Use of Recron 3S fibres in Improving Engineering Properties of Construction Materials: A Review

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ABSTRACT

Recron 3S fibres have emerged as an effective solution to enhance the engineering properties of soil, cement mortar, and concrete, making them crucial for modern civil engineering applications. The fibres improve mechanical strength, crack resistance, and durability in cement-based materials. In soil stabilization, Recron 3S enhances soil strength, flexibility, and resistance to moisture fluctuations, making it particularly useful for clayey soils in regions prone to seasonal wetting and drying cycles. When added to cement mortar and concrete, Recron 3S fibres significantly reduce shrinkage-induced cracking, improve tensile and compressive strength, and enhance the durability of structures under dynamic loads. Furthermore, Recron 3S reinforces concrete by reducing permeability and improving performance in extreme conditions such as elevated temperatures. This review article examines various studies on the use of Recron 3S in construction materials, emphasizing the mechanical and durability improvements in soil properties, cement mortar and concrete grades like M30, M35, and M40. The findings indicate that incorporating Recron 3S in construction materials leads to superior performance, making it a vital material in the quest for more sustainable and long-lasting infrastructure. This review provides a comprehensive analysis of the potential of Recron 3S to revolutionize the construction industry by enhancing the properties of critical building materials.

Keywords: Fibre Reinforced Concrete, Recron 3S, Split tensile strength, ferrocement, soil stabilization

1. INTRODUCTION

Recron 3S fibres, a synthetic polymer, have gained significant attention in civil engineering applications due to their ability to enhance material properties in various domains. These fibres are primarily composed of polyester and are known for their durability, high tensile strength, and resistance to harsh environmental conditions. Their versatile nature has made them applicable across three major sectors of civil engineering: geotechnical engineering, cement mortars, and concrete technology.

In geotechnical engineering, Recron 3S fibres have been used to stabilize a wide range of soils, improving parameters such as California Bearing Ratio (CBR) and unconfined compressive strength (UCS). These fibres are particularly beneficial for stabilizing problematic soils like black cotton soil, where conventional techniques may not provide satisfactory results. In cement mortar applications, the fibres have demonstrated the potential to increase compressive and tensile strengths, especially in masonry work. This improvement not only contributes to better load-bearing capacity but also ensures the longevity of structures. Lastly, in concrete technology, Recron 3S fibres have been found to enhance mechanical properties of cement concrete, such as compressive strength, split tensile strength, and flexural strength. These fibres also improve durability and resistance to shrinkage and cracking, making concrete more suitable for long-term structural applications.

This review aims to present a comprehensive analysis of the applications of Recron 3S fibres in these three domains, providing insights into their performance benefits and identifying optimum fibre content for various materials.

2. LITERATURE REVIEW

Recron 3S fibres for its applications, are observed to be studied in three domains of civil engineering as follows:

2.1 Geotechnical Engineering,

2.2 Cement mortars and

2.3 Concrete Technology

2.1 Application of Recron 3S fibres in Geotechnical Engineering:

Husain et. al (2015) investigated use of Recron 3S fibres for the stabilization of locally available silty soil. The parent soil was tested for index and engineering properties. Recron 3S fibres were added to the experimental samples in 0.15%, 0.30%, 0.45% and 0.60% by weight of dry soil sample. Modified Proctor Test, California Bearing Ratio and Unconfined Compressive Strength test were conducted on each group of the soil samples. The experimental results showed that there is no justified trend was observed in Modified Proctor Test for Optimum Moisture Content and Maximum Dry Density of the soil that could be due to resistance to repacking of the soil grains. CBR value was observed to be substantially increased by 5.77 times for 0.15% content of the fibres and similarly, UCS of the soil was found to be increasing with increase in content of the fibres, but the rate of increment was not observed as high as for 0.15% content of fibres.[1]

P. Sowmya Ratna et. al (2016) focussed on use of Recron-3S fibres to improve properties of black cotton soil mixed with optimum lime content to stabilize the soil. Initially, index and engineering properties of the black cotton soil were determined. The commercial lime was then mixed with 0%, 2%, 4% and 6% of dry weight of soil to determine consistency limits, optimum moisture content and maximum dry density of the soil. With reference to obervations, optimum lime content was decided as 4% to determine optimum content of Recron-3S fibres. Heavy compaction test and California Bearing Ratio test were conducted on the black cotton soil mixed with 4% lime. For the tests, the fibres were mixed in 0%, 0.5%, 1%, 1.5% and 2%. Thus, it was observed that at 4% lime content and 1% fibres content, the greatest CBR value was observed. Therefore, it was concluded that clayey soils can be stabilized using 4% lime and 1% Recron-3S fibres as the optimum dose.[2]

Subbarayudu et. al (2017) aimed to stabilize a soil using Recron-3S fibres, Fly ash and lime to make the soil suitable for pavement design. In all 8 combinations of soil, fly ash, lime and fibres were designed. One was the only soi sample, 5 combinations were with fly ash and lime used in various percentage and remaining 2 were soil, fly ash, lime and the fibres. The soil samples without fibres (6 combinations) were tested for the maximum dry density and corresponding optimum moisture content using standard proctor test. For the pure soil sample and soil samples with various percentage of fibres (i.e. 1% and 2%), Standard Proctor test and California Bearing Ratio test were conducted. The optimum moisture content was observed 12.19% for 2% fibre content which is in comparison lesser than that for 1% fibre content. The corresponding maximum dry density was observed 1.77 g/cc for 2% fibre content which is relatively greater than that for 1% fibre content. CBR tests indicated that for 1% fibre content, CBR values were the maximum which are 1.71 and 1.41 times higher for 1% fibre content than that for only soil without any additives. Thus, it was concluded that the additives can be used to improve the soil properties for its application as subgrade and subbase layers in pavements.[3]

Tangodar et. al (2018) used Recron 3S fibres improve the soil properties. The tests such as Optimum Moisture Content, Maximum Dry Density, Unconfined Compressive Strength for shear parameters were conducted on the soil sample reinforced with Recron 3S fibres. The soils under investigation were Black cotton Soil and Red Soil. The quantities of the fibres were 0%, 0.10%, 0.25%, 0.50%, 0.75%, 1% and 1.25% by weight of the dry soils. Maximum Dry density of the reinforced soil was observed to be decreasing with the increase in the content of the fibres, whereas its unconfined compressive strength found to be maximum at 1% quantity of fibres which is 4.2 times greater than that of the unreinforced soil.[4]

Jyothi Raju K et. al (2019) used quarry waste i.e. dust and Recron 3S fibres to improve properties of black cotton soil. Atterberg's consistency limits, swell index, optimum moisture content and maximum dry density and CBR value of the soil were determined in the lab. Similarly, properties of quarry dust were also found out. Compaction test was carried out on black cotton soil by changing content of quarry dust as 5%, 10%, 15%, 20% and 25% and observed that at 20% blending of quarry dust, the soil had maximum dry density of 15.47 kN/cu.m. and optimum moisture content as 24.38%. For this blend proportion of the soil and quarry dust, Recron 3S fibres in 0.5%, 1%, 1.5% and 2% were mixed and again the compaction test was conducted. It showed maximum dry density of 16.23 kN/cu.m. at 25.83% moisture content with 1.5% Recron 3S fibres. In CBR tests on the soil blended with 5%, 10%, 15%, 20% and 25% quarry dust gave maximum CBR value as 4.03 at 20% blending. Further, CBR tests were conducted on this blended soil (20% dust) with 0.5%, 1%, 1.5% and 2% Recron 3S fibres. The results indicated that the maximum CBR value of 8.06 was observed at 1.5% content of the fibres. The cyclic plate load tests on the untreated and blended soil (20% quarry dust & 1.5% fibres) showed that treated soil exhibited 1200 kPa ultimate pressure which is almost twice as compared to untreated soil, at 2.41 mm deformation. Thus, it was concluded that black cotton soil can be treated using quarry dust and Recron 3S fibres to improve its mechanical properties.[5]

2.2 Application of Recron 3S fibres in Cement mortar:

Ahuja et. al (2019) investigated use of Recron 3S fibres to improve cement mortar properties for its use in brick masonry. Portland Pozzolana cement, fine aggregates, 12 mm long Recron 3S fibres and first class bricks were used. Four cement mortar proportions 1:3, 1:4, 1:5 and 1:6 were used. Fibres were added as 0%, 0.1%, 0.25% and 0.50% for each cement mortar mix proportion. Three cubes (50 sq.cm.) and cylindrical (50 mm x 100 mm) specimens of each mix proportion and fibre content combination were casted for compression and split tensile tests. Brick masonry units in 54 numbers, each consisting of 5 bricks separated by 10 mm thick mortar layer, were made for the compression test. The maximum cube compressive strength was observed 20.8 MPa for cement mortar 1:3 and fibres 0.1%, after that it started decreasing with the increase in the fibre content. The maximum split tensile strength was found to be 0.19 MPa for the same mix proportion and fibre content. The compressive strength of masonry units with fibre reinforced mortar was observed 15% - 25% more than the plain cement mortar.[6]

2.3 Application of Recron 3S fibres in Concrete Technology:

Nehvi et al. (2016) studied workability and strength characteristics of M35 grade concrete when reinforced with Recron 3S fibres. The percentage content of the fibres was ranging from 0.1% to 0.5% with 0.1% increment. On fresh concrete, slump test was conducted and mechanical properties were found out on hardened concrete after 7, 14 and 28 days of curing. 54 specimens were casted for each strength test i.e. compressive, split tensile and flexural strength tests. For each percentage content of fibres, 9 specimens were casted. The slump test showed that with increase in the content of the fibres in the concrete, its workability went on decreasing. Compressive strength test results showed that the strength went on increasing with the increase in the content the fibres from 0% to 0.5% with the maximum value as 40.1 MPa. Split tensile strength indicated that the peak value of 3.56 MPa was at 0.3% and Flexural strength also was the maximum at 0.3% fibre content as 8.25 MPa. Thus, use of Recron 3S fibres was observed to improve the durability and tensile strength of concrete for long term.[7]

Sekhar et. al (2017) investigated performance of concrete of various grades when added with Recron 3S fibres and subjected to elevated temperatures. The concrete cubes and cylinders were made with 53 grade Ordinary Portland Cement. Zone II fine aggregate and 20 mm size coarse aggregates. The concrete mix design was done for M30, M35 and M40 grades. The content of Recron 3S fibres was 0.10%, 0.15%, 0.20%, 0.25%, 0.30%, 0.35% and 0.40% by the weight of the concrete. The compressive strength and split tensile strength of all the grades of concrete were found at 7, 28 and 56 days of curing. The specimens were heated in a muffle furnace for the period of 1 hour, 2 hours and 3 hours before testing. It was observed that at 0.30% Recron 3S fibres content, compressive and split tensile strength were found to be maximum for all the grades of concrete. The compressive and split tensile strengths were observed to be increasing when heated upto 250 degree Celsius, with or without Recron 3S fibres, when heated for 1 hour and 2 hours. After 250 degree Celsius temperature, the strengths started decreasing because of melting of the fibres. Thus, it was concluded that 0.30% content of fibres up to 250 degree Celsius temperature was the optimum fibre content in concrete irrespective of the three grades of concrete.[8]

Anil Kumar et. al (2017) investigated study of properties of M25 and M40 grade concrete added with Recron 3S fibres. The mix proportions for M25 and M40 grade concrete were 1:1.94:3.57 & 1:1.51:2.98 respectively. The corresponding water - cement ratios were 0.46 and 0.38. Four categories of each grade of concrete were made with 0%, 0.2%, 0.3% and 0.4% addition of Recron 3S fibres. Workability tests i.e. slump cone test, compaction factor test & Vee-Bee time test, then, compressive strength, split tensile and flexural strength tests were conducted on the concrete of both the grades. In workability tests, decrease in the workability with the increase in the fibre content was observed. In compressive strength tests, irrespective of grade of concrete, the optimum fibre content was observed 0.3% at which the greatest compressive strengths were 38.48 MPa and 54.56 MPa respectively for M25 and M40 grade concretes. The split tensile strengths for M25 and M40 grade concretes were maximum at 0.3% fibre contents. Similar results were observed for flexural strength. Thus, as far as strength parameters are concerned, 0.3% fibre content was observed as optimum content.[9]

Prem Kumar et al. (2017) experimented on concrete of three grades using Recron 3S fibres to determine the optimum dose of the fibres. The mix was designed for M25, M60 and M80 grades of concrete. The water - cement ratio was taken 0.27. The contents of fibres were 0% (control specimen), 1% and 2% by the weight of fine aggregates. The concrete cubes of 150 mm x 150 mm x 150 mm, concrete cylinders of 150 mm x 300 mm size and concrete beams of 150 mm x 150 mm x 700 mm were casted respectively for compressive, split tensile and flexural strength determination. In each category, the percentage of Recron 3 S fibres was varied as 0%, 1% and 2%. All the tests were conducted after 14, 28 and 56 days of curing. It was observed that irrespective of grade of concrete and content of the fibres, the compressive, split tensile and flexural strength of the concrete, went on increasing with the increase in the curing period. The maximum values of all the strengths were observed for 1% content of the fibres for all the grades of concrete. The decrease in the compressive strengths was observed for 2% content of the fibres, which was 0.75%, 2.8% and 9% respectively for M25, M60 and M80 grade of concrete. In the same manner, split tensile and flexural strength were the highest for 1% content of the fibres. Thus, 1% content of the fibres was inferred as the optimum dose for improving the properties of concrete.[10]

S. Satish Kumar et al. (2018) studied strength properties concrete using egg shell powder at 5%, 10%, 15% and 20% of cement with the objective of replacing the cement with another cementitious material. Ordinary portland cement and pozzolana slag cement were used in the study. Compressive strength and split tensile strength were found out using cubes and cylindrical samples at 7, 28 and 60 days of curing. The optimum percentage of egg shell powder for concrete with ordinary portland cement was found out fo be 5% at which both the compressive strength and split tensile strength were the maximum i.e. 41.67 MPa and 3.69 MPa respectively, for 28 days of curing. In case of concrete prepared using portland slag cement, the optimum percentage of egg shell powder was observed 10% with the highest compressive and split tensile strength values as 45.32 MPa and 3.82 MPa respectively for 28 days of curing. Recron 3S fibres with 0.2%, 0.3%, 0.4% and 0.5% were added in respective concretes prepared at their corresponding optimum content of egg shell powder and again tested for compressive and split tensile strengths. The results indicated that for both the types of concretes, with the increase in the content of the fibres, both the strengths deceased. Thus, at 0.2% content of the fibres, the strengths were observed the maximum. For concrete with ordinary portland cement & 5% egg shell powder, the maximum compressive and split tensile strengths were 55.47 MPa & 4.51 MPa respectively. The corresponding values for concrete with portland slag cement & 10% egg shell powder were 47.76 MPa & 4.86 Mpa. Thus, increase in the strengths was observed when the fibres were added, but the strengths decreased when the fibre content was increased.[11]

M. Prabu et. al (2019) observed that Fibre Reinforced concrete shows better resistance to internal microcracking and shrinkage. The concept was investigated using Recron 3S fibres in various grades of concrete prepared using manufactured sand as the replacement of common river sand. M20, M25, M30 & M35 grades of concrete were designed with the water-cement ratio of 0.55, 0.5, 0.45 and 0.40 respectively. Total 60 cubes (150 mm x 150 mm x 150 mm), 20 cylinders (150 mm diameter, 300 mm high) and 20 prisms (100 mm x 100 mm x 500 mm) were casted. In each category of specimens, Recron 3S fibres were used in 0%, 0.25%, 0.5%, 0.75% and 1% quantity by weight of cement. The cube specimens were tested for Compressive strength of 7, 14 and 28 days of curing and compressive strength corresponding to 0.75% addition of the fibres was found to be the maximum. The cylindrical specimens when tested for split tensile test showed maximum strength at 0.75% and similar was the observation in flexural strength of the prisms. Therefore, it was concluded that 0.75% addition of Recron 3S fibres is the optimum dose for the best results.[12]

Pandey et al. (2020) experimented on M30 grade concrete with glass and Recron 3S fibres. M30 grade concrete with water-cement ratio 0.45 was designed with 60% content of 20 mm aggregate and 40% content of 10 mm aggregate. The percentage content of both the types of fibres was 0%, 0.1%, 0.2% and 0.3%. The tests were conducted for compressive strength (7, 28 and 60 days), split tensile strength and flexural strength. The uncertain results were observed for compressive strength of the concrete as the strength for 0% fibre content was observed greatest, but further among 0.1%, 0.2% and 0.3% fibre content, compressive strength was reported the maximum i.e. 30 MPa. When in the same proportion the glass fibres were mixed in the concrete, the compressive strength was observed greater for 0.2% glass fibres as compared to Recron 3S fibres. The work also reported that split tensile strength of the concrete was greater for Recron 3S fibres and its flexural strength was more for the glass fibres.[13]

3. SUMMARY

Recron 3S fibres have been extensively studied for their applications in improving the mechanical properties of soils, cement mortars, and concrete. In geotechnical engineering, Recron 3S fibres are employed to stabilize various soils, including silty soils and black cotton soil. Research shows that incorporating fibres at specific dosages significantly enhances CBR and UCS values, improving soil suitability for use in pavements and other construction applications. The optimum fibre content for soil stabilization varies, with 1% often yielding the best results in terms of strength and compaction.

In cement mortars, the inclusion of Recron 3S fibres enhances compressive and tensile strengths, with a notable improvement observed in brick masonry units. Fibres reduce shrinkage and cracking, making mortar mixes more durable. However, an excess of fibre content may lead to a reduction in strength after reaching an optimum point, typically around 0.1%–0.3% fibre content. Even more research on the use of Recron 3S fibres on the properties of cement mortar will provide better and thorough insight.

For concrete technology, Recron 3S fibres improve workability and strength characteristics. Studies have shown that fibre content between 0.3% and 0.5% significantly enhances compressive, tensile, and flexural strengths, especially in high-grade concretes. Despite the improvement in strength, workability may decrease with increasing fibre content, necessitating adjustments in mix design for specific applications.

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