Section A -Research paper

AN EXPERIMENTAL STUDY ON MECHANICAL CHARACTERISTICS OF WASTE CERAMIC TILE CONCRETE WITH ADDITION OF COCONUT FIBER

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Abstract

In concrete the problem is in availing the materials. It is due to the scarcity or their high cost in the market. Many researchers have found alternatives to the ingredients which succeeded in terms of durability, Strength and low cost like coconut shell, ceramic tile, recycled aggregates, saw dust, m – sand, rice husk, etc. Hence, this research paper presents the use of ceramic tile concrete with addition of coconut fiber, use of fiber in this study is to restrict cracks in the concrete. Ceramic tiles are partially replaced in 5%, 10%, 15% and 20% to this, the compression, tensile, flexural and impact resistance of concrete are found out. 15% the optimum ceramic tile content considered for further work of adding coconut fiber in 1%, 1.5% and 2% in ceramic tile concrete. The results obtained were at 1% addition of coconut fiber and when observed the increase in quantities of ceramic tile and coconut fiber were resulted in poor strength performance. In addition to this the bonding ability of ceramic tile and fiber in concrete is observed using nano particular tests which determines the particle distribution and its bonding with cement which seems better in resisting the crack development.

Keywords: Construction Industry, Durability, Ceramic Tile Concrete, Coconut Fiber, Strength Performance, Nano Particle Test and crack development.

1 Introduction

Ceramic tiles are been used widely in the construction industry for many activities like flooring, roofing, etc, Due to over usage of ceramic tiles, the waste material generated in the process of manufacturing, construction is difficult to dispose the wastage. Ajamu S O etal[2]Reuse of Ceramic tile waste in concrete as a partial replacement to the coarse aggregate, this results in positive effect on environment. AMBROSE E et.al [5]. So, by this we can reduce the environmental pollution by replacing the ceramic waste aggregate in concrete Akash Gaikwad et al [3]. There are many recyclable waste materials like recycled coarse aggregate, coconut shell, ceramic tiles, wood etc., The main agenda of choosing the ceramic tile waste as a replaceable material is the properties of ceramic tile is same as the aggregate and it is an easily available material.Paul O. Awoyeraet.al [21]. So, from many researchers it was found that ceramic tile can be used for partial or full replacement of aggregate. Amanpreet Singh [7]. When we use full replacement with ceramic tiles, the concrete can decrease its

strength. So, keeping this mind we have used ceramic tiles as partial replacement with 5%, 10%, 15% and 20%AdiniranJolaadeAdeala et.al [1].Apart from this there was one more thing to be considered while manufacturing concrete, it is use of a material that could arrest the crack initiation et.al []. Fibre reinforced concrete (FRC) is the best practiced way of resisting cracks in the concrete, although there are different varieties of fibres are available in the market to use in concrete. Here, in our work we have used coconut fibre which is a successful fibre been used in the concrete Gunasekar Kandasamy et.al [12]. The fibre is used in percentages of 1, 1.5 and 2 as an addition to concrete volume. This could help in to reduce the micro cracks in the concrete. Anand Rameshet.al [6]. Finally, it was to deliver a better concrete with good strength parameters, durability and eco-friendly concrete.

. Materials and Methodology

For the following study, the materials required are cement, Fine aggregate, coarse aggregate, waste ceramic tile aggregate and coconut fiber. The materials are collected from the nearer to the experimental laboratory.

2.1 Cement

Cement is the one of the main materials in the study which it has more binding action. The type of cement used is OPC 53 grade. The cement was collected from the nearby site.The properties of cement are as in the following table:

Table 1 Properties of cement

S. No	Description	Value
1	Normal consistency of cement	29%
2	Specific gravity	3.15
3	Soundness Test	1
4	Initial Setting Time	31

2.2 Fine Aggregate

Fine aggregate is collected from the nearby river. The size of particle which passes through 4.75mm sieve is considered for the study. The properties of sand are shown in the following table:

Table 2 Properties of Fine aggregate

S. No	Description	Test Value
1.	Bulk Density	10.667
2.	Specific gravity	2.64
3.	Zone	II

2.3 Coarse Aggregate

Coarse aggregate is composed of small pieces of stone that are uneven in shape. The Coarse aggregate is collected from nearby site. The purpose of coarse aggregate in concrete is to provide rigidity and brittle nature to concrete.

Table 3 Properties of Coarse aggregate

S. No	Description	Coarse aggregate
1.	Aggregate size	12.5 mm
2.	Specific gravity	2.52
3.	Water absorption	1.25%

2.3 Ceramic Tile Aggregate

The waste Ceramic tiles are collected from the nearby experimental laboratory. Ceramic wastes are crushed evenly by using hammer. The size of the particle which passes through 20mm IS sieve and retained on 12.5 mm IS Sieve

Table 4 Properties of Ceramic tile aggregate

S. No	Description	Ceramic aggregate
1.	Aggregate size	20 mm
2.	Specific gravity	2.32
3.	Water absorption	2.02%

Fig 1. Ceramic tiles

2.4 Coconut Fibre

Coconut fibre is an easily available natural material. coconut fibre is extracted from the coconut thread where the coconut thread is collected from the nearby shops. The size of the coconut fibre is 50mm in length and the diameter is 0.2 – 0.5 mm.

Fig 2. Coconut fibre

3. Experimental Study

3.1 Mix Proportion:

The grade of concrete used in the study is M30. The mix proportion was 1:1.55:1.95 with a water cement ratio of 0.40. The quantity of cement used in the concrete was 495kg/m^3. The five different mixes were used in the study. Firstly, we prepared the mix for the control concrete. The control concrete can be prepared by according to the mix proportions, a determined quantity of cement, fine aggregate, coarse aggregate, and water was mixed. The other mixes were made by replacing ceramic tile waste mix for coarse aggregate in various proportions like 5%, 10%, 15%, and 20%. From these optimum results again, we added the coconut fibre in the concrete to increase the strength. The coconut fibre can be added in a ceramic tile waste concrete with a different proportion like 1%, 1.5% and 2%.

4. Result and Discussion

4.1 Workability:

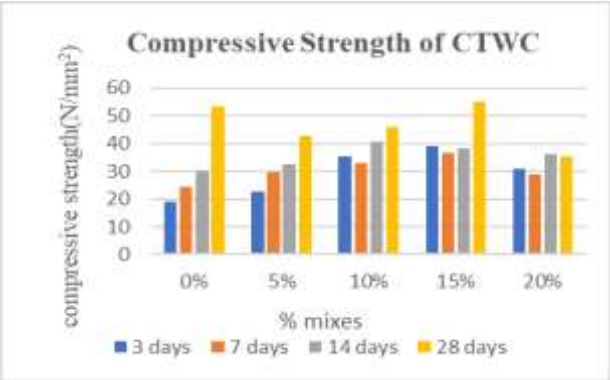
It is one of the important properties which decides the strength and durability of concrete. The tests to determine workability are performed in fresh stage to identify the plastic nature and easy moulding ability of concrete. The below fig 3(a) and (b) is the slump cone test performed on concrete. The value of slum for the concrete with ceramic tile waste concrete at 15% replacement is 39mm and the same with addition of coconut fibre is 31mm.

Fig 3 (a) Slump cone test

Fig 3 (b) Slump Measurement

4.2 Compressive Strength Test

The Compressive strength was performed on cubes of size 150×150×150 mm. The cubes are casted with the 5%, 10%, 15% and 20% and the specimens are allowed to tested for compressionat3, 7, 14, and 28 days. From this the optimum percentage where concrete has achieved better strength is noted and to that coconut fibre is



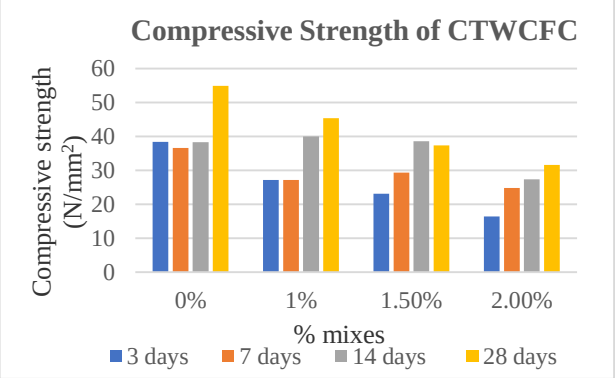


Fig.4 Graphical representation of compressive strength of CTWC and CTCW CF

Table 5. Compressive Strength test values

Compressive Strength (N/mm^2)					
Mix	% Replacement	3 days	7 days	14 days	28 days
CTWC	0%	19.11	24.44	30	53.33
	5%	22.88	29.55	32.33	42.66
	10%	35.55	33.11	40.55	45.99
	15%	38.88	36.55	38.22	54.88
	20%	30.77	28.77	36.22	35.44
CTWCFC	0%	38.88	36.55	38.22	54.88
	1%	29.11	35.11	39.38	51.33
	1.5%	23.11	29.33	39.55	37.33
	2%	16.36	24.76	27.35	31.57

added in 1%, 1.5% and 2% with same testing days. The results obtained from the compressive strength test in the following table 5.

From the above graphical representations it is observed that the compressive strength of control concrete is 53.33 N/mm^2. The replacement ceramic tile concrete got optimum value at the 15% replacement i.e., is 54.88 N/mm^2. The ceramic tile waste concrete (CWTC) has got more compressive strength than the conventional concrete. By increasing the percentage of ceramic tile in the concrete, the compressive strength can be gradually decreased at the 20%. To decrease the micro cracks in the concrete we added the coconut fibre as a micro crack resistance material. By addition of coconut fibre in the ceramic tile waste concrete the 28 days compressive strength is decreased. Due to the coconut fibre the internal micro area voided but the overall strength of the concrete is decreased.

4.3 Split Tensile test

The size of cylinder used in the test was 150mm diameter and 300mm height. The specimens can be casted with different percentages of waste ceramic tile concrete and later addition of coconut fibre into the CWC. The specimens can be tested after the 3 days, 7days, 14 days and 28 days of proper curing.

Table 6. Split tensile test values

Split Tensile Strength (N/mm^2)					
Mix	% Replacement	3 days	7 days	14 days	28 days
CTWC	0%	2.051	2.263	2.97	1.966
	5%	1.698	1.977	2.447	2.405
	10%	1.824	2.171	2.362	2.23
	15%	2.072	2.821	2.652	2.454
	20%	1.966	2.405	2.362	2.709
CTWCFC	0%	2.072	2.821	2.652	2.454
	1%	1.909	1.061	2.546	2.758
	1.5%	2.051	1.0	1.768	2.574
	2%	1.237	1.767	2.12	2.46

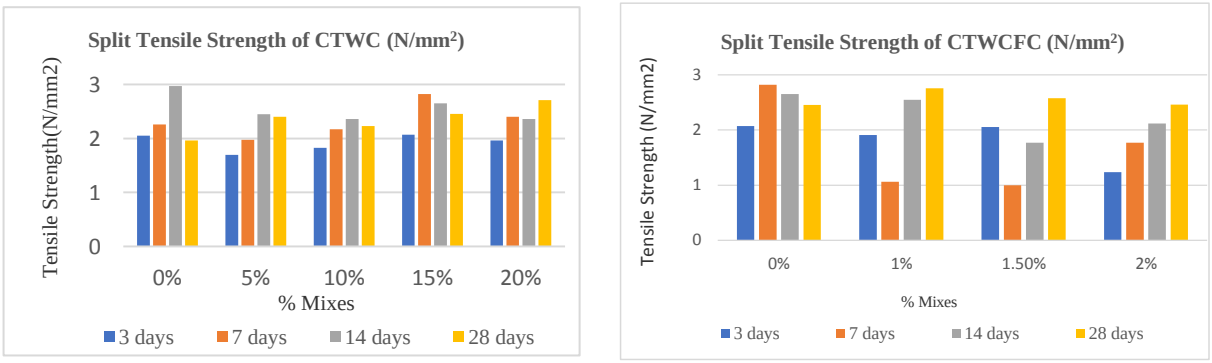


Fig 5 Graphical representation of split tensile strength of CTWC and CTCWFC

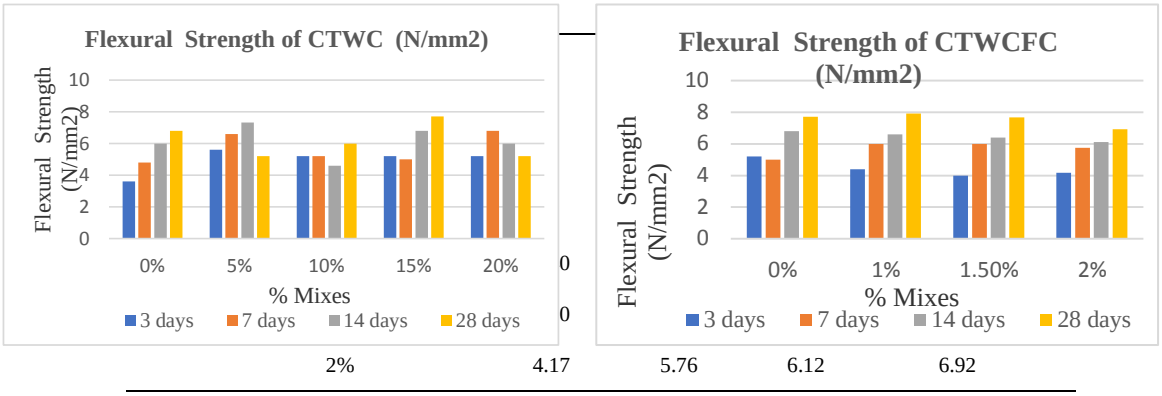
From fig 5 it is observed that, the tensile strength of control concrete after the 28 days of testing was 1.96 N/mm. The optimum value of tensile strength got at the 20% replacement of ceramic tile waste i.e., 2.709 N/mm^2.we have already known that the concrete is weak in the tensile and strong in the compression so by replacing of aggregate with the ceramic tile the tensile strength is increased. After the addition of coconut fibre into the ceramic tile waste concrete (CTWC) the tensile strength of concrete is increased at the 1% addition of coconut fibre. Because the coconut fibre material acts as a tensile to the concrete so the concrete got more tensile strength.

4.3 Flexural Strength Test

The size of the specimen used in the flexural strength test was 100x100x500 mm. The specimens can be tested after 3 days, 7 days, 14 days and 28 days of a curing period. The test results can be shown in the table:

Table 7. Flexural tensile strength test values

Flexural Strength(N/mm2)					
Mix	% Replacement	3 days	7 days	14 days	28 days
CTWC	0%	3.6	4.8	6	6.8
	5%	5.6	6.6	7.32	5.2



0

0

2% 4.17 5.76 6.12 6.92

Fig 6 Graphical representation of Flexural strength of CTWC and CTWCFC

The flexural strength of control concrete is 6.8 N/mm^2. After the replacement of aggregate with the ceramic tile waste the flexural strength of concrete is 7.72 N/mm^2 which has got better result than the conventional concrete. The more flexural strength got at the 15% replacement ceramic tile waste concrete. The more flexural strength of CTWCFC is 7.92 at 1 % addition of coconut fibre which is more than the Ceramic tile waste concrete.

4.4 Impact test

Impact load is a characteristic of sudden load applied on the body. The size of the mould used in the impact test was 150 mm diameter and 65mm height.

Table 8. Impact test values

Impact test			
Mix	% Mix	No. of blows for 28 days	
		Initial crack	Final crack
CTWC	0%	505	527
	15%	376	381
CTWCFC	1 %	461	476

4.5 XRD Analysis:

X-ray diffraction is a technique used in determining the material's crystallographic structure. It works by projecting x-rays through the material in different scattered angles. MEDINA C [17] Along with crystallographic nature, the phase composition and phase parameters are also can be determined.

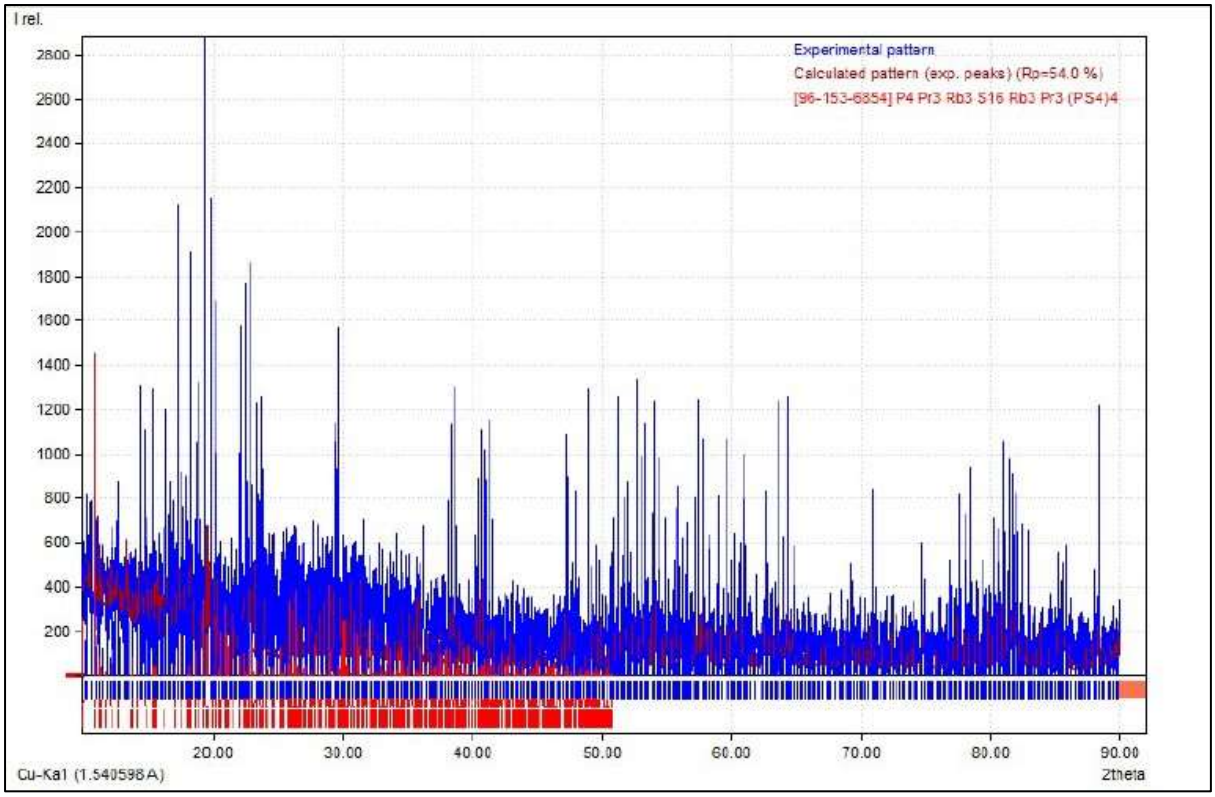


Fig. 7(a). Graphical representation of XRD analysis of CTWC at 15% replacement

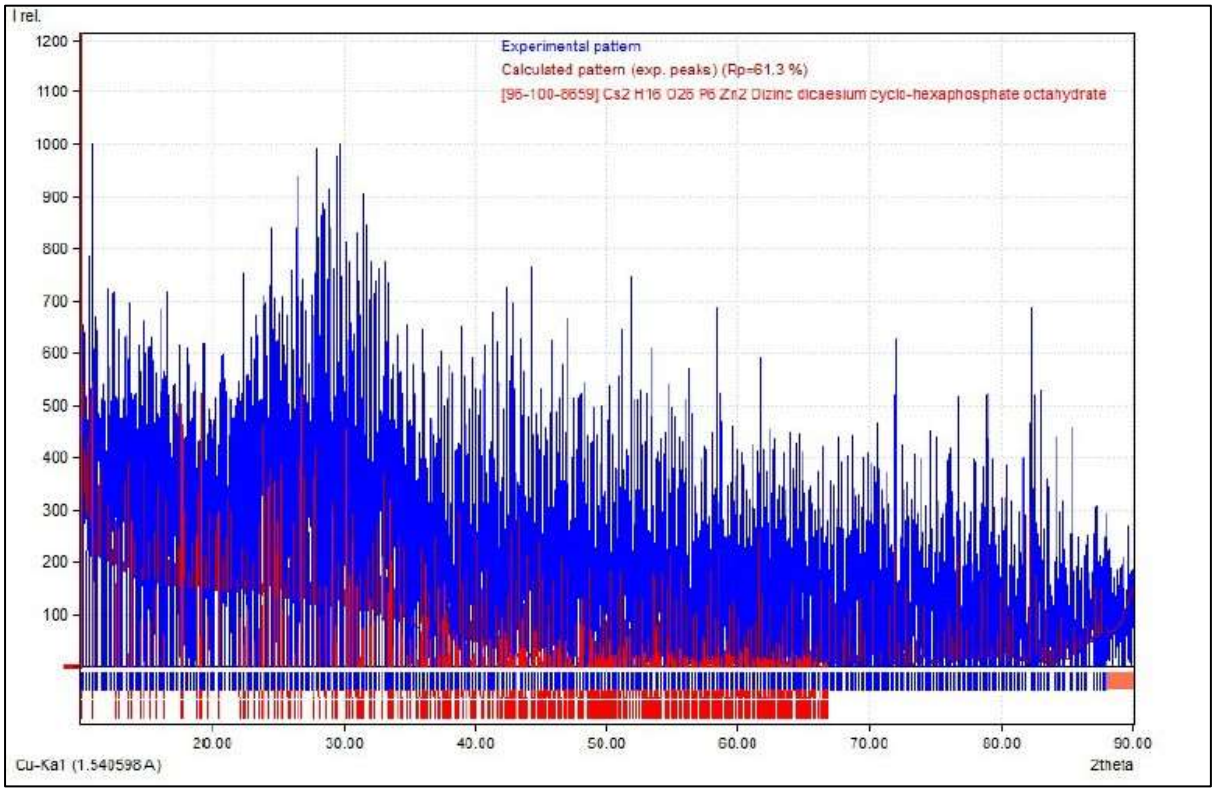


Fig 7(b). Graphical representation of XRD analysis of CTWC at 1% CF.

Fig 7(a) and 7(b) shows the different chemical compositions that are identified in the sample using X-Ray diffraction. But, as the sample is majorly with calcium the report shows that the density of calcium is 4.05g/cm^3

for 15% replacement with ceramic tiles and 2.732g/cm^3 is for 15% CTWC with 1% coconut fibre which is a sign that shows the sample manufactured using ceramic tile and coconut fibre is so crystalline. The report also suggest that XRD analysis graphs with peaks containing phase composition of meionite and marialite in most cases of orientation for 15 % CTWC and CTWC with 1% coconut fibre.

5. Conclusion

The concrete made from the ceramic tile waste as a partial replacement to coarse aggregate with addition of coconut fibre has given some better results when in compared to conventional concrete. The following are the conclusions made.

- ***Compressive strength:*** The compressive strength of the ceramic tile waste concrete is 54.88MPa at 15% replacement without the addition of fibre which is optimum percentage of replacement of ceramic tile to concrete and for CTWC CF of 1% the compressive value is 51.33MPa
- ***Split Tensile Strength:*** The Split tensile value of the CTWC is 2.45MPa at 15% replacement without the addition of fibre which is optimum percentage of replacement of ceramic tile to concrete. and for CTWC CF of 1% the split tensile value is 2.748MPa
- ***Flexural Strength:*** The flexural resistance value of the CTWC is 7.72MPa at 15% replacement without the addition of fibre which is optimum percentage of replacement of ceramic tile to concrete and for CTWC CF of 1% the flexural resistance value is 7.92MPa. The use of fibre in concrete is to reduce the crack initiation and here, in this case we have the positive results.
- ***Impact Test:*** final crack for CTWC of 15% replacement is at 381blows and for CTWC CF of 1% addition of fibre is at 476blows. The sudden loading resistance is also suggested as a better alternative to use in cement concrete roads.

The final conclusion that can be made on this research work is that the concrete made from ceramic tile waste can be used as building material. the CTWC when added with coconut fibre it has shown some greater results in terms holding the concrete from cracking and controlled in crack initiation.

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