Assessment of Strength Charactertics in Concrete & Mortar incorporating Ceramic Waste for Cement

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***Abstract*— Ceramic waste is most commonly produced from ceramic industry, which is produced at the end of polishing and finishing of ceramic tiles. In this study is concerned with the experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing cement via 0%, 10%, 20%, & 30%, of ceramic waste in M25 grade of concrete. The various mixtures of concrete were produced & testing such as flexural strength, split tensile strength & compressive strength had done. The results were compared into conventional concrete. As a result, the strength achieved up to 20% replacing cement with ceramic powder in concrete. In this study is also concerned with another experimental investigation on strength of cement mortar and optimum percentage of the partial replacement by replacing cement via 0%, 10% & 20% of ceramic waste in CM 1:5. Mortar mixtures were produced & testing had done and compared to the conventional cement mortar. As a result, the strength achieved up to 10% replacing cement with ceramic powder in Mortar. Thus, the replacement of Cement in concrete & Mortar by ceramic wastes will have major environmental benefits.**

***Keywords*—Ceramic Powder, Mortar, Environmental,Energy savings,Cement,Waste,Industry,Compressive strength.**

I. INTRODUCTION

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 other mode. The ceramic waste is hard-wearing, strong and highly resistant to organic & degradation forces. The Ceramic industries

are discarding the powder in nearby ditch or available free areas. This leads to severe environmental and air pollution. It is essential to discard the Ceramic waste rapidly and utilize in the construction industry. The advancement of concrete technology can reduce the consumption of natural resources. They have strained to spotlight on revival, recycle of natural resources and discover different alternatives. The use of the replacement materials offer cost decline, savings in energy and less environmental hazards. In construction industry, the production of one tonne of cement generates 0.55 tonnes of chemical CO_2 and requires an additional 0.39 tonnes of CO_2 in fuel emissions, accounting for a total of 0.94 tonnes of CO_2. Therefore, the replacement of cement in concrete by ceramic wastes represents a tremendous saving of energy and has important environmental benefits.

II. Material And Test Result

A. *Ceramic waste powder*

Ceramic waste is produced from ceramic industry at the end process of polishing and finishing. This waste is collected in the form of pest and after drying and hand crushing it passing through 90 microns and replaced by cement. Specific gravity of ceramic waste powder is 3.09.

B. *Cement*

The Ordinary Portland Penna cement 53 grade conforming to IS:8112-1982 is being used. Normal consistency of cement is 31%, initial setting time 30 minutes, final setting time is 600 minutes and specific gravity is 3.16.

C. *Coarse aggregate*

The 20mm size of aggregate is used. Physical property was determined, specific gravity of coarse aggregate is 2.73.

D. *Fine aggregate*

River sand is used. It is conformed as per the IS code 383:1970, specific gravity of sand is 2.63 and fineness of modulus is 3.44.

E. *Water*

Portable water is used.

III. Experimental Methodology

A mix M25 grade of concrete is design as per the Indian Standard code 10262-2009 and design mix proportion is shown in table no.2.

TABLE I. Mix Design-M25 grade of concrete

Proportion	**Materials**			
	Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**
Weight Kg/m^3	149.7	332.71	686.69	1318.92
Ratio - 1:2.06:3.96:0.45				

TABLE II. Design mix proportion of cement mortar 1:5

Proportion C.M 1:5	**Materials**		
	Water	**Cement**	**Fine Aggregate**
Weight Kg/m^3	145	384.5	1922.5

The utilization of ceramic waste use as a replacement of cement material beings with the concrete and mortar testing. The mould size of 150mm X 150mm X 150mm and cylinder 150 mm diameter and 300 mm height is casted as per the concrete mix with a proportion of shown above table no. I. The mould size of 70.6mm X 70.6mm X 70.6 mm is casted as per the mortar mix with a proportion of shown above table no. II. M25 grade concrete casted and compressive strength & flexural strength was carried out at 7 and 28 days.CM 1:5 was casted and compressive strength was carried out at 7 and 28 days.

IV. Compressive Strength

The performance on compressive testing machine the concrete cube and mortar cube is place as shown figure no. 1 & 2 and continuous loading is applied on it, after shown first crack in mould of 150mm x 150mm x 150mm and mortar cube is 70.6mm x 70.6mm x 70.6mm its reading which is in tone is noted down,

Fig. 1. Testing of Compressive Strength of Concrete Cubes

Fig. 2. Testing of Compressive Strength of Mortar Cubes

For concrete 3 cubes were casted for each batch of A0, A1, A2 and A3. As shown in figure no. 3 up to 20% replacement it achieves the desired strength of concrete. After that the compressive strength continuous decreased with replacement of ceramic waste powder.

TABLE III. TEST RESULTS

MIX ID	AVERAGE COMPRESSIVE STRENGTH FOR CONCRETE N/mm^2		AVERAGE SPLIT TENSILE STRENGTH N/mm^2	AVERAGE FLEXURAL STRENGTH N/mm^2
	7 DAYS	28 DAYS		
CP 0	25.19	35.39	2.72	4.78
CP 1	22.95	30.18	2.34	4.7
CP 2	24.8	34.9	2.68	4.71

CP 3	19.93	24.85	1.87	2.21

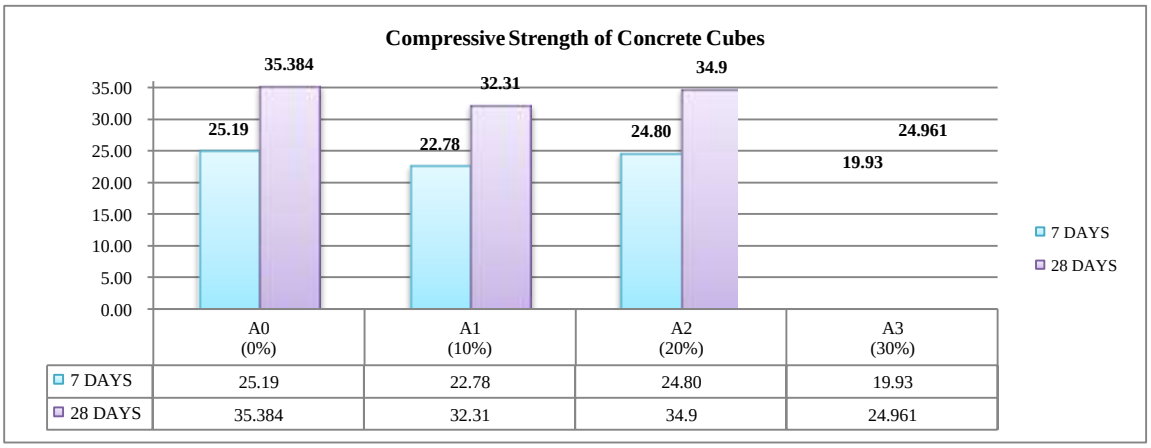

Fig. 3. Compressive strength of Concrete Cubes at 7 and 28 days

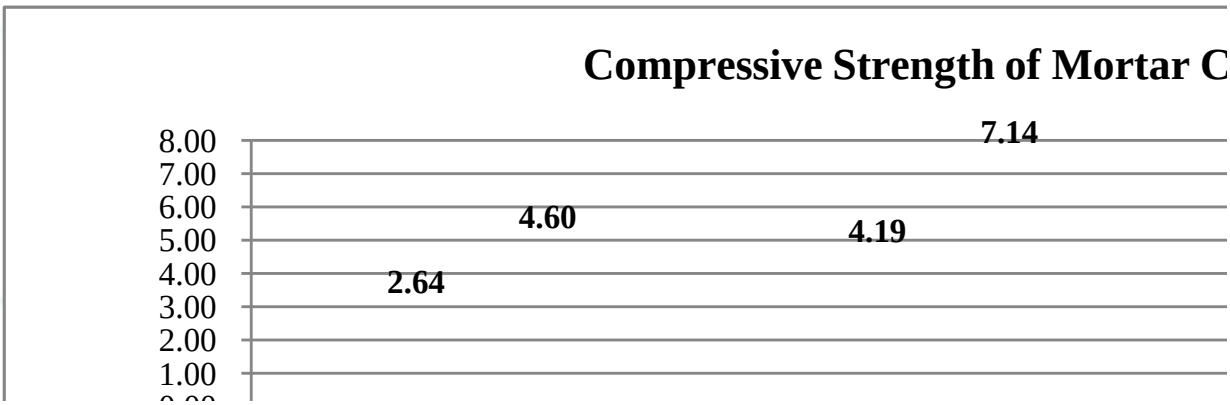

Fig. 4. Compressive strength of Mortar Cubes at 7 and 28 days

For mortar 3 cubes were casted for each batch of B0, B1, and B2. As shown in figure no.4 up to 10% replacement it achieves the desired strength of mortar. After that the compressive strength continuous decreased with replacement of ceramic waste powder.

V. Split Tensile Strength

The performance on compressive testing machine the cylinder is place as shown in figure no. 3 and continuous loading is applied on it, after shown first crack in mould of 150 mm diameter and 300 mm height

its reading which is in tone is note down, as per the equation $2P/(\pi \times D \times L)$ cylinder split tensile strength is find out.

In grade of M25 concrete 3 cylinders is casted for each batch of C0, C1, C2 and C3. As shown in figure no. 5 up to 20% replacement it achieves the desired strength of concrete cube. After that the compressive strength continuous decreased with replacement of ceramic waste powder.

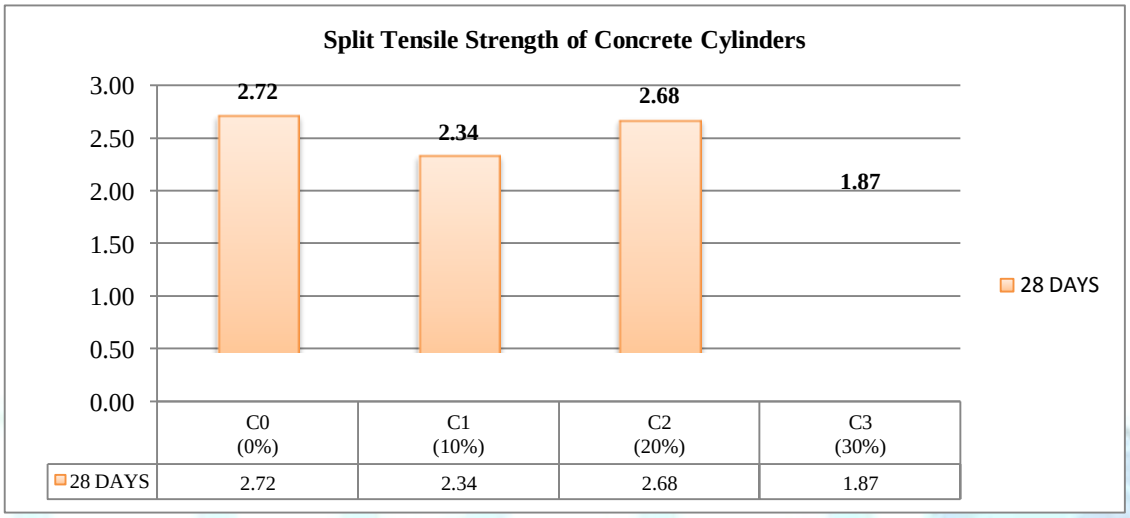

Fig. 5. Split tensile strength of Concrete Cylinders at 28 days

VI. FLEXURAL STRENGTH

Flexural Strength is giving a deflection of beam. For flexural strength size of 100mm X 100mm X 450 mm beam casted and after 28 days curing it is tested. In testing double point load is applied continuously on beam as per shown in figure no 4. As per the figure no.6 its flexural strength is decreased continuous replacement of 10% addition of ceramic waste powder.

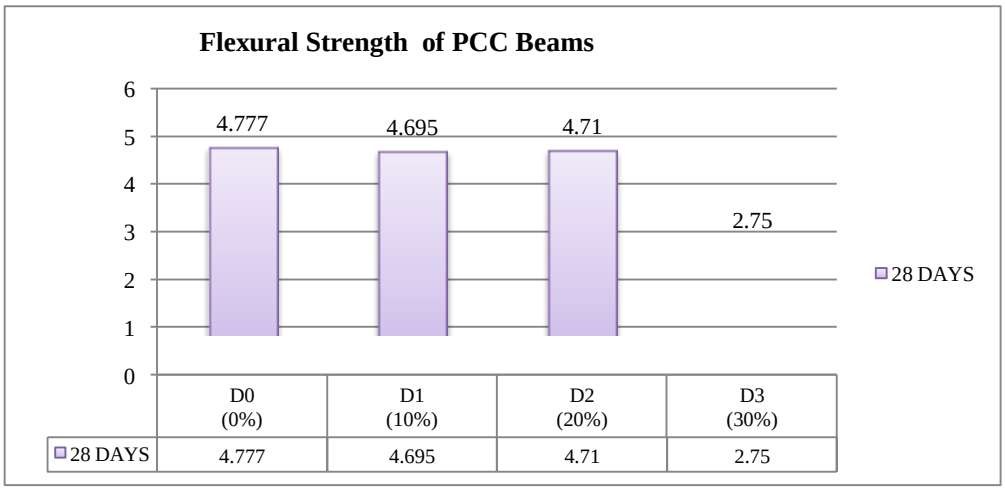

Fig. 6. Flexural Strength of Concrete Beams at 28 days

VII. Result And Analysis

A. *Effect of ceramic waste powder on compressive strength:*

Compressive strength is determined at 7 and 28 days after successful curing period. Due to high percentage of silica oxide in ceramic waste its core compressive strength is achieve at 20 % replacement of ceramic waste concrete. By more than 20% of replacement, compressive strength is decreasing, so more research on it is preferred. Mortar compressive strength is achieved at 10% replacement of ceramic waste powder. Further replacement its compressive strength is decreased.

B. *Effect of ceramic waste powder on split tensile strength:*

Split tensile strength is determined at 28 days after successful curing period. Due to high percentage of silica oxide in ceramic waste its core Split tensile strength is achieve at 20 % replacement of ceramic waste concrete. By more than 20% of replacement, Split tensile strength is decreasing, so more research on it is preferred.

C. *Effect of ceramic waste powder on flexural strength:*

Flexural strength is determined at 28 days after curing .when compared to the conventional concrete up to 20% replacement the strength is achieved desired degree.

VIII. CONCLUSION

In this project to utilize the ceramic waste as a replacement of cement in construction industry. The percentage replacement of ceramic waste varied from 0% to 30% in M25 grade concrete & 0% to 20% in cement mortar (C.M 1:5). Various tests were performed and results were examined. The Graphs were obtained for various proportions of ceramic waste. The influence of ceramic waste by replacing cement in concrete & mortar was examined and the following conclusions were derived.

- In both compressive , split tensile test & flexural strength test results it shows that when compare to conventional concrete the % replacement in concrete (10%, 20% & 30%) & its strength are reduces. But the strength is optimum at 20% replacement mutually. Thus we have to utilize ceramic waste 20% by replacing cement in M25 grade of concrete.
- From compressive strength test result, the mortar cube strength is optimum in 10% replacement mutually. Thus we have to utilize ceramic waste 10% by replacing cement in cement mortar.

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