A COMPARATIVE STUDY ON THE COMPRESSIVE STRENGTH OF CONCRETE USING COCONUT FIBER AND EPS BEADS

BY

SAFIQUL ISLAM	BCE2001019232
NAJMUL HOSSAIN	BCE2001019203
SAYKAT RAYHAN	BCE2001019202
KHOBAER HOSSAIN	BCE2001019204
SHARIFUL ALAM	BCE2001019195
MR SHOHAIL	BCE2001019215

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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MR SHOHAIL	BCE2001019215

Supervisor

MD RAKIB HOSSAIN

Lecturer & Assistant Coordinator

Department of Civil Engineering

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....

1. MD RAKIB HOSSAIN — Chairman

   Lecturer & Assistant Coordinator
   Department of Civil Engineering
   147/I, Green Road, Dhaka-1215,
   Bangladesh

....

2. Internal / External Member — Member

....

3. Internal / External Member — Member

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It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

STUDENT NAME	STUDENT ID.	SIGNATURE
SAFIQUL ISLAM	BCE2001019232	
NAJMUL HOSSAIN	BCE2001019203	
SAYKAT RAYHAN	BCE2001019202	
KHOBAER HOSSAIN	BCE2001019204	
SHARIFUL ALAM	BCE2001019195	
MR SHOHAIL	BCE2001019215	

Dedicated

To

"OUR PARENTS & TEACHERS"

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ABSTRACT

Expanded polystyrene (EPS) beads are lightweight aggregates that can be used to produce lightweight concrete. Coconut fiber is a natural fiber that can be used as reinforcement in concrete. This study investigated the compressive strength of lightweight concrete made with different percentages of EPS beads and coconut fiber. In this thesis project, we used 0% EPS beads, 5% EPS beads and 10% EPS beads respectively. EPS and coconut fiber were used as partial aggregate replacements for volume in the mixes. Cylinders of 4 to 8 inches in size were prepared in this study. These include full water curing, air-dry curing, 7-day curing, and 28-day curing. The water absorption of a cylinder with EPS beads and coconut fiber is 0%, 5%, and 10% EPS beads and coconut fiber, respectively. 7 days for EPS, it was found that in the 0%, 5%, and 10% EPS beads. It was found after 28 days for EPS beads that in the 0%, 5%, and 10% EPS beads. It was discovered after 7 days that the 0%, 5%, and 10% coconut fiber. It was found after 28 days for coconut fiber that in the 0%, 5%, and 10% coconut fiber. The results showed that the compressive strength of the concrete increased with the addition of EPS beads and coconut fiber. The optimum percentage of EPS beads and coconut fiber for maximum compressive strength. The study also investigated the effects of EPS beads and coconut fiber on the workability and flexural strength of the concrete. The results showed that the workability of the concrete decreased with the addition of EPS beads and coconut fiber. However, the flexural strength of the concrete increased with the addition of EPS beads and coconut fiber. The results of this study suggest that EPS beads and coconut fiber can be used to produce lightweight concrete with high compressive and flexural strength. This type of concrete can be used in a variety of applications, such as roofing, flooring, and wall panels.

compressive strength, Expanded Polystyrene Beads, Coconut Fiber, Universal Testing Machine.

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CHAPTER 1

INTRODUCTION

1.1 Background

Concrete is a flexible and frequently used building material. One of its most crucial characteristics is its compressive strength, which governs how much weight concrete structures can support. The type of cement used, the amount of water to cement, the amount of aggregate, and the curing conditions are some of the variables that might impact the compressive strength of concrete.

We will go over the elements that impact the compressive strength of typical concrete in this brief article. The significance of compressive strength in concrete design and construction will also be covered. The results of current studies on the compressive strength of typical concrete will be shown before we conclude.

1.2 The definition of compressive strength and its importance in concrete design and construction.

A material's capacity to withstand compression is known as compressive strength. Megapascals (MPa) are used to measure it. Concrete has compressive strengths that typically range from 20 to 40 MPa, making it a powerful material. Importance in the design and construction of concrete o Compressive strength is one of the most crucial characteristics of concrete since it determines the ability of concrete structures to support loads.

Concrete constructions are made to resist the loads they are expected to sustain. The maximum load that a structure can support before failing is calculated using the concrete's compressive strength. Concrete's compressive strength is crucial in building. The concrete needs to be strong enough to handle the loads and the weight of the construction.

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1.3 Organization of the thesis

The layout of the thesis is written through five chapters in the following sequence. Chapter one deals with the background and the definition of compressive strength and its importance in concrete design and construction. Chapter Two is literature review which includes the definition of compressive strength of EPS beads & coconut fiber. Chapter Three contains Methodology and Experimental Program which Material, Procedure of the Making the cylinder, methodology Overview and Summary. Chapter Four contains the experimental results along with the data, figure and graphs obtained from the laboratory tests, discussions on the test results, specific

aim and summary. Chapter Five describes conclusion of the research work and recommendation for further research.

1.4 Objective

In this project coconut shell and expanded polystyrene beads are used as a partial replacement to the coarse aggregate. The use of coconut shells as an aggregate in concrete making not only solves the issue of solid waste disposal, but also helps to protect natural. Coconut fiber has the greatest toughness among all known natural fibers, which is the main reason for its selection in the current study. The research significance of this study is the exploration of the use of coconut fibers in high strength concrete with admixtures from a material properties perspective. A construction technique using lightweight geomaterials has many practical advantages because of their light self-weight, which makes it possible to reduce large deformations and differential settlement of soft ground or a foundation with poor bearing capacity.

CHAPTER 2

Literature Review

2.1 General

A number of studies have been conducted on the compressive strength of coconut fiber and EPS beads concrete. These studies have shown that the compressive strength of concrete can be significantly improved by adding coconut fiber or EPS beads. The compressive strength of coconut fiber and EPS beads concrete is affected by a number of factors, including the type of fiber, the length of the fiber, the amount of fiber, the size of the EPS beads, and the curing conditions. In general, the compressive strength of coconut fiber and EPS beads concrete increases with the amount of fiber or EPS beads added to the mix. However, the compressive strength of concrete can also decrease if too much fiber or EPS beads are added.

2.2 EPS

Concrete is an artificial material used to construct various civil engineering structures [1]. Concrete is the most commonly used substance in construction and can be used as standalone mass concrete, reinforced concrete, or prestressed concrete when combined with steel [2]. For every ton of cement produced, one ton of carbon dioxide (CO_2) is emitted into the atmosphere. Cement manufacturing is responsible for 5% of anthropogenic CO_2 emissions [3]. Cement production produces a significant amount of CO_2 and requires a large amount of energy during the manufacturing process. Given that Pakistan is already facing an energy crisis, the high energy consumption in cement production puts additional pressure on its energy sector. As a result, the price of cement is rising daily. Furthermore, waste disposal and the restoration of concrete components after demolition have negative environmental consequences. As a result, the use of this waste reduces cement manufacturing and energy consumption while also helping protect the environment [4]. One of the drawbacks of traditional concrete is its high self-weight. The density of regular concrete ranges between 2200 and 2600kg/m3 making it an uneconomical structural material. Several attempts have been made in the past to reduce the self-weight of concrete to increase its efficiency. Lightweight Concrete (LWC) is a type of concrete with a density ranging from 300 to 1850kg/m3 [5]. Since LWC was first used approximately two thousand years ago, several lighter structures were built, particularly in the Mediterranean region. The three most important structures built during the Roman Empire are the Coliseum, the Port of Coosa, and the Pantheon Dome [6]. The use of LWC in buildings, structural and non-structural, as construction material must have specific characteristics that meet the requirements of strength and performance for the application. Before using any material in construction, there is a need to study its mechanical properties to determine its suitability [7].

Figure: 1.1EPS (BEADS)

2.3 COCONUT FIBER

Coconut fiber use in a reinforced concrete mixture to increase its strength is widely researched. In this study, we used coconut fiber for a mixture of paving blocks. Nowadays the technology development in the field of construction has been increased, especially for highway pavement. Paving block pavements start to be widely used for pavement construction on roads [8]. This can be seen from the use of paving blocks which are increasingly used as asphalt replacement because they are easy to install, do not require heavy equipment, can be mass produced, and are easy to maintain and reinstalled. The quality of paving blocks can be measured by their strength in compressive loads and resistance [9]. Paving can withstand small earthquakes, freeze and melt [10]. The contribution of this research is the utilization of coconut fiber as a substitute for steel to paving blocks, making it cheaper.
This reason the research of sustainable composite concrete is necessary [11]. 2)Effect of Coconut Coir Fiber Traditionally coconut fiber is used for household products. Coconut fiber is used in mixes with construction materials to increase their strength [12]. Coconut fiber is divided into two types of colors, namely white from young coconut and brown from old coconut, both with low thermal conductivity [13].

The stress and strain produced by coconut coir fibers have a higher value than other natural fibers [14, 15]

Figure: 1.2 COCONUT FIBERS

CHAPTER 3

Methodology

3.1 MATERIALS

3.1.1 Cement: Ordinary Portland Cement (OPC) is the most widely used and fundamental type of cement in construction. It serves as the foundation for various concrete applications due to its versatility, availability, and consistent performance. OPC is manufactured by grinding clinker (a material produced through the heating of limestone and other components to high temperatures) with a small amount of gypsum to control its setting time. Type I: This is a general-purpose cement suitable for most construction applications, offering good strength and durability. It's commonly used in building foundations, walls, pavements, and more. Type II: Type II

Figure: 1.3 Cement

OPC produces less heat during hydration, making it suitable for projects where heat generation can cause issues like thermal cracking. It's commonly used in large-scale concrete projects and structures. Type III: Type III OPC is known for its rapid-setting and high early strength development. It's often used in situations where quick construction or early load-bearing capacity is essential. Type IV: Type IV OPC generates less heat during hydration than Type I and Type II cements, making it suitable for massive concrete structures with low heat tolerance. Type V: Type V OPC has high sulfate resistance, making it ideal for environments with high sulfate content in soil or water. It's commonly used in marine structures and environments with exposure to sulfates. All specimens were cast using Ordinary Portland Cement (OPC) Type I throughout the experiment. This kind of cement complies with the Iraqi specification 5/2019 [16].

3.1.2 Fine Aggregates: Fine aggregates are an essential component in the construction industry, forming a significant portion of concrete, mortar, and other building materials. They are granular materials, typically smaller than 5mm in diameter, that play a crucial role in enhancing the workability, strength, and durability of construction mixes. Here's an in-depth overview of fine aggregates. Sylhet sand was used for producing lightweight cylinder for performing compressive strength test.

Figure: 1.4 **Fine Aggregates**

3.1.3 Coarse Aggregates: Coarse aggregates are an integral component in construction, constituting a substantial portion of concrete, asphalt, and other building materials. These granular materials, typically larger than 5mm in diameter, play a crucial role in providing structural strength, stability, and durability to construction mixes. Here's an in-depth exploration of coarse aggregates. Natural gravel from the Al-Nibaee region with a nominal aggregate size of 5-10mm, shown in Figure 3.3, was used as coarse aggregates in all mixes. The physical and chemical parameters of the coarse aggregates comply to the Iraqi standard 45/1984 [17].

Figure: 1.5 **Coarse Aggregates**

3.1.4 Water: According to IS 456 : 2000, water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable

Figure: 1.6 **Water**

water is generally considered satisfactory for mixing concrete. The pH value of water shall be not less than 6. Water is a fundamental and essential element in the construction industry, playing a critical role in various construction processes and materials. It serves as a mixing and curing agent, a component of construction materials, and a medium for cleaning and hydration. Here's an exploration of the significance and functions of water in construction

3.1.5 Expanded Polystyrene Beads (EPS): This study used spherical-shaped EPS beads with a maximum nominal size of 10mm to replace coarse aggregates. The gradient and physical properties of EPS beads. Expanded Polystyrene (EPS) beads are a versatile and lightweight material with a wide range of applications across various industries, including construction, packaging, and manufacturing. EPS is created from

Figure: 1.7 **Expanded Polystyrene Beads (EPS)**

polystyrene resin through a process of expansion, resulting in small beads with unique properties. Here's an in-depth overview of EPS beads.

3.1.6 Coconut Fiber: Coconut fiber is a natural fiber that is extracted from the outer husk of coconuts. It is a type of lignocellulose fiber, which means that it is made up of cellulose, hemicellulose, and lignin. The exact composition of coconut fiber varies depending on the maturity of the coconut and the processing method used.

Figure: 1.8 **Coconut Fibers**

Coconut fiber, also known as coir, is a natural fiber extracted from the husk of coconuts. This versatile and sustainable material has a range of applications across various industries due to its strength, durability, and eco-friendly nature. Here's a comprehensive overview of coconut fiber.

3.2 Procedure of the Making the cylinder

The mixture composition paving cylinder used the ratio of 1:2: 2 which is 1kg cement, 2kg sand, and 2kgCoarse Aggregates Expanded Polystyrene Beads (EPS)& Coconut Fiber with the addition of 1200ml of water (not too much water should be added in order to get maximum water-cement ratio). Coir fibers by 0%, 5%and 10% of all Aggregates weight were added. The mixture compositions were mould. The mould was hit 6 times in order to even up the mixture so there were no air voids. The finished mixture was taken out from the mould into plywood.

Figure: 1.9 Concert mixed with Expanded Polystyrene Beads (EPS)

Figure: 1.10 Concert mixed with Coconut Fiber

3.3 Methodology Overview

The methodology employed for investigating the compressive strength of concrete using EPS beads and coconut fiber involves a systematic approach that encompasses various experimental and analytical steps. This section provides a concise overview of the key methodologies utilized in the research process

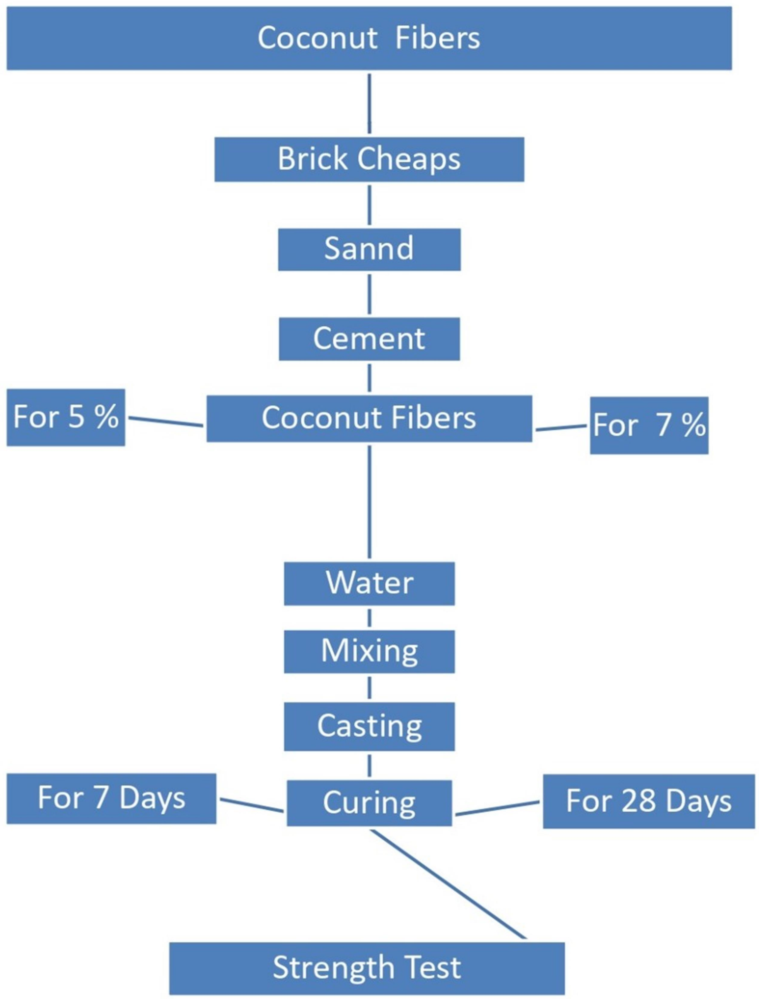

Figure 1.11 Overview of the coconut fibers methodology.

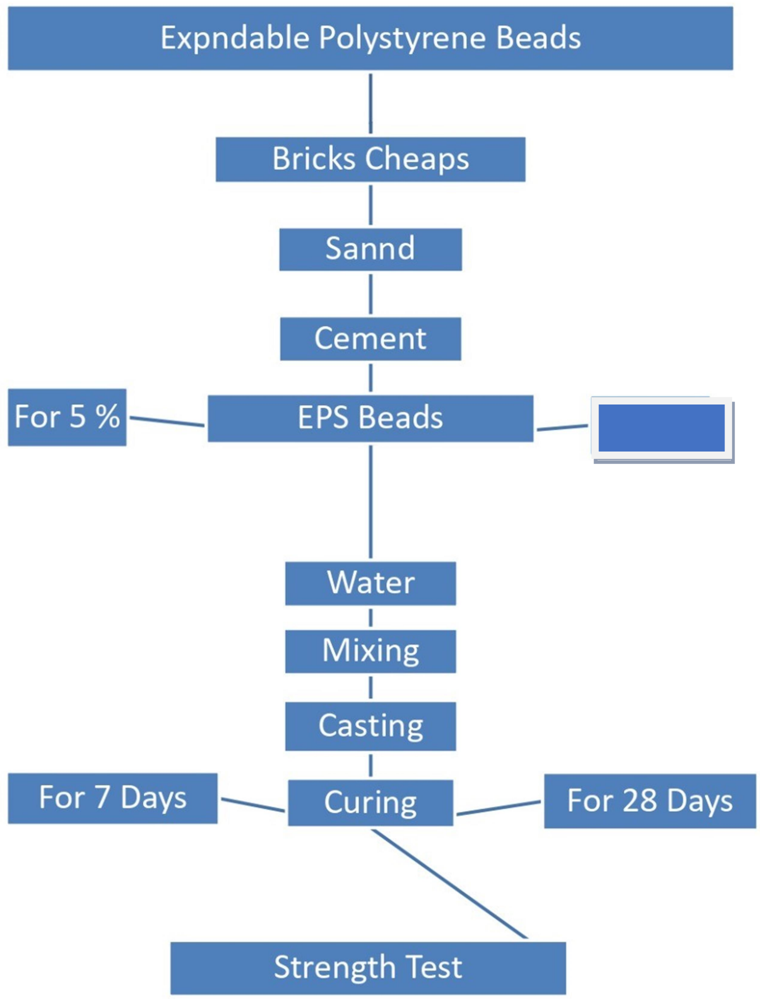

Figure 1.12 Overview of the Expanded Polystyrene Beads (EPS) methodology**.**

3.3.1 Materials Selection and Preparation:

The materials for the concrete mixture will include Portland cement, fine and coarse aggregates, water, EPS beads, and coconut fiber. High-quality materials will be selected to ensure accurate and repeatable results. The EPS beads will be of uniform size, and the coconut fiber will be properly processed to remove impurities.

3.3.2 Mix Proportioning:

A series of concrete mixtures will be designed with varying proportions of EPS beads and coconut fiber. The mix design will be based on established guidelines for achieving desired compressive strength. The control mixtures without any additives will also be prepared for comparison.

Figure: 1.13 **Mix Proportioning**

3.3.3 Concrete Mixing:

The concrete mixtures will be batched using a concrete mixer, following standard mixing procedures. The sequence of adding materials, mixing duration, and water-cement ratio will be consistent for all batches to ensure consistency.

Figure: 1.14 **Concrete Mixing**

3.3.4 Specimen Casting:

The freshly mixed concrete will be cast into standard cylindrical or cubic molds, adhering to relevant testing standards. Special care will be taken to prevent segregation during casting. The molds will be properly vibrated to eliminate air voids.

Figure: 1.15 Specimens Casting

3.3.5 Curing Regime:

The cast specimens will undergo a controlled curing process to simulate real-world conditions. This process will involve both moist curing and air curing, as per established concrete curing practices. The curing duration will be chosen to ensure proper hydration and development of strength.

Figure: 1.16 Curing Regime

3.3.6 Compressive Strength Testing:

After the curing period, the specimens will be carefully demoded and tested for compressive strength using a universal testing machine. The load will be applied gradually and uniformly until failure occurs. The maximum load at failure and the corresponding stress will be recorded to calculate the compressive strength.

Figure: 1.17 Compressive Strength Testing

3.3.7 Data Collection and Analysis:

The obtained compressive strength values from different mixtures will be compiled and analyzed statistically. The effects of varying proportions of EPS beads and coconut fiber on the compressive strength will be studied. Comparative analysis will be conducted between the modified concrete mixes and the control mixes.

3.4 Summary

The methodology outlined above will provide a comprehensive approach to investigating the effect of incorporating EPS beads and coconut fiber on the compressive strength of concrete. The combination of mechanical testing, microstructural analysis, and durability assessment will yield valuable insights into the viability of these additives as sustainable enhancements for concrete performance. The subsequent sections of this research paper will delve into the detailed experimental procedures and results of the study.

CHAPTER 4

Results and Discussion

4.1 Introduction

This pivotal section delves into the empirical outcomes and insightful interpretations derived from the experimental investigation on the utilization of EPS beads and coconut fiber as additives in concrete. The primary focus centers on the compressive strength characteristics of the modified concrete mixes.

4.2 Results

4.2.1 Density

The quantity and density of lightweight aggregates are two of the most crucial elements in regulating a variety of physical properties in LWC. Due to the low density of polystyrene, the density of LWC falls as polystyrene volume increases [18-19]. Table VII shows the densities of the samples and their density variation with age.

4.2.2 Compressive Strength

This rise is the result of the cement hydration process becoming more advanced with time. and both provide a comparison of the compressive strengths of several specimens at 7 and 28 days of age.

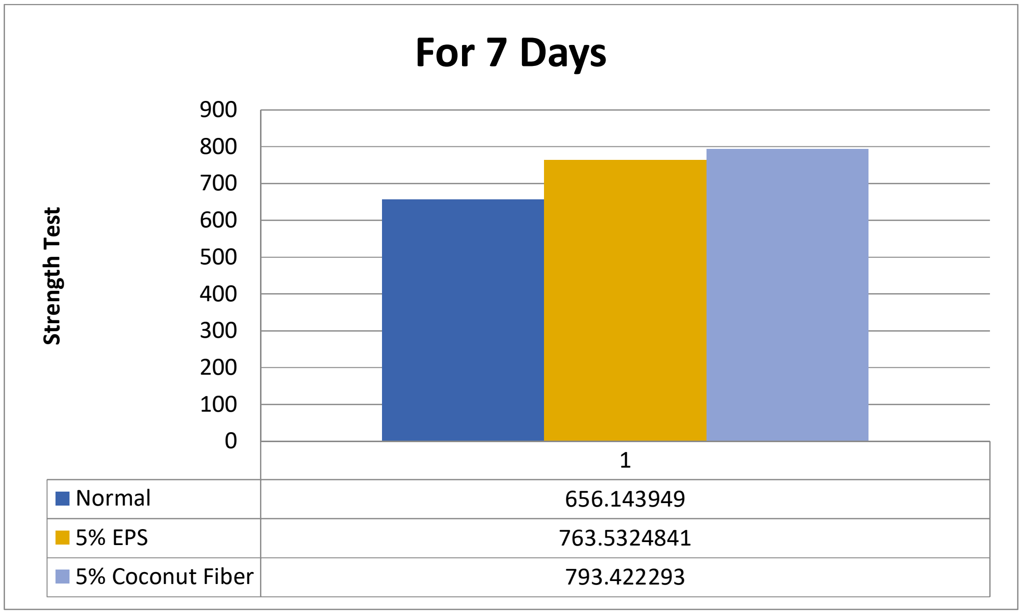

Figure 1.18 Compare Compressive Strength with Normal Concert, 5% EPS, 5% Coconut Fiber

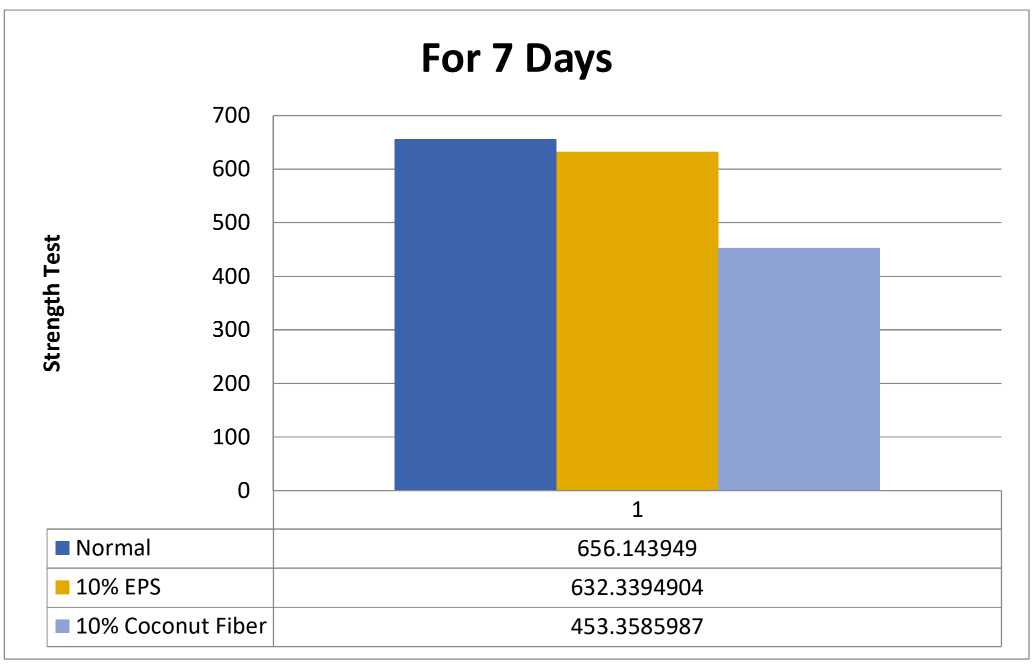

Figure 1.18 Compare Compressive Strength with Normal Concert, 10% EPS, 10% Coconut Fiber

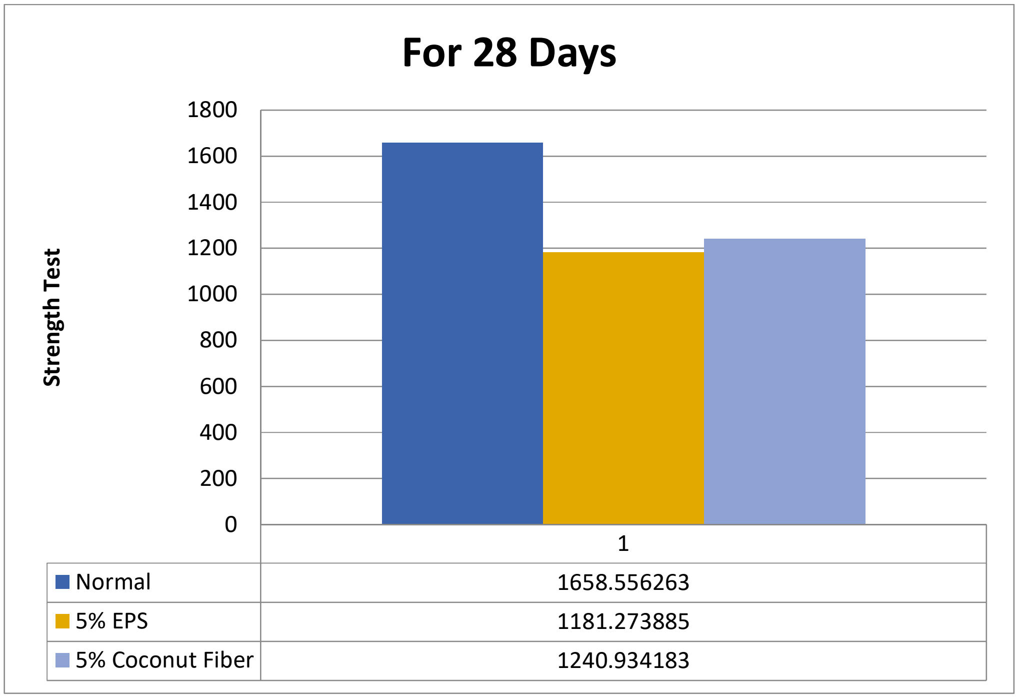

Figure 1.18 Compare Compressive Strength with Normal Concert, 5% EPS, 5% Coconut Fiber

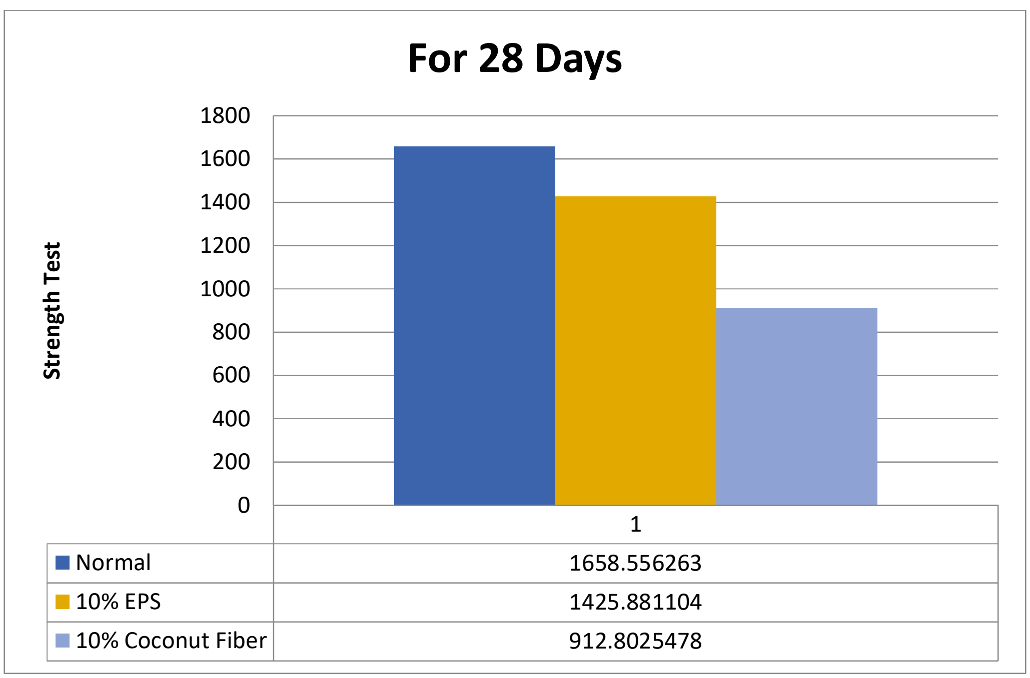

Figure 1.19 Compare Compressive Strength with Normal Concert, 10% EPS, 10% Coconut Fiber

Table 4-1. Summary of the goodness-of-fit of the prediction models.

For 7 Days							
No	hight-inc	dia-inc	W-kg	KN	Average	KN-in2	psi
5% CocunatFaiber							
1	8.1	3.931	3.311	52	44.33	3.529459	793.4223
2	8.1	3.919	3.341	42			
3	8.1	3.913	3.237	39			
10% CocunatFaiber							
1	8.4	3.92	3.38	23	25.33	2.01672	453.3586
2	8.4	3.958	3.362	24			
3	8.1	3.899	3.189	29			
5% EPS							
1	8.1	3.875	3.284	44	42.66	3.396497	763.5325
2	8.2	3.918	3.278	49			
3	8.1	3.925	3.191	35			
10% EPS							
1	8.3	3.943	3.195	33	35.33	2.812898	632.3395
2	8.2	3.962	3.198	36			
3	8.3	3.985	3.199	37			
Normal							
1	8.4	3.952	3.386	32	36.66	2.91879	656.1439
2	8.4	3.928	3.377	35			
3	8.4	3.915	3.271	43			

Table 4-2. Summary of the goodness-of-fit of the prediction models.

For 28 Days							
No	hight/inc	dia/inc	W/kg	KN	Average	KN-in2	psi
5% CocunatFaiber							
1	8.3	3.865	3.257	65	69.33333	5.52017	1240.934
2	8.2	3.988	3.485	75			
3	8.2	3.928	3.219	68			
10% CocunatFaiber							
1	8.3	3.943	3.303	44	51	4.06051	912.8025
2	8.1	3.935	3.264	48			
3	8.1	3.914	3.2	61			
5% EPS							
1	8	3.912	3.192	67	66	5.254777	1181.274
2	8.3	3.982	3.253	67			
3	8.1	3.936	3.019	64			
10% EPS							
1	8.2	3.812	3.147	67	79.66667	6.342887	1425.881
2	8.2	3.944	3.306	85			
3	8.2	3.959	3.319	87			
Normal							
1	8.2	3.95	3.504	100	92.66667	7.377919	1658.556
2	8.2	3.98	3.518	93			
3	8.2	3.914	3.388	85			

4.3 Summary

The "Results and Discussion" section stands as the culmination of empirical data and interpretative insights, driving the narrative towards a more profound understanding of the application of EPS beads and coconut fiber in enhancing concrete's compressive strength and broader performance attributes..

CHAPTER 5

Conclusions

5.1 Conclusions

We added 5% and 10% EPS to normal concrete and 5 % and 10% coconut fiber to normal complete. For high strength and it has been compressive stand tested for 7 days and 28 days. The results show that 5% and 10% of the cylinders were formed for 7 days and the strength was much higher than that of normal concrete. And cylinders made of 5% and 10% EPS obtained strength at 28 days much higher than normal concrete. Also cylinder made with 5% coconut fiber gives good results for 7 days but cylinder made with 10% coconut fiber does not give good results for 7 days. Also cylinder made with 5% coconut fiber gives good results for 28 days but cylinder made with 10% coconut fiber does not give good results for 28 days. From this we understand that 5% coconut fiber is usable but 10% coconut fiber are not usable but 5% & 10% eps beads is usable for compressive strength. 5% & 10% EPS beads is usable for compressive strength 5% coconut fiber is usable but 10% coconut fiber are not usable for compressive strength.

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