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Workability study of concrete manufactured by partial replacement of river sand (fine aggregates) with ceramic waste

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Abstract — Among the waste generated in tile manufacturing industry, ceramic waste is one of the most important reasons of pollution. Ceramic powder is the waste product of many tile manufacturing companies and is responsible for environmental pollution. During summer season its effect is more serious on both agriculture products and public health. So taking this fact into consideration, utilizing this ceramic waste is the need of today. Various studies are carried out for making concrete cost effective and environment friendly by replacing conventional ingredients of concrete by greener alternatives. Replacing ceramic waste by sand is one such constructive way. As per Indian Standards various tests were carried out on M20 grade of concrete by replacing ceramic waste at 10%, 20%, 30%, 40% and 50% proportion of sand. Comparative study of slump value and its cost effectiveness as per percentage of replacement of ceramic waste is the main highlight of this paper.

Keywords— ceramic waste, environment friendly, greener elements, convectional material

I. INTRODUCTION

Construction industry is huge and plays vital role in infrastructural development of any region. Concrete is the key element and is made up of natural aggregates and binder (cement). Growth of infrastructure is very rapid and consumption of natural materials will lead to their exhaustion. On the other hand waste generation from various industries is very large and it is the need of the hour to utilise this waste.

Indian ceramic industry is very large and it produces million tons of waste every year. About 30% waste is generated of the total production. This waste is dumped into various places and there is no provision for recycling it. This waste has various properties i.e. they are hard, durable, resistant to physical, chemical and biological factors. This ceramic dust causes dust pollution and so it is necessary to find solution for this problem. Now a day, concrete technology is more interested for reusing waste material in concrete to reduce consumption of traditional ingredients. Replacement materials help in cost reduction, saving energy, reducing environmental damage and producing superior products. It is possible to use ceramic waste as partial replacement of cement or partial replacement of sand in order to achieve different properties of concrete.

II. OBJECTIVE

1. To reduce the adverse impact of ceramic waste on environment.
2. To study and compare the slump value of varying percentage of ceramic waste in concrete.
3. To check the feasibility of ceramic waste in concrete.

III. METHODOLOGY

1. Obtaining ceramic waste:

The ceramic waste required for the study was obtained from H.R. Johnson plant located near pen, raigad.

2. testing of materials obtained:

Tests such as sieve analysis, specific gravity, water absorption etc. were carried out on materials obtained.

3. Slump test :

Slump test as per varying percentage of ceramic waste in concrete were carried out and results were noted.

4. Results :

Study and evaluation of slump test results are obtained.

IV. MATERIAL TESTING

Various tests were conducted on material used in mix design. The results obtained from these results are tabulated as below.

1. Particle size distribution

Sieve analysis test results of ceramic waste.

TABLE NO. 1
PARTICLE SIZE DISTRIBUTION

Size (mm)	Wt. retained	Cumulative Wt. retained	Cumulative % retained	Cumulative % passing
4.75	0	0	0	100
2.36	360.5	360.5	36.05	63.95
1.18	189.5	550	55	45
0.5	91.6	641.6	64.16	35.84
0.3	102.2	743.8	74.38	25.62
0.15	141.2	885	88.5	11.5
Pan	75.5	959.5	95.95	0

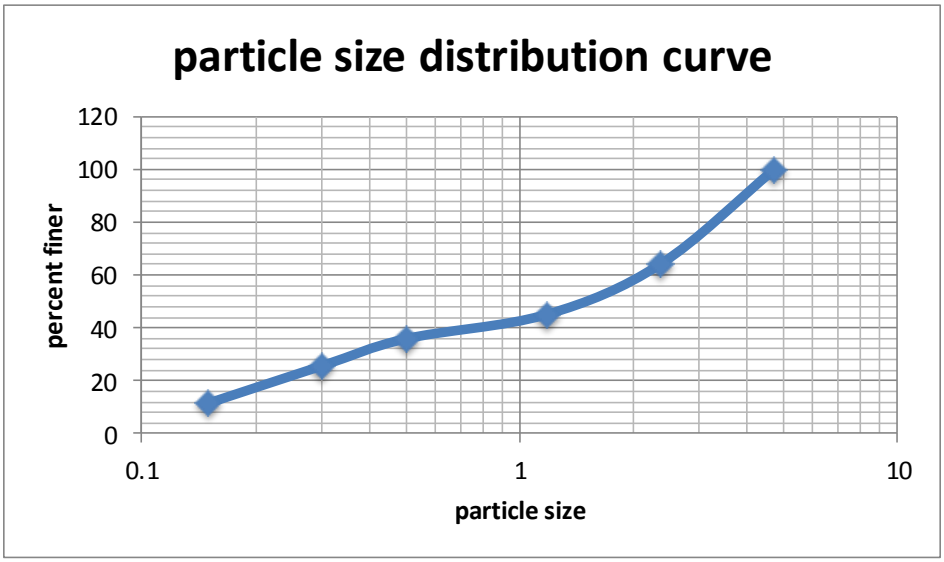

Fig .1 Particle Size Distribution Curve

The fineness modulus of ceramic waste was found to be 3.18

2. **Specific Gravity**

TABLE NO. 2
SPECIFIC GRAVITY RESULTS

Sr. No.	Observations and Calculations	Determination No.	
		Sand	Ceramic Waste
Observation			
1	Pycnometer No.	1	2
2	Room Temperature	27^0C	27^0C
3	Mass of empty Pycnometer (M_1)	633.6	633.6
4	Mass of Pycnometer and dry soil (M_2)	833.6	833.6
5	Mass of Pycnometer, soil and water (M_3)	1651.7	1633.5
6	Mass of Pycnometer and water (M_4)	1528.5	1528.5

Calculations			
7	$M_2 - M_1$	200	200
8	$M_3 - M_4$	123.2	105
9	Calculate G using formula	2.6	2.11

The specific gravity of sand and ceramic waste is determined using the relation:

$$G = \frac{M_2 - M_1}{(M_2 - M_1) - (M_3 - M_4)}$$

Where
M_1 = mass of empty Pycnometer,
M_2 = mass of the Pycnometer with dry soil,
M_3 = mass of the Pycnometer and soil and water,
M_4 = mass of Pycnometer filled with water only.
G = Specific gravity of soils.

3. Water absorption

TABLE NO. 3
WATER ABSORPTION READINGS

Description	Natural Sand			Ceramic Waste		
	I	II	III	I	II	III
W1	300	300	300	300	300	300
W2	376.8	360.8	368.2	410.4	416.5	420.6
W3	358.9	348.3	352.4	401.6	397.5	403.1
(W3-W1)/W1 X100	19.63 %	16.1%	17.46 %	33.86 %	32.5 %	34.36 %
Water Absorption	17.73%			33.57%		

Percent Water Absorption = (W3-W1)/W1X100
W1= weight of oven dried sample
W2=weight of saturated sample
W3=weight of surface dried sample

From the above results it's clear that water absorption of ceramic waste is more as compared natural sand

V. SLUMP CONE TEST

Slump test were conducted on prepared mix and results obtained are tabulated as below:

TABLE NO. 4
SLUMP VALUE RESULTS

Trial	10%	20%	30%	40%	50%
1	80	75	70	65	40
2	85	80	60	55	35
3	82	80	62	58	38
Slump	83	78	64	60	38



10% Replacement 20% Replacement 30% Replacement


40% Replacement 50% replacement

Fig.2: Slump test for various percentage of replacement

VI. COST ANALYSIS

The cost analysis is carried out by considering M 20 grade of Concrete.
For 10 cum
Dry volume = 15.4 cum

1) Cement = 15.4/5.5
= 2.8 cum
= 2.8 × 1440 kg
= 4032 kg
= 81 bags
2) Sand = 1.5 × 2.8
= 4.2 cum
3) Aggregate = 3 × 2.8
= 8.4 cum

Total Price:

1. Cement = 81 × 210 = Rs 17010
2. Sand = 1500 × 4.2 = Rs 6300
3. Aggregate = 8.4 × 750 = Rs 6300

Total = Rs 29610

As sand is partially replaced by ceramic waste, quantity of sand varies as per percentage of ceramic waste

TABLE NO 5
COST ANALYSIS

Replacement of ceramic waste (percentage)	Sand quantity required depending on percentage of replacement by ceramic waste (cu.m.)	Cost of sand (Rs)	New Total Cost (cement+ sand+ aggregate)	For 10 cu.m. Saving in cost (Original total cost – New total cost)	For 1 cu.m. Saving in cost	Total Saving in %
10 %	3.78 cu.m.	Rs 5670	Rs 28980	Rs 630	Rs 63	2.12
20 %	3.36 cu.m.	Rs 5040	Rs 28350	Rs 1260	Rs 126	4.25
30 %	2.94 cu.m.	Rs 4410	Rs 27720	Rs 1890	Rs 189	6.38
40 %	2.52 cu.m.	Rs 3780	Rs 27090	Rs 2520	Rs 252	8.51
50 %	2.10 cu.m.	Rs 3150	Rs 26460	Rs 3150	Rs 315	10.63

VI: **CONCLUSION**

The following conclusions can be derived from various tests and observations:

1. The fineness modulus of ceramic waste was found to be 3.18, as result of which it qualifies to be used as replacement of sand.
2. The water absorption of ceramic waste is more however due it's lesser specific gravity water, water addition for reduces with increment in use of ceramic waste.
3. With increment of ceramic replacement slump value decreases. At 30-40% replacement satisfactory results can be obtained
4. From cost analysis it's evident that with each increment in replacement, manufacturing of concrete becomes more economical.

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