

Restrengthening of RCC Rectangular Column Using Jacketing Method with Admixture Design

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Abstract - RCC Jacketing (Reinforced Cement Concrete Jacketing) is one of the most widely used structural strengthening and rehabilitation techniques used to increase the load carrying capacity, stiffness, durability, and seismic resistance of existing reinforced concrete members such as columns, beams, slabs, and foundations.

In RCC jacketing, an additional layer of reinforced concrete with steel reinforcement is added around the existing structural member. This effectively enlarges the cross-section and improves the structural performance of the member.

It is especially important in old, distressed, damaged, under-designed, or earthquake-prone structures.

Key Words: Reinforced Concrete, Jacketing, PCE

1. INTRODUCTION

This project report presents the detailed design procedure, construction methodology, seismic stability analysis, and strengthening process for RCC jacketing of an existing rectangular reinforced concrete column of size 400 mm × 600 mm using M25 grade concrete.

RCC jacketing is one of the most widely adopted retrofitting techniques used for enhancing the load carrying capacity, ductility, stiffness, and seismic resistance of existing reinforced columns.

The strengthening is carried out by increasing the sectional dimensions of the column with additional reinforcement and concrete surrounding the existing member.

2. OBJECTIVE AND METHODOLOGY

Aim of Research

- To increase axial load carrying capacity.
- To improve seismic resistance.
- To restore deteriorated structural members.
- To enhance stiffness and ductility.
- To reduce chances of brittle failure during earthquake loading.
- To increase service life of the structure.

3. DETAILED NUMERICAL MODELLING AND STUDY

3.1.1 Model Parameter

Parameter	Value
Existing Column Size	400 mm × 600 mm
Existing Concrete Grade	Assumed M20
Jacketing Concrete Grade	M25
Existing Reinforcement	8 Nos 20 mm dia bars
Existing Tie Reinforcement	8 mm dia @ 200 mm c/c
Storey Height	3.2 m

Structural System	RCC Framed Structure
Seismic Zone	Zone III (Assumed)
Importance Factor	1.0
Soil Type	Medium Soil

3.1.2 Concrete

Property	Value
Grade of Concrete	M25
Characteristic Strength (f _{ck})	25 MPa
Density of RCC	25 kN/m ³
Modulus of Elasticity	25000 MPa

3.1.3 Reinforcement Steel

Property	Value
Steel Grade	Fe500
Yield Strength (f _y)	500 MPa
Modulus of Elasticity	200000 MPa

3.2. DESIGN CODES USED

The design and detailing are based on the following Indian Standard Codes:

- IS 456:2000 – Plain and Reinforced Concrete
- IS 13920:2016 – Ductile Detailing of RCC Structures
- IS 1893 (Part 1):2016 – Criteria for Earthquake Resistant Design
- IS 875 (Part 1 & 2) – Dead and Imposed Loads
- SP 16 – Design Aids for RCC

3.3. CONDITION ASSESSMENT BEFORE JACKETING

The following observations were made during inspection:

- Cracks observed near beam-column junction.
- Honeycombing in existing concrete.
- Reduction in load carrying capacity.
- Inadequate confinement reinforcement.
- Corrosion marks on reinforcement.
- Requirement of seismic strengthening.

3.4. RCC JACKETING DETAILS

3.4.1 Proposed Jacket Size

Assumed jacket thickness = 100 mm on all sides.

Final Jacketed Column Size:

Width = 400 + 2 × 100 = 600 mm

Depth = 600 + 2 × 100 = 800 mm

Final Column Size:

600 mm × 800 mm

3.4.2. Dead Load Calculation

Assumed tributary load on column:

Slab Load

Slab thickness = 150 mm

Self weight of slab:

= 0.15×25

= 3.75 kN/m²

Floor finish load = 1.5 kN/m²

Partition load = 1.0 kN/m²

Total Dead Load:

= $3.75 + 1.5 + 1.0$

= 6.25 kN/m²

Assumed tributary area:

= $4 \text{ m} \times 5 \text{ m}$

= 20 m²

Dead load transferred:

= 6.25×20

= 125 kN

3.4.3 Live Load

Assumed live load = 3 kN/m²

Live load transferred:

= 3×20

= 60 kN

3.4.4 Self Weight of Beam

Assume:

Beam size = 300 mm × 500 mm

Beam length = 5 m

Self weight:

= $0.3 \times 0.5 \times 25$

= 3.75 kN/m

Reaction on column:

= $(3.75 \times 5)/2$

= 9.375 kN

Assume 4 beams:

Total beam load:

= 9.375×4

= 37.5 kN

3.4.5 Total Service Load

Total Load:

= Dead Load + Live Load + Beam Load

= $125 + 60 + 37.5 = 222.5 \text{ kN}$

Factored Load:

$1.5 \times 222.5 = 333.75 \text{ kN}$

3.5. SEISMIC LOAD CALCULATION

Earthquake load is calculated according to IS 1893:2016

3.5.1 Assumed Parameters

Parameter Value

Seismic Zone III

Zone Factor (Z) 0.16

Importance Factor (I) 1.0

Response Reduction Factor (R) 5

Soil Type Medium

Damping 5%

9.2 Horizontal Seismic Coefficient

The design horizontal seismic coefficient:

$A_h = [Z/2] \times [I/R] \times [S_a/g]$

Assume:

$S_a/g = 2.5$

Therefore:

$A_h = (0.16/2) \times (1/5) \times 2.5$

$A_h = 0.04$

3.5.2 Seismic Force

Seismic force:

$V_b = A_h \times W$

Where:

W = Seismic weight = 222.5 kN

Therefore:

$V_b = 0.04 \times 222.5$

= 8.9 kN

Thus lateral seismic load acting on the column is approximately:

= 9 kN

3.5.2. COLUMN DESIGN CHECK

10.1 Gross Area of Jacketed Column

$A_g = b \times D$

$A_g = 600 \times 800$

= 480000 mm²

10.2 Reinforcement Requirement

Minimum steel percentage for columns:

= 0.8%

Required steel area:

$A_{st} = 0.8/100 \times 480000$

= 3840 mm²

provide:

12 nos 25 mm diameter bars

Area provided:

= 12×490.9

= 5890 mm²

Hence safe

3.6. STABILITY CHECK

11.1 Slenderness Ratio:

Effective length:

$L_e = 0.65 \times 3200$

= 2080 mm

Least lateral dimension:

= 600 mm

Slenderness ratio:

= $2080 / 600$

= 3.47

Since:

$$3.47 < 12$$

Therefore column is short and stable.

3.6. ADMIXTURE DESIGN

3.6.1 Type of Admixture

Recommended admixture:

Superplasticizer based on Polycarboxylate Ether (PCE)

3.6.2 Purpose

- Improve workability.
- Reduce water cement ratio.
- Increase strength.
- Reduce segregation.
- Improve bonding with old concrete.

3.6.3 Dosage

Recommended dosage:

0.8% to 1.5% by weight of cement.

Assume:

Cement content = 400 kg/m³

Admixture dosage = 1%

Required admixture:

$$= 1/100 \times 400$$

$$= 4 \text{ kg/m}^3$$

3.7. SURFACE PREPARATION PROCEDURE

Before jacketing the following procedures must be followed:

- Remove plaster and loose concrete.
- Roughen existing column surface.
- Clean reinforcement rust using wire brush.
- Apply epoxy bonding agent.
- Drill and fix shear connectors.
- Fix additional reinforcement cage.
- Install formwork.
- Pour M25 micro-concrete.
- Proper compaction using needle vibrator.
- Cure for minimum 14 days.

3.8. REINFORCEMENT DETAILING

Longitudinal Reinforcement

12 nos 25 mm dia bars.

Corner bars mandatory.

Proper anchorage into footing and beam.

Lateral Ties

10 mm dia ties.

Spacing = 100 mm c/c near joints.

Spacing = 150 mm c/c at mid-height.

3.9. DUCTILE DETAILING AS PER IS 13920

The following ductile detailing provisions are adopted:

135° hooks in ties.

Closely spaced confinement reinforcement.

Lap splice away from beam-column junction.

Minimum confinement length maintained.

Shear failure prevented.

3.10 CONSTRUCTION METHODOLOGY

Step 1: Inspection

Visual inspection and NDT testing.

Step 2: Surface Chipping

Remove weak and damaged concrete.

Step 3: Cleaning

Clean surface using air compressor and wire brush.

Step 4: Connector Fixing

Install anchor bars using epoxy grout.

Step 5: Reinforcement Placement

Fix additional steel cage.

Step 6: Formwork Installation

Leak-proof shuttering arrangement.

Step 7: Concrete Pouring

Place M25 concrete with admixture.

Step 8: Curing

Maintain curing for minimum 14 days.

3.11 QUALITY CONTROL CHECKS

The following quality checks shall be performed:

- Test Frequency
- Slump Test Every batch
- Cube Test Every 15 m³
- Rebar Inspection Before concreting
- Cover Check Before pouring
- Alignment Check During shuttering

3.12. SAFETY PRECAUTIONS

- Use PPE during chipping work.
- Proper scaffolding arrangement.
- Electrical safety during drilling.
- Adequate ventilation.
- Safe handling of epoxy chemicals.

3.13. ADVANTAGES OF RCC JACKETING

- Economical strengthening technique.
- Increases axial and lateral load capacity.
- Improves seismic behavior.

- Extends structural life.
- Easy execution on site.
- Suitable for retrofitting old buildings.

Visakhapatnam

3.14. LIMITATIONS

- Increases member size.
- Additional dead load.
- Requires skilled workmanship.

Temporary support may be required.

4. CONCLUSIONS

- The RCC jacketing of the 400 mm × 600 mm rectangular column using M25 grade concrete significantly improves the structural strength, stiffness, and seismic performance of the member.
- The proposed jacketing system with additional reinforcement and ductile detailing satisfies the stability requirements and enhances the overall safety of the structure under gravity and seismic loading.
- Proper surface preparation, use of suitable admixture, quality control, and adherence to IS code provisions are essential for successful retrofitting.

5. REFERENCES

- IS 456:2000 – Plain and Reinforced Concrete.
- IS 13920:2016 – Ductile Detailing.
- IS 1893:2016 – Earthquake Resistant Design.
- SP 16 – Design Aids for RCC.

Structural Retrofitting Guidelines

– CPWD

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