A Study on Ceramic Waste Powder

Dr.M.Swaroopa Rani
Associate Professor, Dept. of Civil Engineering, UCEK,
JNTUK, Kakinada, E.G. Dist , A.P, 533003 India

Abstract

The ceramic industry inevitable generates wastes, irrespective of the improvements introduced in the manufacturing process. In the ceramic industry, about 15%-30% production goes as waste. These wastes pose a problem in present-day society, requiring a suitable form of management in order to achieve sustainable development.

The wastes employed is from ceramic industry which had been deemed unfit for sale due to a variety of reasons, including dimensional or mechanical defects, or defects in the firing process. The results demonstrate that the use ceramic masonry rubble as a active addition endows cement with positive characteristic as major mechanical strength and the economic advantages.

In this research study the ordinary Portland cement has been replaced by ceramic waste powder accordingly in the range of 0%, 10%, 20%, 30%, 40%, and 50% by weight for M-40 grade concrete and the compressive strength is calculated .

Keyword - *ceramic powder, compressive strength*

I. INTRODUCTION

A. Admixtures:

Definition : Admixture is defined as a material other than cement, fine aggregate, coarse aggregate and water, used as an ingredient of concrete and is added to the batch immediately before or during mixing.

These days concrete is being used for wide varieties of purpose to make it suitable in different conditions. In these conditions ordinary concrete may fail to exhibit the required quality performance or durability. In such cases, admixture is used to modify the properties of ordinary concrete so as to make it more suitable for any situation. Ceramic tile powder is one such admixture.

B. Ceramic Tile Powder:

Ceramic waste from factories producing construction 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 scant environmental control exercised, have a significant visual impact that destroys the intrinsic quality of the landscape.

Indian ceramic production is 100 Million ton per year. In ceramic industry, about 15%-30% waste material generated from the total production. This waste is not recycled in any form at present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces.

In addition to helping protect the environment, use of such waste offers a series of advantages such as a reduction in the use of other raw materials, contributing to an economy of natural resources. Moreover, reuse also offers benefits in terms of energy, primarily when the waste is from kiln industries (the ceramics industry) where highly endothermic decomposition reactions have already taken place, thus recovering the energy previously incorporated during production.

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). According to the Integrated National Plan on Waste 2008-2015, NHIW is all waste generated by industrial activity which is not classified as hazardous in Order MAM/304/2002, of the 8th February, in accordance with the European List of Waste (ELW) and identified according to the following codes:
10 Waste from thermal processes.
10 12 Waste from the manufacture of ceramic products, bricks, roof tiles and construction materials.
10 12 08 Ceramic, brick, roof tile and construction materials waste (fired).
The second source of ceramic waste is associated with construction and demolition activity, and constitutes a significant fraction of construction and demolition waste (CDW), as will be addressed in more detail below. This kind of waste is classified by the ELW according to the following codes:
17 Construction and demolition waste
17 01 Concrete, bricks, roof tiles and ceramic materials
17 01 03 Roof tiles and ceramic materials

Ceramic Powder

II. LITERATURE REVIEW

Amitkumar D. Raval, Indrajit N. Patel, Jayeshkumar Pitroda Use Of Ceramic Powder As A Partial Replacement Of Cement the OPC cement has been replaced by ceramic waste powder accordingly in the range of 0%, 10%, 20%, 30% 40%, & 50% by weight for M-25 grade concrete. The Compressive Strength of M25 grade concrete increased when the replacement of cement with ceramic waste up to 30% by weight of cement and further replacement of cement with ceramic powder the compressive strength decreased.

D. Tavakolia, A. Heidari*, b and M. Karimianb conducted by using ceramic wastage in concrete production causes no remarkable negative effect in the properties of concrete. The optimal case of using tile wastage as sand are amounts of 25 to 50 percent, besides, the best case of their use as coarse aggregate are as amounts of 10 to20 percent.

Siva Nageswara Rao (1996) proposed two efficiency factors, first, a general efficiency factor and the second factor, corresponds to the percentage replacement. If the efficiency factor is known, the strength of MA mixes can be determined by modifying the Bolomey (1927) .

R. Malathy, Kongu Engineering College, India K. Subramanian, CIT, Coimbatore, India has proposed that efficiency factor for silica fume and metakaoline at various replacement levels and conclude that the proposed method of mix proportioning combined the use of super plasticizer and cement replacing material for obtaining economical HPC mix.

III. MIX PROPORTION

The mix proportion for M 40 Grade of concrete with W/C ratio 0.40.

The mix proportion is

C : F.A : C.A

1 : 1.127 : 2.39

For all the mixes, the proportion of materials can be given in the below table.

Table 1 Mix Proportions

Material	Normal Concrete	10% ceramic powder	20% ceramic powder	30% ceramic powder	40% ceramic powder	50% ceramic powder
Cement (kg/m^3)	492.50	443.25	394	344.75	295.50	246.25
Ceramic powder (kg/m^3)	0	49.25	98.5	147.75	197	246.25
Fine aggregate (kg/m^3)	555.52	555.52	555.52	555.52	555.52	555.52
Coarse aggregate (kg/m^3)	1180.54	1180.54	1180.54	1180.54	1180.54	1180.54
Sp (conplast) % by weight of binder	0	0.6	0.6	0.6	0.6	0.6

IV. EXPERIMENTAL WORK

A. *Compression Test*

Compression test was conducted on 150mm x 150mm x 150mm cubes. Concrete specimens were removed from curing tank and cleaned. In the Compressive testing machine, the cube is placed with the cast face at right angles to that of compressive faces, then load is applied at a constant rate of 1.4 kg/cm^2 minute up to failure and the ultimate load is noted. The load is increased until the specimen fails and the maximum load is recorded. The compression test are carried out at 7, 28 and 56 days. For strength computation, the average load of three specimens was reported as the cube compressive strength.

$$Cube\ compressive\ strength = \frac{Load}{Area\ of\ crosssection}$$

Table 4.1. 7 Days Compressive Strength

S.no	Percentage Replacement	Compressive Strength N/mm^2
1	0% replacement	41.92
2	10% replacement	41.62
3	20% replacement	38.81
4	30% replacement	25.77
5	40% replacement	21.62
6	50% replacement	21.62

Figure 2 : Compression Testing Machine

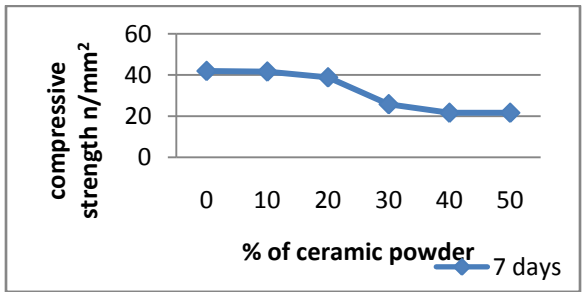
B. Compressive Strength

Total no of 54cubes were cast for the six mixes. i.e., for each mix 9 cubes were prepared. Testing of the specimens was done at 7 days, 28 days and 56 days, at the rate of three cubes for each mix on the particular day. The average value of the 3 specimens is reported as the strength at the particular age.

The compressive strength test was conducted for all the mixes and the results are shown in the tables below.

C. Compressive Strength at 7 Days

Cement is replaced 0%, 10%, 20%, 30%, 40% and 50% by Ceramic power for determining the compressive strength at 7 days. Percentage replacement of ceramic powder v/s compressive strength at 7 days has been plotted below.



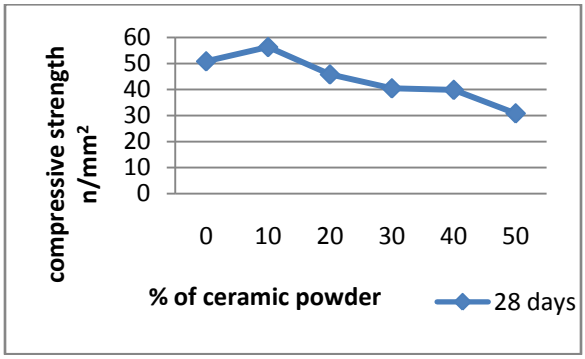
Graph 4.1: % of Ceramic Powder v/s 7 Days Compressive Strength (N/mm^2)

D. Compressive Strength at 28 Days

Ceramic power is replaced 0%, 10%, 20%, 30%, 40% and 50% as cement for determining the compressive strength at 28 days. Percentage replacement of ceramic powder v/s compressive strength at 28 days has been plotted below.

Table 4.2. 28 days Compressive Strength

S.NO	TYPE OF MIX	28 DAYS AVERAGE COMPRESSIVE STRENGTH(N/mm^2)
1	0% replacement	50.81
2	10% replacement	56.29
4	30% replacement	40.43
5	40% replacement	39.84
6	50% replacement	30.81



Graph 4.2. % of Ceramic Powder v/s 28 Days Compressive Strength (n/mm^2)

E. Compressive Strength at 56 Days

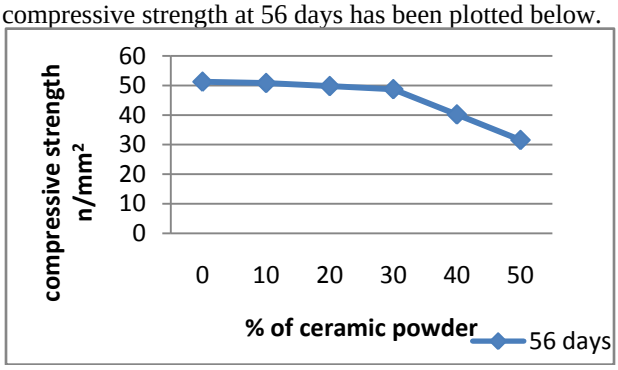
Ceramic power is replaced 0%, 10%, 20%, 30%, 40% and 50% as cement for determining the compressive strength at 56 days. Percentage replacement of ceramic powder v/s compressive strength at 56 days has been plotted below.

Table 4.3. 56 Days Average Compressive Strength

S.NO	TYPE OF MIX	56 DAYS AVERAGE COMPRESSIVE STRENGTH(N/mm^2)
1	0% replacement	51.25
2	10% replacement	50.81
3	20% replacement	49.77
4	30% replacement	48.73
5	40% replacement	40.18
6	50% replacement	31.55

F. Compressive Strength at 7Days, 28 Days and 56 Days

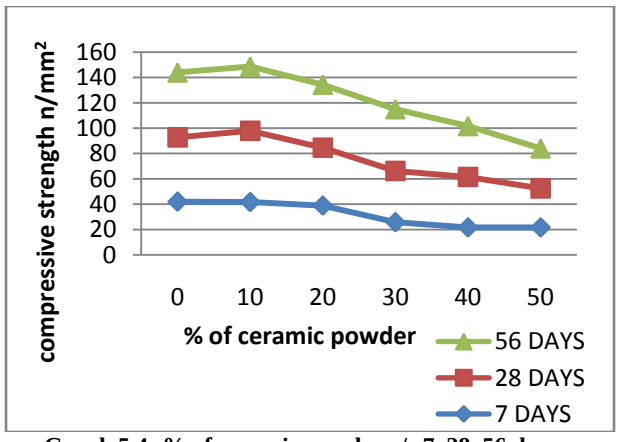
Ceramic power is replaced 0%, 10%, 20%, 30%, 40% and 50% by cement for determining the compressive strength at 7 days, 28 days and 56 days. Percentage replacement of ceramic powder v/s compressive strength at 56 days has been plotted below.



Graph 4.3: % of Ceramic Powder v/s 56 Days Compressive Strength (N/mm^2)

Table 4.4. 7 Days, 28 Days and 56 Days Compressive Strength

S.NO	TYPE OF MIX	7 DAYS	28 DAYS	56 DAYS
1	0% replacement	41.92	50.81	51.25
2	10% replacement	41.62	56.29	50.81
3	20% replacement	38.81	45.77	49.77
4	30% replacement	25.77	40.43	48.73
5	40% replacement	21.62	39.84	40.18
6	50% replacement	21.62	30.81	31.55



Graph 5.4: % of ceramic powder v/s 7, 28, 56 days compressive strength (N/mm^2)

Effect of replacement of ceramic powder as a partial replacement of cement the compression test results are shown above. It is observed that the compressive strength of concrete increases for 10% replacement with ceramic powder and the compressive strength decreases above 10% replacement from the above figures.

From the above results the percentage replacement of ceramic powder the compressive strength of concrete value will not obtained in early age, it will obtained in a lateral age. The above results 10%, 20%, 30%, 40% and 50% replacement of ceramic powder 7 days compressive strength value is low compared to 28 days compressive strength and 28 days compressive strength will be low compared to 56 days compressive strength. The compressive strength for ceramic powder showed increasing trend as the curing period was increased indicating slower pozzolanic reaction at early age. Thus, it is essential that the concrete containing ceramic powder requires prolonged curing.

From the above results finally we can conclude that 10% replacement with ceramic powder will give good compressive strength. It is observed that the compressive strength of 10% replacement of ceramic powder 28 days strength will be higher than 0% replacement. Concrete on 10% replacement of cement with ceramic waste, compressive strength obtained is 56.29 N/mm^2 and vice-versa the cost of the concrete is reduced in M40 grade and hence it becomes more economical without compromising concrete strength than the standard concrete. It becomes technically and economically feasible and viable.

CONCLUSIONS

All the experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties. These results are of great importance, from the above study, it is concluded that the ceramic tile powder can be used as a replacement material for cement upto 10%.

The following conclusions can be made from this study:

- The chemical compositions of ceramic tile powder such as SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, P_2O_5, K_2O, Na_2O, SO_3, CL, TiO_2, SrO_2, Mn_2O_3 and L.I.O are comparable with that of cement.
- The Compressive Strength of M40 grade concrete increases when the replacement of cement with ceramic waste is up to 10% by weight of cement, and further replacement of cement with ceramic powder decreases the compressive strength.

- On 10% replacement of cement with ceramic waste, compressive strength obtained is more and the cost of the concrete is reduced, hence it is more economical without compromising concrete strength. It becomes technically and economically feasible.
- Utilization of ceramic waste and its application are used for the development of the construction industry.
- By the use of waste material such as ceramic waste, usage of concrete industry's waste products is increased by 20%.

REFERENCES

[1] D. Tavakolia, A. Heidari*, b and M. Karimian Department of Civil Engineering, Najafabad Branch, Islamic Azad University, Najafabad.

[2] 2 Bolomey, J. (1927). durecissenment des Mortiers ets Benton", Tech Suisse Romande, Nos, 16 :22/24.

[3] ASTM C 125, Standard Terminology Relating to Concrete and Concrete Aggregate, 1994 Annual Book of ASTM Standards

[4] 4.Piccolroaz, D. Bigoni and A. Gajo, An elastoplastic framework for granular materials becoming cohesive through mechanical densification. Part I - small strain formulation. European Journal of Mechanics A: Solids, 2006, 25, 334-357.

[5] 5.Ceramic Manufacturing Industry, EUROPEAN COMMISSION, August 2007 [4] César Medina1, M.I.Sánchez de Rojas, Moisés Frías and Andrés Juan, "Using Ceramic Materials in Ecoefficient Concrete and Precast Concrete Products", Spain

[6] 6.Schiessl, Hardtli (1991): Efficiency of fly ash in concrete-evaluation of ibac test results, Technical report of Institute for Bauforsching, RWTH, Aachen, pp. 1 -31.

[7] 7. İ.B.Topcu And M.Canbaz, "Utilization of crushed tile as aggregate in concrete", Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 31, No. B5, pp. 561-565, 2007.

[8] 8.P.K.Mehta, Puzzolanic and cementitious by products as mineral admixtures for concrete, fly ash,

PHOTOGRAPHS

silica fuÈme, slag and other mineral byproducts in concrete, ACI SP (79)(01)(1983)

Casting of cubes

Curing Of Cubes

Testing of cubes