

Study on Structural Failures and Remedial Measures

Dr.G.Baskar¹ Research Guide

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Abstract: Structural failures are one of the important phenomena which should be very important to dealt with. Structural failures occur then and causing heavy damage to both property and human lives. Structural elements include beam, column, slab etc. The failure of the horizontal load bearing member beam is considered. The beams of Eighteen members were casted; keeping three as control specimens and others grouped into Five groups. All specimens are subjected to Failure load and Five methods of retrofitting were done. After the curing period the retrofitted elements were tested for Ultimate load bearing capacity. The values are tabulated and compared. The best method regarding high load bearing strength and lowest deflection were found out.

Key words: Structural failures; reasons; practical investigations; retrofitting materials; GFRP 225gsm; GFRP 400GSM; GFRP 300GSM; Jute Fiber; Steel Jacketing; Comparison; conclusion.

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I. Introduction

In early days man used to live in huts which were constructed with the materials available in abundance in nature. But due to increase in population and the invention of new building materials, it becomes important to know about failures in structures and their remedial measures. Failures in construction are caused by deterioration of various building materials with age. Awareness about various agencies causing deterioration is essential to understand the problem and to find out the solution for it.

The history of failure of structures started from very olden time from 300A.D. and continues till date. Figure 1.1 shows the splitting of a tall structure into two portions in a vertical manner at Oogue at Siberia. One more example is the failure of World Trade Centre at New York by air crash.



Figure 1.1 Splitting of a tall structure into two portions in a vertical manner at Oogue at Siberia

Generally the structural failures are classified as Cracks, Damping, Leakage and Spalling. The reasons for failures may be due,

- (i) Inferior quality of materials
- (ii) Poor workmanship
- (iii) Improper study
- (iv) Weathering actions

- (v) Effect of chemicals
- (vi) Fire Hazards
- (vii) Faulty construction
- (viii) Faulty system of maintenance
- (ix) Inappropriate cleaning
- (x) Misuse of buildings
- (xi) Environmental aspects
- (xii) Chemical factors and
- (xiii) Biological growth

The failures in building like Cracks, Dampness, Leakage and Spalling shows the weakness of building. That is the way of talking of a building to a Civil Engineer as a patient talks to a Doctor about his/her illness. So we have to take care of the buildings. Some of the examples of failures are shown the Figures 1.2, Figure 1.3 and Figure 1.4.



Figure 1.2 Corrosion of steel and Spalling of concrete in a RCC canopy.



Figure 1.3 Corrosion of steel and Spalling of roof concrete on a slab



Figure 1.4 Crack in concrete due to corrosion of steel

II. Methodology

Then beams of eighteen numbers are casted. After curing they were tested. They were tested for initial crack condition. To the cracked beams five methods of retrofitting is done. Then the repaired beams were tested up to ultimate failures. All the values are noted.

To cross check the experimental work, theoretical calculation is calculated in Limit State Design Method by the clauses which is stated under IS 456-2000 code and compared with the ultimate load which is obtained from the experimental test.

With the testing results of rehabilitated beams, various graphs will be plotted for comparisons like load vs. deflection, load comparison, deflection comparison are done.

And the ultimate load will be compared with the rehabilitated beam to conventional beam and the difference is plotted in bar chart as percentage of increment. All these process can be expressed in the form of following flow chart as in Figure 2.1.

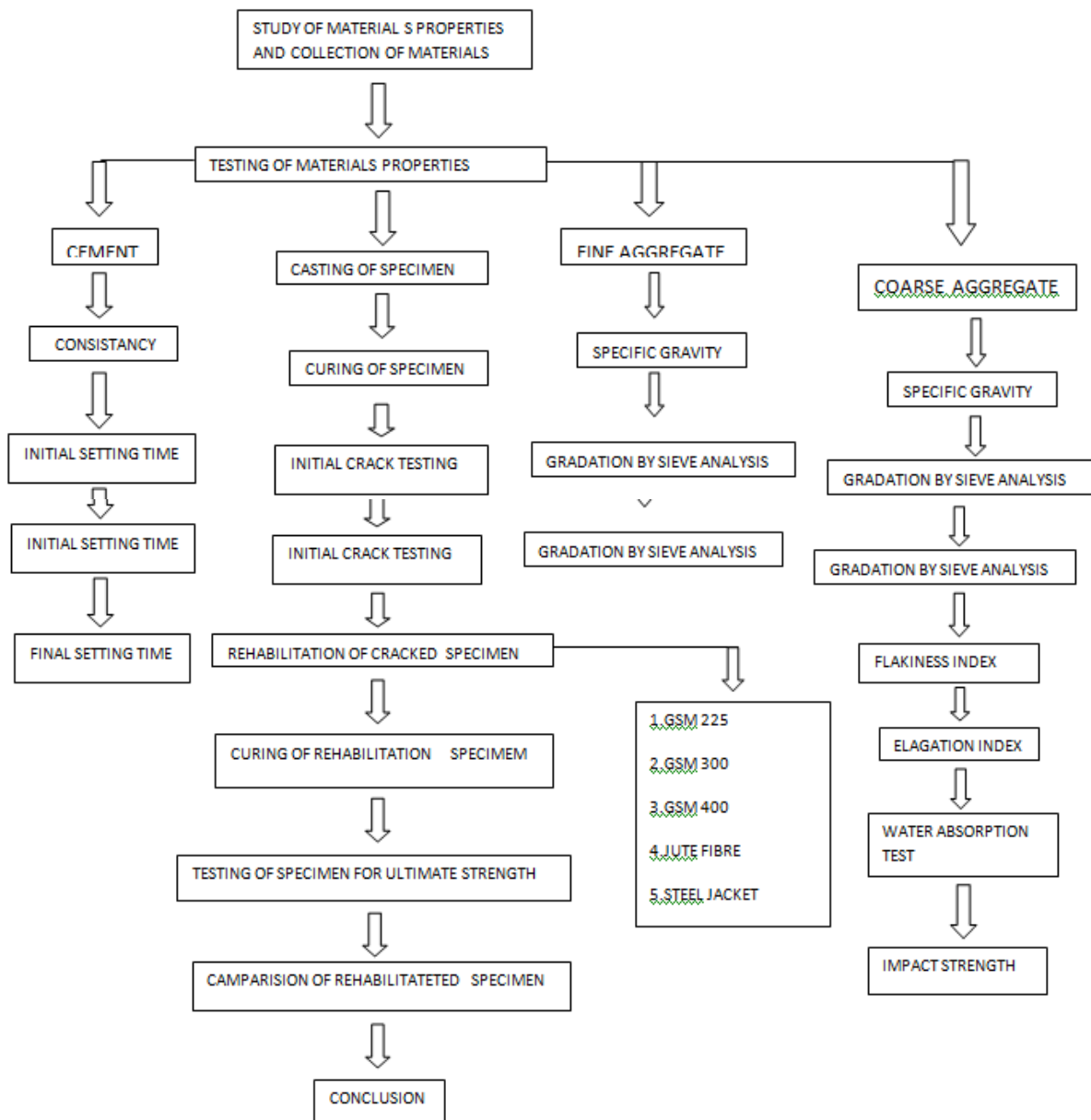


Figure 2.1 Flow chart of Methodology

III. Results And Discussions

Since in this project casting of beam and testing before and after failure are the important, beam moulds are casted in a Engineering work and brought to the place where the beams to be tested. Then the beams are tested. For this research work, rectangular beam is chosen for casting purpose. The size of the beam is 150 mm width and 200 depth with span of 1500 mm. Totally 5 repair methods are adopted, for each repair method 3 beams are casted and to check the ultimate load of the beam, 3 numbers of controlled beam is casted. Therefore totally 18 numbers of beam were casted. The grade of concrete is M25 and steel is Fe415. For concrete OPC 43 grade cement is used. Water cement ratio is 0.4.

The ultimate load carrying (mean) capacity of the beam is calculated as **65.33kN**. The theoretical value of the beam is calculated as **61.60kN**, **when compared with the theoretical value to the experimental value, the beam is carrying 6% higher load than the theoretical value.**

Rehabilitation Methods

Five methods of rehabilitation are for our flexural member. They are

- Method 1 – GFRP – Woven Roving 225 GSM
- Method 2 – GFRP – Woven Roving 400 GSM

- Method 3 – GFRP – Chopped Strand Mat300 GSM
- Method 4 – Jute Fiber
- Method 5 – Steel Jacketing Method

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

3.1 Method -1: GFRP Woven Roving – 225 GSM

For rehabilitation purpose three number of beam where loaded until the initial crack is appeared, when the crack is appeared loading is stopped and rehabilitation is done.

The average mean cracking load is found to be 54kN.

After the appearance of the initial crake, loading was stopped and the specimen where rehabilitated with the E-Class Glass Fiber with 225GSM using the polyester resin. And the specimen is left for curing for 24 hours.

After curing the beams, they are tested for their ultimate load carrying capacity. The average value of the Ultimate load is 74kN.

When compared with the control Specimen to the rehabilitated beam the ultimate load has been increased 10.2%.

3.2 Method - 2: GFRP Woven Roving – 400GSM

From the result the mean cracking load is found to be 55.33kN.

After applying the Rehabilitation Material and after curing the beams are tested and the average vale is found to be 85.67 kN.

When compared with the control Specimen the ultimate load carrying capacity of the beam is increased 20.33kN, which is 31% of higher load carrying capacity than the controlled beam.

When comparing the deflection for both beams, rehabilitated beam has deflection of 16.73mm, which is 2.63mm higher than the control Specimen. **Thus the rehabilitated beam deflects 18% higher than the controlled beam and carries 31% higher load than the control Specimen.**

3.3 Method – 3: GFRP Chopped Strand Mat – 300 GSM

From the result the mean cracking load is found to be 53kN.

After applying the Rehabilitation Material and after curing the beams are tested and the average vale Ultimate load is found to be 71 kN.

When compared with the control Specimen the ultimate load carrying capacity of the beam is increased to 5.67kN. Thus the rehabilitated beam can carry 9% more load than the control Specimen.

When comparing the deflection of the control Specimen to rehabilitated beam the deflection is reduced in the rehabilitated beam. **Deflection in the control Specimen is 14.1mm and deflection in the rehabilitated beam is 13.27mm only, thus the deflection is reduced 0.83mm.**

3.4. Method – 4: Jute Fiber

From the result the mean cracking load is found to be 56.33kN.

After applying the Rehabilitation Material and after curing the beams are tested and the average vale is found to be 68.33kN.

The increased load carrying capacity is 3kN than the control specimen; this value seems that the increment of the load is much less.

3.5 Method – 5: Steel Jacketing Method

Like in all other method, here also the beam is tested for its cracking load first and then the beam is rehabilitated. The Mean values of three beams are found to be 52.33kN.

After rehabilitation by Steel Jacket Method the beams are tested for Ultimate Load and the mean value is found to be 111kN.

When comparing the ultimate load of the rehabilitated beam to the control Specimen the load carrying capacity of the rehabilitated beam is increased as 44.67kN. Thus the load carrying capacity of the load is increased 70% more than the controlled beam.

The deflection of the controlled beam is 14.1mm and the deflection of the rehabilitated beam is 11.9mm, which is lower than the controlled beam. **In rehabilitated beam the deflection is reduced to 2.2mm, which is 16% lower than the controlled beam.**

Load comparison for Rehabilitation method is as shown in Figure 3.1.

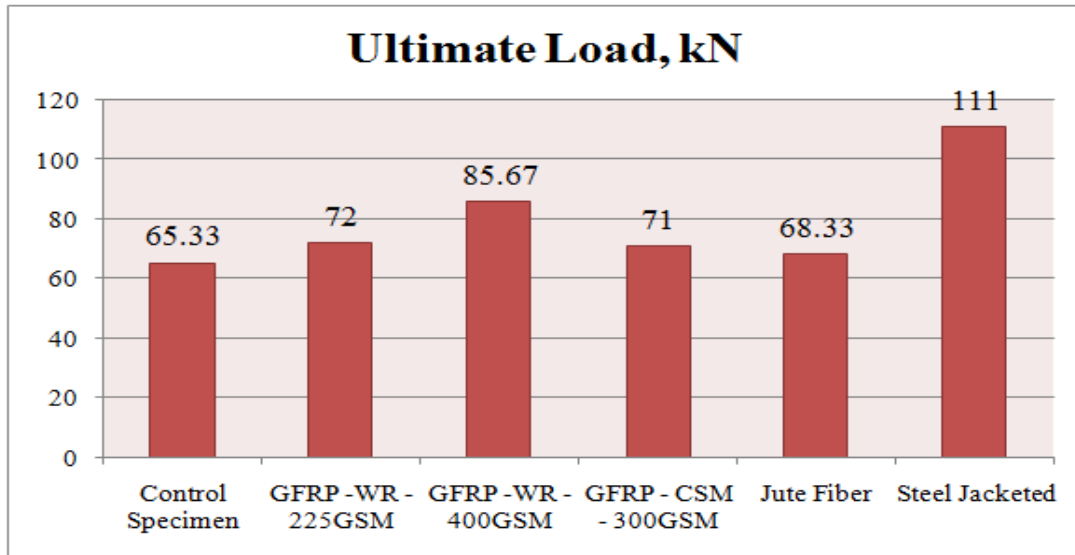


Figure 3.1 Load Comparison for Rehabilitation Method.

3.6 Deflection Comparison:

The deflection of the rehabilitated beams is compared with the control Specimen. The comparison is made and it is charted in Figure 3.2.

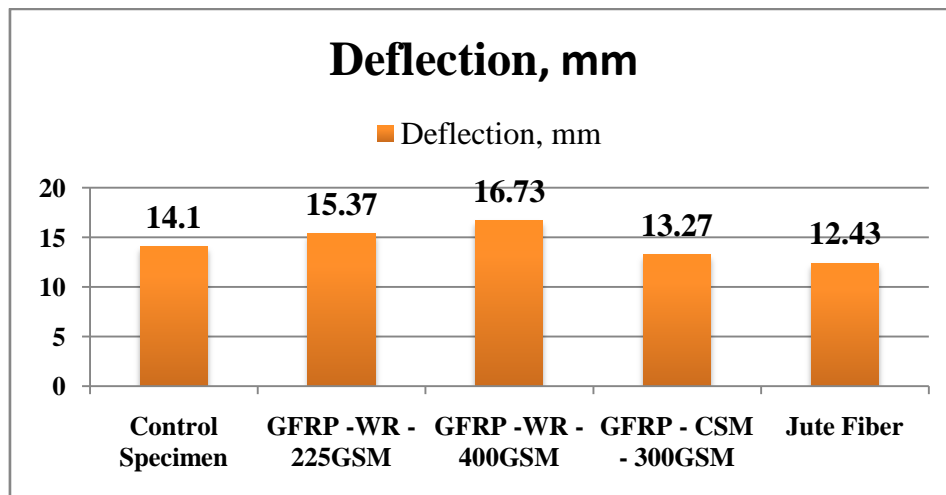


Figure 3.2 Deflection Comparison of Rehabilitated Beam

IV CONCLUSION

- The beam reaches the cracking load

- Control Specimen – 54kN
- Method – 54kN
- Method – 55.33kN
- Method – 53kN
- Method – 56.33kN
- Method – 52.33kN

- The beam reaches the Ultimate load

- Control Specimen – 65.33kN
- Method – 72 kN
- Method – 85.67kN
- Method – 71kN
- Method – 68.33kN
- Method – 111kN

- Load Comparison

As for as Strength is concerned Steel Jacket method is found to the best.

- Deflection Comparison

As per deflection concept Jute Fiber gives the lowest Deflection.

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