Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 572-584, 2, 2024

Araştırma Makalesi

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 572-584, 2, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

Effects Ofnylon Fiber And Steel Fiber On Compressive Strength, Split Tensile Strength And Flexural Strength Of Concrete

Muhammad Mubeen[1], Zaheer Ahmed[2], Umer Shahzad[3], Awais Masood Ahmed[4], Amin Ahmed[5], Naveed Anjum[6], Muhammad Moavia[7]

[1]*Khawaja Fareed University of Engineering & Information Technology64200 RYK, Punjab, Department of Civil Engineering, Pakistan,mubeenyounis0044@gmail.com*
[2]*Khawaja Fareed University of Engineering & Information Technology 64200 RYK, Punjab, Department of Civil Engineering, Pakistan, dr.zaheer@kfueit.edu.pk*
[3]*Khawaja Fareed University of Engineering & Information Technology 64200 RYK, Punjab, Department of Civil Engineering, Pakistan, umershahzad1995@gmail.com*
[4]*Khawaja Fareed University of Engineering & Information Technology 64200 RYK, Punjab, Department of Civil Engineering, Pakistan, awais.masood@kfueit.edu.pk*
[5]*Khawaja Fareed University of Engineering & Information Technology 64200 RYK, Punjab, Department of Civil Engineering,Pakistan, amindawar85@gmail.com*
[6]*Khawaja Fareed University of Engineering & Information Technology 64200 RYK, Punjab, Department of Civil Engineering, Pakistan, naveed.anjum@kfueit.edu.pk*
[7]*Khawaja Fareed University of Engineering & Information Technology 64200 RYK, Punjab, Department of Civil Engineering, Pakistan, moaviabaloch92@gmail.com*

(Received: 13 March 2024, Accepted: 13 March 2024)

(4th International Conference on Innovative Academic Studies ICIAS 2024, March 12-13, 2024)

ATIF/REFERENCE: Mubeen, M., Ahmed, Z., Shahzad, U., Ahmed, A. M., Ahmed, A., Anjum, N. & Moavia, M. (2024). Effects Ofnylon Fiber And Steel Fiber On Compressive Strength, Split Tensile Strength And Flexural Strength Of Concrete. *4th International Conference on Innovative Academic Studies*, 8(2), 572-584.

Abstract – This study investigates the effect of waste nylon fiber (fish wire) and steel fiber addition on the mechanical properties of concrete. Different samples containing different percentages of nylon fiber and steel fiber were prepared and subjected to compression, splitting tensile and flexural strength tests. The results show that the addition of nylon fiber and steel fiber generally improves the mechanical properties of concrete, such as increase in compressive strength, splitting tensile strength and flexural strength compared to conventional concrete. Therefore, in this study, 1:2:4 ratio of concrete was reinforced with nylon and steel fibers were added separately and combined at 1%, 2% and 3% weight of cement. In this research, nylon and steel fiber is used at length of 25mm and thickness of 0.6mm and aspect ratio of 41.67. The cubes having size of 6"x 6" x 6", the cylinder having 6" diameter and 12" height, the beam having size of 20"x6"x6", were prepared and cured properly in curing tank. Results showed that concrete with 1% of nylon fiber, 2% of steel fiber and 2% of mixed nylon and steel fiber showed a maximum enhancement of the mechanical properties of concrete compared to the control mix of concrete. The findings demonstrate the ability of nylon fiber and steel fiber reinforcements to improve the performance and durability of concrete.

Keywords – Nylon Fiber Reinforcedconcrete, Steel Fiber Reinforcedconcrete, Fiber Reinforcement, Compressive Strength, Splitting Tensile Strength, Flexural Strength, Eco-Friendly Environment.

I. INTRODUCTION

Concrete is a fundamental construction material consisting of a mixture of cement, (Fine & Coarse) aggregates, water.Concrete is a brittle material.Concrete is strong in compression and weak in tension. Concrete can be used to build a wide range of structures, from small buildings to large dams and bridges.
Nylon fiber concrete also known as nylon fiber-reinforced concrete (NFRC), is a composite construction material that combines synthetic nylon fibers with concrete mixtures to enhance its mechanical properties and durability. Nylon fibers are added to the concrete mix during the batching process, becoming an integral part of the mixture. One of the main advantages of NFRC is its ability to improve compressive, tensile and flexural strength. Nylon fibers increase the ductile behavior of concrete. This makes it suitable for applications requiring load-bearing concrete structures. NFRC are used in the construction of highway pavements, precast elements, airport runways, industrial flooring and where resistance to heavy traffic loads and possible cracking is essential.
In order to improve the mechanical qualities and performance of concrete, steel fibers are added to the mixture to create steel fiber-reinforced concrete, or SFRC. NFRC have ability to improve compressive, tensile and flexural strength of concrete.These steel fibers are typically short (ranging from 20 to 60mm in length and 0.5 to 1mm in diameter) that are uniformly distributed throughout the concrete matrix. Steel fibers increase the ductile behavior of concrete. SFRC are commonly used in the construction of Industrial Floors, Pavements and Highways, Blast-Resistant Structures, Seismic resistant structures and Precast elements.

II. PROBLEM STATEMENT

The normal concrete weak in tensile strength and flexural strength and not strong enough to resist heavy loads on Structure. The research aims to increase the strength properties of normal concrete by using nylon and steel fiber. Nylon and steel fiber are strong and durable material that can help to improve the strength of concrete. This would make concrete more resistant to heavy loads like (seismic or Earthquake loads).

III. AIM AND OBJECTIVES

- To determine the compressive, split tensile and flexural strength of concrete with different percentages (%) of Nylon fiber.
- To determine the compressive, split tensile and flexural strength of concrete with different percentages (%) of Steel fiber.
- To compare the Workability of concrete with different percentages % of Nylon & Steel Fiber.

IV. MATERIALS AND METHODS

4.1 Mix Proportion

Throughout the study, a fixed proportion of 1:2:4 was immersed in a water tank for the purpose of curing.

Table 1: Details of batches of specimens

Serial No	Batch	Fiber Addition percentages%
1	B-1	1% Nylon fiber
2	B-2	2% Nylon fiber
3	B-3	3% Nylon fiber
4	B-4	1% Steel fiber
5	B-5	2% Steel fiber
6	B-6	3% steel fiber
7	B-7	1% combine fiber (0.5% Nylon and 0.5% Steel)
8	B-8	2% combine fiber (1% Nylon and 1% Steel)
9	B-9	3% combine fiber (1.5% Nylon and 1.5% Steel)

4.2.Testing of the Specimens

In this study, Flexural strength, compressive strength, and split tensile strength tests were conducted. Workability of concrete is determined by Slump Cone test.

4.2.1. Compressive strength:

Compressive strength of concrete is its ability to withstand axial loads. Specimens that are cubes are broken in a compression testing equipment to determine the compressive strength. Compressive strength is expressed in megapascals (MPa) or pounds-per-square-inch (psi) units and is computed by dividing the failure load by the cross-sectional area resisting the load.

4.2.2. Split Tensile strength:

Concrete's split tensile strength indicates how well it can withstand tensile stresses under diametrical compression. A cylindrical concrete specimen is subjected to a compressive load along its length to evaluate its fracture strength. The split tensile strength is then determined by measuring the force necessary to create this splitting.

4.2.3. Flexural strength:

Concrete's flexural strength, commonly referred to as its modulus of rupture, gauges how well it can withstand bending or flexural forces. It is ascertained by placing a load on a concrete prismatic or cylindrical specimen until the failure to bend occurs. The specimen's dimensions and the maximum bending moment applied to it are used to compute the flexural strength. This characteristic is essential for evaluating how concrete behaves in bending structural elements like slabs and beams.

V. RESULTS

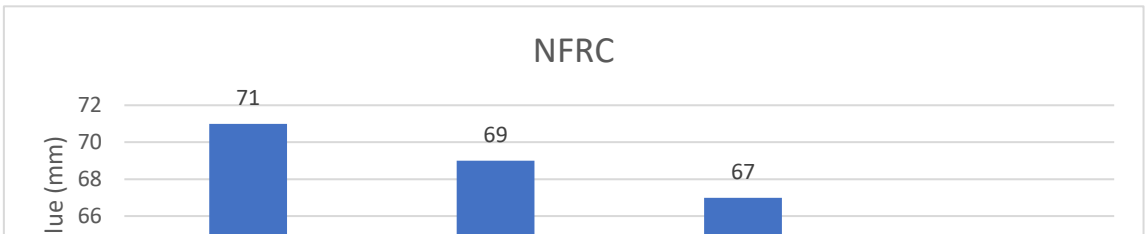
This study's main goal was to investigate how nylon and steel fibers affects concrete's strength characteristics. Nylon and steel fibers were added separately and combined at 1%, 2% and 3% with respect to weight of cement.

5.1 Workability:

The results of workability (slump value) of concrete with respect to different nylon fiber &steel fiber percentages are shown in table 2 and figure 1 shows the graphical representation of table 2. The workability of concreteat1%, 2% and3% with fibers.

Table 2: Workability of concrete by using Nylon and steel fibers at different percentages %.

Sr. No.	**Fibers Percentages %**	**Slump value (mm)**	**Percentage difference in the Slump value of concrete whenFibers used in concrete compared to conventional concrete.**
1	0% fibers	71	-------
2	1% Nylon fiber	69	-2.90
3	2% Nylon fiber	67	-5.97
4	3% Nylon fiber	63	-12.7
5	1% Steel fiber	68	-4.41
6	2% Steel fiber	65	-9.23
7	3% Steel fiber	61	-16.39
8	1% combine fiber (0.5% Nylon and 0.5% Steel)	69	-2.90
9	2% combine fiber (1% Nylon and 1% Steel)	66	-7.58
10	3% combine fiber (1.5% Nylon and 1.5% Steel)	62	-14.52



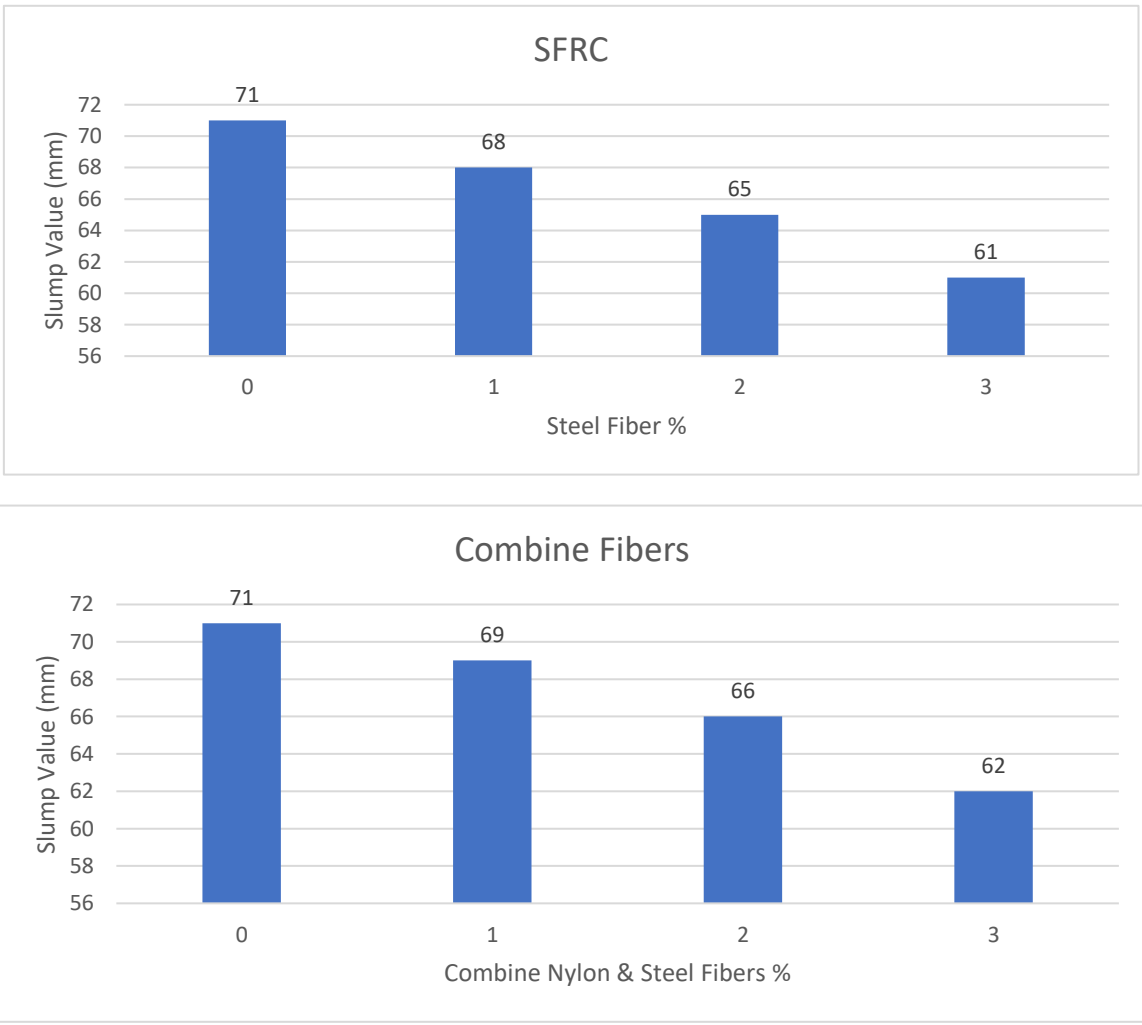


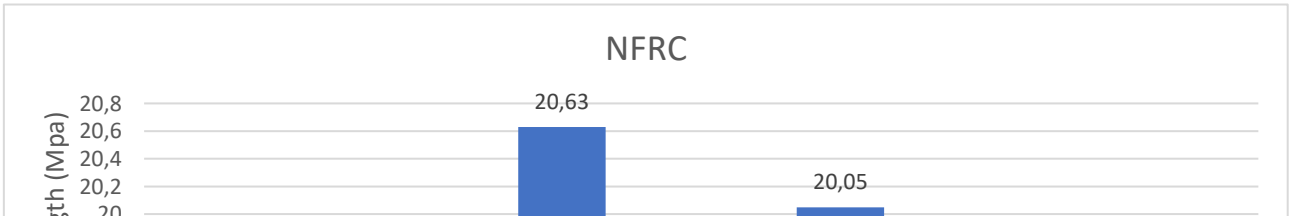
Figure 1: Graph showing workability of concrete with respect to % of Nylon& Steel Fibers

5.2 Compressive strength:

The results of compressive strength of concrete at 28 days with respect to different nylon fiber &steel fiber percentages are shown in table 3 and figure 2 shows the graphical representation of table 3. The compressive strength of concreteat1%, 2% and3% with nylon & steel fibers.

Table 3:Compressive Strength of concrete by using nylon and steel fibers at different percentages %.

Sr. No.	% ofFibers	Avg. compressive strength (Mpa)	Percentage difference in compressive strength of concrete when Fibers used in concrete compared to conventional concrete (%)
1	0% fibers	19.51	-------
2	1% Nylon fiber	20.63	5.43
3	2% Nylon fiber	20.05	2.69
4	3% Nylon fiber	19.55	0.20
5	1% Steel fiber	20.89	6.61
6	2% Steel fiber	21.22	8.06
7	3% steel fiber	20.74	5.93
8	1% combine fiber (0.5% Nylon and 0.5% Steel)	20.75	5.98
9	2% combine fiber (1% Nylon and 1% Steel)	20.98	7.01
10	3% combine fiber (1.5% Nylon and 1.5% Steel)	20.12	3.03



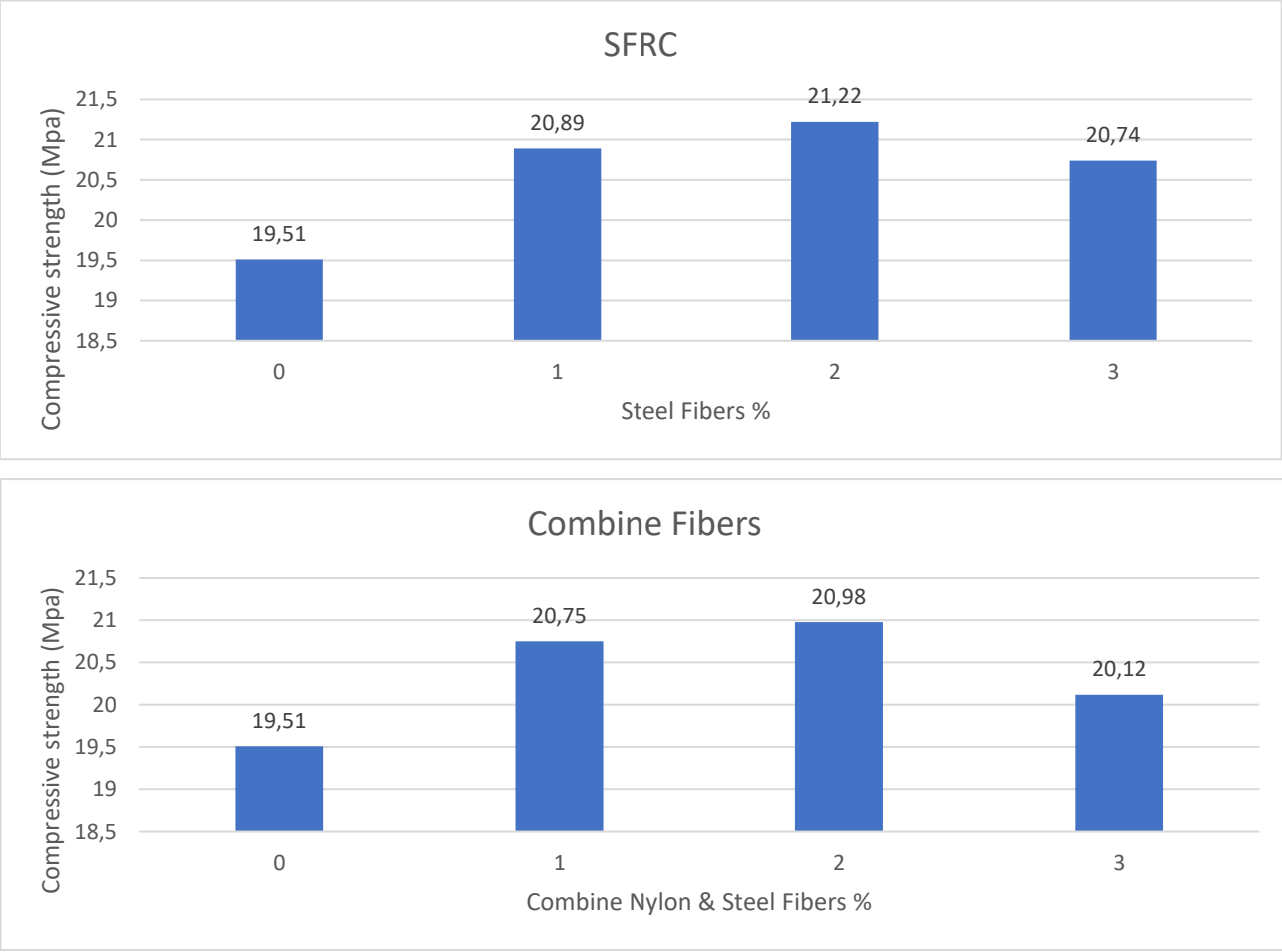


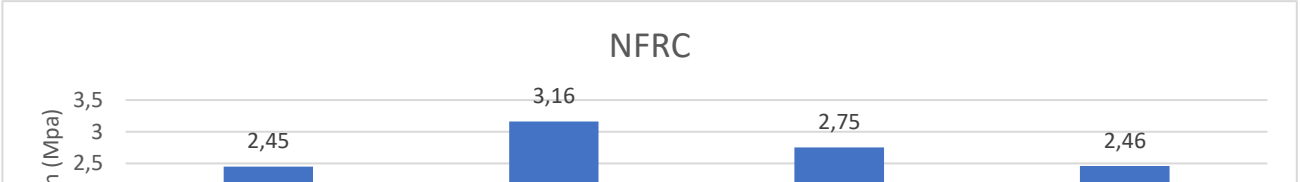
Figure 2: Graph showing compressive strength of concrete with respect to different % Nylon & Steel Fibers

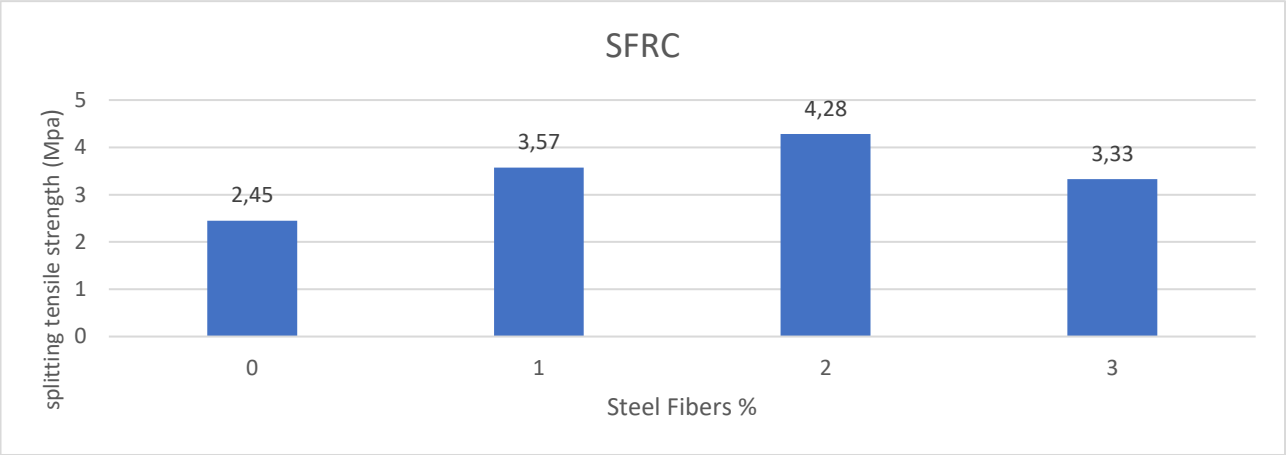
5.3 Splitting Tensile Strength:

The results of splitting tensile strength of concrete at 28 days with respect to different nylon fiber & steel fiber percentages are shown in table 4 and figure 3 shows the graphical representation of table 4. The splitting tensile strength of concrete at 1%, 2% and 3% with nylon & steel fibers.

Table 4:Splitting tensileof concrete by using nylon and steel fibers at different percentages %.

Sr. No.	% ofFibers	Avg. splitting tensile strength (Mpa)	Percentage difference in splitting tensile strength of concrete when Fibers used in concrete compared to conventional concrete (%)
1	0% fibers	2.45	-------
2	1% Nylon fiber	3.16	22.47
3	2% Nylon fiber	2.75	10.91
4	3% Nylon fiber	2.46	0.41
5	1% Steel fiber	3.57	31.37
6	2% Steel fiber	4.28	42.76
7	3% steel fiber	3.33	26.43
8	1% combine fiber (0.5% Nylon and 0.5% Steel)	3.37	27.30
9	2% combine fiber (1% Nylon and 1% Steel)	3.82	35.86
10	3% combine fiber (1.5% Nylon and 1.5% Steel)	2.75	10.91





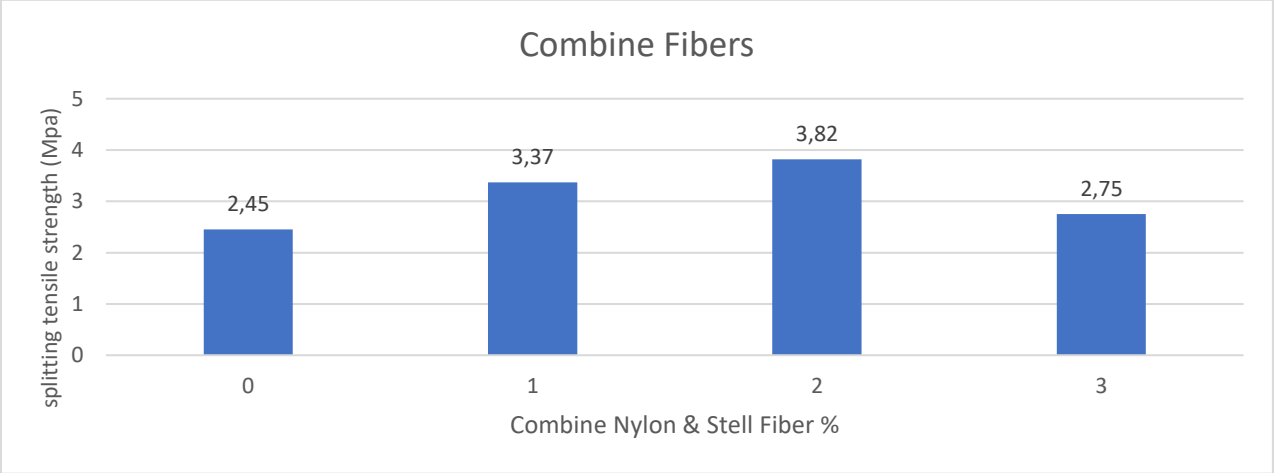


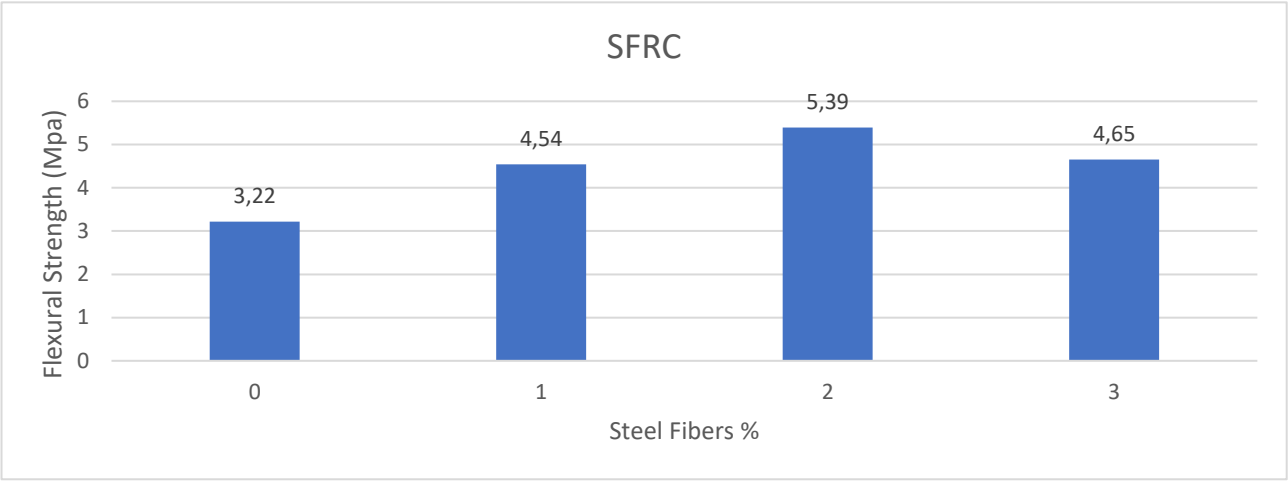
Figure 3: Graph showing splitting tensile strength of concrete with respect to different % of Nylon & Steel Fibers.

5.4 Flexural strength:

The results of flexural strength of concrete at 28 days with respect to different nylon fiber & steel fiber percentages are shown in table 5 and figure 4 shows the graphical representation of table 5. The flexural strength of concrete at 1%, 2% and 3% with nylon & steel fibers.

Table 5:flexural strengthof concrete by using Nylon and steel fibers at different percentages %.

Sr. No.	% ofFibers	Avg. Flexural strength (Mpa)	Percentage difference inflexural strength of concrete when Fibers used in concrete compared to conventional concrete (%)
1	0% fibers	3.22	-------
2	1% Nylon fiber	4.29	24.94
3	2% Nylon fiber	3.74	13.90
4	3% Nylon fiber	3.33	3.30
5	1% Steel fiber	4.54	29.07
6	2% Steel fiber	5.39	40.26
7	3% steel fiber	4.65	30.75
8	1% combine fiber (0.5% Nylon and 0.5% Steel)	4.43	27.31
9	2% combine fiber (1% Nylon and 1% Steel)	4.98	35.34
10	3% combine fiber (1.5% Nylon and 1.5% Steel)	4.31	25.29



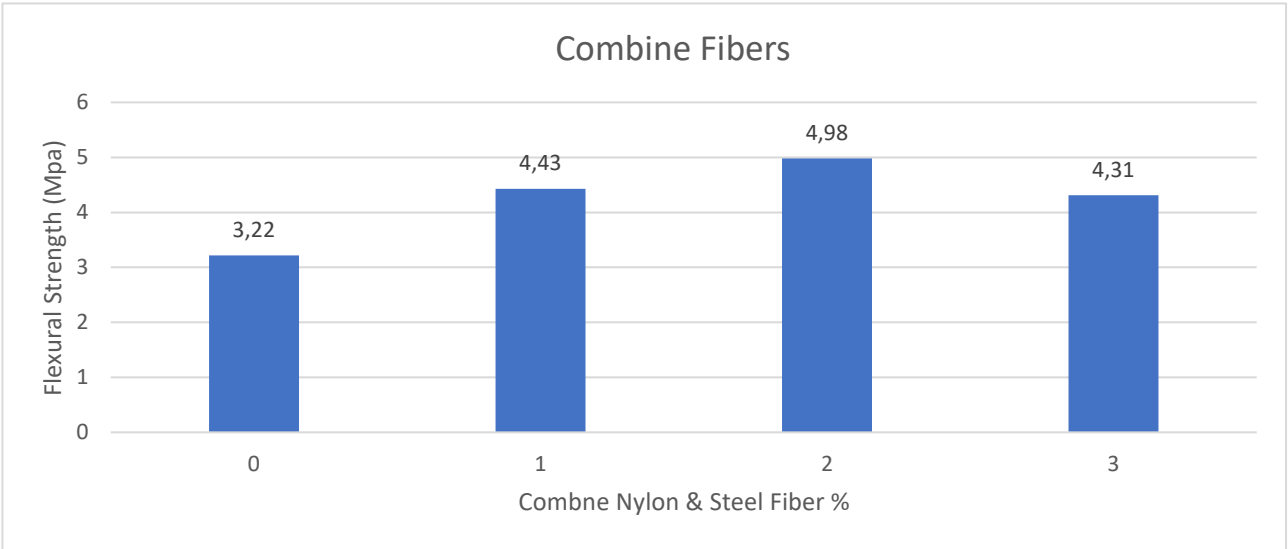


Figure 4: Graph showing flexural strength of concrete with respect to different % of Nylon & Steel Fibers.

VI. CONCLUSION

This study investigates the effects of nylon and steel fibers on the engineering properties of concrete. Slump, compression strength, Splitting tensile strength, flexural strenght tests were conducted on the concrete specimens with different contents of nylon and Steel fibers. These are the following conclusions:

- The compressive strength of concrete increase at 1%Nylon fiber content. Nylon fibersincrease the compressive strength of concrete by 5.43%.
  The compressive strength of concrete increase at 2%Steel fiber content. Steel fibers increase the compressive strength of concrete by 8.06%.
  The compressive strength of concrete increase at 2%nylon and steel fibers content together. Nylon and steel fibers content together increase the compressive strength of concrete by 7.01%.

- The Splitting tensile strength of concrete increase at 1%Nylon fiber content. Nylon fibers increase the Splitting tensile strength of concrete by 22.47%.
  The Splitting tensile strength of concrete increase at 1%Steel fiber content. Steel fibers increase the Splitting tensile strength of concrete by 42.76%.
  The Splitting tensile strength of concrete increase at 2%nylon and steel fibers content together. Nylon and steel fibers content together increase the Splitting tensile strength of concrete by 35.86%.

- The flexural strength of concrete increase at 1%Nylon fiber content. Nylon fibers increase the flexural strength of concrete by 24.94%.
  The flexural strength of concrete increase at 1%Steel fiber content. Steel fibers increase the flexural strength of concrete by 40.26%.
  The flexural strength of concrete increase at 2%nylon and steel fibers content together. Nylon and steel fibers content together increase the flexural strength of concrete by 35.34%.

- The nylon and steel fibres when used as reinforcement in concrete significantly reduces its workability.

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