Experimental Investigation on Portland Pozzolana Cement Concrete by Partial Replacement of Fine Aggregate with Ceramic Waste and Quarry Dust

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***Abstract*- This paper presents the effect of mix proportions had been determined for M40 grade concrete as consistent with the guide traces given in IS 10626- 2009. In the present investigation fine aggregate has been replaced with unique chances of ceramic waste i.e.,via 0%.10%,15%,20%, and 25%and Quarry dust via 0%.10%,15%,20%, and 25% mixture of each substances . For examine of diverse residences, concrete specimens have been examined. Constant water-cement ratio of 0.4 has been adopted. The experimental investigation began with selection of substances and followed by means of their trying out, casting of specimens and curing eventually by means of testing of specimens.**

***Index Terms*- Ceramic waste, Quarry dust, PPC, Mechanical properties**

I. INTRODUCTION

Concrete is a composite material which is predominantly used all over the world. It is obtained by mixing cementing materials, aggregates and water in required quantities. The word concrete" is originates from the Latin verb "concretus" which means to grow together. The concrete has three basic components which are cement, fine and coarse aggregate. In these components only cement is manufactured and both fine and coarse aggregate has been obtained naturally. This has brought up with a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem. To solve both these problems use of waste materials such as concrete waste, rice husk, pond ash, quarry waste, marble waste and ceramic waste etc if are dumped in open ground is hazardous to environment. These materials have also benefits that these materials are easily available and economical. In this research ceramic waste and quarry dust are used in sand.

II MATERIALS AND METHODS

Materials

There are many types of concrete available , created by varying the proportions of the main ingredients below. In this way or by substitution for the cementitious and aggregate phases, the

Finished product can be tailored to its application with varying strength, density or chemical and thermal resistance properties.

2.1. Cement :

Portland Pozzalona cement of 53 grade manufactured by Zuari cement company confirmed IS:1489 -1 (1991) is used. The various properties of materials such as cement sand, fine aggregate, coarse aggregate, ceramic waste, & quarry dust.

Table No.1Pysical properties of materials

Materials	Properties
Cement	Specific Gravity-2.89 Normal consistency-29% Initial Setting-30 min Final Setting -5 hours
Coarse aggregate	Specific Gravity-2.6 Fineness modulus -7.86
Fine Aggregate	Specific Gravity-2.65 Fineness modulus -2.74

2.2. Fine aggregate :

Sand as high-quality aggregates are amassed from domestically available river and the sieve analysis of the samples are done. Fine combination conforms to Grading Zone -II as according to IS:383-1970.Fineness modulus of nice combination is calculated from table 3.2. IS 383-1970 values shown in table 3.3

Table No.2 Test Results on Fine Aggregate(IS 383-1970)

Properties	Results obtained	IS 383(Value)
Specific gravity	2.65	2.5-3.0
Finess modulus	2.74	2-3.5
Water absorption	0.26%	2%

Weight of fine aggregate is taken = 1000 gm

2.3. Coarse aggregate:

In the present investigation locally available crushed granite stone aggregate of size 20mm passing and retainedin 10mm IS sieve used and the various tests were carried out as per IS:383-1970 part II. The coarse aggregate used contains 50% fraction between 20mm – 12.5mm and remaining 50% fraction in between 12.5mm -10mm.Specific gravity are determined found to be 2.60.

Table No.3 Test Results on Coarse Aggregate (Is:383-1970)

Properties		Results obtained	Range
Shape Tests	Flakiness index	21.52%	<35%
	Elongation index	26.32%	<40%
Specific Gravity Tests		2.60	2.6-2.8

2.4. Water:

Ordinary potable water available locally, which is free from concentration of acid and organic substances as per IS: 456-2000, is used for all the studies and experimental investigation considered in this project.

2.5. Ceramic:

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
form at 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.

2.6.Quarry Dust :

Quarry dust has been used for different activities in the construction industry such as road construction and manufacture of building materials such as light weight aggregates, bricks, and tiles. The use of quarry dust in concrete is desirable because of its benefits such as useful disposal of byproducts, reduction of sand consumption as well as increasing the strength parameters and increasing the workability of concrete (Jain et. al., 1999). Attempts have been made to investigate some property of quarry dust and the suitability of those propertiesto enablequarry dust to be used as partial replacement material for sand in concrete.

Table No.4 Chemical Properties of Quarry Dust & Ceramic Waste

Constituents	Quarry Dust (%)	Ceramic waste (%)
SiO_2	62.48	63.29
Al_2O_3	18.72	18.29
Fe_2O_3	6.54	4.32
CaO	4.83	4.46
MgO	2.56	0.72
Na_2O	Nil	0.75
K_2O	3.18	2.18
TiO_2	1.21	0.61
Loss of ignition	0.48	1.61

III. MIX PROPORTIONING

In the present investigation M40 grade concrete mixtures were used with a constant W/C ratio 0.4. M40 grade concrete and mix design is done as per IS: 10269-2009 with the mix proportional 1:1.4:2.65. Concrete specimens were prepared varying the percentage of replacement of fine aggreagate with ceramic waste & quarry dust by 0%,10%,15%,20% and 25%.

IV. EXPERIMENTAL INVESTIGATION

4.1 Casting and curing of concrete :

IS standard cube sizes of 150 mm X 150mm X 150mm, cylinder size of 150 mm X 300 mm and beam of size 750 mm X 150mm X 150 mm were cast from each mixture to evaluate compressive strength, split tensilestrength and flexural strength. Concrete was prepared us by manual mix.

4.2 Compressive strength test :

Compression test on cube was conducted with 2000KN capacity compression testing machine available in concrete technology laboratory at AITS, Rajampet. The experimental arrangement is shown in figure no 2. The specimens were placed centrally on the base plate of the machine and the load was applied gradually at the constant rate of 140 kg/cm2/min till the specimen failed. The maximum load applied was noted for each test. The specimen results were calculated at 7days, 14days, 28days and 60days and tabulated. The cube compressive strengths of various concrete mixtures are presented in graphical form. The crushing strength is the ratio of failure load to the area of cross section of specimen.The cube compressive strength can be calculated as follows:

If fc is the cube compressive strength,

Then $f_c=\frac{P}{A}$ N/mm^2,

Where P is an ultimate load in Newtons.

A is a cross sectional area of cube =150 x150 in mm^2

Coss sectional area of cube in mm^2

Table No.5 Compressive Strength of Ceramic Waste Concrete in Mpa

Mix designation	Proportion of binding material	3 days	7 days	28days
A1	100% fine aggregate	27.3	41.2	49.5
A2	10% Ceramic + 90%F.A	27.1	42.9	46.2
A3	15% Ceramic + 85%F.A	25.7	33.5	36.3
A4	20% Ceramic+ 80%F.A	26.3	37.7	53
A5	25% Ceramic+ 75%F.A	27.5	43.1	56.8

From the table 4.1 it has been observed that the compressive strength will be maximum for 25% Ceramic waste replacement level at 3,7,28 days. Up to 25% compressive strength value is increasing. For 15% replacement level compressive strength value is decreasing at all ages of concrete. Compressive strength will be greater than the Reference concrete at 25% replacement of 3, 7, 28,days age. In this work Ceramic waste Maximum compressive strength is 56.8MPa at 28 days and least compressive strength is 21.1 MPa at 3 days. At 25% replacement of Ceramic waste concrete Compressive strengths are 27.5 Mpa,43.9 Mpa, 56.8 Mpa for 3, 7, and 28 days.At 15% replacement of Ceramic Waste concrete Compressive strengths are 25.7 Mpa,33.5 Mpa, 36.3 Mpa for 3,7, and 28 days.

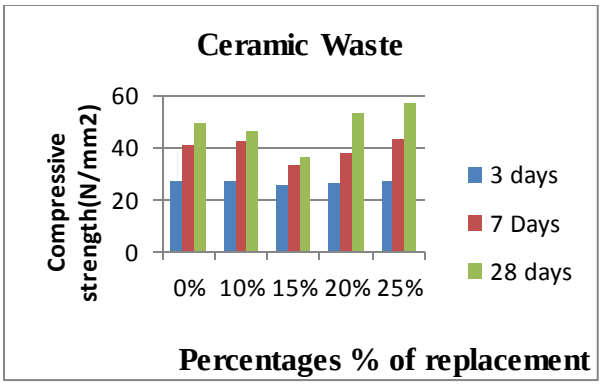

Fig .1 Compressive strength of Ceramic waste

Table No.6 Compressive Strength of Quarry Dust Concrete in Mpa

Mix designation	Proportion of binding material	3 days	7 days	28days
B1	100% fine aggregate	27.3	41.2	45.2
B2	10% Quarry dust + 90%F.A	25	30.2	41.6
B3	15% Quarry dust + 85%F.A	25.7	35.9	46.2
B4	20% Quarry dust+ 80%F.A	30.26	40.26	48.2
B5	25% Quarry dust+ 75%F.A	31.76	45.2	55.6

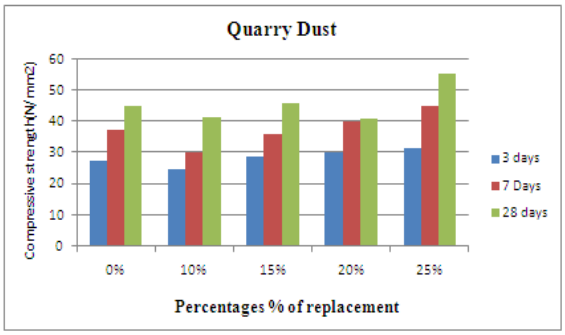

Fig .2 Compressive strength of Quarry dust

Table 6shows compressive energy can be maximum for 25% Quarry dirt substitute stage at three, 7, 28 days. Up to 25% Quarry dust compressive strength increasing after strength can be decreasing. In this graph Maximum strength is 55.6 MPa and Minimum compressive strength is 25 MPa. From the take a look at outcomes it's been discovered that the compressive strength of M40 grade concrete reaching 87.97% of strength for manage blend concrete. Horizontal axis is quarry Dust substitute and Vertical axis is Compressive strength.

4.3 Tensile Strength of Concrete

The Split tensile strength of cylinders were carried out as per Indian Standard code 5816:1999.The dimensions of cylinder is one hundred fifty mm

diameter with 300 mm long. The concrete cylinder specimen installed water for curing for three, 7, 28 days and on elimination had been tested in moisture circumstance with the aid of wiping water and grit(small sand debris) gift at the surface of cylinder specimens. The cut up tensile strength take a look at became performed through putting a cylindrical specimen horizontally inside the center of the loading surface of compression testing device and the burden can be implemented until failure of the take a look at specimen alongside the vertical diameter. The most load is carried out to the cylindrical specimen turned into then recorded. Average three values is taken for one blend. To locate the split tensile power equation three.2has used.

$$\text{Split Tensile strength} = \frac{2P}{\pi DL} \quad (4.2)$$

Where,

P=maximum load in N

L=length in mm

D=diameter in mm

Table No.7 Tensile strength of Ceramic Waste concrete in MPa

Mix designation	Proportion of binding material	3 days	7 days	28days
A1	100% fine aggregate	3.10	3.69	3.98
A2	10% Ceramic + 90%F.A	2.90	3.81	3.82
A3	15% Ceramic + 85%F.A	3.12	3.83	3.84
A4	20% Ceramic+ 80%F.A	3.20	3.94	4.15
A5	25% Ceramic+ 75%F.A	2.42	3.63	3.69

Table 7 shows Tensile Strength of Ceramic Waste concrete. At 15% Replacement of Ceramic waste concrete Tensile strengths are 2.99 Mpa, 3.94 Mpa for 3, 7 days respectively. At 10% replacement of ceramic waste concrete Tensile strengths are 2.92 Mpa,3.83 Mpa, 3.84 Mpa for 3, 7,28 days respectively .At 5% replacement of Ceramic waste concrete Tensile strengths are 2.90 Mpa, 3.81 Mpa for 3, 7 days respectively .At 20% replacement of Ceramic waste concrete Tensile strengths are 2.42 Mpa, 3.63 Mpa for 3, 7 days respectively. Reference mix tensile strengths are 3.10, 3.69 and 3.98 for 3, 7, 28 days respectively.

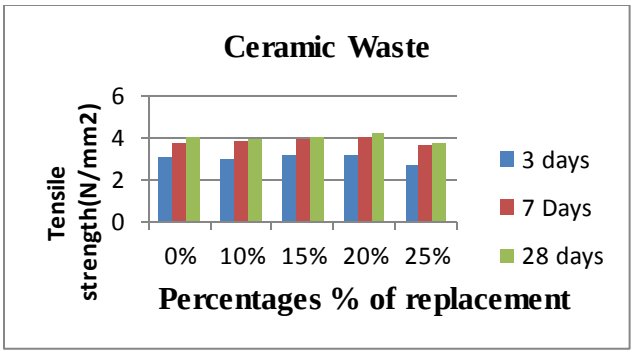

Fig .3 Tensile strength of ceramic waste concrete

From the Fig 3 it is able to be observed strength going to be improved at 10% alternative of ceramic waste is three.Eight% compared to Reference mix concrete at 7 days strength. At 7 day 6.77% increasing strength (15% ceramic waste substitute) compared to Reference concrete mix. At 28 day (15% Replacement) energy is four.2% greater in comparison Reference concrete.

Table No.8 Tensile strength of quarry dust concrete in MPa

Mix designation	Proportion of binding material	3 days	7 days	28days
B1	100% fine aggregate	3.1	3.69	3.98
B2	10% Quarry dust + 90%F.A	2.96	3.84	3.90
B3	15% Quarry dust + 85%F.A	3.11	3.96	4.02
B4	20% Quarry dust+ 80%F.A	3.12	3.99	4.23
B5	25% Quarry dust+ 75%F.A	2.72	3.65	3.69

From the table 8 it could be located that strength going to be accelerated at 5%, 10% and 15% replacement of ceramic waste is 4%, 7.Three% and eight.Thirteen% as compared to Reference mix concrete at 7 days strength.28 days Tensile Strength is 1%, 6.28% more at 10%, 15% substitute in comparison to Reference concrete.

The Tensile strength will be most for 15% quarry dust replacement degree at three, 7, 28 days. Up to 15% quarry dust substitute Tensile strength increasing after strength might be decreasing. Quarry dust concrete Tensile strength may be greater than the Reference concrete at 15% alternative. At 20% alternative Tensile strength is 3.69.Maximum Tensile strength is 4.23 at 15% replacement.

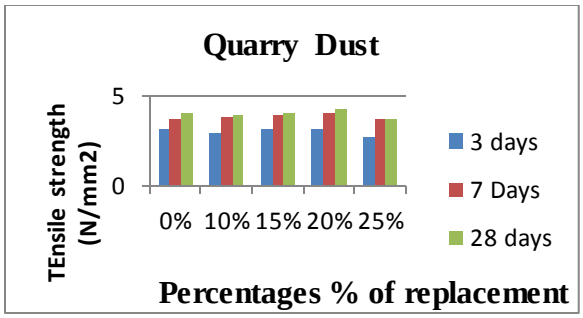

Fig .4 Tensile strength of quarry dust concrete

4.4 Flexural strength

Flexural strength take a look at was performed by using the usage of the method prescribed by using IS 516 – 1959.Beams of 700mm × 150mm × 150mm have been used for this check.The check specimen is located within the system on the bearing surfaces of the assisting and loading rollers. The load turned into carried out with out shock and improved constantly at a fee of loading of 400 kg/min for the 150mm specimens. The load turned into accelerated till the specimen failed, and the most load applied to the specimen throughout the test was recorded.

The flexural strength is calculated using the formula f = PL/Bd^2

Where P is the load in KN.

L and Bare the length and breadth in mm.

d is depth in mm.

f is the flexure strength in N/mm^2

Table No.9flexural strength of Ceramic waste concrete

Mix designation	Proportion of binding material	28days
A1	100% fine aggregate	5.1
A2	10% Ceramic + 90%F.A	6.1
A3	15% Ceramic + 85%F.A	8.25
A4	20% Ceramic+ 80%F.A	8.35
A5	25% Ceramic+ 75%F.A	4.79

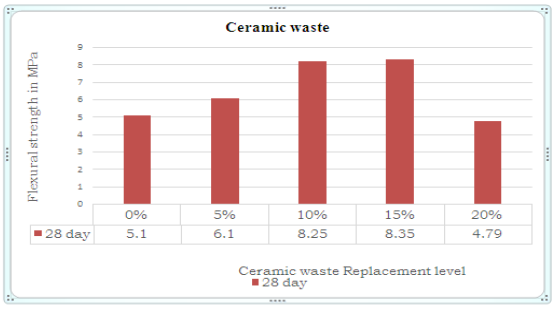

Fig .5 Flexure strength of ceramic waste concrete

From the table 5 it may be Observed Strength going to be extended step by step at 10%, 15% alternative of ceramic waste is 16%, 20% .Optimum alternative of ceramic waste for Flexural power is 20%. At 10% alternative of ceramic waste concrete Flexural strengths are 6.1 Mpa, 28 days respectively. At 15% replacement of ceramic waste concrete Flexural strengths are eight.25 Mpa for 28days respectively. At 20% replacements of ceramic waste concrete Flexural strengths are, 8.35 Mpa for 28days respectively.

Table No.10 Flexural strength of quarry dust concrete

Mix designation	Proportion of binding material	28days
B1	100% fine aggregate	5.1
B2	10% Quarry dust + 90%F.A	5.8
B3	15% Quarry dust + 85%F.A	6.4
B4	20% Quarry dust+ 80%F.A	6.49
B5	25% Quarry dust+ 75%F.A	4.89

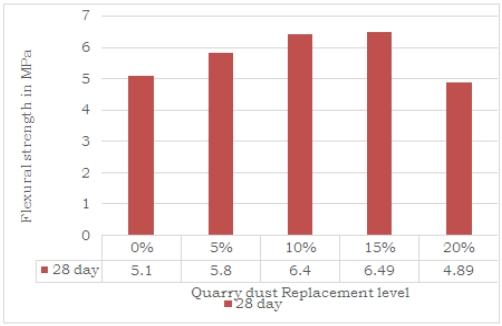

Fig 6 Flexural strength of Quarry dust concrete

From the table 6 it may be Observed Strength going to be extended step by step at 10%, 15% alternative of quarry dust is 20% .Optimum alternative of ceramic waste for Flexural strength is 20%. At 10% alternative of quarry dust concrete Flexural strengths are 6.4Mpa, 28 days respectively. At 15% replacement of quarry dust concrete Flexural strengths are 6.49Mpa for 28days respectively. At 20% replacements of quarry dust concrete Flexural strengths are, 4.89Mpa for 28days respectively..

VI. CONCLUSION

Research on the usage of waste construction materials increasing daily with the growing

population and increase in infrastructure development. Ceramic waste and Quarry dust are very clean to achieve and expenses cheaper than the quality mixture. The purpose of the present research is to determine the mechanical properties of concrete with Ceramic and quarry dust as the admixtures for M40 Grade concrete. On the idea of Experimental research of the existing studies study, the following conclusions were drawn.

1. The compressive strength, tensile strength and flexural strength of concrete increases at all ages with increase in ceramic waste replacement with fine aggregate up to 25%

a) The increase in compressive strength of concrete with 25% ceramic waste replacement in fine aggregate is 56.8% at 28 days in comparison with conventional concrete.
b) The increase in tensile strength of concrete with 20% ceramic waste replacement in fine aggregate is 4.15% at 28 days in comparison with plain concrete.
c) The increase in flexural strength of concrete with 25% ceramic waste replacement in fine aggregate is 4.79% at 28 days in comparison with conventional concrete.

Hence, it is concluded that 75% conventional fine aggregate and 25% ceramic waste is proved to be optimum.

2. The compressive strength, tensile strength and flexural strength of concrete increases at all ages with increase in quarry dust replacement with fine aggregate up to 25%.

a) The increase in compressive strength of concrete with 25% quarry dust replacement fine aggregate is55.6% at 28 days in comparison with conventional concrete.
b) The increase in tensile strength of concrete with 20% quarry dust replacement in fine aggregate is4.23% at 28 days in comparison with plain concrete.
c) The increase in flexural strength of concrete with 25% quarry dust replacement is 4.89% at 28 days in comparison with conventional concrete.

Hence, it is concluded that 75% conventional fine aggregate and 25% quarry dust is proved to be optimum.

3. In combination of both ceramic waste and quarry dust, the optimum combinations are

a) For compressive strength of concrete at 20% ceramic waste and 20% quarry dust has shown inclination of 58% at 28 days in comparison with plain concrete.
b) For tensile strength of concrete 25% ceramic waste and 25% quarry dust has shown inclination of 3.65% at 28 days in comparison with plain concrete.

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