



## Strength Evaluation of Concrete By Replacing Steel Slag for (F A) and Utilisation of Limestone Coarse Aggregate

### KEYWORDS

Steel slag, lime stone coarse aggregates, Compressive strength, OPC, M20 Grade.

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### ABSTRACT

*Global warming and environmental destruction have become the major issue in recent years. Use of more and more environmental friendly materials in any Industry in general and construction industry in particular, is of paramount importance. Preventing the depletion of natural resources and enhancing the usage of waste materials has become a challenge to the scientist and engineers. In this study fine aggregates of concrete are replaced by steel slag which is an industrial byproduct getting generated in large quantity and replacing lime stone as coarse aggregates. SS (Steel slag) is a waste by-product obtained from the iron and steel plants and waste limestone aggregates are the waste broken pieces of limestone obtained from the limestone quarries. In this work, we have made an attempt to study the compressive strength of M20 grade cement concrete by using steel slag and waste limestone aggregate as partial replacement to fine aggregates and coarse aggregates. The compressive strength test is evaluated for 3,7,21 and 28 days of curing period with various percentage variations of steel slag. The compressive strength of cement concrete is highest at 40% SS replacement, which is 31.186 N/mm<sup>2</sup> at 28 days of curing period. which are higher than the normal conventional cement concrete strength. From this study it is concluded that the natural fine aggregates can be replaced by steel slag up to 50%.*

### INTRODUCTION

Construction industry, consist of vertical construction and horizontal construction. Vertical construction refers to the building construction and horizontal construction refers to the heavy construction. Construction of building structure like public and private buildings residential and non-residential building structures comes under the building construction. Many of the largest and spectacular structures comes under the heavy construction which includes structures like railways, highways, airports, harbors, dams, canals, bridges and many other major public works. Other miscellaneous specialist structures of the construction industry includes industrial construction, marine construction etc. Thus in construction of these major and spectacular structures, large and heavy amount of cement concrete is required. Since the civilization started in this world, man has always been involved in some form of the construction activities, which also directly involves the use of cement concrete. In this present day world, the technical modifications have revolutionized the construction industry and construction activities. Cement Concrete is one of the world's most versatile and widely used construction materials. Concrete is the primary construction material which is widely used in all the construction activities around the world. Day by day construction activities are increasing which is resulting in the excessive utilization of cement concrete. And the cement concrete material requires excessive amount of extraction of natural resources or naturally available materials like natural river sand, stones, lime, clay, water etc. Cement concrete is the second larg-

est consumed material on earth. The attractive property of cement concrete includes economy, efficiency, durability, strength, mould ability, flexibility and rigidity. These properties give the cement concrete a wide range of structural applications, investigated the use of blast furnace slag as aggregates in concrete. The results showed that it has properties similar to natural aggregates and it would not cause any harm if incorporated into concrete. The research was encouraging, since they show that using blast furnace slag as coarse aggregates in concrete has no negative effects on the short term properties of hardened concrete<sup>1</sup>.

studied on replacement of coarse and fine aggregate in concrete by slag. Concrete of M20, M30 and M40 grades were considered for a W/C ratio of 0.55, 0.45 and 0.40 respectively for the replacements of 0, 30, 50, 70 and 100% of aggregates (Coarse and Fine) by slag. Whole study was done in two phases, i.e. replacement of normal crushed coarse aggregate with crystallized slag and replacement of natural fine aggregate with granular slag<sup>2</sup>.

### 2. OBJECTIVE

1. To study the Development of Compressive Strength of M20 grade plain cement concrete with different levels of replacement of Steel Slag as fine aggregate and using lime stone as coarse aggregate.

2. To study the development of compressive strength of concrete prepared with zero percent replacement of steel slag and compares this strength with the compressive

strength of normal concrete.

**3. MATERIALS &METHODOLOGY**

[3.1] CEMENT: The common OPC 53 grade cement is used. The physical properties of the cement tested according to standard procedure conform to the requirement of IS 12269:1989

**Table 1 Physical properties of Cement.**

S. No	Characteristics	Value obtained experimentally
1	Standard Consistency	40%
2	Fineness' (90 micron sieve)	3%
3	Initial setting time	30 minutes
4	Specific gravity	2.69

[3.2] FINE AGGREGATE: Locally available river sand passing through 4.75mm sieve conforming to the recommendation of IS383-1970 was used.

**Table 2 Physical properties of Fine Aggregate**

S. No	Characteristics	Value obtained experimentally
1.	Fineness modulus	2.95
2.	Specific gravity	2.60

[3.3] COARSE AGGREGATE (limestone): Nearby locality available coarse aggregates in shabad taluka of Gulbarga district retaining on 4.75mm sieve is used.

**Table3Physical properties of Coarse Aggregate**

S.NO	characteristics	Value obtained experimentally
1.	Fineness modulus	3.8
2.	Specific gravity	2.727

[3.4] STEEL SLAG: This steel slag can be used in the construction industry as aggregates in concrete by replacing natural aggregates. Steel slag is obtained from Agni steels

**Table 4 Physical properties of Steel Slag.**

S.NO	characteristics	Value obtained experimentally
1.	Fineness modulus	2.97
2.	Specific gravity	2.93



Steel slag sample

**[3.5]WATER: Portable water is used for casting and curing of specimens.**

**3.6 EXPERIMENTAL STUDY**

In general, the mix design (M20) is arrived based on the physical properties of materials and according to with IS 10262:2009.

[1] COMPRESSION STRENGTH TEST: Totally 48 concrete cubes were casted and it is allowed for 3,7,21 and 28 days curing. After drying, cubes were tested in Compression Testing Machine (CTM) to determine the ultimate load. Replacement made for 0%, 30%, 40% and 50%. For this study the water cement ratio of 0.48 is maintained uniformly.



**4. RESULT AND DISCUSSIONS**

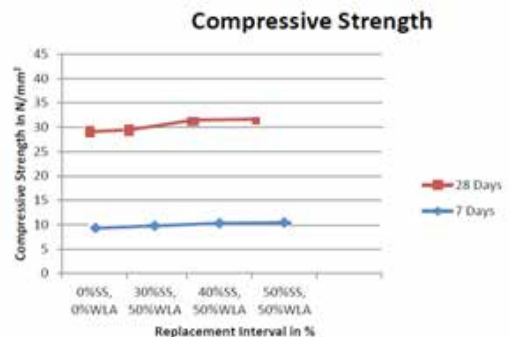
Experimental investigations are shown graphically. All the values are average of the three specimens tested. The compression strength of cubes. The values of compressive strength obtained are tabulated in tabular form as shown in the Table 5 in the following lines.

The compressive strengths obtained at various levels of steel slag replacements of 0%,30%,40%,50% after 28 days of curing 26.611N/mm<sup>2</sup>,29.587N/mm<sup>2</sup>,31.86N/mm<sup>2</sup> 31.061 N/mm<sup>2</sup> respectively.

It can be observed from the tabular columns of the table that at 40% replacement of steel slag highest compressive strength of concrete is obtained thereafter if we increase further then there is decrement in strength of concrete is noticed.

Further also it can be noticed that at all the points of replacement levels the strength of concrete is increasing compared to normal concrete. Then we can say that steel slag incorporation in the concrete preparation is extremely advantageous.

Graph is plotted only by taking 7 and 28 days strength development



% of steel Slag used	3days	7 days	21 days	28 days
0	5.20	12.05	23.058	26.611
30	6.15	15.775	26.56	29.587
40	6.49	18.51	27.90	31.186
50	6.23	16.50	27.3	31.061

**Table 5 Compression strength of cubes n/mm<sup>2</sup>**

## 5. CONCLUSION

1. The results lead to the applicability of replacing the coarse aggregate (normal aggregate in concrete mix) by limestone aggregate with the standard specifications of concrete mixture.

2. For most economic design of mixtures use the limestone that available in many locations of shabad.

3. From this study, we can conclude that, both river sand and natural coarse aggregate can be replaced by steel slag as a fine aggregate and waste limestone aggregate as a coarse aggregate up to 50% for the manufacturing of cement concrete.

4. From the above study, we can conclude that the strength characteristics of cement concrete is showing optimum results at 40% replacement of natural fine aggregate by steel slag.

5. It is concluded that, the strength characteristics of cement concrete decreases as the percentage of replacement of natural fine aggregates by steel slag increases above 50% .

6. With the above study, the mean target strength of M20 grade cement concrete is Achieved with partial replacement of natural fine aggregate by steel slag and natural coarse aggregate by waste limestone aggregate.

7. With the above study, the combined effect of using steel slag as a fine aggregate and Waste limestone aggregate as a coarse aggregate as partial replacements is achieved in M20 grade plain cement concrete

8. Cement concrete can be made economical by partially replacing the natural fine Aggregates by steel slag.

9. By this study, we can produce green, sustainable and eco-friendly cement concrete by partially replacing the natural fine aggregate by steel slag.

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