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An Experimental Study on Strength Properties of Concrete by Utilisation of Steel Slag And Metakaolin

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ABSTRACT
Because of the rising developments in constructions, the utilization of natural river sand is additionally expanded at quicker rate. For figuring out the arrangement of these issue and furthermore meet the ecological agreeable, the steel slag and metakaolin are utilized as replacement for fine aggregate and cement respectively. Based on the literature studies, this work includes the choice of materials and testing on the material properties. The mechanical properties of concrete determined by replacement of sand by steel slag with 10%, 20% & 30% and replacement of cement by metakaolin with 20%. This experimental study is carried out the strength properties of concrete for M30 grade of concrete such as compressive, tensile and flexural strength after 7, 14, and 28 days curing.
Keywords: *Steel slag, Metakaolin, Aggregate, Mechanical properties*

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I. INTRODUCTION

The concrete plays an imperative part in construction industry. Aggregates are dormant grainy materials such as sand, gravel or crushed stone that are an end product in their own right and are an essential ingredient in concrete.

Genuine ecological issues in the past started from over the top sand taken from streams. Luckily it has been considered for certain many years the opportunity to utilize diverse reused materials as s concrete aggregates, even if just in partial replacement of natural counterparts.

Steel slag is acquired from the steel producing industry. It is created in enormous amounts during the steel-production tasks. Steel slag has a harmful impact on the environment when disposed. In concrete, aggregates are occupying 70-80 percent of the volume, their effect on different qualities and properties of concrete is without a doubt extensive. So for the increasing demand of natural aggregate, substituting all or some portion of fine aggregates with steel slag would prompt extensive ecological advantages.

Thinking about the particularity of physical and compound properties of slag and series of opportunities for their utilization in other technical branches and in the branch of engineering concerned with the design and construction, this report shows the chance of utilizing steel slag as partial replacement of sand in concrete. Engineering features of steel slag have shown that, it can be the good alternative of fine aggregate.

Although a large number of investigations has carried out to investigate the features of concrete made with steel slag as partial replacement of fine aggregate. The primary objective of this research work is to observe the suitability of steel slag as an alternative of fine aggregate by checking the mechanical features of steel slag concrete. Cement is also partially replaced with Metakaolin to economize the mix and enhance the strength of mix. Metakaolin one of the SCM's which can significantly improve the performance as well as strength of Portland cement based.

For the present study work, M30 grade of concrete mix has taken. Hence from the literature study, an endeavor has been to study the effect of replacement of fine aggregate using steel slag and metakaolin by cement on compressive strength, split tensile strength and flexural strength of concrete.

II. MATERIAL PROPERTIES

CEMENT

Conventional Portland concrete (OPC) affirming to IS 8112 (53 Grade) was utilized for the test work. The tests were conducted on cement to determine specific gravity, fineness, standard consistency, initial setting time and final setting time. The properties of cement are present in table 1.

Table 1.Properties of Cement

Particulars	Values
Grade	OPC 53 Grade
Specific gravity	3.15
Fineness	4%
Standard consistency	35%
Initial setting time	45 minutes

FINE AGGREGATE

Good quality river sand was used and it is tested to determine the different physical properties as per 1S 383 (Part III)-1970. River sand having fineness modulus 3.2 and specific gravity 2.67.

COARSE AGGREGATE

Natural aggregates were used to manufacture specimens for the control mix to be compared with that of the proposed mixes. Coarse aggregate having fineness modulus 7.2 and specific gravity 2.81.

STEEL SLAG

In this study the collection of steel slag is obtained from Agni Steels Private Limited, Ingur, TamilNadu.

Table 2 Physical properties of steel slag

Description	Value
Colour	Light to dark brown
Shape	Highly angular
pH (in water)	8
Surface Texture	Rough
Specific gravity	2.93

METAKAOLIN

It is highly pozzolanic material; highly active alumina and silica. The specific gravity of Metakaolin is 2.54.

III. EXPERIMENTAL PROGRAMME

COMPRESSIVE STRENGTH

For cube test specimen cubes of 15 cm x 15 cm x 15 cm specimens were used. These specimens are tested by compression testing machine after 7 days curing and 28 days curing.

Load was applied until failure of specimens. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Table 3. Compressive Strength Test (7 & 28 Days)

S.No	% Steel Slag	Compressive Strength (N/mm^2)			
		7 Days	Avg.	28 Days	Avg.
1.	0%	20.86	20.59	35.45	36.85
		21.80		38.30	
		19.10		36.80	
2.	10%	20.40	22.63	38.77	39.73
		22.70		40.65	
		24.80		39.78	
3.	20%	26.73	25.38	31.48	37.30

		24.80		41.62	
		24.60		38.80	
4.	30%	27.66	25.62	42.40	41.68
		25.55		40.23	
		23.66		42.40	

SPLIT TENSILE STRENGTH

Concrete cylinders (150mmx300mm) were casted for 0%, 10%, 20% and 30% of steel slag with 20% of Metakolin. The split tensile strength for M30 grade of concrete is tested for 28 days of curing and the results are tabulated and plotted below.

Table 4. Split Tensile Strength Test (7&28 Days)

S.No	% Steel Slag	Split Tensile Strength (N/mm^2) 28Days	Average
1.	0%	3.396	**3.415**
		3.386	
		3.465	
2.	10%	3.280	**3.409**
		3.496	
		3.450	
3.	20%	3.462	**3.563**
		3.662	
		3.565	
4.	30%	3.578	**3.660**
		3.723	
		3.680	

FLEXURAL STRENGTH

Flexural Strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 6 x 6 inch (150 x 150 mm) concrete beams with a span length at least three times the depth.

Table 5. Flexural Strength Test

S.No	% Steel Slag	Flexural Strength (N/mm^2) 28 Days	Average (N/mm^2)
1.	0%	3.250	**3.300**
		3.300	
		3.350	
2.	10%	3.386	**3.422**
		3.480	
		3.400	
3.	20%	3.250	**3.408**
		3.550	
		3.425	
4.	30%	3.880	**3.833**
		3.970	
		3.650	

IV. CONCLUSION

- The preliminary tests of conventional concrete materials were completed.
- The use of steel slag affects workability adversely but it improves the tensile strength and compressive strength to a considerable extent
- Conventional and partially replaced reinforced concrete beams were casted and tested.
- Strength of M30 grade of concrete increases with increases in steel slag quantity.
- The compressive, Split and Flexural Strength of partially replaced Steel Slag (30%) is found greater than conventional concrete.

• Thus we conclude that, the industrial by-products like steel slag can be used in concrete to improve the strength & reduce the environmental effects

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