International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

USE OF CERAMIC POWDER IN THE CONSTRUCTION OF RIGID PAVEMENTS

Prakhar Sharma[1], A. Khan[2]

[1]Prakhar Sharma, B.Tech, Zakir Husain College of Engineering and Technology, Aligarh Muslim University, Aligarh, UP, India
[2]A.Khan, B.Tech, Zakir Husain College of Engineering and Technology, Aligarh Muslim University, Aligarh, UP, India

---

Abstract - *As enhancement in the lifestyle and needs of the people is increasing day by day therefore, construction and demolition demand are also increasing exorbitantly. Due to this increment, generation of construction and demolition waste, and ceramic waste obtained from the raw materials (like ceramic bricks, roof and floor tiles, stoneware etc.) has also increased. Therefore, restoring the life of this waste will not only help in regaining its actual value but also would decrease the overall cost of construction. The main aim of this paper is to examine the suitability of ceramic waste as a partial replacement of cement used in the concrete mix for the construction of rigid pavements. The experiment was carried out by replacing OPC 53-grade cement with ceramic dust passing 75µm in the range of 0%, 10%, 20% and 30% by weight for M35 grade concrete. The specimen was tested for varied ages and its various properties like compressive strength, workability, flexural strength, tensile strength, and elastic modulus were analyzed. It was observed that the properties were within the efficient and usable limit up to 30% replacement of cement with ceramic powder whereas beyond 30%, strength of the concrete gradually decreases.*(Cement, 2013; Fatima, Jhamb, & Kumar, 2013; Lakshmi, 2015)

Key Words: Construction and demolition waste, ceramic waste, partial replacement, concrete mix, strength.

1. INTRODUCTION

The demand for natural resources and fossil fuels is increasing day by day due to the upgradation in the lifestyle of the people, leading to the depletion of natural resources. Now the time has come for us to emphasize on the conservation of natural resources. Therefore, development in the field of concrete technology can play a major role in controlling the depletion of natural resources.

In India, a large part of the waste consists of construction and demolition waste, and of which dust powder generated by the tile industry (tiles, bricks, refractive and ceramic materials) comprises the most. About 100 million ton per year ceramic is produced in India from which 15-30% is produced as waste. All this waste is dumped into the landfills causing environmental and soil degradation problems. Therefore, it has the potential to be reused again after recycling as it does not contain hazardous particles and resembles pozzolanic properties (durable, hard and resistant to external degrading forces). (Fatima et al., 2013; Herrador et al., 2012; Hota & Srivastava, 2016)

2. MATERIALS USED IN EXPERIMENT

2.1. Cement (OPC)

Ordinary Portland Cement of grade 53 (Brand- Bangur cement) was used confirming to IS 12269-2013. The specific gravity of the cement used is 3.15 with the initial setting time of 90 minutes and final setting time of 212 minutes.

2.2. Ceramic powder

Ceramic powder is the major waste coming from the ceramic industry during the dressing and polishing process. During the manufacturing of ceramic material, 15%-30% of the product obtained is waste. The major constituents of ceramic powder are Al_2O_3, CaO, Fe_2O_3, MgO, K_2O, SiO_2, Na_2O.

The ceramic waste used in the experiment was collected from the Orient Bell tile factory, Sikandrabad, UP, India.

2.3. Aggregate

The coarse aggregate and fine aggregate confirming to IS 383-1970 were used and their physical properties were analyzed in Transportation Engineering lab, ZHCET, AMU by performing tests like Los Angeles Abrasion test, aggregate impact test, water absorption test, flakiness index test and elongation test (as shown in table-1).

2.4. Superplasticizer

Admixture Conplast SP430- Fosroc is used having the appearance of brown liquid with alkali content less than 72 grams and specific gravity is 1.18.

2.5. Water

Potable water is used in the concrete as it plays a major role in the chemical reaction, resulting in the strengthening of cement gel.

3. MIX PROPORTION AND EXPERIMENTAL METHODOLOGY

In this experiment, specimens were made by using ceramic waste, cement, sand, coarse aggregates, fine aggregate, potable water and admixture. The materials used in the manufacturing of specimen were used as per code IS-456:2000. The fresh ceramic waste was crushed in the form of dust or powder manually in ZHCET, AMU transportation lab. The powder formed was then passed through 0.75mm sieve and its specific gravity was analyzed and came out to be 2.64.

The methodology for concrete mix design was done by using the absolute volume method. The cement was replaced by 10%, 20%, 30% ceramic powder with the w-c ratio of 0.45. 6 specimens, each were made by using 0%, 10%, 20% and 30% ceramic powder, hence; different tests were conducted according to the physical strength of dry lean concrete (DLC) layer and pavement quality concrete (PQC) layer.

To determine the compressive strength, 24 cube samples (6 cubes each with varied content of ceramic powder) of 150mm x 150mm x 150mm were cast. After 24 hours, cubes were demoulded and kept in fresh water for curing till the cubes were tested for compression strength after 7 and 28 days. The load of 2000KN was gradually applied at the rate of 140kg/ cm^2/min till the specimen could not sustain the further load and eventually breaks down. (Cement, 2013; Kisan, Sangathan, Nehru, & Pitroda, 2009; Standards, 2000)

Slump cone test was used for the determination of workability in which mould was filled by using the flow table and was then tampered well. No harmful effects were observed until 20% replacement by ceramic powder and the maximum slump value varied between 75mm to 100mm.

To determine the split tensile strength, 24 cylindrical samples of dimension 150mm diameter and 300mm length were cast with a varied proportion of ceramic powder.

The flexural strength was determined by using the two-point loading system for a total of 24 beams of size 1000mm x 150mm x 150mm were cast with different proportions of ceramic powder (6 each). (Cement, 2013; "GUIDELINES FOR CEMENT CONCRETE MIX DESIGN," 2008; "IRC-58-2002.pdf," n.d.)

Table -1: Properties of fine aggregate and coarse aggregate

Sr. No.	Tests	Results	
		Fine Aggregate	Coarse Aggregate
1.	Los Angeles Test	17.16%	
2.	Aggregate Impact Test		20.29%
3.	Specific Gravity	2.64	2.81
4.	Water Absorption	1.21%	1.821%
5.	Bulk Density	1.655 gm/cc	1.434 gm/cc (10mm), 1.461 gm/cc (20 mm)
6.	Flakiness Index	9.38%	
7.	Elongation Index	12.58%	

Table -2: Compressive Strength

Ingredients	% of Ceramic waste dust			
	0	10	20	30
Cement (kg)	9.28	8.35	7.43	6.5
Ceramic Waste (kg)	0	0.93	1.85	2.78
Water (liter)	4.2	4.2	4.2	4.2
Sand (kg)	17.84	17.76	17.69	17.5
Coarse Aggregate (kg) (10mm)	8.36	8.28	8.24	8.16
Coarse Aggregate (kg) (20mm)	21.47	21.31	21.18	21.06
Admixtures (gms) (Conplast SP430)	24	26	27	27

Table -3: Split tensile strength

Ingredients	% of Ceramic waste dust			
	0	10	20	30
Cement (kg)	6.05	5.55	4.84	4.23
Ceramic Waste (kg)	0	0.605	1.21	1.82
Water (liter)	2.68	2.68	2.68	2.68
Sand (kg)	11.67	11.79	11.48	11.38
Coarse Aggregate (kg) (10mm)	5.44	5.50	5.35	5.31
Coarse Aggregate (kg) (20mm)	14	14.15	13.80	13.66
Admixtures (gms) (Conplast SP430)	15.5	17	17	17.5

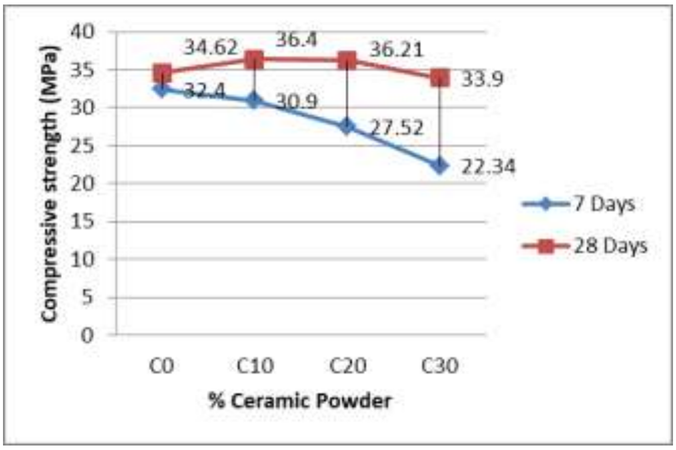
Table -4: Flexural strength

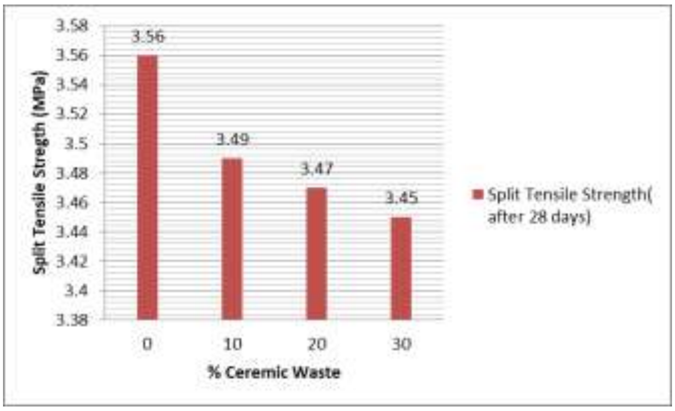
Ingredients	% of Ceramic waste dust			
	0	10	20	30
Cement (kg)	20.3	18.27	16.2	14.2

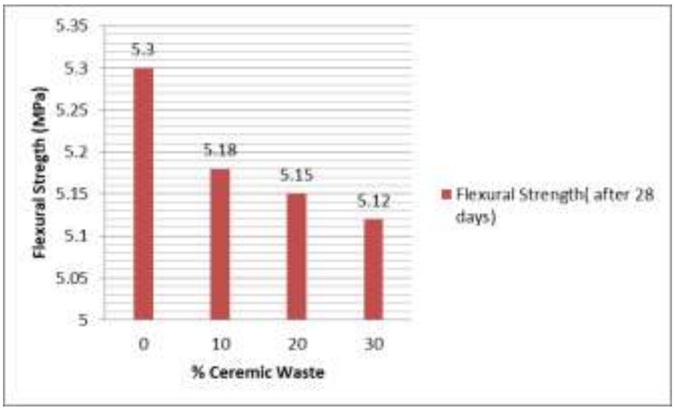
			4	1
Ceramic Waste (kg)	0	2.03	4.06	6.09
Water (liter)	9.14	9.14	9.14	9.14
Sand (kg)	39.14	38.85	38.57	38.28
Coarse Aggregate (kg) (10 mm)	18.27	18.13	18	17.87
Coarse Aggregate (kg) (20mm)	33.85	46.62	46.28	45.93
Admixtures (gms) (Conplast SP430)	51.5	55.5	57.5	57.5

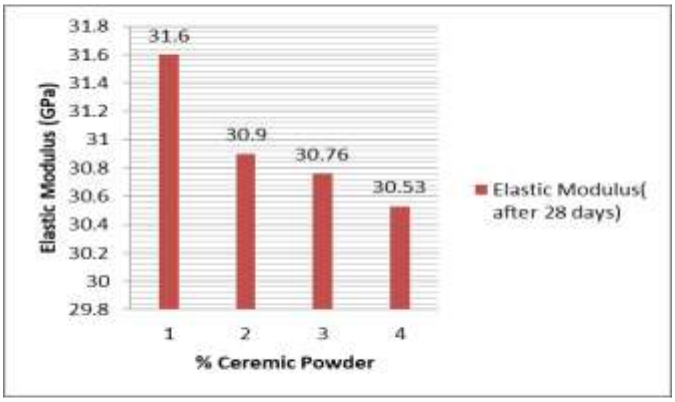
4. RESULTS AND DISCUSSION

To determine the compressive strength, split tensile strength, flexural strength and modulus of elasticity; the experimental analyzing was done by replacing cement by ceramic powder with proportions of 10%, 20%, and 30% for dry lean concrete (DLC) and pavement quality concrete (PQC). The observations were recorded at the end of 7 and 28 days (as shown in the charts below).









5. CONCLUSION

The main objective of the paper is to analyze, up to what content of ceramic waste, concrete is efficiently usable in rigid pavements. For this, we carried out various tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity for the various proportion of ceramic powder in concrete and compared them with the properties of control mix. The following observations were made based on the experimental study:

1. The compressive strength, split tensile strength and flexural strength are in the permissible limit up to 30% replacement of cement with ceramic powder i.e. it is safe to use in DLC and PQC layer.
2. The durability performance of the concrete made up of ceramic powder is increased.
3. The maximum slump value of ceramic powder concrete mix varied between 75mm to 100mm. Therefore, the workability of the concrete mix is suitable for use in rigid pavements.
4. Use of ceramic powder in concrete can be the appropriate solution that would not only be efficient for the construction industry but will also overcome the waste disposal problem making the environment more sustainable and friendly.

6. REFERENCES

[1] Cement, O. P. (2013). ORDINARY PORTLAND CEMENT , (First Revision), (March).

[2] Fatima, E., Jhamb, A., & Kumar, R. (2013). Ceramic Dust as Construction Material in Rigid Pavement, *1*(5), 112–116. https://doi.org/10.12691/ajcea-1-5-5

[3] GUIDELINES FOR CEMENT CONCRETE MIX DESIGN. (2008).

[4] Herrador, R., Pérez, P., Garach, L., Ph, D., Ordóñez, J., & Ph, D. (2012). Use of Recycled Construction and Demolition Waste Aggregate for Road Course Surfacing, *138*(FEBRUARY), 182–190. https://doi.org/10.1061/(ASCE)TE.1943-5436.0000320.

[5] Hota, S., & Srivastava, V. (2016). Partial Replacement of Fine Aggregate with Ceramic and Demolition Waste in Rigid, 15141–15151. https://doi.org/10.15680/IJIRSET.2016.0508067

[6] IRC-58- 2002.pdf. (n.d.).

[7] Kisan, M., Sangathan, S., Nehru, J., & Pitroda, S. G. (2009). म ा नक.

[8] Lakshmi, M. S. (2015). Tile powder as partial replacement of cement in concrete, 75–77.

[9] Standards, O. F. I. (2000). PLAIN AND REINFORCED CONCRETE - CODEOFPRACTICE, (July).