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RETROFITTING AND REHABILATION OF EXISTING STRUCTURES

S.Y. B. Tech. Minor Project Report

SUBMITTED BY

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MIT ACADEMY OF ENGINEERING, ALANDI (D), PUNE-412105

MAHARASHTRA (INDIA), 2021

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RETROFITTING AND REHABILATION OF EXISTING STRUCTURES

S.Y. B. Tech. Minor Project Report

Submitted in partial fulfillment of the
Requirements for the award of the degree

of

Bachelor of Technology

In Civil

ENGINEERING

BY

Shambhuraj Patil, Yogam Dekate

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CERTIFICATE

It is hereby certified that the work which is being presented in the SY B.Tech. Mini Project Report entitled**"Rehabilitation and Retrofitting of Existing Structures",** in partial fulfillment of the requirements for the award of the **SYBtech in Civil Engineering** and submitted to the **School of Mechanical and Civil Engineering of MIT Academy of Engineering, Alandi(D), Pune, Affiliated to Savitribai Phule Pune University (SPPU), Pune** is an authentic record of work carried out during an Academic Year 2020-2021,under the supervision of **Prof.Mr.Nilesh Baglekar, School of Mechanical and Civil Engineering**

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1.Yogam Dekate sign

2.Shambhuraj Patil sign

ABSTRACT

The rehabilitation of existing reinforced concrete (RC) bridges and building becomes necessary due to ageing, corrosion of steel reinforcement, defects in construction/design, demand in the increased service damage in case of seismic events and improvement in the design guidelines. Carbon Fiber-reinforced polymers (CFRP) have emerged as promising material for rehabilitation of existing reinforced concrete structures. The rehabilitation of structures can be in the form of strengthening, repairing or retrofitting for any type of deficiencies. Study has been carried on repair mechanism for the concrete beams with a particular percentage of damage. Carbon Fiber-reinforced polymers (CFRP) which is a well-accepted and efficient material for repair and rehabilitation is studied.

1.INTRODUCTION:

We all know that whenever rehabilitation or retrofitting and regeneration of the existing structure reinforced concrete plays a important role because Reinforced concrete (RC) is an extremely popular constr- uction material. But the Lack of durability of Reinforced concrete structures has damage or sometimes its collapse. so to prevent this incident CFRP plate coating has a major role and to Develop of innovative and cost-effective structural materials and tools to repair, rehabilitate and retrofit structures.

A composite material , carbon fibre -reinforced-polymer (CFRP), has been identified as a suitable material for the rehabilitation and retrofitting of structures . CFRP has a high tensile strength, non-corroding behaviour , low weight and no magnetic conductivity. Compared to the other FRPs, carbon fibre -reinforced-polymer (CFRP) has a higher tensile strength, a higher modulus of elasticity, a longer fatigue life and better creep properties. Different forms of CFRP composites have been used by structural engineers, including plates, rods, and sheets. The load capacity(Flextural Strength,Shear Strength) of an existing building may be increased by adding new structural elements(CFRP Plates) to resist part or all of the seismic or wind forces of the structure. The newly added elements may be shear and/or wing walls in a frame or skeleton structure. The choice of the number and size of the added elements depends on the particularities of the existing structure and the functional layout of the building.

In reinforced concrete, the steel is in concrete in such a manner that the two materials act together in resisting forces. The reinforcing steel-rods, bars, or mesh absorbs the tensile, shear, and sometimes the compressive stresses in a concrete structure.

The deterioration of building or any structure is mainly due to environmental effects, which includes corrosion of steel, gradual loss of strength with ageing, repeated high intensity loading, variation in temperature, freeze-thaw cycles, contact with chemicals and saline water and exposure to ultra-violet radiations. And also due to the natural phenomena like earthquakes or environmental deteriorating forces, demands development of successful structural retrofit technologies.

1.1. Motivations

The rehabilitation of existing reinforced concrete (RC) bridges and building becomes necessary due to ageing, corrosion of steel reinforcement, defects in construction/design, demand in the increased service loads, and damage in case of seismic events and improvement in the design guidelines. Carbon Fiber reinforced polymers (CFRP) have emerged as promising material for rehabilitation of existing reinforce concrete structures.

1.2. Problem Statement

Increase Structural and flexural strengthening of beam using CFRP plates for retrofitting purpose

1.3. Objectives and Scope

- To know the flextural or structural strength that can imparted using CFRP coating
- Study for Carbon Fiber-reinforced polymers (CFRP) sheet bounded to the beams with different
- Public safety is the main factor and their main goal is to protect human life ensuring the structure will not Collapse upon its occupant .Therefore the aim is to upgrade lateral strength of structure and increase ductility.

2.LITERATURE SURVEY

RESEARCH PAPER 1: A study of strengthening of concrete using carbon fiber reinforced polymer for retrofitting purpose

PUBLICATION NAME :- International Journal For Technological Research In Engineering

AUTHOR NAME :- Nitin Mehta, Rakesh Kumar

LITERATURE REVIEW: This study has been carried on repair mechanism for the concrete beams with a particular percentage of damage. Carbon Fiber-reinforced polymers (CFRP) which is a well-accepted and efficient material for repair and rehabilitation is studied.

The variables investigated in this research study included steel stirrups (i.e., beams with and without steel stirrups), shear span-to depth ratio (i.e., a/d ratio 3 versus 4), CFRP amount and distribution (i.e., Continuous wrap versus strips), bonded surface (i.e., lateral sides versus U-wrap), fiber orientation (i.e., 90°/0° fiber combination versus 90° direction), and end anchor (i.e., Uwrap with and without end anchor).

The results of tests performed in this study indicate that stiffness increases while increasing the CFRP sheet area at the flanks. Wang et al.(2001) examine the behavior of reinforced concrete Tbeams retrofitted with carbon-fiber-reinforced polymer (CFRP) plates which were bounded to the underside of the beams to increase the service life load capacity. The beams were subsequently loaded to failure. The results shows that beam with full length or staggered CFRP plates behave in a similar manner at the service load range so that the use of staggered CFRP plates instead of full length CFRP plate is much economical to increase service live load capacity of the beam

CONCLUSION: From this experiment we conclude that ultimate load carrying capacity of the CFRP coated beams is enhanced as compared to the beam without CFRP.We care working virtually so as per literature review we can conclude that The flexural strength of the CFRP U - wrap beam is increased as compare to the beams without CFRP. The load carrying capacity of the beams after 28 days without CFRP is 53 KN. It is observed BEAM-2 (U-wrap) the load carrying capacity is 67 kN

REARCH PAPER 2: RISK ASSESSMENT AND RETROFIT OF EXISTING BUILDINGS

PUBLICATION NAME :- Structural Engineer, Rutherford & Chekene, San Francisco, CA; Email: wholmes@ruthchek.com

AUTHOR NAME :- William T HOLMES

LITERATURE REVIEW :In the case of new buildings, the basic configurations and design criteria needed to prevent catastrophic failure are well known for most building types around the world. Although building codes are still constantly being refined, the issues with new buildings are more associated with the economic and political will to implement and renforce design requirements rather than deciding what requirements are appropriate.

For a small percentage of new construction, owners may request non-prescriptive designs aimed at seismic performance better or more reliable than the minimum standards of the building code. However, it is the older buildings that were constructed with little or no seismic considerations that represent the largest risk to most communities. These buildings must be evaluated by owners or communities, their level ofrisk determined, and unacceptable risks reduced or eliminated. This paper focuses on the issues associated withdetailed procedures for risk assessment and retrofit of individual buildings (risk assessment in this limited sense is also often referred to as evaluation).

CONCLUSION: This paper describes complex nonlinear analytical and design method in use today by engineers specializing in seismic evaluation and retrofit of existing buildings. These methods are used on buildings where interaction between new and old elements is important or when performance is heavily dependent on existing., “nonconforming” elements. There is variability in the application of the methods, leading in some cases to lack of agreement among engineers and loss of confidence by owners.

RESEARCH PAPER3: -Retrofitting and Rehabilitation of damage footbridge over Yamuna River.

PUBLICATION NAME-International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-2, July 2019 .

AUTHOR NAME- Anjani Kumar Shukla, P R Maiti .

LITERATURE REVIEW- Cement concrete reinforced with steels bars is an important property that cures the rate of corrosion. And this technique is very effective and too fast for earthquake affected structure and retrofitting of structure against possible earthquake phenomenon.

CONCLUSION-From this research papers we observed that cement concrete reinforced is very good forv repair and rehabiliting the existing damage concrete structures as it increases the flexural and compressive strength.

RESEARCH PAPER4: Recent advances in repair and rehabilation of RCC structure with non metallic fibre.

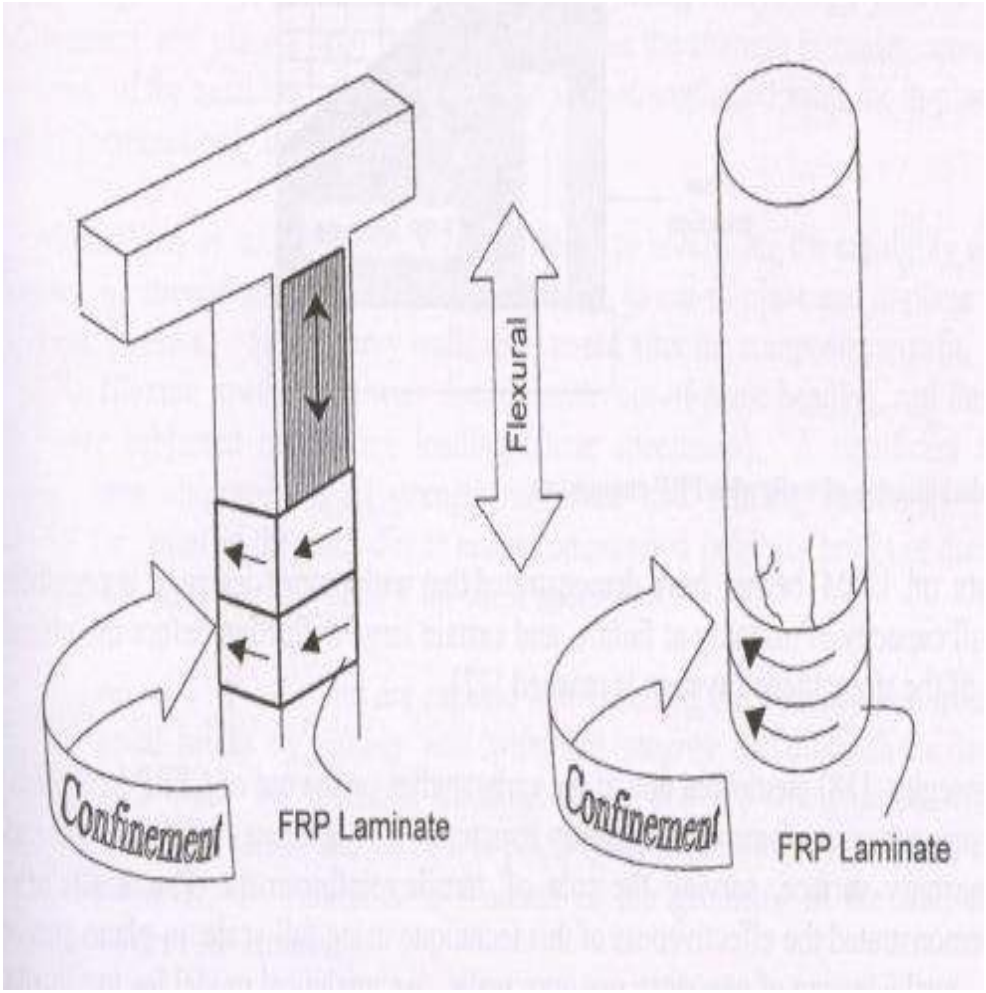
AUTHOR NAME –Abhijeet Mukherjee, Mangesh joshi

LITERATURE REVIEW- The most important application of these RCC structure with non metallic fibre is decrease the rate of corrosion and gives the exixting strength to material or body. This technique is very effective and fast for earthquake affected structure and existing monuments and building etc.as this is very good method to rehabilate and retrofit the existing buildings.

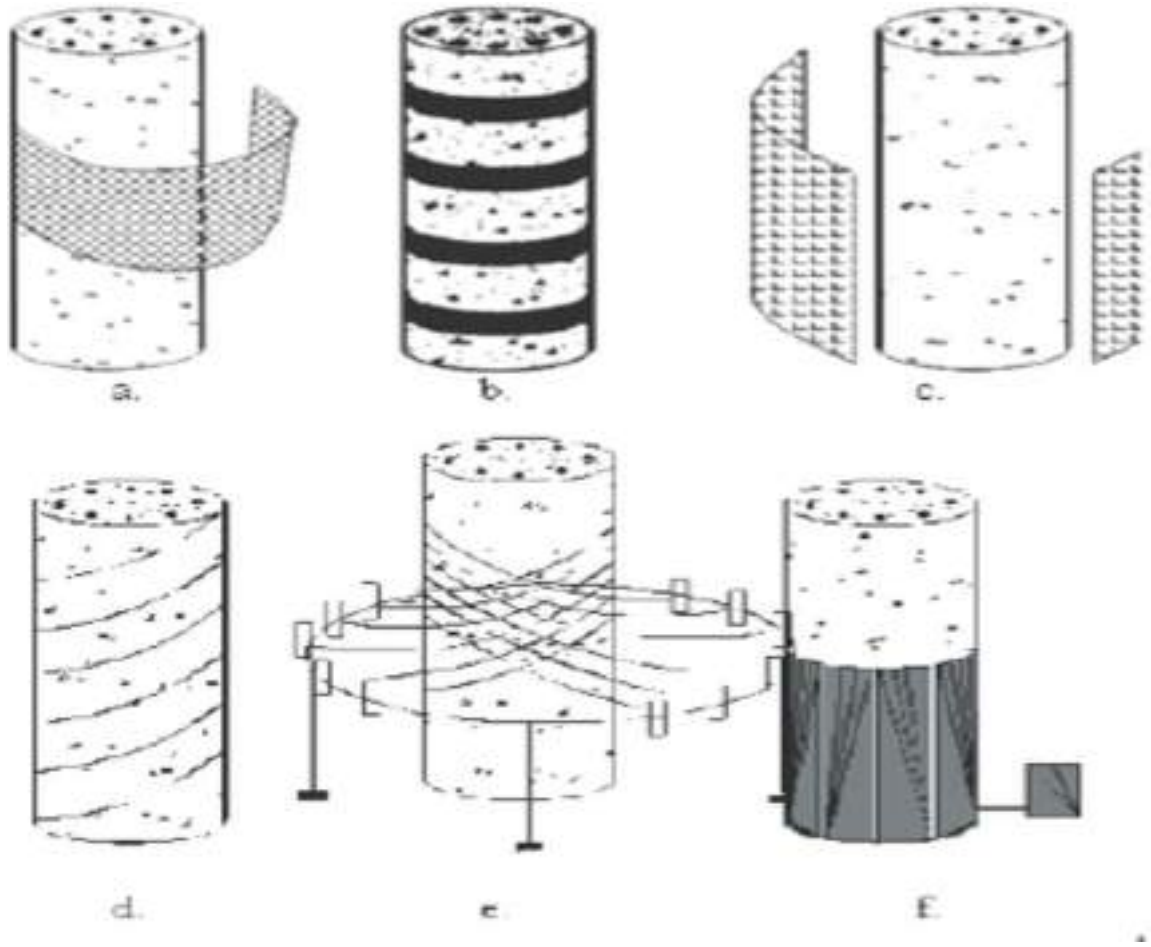
CONCLUSION-From this research papers we observed that RCC structure with Non metallic fibre is very good for repair and rehabiliting the existing damage concrete structures as it increases the flexural and compressive strength.

3. Structural Diagram or

3.1 Block Diagram:-



3.2 Mechanical Diagram:



During the latest decades Carbon Fibre Reinforced Polymer (CFRP) composite materials have proven valuable properties and suitable to be used in construction of new buildings and in upgrading the existing structure. Nowdays a wide range of available types of CFRP composites (with polyester, epoxy or vinyl-ester matrices) reinforced with glass, carbon and aramid fibers with suitable properties for different applications in civil and structural engineering. However, the particularities of behavior of CFRP bars and the insufficient experimental data on structural and long time behavior of concrete elements reinforced with internal CFRP composite bars still requires extensive theoretical studies and experimental programs to be able to fully increase the strengthening of existing structure.

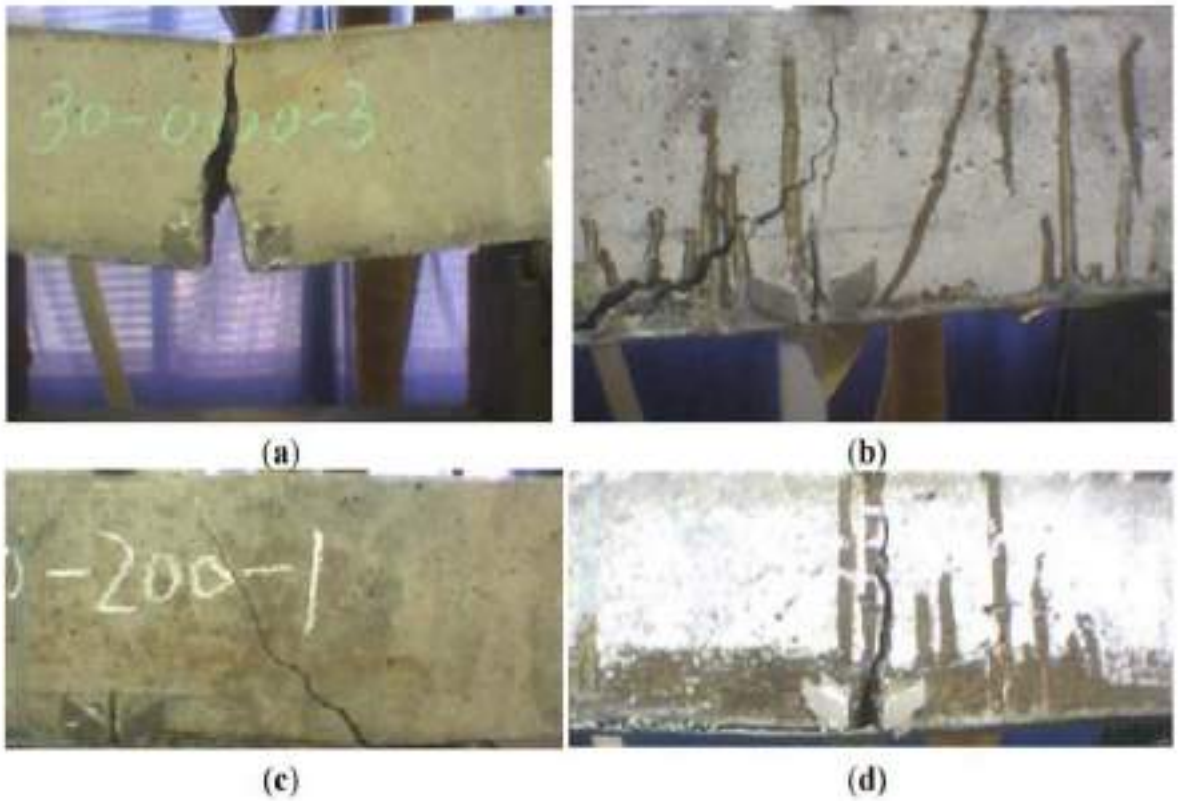
3.3 Activity Diagram

Retrofit using CFRP plates

1)Using Square Sheet of CFRP

CFRP coating for beam

- For implementation of the process firstly we see the things like buildings or monuments in our locality which was near by our city and observed it and we took some views from the people like what is the main cause of failure of building or monument ,and after discussing as we go through some case study or research papers and read it like it was of early yrs of 18's and 19's we done some study on it why it got failures and what are the measures they had taken to overcome the solution .
- And by this we come to our problem of implementing by taking ideas and observations from it for implementing in our topic, like applying cfrp plates, polymer plates ,jacketing etc. by this method we took the idea of overcoming the problems of cracking and failure of such a buildings and monuments, to increase it's strength and stability over the years .



Here is some failure mode of beams.

Properties of CFRP

Property	Value
Fiber density	1.8 g/cm^3
Ply thickness	0.381 mm
Ply weight	230 g/m^2
Elongation	1.5%
Tensile strength	3.45 GPa
Tensile modulus	230 GPa

METHODOLOGY For applying CFRP Plates:

1. Removeper layer of concrete & expose reinforcing steel all round.
2. De-rust the steel by, brushing or any other methods.
3. Restore reinforcement with shear connectors, wherever required.
4. Apply coat of polymers based materials.Use one of the several stitching techniques to restore concrete to the original surface level.
5. Inject the cement slurry or polymer modified slurry to fill up the Pores,

   internal cracks or segregation.

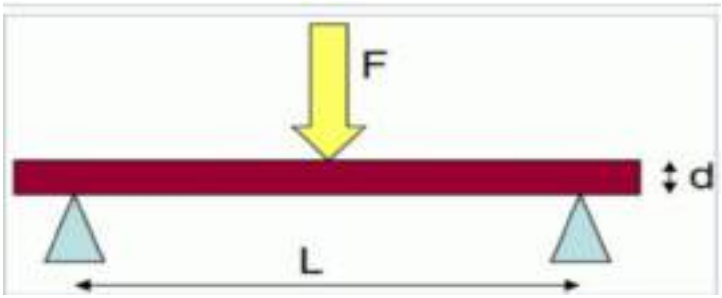
   Apply CFRP Plate for suitable protective coating

4.IMPLEMENTATION METHADOLOGY/PLANNING

Preparation of the Beams

Sample beams using in laboratory 30 days after manufacturing. Three beam samples set aside and the remaining 6 beams processed for strengthening. Sides and the bottom of the beams ground to remove the uneven parts caused by the mould. Dust was removed by pressurized water. Preparation of experimental beams.

Measuring the strength(Analyticaly):



For beam a load in a three-point bending setup .

{ Flexural strength =3FL/2bd^2}

- *F* is the load (force) at the fracture point (N)
- *L* is the length of the support span
- *b* is width
- *d* is thickness

Load Carrying Capacity of the Concrete Beams

If loading is in low in a concrete beam will deflect, there may not exist any cracking in tensile regions. In that case, reinforcement and concrete carry the load on the tensile section altogether. Concrete between cracks may help the tensile a little bit. Because this help is in a negligible amount, in a cracked section, all load carrying is assumed to be maintained by reinforcement. One thing that is for sure is that reinforcement cannot prevent cracking. The main function of reinforcement is to satisfy the tensile stress and keep cracks at minimum in size

Beam - 1 Concrete beam without CFRP Coating

Beam 1 The reinforcement consists of 4 numbers of 8 mm φ HYSD bars. This beam was not strengthened with CFRP sheet. It was an un-cracked beam. It was checked for its ultimate load bearing capacity under two point loading setup.

Beam - 2 Concrete Beam with CFRP Coating (U-wrap) and The beam was strengthened with one layer of CFRP sheet having U-wrap on bottom and web portions and then checked it to its ultimate load capacity under two point loading setup.

Like that from first three beams to find out load bearing capacity and flexural strength of beam .

1)At first We took 9 samples of beam for testing and then at first stage we took 3 samples of beam and on that 3 beams we will test The amount of reinforcement after testing the load bearing capacity of beam and will find out ultimate load.

2)Then from the remaining 6 samples of beam we will again take 3 beam sampleand we will do coatings to all 3 beams from 3 sides in an U-shape and from the ultimate load we will divideit by factor of safety and after dividing we will lead to find out working load and will come to see first crack of beam.

3)As the Crack is occured then we will work on reversing and restricting that amount load and crack of beam then after doing this the crack will be invisible to us after reversing the beam.

4)To the Remaining 3samples of beam of that 9.we will coat it by using CFRP 300 and changing to it we will find out ultimate load of beam and will come to know wether it is deacreded or incresed or it can impart from structural strength by CFRP by some amount of %.Then For Shear. As shear stress applied to support and maximum at it's neutral axis and flexural coat will be maximum at mid pan and will occur contraction.

5)By this shear method to as we will initiate shear to beam or will apply flipp perpendicular to opposite angle of (45 degree) then after testing we will come to know the shear crack occured or not by this method of shear stress to beam.

METHODOLOGY For applying CFRP Plates:

1.Removeper layer of concrete & expose reinforcing steel all round.

2.De-rust the steel by, brushing or any other methods.

3.Restore reinforcement with shear connectors, wherever required.

4.Apply coat of polymers based materials.Use one of the several stitching techniques to restore concrete to the original surface level.

5.Inject the cement slurry or polymer modified slurry to fill up the Pores,

internal cracks or segregation.

Apply CFRP Plate for suitable protective coating

5)Result(By refererring research paper):

Beam	Plain cement concrete beams		One sided CFRP wrapped concrete beams		Two sided CFRP wrapped concrete beams		Three sided continuous CFRP wrapped concrete beams	
	Load in kN		Load in kN		Load in kN		Load in kN	
	7 days)	28 days)	7 days)	28 days)	7 days)	28 days)	7 days)	28 days)
B-1	27	32	32	41	27	33	38	49
B-2	24	31	30	39	29	31	37	54
B-3	27.5	32	31	40	30	38	38	57
Average load (kN)	26.16	31	31	40	28.67	34	37.33	53.33

- Strength increasing of the beams strengthened with CFRP was 84% and the displacement reduction was found to be 39.5%. Strength increasing of the beams strengthened with GFRP was 45%, and the displacement reduction was found to be 53.6%.
- In reinforced concrete beams strengthened with CFRP, there occurred a failure reduction by 29% as compared to control beams but energy consumption was increased 14.5%. In reinforced concrete beams specimens strengthened with GFRP, there occurred a failure reduction by 25% as compared to control beams specimens but energy consumption was increased 18%.

6.CONCLUSION AND FUTURE SCOPE

- The ultimate load carrying capacity of the CFRP coated beams is increased as compared to the beam without CFRP.
- The flexural strength of the CFRP beam is increased as compare to the beams without CFRP.
- As it decrease working space of concrete structure due to extension in structural elements and affects appearance and it upgrade the lateral strength of structure and increase the flexural and compressive strength and ductility.
- The CFRP can significantly improve the load-bearing capacity for strengthened concrete beams

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