International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

Experimental investigation of ceramic waste concrete using magnetized water

Piyush H. Lamkhade [1], Nutan J. Pathak[2], Dr. S. C. Potnis[3]

[1]PG Student, Applied mechanics Dept., Maharashtra Institute of Technology, Pune, Maharashtra, India
[2] Associate Professor, Applied mechanics Dept., Maharashtra Institute of Technology, Pune, Maharashtra, India
[3]Professor, Applied mechanics Dept., Maharashtra Institute of Technology, Pune, Maharashtra, India

---

Abstract – *Concrete is a composite material made with cement, aggregates and water in construction industry. New innovations and developments in construction field, the global consumption of natural aggregates is increasing day by day and at the same time production of solid wastes from the manufacturing units and demolitions are also very high. The ceramic industry generates about 30 per cent wastes every year. Its massive part is used into landfill. Use of ceramic wastes in construction industry is very low because of absence of guidelines, prevention of risk, less information and skills. The water which is subjected to high intense and focused magnetic field is called magnetized water. Magnetic water shows significant results on workability, strength and mechanical properties of concrete. However, the research on ceramic wastes as partial substitute for coarse aggregate as well as the effect of magnetic water on compressive strength and workability of concrete has not been studied. This research has been concluded with focus on examining use of ceramic tile wastes as partial substitute for coarse aggregates and magnetic water can prove to be useful. This experiment contains the preparation of standard cubes of various concrete mixes of ceramic waste, magnetic water and tap water. In this project, we have attempted to replace the various proportions ceramic wastes as coarse aggregate with normal water and magnetic water, compressive strength and workability of the concrete was calculated as well as various properties of the ceramic waste and magnetic water are studied.*

Key Words: Ceramic Waste Aggregates, Coarse Aggregate, Magnetic water, Compressive Strength.

1.INTRODUCTION

Concrete is one of the most common construction material used for structures. Cement concrete is an artificial stone produced by hardening mixture of cement, sand, gravels and water and admixtures in some cases. Due to the increasing demand of construction material and degradation of environment, there is need to explore alternative construction material from industrial as well as household waste and recyclable materials.

Large quantity of waste is generated in Ceramic industries which can cause environmental hazard. This waste needs to be recycled as the waste is increasing up every day. There is a pressure on ceramic industries to find a solution for waste disposal.

Ceramics include such wide range of materials that a definition is almost impractical. However, one workable description of ceramics is a refractory, non-metallic material and inorganic. Ceramic waste has similar pozzolanic properties of concrete ingredients Ceramics can be classified into two types as follow:

a) Traditional Ceramics: It consist of clay products, silicate glass and cement.
b) Advanced Ceramics: It consist of nitrides (Si_3N_4), pure oxides (Al_2O_3), carbides (SiC), non-silicate glasses and several many others.

2. MAGNETIC WATER

The Magnetic water treatment is one of the finest proposed methods of reducing the effects of hard water to make soft, as an alternative for water softening. Softening intensity is depends on the magnitude of flux induced to water. Such treated water known as magnetic water or magnetized water. The usage of magnetic water for the preparation of concrete would increase strength of the concrete and also there will be higher workability for the same water cement ratio. Many results of paper show that the compressive strength of concrete samples prepared with magnetic water increases 10-20% more than that of the normal water samples. The initial research and scientific testing regarding the application of a magnetic field to concrete manufacturing were commenced in Russia in 1962 for military constructions such as airports and jetties. The magnetic field breaks down water molecules and reduce the bond angle and hence increase solubility. It is believed that after applying a strong magnetic field, water will show diamagnetism.

3. MAGNETIC DEVICE

The magnet which is used in many Household appliances, Automobile industries and Industrial machines, can be used as magnetizer. We can use this type of magnet to produce a magnetic field. Advantage of this type of magnet is we can control the magnetic field strength by controlling the voltage of the electric current by passing through the coil wire. Figure

1 shows the magnetic field which is generated from the coil after passing current.

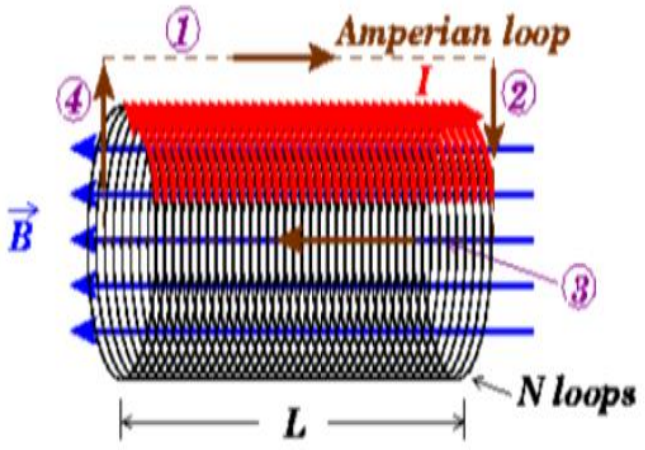

Fig 1 Magnetic Field Generator

The Ampere's function is used for finding out the magnetic field inside the coil, which is as follows (as per Reitz, 1971):

$\beta = \mu o (N \times I) / L$

Where:
β: magnetic field (intensity), measured in tesla.
μo: magnetic constant +(known as the permeability of vacuum can be exact with formula $4\pi \times 10^{-7}$ N/A^2, (in SI units).
N: total number of rolls in the coil in throughout the length (non-dimensional).
I: current passing in wire, measured in amperes.
L: total length of the coil which is rounded along length, measured in meter.

The strength or intensity of a magnet is measured by its magnetic flux density, which is measured in unit of gauss, i.e. (1 gauss = 10^{-4} tesla = 100 micro-tesla (μT)), the magnet strength of which is used in the study is of (1.2) Tesla, and in SI units of tesla can be given as, 1 T = 1 $kg \cdot S^{-2} \cdot A^{-1}$. An equivalent, but older unit for 1 Tesla was $Weber/m^2$. The type of magnetizer used in this study is made for domestic use. It is a set of permanent series of ring magnet materials arranged a Poly Venial Chloride (PVC) body of rounded shape to form of magnetic field with length greater than its radius. Figure shows the water magnetizer used in this study. Its output of water from magnetizer is up to 9 $m^3/hr.$, it is made of PVC body. [9]

The study program includes the experimental investigation of the behavioral conducts of fresh and hardened concrete along with ceramic waste coarse aggregate as well as magnetic water and to compare the relevant properties and behavior with conventional concrete.

4. RESEARCH OBJECTIVE

The objectives of the present study are as follow:

1)To examine and estimate the potential for products like ceramic waste and magnetic water for use in concrete production.
2)To study the effect of ceramic waste and magnetic water on strength characteristics of concrete.
3)To minimize the overall environmental effects of concrete production by use of magnetic water and ceramic waste materials as partial replacement.
5. METHODOLOGY

I. Materials

A) Ceramic waste as Coarse Aggregate: Ceramic wastes, such as roof tiles, floor tiles were broken down into small pieces of about 2.75 - 40 mm in size by a hammer. After that it sieved to attain the essential sizes of 2.75 – 20 mm.

B) Cement: The cement used for this study is Portland Pozzolanic Cement is conforming to Indian Standard IS 8112:1989 of grade 43.

C) Fine aggregate: Fine aggregate (sand) is sourced from a local supplier.

D) Coarse Aggregate: Crushed coarse aggregates with nominal sizes of 12 mm and 20mm maximum size obtained from the local crushing plants.

E) Magnetic Water: Magnetic water is prepared by passing it through a magnetizer of magnetic field of strength of about 1.2 tesla and with a velocity of 9 m^3/h.

II. Concrete Mix Design

In the present study, Ceramic mix M25 grade was designed as per Indian Standard method (IS 10262-2009) and the same has been used to prepare the test samples.

Table-1: Details of mix types

Mix Type	% Replacement 0f Course Aggregate		Type of Water
	Natural Coarse Aggregate	Ceramic Waste	
Normal	100%	-	Tap
N-20	80%	20%	Tap
N-40	60%	40%	Tap
N-60	40%	60%	Tap
Magnetic	100%	-	Magnetic

M-20	80%	20%	Magnetic
M-40	60%	40%	Magnetic
M-60	40%	60%	Magnetic

The evaluation of ceramic waste for use as a replacement of coarse aggregate begins with the concrete testing. Concrete contains cement, water, fine aggregate, coarse aggregate and ceramic waste. With the control concrete, i.e. 0% 20%, 40%, and 60% of the coarse aggregate is replaced with ceramic waste casts with normal water and magnetic water, data from the ceramic waste concrete casts and curing with magnetic water and normal water is compared with data from a standard concrete. 20 cube samples were cast for each type on the mould of size 150*150*150 mm. After about 24 hours the specimens were demoulded and water curing was continued till the respective specimens were tested after 7, and 28 days for compressive strength test. Compressive strength tests were performed on testing machine using cube samples. 20 samples per batch were tested with the average strength values reported in this paper. The details of mix designations and replacements of percentage of ceramic waste and water are shown in table 1 above.

III. Test Performed

a) Concrete consistency (workability): The consistency of concrete i.e. workability is most frequently measured by the slump test. The slump is a good measure for calculation of total water content in concrete mix. The slump cone test for each group of concrete mixes is to be carried out to check slump.

b) Compressive strength: All the samples are standard size of cubic specimens having dimension of (150*150*150mm) in accordance with IS, and tested immediately after removing from water for 7 and 28 days, compressive strength of each group of concrete will be carried out according to IS 516-1959 specification.

6.RESULT AND DISCUSSION

Following results are obtained after performing procedure of experiment and conducting tests

1. Slump value

The slump value reduced when the percentage of ceramic waste was increased from 0 to 60% in concrete. The increase in percentage of replacement of ceramic waste in concrete, Improvement in slump value measuring workability reduces from 6 to 7 mm. This is due to ceramic waste aggregates have higher water absorption and irregular shape. Ceramic waste concrete with magnetic water shows better results than ceramic waste concrete contains normal water. Slump values obtained from experiment are given below.

Table 2: Workability of Concrete

Mix Type	Slump Value (mm)	Mix Type	Slump value (mm)	Increase in workability (mm)
Normal	47	Magnetic	56	9
N-20	43	M-20	49	6
N-40	37	M-40	44	7
N-60	33	M-60	39	7

2.Compressive strength

The variation of compressive strength at 7 days and 28 days with different percentages of tile waste aggregate are tabulated and plotted below. Compressive strength at 7 days and 28 days of normal concrete and concrete with 20 % ceramic waste is nearly same. Compressive strength of concrete is decreases with further increasing % of ceramic waste in concrete. Physical properties of ceramic waste aggregate affects bonding between the cement paste and aggregate also the compressive strength the specimens. Strength of ceramic waste aggregate concrete monitored weakening trend due to higher water absorption, porcelain texture and volume fraction of ceramic waste aggregate in the concrete composition. Ceramic waste concrete cast in M W has higher compressive strength at 7th day than ceramic waste concrete cast in N W. Percentage variation of N W and M W concrete is nearly 26% to 28% as tabulated in Table 3.

Table 3: Compressive Strength of Concrete at 7th day

Mix Type	C. S. at 7th day (MPa)	Mix Type	C. S. at 7th day (MPa)	Percentage variation (%)
Normal	18.78	Magnetic	24.03	27.96
N-20	18.63	M-20	23.48	26.03
N-40	17.15	M-40	21.78	26.997
N-60	16.23	M-60	20.49	26.24

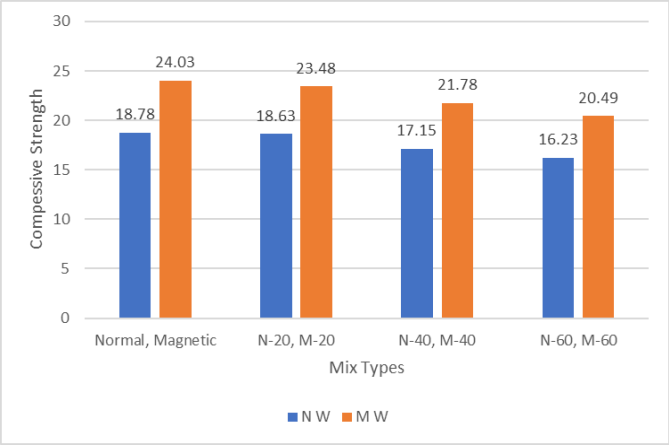

Fig 2: Comparison of Compressive Strength at 7th day of TW and MW Specimens.

Also, ceramic waste concrete cast in M W has higher compressive strength at 28th day than ceramic waste concrete cast in N W. Percentage variation of N W and M W concrete is nearly 10% to 15% as shown in tabulated in Table 4.

Table 4: Compressive Strength of Concrete at 28th day

Mix Type	C. S. at 28th day (MPa)	Mix Type	C. S. at 28th day (MPa)	Percentage variation (%)
Normal	32.75	Magnetic	36.35	10.99
N-20	31.05	M-20	34.83	12.17
N-40	29.36	M-40	33.46	13.96
N-60	28.23	M-60	32.44	14.91

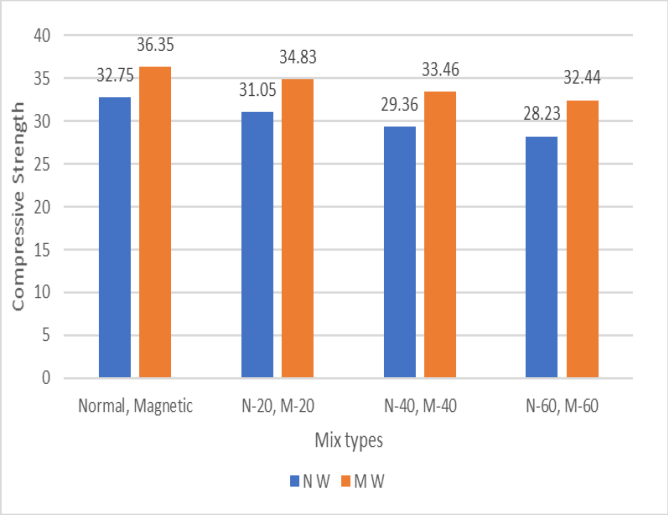

Fig 3: Comparison of Compressive Strength at 28th day of TW and MW Specimens.

It is shown in Figures 2 & 3 that the compressive strength of concrete increases with the usage of magnetized water, and this increase in the strength is due to cluster concept of water and also memory of water concept. But when water is exposed to magnetized field, it is observed that the number of water molecules decreases to a smaller amount. As the more water is available for hydration, the more number of cement particles are hydrated, and this result in better quality and density of hydration products of cement. This increase in hydration may lead to increase in the compressive strength of the concrete. This effect results to increase in efficiency of cement used in concrete.

7. CONCLUSION

1. Mechanical properties such as Impact value, Crushing Value and Abrasion value of ceramic waste aggregate is slightly higher than those for natural coarse aggregate. However, all values are less than 30%, hence ceramic waste aggregate can be safely used in concrete composition as alternative material for coarse aggregate.

2. Workability of concrete decreases with increase in percentage of ceramic waste in concrete.
   a. Workability of ceramic waste concrete using magnetized water increases with respect to ceramic waste concrete using normal water.
   b. But the increase in percentage of replacement of ceramic waste in concrete, Improvement in workability reduces from 6 to 7 mm.

3. Compressive strength of ceramic waste concrete decreases with the increase of ceramic waste aggregate in concrete.
   a. Ceramic waste concrete using magnetized water has more compressive strength than that of ceramic waste concrete using normal water.
   b. Ceramic waste concrete cast in M W has higher compressive strength at 7th day (about 25% - 27%) than ceramic waste concrete cast in N W.
   c. Ceramic waste concrete cast in M W has higher compressive strength at 28th day (about 10% -15%) than ceramic waste concrete cast in N W.

4. Using magnetic water up to 60 % ceramic waste can be replaced with natural coarse aggregate in concrete without affecting desired compressive strength.

REFERENCES

1. A., Harry, and E., Ekop, "Compressive strength characteristics of tile waste concrete", International Journal of engineering sciences & research Technology, August 2016, Vol.1 (3), pp. 268-273.

2. Janarthanan, R. Radha, Srinivasan, Muthu, and Mariappan, P., "Effective Utilization of Ceramic Waste as a Raw Material in Concrete", IJSRD - International journal for scientific research & development, 2015, Vol. 3(01), pp. 904-906.

3. Siva, Konda, Reddy, Vaishali, G., Ghorpade, and H., Sudarsana, Rao, "Use of magnetic water for mixing and curing of concrete", International journal of advanced engineering research and studies, Oct. - Dec, 2014, Vol. 4(1) pp. 93-95).

4. Siddharth, Pednekar, Nutan, J., Pathak, and Dr. S., C., Potnis, "Experimental Investigation of Properties of Concrete Cast in Magnetized Water", International journal of science technology & engineering, January 2017, Vol. 3(07), pp 1-4.

5. Sujit, V., Patil, and N., J., Pathak, "The Experimental Study on Compressive Strength of Concrete using AR Glass Fibers and Partial Replacement of Cement with GGBS with Effect of Magnetic Water", International journal of engineering technology, management and applied sciences, August 2016, Vol. 4(8), pp 21-29.

6. T., Manjupriya, and Dr. R., Malathy, "Experimental investigation on strength and shrinkage properties

of concrete mixed with magnetically treated water", International journal of engineering and advanced research technology (IJEART), March 2016, Vol. 2(3), pp 46-50.

7. Veera, Reddy, M., "Investigations on stone dust and ceramic scrap as aggregate replacement in concrete", International journal of Civil and structural engineering, 2010, Vol. 1(3), pp. 661-666.

8. Vikas, Rajora, Gurtej, Singh, Sidhu, "Effect of Partial Replacement of Fine and Coarse Aggregate (10mm) with Ceramic Waste on the Properties of Concrete", International journal of science and research (IJSR), August 2016, Vol. 5(8), pp. 75-77.

9. Saddam, M., Ahmed, "Influence of magnetic water on compressive strength and workability (consistence) of concrete", Al-Rafidain Engineering, Feb. 2009, Vol.17(1), pp 71-82.

10. Siva, Konda, Reddy, Vaishali, G., Ghorpade, and H., Sudarsana, Rao, "Influence of Magnetic Water on Strength Properties of Concrete", Indian journal of science and technology, January 2014, Vol 7(1), pp. 14–18.

11. IS: 516 – 1959 "Indian Standard methods of Test for strength of concrete", Bureau of Indian Standards, New Delhi.

12. IS 383 – 1970: Indian Standard "Specification for coarse and fine aggregates from naturals sources for concrete", BIS, New Delhi.

13. IS 2386-1: "Indian Standard Methods of Test for Aggregates for Concrete, Part I: Particle Size and Shape", BIS, New Delhi.

14. IS 2386-3: "Indian Standard Methods of test for aggregates for concrete, Part 3: Specific gravity, density, voids, absorption and bulking", BIS, New Delhi.

15. IS 8112:1989, "43-Grade Ordinary Portland Cement – Specification", BIS, New Delhi.

16. IS 456:2000 "Indian standard plain and reinforced concrete code of practice", BIS, New Delhi.

17. IS 3025 (Part 11), "Method of Sampling and Test (Physical and Chemical) for Water and Wastewater: pH Test", Part 11: (Revision 2002), BIS, New Delhi.

18. IS 10262:2009 "Indian standard recommended guidelines for concrete mix design", BIS, New Delhi.

19. IS 3025 (Part 16), "Method of Sampling and Test (Physical and Chemical) for Water and Wastewater: Filterable Residues (Total Dissolved Solids)", Part 16: (Revision 2002), BIS, New Delhi.

20. M., S., Shetty, "Concrete Technology" (Theory and Practice), S. Chand & Company Limited, New Delhi, Sixth Edition, May-2005.

21. M., Neville, "Properties of Concrete", Pearson Education, Published in India by Dorling Kindersley India Private Limited, Fourth Edition, 2007.