TIME DEPENDENT EFFECT OF TEMPERATURE ON THE COMPRESSIVE STRENGTH OF CONCRETE MADE WITH PARTIALLY REPLACED RECYCLED PHARMACEUTICAL BLISTER AS FINE AGGREGATE AND DRINK CAN AS COARSE AGGREGATE

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department of Civil Engineering

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147/I, Green Road, Dhaka-1215, Bangladesh

Section: 19C+19E

Semester: Fall-2023

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Dedicated

to

“Our Parents

&

Respectable Teachers”

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ABSTRACT

If a multi-storied building catches fire, the walls collapse first, followed by columns, beams, and slabs. The building collapsed, and many people died until the fire was extinguished by evacuating the people and belongings inside. The study aims to increase concrete strength and make it last longer in fire than normal concrete. Aluminum increases the strength of concrete by resisting fire and bonding better with concrete. Therefore, in this experiment, waste drink cans and pharmaceutical blisters have been used as aluminum. In this study, partially replaced (5%, 10%, 15%, & 20%) recycled pharmaceutical blister as fine aggregate and partially replaced (5%, 10%, 15%, & 20%) recycled drink cans as coarse aggregate. The pharmaceutical blister & drinks can sizes used were 2mm × 2mm and 17.5mm × 17.5mm, the water-cement ratio was 0.55, and for 54 cylinders, the concrete mixing ratio was 1:1.74:2.72, the concrete mixing ratio followed by mix design. According to the results, there was a decreased compressive strength of pharmaceutical blister mix concrete. After 28 days, the maximum compressive strength at 5% drink cans mixed concrete at normal temperature and 60 minutes at 1000°C was 25.7MPa and 19.27MPa, respectively, whereas the maximum compressive strength for normal concrete, at normal temperature and 60 minutes at 1000°C, was 20.02MPa and 13.07Mpa, respectively, and for pharmaceutical blister mix concrete at 5%, 22.05MPa and 17.88MPa, respectively.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 General

Concrete is the most widely used construction material in the world, but it is also a major contributor to climate change. The production of cement, the main ingredient in concrete, accounts for about 8% of global CO2 emissions. Recycled aggregates are a promising way to reduce the environmental impact of concrete production. Recycled aggregates can be made from a variety of waste materials, such as construction and demolition waste, electronic waste, and plastic waste. These materials are processed and cleaned to remove any contaminants, and then they can be used to replace natural aggregates in concrete.

In this study, we will investigate the use of recycled pharmaceutical blister and drinks cans as fine and coarse aggregates in concrete. Pharmaceutical blister packs and drinks cans are both common types of waste materials, and they can be easily recycled into aggregates.

We will study the time-dependent effect of temperature on the compressive strength of this type of concrete. Compressive strength is an important property of concrete, and it is affected by several factors, including the type of aggregates used. We will test the compressive strength of concrete made with recycled pharmaceutical blister and drinks cans at different temperatures over time.

This will help us to understand how the type of aggregates and the temperature affect the durability of concrete. The results of this study will be valuable for the construction industry. If we can show that recycled pharmaceutical blister and drinks cans can be used to produce concrete with good compressive strength and durability, then this could lead to a significant reduction in the environmental impact of the construction industry. In addition to the environmental benefits, using recycled aggregates in concrete can also have economic benefits. Recycled aggregates are often less expensive than natural aggregates, and they can help to reduce the amount of waste that goes to landfills. Overall, this study has the potential to make a significant contribution to the development of more sustainable and environmentally friendly concrete.

1.2 Compressive Strength

Compressive strength is one of the most important properties of concrete. Concrete can resist compressive forces, such as the weight of a building or the load of traffic on a bridge. Compressive strength is important for many types of concrete structures, such as buildings, bridges, and roads.

Some factors affect the compressive strength of concrete, including:

1. **Cement type and strength:** High-strength cement will produce concrete with higher compressive strength.
2. **Water-cement ratio:** A lower water-cement ratio will produce concrete with higher compressive strength.
3. **Aggregate type and grading:** Well-graded aggregates will produce concrete with higher compressive strength.
4. **Curing conditions:** Concrete that is cured properly will have higher compressive strength.

Increasing the compressive strength of concrete can be achieved by using high-strength cement, reducing the water-cement ratio, and using well-graded aggregates. However, these measures can also increase the cost of concrete. The highest compressive strength of concrete is used in structures that need to withstand high loads, such as high-rise buildings and bridges.
For example, the concrete used in the Burj Khalifa, the tallest building in the world, has a compressive strength of over 100 MPa. The lowest compressive strength of concrete is used in structures that do not need to withstand high loads, such as sidewalks and patios. For example, the concrete used in a sidewalk typically has a compressive strength of around 20 MPa.
In general, the higher the compressive strength of concrete, the more expensive it is. However, it is important to choose the right concrete mix for the job. Using concrete with a higher compressive strength than necessary is a waste of money, and using concrete with a lower compressive strength than necessary could lead to structural failure.
Here are some additional considerations for increasing the compressive strength of concrete without increasing cost:

1. **Use mineral admixtures:** Mineral admixtures, such as fly ash and ground granulated blast-furnace slag, can be used to replace some of the cement in a concrete mix. This can reduce the cost of the concrete mix while still maintaining good compressive strength.
2. **Use recycled aggregates:** Recycled aggregates can be used to replace some of the natural aggregates in a concrete mix. This can reduce the cost of the concrete mix while also reducing the environmental impact of concrete production.
3. **Optimize the concrete mix design:** A well-designed concrete mix can achieve high compressive strength without using excessive amounts of cement or other expensive materials.

By considering these factors, it is possible to increase the compressive strength of concrete without increasing cost. This can lead to more durable and sustainable concrete structures.

1.3 Background and Motivation

Concrete, while non-combustible, remains susceptible to damage when exposed to high temperatures. The heat from a fire can lead to the evaporation of water within the concrete, causing the cement paste to crack. This process compromises the concrete's structural integrity, potentially leading to a loss of strength and even structural collapse. To enhance concrete's fire resistance, several strategies can be employed. One effective approach is the use of aggregates with high melting points, such as recycled pharmaceutical blister and drinks cans.

The temperature generated during a building fire can vary significantly depending on factors such as the building's type and the materials used in its construction. In extreme cases, temperatures within a burning building can reach as high as 1000 degrees Celsius (NFPA 921: Guide for Fire and Explosion Investigations). Four of the biggest construction-related fire accidents in Bangladesh are:

Sejan Juice Factory: It occurred on July 9, 2021, at a juice factory in Rupganj, Bangladesh. The fire killed 52 people and injured many others. The fire is believed to have started in a warehouse on the third floor of the factory and quickly spread to other parts of the building. Many of the workers who died were trapped inside the factory because the only exit was locked.

Banani FR Tower: It occurred on March 28, 2019, at the FR Tower in the Banani area of Dhaka, Bangladesh. The fire broke out on the 11th floor of the building and quickly spread to other floors. Several people were feared trapped inside the building, but all were eventually rescued safely. The fire caused extensive damage to the building, and it took several hours for firefighters to bring it under control. The cause of the fire is still under investigation, but it is believed to have been caused by an electrical short circuit.

Bangabazar fire: On April 4, 2023, a devastating fire broke out in the Bangabazar Shopping Complex, one of the largest wholesale clothing markets in Dhaka, Bangladesh. The fire, which originated from a tailor shop on the second floor of the market, quickly spread throughout the complex, engulfing thousands of shops and causing widespread damage.

The cause of the fire was determined to be accidental, likely caused by a discarded cigarette or mosquito coil. However, the fire's destructive impact was exacerbated by several factors, including the narrow alleyways and congested layout of the market, the use of flammable materials in the construction of the shops, and the inadequate fire safety measures in place.

Tazreen Fashions fire: This fire killed 112 people and injured over 200 more. The Tazreen Fashions was a garment factory, and the fire was caused by an electrical short circuit (BBC News)
Notably, recycled pharmaceutical blister and drinks cans, which exhibit high melting points of up to 1200 degrees Celsius, offer significant potential to enhance concrete's fire resistance, making them valuable components in fireproofing measures (Manufacturer Data; NFPA 921: Guide for Fire and Explosion Investigations).

1.4 Objective and overview

The objective of this study is to investigate the time-dependent effect of temperature on the compressive strength of concrete made with partially replaced recycled pharmaceutical blister as fine aggregate and drinks can as coarse aggregate. This is an important area of research, as concrete is the most widely used construction material in the world, and it is also a major contributor to climate change. The production of cement, the main ingredient in concrete, accounts for about 8% of global CO2 emissions.

Recycled aggregates are a promising way to reduce the environmental impact of concrete production. The specific objectives of the study are to:

1. Fire-affected concrete should increase fire resistance for a longer period of time than normal concrete.

2. Partially use waste aluminum fiber (pharmaceutical blisters & drink cans) as fine and coarse aggregate to protect the environment from pollution.
3. The use of aluminum waste improves the fire resistance of concrete and its compressive strength through better bonding.

These objectives are well-defined and achievable, and the proposed methodology is sound. The study will be conducted in three phases:

1. **Phase 1:** Concrete specimens will be prepared with different percentages of recycled pharmaceutical blister and drinks cans as fine and coarse aggregates.
2. **Phase 2:** The concrete specimens will be cured at different temperatures.
3. **Phase 3:** The compressive strength of the concrete specimens will be tested at different curing times.

The results of this study will be valuable for the construction industry. If the study shows that recycled pharmaceutical blister and drinks cans can be used to produce concrete with good compressive strength and durability, then this could lead to a significant reduction in the environmental impact of the construction industry.

In addition to the environmental benefits, using recycled aggregates in concrete can also have economic benefits. Recycled aggregates are often less expensive than natural aggregates, and they can help to reduce the amount of waste that goes to landfills. Overall, this study has the potential to make a significant contribution to the development of more sustainable and environmentally friendly concrete.

1.5 Public Perception of Recycle Aggregate Concrete (RAC)

Public perception of Recycled Aggregate Concrete (RAC) is generally positive. RAC is seen as a sustainable and environmentally friendly alternative to natural aggregates. Recycled aggregates can be made from a variety of waste materials, such as construction and demolition waste, electronic waste, and plastic waste. Using recycled aggregates in concrete can help to reduce the environmental impact of the construction industry.

However, there are some concerns about the quality and performance of RAC. Some people believe that RAC is not as strong or durable as concrete made with natural aggregates. Others are concerned about the potential presence of contaminants in recycled aggregates. It is important to educate the public about the benefits of RAC and to address any concerns they may have. This will help to increase the use of RAC in the construction industry.
Here are some of the benefits of RAC:

1. RAC is more sustainable and environmentally friendly than concrete made with natural aggregates.
2. RAC can help to reduce the amount of waste that goes to landfills.
3. RAC can help to reduce the environmental impact of the construction industry.
4. RAC is often less expensive than concrete made with natural aggregates.

Here are some of the concerns about RAC and how to address them:

1. **Concern:** RAC may not be as strong or durable as concrete made with natural aggregates.
2. **Response:** RAC can be just as strong and durable as concrete made with natural aggregates, depending on the type of recycled aggregates used and the mix design. Many studies have shown that RAC can meet or exceed the performance requirements for concrete structures.
3. **Concern:** Recycled aggregates may contain contaminants that could harm human health or the environment.
4. **Response:** Recycled aggregates are typically processed and cleaned to remove any contaminants. However, it is important to test recycled aggregates before using them in concrete to ensure that they meet quality standards.

Educating the public about the benefits of RAC and addressing any concerns they may have is important to increase its use in the construction industry. This can be done through a variety of channels, such as public awareness campaigns, educational programs, and industry events. By increasing the use of RAC, we can reduce the environmental impact of the construction industry and build a more sustainable future.

1.6 Outline of the Study

This thesis is divided into five chapters:

1. Introduction
2. Literature Review
3. Experimental Program
4. Results and Discussion
5. Conclusions and Recommendations

Chapter 2 will review the existing literature on the use of recycled aggregates in concrete and the effect of temperature on the compressive strength of concrete.
Chapter 3 will describe the experimental program that will be conducted to investigate the time-dependent effect of temperature on the compressive strength of concrete made with partially replaced recycled pharmaceutical blister and drinks cans as fine and coarse aggregates.
Chapter 4 will present the results of the experimental program and discuss the implications of the results.
Chapter 5 will summarize the main conclusions of the study and provide recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The use of recycled materials in concrete production has gained significant attention in recent years due to its potential to reduce environmental impact & promote sustainable construction practices. Recycled pharmaceutical blisters and drink cans are two promising sources of recycled materials for concrete production.

The main focus of the study is increase concrete strength and make it last longer in fire than normal concrete. Aluminum increases the strength of concrete by resisting fire and bonding better with concrete. Therefore, in this experiment waste drink can and pharmaceutical blister have been used as aluminum.

However, the use of these materials can affect the properties of concrete, particularly its compressive strength. This study aims to investigate the time dependent effect of temperature on the compressive strength of concrete made with a partially replaced pharmaceutical blister as fine aggregate and drink cans as coarse aggregate.

2.2 Partially Replaced Recycle Aggregate Related Study

(Mbadike & Osadere, n.d.) In this study, total 216 concrete cubes were cast. The cubes have a dimension of 150mm x 150mm x 150mm. The cube samples were tested for 7, 14 and 28days strength. Black color and irregular shape aluminum waste was sieved with 150µm sieve size to obtain a finely divided (powdered) material which was used in this research work. The result showed that the addition of 5% Aluminum waste to a standard 1:2:4:0.55 mix caused the compression strength of the concrete to rise from 26.07N/mm2 to 28.47N/mm2. This result represents an increase of 9.21% in compressive strength.

(Dalal et al., 2022) In this study, the waste pharmaceutical blister (PB) were grinded and used as replacement of fine aggregate (sand) at substitution levels of 5%, 10%, 15%, 20%, 25% and 30% by weight of sand per cubic meter of concrete. Maximum compressive strength 29.8 N/mm2 found from 28 days curing age at 30% PB replacement of fine aggregate (sand).

(Syamsir et al., 2020) This study investigated the combine effect of 0.2 % drink cans and steel fibers with volume fractions of 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3% to the mechanical properties and impact resistance of concrete. Hooked-end steel fibers with a length of 30mm and diameter (d) of 0.75mm or aspect ratio (l/d) of 40 and drink can fibers with a length (l) 30mm and diameter (d) of 10mm were twisted manually and were prepared in the experimental study. The drinks cans fiber were twisted manually in order to increase friction between fiber and concrete. Maximum compressive strength 64Mpa found from 56 days curing age at 2% steel fiber and 0.2% drink cans replacement.

(Akhund et al., 2017) This study aimed to determine the effect of soft drink tins as used fiber reinforcement on compressive strength of concrete. There were 30 cubes in total were casted by utilizing this ratio 1: 1.69: 3.15 at 0.54 w/c ratios by using mix design method. The cubes were casted using a proportion of fibers 1%, 2% and 3% by weight of cement using ½", 1" and 1 ½" long strip respectively. Results shows that with the increase in the percentage and size of strips in concrete, the workability of concrete is decreased and the compressive strength is significantly increased in fiber made mix concrete. Maximum compressive strength 26.31Mpa is obtained using 1.5" long with 3% of fiber strips.

(Wijatmiko et al., 2019) This paper aims to increase the strength characteristic of both compressive and flexural lightweight concrete by introducing wasted soft-drink cans as fiber reinforced. This study cleared the effect of various fractions (10%, 15% and 20% by volume of concrete using 2mm width and 40mm long strip respectively), followed by two types of fiber shape (hooked and clipped) to the lightweight concrete compressive and split tensile strength. The experimental results of cylindrical lightweight concrete were compared to the normal lightweight concrete. The result showed that the introduction of 10% of fiber performed in higher tensile strength with an increase of 23%, while the hooked shape of fiber increased the compressive strength by more than 40%.

(Noori et al., 2021) This research provides the possibility of reusing one of these wastes solid aluminum scrap (Als) by using it to produce a modified type of cement mortar. The research focuses on the mechanical behavior of the new cement mortar type obtained by adding aluminum scrap by different percentages (1%, 2%, 3%, 4%, and 5%) as a replacement ratio from the weight of sand mixed with Ordinary Portland Cement (OPC). Aluminum scraps cleaned of impurities and all foreign objects and then sieved on a sieve 4.75 mm and taken a pass from it for use in the production of modified cement mortar. Maximum compressive strength found from 28 days curing age 33.82Mpa, 2018Mpa, 17.64Mpa, 16.98Mpa, 12.47Mpa, 7.12Mpa is obtained using 0%, 1%, 2%, 3%, 4%, 5% aluminum scraps replacement by weight of sand.

(Suryadi & Rochman, n.d.) This paper examines the effects of substituting aluminum waste grains for sand in normal concrete. Aluminum waste grains with grade of IV are unsuitable for use as fine aggregates in normal concrete due to their excessive smoothness. The idea of replacing 0%, 10%, 20%, and 30% of sand with aluminum waste grains with equal proportion, and its ability to be permitted to create zone II gradation. According to the results, introducing aluminum waste grains decreases compressive strength. The average concrete compressive strength after 28 days is 26.20 MPa, whereas the average compressive strength of 10%, 20% and 30% aluminum replacing sand are 17.87 MPa, 15.14 MPa, and 15.35 MPa respectively. Hence, the average compressive strength 10%, 20% and 30% aluminum waste replacing sand dropped by of 31.78 %, 42.17%, and 60.49% respectively.

(Muwashee et al., 2018) In this study, Aluminum strips was prepared by cutting the Coca- Cola cans as strips in concrete. The reason of using Alu-minum strip is low density and good tensile strength (about 310 MPa) and also has a good ductility. The Aluminum strips have been used with different ratios ranging from 0% to 2.5% with 0.5% increment for concrete; whereas, these ratios are from 0% to 3% for mortar. Using Aluminum strips from Coca-Cola cans and which was cut to average dimensions of 1cm width and 2cm length. To conduct the tests, 54 specimens (10*10*10 cm) were for concrete and 63 specimens (10*10*40 cm) for mortar. Using concrete mixing ratio 1:1.75:3.6 (cement: sand: (crushed gravel) and w/c is 0.45. The results of this study show good improvements in compressive, tensile and flexural strengths using 117 tested specimens for both concrete and mortar. In brief, about 22 % increment in compressive strength of Aluminum strip concrete and flexural strength increases from 3.31 MPa to 11.20 MPa when using Aluminum strips with 2.5 % by volume of concrete. The reinforced mortar with Aluminum strips demonstrates significant increments which are 27% for compressive strength and more than 100% for both flexural and tensile strengths comparing with reference mix.

(Elinwa & Mbadike, 2011) Aluminum wastes (AW) have been used to produce concrete samples used for this work. Tests on the setting times, compressive and flexural strengths were conducted at replacement levels of 5, 10, 20, 30 and 40 % by weight of cement. Black color and irregular shape aluminum waste was sieved with 150µm sieve size to obtain a finely divided (powdered) material which was used. The results showed that AW can be used as a retarder and thus, a good material for hot weather concreting. Optimum replacement values for the compressive and flexural strengths are at 10% replacement ant the statistical models developed on them are significant.

(Abdul Awal et al., n.d.) An investigation was carried out to study the behaviour of concrete incorporating recycled soft drink aluminum can as fibre reinforcement. Following standard mix design, ordinary Portland cement (OPC) concrete was made to have a target mean strength of 30 N/mm2 with 50 ± 10 mm slump. Having the same workability, OPC concrete with 0%, 1% and 2% by weight of soft drink can-fibre was prepared, and tested for compressive strength. The recycle soft drink aluminum cans were cut into fibre types with constant lengths of 10, 20 and 30mm, and 1mm width. Maximum compressive strength 35.10Mpa is obtained using 1% soft drink can-fiber.

(Haque et al., n.d.) This study concentrates on the relative comparison of the compressive strength of concrete cylinder, the flexural strength of rectangular beam and workability in term of slump by using full and partial replacement of sand with stone dust in concrete with 0%, 0.5% and 1% of condensed milk-can fiber based on the weight of cement. Condensed milk can fiber cut in to 20mm length and 2mm width. Using concrete mixing ratio 1: 1.25: 2.4, w/c 0.48 and cylinder dimension 4″×8″.

(Varghese & Viswanath, 2017) The study was conducted on the M25 mix with water cement ratio 0.40. The fine aggregate was partially replaced with glass powder at percentages of 10, 20, 30, 40 and 50. The addition of fibers was studied at various percentages of 0.5,1,2 and 3. Glass powder is obtained by crushing the beverage bottles. The glass powder is used as partial replacement of fine aggregate. The size of particles used is 0.006-1.18mm. Soft drink tin cut into strips of size 3mmx10mm were used as fibers. Using concrete mixing ratio 1: 1.17: 2.1 and w/c 0.40. Maximum compressive and tensile strength at 30% replacement glass powder 50.46Mpa and 3.05Mpa respectively. Maximum compressive and tensile strength at 0.5% replacement drink can fiber 40.94Mpa and 3.3Mpa respectively.

(Kishore, 2019) In this research paper, comparison of compressive strength is made on the use of steel fiber. Steel fibers in the form of waste such as lathe waste, empty tin, soft drink bottle caps are deformed in desired shape and are used in the fractions of 0%, 0.50%, 0.75%, 1.0% & 1.5% in the preparation of concrete specimen and samples were observed for compressive strength and split tensile strength for 7, 14 and 28 days. Using concrete mixing ratio 1:1.63:2.52 and w/c 0.45. Maximum compressive strength at 0.5% replacement tin cans and steel fiber 39Mpa and 48Mpa respectively.

(Panditharadhya et al., 2018) The present study investigates the utilization of secondary aluminum dross as a binder in producing the concrete. It is observed that the initial setting time of the cement paste increases and final setting time decreases with varying percentages of Aluminum dross replacement. This property makes it suitable for hot weather conditions. It was replaced in 5, 10, 15 and 20% of the weight of the cement and optimum dosage is found to be 15 %. The mechanical properties like Compression strength, split tensile strength, flexural strength and water absorption of the M40 grade concrete were determined. It is observed that up to 15% replacement of cement by secondary aluminum dross is giving better results comparable with the conventional concrete.

(Aissa et al., 2018) In this study, partially replaced 10% pharmaceutical wastes by weight of cement. All concretes were mixed in accordance with ASTM C192 standard in a power-driven revolving pan mixer. Concrete cubes of 280x70x70mm in size, and cylinders of dimensions 160mm x320mm were cast in steel moulds for the study of the compressive strengths, rapid chloride permeability test, and oxygen permeability test, respectively. Maximum compressive strength 61Mpa found from 365 days age curing.

(Syamsir* et al., 2018) In this study, focuses on the improvement of impact resistance of concrete slab by inclusion drink cans fiber. A concrete mixtures with 0.4 water-cement ratio made with waste long cans fibre and silica fume are used to produce the slabs. The long drink cans fibres are produced by cutting drink cans tin into 250 mm long and 10 mm wide. The fibres are arranged with various directions of 0°, 0°+ 90°, 0o + 45° in order to find the best fibres arrangement that producing the highest impact strength. The results show that by inclusion of cans fibre improves impact performance of concrete slab. Sample S3 with fibre arrangement of 0°+ 90° produced the highest impact energy of 73.575 kN mm and 127.53 kN mm for initials and failure crack, respectively. A fibre direction of 0o + 45° produce the same impact energy with the control sample, it reveal that concrete S4 provide lesser contribution to crack propagation prevention rather than concrete S3.

(Ilya & Cheow Chea, 2017) In this study, OPC concrete with 0%, 1% and 2% of soft drink can aluminium fibre was prepared based on weight of cement. By following standard mix design, Ordinary Portland Cement (OPC) concrete was made to have a target mean strength of 30 N/mm2 with not more than 30 mm of slump. The specimens were tested for compressive strength and flexural strength. Laboratory test results based on short term investigation reveals that the compressive strength and flexural strength of concrete containing fibre are higher than of normal OPC concrete. Among two volume fractions, concrete with 1% of soft drink can fibre have performed better result in compressive strength and flexural strength compared with 2% amount of soft drink can fibre. The optimum proportion of aluminium fibre to be added in the concrete as fibre reinforcement is 1% fibre content by weight of cement which gave all the positive response from all the tests conducted.

(Channa & Saand, 2021) In this research work, similar efforts are made to present the effects of soft tin fibers or aluminium waste material as a reinforcing material in concrete and to assess the mechanical behavior of concrete. Particularly, this research work aimed to investigate experimentally the effect of soft drink tins on tensile (cylinder splitting tensile strength) and flexural strength. Soft tin fibers of 25.4 × 5 × 0.5 mm in size were used and added from 1 to 5% by the weight of cement with the design mix of 1:1.624:2.760 at 0.50 w/c ratio. Therefore, 6 batches (every batch contained 3 prisms and 3 cylinders) were prepared and cast for evaluation of tensile and flexural strength. One batch was cast without inclusion of fibers (controlled batch) and remaining 5 batches were cast with the addition of fibers using 1, 2, 3, 4, and 5% respectively. It was revealed from obtained results that split tensile strength and flexural strength of specimen increases as compared to controlled batch up to 4% addition of fibers. Moreover, beyond 4% soft drink tin fiber level, strength begins to fall down. Thus, it can be suggested that mechanical properties of concrete can be enhanced by 4% of soft drink tin fibers.

(Ahmed et al., 2022) This study investigated the effect of glass waste (10%, 20% and 30%) as replacement of river sand along with addition of condensed milk can (0.5%, 1% and 1.5%) as fiber reinforcement. Using condensed milk can waste 20mm length and 2 mm width and glass waste has used in powder form. Maximum compressive and tensile strength found 34.14Mpa and 3.64Mpa at 56 days age curing.

(Nursyamsi* & Luhut parulian Bagariang, 2014) In this study, can fiber and fly ash are added in the concrete mixture. Variation I is a normal concrete, variation II with the addition of can fiber by 20%, and variation III with the addition of can fiber by 20% and fly ash by 15% of volume of cement. Tests are conducted in form of slump test, compressive strength, split tensile strength and abs orption of concrete. From the test result, it is obtained the increase in the compressive strength, split tensile strength, and absorption. But the biggest improvement is the wet treatment compared to initial wet treatment for 7 days and initial dry treatment for 7 days. The best increase in compressive strength is variation III with 8.333% of normal concrete. Split tensile strength were increased by 18.414% of normal concrete. Concrete absorption decreased by 0.183% and 0.392% of normal concrete.

2.3 Expected Outcomes

The expected outcomes of this study are to:

1. To determine the effect of partial replacement of natural aggregates with recycled pharmaceutical blister and drink can aggregates on the compressive strength of concrete.

2. Investigate the time-dependent effect of temperature on the compressive strength of concrete made with recycled pharmaceutical blister and drink can aggregates.

3. To develop a model to predict the compressive strength of concrete made with recycled pharmaceutical blister and drink can aggregates at different time burning temperature and curing times.

2.4 Overview

In this chapter, known about which recycled materials can be partially used with concrete, how much percentage can be used, what size should be used. Learned more about cement, sand, stone chips and water. From the result and discussion of the literature, known about the compressive and tensile strength of recycled aggregate mixed concrete. Later we decide whether those recycled materials can be used in our study.

CHAPTER 3

METHODOLOGY

3.1 Physical Tests of Materials

3.1.1 Cement

In this experiment Ordinary Portland Cement (OPC) scan branded cement was used. The cement specific gravity & density was 3.15 & 1294 kg/m^3.

3.1.2 Water

In this experiment used normal tap water for casting and curing at Green Road, Dhaka, Bangladesh. The unit weight of water we was used 1000(kg/m^3) and the air percent of the mix design is assumed as 2%. Water is binding materials for the concrete. Water is crucial in the concrete mix as it combines with cement to form a paste, initiating the binding process by hardening & setting the concrete.

3.1.3 Sieve Analysis for Fine Aggregate

The portion of an aggregate passing the 4.75mm (No. 4) sieve and retained on the 0.15mm (No. 100) sieve is called fine aggregate or sand. In other word, fine aggregate is the aggregate most of which passes through No. 4 sieve (4.75 mm opening) and contain only that much coarser material as is permitted by the specification. It should be clean and free from organic substances and size should be uniformly distributed.

3.1.4 Gradation of Fine Aggregate

Table 3.1: Gradation of fine aggregate

Sieve size/Sieve no.	Sieve opening (mm)	Retained, b (gm)	%Retained (c= b×100/1000)	Cumulative % Retained, d	% Finer (100-d)	F.M
#4	4.75	0	0	0	100	3.275
#8	2.36	74	7.4	7.4	92.6	
#16	1.19	380	38	45.4	54.6	
#30	0.59	339	33.9	79.3	20.7	
#50	0.3	171	17.1	96.4	3.6	
#100	0.15	26	2.6	99	1	
Pan		10	1	100	0	
Total =		1000				

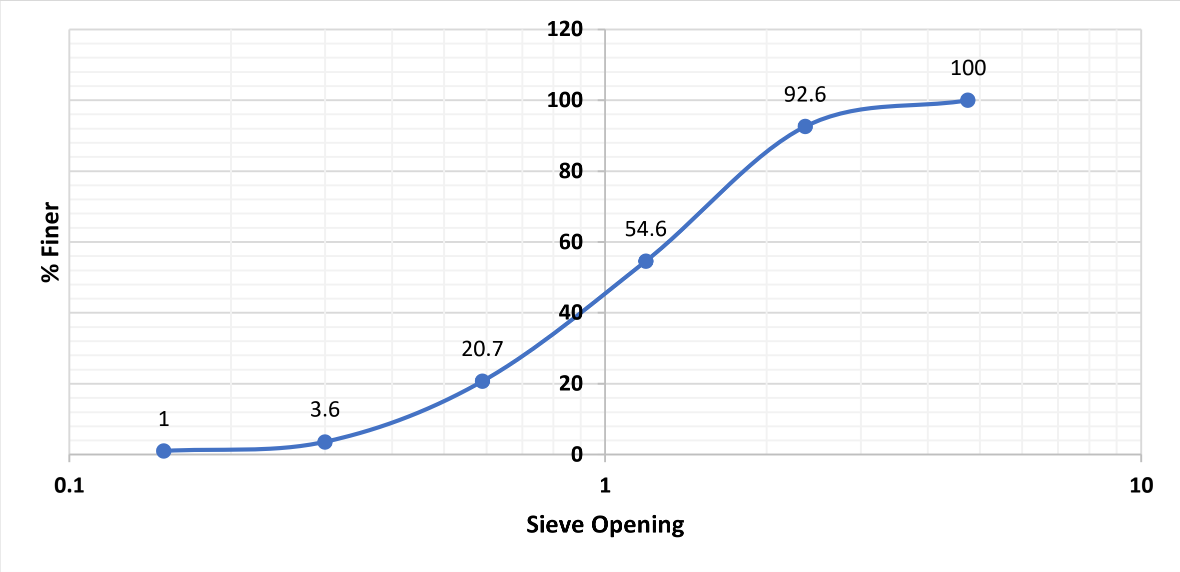

Figure 3.1: Grain size distribution curve of fine aggregate

3.1.5 Sieve Analysis for Pharmaceutical Blister (P.B)

In this experiment pharmaceutical blister cut in $2mm \times 2mm$. Pharmaceutical blisters were used replaced by sand. In sieve analysis sand is passing the 4.75mm sieve and it's retained in 0.15mm sieve. So that, decided to cut the pharmaceutical blister in $2mm \times 2mm$. Because it is 4.75mm to smaller and 0.15mm to larger.

3.1.6 Gradation of Pharmaceutical Blister

Table 3.2: Gradation of Pharmaceutical Blister (P.B)

Sieve size/Sieve no.	Sieve opening (mm)	Retained, b (gm)	%Retained (c= b×100/200)	Cumulative % Retained, d	% Finer (100-d)	F.M
#4	4.75	29	14.5	14.5	85.5	
#8	2.36	152	76	90.5	9.5	
#16	1.19	16	8	98.5	1.5	
#30	0.59	2	1	99.5	0.5	4.03
#50	0.3	1	0.5	100	0	
#100	0.15	0	0	100	0	
Pan		0	0	100	0	
Total =		200				

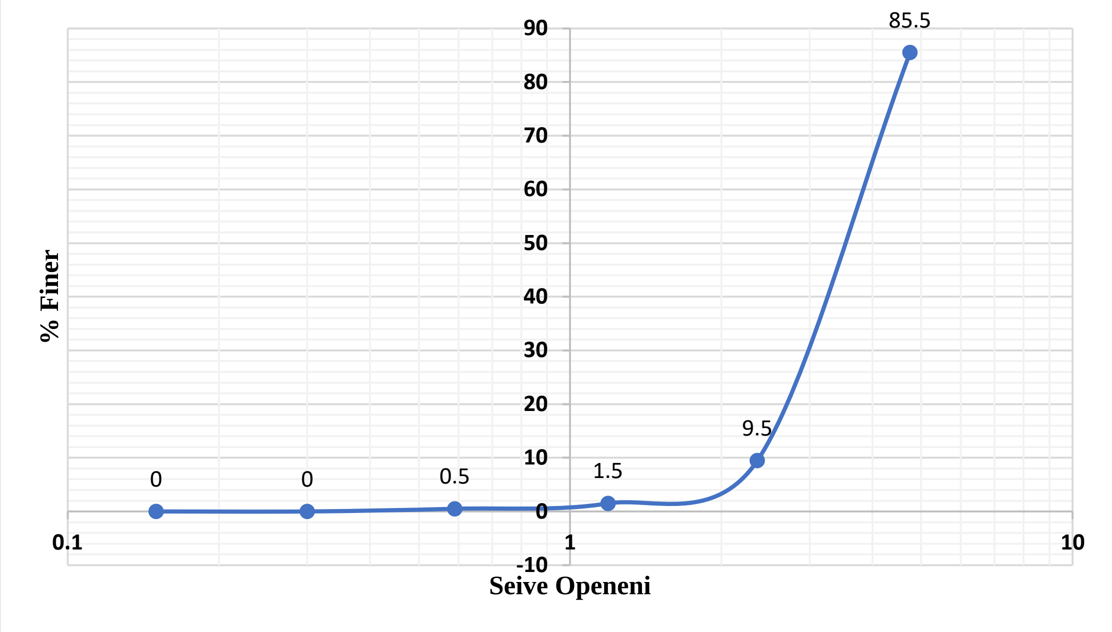

Figure 3.2: Grain size distribution curve of Pharmaceutical Blister (P.B)

3.1.7 Sieve Analysis for Coarse Aggregate

The portion of an aggregate passing the 20mm (3/4”) sieve and retained on the 4.75mm (No. 4) sieve is called coarse aggregate or stone chips. In other word, coarse aggregate is the aggregate most of which passes through 3/4” sieve (20 mm opening) and contain only that much coarser material as is permitted by the specification. It should be clean and free from organic substances and size should be uniformly distributed.

3.1.8 Gradation of Coarse Aggregate

Table 3.3: Gradation of coarse aggregate

Sieve size/Sieve no.	Sieve opening (mm)	Retained, b (gm)	%Retained (c=b×100/1500)	Cumulative % Retained, d	% Finer (100-d)	F.M
3/4"	19.05	396	26.4	26.4	73.6	2.23
3/8"	9.5	1057	70.46667	96.86667	3.133333	
#4	4.75	47	3.133333	100	0	
Pan		0	0			
Total =		1500				

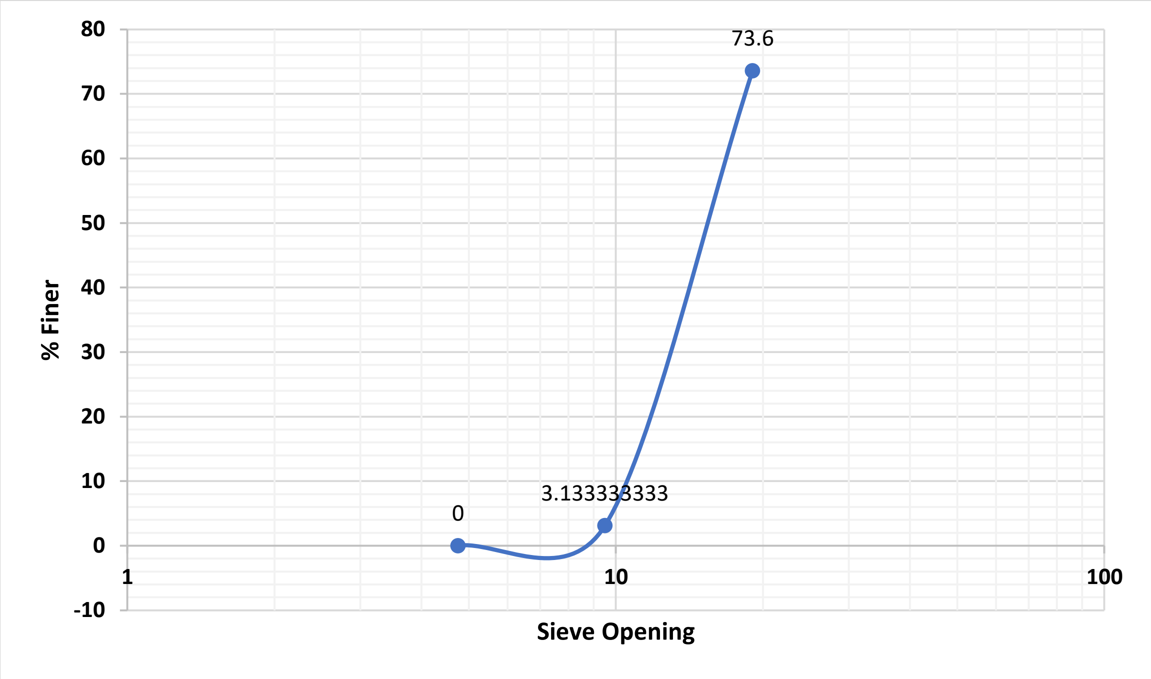

Figure 3.3: Grain size distribution curve of coarse aggregate

3.1.9 Sieve Analysis for Drink Can (D.C)

In this experiment drink can cut in $17.5mm \times 17.5mm$. Drink can were used replaced by stone chips. In sieve analysis coarse aggregate is retained in 4.75mm and it is passed by 20mm sieve. So that, decided to cut the drink can in $17.5mm \times 17.5mm$**.** Because it is 20mm to smaller and 4.75mm to larger.

3.1.10 Gradation of Drink can (D.C)

Table 3.4: Gradation of Drink Can (D.C)

Sieve size/Sieve no.	Sieve opening (mm)	Retained,b (gm)	%Retained (c= b×100/200)	Cumulative % Retained, d	% Finer (100-d)	F.M
3/4"	19.05	3	1.5	1.5	98.5	1.94
3/8"	9.5	185	92.5	94	6	
#4	4.75	9	4.5	98.5	1.5	
Pan		3	1.5	100	0	
Total =		200				

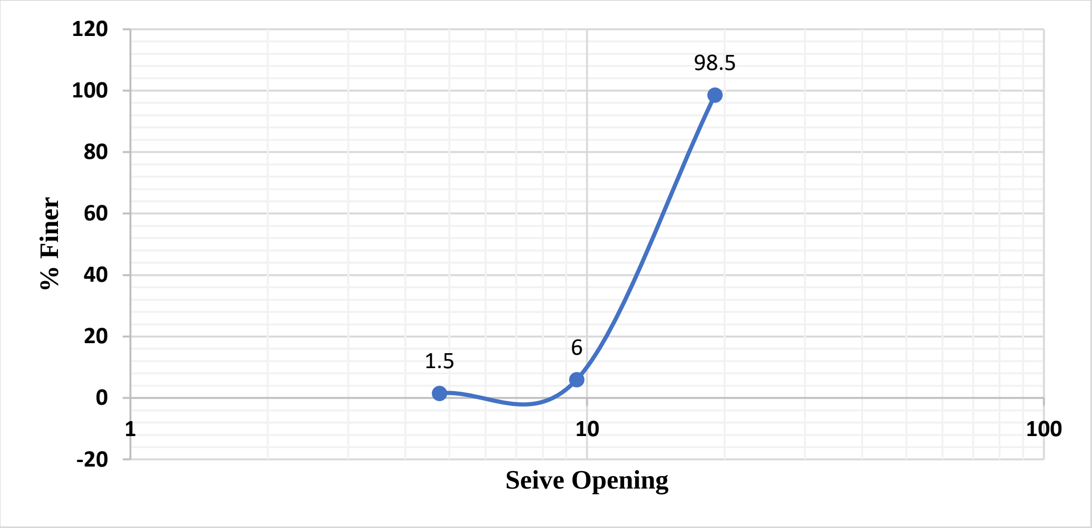

Figure 3.4: Grain size distribution curve of Drink Can (D.C)

3.1.11 Specific Gravity of Coarse Aggregate

Table 3.5: Data sheet for specific gravity of coarse aggregate

Wt. of S.S.D sample in air, B (gm)	Wt. of S.S.D sample in water, C (gm)	Oven dry wt. of sample in air, A(gm)
2770 gm	1745 gm	2730 gm

Table 3.6: Specific Gravity of Coarse Aggregate

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/A-C	2730/2730-1745	2.77
Bulk Specific Gravity (Oven Dry Basis)	A/B-C	2730/2770-1745	2.66
Bulk Specific Gravity (S.S.D Basis), G	B/B-C	2770/2770-1745	2.7
Absorption Capacity, D %	(B-A)×100/A	(2770-2730)× 100/2730	1.47

3.1.12 Specific Gravity of Fine Aggregate

Table 3.7: Data sheet for specific gravity of fine aggregate

Wt. of pycnometer Filled with water to Calibration, B (gm)	Oven Dry Wt. in air, A (gm)	Wt. of Pycnometer with Specimen and water to Calibration mark, C (gm)	Wt. of S.S.D sample in air, S (gm)
653 gm	291 gm	836 gm	300 gm

Table 3.8: Specific Gravity of Fine Aggregate

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/B+A-C	291/653+291-836	2.69
Bulk Specific Gravity (Oven Dry Basis)	A/B+S-C	291/653+300-836	2.49
Bulk Specific Gravity (S.S.D Basis), G	S/B+S-C	300/653+300-836	2.56
Absorption Capacity, D %	(S-A)×100/A	(300-291)×100/291	3.09

3.1.13 Unit Weight of Fine Aggregate

Bucket Dia, d = 15.24 cm

Bucket Height, h = 15.24 cm

(1) Free/ Loose Condition:

(A) Wt. of bucket + aggregate = 8055 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 8055-4000 = 4055 gm

(D) Volume of bucket = π(d)^2×h/4 = 3.1416×(15.24)^2×15.24/4 = 2780 gm/cc

(E) Free/ Loose Unit Weight = C/D = 4055/2780 = 1.459 gm/cc

(2) Tamping Condition:

(A) Wt. of bucket + aggregate = 8376 gm/cc

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 8376-4000 = 4376 gm/cc

(D) Volume of bucket = $\pi(d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Tamping Unit Weight = C/D = 4376/2780 = 1.574 gm/cc

(3) Jiggling Condition:

(A) Wt. of bucket + aggregate = 8618 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 8618-4000 = 4618 gm

(D) Volume of bucket = $\pi(d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Jiggling Unit Weight = C/D = 4618/2780 = 1.661 gm/cc

3.1.14 Unit Weight of Coarse Aggregate

Bucket Dia, d = 15.24 cm

Bucket Height, h = 15.24 cm

(1) Free/ Loose Condition:

(A) Wt. of bucket + aggregate = 7855 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 7855-4000 = 3855 gm

(D) Volume of bucket = $\pi \times (d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Free/ Loose Unit Weight = C/D = 3855/2780 = 1.387 gm/cc

(2) Tamping Condition:

(A) Wt. of bucket + aggregate = 8323 gm/cc

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 8323-4000 = 4323 gm/cc

(D) Volume of bucket = $\pi(d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Tamping Unit Weight = C/D = 4323/2780 = 1.555 gm/cc

(3) Jiggling Condition:

(A) Wt. of bucket + aggregate = 8516 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 8516-4000 = 4516 gm

(D) Volume of bucket = $\pi(d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Jiggling Unit Weight = C/D = 4516/2780 = 1.624 gm/cc

3.1.15 Unit Weight of Pharmaceutical Blister (P.B)

Bucket Dia, d = 15.24 cm

Bucket Height, h = 15.24 cm

(1) Free/ Loose Condition:

(A) Wt. of bucket + aggregate = 4768 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 4768-4000 = 768 gm

(D) Volume of bucket = $\pi(d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Free/ Loose Unit Weight = C/D = 768/2780 = 0.276258 gm/cc

(2) Tamping Condition:

(A) Wt. of bucket + aggregate = 4996 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 4996-4000 = 996 gm/cc

(D) Volume of bucket = $\pi(d)^2 \times h/4 = 3.1416 \times (15.24)^2 \times 15.24/4 = 2780$ gm/cc

(E) Tamping Unit Weight = C/D = 996/2780 = 0.358273 gm/cc

3.1.16 Unit Weight of Drink Can (D.C)

Bucket Dia, d = 15.24 cm

Bucket Height, h = 15.24 cm

(1) Free/ Loose Condition:

(A) Wt. of bucket + aggregate = 4472 gm

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 4472-4000 = 472 gm

(D) Volume of bucket = π(d)^2×h/4 = 3.1416×(15.24)^2×15.24/4 = 2780 gm/cc

(E) Free/ Loose Unit Weight = C/D = 472/2780 = 0.169784 gm/cc

(2) Tamping Condition:

(A) Wt. of bucket + aggregate = 4640 gm/cc

(B) Wt. of empty bucket = 4000 gm

(C) Wt. of materials = A-B = 4640-4000 = 640 gm/cc

(D) Volume of bucket = π(d)^2×h/4 = 3.1416×(15.24)^2×15.24/4 = 2780 gm/cc

(E) Tamping Unit Weight = C/D = 640/2780 = 0.230215 gm/cc

3.1.17 Pharmaceutical Blister (P.B) Heating Test

Applied heat the pharmaceutical blister at a temperature of about 300℃ . A pharmaceutical blister has two parts, one at the top & other at the bottom. At first after 15 minutes we saw the two parts of the pharmaceutical blister separate from one part to the other. Again placed the pharmaceutical blister on fire and remove it after 45 minutes. Totally after 60 minutes, the blister structure was no changes by fire observed.

3.1.18 Drink Can (D.C) Heating Test

Applied heat on beverage can to about 300°C. Totally after 45 minutes we saw, just the beverage cans tag mark color some removed and the can fiber’s color change to golden. There is no had any change to beverage can structure by fire observed.

3.2 Mix Design of Concrete

Select a target compressive strength of 25 Mpa for the study. According to ACI code, the mix design for the same was completed for moderate workability using a 50 mm design slump value. From ACI code maximum allowable water content (190 kg) and maximum free water cement ratio (0.5) are also met. Collected aggregates density, specific gravity and fineness modulus was for fine aggregate 1574 kg/m^3, 2.49 and 3.28 and for course aggregate 2.77, 1555 kg/m^3, 2.23. Course aggregate size was used 20mm. The proportion of coarse aggregate to fine aggregate is taken to be constant at 731.40 kg/m3 and 1130.45 kg/m3, respectively. The total amount of aggregates stays at 1861.85 kg/m3. From the mix design we find the concrete mixing ratio 1:1.74:2.72 for 54 concrete cylinders specimen. Six of the 54 cylinders were constructed using control concrete. Additional 24 cylinders, six cylinders were made with 5% pharmaceutical blisters, six cylinders with 10% pharmaceutical blisters, six cylinders with 15% pharmaceutical blisters, and six cylinders with 20% pharmaceutical blisters. Twenty-four cylinders were made with 6 at 5% drink cans, 6 at 10% drink cans, 6at 15% drink cans, and 6 at 20% drink cans. The pharmaceutical blister size was applied $2mm \times 2mm$ and drink can was applied at $17.5mm \times 17.5mm$.

3.2.1 Mix Design of Concrete (Weight Based)

It is urgent to test the materials before use it in casting.

Name of the test that performed

- Specific gravity of cement
- Specific gravity of coarse & fine aggregate
- Unit Weight of cement
- Unit weight of coarse & fine aggregate

Parameters that are considered for mix design

- Weight of cement, naturally 400, 450, 500 kg/m^3
- Water to cement ratio, naturally 0.55. For high strength concrete water to cement ratio should be reduced.
- Sand to aggregate volume ratio, naturally 0.36 to 0.44

<u>Derivation:</u>

Let,

$$\frac{W}{C} = 0.55$$

Slump = 50mm

Water = 190 Kg/m^3

∴ Weight of cement, Wc = 190/0.55 = 345.45 Kg/m^3

Table 3.9: Approximate mixing water and air content requirements for different slumps and maximum sizes of aggregates for non-air entrained concrete

Slump, mm	Water, Kg/m^3 of concrete for indicated nominal maximum sizes of aggregate							
	9.5 mm	12.5 mm	19 mm	25 mm	37.5 mm	50 mm	75 mm	150 mm
Non-air-entrained concrete								
25 to 50	207	199	190	179	166	154	130	113
75 to 100	228	216	205	193	181	169	145	124
150 to 175	243	228	216	202	190	178	160	-
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2

Vc+Vca+Vfa+Vw+Vv=1

=> $\frac{Wc}{Gc\times\gamma w}+\frac{Wca}{Gca\times\gamma w}+\frac{Wfa}{Gfa\times\gamma w}+\frac{Ww}{Gw\times\gamma w}$ +2% = 1

=> $\frac{345.45}{3.15\times1000}+\frac{Wca}{2.77\times1000}+\frac{Wfa}{2.69\times1000}+\frac{190}{1\times1000}$ +0.02 = 1

=> $\frac{Wca}{2.77\times1000}+\frac{Wfa}{2.69\times1000}=$ 0.680 ……….. (i)

Again,

$\frac{Vs}{Va}$ =0.40

$$=> \frac{\frac{Wfa}{Gfa\times\gamma w}}{\frac{Wca}{Gca\times\gamma w}+\frac{Wfa}{Gfa\times\gamma w}} = 40$$

$$=> \frac{\frac{Wfa}{2.69\times1000}}{\frac{Wca}{2.77\times1000}+\frac{Wfa}{2.69\times1000}} = 0.40$$

$$=> \frac{Wfa}{2690} = 0.40\times(\frac{Wca}{2790}+\frac{Wfa}{2690})$$

$$=> Wfa = 0.40 \times 2690 \times (\frac{Wca}{2770} + \frac{wfa}{2690})$$

$$=> Wfa = \left(1076 \times \frac{Wca}{2770}\right) + \left(1076 \times \frac{Wfa}{2690}\right)$$

$$=> wfa - \frac{1076 \times Wfa}{2690} = \frac{1076 \times Wca}{2770}$$

$$=> \frac{(2690 \times Wfa) - (1076 \times Wfa)}{2690} = \frac{1076 \times Wca}{2770}$$

$$=> \ (1614 \times Wfa) \times 2770 = (1076 \times Wca) \times 2690$$

$$=> \ Wfa = \frac{(1076 \times Wca) \times 2690}{1614 \times 2770}$$

$=> Wfa = 0.647 \times Wca$…………………… (ii)

From equation (i) & (ii),

$$=> \frac{Wca}{2.77 \times 1000} + \frac{0.647Wca}{2.69 \times 1000} = 0.680$$

$$=> Wca\left(\frac{1}{2.77 \times 1000)} + \frac{0.647}{2.69 \times 1000}\right) = 0.680$$

$\therefore Wca = 1130.45$ kg/m^3

$\therefore Wfa = 0.647 \times 1130.45$

$= 731.40$ kg/m^3

So, material required for making 1m^3 of concrete is as follows:

Cement: 345.45 kg/m^3

Coarse Aggregate: 1130.45 kg/m^3

Fine Aggregate: 731.40 kg/m^3

Water: 190 kg/m^3

Unit Weight of Concrete = 345.45+1130.45+731.40+190

= 2397.30 kg/m^3

Volume ratio:

If Unit weight of cement = 1294 kg/m^3

Unit weight of fine aggregate = 1574 kg/m^3

Unit weight of coarse aggregate = 1555 kg/m^3

$$Vc = \frac{345.45}{1294} = 0.2669\ m^3 = 9.43\ cft$$

$$Vs = \frac{731.40}{1574} = 0.465\ m^3 = 16.41\ cft$$

$$Vca = \frac{1130.45}{1555} = 0.727\ m^3 = 25.67\ cft$$

$$Vc{:}\,Vs{:}\,Vca = 9.43{:}\,16.41{:}\,25.67$$

$$= 1{:}\,1.74{:}\,2.72$$

Now,

$$Vc = \frac{345.45}{3.15 \times 1000} = 0.109668\ m^3$$

$$Vca = \frac{1130.45}{2.77 \times 1000} = 0.4081039 m^3$$

$$Vfa = \frac{731.40}{2.69 \times 1000} = 0.271895 m^3$$

$$Vw = \frac{190}{1 \times 1000} = 0.19\ m^3$$

$$Vv = 2\% = 0.02\ m^3$$

Total = 0.999669 m^3

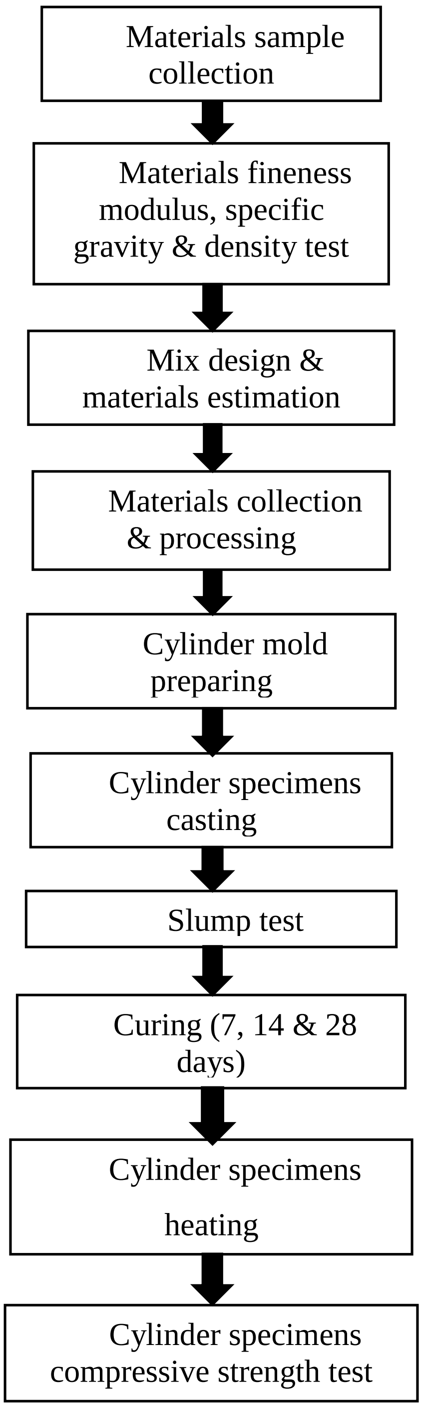

Fig. 3.5: Working Procedure flowchart

3.3 Materials Collection & Processing

3.3.1 Coarse Aggregate (Stone Chips)

Black color 3/4” down (20mm) crushed stone chips collected from Gabtoli, Dhaka, Bangladesh. Collected 80kg stone chips from there. The stone chips were then brought to the lab, cleaned and separated through a twenty mm sieve.

Figure 3.6: Coarse aggregate collect from a stack, clean and separated

3.3.1.1 Characteristic of Good Stone Chips (Coarse Aggregates):

Size and Gradation:
Well-graded aggregates with a range of sizes for compactness and strength.

Cleanliness:
Free from dust, clay, and organic matter. Clean aggregates contribute to durable concrete.

Hardness:
Hard, durable stones resist wear and provide long-lasting strength to concrete.

Shape:
Angular or cubical shapes enhance interlocking, improving the strength of the concrete.

Absorption:
Low absorption rates prevent excess water absorption, reducing the risk of cracking and degradation.

Soundness:
Resistant to weathering and volume changes, ensuring long-term stability.

Specific Gravity:
Influences the weight and density of concrete. Higher specific gravity can lead to stronger concrete.

Texture:
Smooth and clean surfaces ensure good bonding with cement paste.

Chemical Inertness:
Chemically stable aggregates reduce the risk of undesirable reactions within the concrete.

Color:
Natural color without unusual variations. Uncommon colors may indicate impurities.

Ensuring these characteristics in stone chips contributes to the production of high-quality and durable concrete mixes.

3.3.2 Fine Aggregate (Sand)

Collected red colored sand from Gabtoli, Dhaka, Bangladesh. The sellers collect this sand from Durgapur, Netrokona, Bangladesh. Then the sand brought the lab, cleaned and separated through a 4.75mm sieve.

Figure 3.7: Fine aggregate collect from a stack, clean and separated

3.3.2.1 Characteristic of Good Sand (Fine Aggregate)

Grain Size:
Uniform particle size is desirable for even compaction. A mix of coarse and fine grains is often ideal.

Cleanliness:
Free from impurities, clay, and silt. Clean sand improves the quality of concrete and prevents undesirable reactions.

Shape:
Well-graded, angular grains provide better interlocking, enhancing the strength of the concrete.

Color:
Natural color without excessive variations. Unusual colors may indicate impurities.

Consistency:
Consistent quality throughout the source, ensuring uniformity in concrete batches.

Particle Surface:
Rough surfaces increase bonding with cement, enhancing the overall strength of the concrete mix.

Moisture Content:
Optimal moisture content is essential for workability. Excess moisture can lead to problems like segregation.

Ensuring these characteristics in sand contributes to the production of high-quality and durable concrete mixes.

3.3.3 Pharmaceutical Blister (P.B)

The most challenging part of our experiment was collected the partially replaced recycled aggregate. Collected pharmaceutical blister from customer/patients, old hardware shop and pharmacies at Faridpur, Dhaka, Bangladesh and Moghbazar, Dhaka, Bangladesh. Then the blister was washed by detergent & water and dry it by sunlight. Then the blister was cut in $2mm \times 2mm$. Pharmaceutical blisters were used replaced by sand.

Figure 3.8: Empty pharmaceutical blister & pharmaceutical blister at cutting form.

3.3.4 Drink Can (D.C)

Drink can was collected from old hardware shop from Faridpur, Dhaka, Bangladesh and Gabtoli, Dhaka, Bangladesh. At first separated the can's top and bottom part and cleaned by weir brush. Then it is cut in $17.5mm \times 17.5mm$. Drink can were used replaced by stone chips.

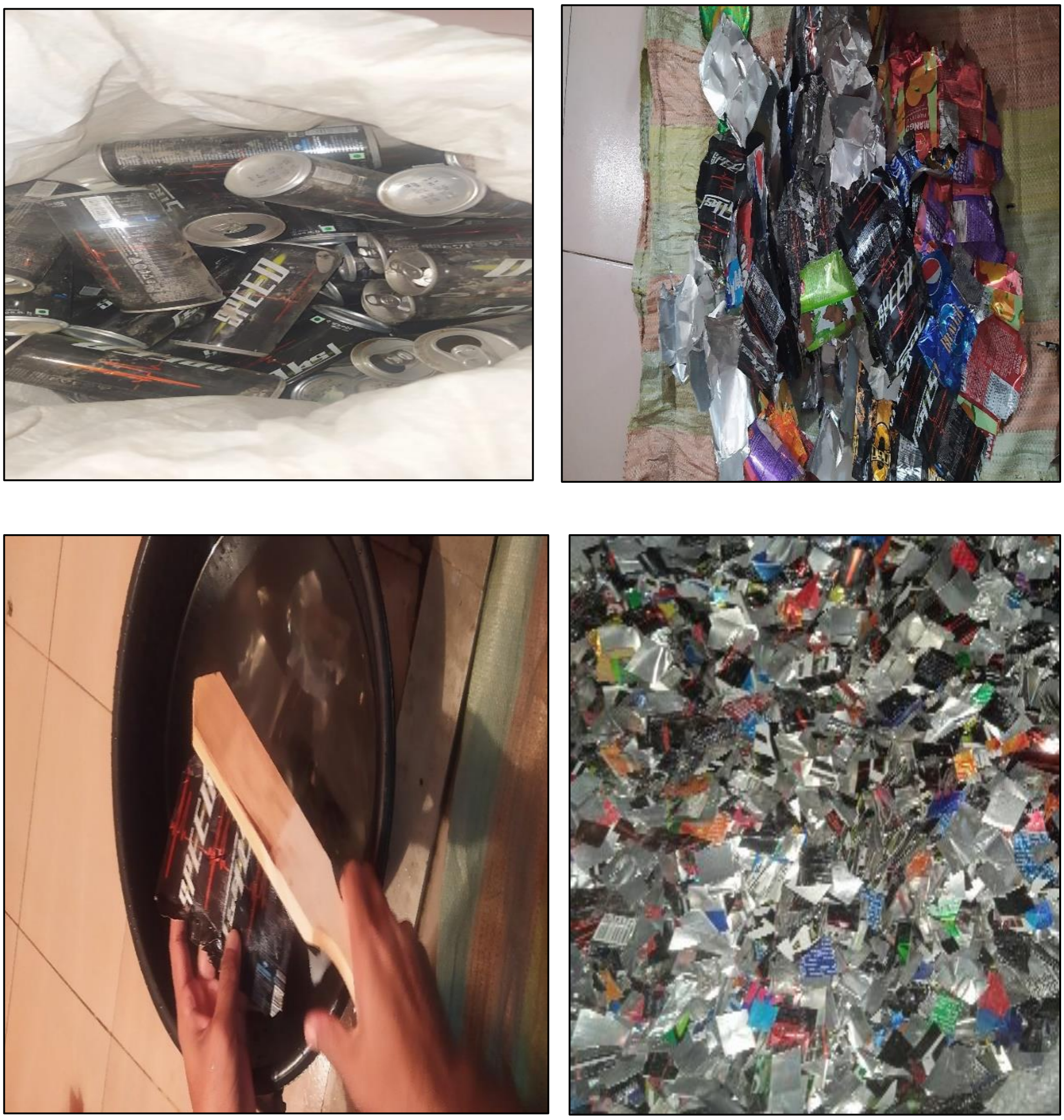

Figure 3.9: Empty Drink Can (D.C) collect, clean and cutting form

Table 3.10: Design mixes properties of the study

Use of recycle aggregate	W/C Ratio	Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)	Water (kg/m^3)
0%	0.55	345.45	731.40	1130.45	190

Table 3.11: The design mixes after pharmaceutical blister is replaced for sand and drink can is replaced for stone chips.

Partially replacement	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)	Pharmaceutical blister (P.B) (kg/m^3)	Drink Can (D.C) (kg/m^3)
5% (P.B)	694.83	1130.45	36.57	
10% (P.B)	658.26	1130.45	73.14	
15% (P.B)	621.69	1130.45	109.71	
20% (P.B)	585.12	1130.45	146.28	
5% (D.C)	731.40	1073.93		56.52
10% (D.C)	731.40	1017.4		113.05
15% (D.C)	731.40	960.88		169.57
20% (D.C)	731.40	904.36		226.09

3.4 Cylinder Molds Preparing

Clean The Molds:
Ensure that the cylinder molds are clean and free from any debris or previous concrete residue. Clean them thoroughly to avoid contamination.

Check The Molds Nuts and Bolts:
Ensuring that nuts and bolts are securely tightened helps maintain the structural integrity of the cylinder molds. Tightening nuts and bolts helps to create a watertight seal in the mold. This is crucial to prevent the escape of concrete slurry during casting, which could result in inaccurate test results and affect the quality of the cylinders. Loose

or damaged fasteners can lead to leaks during casting, compromising the quality of the test specimens.

Apply a Release Agent:
Coat the interior surfaces of the cylinder molds with a suitable release agent. This prevents the concrete from sticking to the mold and makes it easier to remove the cylinders after casting.

Check for Leaks:
Inspect the molds for any cracks or gaps that could allow concrete to leak during casting. Repair or replace any damaged molds.

Place Molds on a Level Surface:
Set the cylinder molds on a level and stable surface to ensure that the cylinders cure uniformly and do not distort.

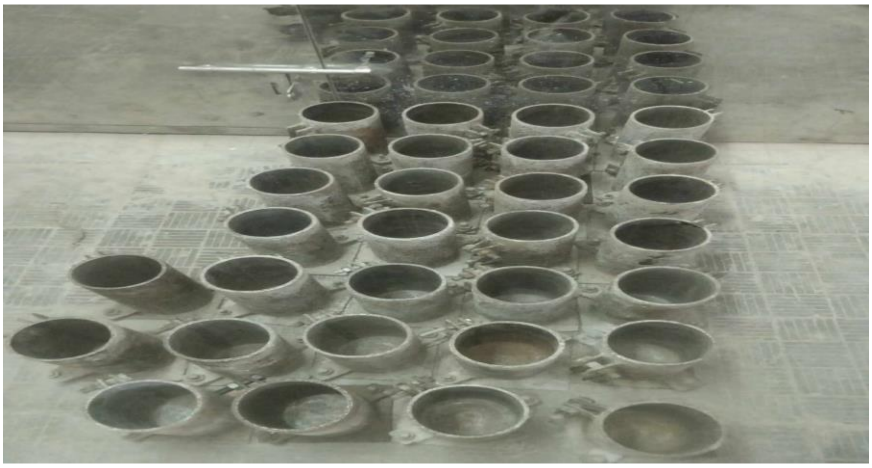

Fig. 3.10: Empty Cylinder molds

3.5 Concrete Cylinder Casting

Nine times, independently, for six cylinders each, mixed the concrete at a ratio of 1:1.74:2.72 and a w/c ratio of 0.55. First measured the dry ingredients and mixed dry and slowly mixed them with water. In order to achieve a smooth surface and easy release from the mold, applied release agent within the cylinder mold prior to pouring concrete. The size of the cylinder was $100mm \times 200mm$ but actually find $101mm \times 204.8mm$. After mixing the concrete, conducted a slump test; the average slump value was 51mm.

Fig. 3.11: Concrete mixing & pouring

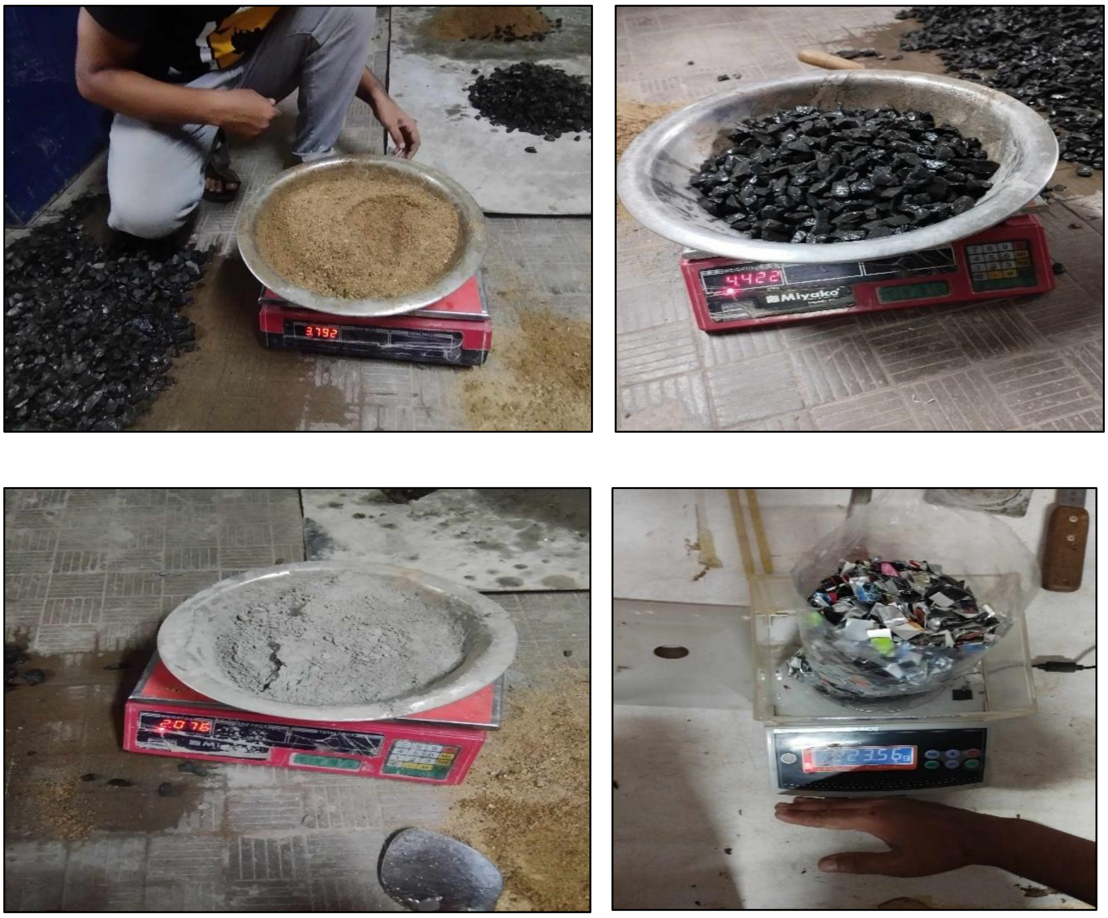

Fig. 3.12: Materials weight taken

3.5.1 Slump Test

The slump test is a simple and widely used method to assess the consistency and method to assess the consistency and workabilty of fresh concrete. Here’s the process of slump test:

1. Prepare Equipment:
Gather the necessary equipment, including a slump cone, a tamping rod, a base plate, and a scoop.

2. Setup:
Place the slump cone on a level, firm surface such as a base plate.

3. Mix Concrete:
Prepare a representative sample of the concrete mix that you want to test. Ensure it is thoroughly mixed and uniform.

4. Fill the Cone:
Fill the slump cone in three layers, each approximately one-third of the cone's height. Compact each layer with a set number of tamping rod strokes.

5. Strike Off Excess Concrete:
After the cone is filled, strike off the excess concrete using the tamping rod, ensuring a smooth and level surface.

6. Lift the Cone:
Lift the slump cone vertically, allowing the concrete to flow and settle. Do this in a steady, smooth motion without any lateral or twisting movement.

7. Measure Slump:
Measure the difference in height between the original height of the cone and the subsided height of the concrete. This difference is the slump.

8. Record Results:
Record the slump value. It's typically measured in millimeters (mm) or inches and indicates the workability of the concrete mix.

From the experiment collected slump value is 51mm.

Fig. 3.13: Slump Test

3.5.1.1 Necessity of slump test

The slump test for concrete is necessary because it provides a simple and quick measure of the consistency and workability of fresh concrete. Here's why the slump test is important:

Consistency Assessment: The test helps evaluate the flow and fludity of the concrete mix, indicating its ability to be placed and compacted effectively.

Workability Verification: Workability is crucial for proper placement and finishing of concrete. The slump test helps ensure that the concrete can be easily worked with while maintaining the desired quality.

Quality Control: By monitoring the slump, construction professionals can maintain consistent concrete quality, reducing the risk of defects and ensuring that the mix meets design specifications.

Troubleshooting: If the slump deviates from the specified range, it can indicate potential issues with the mix design, proportions, or water content, promting corrective actions to be taken.

3.5.2 Effect of pharmaceutical blister with concrete

About ten minutes after pouring the pharmaceutical blister mixed concrete into the cylinder mold, the blisters chemical reaction with the cement to form bubbles and the concrete swells.

(a) Concrete pouring after 10 minutes (b) after release from cylinder

Fig. 3.14: Pharmaceutical blisters chemical reaction with concrete

3.6 Concrete Cylinder Specimens Curing

Curing is the process of maintaining adequate moisture, temperature, and time to allow concrete, mortar, or other construction materials to achieve their desired strength and durability. There are two main types of curing:

1. Water Curing: Involves keeping the concrete continuously wet for a specific period, either by ponding, wet coverings, or spraying.

2. Membrane Curing: Involves using materials like curing compounds or membranes to seal the surface and retain moisture.

The necessity of curing lies in ensuring the hydration of cement, which is crucial for the development of strength and durability in concrete. Proper curing helps prevent cracks, increases resistance to weathering, and enhances overall performance of the construction material.

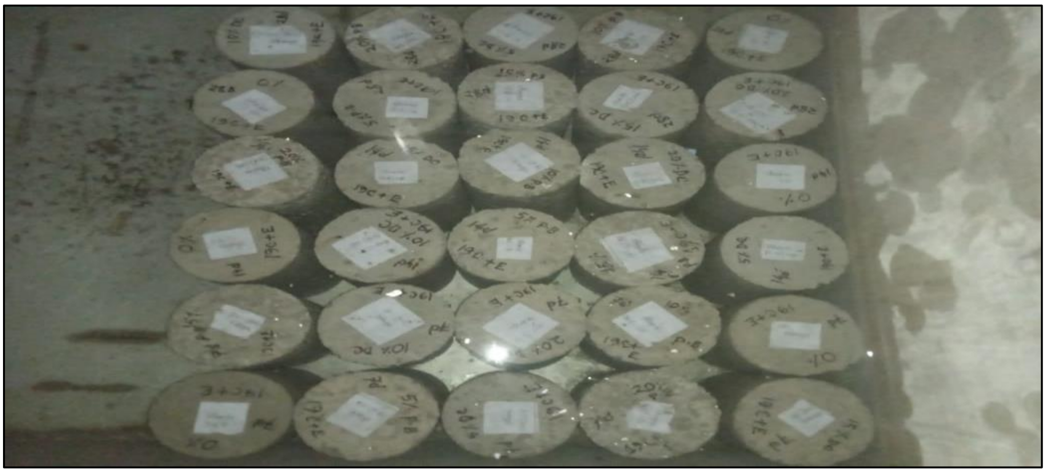

Fig. 3.15: Concrete specimens curing

3.7 Concrete cylinder specimens heating

At first heated the concrete specimens to temperature balance with gas fire and then burned the 7 days curing concrete specimens for 15 minutes, the 14 days curing concrete specimens for 30 minutes and the 28 days curing concrete specimens for 60 minutes at a temperature of 1000℃. Burned the concrete cylinder specimens from Doyaganj, Jatrabari, Dhaka. Copper is mainly smelted there, the melting point of cupper is 1065℃. (*Messrs. R. E. Slade and F. D. Farrow.*, n.d.) Total 54 concrete cylinder specimens used, 27 were heated and the other 27 were not.


Fig. 3.16: Concrete cylinder specimens heating for temperature balance & deep heating in the oven.

3.7.1 Heating effect of concrete cylinder specimens

Exposing concrete cylinder specimens to temperatures as high as 1000°C can have significant effects on their mechanical and physical properties.

Loss of Strength:
High temperatures can lead to a significant reduction in the compressive strength of concrete. The exact extent of strength loss depends on factors such as concrete mix design, aggregate type, and curing conditions.

Structural Changes:
Elevated temperatures cause physical and chemical changes in the concrete matrix. The hydration products may decompose, and the aggregates might undergo thermal expansion, potentially leading to cracking.

Cracking:
The thermal gradient within the concrete can induce internal stresses, leading to cracking and of the surface. This can compromise the integrity of the specimen.

Color Change:
Concrete may undergo color changes due to the effects of high temperature. This is often associated with oxidation of iron compounds present in the concrete.

Microstructural Changes:
The microstructure of the concrete, including the cement paste and aggregates, can be altered at elevated temperatures. This can impact the overall durability of the material.

Loss of Moisture:
High temperatures lead to the evaporation of moisture within the concrete. Loss of water can contribute to dimensional changes and affect the overall volume stability of the specimen.

Loss of Weight:
If apply heat on concrete then loss of moisture. So that, concrete loss weight.

Fig. 3.17: Heating effect of concrete cylinder specimens

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The compressive strength test is a crusial measure of the ability of concrete to withstand axial loads (compression). It involves applying a force to a concrete cylinder or cube until it fails, and then calculating the compressive strength using the appropriate formula. Follow standard testing procedures (e.g., ASTM C39). Conduct tests at standard ages (e.g., 7, 14, or 28 days) based on project requirements.

4.2 Concrete cylinder specimen compressive strength test

Compressive strength test was done by compression testing machine (CTM). At first, the concrete specimens was placed in the CTM machine along the center and compression was started by setting up the machine, when the concrete specimens failed then the compression was turned off. At curing duration 7 days, 14 days & 28 days concrete specimens were tested for compressive strength. Tested the compressive strength of concrete specimens at normal temperature and after burning at 1000℃. A compressive strength test was conducted 24 hours after the burn was finished, and a burn was completed 24 hours after the curing process was finished. The maximum compressive strength was reached after 28 days of curing; at room temperature and at 1000°C, it was 25.7 MPa and 19.27 MPa, respectively.

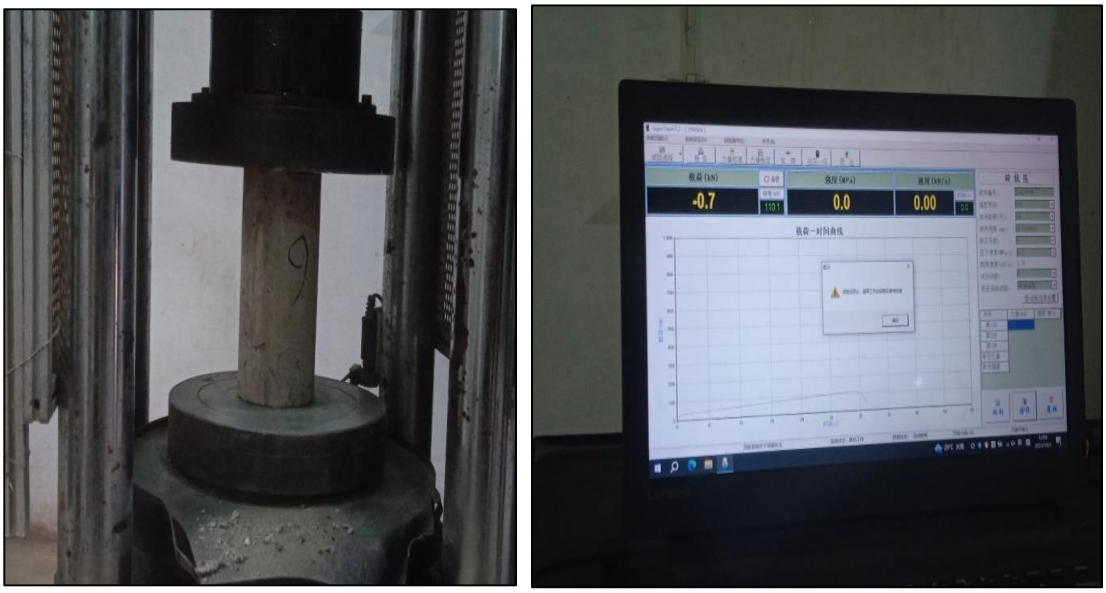

Figure 4.1: Concrete Cylinder Compressive Strength Test

Figure 4.2: Concrete cylinder after compressive strength test

4.3 Compressive Strength Test Result

Table 4.1: 7 Days Compressive strength test result for 1:1.74:2.72 concrete mixing ratio

		Compressive Strength (Mpa)					
Temp. (◦C) & Burning Duration (mins)	Partially replaced aggregate	Normal concrete at normal temp.	Normal Concrete at 1000 (◦C)	P.B mixed con-crete at normal temp.	P.B mixed concrete at 1000 (◦C)	D.C mixed concrete at normal temp.	D.C mixed concrete at 1000 (◦C)
1000℃ at 15mins	0%	14.96	8.23				
1000℃ at 15 mins	5%			10.41	6.51	16.32	12.27
1000℃ at 15 mins	10%			12.86	7.46	12.86	9.4
1000℃ at 15 mins	15%			6.48	4.21	12.43	9.31
1000℃ at 15 mins	20%			6.03	4.06	11.72	8.89

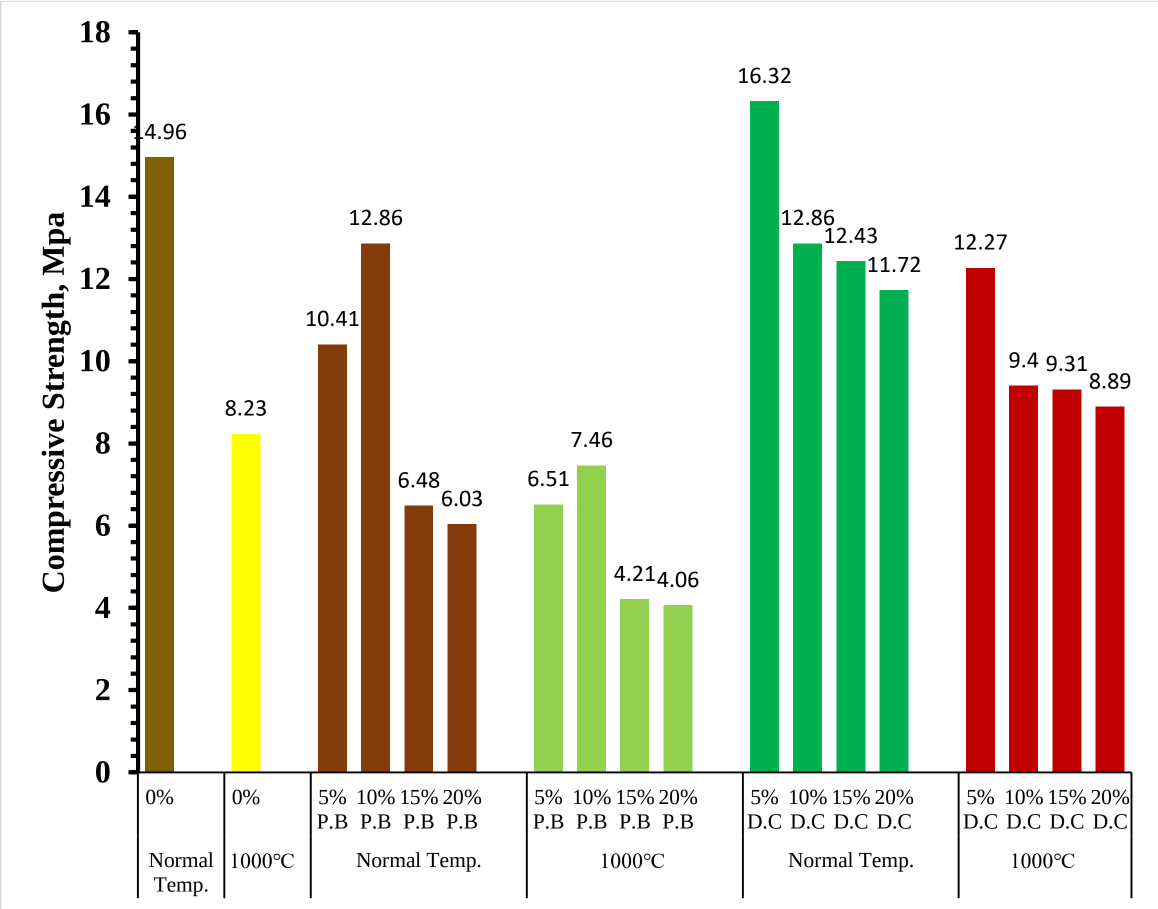

Fig. 4.3: 7 Days compressive strength test result column chart

The maximum compressive strength for 7 days was found in concrete mixed with 5% drink can. Compressive strength was found at normal temperature 16.32 Mpa and at 1000℃ 12.27 Mpa respectively. Normal concrete had compressive strength at normal temperature and at 1000℃ 14.96 Mpa & 8.23 Mpa respectively. For partially replaced pharmaceutical blister mixed concrete compressive strength at normal temperature and 1000℃ was at 5% 10.41 Mpa & 12.27 Mpa, at 10% 12.86 Mpa & 7.46 Mpa, at 15% 6.48 Mpa & 4.21 Mpa, at 20% 6.03 Mpa & 4.06 Mpa. For partially replaced drink can mixed concrete compressive strength at normal temperature and 1000℃ was at 5% 16.32 Mpa & 12.27Mpa, at 10% 12.86 Mpa & 9.40 Mpa, at 15% 12.43Mpa & 9.31 Mpa, at 20% 11.72 Mpa & 8.89 Mpa.

Table 4.2: 14 Days Compressive strength test result for 1:1.74:2.72 concrete mixing ratio

		Compressive Strength (Mpa)					
Temp. (◦C) & Burning Duration (mins)	Partially replaced aggregate	Normal concrete at normal temp.	Normal Concrete at 1000 (◦C)	P.B mixed concrete at normal temp.	P.B mixed concrete at 1000 (◦C)	D.C mixed concrete at normal temp.	D.C mixed concrete at 1000 (◦C)
1000℃ at 30 mins	0%	17.23	13.1				
1000℃ at 30 mins	5%			15.44	13.2	17.85	13.59
1000℃ at 30 mins	10%			10.32	8.99	14.6	12.52
1000℃ at 30 mins	15%			8.88	6.25	13.46	11.36
1000℃ at 30 mins	20%			8.66	6.28	12.7	10.7

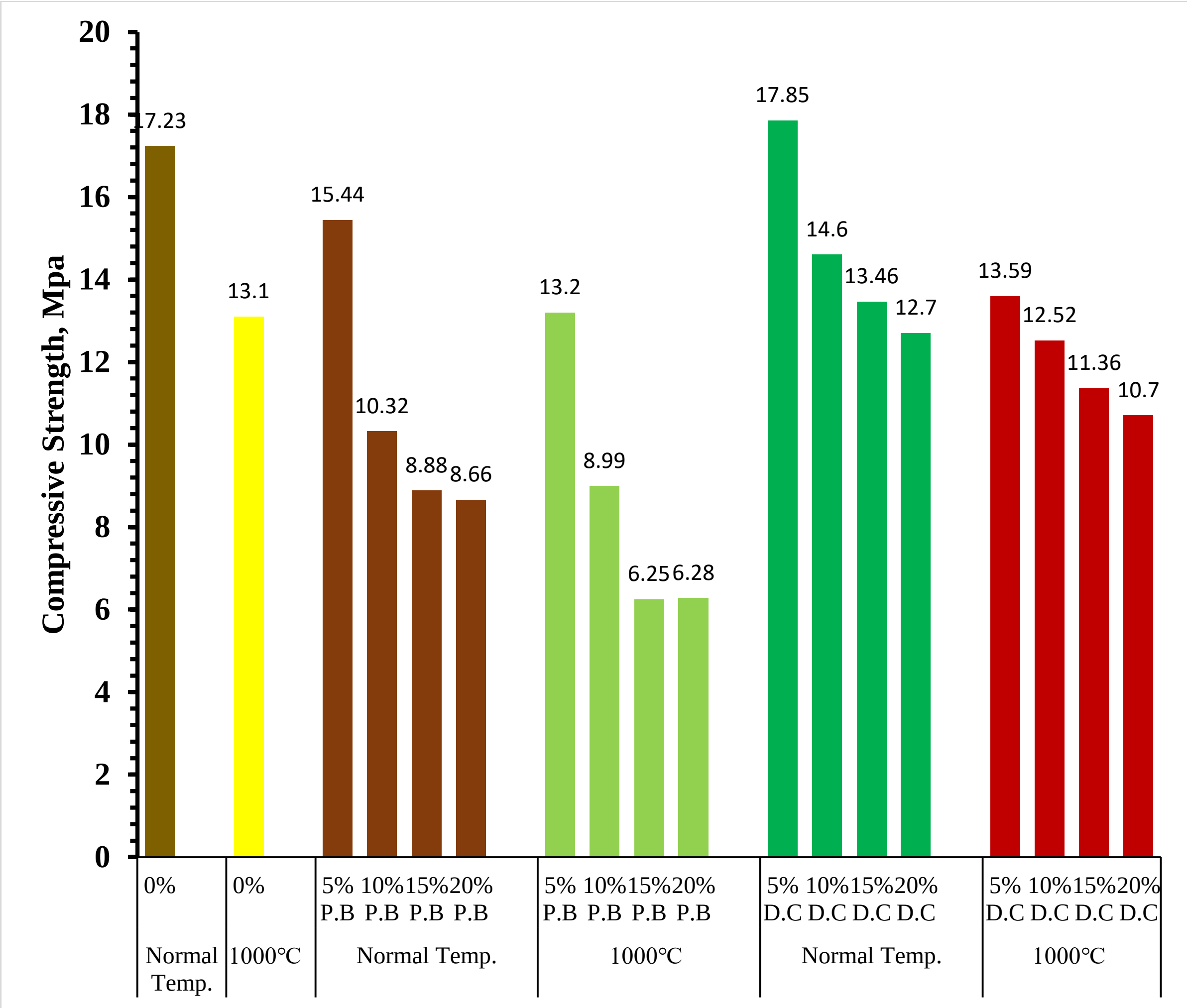

Fig. 4.4: 14 Days compressive strength test result column chart

The maximum compressive strength for 14 days was found in concrete mixed with 5% drink can. Compressive strength was found at normal temperature 17.85 Mpa and at 1000℃ 13.59 Mpa respectively. Normal concrete had compressive strength at normal temperature and at 1000℃ 17.23 Mpa & 13.1Mpa respectively. For partially replaced pharmaceutical blister mixed concrete compressive strength at normal temperature and 1000℃ was at 5% 15.44 Mpa & 13.20 Mpa, at 10% 10.32 Mpa & 8.99 Mpa, at 15% 8.88 Mpa & 6.25 Mpa, at 20% 8.66 Mpa & 6.28 Mpa. For partially replaced drink can mixed concrete compressive strength at normal temperature and 1000℃ was at 5% 17.85 Mpa & 13.59 Mpa, at 10% 14.60 Mpa & 12.52 Mpa, at 15% 13.46Mpa & 11.36 Mpa, at 20% 12.7 Mpa & 10.70 Mpa.

Table 4.3: 28 Days Compressive strength test result for 1:1.74:2.72 concrete mixing ratio

		Compressive Strength (Mpa)					
Temp. (◦C) & Burning Duration (mins)	Partially replaced aggregate	Normal con-crete at normal temp.	Normal Con-crete at 1000℃	P.B mixed con-crete at normal temp.	P.B mixed con-crete at 1000℃	D.C mixed con-crete at normal temp.	D.C mixed con-crete at 1000 ℃
1000℃ at 60 mins	0%	20.02	13.07				
1000℃ at 60 mins	5%			22.05	17.88	25.7	19.27
1000℃ at 60 mins	10%			15.00	12.3	16.78	14.07
1000℃ at 60 mins	15%			13.35	10.42	13.26	12.28
1000℃ at 60 mins	20%			10.88	8.25	11.9	9.83

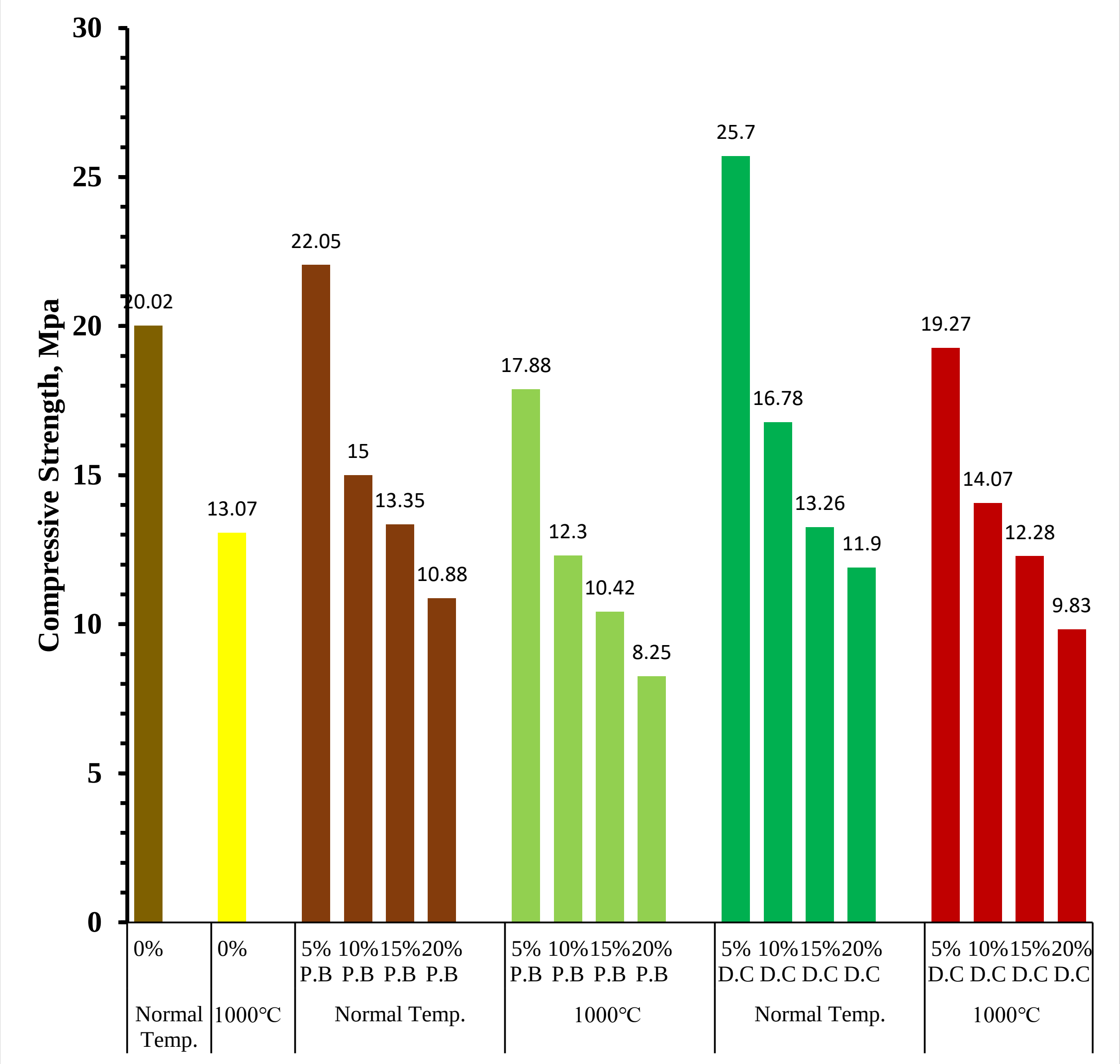

Fig. 4.5: 28 Days compressive strength test result column chart

The maximum compressive strength for 28 days was found in concrete mixed with 5% drink can. Compressive strength was found at normal temperature 25.7 Mpa and at 1000℃ 19.27 Mpa respectively. Normal concrete had compressive strength at normal temperature and at 1000℃ 20.02 Mpa & 13.07 Mpa respectively. For partially replaced pharmaceutical blister mixed concrete compressive strength at normal temperature and 1000℃ was at 5% 22.05 Mpa & 17.88 Mpa, at 10% 15 Mpa & 12.3 Mpa, at 15% 13.35 Mpa & 10.42 Mpa, at 20% 10.88 Mpa & 8.25 Mpa. For partially replaced drink can mixed concrete compressive strength at normal temperature and 1000℃ was at 5% 25.7 Mpa & 19.27 Mpa, at 10% 16.78 Mpa & 14.07 Mpa, at 15% 13.26 Mpa & 12.28 Mpa, at 20% 11.9 Mpa & 9.83Mpa.

4.4 Compare between normal temperature and applied heated concrete

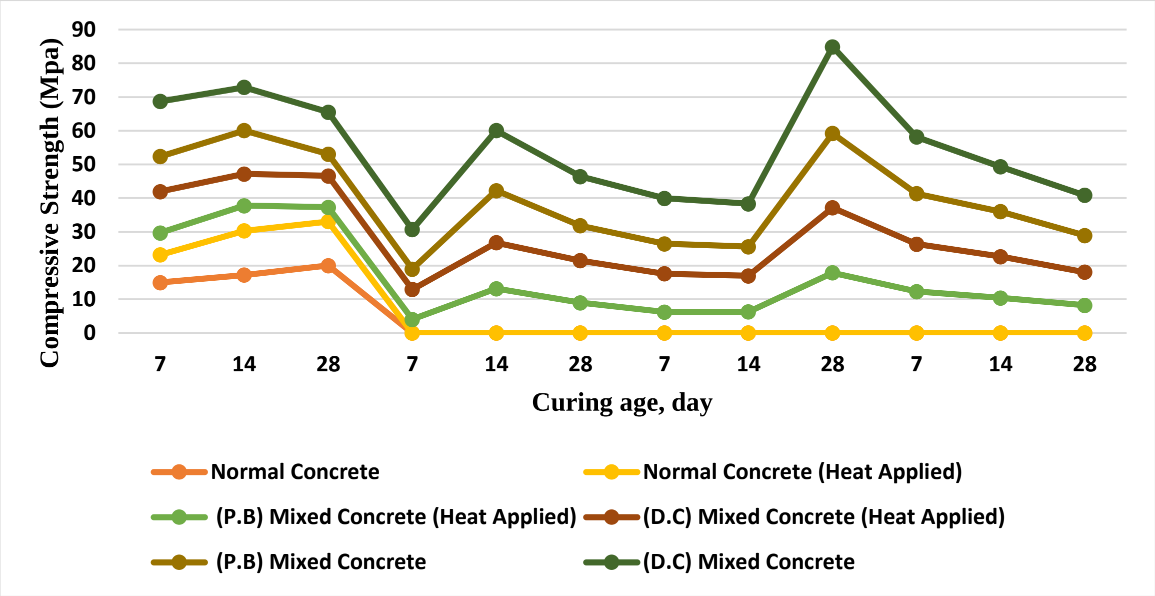

Fig. 4.6: Compare between normal temperature and applied heated concrete compressive strength

The maximum compressive strength at normal temperature and after 60 minutes of burning at 1000°C for regular concrete were 20.02 MPa and 13.07 MPa. respectively. Strength reduction upon burn was 34.72%. The maximum compressive strength at normal temperature and after 60 minutes of burning at 1000°C for Pharmaceutical blister mixed concrete were 22.05 MPa and 17.88 MPa, respectively. Strength reduction upon burn was 18.91%. The maximum compressive strength at normal temperature and after 60 minutes of burning at 1000°C for drink can mixed concrete were 25.7 MPa and 19.27 MPa. respectively. Strength reduction upon burn was 25.02%.

4.5 Compare between pharmaceutical blister (P.B) and drink can (D.C) mixed concrete

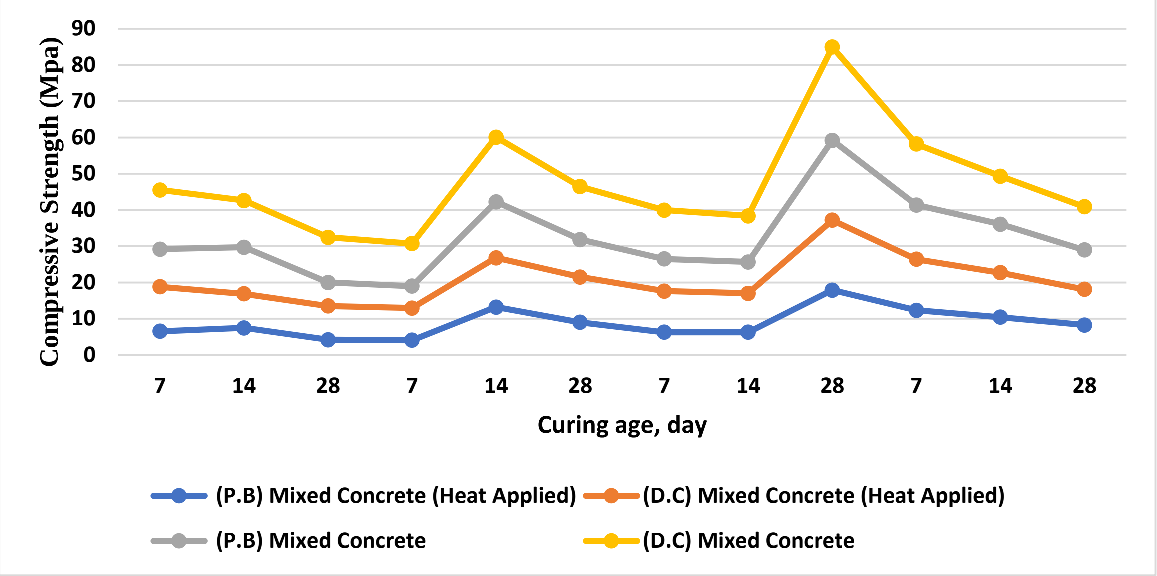

Fig. 4.7: Compare between pharmaceutical blister (P.B) mixed concrete and drink can (D.C) mixed concrete

4.6 Effect of drink can (D.C)

Drink can has good bonding and fire resistance capacity. Maximum compressive strength of 5% drink can mixed concrete after 60 minutes of burning at 1000°C was 19.27 MPa. Where 25.7 MPa is the maximum compressive strength at normal temperature. Strength reduction upon burn was 25.02%.

4.7 Effect of Pharmaceutical blister (P.B)

Pharmaceutical blisters react with cement to make air bubbles and swelling of the concrete. Numerous air bubbles are discovered in the pharmaceutical blister mixed concrete specimens during the compressive strength test. 17.88 Mpa was discovered to be the greatest strength after burning at 1000°C. When the greatest compressive strength at normal temperatures is 22.05 MPa. Strength reduction upon burn was 18.91%.

CHAPTER 5

Conclusions and Future Works

5.1 Conclusions

In this experiment used partially replaced recycled pharmaceutical blister (P.B) as fine aggregate and partially replaced recycled drink can as course aggregate, the partially replaced recycle aggregate was used 5%, 10%, 15% & 20% and the sizes of pharmaceutical blister & drink can were $2mm \times 2mm$ and $17.5mm \times 17.5mm$. The maximum compressive strength at 5% drinks can mixed concrete was determined to be 19.27 MPa and 25.70 MPa, respectively, after burning for 60 minutes at 1000°C and at normal temperature. On the other hand, the maximum compressive strength at 5% pharmaceutical blister mixed concrete was determined to be 17.88 MPa and 22.05 MPa, respectively, after burning for 60 minutes at 1000°C and at room temperature. The maximum compressive strength at regular concrete was determined to be 13.07 MPa and 20.02 MPa, respectively, after burning for 60 minutes at 1000°C and at normal temperature.

5.2 Limitations and Recommendations for Future Works

Limitations of the Study:

- For drink can fiber before use with concrete, first cut the cans top and bottom parts; it's made like a sheet. Apply the sketch to the drink can fiber surface with a weir brush and wash with water. It's necessary because the drink can's trademark color and liquid drink cause chemical reactions with concrete. By sketching on beverage cans, fiber surfaces make a good bond with concrete. After drying in sunlight, it is cut into strips measuring 0.5”×0.5”, 1”×1”, 1”×0.5”, 0.5”×1.5”, etc.

- For pharmaceutical blisters before use with concrete, first clean the blister pack with detergent and let it dry in sunlight. It is best if used as a powder. Can be used as a strip (1cm×1cm, 1mm×10mm, 2mm×2mm, etc.) if powdering equipment is not available. But pharmaceutical blister strip cause a chemical reaction with concrete. Chemical reactions create numerous air voids, leading to a reduction in compressive strength.

- The compressive strength decreases as a result of burning concrete specimens.

Future Works:

- According to the results of this present study, drink can fiber can be used in concrete construction.
- From the literature review pharmaceutical blister can be used partially as powder with concrete materials.

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APPENDIX

Fig. 1: Sieve analysis of fine aggregate test

Fig. 2: Sieve analysis of coarse aggregate test

Fig. 3: Specific gravity of fine aggregate test

Fig. 4: Specific gravity of coarse aggregate test (Coarse Aggregate weight on air, SSD sample & in water)

Fig. 5: Unit weight test of fine aggregate

Fig. 6: Unit weight of coarse aggregate

(a) Fire Resistance after first 15 minutes

(b) Fire Resistance after last 45 minutes

Fig. 7: Fire resistance test of pharmaceutical blister (P.B)

Figure 8: Fire resistance test of drink can