amount of cement replacement by GGBFS was varied from 20% to 60%. The static modulus of elasticity of concrete containing GGBFS has been found to be lower than the plain concrete for all replacements of cement at all ages and for all the mixes. Three plain concrete mixes designated as M10, M20 and M30 with strength of 46.5, 37.0 and 27.0 MPa respectively were prepared based on the trial method. GGBFS concrete mixes were prepared after re-proportioning the three plain concrete mixes. The ratio of fine aggregate to coarse aggregate was kept constant throughout the investigation. The cement in the plain concrete mixes was directly replaced by the equal weights of 20%, 40% and 60% of GGBFS to obtain corresponding GGBFS based concrete. GGBFS replacement up to 40% may be useful for reinforced cement concrete and prestressed concrete, whereas, 60% replacement may be used for mass concrete works. The water to binder ratio for a particular mix was also kept constant.

A. Adamsjoe, A.maria rajesh(2014)in this paper to be investigated that the focuses characteristics of M40 concrete with Various proportional of replacement of cement with Ground Granulated Blast furnace Slag (GGBS) and adding 1% of steel fibre. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituent sand normal mixing. Ten mixes were studied with GGBS & Steel Fibre using a water binder ratio of 0.35 and super plasticizer CONPLAST SP-430. The cubes, cylinders and prisms were tested for both Compressive, Split tensile, Flexural and Pull out strengths GGBS can enhance the durability aspects of HPC compared to control mix. Among the mixes the mix with replacement level as 0%,10%,20%,30%,40% & 50% of GGBS and 1% steel fibre is better with respect to strength and durability. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. It is found that by the 40% replacement of cement with GGBS and steel fibre helped in improving the strength of the concrete substantially compared to Control concrete.

Rajesh Kr. Pandey et.al (2014) investigated the effects of partial replacement of cement with GGBFS on compressive strength, split tensile strength and flexural strength of concrete at 28, 90, 180 and 360 days. He used 50% GGBFS 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 appreciable amount of strength at later ages (90 days onwards) and it increases with decrease in 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 reduction in cost of concrete at the current market rate by 14%.

Shaik Asif Ali (2014) The cement in concrete is replaced accordingly with the percentage of 20% by weight of slag and 1.5% by weight of steel fiber. Concrete Samples are tested at the age of 7,14 and 28 days of curing. Powder to cement and steel fiber without changing much the compressive strength is 20 % & 1.5 % respectively for M20 Grade. For partial replacement of cement with GGBS (20%) + Steel fiber (1.5%) fiber reinforced concrete got maximum strength as compared to conventional concrete, the strength development of the concrete is increases slightly as its age increases. Test results reveal that higher fiber content has brought about increased compressive strength, flexural strength, abrasion resistance, and fiber crack-control effect.

M.J. Ewswara reddy and T.Chandrasekhara reddy (2015) in this project to be investigated that were carried out on durable and strength properties of M80 grade of HSC mixes with different replacement levels, such as 10%, 20%, 30% and 40% of GGBS with cement and optimum percentage level of GGBS constant and sand are replaced with GBS by different level 10%, 30%, 50%, 70%, 90%. Keeping both optimum percentage levels of GGBFS is constant and cement replaced with Tio2 with different level 1%, 2%, 3%, 4%, 5% by cement replacement. The HSC mix, grade M80 concrete is designed as per ACI 211. 4R-08 Guide for selecting proportions for high strength concrete with Pozzolana Portland cement and other cementitious materials. The result of these investigations demonstrates the strength characteristics of GGBS based concrete mixes. Based on the results obtained, the replacement of 20% of GGBS, and 70% GBs with 3% of Tio2 which superior strength characteristics were arriving with compared to conventions**.**

Naveen Kumar.D et.al(2015)in this paper deals with the influenceof partial replacement of cement with iron dust and addition of steel fibers, Iron dust otherwise known as iron ore finds. Iron dust is an industrial by-products obtained from steel factories. It is a waste material. It is used as a pozzolanic material in concrete to improve the strength. It is important to maintain the particle size of iron dust. It is replaced with cement so the size of iron dust should be less than 0.75 micron. Steel fiber is produced from steel industries as a main product. The addition of steel fiber improves the mechanical properties of concrete. Steel fibers are used to reduce the initial cracks during shrinkage. Iron dust is partially replaced instead of as an alternate. Then the concrete is subjected to various tests in order to find the compressive strength, flexural strength and split tensile strength.

B.A.V. Ram kumar and J. Venkateshwara Rao (2015) In this experimental investigation compressive strength, flexural strength and water absorption of paver block were evaluated by replacing portion of cement with the GGBS (ground granulated blast furnace slag). Glass fibers were also incorporated along with the GGBS to further enhance the mechanical properties. Different proportions of glass fiber starting from 0.1% to 0.4% by weight of cement in the paver block were added. The optimum fiber content from test results was found to be 0.2% by weight of cement. 10% to 40% by weight of cement was replaced with the GGBS. From the test results obtained the optimum GGBFS and glass fiber content were found to be 30% and 0.2% respectively. Cost analysis of paver block was done and was compared with conventional paver block.

D. Suresh1 and K. Nagaraju (2015) in this paper to be investigated that the Ground Granulated Blast Furnace Slag (GGBS) is a by products from the blast furnaces used to make iron. This „granulated" slag is then dried and ground to a fine powder. similar 28 day strengths to Portland cement will normally be achieved when using up to 50% GGBS. By comparison, a 50 % GGBS concrete will typically achieve about 45 to 55 % of its 28 days' strength at seven days, with a gain of between 10 and 20 % from 28 to 90 days. At 70 % GGBS, the seven days' strength would be typically around 40 to 50 % of the 28 days' strength, with a continued strength gain of 15 to 30 % from 28 to 90 days. A typical combination is 50% GGBS with 50% Portland cement, but percentages of GGBS anywhere between 20 and 80 % are commonly used. As we have seen GGBS is a good replacement to cement in some cases and serves effectively.

Hyun-Oh Shin et.al (2015)in this project to evaluate that the application of ground granulated blast furnace slag (GGBFS) and steel fibers in prestressed concrete railway sleepers was investigated in this study. railway sleepers. Steel fibers improves the durability and structural performance in terms of crack control and reduction of spalling and can replace shear reinforcement. The mix proportions of the concrete incorporating GGBFS (56% GGBFS) and GGBFS with steel fibers (56% GGBFS and 0.75% steel fibers) were determined through a series laboratory tests and a life cycle assessment. The mix with partial replacement of Type III Portland cement by GGBFS showed an improved resistance tochloride ion penetration and freezethaw cycles compared with the concrete used for current railway sleepers.

P. Markandeya Raju et.al (2015) The present paper focuses on investigating characteristics of M20 grade concrete with partial replacement of cement with ground granulated blast furnace slag (GGBS) by replacing cement via 30%, 40%, 50%. The cubes, cylinders and prisms are tested for compressive strength, split tensile strength, flexural strength. The compressive strength of concrete increased when cement is replaced by GGBS for both M20 and grade of concrete. At 40% replacement of cement by GGBS the concrete attained maximum compressive strength for both M20 grade of concrete. The split tensile strength of concrete is increased when cement is replaced with GGBS. The split tensile strength is maximum at 40% of replacement. The flexural strength of concrete is also increased when the cement is replaced by GGBS. At 40% replacement, the flexural strength is maximum.

Siddharth et.al (2015) In this experimental work the compressive strength, split tensile strength, flexural strength tests were conducted by adding ground granulated blast furnace slag GGBS in various different of 0%,10%,20%,30%and 40% to the weight of cement and 1% steel fiber. That strength of the concrete increase with the increase of GGBS up to 40% and also increase in load carrying capacity of 40% GGBS beams compare to conventional beams. compressive strength and split strength of concrete increased about 13% and 18.20% respectively. flexure strength of prisms and beam increased about 15.16% and 15.32% respectively.

M.Shariq et.al (2016) experiments were conducted on 150×600mm cylindrical specimens to investigate creep and drying shrinkage of concrete containing ground granulated blast furnace slag (GGBFS). The creep strain was measured for 150 days under a constant sustained load. The shrinkage strain was also measured for 180 days. The amount of cement replacement by GGBFS was 20%, 40% and 60% by weight of cement. The test results indicate that higher GGBFS percentage exhibits higher creep and shrinkage strains. At 150days of sustained loading, the average creep coefficients of 20%, 40% and 60% GGBFS concrete are 16.3%,33.3% and 55.2% higher than plain concrete. Higher ggbfs percentage exhibits higher creep effect. At 150 days of sustained loading, the average creep coefficients for 20%, 40% and 60% GGBFS concrete are16.3%, 33.3% and 55.2% higher than plain concrete. A comparison of creep recovery in GGBFS concretes with plain concretes shows that the average creep recovery for 20%, 40% and 60% GGBFS concretes is 5.8%, 11.8% and 13.8% less respectively.

A.I.Tamboli et.al(2016) The paper deals with strength of charactestics of concrete with partial replacement of cement with addition of steel fibre. The ggbfs replaced with (10%,20%,30%,40%) by weight and addition of steel fibre in different percentage (0.5%,1%,1.5%2%) Strength of concrete was determined by performing Compression test (150mmX150mmX150mm) size cube, and Split tensile test (150mm diameter and 300mm length cylinders). Replacement of cement by 20% and addition of steel fibre at 1% gave maximum compressive and split tensile strength. The concrete mixture with 20% GGBS and 1% steel fibre achieved highest compressive and split tensile strength at end of curing day with all variations in comparison to plain concrete mixture. the optimum value is achieved for 20% GGBS and addition of 1% Steel fibre. testing the specimen, the plain concrete specimens showed a typical cracking pattern. But due to addition of steel fibre in concrete cracks gets reduced which shows the ductile behaviour of steel fibre.

Erdog an ozbay et.al (2016) discussed the results of partial replacement of cement with 50% - 80% of GGBFS 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% GGBFS as replacement showed maximum compressive strength at 28 days. Experiments were also conducted on beam-column with and without GGBFS with 50% replacement. The specimen was tested at 28 days under constant axial load and varying lateral load which showed increase in load carrying capacity of the specimen by 6.6 %. Thus 50% GGBFS as replacement can be used in RC specimens.

P. Lakshmaiah Chowdary et.al (2017) This experimental study the effect of GGBS on strength of referral concrete M20 was made using 43 Grade PPC and the other mixes were prepared by replacing part of PPC with GGBS. The replacement levels were 10%, 20%, 30%, 40% (by weight of cement) for GGBS. Test results indicate that use of replacement cement by GGBS in concrete has improved performance of concrete up to 10% to 30%. mix design for M_{20} grade of concrete was carried out using the above coarse aggregate, fine aggregate, and the binder. The proportion of the materials by weight was 1:1.65:2.84 ratio 0.53. The cement constituent was subsequently replaced with percentage of GGBS (by mass). The percentage of cement was 0%, 10%, 20%, 30% and 40%. Test for compressive strength is carried out either on cube or cylinder. The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces.

J. Vengadesh Marshall Raman et.al (2017) The cement has been replaced by GGBS in the percentage of (0%, 25%, 30%, 35%, and 40%) by weight of cement for M-20mix. Self-compacting Concrete mixtures produced, tested and compared in terms of compressive, split tensile strength and flexural strength with the conventional concrete for 7,14,28 days. The replacement of GGBS was carried out at levels of 25%, 30%, 35% and 40% of cement content. The compressive strength at the end of 28 days' decreases when the GGBS percentage is increased beyond 40%. However, the compressive strength of M20 concrete at the end of 28 days for 40% replacement of GGBS. The split tensile strength at the end of 28 days' decreases when the GGBS percentage is increased beyond 40%. However, the split tensile strength of M20 concrete at the end of 28 days for 40% replacement of GGBS

Yingbin Wang et.al (2018) The aim of this paper is to evaluate the self-hydration characteristic of GGBFS activated by wet-grinding treatment (WGT). the effect of wet-grinding on the self-hydration performance of GGBFS without chemical admixture The compressive strength results of the hardened GGBFS pastes of sample S2, S4 and S6 compressive testing machine with a loading rate of 0.5 kN/s. The compressive strength of hardened GGBFS pastes was the average value of six specimens The compressive strength of hardened GGBFS pastes at all curing age increased with the increasing of wet-grinding duration. For instance, the compressive strength of sample S2 at 3 d was 13.3 ± 0.4 MPa, which increased to 16.1 ± 0.8 MPa and 20.1 ± 0.3 MPa when the grinding time was increased to 40 min and 60 min, respectively. Moreover, the compressive strength at 28 d increased from 20.5 ± 0.4 MPa to 27.2 ± 0.5 MPa as the grinding time increased from 20 min to 60 min.the compressive strength of sample S6 at 3 d and the compressive strength of sample S2 at 28 d were nearly the same.

G. PhaniLakshmi and B.Sree (2018) the increased quest for sustainable and eco-friendly materials in the construction industry has led to research on partial replacement of conventional constitutions of concrete. The main aim of this work was to investigate the effects of partially replaced ordinary Portland cement (OPC) by ground granulated blast furnace slag (GGBS) on properties of concrete including fresh properties, compressive strength, tensile splitting strength and flexural strength. The GGBS is added at volume fraction of 0.5%, 1.0%, 1.5% and 2.0%..The optimum value for 28days of GGBS mix is obtained at 15% replacement of cement with GGBS. The optimum value obtained in compressive strength at 28days of curing is 37.92Mpa at 15% replacement, the optimum value obtained in split tensile strength is 3.34Mpa at 15% replacement, the optimum value obtained in flexural strength is 4.18Mpa at 15% replacement. The maximum compressive strength obtained after adding steel fibers is 39.5Mpa at 2% of steel fibers.

2.3. OVERVIEW FROM LITERATURE STUDY

- ✓ Using of GGBFS in concrete to improve the compressive strength and sulphate resistance and reduces the heat of hydration.
- ✓ GGBFS to replace with 50-80% cement to improve the fire resistance.
- ✓ GGBFS is the best suitable alternative binder material replaces the cement.
- ✓ It also improves the durability properties at the life time of structure.
- ✓ If the thermal properties of GGBFS typically in the range of 5-15% mean it modify the porosity property of concrete.
- ✓ When the Temperature of concrete reaches 350°c will result in the reduction of the compressive strength, spilt tensile strength and modulus of elasticity because of GGBFS present in concrete.
- ✓ 20% replacement of GGBFS is suitable for thermal behaviour, porosity, permeability.
- ✓ GGBFS has high corrosion resistance property on concrete.
- ✓ 30-50% of replacement of GGBFS is suitable for the carbonation process and increase the carbonation rate.

3.CONCLUSION

Based on the study, the following conclusion is arrived for the GGBFS powder to provide an alternative source for natural cement. We have collect the different literature form the journal which is based on to choose the percentage of GGBFS used in concrete and steel fibers. Over all from the literate review GGBFS to be used in concrete to replace the cement in different percentage of 20, 40, 60, 80 and 100% to be caste the specimen in cube and cylinder. To determine the compressive and spilt tensile strength test of GGBFS combination steel fibers concrete specimen results which is based this is compare to natural cement.

4. REFERENCES

1. Dhanya R, Arasan G.V, Ganapathy Ramasamy. "Study on strength properties of concrete using GGBS and steel fiber as partial replacement of cement".(2017) Industrial Pollution Control. Pg. No – 1255- 1259.
2. Santosh Kumar Karri, G.V. Rama Rao, P.Markandeyaraju. "Strength and durability studies on GGBS concrete".(2015) SSRG International Journal Of Civil Engineering. Vol- 2, Pg. No
3. NaveenKumar D, Vignesh M, Vijaikumar C, Vinithkumar S, Selvi K. "Influence of concrete behavior by partial replacement of cement with iron dust and addition of steel fiber". (2018) International Journal Of Intellectual Advancements Ans Research In Engineering Computations. vol – 6, Pg. No – 1264 – 1267.
4. B.A.V. Ram Kumar, J. Venkateswara Rao. "Effect of inclusion of glass fibers and GGBS in concrete paver blocks ".(2015) IOSR Journal Of Mechanical And Civil Engineering. Vol- 12, Pg. No - 81- 88.
5. G. Phani Lakshmi, B. Sree Kala. "Utilization of GGBS as partial replacement of cement by adding steel fibers (M30 Grade)".(2018) International Journal Of Professional Engineering Studies. Vol- 9, Pg. No - 134 – 143.
6. D. Suresh, K. Nagaraju. "Ground Granulated Blast Slag (GGBS) In Concrete – A Review". (2015)IOSR Journal of Mechanical and Civil Engineering. Vol – 12. Pg. No -76 - 82.