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Green Concrete Development Using Industrial and Agricultural Waste Materials: Ceramic Insulator and Tea Ash

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ABSTRACT: The growing need for eco-friendly building materials has led to thorough research on using waste from industries and agriculture in concrete. This research looks at how crushed ceramic insulator waste (CCIW) can partially replace fine aggregate and how waste tea ash (WTA) can serve as a partial substitute for cement in concrete. Fine aggregate was substituted with CCIW in amounts of 0%, 5%, 10%, 15%, 20%, 25% and 30%, while cement was replaced with WTA at levels of 0%, 2.5%, 5%, 7.5% and 10% by weight for M40 Grade of concrete. Before mixing, the physical and chemical properties of the waste materials were analyzed.

Different concrete mixtures were created and tested to measure workability, density, compressive strength, split tensile strength, flexural strength, and water absorption at different curing times (7, 14, and 28 days) for M40 Grade of concrete.

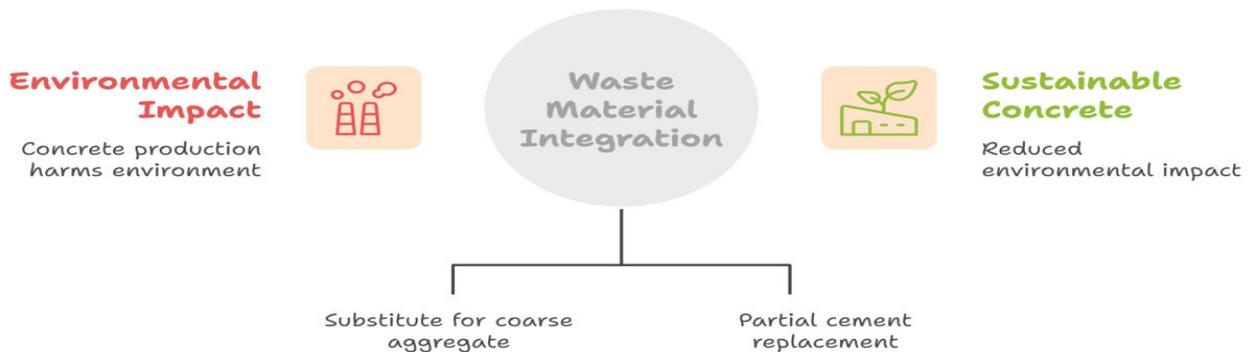
The findings showed that using CCIW slightly decreased workability because of its uneven and porous texture, while WTA affected how quickly the concrete sets and its early strength. The best results were seen with 0–30% CCIW and 0–10% WTA, where the compressive strength was similar to the regular mix. Going beyond these percentages led to a gradual decrease in strength, mostly due to higher porosity and less reactivity of the binder. However, all the adjusted mixes showed adequate strength and some tests for applications that don't require heavy loads. The study concludes that using crushed ceramic insulator waste along with waste tea ash offers a practical and sustainable alternative to traditional materials, encouraging recycling and minimizing the environmental impact of concrete manufacturing.

KEYWORDS: Crushed Ceramic insulator waste, Waste Tea Ash, regular mix, porosity

I. INTRODUCTION

Concrete stands as the most prevalent building material globally, recognized for its adaptability, strength, and relative affordability. Nonetheless, its manufacturing process leads to considerable environmental challenges, mainly due to the substantial energy usage and carbon dioxide output from cement production, in addition to the heavy extraction of natural aggregates. In light of increasing worries surrounding sustainability and environmental safeguarding, researchers are investigating methods to create eco-friendly or “green” concrete using waste materials from industrial and agricultural sources.

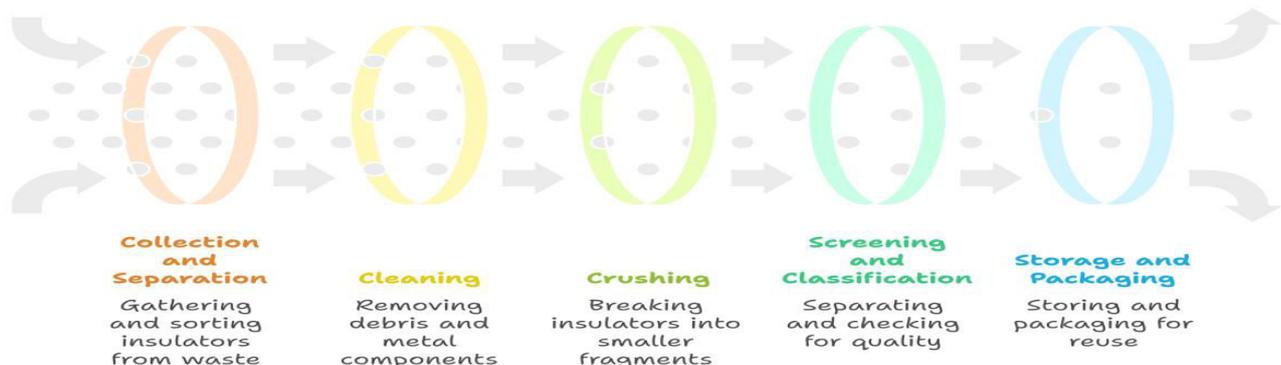
Creating Green Concrete with Waste



Crushed Ceramic Insulator Waste (CCIW):

The building sector is always looking for green options to traditional materials to lessen harm to the environment and decrease the use of natural resources. One of the promising methods is using waste from factories when making concrete. In this case, waste from ceramic insulators has drawn interest because it contains a lot of silica and alumina, is very heat-resistant, and is naturally strong. When this waste is crushed into fine or larger pieces, it can serve as a substitute for natural stones, creating what we call Crushed Ceramic Insulator Waste (CCIW).

Ceramic insulators are commonly found in the electrical and telecommunications fields, and many of them become useless due to breaking or being taken out of service. Throwing these materials in landfills adds to pollution. By reusing CCIW in concrete, we can cut down on waste, save natural stones, and create environmentally friendly, light, and strong concrete.



Waste Tea Ash (WTA):

Waste Tea Ash (WTA) is a growing eco-friendly substance created from the burning of spent tea leaves, which are one of the most prevalent organic waste products found globally. Daily, vast amounts of tea are consumed, and the way used tea leaves are discarded raises environmental issues due to inadequate waste handling and decay processes. By burning these exhausted leaves in regulated manner, WTA is generated—a fine gray powder that is rich in silica (SiO_2), alumina (Al_2O_3), calcium oxide (CaO), along with various other oxides.

Recent research has investigated the use of WTA as a potential supplementary cementitious material (SCM) or an additive in construction projects. When added to concrete, mortar, or bricks, WTA can improve mechanical strength, decrease porosity, and enhance longevity, while also lessening the dependence on conventional cement and decreasing carbon emissions.



II. LITERATURE SURVEY

Experimental Investigation on Partial Replacement of Waste Ceramic Powder in Concrete — Santhosh Kumar E & Parkavi D C-This experimental study evaluates the feasibility of using waste ceramic powder as a partial replacement for ordinary Portland cement in M-25 concrete. Cement was replaced at 0, 10, 20, 30, 40 and 50% levels and specimens were tested for compressive, split tensile and flexural strengths at 7 and 14 days, alongside water absorption tests. Results indicate that replacements up to approximately 30% provide acceptable mechanical performance with reduced water absorption, while higher replacement levels lead to a notable reduction in early-age strength. Microstructural observations suggest improved particle packing and reduced porosity at optimal replacement percentages. The study demonstrates that appropriately processed ceramic powder can serve as a sustainable cementitious additive, contributing to waste valorization and reduced cement consumption. Ceramic Waste Powder as a Partial Substitute of Fly Ash for Geopolymer Concrete Cured at Ambient Temperature — Jay K. Bhavsar & M. S. Patel.

Tea Waste Ash: Characterization, Pozzolanic Activity, and Effects on the Fresh Properties of Cement Pastes by Bekem Kara & Cuma Kara (2025) – Challenge: Concrete Research Letters. This experimental study focuses on the characterization and pozzolanic evaluation of tea waste ash (TWA) produced by burning spent tea leaves at 850 °C. The chemical composition, mineralogical structure, and particle morphology were determined using XRF, XRD, and SEM analyses. Tea waste ash was then used to replace cement at 2%, 4%, 6%, 8%, and 10% levels in cement pastes, and the effects on water demand, consistency, and setting times were measured. Although the pozzolanic reactivity was found to be limited, small substitutions (up to 8%) provided acceptable workability and setting characteristics. The study suggests potential use of TWA as a supplementary or accelerating additive in cementitious systems.

III. METHODOLOGY

Cement

A cement particle bonds firmly to the stone when it comes into touch with water. The compounds found in cement stay in the finished result, giving it the desired qualities and encouraging its inclusion into the concrete. The cement is ACC cement, more precisely Ordinary Portland cement (OPC 43 Review).

Fine Aggregate

Fine sums are tiny particles with a diameter of 4.75mm that are extensively used in the improvement business. They are used to fill the gaps between larger particles, which are mostly made of 77% calcium oxide. This improves the dimensional robustness of the concrete mix. The sand used is locally obtained and fits zone I specifications. It underwent strainer testing inside the investigation office in accordance with IS 383:1970 guidelines.

Coarse Aggregate

The coarse particles of a certain size and irregular shape used in development activities make up the approximate amounts acquired by the mining approach. These sizes, which include ratings exceeding 40mm, 20mm, and 10mm, are offered in the showcase. This raises the concrete's quality considerably. According to IS 383-1970, the quantity utilized is roughly one and rated at 20 mm.

Crushed Ceramic Insulator Waste

It is used as a partial replacement for fine aggregate is produced through a systematic process that ensures the waste material attains suitable characteristics for incorporation into concrete. The manufacturing process begins with the collection of discarded ceramic insulators from electrical substations, transmission line maintenance sites, and ceramic industries.

Waste Tea Ash

It is used as a partial replacement for cement is produced through a controlled process that converts discarded tea residues into a fine, cementitious powder suitable for concrete applications. The process begins with the collection of used tea waste generated from households, restaurants, tea stalls, and food industries. The collected tea waste is first cleaned to remove contaminants such as plastics, sugar residues, or non-organic materials that may negatively affect the ash quality.

Methodology

1. Understudy of WTA to Cement & CCIW to Sand with a fixed proportion of 10% in cement & a variable proportion of 0%-40% with frequency of 10% in Sand respectively.
2. Property check of Compressive Strength for cubes with a size of 150mm*150mm*150mm.
3. Property check of Tensile Strength for cylinder with dimensions of 150mm diameter & 300mm Height.
4. Property check of Bending Strength for Beam with a dimensions of 500mm*100mm*100mm.



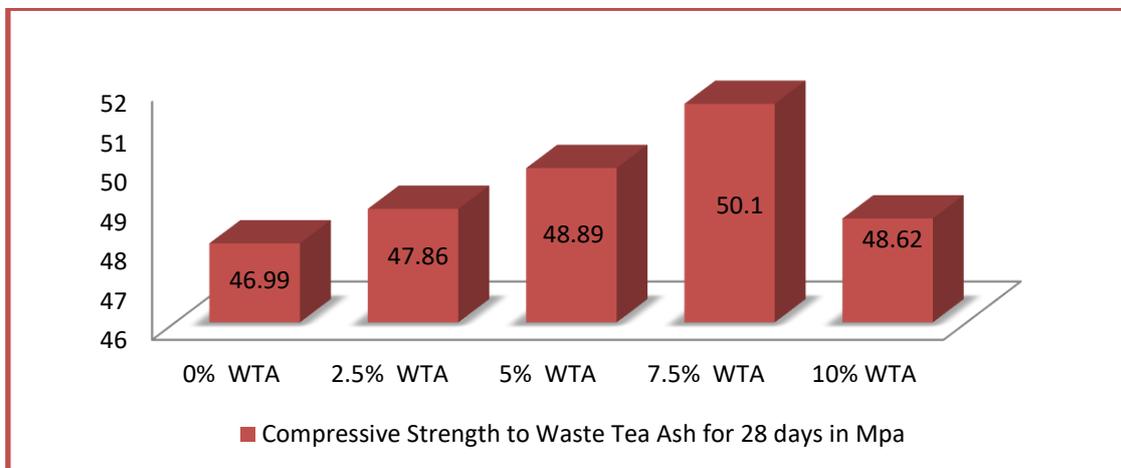
(a) Casting of concrete cubes



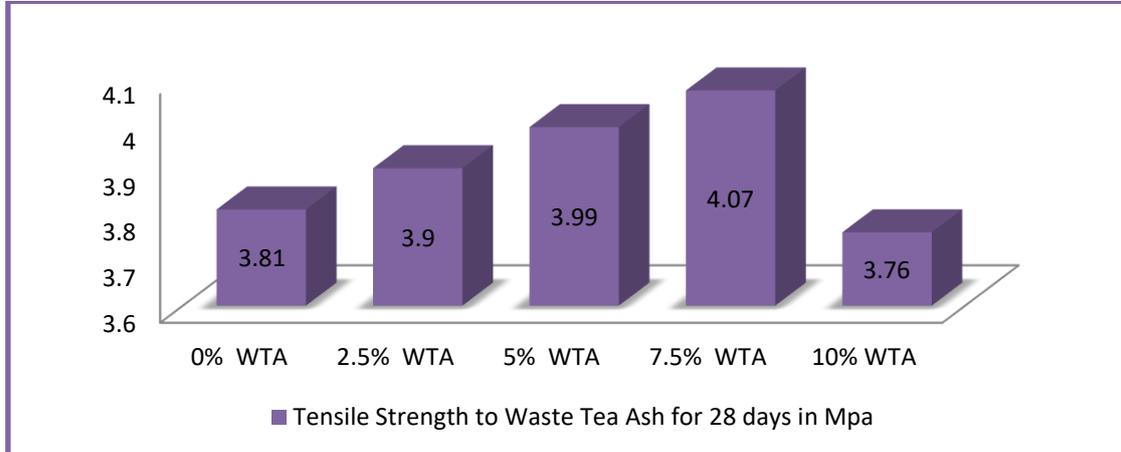
(b) Curing of cubes, cylinders and beams

IV. EXPERIMENTAL RESULTS

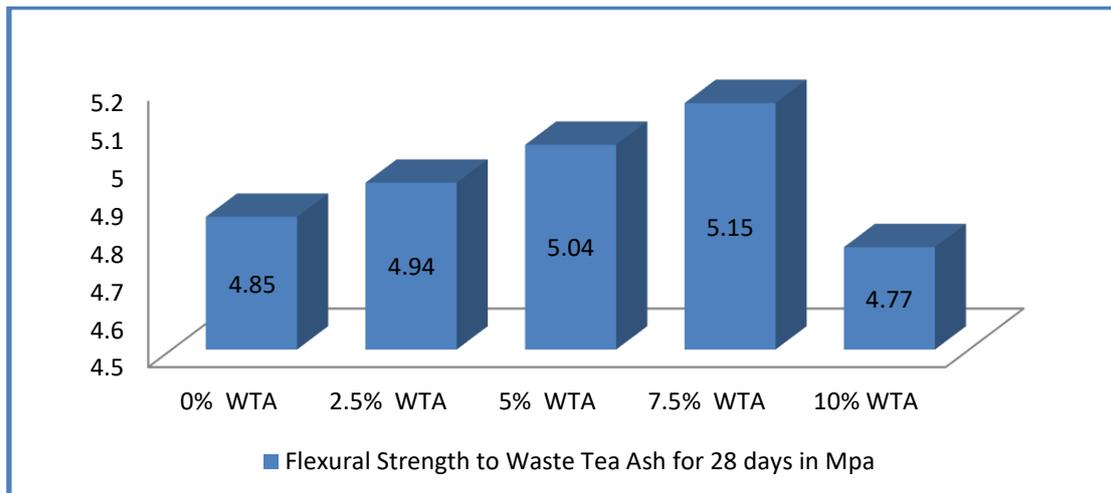
Compressive Strength To Waste Tea Ash For 28 Days At Different Percentages



Split Tensile Strength To Waste Tea Ash For 28 Days At Different Percentages



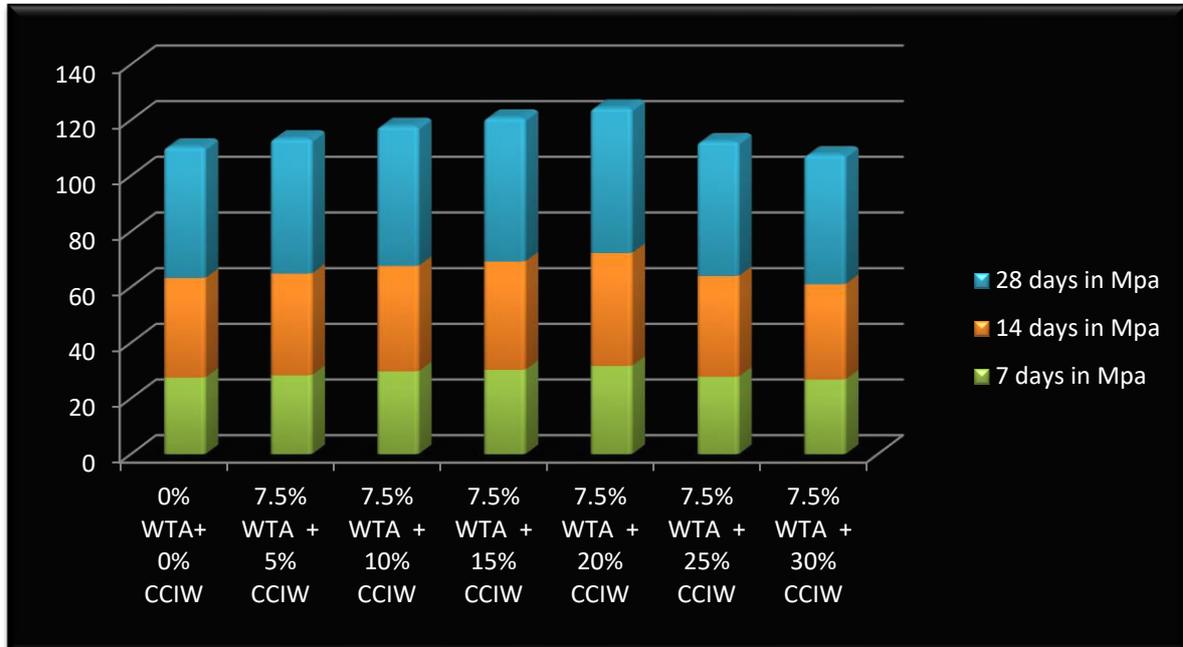
Flexural Strength To Waste Tea Ash For 28 Days At Different Percentages



Compressive Strength Test Results for 7 days, 14 days & 28 days

Table 1: Test results of Compressive Strength at 7 days, 14 days & 28 days

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0% WTA+ 0% CCIW	27.54	35.77	47.12
7.5% WTA + 5% CCIW	28.38	36.54	48.45
7.5% WTA + 10% CCIW	29.77	37.89	50.19
7.5% WTA + 15% CCIW	30.34	38.93	51.58
7.5% WTA + 20% CCIW	31.73	40.55	52.14
7.5% WTA + 25% CCIW	27.85	36.2	48.35
7.5% WTA + 30% CCIW	26.85	34.24	46.55

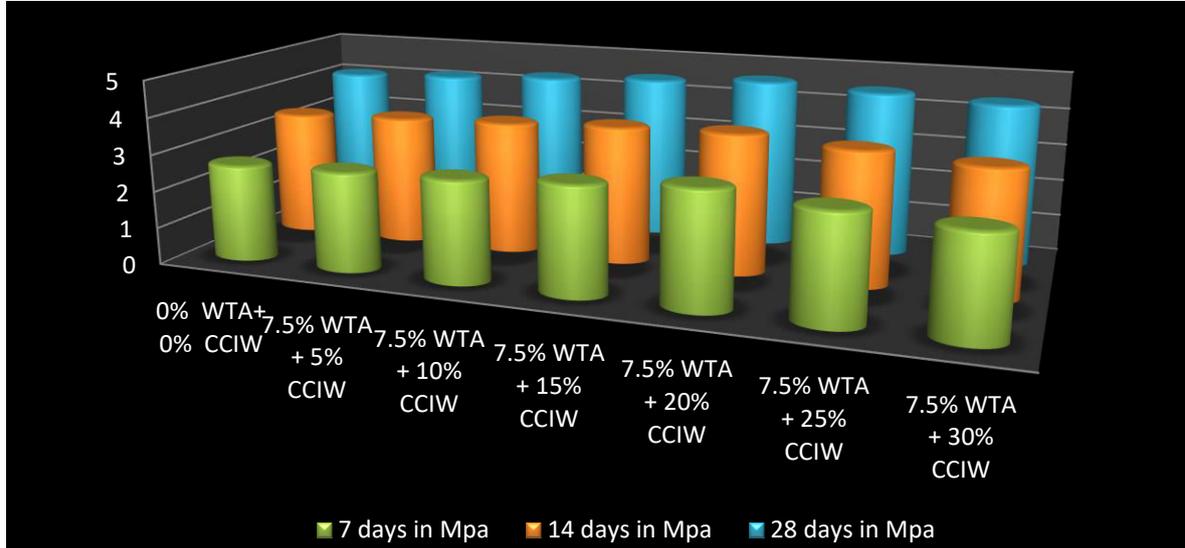


Graph 1 Test results of Compressive Strength at 7 days, 14 days & 28 days

Split Tensile Strength Test Results for 7 days, 14 days & 28 days

Table 2: Test results of Split Tensile Strength at 7 days, 14 days & 28 days

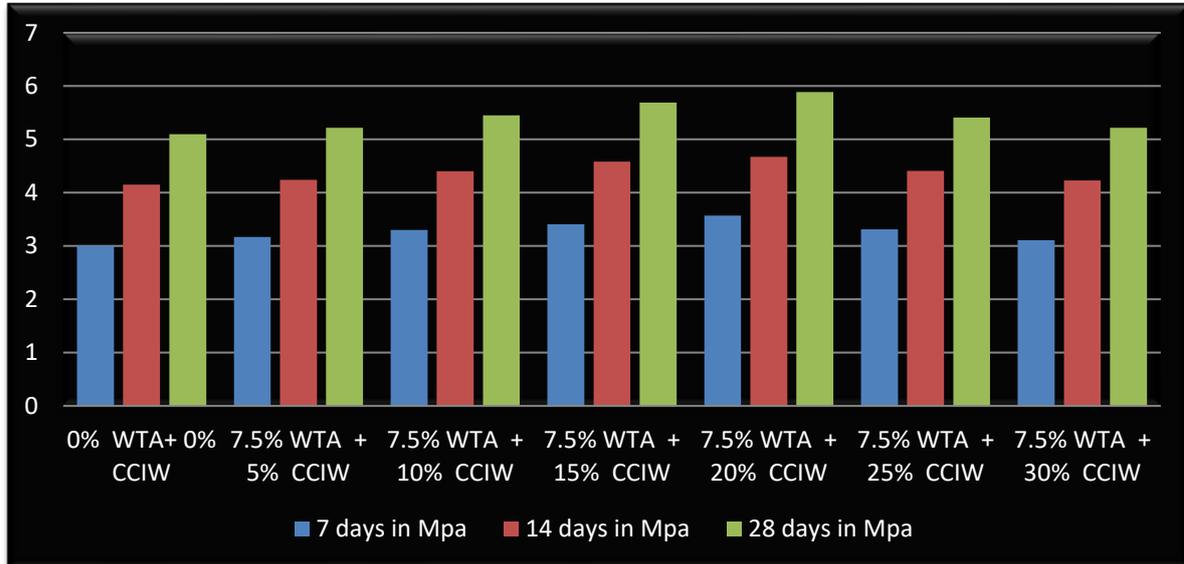
Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0% WTA+0% CCIW	2.64	3.42	4.1
7.5% WTA + 5% CCIW	2.72	3.53	4.21
7.5% WTA + 10% CCIW	2.8	3.62	4.35
7.5% WTA + 15% CCIW	2.96	3.74	4.48
7.5% WTA + 20% CCIW	3.15	3.8	4.62
7.5% WTA + 25% CCIW	2.91	3.62	4.5
7.5% WTA + 30% CCIW	2.75	3.45	4.39



Graph 2 Test results of Compressive Strength at 7 days, 14 days & 28 days

Table 3: Test results of Flexural Strength at 7 days, 14 days & 28 days

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0% WTA+ 0% CCIW	2.64	3.42	4.1
7.5% WTA + 5% CCIW	2.72	3.53	4.21
7.5% WTA + 10% CCIW	2.8	3.62	4.35
7.5% WTA + 15% CCIW	2.96	3.74	4.48
7.5% WTA + 20% CCIW	3.15	3.8	4.62
7.5% WTA + 25% CCIW	2.91	3.62	4.5
7.5% WTA + 30% CCIW	2.75	3.45	4.39



Graph 3 Test results of Compressive Strength at 7 days, 14 days & 28 days

V. CONCLUSION

Current research shows that waste tea ash (WTA) can be used as a partial cement substitute in concrete, whereas crushed ceramic insulator waste (CCIW) can be used as a partial fine aggregate replacement. Due to its angular form and surface texture, which improved the connection between the aggregate and cement paste, the integration of CCIW enhanced particle packing and contributed to good mechanical performance. When the quantity of CCIW used to replace concrete was at its best, the resulting concrete displayed comparable or higher strength qualities when compared to regular concrete.

When utilized in regulated quantities as a partial cement replacement, WTA likewise demonstrated encouraging results at 7.5%WTA gives the highest value for compressive strength and taking it as constant and other CCIW is changed to know the maximum strength of concrete. Due to its pozzolanic properties, WTA facilitated secondary hydration processes, which resulted in increased strength and densification of the concrete matrix at later stages. However, because of the dilution of cement content, excessive substitution levels of WTA led to lower workability and strength.

By lowering the environmental impact associated with cement production, reducing the use of natural resources, and minimizing industrial and agricultural waste disposal, the combined use of CCIW and WTA in concrete optimum values at 7.5%WTA and 20%CCIW gives the compressive strength of concrete is 52.14MPa and also provides a sustainable and environmentally responsible alternative to traditional materials overall. The study concludes that CCIW and WTA may be used effectively in concrete if properly proportioned, without sacrificing performance, making them viable materials for sustainable building techniques.

REFERENCES

1. Paul, S. C., Faruky, S. A. U., Babafemi, A. J. et al. (2023) – Eco-friendly concrete with waste ceramic tiles as coarse aggregate: mechanical strength, durability, and microstructural properties.
2. The Use of Waste Ceramic in Concrete: A Review (2024) – Overview of ceramic waste utilization and mechanical effects.
3. Joshi, T., Dave, U., Raman, S. N. et al. (2025) – Evaluation of strength, durability, and microstructural properties of concrete with ceramic waste aggregates.

Volume 15, Issue 3, March 2026

|DOI: 10.15680/IJIRSET.2026.1503126|

4. Utilisation of Ceramic Stoneware Tile Waste as Recycled Aggregate in Concrete” (2023) – Effects on compressive and tensile strength with recycled ceramic aggregate.
5. Performance of Ceramic Tiles Waste as a Partial Replacement of Brick Aggregate on Concrete” (2024)
6. Caronge, M. A., Tjaronge, M. W., Rahim, I. R. et al. (2022) – Feasibility study on the use of processed waste tea ash as cement replacement for sustainable concrete production.
7. Djamaluddin, A. R., Caronge, M. A., Tjaronge, M. W. et al. (2020) – Evaluation of sustainable concrete paving blocks incorporating processed waste tea ash.
8. Caronge et al. (2022) – Similar study on PWTa with strength indices analysis showing pozzolanic effects of up to 10% replacement.
9. Kara, B. (2025) – Characterization and pozzolanic activity of tea waste ash in cement mortar.



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