Research Paper Engineering

Experimental Study on Compressive Strength of Concrete With Partially Replacement of Fine Aggregte by Steel Slag and Using Basalt As Coarse Aggregate

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ABSTRACT

As the river bedded sand is in scarce and its continuous utilization causes environmental effects also it is becoming very costly hence affecting the construction activities to a great extent, this factor have motivated the authors to do the research work under consideration. In this study fine aggregates of concrete are replaced by steel slag which is an industrial byproduct getting generated in large quantum. The local area of authors are comprised of large terrains of basaltic origin hence authors have utilized the coarse aggregates of basaltic rock. Within this research work concrete of grade M20 is used. Partially replacement of steel slag is made for the varying percentages of 0%, 30%, 40%, and 50%. The result shows that optimum percentage replacement of fine aggregate by steel slag is 40% and at this particular level the concrete is showing highest strength, beyond this limit the compressive strength of concrete starts decreasing but still it is more compared to normal concrete without any replacement.

KEYWORDS : Steel slag, Basalt coarse aggregates, Compressive strength, OPC, M20 Grade.

INTRODUCTION

The primary problems faced by the use of cement concrete is that the ever increasing demand of cement concrete, cost of cement and concrete, pollution due to the cement production, excessive utilization of natural resources in cement production and in construction activities, excessive use of sand and aggregates and potable water, carbon emissions during concrete productions etc. The manufacture and usage of cement concrete also exerts large amount of social and environmental problems. Natural river sand is one of the important constituent in the cement concrete production. Now a day the sand is being extensively utilized in almost all around the world in the construction activities. Throughout the world at all places, construction industries are developing at a faster rate which in-turn is resulting into the higher demand for concrete, sand and other concrete making materials. Natural river sand is highly expensive and is also depleting at a faster rate. The main function of sand in concrete is to improve the workability and uniformity of the concrete mixture. The main source of sand is the river bed deposits, because of the expensive sand and its increasing depletion, it has become very important to protect and preserve the environment and its natural resources which is an important step towards any development. The higher amount of sand depletion creates sensitive environmental damages. Government is now a day's banning the sand mining, which is affecting the cost of the materials and time of the completion of construction project works. If this extensive utilization of sand continues in future, the sand may get completely depleted from the river beds. To overcome this problem, it is very necessary to search for the alternative materials for concrete production and in construction activities. For the economical and environmental purpose, it is important to think about and make use of the industrial waste by-products as the alternative materials in the construction activities and in the production of cement concrete. By utilizing the industrial waste by-product materials as the alternative materials it may reduce the cost of concrete production, reduce the pollution which helps in the effective ways of utilization for our development. Many industries and factories generate huge amount of wastes as a by-products during the time of processing. Safe disposal of these waste materials is the main problem. Unsafe disposal of these wastes can cause environmental problems. This made to think about how these waste materials can be put into its utilization without causing any damage to the environment. Out of many wastes Steel Slag from the iron and steel plants and which is requiring its attention towards its safe disposal and effective utilization. In this project work carried out, in the preparation of cement concrete, steel slag has been used in place of natural river sand as a partial replacement, Steel Slag is the waste by-product obtained from the iron and steel plants. Good strength is expected with these materials in concrete as a partial replacement in concrete with or without admixtures. 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[1]. 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[2], 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[3].

2. OBJECTIVES

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 basalt stone as coarse aggregate.

2. To study the development of compressive strength of concrete prepared with zero percent replacement of steel slag and compare this strength with the compressive strength of steel slag incorporated concretes.
3. To study the Workability characteristics of M20 grade plain cement concrete with different levels of replacement of Steel Slag.

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	33%
2	Fineness (90 micron sieve)	3%
3	Initial setting time	30 minutes
4	Specific gravity	3.0

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	2.68

[3.3] COARSE AGGREGATE (Basalt): Locally available coarse aggregate retaining on 4.75mm sieve of basalt stone is used.

Table 3 Physical properties of Coarse Aggregate (Basalt stone)

S.NO	characteristics	Value obtained experimentally
1.	Fineness modulus	7.73
2.	Specific gravity	2.59

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

3.5 WATER: Normal portable water 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 showin 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 are 27.05 N/mm^2,32.30 N/mm^2,32.33 N/mm^2,30.82 N/mm^2 respectively.

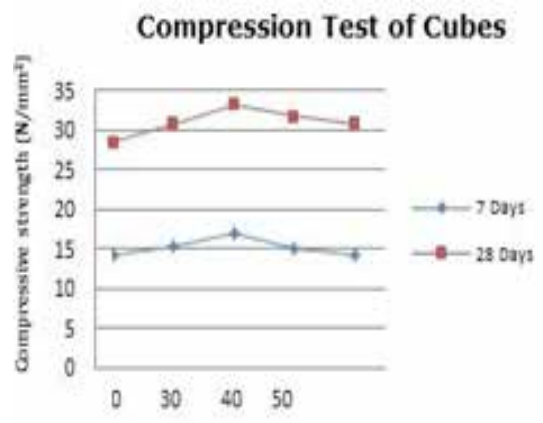
It can be observed from the tabular columns of the table that at 40% replacement of steel slag highest compressive strength of concrete is obtained thereafter if we increase further then there is decrement in strength of concrete is noticed.

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.

Table 5 Compression strength of cubes in N/mm²

% of steel Sag used	3 days	7days	21 days	28days
0	8.06	15.2	23.90	27.05
30	9.56	18.03	29.04	32.30
40	10.19	16.56	29.50	32.33
50	9.095	14.78	27.67	30.82

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



5. CONCLUSION

1. From this study, we can conclude that, river sand can be replaced by steel slag as a fine aggregate up to 50% for the manufacturing of cement concrete.
2. From the above study, we can conclude that the compressive strength of cement Concrete is showing optimum results at 40% replacement of natural fine aggregate by Steel slag.
3. It is concluded that, the compressive strength of cement concrete decreases as the percentage of replacement of natural fine aggregates by steel slag increases above 40%.
4. 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.
5. Cement concrete can be made economical by partially replacing the natural fine Aggregates by steel slag.
6. 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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