

A review on Strengthening of RCC square columns with Reinforced Concrete Jacketing

Tabish Rasool Sheikh¹, Mohd Kashif Khan², Tabish Izhar³

¹ PG Student, Structural Engineering, Integral University, Lucknow, Uttar Pradesh, India.

² Associate Professor, Dept. of Civil Engg. Integral University, Lucknow, Uttar Pradesh, India.

³ Assistant Professor, Dept. of Civil Engg. Integral University, Lucknow, Uttar Pradesh, India.

Abstract – In this Paper, the overall review about the change in strength and the ductility behavior of Reinforced concrete square columns is discussed when strengthened with classical reinforced concrete jacketing. Although on a large scale numerous laboratory studies on strengthening of columns by RC jacketing are conducted and then reported, but there is still an apparent need for finding and executing new ways to improve the performance of classical RC jacketing. As in the case of RC structure, columns are subjected to uniform and continuous loading which increases with the increase in no. of storeys and may lead to partially damage or even total failure of the column. In order to overcome the total failure of RC columns even before its service period is over an immediate attention is required in and the damaged part of reinforced concrete is repaired by classical reinforced concrete jacketing. This paper also focuses on the effect of providing dowel rebars by drilling holes, and the use of concrete jackets made with different types of concrete. And it was found that both using dowel rebars and different types of concrete increases the bond strength, overall load carrying capacity and first crack load.

Key Words: Reinforced Concrete column, Strengthening, Dowel rebar, Shear Connector and RC Jacketing

1. INTRODUCTION

Columns are one of the most important structural member which transfers the entire loads to the foundation. The behavior of columns in tall structures is very important since column failures lead to additional structural failures and can result in total building collapse. Replacement of the damaged structural elements is very difficult and may create a high risk to the overall structural integrity. Generally, strengthening techniques for reinforced concrete structures can be divided into: addition of new structural elements or else strengthening of the existing structural elements. Thus, in order to strengthen the damaged part of RC column, retrofitting technique is the only solution to be used all over the world. Experimentally, Retrofitting can be done in two different ways, depends on the position and the extent of damage in structural member:

- Global Retrofitting
- Local Retrofitting

In case of Global Retrofitting, the entire structure is retrofitted which involves the overall analysis and design of the entire structure as per the specifications given in standard codes. Whereas, in case of Local Retrofitting, only a specific structural member is either strengthened or totally replaced. Jacketing technique is the most preferred method of retrofitting used both in practical and experimental purposes and can be applied by the following techniques including the traditional RC jacketing:

1. Wrapping the sheets of fiber reinforced polymers such as carbon fiber and glass fiber reinforced polymers. (CFRP) and (GFRP)
2. Classical Reinforced concrete jacketing. It can be done with or without Rebaring, depending upon the core size of column.
3. Confinement with Ferrocement. I.e. Wire mesh Mortar Jacketing.

In comparison to the above, strengthening with classical Reinforced concrete jacketing is the traditional and cost effective technique mostly used to retrofit or repair the damaged concrete structures even in earthquake-prone areas. In fact it has been recognized that from the past work classical RC jackets being economical do provide an increased strength, total stiffness, and overall enhancement of the structural performance. And, no doubt for this reason although classical RC jacketing exhibits few shortcomings, it is frequently used either prior to or even after the damage of RC structural member such as Column. Moreover, it is a well-known fact that the success of the RC jacketing depends upon the good bond between the damaged column and the added jacket and this can be achieved first by increasing the roughness of the interface with hammer and chisel and then either by using a bonding agent such as epoxy or by installing shear connectors and dowel rebars.

2. LITERATURE REVIEW

E S Ju'lio, F Branco and V D Silva _2003 ^[1] studied the structural rehabilitation of columns with reinforced concrete jacketing and concluded that the RC jacketing strengthening method, unlike other techniques, leads to a uniformly distributed increase in strength and stiffness of columns. Further, the durability of the original column is also improved, in contrast to the corrosion and fire protection needs of other techniques where steel is exposed or where

epoxy resins are used. Moreover, removing the concrete from the deteriorated zone by hand chipping, jack-hammering, electric hammering or any other method that causes micro-cracking of the substrate, should be followed by sand-blasting or water demolition techniques.

Gnanasekaran Kaliyaperumal and Amlan Kumar Sengupta_2009 ^[2] investigates the effect of concrete jacketing on the flexural strength and performance of columns and it was concluded that the self-compacting concrete was found to be suitable for use in the concrete jacket and the retrofitted specimens did not show any visible delamination between the existing concrete and the concrete in the jacket. Moreover, the roughening of the surface of the existing concrete by motorized wire brush was found to be satisfactory for the type of tests conducted. Further, this study can be extended to the exterior or corner columns by testing the corresponding sub assemblage specimens.

Hamidreza Nasersaeed_2011 ^[3] stated that using concrete jacket is effective method in increasing strength and stiffness in a structural frame and further concluded that RC jacketing technique is cheaper than other retrofitting techniques because of availability of materials and no requirement of highly trained labor. Also the congested arrangement of reinforcement limits the volume of extra concrete and buckling of longitudinal bars in the repaired concrete column.

Bhavar Dadasaheb et. al. 2013 ^[4] studied the structural behaviour of RCC building and stated that it is better to implement classical reinforced concrete jacketing due to its feasibility and ease for execution. Further, Strengthening of building considered in this study is an attempt to increase the life and to sustain the unwanted disturbances like, earthquakes floods etc. It is recommended to retrofit the old RCC structures with this suitable type of jacketing at proper time such that it may prove economical and safe for the future.

Sayed H. Sayed_2015 ^[5] investigates the effect of repairing concrete columns after exposure to Elevated temperature using concrete jackets made of different types of concrete and the effect of using shear connectors on the bond between column surface and the jacket and concluded that there is a reduction of ultimate load of concrete columns exposed to elevated temperatures and there is a slight improvement from the use of shear connector. Further, it is said that for such columns exposed to elevated temperatures use of self compacting concrete jacket is most suitable but the use of recycled concrete is not recommended for repairing RC columns.

Hazem M.F. Elbakry and Ahmed M. Tarabia_2016 ^[6] studied the effects of surface preparation, the contributions of dowels and concrete jacket transverse reinforcement on the overall bond strength between new concrete jackets and

old concrete. Thus, concluded that increasing the surface roughness of the substrate concrete by hand-chiselling is considerably more effective than grinding and the use of steel dowels to connect the new jacket concrete to the old concrete significantly improved the overall bond strength due to the developed shear friction.

3. CONCLUSIONS

In general, a comprehensive literature review of the work done in the past was studied in order to get a better idea of the key issues relevant to strengthening of RC columns with classical reinforced concrete jacketing. Moreover, unlike other techniques, the existing investigations have revealed that the classical RC jacketing leads to a uniformly distributed increase in strength and stiffness of columns and, in many cases, even allows the structure to carry the heavy seismic loads. In addition to that, the durability of the original column is also improved. With the increased demand of repairing and rehabilitation in the field of structural engineering, Traditional RC jacketing will continue to grow as an economical and long lasting retrofitting technique. Based on this review, following conclusions and recommendations are drawn:

- RC jacketing leads to a uniformly distributed increase in strength and stiffness of column.
- The durability of deteriorated columns shows a better improvement.
- Increase in the total stiffness of the column.
- The Column specimens provided with a bonding agent (Epoxy) or with shear connectors will show an improved adherence of the RC jacket to the old concrete.
- Better to use different types of concrete in jacketing, so that the most suitable type of concrete will be defined for future.
- It is better to remove the concrete from the deteriorated zone with hammer and chisel, followed by sand blasting to make the rough interface.
- The use of dowel rebars to connect the new jacket concrete to the old deteriorated concrete significantly improved the overall bond strength due to the developed shear friction Hence, providing the dowel rebars will increase the total strength and stiffness under cyclic loading.
- Providing a shear connector will make a slight improvement in the overall structural behaviour of column.
- Use of re-cycled concrete in the RC jacketing is not recommended for repairing short columns.
- It is recommended to use fibrous and self-compacting concrete jacket for repairing the concrete short columns subjected to elevated temperatures.
- On using the Self compacted concrete in RC jacketing the retrofitted specimens did not show any kind of visible delamination between the existing concrete and the concrete in the jacket.

Further, from the review and discussion of the literature, it was also concluded that there is a need to perform an additional experimental work on the retrofit of columns by composite jacketing and even using different types of concrete and making proper bond, such that classical RC jacketing can be compared with other types of jacketing.

ACKNOWLEDGEMENT

I would like to express a deep sense of gratitude to all the scholars, authors and publishers whose articles and journals are cited and from that a valuable data was reviewed and discussed for completing this review paper.

REFERENCES

- [1] E S Ju'lio, F Branco and V D Silva, "Structural rehabilitation of columns with reinforced concrete jacketing". Prog. Struct. Engng Mater – 2003
- [2] Gnanasekaran Kaliyaperumal and Amlan Kumar Sengupta, "seismic retrofit of columns in buildings for flexure using concrete jacket". ISET Journal of Earthquake Technology, Paper No. 505, Vol. 46, No. 2 – June 2009
- [3] Hamidreza Nasersaeed, "Evaluation of Behaviour and Seismic Retrofitting of RC Structures by Concrete Jacket." Asian Journal of Applied Sciences. – 2011
- [4] Bhavar Dadasaheb, Dhake Pravinchandra D. and Ogale Ramesh A. "Retrofitting of Existing RCC Buildings by Method of Jacketing". IJRMEET Vol. 1, Issue: 5, June – 2013.
- [5] Sayed H. Sayed, "Retrofitting of Concrete Short Columns after Subjecting to Elevated Temperature Using Different Types of Concrete Jackets". World Applied Sciences Journal 33 (5): 790-796 – 2015
- [6] Hazem M.F. Elbakry and Ahmed M. Tarabia, "Factors affecting bond strength of RC column jackets" Alexandria Engineering Journal - 2016