ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

VALORIZATION OF CERAMIC WASTE AND STEEL FIBERS INTHE PRODUCTION OF CONCRETE: A MECHANICAL APPROACH

M. Pratyusha[1], Irfan Ansari[1], Anil Kumar Mandal[1], K. Akhil[1], K. J. Chandu[1], V. Suresh[1], P. Ravi Kishore[2]

[1]UG students, Department of Civil Engineering, Aditya Engineering College (A), Surampalem, India

[2]Assistant professor, Department of Civil Engineering, Aditya Engineering College (A), Surampalem, India

ABSTRACT

In the present scenario, use of concrete as a structural material is limited to certain extend by deficiencies like brittleness, poor tensile strength, and poor resistance to impact strength, low ductility and low durability. The ceramic industry inevitable generates wastes, irrespective of the improvements introduced in the manufacturing process. In the ceramic industry, about 15%-30% production goes as waste. These wastes pose a problem in present-day society, requiring a suitable form of management in order to achieve sustainable development. In this study, experimental investigation on the compressive, tensile, flexural strength of concrete by adding steel fibers and effective replacement of cement with ceramic tile powder of 5%, 10%, 15% is calculated by casting the concrete into cubes, beams and cylinders. The grade of cement used is 53 and concrete is M35, size of coarse aggregates used is 20mm, fineaggregated should be passed through 4.75mm sieve.

Concrete mixtures were produced, tested and compared in terms of compressive strength, tensile strength and split tensile strength to the control concrete. These tests were carried out to evaluate the mechanical properties for 7, 28 and 56 days.

Key Words: Concrete, Superplasticizer, Workability, Aspect Ratio

1. Introduction:

Concrete is a material composed of cement, fine aggregates and coarse aggregates mixed with water. To increase the strength of concrete an alternative method we choose is to replace the cement with any other cementitious material. Ceramic powder is used as alternative. Indian ceramic production is 100 million ton per year. In ceramic industry, about 15%-30% waste material generated from the total production. The ceramic waste is durable, hard and highly resistant to biological, chemical, and physical forces. Common materials used to produce ceramic tiles include white clay, talc, sand, feldspar, dolomite and calcite.

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 thepowder dries up so it

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

is necessary to dispose the Ceramic waste quickly and use in the construction industry as the ceramic waste is piling up every day, there is a pressure on ceramic industries to find a solution for its disposal. The advancement of concrete technology can reduce the consumption of natural resources.

NDT is particularly effective because materials are tested in ways that do not alter the integrity or usefulness of the substance being examined. This makes the technique incredibly useful for determining the safety and reliability of products that are currently in- use as well as those intended for future use. NDT methods can detect internal and external irregularities and imperfections, determine the structure or composition of materials, and make accurate measurements of the products being tested – without destroying them.

2. Literature Review

Amitkumar D. Raval, Dr.Indrajit N. Patel, Prof. Jayeshkumar Pitroda Utilization of Ceramic waste and its application are used for the development of the construction industry, Material sciences. Jagadeesh Bommisetty, Tirukovela Sai Keertan, A. Ravitheja, K. Mahendra The alternative materials can be effectively used as replacement of aggregates in concrete. This helps in the disposal of these alternative materials in a safe manner from the environment point of view.S.M. Shaik-ul-Karim, Shafkat Ahmed and Ismail Saifullah. Based on the compressive and tensile strength of mortar, it can be concluded that there is no significant reduction of strength up to 20% replacement of cement using CWP.Mayank Bhargav, Prof. Rajeev Kansal , The compressive power of concrete content with a fractional replacement of cement with ceramic tiles Powder up to 15% can be equivalent to standard concrete. Atul Uniyal, Karan Singh, Utilization of tile powder and its application for the sustainable development of the construction industry is the most efficient solution and also address the high value application of such waste. Lilesh Gautam, Jinendra Kumar Jain, Abhishek Jain, Pawan Kalla , The mix prepared using 10% BCPW and 30% GW (i.e. C10G30) exhibited the highest compressive strength. The pozzolanic behaviour of BCPW and better filler efficiency of GW particles led to strength increment. Dr.M.Swaroopa Rani, All the experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties.

3. Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, andworkability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

Mix Design of M35 Grade Concrete (As Per Is: 10262-2009 And Is:456 - 2000):

Mix no.	Cement	Water	FA	CA		CTP	CTP (%)	steel fibres %	Slump Value (mm)
				10 mm	20 mm				
CC	437.78	197	643.21	568.13	568.13	0	0	1.75	84
1	415.891	197	643.21	568.13	568.13	21.889	5	1.75	82
2	394.002	197	643.21	568.13	568.13	43.778	10	1.75	81
3	372.113	197	643.21	568.13	568.13	65.667	15	1.75	80

4. Tests on Hardened Concrete:

Compressive Strength Test:

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, is compressed between the platens of a compression-testing machine by a gradually applied load.

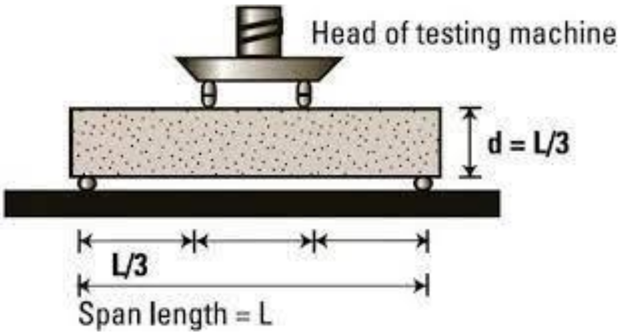
Fig 5.8: compression of cubes

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

Flexural Strength Test:

Flexural testing is used to determine the flex or bending properties of a material. Sometimes referred to as a transverse beam test, it involves placing a sample between two points or supports and initiating a load using a third point or with two points which are respectivelycall 3-Point Bend and 4-Point Bend testing.

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 6x 6-inch (150x150mm) concrete beams with a span length at least three times the depth.



6.1 flexural test on beams

Split Tensile Test:

The splitting tensile strength test consists of applying a diametric compressive load along the entire length until failure occurs. This loading induces tensile stresses on the planecontaining the applied load and compressive stresses in the area around the applied load. The splitting tensile strength test is performed on hardened concrete to determine its tensile strength. Marginal variations in water to cement ratio, ingredient proportioning, increase ina slump, etc impacts the desired concrete strength. This in turn affects the strength andstability of structures.

Fig 5.11: split tensile test

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

Non-Destructive Tests:
Rebound Hammer Test:

Rebound hammer test method is based on the principle that the rebound of an elastic mass depends on the hardness of the concrete surface against which the mass strikes. The operation of the rebound hammer is shown in figure. When the plunger of rebound hammer is pressed against the concrete surface, the spring controlled mass in the hammer rebounds. The amount of rebound of the mass depends on the hardness of concrete surface. Thus, the hardness of concrete and rebound hammer reading can be correlated with compressive strength of concrete. The rebound value is read off along a graduated scale and is designated as the rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.

Fig 5.12 rebound hammer test

Ultra Sonic Pulse Velocity Test:

An ultrasonic pulse velocity (UPV) test is an in-situ, non-destructive test to check the quality of concrete and natural rocks. In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic passing through a concrete structure or natural rock formation. This test is conducted by passing a pulse of ultrasonic through concrete to be tested and measuring the time taken by pulse to get through the structure. Higher velocities indicate good quality and continuity of the

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

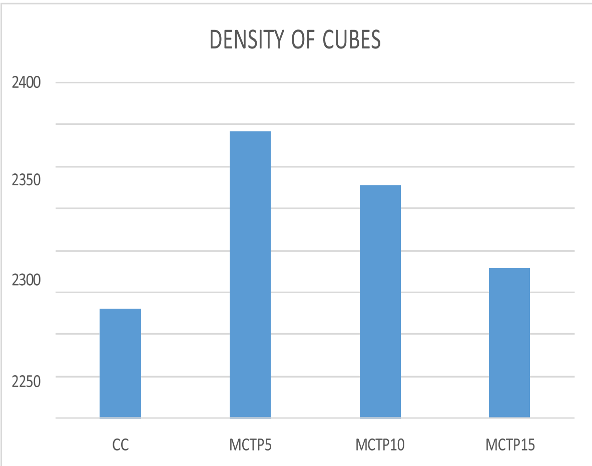
material, while slower velocities may indicate concrete with many cracks or voids. Ultrasonic testing equipment includes a pulse generation circuit, consisting of electronic circuit for generating pulses and a transducer for transforming electronic pulse into mechanical pulse having an oscillation frequency in range of 40 kHz to 50 kHz, and a pulsereception circuit that receives the signal.

5. Results and Discussion

Density of Cubes:

Table:

Graph 6.1:



Mix.	DENSITY OF CUBES
	28 days
CC	2130.33
MCTP5	2342.67
MCTP10	2276.67
MCTP15	2179.00

When compared with the control concrete the density of concrete cubes are rapidlyincreasing, but high density is obtained at 5% CTP.

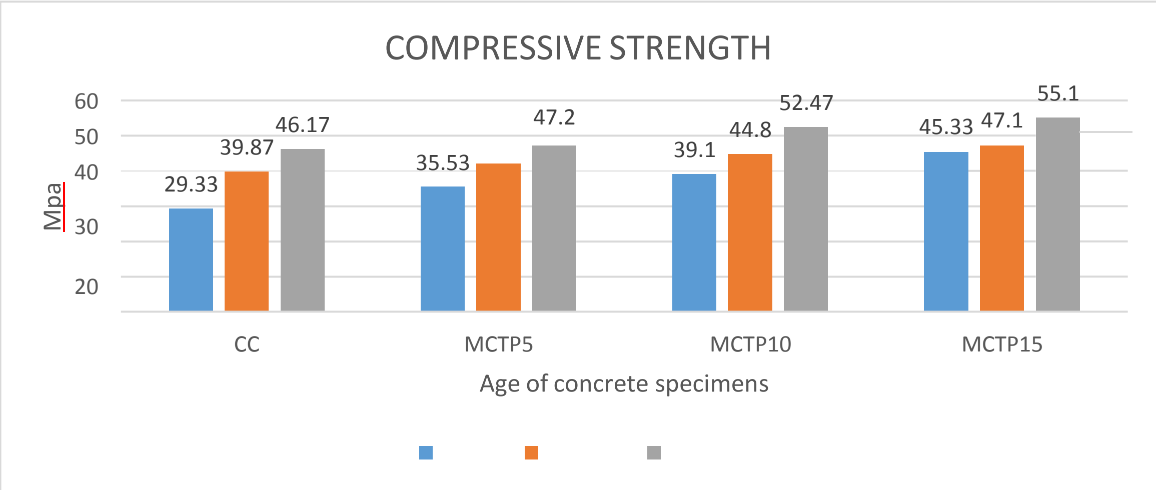
Compressive Strength Test:

TABLE:

Mix.	Compressive Strength		
	7 days	28 days	56 days

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

CC	29.33	39.87	46.17
MCTP5	35.33	42.10	47.20
MCTP10	39.10	44.80	52.47
MCTP15	45.33	47.10	55.10



The above results are obtained by testing the cube specimens of size 150mm under compressive testing machine (CTM), it is observed that when compared to the grade of concrete each and every replacement proportions have given satisfied values. But, if we observe that from 5 to 15 of CTP has given increasing value of compressive strength. Compressive strength test shows the resistance offered by the internal particles of the specimen towards failure. As we all know that concrete is strong in compressive and weekin tension, this is why everywhere throughout the world the first and foremost test performance will be compressive strength.

Split Tensile Strength Test:

This test is done to determine the indirect tensile strength of the concrete specimen. In this method, the concrete specimen is tested as in a similar way to the compressive strength of concrete, but the test specimen varies in the dimension. Here the concrete cylinder is used as the test specimen, which has the dimension of 150mm diameter and 300mm length.

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

The results obtained are compared with the control concrete reading, there is a drastic decrease in value where 5% of CTP is used and almost same results as of control concrete are obtained with 15% CTP and steel fibers withhold the concrete even if it gets failed.

Flexural Strength Test:

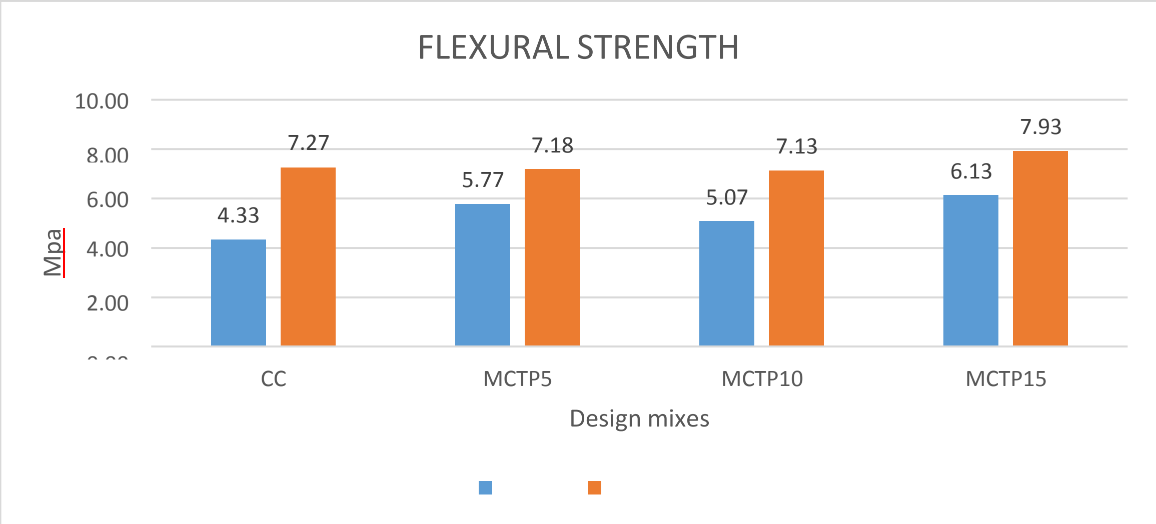
It is seen that strength of concrete in compression and tension (both tension and flexural tension) are closely related, but the relationship is not of the type of directly proportional.

The ratio of two strengths depends on general level of strength of concrete shows higher tensile strength, but the rate of increase of tensile strength is of decreasing order.

TABLE:

Graph 6.4:

Mix.	**Flexural Strength**	
	7 days	**28 days**
CC	4.33	7.27
MCTP5	5.77	7.18
MCTP10	5.07	7.13
MCTP15	6.13	7.93



When compared to the control concrete great results are obtained with increase in tensile strength of concrete. Optimum results are observed at 15% of CTP when compared to 5% and 10%.

Non-Destructive Tests:

Rebound Hammer Test:

These values obtained from the rebound hammer are seen on the graphic values present onthe hammer called rebound number and alternatively observed the mix proportion to determine the strength of the concrete.The values when compared with the control concrete, we can observe there is a increase instrength with the increase in mix proportion.

6. **Conclusions:**

Based on the results of the study lead to the following conclusions:

1) Utilization of Ceramic waste and its application are used for the development of the construction industry, Material sciences.
2) The Compressive Strength of M35 grade concrete increases when the replacement of cement with ceramic waste up to 15% and increase in the percentage replacement of cement with ceramic tile powder can give the optimum results.
3) The flexural strength also gets increased with increase in the percentage of ceramic tile powder replacement and addition of steel fibers adds extra strength to the beam.
4) The split tensile strength values increased with increase in the percentage of ceramic tile powder replacement, but when compared to the control concrete the results obtained at 5%, 10% replacement are less, the ceramic tile powder which possess pozzolonic properties is week in tension and good at compression.
5) The values obtained from the non-destructive tests are also increased with increase inthe percentage replacement, also greater than the control concrete.
6) It is the possible alternative solution of safe disposal of Ceramic waste.
7) Ceramic tile powder can be used as a effective replacement of cement. Strength is increased with increase in percentage replacement of cement and

ISSN- 2394-5125 VOL 09, ISSUE 03, 2022

can be used in load bearing structures.

7. References:

1) L. Gautam, J.K. Jain, P. Kalla, S. Choudhary, A review on the utilization of ceramic waste in sustainable construction products, Mater. Today Proc. 43 (2021) 1884–1891.
2) S. Siddique, S. Shrivastava, S. Chaudhary, T. Gupta, Strength and impact resistance properties of concrete containing fine bone china ceramic aggregate, Constr. Build. Mater. 169 (2018) 289–298
3) G. F. Huseien, A.R.M. Sam, K.W. Shah, J. Mirza, Effects of ceramic tile powder waste on properties of self-compacted alkali-activated concrete, Constr. Build. Mater. 236 (2020) 117574.
4) A.S. El-Dieb, D.M. Kanaan, Ceramic waste powder an alternative cement replacement
   – Characterization and evaluation, Sustain. Mater. Technol. 17 (2018).
5) De Brito, J., Pereira, A. S., and Correia, J. R. (2005). Mechanical behaviour of nonstructural concrete made with recycled ceramic aggregates. Cement and Concrete Composites, Cement and Concrete Composites, 27(4), 429-433.
6) Guerra, I., Vivar, I., Llamas, B., Juan, A., and Moran, J. (2009). Eco-efficient concretes: The effects of using recycled ceramic material from sanitary installations on the mechanical properties of concrete. Waste Management, 29(2), 643-646.
7) Senthamarai, R. M., Manoharan, P. D., and Gobinath, D. (2011). Concrete made from ceramic industry waste: durability properties. Construction and Building Materials, 25(5), 2413-2419.
8) Zimbili, O., Salim, W., & Ndambuki, M. (2014). A review on the usage of ceramic wastes in concrete production. International Journal of Civil. Architectural, Structuraland Construction Engineering, 8(1), 91-95.
9) KM AF, Varghese S (2014) Behavioural study of steel fiber and polypropylene fiber reinforced concrete. Int J Res Eng Technol 2(10):17–24.
10) Atiş CD, Karahan O (2009) Properties of steel fiber reinforced fly ash concrete. ConstrBuild Mater 23(1):392–399.