International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 01 Jan. 2025, pp: 492-500 www.ijaem.net ISSN: 2395-5252

Experimental Study on Flexural Behaviour of RCC Beam Using Natural Fiber Wrapping

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Date of Submission: 20-01-2025 Date of Acceptance: 30-01-2025

ABSTRACT
For a variety of causes, the infrastructure associated with Reinforced Concrete (RC) constructions has been shown to be structurally deficient, and the ageing of such structures is frequently recorded. The External strengthening using jute fibre Composites are rapidly gaining acceptance as a cost effective and widely accepted in engineering practice. However, this system requires specialized surface preparation of the concrete to develop adequate bond strength between the jute fibre strip the concrete substrate. The main objective of this investigation the behaviour of RC beams. The beams were tested until failure to understand the contribution of fasteners on the behavior of RC beams. The experimental results revealed that the introduction of fasteners significantly increases the composite action between the concrete and jute fibre. To study the flexural behaviour of RC beams strengthened using natural fibre wrapping. To study the behaviour of reinforced concrete beams with and without FRPScheme of wrapping, Types of FRP used.To increase ductility of concrete beam whenever repair and strengthening process involved. To study the behaviour of concrete beam with and without FRP strengthening techniques.To study flexural behaviour of beam under loading conditions. To arrive the mix ratio for M40Comparitive study on increased strength of beam by using jute fibre retrofitting techniques.

I. INTRODUCTION

In recent decades, there has been an increase in the demand for reinforcing, upgrading, and repairing civil infrastructure. The reasons are mostly connected to material degradation and the desire for larger loads. Every year, building owners confront the cost of reinforcing concrete members. Some of the treatments include patch removal and the placement of water-proofing membranes. Repair and rehabilitation of RC structures can only be successful if the new materials adhere adequately to the old concrete. Concrete pieces are destroyed as a result of inadequate design and poor construction quality. Structures that are demolished or rebuilt incur greater expenditures. Repairs have been increasingly significant during the previous decade. Jute fibre is a great approach to mend and reinforce the process.The retorting of jute fibre materials with acceptable qualities is a good substitute for conventional materials, such as steel jackets, to strengthen reinforced concrete structural components.

Existing research have demonstrated that the use of jute fibre materials restores or increase the beam's original design strength for potential flexure and, in certain situations, allow the structure to handle greater weight than it was designed for. Strengthening and repairing RC structures with jute fibre reinforcement has become a common engineering procedure. Repair and strengthening using jute fibre reinforced has increased their service life. Over the last two decades, civil engineers have been urged to employ jute fibre material for the restoration and strengthening of reinforced concrete buildings due to its remarkable qualities. Jute fibre sheets were first used in civil engineering for the repair and rehabilitation of existing damaged and inadequate structures in the 1990s due to their advantages, which include excellent mechanical properties, high corrosion resistance, low density, ease of installation, and tremendous design flexibility.

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According to previous research, many studies have been conducted on the strengthening of RC structures using externally bonded jute fibre systems. However, no guidelines have been proposed to predict the moment carrying capacity or deflection wrapping scheme of jute fibre composites. The current work focuses on the strengthening of RC beams using top-bottom, U-wrapping, and full-wrapping schemes using single and double layers of jute fibre composites.

II. LITERATURE REVIEW

Engr. Azam Amir, Dr.AmjadNaseer, Engr. OroojAzam (2013)RC column was analysed using FRP. This research investigates the use of FRP wrap to strengthen defective building columns and compares its efficacy to wire mesh. Three full-scale building columns were tested under cyclic loads at the Earthquake Engineering Centre of the University of Engineering and Technology in Peshawar. The columns were 12"x12" with a height of 10', which is the most typical size in practice. All columns were constructed with the same quality concrete and reinforcing features. The study was separated into four major phases: cylinder testing to obtain target strength, column manufacturing, application of FRP wrap and wire mesh at the crucial portion, development of a column testing strategy, and quasi-static testing.

AzadehParvin* and David Brighton (2014)This study examines the use of fibre reinforced polymers (FRP) composites to strengthen RC columns for various force scenarios, including impact loads. FRP materials can prevent collapse, minimize damage, and reduce the need for costly replacements. Retrofitting with FRP materials is an ideal substitute for conventional materials like steel jackets, as studies show they can restore or increase a column's original design strength for potential axial, shear, or flexure loads.

SandeepG.sawant (2013) Fibre reinforced polymer wraps, laminates, and sheets were studied for application in the repair and strengthening of reinforced concrete components. Fibre reinforced polymer application is a highly successful technique of repairing and strengthening structures that have grown structurally deficient initial stage their lifetime. FRP repair methods provide a cost-effective substitute to standard repair processes and materials. Experimental details on load, deflection, and failure modes are collected. The detailed technique for applying GFRP sheets to reinforce RC beams is also presented. It is looked at how the quantity and orientation of GFRP layers affect the final load carrying capacity and beam failure mode.

T. Manikandan (2013)the study explores the flexural properties of fibre reinforced polymer beams using various externally bonded designs. It proposes extra U jacket strip sheets to delay GFRP debonding and improve efficiency. Ten rectangular RC specimens are examined to determine the effect of adding U-shaped GFRP. FRP sheets and spaced u strips are used to debon the laminate's intermediate cracks. The study also explores the effects of fibre orientation on side-bonded sheets. The beam specimens are initially loaded to 75% of the projected ultimate load, treated, and tested to failure.

The analysis of the literature also revealed the necessity for further study on the FRP retrofit of columns subjected to impact loadings. With more research, addition approaches to increase energy absorption capacity and ductility of structural systems and composite materials, life cycle cost savings will exceed the higher upfront cost of FRP retrofit over conventional retrofit procedures.

III. EXPERIMENTAL PROGRAM

3.1 Cement

This investigation used ordinary Portland cement grade 53 provided by Dolmia Cement. The specific gravity of cement is 3.15 when measured using a pycnometer.

3.2 Fine Aggregate

The maximum size of coarse material utilised is 20 mm. The specific gravity of coarse aggregate is 2.65, as determined using a volumetric flask equipment. The fine aggregate used here falls beneath zone II, as indicated by a sieve analysis test. The specific gravity of fine aggregate is 2.67, which was determined using pycnometer equipment.

3.3 Coarse Aggregate

Coarse aggregate is defined as the material retained on a 4.75 mm sieve. Commonly utilised materials for coarse aggregate in concrete include natural gravel and crushed stone. The maximum aggregate size is 20 mm, and well-graded angular aggregate is used. According to Indian Specifications IS 383-1970, tests on coarse aggregate were conducted.

3.4 Jute Fibre Fabrics

The decision was made to employ jute fibre because of the unique mechanical qualities of

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steel, as glass's modulus of elasticity is comparable to that of steel. In this investigation, SIKA India Inc.'s SIKAWRAP -25 G/45 jute fibre was utilised. This jute fibre has a low modulus, measuring 26.49 kN/mm2.The fibre measured 0.15 mm in both thickness and breadth. It's a fabric kind that can be shaped into any shape that you like.

3.5 Matrix Material

The performance of the epoxy resin utilised is a significant factor in the strengthening technique's effectiveness. There are several varieties of epoxy resins on the market with a broad variety of mechanical characteristics. In this investigation, the SIKA India Inc.-supplied SIKADUR-330, two-part epoxy impregnation resin was utilised to provide enough bonding between glass fibre and concrete. The system consists of two parts: a hardener and a resin, which were mixed in a ratio of 100:40.

Table 1. Mix Proportion

Cement kg/m^3	Fine aggregate kg/m^3	Coarse aggregate kg/m^3	Water content (lit)
400	647	1178	186
1	1.62	2.95	0.44

Table 2. Wrapping schemes for Flexural Strengthening

Parameter	Number of beam
Conventional Beam	3
SINGLELAYER WRAPPING	
U wrapping	3
Full wrapping	3
DOUBLE LAYER WRAPPING	
Bottom wrapping	3
Top and bottom wrapping	3
U wrapping Full wrapping	3 3

3.5 Mould Details

A 850 x 100 mm steel mould was made, and in order to achieve a flat surface, the interior of the mould was completely covered with crude oil before being filled with concrete.

Fig.1 Mould Details

3.6 Steel Reinforcement

This study made use of the commercial reinforcing steel bar that RANA TOR provided. The tension and compression zones of the beam are equipped with 10mm and 8mm diameter bars. The reinforcing bar has a tensile strength of 415N/mm^2.

Fig. 2 Reinforcement in Steel Mould

3.7 Specimen Fabrication

The steel reinforcement was inserted into the mould along with the necessary cover. The mould was then filled layer by layer, and a needle vibrator was used to thoroughly compact each layer.

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Fig.3 Casting of Beam SpecimensCuring

The specimens were then allowed to cure after being demolded following a 24-hour casting period. The compressive strength of each batching was measured after 28 days to ensure quality control.

Fig.4 Curing of Beam SpecimensSurface Preparation

With jute fibre sheet, the surface face creates as much friction as feasible. To ensure that there is no dust or residue on the surface, it is cleaned.

3.8 STRENGTHENING BY JUTE FIBRE LAMINATE

Using various wrapping techniques, the jute fibres were attached to the outside surface of the RC beam members. The study employed the following wrapping techniques, which are listed below. A ribbed roller that moves in the direction of the fibre is used to remove excess epoxy and air after the resin and hardener have been properly metered and mixed together during the wrapping of the RC beam. The following is the methodical process for creating jute fibre laminates using RC beam specimens.

Fig.5 Surface Preparation

Fig. 6 Applying Resin over Surface of Beam

Feig. 7 Bonding between Beam and jute fibre

IV. RESULTS AND DISCUSSIONS

4.1 Description of Specimen

Fifteen beams in all, three control beams not included, were reinforced using jute fibre composites utilising all-purpose resin. The beams measured 850 mm by 100 mm by 125 mm. In order to make it easier for people to recognise the specimen, the designations CB, SSD, TSD, USS, USD, FSS, and FSD were placed on the beams. CB was the designated control beam.

4.2 Failure Modes

Every beam was positioned to ensure flexural loads and support. The failure mode of the control beam was flexural failure. One or two

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layers of jute fibre reinforced each beam using a top-bottom and U-wrapping complete wrapping technique. Reinforced concrete beams enhanced with jute fibre exhibit two distinct failure mechanisms. (1) The concrete at the top of the beam is crushed; (2) the jute fibre mat at the bottom of the beam ruptures. Following significant flexural cracking and vertical deflection, both failure modes take place. As the load rose, the flexure zone was identified as the mode of failure. As the strain increases, these fissures progressively get taller.

Fig. 8 Failure pattern of CB

Fig. 9 Failure pattern of SSD

Fig. 10 Failure pattern of TSD

When the control beam approached its maximum load, little fractures were first noticed in the centre of the beam and then became wider towards the bottom. The ultimate load was enhanced by the amount of jute fibre layers. The reinforced beams had less flexural cracking than the control beam. In reinforced beams, the ultimate load bearing capability grew over time.Partial jute fibre wrapping, failure in the flexural zone, concrete crushing in the compression zone, and jute fibre rebonding at the bottom of the beam all happened.

Fig. 11 Failure pattern of USS

Fig. 12 Failure pattern of USD

Fig. 13 Failure pattern of FSS

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Fig. 14 Failure pattern of FSD

4.3 Load Deflection Behaviour

The load-deflection behaviour of reinforced beams made of jute fibre in comparison to a control specimen. All of the beams with both wrapping strategies showed linear elastic behaviour up until the control beam's failure load, and thereafter inelastic behaviour as the load increased. As anticipated, external jute fibre bonding greatly lowers the beam's deflection and increases its stiffness in comparison to the control beam. The beam was fortified by completely enveloping it in two layers of control beam material instead of just one.

When the behaviour of the control beam is compared to that of the beam SSD, TSD, USD, FSS, and FSD, it demonstrates a notable improvement in stiffness and deflection control, with TSD exhibiting the best performance. The mid span deflections of the SSD, TSD, USD, FSS, and FSD beams were 16.5 mm, 13.2 mm, 12.6 mm, 11.4 mm, 9.8 mm, and 8.1 mm, respectively, at the control beam failure load. The improvement in deflection control of the SSD, TSD, USD, FSS, and FSD beams was seen in comparison to the control beam. The aforementioned variation in deflection control is ascribed to the layers of jute fibre; as the number of layers increases, the fibre supplies the necessary tensile strength under significant bending.

When comparing the behaviour of each beam, it can be shown that sikadur-330 increased the connection between the concrete and jute fibre, which led to a significant load transfer. Increasing the layer may also have contributed to the improvement in tensile strength while bending by reducing deflection.

4.4 Flexural Strength

Control beam

Trial no	Load in kN	Flexural strength N/mm^2
1	42.10	44.62
2	43.25	45.68
3	45.02	47.81

Average flexural strength = 46.04N/mm^2

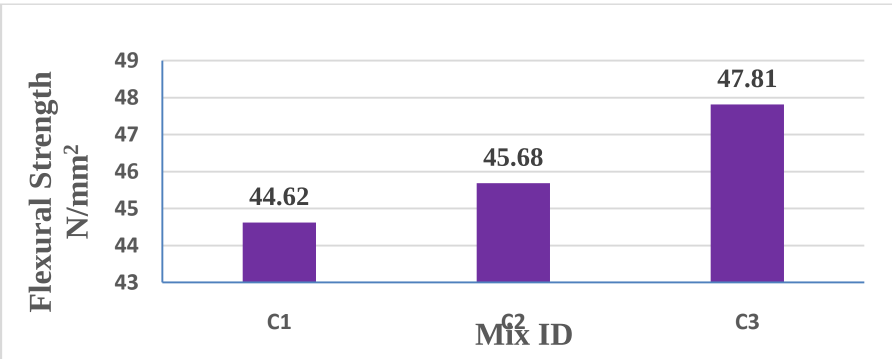

Fig. 15 Flexural strength of control beam specimens

DOUBLE LAYER

Bottom layer

Trial no	Load in kN	Flexural strengthN/mm^2
1	53.98	57.37
2	58.21	61.62
3	59.93	63.74

Average flexural strength = 60.91 N/mm^2

Top-bottom layer

Trial no	Load in kN	Flexural strength N/mm^2
1	73.89	78.62
2	75.11	79.68
3	81.91	87.12

Average flexural strength = 81.81 N/mm^2

U WRAPPING

Single layer

Trial no	Load in kN	Flexural strength N/mm^2
1	43.25	45.68
2	45.05	47.81
3	48.43	50.99

Average flexural strength = 48.16 N/mm^2

Double layer

Trial no	Load in kN	Flexural strength N/mm^2
1	51.13	54.18
2	53.09	56.31
3	55.00	58.43

Average flexural strength = 56.31 N/mm^2

FULL WRAPPING

Single layer

Trial no	Load in kN	Flexural strength N/mm^2
1	49.43	52.06
2	51.24	54.18
3	54.09	57.37

Average flexural strength = 54.54 N/mm^2

Double layer

Trial no	Load in kN	Flexural strength N/mm^2
1	55.04	58.43
2	59.35	62.68
3	63.06	66.93

Average flexural strength = 62.68 N/mm^2

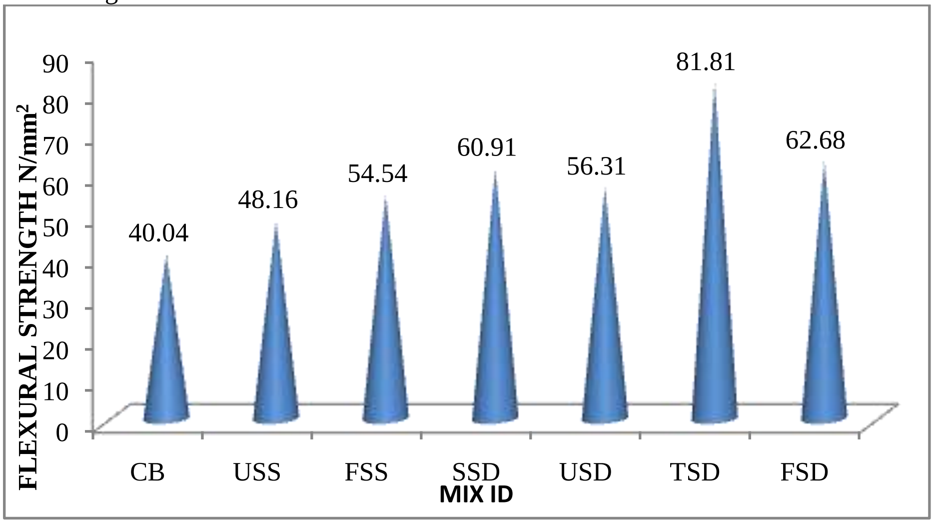

Fig. 16 Comparison of flexural strength

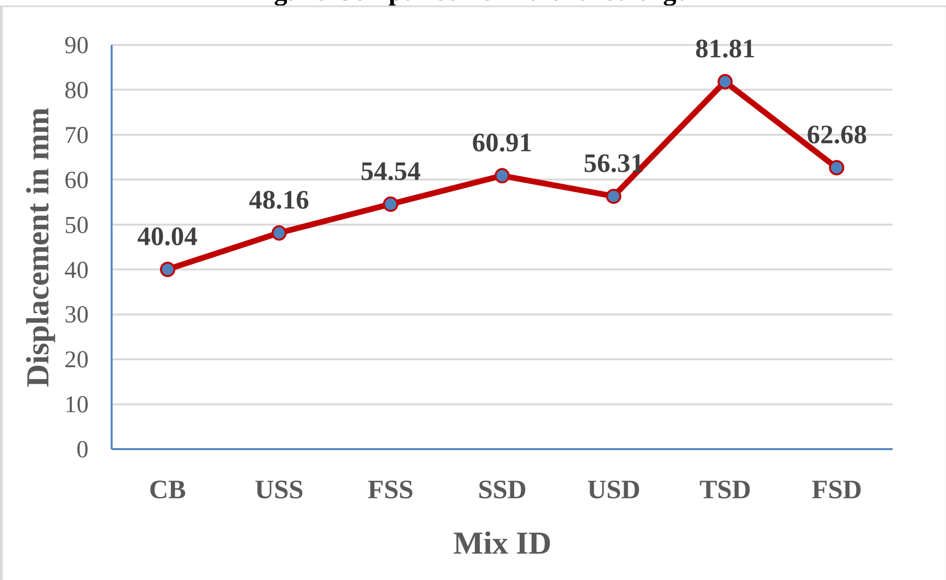

Fig. 17 Comparison of displacement of wrapping specimens

4.5 Flexural strength

This study's primary goal is to use jute fibre textiles to increase the flexural capacity of RC beams. As anticipated, the flexural strength capacity of the RC beams is much increased by the external bonding of fibre, particularly for the beam that has been fully wrapped. It demonstrates how the flexural strength of beams reinforced with jute fibre is increased when compared to a control beam.

The findings of various strengthening techniques showed that the flexural strength of the beam increased significantly when jute fibre was included at the outer limits, particularly for the two-layer strengthened beam. Beams top-bottom-1 and top-bottom-2 showed 41% and 44% improvements in flexural strength compared to the control beam, respectively. Jute fibre layers offer tensile strength when bending, increasing the beam's flexural strength.

V. CONCLUSION

- External jute fibre bonding improves beam stiffness and delays deflection, as predicted.
- The study found that adding jute fibre to the beam's outside limits significantly improves its flexural strength, particularly when reinforced with two layers of complete wrapping.
- The use of jute fibre in the beam's outer limits boosted its tensile strength during bending, resulting in higher flexural strength.

- Flexural strength gains for beams SSD, TSD, USS, USD, FSS, and FSD were 23%, 25%, 31%, 33%, 41%, and 44%, respectively.

REFERENCES

[1]. Strengthening of RC beam using GFRP and CFRP T.Jaya, JessyMathi (2014)
[2]. Rehabilitation and strengthening of RCC structure by using FRP compositesRahul Kumar Satbhaiya, Shishir Gupta (2013)
[3]. FRP composites strengthening of concrete column under various loading conditions Azadehparvin , David Brighton (2014)
[4]. Flexural behaviour of Reinforced Cement Concrete Beam Wrapped With GFRP sheet D.N. Shinde, Nair Veena (2014)
[5]. Strengthening of RC Beam using GFRP wraps T. Manikandan , G. Balaji (2013)
[6]. Flexural strengthening of reinforced concrete beams using fibre reinforced polymer G. Murali, N. Pannirselvam (2012)
[7]. R. Rahul Kumar and T.R. Arora Rehabilitation and Strengthening of RCC structures by using FRP composites