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PARTIAL REPLACEMENT OF SAND BY WASTE FOUNDRY SAND

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Abstract - *The paper represents the current utilization of fine sand in the construction industry. The amount of waste foundry sand generated also encrypted in this paper. The paper also gives the remark on the utilization of waste foundry sand in the construction industry. The paper mostly focuses on the amount of foundry sand can be used as a cementitious material. The percentage of foundry sand which gives the maximum strength according to our conclusion has been also recorded here. The paper gives the noticeable and remarkable conclusion on utilization of foundry sand as a cementitious material. Paper gives the remarkable results about the properties according to compressive strength and flexural strength.*

This paper also gives the potential of this area by providing the careful study of some number of research papers of this topic. The review integrates all the important results. The review paper summarizes the conclusion on the basis of teste conducted for various properties of concrete like strength , durability etc. the paper review shows the positive as well as negative changes in the properties of concrete on the partial replacement of fine sand by waste foundry sand. from the past researches and the conclusion made by us shows the positive change in the utilization of waste foundry sand in construction field. As this results gives the great potential towards the development on environment friendly and strengthen cementitious concrete.

Key Words: Waste foundry sand, Slump cone test, Compressive strength, flextural strength, Concrete mix.

1. INTRODUCTION

Concrete is the main part of any construction work which is composed of gravels or crushed stones, sand and hydrated cement etc. it has been used over a century in all construction work. As the result owing to concrete is best, concrete is the main invention in our construction industry. Concrete mainly consist of cement, fine aggregate, coarse aggregate, water and now a days admixtures are used. One of this main constituents fine aggregate is the component which has been used in large quantity all over the world. The worldwide consumption of fine sand is around the world is very high and also this demand is increasing day by day. To overcome this demand is the main question arises in front of our construction industry.

While on the other side the industries has developed on large quantity. Metal industry is one of them. Metal industry has many waste product, and at a certain period this wastes are not used further. This waste generated is the main environmental problem. One of the waste generated from metal industries which can be helpful to overcome the demand fine sand is 'foundry sand'.

Foundry sand is uniformed sized, high quality silica sand is bound to form a mould for casting of ferrous and nonferrous metal. This sand is finer than fine sand. Burnt foundry sand is used many times in metal casting process, when it is no longer used it is removed from foundry as waste foundry sand. This waste foundry sand is useful to overcome the demand problem of fine sand. The replacement of fine sand in construction industry will lead it to economical, environmental friendly, light weight and high strength concrete.

Concrete is a composed material. All of its constituents contributes to its properties like fresh and harden properties. As the foundry sand is more finer than fine sand it is partially or up to certain limit replaceable. By finding the optimum percentage of foundry sand in concrete we can achieve the strength, economy, low cost concrete, environment friendly.

1.1 OBJECTIVES

1. To check the strength and properties of concrete.
2. To overcome the disposal problem of industrial waste.
3. Reduce the construction cost.
4. To analyze the different areas of civil engineering in which foundry sand can be efficiently used.

2. LITERATURE REVIEW

Several authors have reported the use of waste foundry sand in various civil engineering applications.

Vema Reddy, S.Sridhar have investigated the performance of fresh and hardened properties of concrete containing discarded foundry sand in place of fine aggregate. They have performed the test on the cubes and cylinders having 20%-100% replacement of foundry sand. They have concluded that the slump of the concrete decrease with increase in the % of foundry sand and the compaction factor increases with increase in the % of foundry sand. The compressive strength of the concrete has increased by 13.42% by the replacement of 20% of foundry sand over normal sand. Their results have concluded that up to the 60% of the replacement of the foundry sand gives rise to the compressive strength of the concrete. The split tensile strength increases up to 60% replacement of foundry sand after that decrease till 100%.

Pranita Bhandari, Dr. K.M.Tajne, have performed the test to check the compressive strength of concrete at the replacement of sand by foundry sand. They have conducted the test up to the 100% replacement of foundry sand. By this experimental work they have concluded that the compressive strength of the concrete at the 28Th day gives maximum strength when the sand is replaced up to 10%-20%.

Eknath P. Salokhe, D.B.Desal, conducted experimental studies to evaluate the performance of foundry sand in concrete. They have concluded that the slump is observed is decreases with the introduction of foundry waste sand. Density of mixture with FWS was observed to be less than that without FWS. They have performed the compressive strength test to the ferrous FWS and non-ferrous FWS. They have concluded that 20% replacement of fine aggregate by ferrous FWS gives more strength at 28 days than non-ferrous FWS. Whereas the 30% ferrous FWS gives almost same strength as that of ordinary concrete and both the ferrous and non-ferrous FWS gives dense concrete at 20% addition.

Preeti Pandey, Alvin Harison, Vikas Srivastava, have performed the test to check the fresh and harden properties of concrete with replacement of fine aggregate by foundry sand up to 50%. They have concluded that workability is slightly increases with replacement level. They have concluded that optimum replacement level of foundry sand is 10% which gives the maximum compressive strength at 28 days.

Rafat Siddique(2008) presented the results of an experimental investigation came out to evaluate the mechanical properties of concrete mixtures in which fine aggregate was partially replaced with used foundry sand. Fine aggregates were replaced with three percentages (10%, 20%, and 30%) of UFS by weight. Tests were performed for the properties of fresh concrete, compressive strength, flexural strength and modulus of elasticity was determined at 28, 56, 91 and 365 days. Test results indicated a marginal increase in the strength properties of plain concrete by inclusion of UFS as partial replacement of fine aggregate sand and that can be effectively used in making good quality concrete and construction materials.

Khatib and Baig investigated fresh and hardened properties of concrete containing waste foundry sand (WFS) replaced with 0 to 100% with fine aggregate. The water to cement for all mixes was kept constant. Testing on hardened properties was mainly conducted at 14, 28 and 56 days. The results show that the incorporation of waste foundry sand in concrete causes a systematic decreases in workability, ultrasonic pulse velocity and strength and an increase in water absorption and shrinkage of concrete. They also reported that an acceptable concrete strength can be achieved using foundry sand.

Kumbhar investigated the various mechanical properties of concrete containing used foundry sand. Concrete was produced by replacing natural sand with UFS in various percentages (10%, 20%, 30% and 40%). Based on the test results they concluded that (i) workability goes on reducing with increase in UFS content; (ii) At 28-days, Compressive strength, splitting tensile strength and flexural tensile strength for different replacement levels of UFS is increased whereas flexural tensile strength goes on reducing for UFS content more than 20%; (iii) At 28-days, the modulus of elasticity values increases with replacement of UFS up to 20%. They also concluded that the UFS can be utilized as a replacement to regular sand in concrete up to about 20%.

Han-Young investigated two types of Foundry Sands like clay bonded sand (CLW) and silicate bonded sand (COW) as a fine aggregate for concrete and basic properties such as air contents, setting time, bleeding, workability and slump loss of the fresh concrete with WFS were tested and compared with those of the concrete mixed without WFS. Also compressive strength and tensile strength of hardened concrete of 28 days were measured. The results showed that (i) flow value and compressive strength of mortar is very rapidly decreased with increasing the replacement ratio of COW and CLW; (ii) Bleeding of concrete with COW, CLW are decreased according to increasing replacement ratio of COW and CLW; (iii) concrete mixed with COW of 30%, compressive and tensile strengths of concrete are higher than those of any other concrete without COW, whereas concrete mixed with CLW, compressive and tensile strengths of concrete are a bit smaller than that of control concrete.

Khatib and Herki investigated the concrete produced by replacing the fine aggregates with 0%, 30%, 60% and 100% WFS. The water content, coarse aggregate, cement and the water to cement ratio remained constant. The properties investigated at 7, 28 and 90 days curing times. The results indicate that there is systematic increase in water absorption by capillary action, a decrease in compressive strength and Ultrasonic pulse velocity with increasing amounts of WFS in concrete. They also reported that adequate strength can be achieved using an appropriate replacement level of foundry sand.

Gurpreet Singh and Rafat Siddique investigated the strength and durability properties of concrete mixtures, in which natural sand was replaced with five percentage (0%, 5%, 10%, 15% and 20%) of waste foundry sand (WFS) by weight. Compression test and splitting tensile strength test were carried out at the age of 7, 28 and 91 days and Modulus of elasticity, ultrasonic pulse velocity and Rapid Chloride Permeability test were conducted at the age of 28 and 91

days. The abrasion resistance of concrete containing WFS was also investigated. Based on the results obtained they concluded that (i) Maximum increase in compressive strength, splitting tensile strength and modulus of elasticity of concrete was observed with 15% WFS, both at 28 and 91 days; (ii) WFS increases the ultrasonic pulse velocity values and decreased the chloride ion penetration in concrete; (iii) Abrasion resistance of concrete increased with the increase in WFS content. They also added that WFS can be suitably used in making structural grade concrete, as well as for applications where abrasion is also important parameter.

3. METHODOLOGY

3.1 Material

The material required and determining their various properties has been carried out in this phase. The Constituents of concrete viz. cement, fine aggregate, and coarse aggregate are procured and their various properties are determined.

3.1.1 Testing of Cement

The type of cement is important mainly through its influence on the rate of development of compressive strength of concrete. The choice of the type of cement depends upon the requirements of performance at hand. The most commonly used cement is ordinary Portland cement. Variation in the cement quality will cause the compressive strength to vary more than any other single material.

Cement used throughout the experimental work is ordinary Portland cement 53 grade conforming to IS 269-1967, manufactured by Ultratech Company. It is stored in laboratory under proper conditions. The following standard tests have been carried out as per IS recommendation.

1. Fineness
2. Consistency of cement
3. Initial setting time
4. Final setting time
5. Soundness of cement

Test result of properties of cement

Property	Average value for OPC used in present investigation	Standard value for OPC
Fineness (%)	3.87	<10%
Consistency (%)	30	-
Initial setting time (min)	32	>30
Final setting time (min)	570	<600

Testing of Aggregates

About 70% of volume of concrete is composed of aggregate and hence properties of aggregate affect the properties of concrete such as workability, strength, durability and economy.

Coarse Aggregate

Crushed stone aggregate has been used. It is a locally available with sharp, angular aggregate, with maximum size of aggregate 20 mm. The following tests have been carried out on the coarse aggregate sample.

a) Fineness modulus
b) Specific gravity
c) Water absorption

Test results of physical Properties of Coarse Aggregate

Sr. No	Property	Average value
1	Specific Gravity	2.806
2	Water absorption	1.52%
4	Type	Crushed
5	Fineness modulus	6.13

Fine Aggregates

The sand used for the experimental works was locally procured and conformed to grading zone III. Sieve Analysis of the Fine Aggregate was carried out in the laboratory as per IS 383-1970. While the fine aggregate shall conform to the grading zone III. The following tests have been carried out on the fine aggregate sample.

a) Specific gravity
b) Water absorption
c) Moisture content
d) Fineness modulus
e) Grading zone

Test results of Physical Properties of Fine Aggregate

Sr. No	Property	Average value
1.	Specific Gravity	2.80
2.	Water absorption	4.25%
3.	Moisture content	5.29%
4.	Fineness Modulus	3.24
5.	Type	Natural Sand
6.	Grading Zone	III

Water

Fresh and clean water is used for casting the specimens in the present study. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material etc. as per Indian standard. The pH value not less than 6.

Waste Foundry Sand

The raw materials used for making sand molds for metal castings are usually recycled. After a repeated use they lose their characteristics, thereby becoming unsuitable for further use in the manufacturing process. All these materials are then discarded as a waste. They are mainly molding sand and core sand.

Molding sand is the sand which is compacted and shaped according to a pattern that is going to be produced. The by-product materials that result from the molding sand are dust particles and cleaned sand from the casting, and excess system sand which is in the form of large lumps of fine sand.

In the present work foundry sand is obtained from metal industries in Nashik, Maharashtra. The physical properties of the foundry sand are given below.

For this study 54 cubes, 36 cylinder and 36 beams have been cast by replacing fine aggregate by waste foundry sand. Compressive strength, split tensile strength and flexural strength of foundry sand concrete will observed and compared with those of conventional concrete.

To achieve this comparative study cubes, cylinder and beams will cast replacing sand by 0% ,10%, 20%, 30%, 40%, and 50%, with foundry sand. These specimens will tested after 3, 14 and 28 days. To identify strength a nominal mix of 1:1.5:3.18 was used during the investigations.

Fineness modulus of waste foundry sand = 3.96

Specific gravity of waste foundry sand = 2.42

Water Absorption % = 0.43

Moisture Content %= 1.5

Chemical oxide composition of waste foundry sand

Constituent	Value (%)
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
SO_3	0.09
Na_2O	0.19
K_2O	0.25
TiO_2	0.15
P_2O_5	0.00
MnO_3	0.02
SrO	0.03
LOI	5.15(0.45 to 9.47) 2.1-12.1
Total	99.87

4. RESULTS AND DESCUSSION

COMPRESSIVE STRENGTH (N/mm2)

SR. NO.	% REPLACED	3 DAYS	14 DAYS	28 DAYS
1	0%	10.67	21.36	32.83
2	10%	13.38	21.55	34.94
3	20%	16.09	26.03	35.64
4	30%	15.41	27.94	40.87
5	40%	8.02	14.22	27.42
6	50%	6.3	12.49	23.92

FLEXURAL STRENGTH (N/mm2)

SR. NO.	% REPLACEMENT	3 DAYS	14 DAYS	28 DAYS
1	0%	3.9	5.6	7.5
2	10%	4	6.4	8
3	20%	4.5	6.6	8.1
4	30%	5	7.4	8.8
5	40%	3	5.6	7.4
6	50%	2.5	4.8	6.3

COST FEASABILITY

Sr. No.	Material	Rate (Rs/Kg)
1.	Cement	6.0
2.	Fine aggregate (sand)	1.13
3.	Coarse aggregate (> 20mm)	0.50
4.	Foundry sand	0.15

Workability of Concrete:

Slump Cone Test:-

The slump test is the most simple workability test for concrete, involves low cost and provides immediate results. Due to this fact, it has been widely used for workability tests since 1922. The slump is carried out as per procedures mentioned in ASTM C143 in the United States, IS: 1199 – 1959 in India and EN 12350-2 in Europe.

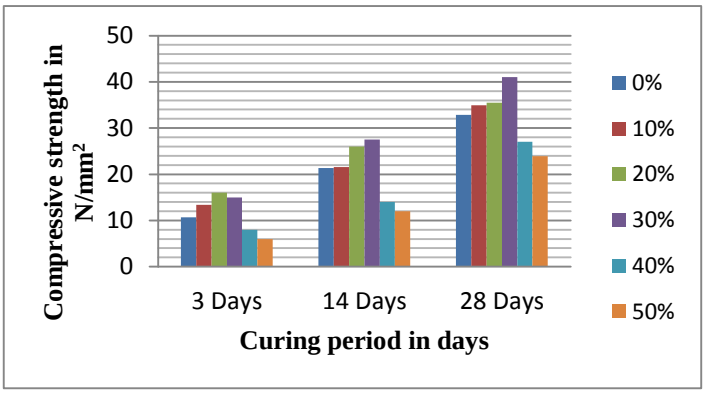
Generally concrete slump value is used to find the workability, which indicates water-cement ratio, but there are various factors including properties of materials, mixing methods, dosage, admixtures etc. also affect the concrete slump value.

Workability of concrete

Sr. No.	% Replacement of foundry sand	Slump (mm)
1	0	100
2	10	95
3	20	95
4	30	80
5	40	40
6	50	35

Compressive Strength

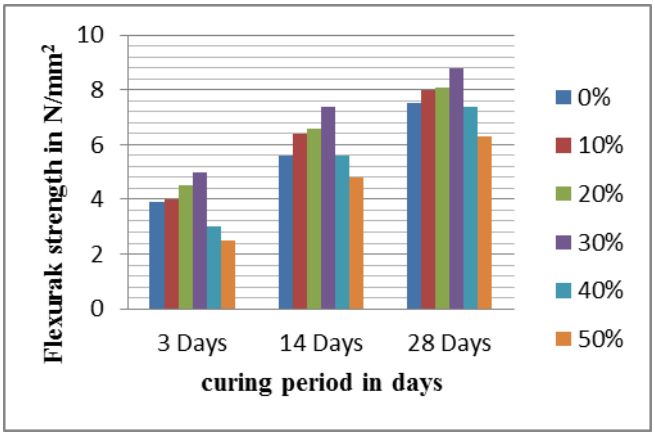
Compressive strength at various percentage of replacement of fine aggregate with waste foundry sand. The cube specimens were tested for compression and the ultimate compressive strength was determined with the help of compressive testing machine (CTM). The average value of compressive strength of three specimen for each percentage replacement at the age of 3, 14, 28 days were studied. The graph shows the difference between compressive strength of the specimen at various percentage replacements



From the above graph there is a considerable improvement in the compressive strength of concrete with increase in the percentage of waste foundry sand up to 30%. The above graph shows that the compressive strength at the 30% replacement is higher than another percentage. It shows that the foundry sand is more effective for compressive strength at replacement of 30%.The graph shows that the strength also goes on increasing with age of curing. The maximum compressive strength was achieved with 30% replacement of fine aggregate with waste foundry sand.

Flexural Strength:

Flexural strength tests were performed on universal testing machine (UTM) of 600 KN capacities. Three beams of 500*100*100 mm from each batch were subjected to this test. The comparative study was made on properties of concrete after percentage replacement of fine aggregate by waste foundry sand in the range of 0%, 10%, 20%, 30% 40%and 50%.



From the above graph beam specimen were tested for flexural strength. Flexural strength of the concrete at various percentage level was calculated with the help of universal testing machine (UTM). The tests were carried out confirming to IS: 516-1959(8). The specimen was tested under two point loading. The average value of 2 specimen were calculated at the age of 3, 14, 28 days There is considerable increase in the flexural strength of concrete with the increase in the percentage of waste foundry sand up to 30%. However there was decrease in the strength compared to normal concrete mixture.

DISCUSSION

Based on various researchers, it is observed that 30% replacement generally gives higher strength compared to normal concrete. Above which it is equal to or below the normal concrete. Some papers show the positive as well as negative changes in the properties. The changes in the concrete will be differing with the change in manufacturing process and resources of foundry sand. it gives that within this limit we can use foundry sand as a replacement of fine sand. So we can make concrete effective and environment friendly.

Effect of the following parameters are studied to find the influenced of waste foundry sand on strength properties of plain concrete.

Workability of the concrete goes on increasing with increase in the percentage of waste foundry sand. As the foundry sand contains more fine particles which increase the fineness of the concrete which results in the increase in the workability.

5. CONCLUSION

Based on the experimental study undertaken the following conclusion are drawn.

Waste foundry sand can be effectively used as fine aggregate in concrete.

Replacement of fine aggregate with foundry sand gives optimum strength at 30% replacement then there was a marginal decrease in the strength.

At 30% replacement of sand gives maximum strength at the age of 28 days,

The flexural strength also gives the maximum result at 30% and at the age of 28 days. After which it shows decrease in the strength.

Thus the foundry sand is the good replacement of fine aggregate.

Achieved economy, strength with the use of foundry sand.

It gives the environment friendly concrete.it helps in preparing green concrete.

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