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Overview on Strengthening of RC column by jacketing with concrete modified with admixture

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ABSTRACT-As in the case of RC structure, columns are subjected to uniform and non-stop loading, which increases within a number of stories and might cause partly damage or even general failure of the column. To overcome the whole failure of RC columns, instant attention is needed in and the broken part of reinforced concrete repaired by way of reinforced concrete jacketing. This paper highlights the review of the effects of concrete surface treatment and loading on the structural behavior of reinforced concrete (RC) columns retrofitted with RC jackets. The concrete surface treatment aspect is assessed based on the surface roughness, use of dowel bars, use of shear connectors, and applying bonding agent between the column core and the jacket. However, the loading aspect is evaluated based on preloading history and the applied loading pattern. The latest researches and recommendations for concrete jacketing are presented. It is found that sand-blasting with the use of dowel bars or shear connectors helps the retrofitted column to behave monolithically. Preloading does not have a significant effect on the retrofitted column. However, it is recommended to apply the load on the full retrofitted cross-section.

Keywords-Rc-column,Strengthening, Jacketing.

I.INTRODUCTION

The failure of the most important structural elements i.e. columns,may lead to the total collapse of frame structured buildings because they are the only structural elements that convey the total vertical loads of building to the soil.reinforced concrete is one of the most abundantly used construction material not only in the developed world,but also in the remotest parts.The deficient frame members and joints are identified during detailed evaluation of building.Members requiring strengthening or enhanced ductility shall be jacketed by reinforced concrete jacketing ,steel profile jacketing and steel encasement or wrapping with FRPS where possible.The deficient members shall first be stress relieved by propping.

Reinforced concrete jacketing involves placement of new longitudinal reinforcement and transverse reinforcement bars in the newconcrete overlay around existing member.Reinforced concrete jacketing improves column flexural strength and ductility.closely spaced transverse reinforcement provided in the jacket improves the shear strength and ductility of the column .

The minimum specifications for jacketing columns are:

A) Strength of the new materials shall be equal or greater than those of the existing column.Concrete strength shall be at least 5 MPA greater than the strength of the existing concrete.
B) For columns where extra longitudinal reinforcement is not required,a minimum of 12 mm dia. bars in the four corners and ties of 8 mm dia. bars @ 100 c/c should be provided with 135 degree bends and 10 mm dia. leg lengths.
C) Minimum jacket thickness shall be 100 mm.
D) Lateral support to all the longitudinal bars shall be provided by ties with an included angle of not more than 135 degree.
E) Minimum diameter of ties shall be 8 mm and not less than one-third of the longitudinal bar diameter.
F) Vertical spacing of ties shall not exceed 200 mm,whereas the spacing close to the joints

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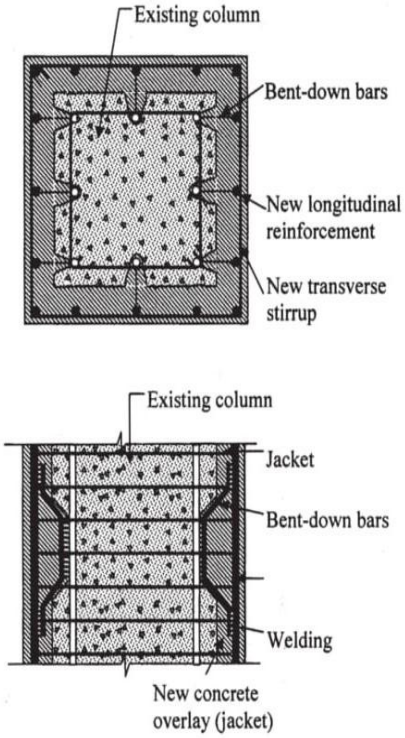
within a length of ¼ of the clear height shall not exceed 100 mm.Preferably ,the spacing of ties shall not exceed the thickness of the jacket or 200 mm whichever is less.



II.NEED FOR STUDY

Lots of study has been guide under the process of concrete jacketing which examine the strengthening method of jacketing of RC column. In PCMC area,at site the government allowed for only 10 storey building after that they gave permission for 12 storey building construction. So for built up of upper 2 storey we used concrete jacketing method for strengthening of column. The findings of study will be helpful in planning methodology and solutions in construction industry. As this survey will help in getting some ideal answer for the question.

III.OBJECTIVES

- To study the strengthening methods of jacketing of RC column.
- To evaluate analytically strength of existing column.
- To design jacketing with concrete modified using admixture for strength of column.

IV.LITERATURE REVIEW

In this survey we have collected papers on the topic

Sayed {2020] carried out a study to investigate the effect of increasing longitudinal reinforcing steel bars on concrete jacketing performance. Fifteen columns were fabricated in three categories: five square columns with dimensions (200*200*1200) mm, five rectangular columns with dimensions (160*250*950) mm and five circular columns with a dimeter of 160 mm. First and second groups were strengthened with 50 mm thick reinforced concrete jacket and different reinforcing steel bars (4Ø 12, 6Ø 12, 8Ø 12) while circular columns were strengthened with (4 Ø 10, 6 Ø 10, 8 Ø 10). Anchorage bolts and Kemapoxy adhesive material were used to improve bonding strength between column surface and the concrete jacket. the testing results showed that using reinforced concrete jackets increased column ultimate load capacity. Also, results indicated that ultimate load capacity increases with the increase in the longitudinal steel bars.
The effect of adding longitudinal reinforcing steel bars to the reinforced concrete jackets on the ultimate load capacity is approximately linear.

Tayeh [2019] investigated the efficiency of concrete cover types that were used for rehabilitation of damaged concrete columns. Forty-five normal strength concrete columns have been tested. Nine columns were considered as reference columns which included three unjacketed columns

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and six columns with (25, 35) mm thick normal strength concrete jackets. The other thirty-six columns were strengthened with concrete jackets that included additional reinforced steel bars (4 Ø 10), (25,35) mm jacketing thickness, ultra-high-performance fiber-reinforced self-compacting concrete (UHPFRSCC) and normal strength concrete (NSC) as concrete jacketing materials. Surface roughening using mechanical wire brushing and mechanical scarification, and using shear studs were employed as methods to improve bonding between columns and concrete jackets. The results indicated that using (UHPFRSCC) jacket exhibited higher ultimate load capacity than (NSC) jacket. Also, increasing the jacket thicknessincreased ultimate load capacity. Furthermore, bonding using shear studs increased ultimate load capacity more than other bonding methods.the ultimate load capacity depends on the material properties used in the cover jacket. Ultra-high performance fibre-reinforced self-compacting concrete (UHPFRSCC), Fibrous concrete reinforced and normal strength concrete (NSC) are the commonly used materials for concrete jacketing. Previous studies showed that (UHPFRSCC) performs better that the other types.

Mahmud [2020] performed an experimental study to investigate the effect of interface preparation on the developed bond strength between the column and the added concrete jacket. Twelve columns were fabricated with dimensions (102*102*800) mm and weak concrete (10 -14) MPa. The columns were strengthened with four additional longitudinal steel bars and (25 -31.5) mm concrete jacket thickness. Eleven columns were prepared with different bonding conditions: untreated and unbonded surface, treated and bonded surface and treated and bonded surface with welded ties. The experimental results showed that RC column jacket increased the column capacity, and the degree of enhancement varied according to the bonding conditions. Treated and bonded surface with welded ties showed higher load capacity than other conditions.In order to provide good mechanical interlocking between old and new concrete, suitable methods must be used to roughen the column surface. There are many methods used to roughen column surface such as sandblasting, hand chipping, jackhammering, electric hammering, water demolition and iron brushing. Previous studies stated that sandblasting was the most efficient roughening method among those considered [6]. For high-quality bonding condition, cementitious Grouting Solutions (BASF Master Flow), anchorage bolts, welding and different adhesive materials are used.

Connor Mills and Benjamin Z. Dymondat al[2019] stated that post-installed reinforcement is used to connect a new concrete member to an existing concrete structure .Typically ,uncoated rebar post-installed with a chemical adhesive is used in these applications,which may lead to corrosion.This work examined what effects what effects the epoxy coating had on the tensile pullout strength and compared the results for epoxy-coated and uncoated rebar.The ratio of the tensile pullout strength of the epoxy-coated reinforcing bars to the tensile pullout strength of the uncoated reinforcing bars ranged from 0.94 to 1.05 and varied based on the chemicals adhesive manufacturer. The average ultimate tensile load for epoxy-coated reinforcing bars post-installed using HIT-RE 500 V3 was 33.00 kips.The average ultimate tensile load for uncoated reinforcing bars post-installed using Hilti HIT-RE 500 V3 was 33.76 kips(2% higher). The ratio of the ultimate tensile capacity of the epoxy-coated reinforcing bars to the uncoated reinforcing bars was 0.98.The average displacement at the ultimate tensile load for epoxy-coated reinforcing bars was 0.30 in.and the average displacement at the ultimate tensile load for uncoated reinforcing bars was 0.43 in.The experimental data from testing both the epoxy-coated and uncoated reinforcing bars is shown in table.The failure mode for all of the epoxy-coated and uncoated and uncoated reinforcing bars was steel rupture.The failure modes for reinforcing bars post-installed with Hilti HIT-R

Experimental results for both epoxy-coated and uncoated reinforcing bars post-installed with Hilti HIT-RE 500 V3 adhesive .Table 1

Specimen	Reinforcing bar coating	Ultimate load(kips)	Displacement at ultimate load(in.)	Failure mode
ECH1	Epoxy-coated	32.98	0.39	Steel rupture
ECH2		33.30	0.33	
EHC3		33.18	0.26	
ECH4		32.64	0.34	
ECH5		32.84	0.29	

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ECH6		33.05	0.16	
Average epoxy-coated		33.00	0.30	
ECH1	Uncoated	33.94	0.51	Steel rupture
ECH2		33.73	0.43	
ECH3		33.62	0.41	
ECH4		33.96	0.48	
ECH5		33.96	0.34	
ECH6		33.37	0.43	
Average uncoated		33.76	0.43	
Average epoxy-coated/Avg. Uncoated=			0.98	

Prathmesh Dingorkar and Ayush Srivastava[2016]have discussed the comparitive study of percentage increase in strength after adopting RC jacketing and FRP wrapping. Percentage increase in strength achieved after RC jacketing and FRP wrapping is determined and compared. This study is fruitful to gauge suitability of the two retrofitting methods for weakened structural members. The study will be handy to help the structural engineer to decide which method of retrofitting should be adopted for acquiring the required increase in strenth.

Comparative study of percentage increase in strength

1.Percentage increase in strength after jacketing

Maximum condition=(0.04% steel)
Providing 100mm jacketing on all sides
Area of jacket=(550*430)-(230*350)
=156000 mm^2
As=0.04 % of Ag
=0.04%*156000=62.4 mm^2
Ac=156000-62.4=155937.6 mm^2
Pu"=Pu+Pu'
=653.704*10^3+{(0.4*25*155937.6)+
0.67*415*62.4)}
Pu"=2230.43 KN
Percentage increse in strength (original)
={(2230.43-1020.78)/1020.78}*100=118.5%
Increse (deteriorated)=241.19%
Minimum condition-(0.015% steel)
Area of jacket = 156000 mm^2
As =0.015%x156000= 23.4mm²
Ac 156000 - 23.4= 155976.6mm²
Pu" = Pu + Pu'
=653.704x103+((0.4x25x155976.6)+
(0.67*415*23.4)}
Pu"= 2219.976 KN
Percentage increase in strength (original)
=((2219.976-1020.78)/ 1020.78) × 100
= 117.478%
Percentage increase in strength (deteriorated)
=239.59%

2. Percentage Increase in strength after FRP Wrapping

(For 2 layer of FRP)
Minimum condition - (a= 0.67).
Pu= cxaxf' ccx(Ag - Ast) + þsxfyxAst = 1x0.67x24.657x(80500-805) + 1x0.3x415x805
Pu= 1416.79 KN
Percentage increase in strength (x original)
= {(1416.79-1020.78)/1020.78] x100
= 38.79%
Percentage increase in strength (deteriorated)= 116.73%
For Maximum condition
Pu=1770.506 KN
Percentage increase in strength (original) = 73.45%
Percentage increase in strength (deteriorated) = 170.84%

(For 1 layer f FRP)
For minimum condition
Pu 1249.724 KN
Percentage increase in strength (original) = 22.42%
% increase in strength (deteriorated) - 91.17%
For maximum condition
Percentage increase in strength (original) = 52.68%
Percentage increase in strength (deteriorated) = 138.42%.

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Comparison of increase of strength between RC jacketing and FRP Wrapping.Table 2

Methods	**Minimum condition**		**Maximum condition**	
	Original	Deteriorated	Original	Deteriorated
RC Jacketing	(0.015 % of steel jacket)		(0.04% steel in jacket)	
	117.478%	239.59%	118.5%	241.19%
FRP Wrapping (With 2 layers)	(alpha=0.67)		(alpha=0.85)	
	38.79%	116.73%	73.45%	170.84%
FRP Wrapping (with 1 layer)	(alpha=0.67)		(alpha=0.85)	
	22.42%	91.17%	52.68%	138.42%

Alaa Jaleel Naji [2021] have discussed the Rehabilitation and strengtheningexisting reinforced concrete facilitieshave become an essential part of theconstruction work. This study aims toreview and evaluate methods of strengthening RC columna. Steel jacketing, ConcreteJacketing, ferrocement facketing.CFRPjacketing and GFRP jacketing are themost common techniques which have been used for rehabilitation of RC columng. Each method of strengtheningis reviewed with emphasis on its performance, advantage, disadvantages, applicationdetails and factors that influenced the design and scope of applicability. Concrete jackets in corporate theaddition of concrete, longitudinal &transverse reinforcement as a shell that encloses the existing member. This streng thening techniques improves the column axial, shear flexural strength and stiffness. The bond between the old and new concrete should be enhanced before hand by roughening the surface to of the original member.

K. P. Jaya and Jessy Mathai carried out The present study focuses on the behaviour of reinforced concrete beam-columns strengthened using Glass Fibre Reinforced Polymer (GFRP) and Carbon Fibre Reinforced Polymer (CFRP) subjected to reverse cyclic loading. Reinforced concrete columns designed as per IS 456-2000 possess less necessary ductility to dissipate seismic energy during earthquake. Such beam-columns are seismically deficient and require additional confinement to improve their seismic parameters. Fiber reinforced polymer (FRP) composites are increasingly used for this purpose. Hence, experiments were conducted on Reinforced concrete beam-columns with and without FRP wrapping. One Specimen each was tested without GFRP and CFRP wrapping, three specimens were tested with 2 layers, 4 layers and 6 layers of GFRP wrapping and other two specimens were tested with CFRP wrapping. The specimens were tested under a constant axial load and reversed cyclic lateral loading. Experimental results indicate a significant increase of ductility and increase in energy absorption capacity of RC beam-column when strengthened by both GFRP and CFRP Jacket.

Saim Raza and John L. Wilson[2019] stated that RC jacketing has been used extensively for strengthening and repairing deficient and damaged RC columns, respectively. In traditional reinforced concrete jacketing, the section of the column is enlarged by casting a new reinforced concrete/mortar section over a part or the entire length of the column. The new section is bonded to the original section through anchor rebars or high-strength bolts. Although this technique improves the seismic performance of the column in terms of axial load arrying capacity, flexural strength and ductility, it is costly and time consuming due to the installation of the formwork. Moreover, the improvement in ductility is relatively small because the jacketing material (i.e., concrete) is brittle. Furthermore, it results in a change in the cross-sectional area of the column, thereby changing the mass and stiffness of the structure, and hence reducing the natural period of the structure, which consequently results in higher seismic demands on the structure. Therefore, high-performance RC materials have been used more recently for jacketing purposes, so that the specimen is strengthened/repaired without a change in the cross section.

V.CONCLUSION

We have discussed and presented number of different methods of strengthening of existing RCC column in this paper. The experimental methods and results of various previous investigations were reviewed, finally we decided to go with RC Jacketing and the parameters that have a future scope in this field were summarized. The various outcomes are…… 1.Comparative study of percentage increase in strength depicted

clearly that RC jacketing exhibits higher percentage of increase in strength.

2. Conventional concrete jacketed column showed an increase of 12.5 % in ultimate load. When compared with control column, micro concrete jacketed column showed 86.6 % increase in ultimate load and with concrete jacketed column showed an increase of 65.8 % in ultimate load and decrease of 25.3 % in axial deformation.

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