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# Study of Mechanical Properties of Concrete Incorporating Waste Foundry sand and Waste Ceramic Tiles

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**ABSTRACT:** Concrete is one of the vital and common material used in the construction field. From the last few years researchers had done work in concreting and invent various techniques and methods to produce concrete which has the desired properties. The current area of research in the concrete was introducing waste foundry sand (WFS) and waste ceramic tiles in the ordinary concrete. The research was carried out to produce an ecofriendly concrete. This paper recommends the effective use of waste foundry sand as a partial replacement for fine aggregates and waste ceramic tiles as a partial replacement for coarse aggregates in concrete. An experimental investigation was carried out on concrete containing waste foundry sand(WFS) in range of 0%, 10%, 20%, and 30% and waste ceramic tiles (WCT) in the range of 0%, 10%, 20% and 30% by weight for M-40 grade concrete. Concrete was produced, Tested and compared with conventional concrete in plastic state as well as in hardened state for workability, Compressive strength and tensile strength. These tests were carried out on standard cubes, Cylinder for 7 and 28 days to determine the properties of concrete. The aim of this research was to know the behaviour and mechanical properties of concrete for its ecofriendly and economical use.

**KEYWORDS:** WCT, WFT, Materials, mix design

## I. INTRODUCTION

In this era challenges of the civil engineers are how to enhance the work culture of using waste by-product in construction and in the evolution of low cost concrete. Construction sectors are deploying rapidly on a large scale and also marching to involvement of new construction technologies. The consumption of natural resources in construction has common from decades, which is the result of high cost. To overcome the use of natural resources and use of waste material like waste ceramic tiles and foundry sand in concrete could be make possible to achieve the low cost construction. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder (bentonite, sea coal, resins) and dust. Foundry sand can be used in concrete to improve its strength and other durability factors. Foundry Sand can be used as a partial replacement of cement or as a partial replacement of fine aggregates.

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**FIG1. WASTE FOUNDRY SAND**



**FIG. 2 WASTE CERAMIC TILES**

A ceramic material is an inorganic, non-metallic, often crystalline oxide, nitride or carbide material. Some elements, such as carbon or silicon, may be considered ceramics. Ceramic materials are brittle, hard, and strong in compression. Ceramic tile aggregates are hard having considerable value of specific gravity, rough surface on one side and smooth on other side, having less thickness and are lighter in weight than normal stone aggregates. Using ceramic tile aggregate in concrete not only it will be cost effective, but also provide considerable strength to the concrete. In the present study, effect of foundry sand as fine aggregate replacement and waste ceramic tile as coarse aggregate replacement on the compressive strength, split tensile strength and modulus of elasticity of concrete having mix proportions of M 40 grade was investigated. Fine and coarse aggregates were replaced with three percentages of foundry sand. The percentages of replacements were 0, 10, 20, and 30 % by weight of fine aggregate. Tests were performed for compressive strength, for all replacement levels of foundry sand at different curing periods (7&28-days). Test results showed that there is some increase in compressive strength, after replacing the fine aggregates with certain percentage of foundry sand so foundry sand can be safely used in concrete for durability and strength purposes.

## II. EXPERIMENTAL WORK

In the present study the materials used are Cement, river sand, coarse aggregate, Waste ceramic tiles(WCT) And Waste Foundry sand(WFS). The properties of the materials used are as shown in below table 1.

**Table 1: Properties of the materials**

Materials	Properties	Results
Cement	Specific gravity	3.05
	Normal consistency	32%
	Initial setting time	45 minutes
	Final setting time	10 hours
Sand	Specific gravity	2.58
	Zone	II
	Free moisture	1%
Coarse aggregate	Specific gravity	2.6
	Water absorption	0.15%
	Nominal size	20 mm
Waste ceramic tiles WCT	Specific gravity	2.56
	Water absorption	0.20%
	Nominal size	16.5 mm
Waste Foundry sand WFS	Specific gravity	2.42
	Water absorption	0.45%

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## MIX DESIGN

Concrete mix design as per IS 10262 of M 40 grade of concrete and obtained final mix proportion

% of replacement	Cement	Sand	WFS	Coarse aggregate	WCT	Water
0%	1	1.45	-	2.74	-	0.45
10%	1	1.38	0.072	2.603	0.137	0.45
20%	1	1.305	0.145	2.466	0.274	0.45
30%	1	1.232	0.218	2.329	0.411	0.45

## METHODOLOGY

Cube of size 150 mm were cast by replacement of coarse aggregate by ceramic waste and fine aggregate by foundry sand starting from 0 to 30% with an increment of their weight and are represented as 0%, 10%, 20% and 30% respectively. The earlier procedure was followed for Cylinders of size 150 mm x 300 mm respectively. Details of specimens are presented in Table 2.

TABLE 2 DESCRIPTION OF SPECIMEN

Sl no	Specimen description	Cube(nos)	Cylinder(nos)
1	Conventional concrete	6	6
2	10% Replacement of CA & FA	6	6
3	20% Replacement of CA & FA	6	6
4	30% Replacement of CA & FA	6	6

## III.RESULTS AND DISCUSSIONS

### GENERAL

Various properties of concrete incorporating foundry sand and waste ceramic tiles at various replacement levels with fine aggregate and coarse aggregate were studied, results were compared and checked for compressive strength, split tensile strength and modulus of elasticity of foundry sand mix with ordinary mix.

### COMPRESSIVE STRENGTH

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 150 mm x 150mm cube with proper compaction, after 24 hrs place the specimen in water for curing of about 7 and 28 days. After the curing the compressive test to be carried out for 0%, 10%, 20% and 30% replacement of WFS and WCT and the result were obtained as mentioned in below table no 3.

COMPRESSIVE STRENGTH = (LOAD / AREA) in N/sq.mm

TABLE 3 COMPRESSIVE STRENGTH TEST RESULTS

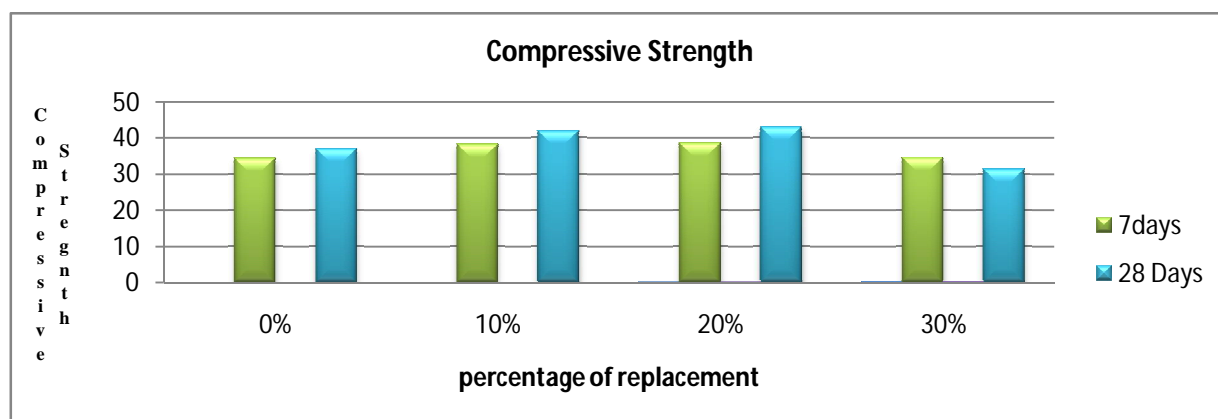
Sl no	% replacement	Average ultimate compressive strength	
		@ 7 days(N/mm <sup>2</sup> )	@ 28 days (N/mm <sup>2</sup> )
1	0%	34.46	37.08
2	10%	38.38	42.14
3	20%	38.69	43.04
4	30%	34.66	31.43

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**Fig 3 Graphical representation of compressive strength**

It is evident from the above figures and tables that compressive strength of concrete mixtures with partial replacement of 10%, 20% and 30 % of foundry sand as sand replacement and aggregates as ceramic tiles was higher than the nominal mixture at all ages and that the strength of all mixtures continued to increase with the age.

But the increase in compressive strength can be seen up to a 20% replacement thereafter there is a decrease in the strength so the optimum % of replacement is 20% for better strength and stability.

## Tensile strength

that split tensile strength of concrete incorporating foundry sand (using 10 %, 20 % and 30 % replacement levels with fine aggregate and a w/c of 0.45) depended on the percentage of foundry sand and ceramic aggregates used. The variation of split tensile strength is shown below table 4.

The splitting tensile strength is calculated using the formula =  $\frac{2P}{\pi LD}$

Where, P = applied load

D = diameter of the specimen

L = length of the specimen

**TABLE 4 TENSILE STRENGTH RESULTS**

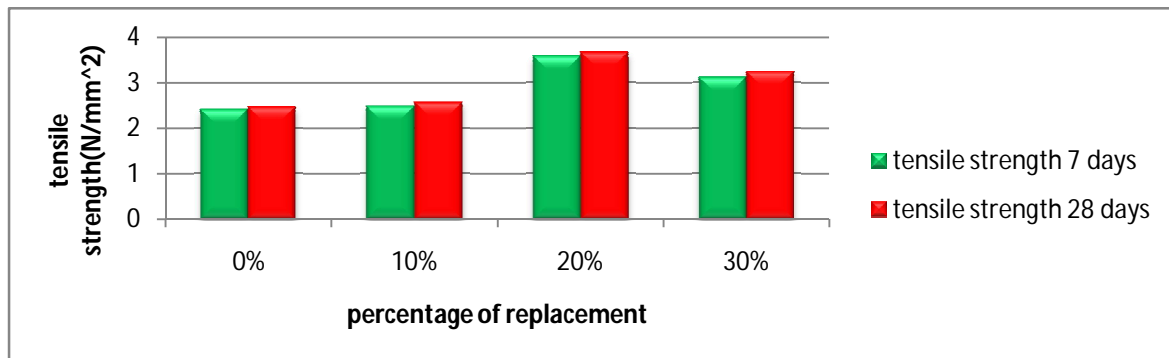
Sl no	% Replacement	Average tensile strength @ 7 and 28 days	
		@ 7 days(N/mm <sup>2</sup> )	@ 28 days (N/mm <sup>2</sup> )
1	0	2.42	2.47
2	10	2.49	2.57
3	20	3.58	3.67
4	30	3.12	3.25

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**Fig 4**Graphical representation of tensile strength

The above figure shows the variation of split tensile strength with replacements of foundry sand and ceramic aggregates with various levels of fine aggregate and coarse aggregate at 7 and 28-days. It shows that split tensile strength increases with the increase in replacement of percentage of sand with foundry sand and aggregates with ceramic at 7 and 28 days. For control mix, split tensile strength was increase with 10%, 20%, and decreased at 30% with respect to different replacement levels of sand with foundry sand and aggregates with ceramics at 7 and 28 days.

## IV. CONCLUSION

Depending upon the above experimental results and methods adopted the following conclusions are made regarding various properties of concrete incorporating the waste foundry sand and waste ceramic tiles:

- 1) It is found that compressive strength of concrete mix is increases with increase in percentage of waste foundry sand and waste ceramic tiles as compare to regular concrete.
- 2) The concrete with 10 and 20% replacement satisfies the compressive strength of M40 grade however higher the percentage addition of ceramic waste reduces the strength of normal concrete. It is also found that split tensile strength increases with increase in percentage of waste foundry sand and waste ceramic tiles up to 20 % replacement after that it reduces.
- 3) The split tensile strength of ceramic tile aggregate and foundry sand is very much in a straighter path compared to the conventional grades of concrete.

## REFERENCES

- [1] Daniela Sani and Francesca Tittarelli, "Used Foundry Sand in Cement Mortars and Concrete Production" Open Waste Management Journal, 2010, 3, 18-25.
- [2] RafatSiddique, YogeshAggarwal, ParatibhaAggarwal, El-HadjKadri, RachidBennacer, "Strength, durability, and micro-structural properties of concrete made with Used-foundry sand (UFS)", Construction and Building Materials 25 (2011) 1916–1925
- [3] El-HadjKadri, RafatSiddique, "Effect of metakaolin and foundry sand on the near surface characteristics of concrete", Construction and Building Materials 25 (2011) 3257–3266.
- [4] RafatSiddiquea, Gurpreet Singh, "Utilization of waste foundry sand (WFS) in concrete manufacturing", Resources Conservation and Recycling 55 (2011) 885– 892
- [5] Gurpreet Singh, RafatSiddiqu, "Effect of waste foundry sand (WFS) as partial replacement of sand on the strength, ultrasonic pulse velocity and permeability of concrete", Construction and Building Materials 26 (2012) 416–422
- [6] H. MerveBasar, NuranDeveciAksoy, "The effect of waste foundry sand (WFS) as partial replacement of sand on the mechanical, leaching and micro-structural characteristics of ready-mixed concrete", Construction and Building Materials 35 (2012) 508–515
- [7] Gurpreet Singh, RafatSiddique, "Abrasion resistance and strength properties of concrete containing waste foundry sand (WFS)", Construction and Building Materials 28 (2012) 421–426
- [8] GurdeepKaur, RafatSiddique, Anita Rajor, "Properties of concrete containing fungal treated waste foundry sand", Construction and Building Materials 29 (2012) 82–87



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