

Experimental Study on Concrete Using Steel Scrap, Foundry Sand and Robo Sand as Partial Replacement of Fine Aggregate

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Abstract

Robo sand is one of the most used among such materials to substitute river sand, which can be used as an replacement to fine aggregate in concrete. In the present investigation workability and strength of concrete was evaluated by replacement of natural sand by robo sand in proportions of 0%, 30%, 50%, and 60% is studied for M25 grade concrete cubes, cylinders and beams. Slump cone method is taken for finding workability. For strength parameters for each grade of concrete Cubes, Cylinders and beams were casted and tested at the age of 7, 14 and 28 days. In this present experimental study on concrete having grades of M25 are prepared by replacing natural sand by Robo sand. Concrete specimens were tested for evaluation of compressive strength and water absorption. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure Viz., buildings, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. Concrete containing robo sand, WFS. Steel scrap is a concrete combinations of performance and uniformity specifications that cannot be always achieved routinely by using conventional constituents and normal mixing. This leads to examine the effect what changes can improve the performance of the concrete.

On the other side, cost of concrete is attributed to the cost of its ingredients which is scarce and expensive, this leading to usage of economically alternative materials in its production. This requirement is drawn the attention of investigators to explore new replacements of ingredients of concrete.

The present paper focuses on investigating characteristics of M25 concrete with partial replacement sand with Waste foundry sand with the ROBO sand (crusher dust) having appropriate quantity of steel scrap. The cubes and cylinders are tested for both compressive and tensile strengths. It is found that by the partial replacement of cement with steel scrap and sand with ROBO sand and WFS improves the strength of the concrete substantially compared to normal mix concrete

1. Introduction

Robo Sand is a fine aggregate that is produced by crushing stone, gravel, or slag. Used for aggregate material less than 4.75 mm that is processed from crushed rock or gravel and intended for construction use. robo sand is a material of high quality, in contradiction to non-refined surplus from coarse aggregate production. Fine aggregate is a component of concrete and cement mortar. So, clean sand should be available in the construction from the point of view of durability of structures. As the demand for Natural River sand is surpassing the availability, it has resulted in fast depletion of natural sand sources. Robo sand is the answer for this problem especially when some states have already banned the use of river sand for construction. As per reports, Robo sand is widely used all around the world and technicians of major projects around the world insist on the use of robo sand because of its consistent gradation and zero impurity. The main objective of the present thesis was to systematically study the workability, strength of concrete with robo sand and percentage replacement of robo sand by river sand by 0%, 30 %, 50%, and 60% respectively. The study was carried out on M25 grade concrete with 0.49 water cement ratio, M25 grade concrete was prepared in which robo sand was used as fine Aggregate. One more issue is that it has to satisfy the technical requisites like workability and strength. On this aspects research on concrete, cement concrete and with robo sand is scarce, so this paper investigates the concrete produced with robo sand.

2. Literature Review

Strength studies on concrete by partial replacement of cement with ggbs and robo sand journal published by K. shashirekha¹, k. venkatakrishna finds that the use of robo Sand as a fine aggregate shows variable effects. robo Sand Mix 2 (30% GGBS, 70% Natural Sand) exhibited better strength compared to robo Sand Mix 3 (50% GGBS, 50% Natural Sand), suggesting that too high a proportion of robo Sand might affect the overall concrete quality.

An experimental investigation on strength characteristics by partial replacement of rice husk ash and robo sand in concrete journal finds that the addition of robo sand can reduce construction cost and also increase the [strength](#) of the concrete. [Rice husk](#) is by-product from crop growing waste and it is burnt to form [Rice Husk Ash](#) (R.H.A) which is used as partially substitute material for cement in concrete by the concrete is prepared with RS as partially substitute material of fine aggregate in different proportions like 0%, 10%, 25%, 50%, 75%, and 100% and R.H.A as partially substitute material for cement in different proportions like 0%, 5%, 10%, 15%, and 20% by D. Chetan, A. Aravindan.

An experimental investigation for replacements of river sand and cement with robo sand, fly-ash and silica fume in concrete to evaluate the influence in durability properties by Suseela Alla^a, M. Jayaram^b, [S.S. Asadi](#) present an experimental study on the durability [properties of concrete](#) with the replacement of cement with [silica fume](#) and fly-ash. In this paper, six samples of cubes, cylinders, and beams of M80 & M90 grade at desired robo sand percentage of 0, 25, 50, 75 & 100 and fly-ash of 20% and 5% of [silica fume](#) with cement in comparison with the control mix (CM). The durability properties were studied through [sulfate attack](#) (H₂SO₄ & HCL). The weight losses were observed in [sulfate attack](#) The random variation of [compressive strengths](#) of the samples was observed 7 and 28 days of water curing and 30 days cured with H₂SO₄ and HCL. The results shown that, the increase in [strength](#) of mixes is due to the increase in age and not due to the durability attacks.

Addition of steel scrap in concrete was found to be beneficial to make it more workable in M20 concrete up to which Compressive strength can be increased to 1.5 % by weight and corresponding compressive strength was 28.4 N/mm² in the journal.

Strength Characteristics Analysis of Concrete Reinforced With Lathe Machine Scrap by Zeeshan Nissar Qureshi¹, Yawar Mushtaq Raina², Syed Mohd Asgar Rufaie³

on July August 2019.

Effect of Lathe Machine Waste on Strength of Concrete journal showed an increase of 28.61% for 0.4% dosage, 34.9% for 0.8% dosage and 43.46% for 1.2% dosage. Published in August 2023.

One more Conducted test and the Results from the test show that the addition of steel scrap waste remarkably increases the strength of concrete. Since, concrete is weak in tension, it is seen that the tensile Strength of Concrete also shows astonishing patterns in

strengthening of concrete using lathe scrap waste journal By Mohdamirsheikh On October 2020

Characteristics of Concrete Containing Waste Foundry Sand and Slag Sand

By joju jose showed compressive strength, split tensile strength, modulus of elasticity and flexural strength of concrete decreased with the increase in waste foundry sand. The replacement of slag sand with waste foundry sand up to 15% is desirable, as it doesn't adversely affect the strength properties of concrete in June 2018.

Study on Strength of Concrete Using Robo Sand as a Partial Replacement of Fine Aggregate was done by S.Rukmangadhara Rao, G.Himali Kumari

Findings are as the compressive strength of concrete specimens made with 50% replacement of river sand by Robo sand gives higher strength of 12% to 15% and with 100% replacement gives a higher strength of 3% to 4% as compare to reference mix. Done onn December 2016

Application of Foundry Waste Sand In Manufacture of Concrete by Eknath P.Salokhe¹ , D.B.Desai²

1. Gives low slump mainly due to the presence of very fine binders, so these mixtures require high superplasticizer dosage in order to maintain a good workability. 2. Compressive strength at 7 days of both ferrous & non ferrous mixtures increases as compared to the ordinary mix. 20% FWS of both types of sand. However 20% ferrous WFS addition gives more value of compressive strength than 20% non ferrous FWS addition. Studied in November 2019

Incorporation Of Waste Foundry Sand by Gurpreet Singh, studies revealed that in concrete WFS can be effectively used as fine aggregate.

It is observed by the research that there is 3.7%, 5.6%, 6.29% and 6.02% increase in Modulus of elasticity after 28 days of curing at replacement of 10, 20, 30 and 40% respectively. In July 2018

Sustainable Concrete Development Using Foundry Sand: Strength and Durability Assessment by Pooja Govindsingh Pawar

Utilizing Waste Foundry Sand (WFS) in concrete mixes offers a compelling solution for boosting performance and promoting sustainability at 20 % in May 2023

Present Study

In the present investigation we design mix for M25 has been calculated using IS 10262-2009

Tests were conducted on cubes, cylinders and beams to study the strength of concrete by using

robo sand and the results were compared with the Natural Sand Concrete. During the present study, 0%, 30%, 50% and 60% of traditional fine aggregate

was replaced with robo sand. Compression, split and flexural strengths were found after 7 days and 28days of curing.

3.Materials and Methods

The research follows a particular approach material collection then testing to ensure quality and suitability.

Concrete mixes are prepared by replacing natural aggregates with lathe machine steel scrap and foundry sand and robo sand.

Then concrete cubes are casted and tested

Finally, all results are analyzed statistically to identify the best and sustainable mix that meets performance standards for cement concrete with lathe machine as scrap, foundry sand and Robo sand.

3.1 Material used**Cement having specific gravity of 3.14**

With initial Setting Time of 40 Minutes, Final Setting Time of 7 hours 50 minutes, Standard Consistency 27%, Coarse Aggregate Size 20mm, having Shape Angular with Fineness modulus 3.3

Specific Gravity 2.64

Fine Aggregate

Natural river sand which is easily available in market which confirms IS 383-1970 zone-II whose size is less than 4.75mm and of specific gravity 2.6 with fineness modulus of 2.91 is used in experiment

Robo Sand properties as

Specific Gravity 2.62

Zone 3

Water as potable water is used in experiment. PH value of water is greater than 6; recommended by IS code

Steel scrap

Steel scrap is waste material produced by working on the lathe machine when used for shaping metals. We have used mild carbon steel scrap in specimens

Lathe scrap Fibre

Average Length(mm) 1-50 Average

Width (mm) 1.50–2.00

Average thickness (mm) 0.30–0.60

Aspect Ratio 50–100

Young's modulus (GPa) 200

Tensile strength (MPa) 970–1190

Density (kg/m³) 7850

Specific Gravity 7.85

Properties Values Foundry Sand

Density (kg/m³) 1645

Fineness modulus 1.81

Specific gravity 2.41

Water absorption (%) 3.78

Moisture content (%) 3.28

3.2 Mix proportions

Concrete of M25 grade is prepared with having steel scrap of percentage of 1.5%. 155.98kg/m³ as the best strength found at this value ,thereafter foundray sand 30% replacing fine sand was taken with cement 398 kg, fine aggregate 761 coarse aggregate 1140 water 199 all per metre cube values.

Accordingly fine aggregate was replaced as per 0%, 30 % 50% 75% by robo sand.

3.3 Sample preparation and curing

All ingredients of the concrete to be proposed and formed are mixed and a cube is formed to test at preliminary stage for having an idea of a generalised mechanical stress.

Take a mix as per given Proportion comprises

Cement :Fine Aggregate : Coarse Aggregate

For finding the compressive strength, cubes of size 15cm×15cm×15cm are casted.

The fine aggregate and cement are mixed and blended then coarse aggregate is added and mixed until it is uniformly distributed. Add water and mix it until concrete appears to be homogeneous and of desired consistency.

Now concrete is casted into moulds and compaction is done. Moulds of concrete specimens are removed and then 24hour sand are kept in water until taken out for testing.

Steel scrap and Foundry sand and robo sand are mixed according to varied proportion a

3.4 Testing Procedure

The following tests were conducted as per the Indian codal provisions:

Rebound hammer test: Rebound hammer testing is done as per IS13311 (Part2):1992

Rebound hammer test is a nondestructive test and it can be used for assessing the compressive strength or quality of concrete from various graphical co-relations. The plunger of the rebound hammer is pressed against the surface of the specimens and the impact gives a reading noted as rebound number. A number of readings are taken and through graphs and co relations compressive strength is worked out.

Compression test: The compression testing is done afterwards which gives more accurate values . The samples are placed in the universal testing machine

The load is applied gradually at the rate of 140 kg/cm²/minute until the specimens fails. The maximum load at which it fails is recorded and compressive strength is determined and

Split tensile test: It is an indirect method of testing tensile strength of concrete using a cylinder which splits across the vertical diameter. The length of the specimens shall not be less than the diameter and not more than twice the diameter. We prepared specimen of specifications: Diameter of specimen d=15cm Length of specimen l=30cm

4. Result and Discussion

Different data for different tests are find out as workability, compressive strength, splitting tensile strength test

4.1 Workability

Workability value reduced as when different workabilty test was done.Slump reduced form 65mm at 0% steel scrap to 12mm at 1.5% steel scrap.

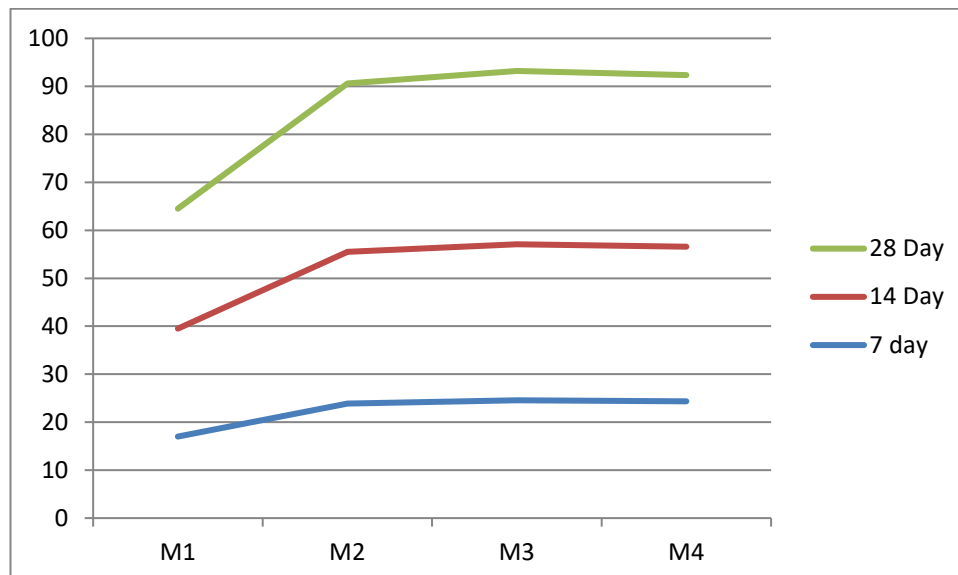
Steel scrap makes interlocking stronger than other so strength increase with reduced workability.

Robo sand increase workability.

4.2 Compressive Strength Test

Table 4.1: Compressive Strenght for Various Mixes M25

Mix ID	Steel Scrap	WFS	Robo Sand	7 day	14 Day	28 Day
M1	0	0	0	17	22.5	25
M2	1.5	30%	30	23.885	31.6125	35.125
M3	1.5	30%	50	24.565	32.5125	36.125
M4	1.5	30%	60	24.344	32.22	35.8



Graph 4.1 Compressive Strength for different Mixes

Flexural Strength:

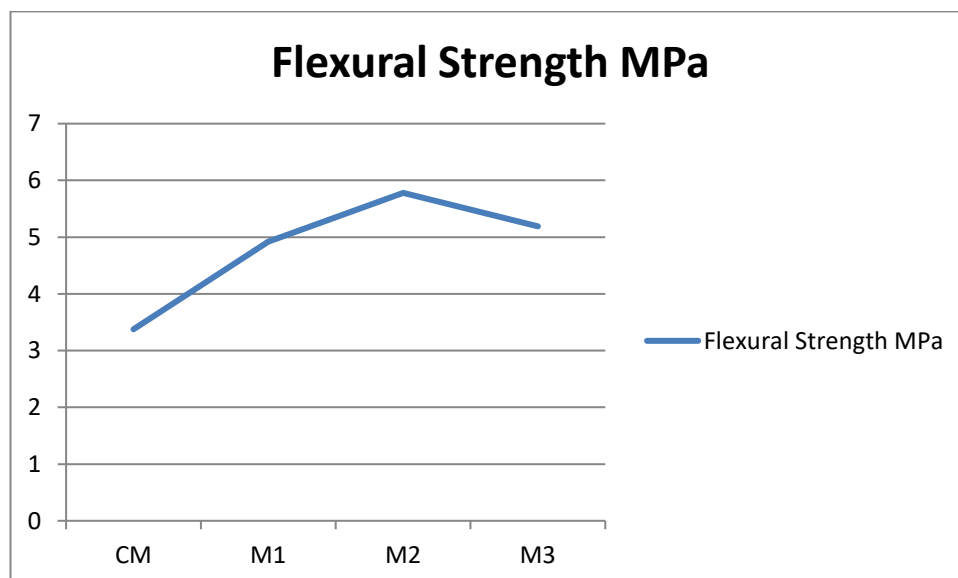
It shows similar trend in somewhat extent as compressive strength test.

Flexural strength comes out to be as follows.

Table 4.2 : Flexural Strength of Beam Specimen (28 days) M25

Mix ID	Steel Scrap	Foundry Sand	Robo Sand	Flexural Strength MPa
CM	0	0	0	3.375
M1	1.5	25	30	4.9175
M2	1.5	30	50	5.78
M3	1.5	35	60	5.191

Graph 4.2 : Flexural Strength of beam specimen(28 days)



4.3 Water Absorption

Water Absorption values are higher for concrete containing robo sand and waste foundry sand reaches upto 15 % of the water to sand ratio.as water absorbing character of robo sand is good but of WFS is on higher side. Water absorption Characteristics are given below by test

Table 4.3 Water Absorption Test Result

Mix ID	Steel scrap	Waste foundry sand	Robo sand	Water absorption
CM	0	0	0	3%
M1	1.5	25	30	8%
M2	1.5	30	50	11%
M3	1.5	35	60	15%

4.4 Acid Resistance

Acid resistance values found to improve.

Table 4.4 Weight Loss % after 28 days in 6% Acid

MIX ID	Steel Scrap	Waste foundry Sand	Robo Sand	Weight Loss
CM	0	0	0	3
M1	1.5	25	30	1.4
M2	1.5	30	50	1.7
M3	1.5	35	60	1.6

5. Conclusion

By performing the research on various aspects of WFS with steel scrap and Robo sand and its potential applications in , concrete. The following conclusions are the result of this work:

Compressive Strength is maximum at 50 % replacement of fine aggregate with robo sand, which is best at 28 days keeping values of steel scrap as 1.5% and WFS 30%

Flexural Strength followed almost the same path with 50 % having highest strength with value of 5.78 MPa for M25 Concrete.

Water Absorption values are maximum for 15 % as water absorbing power of robo sand is found to be high.

Workability tends to decrease with increasing robo sand.

The Changes in the results found in workability, mechanical strength, and durability may be due to differences in composition, fineness modulus, cementitious material, and replacement rate used.

- The inclusion of robo sand with WFS and steel scrap results in material cost savings ranging from 20% to 30%. This will depend on the degree of substitution and the prices of materials in each country.

In summary, while incorporating robo sand with WFS and steel scrap in concrete offers environmental sustainability issues remain in workability and strength, particularly at higher replacement levels.

All the percentage of replacement was found to be good when compared to control concrete

At the substitution of 50% robo sand for M 25 grade, from 7 days to 28 days the pace of increment in compression is of 34.3% and flexural is of 3.5% and tensile strength is of 3%.

Strength increases by 20 to 25% by using robo sand in percentage of 0% 30% 50 % 60%.

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