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EXPERIMENTAL INVESTIGATION ON CONCRETE BEAM USING STEEL SLAG AS COARSE AGGREGATE

A. Silamparasan[1], Mr. S. Kannan[2], Mrs. k.Thamizh Thendral[3]

[1]Student, M.E. Structural Engineering, Oxford Engineering College, Tiruchirappalli, Tamilnadu, India-620009
[2,3]Assistant Professor, Department of Civil Engineering, Oxford Engineering College, Tiruchirappalli, Tamilnadu, India-620009

Abstract - *In the current scenario the demand for reducing over exploitation of the natural aggregate and the disposal problem of Industrial by-products has become an environmental issue due to the pollution caused. This paper gives an idea on replacements in concrete made out of various Industrial by products like Steel Slag in concrete. The main objective of this study is to investigate the feasibility of using steel Slag as filler material to determine the optimum value of steel Slag replacement in concrete admixture in concrete and coarse aggregate by steel Slag in (30%, 40%, 50%, and 60%). This paper presents a detailed experimental study on Compressive Strength and Split Tensile Strength determined at age of 7, 14 and 28 days. Mix design is done for M_{40} grade. The present study investigates the potential use and optimum usage of steel Slag in the production of concrete. Steel Slag is more economical than other Industrial waste and it is harmless and cost effective.*

Key words: steel slag, natural aggregate

1. INTRODUCTION

Concrete is the most popular building material in the world. Conversely, the production of cement has diminished the limestone reserves in the world and requires a great consumption of energy. River sand have be the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental Concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for cement and river sand that are preferably by products. It is hard to point out another material of construction which is as versatile as concrete. Cement replacement materials are special types of naturally occurring materials or Industrial Waste Products that can be used steel slag in concrete mixes to partially replace some of the coarse aggregate. Surprisingly, concrete with cement replacement materials can actually be stronger and durable than concrete with Ordinary Portland Cement (OPC).

2. MATERIAL USED:

2.1 Steel slag:

Steel slag is a industrial by- product, its productive use grant an chance to relocate the utilize of limited natural resources on a large scale. Steel slag is a by-product obtained in the manufacture in the blast furnace and is produced by the blend of down-to-earth constituents of iron ore with limestone flux. Iron and steel slags can be differentiating by the cooling processing when removed from the furnace in the industry. Mostly, the slag consists of, magnesium, aluminium silicates calcium and manganese in various arrangements. Even though the chemical composition of slag same but the physical properties of the slag vary with the varying method of cooling.

Fig .1-steel slag

Table -1: Properties of Steel Slag

S. No.	Properties	Values
1	Specific gravity	2.63
2	Moisture absorption	0.95 %

2.1 Cement:

Ordinary Portland Cement of 53 grade confirming IS 12269. The physical properties of the cement used in this work were tested prior to use as per laid down IS specifications.

Table-2: Test results of cement

S.NO	TYPES OF TEST	CEMENT
1	Specific gravity	3.12
2	Consistency	31%
3	Initial Setting time	32 minutes
4	Final Setting time	260 minutes

2.2 Coarse aggregate

Coarse aggregate is an important constituent in concrete. It gives body to the concrete, reduce shrinkage and effect economy. One of the most important factors that influence the workability of concrete is gradation of aggregates.

Table-3 Test results of Coarse Aggregate

S. NO.	PROPERTIES	VALUES
1	Specific gravity	2.70
2	Moisture absorption	0.8 %

2.3 FINE AGGREGATE

The fine aggregate was screened to remove deleterious materials and tested as per procedure given in IS 2386-1963

Table-4: Test results of fine aggregate

S. No.	Properties	Values
1	Specific gravity	2.62
2	Water content	1.2 %

2.4 WATER

The water used for concrete making and curing was tap water available in the laboratory and free from all types of harmful chemicals, organic material, oil, chloride, silt and suspended materials confirming IS 456-2000.

3. CASTING OF SPECIMEN

Mix design is done to achieve the target mean strength and using of materials with required proportion as per the Indian standard codel provisions .the compressive strength of the concrete was determined by cubes. Split tensile strength of the concrete was determined by cylinder.

3.1 Mixing of concrete

Thorough mixing of the material is necessary for the production of uniform course. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. As the mixing cannot be thorough, it is desirable to add 10% more materials. The mixing was done by concrete mixer machine first pour little amount of water inside the drum. Rotate the drum, add coarse aggregate, cement and steel slag material as in the mix. Add remaining water inside. Rotate the drum continuously till the mix become homogeneous

3.2 casting of specimen

Cube moulds of size 150mm x 150mm x 150mm and cylinder moulds of size 150mm dia and height 300mm were used for casting of concrete .the fresh mix of concrete was poured into the mould and the top surface was finished smooth with trowel.

4. RESULTS AND DISCUSSION

4.1 compressive strength

For cube compression testing of concrete, 150mm cubes were employed. All the cubes be tested in drenched condition, after wiping out the surface moisture. For each trial mix combination, two cubes were tested at the age of 14 and 28 days of curing using compression testing machine as per BIS: 516-1959.

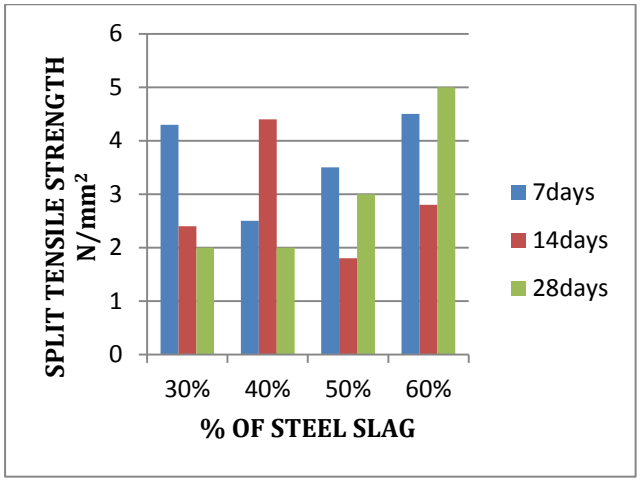
Compression strength = load/area

Fig 2: Compressive Testing Machine

Table-5 compressive strength test

Mix name	Steel slag (%)	Compressive strength in 14 days N/mm²	Compressive strength in 28 days N/mm²
C.C	0	22.40	26.70
M-1	30	20.40	27.50
M-2	40	25.0	28.02
M-3	50	25.80	28.57

Chart 1: compressive strength of test



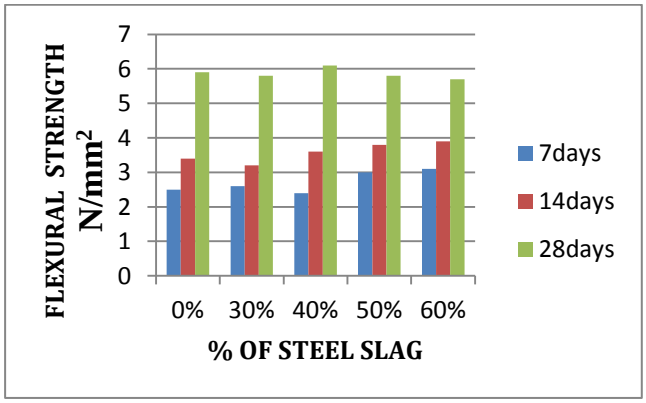
4.2 Flexural Strength Test

Flexural strength, also familiar modulus of split, bend strength, or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. Bending test is most commonly employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol f_b. Flexural and splitting tensile strength shall be obtain as described in IS 516 and IS 5816 respectively.

Table-7 Flexural Strength Test

S. No	Mix Designation	Flexural Strength N/mm²		
		7 Days	14 Days	28 Days
1	Conventional Mix	2.5	3.4	5.9
2	30% of steelSlag	2.6	3.2	5.8
3	40% of steelSlag	2.4	3.6	6.1
4	50% of steelSlag	3.0	3.8	5.8
5	60% of steelSlag	3.1	3.9	5.7

Chart-2 Flexural Strength Test



5. CONCLUSIONS

- The optimum replacement of Steel Slag is on 50% replacement as per considering the Compressive and Tensile strength aspects.
- The optimum replacement level of steel Slag is on 50 % of, by without considering the Compressive and Tensile strength aspects.
- The inclusion of steel Slag partial replacement content in concrete due to it is workability and strength property.
- From all the results the optimum effective partial replacement of steel Slag in concrete is at M40 Mix i.e., steel Slag 50%.

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