Effect on Strength of Immersed Solution of Ceramic Waste Used In Concrete

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Abstract- *In this modern era, day by day huge development takes place in construction industries. Due to continuous construction, the natural resources become exhausted and huge amount of waste materials generated by construction and demolition. In construction, the huge consumption of natural resources and disposal of waste materials, both are causes of environmental hazards. The construction and demolition waste has reached horrible proportion therefore it required to the uses of construction and demolition waste in concrete manufacture is a necessity than an aspiration. Hence the fine aggregate can be substituted completely or partially by materials like stone dust, stone dust, adage dust, rice husk ash, ceramic waste, glass waste etc. in concrete. Ceramic waste can be used as an alternative for natural aggregate. In the present study it was intended to determine the strength characteristics of recycled aggregates for application in concrete, with ceramic aggregates as an alternative material to fine aggregate in concrete. A concrete mixes of grade M25 (1:1.58:3 with a W/C ratio of 0.45), concrete specimens at different replacement level (0%, 10%, 20%, 30%, 40%, and 50%.) of ceramic aggregate were cast and tested for workability at fresh stage and for compressive strength after 7 and 28 days curing. After that the optimum replacement level (40%) of ceramic waste aggregate, cast specimen and specimen were cured in immersed solution (5% and 10% respectively Chloride Solution) for a period of 7, 28 and 56 days. This experimental study shows that the results concluded that utilization of Ceramic waste in concrete cured in immerse solution is more effective in strength as well as economic aspects.*

Key words- Ceramic Waste, Aggregate replacement, PPC Concrete, Compressive strength, immersed solution and Durability.

I. INTRODUCTION

In recent constructions, the consumption of ceramic materials is increasing day by day in the form of tiles, sanitary fittings, electrical insulators etc. On the other hand a large quantity of ceramic materials converted into wastage during processing, transporting and fitting due to its brittle nature. Therefore, using these wastes in concrete production could be an effective measure in maintaining the environment and improving the properties of concrete. 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 reprocessed in any form at present-day. Conversely, the ceramic waste is durable, hard and highly impervious to biological, chemical, and physical degradation forces. The Ceramic industries are propelling away the powder in any nearby pit or available spaces, near their unit although informed 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 rapidly and use in the construction industry. As the ceramic waste is highly increasing day by day, there is a high pressure generated on ceramic industries to find a solution for its disposal. The advancement of concrete technology can reduce the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement waste materials offer cost decreases, energy savings, arguably greater products, and fewer hazards in the environment. Daniyal *et al.*(2015) reported that using coarse waste ceramic tile within the concrete mix lead to a substantial reduction in the workability for all the mixtures. Also, it was observed that the workability of concrete progressively decreased with the increase of quantity of waste ceramic tile content. Compressive strength of concrete gradually increased with the increase of quantity of coarse waste ceramic tile aggregate up to certain limits i.e 20% for w/c ratio of 0.4, 30% for w/c ratio of 0.5 and 40% for w/c ratio of 0.6. The greatest compressive strength was observed for C5-10 concrete. K. Ramadevi (2017)investigated that ceramic waste may be used in concrete up to 50% there by it improves the strength as well as saves the natural resources. From this results it is inferred that 50% replacement by ceramic waste gain more strength and gives better result. Beyond 50% replacement the strength decreased. The strength loss may be due to increase in consumption of water to improve workability. Amit *et al.* (2013) reported that the Utilization of Ceramic waste and its application are used for the development of the construction industry, Material sciences. It is the possible alternative solution of safe disposal of Ceramic waste. Hemanth *et al.* (2015) reported that the maximum compressive strength is obtained for the mix having 20% of tile powder. For the combinations compressive strength is increased for all mixes and maximum compressive strength obtained for the mix having 10% of crushed tiles and 20% of tiles powder. The optimum percentage of coarse aggregate that can be replaceable by crushed tiles is 10%.

II. MATERIAL AND METHODOLOGY

1) ***Cement***- In this study, Portland Pozzolana Cement (fly ash based) of (Prism Brand) single batch was used conforming to IS 1489(part I):1991 specification. Properties of PPC are as listed below in table-1.

Table-1, Properties of Portland Pozzolana cement (PPC)

Properties	Result value
Initial setting time	135 minutes
Final setting time	265 minutes
Standard consistency %	32%
Fineness(% retained on 90µ in sieve)	3.65%
Specific gravity	2.73
Soundness(Le-chatelier expansion)	0.65 mm

2) Fine Aggregate-Fine aggregate (FA) used in this experimental study was the natural river sand passing completely through 4.75 mm aperture size sieve and conforming to zone II as per IS:383-1970 specification. Its fineness modulus and specific gravity were 2.65 and 2.36 respectively and bulk density1.676 kg/liter. Particle size distribution as grading curve of the recorded sieve analysis test result for the same is shown in figure-1 with Upper and Lower Permissible limits (UPL and LPL) as per codal recommendation.

3)Coarse Aggregate-Coarse Aggregate is the stone that are retained on 20mm and 10mm sieve. Coarse aggregate are locally available quarry having two different size, one .A Combined grading of the two individual 20 mm and 10 mm Nominal size coarse aggregate (20mm CA & 10mm CA) grading was used with the ratio of these coarse aggregates as 60:40 respectively. Particle size distribution curve of the Achieved Combined coarse aggregate with these two (20 mm and 10 mm) coarse aggregate by the Recorded sieve analysis test result with permissible limits (UPL & LPL) is shown in figure 2. Properties of the Achieved Combined coarse Aggregate (CCA) of 20 mm Nominal size are shown in Table 2.

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Table-2, Properties of Coarse Aggregate (CA)

Properties		Result value
Fineness Modulus	10 mm Aggregate(10mm CA)	6.436
	20 mm Aggregate(20mm CA)	7.432
	Combined Coarse Aggregate(CCA)	6.875
Water absorption (%)		0.88
Specific gravity		2.75

4) Ceramic Waste -Ceramic tiles were obtained from building construction sites. For this Experiment a Varmora Verified tiles was used. Its bulk density and water absorption were 2.35 gm/cc and 0.08% respectively.

5) ***Super Plasticizer***– Sulphonated naphthalene formaldehyde (SNF) based Super plasticizer (KEM SUPLAST 101 S) of Chembond chemicals was used which conforms to IS:9103-1999 specifications. It was in liquid form compatible with the used Cement, brown in colour having specific gravity 1.25 and It showed good deflocculation and dispersion with cement particles to enhance the workability of concrete mix.

6) Mix Design of the Referral Concrete **–**M-25 grade of concrete conforming to IS:10262-2009 guidelines was designed as the referral concrete with the mix proportion of (1:1.58:3)and water-cement ratio(W/C) of 0.45 by weight taking with 0.6% super plasticizer dose by weight of cement.

7) Water **–**Potable water was used for mixing the concrete mix in entire investigation and for curing the concrete in the determination of the optimal percentage of stone dust as fine aggregate replacement.

III. EXPERIMENTAL DESIGN

The cubes were cast in steel moulds of inner dimensions of 150 x 150 x 150 mm, all the materials are weighed as per mix proportion of 1:1.58:3 with a W/C ratio of 0.45 which correspond to M25 grade of concrete. Fine aggregate is replaced by ceramic waste. Each mix comprises of various percentages of fine aggregate replacement material in increasing order i.e. 10%, 20%, 30%, 40%, and 50%. The specimens were cured in tap water for a period of 7 and 28 days. After that the optimum replacement level of ceramic waste aggregate, cast specimen and specimen were cured in immersed solution (5% and 10% respectively Chloride Solution) for a period of 7, 28 and 56 days.

IV. RESULT AND DISCUSSION

A) Workability- Workability is property of concrete which determine ease in mixing, placing and compaction of concrete. The results of workability in terms of slump for concrete made using ceramic waste as fine aggregate replacement are shown in Table -3. The same results are given in figure -1, for visual observation and having the idea about variation pattern. It was observed that at constant dose of Super plasticizer (0.6%), workability of concrete made using ceramic waste as fine aggregate replacement was decreased with increasing replacement level. This decrement was due to the increasing content of ceramic waste with is hydrophobic in nature. Resulting is more availability of water as compare to conventional concrete.

Table 3 – Variation of Slump at different replacement levels (%) of Fine aggregate

S.No.	Specimen Designation	Replacement level (%)	Slump (mm)
1	C0	0	105
2	C1	10	95
3	C2	20	80
4	C3	30	72
5	C4	40	65
6	C5	50	48

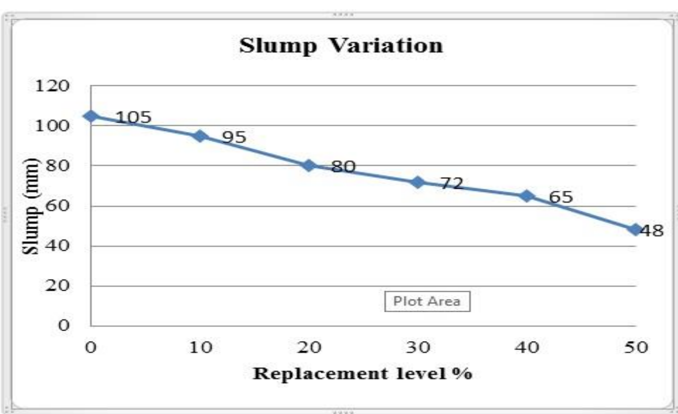

Figure.1 Variation of Slump at different replacement levels

B) Compressive Strength:- Compressive strength of the concrete cube specimen was calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area. The average of three values of compressive strength was taken as the representative compressive strength. In test, cube specimen was placed in the CTM machine in such manner that the load was applied to the opposite sides of the concrete cube as cast, that is, not to the top and bottom as per IS: 516-2004 specification. Result of compressive strength of specimens cast for different replacement levels of fine aggregate with stone dust in Portland Pozzolana Cement (PPC) concrete, and a constant dose of super plasticizer are discussed here in after. The average compressive strength of concrete for 7 days and 28 days were tested as per IS 516 – 2004 guidelines and results are tabulated in table-4 and its graphical representation on figure-2 (line chart).

Table4 -Compressive strength of ceramic aggregate concrete at different replacement level

S.No.	Specimen Designation	Replacement level (%)	Compressive strength(N/mm²)	
			7Days	28 Days
1	C0	0	24.64	32.25
2	C1	10	24.96	36.80
3	C2	20	26.38	38.10
4	C3	30	27.70	38.92
5	C4	40	26.86	41.65
6	C5	50	24.84	33.42

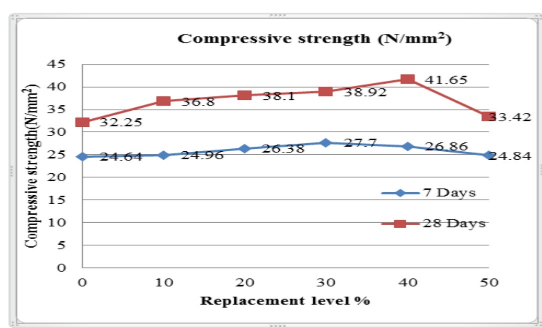

Figure.2 Compressive strength of ceramic aggregate concrete

C) Durability- Durability of concrete made using ceramic waste (at optimum replacement level) was determine in tap water, 5%,10% chloride solution and this results were compared with the results of similar referral conventional concrete. The results of durability are shown in table 4 and table 5 and figure 6 and figure 7. It is evident that compressive strength of concrete increased in chloride environment as compared to the specimens cured in tap water at 56 days. However compressive strength of specimen made using ceramic waste and cured in chloride environment was more than that of specimens of referral PPC cured in tap water.

Table 5 – Compressive strength of conventional concrete at curing in chloride solution

Replacement level (%)	Compressive strength (N/mm^2)			
	Curing in→ ↓	0% Chloride Solution (Tap water)	5% Chloride Solution	10% Chloride Solution
0(*Conventional Concrete*)	7 Days	24.64	28.46	26.56
	28 Days	32.20	38.10	37.13
	56 Days	40.43	43.28	41.92

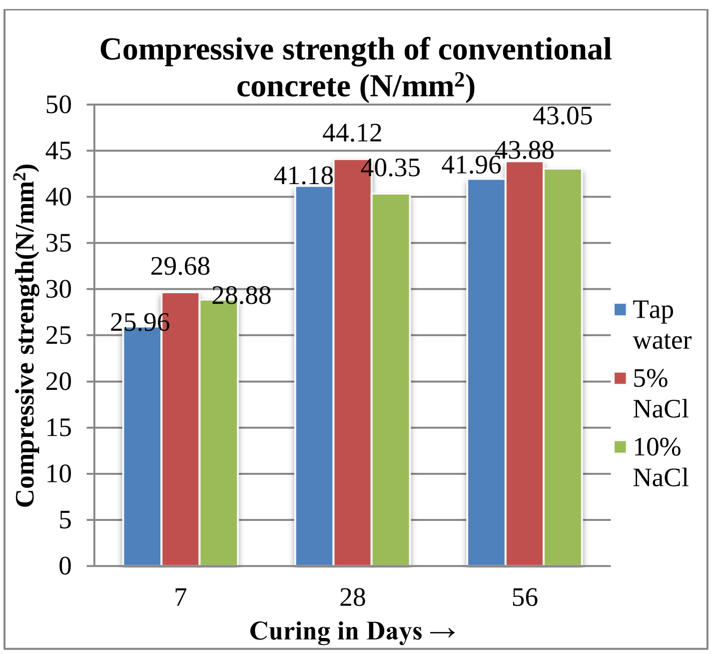

Figure.3 Variation of Compressive strength of conventional concrete

Table 6 – Compressive strength of ceramic aggregate concrete at curing in chloride solution

Replacement level (%)	Compressive strength (N/mm^2)			
	Curing in→ ↓	0% Chloride Solution (Tap water)	5% Chloride Solution	10% Chloride Solution
40 (*Ceramic mixed concrete*)	7 Days	25.96	29.68	28.88
	28 Days	41.18	44.12	40.35
	56 Days	41.96	43.88	43.05

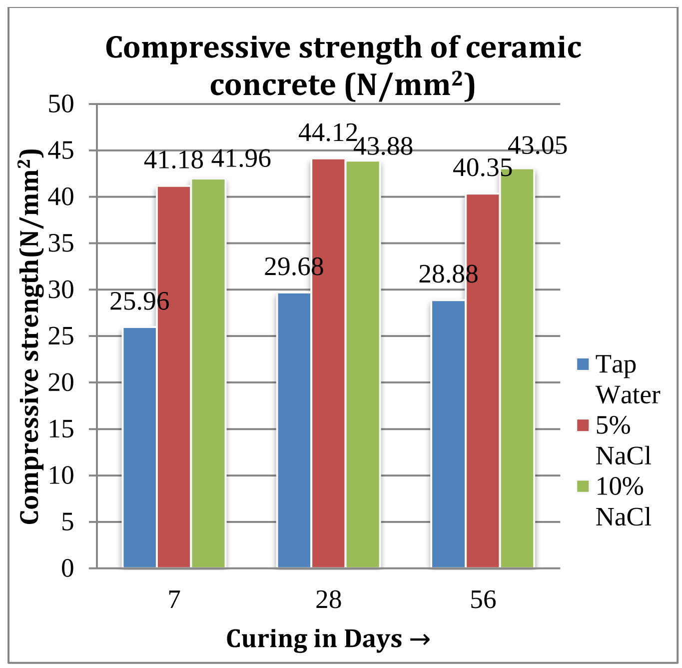

Figure.4 Variation of Compressive strength of ceramic aggregate concrete

CONCLUSION

From the above study following conclusion may be drawn:

- While using ceramic tiles as partial replacement of fine aggregate, workability decreased with increase in replacement level.

- It is observed that, compressive strength of concrete made using ceramic waste increased with replacement level (up to 40%).
- Optimum replacement level of fine aggregate with ceramic waste is 40%.
- In chloride environment concrete with ceramic waste shows better performance than conventional concrete.
- Ceramic waste can effectively be used as alternative & supplementary materials in concrete.

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