SUSTAINABILITY POTENTIAL OF POLYESTER FABRIC REINFORCED CONCRETE BEAM

Submitted By
Md. Abir Khan
ID: 201-47-364
Mahidi Hasan Bijoy
ID: 201-47-345

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The thesis titled "Sustainability Potential of Polyester Fabric Reinforced Concrete Beam" Submitted by Md. Abir khan , Student ID: 201-47-364, Mahidi Hasan Bijoy, Student ID:201-47-345,has been accepted as satisfactory in partial fulfillmentof the requirement for the degree of Bachelor of Science in Civil Engineering on 20-11-2024.

Board of Examiners

(Supervisor)
Mr. Md. Assaduzzaman Naeem
Lecturer
Department of Civil Engineering
Daffodil International University, Daffodil Smart City, Ashulia, Dhaka.

(Chairman)
Dr. M. R. Kabir
Professor, Department of Civil Engineering
Daffodil International University, Daffodil Smart City, Ashulia, Dhaka.

MMHZam
(Internal Member-1) 02-Dec-2024
Dr. Miah M. Hussainuzzaman
Associate Dean & Associate Professor, Department of Civil Engineering
Daffodil International University, Daffodil Smart City, Ashulia, Dhaka.

02/12/24
(Internal Member-2)
Engr. Ahad Ullah
Sr. Lecturer, Department of Civil Engineering
Daffodil International University, Daffodil Smart City, Ashulia, Dhaka.

20/11/24
(External Member)
Md. Rasel Chowdhury
Deputy Director
Padma Associates & Engineers Limited

DECLARATION

I conducted the dissertation titled "**Sustainable Potential of Polyester Reinforced Concrete Beam",** under the guidance of Mr. Md. Asaduzzaman Naeem, Lecturer at the Department of Civil Engineering, Daffodil International University, Dhaka, Bangladesh. This dissertation has been approved as part of my Bachelor of Science in Civil Engineering degree requirements. To the best of my knowledge, everything in this dissertation is my own work, and any sources or materials used are properly referenced.

Md. Asaduzzaman Naeem

Lecturer

Department of civil Engineering

Md. Abir khan
Id: 201-47-364
Department of civil Engineering,
Daffodil International University

Mahidi Hasan Bijoy
Id: 201-47-345
Department of civil Engineering,
Daffodil International University

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I'd like to thank my beloved family; I want to give them my deepest love and gratitude for being very supportive and for their inspiration and encouragement during my studiesat this University.

DEDICATION

Dedicate to Our Parents and Teacher

ABSTRACT

Concrete reinforced with polyester fabric is a novel material that combines the improved performance qualities of polyester fabric reinforcement with the structural advantages of conventional concrete. This study assesses polyester fabric reinforced concrete beams' mechanical and structural performance in order to determine whether or not they can replace conventional steel reinforcement. Evaluating polyester fabric's effect on concrete beams' tensile strength, flexural performance, fracture resistance, and durability is the main goal.

Reinforced concrete, made of polyester fabric, is incorporated into the concrete matrix to offer a corrosion-resistant, lightweight, and flexible reinforcing solution. Polyester fabric reinforcement improves load-bearing capacity and deformation control by strengthening the concrete's resistance to tensile stresses.

In this study, the flexural strength and load-deflection behavior of beams reinforcedwith polyester fabric were assessed under both static and dynamic loading situations.In comparison to traditional concrete beams with steel reinforcement, the results demonstrated that polyester fabric reinforced concrete beams demonstrated increased crack resistance, higher energy absorption capacity, and decreased crack width. Furthermore, the addition of polyester fabric resulted in a decrease in the overall weight of the beam, making it an economical and environmentally friendly choice for building.

The study also looked at the advantages of employing polyester fabric reinforcement for the environment, including how it can reduce steel use and be repurposed to meet global sustainability goals. According to the research, polyester fabric reinforced concrete beams are a viable option for infrastructure projects that call for strong, long lasting, and environmentally friendly materials.

Polyester fabric reinforced concrete beams not only exceed the mechanical performance requirements for structural applications, but they also help reduce the environmental impact of the building sector. And all the tests we have done are: compression test cylinder and beam, elongation test and pull-out test of polyester fabric.The main reason for doing this test is to check the bearing capacity of the rope and stability inside the concrete and to reduce the weight and cost of the beam.

CHAPTER 1

INTRODUCTION

1.1 General

The building sector is becoming more and more aware of the need of sustainable methods to solve resource depletion and environmental issues. A novel method that is gaining popularity is the application of Polyester fabric reinforced concrete beams. This technique offers a promising alternative for sustainable building by fusing the strength and longevity of conventional concrete with the flexibility and light weight of polyester fabric.

The use of polyester fabric reinforced concrete has several sustainability benefits, such as reducing the cost of building structures. Won't get lost easily. There is no problem with rust or salt exposed areas. Polyester fabric is not hazardous. They are very light, keep the weight of the beam at the right level, originated, has emerged as an effective material for concrete reinforcement. It has good tensile strength, flexibility, and chemical resistance, making it ideal for structural applications. The use of polyester fabric as a reinforcement material in concrete beams may reduce the need for traditional steel, cutting both resource demand and the carbon footprint of construction projects. Furthermore, polyester is less prone to corrosion and deterioration in harsh settings, preserving the durability of concrete buildings.

Polyester fabric can be created with less energy and produces less greenhouse gases. Furthermore, polyester fabric may be made from recycled plastics, which aligns with the ideals of the circular economy. This reduces waste and lowers the environmental impact of synthetic polymer manufacture. structure's life polyester fabric reinforcement is also easier to separate and recycle than steel, polyester fabric reinforcement concreteis typically deeply set in concrete and difficult to retrieve.

Durability is another key factor in the sustainability potential of polyester fabric reinforced concrete beams. Traditional steel reinforcement is prone to rust when exposed to moisture and salts, leading to cracking and spalling in concrete structures.In contrast, polyester fabric reinforcement is impervious to such corrosion, which helps maintain the integrity of the concrete for longer periods. This reduces the need for repairs, maintenance, and reconstruction, all of those have significant environmental and financial costs.

Moreover, polyester fabric reinforced concrete beams have the potential to improve the energy efficiency of construction. Polyester fabric is much lighter than steel, which reduces transportation energy and costs. The lightweight nature of polyester also simplifies the handling and installation process, allowing for more efficient construction practices. This can lead to faster project completion times and lower overall energy consumption during the building phase.

1.2 Research Objectives

- The compressive, tensile and flexural strength of polyester fabric reinforced concrete is comparatively less than conventional reinforced concrete
- Investigate the adherence of the polyester fabric to the concrete matrix and itsimpact on structural performance, particularly under varying loading situations.
- Comparing the total cost of polyester fabric reinforced concrete to normal reinforced concrete, taking into account material and maintenance

1.3 Purpose of the Study

This study aims to investigate the mechanical performance, material efficiency, and environmental impact of Polyester Fabric Reinforced Concrete polyester fabric reinforced concrete beams in order to determine their potential for sustainability. The objective is to ascertain the advantages of employing recycled polyester materials, investigate their enduring quality, and encourage their integration into environmentally conscious building methods. In the end, the study aims to show how polyester fabric reinforced concrete beams can help lower the building industry's carbon footprint without sacrificing structural performance or integrity.

CHAPTER 2
LITERATURE REVIEWS

2.1 Introduction

The building sector is experiencing two major issues at this time: resolving environmental concerns and satisfying the growing structural needs. There has never been a greater need for sustainable building materials and techniques due to global urbanization and population expansion. The application of Polyester Fabric Reinforced Concrete polyester fabric reinforced concrete beams is one of the creative solutions that are being developed to address these issues. This composite material offers a viable substitute for conventional concrete solutions by fusing the tensile qualities of polyester fabric with the inherent strength of concrete. Recent studies have indicated that polyester fabric reinforced concrete beams possess unique characteristics that enhance their performance while contributing to sustainability. Concrete is a widely used construction material, but its production is responsible for significant carbon emissions, primarily due to the cement manufacturing process. Polyester fabric reinforced concrete beams have the potential to mitigate this impact by allowing for the design of lighter, more efficient structures. By incorporating polyester fabric, these beams can achieve higher tensile strength and ductility, enabling thinner profiles and reduced material usage. This not only conserves resources but also diminishes the overall carbon footprint of construction projects. (Rebeiz, 1995)

Furthermore, there is a great chance to advance circular economy ideas in the building industry by using recycled polyester fabrics into polyester fabric reinforced concrete beams. By making use of waste materials, we may keep them out of landfills and lessen our dependency on virgin resources. This method is in line with the increasing focus on resource efficiency and sustainable methods in building design and construction. The polyester fabric reinforced concrete beam literature identifies a number of important fields of study. Studies on the mechanical characteristics of polyester fabric reinforced concrete have shown that it performs better than conventional reinforced concrete under a range of loading scenarios. Furthermore, studies have looked into the maintenance needs and long-term durability of polyester fabric reinforced concrete beams.

The results indicate that these materials may last longer than those of traditional materials, which could eventually result in lower lifecycle costs and a smaller environmental effect. This literature review aims to provide a comprehensive overview of the current state of research on the sustainability potential of polyester fabric reinforced concrete beams. By synthesizing findings from various studies, it will highlight the mechanical advantages, environmental benefits, and practical applications of this innovative material. Additionally, the review will identify gaps in the existing literature that require further exploration, paving the way for future research and development in the field. (R. K. Chaurasia, 2019)

2.2 Previous Sustainable Potential of Polyester Fabric Reinforcement Concrete.

Polyester fabric reinforced concrete sustainability potential has sparked their curiosity. of the building industry due to its capacity to address some of the primary environmental concerns connected with standard steel reinforcing. Steel, which is often used for concrete reinforcing, has a large carbon footprint due to its energy-intensive manufacturing process. According to the World Steel Association, the steel industry accounts for approximately 8% of worldwide CO_2 emissions, with raw material extraction and processing accounting for the majority. Furthermore, steel-reinforced concrete constructions are prone to corrosion, especially in areas with moisture or salts, resulting in structural deterioration and the need for periodic repairs and maintenance. (U.A. shaikh, 2014)

In contrast, polyester fabric offers a sustainable alternative due to its lightweight, non-corrosive properties, and potential for enhancing the durability of concrete structures. Polyester, a synthetic polymer, is not susceptible to corrosion, making Polyester fabric reinforced concrete particularly well-suited for infrastructure in aggressive environments such as coastal regions or areas with high humidity. This corrosion resistance extends the lifespan of concrete structures and reduces the need for repairs, minimizing both maintenance costs and the environmental impact associated with repair activities over a structure's lifecycle (Mahmoud M. Reda Taha, 2021).

Polyester fabric reinforced concrete has various ecological advantages, making it an appealing material for modern building. Its utilization of recycled materials, decreased energy consumption, increased durability, and less trash creation all contribute to a more environmentally friendly building process. As construction practices shift towards greener alternatives, polyester fabric reinforced concrete emerges as a material that meets both environmental and performance problems. (Zaniewski, 2017)

Polyester fabric reinforced concrete has substantial sustainability benefits, includingwaste reduction, resource efficiency, and longevity. Polyester fabric reinforced concrete uses recycled polyester fabric. (Muttoni, 2020)

2.3 Flow Chart of Research

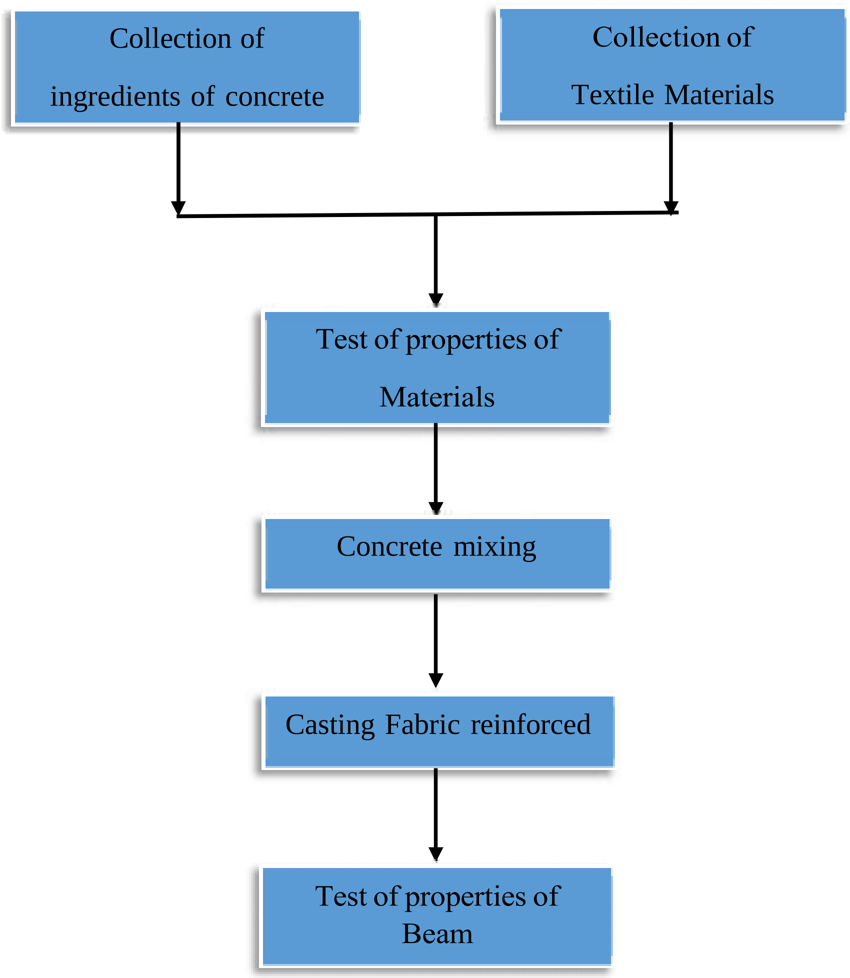


Figure: 2.3: Flow Chart of Research

2.4 Principal of Planning

Material Selection: Determine the environmental impact of the materials used in the concrete matrix and fabric reinforcement. Choose materials with reduced carbon footprints and longer service lives.

Design Optimization: Use structural design strategies that reduce material usage while increasing load-bearing capacity and longevity. This includes optimizing the beam size and reinforcing the configuration.

Conduct a life cycle assessment: Conduct a life cycle assessment to determine the environmental impact of Polyester fabric reinforced concrete beams from raw material extraction to disposal or recycling. Determine potential areas for improvement in terms of energy consumption, emissions, and waste generation.

Durability Enhancements: Additives or treatments can be added to the concrete mixto improve its durability against environmental conditions such as moisture, chemicals, and freeze-thaw cycles. This increases the life of Polyester fabric reinforced concrete beams and lowers the need for frequent replacements.

Construction Practices: Use sustainable construction practices to reduce waste output, energy consumption, and environmental impact throughout the construction period. Consider employing recyclable materials and efficient construction methods.

2.4.1 Principles of Planning Details:

Selecting high-strength polyester fabric, optimizing structural design, ensuring proper bonding, leveraging corrosion resistance, incorporating sustainable materials, employing efficient construction techniques, and adhering to emerging safety and performance standards are all key principles of polyester fabric reinforced concrete.

2.4.2 Future Requirement:

Future requirements for polyester fabric reinforced concrete include enhancing material strength, durability, and bond performance to meet structural demands. Cost reduction and scalability are essential for broader industry adoption. Establishing standardized guidelines for polyester fabric reinforced concrete use in construction and conducting further life cycle assessments will help quantify environmental benefits. Increased research, innovation, and pilot projects will also be needed to improve performance and promote widespread application in sustainable construction.

2.4.3 Orientation:

The orientation of literature reviews on polyester fabric reinforced concrete should encompass material properties, structural performance, environmental benefits, application methods, and comparisons with traditional reinforcement. This comprehensive approach aids in understanding the advancements and future potential of polyester fabric reinforced concrete in construction.

2.4.4 Prospect:

The beam should be capable of carrying a load while still looking good on the exterior.It should be compatible with the column and other structural parts.

2.4.5 Aspect:

The polyester fabric reinforced concrete serves as a cost-effective and environmentally sustainable alternative to steel reinforcement.

CHAPTER 3

MATERIALS AND METHODOLOG

3.1 General

The sustainability potential of polyester fabric reinforced concrete beams lies in replacing traditional steel reinforcement with high-strength or recycled polyester fabric, which reduces corrosion, increases durability, and lowers the overall weight of the structure. By incorporating sustainable materials like supplementary cementitious materials (SCMs) such as fly ash or ground granulated blast furnace slag (GGBS) into the concrete mix, the carbon footprint is further reduced. The methodology involves embedding the polyester fabric in tension zones of the concrete beam, ensuring proper bonding during casting and curing, and enhancing the beam's tensile strength while minimizing environmental impact.

3.2 Materials

- Concrete: Made with Ordinary Portland Cement (OPC), fine aggregates (sand), and coarse aggregates (crushed stone). Cement can be partially replaced with sustainable alternatives like fly ash or ground granulated blast furnace slag (GGBS) to reduce environmental impact.
- Polyester Fabric: High-tenacity polyester or recycled polyester (RPET) is used as reinforcement. It offers high tensile strength, corrosion resistance, and durability. Surface treatments (e.g., epoxy) can be applied to enhance bonding with the concrete.
- Chemical: All the chemicals used in research, Sodium Chloride (NaCl), Calcium carbonate (CaCo3), Magnesium Sulfate (MgSO4), Sulfuric Acid (H_2SO_4).

3.3 Methodology

Concrete Mix Design: A sustainable mix is created, which includes supplementary cementitious materials (SCMs) to lower the carbon footprint.

Fabric Placement: Polyester cloth is inserted in the beam's strain zones. It could be stacked or inserted at strategic spots.

Casting and Curing: Concrete is poured into formwork that includes polyester cloth. Proper curing, such as water or membrane curing, promotes strength growth.

Testing: Flexural strength tests are conducted, alongside sustainability assessments like life cycle analysis (LCA).

3.4 Fine Aggregate

Fine aggregate refers to small particles used in concrete, such as sand or crushed stone, with a diameter of less than 4.75 mm. It fills the spaces between larger aggregates, which improves the concrete's strength, workability, and surface polish. To guarantee excellent concrete performance, fine aggregates should be clean, contamination-free, and properly graded. Sustainable alternatives include recycled materials such as crushed glass or recycled concrete, as well as manufactured sand (M-sand), which serve to mitigate the environmental impact of natural sand mining. Fine aggregate is essential for creating a durable and high-quality concrete mix.

Figure: 3.4.1: Fine Aggregate

Figure: 3.4.2: Fiennes modulus for fine aggregate

Table 3.4.1: F.M Calculation

Sieve No.	Weight of Retained (gm.)	Percent (%) of Retained	Cumulative Total	Fineness Modula’s
#4	0.0	0	0	F.M. $=\frac{159.6}{100}$ =1.596
#8	1.5	0.3	0.3	
#16	1.5	0.3	0.6	
#30	8.0	1.6	2.2	
#50	307.0	61.4	63.6	
#100	146.5	29.3	92.9	
Pan	35.5	-	-	
Total	500		159.6	

3.5 Coarse Aggregate:

The selected coarse aggregate has a unit weight of 1600 kg/m³, indicating its bulk density. It has an absorption capacity of 0.5%, meaning it can absorb 0.5% of its dry weight in water. The bulk dry specific gravity is 2.68, showing that the aggregate is 2.68 times heavier than water. These characteristics are essential for concrete mix design, influencing the mix's overall weight, water-cement ratio, and durability. Proper consideration of these properties ensures optimal strength and performance of the concrete.

Figure: 3.5.1: Fiennes modulus for fine aggregate

Table 3.5.1: Coarse Aggregate Size Analysis

Sieve No. (mm)	Weight of Retained (gm)	Percent (%) of Retained	Cumulative % Retained	Percent Passing
37.5	0	0	0	100
25	18	3.6	3.6	96.4
19.5	114.5	22.9	26.5	73.5
12.5	240.5	48.1	74.6	25.4
6.3	118.7	23.74	98.34	1.66
2.36	6.7	1.34	99.34	0.32
Pan	1.6	0.32	100	0
Total	500			

3.6 Concrete:

This article describes the features of standard concrete mixtures of class M15, which are used to reinforce various types of fabrics.

Table 3.6.1: Quantity of materials (Per Beam)

Component	**kg/m3**
Sand	5.5
Stone	12.375
Cement	28.05
Water	2.75

Table 3.6.2: Concrete Compressive Test for 28 Days.

Slender	Target Strength (MPa)	Test Strength (MPa)
1	15	22
2	15	25
3	15	23

Figure: 3.6.1: Compressive Strength Test for Slender

Figure: 3.6.2: Compressive Strength Test for Slender

The compressive strength test for slender concrete columns determines their ability to bear axial loads while accounting for buckling. Slender columns, with a high slenderness ratio (height-to-width), sometimes break due to lateral instability (buckling) before the concrete reaches its maximum compressive strength. As the slenderness ratio rises, the critical load capacity falls due to second-order phenomena like lateral deflections under stress. This test is critical for understanding how thin columns behave under compressive stresses and for designing columns that minimize buckling, hence assuring structural stability.

Figure 3.6.3: Concrete mix

A concrete mix is a carefully proportioned combination of cement, water, fine aggregates (sand), coarse aggregates (gravel or crushed stone), and sometimes admixtures (e.g., plasticizers, retarders) to achieve desired properties. The mix design is tailored to meet specific performance criteria such as strength, workability, anddurability. The water-to-cement ratio is a key factor influencing strength—lower ratios increase strength but may reduce workability. Admixtures can enhance performance, such as improving flow or setting time. A well-designed mix balances these factors to meet the structural and environmental requirements of a project.

3.7 Reinforcement:

As a textile reinforcement, selected fabrics with a load of 5kN are used.

Figure 3.7.1: Textile Polyester Fabric Reinforcement

Polyester fabric reinforcement uses high-strength polyester fabric to improve the tensile strength of concrete constructions. Polyester textiles are lightweight, resilient, and corrosion-resistant, making them a viable alternative to traditional steel reinforcement, particularly in corrosion-prone settings. They improve structural performance by spreading tensile loads, delaying crack formation, and increasing the overall durabilityof concrete. Polyester fabric rope can also be used, which promotes sustainability. This reinforcement is especially useful in applications requiring flexible, lightweight solutions, such as thin-walled constructions or non-load-bearing parts.

Figure 3.7.2: Textile Fabric Reinforcement Tensile Strength Test

3.7.1 Textile Fabric Reinforcement Tensile Strength Test

In a Textile Fabric Reinforcement Tensile Strength Test, if there is no load but the fabric's length increases, it suggests the material is undergoing elongation without significant resistance. Comparison Variants

3.8 Comparison Variants

A total of four variants of concrete facade panels were compared: Type-1. Use Pure Concrete Without Steel Beam.

Type-2. Use 2@12 mm dia. Bar Steel.

Type-3. Use 3@12 mm dia. Bar Textile Polyester Fabrics.Type-4. Use 2@12 mm dia. Bar Textile Polyester Fabrics.

3.9 Bending Test:

Three-point bending tests were performed on FRC beams under four different conditions using a Universal Testing Machine (UTM) with a 1000 kN hydraulic system. These tests looked at the structural strength of carbon-textile-reinforced concrete. Beams were cast in a wooden formwork, with reinforcement cages added before horizontal casting. After 48 hours, the beams were removed from the formwork and cured in a humid chamber until tested at 28 days. The mid-span deflection was tested with a load of 711.2 mm from both sides with support rollers placed 1524 mm apart. Displacement was set at 1 mm/min, and the rollers allowed for unfettered horizontal movement.

Figure 3.9.1: Formwork setup

Beam formwork setup involves creating a temporary mold to support and shape concrete beams until they cure. The process starts with designing and assembling formwork using materials like timber or metal to match the beam's dimensions. The formwork is carefully aligned and leveled to ensure accuracy. Reinforcing bars are placed within the formwork as specified in the design. Concrete is then poured into the mold, compacted to remove air bubbles, and allowed to cure. The formwork supportsthe beam until the concrete reaches' sufficient strength, ensuring the final beam meets structural requirements and dimensions.

Figure 3.9.2: Concrete Casting

Beam casting is done by proper rules or mixing concrete in proper proportions. Giving clear covering checks. Placement of reinforcement. Tamping with rod according to proper rules. There should be no voids or voids.

Figure 3.9.3: Beam One Day After Curing

Figure 3.9.4: Beam After 28 Days of Curing

Curing concrete for 7 to 28 days is essential for achieving optimal strength and durability. The initial 7 days are critical for early strength development, as concrete continues to hydrate and gain strength. During this period, maintaining adequate moisture and temperature is crucial to prevent cracking and ensure a strong bond within the concrete matrix. Extending curing up to 28 days further improves the concrete's strength and durability, particularly for high-performance or heavily loaded structures. Prolonged curing helps ensure the concrete reaches its full potential, minimizing the risk of long-term issues such as shrinkage and surface deterioration.

Figure 3.9.5: Beam Setup for Test

Figure 3.9.6: Beam Setup for Test

For compression test of beam, Universal Testing Machine (UTM) is beam setup horizontally. Place only two supports and one-point load. The point load should be along the center of the beam. Given the applied load.

3.10 Chemical Test

3.10.1 Rope elegantin test

Polyester fabric rope elongation refers to how much a polyester rope stretches when subjected to tension or load. Polyester is commonly used in ropes due to its strength, low stretch properties, and resistance to environmental factors.

Figure 3.10.1: Rope Elegantin Test

3.10.2 Sodium Chloride (NaCl)

Test for elongation and pul-out of my plaster fabrics rope using Sodium Chloride (NaCl). Sodium Chloride (NaCl) uses 5% water of the rope to verify how much has been developed from normal strength. First of all, curing all the rope for 7 days, 14 days, 28 days. After checking the strength, got the data of elongation and pull out, improved data from normal strength. So, think it is better to use Sodium Chloride (NaCl).

Figure 3.10.2: Sodium Chloride (NaCl)

3.10.3 Calcium carbonate (CaCo3)

Test for elongation and pul-out of my polyester fabrics rope using Calcium carbonate (CaCo3). Calcium carbonate (CaCo3) uses 1% water of the rope to verify how much has been developed from normal strength. First of all, curing all the rope for 7 days, 14 days, 28 days. After checking the strength, the data of elongation and pull out, improveddata from normal strength. So, think it is better to use Calcium carbonate (CaCo3).

Figure 3.10.3: Calcium Carbonate ($CaCO_3$)

3.10.4 Magnesium Sulfate ($MgSO_4$)

Test for elongation and pul-out of my plaster fabrics rope using Magnesium Sulfate (MgSO4). Magnesium Sulfate (MgSO4) uses 10% water of the rope to verify how much has been developed from normal strength. First of all, curing all the rope for 7 days, 14 days, 28 days. After by checking the strength, got the data of elongation and pull out, improved data from normal strength. So, think it is better to use Magnesium Sulfate (MgSO4).

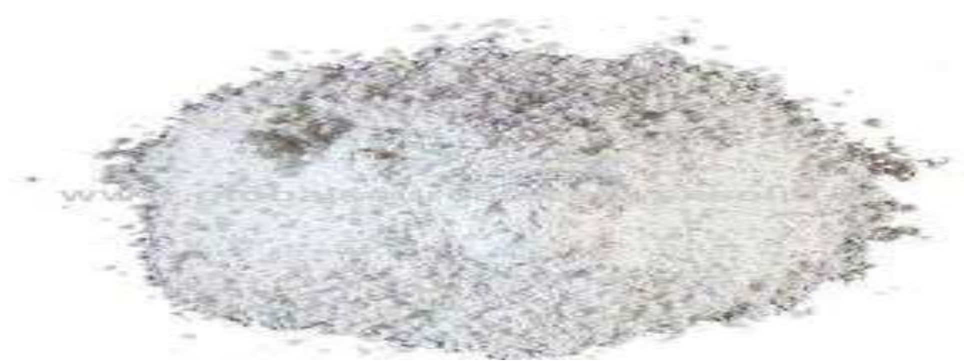


Figure 3.10.4: Magnesium Sulfate ($MgSO_4$)

3.10.5 Sulfuric Acid (H_2SO_4)

Test for elongation and pul-out of my plaster fabrics rope using sulfuric acid (H_2SO_4). Sulfuric Acid (H_2SO_4) used 3% water of the rope to verify how much has been developed from normal strength. First of all, curing all the rope for 7 days, 14 days, 28 days. After checking the strength, got the data of elongation and pull out, improved data from normal strength. So, think it is better to use Sulfuric Acid (H_2SO_4).

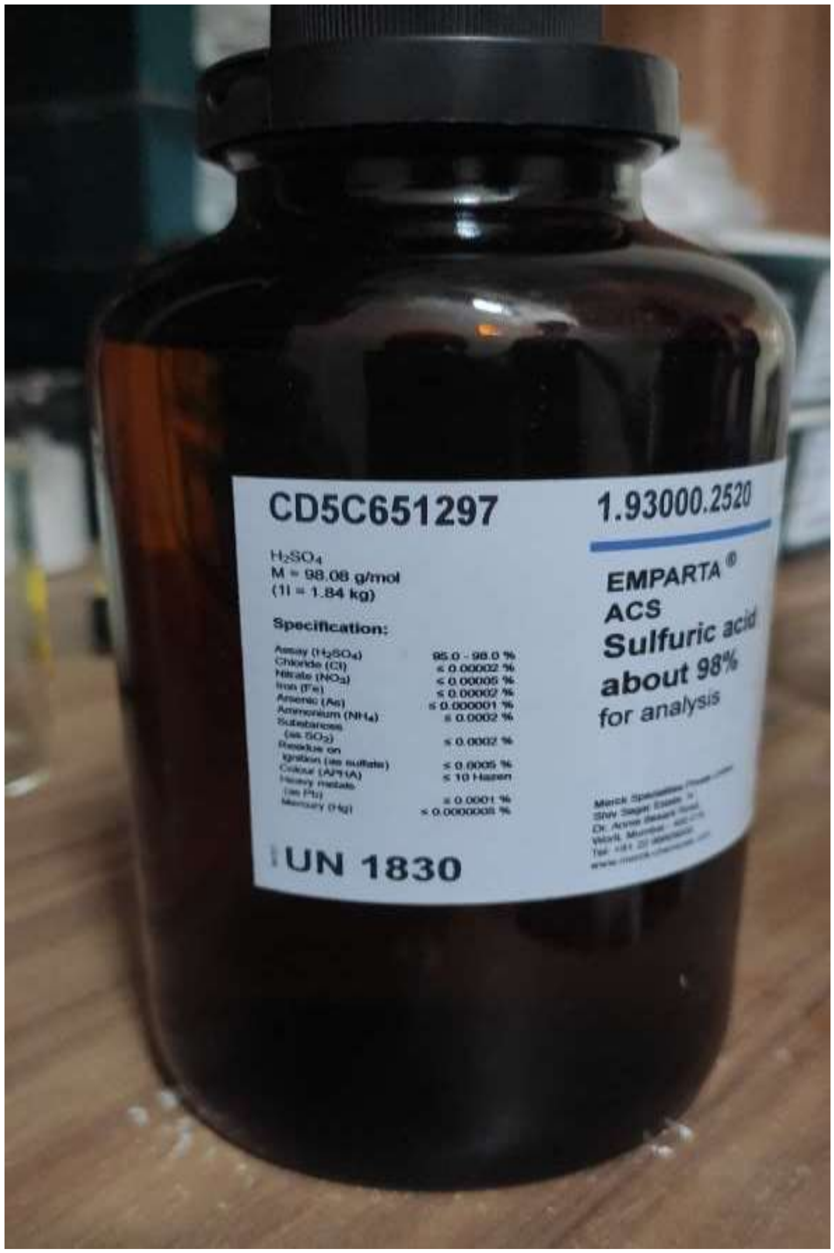


Figure 3.10.5: Sulfuric Acid (H_2SO_4)

3.10.6 Pull Out Test

The Pull-Out Test measures the bonding strength of anchors or embedded materials. It evaluates how much force is required to pull a component out of a substrate. This testis essential in applications like concrete structures. It helps ensure the safety and reliability of various installations. The procedure involves preparing a specimen, securely placing the anchor, and applying a tensile load until failure occurs. The maximum load and mode of failure are recorded. Ultimately, this test provides crucial data for design calculations and material selection, enhancing structural integrity and safety.

Figure 3.10.6: Pul Out Test

CHAPTER 4

RESULT

4.1 Result

Beams are prepared in four different circumstances. Each load and deflection have been controlled. And discuss how much % replace, what amount load, and cost has decreased.

4.2 Use Pure Concrete Without Steel Beam

The first criteria are that the beam is pure concrete. The load capacity is 15 KN, and the deflection is 25mm & 20mm.

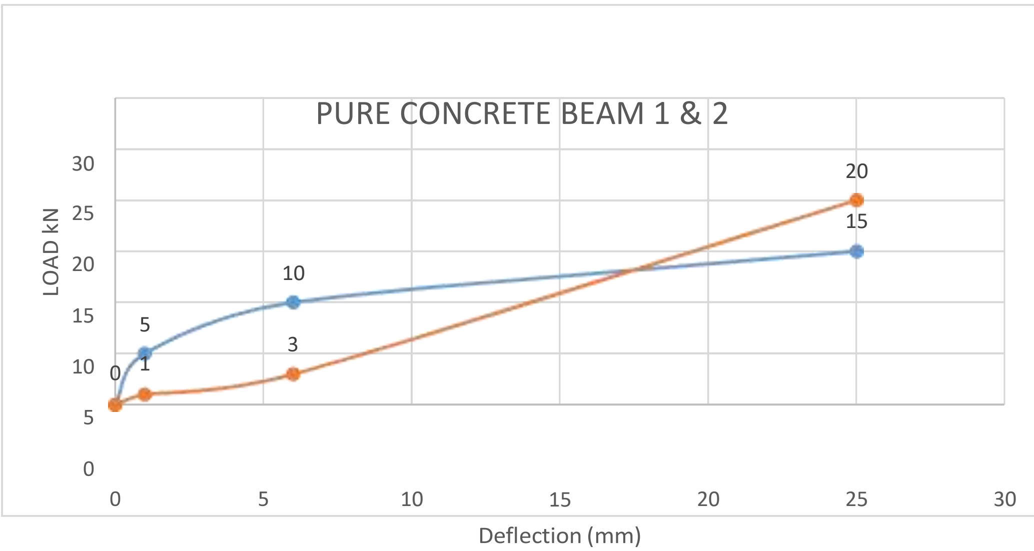


Figure 4.2: Load-Displacement Relation (For Type 1 Beam).

The line graph shows the relationship between load and displacement. A graph below depicts how displacement changes with load based on the information provided. It grows from zero to 0mm as the load increases from zero to 0kN. It increases tow pure concrete beam value to 1.0mm as the load increases to 5kN. As the load increases, so does the displacement. As the load increases to 15kN, this pattern continues, resulting in a displacement of 20mm. and second beam load increases to 15kN, this pattern continues, resulting in a displacement of 25mm.

4.3 Use 2@12 mm dia. Steel Bar

First condition: 100% reinforcement concrete beam. Its load capacity is 40kN and its deflection is 260mm.

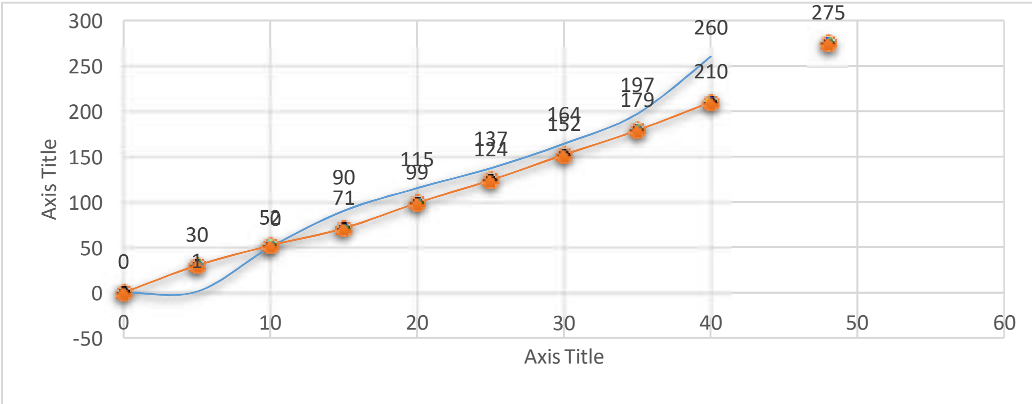


Figure 4.3: Load-Displacement Relation (For Type 2 Beam).

A graph below depicts how displacement changes with load based on the information provided. It grows from zero to 0mm as the load increases from zero to 0kN. It increases tow reinforced concrete beam value to 1.0 & 0 mm as the load increases to 5kN. As the load increases, so does the displacement. As the load increases to 40kN, this pattern continues, resulting in a displacement of 20mm. and second beam load increases to 48kN, this pattern continues, resulting in a displacement of 275mm.

4.4 Use 3@12 mm dia. Bar Textile Polyester Fabrics

3rd Condition we have used 3@12mm dia. Bar textile polyester fabric reinforced. The load capacity applied 15kN and displacement 98mm.

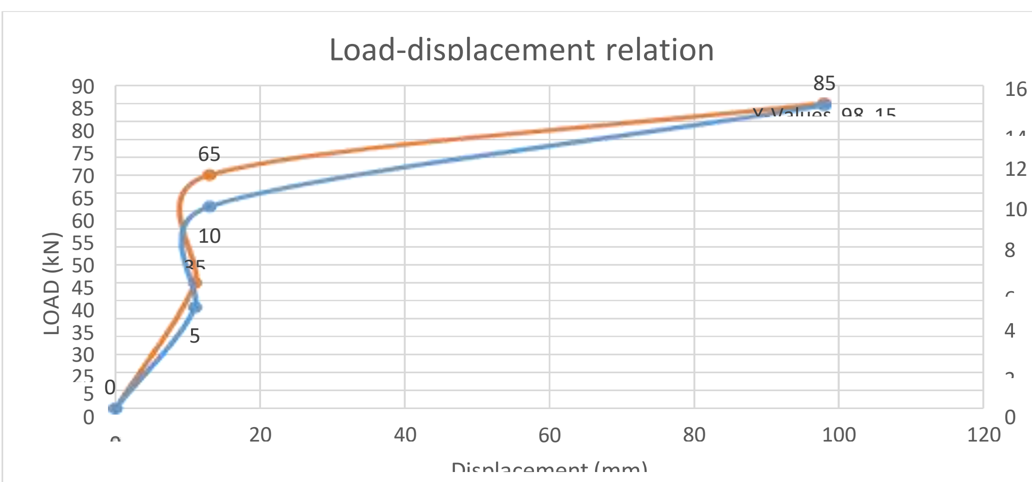


Figure 4.4: Load-Displacement Relation (For Type 3 Beam).

The graph demonstrates the correlation between load and displacement. Based on the provided information, the following is a breakdown of how displacement alters with changing load: The displacement rises to 11mm with a rise in load to 5kN. As the load continues to increase, the displacement increases proportionately. This pattern continues when the load climbs to 15kN, resulting in a displacement of 98 mm.

4.5 Use 2@12 mm dia. Bar Textile Polyester Fabrics

3rd condition we have used 2@12mm dia. Bar textile polyester fabric reinforced. The load capacity applied 15kN and displacement 70mm.

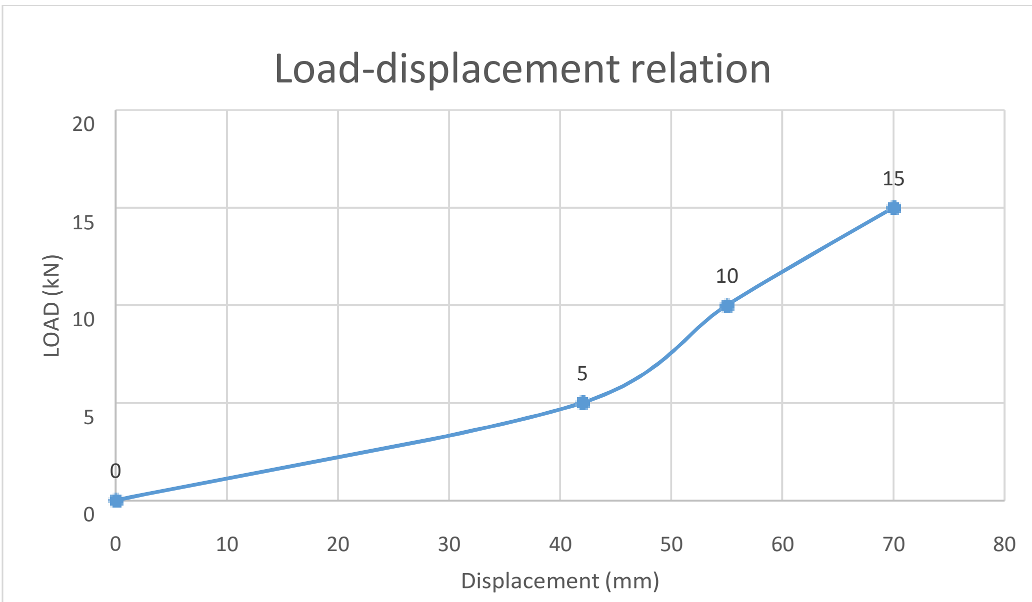


Figure 4.5: Load-Displacement Relation (For Type 4 Beam).

The relationship between load and displacement is depicted in the graph. The information given allows for the following breakdown of how displacement changes in response to a load change. The displacement rises to 42mm with a boost in load to 5kN. As the load continues to increase, the displacement increases proportionately. The pattern persists when the pressure rises to 15kN, providing a displacement of 70 mm.

4.6 Chemical Test Elongation

Table: 4.6: Chemical Test Report.

S/L	Chemical Name	Test of 7 Days	Test 14 Days	Test 28 Days
1	Normal Rope	64 mm		
2	NaCl	72mm	82mm	96mm
3	$CaCO_3$	113mm	128mm	143mm
4	$MgSO_4$	78mm	93mm	115mm
5	H_2SO_4	55mm	63mm	78mm

After doing the normal rope elongation test, the length is 64 mm. And different values have been obtained after the use of chemicals. Namely, the values of first 7 days, 14 days and 28 days after application of this chemical NaCl2 respectively.72mm 82mm 96mm. And after application of CaCO3 chemical the same day values are 113mm 128mm 143mm respectively. and after using MgSO4 chemical respectively same day value 78mm 93mm 115mm. and after using H2SO4 chemical respectively same day value 55mm 63mm 78mm.

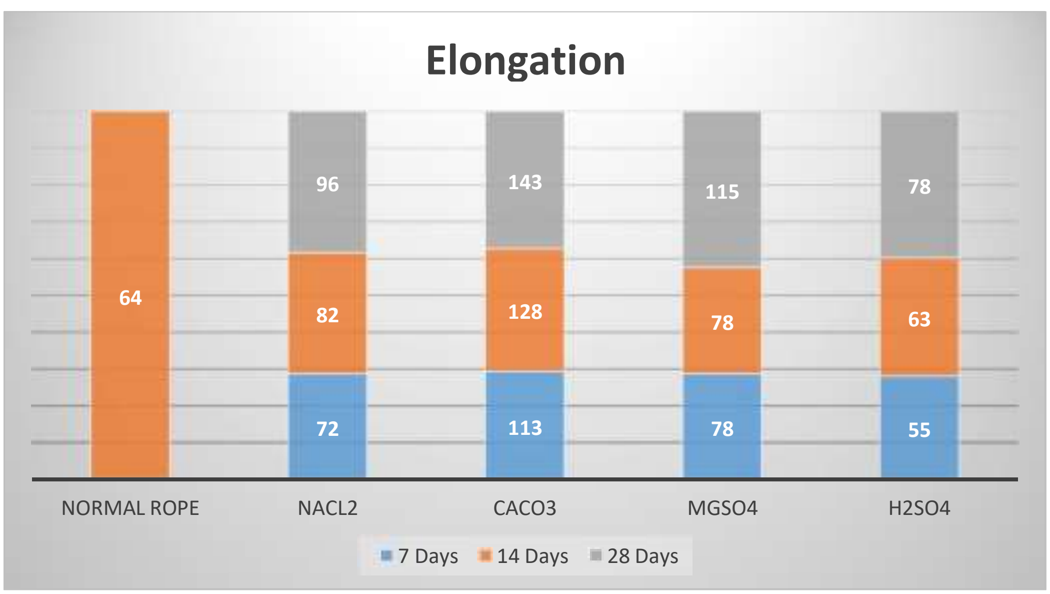


Figure 4.6: Elongation Test Result

4.7 Pull Out Test

Table: 4.7: Pul Out Test Report.

S/L	Name of Chemical	Previous rope length (mm)	After apply Length (mm)	Ave Displacement (mm)
1	NO Chemical			57
2	Heat (200°)			46
3	NaCl	435	513	78
4	$CaCO_3$	433	532	99
5	$MgSO_4$	432	545	113
6	H_2SO_4	438	508	96

The line graph shows the relationship between load and displacement. A graph below depicts how displacement changes with load based on the information provided. Use Pure Concrete Without Steel Beam load capacity is 10 KN, and the deflection is25mm.Use 2@12 mm dia. Steel Bar load capacity is 40kN and its deflection is 260mm. Use 3@12 mm dia. Bar Textile Polyester Fabrics load capacity applied 15kN and displacement 98mm. Use 2@12 mm dia. Bar Polyester Fabrics load capacity applied 15kN and displacement 70mm. Chemical Test Elongation After doing the normal rope elongation test, the length is 64 mm. And different values have been obtained after the use of chemicals. Namely, the values of first 7 days, 14 days and 28 days after application of this chemical NaCl respectively.72mm 82mm 96mm. And after application of CaCO3 chemical the same day.

4.8 Failure pattern

There are two main categories of failure modes in reinforced concrete beams: shear failure and flexural failure. The former happens when the applied load is more than the flexural capacity of the beam's materials, whereas the latter happens when there is insufficient shear resistance between the beam's various materials. This study's beams all experienced flexural failure.

Figure 4.8.1: Failure Pattern (for Type 1-1 Beam)

Figure 4.8.2: Failure Pattern (for Type 1-1 Beam)

Figure 4.8.3: Failure Pattern (for Type 1-2 Beam)

Figure 4.8.4: Failure Pattern (for Type 2-1 Beam)

Figure 4.8.5: Failure Pattern (for Type 2-2 Beam)

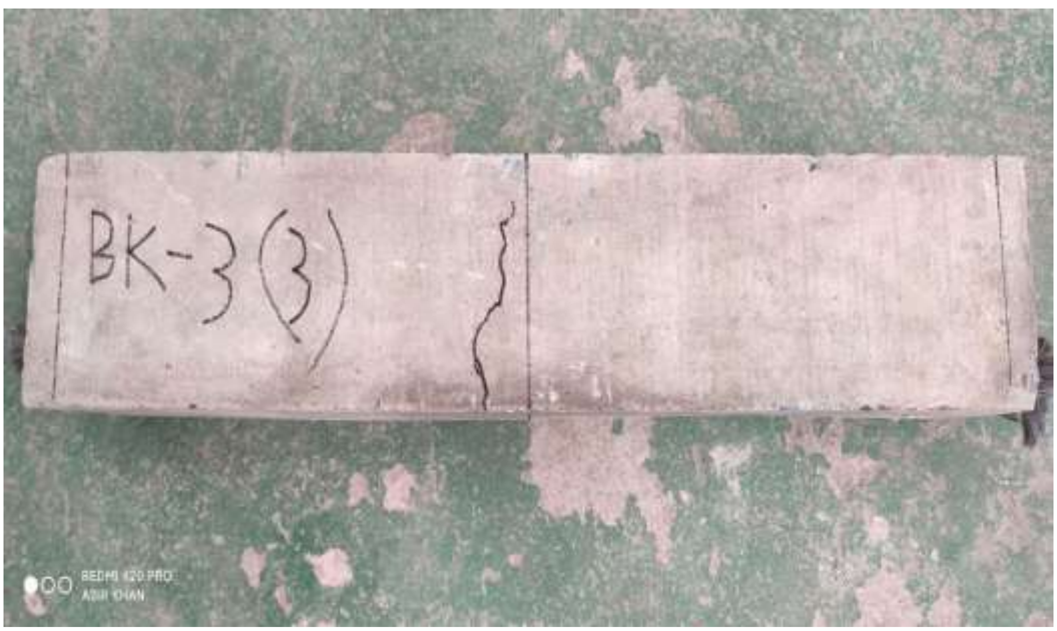


Figure 4.8.6: Failure Pattern (for Type 3-1 Beam)

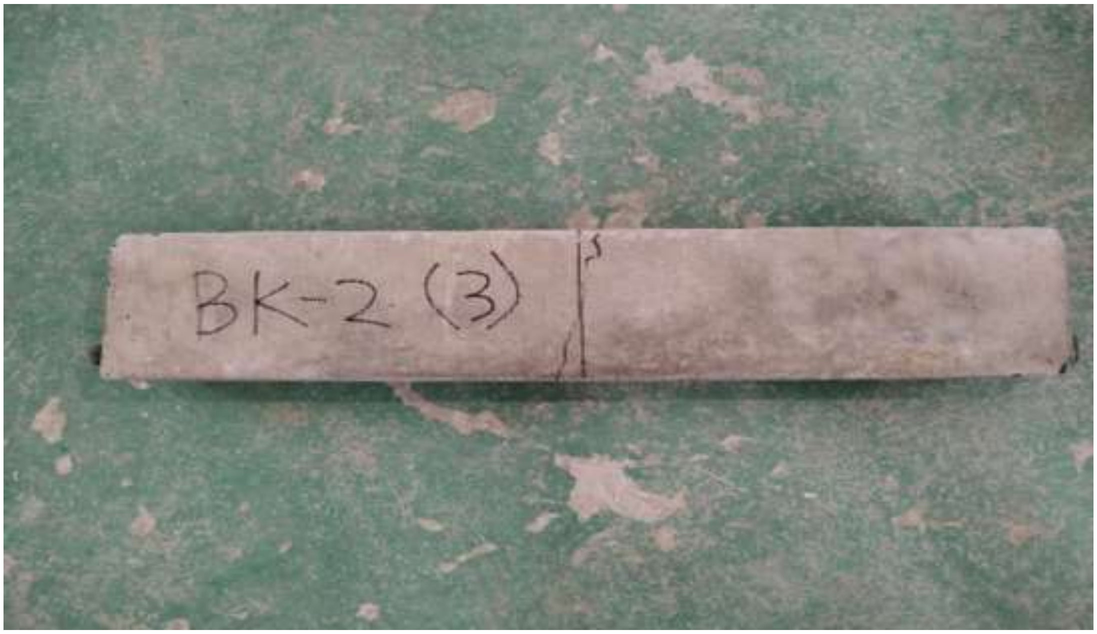


Figure 4.8.7: Failure Pattern (for Type 3-2 Beam)

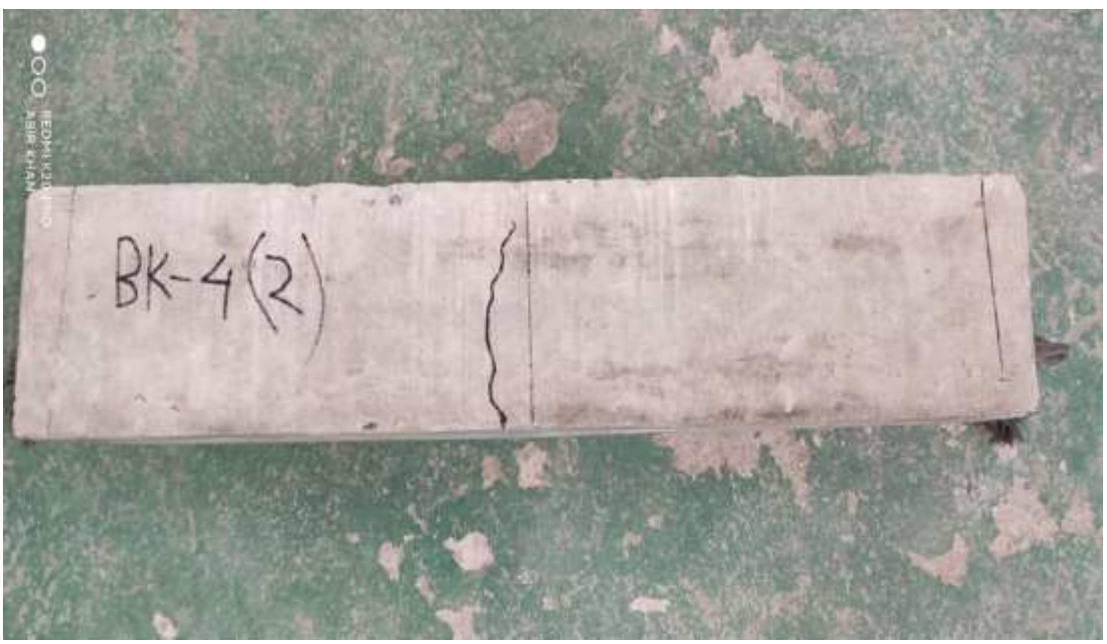


Figure 4.8.8: Failure Pattern (for Type 4-1 Beam)

Figure 4.8.9: Failure Pattern (for Type 4-2 Beam)

Tension Failure: When the tensile reinforcement yields and the concrete cracks in tension, leading to the failure of the beam. This is often due to inadequate steel reinforcement.

Compression Failure: When the concrete in the compression zone of the beam crushes, leading to a brittle failure. This usually happens if the beam is over-reinforced (Excess steel).

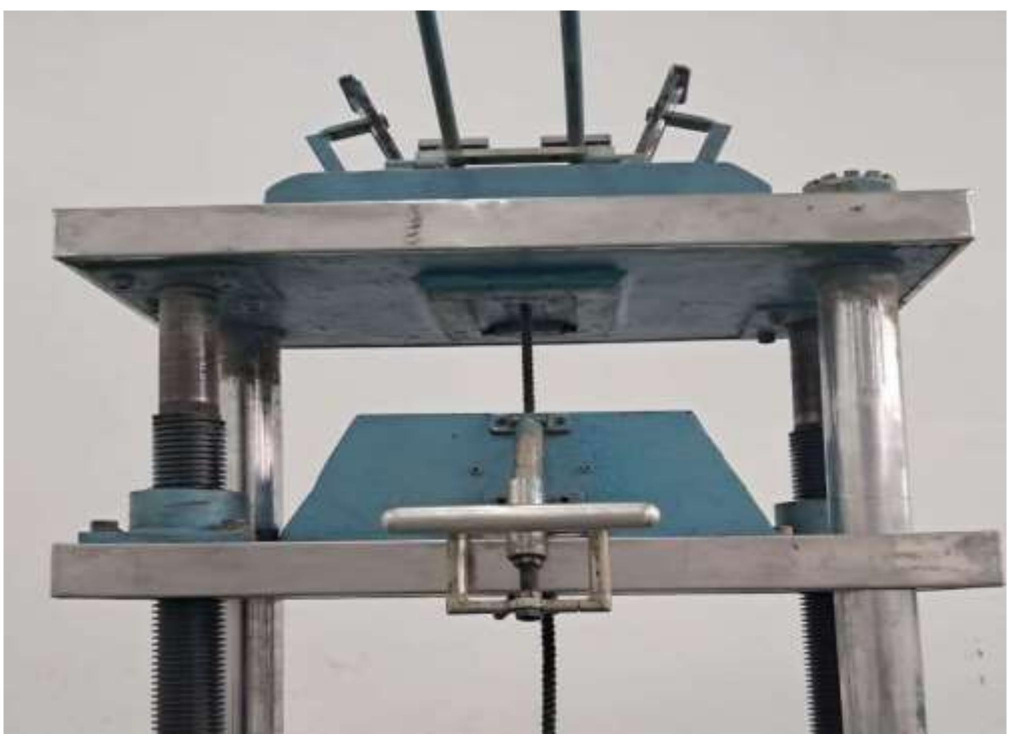


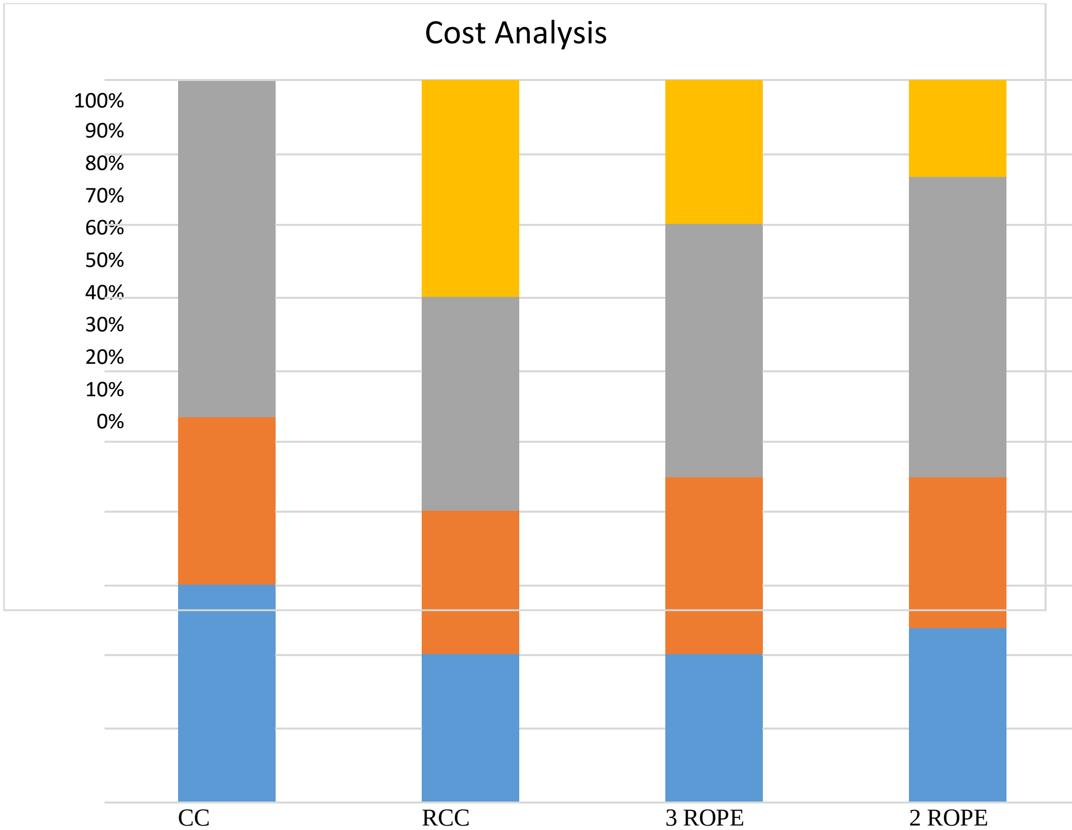
Figure 4.8.10: Failure Pattern (for Elongation)

Figure 4.8.11: Failure Pattern (for PUL-OUT)

Tension Failure When the tensile reinforcement yields and the concrete cracks in tension, leading to the failure of the beam. This is often due to inadequate steel reinforcement. Compression Failure When the concrete in the compression zone of the beam crushes, leading to a brittle failure. This usually happens if the beam is over- reinforced (excess steel). Failure of the pull-out test occurs when the reinforcement or anchor does not resist withdrawal from the concrete, indicating inadequate bonding strength or insufficient embedment depth in the material. Failure of the elongation test occurs when a material stretches beyond its capacity, resulting in breakage or failure to meet specified elongation standards, indicating inadequate ductility or tensile strength.

4.9 Cost Analysis

Four different types of beams have been constructed. It has 100% reinforcements for the first beam. 2nd beam is reinforced with 75% reinforced textile fabric. The thirdbeam is made of 40% reinforced textile fabric, because there is less reinforcement in the second, and third beam, the price is likewise lower.



	CC	RCC	3 ROPE	2 ROPE
Reinforced		125	70	47
Stone	140	140	140	140
Sand	78	78	78	78
Cement	83	83	83	83

Figure 4.9: Cost Analysis

Type-1. Use Pure Concrete Without Steel Beam.

This pure concrete beam, whose size is 2 feet 6 inches, cost **301**±Tk to make.

Type-2. Use 2@12 mm dia. Bar Steel.

This pure concrete beam, whose size is 2 feet 6 inches, cost **301**± Taka to make this beam.

Type-3. Use 3@12 mm dia. Bar Textile Polyester Fabrics.

This is polyester fabric reinforced concrete beam, and we use 3@12mm polyester fabric reinforced beams. The size of this beam is 2 feet 6 inches, it costs **371**± Taka to make this beam.

Type-4. Use 2@12 mm dia. Bar Textile Polyester Fabrics.

This is polyester fabric reinforced concrete beam, and we use 2@12mm polyester fabric reinforced beams. The size of this beam is 2 feet 6 inches, it costs **348**± Taka to make this beam.

CHAPTER 5

5.1 Discussion

Polyester Fabric Reinforced Concrete Beams are a unique concept in civil engineering in which standard steel reinforcing in concrete structures are substituted or enhanced with polyester fabric. This type of reinforcement is very useful in corrosive settings or where minimal weight is an important aspect.

The use of polyester fabric reinforcement provides several distinct advantages, but it also poses issues that must be carefully addressed. Polyester Fabric Reinforced Concrete Beam To investigate, we used one solid concrete beam and two reinforced concrete beams. Make a beam. And apply load using polyester fabric 12 mm size without reinforcement. By analyzing the data here, it can be understood that the replacement is possible in accordance with the reinforcement.

And make concrete cylinder size L 203.2mm and Dia101.6mm. There are 22, 25, and23 MPa applied loads. But the tensile type data of Polyester Fabric is not available. So, we apply elongation and the data we collect is 64 mm displacement without using any chemicals. Then by pull out test we collect the data normal without using any kind of chemicals 57 mm and heating at 200°(degree) Celsius temperature we collect the data 46mm.Different data have been obtained using chemicals. The chemicals are NaCl, $CaCO_3$, $MgSO_4$, H_2SO_4, and elongation and pull-out tests are done by curing in these chemicals for 7 days, 14 days and 28 days.

The cost of steel will be reduced by making these Polyester Fabric Reinforced Concrete Beams. And it is better to use this beam salted area. And steel, like rust, will last for many years if kept dry. The main purpose of this resurgence is to make any small structure possible at low cost and without risk.

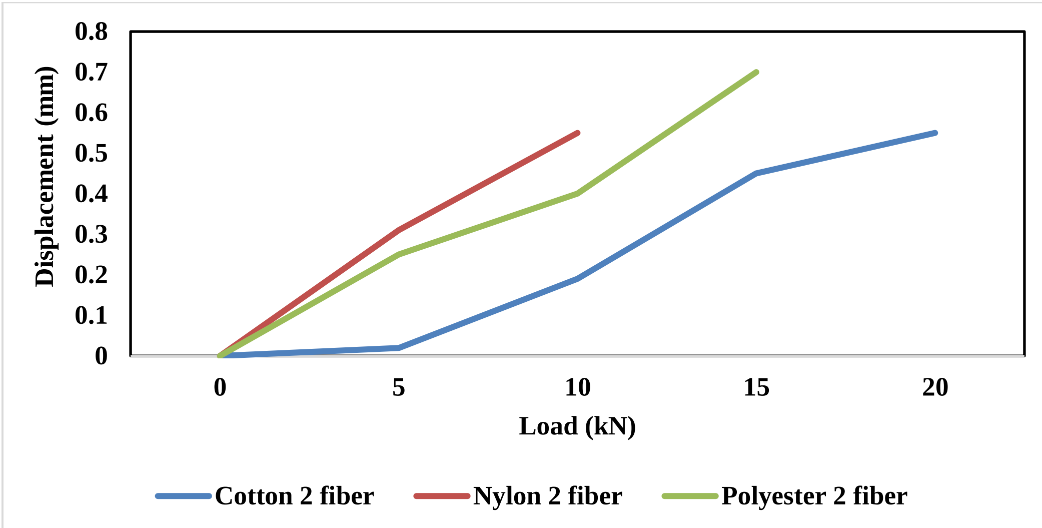
5.2Conclusion

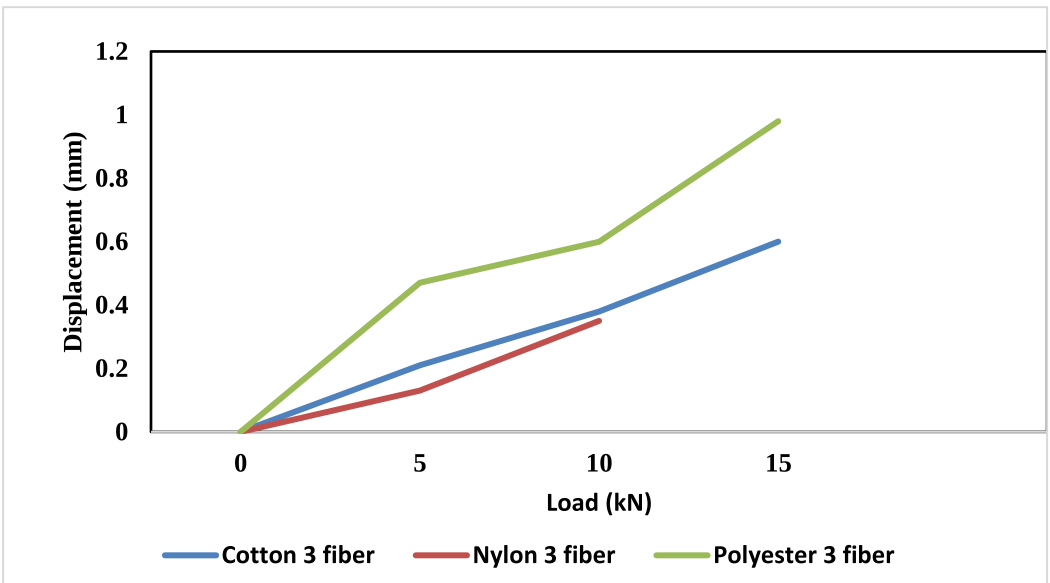
1. This study determines how much load and deflection can be achieved by replacing steel with polyester fabric reinforced, and where it can be used. Comparing a steel beam load and deflection with replacement. There are four different beams constructed, which can be used to discuss where replacement may be used. Beam - CC is made pure concrete beam, has a 10 KN load capacity and a 0.25 mm deflection. Beam - RCC is 2-12 mm diameter reinforced beam, it has a 40 KN load capacity and a 2.60 mm deflection. Beam - 2 Nos fiber is 2-12 mm diameter polyester fabric reinforced Beam; it has a 15 KN load capacity and a 0.70 mm deflection. Beam - 3 Nos fiber is 3-12 mm diameter polyester fabric reinforced beam; it has a 15 KN load capacity and a 0.98 mm deflection. Beam - 2 Nos fiber can carry much less load than Beam - RCC. Beam - 2 Nos fiber can be used where there is less load and no live load.

2. Cost comparison between The RCC Beam and 2 Nos PRC Beam has a 21.05% cost savings and The RCC Beam and 3 Nos PRC Beam has a 14.24% cost savings. Maximum Elongation for 7 days ,14 days and 28 days is found in NaCl chemical polyester fabric fibers. Secondly and Thirdly maximum Elongation shown in $MgSO_4$ and $CaCO_3$ chemical polyester fabric fibers. The lowest Elongation 7 days ,14 days and 28 days is found in H_2SO_4 Chemical polyester fabric reinforced concrete. NaCl chemical effect on the elongation of PF 7 days 48.58%, 14 days 46.55% and 28 days 44.82% increased. $MgSO_4$ chemical effect on the elongation of PF 7 days 47.9%, 14 days 45.47% and 28 days 44.52% increased. $CaCO_3$ chemical effect on the elongation of PF 7 days 51.14%, 14 days 49.43% and 28 days 48.39% maximum increased. H_2SO_4 chemical effect on the elongation of PF 7 days 120.55%, 14 days 115.95% and 28 days 109.55% decreased.

3. polyester fabric reinforcedconcrete (PFRC) beam enhancing sustainability in construction. polyester fibers don’t improve concrete tensile strength, crack resistance, and durability, reducing the need for heavy reinforcement materials like steel.

4. The carbon impact of traditional concrete constructions is reduced. Incorporating polyester fibers into concrete beam offers an eco-friendly alternative, improving both structural performance and sustainability.





Comparisons various type of polymer fiber

5.3 Recommendation

In order to increase the strength of polyester fabric reinforced beams in the future, consider using double reinforcement. Twisting three polyester fabric reinforcements yields a better outcome. Further research is required on this topic. Bitumen or other chemicals can be used to reinforce polyester fabrics for longer-lasting durability. Improved outcomes are thus feasible. Further research is needed to develop innovative and sustainable polyester fabric reinforcing designs.

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APPENDIX

Table 4.8: Load-displacement (for pure concrete beam-1&2).

LOAD (kN)	Beam 1 of Displacement (mm)	Beam 2 of Displacement (mm)
5	1.0	1.0
10	6.0	3.0
15	25	20

Table 4.9: Load-displacement (for reinforced concrete beam-1&2).

LOAD (kN)	Beam 1 of Displacement (mm)	Beam 2 of Displacement (mm)
5	1	0
10	50	30
15	90	52
20	115	71
25	137	99
30	164	124
35	197	152
40	260	179
45		210
48		275

Table 4.10: Load-displacement (for 3@12 mm dia. Bar Polyester Fabrics two beam).

LOAD (kN)	Beam 1 of Displacement (mm)	Beam 2 of Displacement (mm)
5	10	35
10	11	65
15	98	85

Table 4.11: Load-displacement (for Use 2@12 mm dia. Bar Polyester Fabrics beam).

LOAD (kN)	Beam 1 of Displacement (mm)
5	42
10	55
15	70

Table 4.12: Load-displacement of Polyester Fabrics beam Elongation

S/L	Chemical Name	Test of 7 Days	Test 14 Days	Test 28 Days
1	Normal Rope	64 mm		
2	NaCl	72mm	82mm	96mm
3	$CaCO_3$	113mm	128mm	143mm
4	$MgSO_4$	78mm	93mm	115mm
5	H_2SO_4	55mm	63mm	78mm

Table 4.13: Load-displacement of Polyester Fabrics beam pul-out

S/L	Name ofChemical	Previous rope length (mm)	After apply Length (mm)	Ave Displacement (mm)
1	NO Chemical			57
2	Heat (200°)			46
3	NaCl	435	513	78
4	$CaCO_3$	433	532	99
5	$MgSO_4$	432	545	113
6	H_2SO_4	438	508	96