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Repair and Rehabilitation of Concrete structure RCC Column Jacketing: a real time technique

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Abstract — *A building once constructed need time to time repair and rehabilitation. Once the lifespan of the structure is completed it required to inspect and at the end structure stability is required. Instead of demolition and re-construction if we can inspect in such a way and proper repair techniques applied which can be useful to regain its original strength and in working condition it can be. An industrial building which is in Panvel, Mumbai has already completed the lifespan for the said purpose and it required detailed inspection. It is done by the team of engineers and repair techniques applied anlayitically, for the same column jacketing technique also applied for the construction of the slab at site. at the end of the repair work the structure is in working condition.*

Keywords*-column jacketing, repair, rehabilitation, industrial building, structural stability*

I. INTRODUCTION

The term rehabilitation in the broad sense means restoring the structure that has been damaged/deteriorated, to its former condition, by regaining its strength through treatment and techniques. Repair basically means to bring back the architecture shape of the building and to have a proper functioning of the building.

Repair and rehabilitation is usually done as follows :
1.At first all the data of the site is collected, including its soil condition, climatic condition, water table etc
2. Site is then visually investigated and problem (if any) is identified.
3. Proper planning is done and adequate solution is provided.
4. Finally the design is done and work is executed.
Jacketing is the process whereby a section of an existing structural member is restored to original dimensions or increased in size by encasement using suitable materials. A steel reinforcement cage or composite material wrap can be constructed around the damaged section onto which shotcreting or cast-in- situ concrete is placed.
Collars are jackets that surround only for a part of a column or pier. These are usually used to provide increased support to the slab or beam at the top of the column. The form for the jacket consists of timber, corrugated metal, precast concrete, rubber, fiberglass, or special fabric; and may be permanent in some cases. The form must be provided with spacers to ensure equal clearance between it and the existing member. The process of rehabilitation simply repairs the portion of the structure which is being damaged, the rest portion is kept as it is. While in reconstruction of the building whole structure has to be made again, hence rehabilitation is cost effective process.

An industrial building which has already completed its life span is being repaired at the site in Panvel, Mumbai. One portion of the building was having four columns with one of its column having lesser dimension compared to the remaining three. Provision of constructing one slab above those columns was to be made, but practically it was not possible to do so because the structure was not having the necessary strength.

Fig 1 Industrial Building at Panvel, Mumbai

Hence the process of jacketing was adopted and one column which was having shorter dimension was redesigned and the slab was constructed as per the need.

II. 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 behavior 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-chiseling 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.

III. METHODOLOGY

For the actual site work, first of all data collection need to be done. From the owner of the building we got all the drawing and all past records of the building were collected. After the process of data collection, planning of the members to be evaluated bifurcated individually and separated based on the existing condition on site. Further lead to investigate the individual members on site considering site investigation.
After the site investigation done as a structural engineer, concluding remarks made and based on that the lab test, reconstruction of the individual member, repair, retrofit or detailed investigation required were evaluated. At the end for the new construction of the slab demanded by the owner, column jacketing as a conclusion adopted and design for the same explained below. Different methods adopted also explained in brief.

Different methods and materials adopted for the repair and rehabilitation is as follows:

1. Grouting and crack repairs:

Grout is a dense fluid which is used to fill gaps or used as reinforcement in existing structures. Grout is generally a mixture of water, cement, and sand and is employed in pressure grouting, embedding rebar in masonry walls

2.Shotcrete:
Shotcrete, sprayed concrete is concrete or mortar conveyed through a hose and pneumatically projected at high velocity onto a surface, as a construction technique. It is typically reinforced by conventional steel rods, steel mesh, or fibers.

3. active corrosion method
The aim of active corrosion protection is to influence the reactions which proceed during corrosion, it being possible to control not only the package contents and the corrosive agent but also the reaction itself in such a manner that corrosion is avoided. Examples of such an approach are the development of corrosion-resistant alloys and the addition of inhibitors to the aggressive medium.

4.Polymer modification (Resikon-400):
RESIKON 400 is a modified acrylic polymer in emulsion form. It is an excellent material for repair and rehabilitation of different types of structures. It is UV resistant.

Fig 3 resikon repairig materials

5. permanent corrosion protection:
The purpose of permanent corrosion protection methods is mainly to provide protection at the place of use. The stresses presented by climatic, biotic and chemical factors are relatively slight in this situation. Machines are located, for example, in factory sheds and are thus protected from extreme variations in temperature, which are frequently the cause of condensation. Examples of passive corrosion protection methods are:

Tin plating
Galvanization
Coating
Enameling
Copper plating

6. various repair techniques:
Repair techniques included are: acid etching, caulking, coating, conventional replacement plastic and dry pack; grinding or grooving; injection; jacketing; prepacked concrete; resurfacing thin, regular, bonded or unbonded; shotcreting; stitching; and stressing. Repair materials covered are: acids; bentonite; bituminous coatings; concrete, mortar or grout; dry pack; elastomeric sealants; epoxies; expanding mortars, grouts and concretes; fast-setting materials; fibrous concrete; floor hardeners; jacketing materials; latexes; linseed oil; polymers; silicones; and special cements.

7. beam strengthening technique

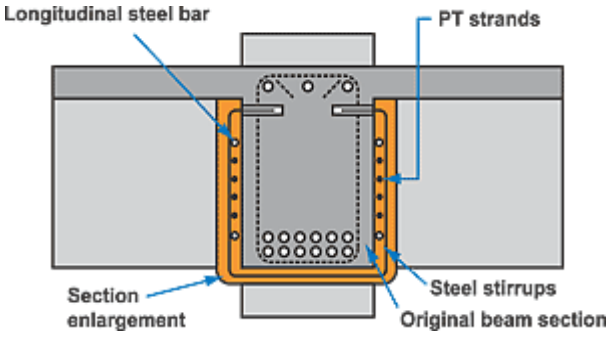

Fig 2. beam strengthening technique

8. RCC jacketing

Jacketing is used to strengthen weak RCC columns which have been deteriorated over a period of time due to adverse atmospheric conditions or due to poor maintenance.

9. Elastomeric materials: .

Elastomeric coating is applied to the masonry and concrete construction to prevent water from penetrating into building interiors

- **Column Jacketing:**

Design working load = 1735.23 / 1.5 = 1156.82 KN Add 10% as self weight of footing = 115.682 KN
Total working load = 1272.50 KN
Area of footing required = Total load / S.B.C = 1272.50 / 392 = 3.24 m^2
Difference between dimension of the column = .3—.3 = 0 m
Existing footing dimension = 1200x900mm
Area = 1.2 x .9 = 1.08 m^2 < 3.24 m^2
Now, as the area of the footing is less than the desired area, structure is not safe.
hence, jacketing process should be adopted.
Footing = 1.2x.9 m and column = .3x.3 m

Jacketing : Extending footing and column dimension as follows:

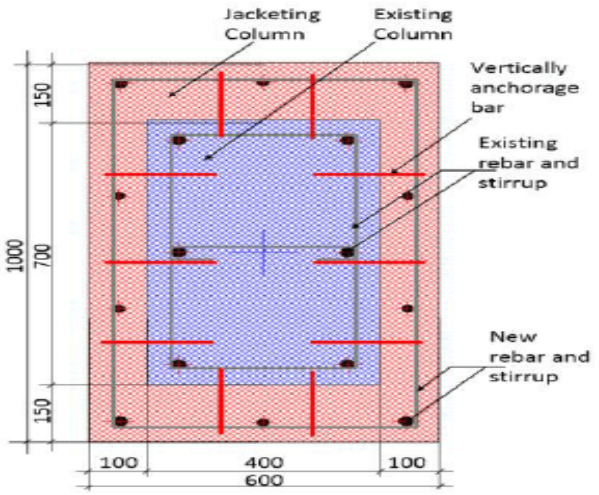

Fig 4 Rcc column jacketing

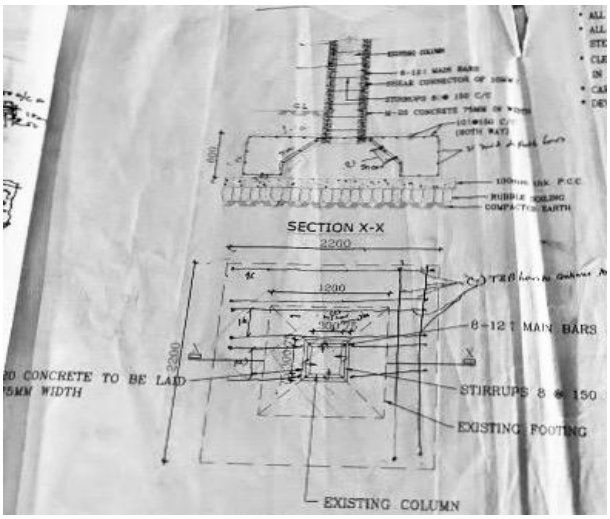

Fig 5 column jacketing design drawing

new footing adopted = 2.2x2.2 m
and new column = .45x.45 m
New area of footing = 2.2 x 2.2 = 4.84 > 3.24 m^2 ……..Safe

IV CONCLUSION

It is concluded from the above work done at the site, by repair and rehabilitation of the structure we can increase the strength and durability of the structure. Further we can narrate that by repair and rehabilitation we can extend the life of the structure without reconstructing the whole building again.
In a nut shell, we can conclude that the cost of the repair and rehabilitation is less as compared to the reconstruction; further the time required in repair is less as compare to reconstruction.
For the above said problem, the process of column jacketing was adopted and the dimensions of column were made equal to the remaining three columns. Hence, construction the slab was made possible.

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