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EFFECT OF WASTE FOUNDARY SAND AND WASTE CERAMIC TILES ON MECHANICAL PROPERTIES OF CONCRETE

Arti B Avhad[1], Bhagyashri P Patil[2], Jyoti S Dargode[3], Kailas T Phalak[4]
[1,2,3,4]*Department of Civil Engineering , Sandip Foundation SIEM*

Abstract— Concrete technology was known by the Ancient Romans and was widely used within the Roman Empire. There are certain modifications has been done till today to produce a concrete having developed characteristics. The very common material which is used in construction industry is concrete. In ordinary concrete, the mixture of waste foundry sand and crushed ceramic tiles introduced in the recent area of research in the concrete. Due to the improper method of disposal of waste product like foundry sand which is a byproduct of metal casting industry, causes severe problems to environment. Also the waste ceramic tiles neither can use in other field nor be disposed off and become harmful to environment. Therefore we are using these two waste materials to produce an eco-friendly concrete. The project demonstrate the use of waste foundry sand as a partial replacement for fine aggregate and waste ceramic tiles as a partial replacement for coarse aggregate in the modified concrete.

The practical investigation is carried out on a concrete, containing materials like waste foundry sand and waste ceramic tiles in the range of 10**%**, 20**%**, 30**%**, 40**%** by weight of material for M-25 grade of concrete. The concrete was produced, tested and compared with the conventional concrete in the term of strength. To determine the mechanical properties of concrete the test were carried out on standard size specimens of cube and beam for 7 and 28 days. The purpose of this research is to know the characteristics and mechanical properties of concrete after modification of it by industrial waste in various proportional by taking test like compressive strength and flexural strength. The research is the resource for the exploring the potential use of industrial waste like waste foundry sand and waste ceramic tiles as an alternative to natural raw materials.

Keywords— Waste foundry sand, mechanical properties, waste ceramic tiles, flexural strength, deficiency, byproduct.

I. INTRODUCTION

Due to the day by day innovations and developments in construction field, the global consumption of natural aggregates is increasing rapidly. Extensive use of concrete leads to deficiency of natural aggregate. Because of this we are introducing the industrial solid waste like waste foundry sand and waste ceramic tiles in manufacturing of concrete to reduce the deficiency of natural aggregates.

A. Ceramic Tiles

In the production of tiles India stands at rank 3 in the world. Solid waste from the industry is also in large amount which is approximately 30 to 40 percent of production. Part of this waste can be effectively used as a replacement to coarse aggregate in concrete in crushed form because of its characteristics.

Crushed ceramic tiles are hard, have considerable specific gravity, less thickness, lighter in weight than normal coarse aggregate and having rough surface on one side and smooth on another side. Tiles manufactured from natural material containing high proportion of clay minerals by firing them at high temperature up to 700ºC to 1000ºC. Ceramic waste may come from two sources. The first source is the ceramics industry, and this waste is classified as non-hazardous industrial waste (NHIW). The second source of ceramic waste is associated with construction and demolition activity, and constitutes a significant fraction of construction and demolition waste (CDW). Reuse of this kind of waste has many advantages, not least of which are the economic advantages, including

job creation in companies specializing in the selection and recycling of this kind of material. It goes without saying that reuse is better than recycling.
Use of crushed ceramic tiles as a replacement to coarse aggregate will reduce cost of aggregate as well as provide considerable strength to the concrete. So, we selected these waste tiles as a replacement material to the basic natural aggregate.

B. Foundry Sand

Foundry sand has been used as a moulding material in ferrous and non-ferrous metal casting industries from centuries because of its thermal conductivity. This sand contains high quality silica with uniform physical properties.
Waste foundry sand is a byproduct of these metal castings. Indian foundries produce approximately 1.71 million tons of waste foundry sand each year (Metal World, 2006). Raw foundry sand contains high quality silica than natural sand used for construction. In the process of moulding, sand is reused and recycle again and again. However, the recycled sand comes to the point at which it cannot further used for casting process and like this the sand comes out as a byproduct. foundry sand is made up of mostly natural sand material. Its properties are similar to the properties of natural or manufactured sand. Thus it can normally be used as a replacement of sand.

II. MATERIAL PROPERTIES

A. Cement

Ordinary Portland cement 53 grade was used. It was tested as per Indian standard specification (BIS1489 part 1:1991). Test results are given below.

"Table1. Physical Properties of ordinary Portland cement"

Physical Properties		BIS-1489:1991	Test Result
Setting time (minutes)	Initial	30 Min.	58
	Final	600 Max.	302
Specific gravity		_	3.15

B. Aggregates

- **Fine aggregates**

Fractions passing from 4.75 mm to 150 micron IS sieves are termed as fine aggregate. The river sand used as fine aggregate conforming to the requirements of IS: 383. Natural sand is screen, to eliminate deleterious materials and over size particles.

- **Coarse aggregate**

The fractions passing from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 is being use.

"Table2. Physical Properties of Aggregate"

Sr. No.	Properties	Fine Aggregate	Coarse Aggregate
1.	Bulk Density (Loose), kg/lit	1.833	1.44
2.	Bulk Density (Compacted), kg/lit	1.87	1.55
3.	Specific Gravity	2.71	2.61
4.	Water Absorption (%)	0.3	0.3
5	Moisture content (%)	1.7	1.78

C. Waste Foundry Sand:

Waste foundry sand is made up of mostly natural sand material. Its properties are similar to the properties of natural or manufactured sand so it can be used as a replacement of sand.

"Table3. Chemical Properties of Foundry Sand"

Sr. No.	Constituent	Value (%)
1	SiO2	83.93
2	Al2O3	0.021
3	Fe2O3	0.950
4	CaO	1.03
5	MgO	1.77
6	SO3	0.057
7	LOI	2.19

Source: *R. Siddique, Waste Materials and By Products in Concrete, Spring-2008*

D. Waste ceramic tiles

Tiles are a mixture of clays that are pressed into shape and fired at high temperatures which gives the hardness. Ceramic tile aggregates are hard having considerable value of specific gravity.

"Figure1. Waste Ceramic Tiles"

"Figure2. Waste Foundry Sand"

III. MODIFIED CONCRETE MIX DESIGN

Mix design was carried out manually confirming to IS 10262:2009. Mix design is process of selecting proper material with their proper proportions to produce a concrete which will not only be economical but also fulfill its job requirements. In mix design firstly correct amount of all ingredients was calculated and then fine aggregates & coarse aggregates were replaced by waste foundry sand & waste ceramic tiles by 10%, 20%, 30%& 40% respectively. The aim behind the mix design is to get quantities of materials from which we can make concrete of desired quality as well as to avoid the wastage of material.

"Table4. Conventional Mix Design (M25)"

Water (Lit.)	Cement (kg/m3)	Fine Aggregate (kg/m3)	Coarse Aggregate (kg/m3)
170	346.93	603.65	1272.96
0.49	1	1.73	3.66

"Table5. Modified MixDesign: Replacement of Fine Aggregate by WFS and Coarse Aggregate by WCT"

Sr. no.	Coding	% replacement	Concrete mix design proportion					
			w/c ratio	C	FA	CA	WFS	WCT
1	NC	0% replacement	0.49	1	1.73	3.66	0	0
2	FC1	10% replacement	0.49	1	1.557	3.294	0.173	0.366
3	FC2	20% replacement	0.49	1	1.384	2.928	0.346	0.732
4	FC3	30% replacement	0.49	1	1.211	2.562	0.519	1.098
5	FC4	40% replacement	0.49	1	1.038	2.196	0.692	1.464

C=Cement, FA=Fine Aggregate, CA=Coarse Aggregate, WFS=Waste Foundry Sand, WCT=waste ceramic tile

IV. EXPERIMENTAL SETUP AND RESULTS ANALYSIS

The intent of the study was to find out the strength of concrete which modified with waste ceramic tiles and waste foundry sand as partial replacement to conventional materials of concrete i.e coarse aggregates and fine aggregates resp. For this motive compressive test and flexural test were performed on standard specimens of cubes having size 150mm X 150mm X 150mm and beams having size 100mm X 100mm X 500mm at the age of 7 & 28 days respectively. Total 60 nos. of specimens were casted & tested as per IS516. Test results are listed below:

A. Compressive Strength

Compressive strength tests were performed on cube samples of size 150mm X 150mm X 150mm using compression testing machine. Three samples per batch were tested with the average strength values reported in table 6.

"Table6. Compressive Strength Test Results"

% Replacement	Designation	Average Ultimate Compressive Strength At 7 Days (N/mm2)	Average Ultimate Compressive Strength At 28 Days (N/mm2)
0%	NC	30.04	40.20
10%	FC1	25.70	36.78
20%	FC2	**29.65**	**39.12**
30%	FC3	24.25	33.46
40%	FC4	22.16	29.48

"Figur3.Compressive Strength Test set up"

B. Flexural Strength

Flexural strength tests were performed on compression testing machine using beam samples of size 100 mm X 100 mm X 500mm. Three samples per batch were tested with the average strength values reported in table 7.

"Table7. Flexural Strength Test Results"

% Replacement	Designation	Average Flexural Strength At 7 Days (N/mm2)	Average Flexural Strength At 28 Days (N/mm2)
0%	NC	2.0	3.73
10%	FC1	1.94	2.43
20%	FC2	**2.16**	**3.83**
30%	FC3	1.78	2.91
40%	FC4	1.42	2.37

"Figure4 .flexural Strength Test set up"

C. Workability

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product**.** Concrete is said to be workable when it is easily placed and compacted homogeneously i.e without bleeding or Segregation. In current research, as waste ceramic tiles have smooth surface on one side gives the advantage of less absorption of water and makes concrete more workable. To check the workability of conventional and modified concrete slump cone tests were performed. The test results are given below:

% Replacement	Designation	Water added (Lit/m^3)	w/c ratio	Slump Value (mm)	Degree of workability
0%	NC	170	0.49	20	V Low
10%	FC1	170	0.49	76	Low
20%	FC2	170	0.49	84	Medium
30%	FC3	170	0.49	96	Medium
40%	FC4	170	0.49	107	High

V. CONCLUSION

Based on above results following conclusion were made regarding properties of concrete incorporating waste foundry sand and waste ceramic tiles.

1. It was observed from comparison of conventional and modified concrete for compressive strength that, results were increasing up to 20% replacement & after that it shows reduction consistently for 30 % & 40 % replacement.
2. Results of flexural strength test by beam model shows that, increase in % replacement of WFS and WCT there is increase in flexural strength of concrete up to 20 % after that it reduces consistently.

3. From above two results it can be concluded that 20 % replacement is the optimum % replacement for fine aggregate and coarse aggregate by WFS and WCT respectively
4. Results for workability of concrete, shows positive sign. It means as % replacement increases workability of concrete also get increase. This is due to smooth surface of tiles and it absorbs less amount of water, because of this we got advantage of handling more workable concrete.
5. Last but not the least, if this modification become practical it will gives us lots of advantages like economical & eco- friendly concrete, effective usage of industrial waste & the most important, saving of natural aggregates.
6. Use of waste foundry sand in concrete reduces the production of waste through metal industries i.e. it's an eco-friendly building material.
7. It can be conclude that the waste foundry sand is good material as a alternative for the fine aggregate
8. As the waste foundry sand is cheap in cost than the natural sand and artificial sand. It also gives reduction in cost of concrete production, it will give economy.
9. The problems of disposal and maintenance cost of land filling is reduced.
10. This research leads to develop an eco-friendly and economical concrete in construction sector and innovative building material.

REFERENCES

[1] Pathariya Saraswati C, Rana Jaykrushna K, Shah Palas A, Mehta Jay G, Patel Ankit N, "Application of Waste Foundry Sand for Evolution of Low-Cost Concrete", International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013
[2] Yogesh Aggarwal a,⇑, Rafat Siddique, "Microstructure and properties of concrete using bottom ash and waste foundry sand as partial replacement of fine aggregates", Construction and Building Materials 54 (2014) 210–223
[3] Daniela Sani and Francesca Tittarelli, "Used Foundry Sand in Cement Mortars and Concrete Production" Open Waste Management Journal, 2010, 3, 18-25
[4] Rafat Siddique, Yogesh Aggarwal, Paratibha Aggarwal, El-Hadj Kadri, Rachid Bennacer, "Strength, durability, and micro-structural properties of concrete made with Used-foundry sand (UFS)", Construction and Building Materials 25 (2011) 1916–1925
[5] Gurpreet Singh, Rafat Siddiqu, "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. Merve Basar, Nuran Deveci Aksoy, "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, Rafat Siddique, "Abrasion resistance and strength properties of concrete containing waste foundry sand (WFS)", Construction and Building Materials 28 (2012) 421–426
[8] Smit m.Kacha, abhay v. Nakum, ankur Bhogayata, "Use of used foundry sand in concrete", International journal of research in engineering and technology eissn: 2319-1163 | pissn: 2321-7308Saveria Monosi,
[9] Hemanth Kumar Ch1,Ananda Ramakrishna K2, Sateesh Babu K3, Guravaiah T4, Naveen N5, Jani Sk6, "Effect of Waste Ceramic Tiles in Partial Replacement of Coarse and Fine Aggregate of Concrete, International Advanced Research Journal in Science, Engineering and Technology
[10] Punit Malik, 2Jatin Malhotra, 3Arjun Verma, 4Piyush bhardwaj , 5Akhil Dhoundiyal and 6Nitin Yadav Mix Design for Concrete with Crushed Ceramic Tiles as Coarse Aggregate
[11] IS:1918–1966 Methods Of Physical Tests For Foundry Sands
[12] IS-456 - 2000-Plain and Reinforced Concrete Code of Practice
[13] IS-516-1959 -Methods of tests for Strength of concrete.
[14] IS 2386 (Part 1, 3 & 4) - 1963, Method of testing of aggregates for concrete.
[15] IS 1199-1959 - Method of sampling and analysis of concrete.
[16] IS 7320-1974 - Specification for concrete slump test apparatus.
[17] IS 5816-1970- Method of test for split tensile strength of concrete cylinders
[18] IS 579-1959 - Method for strength of concrete.
[19] IS 10262-1982 - Recommended guidelines for mix design
[20] IS 383 – 1970 : Indian Standard "Specification for coarse and fine aggregates from naturals sources for concrete"

