



Experimental Study Of Steel Fiber And Fly Ash On Properties Of Concrete.

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Abstract This studies is the mechanical properties of Fiber Reinforced Concrete (FRC) using fly ash as a partial replacement for cement to create a sustainable and high-performance construction material normal concrete has high compressive strength but low tensile strength and brittle behavior due to micro-cracks. To improve these properties M-20 grade concrete was prepared using fly ash and hooked-end steel fibers.

Cement was replaced with fly ash at 15% 20% and 25% while steel fibers were added at 0.5%, 1.0% and 1.5%. A control mix without replacement was also prepared. A cube specimens (150×150×150 mm) were cast and tested for compressive strength at 7, 14, and 28 days using CTM machine.

Results show that steel fibers improve ductility and crack resistance, while fly ash improves long-term strength and durability. The study concludes that using fly ash and steel fibers together can produce eco-friendly concrete with better structural performance and reduced carbon emissions.

Keywords: Fiber Reinforced Concrete, Fly Ash, Steel Fiber, Compressive Strength, Sustainable Concrete.

1.INTRODUCTION

1.1 Evolution of Concrete in Infrastructure

Concrete is the most important construction material due to its strength, durability, and low cost. It is widely used in buildings, bridges, and dams because it can be molded

into any shape. However, traditional concrete has some limitations such as brittle behavior and low tensile

Strength, which requires improvement using, advanced materials.

1.2 Environmental Challenges and Sustainability

Concrete production mainly depends on Ordinary Portland Cement (OPC), which creates environmental problems because cement manufacturing produces a large amount of CO₂. To reduce pollution and make concrete sustainable, industrial by-products like fly ash are now used as partial cement replacement.

1.3 Role of Fly Ash in Concrete

Fly ash is a waste material from thermal power plants. Its use in concrete helps in waste management, reduces cost, and improves durability. Due to its pozzolanic properties, fly ash reacts with cement compounds and increases long-term strength, although early strength may be slightly lower.

1.4 Deficiencies of Plain Concrete

Plain concrete has high compressive strength but low tensile strength and ductility. Micro-cracks develop due to shrinkage and stress, which can cause sudden failure under load.

1.5 Fiber Reinforced Concrete (FRC)

Fiber Reinforced Concrete improves these properties by adding steel fibers. Steel fibers increase tensile strength, ductility, crack resistance, and impact strength. In this study, steel fibers were added in proportions of 0.5%, 1.0% and 1.5%.

1.6 Research Objective

This studies the combined effect of fly ash (15%, 20% & 25%) and steel fibers on M-20 concrete. A cube specimens (150×150×150 mm) were tested for compressive strength at 7, 14, and 28 days. The study shows that using fly ash and steel fibers together produces sustainable concrete with better strength and durability.

2. Advantages of Fiber Reinforced Concrete (FRC)

High tensile strength FRC has higher tensile strength compared to normal concrete. Crack resistance Fibers help to control cracks and prevent their propagation.

better ductility FRC is less brittle and shows more ductile behavior. high impact resistance It can better resist shock and vibration loads improved durability It has a longer service life and better resistance to environmental effects reduced shrinkage cracks Fibers help in reducing cracks caused by drying shrinkage. Better load carrying capacity It improves the strength and load carrying capacity of structures.

Improved flexural strength Bending strength of concrete is increased.

Eco-friendly (when used with fly ash) helps in sustainable construction by reducing cement use.

3. Methodology

The methodology of this study involves the preparation and testing of Fiber Reinforced Concrete (FRC) using fly ash as a partial replacement for cement to evaluate its mechanical properties. M-20 grade concrete was designed according to standard procedures using cement, fine aggregate, coarse aggregate, fly ash, and hooked-end steel fibers. Cement was replaced with fly ash in proportions of 15%, 20%, and 25% while steel fibers were added in 0.5%, 1.0%, and 1.5% volume fractions. The materials were properly mixed to obtain a uniform concrete mix. The fresh concrete was then placed into cube moulds of size 150×150×150 mm and properly compacted. After 24 hours, the specimens were demoulded and cured in water for 7, 14, and 28 days. A cubes including control specimens were prepared. After curing compressive strength tests were conducted using a Compression Testing Machine (CTM). The results were compared with normal concrete to evaluate the improvement in strength and durability.

Table 1: Proportion of Materials used for M-20 grade of concrete

Sr. No	Type	Cement (KG)	Fly Ash (KG)	Steel Fiber (KG)	Fine Agg (KG)	Course Agg (KG)	Water	Total (KG)
1	7 days	7.65	1.35	0.2475	13.5	27	Potable	49.5
2	14 days	7.20	1.80	0.495	13.5	27	Potable	49.5
3	28 days	6.75	2.25	0.7425	13.5	27	Potable	49.5
4	Normal	9	---	---	13.5	27	Potable	49.5

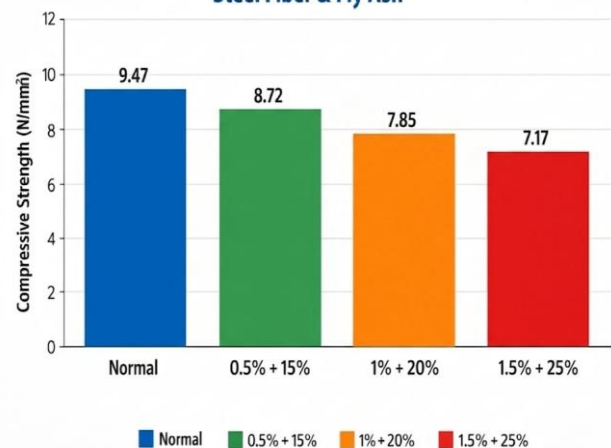
Table-2-Average Compressive Strength of Concrete cube (Normal concrete)

Sr no	Id mark	Average strength (Mpa)		
		7 days	14days	28 days
1	concrete cube	9.47	14.20	21.78

Table 3:-Compressive Strength are as follows(7 days)

Sample ID	% of fiber No of days	0.5 %+15 %	1 %+20%	1.5 %+25%
		FRC-A	7	8.72

Compressive Strength of Concrete Cubes with Steel Fiber & Fly Ash



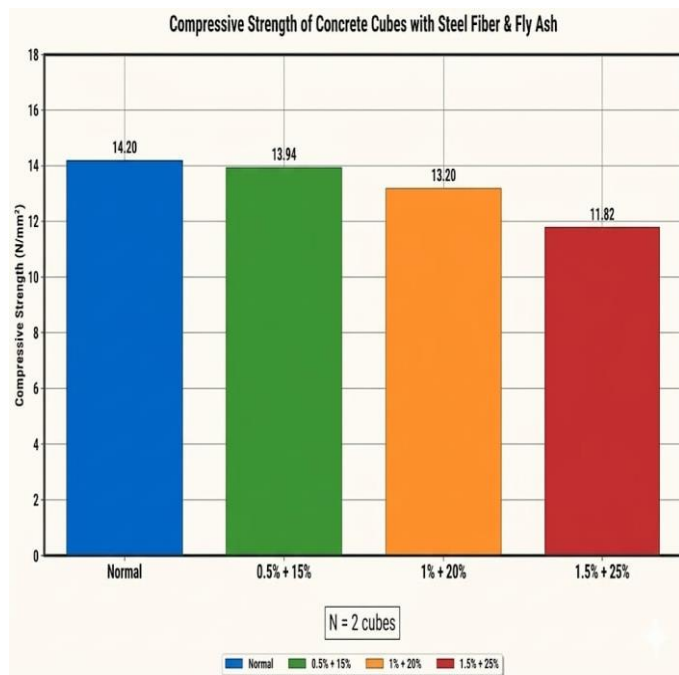
Graph -1 Average Compressive strength of RAC- A Vs Steel Fiber.

This graph shows the compressive strength of concrete cubes with different percentages of steel fiber (SF) and fly ash (FA). The normal concrete mix has a compressive strength of 9.47 N/mm², which is the highest among the tested samples. When 0.5% steel fiber and 15% fly ash are added, the strength decreases to 8.72 N/mm². With 1% steel fiber and 20% fly ash, the compressive strength becomes 7.85 N/mm², and at 1.5% steel fiber with 25% fly ash, it further reduces to 7.17 N/mm². The graph

indicates that increasing the proportion of steel fiber and fly ash in this experiment results in a gradual reduction in compressive strength of the concrete cubes.

Table :4-Compressive Strength are as follows(14 days)

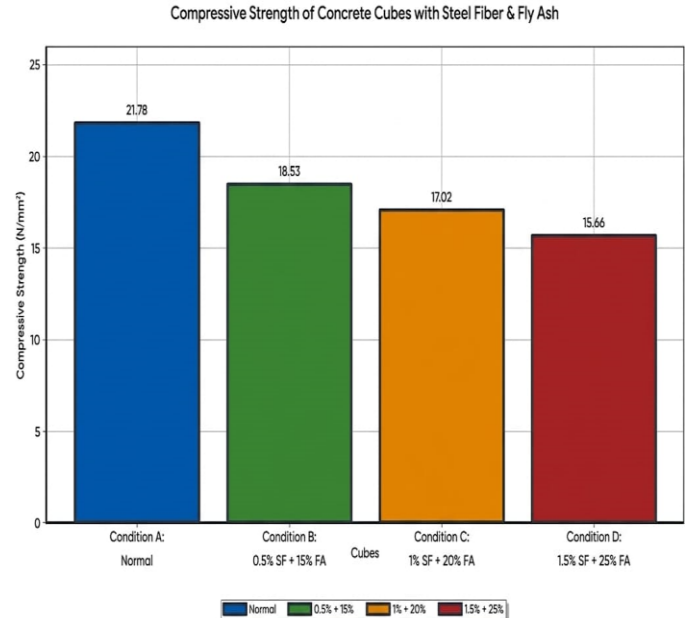
Sample ID	% of fiber			
	No of days	0.5 % +15 %	1 % +20%	1.5 % +25%
FRC-B	14	13.94	13.20	11.82



This graph shows the compressive strength of concrete cubes mixed with different percentages of steel fiber and fly ash. The normal concrete has a compressive strength of 14.20 N/mm². When 0.5% steel fiber and 15% fly ash are added, the strength becomes 13.94 N/mm². With 1% steel fiber and 20% fly ash, the strength decreases to 13.20 N/mm². At 1.5% steel fiber and 25% fly ash, the compressive strength further reduces to 11.82 N/mm². This indicates that increasing the percentage of steel fiber and fly ash in this experiment gradually reduces the compressive strength of the concrete cubes. The test was conducted with N = 2 cubes.

Table :5-Compressive Strength are as follows(28 days)

Sample ID	% of fiber			
	No of days	0.5 % +15 %	1 % +20%	1.5 % +25%
FRC-C	28	18.53	17.02	15.66



This graph illustrates the compressive strength of concrete cubes with different proportions of steel fiber (SF) and fly ash (FA). Under Condition a (Normal concrete), the compressive strength is 21.78 N/mm², which is the highest value. In Condition B (0.5% SF + 15% FA), the strength decreases to 18.53 N/mm². For Condition C (1% SF + 20% FA), the compressive strength is 17.02 N/mm², while in Condition D (1.5% SF + 25% FA) it further reduces to 15.66 N/mm². The graph shows that as the percentage of steel fiber and fly ash increases, the compressive strength of the concrete cubes gradually decreases.

Conclusion

This study concludes that the use of fly ash and steel fibers in concrete significantly improves the performance of conventional concrete. The partial replacement of cement with fly ash (15 to 25%) helps in reducing cement consumption and makes the concrete more eco-friendly and economical. The addition of steel fibers (0.5 to 1.5%) improves tensile strength, ductility, crack resistance, and overall durability of the concrete. From the experimental results, it is observed that Fiber Reinforced Concrete shows better crack control and higher load carrying capacity compared to normal concrete. Although early strength may slightly decrease with higher fly ash content, the long-term strength and durability improve. Therefore, the combined use of fly ash and steel fibers can be considered an effective and sustainable solution for producing high-performance concrete suitable for modern construction needs.

REFERENCES

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2. Swarup R. Pote, 3. Nikhil B Borse, 4. Ajay A Waghre, 5. Pruthaviraj B Gharge, is a final year diploma student in Civil Engineering at P. Dr. V. V. Patil Polytechnic, Loni. A area of interest includes concrete technology, construction materials, and sustainable building practices. This research project on Fiber Reinforced Concrete using fly ash is a part of his academic curriculum. work focuses on improving the strength, durability, and eco-friendly properties of concrete by using industrial waste materials. This study reflects his interest in modern construction techniques and sustainable development in civil engineering.

