Experimental Investigation on Strength Properties of Steel Fibre Reinforced Concrete with Waste Foundary Sand

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Abstract: As the main raw materials for concrete preparation, natural sand and cement are in increasing demand. Meanwhile, the large accumulation of waste foundry sand (WFS) and fly ash (FA) seriously pollutes the environment. The research on the application of waste materials in concrete preparation has become a hotspot for scholars. This study attempts to respectively use WFS and FA to substitute natural sand and cement in the preparation of steel fibre reinforced concrete (SFRC). In this study, industrial waste was recycled for the purpose of producing green concrete by adding crimped steel fibers. The workability of the concrete decreased with the increase in waste foundry sand. Replacing fine aggregate with 30% waste foundry sand + 1% steel fibres provides more compressive strength compared to conventional concrete, increasing the compressive strength by 20.46% Replacing fine aggregate with 50% waste and 1% steel fibers provides bmore flexural strength compared to regular concrete, increasing the flexural strength by 24.91%. This study demonstrates the feasibility of the application of WFS and FA in SFRC preparation, contributing to overcoming the pollution of waste material accumulation and alleviating the shortage of natural resources.

Keywords — ***Compressive Strength, Flexural Strength, M-25 Grade concrete, waste foundry sand and crimped steel fibres.***

I. INTRODUCTION

Concrete is without any doubt a prominent construction material. Initially it was discovered to be a protective shield of steel members, after that it was found out to be very durable, hence is revised and now a day's concrete is used as a structural material very efficiently and steel is installed in it to enhance its properties and provides better strength to the concrete. Concrete ultimately gives many benefits which include resistance to fire (fire proofing), almost zero permeability to water, can be easily mould into any shape and size as per desire, economy and readily availability of material on the job site. After use of concrete in many construction sectors, it was found out that normal concrete has some flaws or weaknesses. Hence to blow away such a weakness led to the development of High Strength Concrete. So with the help of admixtures these days, strength double to that of normal concrete is almost achieved. Concrete is a durable material, enhancing its properties gives it a higher life expectancy, hence on addition of fibres can lead to a high life of concrete. Concrete also possesses an environmental friendly nature, recently is has been found out that various materials that go as a waste and pollute the environment have been used comprehensively with concrete in the form of admixtures or fibres and have been evaluated to possess a strength almost equal to or greater than the normal mix of concrete. Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability. The secret of its popularity lies in the simple fact that except cement, all other ingredients of concrete are commonly available local materials like aggregate and water. Earlier we knew only about the conventional ingredients of concrete like cement, aggregate and water, but today we are well conversant of the importance of admixtures too. The concrete industry is constantly looking for supplementary material with the objective of reducing the solid waste disposal problem. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste

 DOI : 10.35291/2454-9150.2024.0124

material has been emphasized. The potential applications of industry by-products in concrete areas partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size.

II. OVERVIEW OF WASTE FOUNDRY SAND

Presently, the production of waste foundry sand as a by-product of metal casting industries causes various environmental problems. Usage of this waste in building material would help in reduction of stress on environment. Used Foundry sand is a discarded material coming from ferrous and nonferrous metal-casting industry. It's a mixture of high quality size-specific silica sand, few amount of impurity of ferrous and nonferrous by-products from the metal casting process itself and a variety of binders

The burnt sand after the casting process of metal is reuse for many times but when it cannot be longer used it is removed from foundry as a waste for disposal known as "Waste foundry sand". Use of waste foundry sand as a partial replacement or total replacement of fine aggregate in concrete leads in production of economic, light weight and high strength concrete. So, by partial or percentage replacing of material affects different properties of concrete. By using such waste material which harms the environment can be used for the development of low cost and eco-friendly building materials. The main purpose of this study is to investigate the effect of waste foundry sand and steel fibre on strength parameters such as compressive strength and flexural strength

III. OBJECTIVES OF THE PROJECT

In this project our main objective is to study the influence of partial replacement of fine aggregate by waste foundry sand with addition of Steel Fibres.

Specifically the objectives are:

1) To determine the fresh concrete properties of steel fibre reinforced concrete with partial replacement of sand by waste foundry sand.

2) To study the strength properties of steel fibre reinforced concrete with the partial replacement of sand by waste foundry sand and to compare it with conventional concrete.

IV. MATERIALS

Materials used in this study are cement, coarse aggregates, fine aggregates, and water, in addition to waste foundry sand and steel fibres.

Cement: In this project "Ultra-Tech 53 Grade OPC Cement" is used throughout. The physical properties of the cement as found out from various tests conforming to Indian Standard IS: 12269:1987.

Fine Aggregate: The aggregates which pass through 4.75 mm IS sieve is termed as fine aggregates. In this project fine aggregate conforming to IS 383-1970 is used..

Coarse Aggregate: The aggregates having size more than 4.75mm are termed as coarse aggregate. In this project coarse aggregate of 20mm and down size conforming to IS 383-1970 is used.

Waste foundry sand: Waste foundry sand is used as an partial replacement of fine aggregate in concrete, so that strength of the concrete can be increased. We can reduce the environmental pollution by utilizing this waste foundry sand

Steel Fibres: In this project, 60mm length and 0.75 mm thickness crimped steel fibres are used.

Water: The potable water is a general recommendation for mixing and curing of concrete. Hence potable water is used for manufacturing concrete.

V. MIX DESIGN

The mix design is done according to the IS 10262-2009 design method in this project work is carried on M25 grade of concrete. The number of trial mix was conducted to finalize the design mix. Once the design mix is finalized, it is used to produce concrete with partial replacement of fine aggregate from waste foundry sand by 0%, 10%, 30%, 50% and 100% with addition of 1% crimped steel fibres by total weight of material. Then concrete cubes and beams are prepared and have been tested for 28 days to find out the compressive strength and flexural strength of concrete.

Table-3.1 Mix proportion

Cement	Fine aggregate	Coarse Aggregate	Waste foundry sand	water
394	582.26	1198.02	64.41	197
1	1.47	3.04	0.16	0.5

VI. TESTS ON FRESH CONCRETE

Workability Test:

1 Slump Test: The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness. Workability of concrete is mainly affected by consistency i.e. wetter mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. It is also used to determine consistency between individual batches.

 DOI : 10.35291/2454-9150.2024.0124

2 Compaction Factor Test:

Workability is defined as the amount of useful work necessary to produce full compaction. Compaction test is based on this definition. This test consists of essentially applying a standard amount of work to standard quantity of concrete and measuring the resultant compaction. Workability gives an idea of the capability of being worked.

The compaction factor =1

VII. TESTS ON HARDENED CONCRETE:

1. Compressive Strength Test:

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not .Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. Test for compressive strength is carried out on cubes.

2. Flexural Strength test:

For flexural strength test beam specimens of dimension 100 x 100 x 500 mm were casted. The specimens allowed curing for 28 days. These flexural strength specimens were tested under two point loading, over an effective span of 400 mm on Flexural testing machine. In each category 3 beams will tested and their average value is reported.

VIII. RESULTS AND DISCUSSIONS

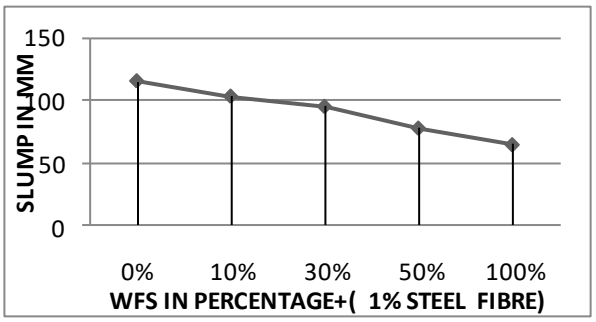
Workability of Concrete:

1. Slump Test Results:

The concrete using WFS as replacement of fine aggregate, the workability analysed by the slump cone test, the workability of M25 grade concrete decreases with the increase in the foundry sand the same is presented in Table 4.1.

Table 4.1 Slump Test Results

Sl No	% Replacement Of WFS	M25 Grade Slump, mm
1	0	115
2	10	103
3	30	95
4	50	78
5	100	65



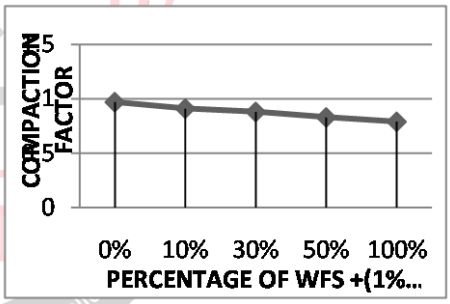
Graph 4.1slump cone test

2. Compaction Factor Test Results:

The concrete using WFS as replacement of fine aggregate, the workability analysed by the compaction factor test, the workability of M25 grade concrete decreases as replacement of WFS increases the same is presented in Table 4.2.

Table 4.2 Compaction Factor Test Results

Sl.No	Percentage of WFS replacement	Compaction factor
1.	0%	0.97
2.	10%	0.91
3.	30%	0.88
4.	50%	0.83
5.	100%	0.79



3. Compressive Strength Test :

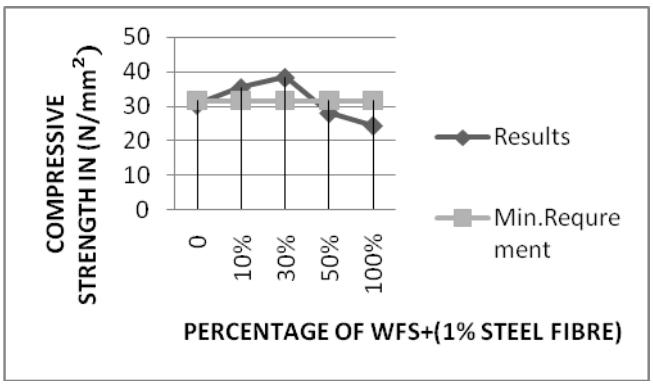
The results of the compressive strength test for M25 grade concrete specimens with partial replacement of fine aggregate by waste foundry sand in addition of 1% steel fibres by total weight of material as follows:

(A) At 28 Days Curing Period:

Table 4.3 Compressive Strength Test

Sl.No.	% WFS Replacement	Mean Compressive strength(N/mm²)
1.	0%	30.51
2.	10%	35.40
3.	30%	**38.36**
4.	50%	28.12
5.	100%	26.07

 DOI : 10.35291/2454-9150.2024.0124



Graph 4.3 Compressive Strength Test

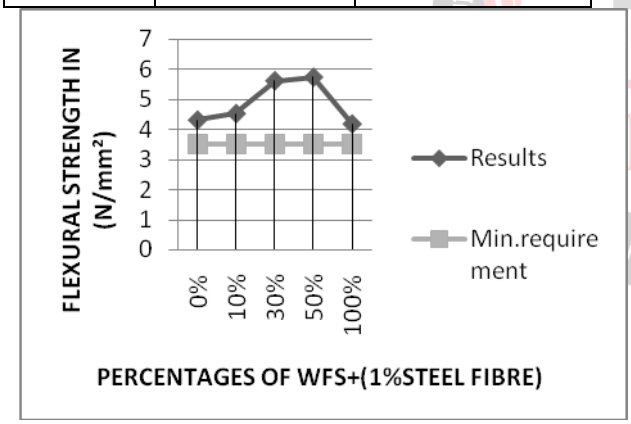
4. Flexural Strength Test:

The results of flexural strength test for M25 grade concrete specimens with partial replacement of fine aggregate with waste foundry sand in addition of 1% steel fibres by total weight of material as follows:

(A). At 28 Days Curing Period:

4. Table 4.4 Flexural Strength Test:

Sl.No.	% WFS Replacement	Mean Flexural strength(N/mm²)
1.	0%	4.31
2.	10%	4.53
3.	30%	5.62
4.	50%	5.74
5.	100%	4.18



Graph 4.4 Flexural Strength Test:

VII. CONCLUSION

In this experimental study, recycling of industrial waste foundry sand for the production of green concrete with addition of crimped steel fibres had been studied and the following conclusions were drawn:

The compressive strength of concrete is increases, when upto 30% fine aggregate is replaced with WFS. The replacement of fine aggregate by 30% of waste foundry sand+1% Steel Fibres *(1)* gives more compressive strength than that of conventional concrete. It increases the compressive strength up to 25.73%. The flexural strength of concrete is increases upto 50% addition of WFS. The replacement of fine aggregate by 50% of waste foundry sand+1% Steel Fibres gives more flexural strength than that of conventional concrete. It increases the flexural strength up to 33.17%.

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Workability of the concrete decreases with the increase in th

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