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Enhancing concrete sustainability by incorporating crushed ceramic tiles as a partial replacement for fine aggregate in concrete mixture

Ashwini Tiwari [1], Ambrish Kumar Tiwari [2,*], Abhay Kushwaha [1], Akash Kumar Vaishya [1], Shikhar Gupta [1], Govind Kumar [1] and Shivendra Yadav [1]

[1] *Department of Civil Engineering, Rajkiya Engineering College, Mainpuri-205119 India.*
[2] *Department of Applied Science and Humanities, Rajkiya Engineering College, Mainpuri -205119 India.*

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Abstract

In this study, the possibility of partially replacing ceramic tiles with fine particles in concrete mixtures is investigated in order to increase the sustainability of concrete. Recycling and utilizing ceramic waste are essential because its disposal causes environmental problems. In this study, we examine how the amount of crushed ceramic tile affects many aspects of concrete, such as compressive strength, durability, and environmental impact. According to our research, adding crushed ceramic tiles to concrete reduces waste while also demonstrating promising outcomes in terms of strength and durability, making it a more environmentally friendly choice than using traditional fine aggregates. Utilizing ceramic waste in concrete production offers the opportunity to be cost-effective and environmentally sustainable, advocating for resource efficiency and eco-friendly construction practices. let's break down how we're going to carry out this project in simple terms. First, we'll gather all the materials we need, like regular concrete stuff and crushed ceramic tiles. Then, we'll mix them up in different ways to see what works best. After that, we'll make small samples and test how strong and durable they are. We'll repeat these tests a few times to make sure our results are reliable. Along the way, we'll keep track of everything we do, so we can explain it to others and make sure our project is solid.

Keywords: Concrete Sustainability; Crushed Ceramic Tiles; Partial Replacement; Concrete Mixture**.**

1. Introduction

The cost of fine aggregate is currently relatively expensive, which raises the overall cost. Furthermore, fine aggregate is a natural resource that has to be protected. Worldwide, crushed and demolished (C&D) wastes account for the largest percentage of trash (75%). Additionally, ceramic materials make the most contributions percentage of trash (54%) that are classified as C&D wastes. This ceramic industry waste discarded in the surrounding area, creating degradation of the environment and harm to the resident's lands used for agriculture. Concrete technology advancements can lower the number of natural resources. It is possible to substitute fine aggregate entirely or in part to prevent this issue by adding ingredients to concrete such as M-sand, sawdust, quarry dust, rice husk ash, and ceramic waste. This project comes from a desire to make buildings in a way that's kinder to the planet. People have been using concrete for a long time, but we've realized it can be tough on the environment. So, we're looking into a new idea: using crushed ceramic tiles to make concrete better for the Earth. It's like a small but important step in the history of finding more eco-friendly ways to build things.

Concrete is easily orchestrated and made in all essential system and it is a compo-site texture. Concrete is made from a three materials fundamentally fine add up to, coarse add up to and cementitious texture. Fine add up to is principal

* Corresponding author: Ambrish Kumar Tiwari.

constituent in concrete stream sand is most common and sensible for fine add up to in concrete. The expect of stream sand it will cause various negative impacts like cause deterioration harmed neighborhood normal life demolish palatable environment and antagonistically impact tourism. Due to this reason substitution of sand is essential and needs in last two spoils. These days number of asking around happening in world on substitution of sand by number of materials like glass powder, went through fire bricks, pulverized bricks, pulverized coarse, fly searing remains etc..., so in our report we to some degree supplant the fine add up to by ceramic waste.

A coarse add up to substitution plan in concrete is inspected with three different waste ceramic tile materials in substitution extents tallying 20%, 25%, 35%, 50%, 65%, 75%, 80% and 100%. Comes almost show up misuse ceramic as a conceivable practicable characteristic coarse add up to substitution texture with unimportant changes in mechanical properties .The maker outlined that the importance of supportability and reusing has finished up dynamically seen and caught on in the academic community and industry over the last a few decades. Reusing improvement and junk and jetsam misuse is one of various streets that allow a mind-blowing opportunity to expect waste texture from entering landfills and reduce the improvement industry reliance on decreasing common resource supplies. (Anderson et al., 2016)

To promote sustainable construction practices, there's a growing interest in exploring industrial by-products for concrete manufacturing. Marble and granite powders, generated during stone cutting and polishing, are abundant worldwide. Despite being slightly coarser than cement and fly ash, these powders have high water absorption due to their fineness. Incorporating them into concrete poses challenges, as their moisture content affects strength dry powders increase strength, while moist ones decrease it. This paper introduces a method for utilizing marble and granite slurry, emphasizing the crucial aspect of moisture correction in achieving design strength. The correction considers water absorption at saturated surface dry (SSD) condition. Proper moisture correction in concrete mix design ensures that strength aligns with the traditional compressive strength vs. water-to-cement (w/c) ratio trend. By effectively using these waste fines, the construction industry can reduce aggregate consumption, address environmental concerns, and move towards a more sustainable future (Meera et. al., 2020).

Author mentioned about utilizing industrial by-products such as marble and granite powders contributes to the production of green concrete without impeding development. This paper sheds light on the production process, challenges associated with slurry generation, and the potential of incorporating it into concrete without compromising quality and strength. Rajasthan leads in marble production, while Andhra Pradesh (and Telangana) are significant contributors to granite production. Granite production, however, generates higher waste per tonne. In an optimistic scenario, the states producing slurry could effectively integrate it into concrete, presenting an opportunity for sustainable waste management and resource utilization. This approach aligns with the goal of promoting green concrete, where industrial by-products play a crucial role in maintaining development momentum while reducing environmental impact (Gupta et. al., 2015).

He indicated that the cement creating handle contributes to nursery gas radiations, contributing to around the world warming. Utilizing mechanical by-products like coal searing remains, misuse plastics, versatile tire scrap, waste glass, foundry sand, and marble powder instep of cement and sand can progress doable enhancement. In any case, waste marble powder has not been broadly inspected for its potential utilize in concrete. This considers centers on investigating the achievability of misuse marble powder as a midway substitution for sand and cement in concrete. Seven concrete mixes were made by generally substituting marble powder (up to 15%) for sand. The mechanical quality, ultrasonic speed (UPV), carbonation, and microstructure of the concrete with changing marble powder substance were evaluated. The revelations suggest that marble powder does not viably take an intrigued in the hydration plan; or possibly, it acts as filler. The perfect substitution was observed when utilizing 10% marble powder in put of both sand and cement amalgam. This examine illustrates the potential for viable utilize of misuse marble powder in concrete, tending to both money related and common concerns related with its exchange from the improvement industry (Ashish, 2018).

This think approximately examines the union of ceramic misuse from diverse sources, such as creating and improvement misuse, as a midway substitute for cement in differing cement composites. The essential objective is to assess the influence of ceramic waste on the unused and mechanical properties of cementitious materials, tallying cement stick, mortar, set concrete, and self-compacting concrete. Prior ask approximately highlights the promising pozzolanic conduct of ceramic waste, supporting its plausibility in cementitious materials. At lower substitution levels, the workability is sensible, but at higher extents, the water substance required for keeping up workability increases. The cement pastes' abandon thrust can move based on the sur-face locale of ceramic waste particles. In terms of mechanical properties, compressive quality is either higher or almost rise to to the reference mix up to a substitution level of 10 to 20%. White ceramic waste appears way way better pozzolanic properties than rosy ceramic misuse.

Combining ceramic waste with other supplementary materials like rice husk cinder and fly red hot remains help moves forward compressive quality (Jain et al., 2022).

Microstructure analysis using scanning electron microscopy and X-ray diffraction confirms the pozzolanic properties of ceramic waste. However, beyond the 20% substitution level, there is a dilution of compounds, leading to retardation in setting and hardening, accompanied by a reduction in compressive strength. Overall, utilizing ceramic waste in construction presents a sustainable approach with ecological benefits. Exploring the combination of ceramic waste and nanoparticles is suggested as a potential future research direction.

The author investigated the impact of partial cement replacement with Metakaolin (MK) and constant percentages of Marble Powder (MP) on concrete strength and durability. Cement replacement levels include 0%, 3%, 5%, 9%, 12%, and 13% with MK, and 0% and 10% (constant) with MP. Concrete, rated at M30 grade, is compared with conventional concrete. Both compressive and tensile strengths of the MK-MP concrete were evaluated and compared to standard M30 concrete. The results indicate a strength improvement with the addition of MK and MP. The optimized strength values were achieved at 9% MK and 10% MP for both compressive and split tensile strength. Durability analysis, conducted through the Rapid Chloride Migration Test (RCMT), reveals a positive trend. As the proportion of Metakaolin and Marble Powder increases, there is a decrease in the rate of chloride ion penetration. This signifies enhanced durability compared to standard concrete. Overall, the study suggests that incorporating MK and MP in concrete mixtures can lead to improved strength and durability properties, offering potential benefits for construction applications (Kaur & Bansal., 2015).

They inspected roughly utilization of dangerous mechanical misuses in concrete era presents an opportunity for a more environmentally neighborly approach. In the ceramic industry, generally 30% of era as of presently closes up as misuse, without reusing. This consider focuses to examine the plausibility of utilizing ceramic mechanical waste as a potential substitute for routine crushed stone coarse add up to in concrete. Tests were conducted to assess the compressive, portion bendable, and flexural qualities, as well as the modulus of adaptability of concrete solidifying ceramic waste coarse add up to. These comes almost were at that point compared with those gotten from standard concrete made with pulverized stone coarse add up to. Additionally, the properties of the sums were analyzed for comparison. The disclosures illustrate that the workability of concrete containing ceramic misuse coarse add up to is positive, and the quality characteristics are comparable to those of standard concrete. This prescribes that uniting ceramic mechanical waste in concrete-making might offer a temperate course of action, suitably reusing a vital divide of ceramic waste though keeping up concrete's essential insight (Senthamarai & Manoharan., 2005)

The author demonstrated as the construction industry rapidly grows, concrete, a vital material, remains costly with its aggregate extraction processes posing environmental concerns. Concurrently, substantial construction and demolition waste is generated, including ceramic tile waste, contributing to environmental issues when improperly disposed. This investigation aimed to explore the potential use of ceramic tile waste in concrete production, aiming to mitigate the environmental impact, reduce reliance on natural.

Concrete waste through sieving to get the required add up to sizes. Diverse tests were conducted to assess add up to properties a few time as of late joining them into unusedconcrete. The disclosures of this ask almost highlight the ampleness of reused sums from the pulverization area in making high-quality concrete. Compressive quality test comes almost illustrate that both fragmentary substitution and full reused add up to concrete show higher qualities compared to standard concrete with resources, and foster sustainability.

The methodology involved selecting natural aggregates, collecting and grindingceramic tile waste as partial replacements for natural sand in M20 concrete. Key laboratory tests, such as con Maker said that in afterward a long time, directing obliterated concrete misuse has created as a basic around the world challenge. This issue demands an creative and capable approach for innate managing with. The objective is to totally reuse pulverized concrete misuse, not as it were to guard ordinary resources but as well to direct common defilement. This ask around paper burrows into an test consider, exploring the achievability and reusing of pulverized concrete misuse for advanced construction. The fundamental center of this examination is to address the challenging task of reusing pulverized waste materials, indicating to lessen advancement costs and help lodging issues stood up to by low-income communities around the world. The get ready incorporates confining pulverized obliterated advanced add up to. This emphasizes the potential of reusing demolished concrete misuse as a conservative and cost-effective course of action in advancement practices. (Hussan & assas,2013).

compressive, split tensile, and flexural tests, were conducted. The results indicated that replacing natural aggregates with ceramic tile waste enhanced strength performance up to a notable 5% replacement. However, further replacements led to diminishing strengths, with reductions of 14%, 19%, and 21% observed for all key strength characteristics tested. This study suggests that incorporating a modest percentage of ceramic tile waste in concrete production can contribute to improved strength properties, aligning with environmental sustainability goals in the construction industry (Mbereyaho et al., 2019).

The advent of industrialization has significantly increased environmental hazards particularly in dealing with hazardous waste disposal. To address this challenge, a shift towards utilizing waste in construction activities has been proposed. A survey revealed that approximately 30% of ceramic production ends up as waste. In response, an approach has been developed to incorporate this waste as a substitute for conventional aggregate in construction materials.

The study involves mapping the properties of conventional coarse aggregate and ceramic waste. Test results indicate that the compressive strength and split tensile strength of concrete with sanitary ceramic waste coarse aggregate, at a 100% replacement level, decreased by 47.5%, 42%, and 35%, 55%, respectively. At a 50% replacement level, the reduction was 24%, 20%, and 17%, 21%, for M-20 and M-30 mixes, compared to the strength characteristics of conventional concrete. This highlights the potential impact of incorporating ceramic waste into concrete, albeit with some reduction in strength characteristics**.**

The goal of this project is to substitute fine aggregate in concrete with different per-centages of ceramic waste. This project comes from a desire to make buildings in a way that's kinder to the planet. People have been using concrete for a long time, but we've realized it can be tough on the environment. So, we're looking into a new idea: using crushed ceramic tiles to make concrete better for the Earth. It's like a small but important step in the history of finding more eco-friendly ways to build things Concrete is successfully organized and made in all assistant system and it is a composite texture. Concrete is made from a three materials fundamentally fine add up to, coarse add up to and cementitious texture. Fine add up to is essential constituent in concrete conduit sand is most common and sensible for fine add up to in concrete. The over the best of conduit sand it will cause various negative impacts like cause crumbling harmed neighborhood common life demolish palatable organic framework and unfavorably impact tourism. Due to this reason substitution of sand is fundamental and needs in last two spoils. These days number of examining happening in world on substitution of sand by number of materials like glass powder, went through fire bricks, pulverized bricks, crushed coarse, fly searing flotsam and jetsam etc., so in our report we generally supplant the fine add up to by ceramic misuse (Vimalkumar N Patel et al., 2017).

In order to construct structural concrete looked at the reuse of trash as recycled coarse aggregate in partial substitution of15%,20%, and 25%. We measure compressive strength at 7, 28, and 90 days. Strength increases as the percentage replacement increases; the best outcomes are seen at 25%, when there is a rise of 21.12%, 11.04%, and 6.70% at 7, 28, and 90 days, respectively (C. Medina et al.,2012).

conducted research on the strength properties of concrete using waste materials, such as broken glass pieces, ceramic insulator trash, and ceramic tiles. In comparison to the other two types of waste, ceramic tiles produced the best outcomes. Similar strength in compression, split tensile, and flexure was achieved by the concrete made with ceramic tile aggregate in comparison to traditional concrete (Sekar, 2011).

Due to the region's ongoing real estate growth estimated the value of the region's real estate at over US$2.39 trillion construction waste recycling plants have begun to proliferate throughout the Gulf Cooperation Council (GCC) a region with limited natural resources, particularly in terms of coarse aggregate. Furthermore, it has been reported that the GCC countries produce 120 million tons of waste annually, with construction waste accounting for 18.5% of this total (Abdelfatah & Tabsh ., 2011)**.**

This consider burrowed into the impacts of supplanting cement with waste ceramic powder (WCP) and waste brick powder (WBP) at changing levels (0%, 5%, 10%, and 15%) on the properties of high strength concrete (HSC). Point by point characterization of WBP and WCP through laser granulometry, XRF, and XRD gone some time recently the standard mixing, era, and curing of concrete tests. Diverse tests, tallying dry thickness, modulus of adaptability, flexural quality, portion malleable quality, compressive quality, resistance to sulfate ambush, water digestion, and ultrasonic beat speed, overviewed the set concrete properties. Comes approximately revealed that while the durability and quality of concrete containing WBP and WCP were to some degree moment rate to the control test, WBP had a less-er negative influence compared to WCP. Strikingly, a mix of 5% WBP and 10% WCP moved forward HSC characteristics compared to individual WCP rates. Microstructure examinations appeared higher hydration things and a to some degree denser concrete grid with 10% WCP and 5% WBP increases. In addition, a 15% substitution of cement with WCP or WBP outlined a 13.1% diminish in specific essentialness utilization, showing an common advantage in concrete production materials. This think almost explores the plausibility of utilizing ceramic mechanical wastes and significant sums of basaltic pumice as substitutes for ordinary crushed fine aggregates in concrete. Test tests were conducted to evaluate the scratched This consider con-ducted exploratory work to assess the ampleness of Ceramic Misuse Powder (CWP), Cera mic Fine Add up to (CFA), and Reused Coarse Add up to (RCA) as substitutions for cement, Characteristic Fine Add up to (NFA), and Characteristic Coarse Add up to (NCA) independently. The significance lies in utilizing ceramic waste and RCA at the same time in concrete mixes to diminish reliance on typical resources, lower carbon radiations from cement era, and decrease dependence on landfills for Advancement and Demolition (C&D) materials. pulverized ceramic misuse and basaltic pumice fine sums, comparing them with conventional concrete definitions. Comes almost appeared that concrete mix-es with ceramic Eight concrete mixes were orchestrated, and their mechanical properties, shrinkage, taken a toll, and CO2 outpourings were evaluated. A advantage record was calculated to choose the reasonability of the unused reused concrete based on mechanical properties, taken a toll, and CO2 spreads. The think around found that a concrete mix with 100% substitution of NCA by RCA, 20% cement substitution by CWP, and 20% NFA substitution by CFA was 26% more important than the control mix in terms of supportability and monetary things. This blend outlined ensure, with 47% of its standard concrete components supplanted by reused spot resistance, chloride entrance profundities, and compressive qualities of concrete mixes containing misuse and basaltic pumice appeared tasteful workability. Be that as it may, they showed up lower scratched spot resistance compared to standard concrete. The consider as well observed that lessening the degree of pulverized ceramic substance moved forward scratched spot resistance. In addition, the rate of pulverized ceramic included alternately associated with chloride entrance significance. These revelations suggest that pulverized ceramic waste and basaltic pumice can be suitably utilized in concrete mixes for applications requiring moo scratched region and higher compressive quality.

2. Material Used

2.1. Cement

Limestone, clay, and other minerals combine to form cement, a fine powder. It creates a paste with water when combined, binding coarse aggregate and sand to create concrete. Owing to its robustness, longevity, and versatility, it is in building. Ordinary Portland cement was used in the experiment for 43 Cement of grades in compliance with BIS 269:2015 was utilized. The outcomes of examinations to determine the properties of cement, such as its consistency, specific gravity, fineness, first and last setting times, and tests of compressive strength were carried out on cement in accordance with IS: 4031-1988; specifics are given in Table 1.

Table 1 Properties of Cement

Sr. No.	Property	Observed Value	BIS 269:2015
1	Specific Gravity (G)	3.13	-
2	Bulk Density	1.38	-
3	Standard Consistency (%)	33	-
4	Fineness (m^2/kg)	178	225
5	Initial setting time (min)	90	30 (min)
6	Final setting time (min)	265	600 (max)
7	3 days compressive strength (MPa)	25.4	23 (min)
8	7 days compressive strength (MPa)	36.68	33 (min)
9	28 days compressive strength (MPa)	46.65	43
10	Soundness (mm)	1	-

2.2. Fine aggregate

In this trial, the small-sized add up to (fine Add up to) utilized was sand which is found near riverbanks and coastal ranges. Since of its small appraise, fine sand is additionally routinely utilized in the making of concrete and mortar, coming around in a smoother wrap up. It is an essential component in the building fragment since of its capacity to provide essential consistent quality and reinforce. Properties of fine add up to are given in Table 2.

Table 2 Properties of Fine Aggregate

Sr. No.	Property	Value
1	Fineness Modulus	3.35
2	Bulk Density	1.76
3	Specific Gravity (G)	2.66
4	Water Absorption (%)	1.3

2.3. Coarse aggregate

Coarse add up to is a sort of advancement texture molded from pulverized rocks like shake or limestone. It is broadly utilized in building improvement wanders, bridges, thruways, and Expressways, Coarse add up to has more noteworthy particles than fine sand, with sizes expanding from 5mm to 20mm. Since of its more noteworthy gauge, it is appropriate for utilize in wanders that ask a tall level of strength and diligence. It is routinely utilized with cement and fine sand to shape concrete, which gives the fundamental quality required to withstand tall weights. In understanding with the subtle elements of common sums were found to be interior the limits of BIS 383:2016 , the sums were assessed for physical properties such as Water Digestion, specific gravity (SG), and Fineness Modulus. Table 3 summarizes the findings of the following tests.

Table 3 Properties of Coarse Aggregate

Sr. No	Property	CA20	CA10
1	Fineness Modulus	7.135	6.05
2	Bulk Density	1.74	1.57
3	Specific Gravity (G)	2.86	2.84
4	Water Absorption (%)	0.25	0.44

2.4. Ceramic waste as fine aggregate

Ceramic is an inorganic, non-metallic material that is created by heating and then cooling. Ceramic materials can have an amorphous (like glass) or partially crystalline structure. Since the majority of common ceramics can be found in crystalline form, inorganic crystalline materials are frequently referred to as ceramic. The earliest ceramics made by humans were pottery objects, including 27,000-year-old figurines, made from clay, either by itself or mixed with other materials, hardened in fire. Then glazing and heating of ceramics is done to create a coloured and smooth surface.

2.4.1. Sources of ceramic waste

Ceramic trash can originate from a number of sources, such as broken or discarded pottery, plates, and tiles. Ceramic waste is also produced by industrial processes like manufacturing and construction. Furthermore, ceramic materials are frequently found in garbage from construction and demolition Table 4.

Table 4 Property of Ceramic Waste as Fine Aggregate

Sr. No	Property	Value
1	Fineness Modulus	2.9
2	Bulk Density	1.7
3	Specific Gravity (G)	2.08
4	Water Absorption (%)	1.2

3. Methodology

3.1. Concrete Mix Design

Concrete mix design for M30 grade is done as per IS: 10262 – 2019. Batching details of the concrete mix are presented in Table 6,&7 and the results of concrete mix design are tabulated below.

Table 5 Batch Mixing

Aggregate	Control Mix Batch	Batch 1	Batch2	Batch3
Natural Fine Aggregate	100	75	50	25
Ceramic Waste	0	25	50	75

Table 6 Mix Proportions for Various Percentages of Fine Aggregates

Material	w/c	cement	Fine aggregate	Coarse aggregate
Ratio	0.45	1	2.48	2.58
Kg/m^3	197	437.77	1087.63	1129.46

Table 7 Mix proportion for various % replacement of fine aggregate

% Replacement	Cement	Water	Fine Aggregate	Ceramic Waste	Coarse Aggregate
0	8.41	3.8	20.88	0	21.72
25	8.41	3.8	15.66	5.22	21.72
50	8.41	3.8	10.44	10.44	21.72
75	8.41	3.8	5.22	15.66	21.72

4. Test and Discussions

The results pertaining to the physical properties of the materials are outlined in the following sections.

4.1. Sieve Analysis

The process of separating an aggregate sample into different fractions, each with identically sized particles, is known as sieve analysis. The purpose of the sieve analysis is to ascertain the aggregate sample's particle size distribution, or "gradation."

Table 8 Sieve Analysis (Calculating Percentage Finer)

Sieve size(mm)	Retained weight (gm)	Individual Retained (%)	Cumulative Retained (%)	Cumulative Passing (%)
10	0	0	0	100
4.75	94	9.4	9.4	90.6
2.36	275	27.5	36.9	63.1
1.18	223	22.3	59.2	40.8
600	209	20.9	80.1	19.9
300	79	7.9	88.0	12

150	87	8.7	96.7	3.3
0.75	31	3.1	99.8	0.2
Pan	2	0.2	100	0

4.2. Specific Gravity test

Sieve analysis is the technique of dividing an aggregate sample into several fractions with uniformly sized particles. Finding the aggregate sample's particle size distribution, or "gradation," is the aim of the sieve analysis Table 9.

Table 9 Observation table for specific gravity of fine aggregate

Weight of empty Pycnometer(w1)	559g
Weight of Pycnometer(w2) + FA	659g
Weight of Pycnometer+ FA+ Water(w3)	1641g
Weight of Pycnometer + Water (w4)	1589g
Specific Gravity	2.08

4.3. Water Absorption Test

Water maintenance is utilized to choose the whole of water ingested underneath demonstrated conditions. Factors affecting water maintenance join: sort of plastic, included substances utilized, temperature and length of introduction. The data sheds light on the execution of the materials in water or moist environments.

4.4. Testing on Concrete

Three numbers of cube shape illustrations of each side 150 mm for Compressive strength test, Barrel illustrations of degree 150 mm Dia and 300 mm length for Spilt tensile stress test and gem illustrations of degree 100 x 100 x 500 mm for Flexural strength test were cast and attempted at 3,7 and 28 days independently after curing.

4.4.1. Slump test

The slump test of concrete is a investigate office or field test that is utilized to choose the workability of concrete. The slump test is fundamentally a degree of the wetness or consistency of the concrete mix Table 10.

Table 10 Slump Test

Test	**Control mix**	**25%**	**50%**	**75%**
Slump Value(mm)	45	40	50	55

From this result it is inferred that workability of fresh concrete gradually increases with the increase in replacement percentage of ceramic waste aggregate.

4.4.2. Compaction factor test

Compaction Calculate Test of Concrete is the workability test for concrete conducted in the investigate office. The compaction figure is the extent of weights of in portion compacted to totally compacted concrete Table 11.

Compaction factor= (W1-W)/(W2-W)

Where, W is the weight of cylindrical mould

W1 is the weight of mould+ weight of partially compacted concrete

W2 is the weight of mould+ weight of fully compacted concrete

Table 11 Compaction factor of concrete**.**

Test	Control Mix	25%	50%	75%
Compaction Factor	0.86	0.809	0.86	0.9

From this result it is inferred that the workability of fresh concrete increases gradually with increase in replacement percentage of ceramic waste aggregate by increasing the compaction factor.

4.4.3. . Compressive strength test

The compressive quality test is an basic test condented on concrete to get to it's quality and quality. Here are the steps included in conducting the compressive quality to conduct as the Indian Standard (IS) code IS: 516-1959 Table 12 and Figure 1

compressive strength = P/A

Here P is applied load in kN

A = area in mm^2

Table 12 Compressive strength of concrete

Mix	% of Replacement	3 days Strength (MPa)	7 days Strength (MPa)	28 days Strength (MPa)
1	0	13.47	21.36	32.87
2	25	17.68	24.88	41.37
3	50	14.93	23.33	44.53
4	75	12.88	16.48	42.93

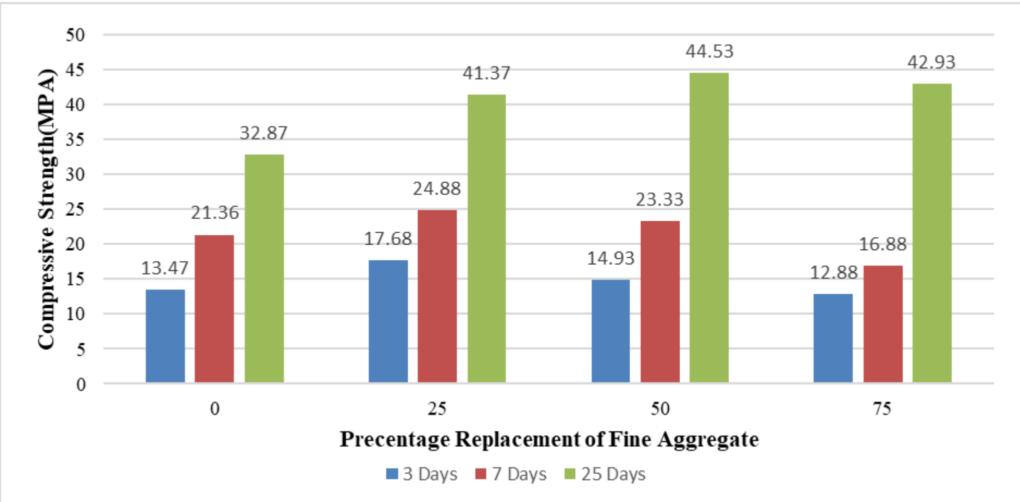

Figure 1 Compressive Strength vs % Replacement of Fine Aggregate

From this result it is found that compressive quality gradually increases with the increase in substitution rate of ceramic waste aggregate. It was celebrated these 50% substitution of ceramic misuse choose up quality and provide predominant comes around than other rate and control mix.

4.4.4. Flexural strength test of concrete

Prism case degree 100 mm stature 100 mm significance and 500 mm length and to be utilized for flexural quality test by distinctive mix degree such as 25%, 50%, 75% the flexural quality (fb) is calculated utilizing the taking after formula Table 13 and Figure 2.

$$F_b = pl/bd^2$$

Where, F_b= flexural strength value (MPa)

b= breath of beam (mm)

d= height of beam (mm)

a= shorter length of beam (mm)

Table 13 Flexural strength of concrete

Mix	% Replacement	3 Day Modulus of Rupture	7 Day Modulus of Rupture	28 Day Modulus of Rupture
1	0	2.4	3.2	5.2
2	25	3.6	5.2	7.6
3	50	4	6	8.4
4	75	4.4	6.4	8.8

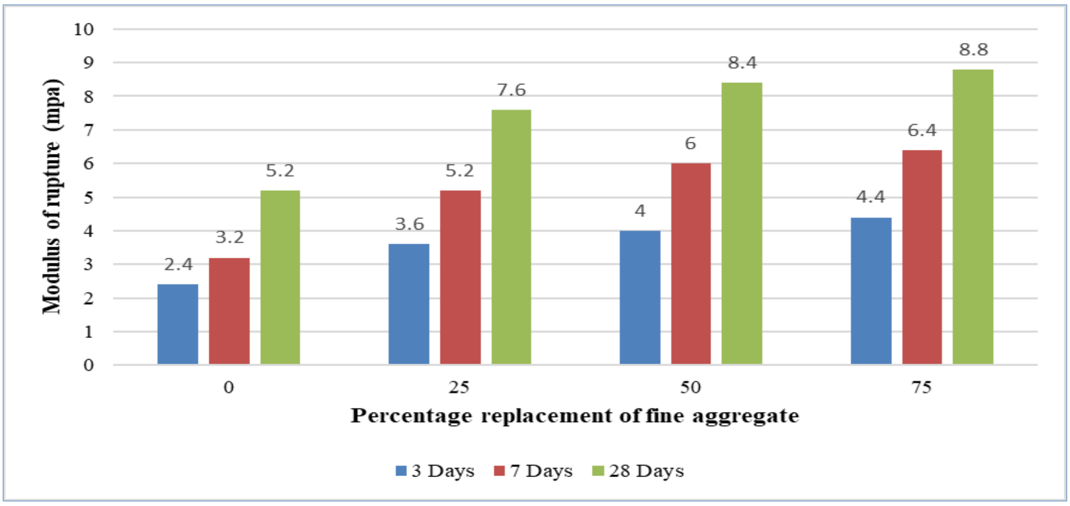

Figure 2 Modulus of Rupture vs % replacement of Fine Aggregate**.**

From this result it is found that modulus of break consistently increases with the increase in substitution rate of ceramic waste add up to It was popular these 50% substitution of ceramic misuse choose up flexural quality and permit predominant comes almost than other rate and control mix

4.4.5. Split Tensile Test

Cylinders are set in the compression testing machine, an lying stack basically to 3d shapes. The barrel is arranged equitably, and the test proceeds. Stack is persistently extended until the case falls level, and the most critical stack in the midst of the test is celebrated. Malleable quality is at that point calculated utilizing the given condition. Portion bendable strength2P/πld Table 14.

Where, P is applied load in kN, l= length of concrete cylinder 300 mm, d= diameter of cylinder 150 mm.

Table 14 Split tensile stress of concrete

Mix	%Replacement	3 Days split Tensile Stress (MPA)	7 Days split Tensile Stress	28 Days split Tensile Stress
1	0	1.4	2.44	3.49
2	25	1.2	2.12	3
3	50	0.99	1.75	2.47
4	75	0.96	1.68	2.40

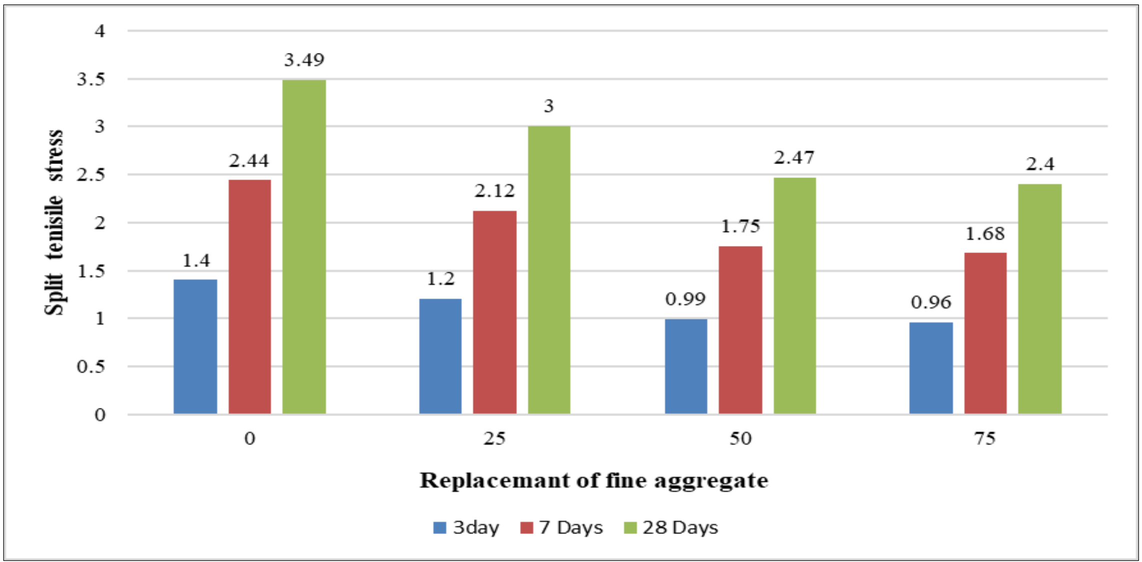

Figure 2 Split Tensile Stress vs Replacement of Fine Aggregate

From this result it is found that portion malleable thrust ceaselessly reduces with the increase in substitution rate of ceramic waste add up to. It was popular these 50% substitution of ceramic waste choose up portion pliable thrust and convey prevalent comes around than other rate and control.

5. Conclusion

The following conclusions can be drawn from the above results.

- In conclusion, incorporating crushed ceramic tiles as a partial replacement for fine aggregates in concrete mixtures holds promise for enhancing concrete sustainability. This eco-friendly approach not only utilizes recycled materials but also contributes to the reduction of environmental impact in the construction industry. Further research and implementation of such practices could pave the way for more sustainable and resilient concrete structures.
- From this result it is initiated that quality gradually increases with the increase in substitution rate of ceramic waste aggregate.
- It was celebrated these 50% substitution of ceramic waste choose up quality and give way superior comes approximately than other rate and control mix.
- .It is concluded that ceramic misuse may be utilized in concrete up to 50% there by it advances the quality as well as saves the characteristic resources.
- From this comes almost it is assembled that 50% substitution by ceramic misuse choose up more quality and gives way superior result. Past 50% substitution the quality reduced. The quality hardship may be due to increase in utilization of water to make strides workability.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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