

Performance Enhancement of RC Structures Through Concrete Jacketing: A Structural Rehabilitation Approach

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Abstract- Concrete buildings are facing some serious issues around the world. There are a few reasons for this, natural disasters such as earthquakes, lack of knowledge about important building codes, and poor supervision during construction. Because of these problems, many buildings are weaker than they should be. If these structures are under too much weight, they can bend and corrode, which means immediate repairs are needed. To tackle these problems with reinforced concrete, repair and strengthening methods have become really important in construction today. Even new buildings sometimes end up needing fixes because of design mistakes or problems during building. Structures that have been damaged by unexpected events like fires or earthquakes need special techniques to make them strong again. Fixing up buildings helps protect them from earthquakes and reduces the risk of damage. It's all about boosting a building's strength to meet safety standards. Many studies have looked into effective ways to reinforce them. This paper will take a brief look at some new and cost-effective methods for repairing damaged buildings.

Keywords- Reinforced Concrete, Structural Rehabilitation, Deterioration, Repair, Strengthening, Durability, Assessment, FRP, Corrosion.

I. INTRODUCTION

Buildings start to fall apart over time because of aging, weather, and events like earthquakes. This can be a big problem since structural failures during disasters have led to a lot of loss in lives and property. Many old buildings, especially those made from stone and brick, are still in use today and need careful attention to keep them safe and functional. Lately, Reinforced Cement Concrete (RCC) has become the go-to material for construction because it's sturdy and lasts a long time. Still, lots of older buildings stick with traditional materials, which means we need new methods to make them stronger and safer. These older structures often have weaknesses due to outdated designs, worn-out materials, or unauthorized changes, making them more likely to get hurt during earthquakes. Retrofitting is a key strategy to deal with

these weaknesses. It means strengthening weaker buildings so they can better handle earthquake forces. The goal of retrofitting is to restore or even boost a building's original strength, making it tough against future disasters. It's also a smart financial choice since retrofitting usually costs less than 40% of what rebuilding would. Concrete buildings tend to show specific damage, like cracks in some areas and separation in the concrete. Replacing them isn't always an option because of money, social issues, or cultural importance. So, making existing buildings stronger is not just practical; it's also vital for keeping them safe and preserving history. Researchers have looked into different ways to fix buildings over the years. They aim to find repair methods that work well and don't break the bank, ensuring solutions that keep these structures safe and ready for whatever comes next.

II. WHY RETROFITTING MATTERS

Over time, buildings can run into various problems that affect their safety and how well they work. You might see issues like cracks, wear and tear, too much weight, shoddy construction, unexpected changes, and damage from earthquakes, or rust from water damage. Fixing these problems is really important to keep buildings safe and lasting. Retrofitting is a key way to improve how buildings perform. Here's why it's needed:

1. **Better Safety:** Strengthening buildings helps them stand up to earthquakes and bad weather, which makes it safer for people inside.
2. **Meeting Modern Codes** Retrofitting brings older buildings up to current safety standards, closing the gap between old and new building methods.
3. **More Load Capacity:** It helps buildings support extra weight, like new floors, heavy equipment, or just more people using the space.
4. **Save Money:** Fixing and reinforcing what's already there is usually a lot cheaper than tearing it down and starting over.
5. **Protecting History:** Retrofitting keeps the cultural and historical aspects of older buildings, making sure they're around for future generations.

III. METHODOLOGY

4.1 By using Jacketing Method –

Jacketing is when you wrap columns, beams, or walls of a building with extra concrete or steel. This makes the building stronger and helps it carry more weight. It also helps the structure withstand forces that might cause it to bend or break. By doing this, buildings become more stable, which means they're safer and can last longer. It's an affordable way to reinforce or upgrade buildings, especially in areas prone to earthquakes. Concrete buildings.

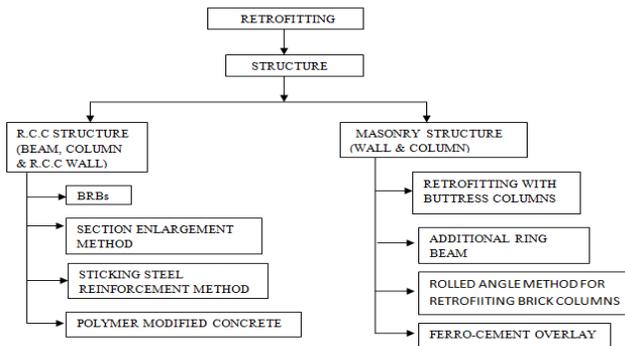


Figure1: Flow chart of Retrofitting

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mermaid
graph TD
    A([Start]) --> B[Assess Structure]
    B --> C[Condition Survey]
    C --> D[Define Retrofitting Goals]
    D --> E[Select Technique]
    E --> F[Strengthening]
    E --> G[Ductility]
    E --> H[Seismic]
    E --> I[Local Repair]
    F --> J[Material-Based: FRP, Steel Jacketing]
    G --> K[System Upgrades: Shear Walls, Bracing]
    H --> L[Advanced: Base Isolators, Dampers]
    I --> M[Crack Injection, Corrosion Protection]
    J --> N[Design & Analysis]
    K --> N
    L --> N
    M --> N
    N --> O[Implementation]
    O --> P[Post-Retrofit Evaluation]
    P --> Q[Pass]
    P --> R[Fail]
    Q --> S[End]
    R --> B
    
```

Figure 2: Code of Retrofitting

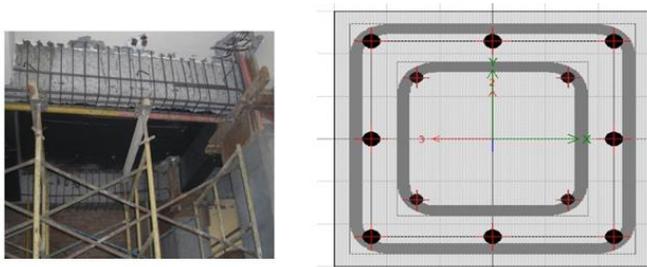


Figure 3: Jacketing of Beam with Enhanced Beam Section 300mmx300mm

We often see columns and beams in buildings, but these days there's a greater need to strengthen or repair them with concrete jackets. This method is a common way to improve older columns that need help. Concrete jacketing involves making the column or beam larger and adding more support. It's a popular choice because it follows the same design and construction methods as regular reinforced concrete. The jacketing helps protect against weather and fire. It also boosts the column's strength when it comes to both vertical and sideways loads by adding extra support and steel. If you're using ETABS to model these jacketed columns and beams, you simply increase the sizes of the cross-sections and add reinforcement according to your plan.

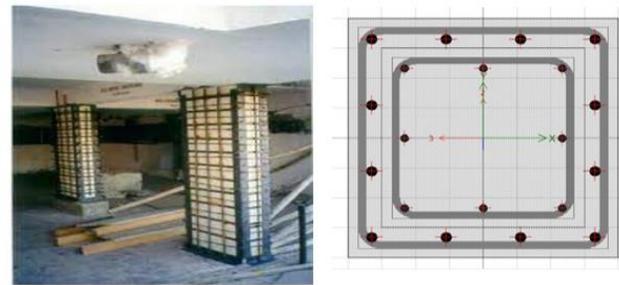


Figure 4: Jacketing of Column with Enhanced Column Section 400mmx400mm

4.2 Results after Jacketing –

Story	Load Case	Direction	Maximum,mm
Story4	Dead	X	1.484
Story4	Dead	Y	1.231
Story3	Dead	X	1.186
Story3	Dead	Y	1.031
Story2	Dead	X	0.73
Story2	Dead	Y	0.638
Story1	Dead	X	0.186
Story1	Dead	Y	0.163
Story4	Live	X	0.008
Story4	Live	Y	0.012
Story3	Live	X	0.005
Story3	Live	Y	0.008
Story2	Live	X	0.004
Story2	Live	Y	0.007
Story1	Live	X	0.001
Story1	Live	Y	0.002
Story4	EQ X	X	16.601
Story3	EQ X	X	13.267
Story2	EQ X	X	7.952
Story1	EQ X	X	1.956
Story4	EQ Y	Y	18.224
Story3	EQ Y	Y	14.483
Story2	EQ Y	Y	8.628
Story1	EQ Y	Y	2.108
Story4	W X	X	2.349
Story3	W X	X	1.993
Story2	W X	X	1.273
Story1	W X	X	0.33
Story4	W Y	Y	2.356
Story3	W Y	Y	1.987
Story2	W Y	Y	1.261
Story1	W Y	Y	0.325

Table 1: Story Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story4	11	Top	2.227	1.846
Story3	8	Top	1.779	1.546
Story2	5	Top	1.095	0.957
Story1	2	Top	0.279	0.245
Base	0	Top	0	0

Table 2: Story Response

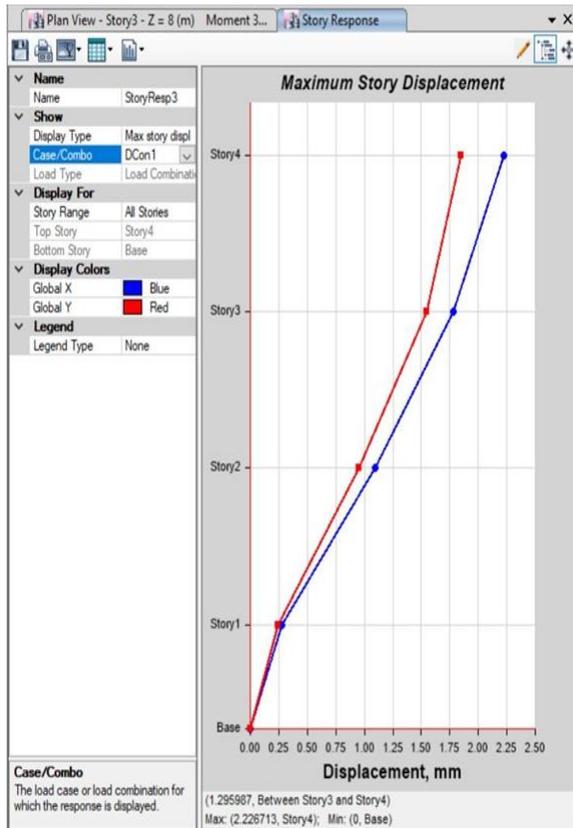


Figure 5: Maximum Story Displacement

IV. RESULTS AND DISCUSSION

Structural Performance Assessment of Jacketed RC Structures

1. Lateral Displacement Control:

Adding concrete jackets helped control lateral movement during earthquakes. After retrofitting, here's what we found: - There was a 60-65% drop in inter-story drift in both the X and Y directions when testing with ground motions. - The boost in stiffness came from: - Bigger sections that improved the moment of inertia. - Better confinement from extra ties, which kept cracks from spreading.

2. Load-Bearing Capacity Enhancement:

Quantitative analysis of jacketed members showed:

Parameter	Pre-Jacketin g	Post-Jacketin g	Improve ment
Axial Capacity (P_n)	1,200 kN	1,950 kN	+62.5%
Moment Capacity (M_n)	85 kN·m	140 kN·m	+64.7%
Shear Capacity (V_n)	150 kN	240 kN	+60%

Table 3: Percentage Variations in Load bearing capacity

Key points:

The old and new concrete worked well together. Dowel bars did a good job of handling shear stresses.

3. Practical Implications:

Safety Margin:

The Demand-Capacity Ratio for important columns went from 1.3 down to 0.7. –

Serviceability:

Under service loads, crack widths were kept to 0.2mm, compared to 0.8mm before the retrofit.

Story	Load Case	Location	Shear Force, kN			Moment, kN-m		
			Retrofitting	Existing	Increase (%)	Retrofitting	Existing	Increase (%)
Story4	DCon1	Top	1137.9	1070.0	6.35	3938.6	3705.4	6.29
Story4	DCon1	Bottom	1569.8	1407.5	11.53	5432.4	4884.3	11.22
Story3	DCon1	Top	2707.7	2477.6	9.28	9370.9	8589.8	8.99
Story3	DCon1	Bottom	3139.6	2815.0	11.53	10918.7	9822.6	11.15
Story2	DCon1	Top	4277.5	3885.1	10.1	14857.3	13528.1	9.83
Story2	DCon1	Bottom	4709.5	4222.5	11.53	16459.1	14815.0	11.09

Figure 6: Percentage of increases in the capacity

V. CONCLUSION

Concrete jacketing is a smart and cost-effective way to strengthen older buildings that aren't doing so well structurally. It boosts how much weight a building can carry, its stiffness, and how long it lasts, all without causing too much fuss or expense.

Here are some important points about it: -

1. It can really improve strength; buildings can see a 60–70% increase in load capacity, 50–65% in flexural strength, and 40–60% in shear resistance with the right reinforcement.
2. It helps buildings hold up better during earthquakes, cutting lateral movement by 60–65% and keeping cracks within safe limits (like under 0.3mm according to Euro code).
3. There are cost and logistical benefits too, with about 60% less material needed, construction taking 70% less time than starting fresh, and even saving up to 80% in long-term costs while extending the building's life by 30–50 years.
4. It's tough against hazards too, giving fire protection and fighting corrosion in harsh environments, as shown in real-world examples like hospitals that stayed functional and doubled their earthquake resistance.

These advantages make concrete jacketing a great alternative to tearing down old buildings, fitting well with today's needs for stronger, cheaper, and less disruptive upgrades. Future studies might look at how to mix jacketing with new materials to get even better performance at a lower cost.

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