# An Experimental Study on Strength and Durability Properties of Steel Fibers & Glass Fibers Concrete Using GGBS

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***Abstract:*** **The ground granulated blast furnace slag (GGBS) is a waste product from the steel plant, which may be utilized as partial supersession of cement in concrete due to its innate cementing properties, which ameliorate mainly the mechanical properties of concrete and additionally reduce the cement consumption by superseding part of cement with these pozzolonic materials. When fibers are integrated in concrete percentage to concrete it amends the mechanical properties, durability and serviceability of the structure. It is now established that one of the consequential properties of Fiber Reinforced Concrete is its superior resistance to cracking and crack propagation. The study has been made to evaluate the effect on mechanical and durability properties of M25 grade concrete with different proportional of supersession of cement with Ground Granulate Blast Furnace Slag (GGBS), (0%, 10%, 20%, 30% and 40%) by weight and the integration of Steel fiber in different percentages (0%, 0.5%, 1%, 1.5% and 2%) and glass fiber in different percentages (0%, 0.1%, 0.2%, 0.3%, 0.4%) .For this purport along with a control mix, 9 sets were made to study the compressive strength, tensile strength and flexural strength and durability properties were studied by performing sulphate attack test cubes. Each set comprises of 15 cubes, 6 cylinders and 6 beams.**

***Index Terms***: **Concrete, Ground Granulated Blast Furnace Slag, Steel Fiber, Glass fiber.**

## I.INTRODUCTION

Concrete is probably the most extensively used construction material in the world. The main constituent in the conventional concrete is Portland cement. The amount of cement manufacture release approximately equal amount of carbon dioxide into the atmosphere. Cement engenderment is consuming paramount amount of natural resources. That has brought pressures to reduce cement consumption by the utilization of supplementary materials. The incorporation of supplementary cementatious material is Ground granulated blast furnace slag (GGBS) is a mineral admixture, which amend mainly the mechanical properties of concrete and additionally reduce the cement consumption by superseding part of cement with these pozzolonic materials. Moreover only constrained studies have been carried out in India on the utilization of slag for the development of high strength concrete with advisement of steel fibers. Plain concrete possesses a very less tensile strength, circumscribed ductility and little resistance to cracking. Internal micro cracks are present in the concrete and its poor tensile strength is due to the propagation of such micro cracks. In plain concrete structural cracks develop even afore loading, due to drying shrinkage or other causes of volume change. The width of these initial cracks is few microns, but their other dimensions may be of higher magnitude. When loaded, the micro cracks propagate and open up, and supplemental cracks form in places of minor defects. The development of such micro cracks is the main cause of inelastic deformations in concrete. It has been apperceived that the integration of diminutive, proximately spaced and uniformly dispersed fibers to concrete would act as crack arrester and uniformly dispersed fibers to concrete would act as crack stop and would substantially upgrade its static and dynamic properties. This type of concrete is kenned as Fiber Reinforced Concrete.

## II.TEST RESULTS

Durability studies of compressive strength of concrete effected with 5% of HCl and $H_2SO_4$ acid is studied at 20% replacement of GGBS along with different percentage of steel and glass fibers. As per the result analysis, the compressive strength values of GGBS concrete affected to HCl were greater than the GGBS concrete affected to H2SO4. The effect of HCl on strength of the concrete is lower than the effect of H2SO4 on strength of the concrete.

**Table 1**: Compressive strength of steel fiber reinforced GGBS concrete after $H_2SO_4$ acid curing

| S.NO | % of GGBS | % of steel fiber | Compressive strength(N/mm2) | |
|---|---|---|---|---|
| | | | 7 days(5%H2SO4) | 28days(5%H2SO4) |
| 1 | 0 | 0 | 12.9 | 22.68 |
| 2 | 20 | 1 | 13.44 | 23.76 |
| 3 | 20 | 1.5 | 14.87 | 24.77 |
| 4 | 20 | 2 | 13.63 | 23.02 |
| 5 | 20 | 2.5 | 12.02 | 22.29 |

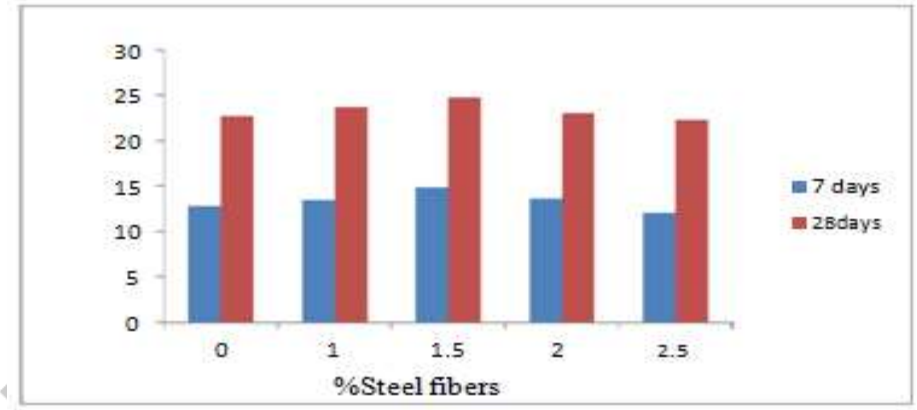


**Fig 1**: Compressive Strength of 5% $H_2SO_4$ cured steel fiber cubes after 7 & 28 days

**Table 2**.Compressive strength for M25 grade concrete after HCl acid curing

| S.NO | % of GGBS | % of steel fiber | Compressive strength(N/mm2) | |
|---|---|---|---|---|
| | | | 7days(5%HCL) | 28days(5%HCL) |
| 1 | 0 | 0 | 14.13 | 23.24 |
| 2 | 20 | 1 | 15.44 | 24.31 |
| 3 | 20 | 1.5 | 15.87 | 24.72 |
| 4 | 20 | 2 | 14.07 | 24.11 |
| 5 | 20 | 2.5 | 13.08 | 23.26 |

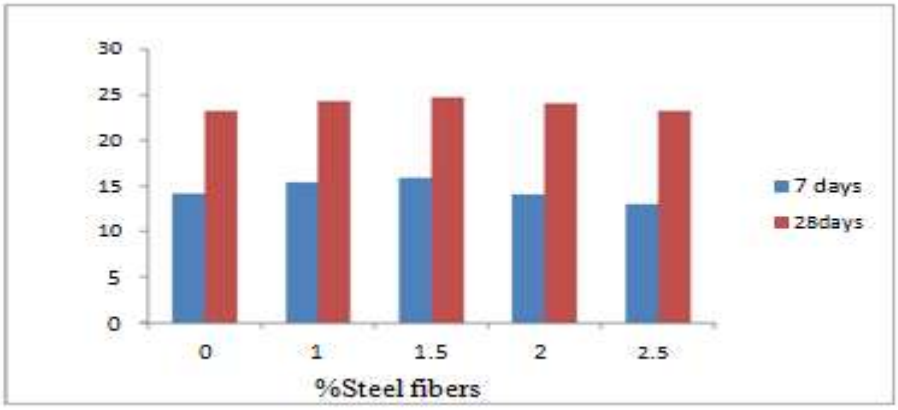


**Fig.2**: Compressive Strength of 5%HClcured steel fiber cubes after 7 &28 days

**Table 3**: Compressive strength for M25 grade concrete after H2SO4 acid curing

| S.NO | % of GGBS | % of glass fiber | Compressive strength(N/mm2) | |
|---|---|---|---|---|
| | | | 7 days(5%H2SO4) | 28days(5%H2SO4) |
| 1 | 0 | 0 | 12.19 | 22.62 |
| 2 | 20 | 0.1 | 12.81 | 23.13 |
| 3 | 20 | 0.2 | 13.85 | 24.44 |
| 4 | 20 | 0.3 | 12.81 | 22.12 |
| 5 | 20 | 0.4 | 12.11 | 21.84 |

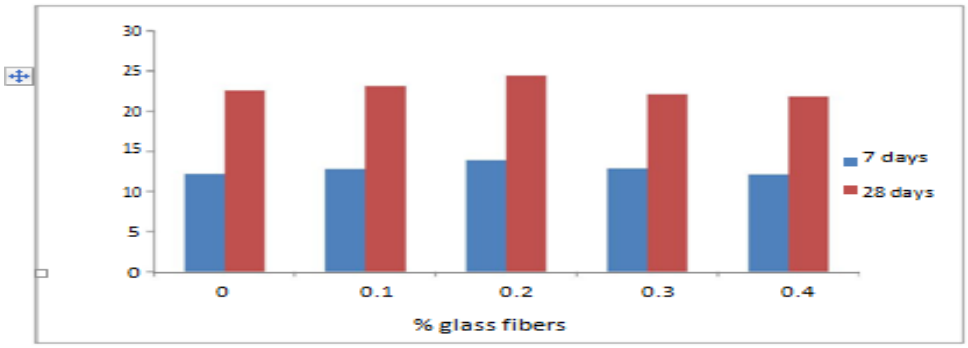


**Fig 3**: Compressive Strength of 5% H2SO4 cured glass fiber cubes after 7 & 28 days

**Table 4**.Compressive strength for M25 grade concrete after HCL acid curing

| S.NO | % of GGBS | % of glass fiber | Compressive strength(N/mm2) | |
|---|---|---|---|---|
| | | | 7 days(5%HCl) | 28days(5%HCl) |
| 1 | 0 | 0 | 14.80 | 23.75 |
| 2 | 20 | 0.1 | 15.03 | 24.80 |
| 3 | 20 | 0.2 | 16.18 | 25.10 |
| 4 | 20 | 0.3 | 14.18 | 24.54 |
| 5 | 20 | 0.4 | 13.83 | 23.86 |

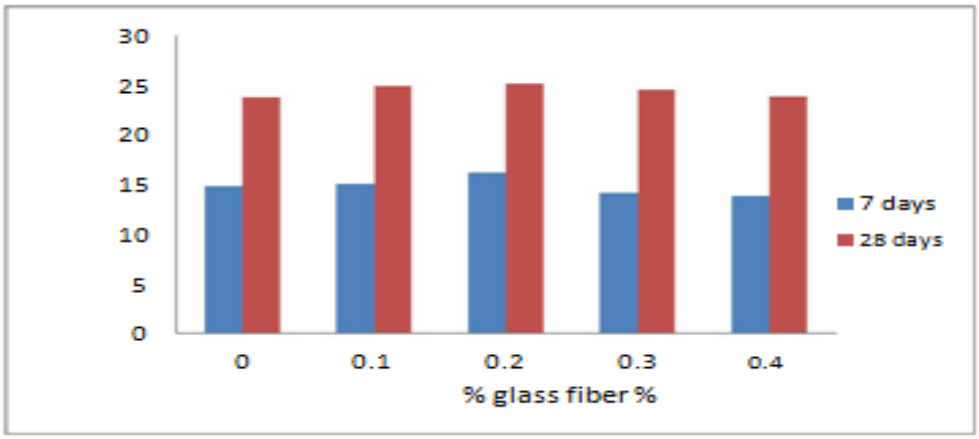


**Fig 4**: Compressive Strength for H2SO4 cured glass fiber cubes after 7 & 28 days

## III.COMPARISON OF STRENGTH AFTER WATER CURING &ACID CURING FOR STEEL AND GLASS FIBERS

Water unsuitable for drinking is generally considered unsuitable for curing concrete as well. Concrete is not fully resistant to acids and most acids disintegrate the cement slowly or rapidly depending on the type of pH value of acidic water.

**Table 5**: 7 days Compressive strength of steel fiber reinforced GGBS concrete

| S.NO | GGBS % | % of Steel Fiber | 7 days water curing (N/mm2) | 7 days (5%H2SO4) | 7days (5%HCl) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 21.92 | 12.80 | 14.12 |
| 2 | 20 | 1 | 23.73 | 13.44 | 15.43 |
| 3 | 20 | 1.5 | 25.58 | 14.86 | 15.88 |
| 4 | 20 | 2 | 24.68 | 13.62 | 14.06 |
| 5 | 20 | 2.5 | 23.72 | 12.05 | 13.01 |

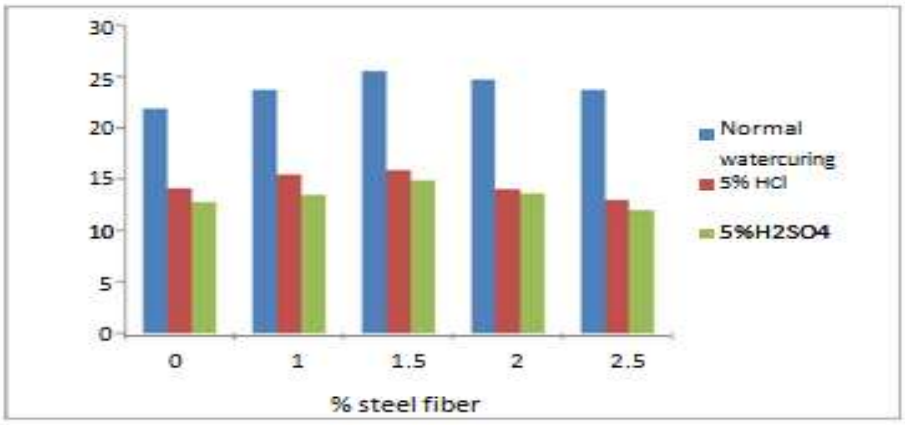


**Figure 5**: 7 days Compressive Strength of Normal water and H2SO4 curing (Steel fiber)

**Table 6**:28 days Compressive strength of steel fiber reinforced GGBS concrete

| S.No | GGBS % | % of Steel Fiber | 28 days water curing (N/mm2) | 28days (5%H2SO4) | 28days (5%HCl) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 32.88 | 22.67 | 23.25 |
| 2 | 20 | 1 | 33.54 | 23.76 | 24.30 |
| 3 | 20 | 1.5 | 33.95 | 24.76 | 24.70 |
| 4 | 20 | 2 | 32.54 | 23.01 | 24.10 |
| 5 | 20 | 2.5 | 31.43 | 22.28 | 23.23 |

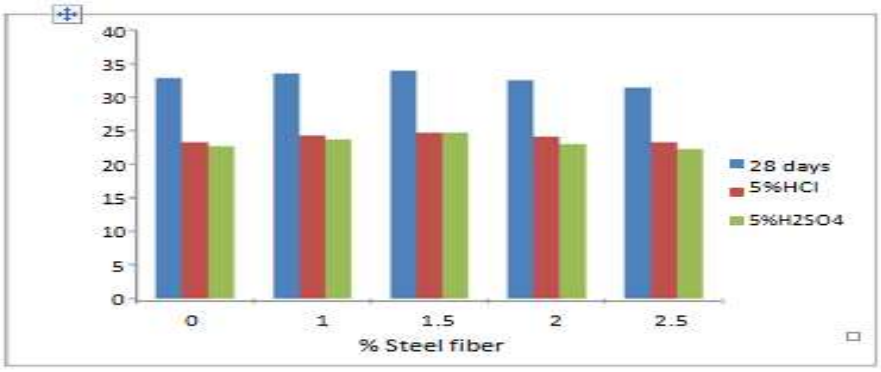


**Figure 6**: 28 days Compressive Strength of Normal water and H2SO4 curing (Steel fiber)

**Table7**: 7 day's Compressive strength of Glass fiber reinforced GGBS concrete

| S.NO | GGBS % | % of Glass Fiber | 7 days water curing (N/mm2) | 7 days (5%H2SO4) | 7days (5%HCl) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 21.92 | 12.16 | 14.82 |
| 2 | 20 | 0.1 | 23.73 | 12.81 | 15.03 |
| 3 | 20 | 0.2 | 25.57 | 13.86 | 16.16 |
| 4 | 20 | 0.3 | 24.68 | 12.82 | 14.12 |
| 5 | 20 | 0.4 | 23.35 | 12.1 | 13.02 |

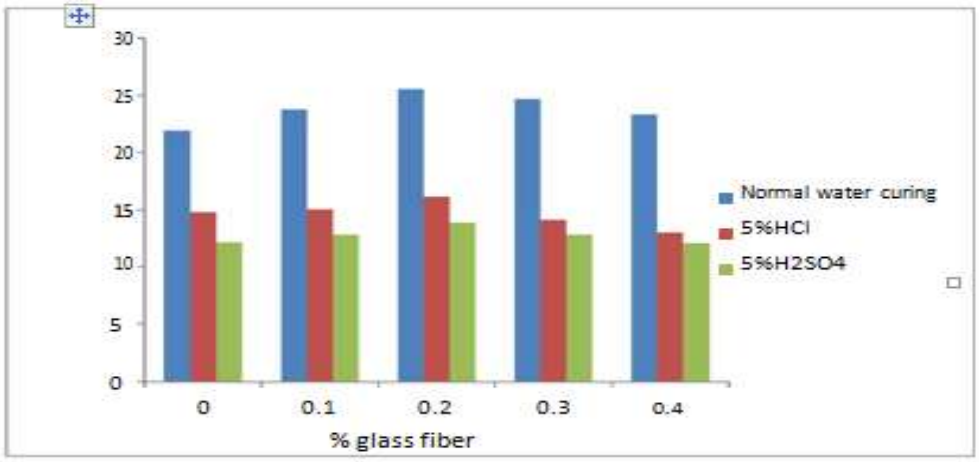


**Figure 7**: 7 days Compressive Strength of Normal water and H2SO4 curing (Glass fiber)

**Table8**: 28 day's Compressive strength of Glass fiber reinforced GGBS concrete

| S.No | GGBS % | % of Glass Fiber | 28 days water curing (N/mm2) | 28days (5%H2SO4) | 28days (5%HCL) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 32.88 | 22.60 | 23.75 |
| 2 | 20 | 0.1 | 33.55 | 23.12 | 24.89 |
| 3 | 20 | 0.2 | 33.96 | 24.42 | 25.10 |
| 4 | 20 | 0.3 | 32.55 | 22.11 | 24.53 |
| 5 | 20 | 0.4 | 31.23 | 21.83 | 23.86 |

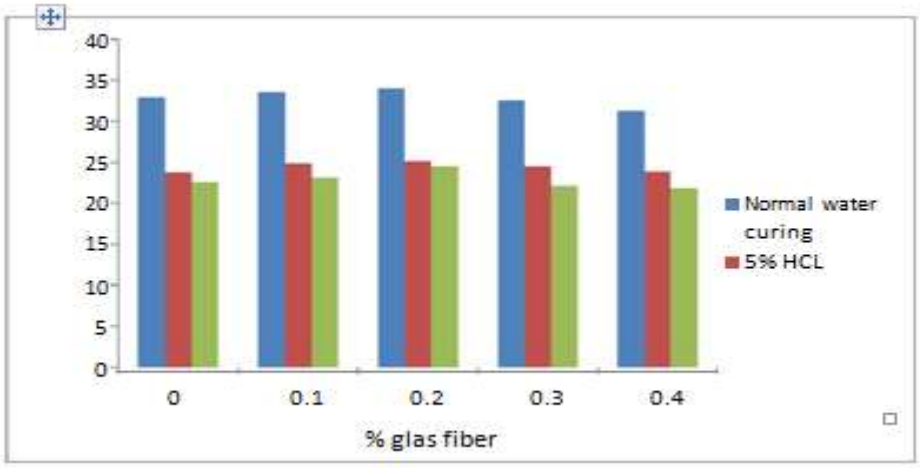


**Figure 8**: 28 days Compressive Strength of Normal water and H2SO4 curing (Glass fiber)

## IV.CONCLUSION

Predicated on the analysis of experimental results and discussion there upon the following conclusions can be drawn that The optimum quantity for partial supersession of cement by ground granulated blast furnace slag is obtained at 20%.The concrete coalescence with 30% GGBS and 1.5% steel fiber has the highest compressive strength, flexural strength and split tensile strength performance at all ages. The concrete coalescence with 30% GGBS and 0.2% glass fiber has the highest compressive strength, flexural strength and split tensile strength performance at all ages. The effect of acid on concrete decreases with the raise of percentage of GGBS.The results show that steel fiber is more efficacious than glass fiber. Ground Granulated Blast Furnace Slag, glass fiber and steel fiber can be utilized in concrete as a felicitous supersession of cement to make the concrete more strength in compression and tension, to make concrete more economical.

## References

1. Santosh Kumar Karri, G.V.Ramarao, P.Markandeyaraju"The Strength and Durability Studies On GGBS Concrete", SSRG-IJCE, Volume 2, Issue10, (October 2015).

2.Arvind B. Nakum, Vatsal N Patel,Vishal B. Patel "Studied The Experimental Study On Mechanical And Durability Properties Of High Strength Concrete Incorporating Ggbs And Steel Fibers"- IJCIET Volume.3, Issue.4, (July –Aug 2015).

3.AvinashGornale, S Ibrahim Quadri, Mehmoodquadri, Syed MdAkramali, Syedshamsuddinhussaini"Strength Aspects OfGlass Fiber Reinforced Concrete", IJSER, Volume 3, Issue, (July 2012).

4. D.Neeraja, "Experimental Investigations On Strength Characteristics Of Steel Fiber Reinforced Concrete", IJSER Volume 2, Issue 07, (February 2013).

5. Siddharth, SeetharamMunnur, "Experimental Study on Strength Properties of Concrete Using Steel Fiber and GGBS as Partial Replacement Of Cement"IJERT Volume 4, Issue 01, (January 2015)

6. Mr.Nikhil A. Gadge, Prof.S. S. Vidhale"Mix Design OfFiber Reinforced Concrete (FRC) Using Slag &Steel Fiber" IJMERWww.Ijmer.Com Vol. 3, Issue. 6, (Nov - Dec. 2013)

7. S.P.Sangeetha, P.S Joanna, "Flexural Behaviour of ReinforcedConcrete Beams with Partial Replacement of GGBS" American Journal of Engineering Research (AJER), Volume-03, Issue-01,(2014)

8. A. Sumathi*, K. Saravana Raja Mohan "Study on the Strength and Durability Characteristics of High Strength Concrete with Steel Fibers" IJCRGG.vol.08 (2015)

9. Milind, V.Mohod,"PerformanceOf Steel Fiber Reinforced Concrete", Volume.1, Issue 12(December 2012)

10. A.m.shende, a.m. pande, m.gulfampathan "Experimental study on steel fiber reinforced concrete for M-40 grade", IRJES 4, issue2,(February-2013volume)