Investigation on Strength of GGBS Concrete by using Bottle Cap as Fibers

V. Gayathri
UG Student in Department of Civil Engineering, Coimbatore Institute of Engineering and Technology, Affiliated to Anna University, Accredited by NAAC, Coimbatore

R. Raja
UG Student in Department of Civil Engineering, Coimbatore Institute of Engineering and Technology, Affiliated to Anna University, Accredited by NAAC, Coimbatore

K. Revathi
Assistant Professor in Department of Civil Engineering, Coimbatore Institute of Engineering and Technology, Affiliated to Anna University, Accredited by NAAC, Coimbatore

Abstract - Concrete plays a vital role in the construction field. The production of cement emits the greenhouse gases into the atmosphere which leads to global warming. Due to this emission of greenhouse gases, the supplementary material can be used. In this investigation, the main aim is direct replacement of cement by Ground Granulated Blast-furnace Slag (GGBS) at different percentage from 10%, 20%, 30% and 40%. GGBS is the waste by-product of iron industry in the form of molten state. GGBS also be used for a greenhouse building in the sustainable construction. The soft drink bottle caps are disposing into an enormous level and can be added as a fiber at various percentages. In this investigation, an attempt has been made to study the compressive strength, split tensile strength and flexural strength of concrete by using direct replacement of GGBS by cement. In this investigation compressive strength, split tensile strength, flexural strength are carried out by 150 mm x 150 mm x 150 mm cube, 150 mm diameter and 300 mm length cylinder and 150 mm x 150 mm x 700 mm size beam. Casted beams, cylinders, cubes are cured for 7 and 28 days respectively. The percentage to be carried out for the replacement of GGBS by cement is 10 %, 20 %, 30 % and 40 % respectively and addition of fiber is taken in percentage of 1 %, 2 %, 3 % and 4 % respectively to the total weight of concrete. The mix proportion adopted for GGBS concrete is 1:1.5:3:0.45.

Keywords: Bottle caps, GGBS concrete, Compressive Strength

I. INTRODUCTION

Concrete works plays a main role in the construction industry. It is a mixture of cement, sand, aggregate and admixture. It is used very rapidly in the construction of building, port, roadways, harbor, etc. The production rate of cement can be increased day by day due to scarcity of raw materials and plays a very high demand for constructing the building, when the supplementary materials can be replaced partially into the cement, the consumption of cement can be decreased and its lower the normal cost of construction.

GGBS is the major supplementary products of cement and it is also a waste product of iron industry. Many of the iron industry is disposing the waste into an environment and it can be easily polluting the environment. GGBS is in form blast furnace and can easily achieve the ultimate strength of GGBS concrete. The main component of GGBS is Cao, SiO_2, MgO. GGBS easily increase the compressive strength for longer period. It cannot achieve strength for a shorter period. It is a direct replacement level for a Portland cement.

Nowadays the soft drink bottle caps can be used very rapidly and it becomes disposed as the waste. The disposable caps can be easily burned by the waste collector and it can be affect the environment. Due to decreasing effect of pollution, the bottle caps can be used as a fiber into the concrete mix. The cement mortar can be taken as the various percentage level of 10%, 20%, 30% and 40% by the weight of cement.

1.1 NEED FOR THE STUDY

- To find an alternative materials for OPC.
- To reduce the CO_2 emission and to protect the environment from global warming.

- To produce the cost effective analysis.

1.2 OBJECTIVES OF THE PROJECT

- The main aim of the project is to study the comparative results for normal conventional concrete with the replacement of GGBS into the concrete.
- To study the properties of GGBS replaced partially into the cement.
- To study the compressive strength of conventional and GGBS concrete.
- To study the flexural strength and split tensile strength of conventional and GGBS concrete.

II. MATERIALS USED

2.1 CEMENT

Cement is a binding material that is used to bind different aggregate in the presence of moisture through a chemical process or man-made process, with adhesive and cohesive properties which make it capable of converting the mineral fragments into a compact whole. For construction purpose, the term cement is used to bonding of material used with stones, sand, bricks and building blocks. The important component of cement which is responsible for strength are C_3S and C_2S. Ordinary Portland Cement (OPC) depending upon the 28 days strength are classified as 33, 43, 53 grades. The numerical value of each grade represents the minimum 28 days strength in N/mm^2. For the present investigation, OPC 53 grade confirming to IS 12269-1987 were taken and the properties are given in the table below.

Table 2.1 Physical Properties of Cement

PROPERTIES	VALUE
Compressive Strength(MPa)	40
Specific Gravity	2.67
Initial Setting Time(minutes)	45
Final Setting Time(hours)	10
Standard Consistency (%)	33

Table 2.2 Chemical Properties of Cement

PROPERTIES	VALUES
CaO (%)	61-67
SiO_2 (%)	19-23
Al_2O_3 (%)	2.5-6
Fe_2O_3 (%)	0-6
Sulphate (%)	1.5-4.5

2.2 COARSE AGGREGATE

Coarse aggregate is the strongest and least porous component in concrete. It reduces drying shrinkage and other dimensional changes and other dimensional changes due to moisture. It is a stable material. For optimum compressive strength with high cement and lower water cement ratio size of coarse aggregate must be used. Ordinary blue granite crushed stone aggregate confirming to IS: 383-1970 was used as a coarse aggregate in concrete. Optimum size of the coarse aggregate taken for this investigation is 20mm. They generally possess all the essential qualities of a good building stone showing very high crushing strength, low absorption value and least porosity.

Table 2.3 Properties of Coarse Aggregate

PROPERTIES	VALUE
Specific gravity	3.1
Size (mm)	20
Water Absorption Ratio (%)	5
Aggregate Impact Test (%)	32.88
Abrasion Test (%)	3.5

2.3 FINE AGGREGATE

Naturally occurring river sand was used as fine aggregate. Advantage of natural sand is that particles are cubical rounded with smooth surface texture. Fine aggregate is not always identical. It depends on place to place being cubical, rounded or smooth textured, it gives good workability.

Table 2.4 Properties of Fine Aggregate

PROPERTIES	VALUE
Specific Gravity	2.57
Size (mm)	4.75
Water Absorption Ratio (%)	1
Fineness Modulus (%)	4.5

2.4 GROUND GRANULATED BLAST FURNACE SLAG

GGBS is a waste material obtained from iron industries.GGBS is obtained by quenching molten iron and steel from a blast furnace in water or steam, to produce a glassy, granular product and is dried and ground into a fine powder.GGBS cement can be added to concrete in the concrete manufacturer's batching plant, along with Portland cement, aggregates and water. The normal ratios of aggregates and water to cementations material in the mix remain unchanged. GGBS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBS vary from 30% to up to 85%. Typically 20% to 40% is used in most instances.

Fig 2.1 Ground Granulated Blast-furnace Slag

Table 2.5 Chemical Properties of GGBS

PROPERTIES	VALUES
CaO (%)	40
SiO_2 (%)	35
Al_2O_3 (%)	10
MgO (%)	8

Table 2.6 Physical Properties of GGBS

PROPERTIES	VALUES
Colour	Off-white powder
Bulk density (loose)	1.0-1.1 tonnes/m^3
Bulk density (vibrated)	1.2-1.3 tonnes /m^3
Relative density	2.85-2.95

2.5 BOTTLE CAP AS FIBERS

Bottle caps are rapidly disposed into open environment and therefore affect the environment very easily. Thereby bottle caps were cut into 3 mm width and 10 mm length.

Fig 2.2 Bottle Caps

Table 2.7 Details of Specimen Casted

Type of specimen	Mould size	No of specimen
Cubes	150 mm x 150 mm x 150mm	24
Cylinders	150 mm diameter and 300 mm height	24
Beams	150 mm x 150 mm x 700 mm	24

Fig 2.3 Mixing of Ingredients

III. RESULTS AND DISCUSSIONS

Table 3.1 - 7 Day Compressive Strength

TYPE OF CONCRETE	COMPRESSIVE STRENGTH (MPa)
G-Fb 0,0	21.3
G-Fb 10,1	20.35
G-Fb 20,2	18.67
G-Fb 30,3	17.78
G-Fb 40,4	17.3

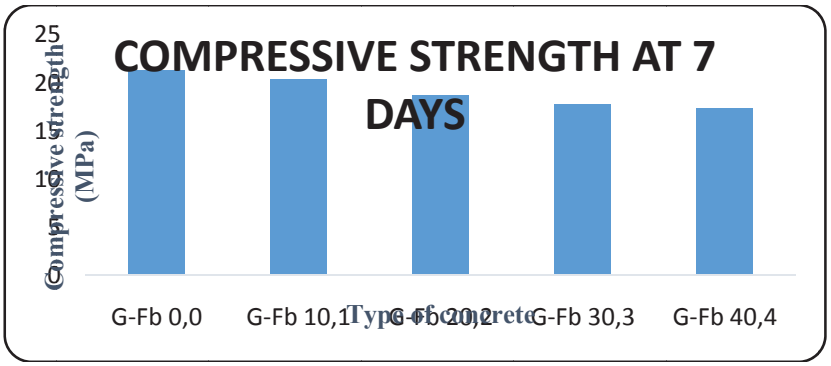

Fig 3.1 - 7 Day Compressive Strength

From the table, it is inferred that the G-Fb 0, 0 and G-Fb 10, 1 will give approximately equal strength in 7 days. For G-Fb 20, 2 the strength was slightly reduced, but it is acceptable. For G-Fb 30, 3 and G-Fb 40, 4 was reduced to about 18.77%.

Table 3.2 - Strength properties (at 28days) of GGBS concrete mixes with bottle cap fibers

Type of concrete	Mix ID	f_c (MP_a)	f_t (MP_a)	f_b (MP_a)	f_t/f_c (%)	f_b/f_c (%)
GGBS concrete with bottle cap fibres	G-F_b0,0	23.11	4.08	1.45	17.65	6.27
	G-F_b10,1	22.4	1.77	2.28	7.90	10.17
	G-F_b 20,2	27.78	1.33	2.07	4.78	7.45
	G-F_b30,3	24.18	2	1.04	8.27	4.30
	G-F_b40,4	23.5	1.11	1.14	4.72	4.72

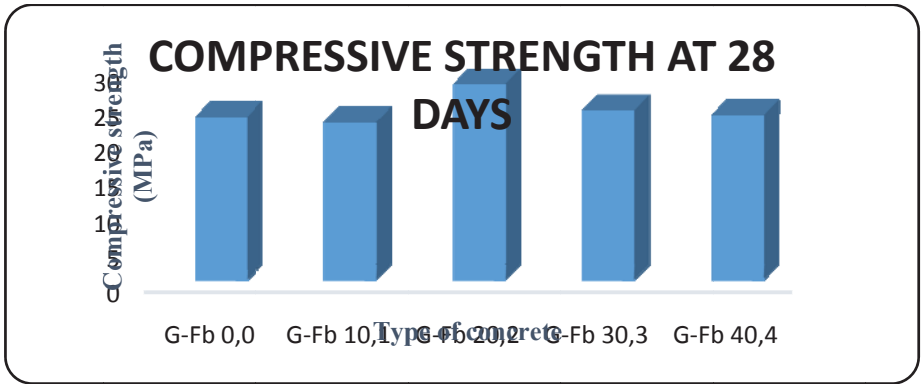

Fig 3.2 - 28 DAYS COMPRESSIVE STRENGTH

From the table, it is inferred that the G-Fb 0, 0 and G-Fb 10, 1 will give approximately equal strength in 28 days. For G-Fb 20, 2 the strength was increased, but it is acceptable. For G-Fb 30, 3 and G-Fb 40, 4 was reduced to about 16.87%.

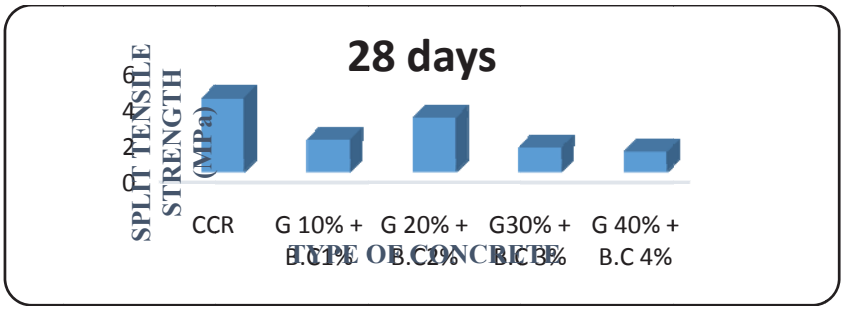

Fig 3.3 - 28 Days Split Tensile Strength

From the table, it is inferred that the G-Fb 0, 0 and G-Fb 20, 2 will give approximately equal strength in 28 days. For G-Fb 10, 1 the strength was reduced, but it is acceptable. For G-Fb 30, 3 and G-Fb 40, 4 was reduced to about 63.96%.

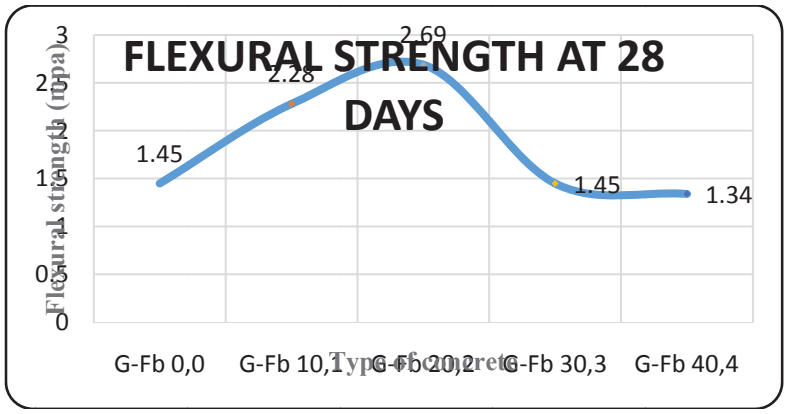

Fig 3.4 - 28 Days Flexural Strength

From the table, it is inferred that the G-Fb 0, 0 and G-Fb 10, 1 will give approximately equal strength in 28 days. For G-Fb 20, 2 the strength was increased, but it is acceptable. For G-Fb 30, 3 and G-Fb 40, 4 was reduced to about 50.18%.

IV. CONCLUSION

- GGBS concrete can be produced from mineral admixtures which are industrial waste such as GGBS.
- There was no problem in incorporating and distributing bottle caps steel fibers in GGBS concrete mixes.
- Required compressive, split tensile and flexural strength found to be achieved by GGBS concrete.
- Compressive strength increases with increase in 2% of bottle cap fibers with 20% replacement of cement by GGBS at 28 days.
- With further addition of bottle cap fibers and increase in GGBS percentage, the compressive strength remains same as conventional concrete at 28 days.
- Flexural strength increases with increase in 2% of bottle cap fibers with 20% replacement of cement by GGBS at 28 days.
- Split tensile strength increases with increase in 2% of bottle capfibers with 20% replacement of cement by GGBS at 28 days.

REFERENCES

[1] IS 12269-1987 recommended guide lines for physical and chemical properties of OPC 53 grade cement.
[2] IS 456-2000 recommended guide lines for plain reinforced concrete for the selection of maximum water cement ratio and cement content.
[3] IS 516-1959 recommended guide lines for the method of test for strength of concrete.
[4] IS 10262-2009 recommended guide lines for the selection of water and sand content.

[5] G.C. Behera[1], R.K, Behera[1], "Increase in Strength of Concrete by Using Bottle Caps" International Research Journal of Engineering and Technology, volume 02, Issue 3, June 2015.
[6] P.Vignesh[1], K.Vivek[2], "An experimental investigation on strength parameters of flyash based Geopolymer concrete with GGBS", International Research Journal of Engineering and Technology, volume 02, Issue 02, May 2015.
[7] Yogendra.O.Patil, Prof P.N.Patil, Dr. Arun Kumar "GGBS as partial replacement of OPC in cement concrete – An Experimental study", volume 02, Issue 11, November 2013.
[8] S. Arivalagan "Sustainable Studies on Concrete with GGBS as a Replacement Material in cement" Jordan Journal of Civil Engineering, volume 8, No.3, 2014.
[9] PremRanjan Kumar, Dr. Pradeep Kumar T.B, "Use of blast furnace slag as an alternative of natural sand in mortar and concrete", IJIRSET, Volume 04, Issue 02, Feb 2015.
[10] Maitri Mapa[1], Hemalatha, T[2], Rama Chandra Murthy A[3] "Investigation on mechanical properties of silica and GGBS incorporated cement mortar", International Journal of Research in Engineering and Technology,volume 04, December 2014.
[11] Siddharth, Prof seetharammunnur "Experimental study on strength properties of concrete using steel fibre and GGBS as partial replacement of cement", International Journal of Engineering Research and Technology, vol. 04, Issue 01, Jan 2015.
[12] Mr.Nikhil A.Gadge[1], Prof.S.S.Vidhale[2] "Mix design of FRC using GGBS and steel fiber" International Journal of Modern Engineering Research, volume 03, Issue 06, December 2015.
[13] K.G.Devaki[1], J.Sreenivasan[2] "Investigation to increases the strength and workability of concrete by using bottle caps with admixture" IOSR Journal of Mechanical and Civil Engineering, volume 11, Issue 2, April 2014.
[14] Chalithra H L[1], Pramod K[2], Dr.Chandrasekar A[3] "An experimental study on partial replacement of cement by GGBS and Natural sand by quarry sand in concrete" International Journal of Engineering Research and Technology.
[15] Sonali K.Gadpalliwar[1], R.S.Deotale[2], Abhijeet R.Narde[3] " To study the partial replacement of cement by GGBS and RHA and natural sand by quarry sand in concrete" IOSR Journal of Mechanical and Civil Engineering.