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Experimental study on partial replacement of course aggregate by steel slag in cement concrete

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***Abstract*—** The paper reports the effect of concrete using steel slag and M-sand as coarse aggregate replacement, in this project work, the concrete grade M25 was selected and IS method was used for mix design, The properties of materials for cement, fine aggregate, coarse aggregate, steel slag and M-sand were studied for mix design, The various strength of concrete like compressive strength, split tensile strength, flexural strength were studied for various replacement of fine aggregate using copper slag and M-sand that are 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, and 45%. The maximum compressive strength of concrete attained at 30% replacement of steel slag by partial replacement of coarse aggregate at 7, 14 and 28 days. The split tensile strength and the flexural strength were also obtained higher strength at 30% of replacement level at 28 days.

Keywords

Cement, fine aggregate (M-sand), steel slag, coarse aggregate and water.

1. INTRODUCTION

Coarse aggregate occupy a major volume in concrete, the volume can be various from 50% to 70%, so we use partial amount of steel slag, in concrete by replacement of coarse aggregate, because the properties of steel slag is same as the coarse aggregate, the properties of the steel slag were researched, and were compared to those of natural coarse aggregate concrete, the steel slag aggregate produced by steel plant is also utilized in asphalt concrete, Generally, the steel slag is formed by a direct reduction of iron in an electric arc furnace, Due to slow cooling in atmosphere, the steel slag has large size fractions, only we used the steel slag is partial in concrete, because the steel lag increased the dead load in concrete ,

Definition of steel slag

Steel slag is a by-product of iron and steel. Steel cannot be prepared in the Basic Oxygen Furnace (BOF) or in an Electric Arc Furnace (EAF) without making its by-product steel slag. In a blast furnace, produces angular

granules which are disposed of as waste or utilized as discussed below

Definition of M-sand

Crushed stone sand is produced by crushing boulders. Manufactured sand is produced by rock-on-rock or rock-on-metal Vertical Shaft Impactor (VSI) in which the process that produced alluvial deposits is closely simulated. Particle size reduction and achieving equidimensional shape is critical to get desired properties. If rock is crushed in compression lot of inherent properties exhibited by natural river sand are lost.

2. Material

a) Cement b) coarse aggregate c) Fine aggregate (M-Sand), d) steel slag, e) Water.

Cement: Ordinary Portland cement of 53-grade was used as it satisfied the requirements of IS: 269- 1969

Coarse Aggregate: coarse aggregate shall comply with the requirement of IS 383 as for as possible crushed

properties	Values
Specific Gravity	2.67
Water Absorption	0.6%
Moisture content	Nil

Table .1 COURSE AGGREGATE TEST

Aggregate shall be used for ensuring adequate durability. The aggregate used for concrete the nominal maxi size of coarse aggregate used in Production of shall be 20

Fine aggregate: Fine aggregate shall conform to requirement of IS 383

properties	Values
Specific Gravity	2.65
Water Absorption	1%
Moisture content	Nil

Table.2 Fine aggregate test

Steel slag: steel slag used for this work is taken from Agni steels Private limited, Ingur, perundurai

Physical properties of steel slag

Particle shape	Irregular
Appearance	Black & glassy
Specific gravity	2.74
Fineness modulus of steel slag	2.35
Crushing strength	2.95

Table .3

Water: The water used for mixing concrete mix should be potable drinking water having PH 6 to 8.

Design Mix

The mix design for M25 grade concrete is carried out using the Indian standard code IS456. For which the water cement ratio is kept as the least value of 0.40, coarse aggregate of 20mm size and below.

Cement =335 Kg/m^3
Water = 160liters
Fine Aggregate = 765Kg/m^3
Coarse Aggregate = 1050Kg/m^3

The proportion for the mix is **1:1:2**

The cubes casted are of 150 x 150 x 150mm in dimension. The cylinders are of 150mm in diameter and 300mm in length. The prisms are of 100m x 100mm x 500mm. The cubes, cylinders and prisms are kept for curing for the duration of 7, 14 and 28 days in water.

Experimental results

The strength test that are considered for are Compressive strength, split tensile and the flexural strength test.

Compressive Strength Test:

% Replacement of steel slag	Compressive Strength (N/mm^2)
0%	18.23
5%	16.52
10%	17.52
15%	18.86
20%	19.58
25%	21.48
30%	22.62
35%	19.86
40%	19.22
45%	18.56

Table.4 Compressive strength at 7 Days

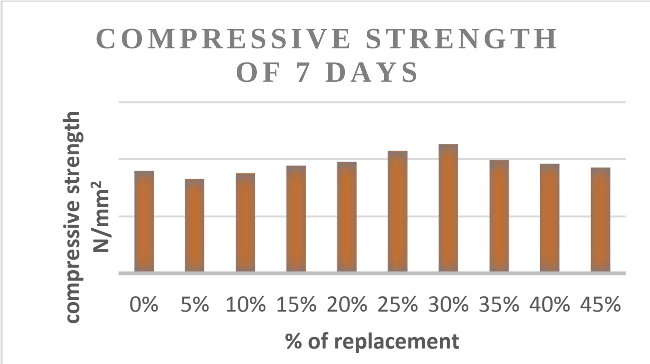
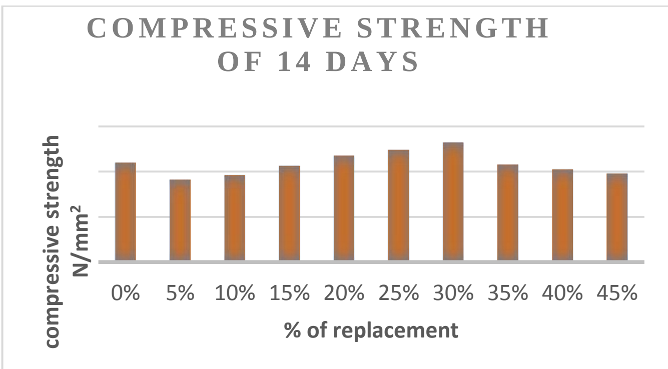
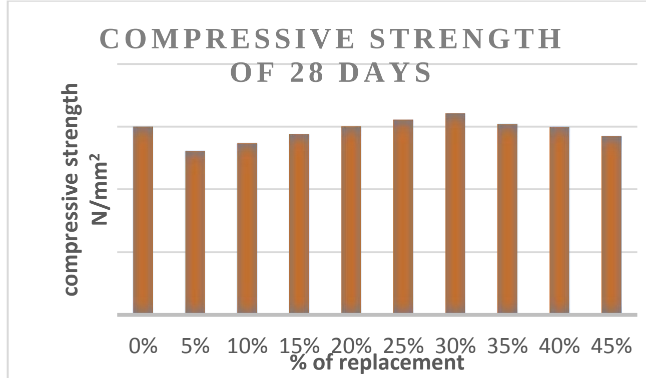


Table .5 compressive strength at 14 days



% replacement of steel slag	Compressive Strength (N/mm^2)
0%	28.52
5%	26.15
10%	27.35
15%	28.82
20%	30.08
25%	31.10
30%	32.15
35%	30.42
40%	29.96
45%	28.52

Table.6 Compressive strength at 28 Days

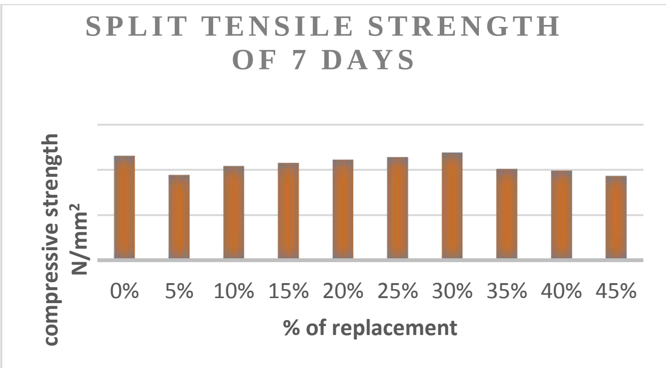


% Replacement of steel slag	Compressive Strength (N/mm^2)
0%	22.23
5%	18.28
10%	19.26
15%	21.28
20%	23.56
20%	24.87
30%	26.52
35%	21.58
40%	20.52
45%	19.58

% Replacement steel slag	Split tensile strength(N/mm^2)
0%	2.31
5%	1.88
10%	2.08
15%	2.15
20%	2.22
25%	2.28

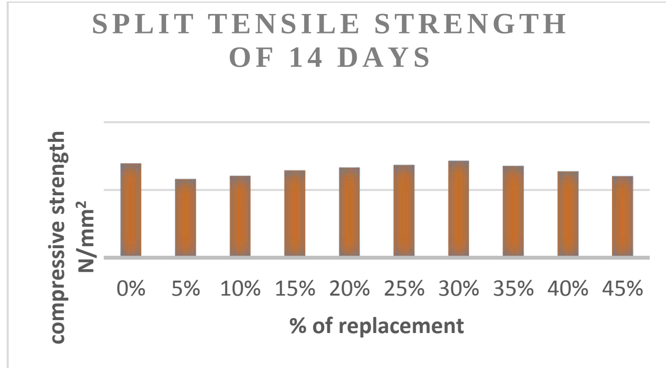
30%	2.38
35%	2.02
40%	1.98
45%	1.86

Table.7 Split tensile strength at 7 days



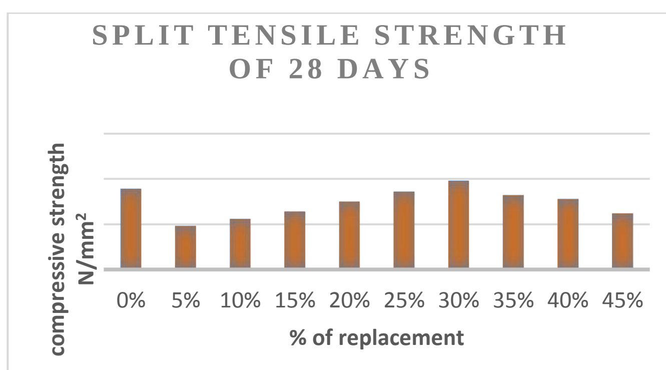
% Replacement steel slag	Split tensile strength(N/mm^2)
0%	2.78
5%	2.32
10%	2.42
15%	2.58
20%	2.66
25%	2.74
30%	2.86
35%	2.71
40%	2.55
45%	2.41

Table.8 Split tensile strength at 14 days



% Replacement steel slag	Split tensile strength(N/mm^2)
0%	3.39
5%	2.98
10%	3.06
15%	3.14
20%	3.25
25%	3.36
30%	3.48
35%	3.32
40%	3.28
45%	3.12

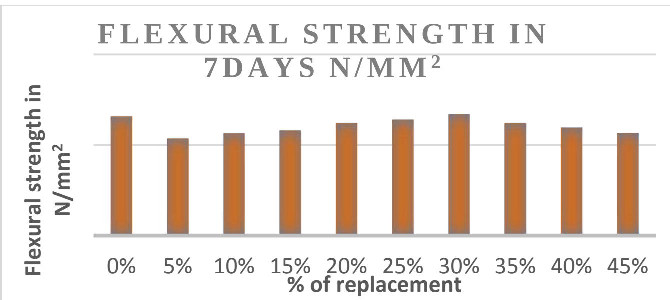
Table.9 Split tensile strength at 28 days



% Replacement steel slag	Flexural strength(N/mm^2)
0%	2.63

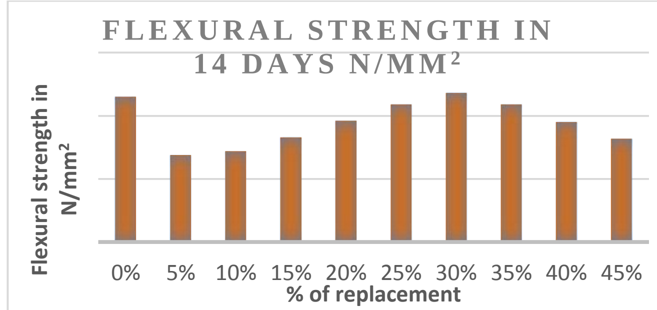
5%	2.14
10%	2.25
15%	2.32
20%	2.48
25%	2.56
30%	2.68
35%	2.48
40%	2.38
45%	2.26

Table .10 Flexural strength at 7 days



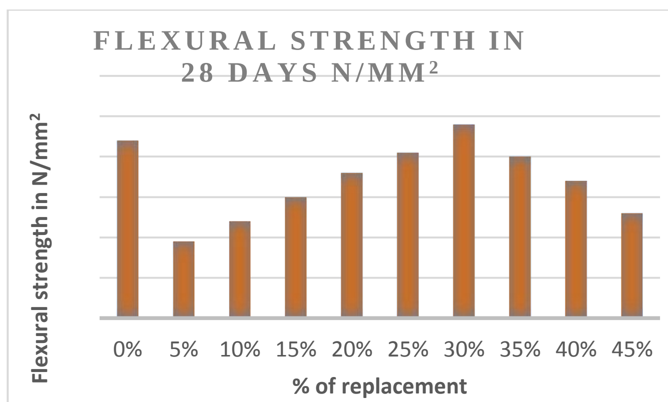
% Replacement steel slag	Flexural strength(N/mm^2)
0%	3.15
5%	2.69
10%	2.72
15%	2.83
20%	2.96
25%	3.09
30%	3.18
35%	3.09
40%	2.95
45%	2.82

Table.11 Flexural strength at 14 days



% Replacement steel slag	Flexural strength(N/mm^2)
0%	3.68
5%	3.18
10%	3.28
15%	3,40
20%	3.52
25%	3.62
30%	3.76
35%	3.60
40%	3.48
45%	3.32

Flexural strength 28 days Table.12



Conclusion

In this paper we concluded that the maximum compressive strength of concrete attained at 30% replacement of **steel slag by partial replacement of** coarse aggregate at 7, 14 and 28 days.

The maximum split tensile strength of concrete attained at 30% replacement of **steel slag by partial replacement of** coarse aggregate at 7, 14 and 28 days.

The maximum flexural strength of concrete attained at 30% replacement of **steel slag by partial replacement of** coarse aggregate at 7, 14 and 28 days.

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