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Experimental Investigation on Partial Replacement of Fine Aggregate with Ceramic Waste on M25 grade Concrete

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Abstract- In India, the manufacturing sector produces a large amount of industrial waste every year and this waste generated from industries have continued to increase due to continued exploitation and use of resources. This waste consists of about a million tons of ceramic waste. India accounts for over 6% of total global production. Globally India is ranked 3rd in world in consumption. So similarly waste generation after consumption of these tiles is also of huge amount and is disposed on large area. Due to large scale construction and infrastructure development, natural sand is getting depleted from rivers quite fast. Hence, finding a substitute or an alternate material for fine aggregate is very important. So both problems dumping of broken ceramic tiles and finding an alternate to fine aggregate can be solved by using ceramic waste powder in concrete.

In the present experimental study ceramic waste powder has been used as partial replacement of fine aggregate in concrete. Ceramic waste (CW) was used as fine aggregate in the varying ratios of 10, 15 and 25% as the total weight of fine aggregate. In all, 4 mixes, i.e. CM (Control Mix), CW10%, CW15% and CW25% of M25 grade of concrete were prepared.

Keywords- Ceramic Waste, Fine Aggregate, Cement, Natural Coarse Aggregate (NCA), Split Tensile, Compressive Strength.

I. INTRODUCTION

Concrete is the most used material at the present time. Concrete consist of coarse aggregate (CA), fine aggregate (FA), cement and water according to its water-cement ratio.Waste generated from industries have continued to increase because of continued exploitation and use of resources. Which has led to cause serious problems like health illness, land pollution, air pollution etc. all over the world. Side by side giving rise to depletion of natural resources as well. One of the ways to optimize the problem is to utilize the waste generated by industries. Demolition and construction waste contribute 75% of waste worldwide. One of the waste from construction industry is ceramic waste. It is estimated that around 30% of daily production of ceramic in the ceramic industry goes to waste. A recent PWC report says ceramic tiles industry in India has grown by approx. 11% between 2013-2014 and expected to reach up to a size equivalent to Rs. 301 billion by 2016, growing at a 15% CAGR. Globally India is ranked 3rd in world. India accounts for over 6% of total global production.

In this experimental study, performance of M-25 grade ceramic waste concrete is investigated by adding ceramic waste to it.

II. OBJECTIVE

The research will cover the enhancement of physical property of concrete via partial replacement of FA by CW. The objectives of the work is to prepare different mix proportions by replacing Fine aggregate with Ceramic waste. To compare the strength parameters of Ceramic Waste Concrete samples with the parameters of conventional concrete. To compare the results of Compressive and Split Tensile strength CWC with conventional concrete.

1. To check the Workability of the conventional concrete to that of CWC.

2. To check the behavior of CWC under compression, Split Tensile Test for 7 & 28 days.

3. To investigate the effect of super plasticizer on the behavior of CWC.

4. This will explore the mechanical properties of Ceramic Waste Concrete (CWC) with partial replacement of Fine aggregate with ceramic waste in 10%, 15% and 25%.

This project is based on behavior of Ceramic waste concrete.

III. LITERATURE REVIEW

Salman Siddique et al [1] (2018) did his study on durability properties of Bone China Ceramic Fine Aggregate Concrete (BCCFA). In this BCCFA was replaced partially with fine aggregate by 0%, 20%, 40%, 60%, 80% and 100.

Salman Siddique et al [2] (2018) studied the strength and impact resistance properties of concrete containing fine bone china ceramic aggregate. In this research he examined mechanical properties and impact resistance of concrete by replacing ceramic aggregate with fine aggregate. 18 mixes

were prepared with 3 water binder ratio i.e. 0.35, 0.45 and 0.55.Replacement of fine bone china aggregate with fine aggregate was done at 0%, 20%, 40%,60%, 80% and 100%.

Salman Siddique et al [3] (2018) investigated strength and impact resistance properties of concrete containing fine bone china ceramic aggregate (BCCA). In his research he investigated mechanical properties of concrete by replacing ceramic aggregate with fine aggregate at 0%, 20%, 40%, 60%,80% and 100% in which 18 mixes were prepared with three water binder ratio i.e. 0.35, 0.45 and 0.55.

Salman Siddique et al [4] (2018) studied permeability properties of Bone China Ceramic Fine Aggregate Concrete (BCCFA). BCCFA was replaced partially with fine aggregate by 0%, 20%, 40%, 60%, 80% and 100% in which water to binder ratio was kept at 0.35 constantly.

Salman Siddique et al [5] (2017) studied the influence of ceramic waste on compressive strength of concrete. In this study, natural sand was replaced with different percentages of ceramic waste from 0, 20, 40, 60 and 100 and mixes were prepared with three water cement ratios that is 0.35, 0.45, 0.55.

G. SivaPrakash et al [6] (2016) did experimental study on partial replacement of sand by ceramic waste in concrete of M25 grade. To analyze compressive strength, he cast samples with 10%, 20%, 30%, 40 %, 50% replacement of fine aggregate using ceramic and then tested it for period of curing of 7 days, 14 days and 28 days. According to his research compressive strength was achieved upto 30% replacement of ceramic waste with sand beyond which addition of ceramic resulted in reduced strength of concrete.

Paul O. Awoyera et al [7] (2016) did an experimental study on characterization of ceramic waste aggregate concrete. The compressive strength of hardened concrete samples having CFA (Ceramic Fine Aggregate) was tested and compared with normal reference concrete at an interval of 3, 7, 14 and 28days

G. SivaPrakash et al [8] (2016) did experimental study on partial replacement of sand by ceramic waste in concrete. To investigate mechanical properties i.e. split tensile strength samples were prepared with 10%, 20%, 30%, 40%, 50% replacement of sand by ceramic waste. For all the experimental study M25 grade concrete was considered.

IV. EXPERIMENTAL WORK

Materials:

Cement: In this study, ordinary Portland cement (OPC) 53 grade is used.

Ceramic Waste: Locally available ceramic waste was used as 10%, 15% & 25% replacement of sand in this work.

Fine aggregates: Fine aggregate is from nearby vicinitywhich is obtainable river sand.

Natural coarse aggregates: Coarse aggregates used in the experimental study were 20 mm down size and tested as per IS: 2386-1963 and confirmed as per IS: 383-1970 specifications.

Water: Normal water was used in this experimental study.

Mix design

The mix proportions are by weight (1:1.91:3.1). The proportioning of concrete mix is carried out in accordance to IS 456-2000 and as per the guidelines of IS 10262:2009 (draft 2007). The process of determining an appropriate mix proportion involved a number of trials casting and testing.

Compressive Strength Test:

Compressive strength was calculated through proper procedure with the cube size being 150*150*150 mm and was cured for 7 and 28 days before testing respectively.

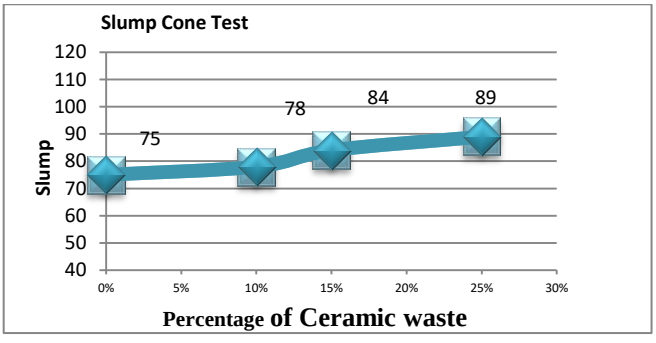
Split Tensile StrengthTest

Sampling of Concrete Cylinders:

The cylindrical mould shell is of metal, 3mm thick. The mean internal diameter of the mould is 15 cm and the height is 30 cm. Each mould is provided with a metal base plate, mould and base plate must be coated with a thin film of mould oil before use, in classify to check bond of concrete.

V. RESULTS & DISCUSSION

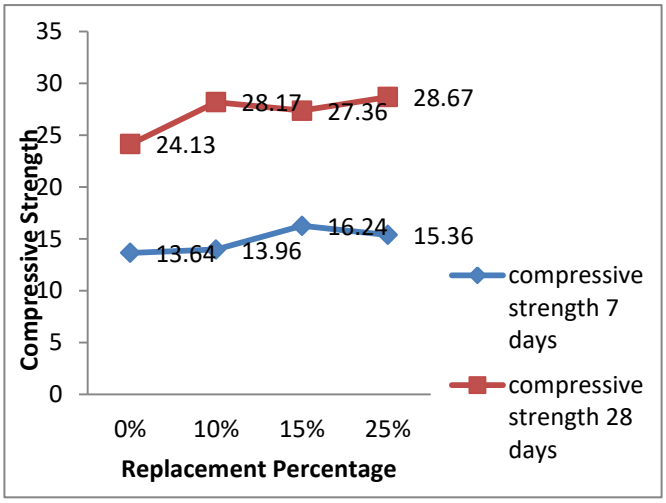
Workability Test:



COMPRESSIVE STRENGTH TEST RESULT

Variation of compressive strength with age

% of CW	0%	10%	15%	25%
7 Days	13.64	13.96	16.24	15.26
28 Days	24.13	28.17	27.36	28.67

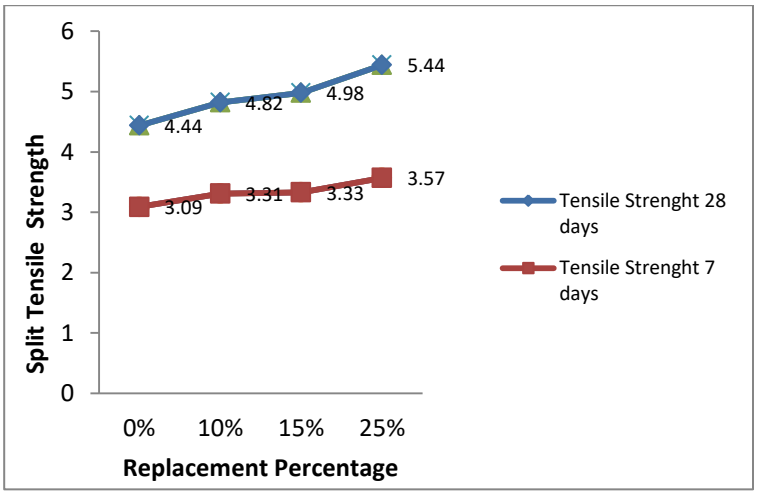


As shown in the graph: (7 days strength), when sand is partially replaced 10% by CERAMIC WASTE, compressive strength is increased by 19.9 %. 28 days strength in graph: show an increment of 26.85% of strength of 25% replacement of CERAMIC WASTE as compared with conventional concrete.

SPLIT TENSILE STRENGTH TEST RESULT

Variation of Tensile strength with age

% of CW	0%	10%	15%	25%
7 Days	2.62 MPa	2.87MPa	3.28MPa	3.33MPa
28 Days	4.70MPa	5.10MPa	5.26MPa	5.64MPa



As shown in the graph: 9 (7 days strength), when sand is partially replaced 10% by CERAMIC WASTE i.e., Split Tensile strength is increased by 38%. Afterwards when % of CERAMIC WASTE is increased the strength starts decreasing

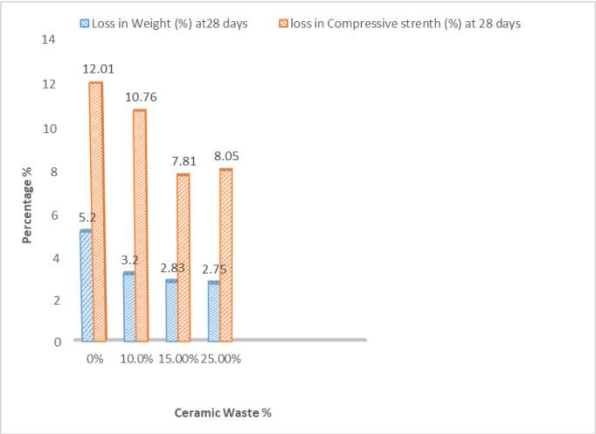
28 days strength in graph: shows an increment of 45.58% of strength of 25% replacement of CERAMIC WASTE as compared with conventional concrete. Again strength is decreased when % of CERAMIC WASTE is increased.

As discussed here, it can be said that an increment in compressive strength of 25 % replacement of CERAMIC WASTE nearly 45% is achieved as compared with conventional concrete mix.

DURABILITY TEST

Effect on ceramic waste with age

S.No.	CW %	Loss in Weight (%) At 28 Days	Loss in Compressive strength (%) At 28 days
1.	0	5.2	12.01
2.	10	3.2	10.76
3.	15	2.83	7.81
4.	25	2.75	8.05



VI. CONCLUSION

The present research study was done to examine the effect of using ceramic waste in replacement of fine aggregate on various Mechanical and Durability properties of concrete. Ceramic waste (CW) was added at 0%, 10%, 15% and 25% replacement levels of fine aggregates (river sand). The effect of this replacement on compressive, splitting tensile strength and durability properties. Decrease in the slump value was observed on increasing ceramic waste content in the concrete. Slump value was decreased from 80mm to 30 mm on replacing 25% of ceramic waste powder with fine aggregate as compared to control concrete. This may be attributed to the high water absorption characteristics of ceramic waste which decreases the availability of free water and hence affects the flow ability and decreases the workability. At both 7 and 28-days, the compressive strength was observed to increase with increase or rise in ceramic waste content in the concrete even at 25% replacement of fine aggregate. At 7 days, maximum increase was 15.30% which was at 25% replacement level and after 28 days, maximum increase was of 18.95% at 25% replacement level as compared to normal concrete. So thereafter increase in the strength was observed on increasing the content of ceramic waste. This was mainly attributed to fine particle size of ceramic waste and presence of high silica content in ceramic composition.

 The split tensile strength of concrete did not show any significant increase beyond 15% replacement level on incorporation of ceramic waste as replacement for fine aggregates. Split tensile strength values for mixes with 15% replacement level rise with 6.2% increase in strength as compared to normal concrete. This was the maximum increase which took place on 15% replacement level .Beyond this level i.e. at 25% replacement strength started decreasing. So the increase in strength up to 15% level was because the density of CW modified mixes increased in all cases due to the densification of concrete caused by pozzolanic action of ceramic waste (CW).

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