

# Studies on Properties of Concrete Replacing GGBS, Steel Slag and Slate

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**Abstract :** The main aim of this study is replacement of industrial waste such as GGBS, Steel Slag and Slate in concrete 10%, 20% and 30%. GGBS is replaced partially upto 30% to the cement, steel slag is replaced upto 10%, 20% and 30% of fine aggregate and slate is replaced partially upto 10%, 20% and 30% of coarse aggregate and which result in betterment of strength, durability and workability than a normal conventional concrete and get good results as it replace upto 20% and the following test is conducted on the specimen for grade M30 and the test are (i) slump cone test (ii) compressive strength test (iii) flexural strength test (iv) water absorption test and (v) Acid resistance test. In this test as it result can be replace upto 20-30% as it gets good strength comparing to the conventional concrete.

**Keywords –** Compressive strength test, Flexural strength test, GGBS, Steel Slag, Slate.

## I. INTRODUCTION

Major issue in recent years is the global warming and environmental destruction. A number of studies have been conducted to concern on the on the protection of natural resources and to prevent the environment from pollution by using the waste materials from iron and steel industries. The major by products from iron and steel industries are GGBS, steel slag, Slate, fly ash, etc. In india, the steel industries producing around 24 million tonnes of blast furnace slag and 12 million tonnes of steel slag annually. While using the iron and steel industrial wastes in concrete, it improves the strength. The GGBS act as a good binding material in concrete when compared to conventional concrete. The replacing of waste materials in concrete would helps to improve eco-friendly atmosphere and also acts as eco-friendly concrete.

## II. RAW MATERIALS

### 1. Cement

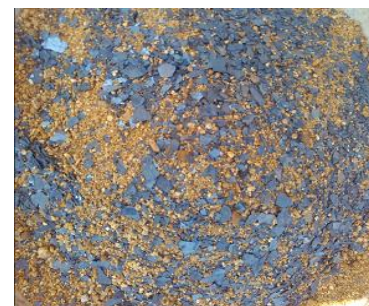
Generally cement is used as a binding the aggregates. It has a cohesive and adhesive property with the presence of water. Cement used in construction as a inorganic material. It may be hydraulic or non-hydraulic depends upon the cement's ability to set with the presence of water.



OPC Cement

### 2. Fine Aggregate

The Steel Slag as Fine Aggregate replacing for making the concrete. The Steel Slag using in the concrete for improving the strength and sustainability. The Steel Slag used as replacing material in concrete with various proportions. The steel slag is used mainly as aggregate foe light weight concrete. Slags are useful alternative raw material for clinker production also. The National Slag Association has proved that Iron and Steel Slag poses no threat to human health or to the Environment. The Iron and Steel Slag have been extensively tested using certified laboratories such as USEPA and American Society for Testing Materials (ASTM). The specific gravity of fine aggregate is 2.65.



Fine aggregate

### 3. Coarse Aggregate

The Steel Slate as coarse aggregate in the concrete. The Steel Slate as an alternative aggregate in concrete for finding the specific properties of it. The aggregates used in

the concrete ranges from 20mm to 12.5mm size. The aggregates are passed on IS Sieve size 20mm and retained on 12.5mm. In this project, the 20mm and 12.5mm size can be used. The steel slag replacing in concrete as aggregate either partially or fully replacement for better improvement of strength. The steel slag as aggregate in concrete with different proportions. The specific gravity of coarse aggregate is 2.33.



#### 4. Ground Granulated Blast Furnace Slag (GGBS)

The present technical report focuses on investigating characteristics of concrete with partial replacement of cement with GGBS. The Ground Granulated Blast Furnace

Slag (GGBS) is a byproduct from the Blast Furnaces used to make iron. It is obtained at the temperature of about 1500 degrees centigrade. From the previous researches, the GGBS is used to make durable concrete structures in combination with OPC. The lifespan of buildings extending from Fifty to Hundred years. Ground Granulated Blast Furnace Slag is Off-white in colour. The chemical composition of GGBS is obtained from X-ray analysis at laboratory. The GGBS is used passes, 90% through 90 micron sieve. The replacement of GGBS with OPC results in 14% reduction in cost of concrete.



GGBS

#### 5. Steel Slag and Steel Slate Waste

The Steel Slag and Slate material is hard and rigid. It is estimated that the volume of slate waste are significantly, between 400-500 million tonnes generated each year.

Generally, the Slate waste aggregates are different from natural aggregates, so that concrete made with the use of them has specific properties.



STEEL SLAG



SLATE

#### 6. Water

It should be free from acids, alkalies, organic and inorganic impurities. The water should be potable.

#### 7. Admixture

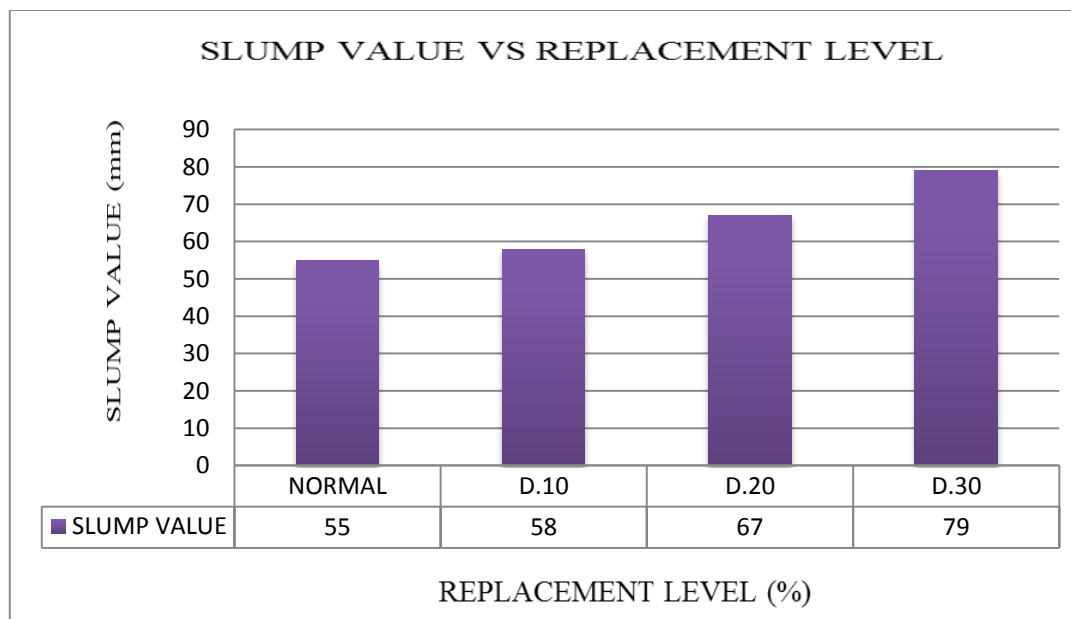
The admixture is used for reducing the water content in concrete. The super plasticizer is the admixture used for making the concrete.

#### III. MIX DESIGN AND MIXING OF CONCRETE

Mix design is a process to determine the relative proportion with the respective objects to produce the concrete. The concrete can be made for M30 grade is 1:1.871:3.376:0.42 (cement, fine aggregate, coarse aggregate, w/c). hand mixing is preferred in this M30 grade concrete.

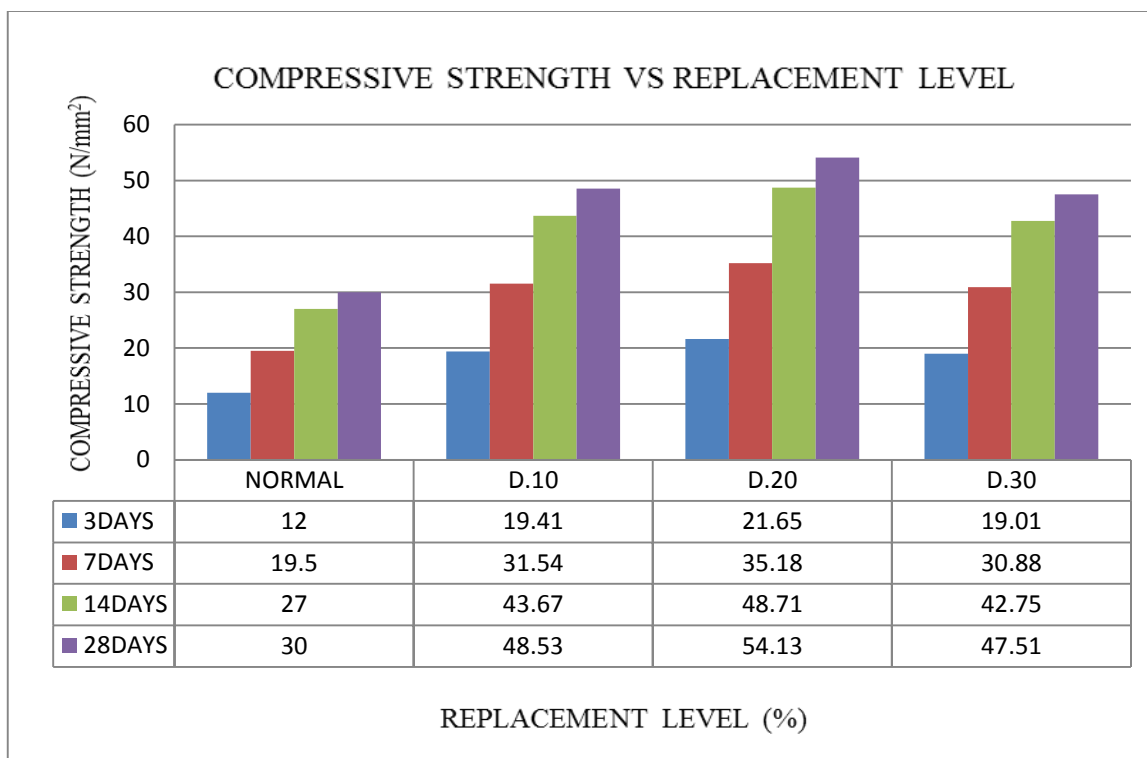
IV. SLUMP CONE TEST

GRADE	SPECIMEN	SLUMP VALUE(mm)
M30	NORMAL	55
	D.10	58
	D.20	67
	D.30	79



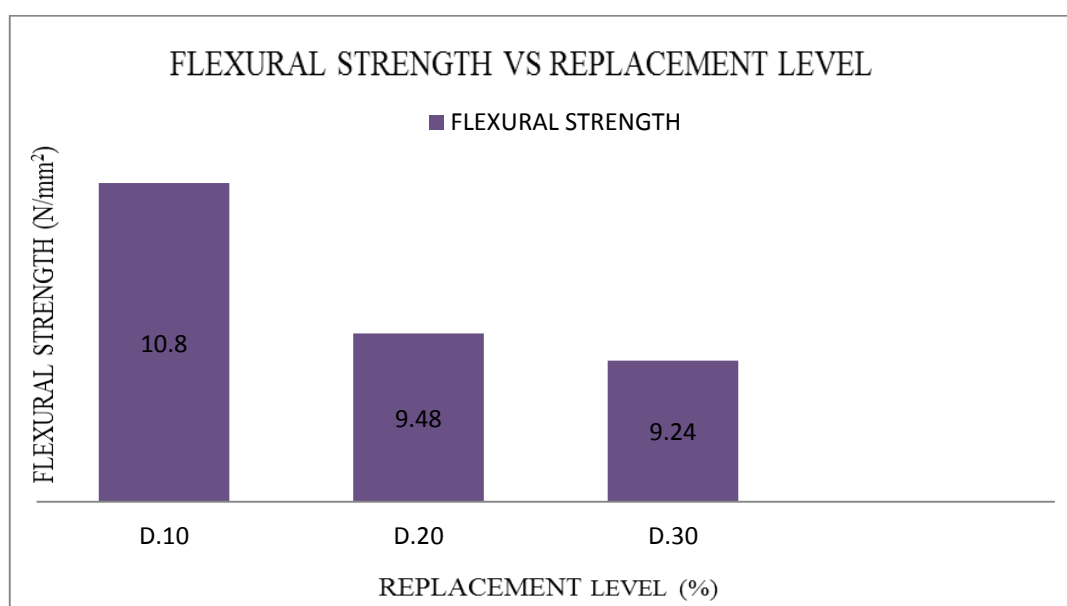
V. COMPRESSIVE STRENGTH TEST

GRADE	SPECIMEN	COMPRESSIVE STRENGTH (N/mm <sup>2</sup> )			
		3 DAY	7 DAY	14 DAY	28 DAY
M30	NORMAL	12	19.5	27	30
	D.10	19.41	31.54	43.68	48.53
	D.20	21.65	35.18	48.72	54.13
	D.30	19.01	30.88	42.76	47.51



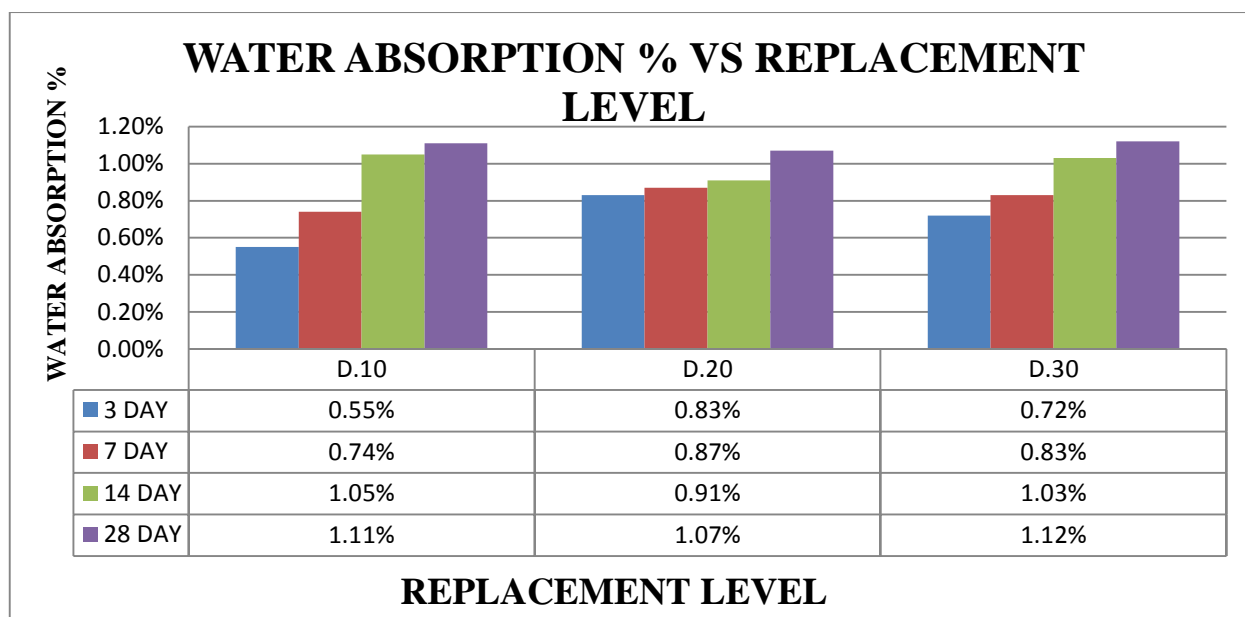
**VI. FLEXURAL STRENGTH TEST**

GRADE	SPECIMEN	ULTIMATE LOAD (KN)	FLEXURAL STRENGTH (N/mm <sup>2</sup> )
M30	D.10	27	10.8
	D.20	23.7	9.48
	D.30	23.1	9.24



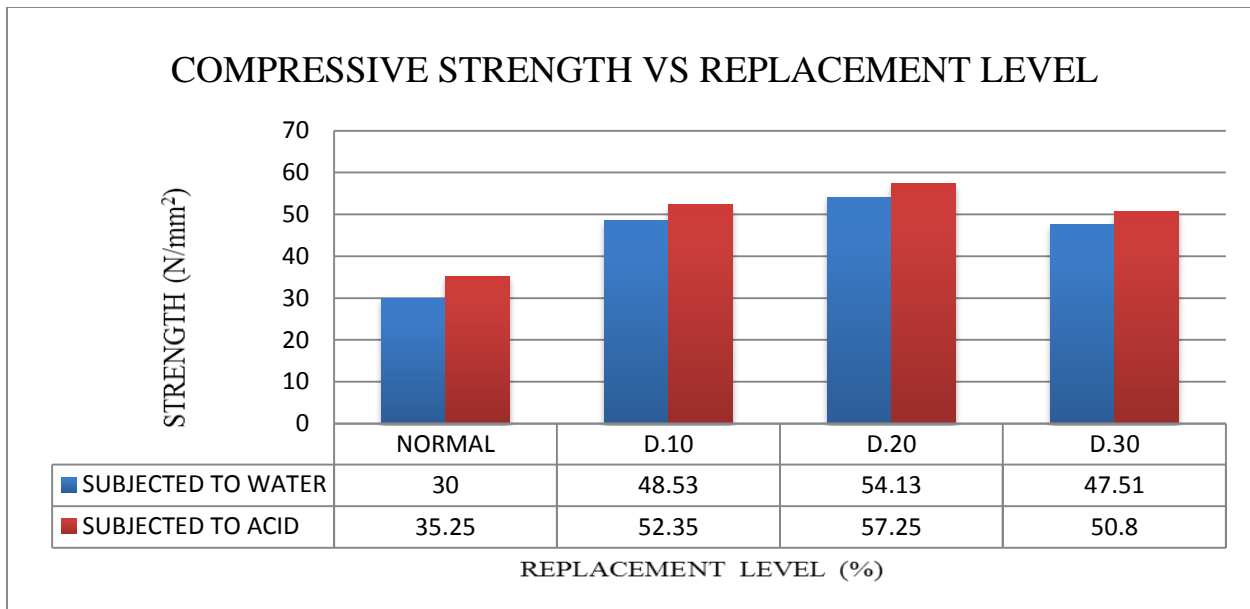
VII. WATER ABSORPTION TEST

GRADE	DAYS	SPECIMEN	DRY WEIGHT (A) Kg	WET WEIGHT (B) Kg	WATER ABSORPTION (%)
M30	3 DAY	1D.10	8.349	8.395	0.55
	7 DAY	2D.10	8.348	8.41	0.74
	14 DAY	3D.10	8.377	8.465	1.05
	28 DAY	4D.10	8.20	8.291	1.11
	3 DAY	1D.20	8.38	8.45	0.83
	7 DAY	2D.20	8.28	8.352	0.87
	14 DAY	3D.20	8.24	8.315	0.91
	28 DAY	4D.20	8.42	8.51	1.07
	3 DAY	1D.30	8.36	8.42	0.72
	7 DAY	2D.30	8.56	8.631	0.83
	14 DAY	3D.30	8.29	8.375	1.03
	28 DAY	4D.30	8.28	8.373	1.12



VIII. ACID RESISTANCE TEST

GRADE	SPECIMEN	STRENGTH BEFORE SUBJECTED TO ACID CURING N/mm <sup>2</sup>	STRENGTH AFTER SUBJECTED TO ACID CURING N/mm <sup>2</sup>
M30	NORMAL	30	30.25
	D.10	48.53	52.53
	D.20	54.13	57.25
	D.30	47.51	50.8



### IX. RESULT AND DISCUSSION

#### a) Workability

Generally concrete slump value is used to find the workability, which indicates water-cement ratio. The slump test is the most simple workability test for concrete, involves low cost and provides immediate results. While using the GGBS, Steel slag and slate in concrete, the workability get reduced as increase in percentage of replacing materials.

#### b) Compressive Strength Test

The Compressive Strength test is required to determine the strength of concrete and therefore its suitability for the work. The sample of concrete shall be taken and used for testing is 15cm\*15cm\*15cm. The maximum load can be applied to the specimen of concrete. The load shall be applied slowly without shock and increased continuously at a rate of approximately 140 kg/sq.cm/min until the specimen get breakdown. The capacity of compressive strength testing machine is 3000KN. While increasing the amount of GGBS beyond 20% the strength get reduced.

#### c) Flexural strength test

The flexural strength is also one of the test to determine the strength of a concrete material. The maximum stress and strain are calculated by this method. When the load supply can be increment in order while using the GGBS, Steel slag and Slate as replacement material in concrete, it decrease the flexural strength when adding the amount more than 20%. The load capacity given to the test is 1000KN

#### d) Water absorption test

This test helps to determine the water absorption of coarse aggregate. For this test a sample not less than 2000g should be used. In this project, the test can be carried out for how much amount of water can absorbed by the specimen. mostly the water absorption is less in quantity it increases the strength while using GGBS as replacing material in concrete it absorbs more amount of water when exceeds 20% of replacement.

#### e) Acid resistance test

The test is conducted for the purpose of determine the concrete material whether it is having good corrosive resistance or not. From the obtained result, the strength of the specimen was increased with decrease in weight.

### X. CONCLUSION

In this project GGBS, steel slag and slate are partially replaced for cement, fine aggregate and coarse aggregate in concrete to found the strength and other properties of concrete. The results concluded from the experiments and the properties of concrete while the iron and steel industry wastes as replacement material. The advantages of the replacement material while using in concrete are listed below:

- It having greater hardness over natural aggregate due to its mineral composition.
- The slag has micropores and therefore, it retains its adhesiveness with wear on road construction also.
- It gives better gripness while using on road construction.
- It gives more compact over natural aggregate.
- It gives better greater stability and last longer.
- It particulate in pollution reducer.
- Concrete made with GGBS will have a high solar reflectance.
- GGBS substantially improves the ability of concrete to resist effects of chlorides even better for fire also.
- For the lowest embodied CO<sub>2</sub>, GGBS is to be preferred.
- It saves energy and reduces the production cost.

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