STRENGTH BEHAVIOUR OF CONCRETE PRODUCED WITH FOUNDRY SAND AS FINE AGGREGATE REPLACEMENT

Shaik Ahamed Mynuddin[1], M. Mohan1[2], T. Indrasena Reddy[3], Nomula Pratik Reddy[4]
[1]Assistant Professor, Department of Civil Engineering, Guru Nanak Institutions, Hyderabad, Telengana.
[2,3,4] Students of Final Year B.Tech, Department of Civil Engineering, Guru Nanak Institutions, Hyderabad, Telengana.

ABSTRACT: Generation of waste foundry sand as by-product of metal casting industries causes environmental problems because of its improper disposal. Thus, its usage in building material, construction and in other fields is essential for reduction of environmental problems. Concrete is the most extensively used construction material in the world, second to water. Increasing rate of urbanization and industrialization has lead to over exploitation of natural resources such as river sand and gravels, which is giving rise to sustainability issues. It has now become imperative to look for alternatives of constituent materials of concrete. Waste foundry sand, a by-product of ferrous and non-ferrous metal casting industries is one such promising material which can be used as an alternative to natural sand in concrete. In last few decades, several studies have been conducted to investigate the effect of addition of waste foundry sand as partial and complete replacement of regular sand in concrete. It has been found suitable to be used as partial replacement of sand in structural grade concrete. A number of properties have been reviewed in the current study and also tests on strength and durability of concrete. This study demonstrates the use of waste foundry sand as a partial replacement of fine aggregate in concrete like 10%,20%,30%. In the present study an attempt is made to understand the applicability of foundry sand in making concrete. Checking suitability of materials, mix design as per test results on materials, and checking strength properties of concrete.

I. INTRODUCTION

1.1. Foundry sand

Foundry sand is a byproduct from the production of both ferrous and nonferrous metal castings. It is high quality silica sand. Foundries use high quality size-specific silica sands for use in their molding and casting operations. In the casting process, molding sands are recycled and reused many times. Foundry sand is material which is obtained from metal casting industries. Basically natural sand is used for moulds preparation in casting industries. During production, ferrous and non-ferrous particles are mix with the sand. That sand is again recycled and used for several times, after that it is not possible to use again, so, that will be simply dumped which is exposes to environment. This final waste product of casting industries is known as Foundry sand. Foundry sand consists primarily of clean, uniformly sized, high-quality silica sand or lake sand that is bonded to form molds for ferrous (iron and steel) and nonferrous (copper, aluminum, brass) metal castings. Although these sands are clean prior to use, after casting they may contain Ferrous (iron and steel) industries account for approximately 95 percent of foundry sand used for castings. The automotive industry and its parts suppliers are the major generators of foundry sand.

Fig-1.1: Foundry sand

1.2. PURPOSE

Due to ever increasing quantities of waste materials and industrial by-products, solid waste management is the prime concern in the world. Scarcity of land-filling space and because of its ever increasing cost, recycling and utilization of industrial by-products and waste materials has become an attractive proposition to disposal. There are several types of industrial by-products and waste materials. The utilization of such materials in concrete not only makes it economical, but also helps in reducing disposal concerns. One such industrial by-product is waste foundry sand. Waste foundry sand is a by-product of ferrous and nonferrous metal casting industries. Foundries successfully recycle and reuse the sand many times in a foundry. When the sand can no longer be reused in the foundry, it is removed from the foundry and is termed as waste foundry sand.

The aim is to keep contaminated foundry waste sands away from landfills that in coming years have more and more limited capacity, and to establish and improve acceptance of this generally valuable cleaned and recycled soil material to be used for geo-engineering applications in the future. In Europe, around 18 M tons of foundry waste sand is left over every year and in many cases big landfills do not have enough capacity to deposit those large amounts of surplus foundry sand. In most countries several smaller landfills are being closed and replaced by large so called “EU landfills”, so the distances and transport costs to the landfills are also increasing for the foundry companies and alternative ways of

treating those wastes in a more environmental friendly way have to be found.
There is a future vision of this sustainable composting system (or service) that can be transferred to the areas where several foundries operate in the same region to clean the surplus foundry sand for re-use purposes.
The main idea is to study the quality target of the piloted foundry sand specimens to fulfil the product requirements for re-using the cleaned sand as substitute ground construction materials or other geo-engineering applications.
1.3. OBJECTIVES

- Replacing of fine aggregate with foundry sand in partial amounts like 10%, 20%, 30% by weight.
- Checking suitability of materials
- Mix design as per test results
- Checking strength properties of concrete like compressive strength, split tensile strength

Fig-1.2: Site location
Foundry sand at BOLLARAM, HYD casting industry

II. LITERATURE REVIEW

TarunNaiket al. (2014) and their fellows investigated the performance of fresh and hardened concrete containing discarded foundry sand in place of fine aggregate. Concrete mixes were proportioned to replace 25% and 35% by weight of regular concrete sand with clean/new foundry sand and used foundry sand. The results of this investigation showed that mix containing 25% discarded foundry sand showed about 10% higher compressive strength at 28 days than the mix containing 35% discarded foundry sand. However, the compressive strength of the control mix was about 20-30% higher than the mixes containing discarded foundry sands. They added that no marked difference was observed in the density of fresh and hardened concrete.

Khatib and Baiget al. (2010, 2011) 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.

Kumbharet al. (2011)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

- workability goes on reducing with increase in UFS content
- 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%.

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%.

III. METHODOLOGY

Generally concrete consists of Cement, Coarse Aggregate, water & Fine Aggregate. In this project we are replacing Fine Aggregate partially with Foundry Sand like 10%, 20%, and 30% by weight of Fine Aggregate. All the materials used for this project work was sourced and purchased from Ibrahimpatnam near to our college, except foundry sand that was sourced from HYD CASTINGS INDUSTRY PVT. LTD located at Bollaram IDA. The methods adopted in the study included the following, collection of materials, testing of materials, calculation of mix design, preparation of specimens and testing of specimens. In this phase various properties of materials are calculated and mix design will be calculated. Based on mix design specimens are going to cast.

The concrete grade adopted in the study was grade 20. The replacement of sharp sand with foundry sand was done at 10%, 20% & 30% The concrete was produced and poured into appropriate moulds (Cubes and Cylinders) which were oiled for easy removal and thoroughly tamped to avoid honey-combs and left to dry.
The concrete was removed from the molds after 24 hours and placed in a water filled tank for curing for 7, 14, 21 and 28 days respectively. The cube specimens were subjected to compressive strength tests at 7, 14, 21, and 28 days while the cylinders were subjected to split-tensile tests at 28days. 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.
Materials Uesd

- Cement
- Coarse Aggregate
- Fine Aggregate
- Foundry Sand
- Water

IV. TESTS ON CUBES

Concrete Cube Testing to determine the strength of concrete. Cube Testing is a Destructive Testing Method of Concrete Testing, as the cubes are crushed in Compression Testing Machine. The cubes are generally tested at 7 & 28 days unless specific early tests are required, for example to remove a concrete shutter safely prior to 7 days. Usually 1 cube will be tested at 7 days and 2 cubes at 28 days, however this may vary depending of the requirements, check the design first. The cubes are removed from the curing tank, dried and grit removed. The cubes are tested using a calibrated compression machine. The mostly tested cubes in practice are of 150x150x150 size in mm.

- Compressive strength test.
- Split tensile test.
- Sulphate attack test.
- Acid attack test.

V. 5. RESULTS AND DISCUSSIONS

TABLE-5.1: TEST RESULTS ON CEMENT

S.NO	TESTS CONDUCTED	RESULTS
1	Specific gravity	2.63
2	Fineness	6%
3	Initial setting time	90 min
4	Final setting time	225 min
5	Soundness	5 mm

TABLE-5.2: TEST RESULTS OF COARSE AGGREGATE

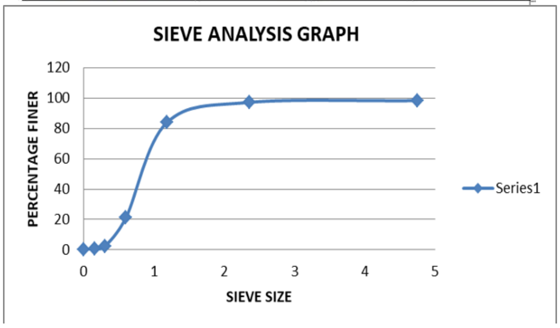
S.NO	TEST	RESULT
1	Specific gravity	2.64
2	Water absorption	0.81%
3	Impact value	15.18%
4	Crushing value	17.23%
5	Attrition value	10%
6	Abrasion value	50%

TABLE-5.3: TEST RESULTS OF FINE AGGREGATE

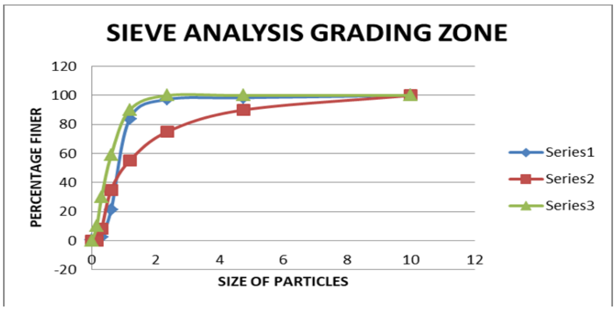
S.No	TEST	RESULT
1	Specific gravity	2.46
2	Sieve analysis	ZONE II
3	Water absorption	0.5 %

TABLE 5.4: SIEVE ANALYSIS RESULT

Sieve sizes	Weight retained	% finer
10 mm	0 gm	0
4.75 mm	16 gm	98.4
2.36 mm	11 gm	97.3
1.18 mm	134 gm	83.9
600 microns	625 gm	21.4
450 microns	183 gm	3.1
300 microns	7 gm	2.4
150 microns	18 gm	0.6



Graph-1: Graph Showing Sieve Analysis For Fine Aggregate



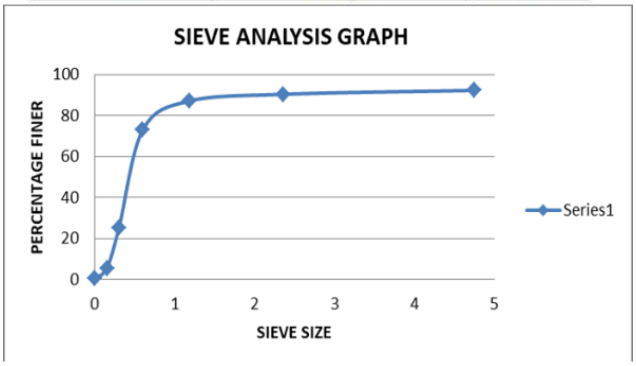
Graph 2: Graph Showing Fine Aggregate Lies In Zone – II

TABLE-5.5: TEST RESULTS OF FOUNDRY SAND

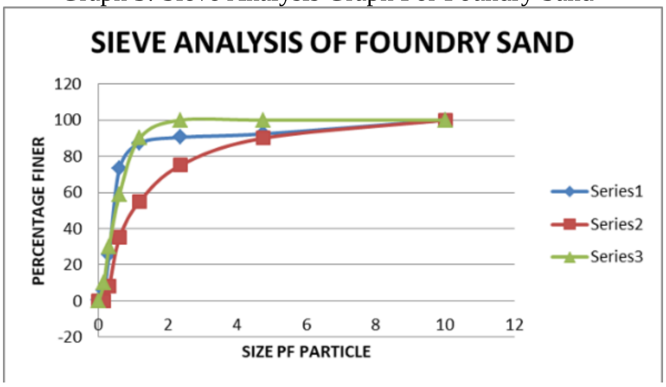
S.No	TEST	RESULT
1	Specific gravity	2.47
2	Sieve analysis	ZONE II
3	Water absorption	0.43%
4	Bulk density	2583 kg/m3

TABLE 5.6: SIEVE ANALYSIS RESULT OF FOUNDRY SAND

Sieve sizes	Weight retained	% finer
10 mm	0 gm	0
4.75 mm	76 gm	92.4
2.36 mm	19 gm	90.5
1.18 mm	26 gm	87.2
600 microns	142 gm	73.2
450 microns	449 gm	28.8
300 microns	35 gm	25.3
150 microns	197 gm	5.6
Pan	52 gm	0.4



Graph 3: Sieve Analysis Graph For Foundry Sand



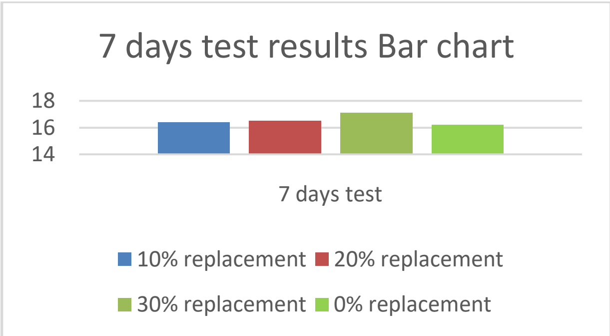
Graph-4: Showing That Foundry Sand Lies In ZONE II

VI. COMPRESSIVE STRENGTH TEST RESULTS ON CONCRETE

Compressive Strength Test Results For 7 Days

Table-5.7: 7 days test Results of compressive strength of cubes

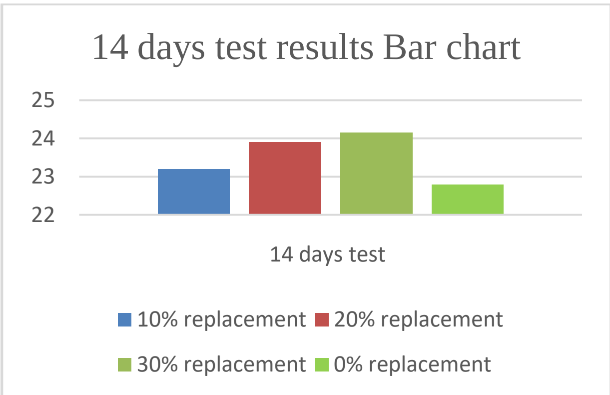
S.No	% of replacement	Compressive strength
1	10%	16.4 N/mm^2
2	20%	16.5 N/mm^2
3	30%	17.1N/mm^2
4	0%	16.2 N/mm^2



Graph 5: Compressive Strength Test Results For 14 Days

Table-5.8: 14 days test Results of compressive strength of cubes

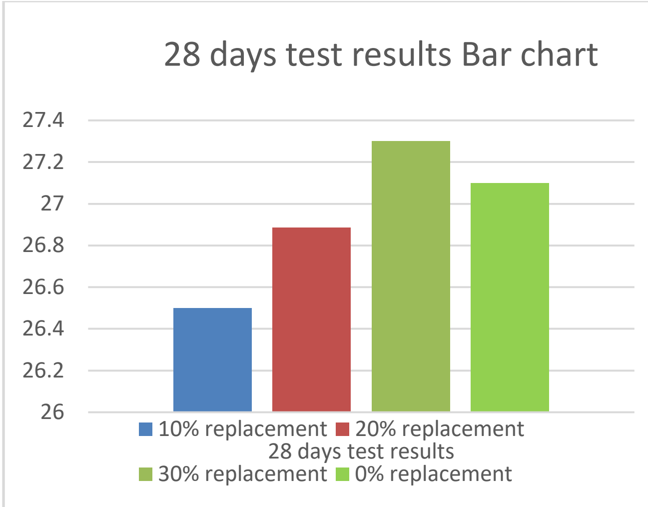
S.No	% of replacement	Compressive strength
1	10%	23.2 N/mm^2
2	20%	23.9 N/mm^2
3	30%	24.1N/mm^2
4	0%	22.8 N/mm^2



Graph 6: Compressive Strength Test Results For 28 Days

Table 5.9: 28 days test Results of compressive strength of cubes

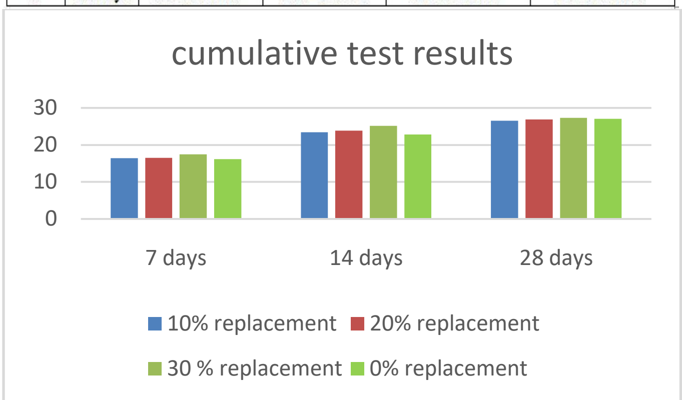
S.No	% of replacement	Compressive strength
1	10%	26.5 N/mm^2
2	20%	26.8N/mm^2
3	30%	27.3 N/mm^2
4	0%	27.1 N/mm^2



Graph 7

TABLE 5.10: CUMULATIVE TEST RESULTS

S.No	No. of days	Compressive strength for 0% replacement	Compressive strength for 10% replacement	Compressive strength for 20% replacement	Compressive strength for 30% replacement
1	7 days	16.2 N/mm^2	16.4 N/mm^2	16. 5N/mm^2	17.5 N/mm^2
2	14 days	22.8 N/mm^2	23.2 N/mm^2	23.9 N/mm^2	24.5 N//mm^2
3	28 days	27.1 N/mm^2	26.5 N/mm^2	26.8 N/mm^2	27.3 N/mm^2

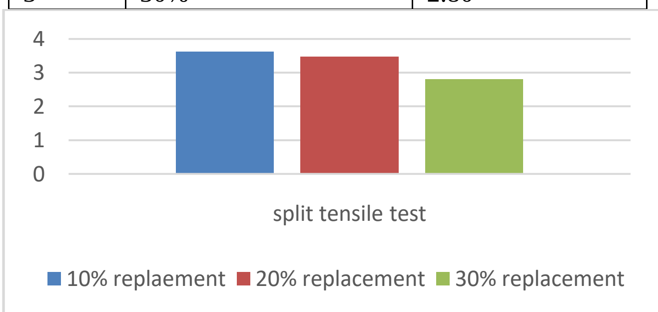


Graph 8

VII. SPLIT TENSILE TEST

Table 5.11: Test Results of Spilt Tensile Test

S. no.	Replacement %	Tensile strength in N/mm^2
1	10%	3.63
2	20%	3.47
3	30%	2.80

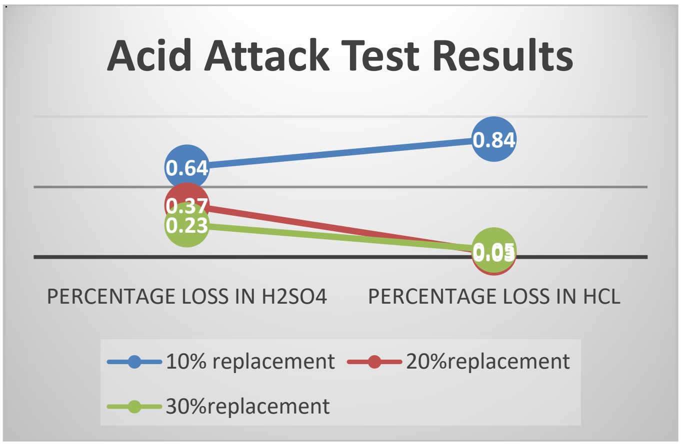


Graph 9

VIII. DURABILITY TEST

TABLE 5.12: Test results of Acid Attack

S.No	% replacement	Percentage weight loss in H_2SO4	Percentage weight loss in HCL
1	10%	0.64	0.84
2	20%	0.37	0.03
3	30%	0.23	0.05



Graph 9

IX. 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 good strength.
- As per our studies 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.
- 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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