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Utilization of Waste Foundry Sand for Development of Eco-Friendly Low Cost Concrete

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Abstract: Now-a-day's good quality natural river sand is not available easily; it is to be transported from a long distance. These resources are also exhausting at a very fast speed. So there is a need to find alternative source to natural river sand. Natural river sand takes millions of years for its formation and is non renewable. Artificial sand is used as an alternative for natural river sand. In this project, the behavior of concrete is assured by partially replacing the natural river sand with foundry sand which is a waste product from machine industries. The experimental work is mainly concern with the study of mechanical properties like compressive strength, flexural strength and also water absorption of concrete by partial replacement of natural river sand by foundry sand as fine aggregate. Tests were carried out on cubes, beam to studies the mechanical properties of concrete using foundries and compare with concrete with natural sand as fine aggregate. Natural river sand was replaced with three percentages (20%, 40% & 60%) of Waste Foundry Sand by weight. A concrete mix of M-25 proportion made with and without foundry sand. Compression test and Flexural strength test were carried out to evaluate the strength properties of concrete at the age of 7&28 days and also water absorption test were carried out. Test results showed a nominal increasing strength property of concrete by the addition of waste foundry sand as a partial replacement of natural sand.
Keywords: Waste Foundry Sand, Fine Aggregate, Compressive Strength Test, Flexural Strength Test, Water Absorption Test.

I. INTRODUCTION

The demand for concreting is increasing; day by day thus the need of river sand is also increasing. So there is a need to find alternative source to natural river sand. Natural river sand takes millions of years for its formation and is not easily renewable. As a substitute to natural sand, foundry sand is used as a partial replacement. Waste foundry Sand is produced at a large scale in Metal Casting Industries. Foundries are recycled successfully and the sand is reused 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 "Foundry Sand". Foundry sand has many beneficial applications to other industries. World Industrial Sector recognizes Kolhapur as a highly casting production sector. In Kolhapur district more than 300 foundry industries are there thus ranking first in Maharashtra state. As per present disposal practices, the waste foundry sand which is dumped on barren land cannot be recovered. So the waste foundry sand should be used for other beneficial applications to reduce its adverse effects.

Foundry sand is made up of high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and nonferrous metal casting industries, where the sand has been used for centuries as a molding material because of its thermal conductivity. Generally, there are two types of binder systems which are used, and based on that foundry sands are classified as: clay bonded systems (green sand) and chemically bonded systems.

Both types of sands are used beneficially, but they have different physical and environmental characteristics. Generally, green sand molds are used to produce about 90% of casting volume. Green sand is composed of naturally occurring materials which are blended together, they are, high quality silica sand (85–95%), a carbonaceous additive (2–10%) to improve the casting surface finish, bentonite clay (4–10%) as a binder, and water (2–5%). Green sand is the mostly recycled foundry sand for beneficial reuse. The Waste generated from the industries cause environmental problems. Hence it is most essential to develop profitable building materials from them.

II. EXPERIMENTAL MATERIALS

A. Foundry Sand

Nowadays, metal industries prefer sand casting system. Mould is made of uniform sized, clean and high silica sand is used. After casting process foundries recycle and reuse the sand several times but after some recycle and reuse it is removed from the foundries and known as waste foundry sand. The application of waste foundry sand to various engineering sector can solve the problems of its

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1) *Disposal and Harmful Effect to Environment:* Type of foundry sand depends on the casting process in foundries. Foundry sand is generally of two types: Green sand and chemically bounded sand. Additive in sand depends on type of metal casting. The use of waste foundry sand as full or partial replacement by fine aggregate helps to achieve different properties and it also helps to solve problem of disposal of waste foundry sand, as it is produced in large quantity. Specific Gravity of Foundry Sand=2.55

Fig.1 Waste Foundry Sand

B. Cement

Cement in concrete acts as a binding material which hardens after the addition of water. It plays an important role in construction sector. In this study the Ordinary Portland Cement (OPC) of 43 grades (Dalmia Cement) is used according to IS: 8112-1989.

C. Coarse Aggregate

Aggregate is a natural deposit of sand and gravel and also give structure to the concrete. The aggregate having size more than 4.75 mm is known as coarse aggregate. To increase the density of concrete aggregate is frequently use in different sizes. The graded coarse aggregate is described by its nominal size i.e. 40mm, 20mm, 16mm, 12.5mm etc. The coarse aggregate used for concrete is passing from 20 mm IS sieve and retained on 10 mm IS sieve. Aggregate acts as reinforcement and introduce strength to the overall composite material. In this study coarse aggregate is conformed to IS: 383-1970.

D. Fine Aggregate

Aggregate passing through 4.75 mm IS sieve is known as fine aggregate. Main function of fine aggregate is to fill the voids in between coarser particles and also helps in producing uniformity in mixture. The aggregate used in concrete for is passing through 4.75 mm IS sieve. In this study fine aggregate is conform to IS: 383-1970.

E. Water

Water plays an important role as it produces chemical reaction with cement. The strength and durability of concrete depends also on the amount of water mixed with it. Too much or too little water can adversely affect the strength of concrete. After concrete is cast, water is used to cure it so that the temperature is controlled and concrete matures slowly.

It is very important to use clean, potable water in quality concrete production. Brackish or salty water must never be used. Contaminated water will produce concrete mortars with lower durability, erratic set characteristics and inconsistent colour.

III. METHODOLOGY

The exact amount of concrete ingredients were weighed and mixed thoroughly in laboratory concrete mixer till the consistent mix was achieved. The standard cube of 150*150*150 mm size of steel mould is used for Compression Strength Test and Water Absorption Test. Beam of size of 150*150*700 mm is used for Flexural Strength Test. Compressive Strength, Water Absorption Test and Flexural Strength were carried out on hardened concrete at 7 and 28 days. The average strength was calculated the acceptance criteria using IS 456 – 2000 is followed and the average values are illustrated in tables.

A. Mix Design

As per IS: 10262-2009 mix design was prepared for M25 grade and same design was used in preparation of test samples.TABLE-1

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shows mix design proportion.

Table-1 Mix Design for M25 Grade

	Cement	Fine Aggregate	Course Aggregate	Water
By weight (Kg/m3)	420	657.67	1174.41	189
Ratio	1	1.56	2.79	0.45

B. Compressive Strength Test

Compressive strength of concrete was carried out on Compression Testing Machine of 3000kN. Two cubes of each batch were subjected to this test. A comparative study was made on properties of concrete after percentage replacement of fine aggregate by waste foundry sand in the range of 0%, 20%, 40% and 60%.

Fig.2 Compression Strength Test Set up

Table-2 Compression Strength of Cubes For M25 Grade

Replacement (%)	Weight(Kg)		Load Taken(KN)		Strength (MPa)	
	7 days	28 days	7 days	28 days	7 days	28 days
0	8.63	770	671.15	769.7	29.78	34.22
20	8.68	847	769	846.8	34.18	37.64
40	9	982	643	982.2	28.58	43.64
60	9	790	620.5	833.8	27.56	35.11

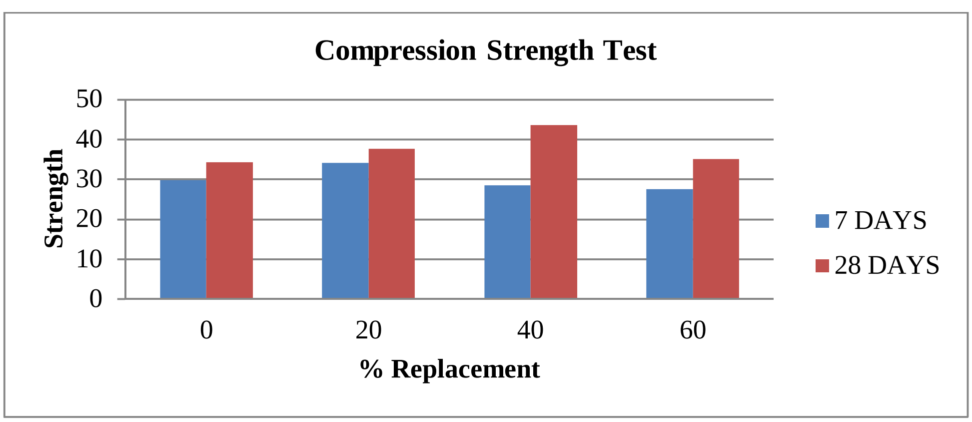

Fig.3 Compression Strength Test

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C. Flexural Strength Test

The tests on beams were carried out on Flexural testing machine of 1000kN capacity under two point loading system.

Fig. 4 Flexural Strength Test Set up

Table-3 Flexural Strength of Beam For M25 Grade

Replacement (%)	Weight(Kg)		Load Taken (KN)		Strength (MPa)	
	7 days	28 days	7 days	28 days	7 days	28 days
0	41.12	41.5	36.85	41.4	6.55	7.36
20	41.3	40	40.15	42.65	7.13	7.58
40	40.98	39.6	36.58	47.2	6.5	8.39
60	39.84	40.6	31.86	44.55	5.66	7.92

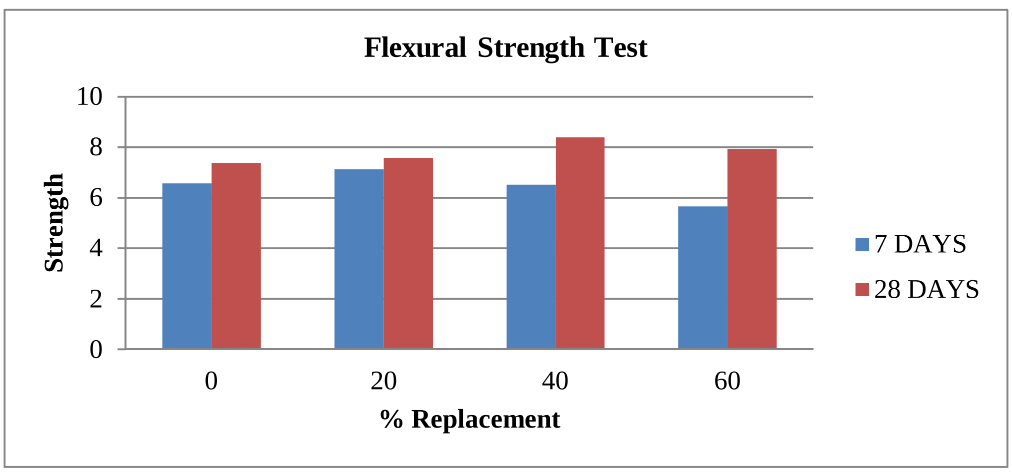

Fig.5 Flexural Strength Test

D. Water Absorption Test

The cubes after casting were immersed in water for 28 days curing. They were then weighted and this weight was noted as the wet weight of the cube.

These specimens were then oven dried at the temperature 105ºC until the mass became constant and again weighed. This weight was noted as the dry weight of the cube.

$$\% \text{ Water Absorption} = [(WW - DW) / DW] \times 100$$

Where, WW = Wet Weight of Cube,

DW = Dry Weight of Cube.

Table-4 Water Absorption Test of Cubes For M25 Grade

Replacement (%)	Wet Weight (Kg)	Dry Weight (Kg)	% Water Absorption
0	8.64	8.38	3.1
20	8.5	8.22	3.4
40	9.08	8.74	3.9
60	8.96	8.62	3.9

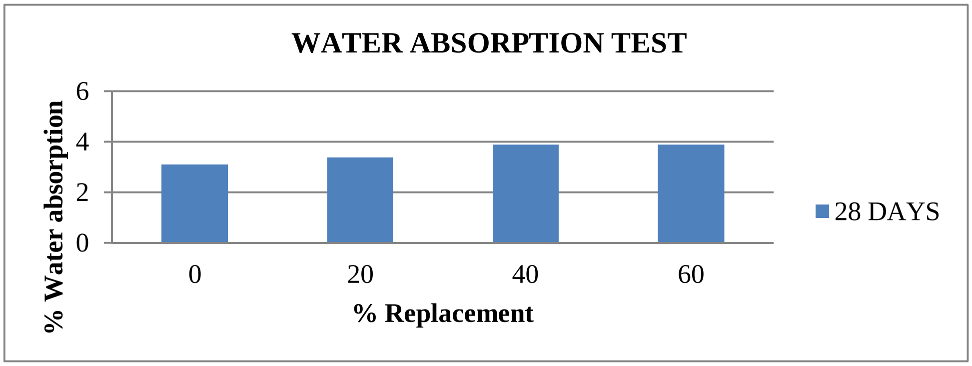

Fig. 6 Water Absorption Test

IV. CONCLUSION

A. Compression strength increases on increasing % replacement of waste foundry sand in concrete.
B. In this study, maximum compression strength is achieved by 40% replacement of fine aggregate by waste foundry sand.
C. Flexural strength is at maximum at 40% replacement of fine aggregate by waste foundry sand.
D. Water absorption is found to be marginally increased with increase in waste foundry sand.
E. The problem of disposal of waste foundry sand is reduced.

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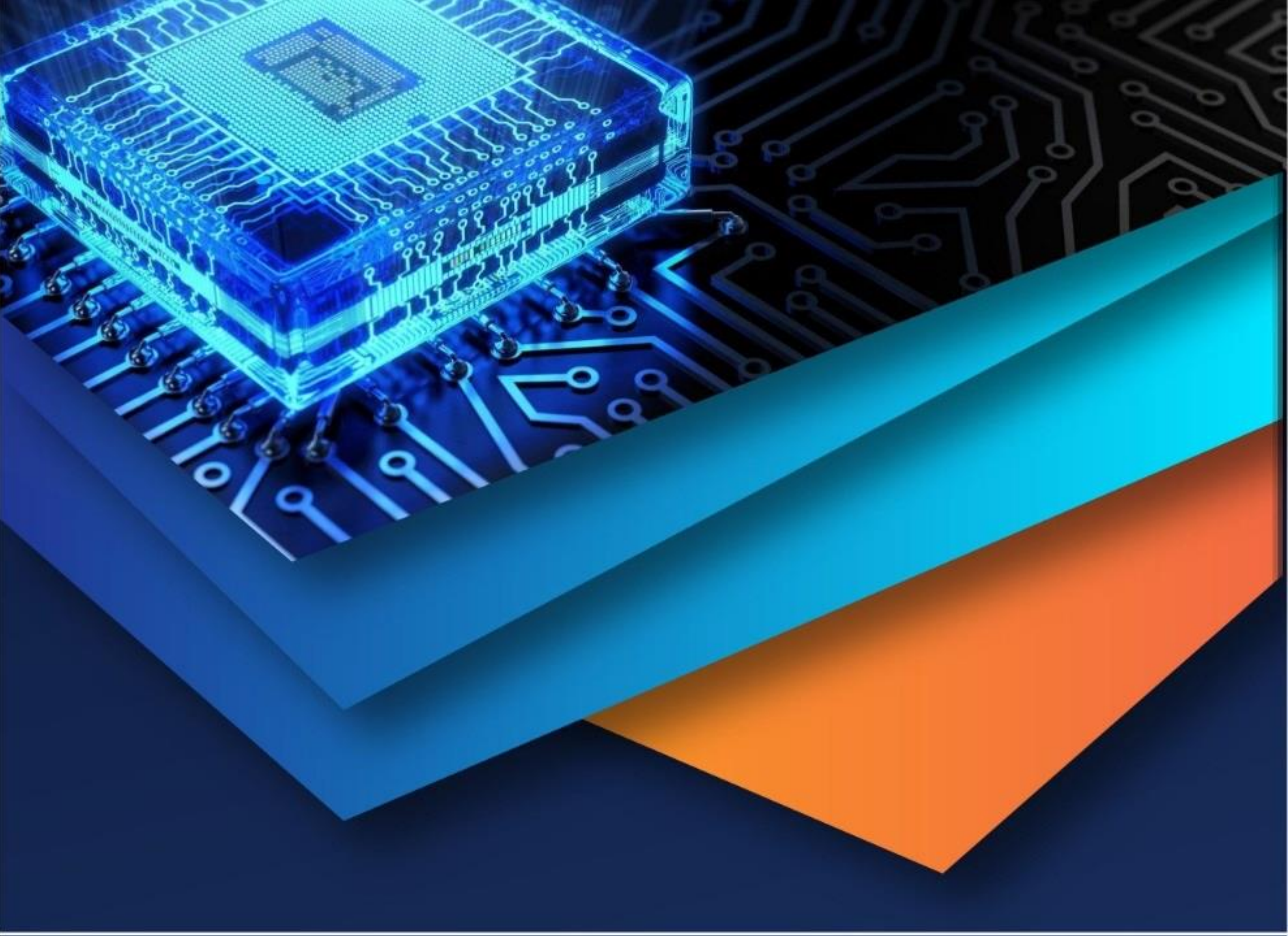

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