Experimental Investigation on Partial Replacement of Waste Ceramic Powder in Concrete

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***Abstract* : Ceramic Waste is a non- biodegradable material its disposal in land up to 15% results in the soil pollution. To avoid this waste Ceramic can be used as partial replacements of cement. This study of examines the replacements of ceramic in the range of 0%, 10%, 20%, 30%, 40% and 50% by weight with M-25 grade concrete. Ceramic Waste added in crushed form .This results demonstrate in reduction of water absorption and improves durability of concrete. A total 15 samples of cubes, cylinders and beams were cast and tested for compressive strength, split tensile strength and flexural strength at 7 and 14 days of curing respectively. Ceramic waste can be used a partial replacement of cement or as a partial replacement of fine aggregate sand as a supplementary addition to achieve different properties of concrete are presented in the paper.**

Keywords : Ceramic Waste powder, Aggregate, Concrete, water, Compressive strength, Flexural strength, Split tensile strength.

I. INTRODUCTION

This research are analysis the impact and the use of ceramic powder obtained in the ceramic industry**.** The Ceramic Waste from the factories producing frequently rubbish tips and creating large piles**.** In this predicted that about **30%** of daily production of Ceramic Waste in India changes in wastage and this amount reaches to million ton per year**.** This waste in not recycled in any form at present**.** However**,** the Ceramic Waste is durable**,** hardly and highly resistant to chemical**,** biological and disposal problems**.** This properties of this materials make them a good and suitable choice to used in the concrete**.** The concrete is a versatile material mostly used in constructions industry. Mostly cement plants consume such energy and to produce a large amount of undesirable products which are affect the environment. Concrete is widely used construction material in present industry. Also the cement manufacturing industry on an average emits 7% of green house gases to earth's atmosphere which leads to global warning. In order to address these environmental affect extensive research is ongoing into the use of cement replacement using many waste materials like waste ceramic powder, plastics, fly ash and industry by products. It's possible to add ceramic in concrete by replacing either of the ingredient partially in a number of forms. Ceramic may be added in crushed form in powder form along with the addition of admixture or without addition of any of the alternate materials in the nominal concrete. It's although a portion of this waste may be utilized on site such as for excavation pit refill. The disposals of these waste materials acquire large land areas and remain scattered all waste Ceramic into the land results in the soil pollution. So to avoid these disposable problems waste Ceramic is used as partial replacements of cement. This results in reduction of water absorption and improves durability of concrete. The addition of ceramic in concrete shows improvement in the compressive strength, flexural strength and tensile strength. The principle waste coming into the ceramic industry is the ceramic powder, Specifically in the powder forms. Ceramic wastes are generated as a waste during the process of dressing and polishing. It is estimated that 15 to 30% waste are produced of total raw material.

1.1 Crushed Ceramic Waste Powder

Ceramic waste from factory producing constructions industry materials has been accumulating on frequently creating increasingly large piles. Although they are usually chemically inert the waste accumulates depending upon their size and the environment control exercised have a significant visual impact of destroys the intrinsic quality during production.

Figure 1 : Crushed ceramic powder

1.2 Scope

To make the concrete specimens by using different percentage of waste ceramic powder mixing with concrete specimens . Investigation and laboratory testing on high strength of concrete with waste ceramic powder. Analysis

the results and recommendation for further research the selected area. To analyze the effect on concrete, when cement is partially replaced by waste ceramic.

- To study on characteristics of compressive strength in concrete, properties of material.
- To the concrete mixes consisted of every 10% increment of cement replacement from 0% to 30%. To minimize the cost of concrete material.
- Present research study explores the possibility of using blast furnace slag and ceramics tiles as replacementof natural aggregate in concrete.

1.3 Economic and Environmental Advantages

To reduce for clinker production (lower energy consumption).Reduced co_2 emission and long term mechanical strength. It has stable resistance in expansion due to presence of free lime sulphate and aggregate alkali reactions. Durable resistance to the action of pure and acids water. Impermeability , reducing porosity and increasing compactness.

II. LITERATURE REVIEW

Literature review is the core of the review paper. Following are some literature review from various national and international journal on use of ceramic waste powder in concrete.

1.D.Tavakolia, A.Heidari and M.Karimianb [2012] In this paper, the optimal case of using wastage as sand are amounts of 25 to 50 percent of besides the best case of their use as coarse aggregate are as amount of 10 to 20 percent conducted by using ceramic waste powder in concrete production causes on remarkable negative effect in the properties of concrete.

2. Siva Nageswara Rao [1996] In this paper proposed two efficiency factors, first a general efficiency factor and the second factor correspond to the percentage replacement. If the efficiency factors is known, the strength of MA mixes can be determined by modifying the Bolomey [1927].

3. Amitkumar D. Raval et al [2013] have use of ceramic waste powder as a partial replacement of cement in M-20 grade concrete. In their study they used ceramic powder instead of ordinary Portland cement as a supplementary material in a proportion of 0%, 10%, 20%, 30%, 40% and 50% by weight of concrete having grade of M20. They performed a comparative study between partially replaced concrete and a comparative study between partially replaced concrete and traditional concrete and they have tested compressive strength to determine mechanical properties of both concrete at 7, 14 and 28 days after the experiment they concluded that by replacing 30% of cement by with ceramic powder they get the compressive strength 22.98 N/mm^2 and the cost of the concrete production is minimize by 12.67% in M20 grade hence it becomes more economical without reducing mechanical characteristics of concrete than the standard concrete [1].

4. Hardik patel et al. [2015] have utilize ceramic waste powder as supplementary product in cement concrete. In this research they have taken ceramic waste powder from ceramic waste powder from ceramic wall tiles industry and utilize as replacement to cement in concrete in different proportions such as 10%, 20%, 30%, 40%, 50% and 60% by weight of cement in concrete for M-25 grade and they have compared the obtained results with standard concrete. After the conduct various tests they conclude that concrete on 30% replacement strength obtained is 33.45 N/mm^2 (30% ceramic waste powder & 2% Na_2SO_4) they suggested. By using of ceramic waste powder as supplementary material in concrete cost is minimize up to 16.3% in concrete having the grade M-25 becomes cheaper with satisfying the expected mechanical properties of concrete. By following the same proportion of replacement split tensile strength of concrete mix is 3.95 and only about 1% of loss is detected with compare to standard concrete [8].

5. Bilaluddin Ahmad et al. [2016] have performed study on reuse of ceramic waste for the intensification of eco-proficient concrete. In their experiment they replace the cement by ceramic waste powder in the proportion of 15%, 20%, 25%, 30% and 35% by weight of concrete having M-20 grade. Conducted various tests on concrete mixtures after 3 and 7 days curing. They perform comparison of compressive strength between the regular concrete and the concrete having ceramic waste after 7 days. After the experiment they concluded that by replacing 30% of cement by with ceramic powder without affecting the characteristics strength of M20 grade concrete. Additional replacement of cement with ceramic waste powder declines the compressive strength of concrete [2].

III. EARTHLY PROPERTIES

Cement
Fine aggregate
Coarse aggregate
Waste ceramic powder
Water

3.1 Cement

Cement is a binding material in concrete with adhesive and strong properties and it is to an extraordinary degree fine grounded material. 43 grade ordinary Portland cement is utilized in the present examination.

3.2 Fine Aggregate

The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75mm. The fine aggregates were tested as per Indian Standard Specifications IS: 383-1970.

3.4 Ceramic Powder

The principle waste coming into the ceramic industry is the ceramic powder, Specifically in the powder forms. Ceramic wastes are generated as a waste during the process of dressing and polishing. It is estimated that 15 to 30% waste are produced of total raw

material used, and although a portion of this waste may be utilized on-site, such as for excavation pit refill, The disposals of these waste materials acquire large land areas and remain scattered all around, spoiling the aesthetic of the entire region. It is very difficult to find a use of ceramic waste produced. Ceramic waste can be used in concrete to improve its strength and other durability factors.

3.5 Water

Ordinary portable water of normally pH 7 is used mixing of concrete and curing the specimen. Water used for mixing is checked to be free from oil, acid, organic materials etc.

IV . METHODOLOGY

3.3 Coarse Aggregate

The natural broken stone (coarse aggregate)

First we conduct test on materials. Next we prepared M25 grade concrete based on mix design as per IS 10262-2009.

Used for the study of 20mm size maximum.

4.1EXPERIMENTAL INVESTIGATION

The following various performance tests are conducted in laboratory tests are as per BIS.

CEMENT

1. Specific gravity test.
2. Fineness test.
3. Initial setting time test.
4. Normal Consistency of Cement.
5. Compressive Strength Of Cement.

CERAMIC POWDER

1. Specific gravity test.
2. Fineness test.
3. Initial setting time test.

FINE AGGREGATE

1. Sieve analysis.
2. Specific gravity test.
3. Water absorption test.
4. Fineness modulus test.

COARSE AGGREGATE

1. Sieve analysis.
2. Specific gravity test.
3. Water absorption test.
4. Impact test.
5. Abrasion test.

4.2 CHEMICAL COMPOSITION

SL.NO	COMPONENTS	CEMENT (%by mass)	WASTE CERAMIC POWDER(%by mass)
1	Silica (Sio_2)	18.89	54.97
2	Alumina (Al_2O_3)	4.24	14.28
3	Iron oxide (Fe_2O_3)	3.83	4.77
4	Calcium oxide (CaO)	62.37	11.14
5	Magnesium oxide (MgO)	0.99	3.63
6	Sulphur trioxide (SO_3)	2.31	2.07
7	Sodium oxide (Na_2O)	0.12	1.27
8	Potassium oxide (K_2O)	1.14	3.08
9	Titanium oxide (TiO_2)	0.30	0.55
10	Manganese (II)oxide (MnO)	0.077	0.06
11	Phosphorus Pentoxide (P_2O_3)	0.12	0.17
12	Loss on Ignition	1.52	0.00

Table 1 : Chemical composition of ceramic powder and cement

V. RESULTS AND DISCUSSION

The results are obtained are as discussed below

5.1 FRESH CONCRETE TEST

SLUMP TEST

To determine the workability of concrete mix by slump test conducted by as per IS 1199-1959.This allows the concrete to subside and the slump shall be measured immediately by determining the difference between the height of the mould and highest point of the specimen being tested. The test results are given in the table.

SL.NO	% CONTAMINATION	SLUMP (mm)
1	0	32mm
2	5	29mm
3	10	25mm
4	15	21mm
5	20	18mm
6	30	12mm

5.2 HARDENED CONCRETE TEST

COMPRESSIVE STRENGTH TEST

It has performed on standard compression testing machine of **2000KN capacity,** as per IS :516-1959 and the casting of concrete cubes of **size 150mm x 150mm x 150mm** of compressive strength for 7days and 14 days.

TESTING OF CONCRETE CUBES

The concrete cubes after casting is allowed for 7days and 14 days curing. After curing, to determine the ultimate compressive load by using Compression Testing Machine (CTM).

From the ultimate load, the compressive strength is obtained by the following formula, **Compressive strength = Ultimate load/Area (N/mm^2)**

CERAMIC WASTE (%)	DAYS OF TESTING	COMPRESSIVE STRENGTH OF CONCRETE (N/mm^2)		
0	7	13.56	13.95	13.75
	14	19.26	19.02	18.95
10	7	14.02	14.25	14.36
	14	19.85	19.65	19.88
20	7	14.55	14.95	14.78
	14	19.88	20.55	20.75
30	7	10.55	10.35	10.12
	14	14.80	15.25	15.15

SPLIT TENSILE STRENGTH TEST

It has performed on standard compression testing machine of **2000KN capacity,** as per IS :516-1959 and the casting of concrete cylinder of **size 150mm dia and 300mm length** of split tensile strength for 7days and 14 days.

TESTING OF CYLINDER

The concrete cylinders after casting is allowed for 7days and 14 days curing. After curing, to determine the ultimate tensile load by using Compression Testing Machine (CTM). From the

SL.NO	CERAMIC WASTE%	7 DAYS OF TESTING	14DAYS OF TESTING
1	0	2.77	2.91
2	5	2.32	3.15
3	10	2.01	2.36
4	15	2.12	2.52
5	20	2.16	2.35

Split tensile strength = 2P/(πDL) (N/mm^2)

FLEXURAL STRENGTH TEST

It has performed on standard flexural testing machine of **2000KN capacity,** as per IS :516-1959 and the casting of concrete beam of **size 500mm x 100mm x 100mm** for determine flexural strength for 7days and 14 days.

TESTING OF BEAM

The concrete beams after casting is allowed for 7days and 14 days curing. After curing, to determine the ultimate flexural strength by using Flexural Testing Machine (FTM).

From the ultimate load, the flexural strength is obtained by the following formula, **Flexural strength = PL/BD^2**

SL. NO	CERAMIC WASTE %	7 DAYS OF TESTING	14 DAYS OFTESTING
1	0	7.1	7.86
2	10	6.6	6.9
3	20	5.78	6.46
4	30	5.18	5.51

VI. CONCLUSION

It was observed that the experimental investigation of using waste ceramic powder in concrete. At the test of different specimens was calculated of curing 7 days and 14 days only. Moreover the concrete containing ceramic powder economical and environment friendly as compared to the conventional concrete. So a detailed study will be undertaken in the nominal concrete with the waste ceramic powder as a partial replacement of concrete.

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