Analysis & Design of R.C.C. Jacketing for Buildings

Vedprakash C. Marlapalle, P. J. Salunke, N. G. Gore

Abstract: ***The objective this paper is to discuss effectiveness of R.C.C. jacketing method used to improve the performance of deteriorated structure, this technique successfully applied on the structure. Also Design method, field application techniques, Advantages, Disadvantages and suitability have been discussed.***

Keywords: ***Jacketing, Retrofitting, Concrete, Strengthening, Repair.***

I. INTRODUCTION

R.C.C. Jacketing is the most popularly used for strengthening of building columns & Beams. The most common types of jackets are reinforced concrete jacket.

The main purposes of jacketing are increases the member size significantly. This has the advantages of increase the member stiffness and is useful where deformation is to be controlled. If columns in the building are found to be slender, RC jacketing provides a better solution for avoiding buckling problems. Design for the strengthening repair work is based on the composite action of the old and new work.

II. THE MINIMUM SPECIFICATIONS FOR JACKETING COLUMNS

1. 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.
2. For columns where extra longitudinal reinforcement is not required, a minimum of 12φ bars in the four corners and ties of 8φ @ 100 c/c should be provided with 135° bends and 10φ leg lengths.
3. Minimum jacket thickness shall be 100 mm.
4. Lateral support to all the longitudinal bars shall be provided by ties with an included angle of not more than 135°.
5. Minimum diameter of ties shall be 8 mm and not less than one-third of the longitudinal bar diameter.
6. Vertical spacing of ties shall not exceed 200 mm, whereas the spacing close to the joints 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.

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Mr. Vedprakash C. Marlapalle, (ME Student), Department of Civil Engineering, M.G.M .College of Engineering & Technology, Kamothe, Navi Mumbai, India.

P. J. Salunke, (Guide), Department of Civil Engineering, M.G.M. College of Engineering & Technology, Kamothe , Navi Mumbai, India.

N. G. Gore, (Guide), Department of Civil Engineering, M.G.M. College of Engineering & Technology, Kamothe, Navi Mumbai, India.

III. ADVANTAGES OF CONCRETE JACKETING

1. To increase the shear & flexural capacity of Beam
2. To improve the compressive strength & Moment caring capacity of column
3. Ease in construction
4. Easily available material

IV. DISADVANTAGE OF JACKETING

1. The sizes of the sections are increased and the free available usable space becomes less.
2. Huge dead mass is added.
3. Requires adequate dowelling to the existing column.
4. Longitudinal bars need to be anchored to the foundation and should be continuous through the slab.
5. Requires drilling of holes in existing column, slab, beams and footings.
6. Placement of ties in beam column joints is not practically feasible.
7. The speed of implementation is slow

V. DESIGN OF RCC COLUMN JACKETING AS PER IS 15988:2013

Height of Column= 3 m, Width (b) = 230 mm, Depth (D) = 450 mm, Ultimate Axial Load (P) = 1037 kN, Ultimate Moment (M) = 25 kN.m, Concrete grade by NDT=12 N/mm^2, d'= effective cover = 50 mm.,

Reinf. Provided: 8-16Ø = 1608 mm^2

Solution:-

Due to corrosion area of reinforcement is reduces

For analysis purpose steel area is neglected

Pu = 0.4 x fck x Ac + 0.67 x fy x Asc

Pu = 0.4 x 12 x ((230x450)-(1608)) + 0.67 x 415 x 0

Pu = 489.06 kN < 1037 kN ……not safe

Load deficiency = 1037 – 489.06 = **547.94 kN**

Reinforcement required

d'/D = 50 / 450 = 0.111

$P/f_{ck}\,bD$ = 548 x 10^3 / (12 x 230 x 450) = 0.44

$M/ f_{ck}\,bD^2$ = 25 x 10^6 / (12x 230 x 450^2) = 0.044

Using the P – M interaction curve for rectangular section

P / f_{ck} = 0.02

% p = 0.02 x 25= 0.5%

∴ Area of steel required = 0.5 % x 230 x 450 = 517.5 mm^2

But as per IS 15988:2013,

Area of steel for jacketing = (4/3) As

= (4/3) x 517.5 = 690 mm^2

But minimum steel for jacketing section= 0.8% of C/S Area of jacketed section

= 1350 mm^2

Hence provide 12-12 Ø for jacketing section.

Thickness of the jacket section to be provided wills 100mm

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∴ Revised jacketed section of the column will be 430mm wide x 650mm deep

Design of literal Ties

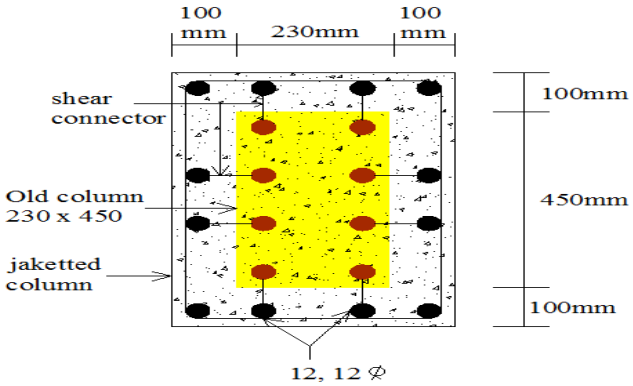
Dia of bar = ¼ of Ø of largest longitudinal bar

= ¼ x 16 = 4mm ….take 8mm

Spacing of bar

1. Least lateral dimension = 230mm
2. 200mm
3. 16 x Ø of smallest longitudinal reinforcement = 16x16 =256mm

Provide 8mm Ø @200mm C/C



Revised Section

VI. DESIGN OF RCC BEAM JACKETING AS PER IS 15988:2013

Mu = 47 kN.m, Ast provided = 2, 16 ϕ = 402.12 mm^2, fck by NDT = 12 N/mm^2,fy =415 N/mm^2, b = 230mm, d=360mm, D = 400mm,

RCC jacketed section

Extra Ast = 2,16 ϕ , b = 430mm, d = 460mm,

D = 500mm

Solution:-

Due to corrosion area of reinforcement is reduces

For analysis purpose steel area is neglected

$$Xu = \frac{0.87X\ fy\ X\ Ast}{0.36Xfck\ X\ b}$$

$$= \frac{(0.87X\ 415\ X\ 0)+(0.87x415x402.12)}{0.36X12\ X\ 430} = 78.15\ mm$$

M.R. = 0.138 fck bd^2 = 0.138 x 12x 420x 460^2

= 147.12 $x10^6$ N.mm

Mu = 0.87 fy Ast (d- 0.42 Xu)

= 0.87 x 415x 402.12 (460-0.42x 78.15)

= 62.01 $x10^6$ N.mm > 47 kN ….safe

VII. DESIGN OF SHEAR REINFORCEMENT

Step: - 1

Vu = 85kN

Ast = 2,16ϕ = 402.12mm^2

Step: - 2

$$Pt\ \% = \frac{100\ x\ Ast}{b\ x\ d} = \frac{100\ x\ 402.12}{430\ x\ 460} = 0.20$$

ζc = 0.31…….. From table

Shear capacity of section = 0.31 x bd = 0.31 x 430x 460 = 61.31kN

But 61.31kN < 85 kN ……not safe

So Design shear reinforcement required Using 2 legged 8mm ϕ

Step: - 3

Spacing Required

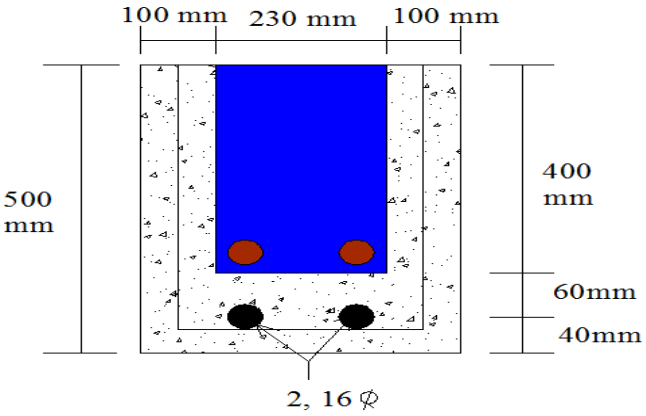
1. $Sv = \frac{0.87xfyxAsvxd}{Vd} = \frac{0.87x415x\left(2x\frac{\pi}{4}x8^2\right)x460}{23.69\ x\ 10^{\wedge}3}$

   = 707.47mm
2. = 0.75xd = 0.75x460 = 345 mm
3. = 300mm
4. $Sv = \frac{0.87xfyxAsv}{0.4xb} = \frac{0.87x415x\left(2x\frac{\pi}{4}x8^2\right)}{0.4x430}$

   = 211mm

   Take minimum of above value

Provide 2 legged 8mm ϕ stirrups @200mm C/C



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VIII. RESULTS

Results of R.C.C. retrofitting technique are significant improvement in Moment resisting capacity, shear strength capacity in Beam and Axial load carrying capacity in column.

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Mr. Vedprakash C. Marlapalle, (ME Structure Student), Civil Engg. Dept., M.G.M .College of Engineering & Tech. Kamothe, Navi Mumbai, India.

P. J. Salunke, (Environmental Engineering - Guide) Civil Engg. Dept. M.G.M. College of Engineering & Tech. Kamothe , Navi Mumbai, India.

N. G. Gore, (Structural Engineering -Guide) Civil Engg. Dept. M.G.M. College of Engineering & Tech., Kamothe, Navi Mumbai, India.

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