Strengthening of Concrete by Recycling Parking Tiles as a Sand Replacement

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DECLARATION

We hereby attest that we are the sole author of this thesis and that no part of it, nor the entire thesis, has been submitted to any other university or institution for a degree. We certify that this project report, "**Strengthening of Concrete by Recycling Parking Tiles as a Sand Replacement"**, is done by us under the supervision of Md. Asaduzzaman Naeem, Lecturer, Department of Civil Engineering, Daffodil International University. We are announcing that this project is our unique work, we additionally proclaim that this undertaking works are unique and have never been submitted in its entirety for any degree or diploma at this university.

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DEDICATION TO

We devote this work to almighty ALLAH first, also our parents and teachers for their deep amicable support and help.

ABSTRACT

The usage of natural aggregates has expanded drastically as a result of day-to-day innovations and progress in the building industry, at the same time, the production of solid wastes from the demolitions of projects has increased to an equally high level. Because of these concerns, the concept of recycling demolition debris, such as parking tiles into new products became a reality in an effort to lessen the load of trash headed to landfills and to alleviate the shortage of natural aggregates used in concrete production. The destruction of various road's isn't the sole source of parking tiles debris, it's also produced in the production process. According to research, between 0 to 40 percent of the raw materials used in the production of tiles end up as landfill garbage. Ten percent of the fine aggregate was swapped out for powdered parking tiles powder. Concrete of the M20 quality was developed and evaluated. Different types of mixtures were designed by substituting crushed parking tiles for the coarse aggregates and fine aggregate in varying ratios. Experiments were conducted to determine the flow ability, compressive strength, split tensile strength, and flexural strength of concrete mixes including 7, 14, and 28 days of cured waste broken and Parking tiles powder. An increase in the proportion of replacement with parking tiles powder and shattered tiles improves work-ability, it has been found. Adding parking tiles aggregate to concrete at a proportion of up to 30% boosts the material's strength. The study evaluates the performance of parking waste tiles as a sand replacement. The experiment was conducted by substituting sand with at various proportions, ranging from 10% to 40%. The properties of the resulting parking waste tiles, including compressive strength, water absorption, and density, were measured. The results showed that the use of as a sand replacement material improved the compressive strength. The highest compressive strength was obtained at 30% replacement, while the lowest water absorption was recorded at 40% replacement. Therefore, the study suggests that can be used as a partial replacement for sand in production, leading to improved performance and sustainability.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The primary objective of this research is to investigate the viability of using parking waste tiles in lieu of sand in the strengthening process. Because of increased building activity and a continuing reliance on traditional materials for marking parking tiles, there is a shortage of the material, which has the effect of lowering the cost of construction. In the course of this research, an investigation was carried out with the purpose of determining whether or not fine aggregate from parking tiles may serve as a suitable alternative to the traditional aggregate found in sands. In Bangladesh, the tiles sector is responsible for producing a significant quantity of garbage each year. A potential win-win scenario would be to recycle these wastes into sands. In order to make sands stronger and more stable, we prefer to use tile waste.

The waste tiles are a mixture of cement, fine aggregates, mixing level of sands aggregates, water, and admixtures if necessary. Once the mixture has been placed in the site and allowed to dry, it becomes as hard as stone and provides a large amount of strength. It is currently and will continue to be the most prevalent construction material since the component components can be obtained in large quantities with relative ease. In addition to this, it has also been reformulated into several new forms, such as Stress concrete, fiber-reinforced concrete, high-strength concrete, and so on. The fact that it can be quickly molded into desirable structural objects of various sizes and forms with almost no significant additional labor expense and that it has a high compressive strength are two of the most essential properties that engineers find appealing about the material. It does not corrode in the form of plain cement concrete and it also does not corrode in the form of reinforced concrete if the appropriate cover is applied. It gets harder over time, and the process of getting harder continues for a considerable amount of time after the concrete has reached its strength. Because of this feature, it is superior to any other material that is used in building. It has a binding property with iron, and because it is weak in tension, iron reinforcement is put in cement concrete at appropriate places to take up the tensile stress. Since it has a binding property with iron, We call this type of concrete "reinforce cement concrete" [1]. Chen et al. (2020) result of its formation of a robust surface that is capable of withstanding wear and impact, it is also suitable for use in the construction of roads[2].

In this particular scenario, fine aggregate has been substituted for tiles waste in order to conduct a comparative analysis of various parameters. These parameters are tested in laboratories in order to determine whether or not the replacement is suitable for adhering to the standard specifications for strength in Bangladesh. The primary purpose of this research is to offer more information on the impacts of varying proportions of sand as partial replacement of waste tiles fine aggregate on work ability, compressive strength, and tensile strength [3]. There have been efforts made to investigate the properties of ceramic waste and the suitability of those properties to enable ceramic waste to be used as a partial replacement material for sand in concrete. These efforts have been made in an effort to reduce the amount of waste that is sent to landfills. The utilization of waste from the production of tiles in concrete is desired due to the advantages it offers, which include the beneficial disposal of waste products, the decrease of consumption of river sand, and the enhancement of the strength parameter.

1.2 Scope of the Study

The rise in population in Bangladesh has resulted in an increase in the country's production of a significant quantity of waste products, including waste parking tiles. The fact that these waste tiles will continue to exist in the environment for hundreds of years is a concern that cannot be avoided in the modern world. It is imperative that a remedy be found for such an issue right away. One of the numerous strategies that has been suggested for lowering the amount of waste products is the use of these waste tiles in concrete, which has the potential to lessen the impact that human activity has on the environment to some degree. It is possible to dispose of these wastes in mass concrete, such as when large mass concreting is done in pavements, as long as the strength of the concrete is not the primary factor that needs to be taken into consideration. A parking lot in Bangladesh could have discarded tiles as one of its components. Because tiles are made of a material with a relatively poor biodegradability, disposing of waste tiles can pose significant challenges for building projects[3]. Since quite a few years ago, researchers have been concerned about whether or not the utilization of tiles from might increase the qualities of concrete. In recent decades, there has been an increased focus on the utilization of by-products in civil construction. These by-products include silica fume, glass culvert, fly ash, powdered granulated blast furnace slag, and others. Concrete can use the waste generated from the production of industrial tiles as a partial or full substitute for cement or aggregate [4]. The usage of these waste tiles in concrete can help reduce environmental problems or limits caused by the disposal of these items in an environmentally friendly manner. In the current investigation, waste tiles were employed to prepare the strength by substituting parking tiles for sand.

1.3 Project Objectives

The major purpose of this research is to assess the overall strengthening performance of parking waste tiles as a sand replacement. In addition to this overarching goal, the following sub-goals have been established:

1. To evaluate the strengthening performance test of parking waste tiles as a sand replacement.
2. To analyze on parking waste tiles as a sand replacement of Bangladesh.
3. To define of sustainable impact of waste tiles based on cylindrical project.
4. To recommend on problem findings about project and reveal way-out.

1.4 Limitation of the Study

The replacement of sand with waste parking tiles can be an interesting and innovative solution, but there may be limitations to its use in certain contexts. Some limitations that could be discussed in a thesis paper on this topic include:

1. **Sample size:** If the study only uses a small sample size, the results may not be representative of the larger population. A larger sample size may be required to draw accurate conclusions.

2. **Generalizability:** The study's findings may not be generalized to other locations or types of construction projects. Different types of waste materials, geographical locations, or construction contexts may yield different results.

3. **Technical limitations:** The study may face technical limitations, such as the inability to test certain aspects

4. **Environmental impact:** While using waste parking tiles can help reduce the amount of waste sent to landfills, the production of these tiles can have an

environmental impact. The study may need to consider the overall environmental impact of the use of waste parking tiles as a replacement for sand.

5. **Cost:** The study may need to assess the cost-effectiveness of using waste parking tiles compared to other materials. The cost of manufacturing, transportation, and installation of the tiles must be taken into account.

6. **Safety concerns:** The study may need to assess the safety concerns associated with the use of waste parking tiles as a replacement for sand. The tiles may be sharp or brittle, and precautions must be taken to ensure that workers are not injured during the construction process. Durability: The study may need to assess the durability of the waste parking tiles in the long-term. The tiles may degrade over time or be subject to other types of wear a tear, which may impact their effectiveness as a replacement for sand.

1.5 Summary

This study makes an attempt to check the suitability of tiles waste in sands as a replacement of coarse aggregate by duly implementing some new methods such as tensile, compression strengthening approach. Previous experimental studies came to the conclusion that the parking tiles wastes were only suitable as a possible partial substitute for conventional crushed stone coarse aggregate. This study makes an attempt to check the suitability of tiles waste in sands as a replacement of coarse aggregate. In this project study, an effort is made to increase the quantity of usage of parking tiles wastes as coarse aggregate by advocating a scientifically new sands mixing method, which is known as the mixing approach. The main drawbacks of parking tiles waste are that they absorb water and have a lower density than other materials. To get around these issues, the mixing approach is used. This body of work is concerned with the variation of compressive strength by experimental analysis involving the modified mixing method by replacing coarse aggregates via 0%, 10%, 20%, 30%, and 40% by weight of M-20 grade concrete of ceramic industrial waste and also by adding sands, a super mixture to it. The experiments were carried out in order to determine how the compressive strength varies as a result of these changes.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Numerous studies on sand have been conducted in an effort to enhance its qualities in every way conceivable in order to build a durable concrete mass. The only way to reinforce the tiles is to replace their components with superior ones. Not only does the use of waste materials make building more environmentally friendly, but it also improves its suitability. In this regard, a great deal of study has been conducted on the use of tile aggregate in concrete, which is a waste product from the destruction of a structure or the recycling of parking tiles. This study focuses solely on the literature about the use of tile aggregate as a substitute for coarse aggregate in parking tiles wastage. The specifics of the literature review are provided below.

2.2 Parking Tiles as Part Replacement to Fine Aggregates

An increasing demand for concrete in building projects has led to a shortage of raw materials and higher construction costs. It would be worthwhile to employ acceptable by-products to replace some of the conventional materials as we struggle to deal with the depletion of traditional resources. Construction debris, such as tile aggregates, must be disposed of securely since their large-scale production contributes to pollution. These materials, however, have untapped potential that may be put to use in a number of ways. Because of this, not only would we be conserving natural resources by utilizing these wastes instead of traditional materials, but we would also be able to put an end to the nationwide issue of trash management.

Most roads nowadays are paved with standard Portland cement concrete. There is an increase in water runoff into the drainage system because of the concrete pavements, which puts an undue strain on the system and leads to flooding in densely populated regions. Since it may help with environmental problems, previous concrete has gained a lot of attention in recent decades. As a rule, previous concrete does not include any fine aggregate and only uses a little amount of cementation paste to cover the coarse aggregate particles while still allowing for a porous and interconnected final product [6]. However, 10% fine aggregate utilization is mentioned in literature for previous concretes [6]. The primary goal of its construction has been the prevention of surface runoff and the recharging of aquifers depleted by storms.

Due to stringent regulations on storm water runoff from the United States Environmental Protection Agency (EPA), the technology for previous concrete was developed in the United States. Previous concrete was created in Europe for both water permeability and noise dampening. Research on the use of previous concrete in Japan has focused on its application not just as a road surface, but also as a plant support system along riverbanks [7].

Numerous variables, such as binder type, aggregate type, aggregate grading, mix combination, compaction, and water content, were discovered to influence the strength and permeability of previous concrete. Very permeable concrete has only around a third or a half the compressive strength of regular concrete [8].

The purpose of this research was to evaluate the feasibility of using tile aggregate as a partial coarse aggregate replacement in both conventional and previous concrete. Important findings are provided after a comprehensive study comparing the strength performance of tiled waste based, tiled waste based previous, and tile based blended concretes to that of respective conventional concretes[9] .

2.3 Concept of Waste Tiles

The manufacturing of ceramic tiles involves a wide variety of steps that vary greatly across various types of tiles. The procedure may be broken down into the following phases.

- Getting ready with clay, either by dry grinding or by wet milling and atomization.
- The tile is formed or shaped using either dry pressing or extrusion.
- Making the glaze.
- Glazing, sealing, and embellishing the tile while it dries.
- Reheating old recipes in a kiln.
- Grouping and packaging

More and more ceramic products like tiles, sanitary fixtures, electrical insulators, etc. are being used in modern building projects. However, because to its fragile nature, a lot of ceramic materials are thrown away during production, transportation, and repair [10].

Therefore, including these wastes into concrete manufacturing has the potential to improve concrete's qualities while also helping the environment.

Figure 2.1 is a flowchart depiction of the procedure, giving a more in-depth overview of the whole operation. In most cases, a distinct group of businesses known as "atomizers" is responsible for preparing the raw materials, especially through the wet milling process (which might include spray drying). The end result is a granule of atomized clay that resembles small hollow spheres. Because it is composed of numerous small spheres [11], this clay exhibits fluid-like behavior while being made from the normally difficult-to-work-with raw clay.

Figure 2. 1: The conventional method of making ceramic tiles involves wet milling, automation, and a single kiln fire.

Source: Ghannam (2016) [11]

2.4 Parking Tiles Waste Generation

There are two distinct types of ceramic debris, each corresponding to a different raw material source. The first category includes all of the slag produced by structural ceramic plants that make solely red paste goods like brick, blocks, and roof tiles. Stoneware ceramics, such as wall and floor tiles and sanitary ware, create a second type of trash: all fired waste [12]. Although some manufacturers employ both red and white pastes, the white paste is used far more frequently and in far greater quantities. After considering the various stages of production, the fired ceramic waste was separated into several bins. The following chart depicts this categorization (Figure 2.2).

Wall and floor tiles, sanitary ware, bricks and roof tiles, refractory materials, technical ceramics, and ceramic products for residential and ornamental use are all sub-industries within the ceramics industry.

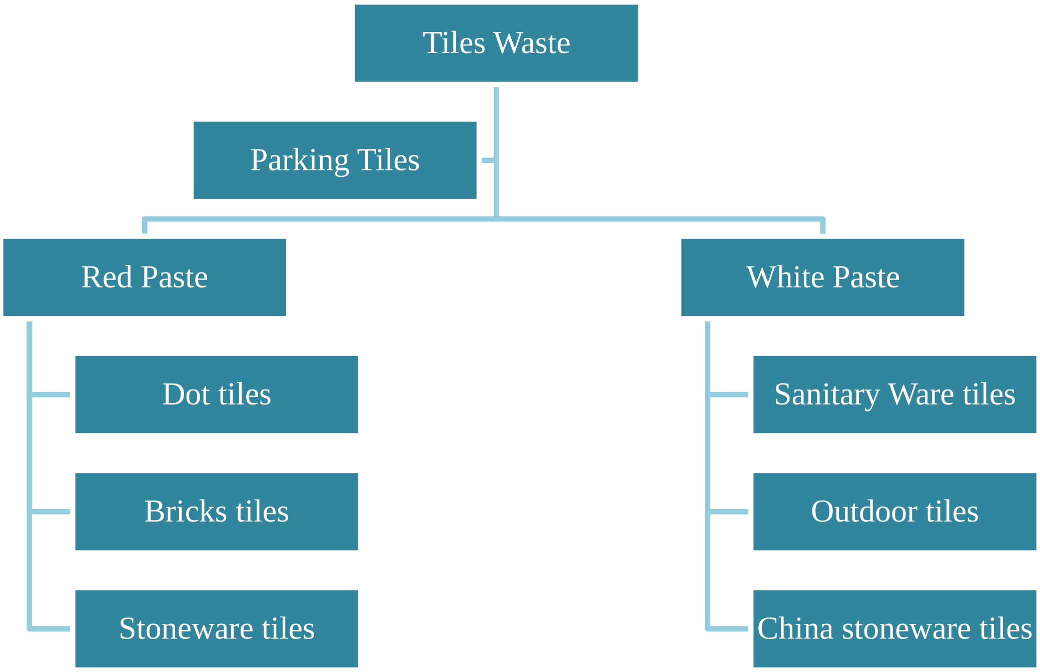

Figure 2. 2: Classification of ceramic wastes by type and production process

Source: Ashish (2016) [11]

2.5 Parking Tiles Garbage

If a tiles user recently finished a bathroom or house repair and found with a large number of unwanted tiles, read on! Getting rid of old tiles, vinyl, or other bathroom tiles is a tough aspect of tile removal. It can't just throw out grimy, old, cracked tiles from the bathroom with the rest of the trash because of the health risks they provide. If dispose of them with the city's regular rubbish collection, they will be sent to a landfill or other landfill [13]. Unfortunately, that's not the best way to get rid of old tiles. Keep in mind that ceramic, porcelain, glass, marble, and cement tiles can break down over time if thrown away carelessly. If the tiles are not disposed of properly, you may be subject to a fine from the local authorities in most areas. There are other ways to get rid of old tiles than to hope that they will be picked up by the garbage service.

Figure 2. 3: Sample of Waste Tiles

2.5.1 Old Tiles Reused

Reusing or re purposing old tiles is an environmentally responsible choice. Numerous shops sell garden decorations and plant pots made from recycled materials such as broken tools, unused tiles, and metal scraps.

- The Uttara recycling center in Dhaka, Bangladesh, collects recyclables for a charge from the local community. They should view the list of acceptable items for Toronto's drop-off centers here.
- The local recycling center in Uttara, Dhaka city, follows strict regulations established for garbage disposal. To find out if used tiles are accepted at the recycling center in your area, call the appropriate number. See a directory of Dhaka's local governments here.

- After confirming with a nearby recycling center that they would accept your tiles, they should clean them, arrange them neatly, and pack them in boxes. Alternatively, they can abide by the city of Dhaka's drop-off guidelines.

2.6 Effect of waste ceramic tile aggregate on concrete work ability

The effect of waste ceramic tile aggregates content into the concrete mix on the work ability of the fresh concrete mix expressed as the slump value for different water-cement ratios [14]. The data interpretation was done on two different bases, the waste ceramic tile content and the mixing water cement ratio. As it can be seen, the fresh concrete work ability is inversely affected by the increase of water cement ratio. The slump value decreases as the amount of tile as coarse aggregate increases. This decrease can be because of higher absorption of water by tiles and also being more angular shape of waste ceramic tile aggregates [15]. On the whole, slump is changing in the samples and this change occurs between 10 to zero millimeters for w/c ratio of 0.4, between 45 to 30 millimeters for w/c of 0.5 and between 120 to 85 millimeters for w/c of 0.6 as shown in figure 2.4. The degree of work ability is very low for w/c of 0.4, which is considered inappropriate for a concrete operation [16]. The degree of work ability is low for w/c of 0.5, but generally it is considered appropriate for a concrete operation. The degree of work-ability is high for w/c of 0.6, which is considered appropriate for a concrete operation.Effect of waste ceramic tile aggregate on compressive strength of concrete

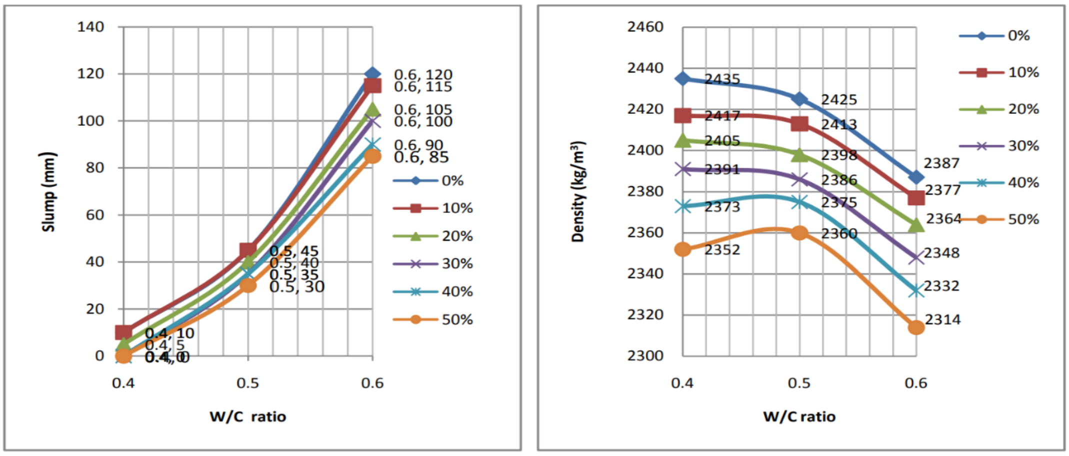

Figure 2. 4: (a) Slump value versus w/c ratio with different percentage of coarse waste ceramic tile aggregates and Concrete density versus W/C ratio with different percentage of coarse waste ceramic tile aggregates.

Source: Guendouz and Boukhelkhal (2019) [17]

The failure mode depicted in Figure 2.5, which depicts a hardened concrete sample that failed during a compressive loading test, is indicative of typical concrete failure. Compressive strength of hardened concrete after 28 days, as affected by the proportion of coarse waste ceramic tiles included in the mix, is shown for a range of water-cement ratios in Figure 2.5. For a w/c ratio of 0.4 up to 20% coarse waste ceramic tile aggregate, it was found that the compressive strength of the concrete was increased after 28 days when compared to the reference concrete. Concrete's compressive strength decreases above a 20% threshold of coarse waste ceramic tile aggregate, when compared to the reference concrete. In addition, the sample that had 10% tile showed a 3.5% improvement in compressive strength, making it the strongest documented. At a 0.5 w/c ratio, the addition of 30% coarse waste tile aggregate improves the compressive strength of the concrete significantly after 28 days when compared to the reference concrete. Compressive strength decreases after adding 30% coarse waste ceramic tile aggregate compared to reference concrete. In addition, the sample that incorporated 10% tile had a compressive strength increase of roughly 8.9%, making it the strongest documented. For a w/c ratio of 0.6, however, compressive strength is enhanced up to a part of 40% coarse waste tile aggregate content without significantly outperforming the reference concrete. Samples consisting of 20 percent tile, whose compressive strength has risen by around 3.2 percent, ranked highest. As can be seen, the compressive strength of concrete made with tile as the coarse aggregate increases by as much as 20 percent at a water-to-cement ratio of 0.4, 30 percent at a w/c ratio of 0.5, and 40 percent at a w/c ratio of 0.6. There is also no decrease in compressive strength. It has been noted that the strength of tile samples is quite similar to that of other samples. However, when the tile aggregate content was more than 20%, 30%, or 40% for a w/c ratio of 0.4, 0.5, or 0.6, respectively, the compressive strength significantly dropped. An increase in the flaky aggregate may be to blame for the decrease in sample strength brought on by a rise in tile content[18]. The flaky forms of the tile aggregates, especially the larger ones, cause the percentage of flaky aggregate in the concrete rise, which weakens the material overall. The smooth surface of aggregates may also contribute to the problem by preventing proper adhesion between the two materials during the concrete-making process.

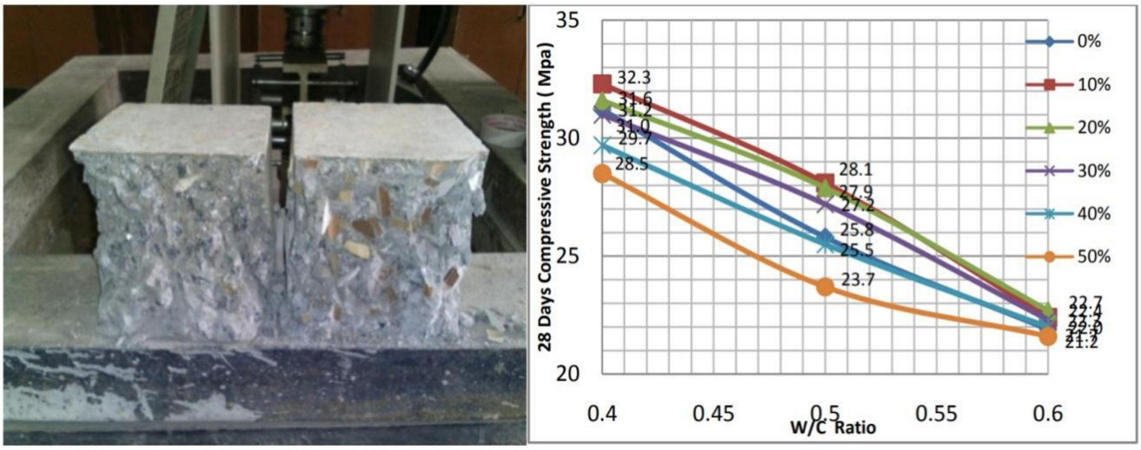

Figure 2. 5: Slump value and concrete density vs W/C ratio with varying coarse waste ceramic tiles.

A comparison of the flexural strength of the ideal concrete mixes to that of the reference concrete mixes is to be conducted. Reference concrete was created with solely natural coarse aggregate, whereas the ideal concrete mixes included 30% coarse waste tiles. For both mixtures, we decided to keep the cement content at 300kg/m3 and the water-to-cement ratio at 0.5 [16].

2.6.1 Environmental and Economic Benefits of Tile Aggregate Concrete

Using tile aggregate as a substitute for coarse aggregate in concrete can help cut costs and construction-related pollution[19]. Using tile aggregate and granite powder in concrete production reduces construction pollution and maximizes the efficient use of construction waste at a fraction of the cost of using traditional concrete.

2.6.2 Effect of waste ceramic tile aggregate on flexural strength of concrete

The flexural test determines how much pressure is needed to get a beam to flex at its ends. The flexural modulus of a material is a measure of how resistant it is to deformation under load. The IS: 516-1959 protocol is followed in this test, with the hardened concrete specimen measuring 101050 cm resting on two 40 cm apart supporting spans and the load being supplied to the center by the loading nose at a set rate until failure (Figure 2.6). As can be seen in Figure 2.6, the tests were performed on both the Reference Concrete (C5-0) and the Ceramic Waste Concretes (C5-30) with the optimal amount of waste ceramic tile aggregate set at 30% [20]. Table 2.1 displays the final output results. The flexural strength of the ceramic waste concrete as a partial substitute for natural coarse aggregate rose as the amount of ceramic waste used in the concrete grew, as shown by the results of the tests conducted [17]. Analysis shows that, when compared to the strength of reference concrete (2067 KN/m^2), the flexural strength of Optimal Ceramic Waste Concrete is 32.2% greater. The pozzolanic quality of ceramic tiles and their ability to absorb water may be to blame for this increase once more, as this quality finally causes the w/c ratio to decrease.

Table 2. 1: Flexural strength test results

Group	28 days Flexural Strength (KN/m^2)
C5-0	2067
C5-30	2733

Source: Thakur et al. (2018) [21]

Figure 2. 6: Instrument for measuring flexural strength, with specimen, failed specimen

Source: Thakur et al. (2018) [17]

2.7 Scope for Waste Tiles Utilization in Porous Concretes

The porosity of previous concretes is shown in Table 4 the porosity of each specimen mean value is reported. Previous concrete shows considerably higher porosity than conventional concrete. With increase in percentage of partial replacement of tile to coarse aggregate the porosity of the samples gradually increased. The porosity of previous concrete lies between 15% to 40%. The different types of pore structure are responsible for this phenomenon [22]. However, the porosity in previous concrete is mainly large size air voids which are bigger than the pores in cement paste. The porosity of previous concrete is influenced by aggregate grading and compaction [23]. Hence, the porosity of the previous does not noticeably changed with an increase in the age of concrete. The results showed that clay roof tiles replacement does not show significant change in porosity.

Table 2. 2: The density increases in percentage of tiles and decreases with.

Tiles (%)	Dry Wt.(kg)	Density of the material (kg/m3)	Avg. density (kg/m3)
0	6.360	1884.44	1862.8
	6.104	1808.59	
	6.397	1895.41	
10	6.145	1820.74	1828.8
	6.142	1819.85	
	6.23	1845.93	
20	6.02	1783.70	1776.6
	5.99	1774.81	
	5.978	1771.26	
30	5.65	1674.07	1701.0
	5.786	1714.37	
	5.787	1714.67	

Source: Allam et al. (2020) [24]

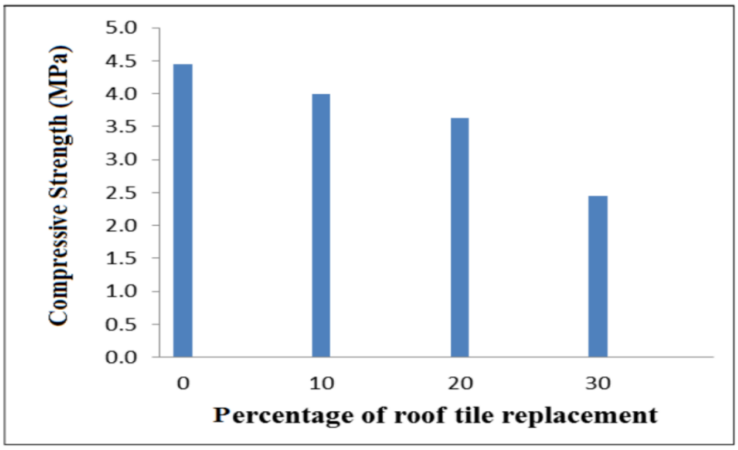

Figure 2. 7: Compressive strength

Source: Allam et al. (2020) [25]

2.7.1 Suitability of Broken Tiles in Blended Concrete

A look of Tables 2.3, 2.4, and 2.5 reveals the obtained slump, densities, and compressive strengths. Data was tabulated, and it revealed that the compressive strength ranges from 24.96 N/mm2 to 44.30 N/mm2. The desired mean strength is reached up to T20F40 when fly ash-clay roof tiles are partially replaced.

Table 2. 3: Slump result for fly ash-tile aggregate based concrete

SI. No.	Mix designation	Slump (mm)
1	TOFO	50
2	T5F10	75
3	T10F20	75
4	T15F30	75
5	T20F40	75
6	T25F50	75

Source: Rambaldi et al. (2007) [26]

Table 2. 4: Densities of tile-fly ash-based concrete

Mix	TOF 0	T5F1 0	T10F20	T15F3 0	T20F4 0	T25F5 0
Avg. density (kg/m 3)	2549	2505	2480	2434	2418	2389

Source: Rambaldi et al. (2007) [26]

Table 2. 5: 28-day Compression test results of fly ash-tile based concrete

2.7.2 Replacement of Sand and Ordinary Portland Cement with Ceramic

Mix designation	Specimen wt. (kg)	Failure load (KN)	Comp, strength (MPa)	Avg. comp, strength (MPa)
TOFO	8.692	920	40.89	44.3
	8.655	1050	46.67	
	8.460	1020	45.33	
T5F10	8.506	740	32.89	34.8
	8.402	800	35.56	
	8.422	810	36	
T10F20	8.390	770	34.22	35.6
	8.340	910	40.44	
	8.377	720	32	
T15F30	8.231	850	37.78	36.0
	8.122	780	34.67	
	8.286	800	35.56	
T20F40	8.149	735	32.67	31.9
	8.155	735	32.67	
	8.170	685	30.44	
	8.122	590	26.22	
	8.015	545	24.22	
	8.048	550	24.44	

Tiles A Theoretical Assessment

A wide variety of wastes are now being utilized as a substitute for cement, and a number of fundamental criteria, ranging from economic feasibility and market stability to the durability of the material, environmental responsiveness, and sustainability, have been explored. In addition to "green manufacturing," the idea of sustainability, which is implemented in the building sector, requires the use of alternative wastes as substitutes for natural resources[27], including extra-cementation materials. These wastes include materials that are not cement-based. The push for more ecologically responsible building practices in the construction industry has resulted in the development of innovative materials that can be put to a variety of purposes while simultaneously lowering costs and improving environmental impact. As a prime illustration, parking tiles are manufactured by subjecting fire clay, feldspar, and quartz to extremely high temperatures. Figure 2.8 shows the process of making the waste tiles powder (WTP) and ceramic fine aggregate (CFA).

Figure 2. 8: Preparation processes of WCP and CFA.

Source: Zafar et al. (2020) [21]

It is important to note that a laboratory investigation on the effect of using WCP and CFA on the mechanical properties of mortars and concrete should be conducted and gathered with those of this study to complete the picture and support the selection of the appropriate replacement materials for cement and other components of mortars and concrete. This inquiry should be conducted because it is crucial to mention that this investigation should be conducted.

2.8 Literature Review Gap

Li et al. (2020) [1], 20mm downsize coarse aggregates, 0%, 5%, 10%, 15%, 20%, and 25% tile waste, and a combination of fly-ash and cement were used to create tile waste based concrete. At a 25% replacement, aggregate concrete for roof tiles reaches its average maximum compressive strength. At 25% replacement with roof tile aggregate, the concrete is 10-15% weaker than with regular aggregate. Recycled concrete from roof tiles is rather easy to deal with. Overall, replacing tiles with concrete is adequate for modest buildings.

Taher et al. (2021) [4] specifically, tiles that have fractured are the ceramic waste that is being used. These tiles may be used to create ceramic waste concrete (CWC) at a percentage of 0%, 15%, 20%, 25%, or 30%. Use of M20 grade concrete with a consistent water-to-cement ratio of 0.48 is mandated. Concrete's defining features, such its workability when first mixed and its Compressive Strength and Split Tensile Strength after 3, 7, and 28 days, are determined at these intervals. The study recommends using 5–30% waste tile aggregate in place of virgin aggregate when working with common mixtures such as M15 and M20.

Kannan (2017) [13]Currently, there is sufficient tile waste production to be used as a coarse aggregate substitute in concrete. Utilizing broken ceramic tiles has beneficial effects on both the environment and the bottom line. The use of tile aggregate reduces the self-weight of concrete by roughly 4 percent, which results in a cost-effective building. When it comes to durability, concrete's compressive and split tensile strengths decrease when tile aggregate is substituted. However, the article investigated the maximum replacements of tile waste, which may be further broken into smaller percentages and used in concrete with suitable qualities.

Oud a and Gharieb, (2021) [26] noted industry ceramic waste in Spain is the primary focus of the research. The concrete was designed in accordance with Spanish concrete standards, and it used recycled ceramic aggregates that complied with all the technical specifications mandated by the relevant Spanish laws in effect at the time. As much as the coarse aggregate, ceramic aggregates can be used in its stead. The mechanical characteristics were compared to those of regular concrete by the use of suitable tests. The characteristics of concrete made using ceramic ware aggregates were found to be comparable to those of concrete made with gravel.

In their 2015 article, Bignozzi and Saccani (2012) Because ceramics are so fragile, a lot of them break or are damaged while being processed, transported, or fixed. With 10%, 20%, 30%, 40%, and 50% substitution rates, the crushed waste ceramic tiles were employed in concrete to substitute natural coarse aggregates. An improvement in compression and flexural strength, as well as other beneficial qualities, was noticed when ceramic tile aggregate was added to concrete, according to the study.

According to[28], in place of traditional coarse aggregates and fine aggregate, crushed waste tiles and Granite powder were employed. Coarse aggregates were substituted by the combustion of waste broken tiles at 10%, 20%, 30%, and 40%, while fine aggregate was replaced with Granite powder at 10%, 20%, 30%, and 40%, all without altering the mix design. The typical batch is made with M25 grade concrete, which was developed for that purpose. Crushed tiles and granite powder were substituted for the coarse aggregates and fine aggregate at various ratios to create a variety of mixes without altering the mix design. The inquiry is conducted experimentally. It has been discovered that the highest compressive strength of concrete is reached when 30% of the coarse aggregate is replaced with granite powder.

Research into a potential alternative to coarse aggregate has been conducted. The quality of three distinct kinds of concrete has been evaluated. Even if the outcomes are unacceptable in comparison to the norm, using ceramic tile aggregate in concrete is a good idea due to its strong qualities. At the end of the day, it was decided that using roughly 20% ceramic tile in M20 grade concrete was the best option.

To quote Paul O. Awoyera (2016): In this article, we see that ceramic tiles are often used in concrete installations. To accomplish this, ceramic fine and ceramic coarse aggregates are used instead of their natural counterparts. These aggregates are sourced from active building sites in Ota, Lagos, and Nigeria. Different strength characteristics are investigated while using ceramic fine and coarse particles in place of regular ones in regular concrete. The report concludes that incorporating ceramic shards into concrete results in a significant strength boost over the norm.

In P. Rajalakshmi's (2016) words, the use of ceramic shards will result in a concrete with enhanced qualities and will be an excellent approach for environmental preservation. There will be significant positive environmental effects from using ceramic wastes as concrete aggregates. About 30% of all ceramics made end up in landfills. Compared to more common coarse aggregates, ceramic waste aggregate is incredibly hard and long-lasting. It can withstand high temperatures well. Aggregate made from ceramic waste has excellent durability characteristics. For this study, ceramic tiles were used to substitute fine aggregate at a weight percentage of 10%, while coarse aggregate was replaced at a weight percentage of 30%, 60%, and 100% of M-30 grade concrete. Since it has good strength qualities, i.e., 10% CFA and 60% CCA being the maximum strength, this article advocates using waste ceramic tiles as an alternate building material to coarse and fine aggregate in concrete instead of the traditional concrete.

Nasr et al. (2020) [14], because they are so widely used, ceramic tiles contribute to environmental degradation because they are often salvaged from factories, building sites, and demolition sites. Crushed tile may have a beneficial influence on the economy if it were used as a coarse aggregate in concrete. In this research, we substituted natural coarse aggregate with ceramic tile waste at several percentages (0%, 10%, 20%, and 30%) and utilized an M20 concrete mix. After 3, 7, and 28 days of curing, the cast concrete molds were put through tests of compressive and split tensile strength. Findings show that when natural coarse aggregate is used to replace ceramic tile aggregate at a ratio of 30%, the resulting material has the highest compressive strength.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The focus of this chapter is on exchanging used parking tiles for fine sand aggregate in concrete. Used parking tiles have been ground into a sand-like substance for the experiment. The findings of this experiment were extraordinary, surpassing those of any previous studies. Waste ceramic has enormous potential to be the appropriate alternative for sand, as fine aggregate and tile share many of the same qualities. In order to complete this study, we gathered broken ceramic tiles and ground them into a powder similar to sand that could be used to make concrete. As the percentage of ceramic grind used in place of sand was increased from 0% to 40% during the course of the procedure, a repeat was unnecessary.

3.2 Methodological Approach

After this introduction, this chapter discuss the procedures used in the experiment and draw comparisons between the outcomes.

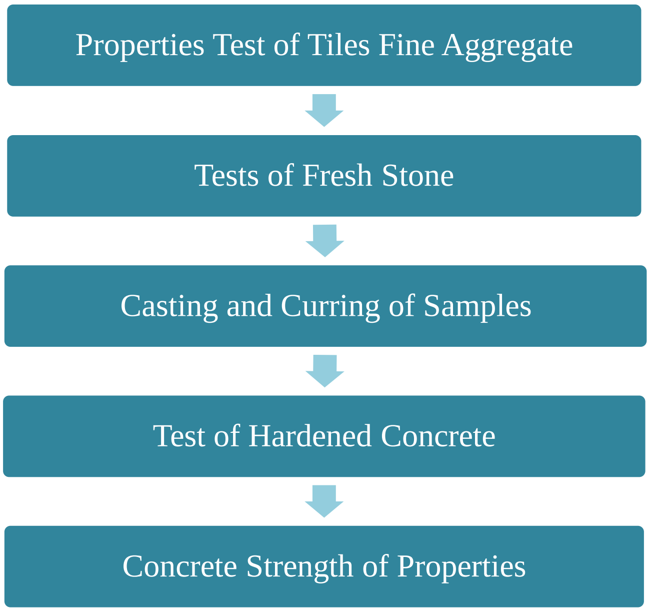

Figure 3. 1: Methodological Process

3.3 Collection of Raw Materials

River sand, designed cylinder, stone, Portland cement, concert in the sun are all examples. These variants are all handcrafted and created for specific uses.

3.3.1 Parking Tiles

The clay used to make parking tiles is heated to the point when the particles partially melt and bind together. When a tile has to be shattered, it is first reduced to a powdery state using a big grinding by hand, flat a hammer. When reduced to powder (amorphous state), they may be spread on soil without causing any harm and be eliminated from landfills entirely.

Table 3. 1: Total details of used tiles

sieve size (mm)	Retained (gm)	% Retained (gm)	Cumulative % retained
9.5	0	0	0
4.75	6.4	2.15	2.15
2.36	28.41	9.52	11.67
1.18	23.32	7.82	19.49
0.6	39.53	13.25	32.74
0.3	48.67	16.32	49.06
0.15	106.76	35.79	84.85
Pan	45.2	15.15	100
Total	298.29		
FM=	2.9829	0	
	≈3		

Used tiles refer to tiles that have already been installed or laid down in a particular area, such as a floor, wall, or roof. These tiles can be made of different materials, such as ceramic, porcelain, stone, or glass, and come in various shapes, sizes, colors, and patterns.

When installing tiles, it is essential to pay attention to the details of each tile, such as its thickness, texture, and quality, to ensure a proper and durable installation. Here are some details that are important to consider when using tiles:

Size: The size of the tiles can vary depending on the area they will be installed in. For instance, smaller tiles are suitable for bathroom floors and walls, while larger tiles are ideal for open areas such as living rooms or hallways. It is crucial to measure the area accurately to determine the number of tiles needed.

Thickness: The thickness of the tile is an important detail to consider, as it affects the durability and longevity of the installation. Thicker tiles are generally more durable and can withstand heavy traffic or weight. However, thicker tiles can be heavier and more challenging to install.

Texture: The texture of the tile determines its slip resistance and grip, making it important to choose tiles with appropriate textures for specific areas. For example, tiles with a smoother texture may be slippery and unsuitable for bathroom floors or outdoor areas.

Quality: The quality of the tile is crucial for ensuring a durable and long-lasting installation. High-quality tiles are less likely to chip, crack, or fade over time, making them a better investment in the long run.

Color and pattern: The color and pattern of the tile can significantly affect the overall look and feel of the area. It is essential to choose tiles that complement the style and decor of the room, while also considering factors such as lighting and furniture.

Figure 3. 2: Broken Parking Tiles (Sample)

3.3.2 Sand

Any natural sand grains that are extracted from the ground during mining are considered fine aggregates. Natural sand or crushed stone with a size of less than a quarter is considered a fine aggregate. To describe the aggregate's size distribution or "grading" the term "$\frac{1}{4}$ minus" is commonly used. Normal consistency is also known as Standard constancy.

Figure 3. 3: Sands and tiles Powder

Table 3. 2: Fineness modulus (sand)

Sieve size (mm)	mass retained (gm)	% Retained	Cumulative % Retained	Cumulative mass retained (gm)	% finer
9.5	0	0	0	0	100
6.3	1.81	0.18	0.18	1.81	99.82
2.36	13.87	1.39	1.57	15.68	98.43
1.18	83.51	8.41	9.98	99.19	90.02
0.6	288.82	29.07	39.05	388.01	60.95
0.3	539.83	54.35	93.43	927.84	6.57
0.15	54,2	5.45	98.86	982.04	1.14
Pan	11.17	1.12	100	993.21	0
Total	993.21		243.07	FM=2.43	

Fineness Modulus (FM) is a measure of the size of particles in aggregates such as sand, gravel, or crushed stone. It is defined as the sum of the cumulative percentages retained on specified sieves divided by 100. The standard sieves used in determining the FM of sand are 4.75 mm, 2.36 mm, 1.18 mm, 600 µm,300 µm,150µm, and 75µm.

The FM of sand is determined by passing a representative sample of the sand through each of the sieves mentioned above and weighing the amount of sand retained on each sieve. The cumulative percentage of sand retained on each sieve is then calculated, and the sum of these percentages is divided by 100.

A high FM value indicates that the sand has a large proportion of fine particles, while a low FM value indicates that the sand has a large proportion of coarse particles. The FM value of natural river sand generally falls between 2.2 to 3.0. The FM value of manufactured sand, which is produced by crushing rock, may vary depending on the type of rock used and the crushing process.

The FM of sand is used in concrete mix design to optimize the proportion of fine and coarse aggregates. A higher FM value of sand requires more water and cement paste to achieve the desired work ability and strength of concrete, while a lower FM value requires less water and cement paste.

3.2.3 Stone Chips and Aggregate

Sand, gravel, crushed stone, slag, recycled concrete, and Geo-synthetic aggregates are all examples of construction aggregate or aggregate, a broad category of coarse particle material used in construction. Aggregates make up the vast majority of all mined commodities. Construction aggregates include crushed stone, sometimes known as stone or angular rock. It is made by extracting rock from the right place, then crushing it into various sizes. Gravel on the other hand is created by natural processes of weathering and erosion, and has a more rounded shape than crushed stone. Because of its adaptability, crushed stone has been employed for decades for many different buildings. It's one of the easiest and most accessible things to find in the world. It's one of the most common and fundamental raw elements we use. From architecture to farming, stones have many practical uses.

The size of coarse aggregate and find aggregate depends upon the nature of work the coarse aggregate used in this experimental investigation are of nominal size 2 mm. The properties of coarse aggregates are given in table 3.3.

Figure 3. 4: Stone chips

Table 3. 3: Flakiness index

Sieve size (mm)	weight of the material retained	% of the material passing (gm)	check if greater than 5% okay or (not okay)	Flakiness index Particular amount retained (gm)
50	0			
37.5	0			
25	0			
20	78	15.6	okay	4
14	215	43	okay	18
10	171	34.2	okay	25
6.3	32	6.4	okay	7
	M1=496	M2=99.2		M3=54
			Flakiness Index = 11%	

The amount of flaky particles in a sample is determined by the flakiness index. By using the particles in the sample, flakiness index sorts of indices can be used to calculate the concentration of a particular sample. This aggregates index value indicates the proportion of aggregate particles by weight whose smallest dimension is less than 0.6 times their mean dimension.

Moreover, because flaky aggregates pack more securely than cubical aggregates, they tend to generate seals with fewer voids. The amount of binders needed for flaky particles is thereby reduced.

Table 3. 4: Elongation Index

Sieve size (mm)	Wt of material retained	% of the material retained	Check if greater than 5% okay or (not okay)	Elongation particle amount retained (gm)
50	0			
37.5	0			
25	0			
20	78	15.6	OK	0
14	215	43	OK	13
10	171	34.2	OK	76
6.3	32	6.4	OK	15
	M1=496	M2=99.2		M3=104
Elongation Index =21%				

The total weight of the material maintained on the various length gauges, represented as a percentage of the sample's overall weight, is what is referred to as the elongation index. In other words, it is the proportion of particles by weight whose largest dimension tends to be bigger than 1.8 times the mean particle dimension. The elongation index of particles flowing through a 63 mm mesh and particles held on a 6.3 mm mesh can both be measured.

A mixture's particle packing can be disturbed and given additional room by the presence of elongated aggregate particles. These aggregate particles have a large surface area to volume ratio, which helps to make concrete less workable. Also, when a large load or stress is applied, using elongated particles for the base course of the pavement can easily lead to the pavement breaking down. Understanding the elongation index of a particular aggregate mix is crucial.

3.3.3 Cement

Cement, in its broadest definition, is a general term for adhesive compounds; in its narrower connotation, it refers to the binding materials used to create buildings and other civil engineering structures. Fine powders, these cements turn into a solid mass when mixed with water. Cement components and water undergo a chemical process called hydration, which results in setting and hardening, and either tiny crystals or a gel-like material with a lot of surface area. Cement used in construction that can still harden when completely immersed in water is frequently referred to as hydraulic cement. Since we have been accustomed to the most important of these components is Portland cement.

3.3.4 Water

Water has to collected from the local fresh sources. We need to make sure that there is no dust or other in the water.

Figure 3. 5: Used Water mixture

3.3.5 Quantity of Material

The waste materials used for the cement-based samples came from operations carried out at parking waste tiles through a procedure that allowed the whole segregation of the conductive metal and the sand replacement separated in table 3.5.

Table 3. 5: Properties of Materials

Details	Quantity
Cement	65 kg
Stone Chips	235 kg
Selection Sands	31 kg
White Sands	62 kg
Parking Tiles	25 kg
Water	Approx. 9 litre

3.4 Procedure and Casting the Specimens

This research was conducted in the concrete technology laboratory of the Department of Civil Engineering at Daffodil International University in Dhaka, Bangladesh. The primary objective of this study was to compare cubes of normal plain cement concrete with cylinders of concrete containing tile fiber based on the compressive strength test, as this is the most commonly used test due to its simplicity and because all of the necessary characteristics of a concrete are somehow related to the compressive strength test. For this experiment, 8-inch-diameter-by-4-inch-diameter concrete cylinders were constructed using M20 plain cement concrete and tile fiber for fiber-reinforced concrete. For each type of grade and concrete, a set of three cylinders were created and evaluated after 7, 14, and 28 days of curing. For the preparation of the concrete, varied percentages of tile waste were combined with cement. Here, we have used parking tiles containing 0%, 10%, 30%, and 40% cement by weight to make specimen cubes of M20 grade concrete for testing.

The tile fiber used in the preparation of the specimen concrete cylinder was gathered for the local market, separated from other garbage, rinsed with water, and then dried properly in the sun. In order to achieve an equal distribution of tiles in the concrete, the dried and discarded tiles were further separated based on their length, color, and texture. The most important aspect of the experiment was to properly mix the dry materials. The molds were kept on a vibrating table to initiate vibrations and to ensure that the concrete was placed properly layer by layer to prevent voids or air gaps between the aggregates and binding material. Finally, the mold was removed from the vibration plate and stored in the laboratory undisturbed for the following 24 hours. Following the removal of the molds, the cubes were placed in the water tank for varied curing periods of 7, 14, and 28 days. Subsequently, the cylinders were tested on a compression testing machine to determine the compressive strength of the mixture. This test was conducted on both types of specimens, i.e., cement, concrete and stone parking tiles, to compare their relative strengths.

The FM of sand is used in concrete mix design to optimize the proportion of fine and coarse aggregates. A higher FM value of sand requires more water and cement paste to achieve the desired work ability and strength of concrete, while a lower FM value requires less water and cement paste.

Figure 3. 6: Mixed Concrete

Figure 3. 7: Slump Test

Figure 3. 8: Mold Preparation

Figure 3. 9: Cylinder are being submerged in the curing pond for curing of 7,14, & 28 days.

3.4.1 Strength Test

Compression Test: Depending on what kind of mechanical and durability qualities are needed for a certain structure's design, concrete may be mixed to provide a broad variety of these characteristics. When developing structures, engineers rely heavily on the compressive strength of concrete. During compressive testing, cylinders of concrete are compressed until they crack.

The results of strength tests performed on cast cylinders can be used for quality control, acceptance of concrete, strength estimation in a structure, or evaluation of the sufficiency of curing and protection offered to the structure. The acceptance and quality control of cylinders that have been treated according to standards. Concrete strength on site may be estimated by testing field-cured cylinders. Cylindrical specimens are evaluated in line with standard-curing and field-curing procedures. Concrete cylinders measuring 4 by 8 inches (100 by 200 millimeters) are the industry standard for testing. In the field and the lab, the smaller specimens are typically easier to create and manage.

Figure 3. 10: Compression strength Test

Figure 3. 11: Split Tensile strength Test.

3.5 Summary

Mix design refers to the process through which the ideal components and proportions of those components are selected for a concrete mixture. Quantities of cement, fine aggregate, and coarse aggregate must be determined, and the relationship between the water/cement ratio and the desired strength must be established for the mix design to be complete.

CHAPTER 4

RESULT AND DISCUSSION

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

Table 4. 1: Compressive Strength for Different mixed ratio of parting waste tile with sand after 7 days

Percent (%)	Average Compressive Strength (MPA)
0	7.45
10	7.23
20	7.63
30	9.17
40	7.4

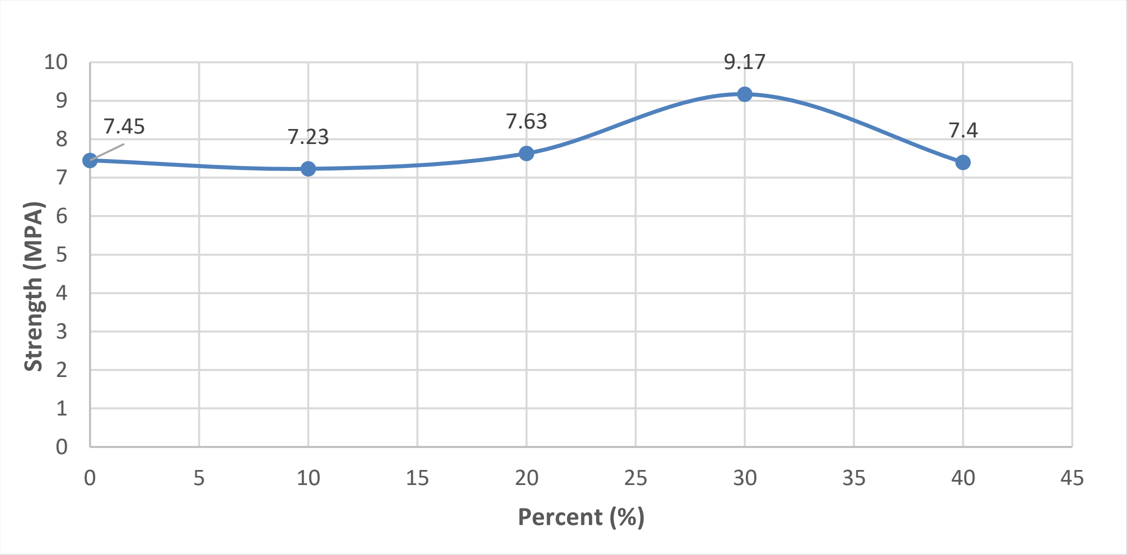

Figure 4. 1: Compressive Strength for Different mixed ratio of parting waste tile with sand after 7 days

According to Table and Figure 4.1, parking tiles are blended 0–40% with concrete. 15 Nos. of Cylinders are tested by the UTM machine after 7 days. 7.45 MPA is the average compressive strength when 0% parking tile powder is not mixed. By combining 10%

parking tile powder, strength is decreased to 7.23 MPA. The average compressive strength rises to 7.63 and 9.17 after mixing 20% and 30% parking tile powder. Once more, it drops to 7.40 MPA at 40%. At 30%, we get the highest average compressive strength 9.17 MPA, and at 10%, the lowest average compressive strength 7.23 MPA.

Table 4. 2: Compressive Strength for Different mixed ratio of parting waste tile with sand after 14 days

Percent (%)	Average Compressive Strength (MPA)
0	10.33
10	10
20	10.57
30	12.7
40	10.26

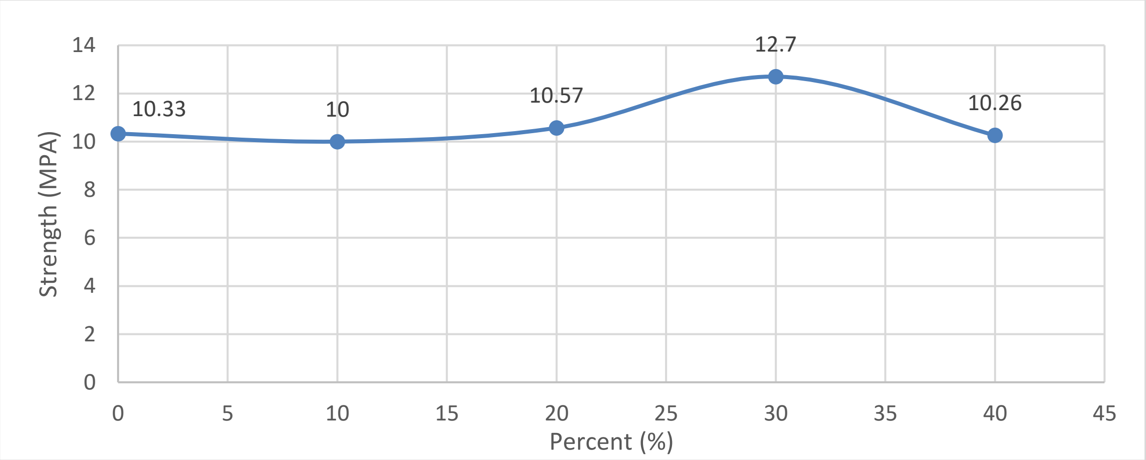

Figure 4. 2: Compressive Strength for Different mixed ratio of parting waste tile with sand after 14 days

According to Table and Figure 4.2, parking tiles are blended 0–40% with concrete. 15 Nos. of Cylinders are tested by the UTM machine after 14 days. 10.33 MPA is the average compressive strength when 0% parking tile powder is not mixed. By combining 10% parking tile powder, strength is decreased to 10 MPA. The average compressive strength rises to 10.57 and 12.7 MPA after mixing 20% and 30% parking tile powder. Once more, it drops to 10.26 MPA at 40%. At 30%, we get the highest average compressive strength 12.7 MPA, and at 10%, the lowest average compressive strength 10 MPA. After 14 days, the average compressive strength value from the 7-day average compressive strength chart is 2.99 MPa at the average growth rate for each.

Table 4. 3: Compressive Strength for Different mixed ratio of parting waste tile with sand after 28 days

Percent (%)	Average Compressive Strength (MPA)
0	11
10	10.67
20	11.26
30	13.53
40	10.93

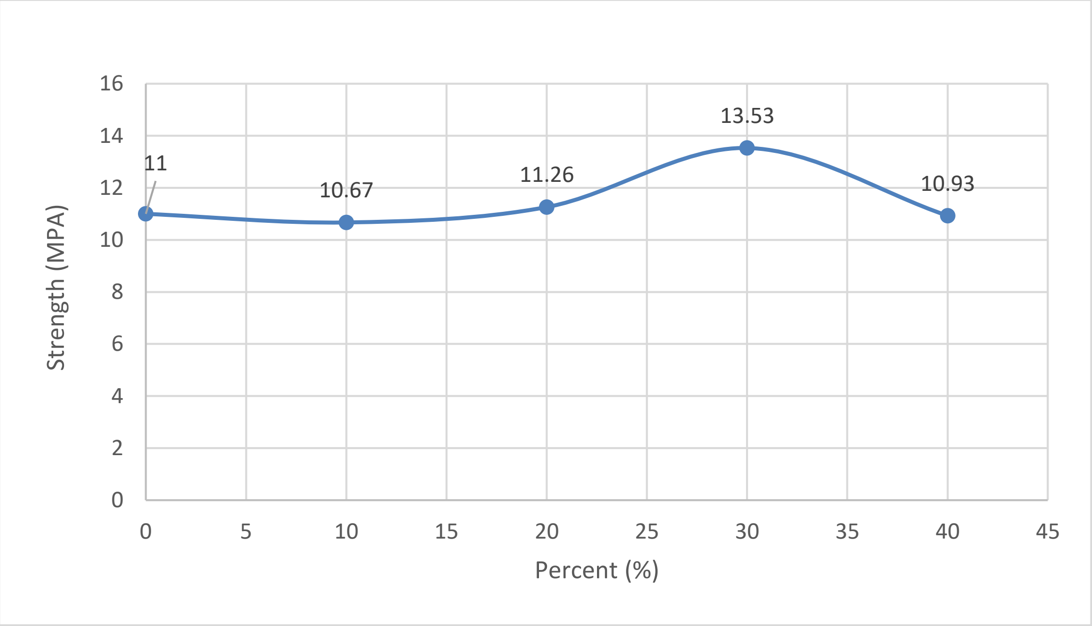

Figure 4. 3: Compressive Strength for Different mixed of parking waste tile with sand after 28 days

According to Table and Figure 4.3, parking tiles are blended 0–40% with concrete. 15 Nos. of Cylinders are tested by the UTM machine after 28 days. 10.67 MPA is the average Compressive Strength when 0% parking tile powder is not mixed. By combining 10%

parking tile powder, strength is decreased to 10.67 MPA. The average compressive strength rises to 11.26 and 13.57 MPA after mixing 20% and 30% parking tile powder. Once more, it drops to 10.93 MPA at 40%. At 30%, we get the highest average compressive strength 13.57 MPA, and at 10%, the lowest average compressive strength 10.67 MPA. After 28 days, the average compressive strength value from the 14-day average compressive strength chart is 0.71 MPa at the average growth rate for each.

Table 4. 4: Tensile Strength for Different mixed of parking tile with sand after 7 days.

Percent (%)	Average Tensile Strength (MPA)
0	6.3
10	5.43
20	5.47
30	6.57
40	5.4

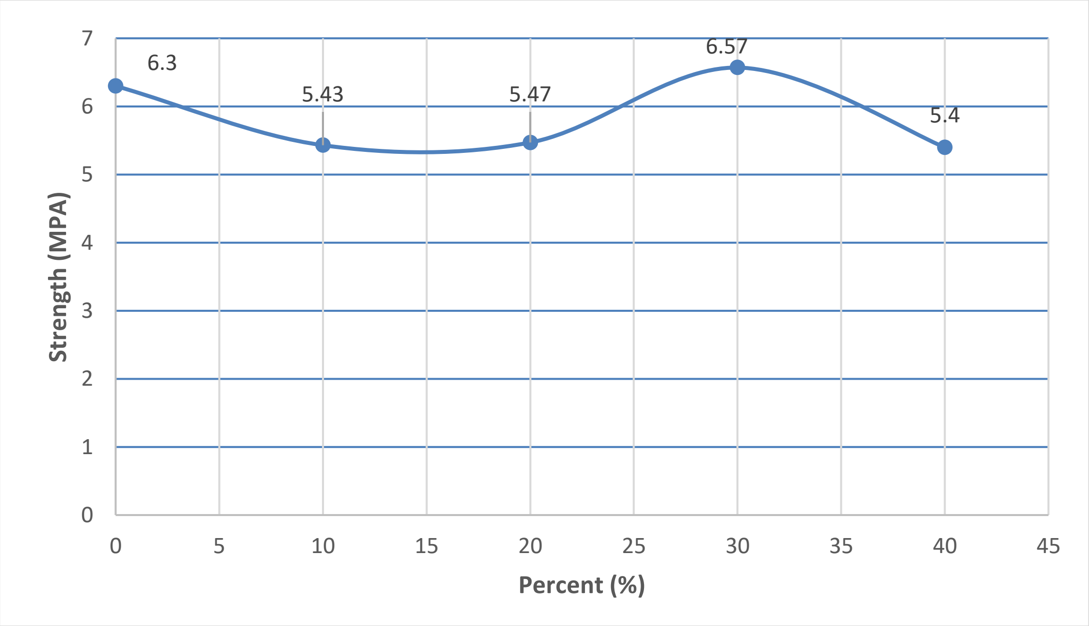

Figure 4. 4: Tensile Strength for Different mixed of parking tile with sand after 7 days

According to Table and Figure 4.4, parking tiles are blended 0–40% with concrete. 15 Nos. of Cylinders are tested by the UTM machine after 7 days. 6.3 MPA is the average Tensile

Strength when 0% parking tile powder is not mixed. By combining 10% parking tile powder, strength is decreased to 5.43 MPA. The Average Tensile Strength rises to 5,47 and 6.57 MPA after mixing 20% and 30% parking tile powder. Once more, it drops to 5.4 MPA at 40%. At 30%, we get the highest average compressive strength 6.57 MPA, and at 40%, The lowest Average Tensile Strength 5.4 MPA.

Table 4. 5: Tensile Strength for Different mixed ratio of parking tile with sand after 14 days.

Percent (%)	Average Tensile Strength (MPA)
0	6.47
10	5.43
20	5.83
30	6.5
40	5.33

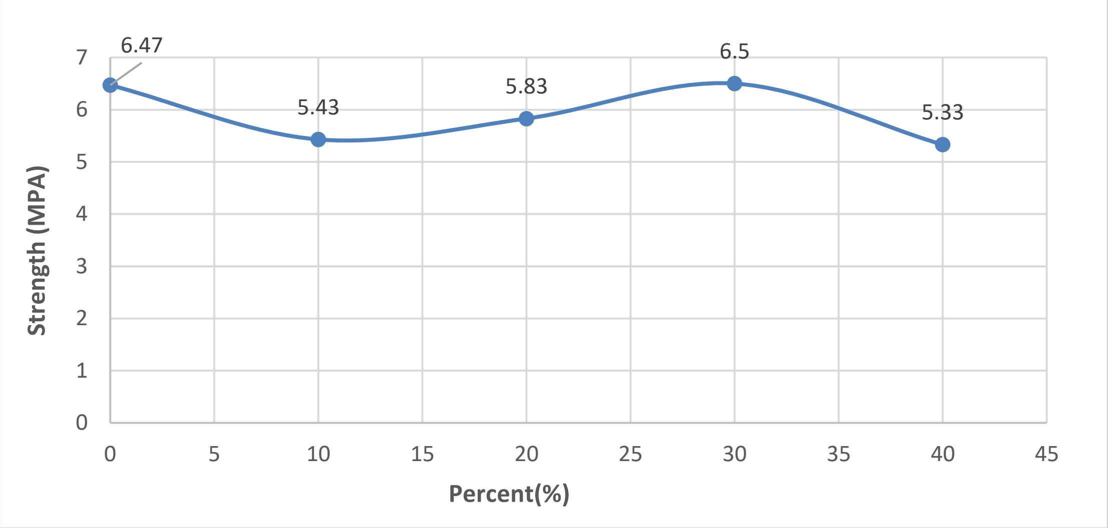

Figure 4. 5: Tensile Strength for Different mixed ratio of parking tile with sand after 14 days.

According to Table and Figure 4.5, Parking tiles are blended 0–40% with concrete. 15 Nos. of Cylinders are tested by the UTM machine after 14 days. 6.47 MPA is the average Tensile Strength when 0% parking tile powder is not mixed. By combining 10% parking tile powder, strength is decreased to 5.43 MPA. The Average Tensile Strength rises to 5.83 and 6.5 MPA after mixing 20% and 30% parking tile powder. Once more, it drops to 5.33 MPA at 40%. At 30%, we get the highest average compressive strength 6.5 MPA, and at 40%, The lowest Average Tensile Strength 5.33 MPA. After 7 days, The Average Tensile Strength value from the 14-day average Tensile Strength chart is 0.08 MPa at the average growth rate for each.

Table 4. 6: Tensile Strength for Different mixed ratio of parking tile with sand after 28 days.

Percent (%)	Average Tensile Strength (MPA)
0	7.2
10	6.9
20	7.07
30	7.26
40	7.13

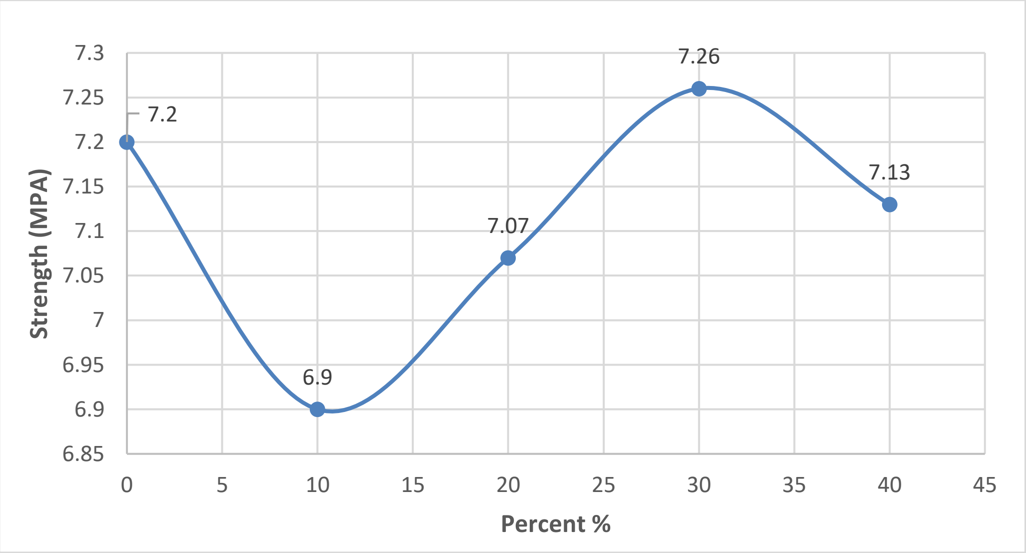

Figure 4. 6: Tensile Strength for Different mixed ratio of parking tile with sand after 28 days.

According to Table and Figure 4.5, Parking tiles are blended 0–40% with concrete. 15 Nos. of Cylinders are tested by the UTM machine after 28 days. 7.2 MPA is the average

Tensile Strength when 0% parking tile powder is not mixed. By combining 10% parking tile powder, strength is decreased to 6.9 MPA. The Average Tensile Strength rises to 7.07 and 7.26 MPA after mixing 20% and 30% parking tile powder. Once more, it drops to 7.13 MPA at 40%. At 30%, we get the highest average compressive strength 7.26 MPA, and at 10%, The lowest Average Tensile Strength 6.9 MPA. After 28 days, The Average Tensile Strength value from the 14-day average Tensile Strength chart is 0.11 MPa at the average growth rate for each.

Table 4. 7: Average Compressive Strength for 0% replacement

Days	Compression Strength (MPA)
7	7.45
14	10.33
28	11

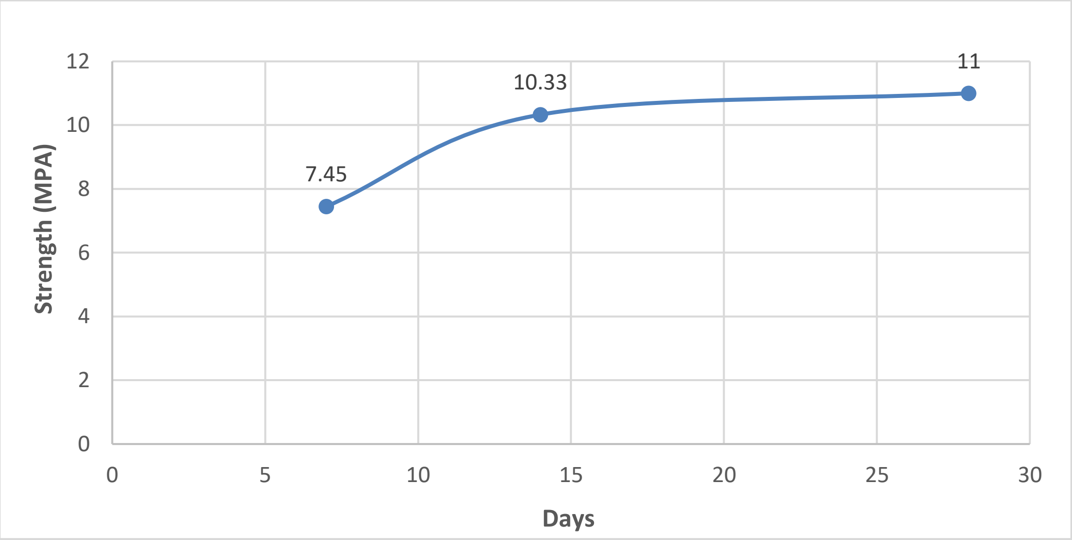

Figure 4. 7: Average Compressive Strength for 0% replacement.

The table and figure 4.7 represent the average compressive strength on a day-to-day basis with 0% replacement. After 7 days, the strength was found to be 7.45 MPa. Following 14 and 28 days, the strength steadily increased to 10.33 and 11 MPA respectively. Highest strength of 11 MPA was attained after 28 days with 0% replacement.

Table 4. 8: Average Compressive Strength for 10% replacement

Days	Average Compression Strength (MPA)
7	7.23
14	10
28	10.67

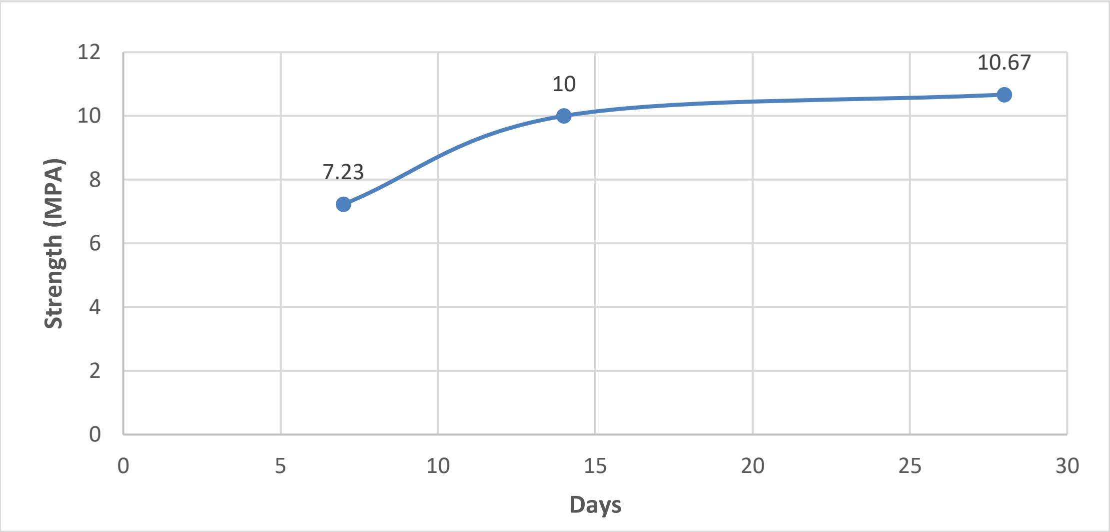

Figure 4. 8: Average Compressive Strength for 10% replacement.

The table and figure 4.8 represent the average compressive strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 7.23 MPa. Following 14 and 28 days, the strength steadily increased to 10 and 10.67 MPA, respectively. Highest strength of 10.67 MPA was attained after 28days with 10% replacement. With 10% replacement, the average compressive strength values were 0.29 MPA less each day than they were with 0% replacement.

Table 4. 9: Average Compressive Strength for 20% replacement

Days	Compression Strength (MPA)
7	7.63
14	10.57
28	11.26

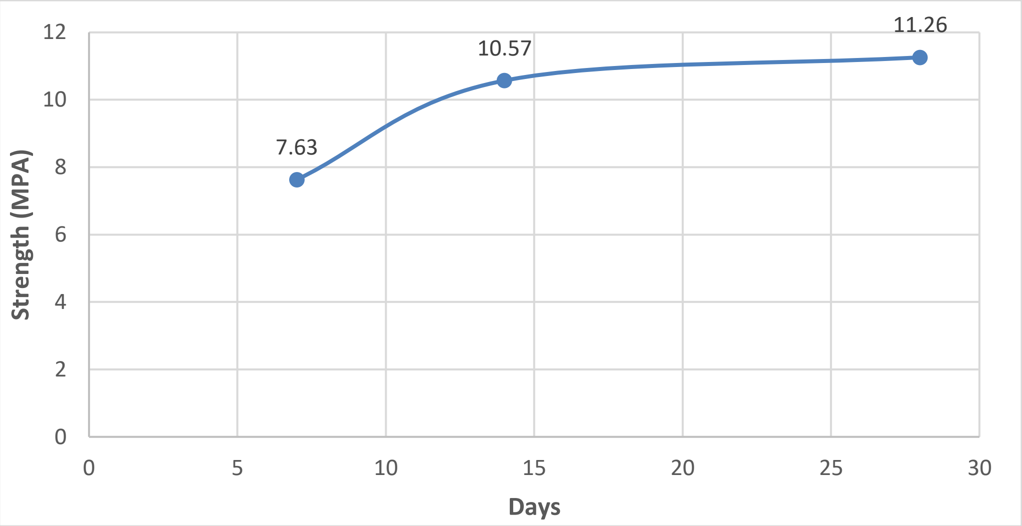

Figure 4. 9: Average Compressive Strength for 20% replacement

The table and figure 4.9 represent the average compressive strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 7.63 MPa. Following 14 and 28 days, the strength steadily increased to 10.57 and 11.26 MPA respectively. Highest strength of 11.26 MPA was attained after 28 days with 20% replacement. An improvement in average compressive strength of 20% with 10% replacement increases by 0.43 MPa per day as opposed to 20% replacement.

Table 4. 10: Average Compressive Strength for 30% replacement

Days	Compression Strength (MPA)
7	9.17
14	12.7
28	13.53

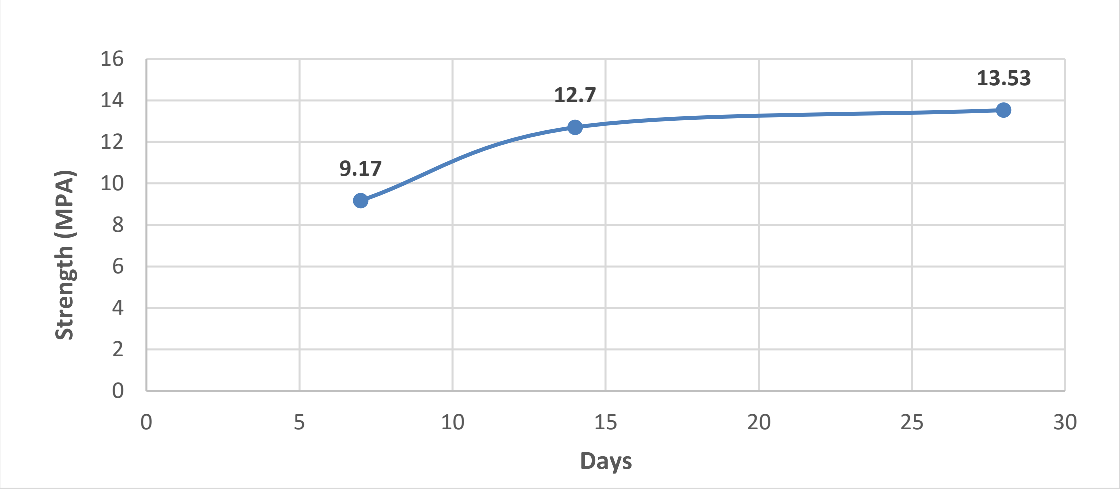

Figure 4. 10: Average Compressive Strength for 30% replacement.

The table and figure 4.10 represent the average compressive strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 9.17 MPa. Following 14 and 28 days, the strength steadily increased to 12.7 and 13.53 MPA respectively. Highest strength of 13.53 MPA was attained after 28 days with 30% replacement. An improvement in average compressive strength of 30% with 20% replacement increases by 1.98 MPa per day as opposed to 30% replacement.

Table 4. 11: Average Compressive Strength for 40% replacement

Days	**Compressive Strength (MPA)**
7	7.4
14	10.26
28	10.93

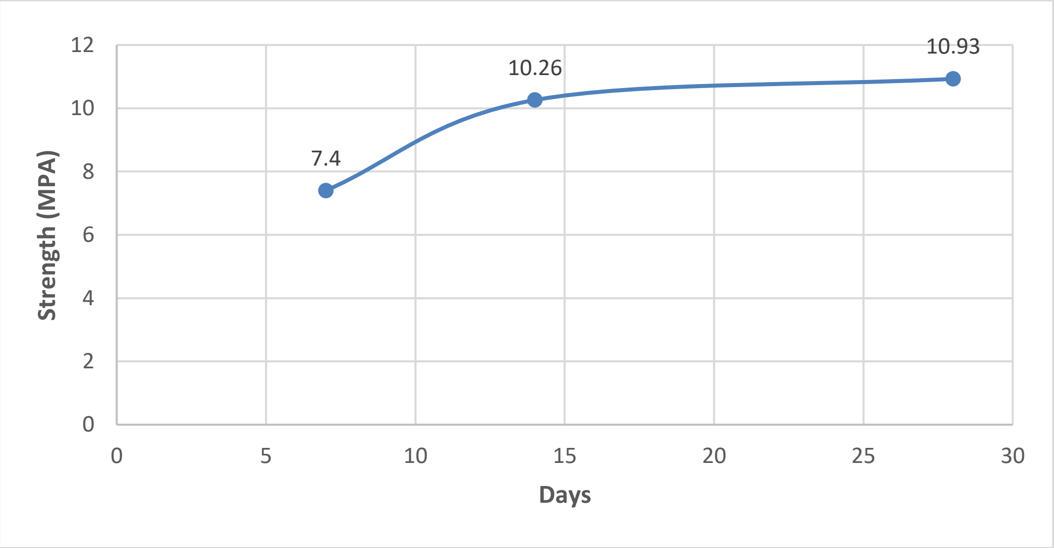

Figure 4. 11: Average Compressive Strength for 40% replacement.

The table and figure 4.11 represent the average compressive strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 7.4 MPa. Following 14 and 28 days, the strength steadily increased to 10.26 and 10.93 MPA respectively. Highest strength of 10.93 MPA was attained after 28 days with 30% replacement. An improvement in average compressive strength of 30% with 20% replacement decreases by 2.27 MPa per day as opposed to 20% replacement

Table 4. 12: Average Tensile Strength for 0% replacement

Days	Tensile Strength (MPA)
7	6.3
14	6.47
28	7.2

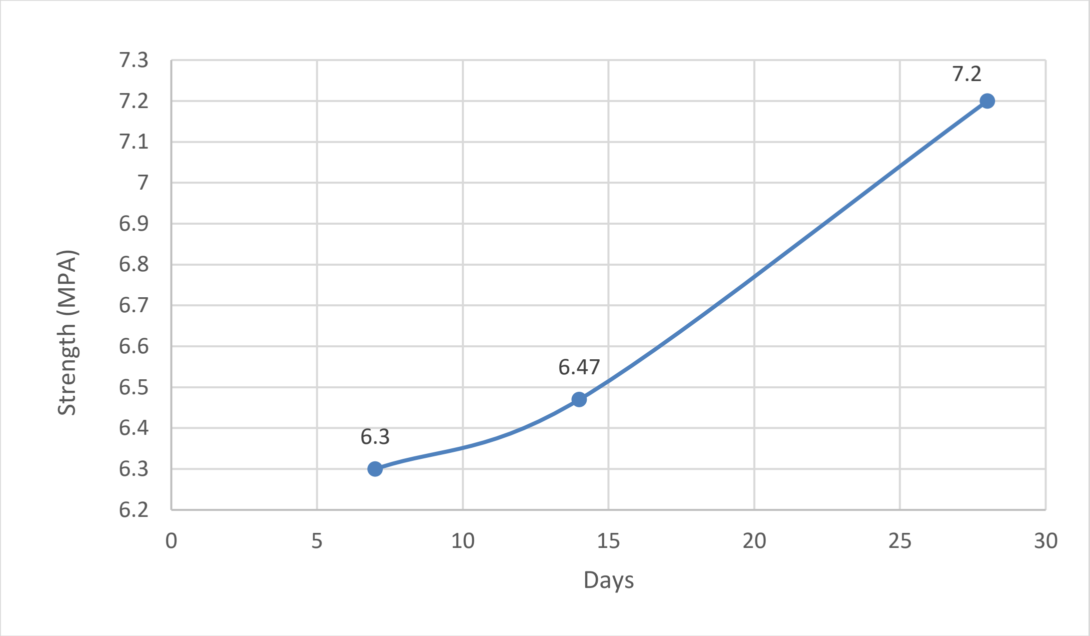

Figure 4. 12:Average Tensile Strength for 0% replacement.

The table and figure 4.12 represent the average Tensile strength on a day-to-day basis with 0% replacement. After 7 days, the strength was found to be 6.3 MPA. Following 14 and 28 days, the strength steadily increased to 6.67 and 7.2 MPA respectively. Highest strength of 7.2 MPA was attained after 28 days with 0% replacement.

Table 4. 13:Average Tensile Strength for 10% replacement

Days	Tensile Strength (MPA)
7	5.43
14	5.43
28	6.9

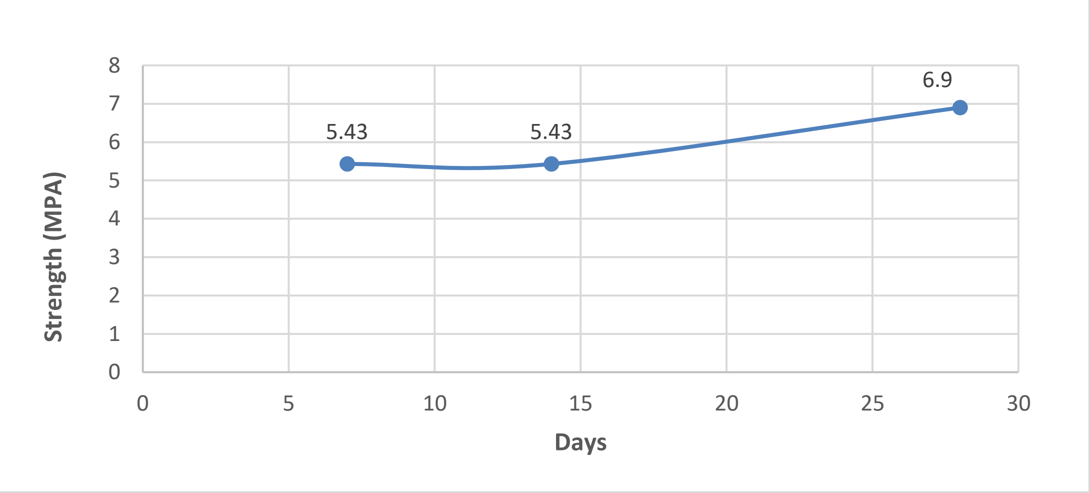

Figure 4. 13:Average Tensile Strength for 10% replacement

The table and figure 4.13 represent the average Tensile strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 5.43 MPa. Following 14 and 28 days, the strength steadily increased to 5.43 and 6.9 MPA respectively. Highest strength of 6.9 MPA was attained after 28days with 10% replacement. With 10% replacement, the average Tensile strength values were 0.74 MPA less each day than they were with 0% replacement.

Table 4. 14: Average Tensile Strength for 20% replacement

Days	Tensile Strength (MPA)
7	5.47
14	5.83
28	7.07

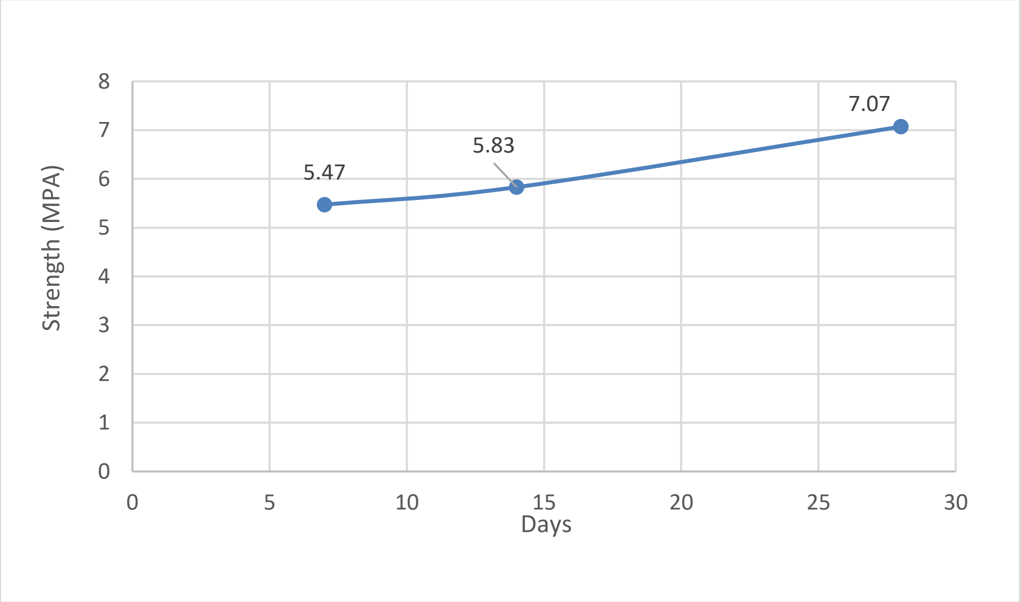

Figure 4. 14:Average Tensile Strength for 20% replacement.

The table and figure 4.14 represent the average Tensile strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 5.47 MPa. Following 14 and 28 days, the strength steadily increased to 5.83 and 7.07 MPA respectively. Highest strength of 7.07 MPA was attained after 28 days with 20% replacement. An improvement in average Tensile strength of 20% with 10% replacement increases by 0.20 MPa per day as opposed to 20% replacement.

Table 4. 15: Average Tensile Strength for 30% replacement

Days	**Tensile Strength (MPA)**
7	6.57
14	6.5
28	7.26

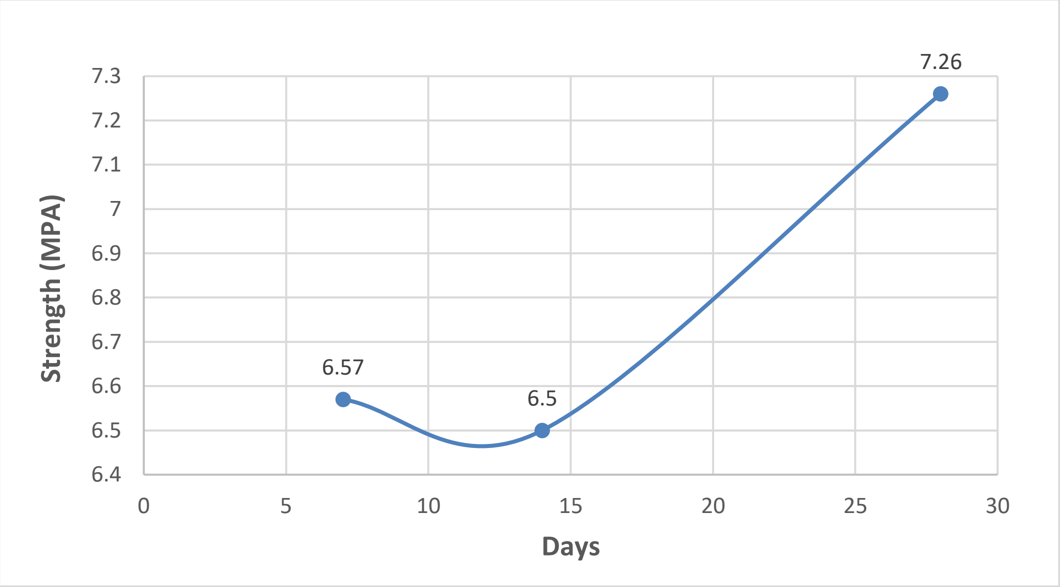

Figure 4. 15:Average Tensile Strength for 30% replacement.

The table and figure 4.15 represent the average Tensile strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 6.57 MPa. Following 14 and 28 days, the strength steadily increased to 6.5 and 7.26 MPA respectively. Highest strength of 7.26 MPA was attained after 28 days with 30% replacement. An improvement in average Tensile strength of 30% with 20% replacement increases by 0.65 MPa per day as opposed to 30% replacement.

Table 4. 16: Average Tensile Strength for 40% replacement

Days	Tensile Strength (MPA)
7	5.4
14	5.33
28	7.13

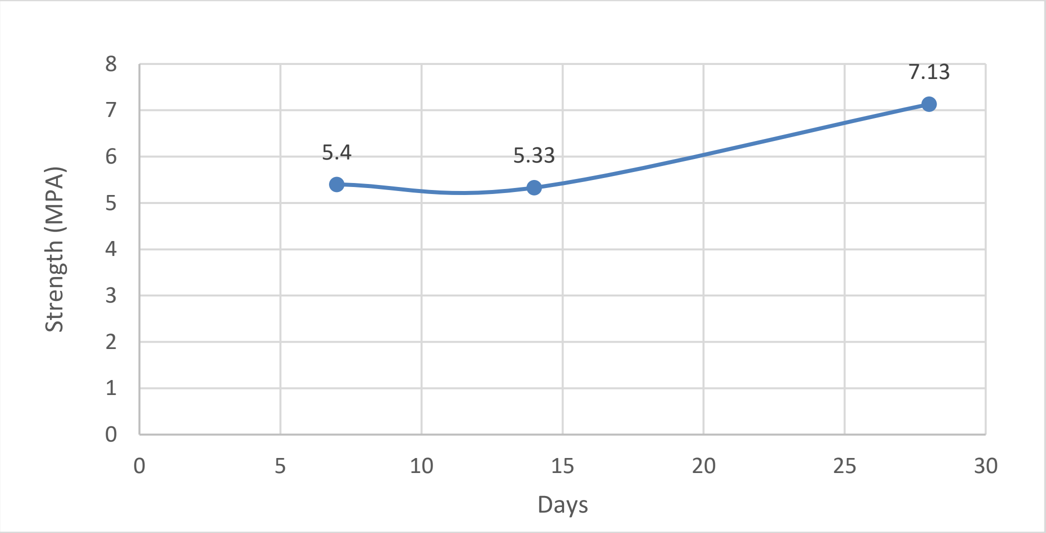

Figure 4. 16:Average Tensile Strength 40% replacement.

The table and figure 4.16 represent the average Tensile strength on a day-to-day basis with 10% replacement. After 7 days, the strength was found to be 5.4 MPa. Following 14 and 28 days, the strength steadily increased to 5.33 and 7.13 MPA respectively. Highest strength of 10.93 MPA was attained after 28 days with 30% replacement. An improvement in average Tensile strength of 40% with 30% replacement decreases by 2.27 MPa per day as opposed to 40% replacement.

CHAPTER 5

CONCLUSION

5.1 Findings

The constructed appropriate-sized (8"*4") cylinder sample was cured for the standard cure times of 7, 14, and 28 days. For the durability assessment, we used the median of three replicates for each mixture. Testing is also done to see if drying time for sand refill impacts the longevity of parking tiles. The extensive study effort led to the following general conclusions:

- The findings indicate that broken waste parking tile fragments can replace 0 to 40% of the fine aggregate.
- Similar patterns may be seen in the changing of cement qualities such as workability, unit weight, and strength when more broken parking tile is used to replace sand.
- The ratio of natural sand to waste tile sand must be 30% for concrete to reach its maximum strength. Sand from waste tiles has more durability than natural sand.
- Adding more finely crushed Parking Tile Wastes Sand caused a little drop in the hardened density of the modified Sustainable Reactive Powder Concrete.
- After substituting more fine sand with varied amounts of finely wasted parking tiles, the compressive strength of the shattered parking tiles dropped.

5.2 Conclusion

This research highlighted the possibilities of using parking waste powder as effective partial replacement of sand in concrete.

Natural resources used in concrete are continuously being depleted, necessitating the adoption of essential substitute materials. In addition, as the population grows, more new homes are built to accommodate the population, which raises the need for concrete and other building supplies. Recycling the waste materials leads to the replacement of the old construction materials with new ones. Waste parking lot tiles have been shown to be a reliable fine and coarse aggregate substitute in concrete production. The goal of this study is to look at the possibility of using used tiles to partially replace fine and coarse particles in concrete. To replace some of the sand, the control mix and additional mixes including cement, water, and broken parking tiles were cast in amounts of 0%, 10%, 20%, 30%, and 40%. This study discovered that for concrete to attain its optimum strength, the ratio of natural sand to waste parking tiles sand must be 30%. Thus, using parking lot waste powder in concrete is one of the most technically, economically, and practically possible options for the secure disposal of Parking waste while maintaining the sustainability of concrete construction. The use of leftover parking lot tiles may aid the construction industry. The major purpose of the research is to use tiny particles to create concrete that is stronger and more durable than normal concrete. The region of strength calculation and comparisons are evaluated for a total of 90 specimens. According to the results of an experimental inquiry on plain cement concrete, the compressive strength of concrete improves by up to 30% to 13.53 MPa with the addition of parking tile waste, after which the strength decreases with successive additions of parking tis waste.

5.3 Recommendation for Future Study

Using recycled parking tiles as a sand replacement in concrete is an innovative idea that has the potential to make a positive impact on the environment by reducing waste and conserving natural resources.

As a future study recommendation, it would be beneficial to conduct further research to determine the optimal percentage of parking tile powder that can be used as a replacement for sand in concrete while maintaining the desired strength and durability properties of the concrete. This could involve conducting laboratory tests on concrete mixtures containing varying percentages of parking tile powder and comparing their strength and durability to that of traditional concrete mixtures.

It may be useful to conduct a cost-benefit analysis to determine the economic feasibility of using parking tile powder as a sand replacement in concrete. This could involve evaluating the cost savings associated with reducing the amount of sand needed in concrete mixtures, as well as any additional costs associated with processing the parking tiles for use in concrete. Overall, further research on the use of parking tile powder as a sand replacement in concrete could help to promote sustainable construction practices and reduce the environmental impact of the construction industry.

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Appendix

Table 1: Result of Compressive Strength for Different mixed of parting waste tiles with sand after 7 days

Compressive (7 Days)				
Percent (%)	Compressive Load (KN)	Día (mm)	Compressive Strength (MPA)	Average Compressive Strength (MPA)
0	81	100	8.100	7.45
0	85	101	7.100	
0	82	102	7.150	
10	75	100	7.500	7.23
10	72	103	7.200	
10	70	104	7.000	
20	76	102	7.600	7.63
20	78	103	7.800	
20	75	104	7.500	
30	93	101	9.300	9.16
30	92	100	9.200	
30	90	102	9.000	
40	76	104	7.600	7.40
40	75	103	7.500	
40	71	102	7.100	

Table 2: Compressive Strength for Different mixed ratio of parting waste tiles with sand after 14 days

Compressive (14 Days)				
Percent (%)	Compression Load (KN)	Día (mm)	Compressive Strength (MPA)	Average
0	104	102	10.4	10.33
0	101	103	10.1	
0	105	100	10.5	
10	102	101	10.2	10.00
10	98	103	9.8	
10	100	102	10	
20	104	101	10.4	10.56
20	105	100	10.5	
20	108	102	10.8	
30	124	102	12.4	12.700
30	130	101	13	
30	127	100	12.7	
40	102	101	10.2	10.267
40	105	103	10.5	

Table 3: Compressive Strength for Different mixed ratio of parting waste tiles with sand after 28days

Compressive (28 Days)				
Percent (%)	Día (mm)	Compressive Load (KN)	Compressive Strength (MPA)	Average Strength (MPA)
0	102	112	11.2	11.00
0	103	110	11	
0	100	108	10.8	
10	102	107	10.7	10.66
10	103	104	10.4	
10	102	109	10.9	
20	101	118	11.8	11.26
20	100	108	10.8	
20	102	112	11.2	
30	102	136	13.6	13.53
30	101	138	13.8	
30	100	132	13.2	
40	101	114	11.4	10.93
40	103	104	10.4	
40	102	110	11	

Table 4: Result of Tensile Strength for Different mixed ratio of parking tile with sand after 7 days

Tensile (7 Day)				
Percent (%)	Tensile Load (KN)	Día (mm)	Tensile Strength (MPA)	Average Tensile Strength (MPA)
0	63	100	6.3	6.3
0	61	101	6.1	
0	65	100	6.5	
10	55	102	5.5	5.43
10	52	103	5.2	
10	56	101	5.6	
20	52	100	5.2	5.46
20	58	102	5.8	
20	54	101	5.4	
30	63	100	6.3	6.56
30	69	100	6.9	
30	65	101	6.5	
40	57	102	5.7	5.45
40	55	100	5.5	
40	50	100	5	

Table 5: Result of Tensile Strength for Different mixed of parking tile with sand after 14 days

Tensile (14 Day)				
Percent (%)	Tensile Load (KN)	Día (mm)	Tensile Strength (MPA)	Average Tensile Strength (MPA)
0	67	103	6.700	6.46
0	65	102	6.500	
0	62	100	6.200	
10	50	101	5.000	5.4
10	55	102	5.500	
10	58	100	5.800	
20	62	104	6.200	5.83
20	55	103	5.500	
20	58	100	5.800	
30	65	102	6.500	6.50
30	64	101	6.400	
30	66	100	6.600	
40	52	100	5.200	5.33
40	55	102	5.500	
40	53	103	5.300	

Table 6: Result of Tensile Strength for Different mixed of parking tile with sand after 28 days

Tensile (28 Day)				
Percent (%)	Tensile Load (KN)	Día (mm)	Tensile Strength (MPA)	Average Tensile Strength (MPA)
0	72	100	7.200	7.16
0	73	102	7.300	
0	70	101	7.000	
10	68	101	6.800	6.90
10	67	100	6.700	
10	72	102	7.200	
20	70	100	7.000	7.10
20	71	100	7.100	
20	72	104	7.200	
30	73	100	7.300	7.26
30	74	102	7.400	
30	71	104	7.100	
40	68	103	6.800	7.13
40	75	102	7.500	
40	71	101	7.100	

Table 7: Fineness Modulus of Sand

Sieve size (mm)	Retained (gm)	% Retained (gm)	Cumulative % retained
9.5	0	0	0
4.75	6.4	2.15	2.15
2.36	28.41	9.52	11.67
1.18	23.32	7.82	19.49
0.6	39.53	13.25	32.74
0.3	48.67	16.32	49.06
0.15	106.76	35.79	84.85
pan	45.2	15.15	100
Total	298.29		298.29
FM= **2.9829 ≈3**			

Table 8: Fineness Modulus of Waste Parking Tiles

Sieve size (mm)	mass retained (gm)	% Retained	Cumulative % Retained	Cumulative mass retained (gm)	% Finer
9.5	0	0	0	0	100
6.3	1.81	0.18	0.18	1.81	99.82
2.36	13.87	1.39	1.57	15.68	98.43
1.18	83.51	8.41	9.98	99.19	90.02
0.6	288.82	29.07	39.05	388.01	60.95
0.3	539.83	54.35	93.43	927.84	6.57
0.15	54,2	5.45	98.86	982.04	1.14
Pan	11.17	1.12	100	993.21	0
Total	993.21		243.07		
FM =2.43					

Table 9: Flakiness Index of Stone Chips

Sieve size (mm)	Weight of the material retained	% of the material passing (gm)	Check if greater than 5% okay or (not okay)	Flakiness index Particular amount retained (gm)
50	0	-	-	-
37.5	0	-	-	-
25	0	-	-	-
20	78	15.6	Okay	4
14	215	43	Okay	18
10	171	34.2	Okay	25
6.3	32	6.4	Okay	7
	M1=496	M2=99.2		M3=54
Flakiness Index = 11%,				

Table 10: Elongation Index of Stone Chips.

Sieve size (mm)	Wt. of material retained	% of the material retained	Check if greater than 5% ok or (not ok)	Elongation particle amount retained (gm)
50	0	-	-	-
37.5	0	-	-	-
25	0	-	-	-
20	78	15.6	OK	0
14	215	43	OK	13
10	171	34.2	OK	76
6.3	32	6.4	OK	15
	M1=496	M2=99.2		M3=104
Elongation Index =21%				