Evaluation of Properties of Grade M20 Concrete Using Lathe Steel Fibre

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Abstract— **Steel Fiber Reinforced Concrete (SFRC) has emerged as a promising construction material due to its superior mechanical properties compared to conventional concrete. This study investigates the properties of SFRC, focusing on M20 concrete reinforced with steel fibers obtained from lathe scrap material. Experimental results reveal key insights into the behavior of SFRC under various conditions. It is found that the addition of steel fibers enhances the compressive, flexural, and tensile strengths of concrete. Optimum dosage of 2% by weight of concrete is determined for steel fiber content, beyond which strength properties diminish. Moreover, SFRC exhibits increased ductility and improved resistance to collapse compared to plain concrete. The study also explores future research avenues including the impact of fiber length, aspect ratio, and content variation on SFRC properties, as well as the utilization of alternative materials like rice husk. Understanding these factors will contribute to further enhancing the structural performance and applicability of SFRC in construction projects.**

Index Terms— **concrete grade M20, lathe steel fibre, compression test value, industrial by-product.**

I. INTRODUCTION

In contemporary construction, concrete reigns supreme as a foundational material, serving diverse purposes from towering edifices to robust pavements. The perpetual quest for concrete with high compressive strength and optimal workability led to the advent of Fiber Reinforced Concrete (FRC), heralding a new era of enhanced mechanical properties. FRC offers comprehensive improvements across critical parameters like tensile strength, toughness, ductility, post-cracking resistance, and durability, addressing challenges such as shrinkage, impact resistance, and cavitation, especially in submerged environments.

This study intersects with the global drive for sustainable development, delving into the transformative potential of waste lathe steel Fiber as a reinforcement in concrete for various construction applications. Often overlooked, lathe Fiber emerges as an economically viable and eco-friendly alternative, augmenting both tensile and compressive strength while curbing construction costs. By reshaping concrete into a more resilient and durable composite material, lathe Fiber stands as a strategic element in the evolution of concrete technology.

Furthermore, this research tackles waste management concerns by repurposing lathe steel Fiber generated during manufacturing processes, presenting it as an appealing substitute for conventional disposal methods and aligning with sustainable practices. Its utilization extends to environmental considerations and energy efficiency, promising enhanced properties in concrete and advocating for sustainable construction practices amid escalating waste production.

The feasibility of integrating lathe steel Fiber into concrete is explored through a comprehensive analysis of compressive strength, splitting tensile strength, and flexural strength of M20 concrete while optimizing Fiber proportions. Lathe Steel Fiber-Reinforced Concrete (LSSRC) emerges as a cost-effective alternative, mirroring the physical properties of conventional steel Fibers. Emphasizing manual optimization and practicality, the study underscores the accessibility and adaptability of the proposed solution in real-world construction scenarios.

Moreover, the research transcends practical benefits to grasp the effectiveness of lathe steel Fiber in enhancing concrete strength and envisages a broader impact on sustainable construction practices. By laying a robust foundation for waste material integration, the study advocates intentional strides towards sustainable construction, fostering a more environmentally conscious future in the construction industry.

II. MATERIAL AND METHODS

In this study, steel fibers with a diameter of 0.6 mm and a length of 45 mm were incorporated into M20 grade

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concrete at varying percentages ranging from 0% to 2.5% by weight of concrete, with a water-cement ratio of 0.42. The research aimed to evaluate the effects of these steel fibers on the mechanical properties of concrete.

The analysis revealed that the inclusion of steel fibers led to notable improvements in compressive, flexural, and split tensile strength of the concrete. Particularly, straight steel fibers were found to enhance the overall properties of the concrete. The steel fibers, sourced from lathe scrap, demonstrated promising results, with the optimum dosage being determined as 2% by weight of concrete.

This optimum dosage resulted in significant enhancements in compressive strength, showing an increase of up to 15%, while split tensile strength improved by 30% and flexural strength by 42%. These findings suggest that the incorporation of steel fibers, especially at the specified dosage, can effectively enhance the mechanical performance of concrete, making it suitable for various structural applications.

The various type of material used in casting process of concrete are: fine aggregate, course aggregate, cement, water, admixture and lathe steel fibre from various steel factories and machine tool manufacture in J&k distt.

a) FIBRES

Scrap steel of 0.5 mm diameter has been used in the preparation of SFRC. The fibre of 40mm in length has been used giving optimum aspect ratio of 80 The properties of fibers are given in

Table 1: Properties of fibres

SR.NO	*Tensile Strength (Mpa)*	*Young's modulus(Mpa)*	*Specific Gravity*	*Length of Fibre (mm)*	*Diameter of Fibre (mm)*	*Aspect Ratio*
1	**360**	**2.05×10^4**	**7.8**	**45**	**0.6 mm**	**75**

b) MIX DESIGN (M_{20})

Test data for materials

Table 2: Proportion of Material Used

SR NO.	*MATERIAL*	*PROPORTION*
1	Specific gravity of cement	3.0
2	Specific gravity of coarse aggregates	3.10
3	Specific gravity of fine aggregates	2.90
4	Zone of fine aggregates	II
5	Water absorption of coarse aggregates	0.43%
6	Water absorption of fine aggregates	3.47%

After studying various properties of the used material for the preparation of the mix design M20 having defined proportion as per IS code. The design for M20 has achieved taking above mentioned material whose result is discussed below:

III. RESULT AND DISCUSSION

1. COMPRESSIVE STRENGTH TEST

30 number of test specimens of size 150x 150x 150 mm were prepared for testing the compressive strength concrete. The concrete mixes with varying percentages (0%, 0.5%, 1%, 1.5%, 2%) of steel fibre as partial replacement of fine aggregate (sand) were cast into cubes. In this study, to make concrete, cement and fine aggregate were first mixed dry to uniform color and then coarse aggregate was added and mixed with the mixture of cement and fine aggregates. Water was then added and the whole mass mixed. The interior surface of the moulds and the base plate were oiled before concrete was placed. After 24 hours the specimens were removed from the moulds and placed in clean fresh water. The specimens so cast were tested after 7 and 28 days of curing measured from the time water is added to the dry mix. The load was applied axially without shock till the specimen was crushed. Results of the compressive strength test on concrete with varying proportions of steel fibre replacement at the age of 7 and 28 days are given in the fig 1.

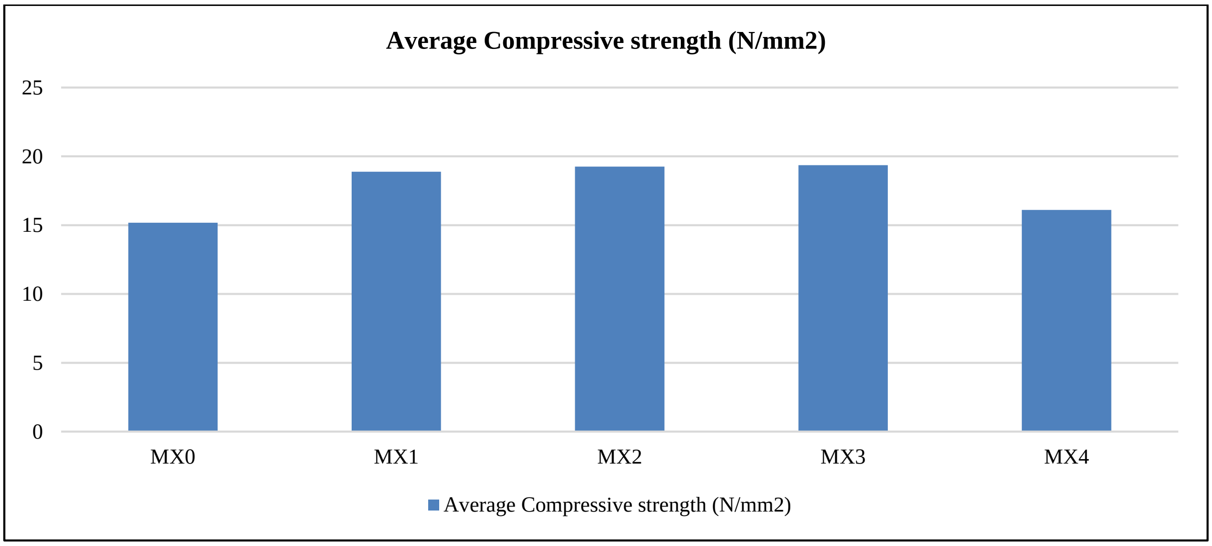

Fig 1: Compressive Strength (N/mm^2) after 7 Days

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The compressive strength of concrete mix with 2 % fibre content was 21.99Mpa after 7 days and36.21Mpa after 28 days. the strength at the % of 0% ,0.5%, 1% ,1.5% ,2% ,2.5% and after 7 days are 15.18, 18.88 ,19.25, 19.36, 21.99, 16.11 as shown in fig 2.

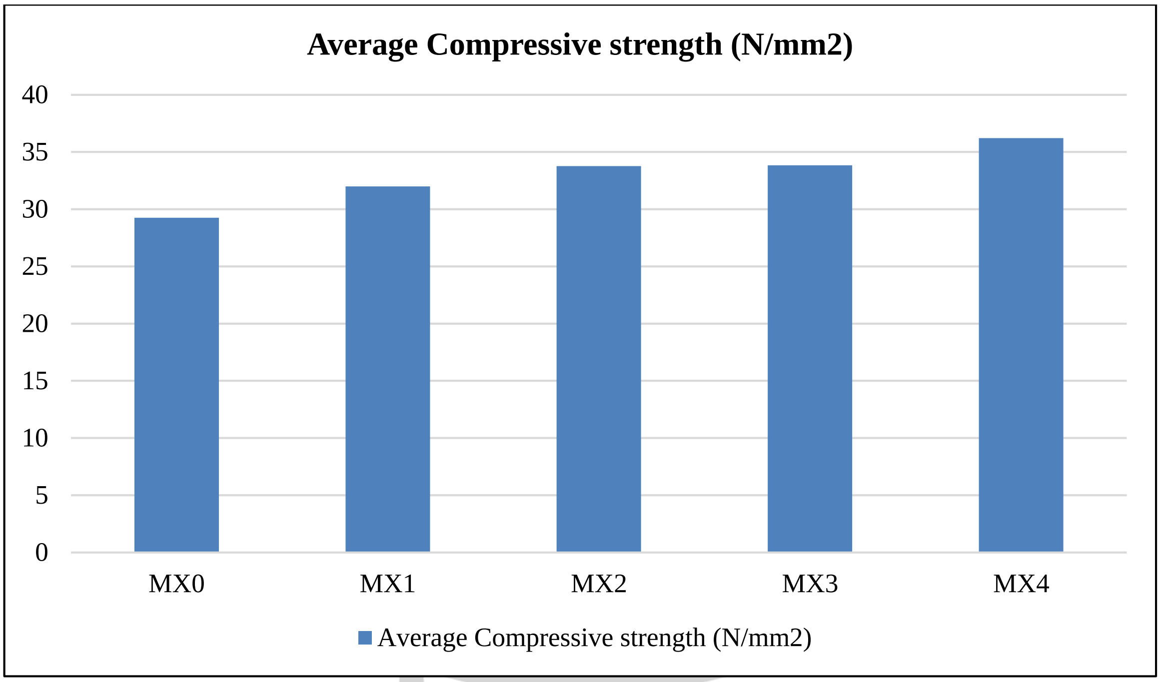

Fig 2: Compressive Strength (N/mm²) after 28 Days

The strength at the % of 0% ,0.5%,1%,1.5%,2%,2.5% after 28 days are 29.25,31.99,33.77,33.84,36.21,32.73 respectively.

The fibres increase the toughness and compressive strength. It has been found that the compressive strength of SFRC based specimen increased 15% with 2% steel fibre weight.

2. Flexure Strength

30 test specimens of 150 X 150 X 700 mm of plain mortar and SFRC have been investigated. The effective length of beam was taken 640mm and the flexural strength were calculated after 7 and 28 days respectively and is shown in Table 4.3 and4.4.

The flexural strength has been calculated as 1.39,1.46,1.77,1.89,2.1,1.79, after 7 days at the percentage of 0%,0.5%,1%,1.5%,2%,2.5, respectively as shown in fig 3:

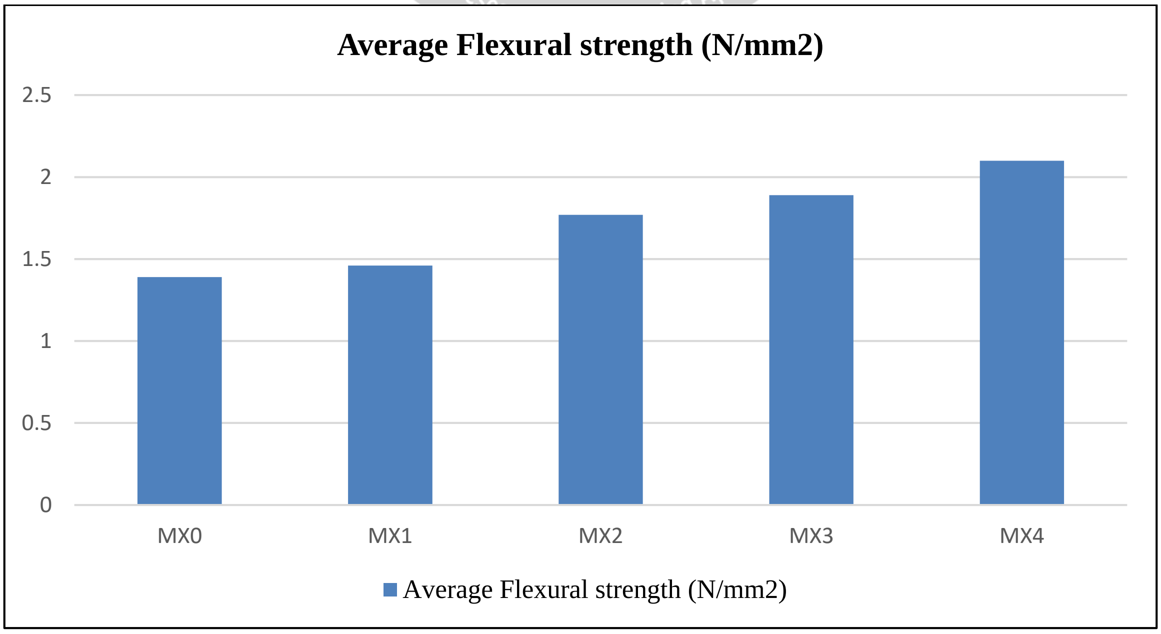

Fig 3: Flexural Strength (N/mm²) After 7 Days

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The flexure strength after 28 days at the percentage of fibre as 0%, 0.55, 1%, 1.5%, 2%, 2.5%, are 2.19,2.98,3.31,3.25,3.53,3.04s respectively as shown in fig 4:

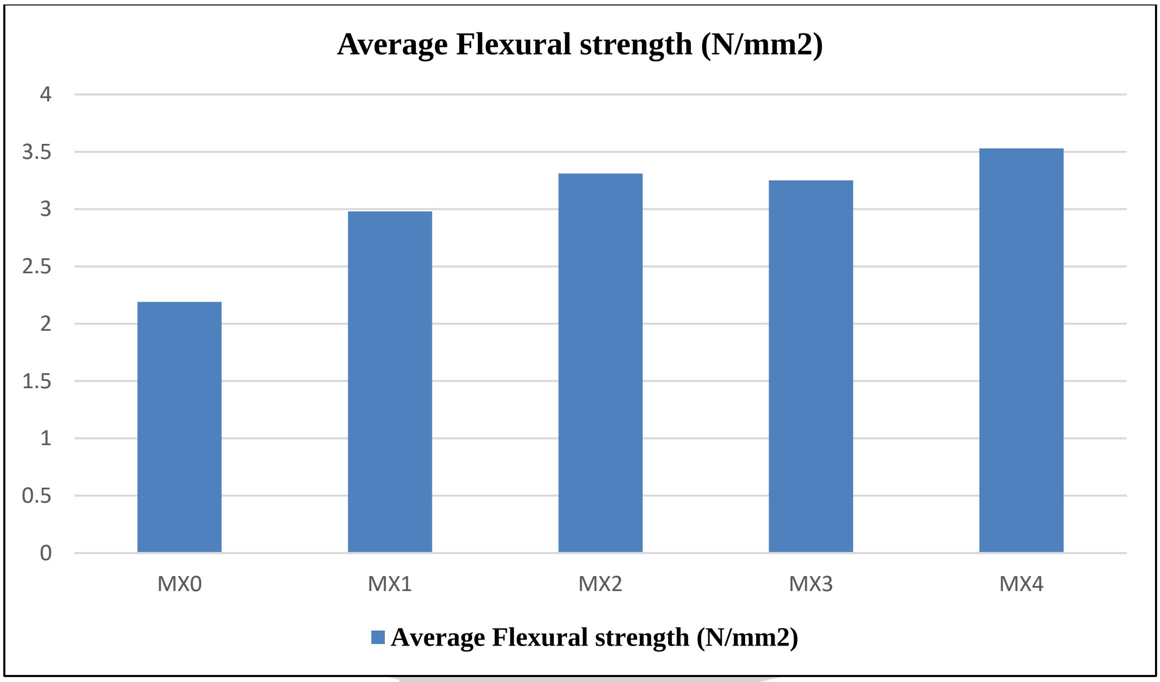

Fig 4: Flexure Strength (N/mm^2) After 28 Days

The flexural strength increases more at the fibre content of 2 % and data are clearly shown in Table 5.4 and plotted in fig.4.4. It has been seen that the plain concrete specimens gets break into two parts as we applied the load, while in case of SFRC beams micro cracks are developed and not break into two parts. It means ductility of concrete increase.

3. Split Tensile Strength

In the split tensile strength specimens of size 300 X 150 mm are taken under the compression testing machine of 100 tonnes capacity. The cylinders are placed in the horizontal position the split strength of plain and SFRC concrete is calculated. The fibers are added to the concrete at varying percentages of 0.5 %,1 %,1.5%,2and ,2.5%. The split tensile strength is calculated after 7 and28 days as shown in the Table 4.5 and 4.6 respectively. as shown in fig 5.

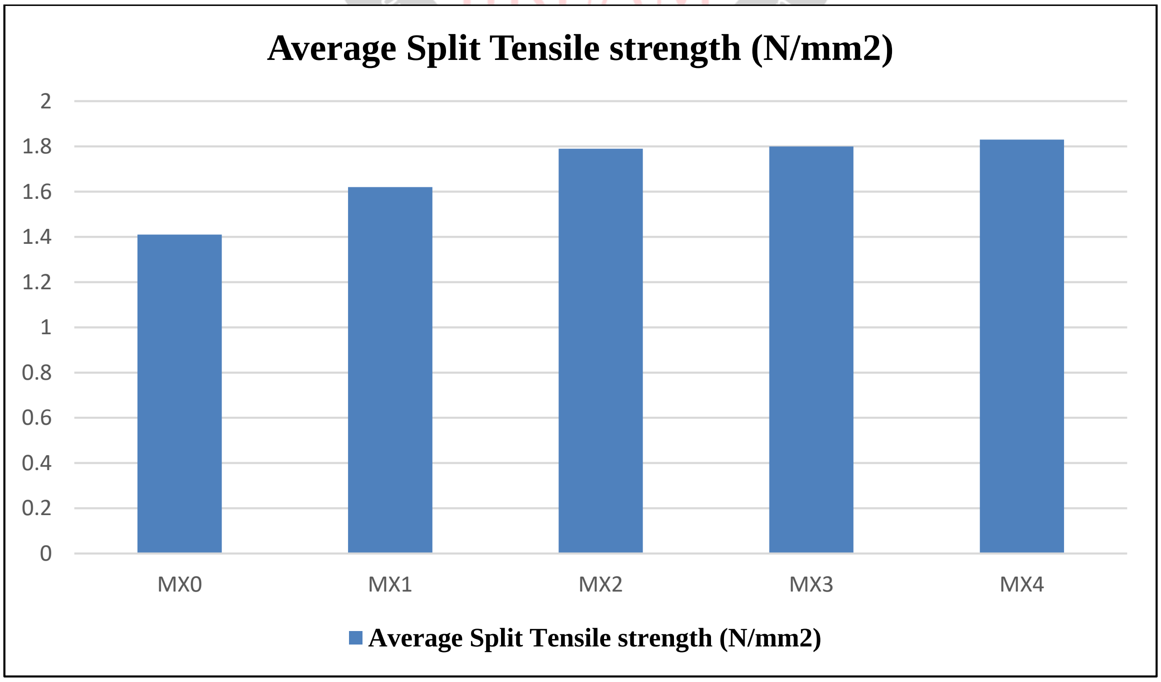

Fig 5: Split Tensile Strength (N/mm^2) after 7 Days

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The split strength after 28 days was calculated as 2.28Mpa, 2.52Mpa, 2.64Mpa, 2.94 Mpa, 3.11Mpa, 2.61Mpa and2.52Mpa. It has been seen that the flexural strength increases 1.10, 1.15, 1.28, 1.36, 1.11and 1.14.

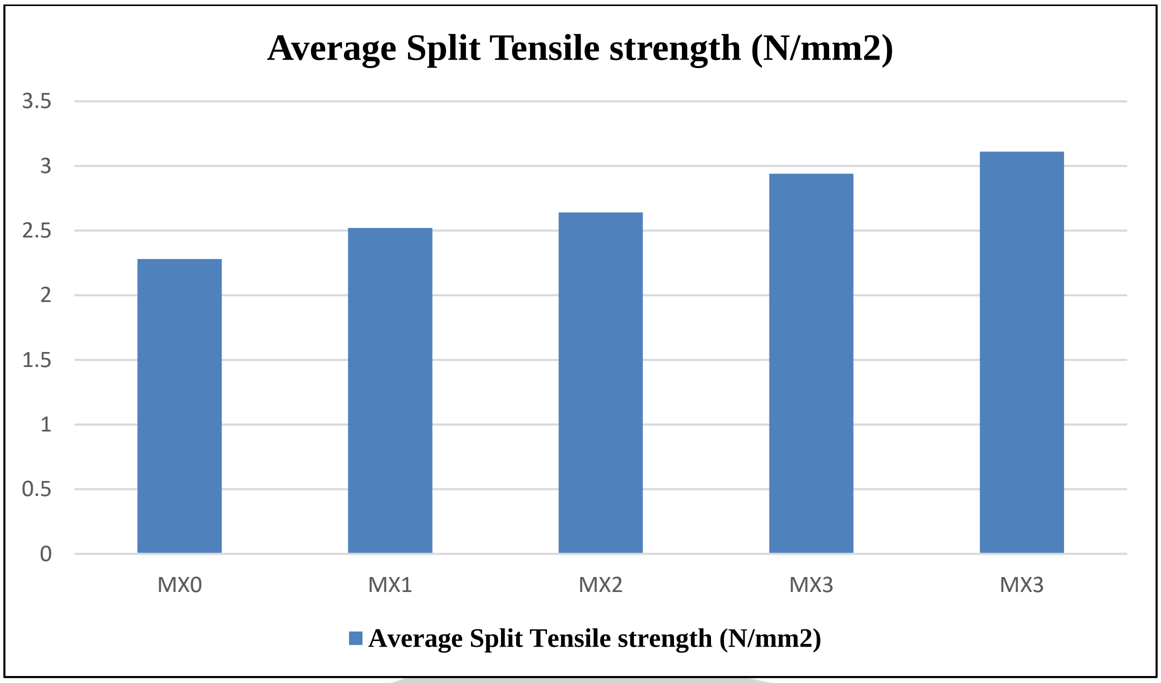

Fig 6: Split Tensile Strength (N/mm^2) after 28 Day

IV: CONCLUSION

From the Results of the experimental investigation following are the conclusion

- The experimental investigation shows the properties of M20 reinforced with scrap material (steel fibres) generated from lathe
- The Experimental work also showed that the workability of SFRC gets reduced as we increased the fibre amount
- It also shows that the compressive strength of SFRC gets increased up to 15% with 2% of steel fibres used as compared to plain concrete
- It has been concluded that use of fibre content of 2% by weight of concrete is the optimum dosage
- The split tensile strength of steel fibre reinforced concrete gets increased up to 30% with 2 % as compared to plain concrete.
- It is observed that the compressive strength of steel fibre reinforced concrete get increased up to 2% dosage amount after that it starts decreases.
- The report work also showed that the flexural strength of steel fibre reinforced concrete gets 42% as compared to plain concrete.
- The specimen prepared reinforced with steel fibres increase the ductility behaviour of SFR.
- Steel Fibre reinforced concrete is very effective, which shows high flexural tensile strength as compared to compressive strength.
- The specimen prepared by the addition of steel fibre generated from lathe does not collapse as compared to plain concrete.

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