

EXPERIMENTAL INVESTIGATION ON CONCRETE USING CERAMIC WASTE

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in
Civil Engineering
By

NAVEEN SANTHANA RAJ J (Register No: 39200026)

SATHISH KUMAR S (Register No: 39200038)

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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DECLARATION

We Naveen Santhana Raj J (Register No: 39200026), Sathish Kumar S (Register No: 39200038), Dwarakesh S (Register No: 39200703) hereby declare that the Project Report entitled “Experimental investigation on concrete using ceramic waste” done by us under the guidance of Mr. PAMALOSAN is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

DATE: 13.04.2023

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SIGNATURE OF THE CANDIDATES

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ABSTRACT

This research report includes an experimental investigation into the usage of ceramic waste as a concrete fine aggregate replacement. The extraction of natural fine aggregate, which is getting more and more expensive, may not be as necessary if ceramic waste is included into concrete. This study's waste material includes pulverized and granulated waste powder from broken toilets and ceramic tiles, which was added to the concrete mix at various replacement percentages ranging from 0% to 30% of the fine aggregate. The mix designs were created using M25 grade concrete, and experimental research was used to assess how well the new concrete worked. Additionally, compression tests on concrete cubes at 7, 14, and 28 days of curing time were performed using various percentages of waste crushed ceramic material in place of fine aggregate.

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LIST OF SYMBOLS AND ABBREVIATIONS

ACRONYMS

%

N

Mpa

psi

ml

Kg

gm.

mm

EXPANSIONS

PERCENTAGE

NEWTON

MEGA PASCAL

PER SQUARE INCH

MILE LITER

KILO GRAMS

GRAMS

MILE METER

CHAPTER 1

INTRODUCTION

1.1 CONCRETE

Water, aggregate, and cement are the main components of the composite material known as concrete. The desired physical qualities can be produced in concrete by adding reinforcements and additives to the mix. These ingredients combine to generate a solid mass that is simple to shape when combined in a certain ratio. The cement in the mixture hardens over time to form a tough matrix that binds the other components together, producing a long-lasting, rigid material with many uses, including building pavements, buildings, and other structures. The earliest known application of concrete technology was in ancient Rome, where it was widely used. The Roman Empire made great use of concrete technology, using it to construct buildings like the Colosseum in Rome. Another illustration of the sophisticated concrete technology used by the Romans is the dome of the Pantheon, which is the biggest unreinforced concrete structure in the world. After the Roman Empire fell in the middle of the fifth century, the technology of employing concrete declined in use. However, concrete has emerged as the most often used man-made material in terms of tonnage in recent times.

1.2 HISTORICAL BACKGROUND

The US defined concrete with a compressive strength of 34MPa as high strength in the 1950s, while concrete with compressive strengths of 41–52MPa was first used commercially in the 1960s. High-strength concrete has been under development for several decades. Concrete having a compressive strength of 62MPa had been created by the early 1970s. With compressive strengths of 110MPa being explored for use in pre-stressed concrete members and cast-in-place buildings in accordance with IS 456-2000, even higher strength concrete has recently emerged in the construction industry. One recent example of such high-strength concrete is reactive concrete, which can support pozzolanic ingredients and have a compressive strength of around 250MPa

The American Concrete Institute has defined high-strength concrete as having a compressive strength more than 42MPa, despite the fact that there is no clear distinction between high-strength and normal-strength concrete. The highest resistance provided by the concrete sample under load is the primary characteristic separating high-strength concrete from nominal-strength concrete.

1.3 PROPERTIES OF CONCRETE

Despite having a low tensile strength compared to other construction materials, concrete has a high compressive strength. It is frequently mixed with substances like steel in order to increase its tensile strength. At low stress levels, the elasticity of concrete is unaffected; nevertheless, when stress levels rise, matrix cracking appears which causes the elasticity to diminish. Concrete shrinks as it ages because it has a low coefficient of thermal expansion. Therefore, strain and shrinkage tend to cause some cracking in concrete buildings. Concrete may creep as a result of long-term stresses.

Various tests can be carried out to make sure the qualities of concrete fulfill the requirements for particular uses. Concrete's strength is expressed in psi or MPa, and different ingredient mixtures produce concrete with varying strengths. Low-strength concrete, which is obtained by adding air or foam or lightweight particles, may be utilised for lightweight purposes, however this lessens the strength of the concrete.

Concrete with strength of 3000 to 4000 psi is frequently utilised for normal building projects. Due to its durability, 5000 psi concrete is frequently chosen for big civil projects. Concrete strength above 5000 psi is often employed for certain architectural parts, such as the bottom floor columns of high-rise buildings, where concrete with a strength of 12,000 psi or more is used to keep the column sizes small.

1.4 CONSTRUCTION WASTE IN INDIA

The usage of ceramic tiles in construction is expanding, and the construction sector is producing more solid waste from demolitions. Most structures use ceramics

as a necessary building component, including wall and floor tiles, sanitaryware, home ceramics, and technological ceramics. Usually, natural materials with a high mineral concentration of clay are used to make them. Ceramic trash is a serious environmental annoyance despite its ornamental benefits. In addition, debris from demolished buildings is used to make waste tiles. 100 million tons of tiles are produced annually in India by the ceramics industry, with 15–30% of the overall production yielding waste. Ceramic waste has qualities including durability, hardness, and great resistance to biological, chemical, and physical degradation, making it an attractive material for replacing natural aggregates and lowering solid waste from demolished structures even though it is not currently recycled. For this, waste tiles and granite powder were gathered from the neighborhood. Several active research projects examine how to utilize construction-related solid waste and lower the amount of solid waste produced. According to these studies, using recycled aggregates in concrete mixes can produce good results when a portion of natural coarse aggregate is swapped out for those from recycled sources.

CHAPTER 2

2.1 LITERATURE REVIEW

Amaziah Walter Otunyo (2019)

Amaziah Walter Otunyo et al. (2019) investigated the use of ceramic waste in M30 grade concrete as a substitute for natural fine aggregates. Compressive strength rose with increasing levels of substitution, up to 40%, according to the researchers, who varied the percentage of ceramic waste utilized from 0% to 40%. The flexural strength of the concrete was also examined by the authors, who discovered that by substituting ceramic waste for 25% to 30% of the natural aggregates, the strength of the concrete increased. The strength was reduced, nevertheless, when 35% of the natural aggregates were replaced.

Ambikesh Singh's (2018)

The purpose of Ambikesh Singh's (2018) study was to examine the effects of using ceramic trash in place of conventional waste materials on the properties of concrete, particularly its workability and compressive strength.

Awoyera Paul O. et al (2018)

In a 2018 study, Awoyera Paul O. et al. replaced fine and coarse aggregates in concrete to examine the mechanical characteristics of ceramic waste. The workability of the resulting concrete was evaluated using the slump cone test after the researchers replaced 25%, 50%, 75%, and 100% of the aggregates with ceramic waste. In the laboratory, using OPC 42.5 grade cement, 150mm x 150mm cubes and 100mm radius, 200mm height cylinders were cast as part of the investigation. The results showed that compressive strength rose with increasing curing age. The study also looked at the split tensile strength of cured concrete and discovered that replacing coarse aggregate with ceramic waste up to 100% of the time boosted strength.

Bommisetty Jagadeesh et al. (2019)

3025Bommisetty Jagadeesh et al. (2019) claim that waste from ceramic products can be used in place of coarse aggregate in M30 grade concrete. According to the study, the strongest material could be made by substituting 20% of coarse aggregate with ceramic waste. This increased the material's strength from 3.18 MPa to 4.1 MPa in split tensile strength tests to 5.015 MPa to 5.43 MPa in other tests of strength. Split tensile strength testing showed that the strength reduced to 3.535 MPa when the replacement percentage was raised to 25%. Therefore, it can be inferred that the best way to increase the strength of M30 grade concrete is to replace 20% of the coarse aggregate with ceramic product waste.

Chandar S. Prakash's (2018)

Chandar S. Prakash's 2018 study was primarily concerned with using ceramic waste in place of fine aggregate in coconut shell concrete. As a replacement for fine aggregate, various percentages of ceramic product waste (10%, 20%, 30%, 40%, and 50%) were employed. Several tests, including compressive strength, split tensile strength, and flexural strength, were conducted, specifically on RCC beams. The results indicated that 40% replacement of fine aggregate with ceramic waste was the optimal level for achieving good strength in coconut shell concrete. The study also showed that in coconut shell concrete, full strength may be achieved by replacing up to 50% of the fine aggregate with ceramic waste. In the split tensile strength test, the strength increased from 3.8 Mpa to 4.7 Mpa due to this degree of substitution. In the flexural strength test, substitution up to a level of 30% increased strength by about 4.97 Mpa, while substitution up to a level of 40% caused the strength to drop to 4.9 Mpa. However, there was an improvement in strength with a 50% substitution of ceramic waste for the fine aggregate.

R. Chandrasekaran (2018)

A study on the use of ceramic waste in construction as a substitute for fine aggregate was carried out in 2018 by R. Chandrasekaran and colleagues. According to the report, ceramic waste accounts for about 25% of the trash produced by the building industry. As a replacement for fine aggregate, different amounts of ceramic product waste (10%, 20%, 30%, and 40%) were employed. The findings showed that the workability of the concrete reduced as the replacement % rose. The study also found that a 40% substitution of ceramic waste for fine aggregate produced the highest level of compressive strength. With a substitution level of 10% to 30%, an increase in strength was seen in terms of flexural strength, going from 3.3 Mpa to 3.8 Mpa. After 28 days of testing, a further replacement of up to 40% caused the strength to drop to 2.4 Mpa.

Elci Hakan (2015)

In a 2015 study, Elci Hakan discovered that the mechanical characteristics of concrete made with floor tile aggregate were comparable to those of concrete made with limestone aggregate. In contrast to limestone concrete, the study discovered that concrete constructed with wall tile aggregate had worse mechanical qualities.

Halicka Anna's (2013)

The goal of Halicka Anna's 2013 study was to determine whether ceramic sanitary waste products might replace both fine and coarse aggregate in concrete. The study also looked at what happened when alumina cement concrete with sanitary waste aggregate was heated to about 1000 °C. The results showed that the concrete had become stronger and had not developed any cracks. The strength of the concrete, however, was reduced when it was overheated.

Leopold Mbereyaho and colleague's et al. (2019)

Leopold Mbereyaho and colleagues' 2019 study found that using ceramic waste in place of fine aggregate increased the strength of M20 grade concrete by up to 5%. However, as replacement continued, strength declined. The specimen's real strength was 2.82 MPa, and it increased to 3.18 MPa after 5% replacement, according to the split tensile strength test, which revealed a rise in strength of about 11%. The strength dropped to 2.33 MPa after 28 days with replacement of up to 15%, though. A 5% replacement of natural aggregate in the flexural strength test resulted in an improvement in strength of roughly 11%.

Madusa Venkata Vijaya Durga (2019)

The study conducted by Madusa Venkata Vijaya Durga et al. in 2019 investigated the replacement of both fine and coarse aggregates with the aim of reducing the water-cement ratio in concrete. Different levels of replacement, ranging from 0% to 30%, were used. Additionally, 10% of marble dust was added to the concrete to increase its strength. The results showed that a 15% replacement of natural aggregate led to an increase in split tensile strength, with an increase of 3.95 MPa observed at 15% replacement. However, further replacement led to a decrease in strength, with strength of 3.47 MPa observed at 28 days. In the flexural test, a 20% replacement of natural aggregate led to an increase in strength, with an increase of 4.98 MPa.

Mohamadhoseini Hossein (2019)

Two varieties of mortar were compared in a study by Mohamadhoseini Hossein et al. (2019). One variant substituted ceramic waste powder for 40% of the ordinary Portland cement (OPC), while the second type substituted 100% ceramic particles for the fine aggregate. The findings suggested that adding fine ceramic particles to ceramic powder decreased the workability of concrete. In contrast to the control concrete, the mortar prepared from ceramic waste showed better compressive and split tensile strengths as well as less drying shrinkage. The study came to the

conclusion that because ceramic waste has better mechanical and microstructural qualities, it may be used as a sustainable resource in concrete. After 7 days, the split tensile strength of the ceramic-based concrete was 4% lower than that of the control concrete.

RM. Senthamarai et al. (2005)

The study by RM. Senthamarai et al. (2005) concentrated on the utilization of waste ceramic product as a coarse aggregate replacement in concrete. The outcomes showed that the concrete made from ceramic waste was more workable. It was discovered that the qualities of the concrete made from waste ceramic products were comparable to those of the controlled concrete. But as the amount of coarse aggregate replaced with ceramic waste increased, the results of the split tensile strength tests decreased from 4.5 MPa to 3.2 MPa and the results of the flexural strength tests decreased from 6.9 MPa to 4.7 MPa.

Pincha Torkittikul (2010)

Ceramic waste had to be crushed in order to pass through a 4.75 mm screen for the study by Pincha Torkittikul et al. (2010). The findings showed that the workability of ceramic waste combined with Portland cement decreased, whereas the workability of ceramic waste mixed with fly ash increased. It was discovered that adding up to 50% of ceramic waste to Portland cement concrete boosted its strength by up to 50%, but adding more ceramic waste than that resulted in a loss of strength. On the other hand, adding ceramic waste to fly ash concrete increased strength by up to 100% of the amount of ceramic waste in the concrete.

Sudarsana (2013)

The effects of water absorption by ceramic waste aggregate on the strength characteristics of ceramic aggregate concrete were examined in a study by Sudarsana et al. (2013). The water absorption of ceramic waste aggregate was 0.08% higher than that of conventional aggregate, according to studies using M20 concrete

with a water-cement ratio of 0.48. At 20% replacement, the compressive strength was found to be at its maximum, reaching 93.4 percent and 98.8 percent, respectively, of that of standard concrete at 7 and 28 days. However, the density decreased as the proportion of replacement was increased; at 100% replacement, the density was 4.43% lower than that of standard concrete. These results imply that ceramic waste aggregate can be a good substitute for regular aggregate.

Sudarsana (2013)

The effect of water absorption by ceramic waste aggregate on the strength properties of ceramic aggregate concrete was examined in a study by Sudarsana et al. (2013). According to the study, there is a 0.08% difference in the water absorption of conventional aggregate and ceramic waste aggregate. The study used M20 concrete with a water-cement ratio of 0.48 and showed that the concrete's compressive strength was at its peak at a replacement rate of 20%, achieving 93.4% and 98.8% of that of regular concrete at 7 and 28 days, respectively. However, as the replacement percentage rose, the density of the concrete dropped; at 100% replacement, it was 4.43% less dense than regular concrete.

Maya et al. (2014)

Maya et al. (2014) studied the mechanical characteristics of roof tiles used as coarse aggregate while exposed to high temperatures, taking into account different ratios of 0.40, 0.45, and 0.50. According to the study, a rise in temperature and the water-cement ratio resulted in a decrease in compressive strength and split tensile. The results thus imply that higher temperatures and an increased water-cement ratio have a detrimental effect on the mechanical characteristics of concrete containing coarse aggregate made of roof tiles.

T. Sekar (2011)

The strength properties of concrete made from waste materials, such as ceramic tiles, ceramic insulator trash, and shattered glass fragments, were examined

in a study done by T. Sekar (2011). According to the findings, when compared to the other two waste sources, the concrete made from ceramic tiles had the highest strength qualities. In particular, the compressive strength, split tensile strength, and flexural strength of the concrete made using ceramic tile aggregate were comparable to those of conventional concrete. These results imply that the use of scrap ceramic tiles as aggregate in the manufacturing of concrete can be a practical substitute for conventional concrete production techniques.

RM. Senthamarai (2005)

The study concentrated on using waste from ceramic products to replace coarse aggregate in concrete. The outcomes showed that the concrete with ceramic waste had improved workability. It was discovered that the ceramic waste concrete's characteristics were comparable to those of the controlled concrete. The strength of the material did, however, decline as the level of substitution rose. More specifically, in the split tensile strength test, further substitution caused the strength to drop from 4.5 MPa to 3.2 MPa. Similar results were observed in the compressive strength test, where greater substitution caused the strength to drop from 6.9 MPa to 4.7 Mpa.

Pincha torkittikul (2010)

Ceramic debris had to be crushed and run through a 4.75mm screen as part of the investigation. When ceramic waste was combined with Portland cement, it was discovered that it became less workable, however when it was combined with fly ash, it stayed good. The findings indicated that adding ceramic waste to Portland cement concrete boosted its strength by up to 50%, but that once the concrete's ceramic waste percentage exceeded 50%, its strength began to decline. But when ceramic waste was added to fly ash concrete, the strength of the concrete increased by up to 100% of the ceramic waste amount. These results imply that increasing the strength of fly ash concrete through the incorporation of ceramic waste can be a practical strategy.

CHAPTER 3

AIM AND SCOPE OF THE INVESTIGATION

3.1 AIM

To analyze the impact of replacing 10%, 20%, and 30% of M sand with ceramic waste on the compressive strength and durability qualities of concrete cubes would be a more precise goal for the experimental inquiry.

3.2 OBJECTIVE

- Use ceramic waste in concrete in various ratios (0%, 10%, 20%, and 30%) to substitute fine aggregate.
- To cast the specimens and test them to determine their compressive strength.
- To compare test results and determine the best proportion of ceramic waste to utilize in concrete.

3.3 SCOPE OF THE PROJECT

The scope of this project includes the following tasks:

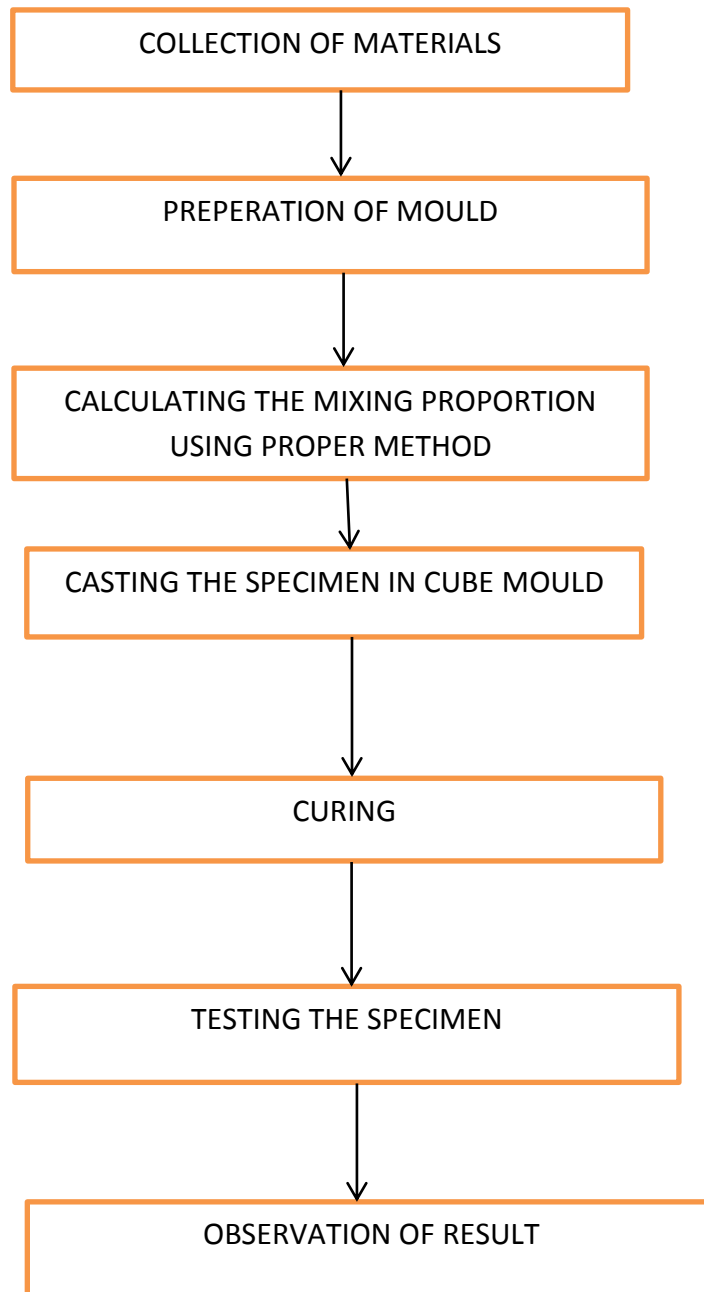
- A comprehensive review of existing literature on the use of ceramic waste as a replacement for M sand in concrete production will be conducted. This will provide the necessary background information and identify the knowledge gaps that need to be addressed in the project.
- Material collection and preparation: The ceramic waste and M sand will be collected and prepared for the production of concrete cubes.
- A suitable mix design will be developed based on the available materials and the desired properties of the concrete cubes.
- Concrete cubes will be produced with varying percentages of ceramic waste replacement, and their compressive strength will be evaluated.

- The data obtained from the testing of the concrete cubes will be analyzed statistically to determine the effect of ceramic waste replacement on the properties of the concrete cubes

CHAPTER 4

MATERIAL AND METHOD OF INVESTGATION

4.1 METHODOLOGY



4.2 CEMENT

Ordinary Portland Cement (OPC), which is a key component of concrete, mortar, stucco, and the majority of non-specialty grout, is the type of cement that is most frequently used globally. The raw components are heated to create clinker, which is subsequently ground into a fine powder to create this cement. Following the grinding stage, minor amounts of other ingredients are added. There are many different types of cement on the market, but 53 Grade OPC Cement is renowned for offering consistently stronger strength than other variations. We used 53 Grade OPC Cement from Dalmia Company for this experiment, which was obtained from a single batch and stored in airtight containers to shield it from the effects of the environment.

Constructional cements, also known as hydraulic cements, are frequently employed in building projects because of their special ability to set and solidify even in water. Portland cement is the hydraulic cement that is most frequently used. This study goes into the chemical composition, characteristics, manufacturing process, historical development, and testing procedures for cement. Portland cement and other hydraulic cements are the main topics of discussion, but other varieties like high-alumina and slag-containing cement are also covered. It also draws attention to the parallels between the manufacture of cement and other ceramic goods like tile, brick, refractories, and abrasives.

4.2.1 APPLICATION OF CEMENT

Construction projects frequently employ cement since it is a flexible building material. It is frequently used to build mortar or concrete, together with aggregate materials like sand or crushed stone. Bricks, blocks, and other building materials are held together by mortar, a compound made of cement, sand, and water. The foundations, floors, walls, and other structural components of buildings are all constructed using concrete, which is a mixture of cement, sand, water, and coarse material, such as crushed stone or gravel from fine sand to huge stones, can be used to make concrete. It is frequently utilised for building foundations, walls, floors, and

other structural components, as well as for paving roads and other constructions .Being a crucial component of concrete, the most often used construction material in the world, cement production is a large industry. The most common kind of cement used in the building sector is Portland cement. It is a hydraulic cement, which means that a chemical reaction with water causes it to set and harden, making it the perfect substance to employ in construction projects that call for strength and durability. Portland cement is used to make a variety of precast concrete products, including pipes, bricks, tiles and railway ties, in addition to concrete and mortar. Because they are created in a controlled environment and delivered to the job site prepared for installation, these goods save time and cut down on construction waste.



Figure 4.1 Cement

SL.NO	Properties	Test results
1	Grade	OPC53
2	Brand	Dalmia
3	Colour	Grey
4	Fineness of Cement	96.6%
5	Consistency Test	27%
6	Initial setting time	30min
7	Final setting time	10 hours
8	Specific Gravity	3.15

TABLE 4.1 Cement properties

4.3 FINE AGGREGATE

As a fine aggregate in concrete, this experiment used locally accessible river sand. The main components of the sand are finely divided stony material and mineral particles, with quartz, which is mostly composed of silica due to its chemical inertness and noteworthy hardness, being the most prevalent component. The sand was put through a number of tests, including gradation, fineness modulus, and specific gravity, in line with IS: 2386-1963, to make sure it complied with the required physical specifications. The sand was surface-dried before being used.

The following are characteristics of fine aggregates:

1. Cleanliness or the absence of lumps, biological material, etc.
2. It must to be sturdy and long-lasting.
3. After mixing, it shouldn't react with cement.
4. It should also have a sturdy floor.
5. It shouldn't soak up more water than 5% at a time.
6. These aggregates shouldn't be permeable or soft.

The broad consensus is that aggregates have a specific gravity of 2.7 in the absence of explicit instructions. This is due to the fact that the majority of aggregates from various sources have specific gravities that range from 2.6 to 2.8. To guarantee that the concrete mix produced for a particular project adheres to the necessary criteria, it is crucial to establish the specific gravity of the aggregates. In conclusion, one crucial factor in the construction of a concrete mix is the specific gravity of the particles. In order to guarantee that the concrete mix produced for a particular project satisfies the necessary criteria, it is crucial to know the specific gravity of the aggregates



Figure 4.2 Fine Aggregate

S.No	Description Test	Result
1	Sand zone	Zone- II
2	Specific gravity	2.65
3	Fines modulus	4.93

Table 4.2 Properties of Fine Aggregate

4.4 COARSE AGGREGATE

Coarse aggregates, such as naturally occurring spherical gravels or irregularly broken stones, are used to make concrete that is intended for structural use. These coarse materials may include angular aggregates like granite and limestone or circular aggregates like river gravels.

Aggregates greater than 4.75 mm in size are referred to as coarse aggregates by industry standards. In contrast, aggregates between 4.75 mm and 80 mm are categorized as coarse aggregates, while those between 150 microns and 4.75 mm are categorized as fine aggregates. It is important to remember that both fine and coarse aggregates often fall within the 4.75 mm size range.

The characteristics that follow of the coarse aggregate used in the development are required:

1. It must be strong and long-lasting.
2. It ought to be strong and durable enough to withstand loads.
3. It must be clear of all dust and organic elements, as they may weaken the bonding power of adhesives like cement and bitumen.
4. After mixing, it must not exhibit a reaction with the cement.
5. It shouldn't be too soft or have a lot of pores.
6. It can only absorb up to 5% of water.
7. It has to be inert chemically.
8. It should, to the greatest extent practicable, be cubical, spherical, or angular in shape.
9. The report includes the table below, which lists the mixture's specific gravity and water absorption.

S. No	Description	Test Results
1	Nominal size	20mm
2	Specific gravity	2.74



Table 4.3: Properties of coarse aggregate

Figure 4.3: Coarse aggregate

4.5 WATER

In defining the material's fresh and hardened qualities, concrete's water content is a key factor. These characteristics include of workability, compressive strength, permeability, water tightness, durability, weathering resistance, drying shrinkage, and cracking potential. For concrete to operate as best it can in a variety of applications, it is essential to understand how water content affects these attributes.

To obtain desired fresh and hardened attributes such workability, compressive strength, permeability, water tightness, durability, weathering resistance, drying shrinkage, and resistance to cracking, effective management of the water content in concrete is essential. In order to provide optimal constructability and increase the service life of concrete structures, it is crucial to regulate and limit the water content of concrete.

An important factor in determining the strength and durability of concrete is the ratio of water to cementations components. Because wet aggregates attach to cement paste more effectively and uniformly than dry ones, water is required to saturate their surface and produce an adhesive bond. The strength and durability of the concrete are

increased by using this procedure, which also results in high-quality concrete with outstanding bonding capabilities.

Water, which is necessary for complete hydration, has a significant impact on concrete's strength. The ideal amount of water to utilise for concrete is roughly 30% of the concrete's weight. For conventional concrete, a water-to-cement ratio of 0.35 is required. The cement paste created by mixing water and cement holds the fine and coarse particles together. However, applying too much water can cause bleeding and segregation, which weakens the concrete. Fibers can be used to absorb extra water and stop bleeding. On the other hand, insufficient workability will arise from employing too little water. It's crucial to utilize drinkable water with a pH of between 6 and 9 while creating concrete.

4.6 CERAMIC WASTE

Tiles, sanitary garbage, and flowerpots were among the ceramic waste products that were to be crushed into fine aggregates for the study. The ceramic waste products had characteristics resembling those of natural aggregates and were categorized as zone I materials. However, it was found that the ceramic waste aggregate's surface roughness was smoother than that of natural aggregates. Ceramic materials are essential parts of the building industry and are widely utilized in a number of applications, including sanitary ware, ceramics for the home, floor tiles, and wall tiles. The majority (39%) of the overall output of ceramics is produced as ceramic tiles. Ceramic waste disposal, despite its aesthetic benefits, presents considerable environmental concerns. Building construction, building destruction and the ceramic industry are only a few of the sources that produce ceramic waste. The use of ceramic waste as both fine and coarse aggregates in concrete has been investigated in studies by researchers from throughout the world [13,14,18,19,24,30,57,63,75,76]. The features of the ceramic aggregates employed in the combination have a significant impact on the attributes of ceramic aggregate concrete, including its physical, mechanical, and durability characteristics.

Recent research has looked into the viability of employing ceramic waste in place of conventional aggregates while making concrete, and the results have been promising. The building industry may be able to decrease waste and find a sustainable solution by substituting ceramic waste for aggregate. It has been determined that the compressive strength characteristics of concrete constructed using ceramic aggregates meet the requirements imposed by several international codes. According to these findings, ceramic waste can produce concrete with the same strength and durability as traditional aggregates while also being a viable alternative.

Construction enterprises can lessen their environmental effect by diverting waste from landfills and promoting the circular economy by employing ceramic waste as a replacement for conventional aggregates. Additionally, the utilization of ceramic waste can reduce the cost of manufacturing concrete, making it a desirable alternative for environmentally friendly building methods. Overall, the building sector and sustainability initiatives stand to benefit from the use of ceramic waste in place of conventional aggregates in concrete. Our experiment involved replacing 100% of the coarse aggregate in M20 grade concrete with waste ceramic aggregate of size 10mm, while maintaining a low water/cement ratio of 0.30 to achieve high strength. However, this resulted in reduced workability, which we addressed by increasing the water-cement ratio to the maximum allowable limit. To further improve workability, we recommend the use of admixtures such as super-plasticizers and silica fume in the concrete mix.



Figure 4.4 Collected ceramic waste

S. No	Description Test	Result
1	Ceramic Zone	Zone- I
2	Specific gravity	2.4
3	Fines modulus	3.314

Table 4.4: properties of ceramic waste

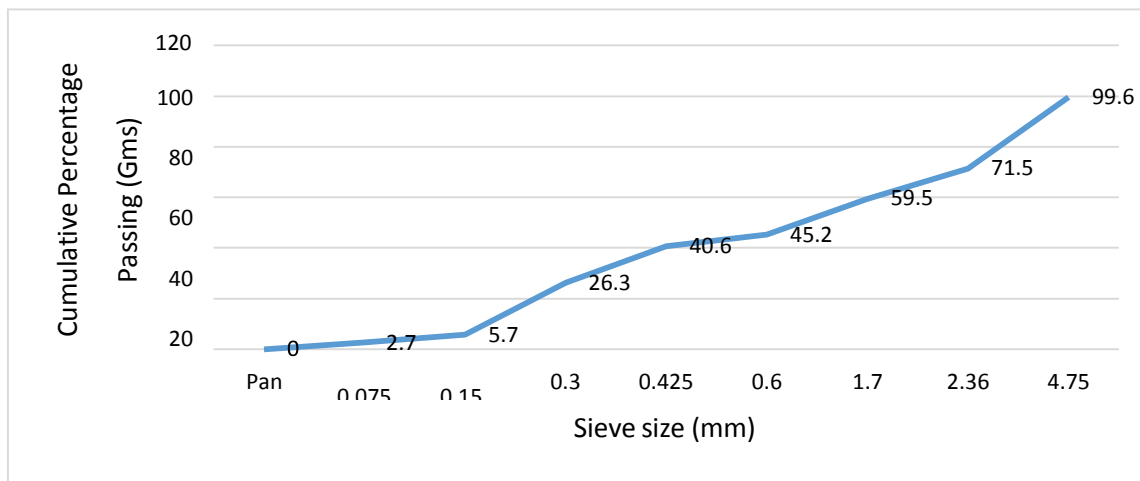


Figure 4.5: Sieve analysis for fine aggregate

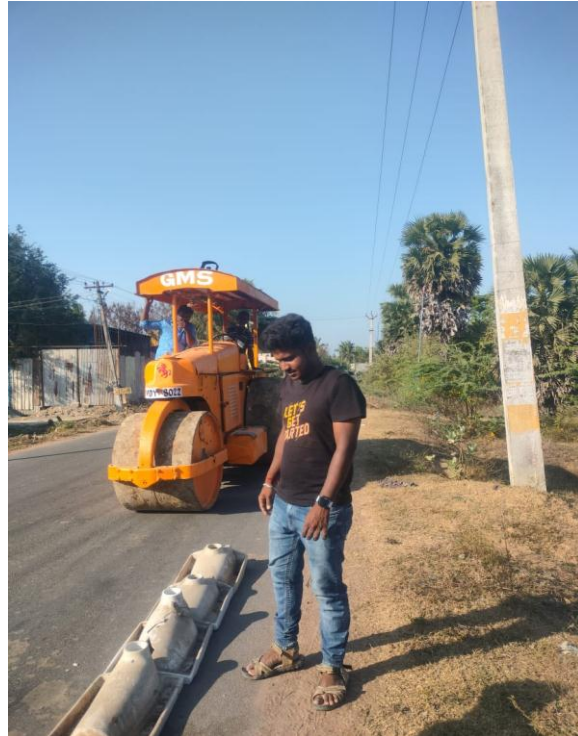


Figure 4.6: Crushing of damaged toilet



Figure 4.7: collecting of ceramic waste

4.7 MIX DESIGN

Mix design is the process of carefully choosing the right materials and figuring out their proper ratios in order to produce concrete that is as strong and durable as possible while still being as economical as possible. Therefore, the fundamental objective of mix

design is to balance creating concrete with the desired qualities while lowering production costs.

According to the definition given above, mix design has two main objectives: first, to ensure that the concrete fulfills the standards for strength and durability, and second, to find the most economical way to produce the concrete. Therefore, achieving the desired strength and durability of the concrete while simultaneously maximizing the economics of the production process are the main goals of mix design.

Various methods for proportioning concrete mixes have been proposed worldwide, but for the present work, the Indian Standard (IS) method was chosen. The mix design employed in this study was determined using the IS method, as presented below.

4.7.1 MIX DESIGN USED:

Mix Design: M25

Mix Ratio : 1: 1: 2

Aggregate	Mix Number			
	A0	A1	A2	A3
Natural Aggregates (%)	100	90	80	70
Ceramic Waste (%)	0	10	20	30

Table 4.5 : Batching Details

Mix Numbers (Kg)	A0	A1	A2	A3
Water content	4.2	4.2	4.2	4.2
Cement	8.5	8.5	8.5	8.5
Fine aggregate	21	18.9	16.8	14.7
Coarse aggregate	16.25	16.25	16.25	16.25
Ceramic Waste	-	2.1	4.2	6.3
Admixture (ml)	43	43	43	43

Table 4.6: Mix proportion

4.8 EXPERIMENTAL INVESTIGATION

In this experiment, we looked at how the compressive strength of regular cement concrete changed when ceramic waste was added. The tests were conducted on the 7th day, the 14th day, and the 28th day in accordance with the guidelines provided in the IS code. Testing was done over a period of time in order to assess the concrete samples' long-term strength growth.

We ran the experiments and looked at the data to see whether there were any notable variations in the compressive strength of the concrete samples. Our investigation centered on determining whether the inclusion of ceramic waste affected the compressive strength of the concrete favourably or unfavourably over time.

Overall, we sought to shed light on the possible advantages of adding ceramic waste to the mix when making concrete, with a focus on improving the strength attributes.

4.8.1 Process

This experiment's method may be broken down into two primary phases: casting and testing. A total of 24 specimens were created during the casting phase in order to get the results for the compressive strength at 7, 14, and 28 days. To calculate the average strength six specimens were made specifically for that type.

Each specimen's compressive strength was assessed during the testing phase at the 7th, 14th, and 28th day points. The specimens' compressive strength at various time intervals was calculated using the results of these tests.

Type	OPC			Replacement about 10%,20% and 30%			Total no. of specimen
	7 th day	14 th day	28 th day	7 th day	14 th day	28 th day	
Cube	2	2	2	6	6	6	24

Table 4.7 Number of specimens

4.8.2 Casting

The investigations made to ascertain the material's qualities in accordance with Indian standards are described in this portion of the report. The investigations carried out were intended to pinpoint the precise properties of the substance. The paper also offers a concrete mix design that is based on Indian specifications.

4.8.3 Mould details

The internal dimensions of the mould are Cubic size = 150mmx150mm x150mm

4.8.4 MOULD

Metal moulds constructed of steel or cast iron that are sufficiently thick to prevent distortion are required for the fabrication of moulded specimens. The specimen should be able to be removed from the moulds without experiencing any harm. Additionally, they should be accurately machined to ensure that, after assembly, their internal faces and dimensions fulfill the accuracy requirements.

The report should specify that a tolerance of 0.2mm must be maintained for both the mould's stipulated height and the distance between its opposing faces. It's also necessary to calculate the angles between internal faces and their surrounding ones, as well as between internal faces and the top and bottom planes of the mould. The mould's inner faces must be flat, with a deviation of no more than 0.03 mm allowed.

Each mould must have a metal base plate with a flat surface large enough to support the mould in order to avoid leaks during filling. It is recommended to use screws or springs to fasten the base plate to the mould. Additionally, during filling and subsequent handling of the filled mould, the assembled mould elements must be held together securely and rigidly. It should be possible to ensure this using appropriate means.

4.8.5 PREPERATION OF MOULD

A thin layer of mould oil is applied to the connections between the mould sections as well as between the contact surface of the mould bottom and the base plate in order to facilitate the assembly of the mould and prevent water from escaping during filling. A similarly thin layer of mould oil is also applied to prevent concrete from adhering to the internal surface of the assembled mould.

A metal cylindrical mould with a minimum thickness of 3mm must be used to make concrete sample. A safe device that guarantees the mould closes tightly while in use should be included. Additionally, it must be made to open lengthwise so that the specimen can be removed with ease. These requirements must be met in order for the finished concrete specimens to have the proper size and shape and to be easily removed from the mould without being harmed or deformed. These specifications are necessary to guarantee the accuracy and dependability of the manufactured concrete specimens for use in various testing and analysis procedures.

The deviation of the mould's ends from a level surface parallel to its axis must not be greater than 0.05mm, as stated in the requirements. The mould shall also have an internal diameter tolerance of 0.2mm and a mean internal diameter of 15.0cm, making sure that no internal diameter measures less than 14.59cm or greater than 15.05cm in any direction. In addition, the mould's height should not exceed or below 300 cm (plus or minus 0.1 mm).

In conclusion, the mould must strictly comply to specifications, with little leeway for deviation, including exact measurements for its ends, internal diameter, and height. These requirements guarantee that the mould is created and ready to operate at its best, meeting the requirements for its intended usage.

A metal base plate and a capping plate, each at least 6.5mm thick and with a 0.02mm maximum deviation from a plane surface, should be included with each mould. To avoid concrete adherence to the mould, the base plate must be tightly fastened to it and support the filling process without allowing any leakage. A steel bar with a pointed end that is 16mm in diameter and 0.6 metres long will be used to tamp the concrete.

4.8.6 PREPERATION OF CONCRETE

Every step of the manufacturing process must be meticulously attended to in order to produce concrete of the highest caliber. It's interesting to note that the ingredients required to create old and low-quality concrete are the same. The correct use of protocols and cautious treatment, however, make a difference. For the finest quality concrete to be produced, it is crucial to comprehend and adhere to the proper procedures at every stage of manufacturing. This will help to avoid any problems and ensure that the finished concrete meets the required criteria.

Process

There are a number of unique steps in the production of concrete that must be followed to guarantee quality and consistency.

1. Batching
2. Mixing
3. Placing

4. Compaction

5. Curing

4.8.7 BATCHING

4.8.7.1 VOLUME BATCHING

To assure the quality of concrete, proper material measurements are crucial. However, it might be challenging to estimate the exact volume of solid granular material that is included in a cubic metre when measuring granular materials by volume. This is because of a number of elements, including the materials' density and moisture content, which have a big impact on their weight and volume.

For instance, damp sand may weigh significantly less than the same volume of dry, compacted sand when it is in a loose state. As a result, depending on volume batching as a technique for material proportioning may not be appropriate. In order to maintain precision and consistency in the quality of the finished product, it is advised to measure concrete materials by weight rather than volume.

We can make sure that the precise amount of each component is used, in accordance with the designated mix design, by weighing the ingredients. As a result, problems like segregation, bleeding, and excessive shrinkage may be less likely to affect the strength and durability of concrete. Therefore, weight batching must be used as the preferable method of material proportioning for the manufacturing of concrete.

4.8.7.2 WEIGH BATCHING

For consistent quality and to ensure the longevity of the finished product while producing concrete, accurate material proportioning is essential. For large-scale concrete projects, it is highly recommended to employ a weigh batching system because it has various advantages over alternative approaches.

The increased precision of weigh batching is one of its key benefits. Even when working with granular materials with varied densities and moisture contents, it is possible to attain far greater accuracy by measuring materials by weight rather than volume. By doing so, waste may be decreased, productivity can be increased, and costs can be reduced.

The versatility of weigh batching is another advantage. Modern weigh batchers make it simple to modify the material proportions in response to modifications in the mix design or other elements. This gives the manufacture of concrete more flexibility and can assist guarantee that the finished product satisfies the project's unique needs.

Furthermore, even for operators with little experience, weigh batching is comparatively straightforward and simple to use. Depending on the requirements of the present project, there are numerous weigh batcher types from which to pick and the technology is generally accessible. These might include everything from simple manual systems to completely automated machines with computer controls.

However, meticulous adherence to weigh batching procedures is required to produce concrete of the highest caliber. This entails utilising standardised practises for material handling and mixing, calibrating the batcher correctly, and performing routine inspections and maintenance to guarantee the system is running precisely and dependably.

Overall, the precision, adaptability, and simplicity of concrete production can be considerably improved by the use of a weigh batching system. Concrete producers may achieve consistent quality and make sure their goods are long-lasting by choosing the right tools and adhering to best practices.

4.8.8 MIXING

For concrete to be produced, uniformity must be achieved, which requires strict material mixing to ensure colour and consistency homogeneity. There are two typical techniques for mixing concrete:

(1) Hand mixing or manual mixing

(2) Machine or mechanical mixing

4.8.8.1 HAND MIXING

Hand mixing concrete for small-scale, inconsequential projects is a typical practice. To ensure the quality of the final concrete, it is advised to add 10% more cement due to the limits of this approach. It is best to utilise a sizable, impervious concrete or brick floor that can fit one cement bag when mixing by hand. The cement should then be added after the coarse and fine aggregates have been laid out in alternate layers. The next step is to vigorously mix the mixture using a shovel until it has a uniform colour. When a uniform and homogenous concrete is achieved, the mixture should be spread out to a thickness of about 20 cm and water should be sprayed on using water can with a rose-head. It is essential to sprinkle water gently rather than spilling it. To get the desired consistency, a small amount of water can be added towards the conclusion of the mixing process. The ultimate quality of the concrete can be greatly affected by even a small variation in the amount of water applied at this stage.



Figure 4.8: preparation of mould



Figure 4.9: Mixing of mortar

4.8.8.2 MACHINE MIXING

Concrete is mixed mechanically using mixers, pumps, and trucks during the machine mixing process. This method is preferred for major construction projects since it is quicker and more effective than hand mixing. The machine mixing process uses a mixer machine to precisely and consistently combine the various concrete ingredients, including cement, water, sand, and aggregates. The components are blended by the machine until a homogeneous mixture is produced.

At the construction site or at a central batching plant, where the concrete is mixed and delivered to the construction site using concrete trucks, machine mixing can be done. Direct pumping of the concrete to the required area can save time and labour.

Better quality control, more efficiency, and quicker production periods are benefits of machine mixing in concrete. To make sure the machines are running properly, though, trained workers and frequent maintenance are needed. All things considered, machine mixing is a dependable and effective way to create high-quality concrete for projects of all kinds.

4.8.9 PLACING

Implementing a well-thought-out and methodical approach is crucial for achieving the best outcomes in concrete placing. In order to pour the concrete properly and effectively and produce a final product of excellent quality, a methodical technique is essential. Consequently, for a concrete placement to be successful, a well-designed plan and a disciplined execution procedure are crucial.

4.8.10 COMPACTION

Concrete must be compacted a critical procedure that involves liberating trapped air. Particularly in concrete with low workability, air can become trapped during the mixing, transport, and placing of concrete. This indicates that compared to concrete

mixes with great workability, stiffer concrete mixes require more effort to compact and remove air. Concrete's strength can be greatly reduced if the air is not completely removed. In actuality, the quantity of air holes left by inadequate compaction directly correlates with the strength of concrete. In contrast, concrete with 10% voids can lose nearly 50% of its strength whereas concrete with 5% voids can lose up to 30% of its strength. To avoid the finished product losing strength, it is crucial to make sure that proper compaction is carried out during the construction process.

To attain the best strength and durability, it is essential to make sure that the concrete is completely compacted. For small-scale concrete projects or when mechanical compaction is not possible, hand compaction techniques including rodding, ramming, and tamping are frequently used. With a layer thickness restriction of 15 to 20 cm, hand compaction maintains the concrete's consistency at a higher level. Using a 16mm diameter rod, often made of iron, bamboo, or cane, to pack the concrete and release trapped air between the reinforcement and pointed corners and edges are known as rodding. For the entire region to be compacted successfully, ongoing rodding is necessary.

4.8.11 CURING

The continual hydration of cement particle is thought to be the source of concrete's strength, according to study. This does not happen suddenly; it is a continual process that occurs over a long length of time. Despite starting out rather quickly, the rate of hydration eventually slows down. The amount of hydration that occurs determines the volume of hydration product and the volume of gel formed as a result of hydration.

As mentioned previously, cement needs a water/cement ratio of about 0.23 to hydrate and a water/cement ratio of 0.15 to fill the spaces in gel pores. A water/cement ratio of roughly 0.38 is required in order to completely hydrate all cement particles and fill the space in gel pores. It is impossible to exaggerate the significance of appropriate curing, particularly given the rising demand for high-quality concrete. There is evidence

to suggest that continuous and effective curing enhances the overall quality of concrete.

Concrete's quality may be severely damaged if curing is neglected in the early phases of hydration. This is due to the heat that concrete produces during hydration, which can be detrimental to volume stability. The finished product may suffer if the generated heat is not extinguished. On the other hand, through-water curing can lessen the harmful effects of heat creation during hydration.

Ponding and wet covering are two cures that have been proven successful. These techniques entail keeping the concrete consistently wet for a long time, which can assist in controlling the temperature and preventing cracking or other damage. It is crucial to properly cure concrete in order to produce concrete of the highest caliber.



Figure 4.10: Mixing of concrete



Figure 4.11: Hand mixing



Figure 4.12: Tamping



Figure 4.13: Prepared concrete mould



Figure 4.14: Removal of mould



Figure 4.15: curing

4.8.12 WATER CURING

This method clearly stands out as the most efficient way to achieve a full cure in terms of providing the necessary conditions for curing, such as promoting hydration, preventing shrinking, and absorbing the heat produced by hydration.

4.8.13 PREPARATION OF SPECIMENS FOR TESTING

The specimens were taken out of the curing tank on the test day and prepared for surface testing. They were let an hour or so to air dry after any surface water and grit were removed. The specimens were then painted to indicate whether they were OPC or included 60mm fiber, and then they were covered in a coating of white wash.

4.8.14 TESTING FOR CONCRETE

Fresh concrete's workability is a key characteristic that defines how much internal work is necessary to thoroughly compact the concrete without generating bleeding or segregation in the final result. This physical characteristic has a considerable impact on the final concrete structure's strength, durability, labour cost, and appearance. When a concrete mixture can be evenly compacted and put without bleeding or segregation, it is said to be workable. The finished product may have noticeable honeycombs or pockets if the concrete mixture is unworkable and requires additional work to compact it in place.

4.8.15 COMPRESSIVE STRENGTH

The compressive strength of each batch is measured at batching plant laboratories to guarantee the proper quality of concrete during casting. The calculation of the members' strength requires this information. Concrete specimens are cast and tested under compressive loads to ascertain its strength.

Concrete's strength is commonly expressed in two units: megapascals (Mpa) in SI units and pounds per square inch (psi) in US values. Commonly abbreviated as f_c or f_{ck} , this strength is known as the concrete's typical compressive strength. Concrete's strength might vary from 10 Mpa to 60 Mpa in typical field usage. To attain exceptionally high compressive strength capacities of up to 500 Mpa, however, concrete mixes can be developed for specific applications and constructions. Common names for this kind of concrete include Powder Reactive Concrete and Ultra High Strength Concrete.

Concrete's strength is often tested using either a Cube Test or a Cylinder Test, which differ in the test specimens' shapes. Concrete cube testing is used to assess the typical compressive strength of concrete according to Indian, British, and European standards. Contrarily, American standards use cylinder strengths obtained from testing concrete cylinder specimens in the construction of reinforced concrete (RC) and

prestressed concrete (PSC) structures. To convert the strength of cube specimens to cylinder specimens and vice versa, however, empirical formulas are available. The typical compressive strength of concrete is defined by the Indian code as the strength of concrete below which not more than 5% of test results are anticipated to fail.

The characteristic compressive strength of 150 mm-size cubes evaluated at 28 days, abbreviated as f_{ck} , is commonly used to describe the compressive strength of concrete. The strength below which no more than 5% of the test results are anticipated to fail is referred to as the typical strength of concrete. This signifies that the required strength value should be met or exceeded in at least 95% of the test results.

Concrete should be combined in the proper ratios and then poured into a mould to take the correct shape to generate a concrete specimen for testing. A cube specimen, for instance, should be made using a 15 cm x 15 cm x 15 cm cube mould. For maximum density and strength, the concrete must be adequately compacted. The specimen must be taken out of the mould after 24 hours and submerged in water to cure.

The actions below were conducted in order to ascertain the specimen's compressive strength:

- The specimen was taken out of the water when the natural process called for it, and any surplus water was wiped off the surface.
- The specimen's measurements were precisely measured, rounded to the nearest 0.2 meters.
- The testing device's bearing surface was properly cleaned and free of any impurities or dirt.
- The specimen was positioned in the machine so that the load would be distributed evenly across the other sides of the forged cube.

CHAPTER 5

RESULT AND DISCUSSION

5.1 COMPRESSIVE STRENGTH

The compressive strength test was conducted on 24 cubes measuring 150 x 150 x 150mm. The cubes were cast and tested after conducting workability tests, with testing performed at both 7 days, 14 days and 28 days. The results of the compressive strength test are presented in the table below:

S. No	Mix Designation	Aggregate Replacements (%)	Compressive strength of M25 grade in N/mm ²		
			7 days	14 days	28 days
1	A0	0%	17.65	23.15	26.30
2	A1	10%	15.13	19.50	25.15
3	A2	20%	13.26	17.33	22.10
4	A3	30%	10.75	18.57	20.67

Table 5.1 Compressive Strength result

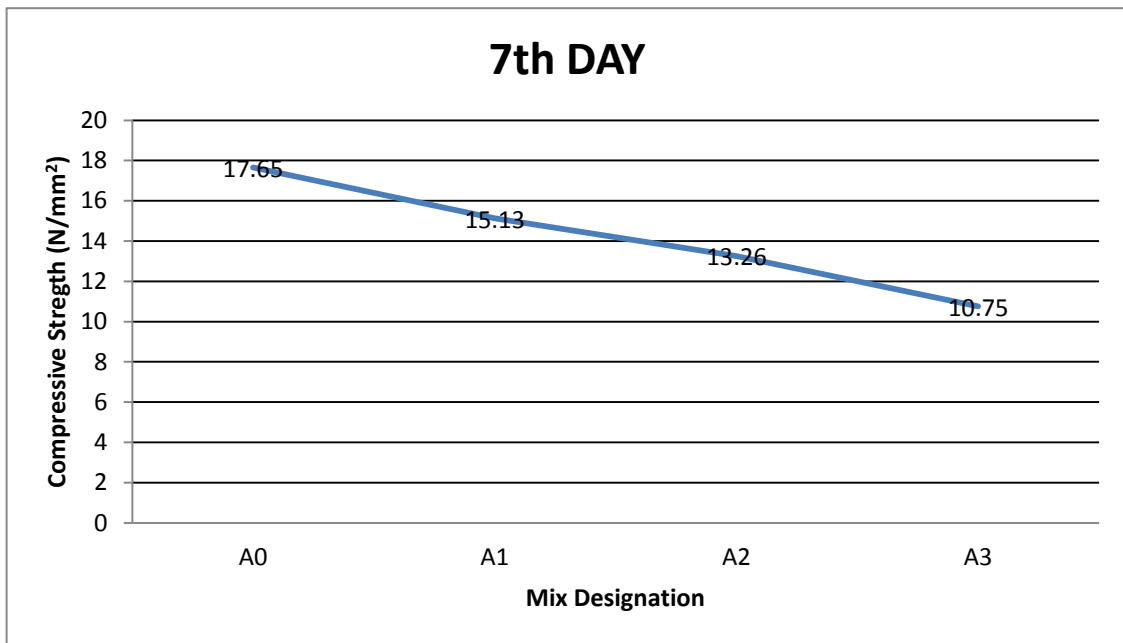


Figure 5.1: Compressive Strength for 7th day

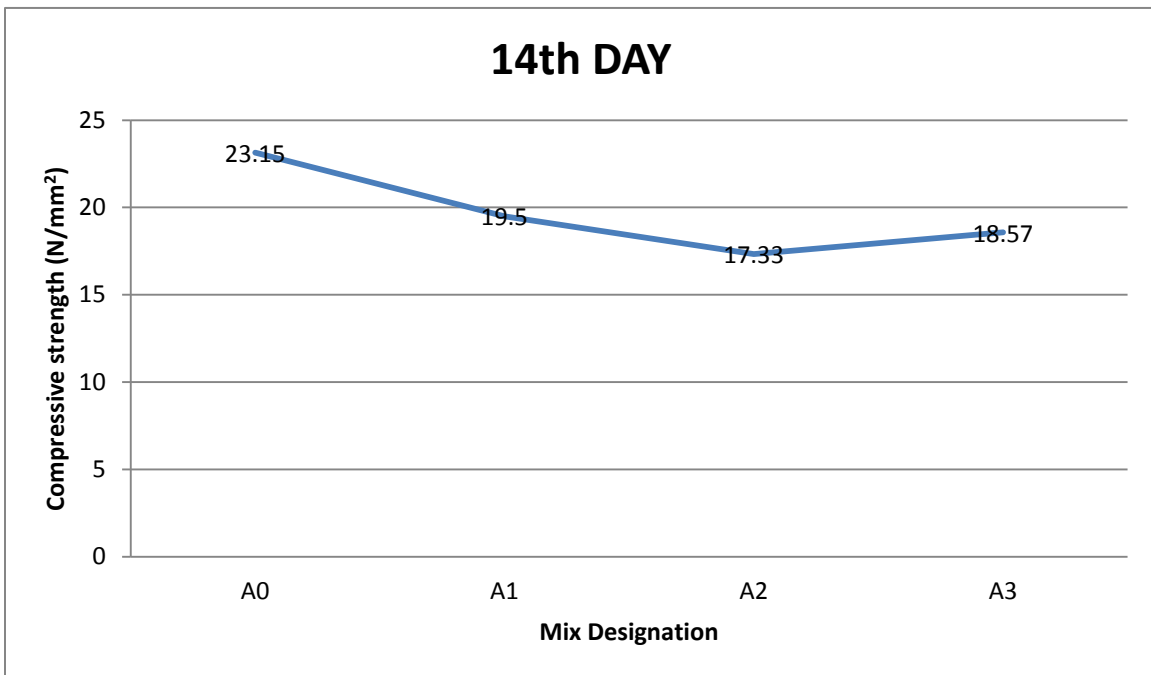


Figure 5.2: Compressive Strength for 14th day

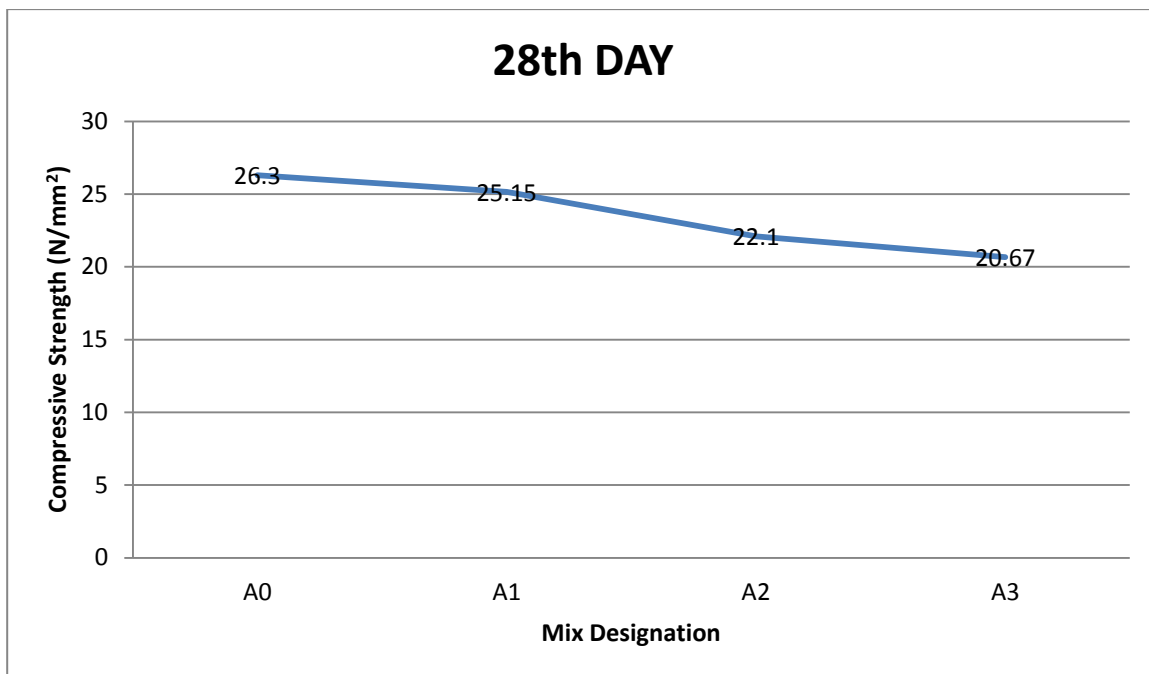


Figure 5.3: Compressive Strength for 28th day

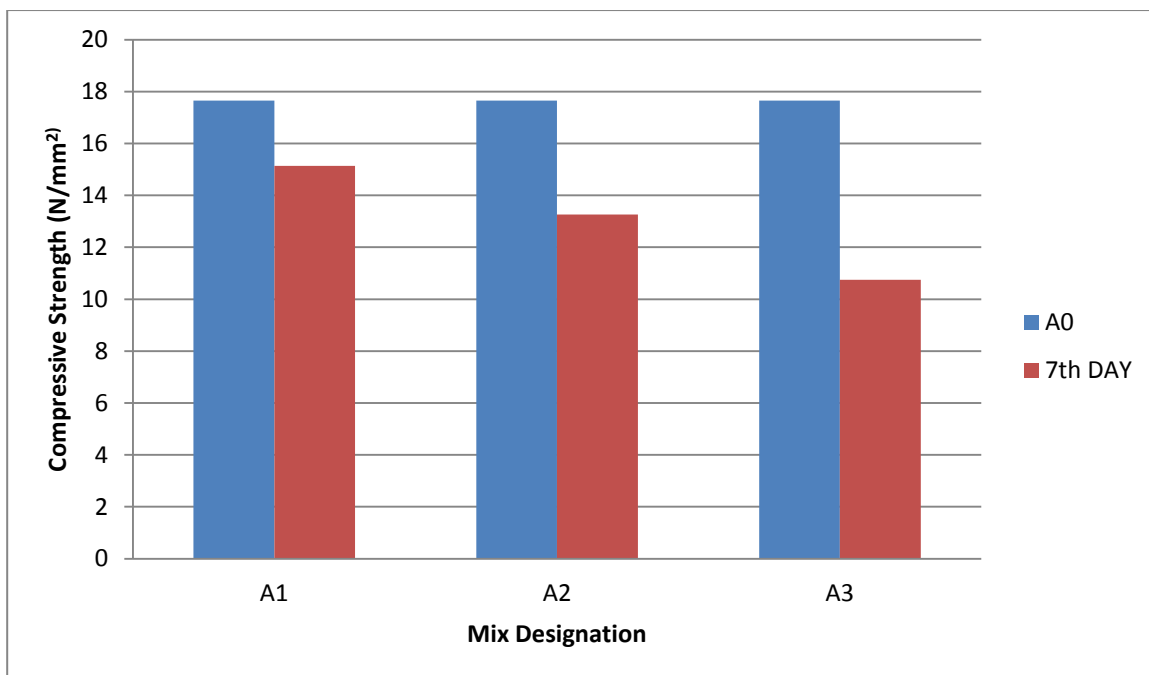


Figure 5.4: Comparison of Compressive Strength for 7th day

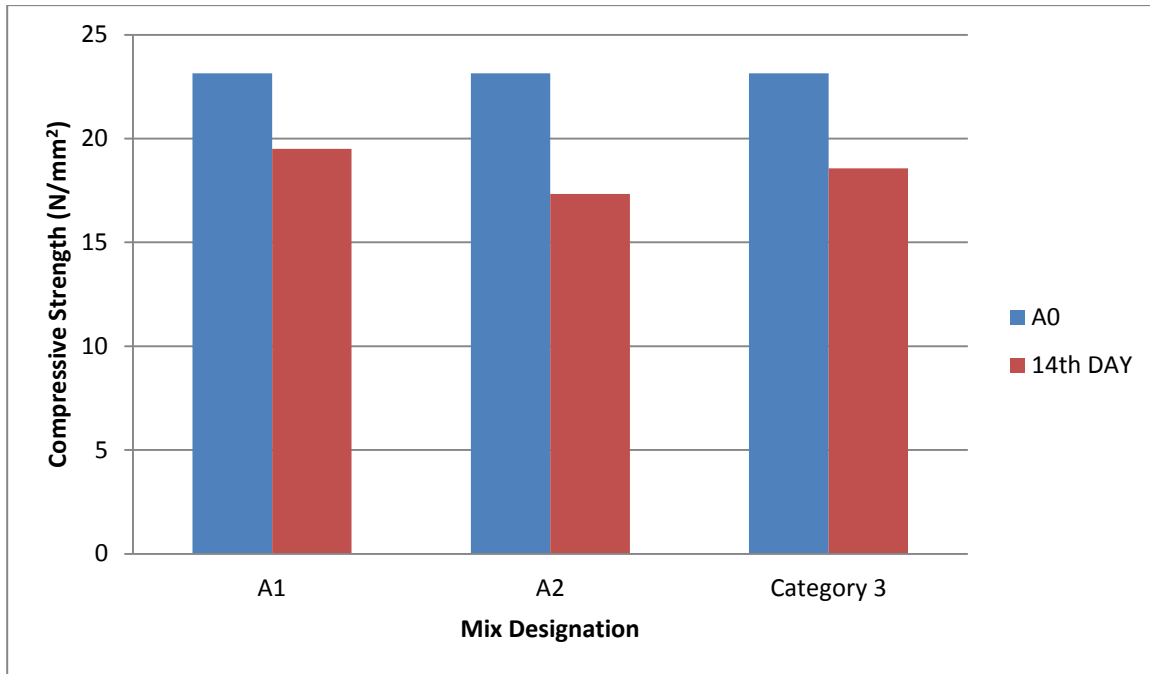


Figure 5.5: Comparison of Compressive Strength for 14th day

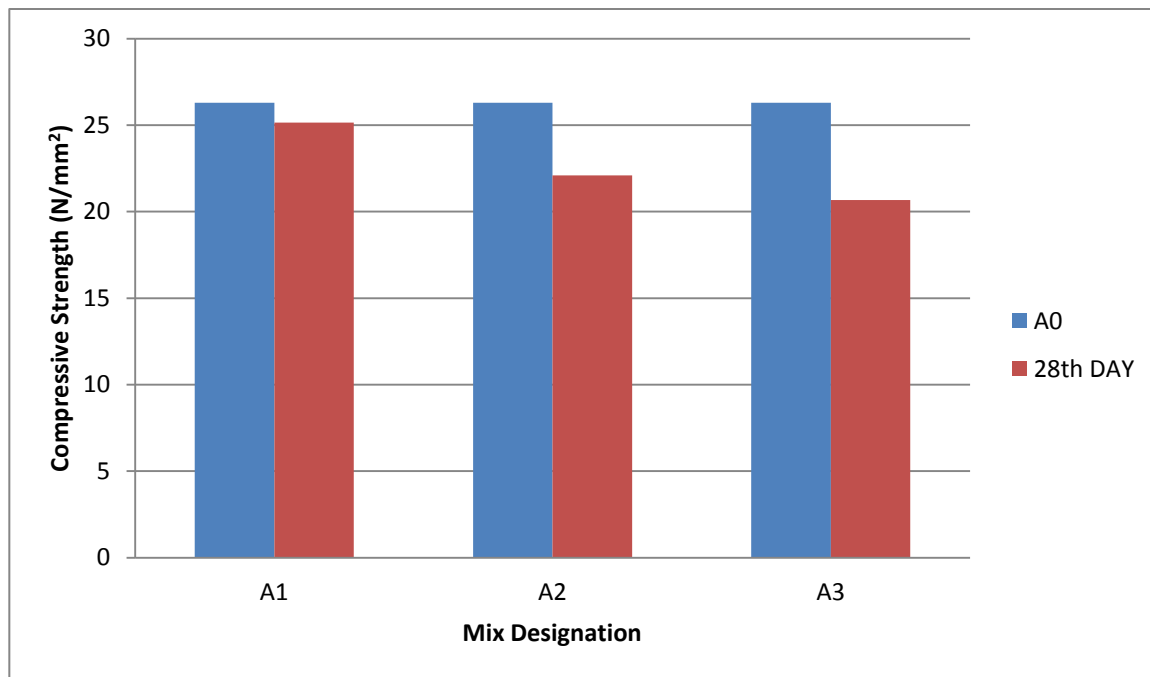


Figure 5.6: Comparison of Compressive Strength for 28th day



Figure 5.7: Testing of cube



Figure 5.8: Calculate the readings

The results obtained above testing gives comprehensive outcome of the project as the replacement the replacement of Ceramic Waste aggregates produces a concrete with suitable properties as conventional.

The Compressive strength of concrete varies as 15.3%, 28.4% and 48.5% for A1, A2 and A3 compared with the conventional concrete (A0) after 7days of curing.

The Compressive strength of concrete varies as 17.1%, 54.3% and 73% for A1, A2 and A3 compared with the conventional concrete (A0) after 14days of curing.

The Compressive strength of concrete varies as 4.4%, 17.13% and 23.9% for A1, A2 and A3 compared with the conventional concrete (A0) after 28days of curing. On comparing the strengths of all mixes, A1 has the highest i.e., 10% replacement of fine aggregate.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 CONCLUSION

The cube Compressive strength value of control mix is 26.30 N/mm² respectively.

For 10% replacement of fine aggregate by ceramic waste, the cube Compressive strength value is 25.30N/mm² respectively.

For 20% replacement of fine aggregate by ceramic waste, the cube Compressive strengthvalue is 22.10N/mm² respectively.

For 30% replacement of fine aggregate by ceramic waste, the cube Compressive strength value is 20.67N/mm² respectively.

From this result it is inferred that strength gradually decreases with the increase in replacement percentage of ceramic waste aggregate.

It was noted these 10% replacement of ceramic waste gain strength and give better results than otherpercentage and control mix.

It is concluded that ceramic waste may be used in concrete up to 10% there by it improves the strength as well as saves the natural resources.

From this results it is inferred that 10% replacement by ceramic waste gain more strength and gives better result. Beyond 10% replacement the strength decreased. The strength loss may be due to increase in consumption of water to improve workability.

REFERENCE

- [1] Amaziah Walter Otunyo , Uwakwe Paul Arinze “Effect of Crushed Waste Ceramic Tiles (CWCT) as Partial Replacement for Fine Aggregate in Concrete” 2018, Vol. 6, No. 3, 129-132
- [2] Ambikesh singh, Dr.Vikas Srivastra “Ceramic Waste in Concrete”, 2018.
- [3] Awoyera, Paul O., et al. "Characterization of ceramic waste aggregate concrete." HBRC journal 14.3 (2018): 282-287.
- [4] Bommisetty, Jagadeesh, et al. "Effect of waste ceramic tiles as a partial replacement of aggregates in concrete." Materials Today: Proceedings 19 (2019): 875-877.
- [5] Chandar, S. Prakash, and et al. "AN EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF SAND BY CERAMIC GRAINS IN COCONUT SHELL CONCRETE."
- [6] Chandrasekaran. P, Ramesh Kumar. R, Praba Rajathi “Experimental Analysis on Concrete by Partial Replacement of Fine Aggregate with Powdered Ceramic Tile”2018, Volume 4, Issue 1
- [7] Elci, Hakan. "Utilisation of crushed floor and wall tile wastes as aggregate in concrete production." Journal of Cleaner Production 112 (2016): 742-752.
- [8] Halicka, Anna, Pawel Ogrodnik, and Bartosz Zegardlo. "Using ceramic sanitary ware waste as concrete aggregate." Construction and Building Materials 48 (2013): 295-305.
- [9] Leopold Mbereyaho, Fidele Amini, Ferdinand Bigirimana & Roger Christian Isengwe “The Use of Ceramic Tiles Waste in Concrete as Partial Replacement of Fine Aggregates”, Volume 3, Issue 3, Pages 122-130, July-September 2019.
- [10] T.M.Maya and Nivin Philip “Mechanical Properties of Concrete

Containing Roof Tile Aggregate Subjected To elevated Temperature”, International Journal of Innovative Research in Advanced Engineering, Vol. 1, No.8, Pp. 255-261, 2014.

- [11] Madasu Venkata Vijaya Durga, K. Narasimha Reddy,” A Study on Partial Replacement of Coarse Aggregate by Ceramic Tile Aggregate and Fine Aggregate by Marble Dust to Improve Concrete Strengths”, Volume-2, Issue-8, August-2019
- [12] Mohammadhosseini, Hossein, et al. "Performance evaluation of green mortar comprising ceramic waste as cement and fine aggregates replacement." SN Applied Sciences 1.6 (2019): 557.
- [13] H. Sudarsana Rao, V. Giridhar and G. Ghorpade “Development of Regression Models For Strength Of Ceramic Waste Aggregate Concrete”, International Journal Of Emerging Trends In Engineering and Development, Vol. 1, NO.5, ISSN. 2249-6149, 2015
- [14] Senthamarai, R. M., and P. Devadas Manoharan. "Concrete with ceramic waste aggregate." Cement and Concrete Composites 27.9-10 (2005): 910-913
- [15] Torkittikul, Pincha, and Arnon Chaipanich. "Utilization of ceramic waste as fine aggregate within Portland cement and fly ash concretes." cement and concrete composites 32.6 (2010): 440-449.