A STUDY ON FAILURE OF BEAMS IN TERMS OF FORMATION OF CRACKS

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ABSTARCT

This research effort comprises examining beam failure and specifically fracture formation. Two retrofitting methods, wrapping technique and steel jacketing procedures, are employed to repair the cracks. The materials used to cast the beam are selected in compliance with the IS Code. The beam has dimensions of 150mm x 200mm and a span of 1500mm. M25 concrete is used, while Fe415 TMT bars are used for the steel. All beams are tested to the first fracture condition first. The shattered beams received five forms of retrofitting or restoration. For their rehabilitation, a Wrapping Method using GFRP of 225GSM, 400 GSM, 300 CSM, and Jute Fiber was employed. The repaired beams were subsequently put through rigorous testing until they failed. The ultimate load obtained from the experimental test is compared to the theoretical calculation for control Specimen in Limit State Design Method using the clauses supplied in IS 456-2000 code to cross-check the experimental work. The testing results were utilized to compare the Ultimate Load Carrying Capacity and Deflections at that Load for each of the five Retrofitting Methods with the Control Specimen. As a consequence of the results, the conclusion was reached.

Keywords: Failure of Beam, formation of crack, retrofitting method, wrapping techique

INTRODUCTION

Man used to dwell in huts made of materials abundant in nature in the early days. They could build their huts in safe areas that were not influenced by natural disasters. If something went wrong, such as a failure, they could fix it with the cheapest materials found in nature. Yet, as the population grows and new construction materials are developed, it is becoming increasingly necessary to understand structural flaws in a structure and the corrective steps to be taken. Engineering construction failures are caused by the deterioration of various building materials with the age owing to a variety of factors. It is critical to be aware of the numerous agencies that are creating degradation in order to grasp the problem and find a solution.

Reinforced cement concrete is material used for structural components because of its durability, and it has been used for manyyears to produce a wide range ofstructures ranging from houses tobridges, roads to bridges, and so on. Concrete structures thathave been well-designed & constructed with high-quality materials require little maintenance or repair work. Concrete consumption expanded substantially throughout the 1960s as a result of ongoing housing shortages. Concrete, being a heterogeneous material, did not perform as well as expected, and its quality is depending on its ingredients. The rising need to maintain and repair structures has resulted in a large differential in spending for restoration versus investment for new buildings in recent years.

Except for certain notable monuments such as the TajMahal, the KutubMinar, the Great Wall of China, and the White House, all civil projects are prone to failures in some form or another at some point in time. Building failures are widely grouped into two groups. There are structural failures and nonstructural failures. Structural breakdown has a notable impact on structures as well as the lives of the people. The failure of a concrete structure to serve the function for which it was built is referred to as structural failure. Nonstructural failures include faults in brickwork, plasterwork, plumbing work, and electrical work, among other things, that do not significantly influence the structural safety. The history of structural collapse dates back to 300 A.D. and

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continues until this day. Figure 1 depicts a towering building in Oogue, Siberia, being vertically divided into two halves. Another example of structural collapse is the aviation disaster that destroyed the World Trade Center in New York.

TYPES OF FAILURE AND THE REASON FOR FAILURE

Cracks, damping, leakage, and spalling are examples of general structural failures that indicate a building's fragility. This might be the cause of these failures.

1. Inferior qualityof materials
2. Poor workmanship
3. Improper study
4. Weatherin gactions
5. Effect ofchemicals
6. Fire Hazards
7. Faulty construction
8. Faulty system of maintenance
9. Inappropriate cleaning
10. Misuse of buildings
11. Environmentalaspects
12. Chemicalfactors &
13. Biologicalgrowth

Speaking about a building's vulnerability to a Civil Engineer is analogous to a patient discussing his or her disease with a doctor. As a result, we must maintain the buildings. Several examples of failures are presented in Figures 2, 3, and 4.

FIGURE 1 SPLITTING OFA TALL STRUCTURE INTO TWOPORTIONS IN A VERTICAL MANNER AT OOGUE ATSIBERIA

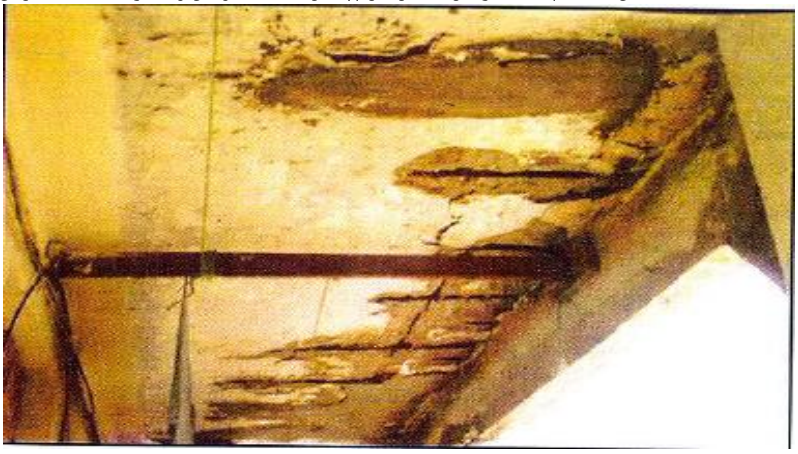

FIGURE 2 CORROSION OFSTEEL AND SPALLING OF CONCRETEIN A RCCCANOPY

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LITERATURE REVIEW

Stefano Miranda (2011) studied how a Simple Beam Model may be used to predict leakage in longitudinally broken pressurized pipes. Water distribution system losses were claimed to be nearing alarming proportions in a number of cities throughout world. Leakage is typically the principal cause ofwater loss due to the ageing and degeneration ofthese systems, and pressure hasbeen shown to play an essential role inwater-loss management. To estimate leak area (from which leakage is then derived) & to investigate impact of pressure on opening area of the fracture in longitudinally fractured pressurised pipes, a simple analytical model based on abeam with elastic limitations was constructed. Before being validated with experimental data, model was calibrated using the results of a 3-dimensional finite-element analysis.

In an experimental investigation, Dario Coronelli et al. (2012) explored cover cracking, spalling, and delamination. A kind of corrosion is stirrup corrosion. Formerly, only corrosion levels resulting to cover breaking along the primary reinforcement were taken into account; however, corrosion of stirrups is commonly overlooked. An experiment was carried out to explore corrosion phenomena such as stirrup corrosion. Corrosion was observed to be severe, damaging up to 20%of main bars & 34% of stirrup legs. Crack propagation, initiation, & cover delamination were also studied. An imposed current was used to corrode the specimens in shape of a beam end,with care made to keep current density as lowas practically practicable for the duration of laboratory testing.

Li, H. Dong (2012) conducted research on relativedisplacement sensing techniquesfor assessing post-event structural damage. According to the findings of the study, relative displacement, defined as the displacement of apoint on astructure with regard to its original position or anadjacent point on structure that hasalso moved, can bean excellent indication of post-event structuraldamage. The known methodologies for assessing relative deformations, as well as their limits and topics for future study, were also examined. Recommendations for present difficulties & research possibilities are made, with an emphasis onaccuracy, necessity fora national database of structural information, & large-scaleautomated evaluation approaches.

Jeong Yeon Lee et al. (2013) explore the effect of transfer on acceptable stress distribution in pretensioned concrete members. To address these concerns, this paper proposed a reasonable estimation equation for allowable compressive stress at transfer based on extensive analyses using the Strength Design Method (SDM), which took into account the eccentricity ratio of the tendon, sectional size and shape, level of prestress, and self-weight moment. Allowable releasing compressive stresses were computed using the approved equation and indicated in international design standards, and they were compared to test data obtained from the literature. These comparisons revealed that current design codes' allowable stresses produced unconservative evaluation results for pretensioned members with low eccentricity ratios and conservative results for those with high eccentricity ratios, whereas proposed equation reasonably evaluated allowable compressive stresses of pretensioned members with rectangular, tee, and inverted tee sections.

Yu-Chen Ou and Dimas P. Kurniawan (2015) examined the Shear Behavior of Reinforced ConcreteColumns Made of High-Strength Steel & Concrete. The test results show that shear failure occurred in all of the columns prior to longitudinal reinforcement yielding. At the maximum applied load, none of the columns' transverse reinforcement yielded. This investigation and the literature were used to get test data for 43 high-strength columns. When compared to the ACI 318 shear-strength calculations, the ACI simplified shear-strength equation offered a conservative value for all columns. The ACI complete shear-strength calculation, on the other hand, produced an unconservative forecast for 19 columns. To overcome this issue, this research suggests adjustments to the ACI detailed shear-strength equation.

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Chitte and Sonawane (2018) look at crack kinds, crack causes, crack preventive methods, and crack treatment choices. Building cracks are most typical sort of issue inany type of structure. As aresult, it is critical to identify root cause and implement preventative actions. While concrete cracks cannot be totally avoided, they may be managed by employing appropriate materials & building procedures, as well as addressingdesign factors. Structural cracksare ones that may jeopardize a structure's safety due to faulty design, poor construction, or overloading. Non-structural broken bones, on the other hand, have an underlying cause, such as changes in moisture or heat, deformation due to elastic creep, chemical reaction, or a foundation soil-related reason, such as movement or settlement, or uncontrolled growth. Internally generated stresses inbuilding materials commonly result in non-structural fractures, which may not result instructural weakness right away.

Marta Sowik (2019) conducted research on failure and fracture development in concrete beams. The outcomes of an experimental research and numerical simulations served as the foundation for the study. The evolution of strain softening of tensile concrete in plain concrete and slightly reinforced concrete beams was investigated using a fictional crack model based on nonlinear fracture mechanics. The analysis discovered that the failure mechanism in flexural beams varies with the longitudinal reinforcement ratio. Brittle failure canoccur in higher reinforcedconcrete beams withouttransverse reinforcement due toshear stress & diagonal crack development. Tensile concrete strain softening, however, is not the sole element influencing the formation of an angled fracture. Mechanisms like aggregate interlock and steel bar dowel action play a significant part in the creation of failure fractures.

Dung DO et al. (2020) look at Structural Failures and Correction Actions. One of the most important issues that must be addressed is structural breakdown. Structural breakdowns occur, inflicting significant property and human life damage. Beams, columns, and slabs are examples of structural components. The failure of the horizontal load bearing member beam is taken into account. Eighteen people had their beams cast, with three kept as control specimens and the others separated into five groups. Using five distinct retrofitting processes, all specimens were tested to failure loads. The changed components were evaluated for ultimate load bearing capability after curing. The data is tallied and compared. The best method for high load bearing strength and little deflection was developed.

Rajai Z. Al-Rousan and Ayah Alkhawaldeh (2021) describe the utility of external fiber reinforced polymer (FRP) composites in rescuing structural performance and regulating the mode of failure of the heated damaged reinforced concrete (RC) beam-column junction (NLFEA) using nonlinear finite element analysis. The FRP strengthening technique of heated damaged RC beam-column joint with FRP composite improved the cyclic performance (higher load capacity, larger horizontal displacement, higher displacement ductility, higher energy dissipation, and slower secant stiffness degradation), and the FRP composite efficiency increased with the heated damage level, according to the NLFEA results.

The stress characteristics of broken flexible reinforced concrete beams were examined by Zhmagul Nuguzhinov et al. (2022). The issue is handled using LIRA-SAPR and beam finite elements, with the nonlinear connection between deformation and stress in concrete taken into consideration. Throughout the solution, a step-by-step loading technique is employed, with an iterative process at each stage. To calculate the stress parameters in bent rectangular reinforced concrete beams with a crack, a rational planning matrix for a multifactor computer simulation was developed. Computer simulations of concrete beams of the C20/25 and B32/40 classes were performed using this technology. Using the established dependencies, we may examine the operability of the structural sections under consideration for both sets of limiting states. They may be used to calculate fracture mechanics parameters and assess a beam's crack resistance.

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Vu Ngoc Son et al. (2022) provide results from a five-full-scale reinforced concrete (RC) column experimental program on the effect of altering axial load on the seismic performance of reinforced concrete (RC) short columns that broke in shear. According to the test results, the lateral load-displacement hysteresis loops of RC columns with variable axial loads are asymmetric. The columns behaved considerably differently when subjected to variable axial load than when subjected to constant axial stress. Different shear failure mechanisms between columns were identified under constant and variable axial strains. The variable range & intensity of appliedaxial stress has a significant impact on column shear strength and degradation. To investigate effectsof changing axial loadon the seismic behavior of RCshort columns exposed to varied axial force, a three-dimensional(3-D) finite element(FE) model is proposed.

Building fractures are by far the most common flaw in any structure, according to Dinesh Harinkhede et al. (2022). We desire a home that is both incredibly durable and artistically pleasing, but this is not always possible. Natural disasters, ground collapse, structural flaws, bad shape, and inadequate connections are all elements that contribute to cracking in the framework. Mortar splits cannot be completely avoided, but they may be reduced by using the best components, building procedures, and technical specifications. This is critical for detecting such issues as soon as possible and taking preventative measures. Active cracking is a big issue that must be handled immediately, despite fact that it is potentially dangerous. As a result, it is vital to understand the many types of cracking, their patterns, & the numerous reasons.

According to Bolin Jiang et al. (2023), fractures in concrete structures will undoubtedly form during normal usage phase owing to load action, fatigue impact, & environmental corrosion. Concrete resistance may be indicative of interior concrete deterioration. Three-pointbending tests on concrete beams were carriedout in this study. We examined concrete beam resistance before & after cracking to see if resistance measurement might be used to provide self-monitoring of concretecracking & crack progression. This paper presents an approach for monitoring engineering constructions. It provides a quantitative reference for link b/w the quantity of steel fibers employed & their electrical and mechanical qualities.

SPECIMEN DETAIL

The beam is 150mm x 200mm and spans 1500mm. The concrete grade is M25, and the steel is Fe415 TMT bars. The beam was cast using OPC 43 grade cement with a water-cement ratio of 0.4. Compression and tension There are two 12mm dia. rod reinforcements and one 8mm dia. rod shear reinforcement at 100mm c/c spacing. Shear reinforcement is given with two legs, each measuring 35mm in length. Table 1 contains information on the specimen.

TABLE 1 DETAILS OF SPECIMEN

SPECIMEN DETAILS	
Depth	200mm
Width	150mm
Length	1500mm
Tension Rod	2 No.s of 12mm Dia.
Compression Rod	2 No.s of 12mm Dia.
Shear Rod	8mm Dia. rod @ 100mm c/c distance
No of Legs	2 Legged (35mm length)
W/c Ratio	0.4
Cement Grade	OPC 43
Concrete Grade	M25(Design mix)1:1.8:2.6
Steel Grade	Fe415
Cover on X Axis	20mm
Cover on Y Axis	25mm

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REHABILITATION METHODS

In every method 3 number of beam were tested and mean value is calculated.

METHOD -1: GFRP WOVEN ROVING – 225 GSM

Three beams were loaded till the initial crack for rehabilitation purposes, and the job was completed with GFRP Woven Roving - 225 GSM and polyester resin. The aforementioned work has been wrapped all the way around the beam. The specimen is then left to cure for 24 hours. Figures 3 and 4 show the wrapped GFRP beam and bonded GFRP after resin application.

FIG 3 GFRP WRAPPED BEAM - 225GSM

FIG 4 AFTER APPLYING POLYESTER RESIN FOR BONDING – 225 GSM

After curing the beams are tested for its ultimate load carrying capacity of the beam. The values obtained were tabulated in Table2.

TABLE 2 EXPERIMENTAL DETAILS OF SPECIMENS WHICH ARE REHABILITATED BY GFRP WOVEN ROVING 225GSM

SL.NO	SPECIMEN	DEFLECTION (MM)	AVERAGE (MM)	ULTIMATE LOAD(KN)	AVERAGE (KN)	DEFLECTION (MM)	AVERAGE (MM)
1	Specimen 4	5.1	4.7	74	72	15.3	15.4
2	Specimen 5	4.4		70		15.4	
3	Specimen 6	4.7		72		15.4	

The rehabilitated beam can withstand an ultimate load of 72kN, whereas the control specimen can only withstand 65.33kN. As compared to the control specimen, the ultimate load on the repaired beam has increased by 10.2%. Figures 5 and 6 show a comparison of the beam's ultimate load bearing capability and deflection.

When comparing the control Specimen to the rehabilitated beam, the deflection increases by just 1.27 mm. When comparing the deflection in percentage, the rehabilitated beam has 9% more deflection than the control Specimen, while the final load bearing capacity increases by 10.2%. Figure 7 depicts the Load versus Deflection graph for the rehabilitation beam for technique 1 beam.

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METHOD - 2: GFRP WOVEN ROVING – 400GSM

To rehabilitate the beam, first load it until the initial fracture emerges; after the initial crack appears, the loading is halted and the beam is rehabilitated. Following the emergence of the initial cracking load, the loading was halted and the beam was rehabilitated using Glass fiber reinforced polymer, which is E-Class glass fiber with 400 GSM. The glass fiber is completely wrapped around the beam member. As shown in Figures 8 and 9, the GFRP is bonded with the Polyester resin and left for 24 hours to cure or harden.

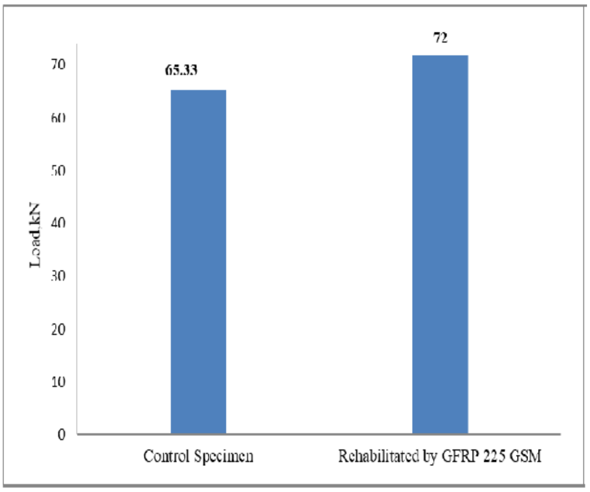

FIG 5 ULTIMATE LOAD

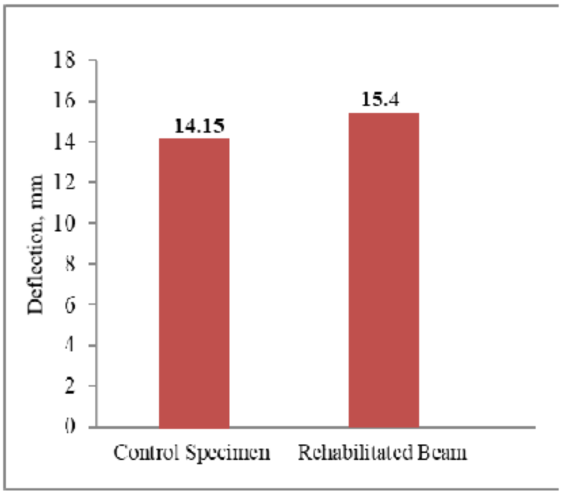

FIG 6 THE DEFLECTION

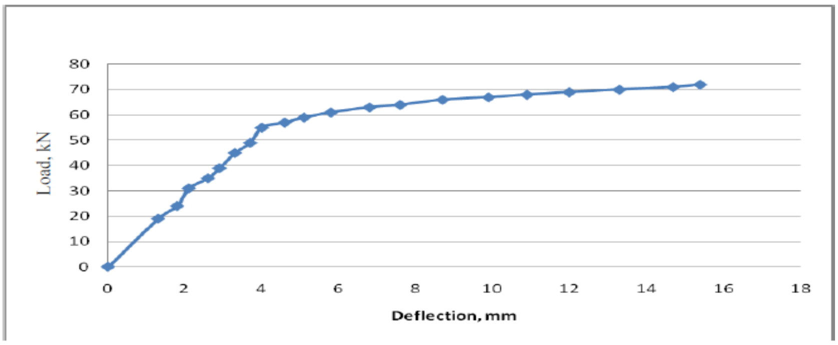

FIGURE 7 LOAD VS DEFLECTION CURVE – REHABILITATED BY GFRP WOVEN ROVING 225GSM

FIG 8 GFRP WRAPPED BEAM

FIG 9AFTER APPLYING RESIN FOR BONDING

The beam is tested for its maximal load after curing for 24 hours. Table 4.4 summarizes the results.

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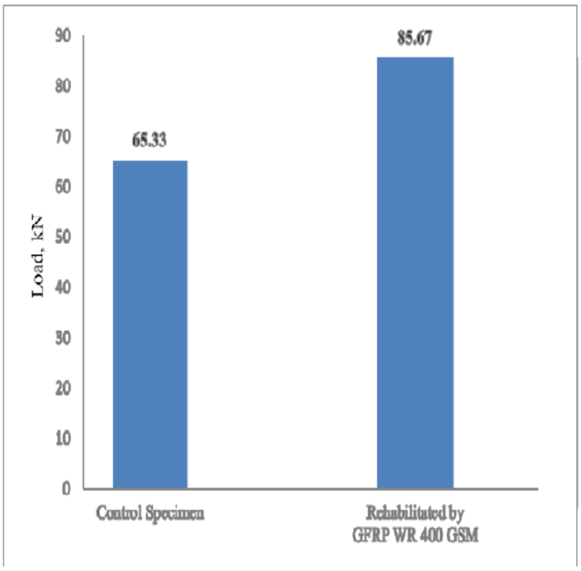
TABLE 3 EXPERIMENTAL DETAILS OF SPECIMENS REHABILITATED BY GFRP WOVEN ROVING 400GSM

SL. NO	SPECIMEN	DEFLECTION(MM)	AVERAGE(MM)	ULTIMATE LOAD(KN)	AVERAGE(KN)	DEFLECTION(MM)	AVERAGE(MM)
1	Specimen 7	4.9	4.8	83	85.67	13.7	16.7
2	Specimen 8	4.8		89		19.8	
3	Specimen 9	4.7		85		16.7	

The restored beam's mean ultimate load is 85.67kN. When compared to the controlled beam, the ultimate load bearing capacity of the beam is raised by 20.33Kn, or 31% more than the control specimen. Figures 10 and 11 show a comparison of ultimate load bearing capacity and beam deflection for control specimen and repaired beam.



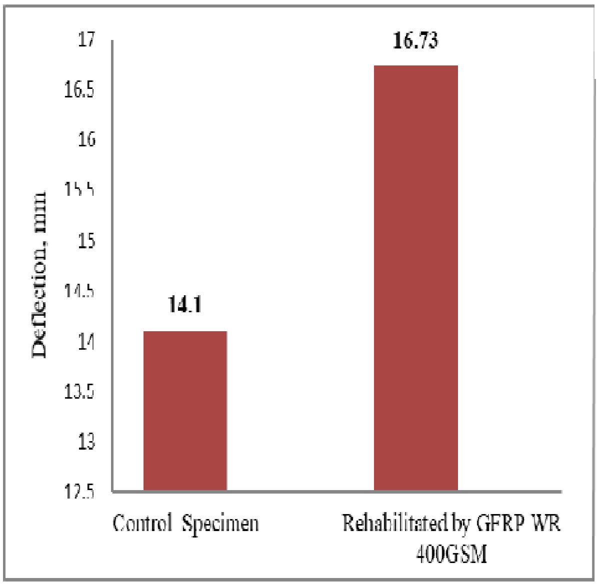


FIG 10 THE ULTIMATE LOAD FIG 11 DEFLECTION FOR REHABILITATED BEAM

When the deflection for both beams is compared, the restored beam has a deflection of 16.73mm, which is 2.63mm more than the control Specimen. As a result, the repaired beam deflects 18% more than the control specimen and bears 31% more weight. The Load versus Deflection graph for the restored beam is shown in Figure 12.

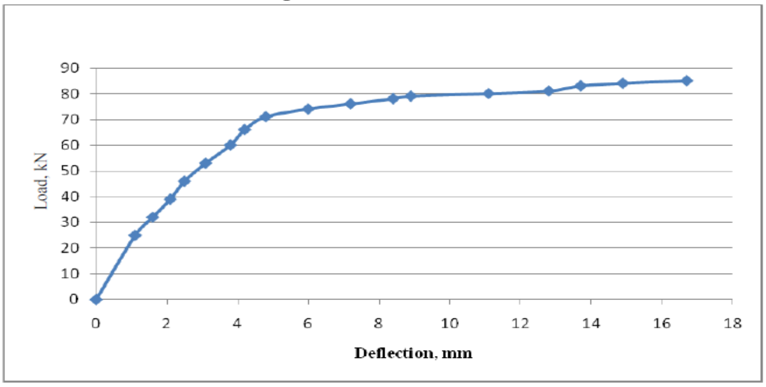


FIGURE 12 LOAD VS DEFLECTION CURVE – REHABILITATED BY GFRP WOVEN ROVING 400GSM

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METHOD – 3: GFRP CHOPPED STRAND MAT – 300 GSM

For rehabilitation, the beam is loaded until the first break emerges. The loading was stopped and the weight was removed when the first crack appeared in the beam. After the discovery of first cracking, the beam is rehabilitated using E-Class Glass Fiber Reinforced Polymer, chopped strand mat 300 GSM. Figures 13 and 14 depict GFRP CSM 300 GSM. Beam wrapped before and after applying resin.

FIG 13 GFRP CSM 300 GSM WRAPPED BEAM **FIG 14 AFTER APPLYING RESIN FOR BONDING**

The GFRP is wrapped first, and then polyester resin is put over it. The rehabilitated beam is then left for 24 hours to cure or harden. After curing, the beam is evaluated for its final weight bearing capabilities. Table 4 summarizes the test outcomes.

TABLE 4.5 EXPERIMENTAL DETAILS OF SPECIMENS WHICH ARE REHABILITATED BY GFRP CHOPPED STRAND MAT – 300 GSM

SL. NO	SPECIMEN	DEFLECTION(MM)	AVERAGE(MM)	ULTIMATE LOAD(KN)	AVERAGE(KN)	DEFLECTION(MM)	AVERAGE (MM)
1	Specimen 10	4.7	4.27	70	71	13.7	13.27
2	Specimen 11	3.8		72		13.6	
3	Specimen 12	4.3		71		12.5	

The restored have an average ultimate load of 71kN. The control Specimen's ultimate load value is 65.33kN. This comparison revealed that the beam's ultimate load bearing capability has improved by 5.67kN. As a result, the repaired beam can withstand 9% greater load than the control specimen. The ultimate load and deflection of the beam for the control Specimen and rehabilitated beam are compared as a consequence, and the comparison is depicted in Figures 15 and 16.

When the deflection of the controlled beam is compared to that of the rehabilitated beam, the deflection of the rehabilitated beam is decreased. The controlled beam deflects 14.1mm, but the rehabilitated beam deflects just 13.27mm, resulting in a 0.83mm reduction in deflection. Figure 17 depicts a load vs. deflection graph.

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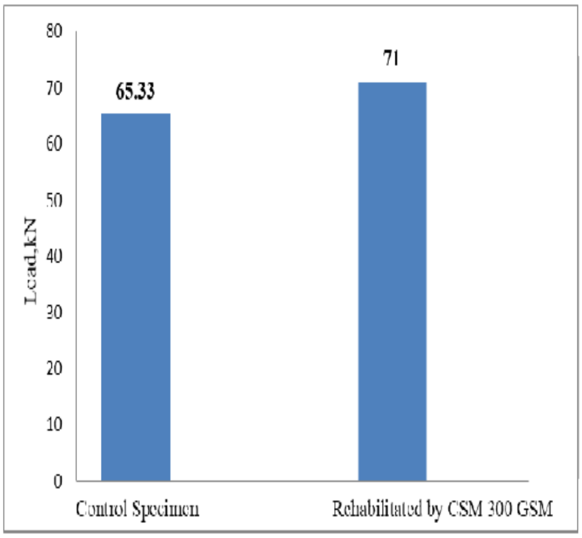

FIG 15 ULTIMATE LOAD

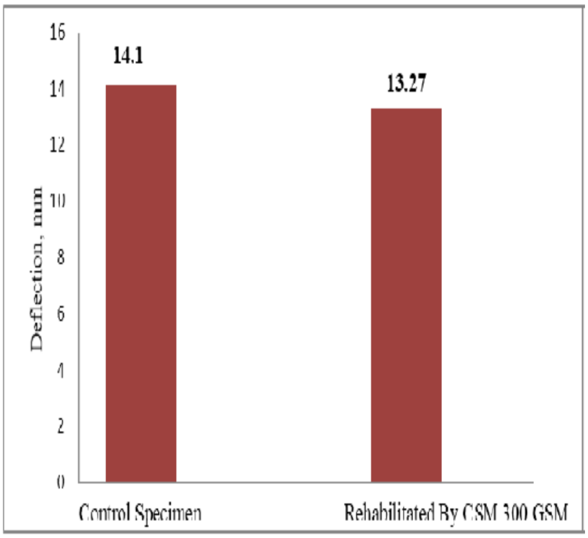

FIG 16 DEFLECTION

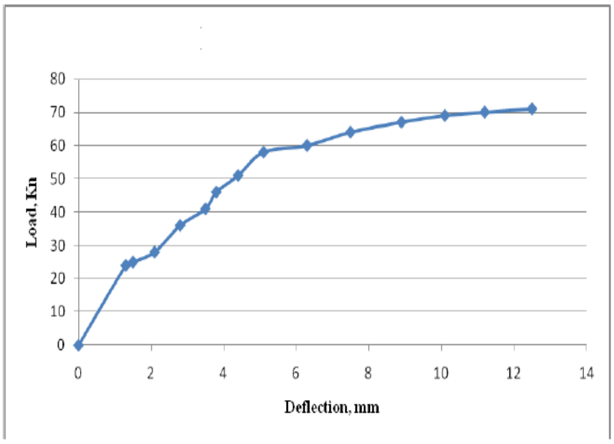

FIGURE17 LOAD VS DEFLECTION CURVE – REHABILITATED BY GFRP CHOPPED STRAND MAT – 300 GSM

METHOD – 4: JUTE FIBER

The beam is tested for rehabilitation by applying a weight until the first crack emerges in the beam. The loading is halted and the imposed weight is withdrawn when the first crack shows in the beam. The restoration is then completed using jute fiber. Polyester resin is used for bonding. After application, the beam is left for 24 hours to cure or harden. Figures 18 and 19 show a beam wrapped in Jute Fiber before and after resin application.

FIG 16 BEAM WRAPPED WITH JUTE FIBER

FIG19AFTER APPLYING RESIN FOR BONDING

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The beam is evaluated for ultimate load bearing capacity after curing. The complete sample is tested, and the results are summarized in table no.5.

TABLE 6 EXPERIMENTAL DETAILS OF SPECIMENS WHICH ARE REHABILITATED BY JUTE FIBER

SL.NO	SPECIMEN	DEFLECTION(MM)	AVERAGE (MM)	ULTIMATE LOAD(KN)	AVERAGE (KN)	DEFLECTION(MM)	AVERAGE(MM)
1	Specimen 13	4.8		67		12.3	
2	Specimen 14	5.1	4.93	70	68.33	13.0	
3	Specimen 15	4.9		68		12.0	12.43

As compared to the ultimate load of the controlled beam, the value of the repaired beam increases as predicted. The improved load bearing capability is 3kN greater than the control specimen; this number appears to indicate that the load increment is substantially smaller. Because the ultimate load is just 5% more than the regulated beam. Nevertheless, the deflection is smaller than that of the controlled beam; the deflection discovered in the control specimen is 14.1mm, while the deflection observed in the rehabilitated beam is only 12.43mm, 1.67mm less than that of the controlled beam. As compared to the control specimen, the restored beam's deflection is reduced by 14%. The ultimate load and deflection of the beam are compared to a control specimen and a repaired beam. And the contrast is depicted in Figures 20 and 4.21.

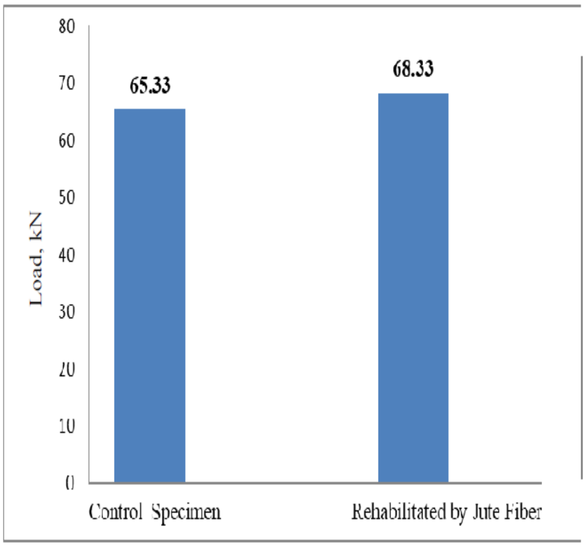

FIG 20 ULTIMATE LOAD

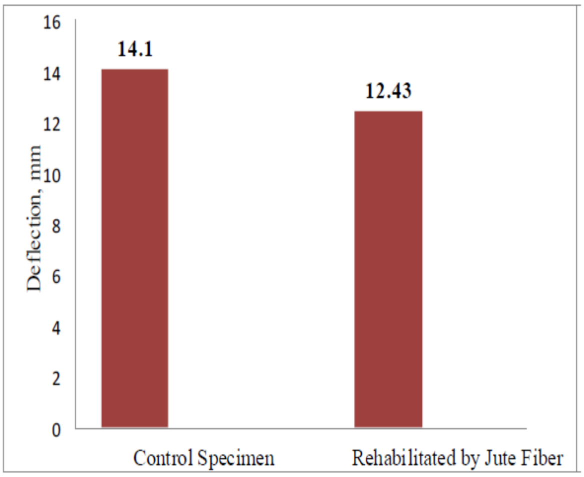

FIG 21 DEFLECTION

And Load Vs Deflection graph is also plotted for the rehabilitated beam in the Figure 22.

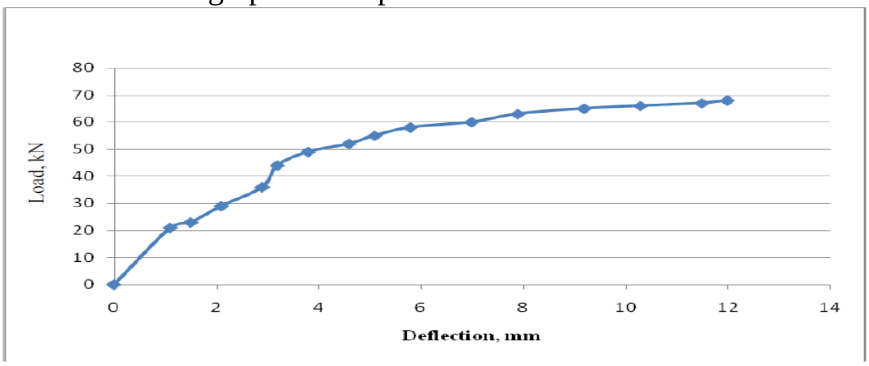

FIGURE 22 LOAD VS DEFLECTION CURVE – REHABILITATED BY JUTE FIBER REHABILITATION

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METHOD – 5: STEEL JACKETING METHOD

Like with all previous treatments, the beam is initially evaluated for cracking load before being repaired. Figure 23 depicts the construction of a Steel Jacketed Beam in a Loading Frame.

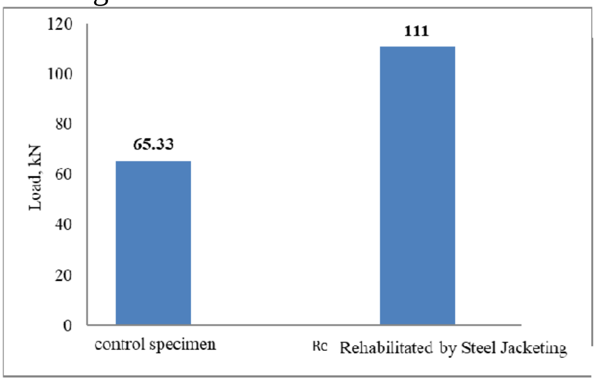
FIGURE 4.22 STEEL JACKETING BEAM

Loading was stopped when the initial crack appeared, and the beam was repaired with steel. Steel is utilized for jacketing in this procedure. The beam is evaluated for its ultimate load after restoration. Table 6 shows the values of the test results.

TABLE 4.6 EXPERIMENTAL DETAILS OF SPECIMENS WHICH ARE REHABILITATED BY STEEL JACKETING METHOD

SL. NO	SPECIMEN	DEFLECTION(MM)	AVERAGE (MM)	ULTIMATE LOAD(KN)	AVERAGE (KN)	DEFLECTION (MM)	AVERAGE(MM)
1	Specimen 16	5.2	4.73	110	111	12.3	11.9
2	Specimen 17	4.8		112		11.6	
3	Specimen 18	4.8		111		11.8	

The ultimate load of the restored beam is determined to be 111kN. The controlled beam's ultimate load bearing capability is just 65.33kN. When the ultimate load of the rehabilitated beam is compared to the controlled beam, the load bearing capability of the rehabilitated beam is 44.67Kn. As a result, the load bearing capacity of the load is raised by 70% above the regulated beam. The ultimate load and deflection of the beam are compared with the controlled beam to the restored beam in Figures 24 and 25.



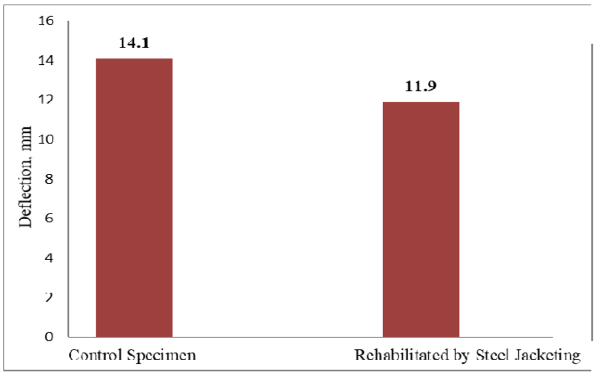


FIG 24 ULTIMATE LOAD 25 COMPARISON OF THE DEFLECTION FOR REHABILITATED BEAM WITH CONTROL SPECIMEN

The control Specimen has a deflection of 14.1mm, whereas the rehabilitated beam has a deflection of 11.9mm, which is less than the control Specimen. The deflection in the restored beam is 2.2mm, which is 16% less than the control specimen.

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Figure 26 depicts the load versus deflection curve for the restored beam.

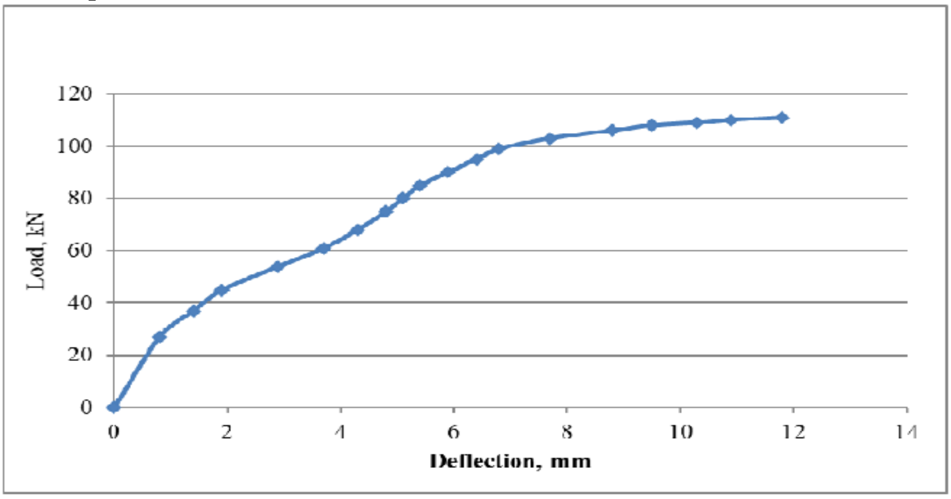

FIGURE 26 LOAD VS DEFLECTION CURVE – REHABILITATED BY STEEL JACKETING METHOD

CONCLUSION

The problem of structural failure has been taken with intention of providing remedial methods to solve the problem. Though there are so many structural failures like cracks, leakage, dampness, spalling and others, the thesis dealt with cracks in beams. Beams are the most important part of any structure. With the detailed study and survey of literature related to structural failures and retrofitting methods, practical work to be done was decided. Before casting beams the base materials were selected and their properties were tested confirmed with IS Codes. Totally Eighteen beams were casted and tested. The report was presented from the findings following details were presented.

- For the beam rehabilitated by GFRP 225 GSM the average ultimate load taken by the beam is 72kN. So the load bearing capacity is increased by 10% . The deflection is 15.37mm which is increased by 9.7%.
- For the beam rehabilitated by GFRP 400 GSM the average ultimate load taken by the beam is 85.67kN. The load bearing capacity is increased by 31% . The deflection is 16.73mm which is increased by 18%.
- For the beam rehabilitated by GFRP 300 GSM the average ultimate load taken by the beam is 71kN. The load bearing capacity is increased by 9% . The deflection is 13.27mm which is more than 0.83mm when compared with control specimen.
- For the beam rehabilitated by Jute Fiber the average ultimate load taken by the beam is 68.33kN. The load bearing capacity is increased by 5% . But the deflection is 12.43mm which is less than 14% when compared with control specimen.
- For the beam rehabilitated by the Steel Jacketing method the mean value of Ultimate load is 111kN. The ultimate load carrying capacity is increased by 70% and the deflection is 11.9mm which is also decreased by 16%.
- This research work shows that the Steel Jacketing method is **the best one** for repairing a Beam. Therefore any structure can be rehabilitated by Steel Jacketing to extend the life of the structure and its serviceability.

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