Performance of Concrete Incorporating Waste Ceramic as Partial Replacement of Fine Aggregate

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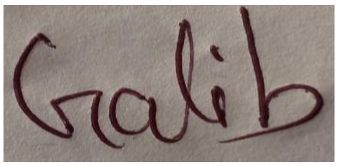
DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Mr. Md. Masud Rana**, Lecturer, Department of Civil Engineering, Faculty of Engineering, Daffodil International University. We also declare that, neither this project nor any part of this project has been submitted for award of any degree or diploma.



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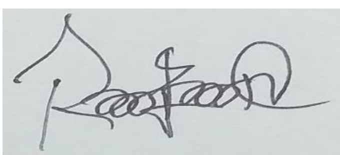

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LETTER OF APPROVAL

This project report prepared by **Saifollah Mohammod Galib** bearing ID: 181-47-109, **Rayhan Hossain** bearing ID: 181-47-108, **Kazi Abbasuddin** bearing ID: 181-47-104 is accepted in partial accordance with the **BACHELOR OF SCIENCE IN CIVIL ENGINEERING** degree requirement. Under my supervision, the said students has completed their project. I considered them honest, hardworking and enthusiastic during the research period.

……………………………

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DECLARATION

First and foremost, we thank Allah for providing us with a sound mind and good health so that we can complete this endeavor successfully.

Special thanks to our honorable supervisor **Mr. Md. Masud Rana**, Lecturer, Department of Civil Engineering, Faculty of Engineering, Daffodil International University for helping and guiding us throughout the thesis period. His never-ending patience, intellectual direction, constant encouragement, energetic supervision, constructive criticism, helpful counsel and reading many poor drafts and fixing them at all stages enable this project to be completed.

Finally, we want to convey our gratitude to our loving parents and friends for their mental support, strength and aid during this research period.

DEDICATION

We dedicate this thesis work to our beloved teacher and our parents.

ABSTRACT

The use of natural aggregate has grown significantly a result of daily advancements and development in the construction industry and the amount of solid waste generated during construction demolition has also expanded significantly. These factors led to the repurposing of destroyed construction wastes like ceramic tiles, which helped to minimize both the amount of solid waste produced and the shortage of natural aggregates needed to make concrete. In addition to the manufacturing, transportation and finishing works also produces waste ceramic tile. In this study an attempt has been made to find suitability for the ceramic tiles wastes as a possible substitute for the conventional fine aggregate (sand). Experiments were carried out to determine the compressive and tensile strength with ceramic tile waste fine aggregate and to compare them those of conventional concrete made with fine aggregate (sand). For this, concrete cylinder specimens were prepared with mixing ratio 1:2:4 using o%, 5%, 10%, 15%, 20% and 25% ceramic fine aggregate.

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Chapter 1

INTRODUCTION

1.1 Introduction

The material concrete is very old. However, the age-appropriate composition, mixed-media design, and techniques varied [14]. Cement, sand or fine aggregates, gravel or coarse aggregate, water, and in some circumstances admixtures are the main components of modern cement concrete [15]. Natural resources including clay, sand, and limestone are needed in the production of cement, significantly depleting them in the process [16].

Due to waste materials being recycled, waste is being used more frequently in concrete. Over the past few decades, recycled coarse and fine aggregates have been employed in concrete. The use of powder in place of cement is also attracting interest. A significant number of ceramic tiles are damaged during transport, handling, and placement each year, resulting in waste [1]. The amount of ceramic and glass garbage generated in Bangladesh's six largest cities—Dhaka, Chittagong, Khulna, Rajshahi, Barisal, and Sylhet—was 21075 tonnes in 2005, and by 2025, it is expected to increase to 128850 tonnes [2]. However, the uses for this waste material benefit resource recycling, which in turn helps to safeguard the environment. Additionally, this offers a practical method for waste management and eventually lowers construction costs.

The primary component of aggregates is thought to be concrete. A sizable quantity of sand, water, and natural particles are being used to produce concrete. Bangladesh has a large number of aggregate demand is primarily from the civil engineering industry for building of concrete and roads. The availability of natural aggregates, however, is a particularly challenging issue nowadays. Globally, natural resources are running out. Therefore, it is imperative to substitute alternative materials for natural aggregates. There is enormous demand on civil engineers to create a resource-efficient and environmentally friendly structure to meet human needs as the world's population continues to grow. Waste ceramic tiles are used as substitute materials in this project. [3]. Clay is used to create ceramic tiles. The waste from ceramic tiles is strong, robust, and remarkably resistant to forces of biological, chemical, and physical deterioration. These materials are a good and appropriate choice for usage in concrete due to their qualities. In addition to improving its qualities, using leftover ceramic tiles in concrete also makes it more cost-effective and addresses some disposal issues. Concrete is made with these used ceramic tiles in place of fine particles [4]. The use of waste tiles in place of fine aggregates will help to reduce environmental pollution by reducing the impact of mining, preserving natural resources, and using less energy during quarrying. Debris tiles will also help to eliminate waste from building and production sites [5].

1.2 Project objective

The major purpose of this research is to assess the overall performance of concrete incorporating wasted waste ceramic in Bangladesh. In addition to this overarching goal the following sub-goals have been established:

a) To investigate the performance of concrete incorporating waste ceramic as fine aggregate.
b) To determine the compressive strength of concrete incorporating waste ceramic as fine aggregate.
c) To determine the splitting tensile strength of concrete incorporating waste ceramic as fine aggregate.

Chapter 2

LITERATURE REVIEW

2.1 General

In order to create a sustainable concrete mass, numerous studies have been conducted on concrete because it is major structural component. Only by substituting superior elements for the existing ones in the concrete can it be strengthened. Utilizing waste materials instead of just replacing materials with them makes building more environmentally friendly. Numerous studies have been conducted in this area on the use of tile aggregate, a waste product directly from industry or indirectly from the destruction of a building. The current analysis is limited to the literature on using tile aggregate in place of fine aggregate in concrete. Below are the specific of the literature review.

2.2 Literature Review

Broken tiles have been used as the ceramic trash. These tiles were used to create ceramic waste concrete (CWC) at 0%, 5%, 10%, 15%, 20%, 25%. Adopting M20 grade concrete all concrete mixes maintain a constant water to cement ration of 0.48. Concrete's physical features such as workability when it is still fresh as well as it's compressive and split tensile strength are discovered after 3. 7 and 28 days. The report recommends that waste tile aggregate replacement should vary from 5 to 30% and that it is suited for regular mixes like M15 and M20 [6].

In this paper, the use of ceramic tile concrete was noted. In this, ceramic fine and ceramic coarse aggregate from building sites in Ota, Lagos and Nigeria are substituted for the coarse and find aggregate in varying amounts. In typical concrete the fine and coarse ceramic particles are replaced separately and the strength parameters are examined. When compared to regular concrete, it concludes that using ceramic waste in concrete significantly increase strength [7].Utilizing ceramic waste will guarantee an efficient technique for preserving the environmental and enhancing concrete's characteristics. Significant environmental advantages will result from using ceramic wastes instead of aggregate in concrete. In the ceramic business 30% percent of production is lost to waste. Compared to traditional coarse aggregate. Ceramic waste aggregate is a more robust and hardly substance. The temperature resistance is good. The ceramic waste aggregate also has outstanding durability qualities. This study examined replacing fine aggregate with ceramic tiles, replacing fine aggregate at a rate of 10% and coarse aggregate at a rate of 30%, 60%, or 100% by weight of M-30 grade concrete. In contrast to traditional concrete, this study suggests using waste ceramic tiles as an alternative building material for the coarse and fine aggregate since it has good strength properties, with a maximum strength of 10% CFA and 60% CCA**.** The objective of this study also is to effectively utilize the waste ceramic tiles from the construction site to substitute various percentages of ceramic waste for the fine aggregate to reduce building industry pollution and discover cheap materials. Since waste ceramic tiles are frequently used in place of fine aggregate in this study, it could represent a breakthrough. Ceramic tile use and waste are both quite common in the modern construction industry [8].

Bangladesh's ceramic industry produces tableware (250 million pieces), tiles (120 million square meters), and sanitary ware (7.5 million pieces), with 20% to 30% of the overall production amounting to waste.In this study, fine aggregate has been replaced to a greater or lesser extent (40, 50, and 60 percent) by crushed waste ceramic tiles. These waste ceramic were used to replace the fine aggregates one at a time, and the outcomes are covered in more detail in the following sections. They had been contrasted with conventional concrete casting in order to assess the durability of this alternative casting. In contrast to concrete manufactured without ceramic waste, which saw an increase in compressive strength up to 50%, concrete made with ceramic waste saw a drop in compressive strength with replacement level (up to 40%, 60%). So, mixtures containing up to 50% ceramic waste fine aggregate are acceptable [10].

2.3 Concrete

Water, aggregate, and cement make up the bulk of the composite material known as concrete. By incorporating reinforcements and additives into the concrete mixture, the physical attributes that are needed for the completed product can be achieved. By combining these elements in a specific ratio, a solid mass that can be easily molded into desired shapes can be created. Buildings, pavements, and other structures can be made from a single hard (rigid) durable material over time thanks to cement's ability to bond the other materials into a strong matrix. The Roman Empire made extensive use of the majority of the concrete technology that had been developed earlier and on a big scale by the ancient Romans. The pantheon dome is the biggest unreinforced concrete structure in the world, while the colosseum in Rome was primarily constructed of concrete. The method was re-pioneered when the use of concrete became less common after the fall of the Roman Empire in the middle of the 18th century. Concrete is currently the most often utilized synthetic material in terms of tonnage [9].

2.4 Properties of Concrete

A material with higher compressive strength than tensile strength is often concrete. It is typically reinforced with some materials that are strong in tension, like steel, due to it's reduce tensile stress. Concrete's elastic behavior is essentially stable at low stress levels. Concrete shrinks as it ages because of its low thermal expansion coefficient.

All concrete constructions have some degree of cracking because of shrinkage and strain. When concrete is subjected to long-term stresses, it is prone to creep. To make sure the qualities of concrete meet the criteria, several tests are carried out for the applications. Different combinations of concrete materials, measured in psi or Mpa, produce concrete with varying strengths. Concrete with varying strengths is used for many types of construction. Very low-strength concrete can be utilized if the concrete needs to be light in weight. By adding air, foam, or lightweight aggregates, lightweight concrete can be produced; however, doing so will weaken the concrete's strength. For regular operations, concrete between 300 and 400 psi is frequently employed. Although it costs more, commercially speaking, the 5000-psi concrete choice is one that is more resilient. Larger civil projects frequently employ concrete with a 5000-psi strength rating. Concrete with a strength of more than 5000 psi was frequently employed for particular building components. For instance, to maintain modest column diameters in high-rise concrete structures with lower floor columns, 12,000 psi or higher strength concrete may be used [11].

2.5 Construction Waste in Bangladesh

Solid trash generated by building demolitions is growing daily in the modern construction industry. Ceramic tiles are being used extensively in today's structures, and their use is only growing. The majority of buildings employ vital construction materials, some of which are ceramic items. Wall tiles, floor tiles, sanitary ware, home ceramics, and technical ceramics are a few examples of commonly made ceramics. They are primarily made of natural materials that are rich in the mineral clay**.** The ceramic waste is strong, hard, and highly resistant to biological, chemical, and physical degradation forces; therefore, we chose these waste tiles as a replacement material to the basic natural aggregate to reuse them and to reduce the solid waste produced from construction demolitions. Currently, this waste is not recycled in any way.

2.6 Tile Aggregate Concrete

Waste ceramic replaced in place of fine aggregate by the percentage pf 10%. The fine aggregate were replaced by these waste ceramic. And also in combinations that is replacement of fine aggregates at a single mix [12].

For analyzing the suitability of these crushed waste ceramic in the concrete mix, workability test conducted for different mixes having different percentages of these materials. Slum cone test is used for performing workability test on fresh concrete. And compressive strength test is also conducted for 7, 14 and 28 days curing periods by casting cylinder to analyze the strength variation by different percentages of this waste materials. This present study is to understand the behavior and performance of ceramic solid waste in concrete. The waste waste ceramic are used to partially replace fine aggregate by 5%, 10% 15%, 20% and 25%.

2.7 Compressive Strength Testing

Concrete's capacity to sustain a static load without being crushed is determined by its compressive strength. The compressive strength of concrete is of the utmost importance in structural design since it is one of the many desired features of concrete that is directly related to its strength. Compressive strength gives a very good and precise representation of how a rise in fiber volume dosing rate impacts test sample strength. Only aggregates larger than 20 mm in diameter must fulfill the standards of AS 1012 for compressive strength, while the cube specimen with 150 mm on each side must meet the requirements of AS 1012 for mega Pascal loading (AS 1012 2002). The compression test was performed in accordance with Test Method AS 1012.9 [13].

2.8 Summary

This chapter literary focus was on the use of ceramic tiles in concrete and how it relates to Bangladesh and other countries. This study's objective was to observe the concrete in order to understand how the ceramic tiles embedded in it behaved. Compressive and split tensile properties of ceramic tile aggregate concrete were tested.

Chapter 3

METHODOLOGY

3.1 Introduction

The combination in this study will be made with various amounts of waste ceramic including 0%, 5%, 10%, 15%, 20% and 25%.

3.2 Collection of Raw Materials

3.2.1 Portland Composite Cement (PCC):

As Portland Composite cement (PCC) we have used Shah Cement brand which is available in any local market in Bangladesh. The properties of cement are mentioned in table 3.1.

3.2.2 Normal Consistency Test

The normal consistency of a cement paste is defined as that consistency (% of water) which will permit that vicat plunger to penetrate to a point 10 mm from the top of the vicatmould. The usual range of values being between 22 to 30 percent by weight of dry cement**.**

3.2.3 Initial and Final Setting Time Test:

Initial setting time of cement is the time when the paste (cement + water) starts losing plasticity. This mean that if the initial setting time of cement is 30 minutes, the cement mortar or concrete must be placed in positon within 30 minutes of adding water. If delayed, mortar or concrete will lose strength. On the other hand, the time at which cement completely loses its plasticity and became hard is a final setting time of cement. The time taken by cement to gain its entire strength is a final setting time of cement. Final setting time i.e. 600 min for Portland composite cement.

Table 3.1: Properties of Cement

Property	Average value of PCC from experiment	Stander value of PCC
Normal Consistency	29%	25 to 30%
Initial Setting Time (min)	42	More than 30 min
Final Setting Time (min)	600	Greater than 600 min

3.2.4 Aggregate

The size of coarse aggregate and fine aggregate depends upon the nature of work. The properties of aggregate are given in table 3.2

Table 3.2 Properties of Aggregate

Property	Fine Aggregate	Coarse Aggregate
Fineness Modulus (FM)	2.98	6.432
Specific Gravity	2.64567	2.67358
Moisture Content	3.71	1.91
Water Absorption %	0.29	3.63
Bulk Density (kg/m^3)	1600-1920	1520-1680

3.2.5 Water

Water have collected from civil lab water source. We make sure that there is no dust or iron in our water.

3.2.6 Tile Aggregate

We collected waste tile from Ab 4 Building Underground, Daffodil International University permanent Campus. Then we crushed tile in our lab and make fine aggregate. The fineness modulus (FM) of waste ceramic is 2.82. In Figure 3.1 shows waste ceramic.

Fig 3.1: Waste Tiles

3.2.7 Procedure and Casting the Specimen

The research has been carried out in the civil laboratory of civil engineering Department of Daffodil International University, Dhaka, Bangladesh. The main working principle behind this current study has been to compare the cubes of normal plain cement concrete with cylinders of concrete having waste ceramic on the basic of compressive strength test as it is known to be the most used test due to its case of performing and also because all the required traits of a concrete are somehow related to the compressive strength. For carrying out this experimentation concrete cylinder size (102 mm × 204 mm) were created having grades M20 plain cement concrete. For each type of concreate a set 3 cylinder was prepared and was tested after curing 7, 14 and 28 days, for preparing the concrete cylinder having waste ceramic were used in varying percentages weight of cement add the amount of cement. Here we have used crushed tile 5%, 10%, 15%, 20% and 25% by weight of fine aggregate for preparing the specimen.

The waste ceramic which have been used for preparing the specimen concrete cylinder were collected form Ab4 building underground and then broke them into small pieces by hammer. Then we crushed them, to make fine aggregate by Los Angeles machine. The picture of this machine in fig 3.2.

Fig 3.2 Los Angeles Machine

A slum test is also done by us shows in figure 3.3, because the concrete slump test gauges how fluid new concrete is before it hardens. It is done to examine whether freshly poured concrete is workable and, consequently, if concrete flows easily. It can also be used as a sign of a batch that has been incorrectly mixed.

Fig 3.3: Slum Cone Test

In Figure 3.4, we prepared mold for our test. We made a total of 118 molds for our test.

Fig 3.4: Mold Preparation.

In Fig: 3.5, we try our best in concrete mixing because proper mixing of concrete ingredients is of utmost importance in order to produce good quality of fresh concrete.

Fig 3.5: Concreate Mixing

We take utmost care while casting our mold to ensure that there is no air inside our mold and also tried to compact concrete well. And we have also taken care that the surface is smooth. The picture of custing are given in Fig: 3.6.

 

Fig 3.6: Casting the mold with concrete.

The main consider in the entire experimentation was to mix the dry materials properly. The molds were kept into a vibrating table to initiate vibrations and to make sure the placing of concrete of concrete in the mold is done properly layer by so as to avoid any voids between the aggregate and binding materials. Should properly place the concrete until it is fully filled to prevent air bubbles or voids from entering the concrete cylinder. The mold was eventually removed from the vibration plate and stored in the lab undisturbed for the following 24 hours. The cylinder were then placed in the water tank for varying curing times of 7, 14, and 28 days after the molds had been removed. In order to determine the compressive strength of the mix, the cylinder was finally tested on a compression testing equipment. In order to compare the strengths of traditional concrete with tiled aggregate concrete, this test was conducted on both types of specimen.

Fig. 3.7: Compressive Strength Test.

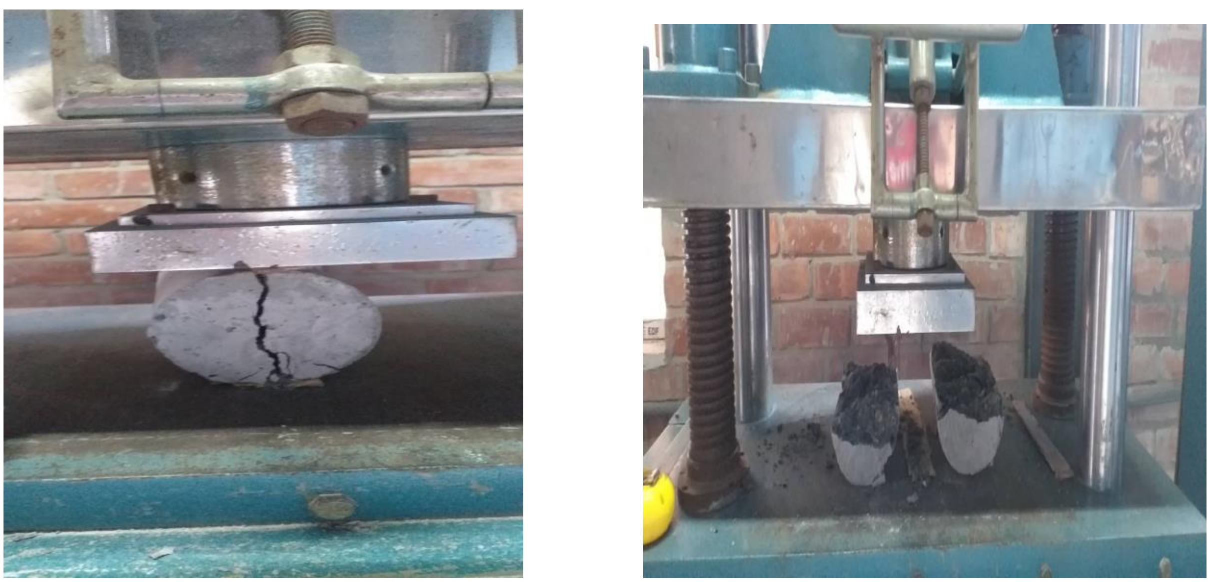

Fig. 3.8: Split Tensile Strength Test

3.3 Summary

Mix design refers to the process of determining the ideal mix components and their proportions in a concrete mixture. The quantity of cement, fine aggregate, and coarse aggregate, as well as the correlation between the water/cement ratio and the desired strength, are all calculated as part of the mix design.

Chapter 4

RESULT AND DISCUSSION

The compressive strength results are introduced in Table 1, 2 & 3 and also the tensile strength result are introduced in table 4, 5 & 6. Every compressive and tensile strength compare with normal specimen which is 0%.

Table 4.1: Result of compressive strength for different mixed of waste ceramic with concrete after

After 7 days.

SL No.	Percentage of Waste ceramic (%)	Compression Load (KN)	Dia (mm)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1	0%	60	101	6.314	6.859
		62	102	6.524	
		67	100	7.738	
2	5%	70	101	8.240	8.570
		72	103	8.641	
		75	102	8.829	
3	10%	64	102	7.832	7.599
		66	101	7.622	
		60	102	7.342	
4	15%	57	103	6.840	6.565
		52	103	6.240	
		53	101	6.615	
5	20%	41	101	5.117	5.377
		46	102	5,629	
		44	102	5.385	
6	25%	35	102	4.283	4.530
		37	103	4.441	
		39	101	4.867	

Compressive strength in 7 days for 0%, 5%, 10%, 15%, 20% and 25% is 6.859 MPa, 8.570 MPa, 7.599 MPa, 6.565 MPa, 5.377 MPa and 4.530 MPa. After observe we find the compressive strength for 5% is high then 0% (normal specimen).

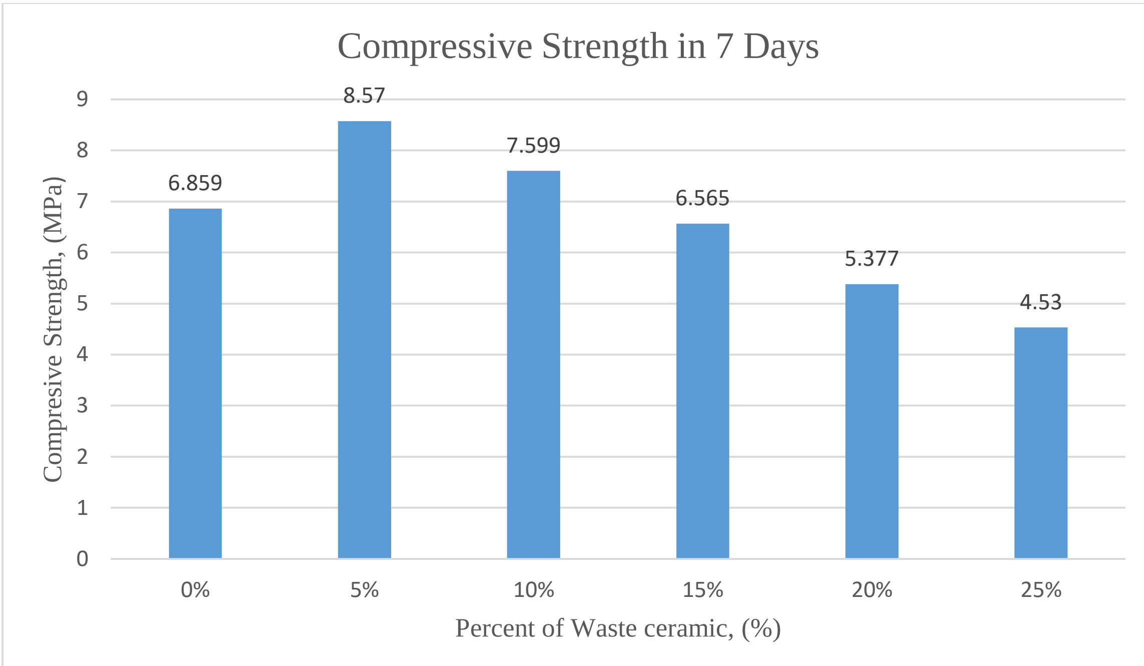

Fig.4.1: 7 Days Compressive Strength

On the other hands for 5%, 10%, 15%, 20% and 25% the result of compressive strength gradually decreases then 0%. So we find out the compressive strength for 7 days is high for 5% mixed of waste ceramic.

Table 4.2 Result of compressive strength for different mixed of waste ceramic with concrete after

14 days.

SL No.	Percentage of Waste ceramic (%)	Compression Load (KN)	Dia (mm)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1	0%	90	102	11.014	10.904
		92	102	11.259	
		87	103	10.441	
2	5%	101	101	11.664	11.852
		99	103	11.881	
		104	102	12.011	
3	10%	95	100	12.096	11.780
		97	101	12.107	
		91	102	11.137	
4	15%	85	102	10.402	10.539
		87	102	10.647	
		83	100	10.567	
5	20%	77	101	9.611	9.632
		76	102	9.301	
		80	101	9.985	
6	25%	68	101	8.487	8.388
		64	101	7.988	
		71	102	8.688	

Compressive strength in 14 days for 0%, 5%, 10%, 15%, 20% and 25% is 10.904 MPa, 11.852 MPa, 11.780 MPa, 10.539 MPa, 9.632 and 8.388 MPa. After observe we find the compressive strength for 5% is high then 0% (normal specimen).

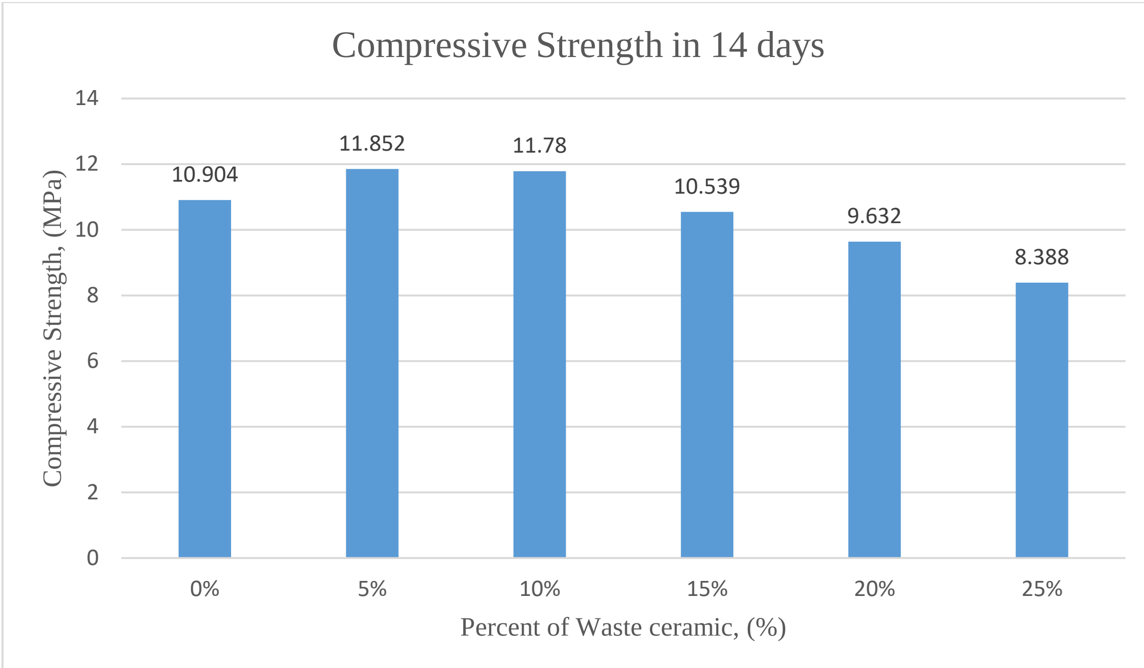

Fig. 4.2: 14 Days Compressive Strength

On the other hands for 5%, 10%, 15%, 20% and 25% the result of compressive strength gradually decreases then 0%. So we find out the compressive strength for 14 days is high for 5% mixed of waste ceramic.

Table 4.3: Result of compressive strength for different mixed of waste ceramic with concrete after

28 days

SL No.	Percentage of Waste ceramic (%)	Compression Load (KN)	Dia (mm)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1	0%	116	101	14.479	14.535
		120	102	14.686	
		118	102	14.441	
2	5%	130	103	15.602	15.778
		135	104	15.892	
		132	103	15.842	
3	10%	121	100	15.406	14.884
		117	102	14.318	
		122	102	14.930	
4	15%	111	101	13.854	13.701
		109	100	13.878	
		105	100	13.369	
5	20%	100	102	12.237	12.444
		99	102	12.115	
		104	101	12.981	
6	25%	91	100	11.586	11.383
		88	100	11.204	
		91	101	11.358	

Compressive strength in 28 days for 0%, 5%, 10%, 15%, 20% and 25% is 14.535 MPa, 15.778 MPa, 14.884 MPa, 13.701 MPa, 12.444 and 11.383 MPa. After observe we find the compressive strength for 5% is high then 0% (normal specimen).

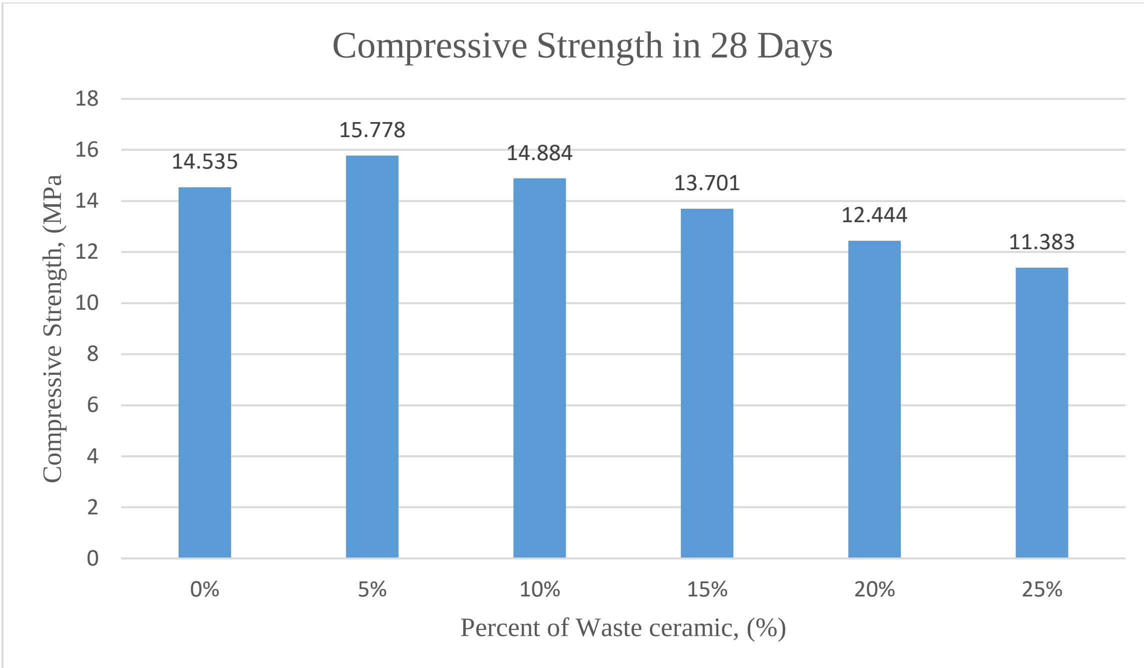

Fig.4.3: 28 Days Compressive Strength

On the other hands for 5%, 10%, 15%, 20% and 25% the result of compressive strength gradually decreases then 0%. So we find out the compressive strength for 28 days is high for 5% mixed of waste ceramic.

Table 4.4: Result of tensile strength for different mixed of waste ceramic with concrete after 7 days

SL No.	Percentage of Waste ceramic (%)	Splitting Load (KN)	Dia (mm)	Tensile Strength (MPa)	Average Tensile Strength (MPa)
1	0%	26	100	0.895	0.883
		28	100	0.963	
		23	100	0.792	
2	5%	35	100	1.204	1.098
		28	101	0.954	
		33	100	1.136	
3	10%	30	101	1.022	0.936
		28	103	0.935	
		25	101	0.852	
4	15%	22	102	0.742	0.829
		23	100	0.791	
		28	101	0.954	
5	20%	19	102	0.641	0.741
		24	100	0.826	
		22	100	0.757	
6	25%	17	101	0.579	0.629
		18	100	0.619	
		20	100	0.688	

Tensile strength in 7 days for 0%, 5%, 10%, 15%, 20% and 25% is 0.883 MPa, 1.098 MPa, 0.936 MPa, 0.829 MPa, 0.741 and 0.629 MPa. After observe we find the tensile strength for 5% is high then 0% (normal specimen).

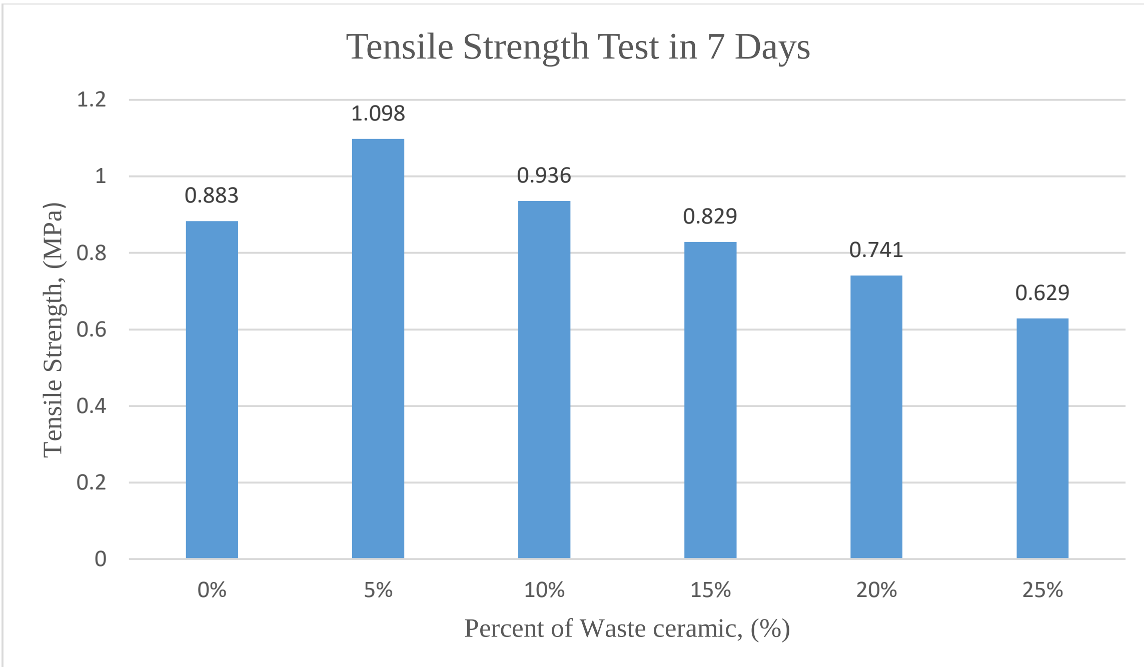

Fig.4.4: 7 Days Tensile Strength

On the other hands for 5%, 10%, 15%, 20% and 25% the result of compressive strength gradually decreases then 0%. So we find out the tensile strength for 7 days is high for 5% mixed of waste ceramic.

Table 4.5: Result of Tensile strength for different mixed of waste ceramic with concrete after14 days.

SL No.	Percentage of Waste ceramic (%)	Splitting Load (KN)	Dia (mm)	Tensile Strength (MPa)	Average Tensile Strength (MPa)
1	0%	41	102	1.383	1.344
		39	100	1.342	
		38	100	1.307	
2	5%	44	102	1.484	1.585
		49	102	1.653	
		47	100	1.617	
3	10%	43	102	1.451	1.539
		45	100	1.548	
		47	100	1.617	
4	15%	39	101	1.328	1.335
		40	103	1.336	
		39	100	1.342	
5	20%	35	102	1.181	1.116
		33	100	1.135	
		30	100	1.032	
6	25%	27	100	0.929	0.975
		28	100	0.963	
		30	100	1.032	

Tensile strength in 14 days for 0%, 5%, 10%, 15%, 20% and 25% is 1.344 MPa, 1.585 MPa, 1.539 MPa, 1.335 MPa, 1.116 and 0.975 MPa. After observe we find the tensile strength for 5% is high then 0% (normal specimen).

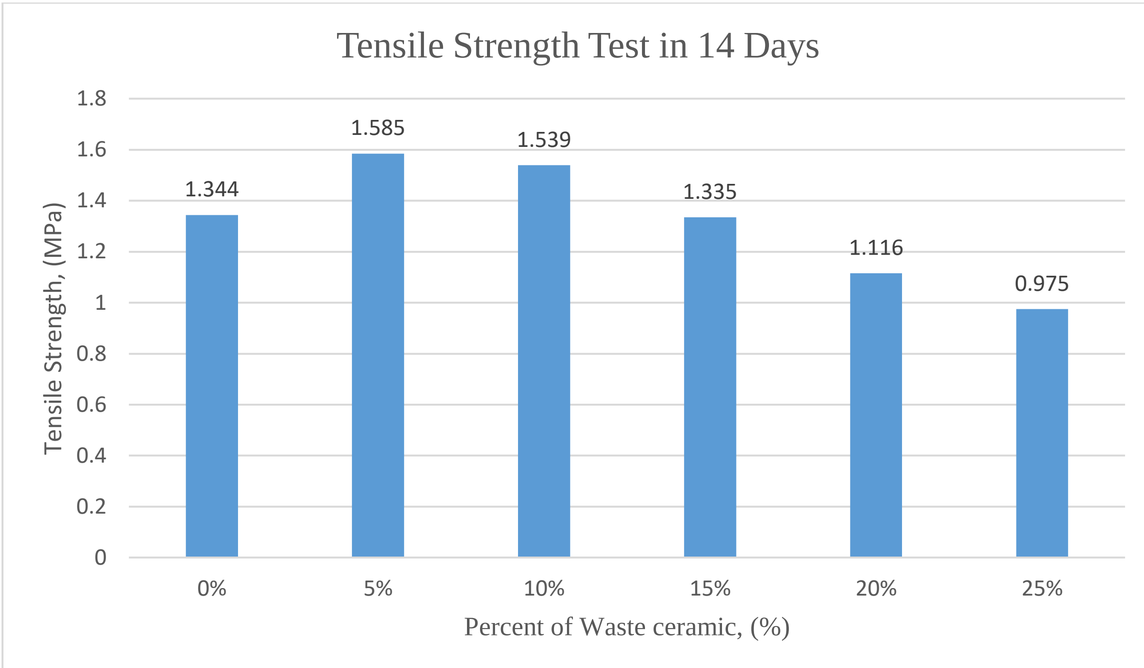

Fig.4.5: 14 Days Tensile Strength

On the other hands for 5%, 10%, 15%, 20% and 25% the result of compressive strength gradually decreases then 0%. So we find out the tensile strength for 14 days is high for 5% mixed of waste ceramic.

Table 4.6: Result of tensile strength of different mixed waste ceramic with concrete after 28 days.

SL No.	Percentage of Waste ceramic (%)	Splitting Load (KN)	Dia (mm)	Tensile Strength (MPa)	Average Tensile Strength (MPa)
1	0%	60	100	2.065	2.096
		63	101	2.146	
		61	101	2.078	
2	5%	70	101	2.385	2.404
		68	100	2.340	
		73	101	2.487	
3	10%	68	102	2.294	2.267
		65	100	2.236	
		66	100	2.271	
4	15%	59	100	2.030	2.012
		58	101	1.976	
		59	100	2.030	
5	20%	46	102	1.551	1.647
		49	100	1.686	
		50	101	1.703	
6	25%	39	100	1.342	1.281
		37	101	1.261	
		36	100	1.239	

Tensile strength in 28 days for 0%, 5%, 10%, 15%, 20% and 25% is 2.096 MPa, 2.404 MPa, 2.267 MPa, 2.012 MPa, 1.647 and 1.282 MPa. After observe we find the tensile strength for 5% is high then 0% (normal specimen).

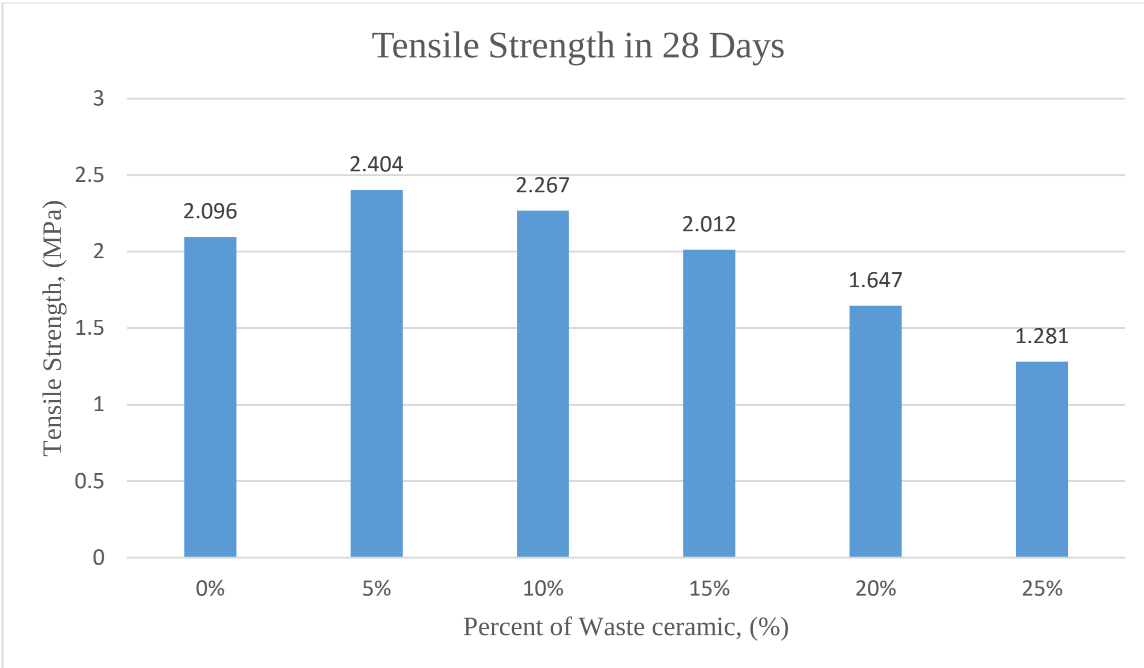

Fig. 4.6: 28 Days Tensile Strength

On the other hands for 5%, 10%, 15%, 20% and 25% the result of compressive strength gradually decreases then 0%. So we find out the tensile strength for 28 days is high for 5% mixed of waste ceramic.

Table 4.7: Result of compressive strength for different mixed of waste ceramic with concrete.

SL No.	Percent of Waste Ceramic (%)	Compressive strength (MPa)		
		7 Days	14 Days	28 Days
1	0	6.859	10.904	14.535
2	5	8.570	11.852	15.778
3	10	7.599	11.780	14.884
4	15	6.565	10.539	13.701
5	20	5.377	9.632	12.444
6	25	4.530	8.388	11.383

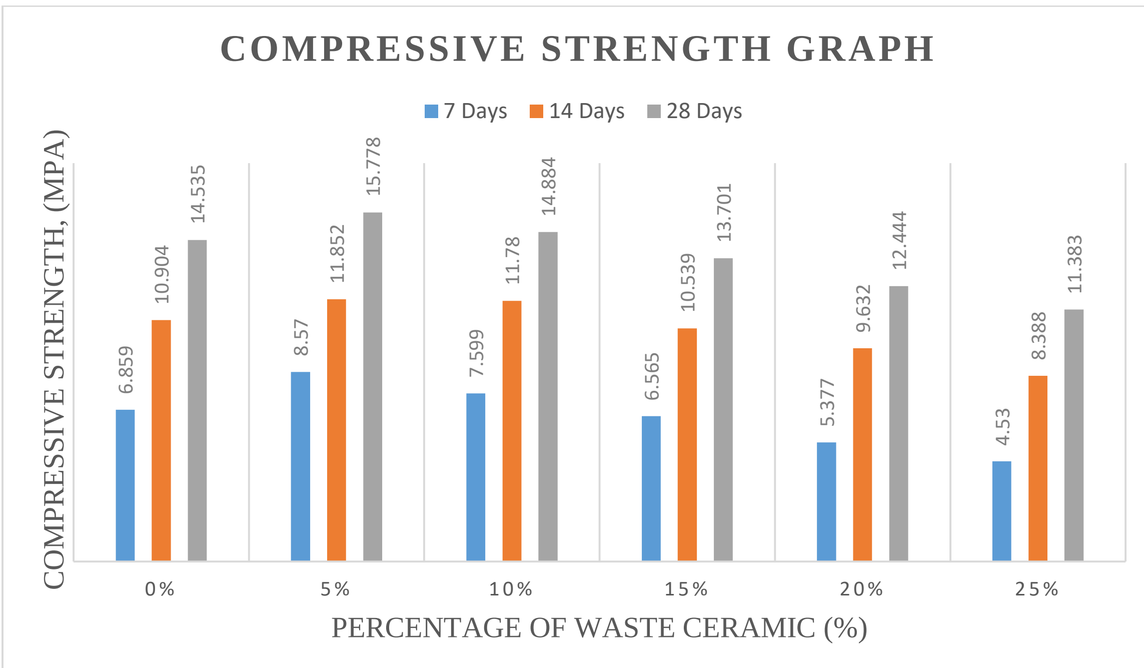

Fig. 4.7: Compressive Strength Graph

From this graph, the compressive strength of concrete reach its highest strength which is 15.778 MPa for 5% waste ceramic.

Table 4.8: Result of tensile strength for different mixed of waste ceramic with concrete.

SL No.	Percent of Waste Ceramic (%)	Tensile strength (MPa)		
		7 Days	14 Days	28 Days
1	0	0.883	1.344	2.096
2	5	1.098	1.585	2.404
3	10	0.936	1.539	2.267
4	15	0.829	1.335	2.012
5	20	0.741	1.116	1.647
6	25	0.629	0.975	1.281

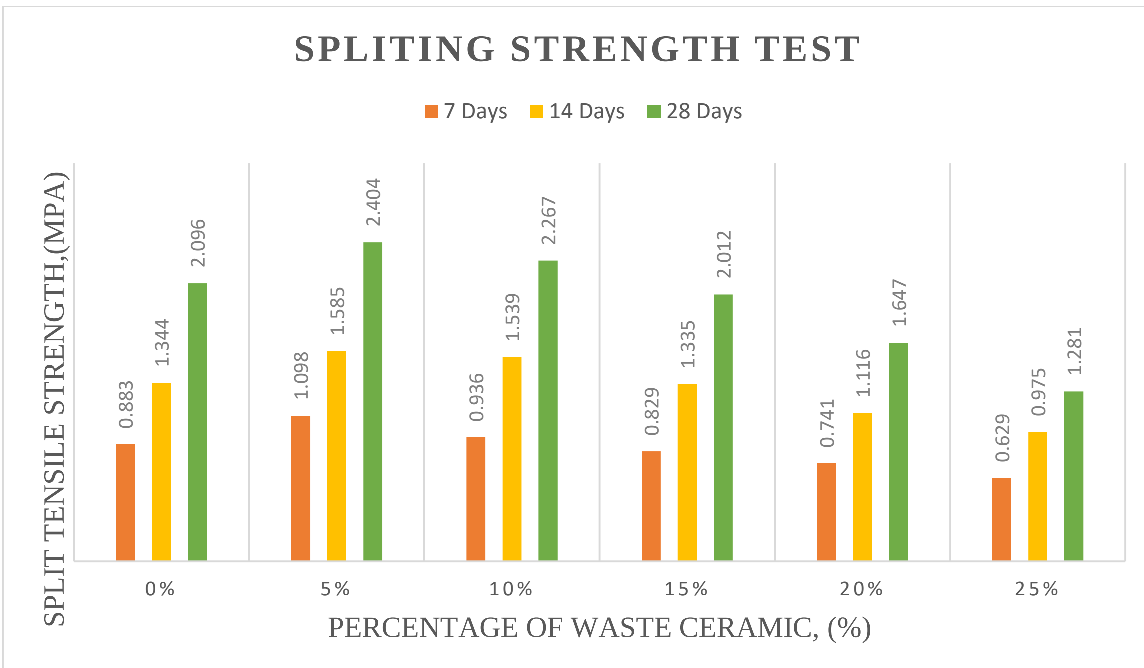

Fig. 4.7: Split Tensile Strength Graph

From this graph, the highest strength which is 2.404 MPa for 5% waste ceramic.

Chapter 5

CONCLUSION

5.1 General

The study's main goal is to make concrete that is more durable and stable than standard concrete by substituting fine particles. A total of 118 specimens are created and tested in the area of strength calculation and also comparisons.

5.2 Conclusion

Based on experimental research on compressive strength and split tensile strength, the following findings are drawn while also taking environmental factors into consideration.

- Concrete becomes more workable as tile aggregate replacement rates rise [23].
- The characteristics of concrete are impacted in some way by the use of ceramic fine aggregate [49].
- Comparing ceramic tile aggregate to ordinary concrete grades, the split tensile strength is significantly more straight [26].

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