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EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF M-SAND BY STEEL SLAG

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Abstract - *In construction materials, concrete is the largest production of all other materials. Aggregates are the important constituents in concrete. The increase in demand for the ingredients of concrete is met by partial replacement of materials by the waste materials which is obtained by means of various industries. Steel slag is a waste product generated during the production of steel. These wastes are disposed in the form of landfills causes an enormous amount of land pollution. So for the increasing demand to protect the normal environment, especially in buildup areas, the needs to use these wastes are very important. Therefore, replacing all or some portion of natural aggregates with steel slag would lead to considerable environmental benefits. The utilization of waste materials from the industries has been continuously emphasized in the research work. The present work is to use steel Slag as replacement for fine aggregate. The M25 concrete with high volume steel slag replacement for fine aggregate are examined in the present study. According to material properties compressive strength. The results were compared with conventional concrete property. The results showed that replacing about 10%, 20%, 30% and 40% of steel slag aggregates by volume for M-sand will not do any harm to concrete and also it will not have any adverse effects on the strength and durability.*

Key Words: *steel slag, partial replacement of fine aggregate*

1. INTRODUCTION

Steel Industries are growing widely nowadays. The extract of steel means steel slag is harmful, which increases pollution, and impossible for easy disposal. So main object of this research is waste management and use of steel slag in making low cost concrete. Nowadays there are many steel industries which produce steel products, and we know as there is production there will be waste generation. Steel Slag is generated at very large amount in Industrial areas. This steel slag damages and affects the environment and it is also difficult for disposal. So this waste or steel slag is used for making Steel Slag Concrete. For the study of Steel Slag concrete we used M25 grade concrete. The concrete cubes as specimens of size (150mm X 150mm X 150mm) are cast for

Partial replacement of steel slag with 10%, 20%, 30%, and 40%.

1.1 CEMENT

The most common cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 53 grades conforming to IS: 8112-1989 is used. Specific gravity, consistency tests, setting time test and fineness modulus are the testes conducted to check the properties of cement. These tests are conducted as per Indian standards. The specific gravity of cement is 3.15

1.2 FINE AGGREGATE

M-sand having 4.75 mm maximum size particles was used. It was tested as per Indian Standard IS: 383-1970. The specific gravity of fine aggregates is 2.66

2. COARSE AGGREGATE

The parts from 20 mm to 4.75 mm are utilized as coarse total. The Coarse Aggregates from smashed Basalt shake, fitting in with IS: 383-1970 are utilized. The specific gravity of coarse aggregates is 2.66

3. STEEL SLAG

Steel slag is a by-product obtained either from conversion of iron to steel in a basic oxygen furnace (BOF) or by the melting of scrap to make steel in the electric arc furnace (EAF). Like other industrial by product , slag actually has many uses and rarely goes to waste

Table – 1: Physical properties of steel slag

S.NO	DESIGNATION	PROPERTIES
1	Colour	Light to dark brown
2	Shape	Highly angular
3	Bulk density	1870 kg/m^3
4	pH (in water)	8
5	Combustibility	Non combustible
6	Surface texture	Rough
7	Specific gravity	2.9

4. METHODOLOGY

The fundamental test are led on different material like OPC53 review bond, fine total, coarse total and steel slag to check their reasonableness for making concrete. The test examination has been done on the test 3 examples of Cubes, Cylinders, and Beams each to think about the quality properties because of supplanting fine total by Steel slag in different rates in particular 0%, 25% and half of steel slag. Examples are given a role according to blend outline and the tests are directed after legitimate curing, the tests are compressive quality of 3D squares (150mm x 150mm x 150mm), split rigidity of barrels (150mm x 300mm) and flexural quality of pillar (100mm x 100mm x 500mm). From the examinations, ideal outcomes are discovered and contrasted and the customary cement.

5. EXPERIMENTAL

A. MIX DESIGN

The mix design formula is based on the IS CODE 10262:2009 for M25 grade of concrete (F_{ck}=25Mpa). Water cement ratio calculated is 0.55. the mix ratio for M25 is (1:0.54:2.214:3.356) which contain cement, steel slag, fine aggregate and coarse aggregate.

B. FRESH CONCRETE

i) slump cone test

ii) consistency test

iii) initial and final setting time

Slump cone test

Slump test is used to determine the workability of fresh concrete. The slump test and its apparatus is executed as per guidelines of Indian Standard IS: 1199: 1959

Table -2: Slump values of various mixes

Proportions	Slump value
Conventional M25	95mm
10 %	100mm
20 %	105mm
30 %	110mm
40 %	115 mm

Average fineness of cement = 0.15 %

Consistency test

The aim is to determine the standard consistency test on cement. The apparatus used are Vicat's apparatus with plunger &mould, weighing balance, mixing pan, measuring jar, trowel.

Table -3: Consistency test on cement

Trial	Wt. of cement taken (g)	Quantity of water added		Penetration index Reading (mm)
		%	ml	
1	400	30	120	30
2	400	30.5	122	23.0
3.	400	31	124	15.5
4.	400	31	126	10
5.	400	32	128	5

The percentage of water required for obtaining cement paste of standard consistency of given sample of cement = 32.0%

Initial and final setting time test

The initial and final setting time of cement are calculated as per IS: 4031 (Part5) – 1988. To do so we need Vicat apparatus conforming to IS: 5513 – 1976.

Table – 4: Setting time of cement

Test particulars	Result obtained	As per IS: 8112-1989
Initial setting time	171 min	30 (minimum)
Final setting time	417 min	600(maximum)

C) HARDEN CONCRETE

i) compressive strength

ii) tensile strength

iii) flexural strength

Compressive strength test

The most common of all tests on hardened concrete is the compression test to find out the compression strength. This is because of the intrinsic importance of the compressive strength of concrete in construction. A grade of the concrete should be recognized based on the compressive strength of the concrete. The test is carried out as per IS: 516-1959. The test specimens are marked and removed from the moulds and unless required for test within 24 hours, immediately submerged in clean fresh water and kept there until taken out just prior to test. The specimen is placed between the steel plates of CTM and load is applied at the rate of 140kg/cm^2/min. And the failure load is observed from the load indicator of CTM.

Table – 5: COMPRESSIVE STRENGTH

S.NO	PERCENTAGE OF STEEL REPLACED	7th DAY (N\mm²)	14th DAY (N\mm²)	28th DAY (N\mm²)
1	0%	17	24	31.2
2	10%	21.9	28.0	32.4
3	20%	22.6	30.0	33.5
4	30%	23.3	30.8	35.0
5	40%	21.3	28.6	31.8

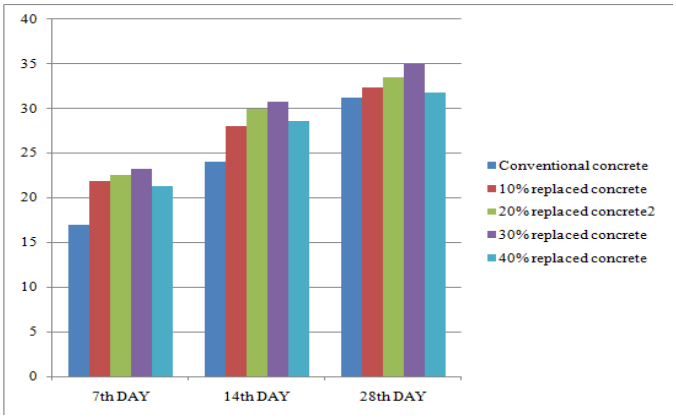

Chart -1: compressive strength

Tensile strength test

The elasticity of cement is one of the fundamental and vital properties. Part elasticity on solid chamber is a strategy to decide the rigidity of cement.

Table – 6: split tensile strength

S.NO	PERCENTAGE OF SLAG REPLACED	7th day (N\mm²)	14th day (N\mm²)	28th day (N\mm²)
1	0%	1.90	2.90	3.63
2	10%	2.10	3.40	4.17
3	20%	2.29	3.82	4.52
4	30%	2.55	4.07	4.80
5	40%	2.07	3.69	4.07

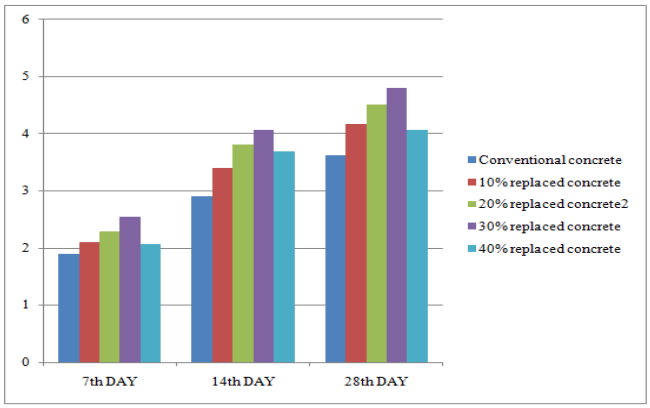

Chart – 2: split tensile strength

FLEXURAL STRENGTH

Flexural strength defined as the stress in a material just before yields in a flexural test. The flexural strength represents the highest stress experienced with in the material as it moment of yield.

Table – 7: flexural strength

S.NO	PERCENTAGE OF SLAG REPLACED	7th day (N\mm²)	14th day (N\mm²)	28th day (N\mm²)
1	0%	2.6	3.90	4.84
2	10%	3.32	4.23	4.92
3	20%	3.41	4.32	5.02
4	30%	3.46	4.36	5.08
5	40%	3.25	4.18	4.96

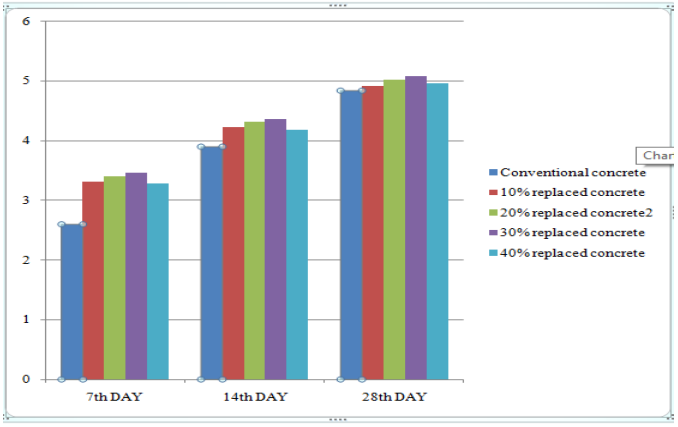

Chart -3: flexural strength

CONCLUSION

The primary point of this examination was to think about the conduct of cement and changes in the properties of cement with steel slag totals by supplanting the utilization of M-sand. Steel slag is a side-effect and utilizing it as totals in

cement may turn out to be a conservative and ecologically neighborly arrangement. The interest for totals is expanding quickly thus as the request of cement. Accordingly, it is ending up more essential to discover appropriate options for totals later on. A through writing survey was directed to contemplate and explore the properties of steel slag totals. The outcomes demonstrated that it has properties like characteristic totals and it would not bring on any mischief if consolidated into concrete. An examination was made between concrete having common coarse totals and cement with different rates of steel slag totals supplanted by weight. The consequences of this exploration were empowering, since they demonstrate that utilizing steel slag as fine totals in concrete has no negative impacts on the transient properties of solidified cement. Consequently, subsequent to playing out every one of the tests and breaking down the outcomes, the accompanying conclusions can be determined: Clearly compressive quality increments with increment in level of steel slag up to 30% by weight of fine total .The upgrade in compressive quality is around 37% for 7days curing and 29% for 14days curing and 13% for 28 days curing .Clearly split elasticity increments with increment in level of steel slag up to 30% by weight of fine total. The upgrade in split rigidity is around 34.5% for 7days curing and 40% for 14days curing and 33% for 28 days curing. Clearly flexural quality increments with increment in level of steel slag up to 30% by weight of fine total .The upgrade in flexural quality is around 33% for 7days curing and 12% for 14days curing and 6% for 28 days curing.From the consequences of compressive quality, split rigidity and flexural quality of 7 days, 14 days and 28 days curing, 30% substitution of fine total by steel slag is the ideal level of substitution of M25 review concrete.

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