

“Experimental Investigation of M30 Concrete with Hybrid Glass and Polypropylene Fibers”

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Abstract - Concrete is widely used in construction because of its high compressive strength, but its low tensile capacity leads to cracking problems that affect durability and performance. To overcome this limitation, hybrid fiber reinforcement using glass fiber (GF) and polypropylene fiber (PP) is adopted. This study investigates the performance of M30 grade concrete with hybrid fibers in different proportions (0%, 0.5%, 0.75%, and 1%). The mix design is carried out as per IS 10262:2019. Experimental tests such as slump test, compressive strength test, and split tensile strength test are conducted. The results show that the addition of hybrid fibers improves strength and crack resistance of concrete. The optimum fiber content is found between 0.5% and 0.75%, beyond which workability decreases and strength gain reduces.

Key Words: Hybrid fiber concrete, Glass fiber, Polypropylene fiber, Compressive strength, Split tensile strength, Workability, M30 concrete

1. INTRODUCTION

Concrete is the most commonly used construction material due to its high compressive strength. However, it has low tensile strength and is prone to cracking. These cracks reduce durability and structural performance.

To overcome this problem, fibers are added to concrete. Fiber Reinforced Concrete (FRC) improves:

- Crack resistance
- Tensile strength
- Durability

Hybrid fiber concrete uses two types of fibers:

- Glass Fiber → improves strength
- Polypropylene Fiber → controls cracks

In this study, hybrid fiber reinforced M30 concrete is prepared using **70% glass fiber and 30% polypropylene fiber** and its performance is evaluated.

2. LITERATURE REVIEW

Various researchers have reported that the addition of fibers improves the tensile and flexural strength of concrete. Glass fibers mainly enhance strength, while polypropylene fibers are effective in controlling micro-cracks. Hybrid fiber systems show better performance due to combined action of different fibers.

Researchers also found:

- Optimum fiber content exists (generally 0.5%–1%)
- Excess fiber reduces workability

- Strength does not increase continuously with fiber addition

3. SCOPE OF WORK

The main objectives of this study are:

- To design M30 concrete mix using IS 10262:2019
- To study effect of hybrid fibers on:
 - i. Workability
 - ii. Compressive strength
 - iii. Split tensile strength
- To determine optimum fiber content
- To compare results with conventional concrete

4. EXPERIMENTAL INVESTIGATION

4.1 Materials Used

- Cement: OPC
- Fine Aggregate: Zone II sand
- Coarse Aggregate: 20 mm
- Water: Potable water
- **Fibers:**
 - Glass Fiber (70%)
 - Polypropylene Fiber (30%)

Ordinary Portland Cement (OPC) was used as the binding material for M30 grade concrete, having standard consistency, specific gravity of about 3.15, and suitable strength characteristics. Fine aggregate consisted of locally available sand conforming to Zone II with specific gravity around 2.65, which helps in achieving good workability and proper grading. Coarse aggregate of angular shape with maximum size 20 mm and specific gravity about 2.74 was used to provide strength and stability to the mix. Clean potable water was used for mixing and curing, ensuring proper hydration of cement. Hybrid fibers consisting of 70% glass fiber and 30% polypropylene fiber were incorporated; glass fibers possess high tensile strength and modulus of elasticity, improving strength and stiffness, while polypropylene fibers have low density and good chemical resistance, helping in controlling micro-cracks and reducing shrinkage.

4.2 Concrete Mix Design

The mix design was carried out using a water-cement ratio of 0.45, water content of 190 L/m³, and cement content of 422 kg/m³ as per IS 10262:2019, ensuring required workability (75–100 mm slump) and strength characteristics.

4.2.1 Mix Proportions

Mix ratio = 1: 1.61: 2.72

Table-1 Mix Proportion (0% Fiber):

Material	Quantity
Cement	422 kg
Water	190 L
Fine Aggregate	681 kg
Coarse Aggregate	1148 kg

Table-2 Mix Proportions (0.5 % Fiber):

Material	Quantity
Cement	422 kg
Water	190 L
Fine Aggregate	675 kg
Coarse Aggregate	1140 kg
Glass Fiber	9.1 kg
PP Fiber	1.36 kg

Table-3 Mix Proportions (0.75 % Fiber):

Material	Quantity
Cement	422 kg
Water	190 L
Fine Aggregate	672 kg
Coarse Aggregate	1135 kg
Glass Fiber	13.65 kg
PP Fiber	2.05 kg

Table-4 Mix Proportions (1 % Fiber):

Material	Quantity
Cement	422 kg
Water	190 L
Fine Aggregate	668 kg
Coarse Aggregate	1130 kg
Glass Fiber	18.2 kg
PP Fiber	2.73 kg

4.3 Test results:

4.3.1 Slump Test Results:

The slump test is used to measure the workability and consistency of fresh concrete. It indicates how easily the concrete can be mixed, placed, and compacted. This test helps in understanding the effect of fiber addition on the flow characteristics of the mix.

Table-5 Slump test results

Mix	Slump (mm)
0% Fiber	95 mm
0.5% Fiber	85 mm
0.75% Fiber	75 mm
1% Fiber	65 mm



Fig -1: Workability test by using slump cone

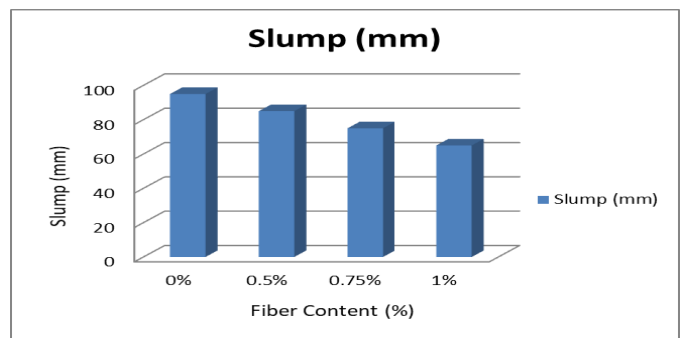


Chart -1: Slump Values (mm)

4.3.2 Compressive Test Results:

The compressive strength test is conducted to determine the load-carrying capacity of hardened concrete. It is the most important property used in structural design. This test evaluates the strength development of concrete at different curing periods.



Fig -2: Compressive test on cubes on CTM

Table-6 Compressive test results

Mix	3 Days (MPa)	14 Days (MPa)	28 Days (MPa)
0% Fiber	18.5	26.5	38.0
0.5% Fiber	20.2	29.8	41.2
0.75% Fiber	21.0	31.5	44.0
1% Fiber	20.5	30.2	42.5

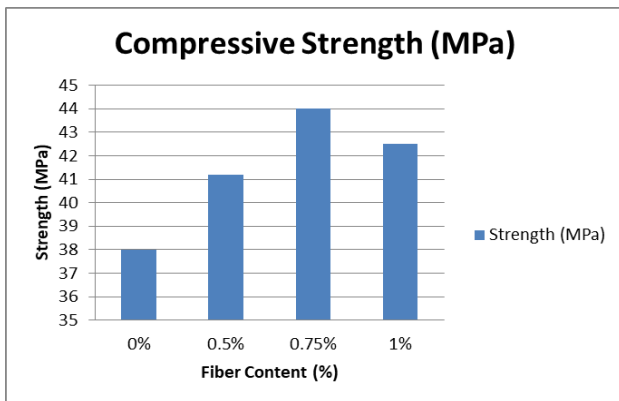


Chart -2: Compressive Strength at 28days MPa

4.3.3 Split Tensile Test Results:

The split tensile strength test is used to assess the tensile behavior of concrete, which is otherwise weak in tension. It helps in understanding the crack resistance and bonding performance of the material. This test is important to evaluate the effectiveness of fiber reinforcement in improving tensile properties.

Table-7 split tensile test results

Mix	3 Days (MPa)	14 Days (MPa)	28 Days (MPa)
0% Fiber	2.1	2.8	3.5
0.5% Fiber	2.4	3.3	4.2
0.75% Fiber	2.6	3.6	4.8
1% Fiber	2.5	3.4	4.5

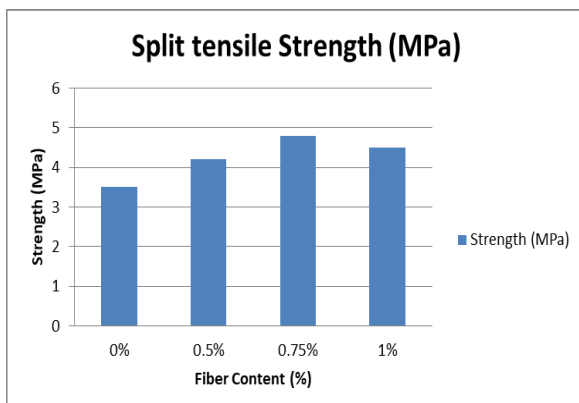


Chart -3: Split tensile Strength at 28 days MPa

5. RESULT AND DISCUSSION

The test results show that adding hybrid fibers improves the performance of M30 concrete. The slump value decreases as fiber content increases, which means workability reduces slightly. The compressive strength increases up to 0.75% fiber content and then decreases slightly at 1%. The split tensile strength also increases significantly due to better crack resistance. The best results were obtained at 0.5% to 0.75% fiber content. This is because glass fiber improves strength and polypropylene fiber helps in controlling cracks.

6. CONCLUSIONS

From this study, it can be concluded that hybrid fiber reinforced concrete performs better than normal concrete. The use of glass fiber and polypropylene fiber together improves strength and reduces cracking. The optimum fiber content is found to be between 0.5% and 0.75%. Hybrid fiber concrete can be used in practical construction where improved durability and crack resistance are required. Thus, hybrid fiber reinforcement is an effective method for improving the performance of conventional concrete.

REFERENCES

- 1) Lei, B., Li, W., Liu, H., Tang, Z., & Tam, V. W. Y., "Synergistic Effects of Polypropylene and Glass Fiber on Mechanical Properties and Durability of Recycled Aggregate Concrete," *International Journal of Concrete Structures and Materials*, Vol. 14, 2020.
- 2) Ahmed, A. A. M., & Jia, Y., "Effect of Using Hybrid Polypropylene and Glass Fibre on the Mechanical Properties and Permeability of Concrete," *Materials*, Vol. 12, 2019.
- 3) Blazy, J., & Blazy, R., "Polypropylene Fiber Reinforced Concrete and Its Application in Creating Architectural Forms of Public Spaces," *Case Studies in Construction Materials*, Vol. 14, 2021.
- 4) Abu-Elgasim, E., Hassan, O., Awad, A., Abdullah, A., & Mahmoud, M., "The Effect of Glass and Polypropylene Fibers on the Properties of Concrete," *International Research Journal of Engineering and Technology (IRJET)*, Vol. 12, Issue 07, 2025.
- 5) Nair, M. J., & Varghese, R., "Influence of Glass Fiber and Polypropylene Fiber on M30 Grade Concrete and its Durability Study," *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 6, Issue 5, 2017.
- 6) **IS 10262:2019**, "Concrete Mix Proportioning – Guidelines," Bureau of Indian Standards, New Delhi.