

RETROFITTING OF RC MEMBERS

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Abstract :-

Reinforced concrete structural components are found to exhibit distress, even before their service period is over due to several causes. Such unserviceable structures require immediate attention, enquiry into the cause of distress and suitable remedial measures, so as to bring the structures back to their functional use again. This strengthening and enhancement of the performance of such deficient structural elements in a structure or a structure as a whole is referred to as retrofitting. The allimportant issue to be addressed in retrofitting is life safety. What can be done to prevent collapse of the structure and prevent injury or death to occupants? Some retrofit requirements may try to address only the issue of life safety, while acknowledging that some structural damage may occur. In the present study an experimental investigation is carried out to study the behavior of Retrofitted RC columns under loading. The columns are strengthened using techniques such as Jacketing and use of Epoxy. Different schemes of strengthening have been employed and compared to get the best method of Retrofitting. The program consists of casting of nine members of overall dimension (150mm X 150mm X 750mm), out of which three members were control members and two different methods have been carried out on the rest of the members.

Keywords: Experimental, Retrofitting, Epoxy, Rehabilitation

INTRODUCTION

A structure is designed for a specific period and depending on the nature of the structure, its design life varies. For a domestic building, this design life could be as low as twenty-five years, whereas for a public building, it could be fifty years. Deterioration in concrete structures is a major challenge faced by the infrastructure and bridge industries worldwide. The deterioration can be 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. As complete replacement or reconstruction of the structure will be cost effective, strengthening or retrofitting is an effective way to strengthen the same.

The maintenance, rehabilitation and upgrading of structural members is perhaps one of the most important and crucial problem in the civil engineering application. Moreover, a large number of structures constructed in the past using the older design codes in the different parts of

the world are structurally unsafe according to the new design codes. Since replacement of such deficient element of structures incurs a huge amount of public money and time. Strengthening has become the acceptable way of improving their load carrying capacity and extending their service lives. Infrastructure decay caused by premature deterioration of building and structure has lead to the investigation of several process for repairing or strengthening purposes. One of the challenges in the strengthening of concrete structures is the selection of strengthening method that will enhance the strength and serviceability of the structure while addressing the limitation such as constructability, building operations an budget, Structural strengthening may be required due to different situations.

Additional strength may be needed to allow for higher loads to be placed on the structure. This is often required when the use of the structure is changed and higher load carrying capacity is needed. This can also occur if additional mechanical equipment, filling system, planters, or other item are being added to a structure.

Strengthening may be needed to allow the structure to resist the loads that were not anticipated in the original design. This may be encountered when the structural Strengthening is required for loads resulting from wind and seismic forces or to improve resistance to blast loading.

Additional strength may be needed due to efficiency in the structure's ability to carry the original design loads. Deficiencies may be the result of deterioration (e.g. Corrosion of steel reinforcement and loss of concrete section), structural damage (e.g. Vehicular impact, excessive wear, excessive loading and the fire), or the errors in the original design or construction (e.g. Misplaced or missing reinforcement steel and inadequate concrete strength).

When dealing with such circumstances,

each project has its own set of restrictions and demands. Whether addressing space restrictions, constructability restrictions, durability demands or any number of other issues, each project requires a great deal of creativity in arriving at a Strengthening solution.

The majority of structural strengthening involves improving the ability of the structural element to safely resist one or more of the following internal forces caused by loading: flexure, shear, axial, and torsion. Strengthening is accomplished by either reducing the magnitude of the forces or by enhancing the member's resistance to them. Typical strengthening techniques suction as section enlargement, externally bonded reinforcement, post tensioning, and supplementing supports may be used to achieve improved strength and serviceability.

Strengthening system can improve the resistance of the existing structure to internal forces in either a passive or active manner. Passive strengthening system are typically engaged only when the additional loads, beyond those existing at the time of installation are applied to the structure. Bonding steel plates or fiber reinforced polymer (FRP) composites on the structural members are examples of the passive strengthening systems. Active strengthening systems are typically engage the

structure instantaneously and may be accomplished by the introducing external forces to the members that counteract the effects of internal forces. Examples of this include the use of external post tensioning systems or by jacketing the members to relieve or transfer the existing load. Whether passive or active, the main challenge is to achieve composite behavior between the existing structure and the new strengthening elements.

The selection of the most suitable method for strengthening requires careful consideration of many factors including the

following engineering issues.

Magnitude of strength increase

Effects of changes in relative member stiffness
Size of project (method involving special materials and methods may be less cost effective on small project)
Environmental conditions (methods using adhesive might be unsuitable for application in high temperature environment, external steel methods may not be suitable in corrosive environment)

In place concrete strengths and substrate integrity (the effectiveness of methods relying on bond to the existing concrete can be significantly limited to the low concrete strength)

Dimensional / Clearance constraints
(Section enlargement might be limited by the degree to which the enlargement can encroach on surrounding clear space)

Accessibility

Operational Constraints (methods requiring longer construction time might be less desirable for applicants in which building operations must be shut down during construction)

Availability of materials, equipment and qualified contractors.

Construction cost, maintenance cost and life cycle cost; and

Load testing to verify existing capacity or evaluate new techniques and materials.

In order to avoid the problem created by the corrosion of steel reinforcement in the concrete structures, research has demonstrated that one could replace the steel reinforcement by fiber reinforced polymer reinforcement. Corrosion of steel reinforcement in reinforced concrete structure affects the strength of both steel and concrete. The strength of corroding steel reinforcing bars is reduced because of reduction in the cross-sectional area of the steel bar. While the steel reinforcing bars are corroding, the concrete integrity is impaired because of the concrete cover caused by the expansion of the corrosion

products.

The Rehabilitation of infrastructure is not new, and various projects have been carried out around the world over the past two decades. One of the techniques used to strengthen existing reinforced concrete members involves external bonding of steel plates by means of two component epoxy adhesives. By this way, it is possible to improve the mechanical properties of a member. The wide use of this method for various structure including building and bridges, has demonstrated its efficiency and convenience. In spite of this fact, the plate bonding techniques presents some disadvantage due to these of steel of as strengthening material. The principal drawbacks of steel are its high weight which causes difficulties in handling these plates on sites and its vulnerability against corrosive environment. Moreover, steel plates have limited delivery lengths and, therefore they require joints.

Various Materials For Retrofitting

The retrofit engineer needs to have information about these materials for designing the retrofit scheme. The repair and retrofit materials can be classified into three categories:

Grouts

Grout is a flow able material, which can be injected into the structural member under pressure. The grout should have negligible shrinkage to fill the gap/void completely and it should remain stable without cracking, delamination or crumbling. Injection grout is used to fill interior space within concrete or masonry created due to cracks, voids or honey combs. Various types of grouts used are: -

Injection grout

The injection grouts can be used for strengthening of old masonry structures, in those cases where mortar has degraded as well as in honey combed concrete.

Cement sand grout

Cement sand grouts are cheapest. For

injection purpose, the grout requires high water and cement contents. This results in shrinkage and cracking of grout at hardening. Suitable shrinkage compensating agents are required to minimize this. Use of cement-sand grout is very common in masonry buildings, but not very common in concrete.

Bonding Agents

These agents provide enhanced bond between existing concrete and new concrete and between concrete and reinforcement. These are very important for effective repair/retrofitting of systems. There are three methods available for enhancing the bond:

Application of adhesive at the interface.

Surface interlocking

Mechanical bonding

Polymer and epoxy is the adhesive used for bonding between old and new concrete and reinforcement. After removal of the concrete cover the existing concrete surface and steel are cleaned by sand or water blasting. After cleaning and drying, concrete and steel is painted by epoxy/polymer or polymer modified cement grout. If the new steel is to be welded, it is welded prior to coating of the concrete and steel. The coating provides enhanced bond between the old and the new material and reduce the risk of corrosion in steel as well.

Replacement and Jacketing Material

In case of damaged structures, materials in some parts of members are to be replaced by new material. For strengthening existing members in deficient buildings, additional material including reinforcement is to be provided. The material used for replacement should have good bond with existing material and it should be non-shrinking. Variety of strengthening and replacement material is available.

Steel plate bonding

Steel plate can be bonded to concrete members as external reinforcement to

increase their strength. The plates are glued to the member surface by epoxies. This requires a careful preparation of the member surface and application of epoxy layer. Steel plates can also be provided in the form of jackets either by gluing to surface or by grouting.

Polymer modified concrete and mortar PMM/PMC

Polymers are long molecule hydrocarbons, built by a combination of single units called monomers. The process is called polymerization. Small diameter particles of polymer emulsified in water are called polymer latexes. These latexes form continuous film at drying. The polymer can also be mixed in the form of dispersible powder in the dry cement aggregate mix. When water is added to the mixture, a process similar to that described above takes place. Some polymers are water soluble. The PMM/PMC has better workability and water retention properties than ordinary concrete/mortar. The main advantage of PMM/PMC is its improved adhesion and bonding with existing concrete and significantly reduced permeability.

Fiber-reinforced polymer/plastic

Fiber reinforced polymer/plastic is a recently developed material for strengthening of RC and masonry structure. It has been found to be an effective replacement of steel

plates for strengthening of columns by exterior wrapping. The main advantage of FRP is its high strength to weight ratio and high corrosion resistance. FRP plates are two to ten times stronger than steel plates, while their weight is just 20% of that of steel. However, at present their cost is high. FRP composites are formed by embedding continuous fiber matrix in resin matrix. The resin matrix binds the fiber together and also provides bond between concrete and FRP. The commonly used polymers are carbon fiber reinforced polymer (CFRP) and glass fiber reinforced polymer (GFRP).

These fibers are available in two forms:

Uni-directional tow sheets

Woven fabrics

The application of resin can be in-situ or in the form of pre-fabrication of FRP plates. On the other hand, prefabricated systems offer better quality control. It is important to note the difference between the properties of steel and FRP and it should be understood that FRP cannot be treated as reinforcement in conventional RC design methods.

LITERATURE REVIEW

In order to collect the necessary and valuable information, the literature survey is carried out. Papers from Journals are referred. The brief of the papers is presented in this chapter.

Darji S. et al (2017)⁽⁹⁾

This paper assesses the effective use of steel scrap in concrete. In this study, total 39 nos. concrete cubes of size 150 mm x 150 mm x 150 mm casted using steel scrap concrete grade M-20. Steel scrap used up to 2.4% by weight, at a gap of 0.2% (i.e. 0.2%, 0.4%, 0.6%, 0.8%, 1.0%, 1.2%, 1.4%, 1.6%, 1.8%, 2.0%, 2.2%, 2.4%). As per Indian standard, after 28 days compressive strength test done on casted concrete cubes and test results are compared with plain cement concrete. After completing study, we know that the 28 days compressive strength of steel scrap concrete is more than plain cement concrete. The main objective of this study to find out optimum percentage of steel scrap in concrete up to which its compressive strength initially increased and then gradually decreased. At the end of the study, we found that up to 1.4% of steel scrap, compressive strength increased then after more percentage of steel scrap causes slight reduction in compressive strength.

Rahman A. et al (2017)⁽¹⁰⁾

This project work emphasis on the study of using steel scrap and manufacture sand in the innovative construction industry. "Steel

scrap" concrete is a concrete containing fibrous material that is uniformly distributed and casually oriented. The steel scrap waste material which is obtainable from the lathe can be used as steel fiber for the innovative construction industry and in pavement construction. It is generated by each lathe industries. Dumping of these wastes contaminates the soil and groundwater, which creates a harmful environment. In addition, to get sustainable development and environmental benefits, lathe scrap with concrete is likely to be used. In this project steel scrap concrete using lathe waste is prepared and its properties are studied. "Manufactured sand" is such alternative for good quality Natural River sand

due to depletion of resources and restriction due to environmental consideration has made concrete manufacturers look for suitable alternative fine aggregate. Though it has been in use in concrete manufacturing in India, the percentage of its contribution is still very negligible in many parts of the country. The tests conducted were slump test, compressive strength test, split tensile strength test and. For this concrete cubes, columns and cylinders were cast and cured and tests were done at 3th day, 7th day and 28th day.

Ramana V. et al (2017)⁽⁸⁾

This paper presents an experimental investigation on retrofitting the capacity of damaged RC columns. In this work retrofitting of shear deficient RCC column using diagonal stitching method will be studies. Nine columns of size 120mm x 210mm x 1500mm were cast. Out of this one control column was used and remaining 8 columns are categorized in to two sets of columns with each set containing 4 columns as shear deficient columns. Out of these 8 columns, two columns were tested without retrofitting and remaining six columns were shear deficient used for retrofitting. Control Column designed for ultimate shear & flexure was loaded up to ultimate load in the Loading frame (of

capacity 1000 kN) using a Hydraulic jack of 500 kN capacity. Shear deficient columns were retrofitted using diagonal stitching and cover concrete was bonded Nitto bond. Load deflection behaviour of columns, retrofitted with different layers of stitched mat was compared. All the columns were casted using M25 grade concrete and Fe500 steel. After the 28 days of curing they were tested and kept safe for retrofitting. It was observed that stitching method is effective in restoring the capacity of damaged columns. Among all the shear retrofitting techniques, diagonal stitching is effective and easy to implement.

Mungale A. et al (2016)^[2]

The purpose of this paper is to present different techniques of retrofitting for RCC members in order to strengthen the structure to its functional continuity. Reinforced concrete jacketing is one of the methods of jacketing which can be employed as a repair or strengthening scheme. Before carrying out jacketing, damaged region of existing members should be repaired. RC jacketing provides a better solution for avoiding the buckling problems. Design for strengthening repair work is based on the composite action of the old and new work. Strengthening of RC columns is required due to design errors, damage due to earthquake, accidents such as collisions

, bad executions process, etc. Retrofitting of deficient column is recommended for several purposes as it gives continuity to the columns and increase the strength of structure.

Elavarasan R. et al, (2016)^[6]

This paper presents an experimental investigation performed on ferrocement slabs, where plain cement mortar of 1:3 mix ratio reinforced with two types of reinforcing wire meshes was studied. Steel meshes with wire woven hexagonal openings and galvanized iron mesh were compared with their performance against impact and fire exposure. The aim of this study is to observe the influence of using

ferrocement in enhancement of the mechanical properties of reinforced concrete slabs subjected to impact and fire exposure. The paper provides evaluation of performance by using the new technique ferrocement, as a strengthening material of reinforced concrete slabs compared with the existing reinforced concrete slabs of heavy self weight and brittle characteristics. Wire mesh is a form of reinforcement that differs from conventional reinforcement by the manner in which the reinforcing elements are dispersed and arranged. The testing program included impact load testing, projectile impact test using projectile (steel ball) of a diameter of 12.5mm and impact load testing done after subjecting the slabs to heat in oven reaching a temperature of 110 degree Celsius for 24 hours. The main findings showed that the use of the ferrocement as a reinforcement to concrete slabs enhanced the perforation resistance and reduce the heat transfer through the thinner thickness of the steel mesh reinforced cement matrix. Ferrocement is a relatively new material consisting of wire meshes and cement mortar. The basic idea behind this material is that concrete can undergo large strain in the neighborhood of the reinforcement and the magnitude of strain.

Eldeen E (2015)^[5]

This paper concerned with strengthening and retrofitting of reinforced concrete columns completely damaged due to flexural failure. The strengthening technique consists of steel wire mesh with and without additional longitudinal steel angles. Twenty four columns 100 mm width, 160 mm depth and 1250 mm overall span (1050 mm effective span) were casted and tested under two points loading. All columns were tested and loaded monotonically to failure, and then cracks were filled with grout mortar. The columns were strengthened and retrofitted under the existing deformation using two and three external plies of expanded galvanized steel

wire mesh with square grids in the form of U-jacket. The investigated parameters were the size of longitudinal steel angles (10x10x3 mm, 20x20x3 mm and 30x30x3 mm) which were added at the bottom corners of columns inside the steel wire mesh. In addition, numbers of vertical steel clamps (2, 4 and 6) were used to fix the jacket to eliminate the debonding. The strengthened and retrofitted columns were again tested under two points loading. The results showed that strengthening and retrofitting reinforced concrete columns with steel wire mesh with and without additional longitudinal steel angles had a considerable increase in ultimate load carrying capacity. Retrofitting columns used 2 and 3 steel wire mesh plies only fixed with 2, 4 and 6 vertical clamps resulted in an increase column carrying capacity from 26.59% to 49.55%. Also, increasing the angle size used at the bottom corners of columns inside the wire mesh increases the column carrying capacity up to 72.51% and 172.51%. In addition, increasing number of vertical clamps increases the column carrying capacity from 26.59% to 49.55%. In other hand, increasing angle size, number of clamps and number of wire mesh plies decreases columns deformation.

Shrivastava P. et al (2014)

These project works assess on the study of the workability and mechanical strength properties of the concrete reinforced with industrialized waste fibers or the recycled fibers. In each lathe industries wastes are available in form of steel scraps are yield by the lathe machines in process of finishing of different machines parts and dumping of these wastes in the barren soil contaminating the soil and ground water that builds an unhealthy environment. Now a day's these steel scraps as a waste products used by innovative construction industry and also in transportation and highway industry. In addition to get sustainable progress and environmental remuneration, lathe scrap as worn-recycle

fibers with concrete are likely to be used. When the steel scrap reinforced in concrete it acquire a term; fiber reinforced concrete and steel fibers in concrete defined as steel fiber reinforced concrete (SFRC). Different experimental studies are done to identify about fresh and hardened concrete properties of steel scrap fiber reinforced concrete (SSFRC) and their mechanical properties are found to be increase due to the addition of steel scrap in concrete i.e. compressive strength, flexural strength, impact strength, fatigue strength and split tensile strength were increased but up to 0.5-2% scrap content. When compared with usual concrete to SSFRC, flexural strength increases by 40% and considerable increases in tensile and compressive strength. These steel scrap also aid to improve the shrinkage reduction, cracking resistance i.e. preventing crack propagation and modulus of elasticity. The workability of fresh SSFRC are carried out by using slump test but it restricted to less scrap contents. This work focuses on the enhancement of structural strength and improvement in fatigue life of concrete pavements by reuse of scrap steel in concrete. These concrete roads with SSFRC promises an appreciably eminent design life, offer superior serviceability and minimize crack growth and corrosion.

MATERIALS AND METHODS

Test Program

The test program is so designed so as to study the behavior of Retrofitted columns subjected to different ways of wrapping the retrofit materials. The test program consist of:

First is the determination of basic properties of constituent materials namely cement, fine and coarse aggregates and steel bars as per relevant Indian standard specifications and designing the relevant concrete mix proportions.

Casting of Nine columns with dimension 150mm x 150mm x 750mm in all test specimens using M-20 grade concrete.

Three columns are considered as control column. The remaining are stressed and retrofitted with RCC & Wire meshing, in-order to find out the load carrying capacity. The stress levels maintained are 80% of the maximum load carrying found out by testing the control column.

The details of the test program are discussed in subsequent sub-sections.

Materials Used

Cement, fine aggregates, coarse aggregates, reinforcing bars and water are used in casting of columns and RCC and Wire Mesh used as the retrofitting material. The specifications and properties of these materials are as under:

Cement

Portland pozzolana cement from a single lot is used for the study. The physical properties of cement as obtained from various tests are listed in Table. All the tests are carried out in accordance with procedure laid down in IS 1489 (Part 1):1991, valid for pozzolana cements.

Fine Aggregate

Locally available sand is used as fine aggregates both in the preparation of cement mortar as well as for the concrete mix. The physical properties and sieve analysis results of sand are shown in Table below.

Coarse Aggregate

Crushed Stone Aggregate (locally available) of 20mm and 10mm are used throughout the experimental study

Water

Fresh and clean water is used for casting and curing the specimens. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard.

Reinforcing Steel

HYSD steel of grade Fe-415 of 8mm, and 6 mm diameters are used in the experimental program. 8 mm diameter bars are used as tension reinforcement and 6 mm diameter

bars are used as stirrups.

Wire Mesh

GI steel wire mesh of diameter 2.4 mm with rectangular grids pattern is used as a part of the Epoxy in jackets.

Concrete Mix

Mixing of concrete is done thoroughly and ensured that concrete of Uniform quantity is obtained. Hand mixing is done in small work, while machine mixing is done for big an important work. Although machine generally does the mixing but hand mixing is needed for sometimes may be necessary. A clean surface was used for this purpose.

M20 grade concrete mix is used using the properties of materials as discussed above and presented in table. The water cement used in the design is 0.5. The mixed proportion used is 1:1.5:3 (cement: sand: aggregate) and compressive strength of materials after 7 and 28 days is 21.5MPa and 29MPa.

Mortar Mix

The range of mix proportion recommended for common ferrocement applications are cement: sand ratio by weight of 1:1.15 to 1:1.25, but not greater than 1:3 and water cement ratio by weight of 0.35 to 0.5. The higher the sand content the higher is the required water content to maintain same workability. Fineness modulus of the sand, water cement ratio and sand-cement ratio are determined from trial batches to ensure a mix that can infiltrate the mesh and develop a strong and denser mortar. The proportion of cement-sand mortar used for ferrocement jackets is 1:3. The water-cement ratio for mortar is 0.5.

DESIGN OF COLUMNS

To study the proposed behavior nine columns specimen were casted using M- 20 grade concrete and Fe-500 grade steel. The column is rectangular in shape with dimension 150mm x150mm and length 750mm. In all columns, the reinforcement consisted of 4 no. of 10mm diameter bars.

The stirrups for specimen consist 8mm bars placed at 150mm c/c. The reinforcement detailing

CASTING OF COLUMNS

The casting of column was done in a single stage. The steel mould was used for casting of columns. Cover blocks of 25 mm were placed under reinforcement to provide uniform cover. Coarse aggregate, fine aggregate, cement and Water are mixed using the concrete mixer as per the proportion. After placing the desired reinforcement, concrete is poured in the mould and vibration are given to the mould with the help of vibrating machine so that the mix gets compacted. The vibration is done until the mould is completely filled and there is no gap is left. The columns were removed from the mould after 24 hours. After demoulding the columns were cured for 28 days in water.

PROCESS OF RETROFITTING

The six columns which were loaded up to 80% of the ultimate load. Each three columns were retrofitted using two different schemes.

Retrofitting using RCC Jacketing.

Retrofitting using mesh wire

The retrofitting Schemes consist of wrapping the columns portion with the help of mesh wire and by using the RCC Jacketing used for retrofitting. Firstly, the surface is cleaned and specimen is prepared for retrofitting. After the process is done the columns were cured for 28 days before testing. Then they are tested with the same procedure as adopted during the testing of control columns.

REINFORCED CONCRETE JACKETING

Properties of jackets: -

Match with the concrete of the existing structure.

Compressive strength greater than that of the existing structures by 5 N/mm² or at least equal to that of the existing structure.

Minimum width of jacket

10 cm for concrete cast-in-place and 4 cm for shotcrete.

If possible, four-sided jacket should be used.

A monolithic behavior of the composite column should be assured.

Narrow gap should be provided to prevent any possible increase in flexural capacity. Minimum area of longitudinal reinforcement

$3A_f y$, where, A is the area of contact in cm² and f_y is in kg/cm²

Spacing should not exceed six times of the width of the new elements (the jacket in the case) up to the limit of 60 cm.

Percentage of steel in the jacket with respect to the jacket area should be limited between 0.015 and 0.04.

At least, 12 mm bar should be used at every corner for a four-sided jacket.

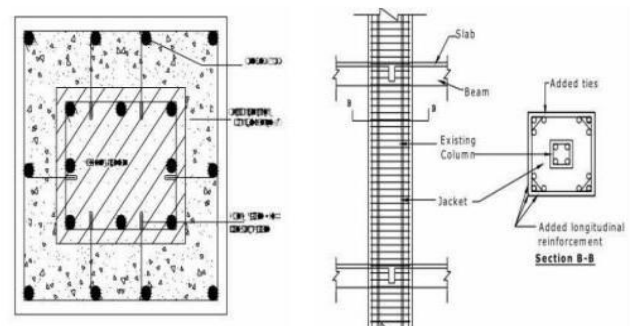
Minimum area of transverse reinforcement

Designed and spaced as per earthquake design practice.

Minimum bar diameter used for ties is not less than 10 mm or 1/3 of the diameter of the biggest longitudinal bar.

The ties should have 135-degree hooks with 10 bar diameter anchorage

Due to the difficulty of manufacturing 135-



degree hooks on the field, ties made up of multiple pieces, can be used.

Shear stress in the interface

Provide adequate shear transfer mechanism

to assured monolithic behavior.

A relative movement between both concrete interfaces (between the jacket and the existing element) should be prevented.

Chipping the concrete cover of the original member and roughening its surface may improve the bond between the old and the new concrete.

For four-sided jacket, the ties should be used to confine and for shear reinforcement to the composite element.

Connectors

Connectors should be anchored in both the concrete such that it may develop at least 80% of their yielding. Due to the difficulty of manufacturing 135-degree hooks on the field, ties made up of multiple pieces, can be used. Shear stress in the interface. Provide adequate shear transfer mechanism to assured monolithic behavior. A relative movement between both concrete interfaces (between the jacket and the element) should be prevented.

Chipping the concrete cover of the original member and roughening its surface may improve the bond between the old and the new concrete.

For four-sided jacket, the ties should be used to confine and for shear reinforcement to the composite element.

Jacketing

Jacketing of columns:

Jacketing of columns consists of added concrete with longitudinal and transverse reinforcement around the existing columns. This type of strengthening improves the axial and shear strength of columns while the flexural strength of column and strength of the column-column joints remain the same. It is also observed that the jacketing of columns is not successful for improving the ductility. A major advantage of column jacketing is that it improves the lateral load capacity of the building in a reasonably uniform and distributed way and hence avoiding the concentration of stiffness as in

the case of shear walls. This is how major strengthening of foundations may be avoided. In addition, the original function of the building can be maintained, as there are no major changes in the original geometry of the building with this technique. The jacketing of columns is generally carried out by two methods

Column jacketing

Beam jacketing:

Jacketing of beam is recommended for several purposes as it gives continuity to the beam and increases the strength and stiffness of the structure. While jacketing a beam, its flexural resistance must be carefully computed to avoid the creation of a strong column-weak beam system. In the retrofitted structure, there is a strong possibility of change of mode of failure and redistribution of forces as a result of jacketing of beam, which may consequently cause beam hinging. The location of the beam critical section and the participation of the existing reinforcement should be taken into consideration. Jacketing of beam may be carried out under different ways, the most common are one-sided jackets or 3- and 4-sided jackets. At several occasions, the slab has been perforated to allow the ties to go through and to enable the casting of concrete. The beam should be jacketed through its whole length. The reinforcement has also been added to increase beam flexural capacity moderately and to produce high joint shear stresses. Top bars crossing the orthogonal beam are put through holes and the bottom bars have been placed under the soffit of the existing beam, at each side of the existing beam. Beam transverse steel consists of sets of U-shaped ties fixed to the top jacketing bars and of inverted U-shaped ties placed through perforations in the slab, closely spaced ties have been placed near the joint region where beam hinging is expected to occur.



Figure.3.14 Reinforced Concrete Jacketing

RETROFITTING USING MESH WIRE:

In this method, we used mesh wire to wrap it on the surface of the column.

Column surface is prepared for wrapping.

Proper tensioning was given at the time of wrapping the wire.

The wire was properly wrapped on the columns at even spacing of 30mm c/c.

After wrapping bonding agent were applied.

Then columns were placed in the mould and concrete was poured in the mould of size 210 mm x 210mm x 810mm.

Then the columns were cured for 28 days before testing.

RESULT

Introduction

In this chapter the load carrying capacity of different specimens are discussed. Initially the control specimen was loaded to Axial Compressive Load. Out of six specimens, three were retrofitted with RCC and three were retrofitted with wire mesh as shown in Figures in previous chapter.

Ultimate Load Carrying Capacity In KN

Testing Methodology

The testing of beams was done with the help of 3000KN Universal testing machine. With the help of Universal testing machine, load was applied axially on the Column. Out of nine specimens casted three specimen were control specimen and was loaded to ultimate load and the data corresponding to it was recorded through data acquisition

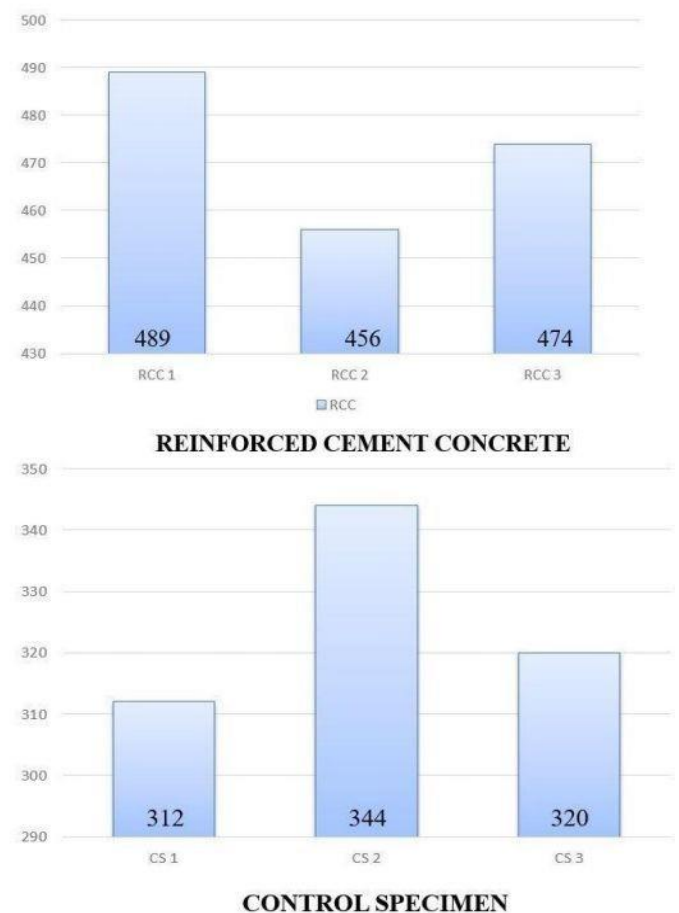
system. The rest six specimens retrofitted

Bar Chart showing Axial Compressive load Capacity of RCC Retrofitted

using two different retrofit techniques.

The ultimate load of the control beam comes out to be 344 KN. Then the retrofitting of column was done with concrete of thickness 30mm along with RCC and wire mesh.

After 28 days of curing the rest of six columns were retrofitted and tested again with same method as control specimen and the corresponding result are recorded in form of axial compressive load.



Bar Chart showing Axial Compressive load Capacity of Control Specimen

CONCLUSION

General

The study is carried out to analyze the effect of Different wrapping Technique on Reinforced Concrete Members. The Important conclusions drawn from the study are listed below; The load Carrying Capacity of Retrofitted beam for both type of Retrofitting techniques increases significantly as compared to control specimen. There was 56.73% increase in Load Carrying Capacity achieved by using RCC Retrofitting. There was 91.89% increase in Load Carrying Capacity achieved by using MeshWire. Wrapping by Mesh wire technique is more effective than using RCC Retrofitting for improving the load carrying capacity of column. There was 50% increase in size of members.

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