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Partial Replacement of Coarse Aggregate in Concrete with Waste Ceramic Tiles

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ABSTRACT: This study examines the compressive strength of concrete cubes using varying proportions of waste ceramic tiles as a substitute for coarse aggregate. The primary goal is to evaluate the viability of integrating ceramic waste into concrete production and its influence on concrete quality. Compressive strength tests were performed on concrete cubes containing replacement percentages of 18%, 20%, 22%, 23%, and 25%, and the results were compared with those of regular concrete cubes. The outcomes suggest that up to a certain replacement percentage, concrete's compressive strength improves, indicating the potential enhancement of concrete properties with the inclusion of waste ceramic tiles. However, beyond this threshold, a decrease in compressive strength occurs, underscoring the importance of optimizing replacement percentages to maintain desired strength characteristics. These findings align with prior studies, underscoring the necessity for controlled integration of ceramic waste in concrete mixes to achieve optimal performance. This study contributes to the expanding knowledge base on sustainable construction materials and practices, highlighting the potential of waste ceramic tiles as a valuable resource in concrete production. Further exploration into optimal mix designs and long-term durability is recommended to enhance the incorporation of waste ceramic tiles in concrete production and promote sustainable construction practices.

KEYWORDS: Waste ceramic tiles, Concrete production, Coarse aggregate replacement, Compressive strength, Sustainability, Sustainable construction, Waste management, Optimization, Mix design, Environmental impact

I. INTRODUCTION

Concrete stands as a cornerstone of modern construction, prized for its robustness, versatility, and widespread applicability. Its fundamental composition, a blend of aggregates bound together by cement, primarily Portland cement, renders it indispensable in a myriad of construction projects, spanning from towering skyscrapers to intricate infrastructure. Yet, amid its ubiquity, concrete production poses significant environmental challenges, chiefly due to the substantial carbon footprint associated with cement manufacturing.

In response to mounting environmental concerns, the construction industry is increasingly turning towards sustainable practices to mitigate its ecological impact. Sustainable construction endeavors to minimize the environmental repercussions of building activities across their entire lifecycle, encompassing design, construction, operation, and eventual dismantling. Within this framework, the management of construction and demolition waste emerges as a critical focal point, with non-biodegradable materials like ceramic tiles posing a particularly daunting challenge.

Ceramic tiles, prized for their durability and aesthetic appeal, contribute significantly to construction and demolition waste streams. Their disposal not only burdens landfills but also exacerbates environmental degradation and greenhouse gas emissions. To counteract this trend, innovative approaches are imperative, and one such avenue involves repurposing waste ceramic tiles as a partial replacement for coarse aggregate in concrete.

Despite the potential benefits of this approach, the research landscape remains relatively uncharted, lacking comprehensive studies on its efficacy and implications. This study endeavors to address this gap by delving into the

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feasibility and effectiveness of utilizing waste ceramic tiles in concrete. Through meticulous experimentation, we aim to assess their impact on concrete's mechanical properties, durability, and overall sustainability.

By elucidating the optimal percentage of ceramic tile replacement, analyzing its effects on concrete performance, and evaluating its sustainability credentials, this study seeks to inform and advance sustainable construction practices. Through such endeavors, we endeavor to foster a more environmentally conscious approach to construction, where waste materials are transformed into valuable resources, contributing to a more sustainable built environment for future generations.

II. OBJECTIVE OF THE STUDY

This study aims to assess the feasibility of incorporating ceramic waste into concrete production, focusing on its impact on concrete quality, particularly compressive strength. Material testing will be conducted on cement, fine aggregate, and coarse aggregate to analyze their physical and mechanical properties. Experimental testing will determine the effect of various replacement percentages (ranging from 18% to 25%) of waste ceramic tiles on the compressive strength of concrete cubes. Comparative analysis will be conducted between concrete cubes containing waste ceramic tile replacements and conventional concrete cubes. The study will identify the optimum replacement percentage that maximizes compressive strength while utilizing waste ceramic tiles, considering material characteristics and concrete performance. Correlations between material properties and concrete strength will be investigated to provide insights into strength enhancement or degradation mechanisms. Recommendations for optimizing mix designs will be proposed based on the material properties of waste ceramic tiles and traditional concrete components, aiming to enhance sustainability and durability in concrete structures.

III. LITERATURE REVIEW

Subedi et al. (2020) explored the use of crushed ceramic tile waste as a partial replacement for coarse aggregate in concrete production. They found that incorporating 15 to 25 percent of ceramic tile aggregate improved concrete quality while addressing waste management issues and reducing reliance on natural aggregates. This approach not only enhanced mechanical properties but also contributed to environmental conservation by reducing the environmental impact of natural aggregate extraction. Additionally, the study highlighted the economic feasibility of using waste ceramic tile aggregate, offering cost savings in concrete production. Overall, the research emphasizes the benefits of incorporating waste ceramic tiles in concrete for improved quality, sustainability, and economic efficiency, while suggesting avenues for further research on optimal mix designs and long-term durability.

Kumar et al. (2016) investigated the partial replacement of sand by ceramic waste in concrete. They experimented with different percentages of ceramic waste (10% to 50%) in M25 grade concrete and evaluated compressive and tensile strength at various curing periods. Results showed that ceramic waste could be used as a partial replacement for fine aggregate, but higher percentages led to reduced concrete strength. Optimal replacements of 10% and 20% showed consistent performance in both compressive and tensile strength. Based on their findings, they suggested that replacing 30% of river sand with ceramic waste in M25 grade concrete could maintain the required strength. The study contributes to sustainable construction practices, highlighting the feasibility of using ceramic waste in concrete production, with further research needed to explore its effects on other concrete properties.

Swathi DP et al. (2020) investigated replacing sand with ceramic waste in concrete. Testing various percentages (10% to 40%) in M20 grade concrete, they found up to 30% replacement increased compressive strength. Tensile strength also rose with ceramic waste addition at the 28-day curing period. They concluded ceramic waste could effectively replace fine aggregate in M20 grade concrete up to 30%. This study showcases ceramic waste as a sustainable alternative in concrete production, prompting further research on its properties.

Murlidharan T et al. (2018) investigated partial replacement of fine aggregate with ceramic waste in concrete. Testing various percentages (15% to 30%) in M25 grade concrete, they found increased ceramic waste led to reduced concrete strength. However, consistent tensile strength was observed at 14 days for replacements ranging from 15% to 30%. They concluded 30% replacement provided adequate strength. This study contributes to sustainable construction

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practices by demonstrating ceramic waste feasibility in concrete production, suggesting further exploration of its effects on other concrete properties.

Samadi et al. (2014) investigated the effects of ceramic powder on mortar by replacing cement with ceramic waste. Testing various percentages (10% to 40%) in mortar, they found that 20% replacement produced the highest compressive strength at all ages. This suggests that ceramic waste, as a fine powder, can enhance mortar performance as a pozzolanic material. The study underscores the potential of ceramic waste as a sustainable alternative to traditional cement in mortar production, aiding in landfill reduction and addressing environmental concerns. Further research could explore the optimal percentage of ceramic waste replacement and its impact on other mortar properties.

Pacheco-Torgal et al. (2009) explored reusing ceramic waste in concrete. Their findings indicate that replacing 20% of cement with ceramic waste resulted in minor strength loss but increased durability. Concrete mixtures with ceramic aggregates outperformed control mixtures in terms of compressive strength, capillary water absorption, oxygen permeability, and chloride diffusion, leading to more durable structures. A water-cement ratio of 0.5 was utilized.

Medina et al. (2013) examined the water resistance properties of recycled ceramic aggregate concretes. Their study focused on substituting 20% and 25% recycled sanitary ware for gravel in coarse aggregate to assess structural recycled concrete resistance to water. Findings indicated that despite slightly higher porosity, the recycled concrete did not exhibit greater permeability. These new recycled concretes were found to be as durable as conventional materials, suggesting good performance throughout their design service life.

Gonzalez Corominas et al. (2014) investigated high performance concrete (HPC) made with recycled fine ceramic and coarse mixed aggregates. Waste material from building demolition and the ceramic industry was utilized. HPC was produced using fine ceramic aggregates (FCA) to substitute 15% and 30% of natural sand, and coarse mixed aggregates (CMA) to substitute 20%, 50%, and 100% of natural coarse aggregates. The study evaluated the physical, mechanical, and durability properties of the recycled aggregate concretes compared to conventional concrete. Findings revealed that concrete with up to 30% FCA achieved similar or improved properties compared to conventional concrete. Additionally, concrete with up to 20% CMA attained similar compressive strength to High Performance conventional Concrete of 100 MPa, with low corrosion risk observed at 180 days of curing for concretes with up to 50% CMA.

Literature Gap

The literature review underscores the growing interest in utilizing waste ceramic tiles in concrete production, citing benefits like improved mechanical properties and environmental sustainability. However, a gap exists regarding specific replacement percentages (18%, 20%, 22%, 23%, and 25%) in M30 grade concrete. Addressing this gap, our project aims to evaluate the feasibility of using waste ceramic tiles in M30 grade concrete, providing valuable insights for sustainable construction practices.

IV. MATERIALS AND METHODOLOGY

4.1 Materials used

1. Waste Ceramic Tiles

Waste ceramic tiles can replace coarse aggregate in concrete, offering sustainability by reusing materials. Crushed tiles need proper sizing and grading for bonding with cement paste, ensuring concrete strength and workability. This approach conserves natural resources, diverts waste from landfills, and improves concrete properties like thermal and acoustic insulation. Properties of waste ceramic tile powder include inorganic composition, chemical and biological resistance, high silica and alumina content, strength, good frictional behavior, thermal expansion coefficient similar to cement, corrosion resistance, and modulus of elasticity comparable to steel. These characteristics make ceramic powder versatile for various industries, including construction. *(Bhavin k vaghadia et. al 2016)*

In our project, Waste Ceramic Tiles is being used as a partial replacement for coarse aggregate in concrete mixes. This means that a portion of the coarse aggregate in the concrete mix is being replaced with Waste Ceramic Tiles. The percentage of replacement can vary depending on the desired properties of the concrete.

2. Cement

In concrete mixes, cement acts as a binding agent, holding the components together to form a solid matrix. It's crucial for achieving desired strength and durability. When partially replacing coarse aggregate with waste ceramic tiles, cement remains essential for bonding the remaining components. Proper selection and proportioning of cement are necessary for optimal concrete performance. Cement undergoes various tests to ensure quality and adherence to standards, including fineness, initial and final setting time, normal consistency, and color tests. These tests help evaluate properties like particle size, setting time, and consistency, ensuring uniformity and reliability in concrete construction.

OPC 43 Grade of Cement (confirming IS-269) is used for casting of Normal Concrete samples and Waste Ceramic Tiles Concrete samples

3. Coarse Aggregate

Coarse aggregates are essential components in concrete mixes, providing strength and durability. Even in M30 concrete, partially replacing them with waste ceramic tiles, coarse aggregates remain crucial. Their characteristics influence concrete strength and workability. Proper selection and management are essential for high-quality concrete. Tests like specific gravity, water absorption, and abrasion value help assess aggregate properties, ensuring optimal concrete performance.

20 mm to 40mm Coarse aggregate was used in this project for both Normal and Waste Ceramic Tiles Concrete. Coarse aggregate sieve analysis was determined according to ASTM C 136.

4. Fine Aggregate

Fine aggregate, or sand, is vital in concrete mixes, contributing to workability, strength, and durability. In M30 concrete, even with partial replacement of coarse aggregate with waste ceramic tiles, fine aggregate remains crucial. Properly graded sand ensures good bonding with cement paste, maintaining concrete strength. Tests like sieve analysis, specific gravity, water absorption, and moisture content assess fine aggregate properties, ensuring optimal concrete performance.

5. Water

Water is crucial in concrete, hydrating cement for setting and hardening. The water-to-cement ratio (w/c ratio) impacts concrete strength and durability, with lower ratios typically yielding stronger results. In M30 concrete with partial coarse aggregate replacement by waste ceramic tiles, water management is key. Adjusting the w/c ratio may be necessary to maintain desired properties. Absorption by waste tiles must be considered, and proper curing is vital for hydration. Water quality conforms to standards, free from contaminants like oils or salts, ensuring optimal concrete performance.

Fig. 1. Materials Used

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4.2 Methodology

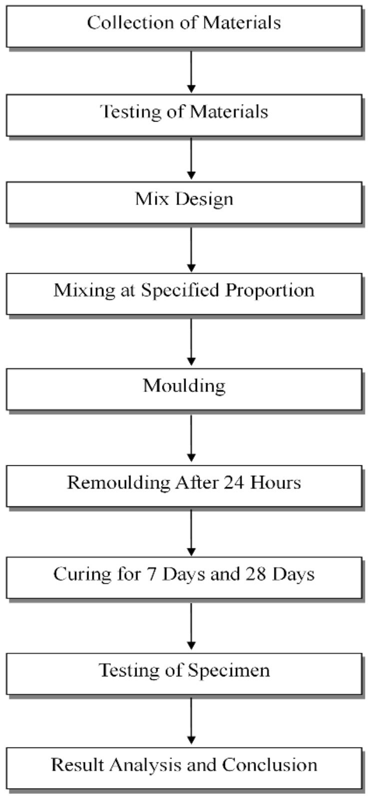

Fig. 2 Schematic Flow of Methodology

In the initial step, all essential materials for creating the concrete mix and test specimens are gathered. These typically include cement, sand, gravel, water, and waste ceramic tiles.
During the mix design phase, specific quantities of each ingredient are determined to influence the concrete's final properties, such as strength. Researchers experiment with various mix ratios to find the optimal combination for incorporating waste ceramic tiles while achieving desired strength.
Once the mix design is finalized, concrete ingredients are combined according to predetermined proportions. Mechanical mixers may be used to ensure a homogeneous mixture.
The prepared concrete mix is then poured into molds to shape the specimens that will be tested for strength. Molds determine the shape of the concrete specimens.
After 24 hours, concrete specimens are removed from the initial molds. This allows them to undergo further curing and testing.

During curing, concrete specimens are placed in a controlled environment with specific temperature and humidity conditions. The curing periods specified are typically 7 days and 28 days.
After the curing period, concrete specimens undergo testing to determine mechanical properties such as compressive and flexural strength. This data is crucial for assessing the effectiveness of the mix design in incorporating waste ceramic tiles for strength optimization.
Finally, researchers analyze the data collected from tests performed on concrete specimens. This analysis helps determine the optimal mix design for using waste ceramic tiles to achieve the desired strength in fiber-reinforced concrete.

4.3 Collection of Raw Materials for Normal and Waste Ceramic Tiles Concrete
Portland Pozzolona Cement (PPC): Ultratech cement collected from local market traders, Gaddigodam, Nagpur
Fine Aggregate: Fine aggregate collected from the Kanhan Quarry
Coarse aggregate: Aggregates passing through 20mm IS sieve
Waste Ceramic Tiles: Collected from Janta Traders, Godhni, Nagpur
Water: Collected from tap water

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4.4 Mix Design

Mix design is defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. Generally we are using M30 grade of concrete for better result

Mix design of M30 grade concrete as per Indian standard codebook:

Normally we used w/c ratio falls under 0.4 to 0.6 as per IS Code 10262 for nominal mix M30 (1:0.75:1.5)

Mixing of Waste Ceramic Tiles

In our experiments, we are focusing on M30 grade concrete mixed with waste ceramic tiles as an admixture. This research involves replacing a range of coarse aggregate with waste ceramic tiles, specifically 18%, 20%, 22%, 23%, and 25%. The primary objective of this study is to assess how the inclusion of waste ceramic tiles affects the performance characteristics of the concrete. By using waste materials as substitutes for traditional components, we aim to explore sustainable practices in concrete production, reduce environmental impact, and promote recycling efforts. This research is crucial for advancing sustainable construction practices and addressing environmental challenges in the construction industry.

Water-cement ratio 0.47 was used in this research. The details of mixes are shown in Table 1

Table 1. Mix Design Calculation

Trail Mix No.						
Mix Requirement			**Mix Input Data**			
Grade	M-30		Material		Specific Gravity	Source
Min. Slump.	100 mm		Cement		3.15	Birla A1
Exposure Type	Moderate		Coarse Aggregate	20mm	2.88	Panchgaon
Maximum Size of Aggregate	20 mm			12mm	2.88	
			Fine Aggregate	Natural Sand	2.67	Kanhan
1.Target Mean Strength (Mpa) As per MORTH Section-1700		27	6.Cement Content(Kg/Cum)			300
2.Maximum W/C Ratio as per MORTH Rev. Fourth Section-1700		0.45	7.Adopted W/C Ratio			0.42
3.Minimum Cement Content(Kg/Cum) as per MORTH Rev. Fourth Section-1700		300	8.Water Content (Kg/Cum)			190
4. Fine Aggregate(%) (Na. Sand)		40%	Natural Sand			70
5. Coarse Aggregate (%) (20mm and 10mm)		60%	20mm Agg.(%)			65
			10mm Agg.(%)			35
A) Volume of expected air [a] (As specified through IS 10262)					0.01	Cu.m
B) Volume of the Solid Concrete = (1-a)					0.98	Cu.m
C) Volume of Cement = (Weight of cement/Sp.Gr of Cement)/1000					0.12518	Cu.m
D) Volume of Water = (Weight of water/Sp.Gr of water)/1000					0.19716	Cu.m
E) Volume of Admixture = (Weight of Admixture/Sp.Gr of Admixture)/1000					0.0000	Cu.m
F) Volume of Total aggregate = (B - (C+D+E))					0.66766	Cu.m
G) Volume of Fine Aggregate = (F x % of Fine Aggregate)					0.38	Cu.m
Natural Sand (%)					0.1937026	Cu.m

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<table>
<tr><td colspan="5">H)Volume of Coarse Aggregate = (F - G)</td><td>0.62</td><td>Cu.m</td></tr>
<tr><td colspan="5">I) Volume of 20mm Aggregate = (H x % of 20mm)</td><td>0.2698</td><td>Cu.m</td></tr>
<tr><td colspan="5">J)Volume of 10mm Aggregate = (H - I)</td><td>0.1452769</td><td>Cu.m</td></tr>
<tr><td colspan="5">K)Weight of Sand = (G x Sp. Gr of Sand)X1000</td><td></td><td></td></tr>
<tr><td colspan="5">Weight of Natural Sand</td><td>484.256</td><td>Kgs</td></tr>
<tr><td colspan="5">I) Weight of Coarse Aggregate 20mm = (I x Sp.Gr of 20mm Aggregate)x1000</td><td>779.72</td><td>Kgs</td></tr>
<tr><td colspan="5">M) Weight of Coarse Aggregate 10mm = (I x Sp.Gr of 10mm Aggregate)x1000</td><td>419.85</td><td>Kgs</td></tr>
<tr><td rowspan="3">Quantity of Material per Cu.m of Concrete (Kg)</td><td rowspan="2">Cement</td><td rowspan="2">Water</td><td colspan="2">Fine Aggregate</td><td colspan="2">Coarse Aggregate</td></tr>
<tr><td>Na. Sand</td><td></td><td>20mm</td><td>10 mm</td></tr>
<tr><td>300Kg</td><td>186Kg</td><td>689.3979Kg</td><td></td><td>722.6 Kg</td><td>48.7335 Kg</td></tr>
</table>

Proportion of Concrete used 1:1.7:2.3

The proportion of concrete used in the ratio of 1:1.7:2.3 (cement:sand:aggregate) has been selected based on careful consideration of various factors essential for achieving the desired concrete properties. This ratio strikes a balance between strength, workability, and durability requirements, ensuring optimal performance of the concrete mix. It also offers economic benefits by efficiently utilizing materials while meeting project specifications. Moreover, the chosen proportion is compatible with available materials and construction practices, ensuring seamless implementation on-site. Overall, this proportion of concrete has been deemed suitable for the intended application, providing a reliable and effective solution for the construction project.

Casting of Specimen

All the specimens were casted referring to the mix proportions mentioned in table. For these mix proportions, required quantities were weighed. Under this project, casting of specimens for different properties. Specimens for Compressive Strength 150x150x150 mm sized cube (18 Cubes) specimens were prepared for compressive strength and split tensile strength. The materials required were weighed according to the mix proportion. Cement, Ground Granulated Blast Furnace Slag, fine aggregates and coarse aggregates were dry mixed first to have a uniform colour.

After that 50% of the total water required was added to the mix to have thorough mixing for 3- 4 minutes. Then 40% of the water was added with addition to the mix. Remaining 10% of water was sprinkled on the above mix and it was thoroughly mixed in the mixer. The oiled samples were then filled with the mix prepared and then filled moulds were put on the vibrating table for their proper mixing. Immediately after casting cubes, the specimens were placed into open air for curing for 24 hours.

Curing

In our project examining the partial replacement of coarse aggregate in M30 concrete with waste ceramic tiles, effective curing is vital for achieving desired strength and durability. Key considerations include maintaining moisture levels to ensure proper cement hydration and strength development, controlling temperature within the recommended range, adhering to the appropriate curing duration, monitoring conditions for quality control, and conducting thorough testing post-curing to assess properties like compressive strength. By optimizing the curing process, you can evaluate the efficacy of waste ceramic tiles as a sustainable alternative in concrete production.

Testing of Specimens (Compressive Strength)

Specimens were tested for various properties including compressive strength after 7 and 28 days of curing. The procedure involved demolding specimens after 24 hours and submerging them in a curing tank. After surface drying, compression tests were conducted using a Compression Testing Machine (CTM) at a load rate of 5 kN/sec, as per IS: 516-1959 guidelines. The failure load determined the compressive strength of both Normal Concrete and Partial Replacement of Coarse Aggregate with Waste Ceramic Tiles, providing reliable data for evaluating their performance and sustainability in concrete production.

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Fig. 3 Curing of Specimen

Fig. 4 Universal Testing Machine (UTM)

Table 2 Assumed Standard Deviation
(Clauses 3.2.1.2, A-3 and B-3) (IS 10262:2009)

Grade of Concrete	Assumed Standard Deviation (N/mm^2)
M10	3.5
M15	3.5
M20	4.0
M25	4.0
M30	5.0
M35	5.0
M40	5.0
M45	5.0
M50	5.0
M55	5.0

As per IS 10262:2009, the target mean compressive strength of concrete (fck) is determined to ensure that a specified proportion of test results meet or exceed the characteristic strength. It is calculated using the formula fck = fck' + 1.65 * s, where fck' is the characteristic compressive strength at 28 days and s is the standard deviation. The standard deviation (s) is calculated based on concrete test results, with a minimum of 30 samples required. If changes occur in concrete production, a separate standard deviation should be calculated. Initially, assumed standard deviation values can be used, but actual test results should be used for accurate mix proportioning as soon as available. IS 10262:2009 provides assumed standard deviation values for different concrete grades, which may need adjustment based on site control practices.

V. RESULTS

Compressive Strength of Normal Concrete Cube
Target Mean Strength for 28 Days as per IS 456-2000

fck = fck +1.65s
M 30 = 30 + 1.65 x 5
M 30 = 38.25 N/mm2
Target Mean Strength for 7 Days as per IS 456-2000
Strength at 7 days is about less than or equal to 0.67 times the Characteristic compressive strength 28 days compressive strength
Therefore,
M 30 = 38.25 x 0.67
M 30 = 25.6275 N/mm2

Table 3 Compressive strength of Normal Concrete Cube

No.	Compressive strength (N/mm2) 7th Day		Compressive strength (N/mm2) 28th Day	
Cube 1	19.55	Average 19.46	31.20	Average 31.55
Cube 2	19.20		31.89	
Cube 3	19.64		31.56	

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Table 4 Compressive strength of 18% Replacement of waste ceramic tiles with coarse aggregate

No.	Compressive strength (N/mm^2) 7th Day		Compressive strength (N/mm^2) 28th Day	
Cube 1	20.59	Average 20.93	32.56	Average 32.26
Cube 2	20.92		31.98	
Cube 3	21.30		32.25	

Table 5 Compressive strength of 20% Replacement of waste ceramic tiles with coarse aggregate

No.	Compressive strength (N/mm2) 7th Day		Compressive strength (N/mm2) 28th Day	
Cube 1	21.90	Average 22.28	32.95	Average 33.01
Cube 2	22.30		32.85	
Cube 3	22.65		33.25	

Table 6 Compressive strength of 22% Replacement of waste ceramic tiles with coarse aggregate

No.	Compressive strength (N/mm2) 7th Day		Compressive strength (N/mm2) 28th Day	
Cube 1	21.00	Average 21.067	31.25	Average 31.00
Cube 2	21.15		30.92	
Cube 3	21.05		30.84	

Table 7 Compressive strength of 23% Replacement of waste ceramic tiles with coarse aggregate

No.	Compressive strength (N/mm2) 7th Day		Compressive strength (N/mm2) 28th Day	
Cube 1	20.50	Average 20.41	30.22	Average 30.14
Cube 2	20.42		30.15	
Cube 3	20.32		30.05	

Table 8 Compressive strength of 25% Replacement of waste ceramic tiles with coarse aggregate

No.	Compressive strength (N/mm2) 7th Day		Compressive strength (N/mm2) 28th Day	
Cube 1	19.55	Average 19.70	29.95	Average 29.84
Cube 2	19.80		29.82	
Cube 3	19.75		29.77	

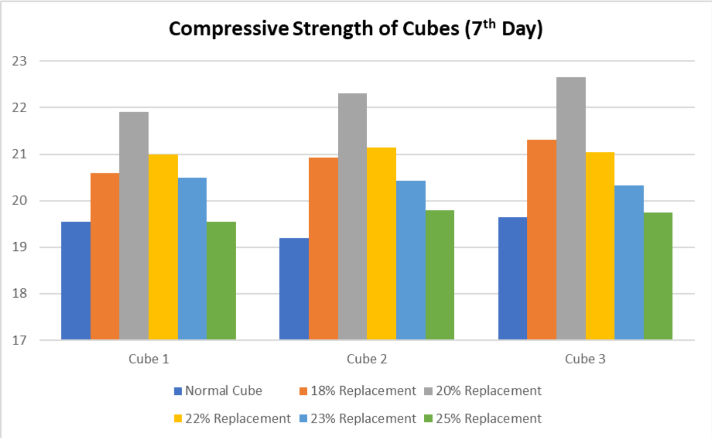

Fig 5 Compressive Strength of Cubes (7th Day)

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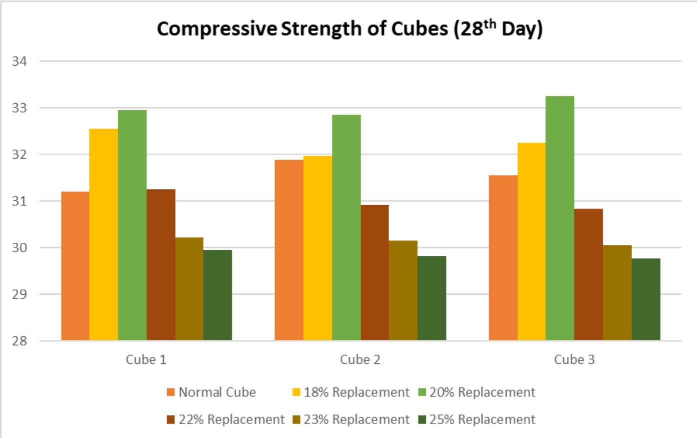

Fig 6 Compressive Strength of Cubes (28th Day)

VI. CONCLUSION

Up to a 20% replacement of coarse aggregate with waste ceramic tiles led to an increase in compressive strength, with the highest strength observed at this replacement level, indicating an optimal percentage for achieving desired strength characteristics. However, beyond the 20% replacement threshold, compressive strength began to decrease, suggesting limitations to the extent of replacement. This study highlights the potential of waste ceramic tiles as a sustainable alternative to conventional coarse aggregates in concrete production, effectively managing ceramic waste disposal and reducing environmental impact. Further research avenues could explore the effects of waste ceramic tile replacement on other concrete properties such as durability, workability, and shrinkage. Long-term performance studies of concrete structures incorporating waste ceramic tiles could provide valuable insights for real-world applications. Overall, this research contributes to the knowledge base on sustainable construction materials and practices, emphasizing the role of waste ceramic tiles in enhancing concrete structure performance and sustainability.

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