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# Effective Utilization of Granulated Blast Furnace Slag as a Fine Aggregate Replacement in the Study of Mechanical Properties of Concrete

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***Abstract:***

This study investigates the effective utilization of Granulated Blast Furnace Slag (GBFS) along fine aggregate (FA) replacement with concrete structures to reduce its adverse environmental impacts. GBFS was used as fine aggregate in place of natural sand (NS) in concrete. Design mix of M30 grade of concrete with water cement ratios of 0.40 was used with the percentage replacement of 0%, 10, 30, 50, 70 and 100%. It was observed from the results indicates the partial utilization of GBFS with 50% as different construction material in place of NS in concrete structures. Reduction in workability measured by slump test was maintained by cast appropriate percentage of super.

***Keywords****: GBFS, Workability, Super Plasticizer, Compressive Strength, Split Tensile Strength, Flexural Strength.*

## I. Introduction

The main objective of solid waste management is to escalate its recycling and restating capacity [1]. Blast furnace slag (BFS) it is derived from iron steel industry, needs a abounding amount of land for storage and it is responsible for pollution created to the soil, atmosphere and underground water [2]. In lately years, the Indian government has been focusing on the sustainable development of structures construction of civilization which is ecological friendly [3]. To utilize industrial waste as different material is widely observe as one of the related efficient resource management steps and in this way sand excavation could be stopped. [4].Blast furnace slag is a byproductattained in the production of pig iron in the blast furnace and is Comprises of silica, Alumina, oxides of calcium, Magnesium, Manganese, Iron etc. [5]. When the molten slag has been speedily cooled with water in pond, with water jets, it converted intoalmost fully non crystalline, so it is known as granulated slag [6]. Such as GBFS, good cementitious properties associated with Portland cement when finely ground was found. Many researchers reported that the exceptional properties of graphene and CNTs improve the flow properties, mechanical properties and microstructure of the cementitious materials [7-9].

## II. MaterialProperties

### 2.1 Cement

The research shows that investigation, 53 grade Ordinary Portland Cement was used. Cement had been tested for diverse properties.

### 2.2 Fine Aggregates

Natural sand and GBFS were used as a fine aggregate in this research work. GBFS comprises mainly of oxides of calcium, silicon, aluminium and magnesium. GBFS was acquired from Durgapur Steel Plant (DSP). The chemical composition of GBFS is shown by table1 used that have been used

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in my project work. The physical attributes of fine aggregate is shown by table2.

It is evident from the table 2 that GBFS is light weight aggregate which can be used to prepare a light weight concrete. We can also see that water absorption of GBFS is also very high as compare to NS. Absorbent of water reduces the workability of material.

### 2.3 Super plasticizer

The specific gravity at 27 °C was 1.145 with approximately 1%. Air entrainment and zero percent chloride content in the admixture. Conplast SP 430 super plasticizer was used to maintain the workability between 25-75 mm.

## III. Test Results & Discussion

Design mix of M30 grade of concrete has been used in the replacement of natural sand by GBFS. The replacement levels have been taken as 0, 10, 30, 50, 70 and 100% for all grades of concrete mixes having w/c as 0.40. For mix concrete cubes of size 150x150 x150cm, cylinder of size 150 mm diameter and 300 mm height and prism of size 10x10x50cm (10cm cross section and 50cm length) have been casted. The samples were demouldedand cured after 24 hours for 7 and 28 days. At the end of each curing period, cubes, cylinder and prism were tested.

### 3.1 Compressive strength for M30 grade of concrete

This evident from the figure 3 that for two ages (7, 28 days) increases up to 30% replacement  so it may further noted thatat 7-daysthe compressive strength of concrete with natural sand has risen by 9.02%, at 28-days 10.33% for 30% when natural sand has been replaced by GBFS for M30 grade of concrete.

### 3.2 Split Tensile and Flexural strength for M30 grade of concrete

The Split tensile and flexural strength increases up to 30% replacement. So it may be noted thatthe split tensile concrete strength has risen by 15.03% and for 30% replacement of natural sand by GBFS, Flexural Strength has increased by 6.05% at 28-days.

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**Fig 1:** Natural Sand and GBFS

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**Table-1: Chemical composition of GBFS (From DSP)**

| Oxide | $SiO_2$ | CaO | $Al_2O_3$ | MgO | MnO | FeO | $K_2O$ | Basicity |
|---|---|---|---|---|---|---|---|---|
| Percentage (%) | 30.8 | 31.6 | 22.7 | 11.6 | 0.28 | 0.44 | 0.74 | 1.40 |

**Table-2:Physical characteristic of Fine Aggregates as per IS: 2386 - IV (1963) [14]**

| Property | Natural sand (NS) | GBFS |
|---|---|---|
| Bulk Density $kg/m^3$ (Compact) | 1.69 | 1.59 |
| Bulk Density $kg/m^3$ (Loose) | 1.56 | 1.48 |
| Specific Gravity | 2.60 | 2.31 |
| Fineness Modulus | 3.48 | 3.40 |
| Water Absorption (%) | 0.30 | 4.06 |

**Table-3: Percentage Super plasticizer for various replacement levels**

| GBFS (%) | 0 | 10 | 30 | 50 | 70 | 100 |
|---|---|---|---|---|---|---|
| **Super plasticizer (%)** | 0 | 0 | 0 | 0.50 | 0.75 | 1.00 |

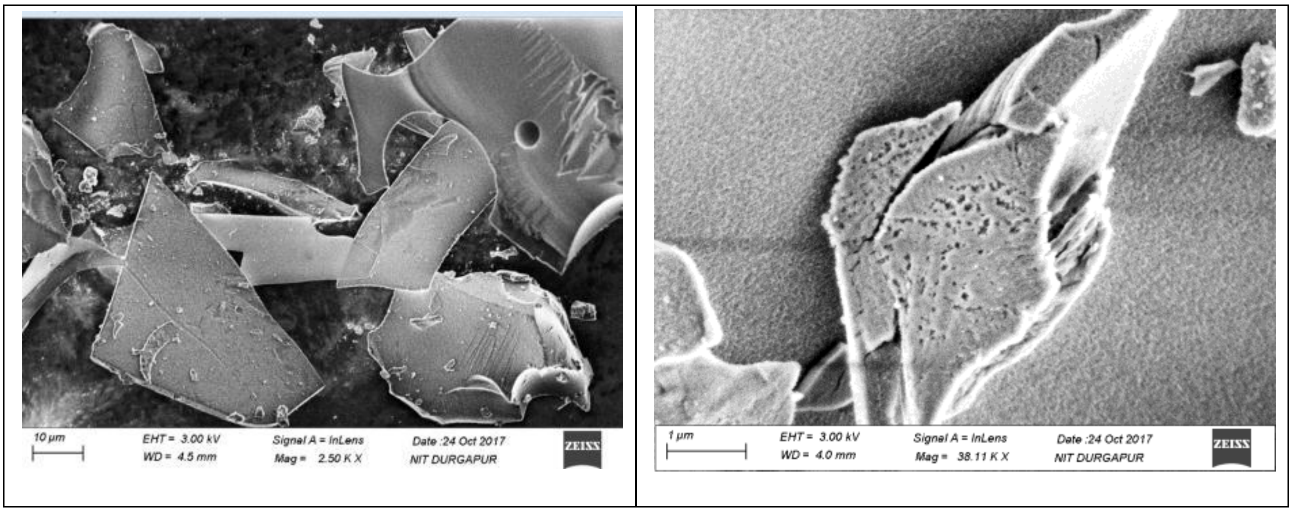


**Fig 2:** SEM Images of GBFS

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**Fig 3:** Test samples on 300 Ton to cause the mechanical properties of specimen

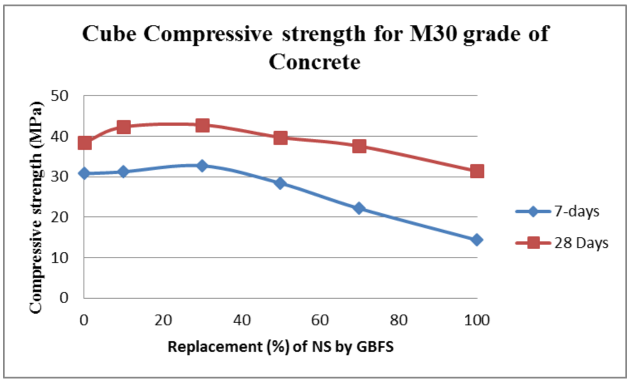


Fig.4: Cube Compressive strength

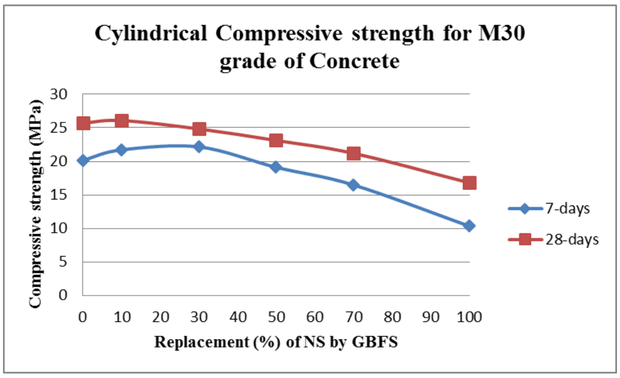


Fig.5: Cylindrical Compressive strength

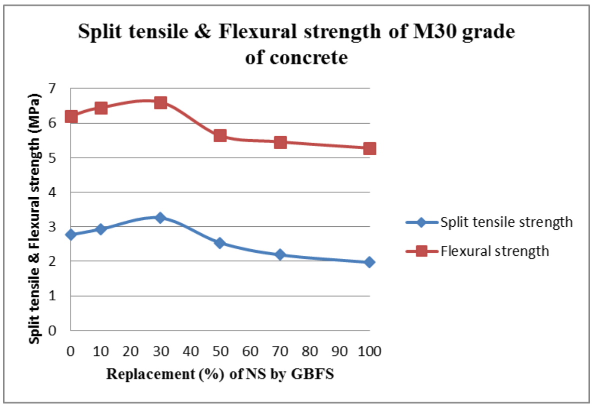


Fig.6: Split tensile & Flexural strength

## IV. CONCLUSION

**1.** The data obtained indicate that as the GBFS increases, it increases its compressive strength, split tensile strength and flexural strength of concrete.

**2.** From the data it is clear that GBFS can be used as a substitute to natural sand from strength consideration.

**3.** This research recommends the utilization of GBFS with NS up to 50%, supporting

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approximately of the strength with concrete without GBFS.

**4.** Considerable difference in mechanical strength has been obtained in control mix and 100% replacement level of natural sand by GBFS.

**5.** The concrete specimen compressive strength increases up to 50% replacement and after that decreases amount till 70% replacement. To maintain the workability, 0.5% to 1% of super plasticizer was used for both control mix and concrete mix with GBFS.

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