Journal of Advanced Engineering Research
ISSN: 2393-8447
Volume 11, Issue 1, 2024, pp.9-11

STUDY ON THE EFFECT OF STEEL FIBRES ON REINFORCED CONCRETE BEAMS WITHOUT STIRRUPS

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ABSTRACT

Reinforced concrete beams are structural elements that designed to carry transverse external loads. Stirrups are mainly provided for holding the primary reinforcement of beam. It prevents the buckling of beam and protect the RCC structure during seismic activity. The addition of steel fibres to concrete has significant effect of tensile strength and modulus of elasticity. The steel fibres were added of different percentages by total volume of beam. Different shapes of steel fibres were added. It have the advantages of saving time, money, and labour. Steel fibres are provided for improving the flexural strength of concrete beam without the need of stirrups. Different shapes of steel fibres provide increased coverage and excellent bonding to reduce cracking.

Keywords–steelfibres,flexuralstrength,cracking

1. INTRODUCTION

Steel fibres can be added to concrete to improve its strength and ductility. When steel fibres are used in beams without stirrups, they can be provide additional reinforcement and improve the performance of the structure under loading conditions. The addition of steel fibres in concrete increases the tensile strength and flexural strength of the material , thereby enhancing the load carrying capacity of the beam. The fibres act as small reinforcement bars, providing additional resistance against crack propagation and enhancing the overall toughness of the concrete. Without stirrups, the addition of steel fibres can help to reduce the formation of cracks in the concrete beams , especially in the compression zone. The fibres distribute the stress more evenly, which can reduce the formation of vertical cracks and improve the overall performance of the beam. Stirrups are an essential components of reinforced concrete beams, as they help to prevent diagonal cracks and increase the beams load bearing capacity. Without stirrups, the beam would be weaker and more prone to failure under load.

Stirrups are used to reduce the beams vertical and horizontal reinforcement bars. They are typically placed at regular intervals along the length of the beam and are designed to resist the shear forces that act perpendicular to the beams longitudinal axis. If stirrups are not used in a reinforced concrete beam, the beam may fail in several ways. For example , it may experience diagonal cracking , which can lead to the eventual collapse of beam. Additionally , the beam may experience excessive deflection or sagging, which can lead to structural instability. Stirrups are a crucial component of reinforced concrete beams, and their absence can significantly compromise the strength and stability of the beam. It is essential to ensure that stirrups are used correctly and at the appropriate intervals to ensure the integrity of the structure.

The use of steel fibres in concrete beams can improve the flexural and shear strength , reducing the need for traditional reinforcement such as stirrups. Steel fibres can increase the toughness of concrete by bridging cracks that occur during loading, thereby improving the post cracking behaviour of the beam. In beams without stirrups, steel fibres can help distribute the shear forces and prevent brittle failure . the fibres also help to maintain the structural integrity of the beam in case of failure of one of the reinforcing bars. However, its important to note that the effectiveness of steel fibres in beams without stirrups depends on several factors, including the type and amount of fibres used, the beams dimensions , loading conditions, and the concrete nix design.

Steel fibres are commonly added to concrete to enhance its mechanical properties, such as its strength, ductility toughness and impact resistance. Steel fibres are typically made from carbon steel and are available in different shapes, size, and aspect ratio. When steel fibres are added to concrete, they help to increase the tensile strength and flexural strength of the material. The fibres act as reinforcement and helps to distribute the load more evenly throughout the concrete.

2. LITERATURE REVIEW

In recent years there has been growing interest in using steel fibres as a replacement for traditional steel stirrups in reinforced concrete beams. These is because stel fibres have been shown to provide enhanced tensile strength, ductility and toughness to concrete, which can help to reduce cracking and improve overall durability. One of the earliest studies on the topic was conducted by alsayed and al-salloum (2010) , who investigated the effect of steel fibres on the behaviour of reinforced concrete beams without stirrups. They found that the addition of steel fibres increased the load carrying capacity and ductility of the beams, as well as improving their crack resistance. In a more recent study , Tavakkoli et al. (2018) evaluated the flexural behaviour of reinforced concrete beams with and without steel fibres. They found that the use of steel fibres resulted in higher flexural strength, stiffness and and energy absorption compared to beam with fibres. Similarly , Gupta et al. (2019) conducted an experimental investigation ton evaluate the flexural strength of reinforced concrete beams without stirrups and with different percentages of steel fibres. They found that the addition of steel fibres significantly improved the ductility , energy absorption , and crack resistance of the beams.

3. METHODOLOGY

3.1 Design of beam

The use of steel fibres in reinforced concrete beams without stirrups is aimed at improving the ductility and toughness of the beam. The methodology to evaluate the effect of steel fibres in such a beam are; first design the reinforced concrete beam without stirrups based on the required loading conditions, span , and other design parameters. The dimensions of the beam should be chosen such that the steel fibres can be uniformly distributed throughout the beam. Beam dimensions are 850x150x150mm and the grade of concrete is M30, the reinforcement details are 10mm diameter and cover is 25mm , the stirrups are 6 bars of 8mm diameter @10 cm cc.

3.2 Specimen preparation

Prepare the test specimens by casting the beams with and without different type of steel fibres, (corrugated and hooked end) using the same concrete mix and reinforcement layout. The length of the beam should be at least 3 times the depth to ensure a pure bending failure. The percentage of steel fibres added are 0%, 0.5%, 0.75%.1%, 1.5%, 2%.

3.3 Testing of beam

Perform a two point bending test on the specimens to evaluate the load –deflection behaviour, and ultimate strength of the beams . load deflection behaviour can be used to determine the ductility and toughness of the beam., while the ultimate strength can be used to evaluate the load carrying capacity. Analyze the test results to determine effect of steel fibres on the load.

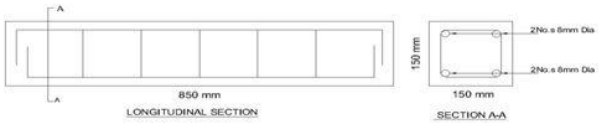

Fig.1 Reinforcement details

Fig. 2 Corrugated and hooked end steel fibres

Fig. 3 Testing of beam

3. RESULTS AND DISCUSSIONS

Two point bending test are commonly used to evaluate the flexural strength and stiffness of reinforced concrete beams. In these tests the beam is loaded at two points near the ends, causing it to bend. The load deflection response of the beam is measured, and the flexural strength and stiffness can be calculating from the resulting data. Steel fibres are often added to concrete to improve its strength and durability. when steel fibres are used, they can help to increase the tensile strength of concrete , which can help to reduce cracking and improve the overall performance of the beam. However, steel fibres alone may not provide enough reinforcement to prevent the formation of cracks and ensure the ductility of the beam, which is why stirrups are commonly used as well. If a two point bending testis conducted on a reinforced concrete beam with steel fibres but without stirrups , the test results will depend on a variety of factors, including the type and amount of steel fibres used the dimensions of the beam, the loading conditions, and the quality of the concrete mix. In general, the addition of steel fibres can improve the flexural strength and stiffness of the beam, but the absence of stirrups may limits its ductility and increase the risk of cracking.

The aspect ratio of hooked end steel fibres is obtained by the ratio of length to the diameter of the fibre (50mm) and for corrugated steel fibre is (60mm). after testing of beams, the average first cracking load obtained was 67KN for beams with hooked end steel fibres and for 69KN for beams with corrugated steel fibres. The average ultimate load obtained was 79KN for beams with hooked end steel fibres and 82KN for beams with corrugated steel fibres. For normal beams, the average first cracking load obtained was 53KN and the average ultimate load was 63KN. The 1% is the optimum percentage of steel fibre sis obtained.

4. CONCLUSION

The use of steel fibres in concrete has improve its mechanical properties, including its strength , ductility, and toughness . in beams, without stirrups, the addition of steel fibres can provide additional reinforcement and help prevent cracking. In the beam, without the need of stirrups, the strength is improved by the addition of steel fibres. The 1% steel fibre is the appropriate percentage of steel fibre to the total volume of beam. It plays an important role in the strength and the cracking behaviour of the beam. The corrugated steel fibre reinforced beam without stirrups has more strength as compared to hooked end steel fibre reinforced beam without the need of stirrups. It is due to crimpled shape that imparts more bonding with the concrete (high aspect ratio).

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