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Experimental Study for the Effect of Utilization Ceramic Powder as Partial Replacement of Cement on the Mechanical Properties of Concrete

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Abstract : *Increasing in the industrial construction activities depending on conventional materials of concrete can lead to increased construction cost as well as scarcity of construction materials. This research was conducted aiming investigation of the changes in the mechanical properties of concrete following incorporation of different percentages of ceramic powder as partial replacement of ordinary Portland cement for compressive, split tensile strength and water absorption in comparison with conventional concrete. Experimental Results gained revealed that the concrete incorporated with low percent of ceramic powder exhibited significant elevation in compressive strength, splitting tensile strength, moreover lower water absorption at various ages compared to those of conventional concrete.*

Keywords: *Ceramic Powder, Cement, Concrete, Mechanical Properties.*

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I. Introduction

The most commonly important building material is concrete which is used worldwide in projects. Over the last years due to the increased demand for construction lead to an expensive concrete production. one of the main aims of using concrete additives in this study is to increase the compressive strength of concrete which will result in a reduction in the size of construction elements consequently reduction in the consumption of natural resources and environmental pollution.Using construction materials that are durable, economic as well as environmentally sustainable is needed by many groups worldwide for the future [1].The objective of this paper is to investigate the enhancement of conventional concrete mix. mechanical properties and the effect of using various percentages of ceramic powder while using a fixed water cement ratio of 47%.Many researchers studied the partial replacement of cement in concrete by using the waste materials like cement kiln dust, ceramic waste, rice husk, sawdust, plastic and fly ash [2,3]. All these materials are hazardous waste materials and will affect the environment [4]. Their conducted experiments have been used by replacing 10%, 20%, 30%, 40% and 50% by weight of Ordinary Portland Cement [5]. Previous researchers have shown also crushed stone dust can be used to replace the natural sand in concrete [6-7]. In the present study, the tests have been carried out for different trial mixes by partially substituting ceramic powder with cement to investigate its effect on mechanical properties with a different percentage started from 2%. The used ceramic powder contains 50% Red Clay (Bentonite), 40% Kaolin, 10% lime and a small percentage of phosphate.

II. Experimental

1. Materials used for investigation

1.1. Cement

Ordinary Portland cement is used in this investigation for all mixtures. The cement used was properly stored. The used cement has a specific gravity of 2.4, standardconsistency of 30% and its compressive strength is 17.9Mpa after 3 days, 35.5 MPa after 7 days and 45.6 MPa after 28 days.

1.2. Fine aggregates

In this laboratory investigation, we are using two fine aggregates sand and ceramic powder which will partially replace the cement in this investigation.

1.3. Sand

Sand was used as fine aggregate. The used sand is well graded and has a specific gravity of 2.61, fine modulus 2.21 and bulk density of 1.42 g/cm3 the water absorption of used sand is 1.5%.

1.4. Ceramic powder

In this study, Ceramic powder from ceramic industry before processing is used as a cement replacement and its properties is presented in Table 2.1.

2. laboratory Specimens preparation

A mixer is used for the preparation of the specimens in the laboratory. Fine aggregate and cement were mixed in their dry state to get a well-graded uniform color mixture. A fixed amount of water was added and the whole content was mixed for five minutes in the mixer.During that the molds surface were oiled and then the mixture is added in three layers using a tamping rod for poking the concrete mixture.After 24 hours all the specimens were removed from the molds and immersed in water container for curing. The curing period is 28 days after that the specimens are removed from the water to dry in the lab under normal conditions.

3. Mix proportions

In the present work, cement is replaced with ceramic powder" CP". The mix proportion of the specimens is 0%, 2%, 4%, 10%, 20% and 30% replacement are done along with fixed water cement ratio of 47%.

4. Spacemen's Tests

For each batch of concrete, three cubes of 150 mm x 150 mm x 150 mm size were tested to determine compressive strength. Three cylinders of 150 mm diameter x 300 mm height size were tested for split tensile strength. for each sample compressive strength and tensile strength has been recorded after 3, 7 and 28 days.

III. Results

In the present investigation, compressive and split tensile strength of the concrete specimens were tested. In this study, we found that the concrete compressive strength increases with the increase of the percentage of ceramic powder 2% replacement of cement but starts to decrease after that yet in the 4% the value of the compressive strength is still higher than the traditional specimens but lower that the 2%.In this study, we found that the split tensile strength of cylinders of concrete increases slightly with increase in percentage of ceramic powder 2% replacement of cement but starts to decrease after that yet in the 4% the value of the split tensile strength is still higher that the traditional specimens but lower that of the 2% replacement.

For water absorption test we used a 150 mm X 150 mm X 150 mm cube specimen after curing for 28 days. We weighted the specimens after drying in an oven for 24 hours. this weight was measured in gm this weight is noted as (W1). Then we kept the specimens in water for 24 hours and weight it again this weight noted as (W2). The used formula to calculate the percentage of water absorption is:

$$\frac{(W2 - w1)}{w1} * 100$$

Where W1= Represent weight of cube after oven drying.
W2= Represent the weight of cube after 24 hours in water.

In this study, we found that the percentage of water absorption of concrete decreases with the increase in the percentage of ceramic powder at 2% as a replacement of cement but starts to increase after that to exceed the normal percentage with no ceramic powder in the 4% replacement percentage.

IV. Result Analysis

An experimental investigation is done to determine the compressive strength, tensile strength and water absorption of concrete with ceramic powder as partial replacement of the cement.

1. Effect of ceramic powder on compressive strength

Compressive strength is determined at 3, 7 and 28 curing periods. ceramic powder increases the compressive strength at 2 % ceramic powder as a partial replacement of cement.

2. Effect of ceramic powder on tensile strength

Tensile strength is determined after 28 days from the curing period. As per the result, the tensile strength is increased with respect to the traditional concrete mix when partial replacement of cement with 2% ceramic powder. But it decreases than the traditional concrete mix after the 4% percentage.

3. Effect of ceramic powder water absorption

Water absorption is measured after 28 days from the curing period. Water absorption is decreased with respect to the traditional concrete mix when partial replacement of cement with 2% ceramic powder.

V. Figures and Tables

Property	Percentage
Red clay (Bentonite)	50%
Kaolin	40%
lime	10%
phosphate	Very small percentage

Table 2.1: Chemical composition of Ceramic powder.

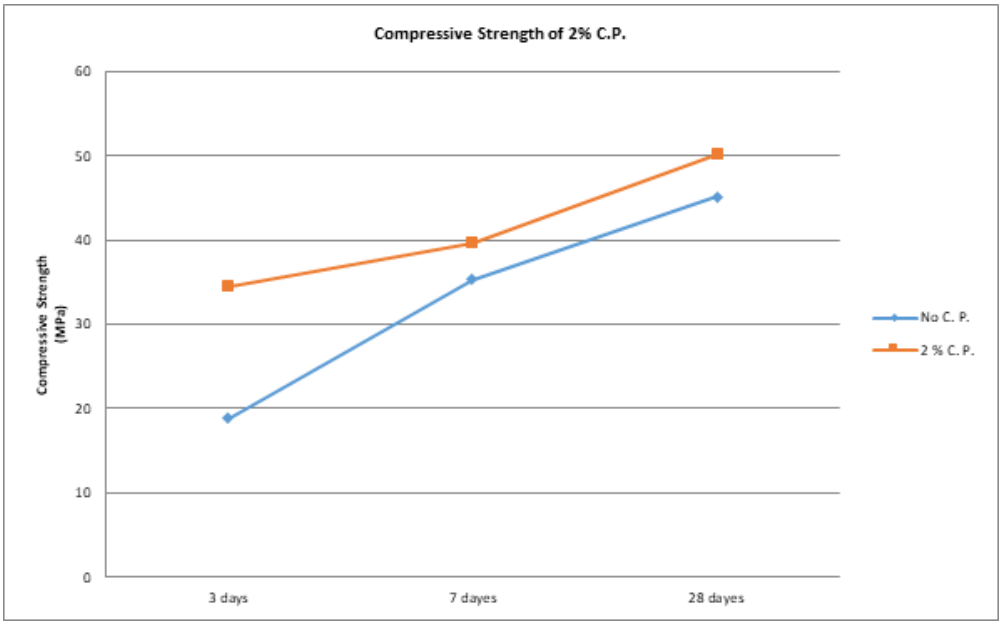

Fig. 1: Compressive Strength of cubes for 2% ceramic powder

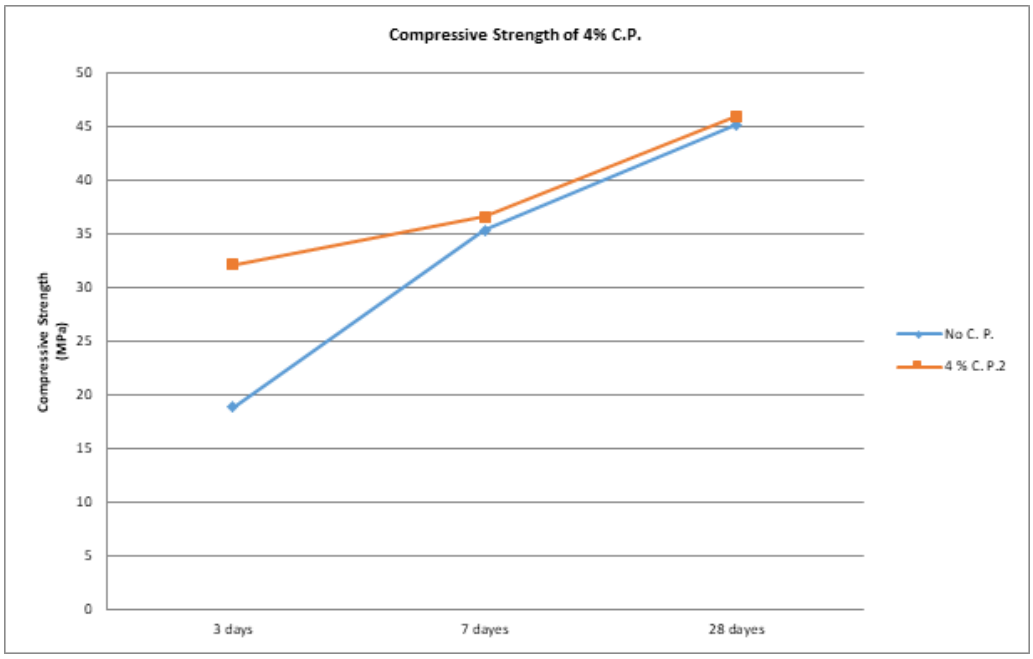

Fig. 2: Compressive Strength of cubes for 4% ceramic powder

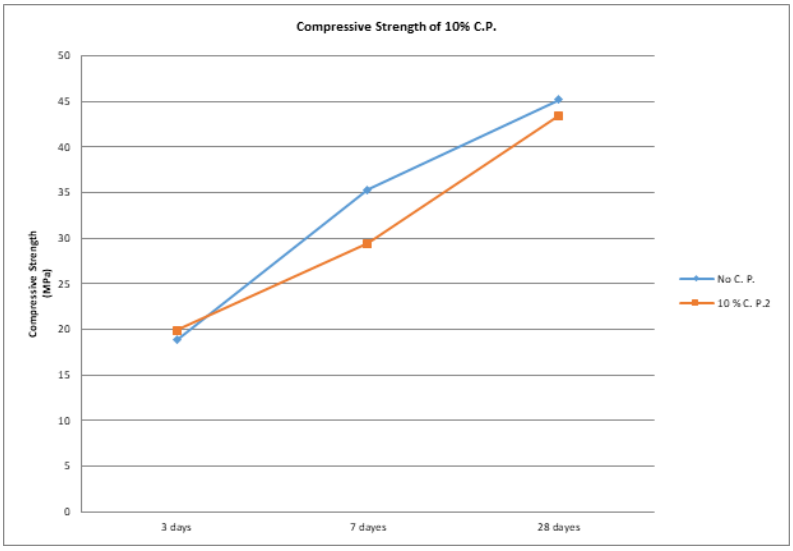

Fig. 3: Compressive Strength of cubes for 10% ceramic powder

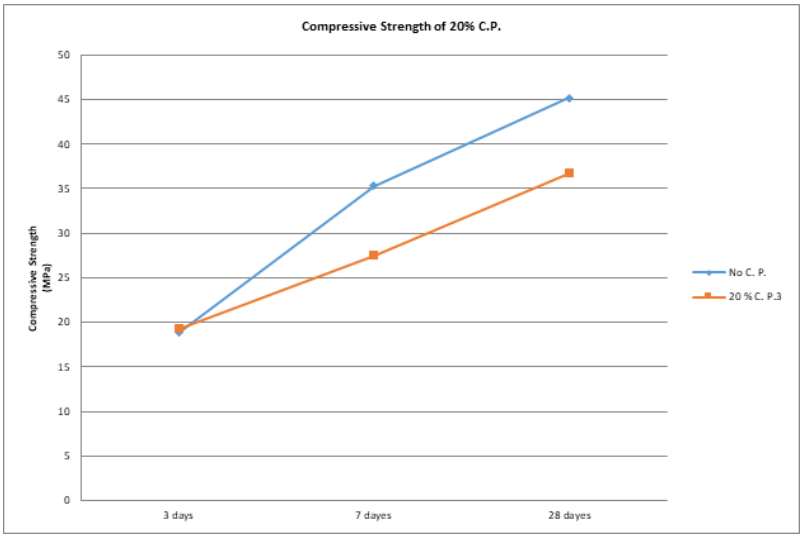

Fig. 4: Compressive Strength of cubes for 20% ceramic powder

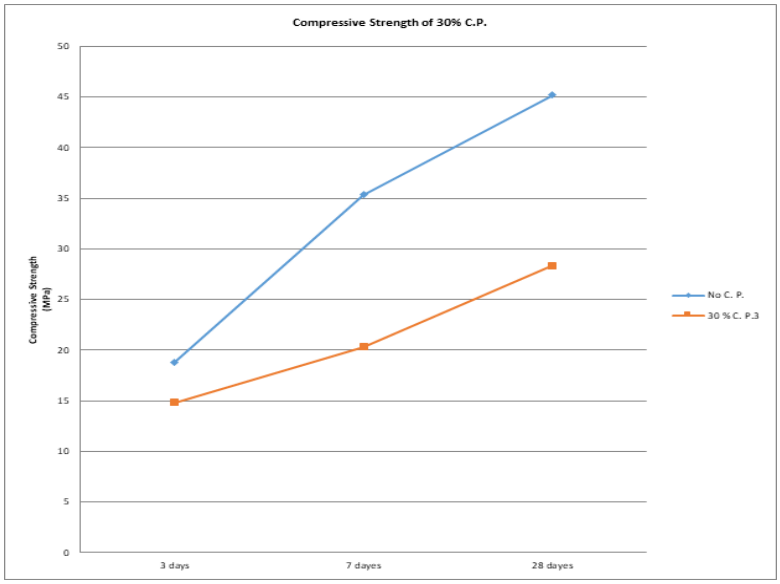

Fig. 5: Compressive Strength of cubes for 30% ceramic powder

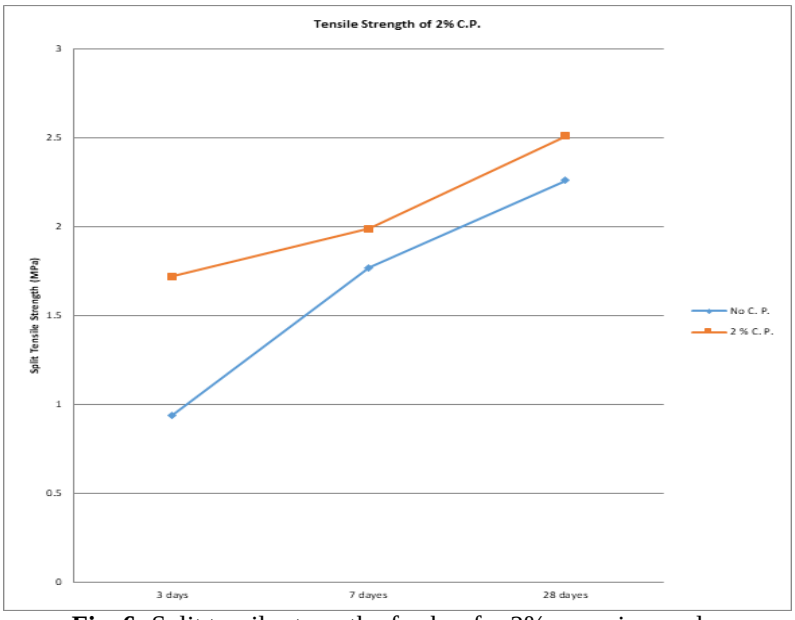

Fig. 6: Split tensile strength of cubes for 2% ceramic powder

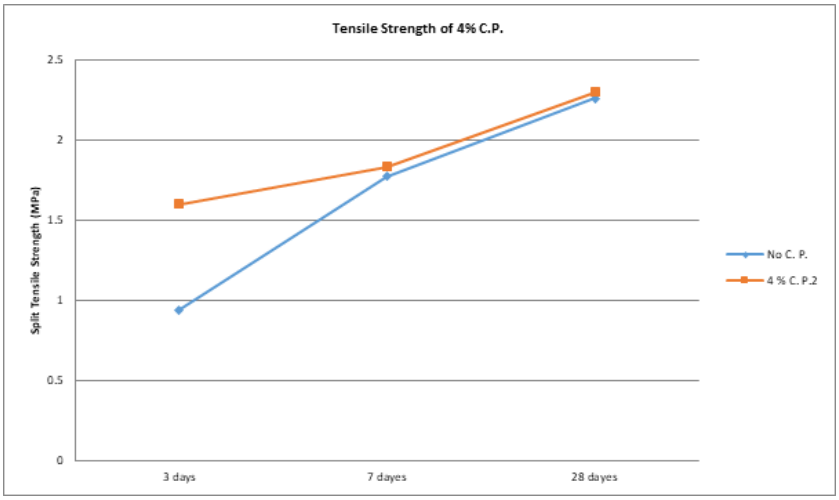

Fig. 7: Split tensile strength of cubes for 4% ceramic powder

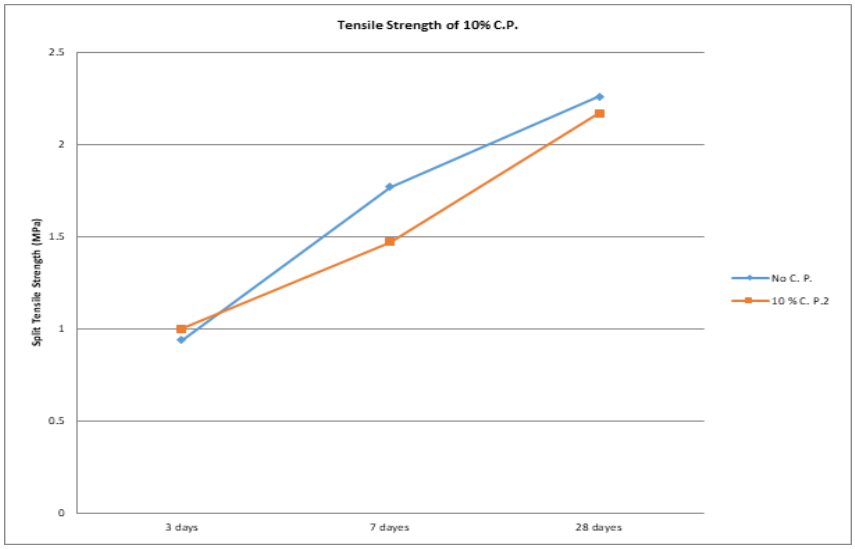

Fig.8: Split tensile strength of cubes for 10% ceramic powder

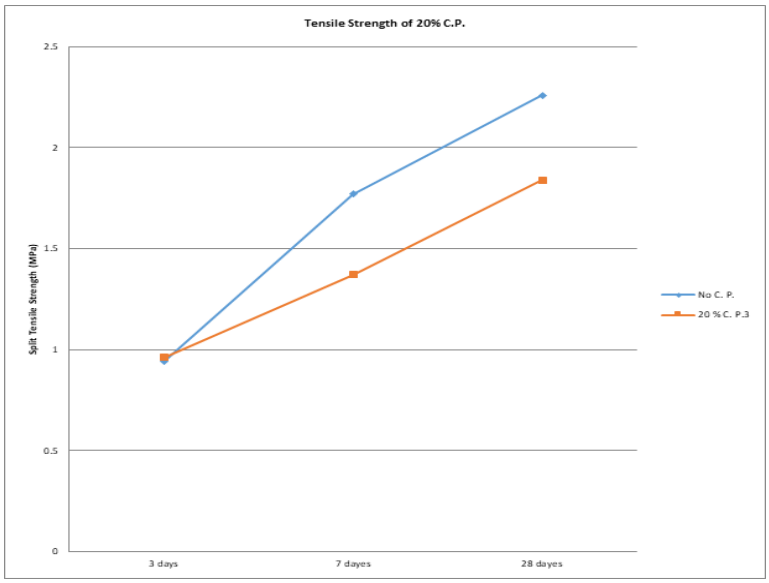

Fig.9: Split tensile strength of cubes for 20% ceramic powder

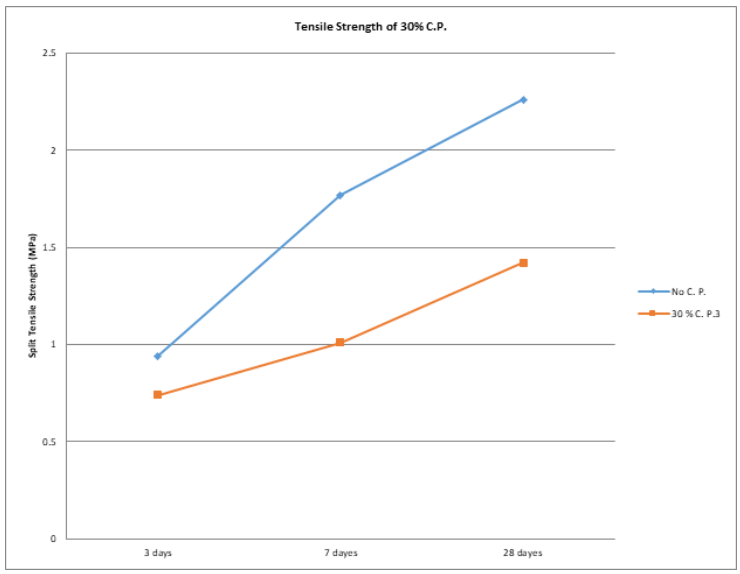

Fig. 10: Split tensile strength of cubes for 30% ceramic powder

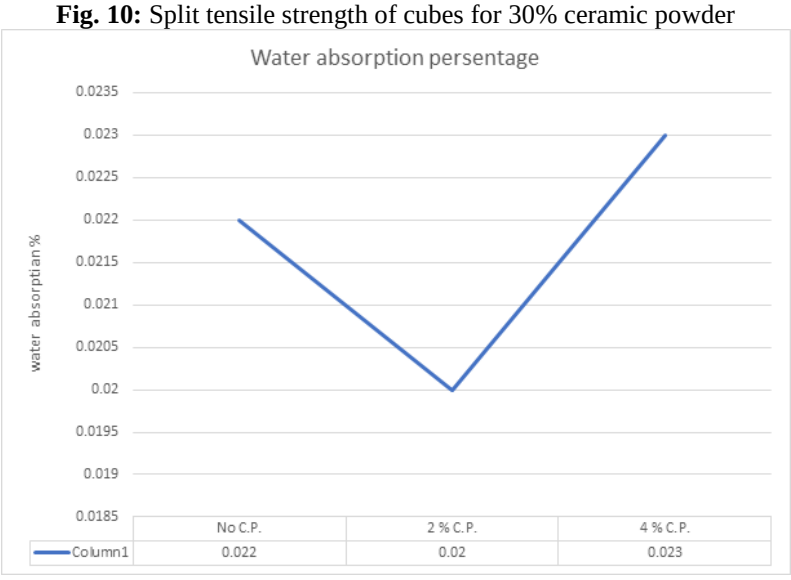

Fig. 12: percentage of water absorption with respect to the use of ceramic powder

VI. Conclusions and Recommendations

6.1. According to the results of this study, the following conclusions are made:

5.1.1. This study shows that ceramic powder can possibly be used as a partial replacement of cement to produce high strength concrete.

5.1.2. According to this study and after reviewing previously Recherche's for traditional concrete the tests indicated that tensile strength and compressive strength for partial replacement of ceramic powder with cement were higher that concrete tests at different ages.

5.1.3. Different percentages of partial replacement of cement with ceramic powder have been used in this study which indicates that the maximum compressive strength and tensile strength occurs at 2 %– 4 %.

5.1.4. The lowest water absorption percentage occur at 2% replacement of cement with ceramic powder.

6.2. Recommendations based on the conclusions from this study:

5.1.5. A finer range of replacement percentage should be tested to find the optimum percentage.

5.1.6. Further tests on the other characteristics of concrete to be made to determine the effect and influence of using ceramic powder in the concrete industry.

References

[1]. Aseel B., KadumMuttar and AynoorIbrahim,"Study the Effect of Recycled Glass on the Mechanical Properties of Green Concrete" TMREES17 ELSEVIER Press, 2017, USA.

[2]. Bhikshma, V., R. Kishore, and N. H. M. Raju. (2010). "Flexural behavior of high strength stone dust concrete," in Challenges.

[3]. Chandana Sukesh, Bala Krishna Katakam, P Saha and K. Shyam Chamberlin, "A Study of Sustainable Industrial Waste Materials as Partial Replacement of Cement", IPCSIT vol. 28 (2012) © (2012) IACSIT Press, Singapore.

[4]. Marthong. Effect of partial replacement of three grades of cement by fly ash on concrete properties M.Tech Thesis, Civil Engineering Department, Institute of Technology-BHU, 2002, Varanasi, India.

[5]. M. Safiuddin, S. N. Raman, and M. F. N Zain, "Utilization of quarry waste fine aggregate in concrete mixtures," Journal of Applied Sciences Research, vol. 3, pp. 202-208, 2007.

[6]. M. Jones and A. McCarthy, "Preliminary views on the potential of foamed concrete as a structural material," Magazine of Concrete Research, 2005, vol. 57, no. 1, pp. 21-31.

[7]. T. R. Naik and B. W. Ramme. Effects of highlime. Fly ash content on water demand, time of set and compressive strength of concrete. ACI Materials Journal, 87, 1990, pp. 619-26.

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