SUSTAINABILITY POTENTIAL OF NYLON-REINFORCED CONCRETE BEAM

Submitted by

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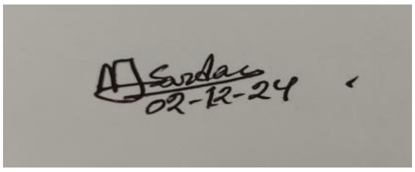

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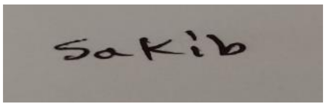

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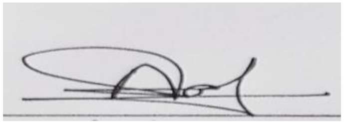

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DEDICATION

This thesis is dedicated to all of our parents, relatives, and teachers who inspired us for made this effort possible.

ABSTRACT

Concrete is one of the most widely used construction materials worldwide, however its environmental impression, especially concerning of carbon emissions, has prodded a search for additional sustainable alternatives. This study investigates the capability of nylon-reinforced concrete beams as an economical answer for construction. In tension, concrete is frequently weaker than in compression. To expanded the tensile strength of cement, fibers are added. Nylon fibers (NF) have shown significant increases in concrete performance. The vital parts of this Nylon fiber (NF) concrete flowability, compressive strength, tensile strength, impact strength, rehabilitation, performance during irradiation, and fire resistance. In addition, the article examines the fracture behavior and failure patterns of nylon FRC. The outcomes show that NF upgraded concrete performance, notably tensile capacity, owing to bridging mechanisms, but lowered concrete flow properties. However, some analyst demonstrates that NF does not improved the compressive capacity significantly.

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CHAPTER 1 INTRODUCTION

1.1 General

In tension, concrete is frequently weaker than in pressure. To expanded the tensile of concrete, fiber is added. Nylon fiber (NF) have shown promising outcomes in past exploration and tests since their presence has shown huge expansions in concrete performance (Qureshi, Ahmad, Aljabr, & Garcia-Troncoso, 2023). Generally, steel has been the essential support material, however late progressions in materials science have introduced alternative fibers, such as nylon, to improve the sustainability and mechanical properties of concrete. Nylon fiber-reinforced concrete (NFRC) presents a promising development in the field of construction materials. Nylon fibers, being synthetic polymers, offer a few benefits including high tensile strength, flexibility, and resistance to chemical degradation. These properties make nylon fibers an attractive choice for improving the toughness and post-cracking behavior of concrete beams. The utilization of nylon fibers in concrete improves its mechanical properties as well as adds to the manageability of the construction industry. Nylon is lightweight, environmentally friendly, and can be created from reused materials, thereby reducing the environmental impact associated with conventional reinforcement methods. Moreover, nylon fiber reinforcement can potentially reduce the amount of steel required, lowering the carbon footprint of concrete structures (Banthia & Gupta, 2004).

This research aims to explore the sustainability potential of nylon fiber-reinforced concrete beams, focusing on their mechanical performance, durability, and environmental impact. By investigating these aspects, the study seeks to provide insights into the feasibility of adopting NFRC as a sustainable alternative in modern construction practices (Samrose & Mutsuddy, 2019).

1.2 Objective

- Comparison of strength between normal reinforced concrete beam and nylon reinforced concrete beam.
- Cost comparison between normal reinforced concrete beam and nylon reinforced concrete.
- Use nylon fiber reinforcement to increase the tensile strength, durability, and crack resistance of concrete.
- Analyses the potential of nylon fiber reinforced concrete to reduce the use of steel reinforcement.

1.3 Purpose of the Study

The construction industry plays a significant role in global environmental challenges, especially through its broad utilization of concrete, which is responsible for a large portion of the world's CO_2 emanations. Concrete is expected to become more popular as urbanization rise up speed, which will enhance its environmental impact. Finding innovative, sustainable solutions for decrease the carbon impression of substantial designs has turned into a basic need. Nylon- reinforced concrete beams offer a promising option by tending to both environmental and structural challenges. Nylon, as a manufactured polymer, is lightweight, corrosion-resistant and more efficient to deliver contrasted with steel. This point is crucial as it lines up with the worldwide push for greener construction methods that limit the carbon impression of foundation projects. By exploring the mechanical and environmental advantages of nylon reinforcement, this research contributes to the development of sustainable alternatives that could help the construction industry transition towards more eco-friendly practices. The reception of such materials could have long haul suggestions for reducing emissions, conserving resources, and promoting sustainable growth in urban areas.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Nylon a synthetic polymer known for its durability and flexibility, is progressively being investigated with regards to sustainable construction. Using nylon fibers into concrete beams provides potential advantages for addressing manageability difficulties and improving fundamental performance. Nylon is non-corrosive, lightweight, and resistant to environmental degradation, which reduces maintenance and expands the lifespan of reinforced structures. Besides, reinforced concrete has the potential to reduce waste through the use of recycled nylon materials, consequently adding to the round economy. This literature review aims to investigate the sustainability potential of nylon-reinforced concrete beams by analyzing existing exploration on the environmental effect, mechanical properties and long-term performance of nylon fibers in substantial applications. It will likewise assess how the reconciliation of nylon strands contrasts and other fiber-built up cements with regards to both ecological and underlying advantages. Understanding these variables is significant for evaluating the plausibility of utilizing nylon-reinforced concrete beams as a sustainable alternative in the construction industry. Therefore, the literature review was to find out the issues and gaps in the available literature that can support the justification of the research objectives. In the first part, studied the materials and their characteristics. And in the second part, discussed the effects and behavior of the material under pressure (Mohiuddin, Abhi, Ulfat, & Chowdhury, 2023).

2.2 Previous Sustainable potential of Nylon Reinforcement concrete

Nylon fibers a synthetic polymer, have received attention for their high tensile strength, flexibility, and resistance to environmental degradation. According to studies, adding nylon fibers to concrete can increase its effect on stress, crack, and toughness resistance. According to, nylon fibers have the ability to improve concrete's post-cracking behavior, which results in improved durability following the initial failure (Frazão, Barros, & Bogas, 2022).

Since nylon is a synthetic polymer with high tensile strength, flexibility, and resilience to chemical degradation, it has gained attention as a potential reinforcement material. Research like that conducted has proven how effectively nylon fibers work to improve the flexibility and crack resistance of concrete (Sbahieh, Tahir, & Al-Ghamdi, 2022).

The use of nylon fibers, which are synthetic polymers derived from polyamides, as reinforcement for concrete is receiving more and more attention. Nylon fibers are an ideal replacement for traditional steel reinforcement because of their high tensile strength, flexibility, and resistance to chemical and biological deterioration. According to studies, adding nylon fibers to concrete can increase its toughness, reduce cracks, and increase its overall durability across a range of loading conditions (Chen, et al., 2019).

Another significant factor influencing NFRC's sustainability is its adaptability. Corrosion resistance is a major advantage of nylon fibers over steel, which rusts easily in severe situations. Since NFRC constructions are resistant to environmental deterioration and chemical attack, they last longer and require less repairs and maintenance over time. According to, NFRC is a durable option for sustainable construction since it keeps its structural integrity over time, even under harsh environmental circumstances (Almasabha, Murad, Alghossoon, Saleh, & Tarawneh, 2023).

Synthetic polymers like nylon are known for their high tensile strength, flexibility, and resistance to degradation by chemicals. Research have shown that adding nylon fibers to concrete may significantly improve its toughness, impact resistance, and post-cracking behavior. Research conducted showed that nylon fibers had the ability to slow the propagation of cracks in concrete, improving the material's overall structural integrity (Alberti, Enfedaque, Faria, & Ruiz, 2014).

In this study 4 different beams are made. The beam was intended to replace steel with nylon reinforcement. Comparing the load and deflection with 100% steel beam and discussing how much % replace can be used where. Coarse aggregate, fine aggregate, cement reinforcement and water are used as materials for making the beam. As a fine aggregate, selected sand with an FM of 1.596 and as a coarse aggregate, selected stone with a unit weight of 1680kg/m3. The coarse aggregate has an absorption of 0.5 percent and a bulk dry specific gravity of 2.68.and Reinforcement is replaced by nylon fabrics.

2.3 Principle of Planning

2.3.1 Principles of Planning details

Sustainability and Performance: Nylon-reinforced concrete beams are an innovative solution aimed at improving the sustainability and performance of construction materials. Environmental and Mechanical: Integrating synthetic fibers like nylon into concrete can offer several environmental and mechanical advantages. Flexibility: The beam should arrange considering future necessities. Environmentally friendly: The Beam design should be harmless to the ecosystem and accommodating to the climate.

2.3.2 Future Requirement

Nylon might corrupt under specific ecological circumstances. Nylon- reinforced concrete beams are generally new in the business. Expanded research, contextual investigations, and shows will be expected to energize more extensive reception. Investigating potential reusing strategies for nylon-reinforced concrete will additionally improve its ecological advantages. To make the beam lightweight. To make the beam slight areas of strength for and a similar time. To utilize the Nylon materials to supplant the steel bar which gets consumed over the long haul. To create an open door to defeat the steel bar issues.

2.3.3 Prospect

Nylon fibers offer a lightweight. It should be a consumption-safe elective that can expand the life expectancy of should designs and lessen their environmental effect.

Beam should be carried; however, it likewise should look great from an external perspective. It should adjust well to the section and different individuals from the structure.

2.3.4 Aspect

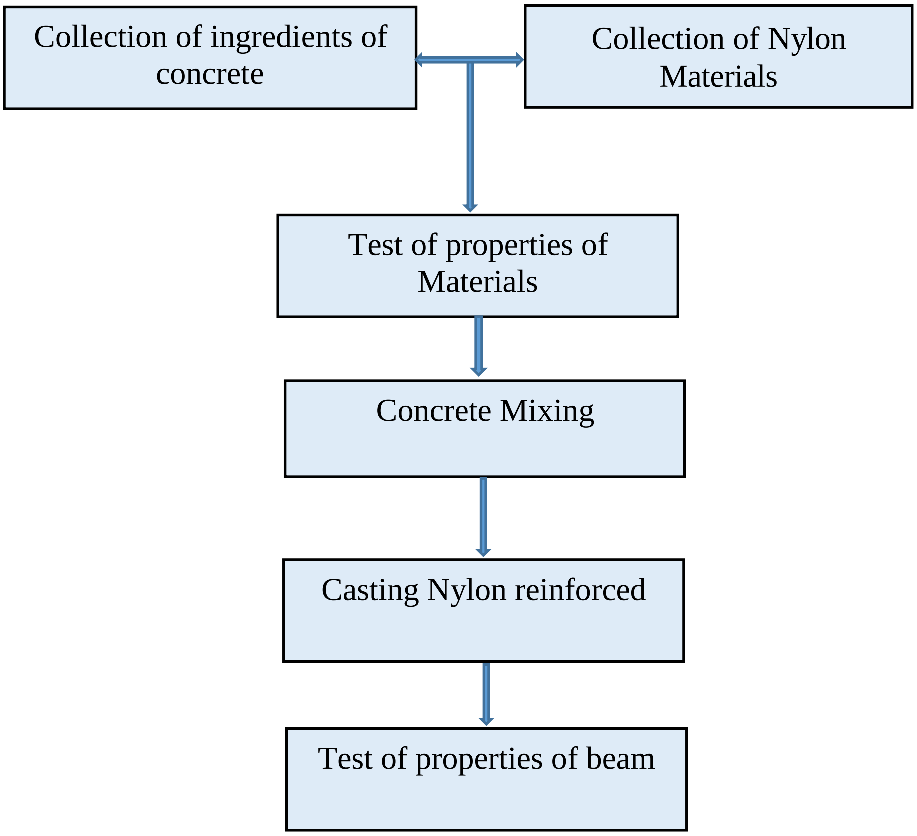
The part of Nylon-reinforced concrete beams addresses a creative methodology in the field of reinforced concrete structures. The primary part of the NRC is to make an affordable and eco-friendly substitute for steel reinforcement.

CHAPTER 3 MATERIALS AND METHODOLOGY

3.1 Material Used

In this work we have used fine aggregate, coarse aggregate, cement, reinforced steel and reinforced cotton fiber. There are some chemical NaCl, $MgSO_4$, $CaCO_3$, H_2SO_4 used this test.

3.1.1 Working Process



3.1.2 Fine Aggregate

As a fine aggregate, selected sand with an FM of 1.6. As a fine aggregate, selected stone with a unit weight of 1600 kg/m³.

Figure 3-1: Fine Aggregate

Table 3-1: FM for Fine Aggregate

Sieve No.	Weight of Retained (gm)	Percent (%) of Retained	Cumulative total	Fineness Modulus
#4	0.0	0	0	F.M.= $\frac{159.6}{100}$ =1.6
#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	

Figure 3-2: Fineness Modulus for Fine Aggregate

3.1.3 Coarse Aggregate

As a coarse aggregate, selected stone with a unit weight of 1680 kg/m³. The coarse aggregate has an absorption of 0.5 percent and a bulk dry specific gravity of 2.68.

Figure 3-3: Coarse Aggregate

Table 3-1: Coarse Aggregate

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	99.68	0.32
Pan	1.6	0.32	100	0
Total	500			

Figure 3-4: Coarse Aggregate

3.1.4 Concrete

The details of mixtures of conventional concrete of class M 15 used for all types of nylon reinforced are described.

Figure 3-5: Before Concrete Mix

Figure 3-6: Concrete Mix with Water

Figure 3-7: Concrete Mix

Figure 3-8: Slump Test

Table 2-3: Quantity of Materials

Component	Kg/m^3
Cement	5.5
Sand	10.45
Stone	20.35
Water	2.64

Table 3-3: Concrete Compressive Test for 28 days

Slender	Target Strength (Mpa)	Test Strength (Mpa)
1	15	17
2	15	20
3	15	18

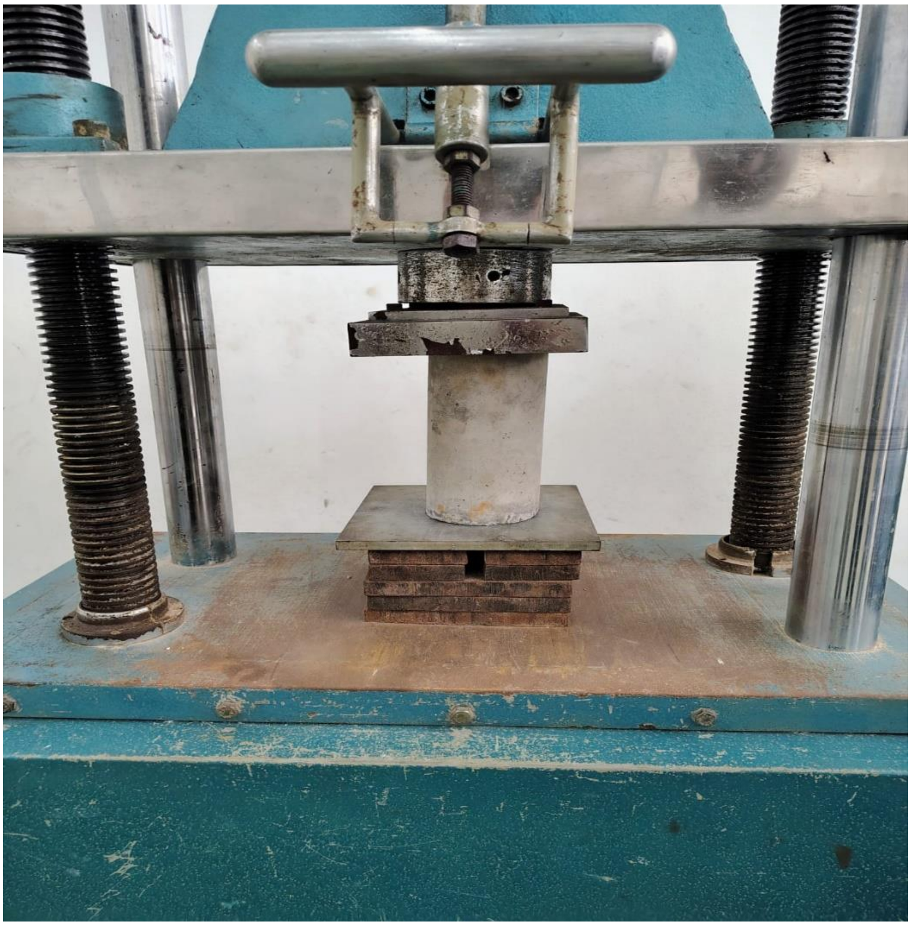


Figure 3-9: Compressive Strength Test for Slender


Figure 3-10: Compressive Strength Test for Slender

3.1.5 Reinforcement

Selected Nylon Fibers with an Elongation Length of 95.43 mm as a Nylon Reinforcement.


Figure 3-11: Nylon Reinforcement

Figure 3-12: Elongation Test of Nylon Reinforcement

3.2 Chemical Test

Table 3-4: Quantity of Chemical

Chemical	Content per litter
$NaCl_2$	100 ml (10%)
$MgSO_4$	100 ml (10%)
$CaCO_3$	10 g (1%)
H_2SO_4	20 ml (2%)

Figure 3-13: Chemical Curing of Nylon

Figure 3-14: Chemical Nylon Dry Process

Figure 3-15: Elongation Test for Chemical Nylon

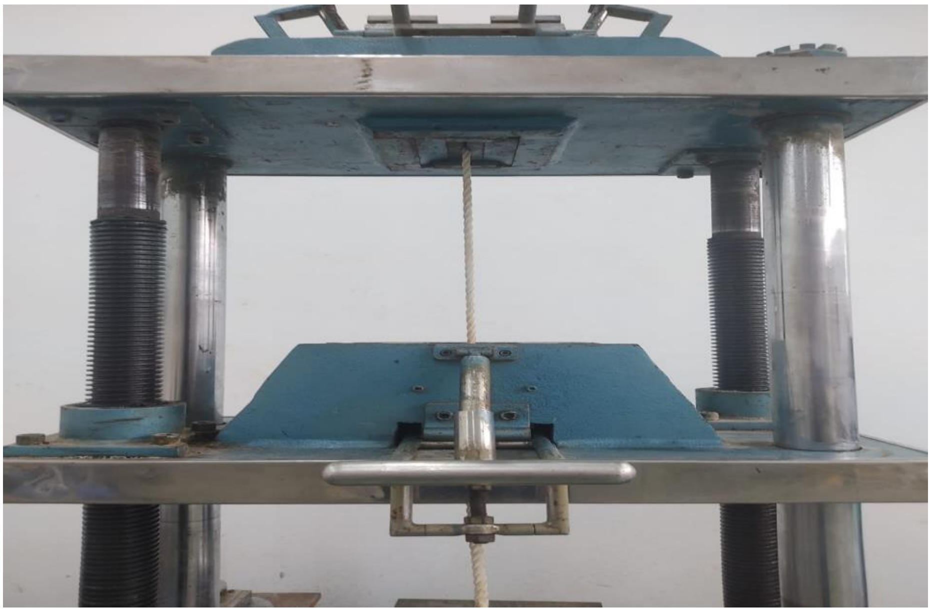


Figure 3-16: Elongation Test for Chemical Nylon

3.3 Cylinder Pull-Out Test

The bonding strength between different components is measured using a method called the pull-out test. The cylinder pull-out test for nylon fiber reinforcement is a useful instrument to evaluate how well nylon fibers bond with the surrounding structural material, which is typically concrete or another composite. Through the process of improved tensile strength, crack resistance, and overall durability, this test evaluates how well the nylon fibers reinforce the material.

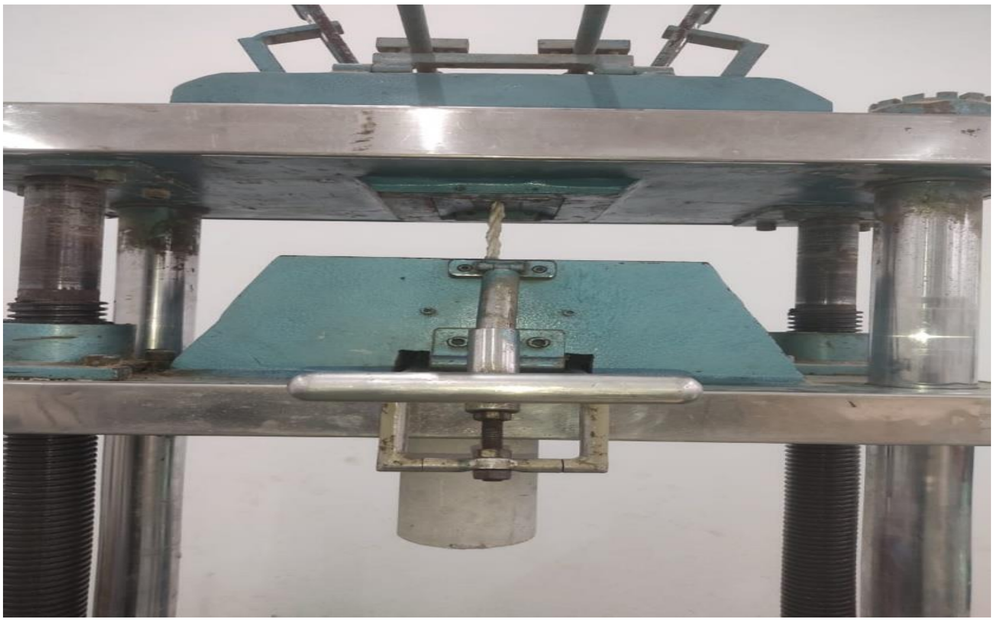


Figure 3-17: Pull-Out Test for UTM

3.3.1 Chemical Nylon Fiber

Figure 3-18: Chemical Nylon Fiber Test for UTM

3.3.2 Heat for 200º C

When using fair effaced in cylinder for 1-hour 200°C in this situation the elongation of the nylon fiber was found to be 52 mm in length under a tensile load.

Figure 3-19: Oven Heat for Cylinder Pull-Out Test

3.4 Comparison Variants

A total of four variants of concrete facade panels were compared:

- Type-1. Use Pure Concrete.
- Type-2. Use 2-12mm diameter bar Steel.
- Type-3. Use 2-12mm diameter bar Nylon Fibers.
- Type-4. Use 3-12mm diameter bar Nylon Fibers.

3.5 Bending Test

To assess the flexural execution of NRC beams in four unmistakable conditions, three-point bending tests were performed on each sample of the four circumstances.

Wooden formwork with the important last aspects was utilized to cast the beams. Before the beam was horizontally cast as delineated, the developed enclosure reinforcement was set into the formwork. Following 48 hours, beams were removed from the formwork and stored in a humid chamber until the test day, which was the point at which they were 28 days old.

Three-point bending tests in an UTM-universal testing machine hydraulic system with a 1000kN capacity were completed to survey the structural strength of the carbon-nylon reinforced concrete. Used to gauge the mid-range redirection of the beams, the investigations were driven by displacement at a 1 mm/min rate.

3.6 Beam

The beam is a part of the structural building. Beams in buildings are mainly spread horizontally and carry the vertical mass. The beam carries vertical gravitational force. firstly, the beam carries the load and transfers it to columns, walls, or girders. This load is finally transferred to the ground.

3.6.1 Types of Beam and Their Classification

There are many types of beams in terms of engineering-

i. Cantilever beam.

ii. Simply supported beam.

iii. Overhanging beam.

iv. Fixed beams.

v. Continuous beam.

vi. Trussed beam.

vii. Double overhanging beam.

viii. Beam on spring supports.

ix. Beam on elastic foundation.

Method different type of beams are given below:

I. Reinforced Concrete Beams.

II. Precast Concrete Beams.

III. Fiber-reinforced beams.

IV. Steel beams.

3.6.2 Formwork

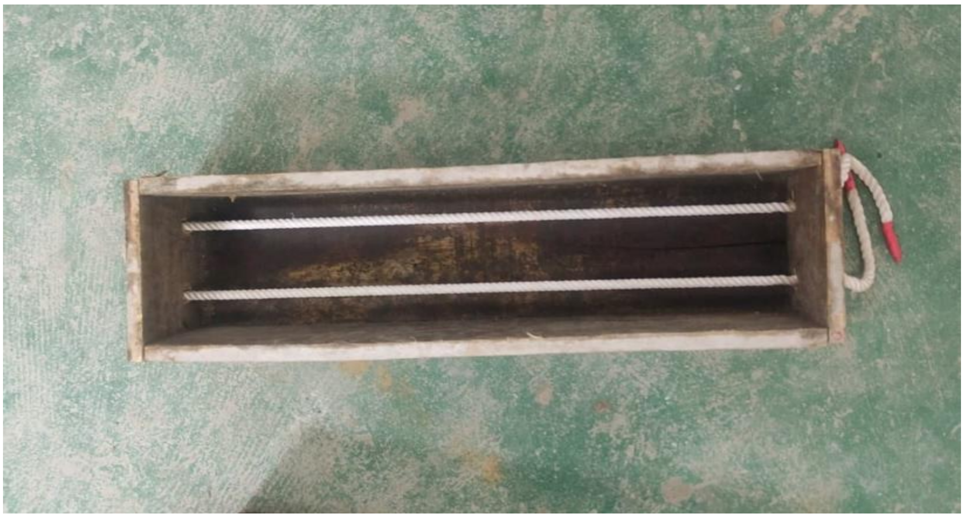


Figure 3-20: 2-12mm diameter bar Nylon Fibers

Figure 3-21: 3-12mm diameter bar Nylon Fibers

3.6.3 Casting

Figure 3-22: NRC Beam Casting

3.6.4 Curing

Figure 3-23: Beam Curing

CHAPTER 4 RESULT AND DISCUSSION

4.1 Chemical Test

4.1.1 Chemical ($NaCl_2$) Test for NF

Nylon fibers with an elongation length of 212.7 mm after curing in $NaCl_2$ chemical for 7 days as nylon reinforcement. Nylon fibers with an elongation length of 224.33 mm after curing in $NaCl_2$ chemical for 14 days as nylon reinforcement. Nylon fibers with an elongation length of 233.77 mm after curing in $NaCl_2$ chemical for 28 days as nylon reinforcement.

Table 4-1: $NaCl_2$ Test

Day	**Elongation (mm)**
7	212.7
14	224.33
28	233.77

4.1.2 Chemical ($CaCO_3$) Test for NF

Nylon fibers with an elongation length of 186.57 mm after curing in $CaCO_3$ chemical for 7 days as nylon reinforcement. Nylon fibers with an elongation length of 192.63 mm after curing in $CaCO_3$ chemical for 14 days as nylon reinforcement. Nylon fibers with an elongation length of 197.2 mm after curing in $CaCO_3$ chemical for 28 days as nylon reinforcement.

Table 4-2: $CaCO_3$ Test

Day	**Elongation (mm)**
7	186.57
14	192.63
28	197.2

4.1.3 Chemical ($MgSO_4$) Test for NF

Nylon fibers with an elongation length of 204.3 mm after curing in $MgSO_4$ chemical for 7 days as nylon reinforcement. Nylon fibers with an elongation length of 209.83 mm after curing in $MgSO_4$ chemical for 14 days as nylon reinforcement. Nylon fibers with an elongation length of 214.33 mm after curing in $MgSO_4$ chemical for 28 days as nylon reinforcement.

Table 4-3: $MgSO_4$ Test

Day	Elongation (mm)
7	204.3
14	209.83
28	214.33

4.1.4 Chemical (H_2SO_4) Test for NF

Nylon fibers with an elongation length of 81.8 mm after curing in H_2SO_4 chemical for 7 days as nylon reinforcement. Nylon fibers with an elongation length of 87.57 mm after curing in H_2SO_4 chemical for 14 days as nylon reinforcement. Nylon fibers with an elongation length of 92.33 mm after curing in H_2SO_4 chemical for 28 days as nylon reinforcement.

Table 4-4: H_2SO_4 Test

Day	Elongation (mm)
7	81.8
14	87.57
28	92.33

These tests are crucial for understanding the chemical stability and overall performance of nylon-reinforced concrete beams.

4.1.5 Combined All Chemical Variants

Maximum Elongation for 7 days ,14 days and 28 days is found in $NaCl_2$ chemical nylon fibers. Secondly and Thirdly maximum Elongation shown in $MgSO_4$ and $CaCO_3$ chemical nylon fibers. The lowest Elongation 7 days ,14 days and 28 days is found in H_2SO_4 Chemical nylon fibers.

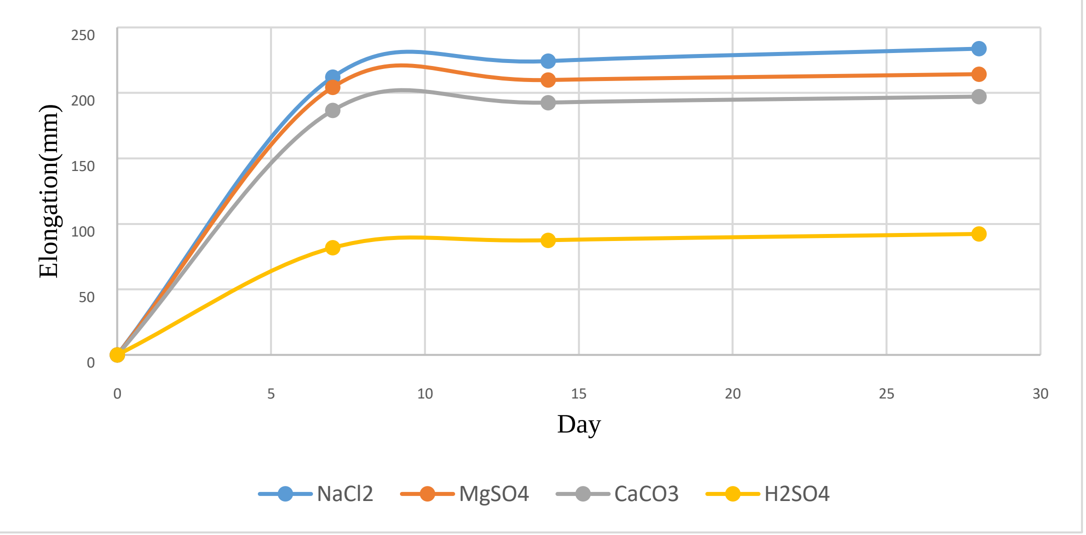


Figure 4-1: All Chemical Variants for Nylon Fiber

4.2 Cylinder Pull-Out Test

4.2.1 Chemical Nylon Fiber

The nylon fiber elongation under a tensile load was found to be 131 mm after 28 days of curing in $NaCl_2$, with an initial length of L_o = 432 mm and a final length of L_1 = 563 mm. The nylon fiber elongation under a tensile load was found to be 105 mm after 28 days of curing in $MgSo_4$, with an initial length of L_o = 432 mm and a final length of L_1 = 537 m21qm. The nylon fiber elongation under a tensile load was found to be 86 mm after 28 days of curing in $CaCO_3$, with an initial length of L_o = 432 mm and a final length of L_1 = 518 mm. The nylon fiber elongation under a tensile load was found to be 64 mm after 28 days of curing in H_2SO_4, with an initial length of L_o = 432 mm and a final length of L_1 = 496 mm.

4.2.2 Combined Pull-Out Test

There are six types of Slender that have been constructed. Firstly, cylinder pull-out test for normal fiber. Secondly, Cylinder is the $NaCl_2$ chemical pull-out test. Thirdly, Cylinder is the $MgSO_4$ chemical pull-out test. Fourthly, Cylinder is the $CaCO_3$ chemical pull-out test. Fifthly, Cylinder is the H_2SO_4 chemical pull-out test and lastly cylinder is the heat analyses pull-out test. In this case there is less Elongation in the last cylinder.

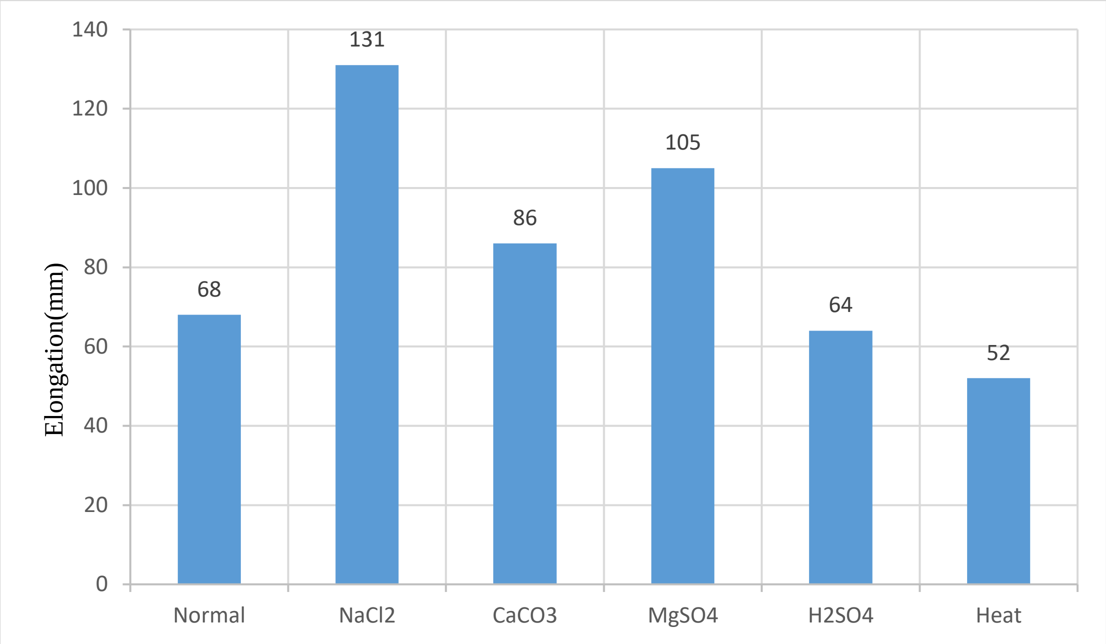


Figure 4-2: Combined Cylinder Pull-Out Test

4.3 Result of Beam Test

Beams are prepared in 4 conditions. The deflection 'f' each has been in govern; discuss replacing reinforced and how much the cost and load have reduced.

4.3.1 Pure Concrete

First condition: Pure concrete beam. It has a 10 KN load capacity and a 0.225 mm deflection.

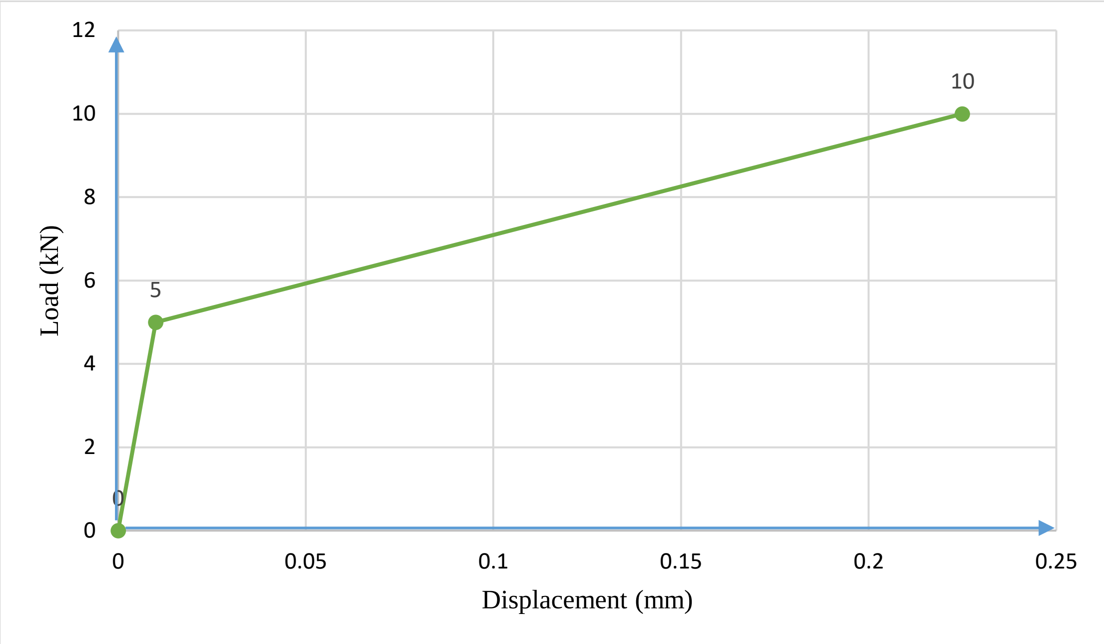


Figure 4-3: Load-Displacement Relation for Pure Concrete

The relationship between load and displacement is shown in the graph. This is an overview of how displacement changing with load based on the information provided.

The displacement rises to 0.01 mm with a further rise in load to 5 KN. The displacement grows in step with the load as it continues to rise. As the load increases to 10 KN this pattern persists, leading to a displacement of 0.225 mm.

4.3.2 Reinforcement Concrete

First condition:2-12mm diameter bar reinforcement concrete beam. It has a 48 KN load capacity and a 2.75 mm deflection.

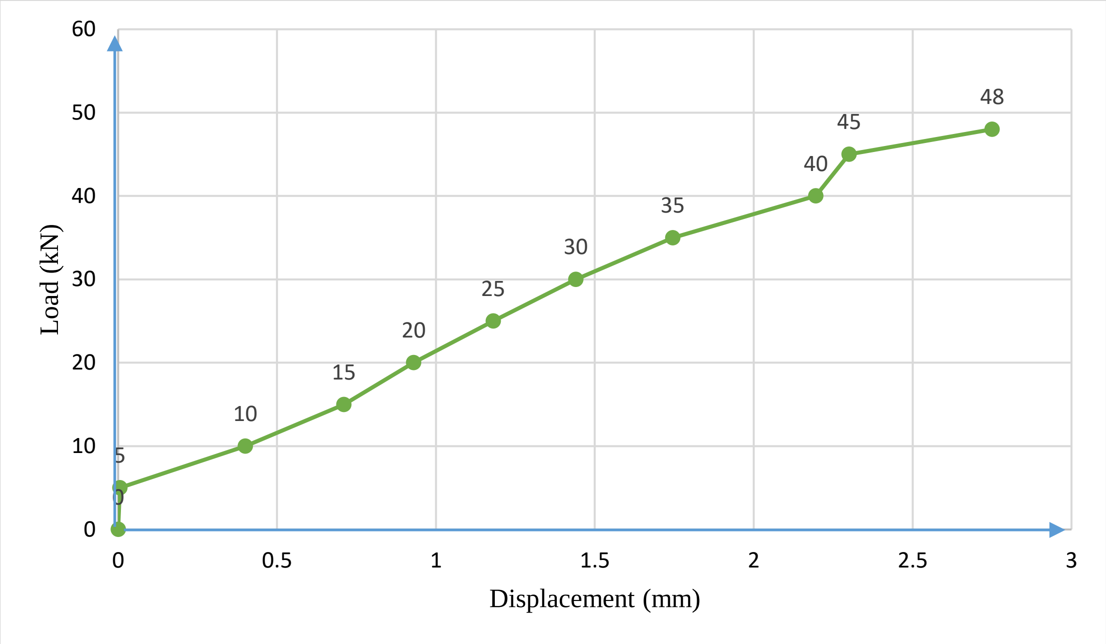


Figure 4-4: Load-Displacement Relation for Reinforcement Concrete

The relationship between load and displacement is shown in the graph. This is an overview of how displacement changing with load based on the information provided.

The displacement rises to 0.005 mm with a further rise in load to 5 KN. The displacement grows in step with the load as it continues to rise. As the load increases to 48 KN this pattern persists, leading to a displacement of 2.75 mm.

4.3.3 Nylon Reinforcement Concrete (Use 2-12mm)

First condition: 2-12mm diameter bar nylon fiber reinforcement concrete beam. It has a 10 KN load capacity and a 0.55 mm deflection.

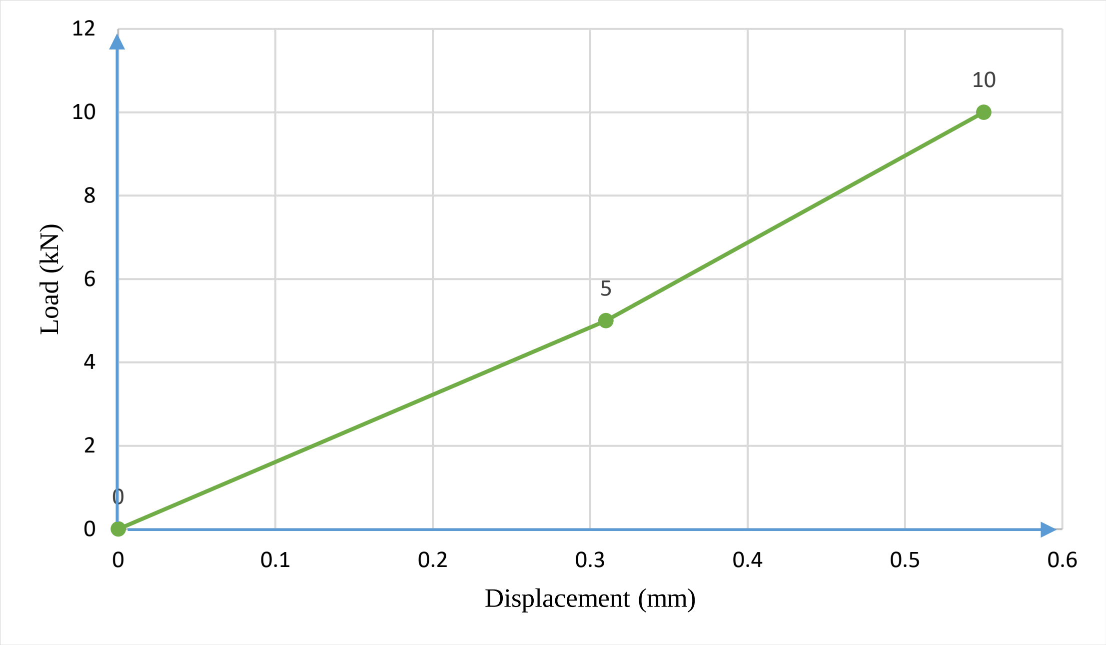


Figure 4-5: Load-Displacement Relation for NRC

The relationship between load and displacement is shown in the graph. This is an overview of how displacement changing with load based on the information provided.

The displacement rises to 0.31 mm with a further rise in load to 5 KN. The displacement grows in step with the load as it continues to rise. As the load increases to 10 KN this pattern persists, leading to a displacement of 0.55 mm.

4.3.4 Nylon Reinforcement Concrete (Use 3-12mm)

First condition: 3-12mm diameter bar nylon fiber reinforcement concrete beam. It has a 10 KN load capacity and a 0.35 mm deflection.

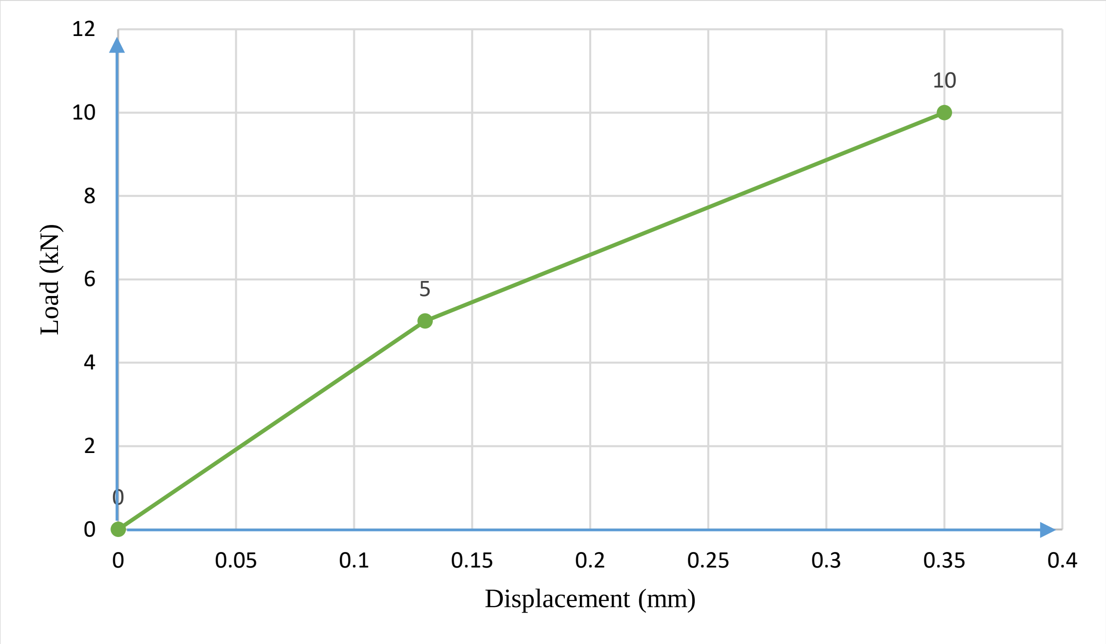


Figure 4-6: Load-Displacement Relation for NRC

The relationship between load and displacement is shown in the graph. This is an overview of how displacement changing with load based on the information provided.

The displacement rises to 0.13 mm with a further rise in load to 5 KN. The displacement grows in step with the load as it continues to rise. As the load increases to 10 KN this pattern persists, leading to a displacement of 0.35 mm.

4.3.5 Comparison All Sample of Beam

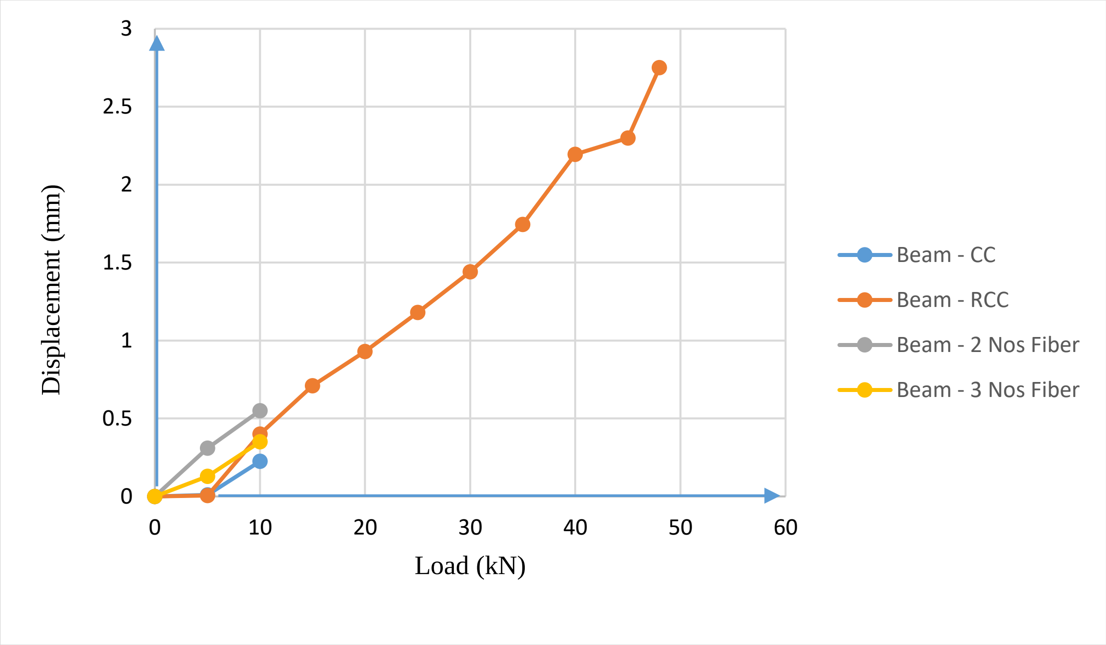


Figure 4-7: Load-Displacement Relation for Combined

The beam-RCC provide a maximum load of 48 KN and a maximum deflection of 2.78 mm. Beam-CC provide the lowest load and deflection, with a load of 10 KN and a deflection of 0.225 mm. From the graph, CC beams are reduced by 1222.22% compared to RCC beams, 2 Nos NRC beams are reduced by 500% compared to RCC beams and 3 Nos NRC beams are reduced by 785.71% compared to RCC beams.

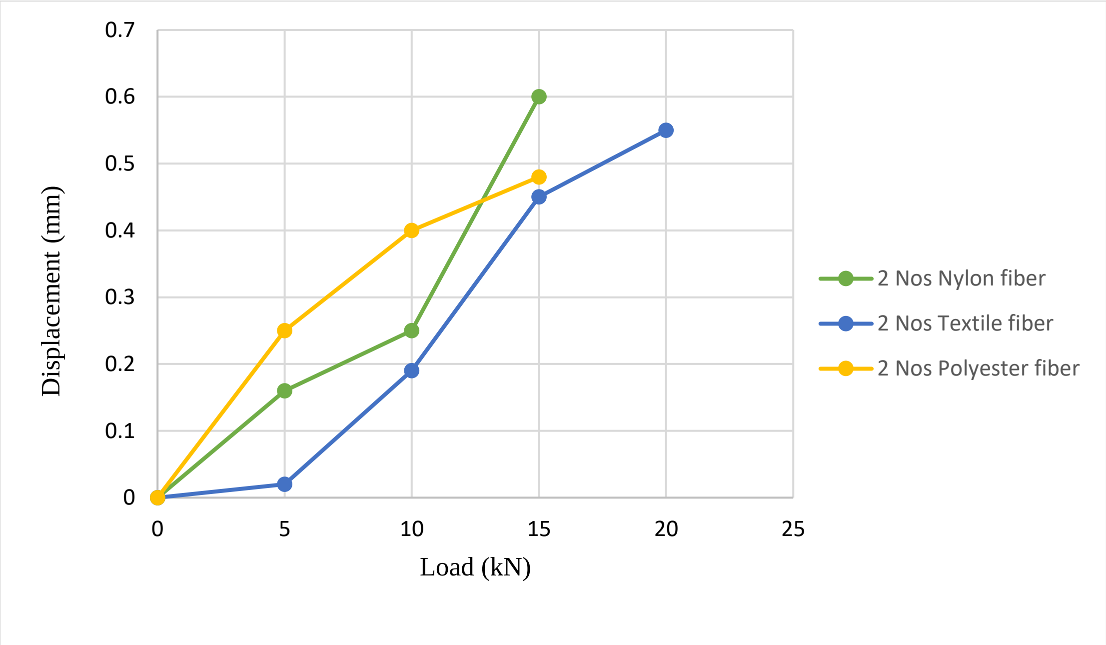


Figure 4-8: Load-Displacement Relation for All Group Sample 2 Nos Fiber

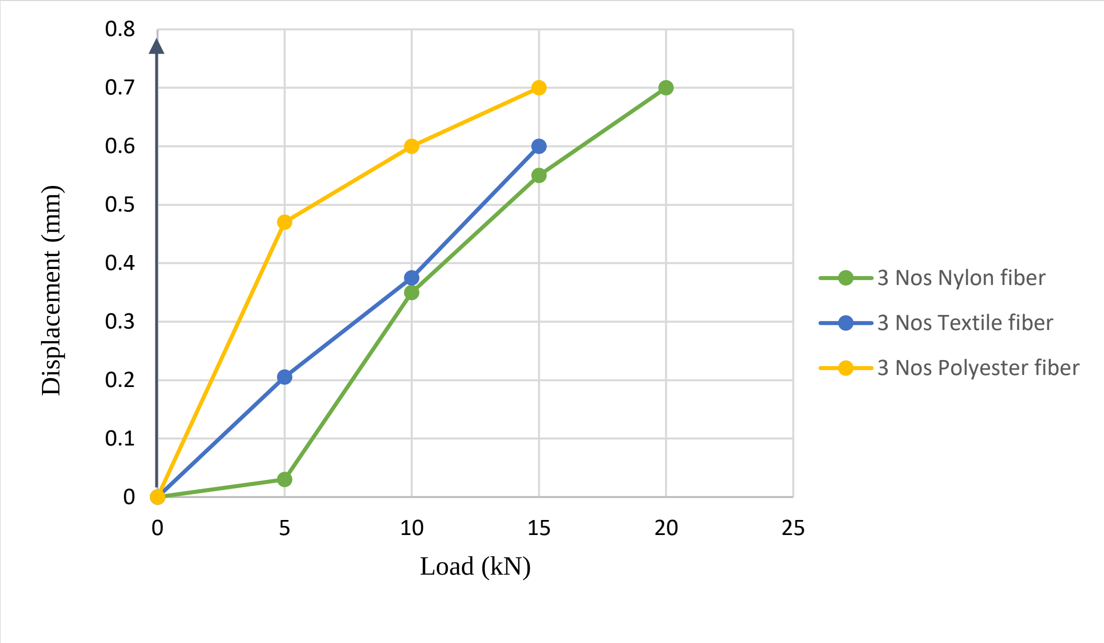


Figure 4-9: Load-Displacement Relation for All Group Sample 3 Nos Fiber

Type 1, Pure concrete load capacity 10 KN and deflection 0.225 mm. Type 2, 2-12 mm diameter reinforced concrete beam load capacity 48 KN and deflection 2.75 mm. Type 3, 2-12 mm diameter textile cotton fiber reinforced concrete beam load capacity 20 KN and deflection 0.55 mm. Type 4, 3-12 mm diameter textile cotton fiber reinforced concrete beam load capacity 15 KN and deflection 0.60 mm. Type 5, 2-12 mm diameter nylon fiber reinforced concrete beam load capacity 15 KN and deflection 0.60 mm. Type 6, 3-12 mm diameter nylon fiber reinforced concrete beam load capacity 20 KN and deflection 0.70 mm. Type 7, 2-12 mm diameter polyester fiber reinforced concrete beam load capacity 15 KN and deflection 0.48 mm. Type 8, 3-12 mm diameter polyester fiber reinforced concrete beam load capacity 15 KN and deflection 0.70 mm.

4.3.6 Failure Pattern

There are mainly two types of failure modes in reinforced concrete beams: shear failure and flexural failure. The former happens when the applied load is greater than the flexural capacity of the beam's materials, and the latter happens when there is not enough shear resistance between the beam different materials. This study beams all occurred flexural failure.

Figure 4-10: Failure Pattern for Pure Concrete-1

Figure 4-11: Failure Pattern for Pure Concrete-2

Figure 4-12: Failure Pattern for Reinforcement Concrete-1

Figure 4-13: Failure Pattern for Reinforcement Concrete-2

Figure 4-14: Failure Pattern for NRC-1(2-12mm)

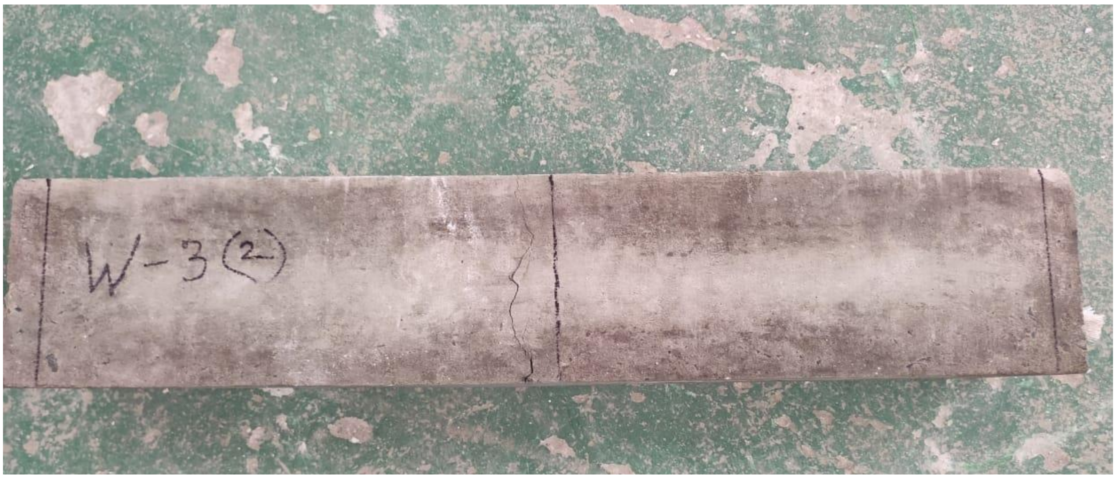


Figure 4-15: Failure Pattern for NRC-2(2-12mm)

Figure 4-16: Failure Pattern for NRC-1(3-12mm)

Figure 4-17: Failure Pattern for NRC-2(3-12mm)

4.4 Cost Analysis

Four different types of beams have been constructed. For the first beam, pure concrete was used. The second beam was use bottom bar reinforced concrete beam having a diameter of 2–12 mm. The third beam has a diameter of 2–12 mm was using the bar bottom nylon fiber reinforced concrete beam. The fourth beam has a 3–12 mm dia. bar bottom nylon fiber reinforced concrete beam. The price is also reduced because the third and fourth beams require less reinforcing.

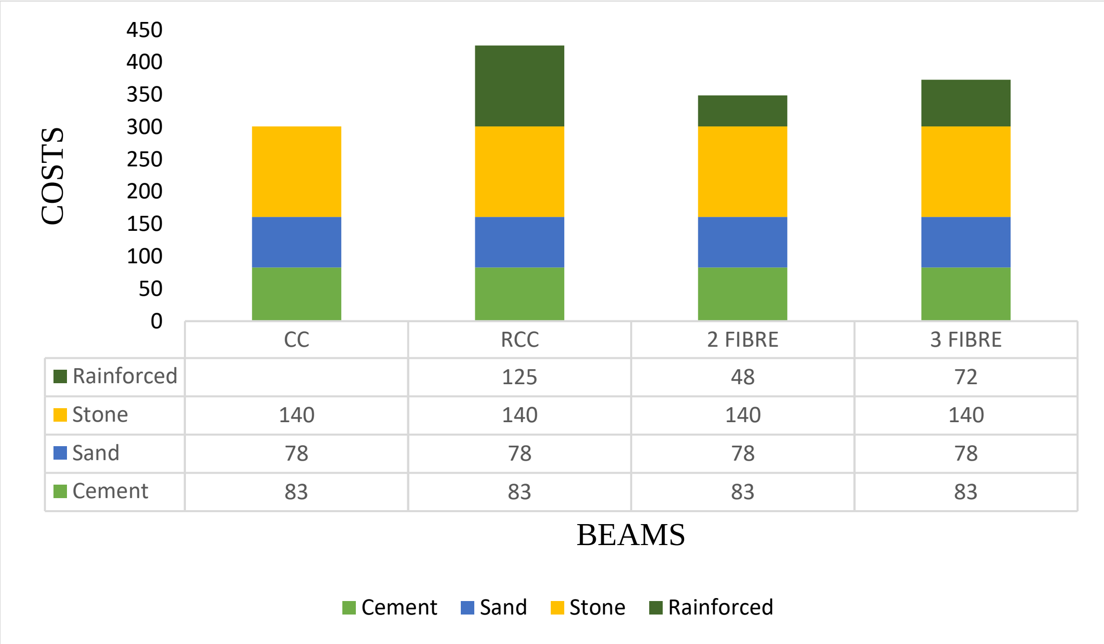


Figure 4-18: Cost Analysis

The third beam has a 18.08% cost savings, and the fourth beam has a 12.44% cost savings. The quantity of cost reduces due to reinforcing with nylon fibers increases. Therefore, converting the reinforcement into nylon fiber reinforcement and apply it when the load is very low.

4.5 Discussion

In this study, eight different beams were constructed, and their loads and deflections were compared with 2-12 mm diameter reinforced concrete beams. The study discusses the amount and application of recycled textile cotton fiber, nylon fiber, and polyester reinforcement for both 2-12 mm and 3-12 mm diameter bars.

The main objective of this study was to replace traditional reinforcement with textile cotton, nylon, and polyester fibers. The eight beams designed are as follows:

Type 1, Pure concrete load capacity 10 KN and deflection 0.225 mm. Type 2, 2-12 mm diameter reinforced concrete beam load capacity 48 KN and deflection 2.75 mm. Type 3, 2-12 mm diameter textile cotton fiber reinforced concrete beam load capacity 20 KN and deflection 0.55 mm. Type 4, 3-12 mm diameter textile cotton fiber reinforced concrete beam load capacity 15 KN and deflection 0.60 mm. Type 5, 2-12 mm diameter nylon fiber reinforced concrete beam load capacity 15 KN and deflection 0.60 mm. Type 6, 3-12 mm diameter nylon fiber reinforced concrete beam load capacity 20 KN and deflection 0.70 mm. Type 7, 2-12 mm diameter polyester fiber reinforced concrete beam load capacity 15 KN and deflection 0.48 mm. Type 8, 3-12 mm diameter polyester fiber reinforced concrete beam load capacity 15 KN and deflection 0.70 mm.

Maximum Elongation for 7 days ,14 days and 28 days is found in $NaCl_2$ chemical nylon fibers. Secondly and Thirdly maximum Elongation shown in $MgSO_4$ and $CaCO_3$ chemical nylon fibers. The lowest Elongation 7 days ,14 days and 28 days is found in H_2SO_4 Chemical nylon fibers.

$NaCl_2$ chemical effect on the elongation of NF 7 days 44.46%, 14 days 42.55% and 28 days 40.82% increased. $MgSO_4$ chemical effect on the elongation of NF 7 days 46.7%, 14 days 45.47% and 28 days 44.52% increased. $CaCO_3$ chemical effect on the elongation of NF 7 days 51.14%, 14 days 49.43% and 28 days 48.39% maximum increased. H_2SO_4 chemical effect on the elongation of NF 7 days 116.65%, 14 days 108.95% and 28 days 103.35% decreased.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

1. This study determines how much load and deflection can be achieved by replacing steel with nylon 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 0.225 mm deflection. Beam - RCC is 2-12 mm diameter reinforced beam, it has a 48 KN load capacity and a 2.75 mm deflection. Beam - 2 Nos fiber is 2-12 mm diameter nylon fiber reinforced beam; it has a 10 KN load capacity and a 0.55 mm deflection. Beam - 3 Nos fiber is 3-12 mm diameter nylon fiber reinforced beam; it has a 10 KN load capacity and a 0.35 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 NRC Beam has a 18.08% cost savings and The RCC Beam and 3 Nos NRC Beam has a 12.44% cost savings. Maximum Elongation for 7 days ,14 days and 28 days is found in $NaCl_2$ chemical nylon fibers. Secondly and Thirdly maximum Elongation shown in $MgSO_4$ and $CaCO_3$ chemical nylon fibers. The lowest Elongation 7 days ,14 days and 28 days is found in H_2SO_4 Chemical nylon fibers. $NaCl_2$ chemical effect on the elongation of NF 7 days 44.46%, 14 days 42.55% and 28 days 40.82% increased. $MgSO_4$ chemical effect on the elongation of NF 7 days 46.7%, 14 days 45.47% and 28 days 44.52% increased. $CaCO_3$ chemical effect on the elongation of NF 7 days 51.14%, 14 days 49.43% and 28 days 48.39% maximum increased. H_2SO_4 chemical effect on the elongation of NF 7 days 116.65%, 14 days 108.95% and 28 days 103.35% decreased.

3. Nylon fiber reinforced concrete (NFRC) beam enhancing sustainability in construction. Nylon 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 nylon fibers into concrete beam offers an eco-friendly alternative, improving both structural performance and sustainability.

5.2 Recommendation

Future reinforcement utilizes a different fiber can be used to increase the strength of the nylon fiber reinforced beam. In order concrete beam reinforced with nylon fibers, the fire test provide protection. More research is needed on this. Using bitumen or other chemicals can provide nylon reinforcing which is last longer. More research will be need to develop advanced and long-lasting nylon reinforcing designs in the future. It can be further improved through research on its capacity and bonding with concrete.

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APPENDIX

Table 6-1: Load Displacement for Pure Concrete

Load (kN)	Displacement (mm)
0	0
5	0.01
10	0.225

Table 6-2: Load Displacement for Reinforcement Concrete

Load (kN)	Displacement (mm)
0	0
5	0.005
10	0.4
15	0.71
20	0.93
25	1.18
30	1.44
35	1.745
40	2.195
45	2.30
48	2.75

Table 6-3: Load Displacement for 2-12mm NRC

Load (kN)	Displacement (mm)
0	0
5	0.31
10	0.55

Table 6-4: Load Displacement for 3-12mm NRC

Load (kN)	Displacement (mm)
0	0
5	0.13
10	0.35

Table 6-5: Load Displacement for Combined

Load (kN)	Displacement (mm) Beam - CC	Displacement (mm) Beam - RCC	Displacement (mm) Beam – 2 Nos Fiber	Displacement (mm) Beam – 3 Nos Fiber
0	0	0	0	0
5	0.01	0.005	0.31	0.13
10	0.225	0.4	0.55	0.35
15		0.71		
20		0.93		
25		1.18		
30		1.44		
35		1.745		
40		2.195		
45		2.30		
48		2.75		

Table 6-6: Elongation test for normal Nylon fiber

Sl. No.	Initial Length (mm)	Final Length (mm)	Distance (mm)	Elongation (mm)
1	432	528.2	96.2	95.43
2	432	523.7	91.7	
3	432	530.4	98.4	

Table 6-7: Elongation test for chemical Nylon fiber -7 Days

Chemical	Sl. No.	Initial length (mm)	Final length (mm)	Elongation (mm)	Ave. Elongation (mm)
$NaCl_2$	1	432	644.1	212.1	212.7
	2	432	648.3	216.3	
	3	432	641.7	209.7	
$MgSO_4$	1	432	634.3	202.3	204.3
	2	432	638.7	206.7	
	3	432	635.9	203.9	
$CaCO_3$	1	432	616.6	184.6	186.57
	2	432	614.3	182.3	
	3	432	621.8	189.8	
H_2SO_4	1	432	511.3	79.3	81.8
	2	432	517.5	85.5	
	3	432	512.6	80.6	

Table 6-8: Elongation test for chemical Nylon fiber -14 Days

Chemical	Sl. No.	Initial length (mm)	Final length (mm)	Elongation (mm)	Ave. Elongation (mm)
$NaCl_2$	1	432	652.2	220.2	224.33
	2	432	649.5	217.5	
	3	432	667.3	235.3	
$MgSO_4$	1	432	644.4	212.4	209.83
	2	432	639.2	207.2	
	3	432	641.9	209.9	
$CaCO_3$	1	432	629.8	197.8	192.63
	2	432	624.6	192.6	
	3	432	619.5	187.5	
H_2SO_4	1	432	517.3	85.3	87.57
	2	432	519.1	87.1	
	3	432	522.3	90.3	

Table 6-9: Elongation test for chemical Nylon fiber -28 Days

Chemical	Sl. No.	Initial length (mm)	Final length (mm)	Elongation (mm)	Ave. Elongation (mm)
$NaCl_2$	1	432	662.9	230.9	233.77
	2	432	659.2	227.2	
	3	432	675.2	243.2	
$MgSO_4$	1	432	647.1	215.1	214.33
	2	432	645.7	213.7	
	3	432	646.2	214.2	
$CaCO_3$	1	432	629.8	197.8	197.2
	2	432	627.5	195.5	
	3	432	630.3	198.3	
H_2SO_4	1	432	522.3	90.3	92.33
	2	432	524.6	92.6	
	3	432	526.1	94.1	

Table 6-10: Pull-out test for Nylon fiber

SI. No.	Initial Length (mm)	Final Length (mm)	Elongation (mm)	Ave. Elongation (mm)
1	432	502	70	68
2	432	497	65	
3	432	501	69	

Table 6-11: Pull-out test for chemical Nylon fiber

SI. No.	Chemical	Initial Length (mm)	Final Length (mm)	Elongation (mm)
1	$NaCl_2$	432	563	131
2	$MgSO_4$	432	537	105
3	$CaCO_3$	432	518	86
4	H_2SO_4	432	496	64

Table 6-12: Pull-out test for fair effaced (nylon fiber at 200°C for 1 hour)

SI. No.	Initial Length (mm)	Final Length (mm)	Elongation (mm)	Ave. Elongation (mm)
1	432	487	55	52
2	432	481	49	
3	432	484	52	