

Ceramic Waste: Effective Replacement of Cement For Establishing Sustainable Concrete

S.Eswar¹, V. Krishna Sai Reddy² & J. Anne Mary³

^{1,2}UG Student, Department of Civil Engineering, Veltech Dr.RR& SR University

³Assistant Professor, Department of Civil Engineering, Veltech Dr. RR& SR University
eswarsidagam7@gmail.com, kusulu2107@gmail.com, & annemary@veltechuniv.edu.in

ABSTRACT

It is most essential to develop eco-friendly concrete from ceramic waste. Ceramic waste powder is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the ceramic waste powder in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. let's see some waste materials that can be used as a building material and save our environment and earth.

KEYWORDS:- Ceramic Waste, Industrial Waste, Sustainable.

INTRODUCTION

Construction materials are essential needs for any construction industry. Sand is a major material used for preparation of mortar and concrete and plays a most important role in mix design. In general consumption of natural sand is high, due to the large use of concrete and mortar. Hence the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth. Indian ceramic production is 100 Million ton per year. In the ceramic industry, about 15%-30% waste material generated from the total production. This waste is not recycled in any format present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces. The Ceramic industries are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. This leads to serious environmental and dust pollution and occupation of a vast area of land, especially after the powder dries up so it is necessary to dispose the Ceramic waste quickly and use in the construction industry. As the ceramic waste is piling up every day, there is a pressure on ceramic industries to find a solution for its disposal. The advancement of concrete technology can reduce the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment.

EXPERIMENTAL INVESTIGATION

MATERIALS USED:-

a) Ceramic waste

The principle waste coming into 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. Ceramic waste can be used as a partial replacement of cement or as a partial replacement of fine aggregate sand as a supplementary addition to achieve different properties of concrete.

MATERIAL	Ceramic Powder (%)
SiO ₂	62.29
AL ₂ O ₃	14.55
L.O.I	1.01
Mn ₂ O ₃	0.04
CL	0.005
So ₃	0.09
K ₂ O	2.01
P ₂ O ₅	0.14
Na ₂ o	0.70

b) Coarse Aggregate

The fractions 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. The Flakiness and Elongation Index were maintained well below 15

c) Fine aggregate

Those fractions from 4.75 mm to 150microns are termed as fine aggregate. The river sand is used in combination as fine aggregate conforming to the requirements of IS: 383. The river sand is washed and screens, to eliminate deleterious materials and oversize particles.

d) Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

e) Cement (OPC)

The Ordinary Portland Cement of 53 grades conforming to IS: 8112 is used.

PHYSICAL PROPERTIES OF (OPC) CEMENT

PROPERTY	IS CODE
	IS:8112-1989
specific gravity	3.12
Consistency	33

Initial setting time	30 min
Final setting time	600 min

f) Aggregate

Aggregates are the important constituent in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is a good gradation of aggregates. Good grading implies that a sample fraction of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, higher strength, lower shrinkage and greater durability.

EXPERIMENTAL METHODOLOGY

The evaluation of ceramic waste for use as a replacement of cement material begins with the concrete testing. Concrete contains cement, water, fine aggregate, coarse aggregate and grit. With the control concrete, i.e. 10%, 20%, 30%, 40%, and 50% of the cement is replaced with ceramic waste, the data from the ceramic waste is compared with data from a standard concrete without ceramic waste. Three cube samples were cast on the mould of size 150*150*150 mm for each 1:1.80:3.84 concrete mix with partial replacement of cement with a w/c ratio as 0.52 were also cast. After about 24 h the specimens were de-moulded and water curing was continued till the respective specimens were tested after 7, 14 and 28 days for compressive strength test.

Compressive strength

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm² per min. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.80:3.84 with partial replacement of cement with Ceramic waste as 10%, 20%, 30%, 40% and 50%.

COMPRESSIVE STRENGTH OF CUBES (150X150X150) FOR M25 MIX AT 7, 14, 28 DAYS

Concrete Type	Average Compressive Strength [N/mm ²]		
	7DAYS	14DAYS	28DAYS
A0	22.55	27.55	29.44
A1	20.55	25.45	27.41
A2	20.01	23.54	25.94
A3	17.88	20.54	21.54
A4	15.87	17.85	18.75
A5	13.25	16.25	17.41

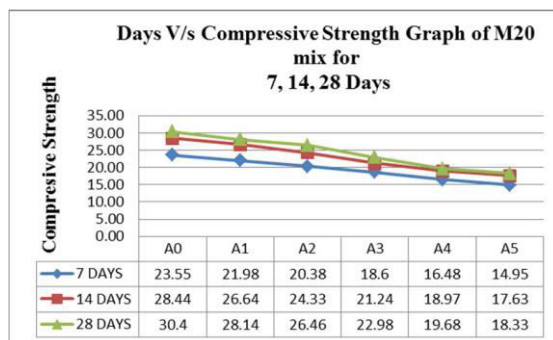


Figure: Percentage Replacement of Ceramic waste V/S Compressive Strength (N/mm²) of Concrete for M20 mix at 7, 14 and 28 day

ECONOMIC FEASABILITY COSTS OF MATERIALS

SL.NO	MATERIALS	RATE (Rs/Kg)
1.	Cement (OPC 53 grade)	6.40
2.	Fine aggregate (Regional)	0.60
3.	Coarse aggregate (Regional)	0.65
4.	Ceramic Waste	0.20

III DESIGN MIX

A mix M20 grade was designed as per Indian Standard method (IS 10262-2009) and the same was used to prepare the test samples. The design mix proportion is done

DESIGN MIX PROPORTION FOR (M20 MIX)

By weight, [kg]	W (Lit)	C (Kg/m ³)	F.A. (Kg/m ³)	C.A. (Kg/m ³) 20mm10mm	Chemical Admixture
	156.23	320.23	720.23	746.26 501.2	

W= Water, C= cement, F.A. = Fine Aggregate, C.A. = Coarse Aggregate

CONCRETE DESIGN MIX (M20 MIX) PROPORTIONS

Sl.no	Concrete type	Concrete Design Mix Proportion			
		W/C Ratio	C	F.A	C.A

		C.W				
1.	A0	0.40	1.0	1.70	3.74	-
2.	A1	0.40	0.90	1.70	3.74	0.10
3.	A2	0.40	0.80	1.70	3.74	0.20
4.	A3	0.40	0.70	1.70	3.74	0.30
5.	A4	0.40	0.60	1.70	3.74	0.40
6.	A5	0.40	0.50	1.70	3.74	0.50

EXPERIMENTAL SET UP

DESIGN MIX PROPORTION FOR VARIOUS CONCRETE

SL. NO	Concrete Type	OPC cement Replacement with Ceramic waste
1.	A0	Standard Concrete
2.	A1	10% replacement
3.	A2	20% replacement
4.	A3	30% replacement
5.	A4	40% replacement
6.	A5	50% replacement

CONCLUSION

Based on experimental investigations concerning the compressive strength of concrete, the following observations are made:

(a) The Compressive Strength of **M20 grade** Concrete increases when the replacement of Cement with Ceramic Powder up to **30% replaces** by weight of Cement and further replacement of Cement with Ceramic Powder decreases the Compressive Strength.

(b) Concrete on 30% replacement of Cement with Ceramic Powder, Compressive Strength obtained is 22.98 N/mm² and vice-versa the cost of the cement is reduced up to 12.67% in M20 grade and hence it becomes more economical without compromising concrete strength than the standard concrete. It becomes technically and economically feasible and viable.

(c) Utilization of Ceramic waste and its application are used for the development of the construction industry, Material sciences.

(d) It is the possible alternative solution of safe disposal of Ceramic waste.

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