STRUCTURAL STRENGTHENING OF REINFORCED COLUMN

GURUPRASAD BIRADAR[1], C H PRAKASH[2], DHAVALA SURESH[3], SHIVA KUMAR KS[4]

[1]PG Student (MTech in Structural Engineering), Global Academy of Technology, Bengaluru,
[2]CEO, NISHICON INFRASTRUCTURES , Bengaluru, Karnataka, India,
[3]Assistant Professor, Department of Civil Engg, Global Academy of Technology, Bengaluru,
[4]Assistant Professor, Department of Civil Engg, Global Academy of Technology, Bengaluru,
biradarguruprasad@gmail.com, nishicon@gmail.com, d.padiwal@gmail.com,
shibks143@gmail.com

Abstract:-*Retrofitting is a method applied to increase the strength of the existing structure and also increases the strength of the newly constructed structures due to the error in the design and construction errors.*
This technique employed for the structural strengthening is jacketing by suitable diameter of bars depending on strength required and type of structure, filling of the structural members with the concrete and use of the other repair materials .The selection of the materials for retrofitting should be easily available and economical. The main necessity of retrofitting is due to the error in the design by the structural designers and by the use of the low grade of the materials for the construction , improper supervision on the site by the engineers ,construction by unskilled labours and during use of the construction equipments like vibrators while concreting.

Keywords: RC jacketing, Rehabilitation, Retrofitting, Strengthening, Structural repair

1. INTRODUCTION

1.1 Concept of Retrofitting

Retrofitting is technical interventions in structural system of a building that improve the strength, ductility and load carrying capacity. Strength of the building is generated from the structural dimensions, materials, shape, and number of structural elements, etc. Ductility of the building is generated from good detailing, materials used.

Due to the variety of structural condition of building, it is hard to develop typical rules for retrofitting. Each building has different approaches depending on the structural deficiencies. Hence, engineers are needed to prepare and design the retrofitting approaches. In the design of retrofitting approach, the engineer must comply with the building codes. The results generated by the adopted retrofitting techniques must fulfill the minimum requirements on the buildings codes, such as deformation, detailing, strength, etc.

1.2 Causes of failure

- Damage to buildings were caused by a combination of affects
- Old decaying buildings predating modern construction practices
- New Buildings not being designed to Indian earthquake codes
- Lack of knowledge, understanding or training in the use of the codes by engineers
- Buildings erected without owners seeking proper engineering advice
- Improper detailing of masonry and reinforced structures
- Poor materials, construction and workmanship used, particularly in commercial buildings
- Buildings having poor quality foundations or foundations built on poor soils
- Little or no regularity authority administering or policing the codes

1.3 Recent Retrofitting Methods:

There are many relatively new technologies developed for Retrofitting which are based on type of structures.

- Steel structures
- Composite structures
- Bridge structures
- Irrigation structures

1.4 Methods of Retrofitting Increase the capacity/strength of the system

- Over Slabbing
- Sprayed Concrete with Additional Reinforcement
- Steel Plate bonding
- External Prestressing
- Concrete Jacketing
- Steel Jacketing.
- FRP Wrapping.

2. STEPS FOR STRUCTURAL STRENGTHENING

1. Visual inspection: In the visual inspection collection of the data from the site inspection.
2. Data collection: Collection of the data from the structural engineer.
3. Analysis of data: Data collected is analyzed from the visual inspection of existing structure.
4. Conduction of the test: Nondestructive test has to be conducted on the existing member.
5. Selection of suitable method for the correction of the error.
6. Providing suitable materials for the structural strengthening.
7. Jacketing of the member if required HYSD (Fe415) of different diameters 8,12,16,20 depending on the strength required.
8. Use of micro concrete for the concreting.
9. Proper compaction of the concrete.
10. Evaluation of the structure after structural strengthening.
11. Conduction of the NDT on the member.
12. Calculation of increase in the structural strength by conduction of the tests.

Fig 1: Showing step by step stages for retrofitting of column

2.1 Methodology used in Column Reinforcement

1. Visual inspection on the size of the column and the number of the storey heights.
2. Calculation of the design errors on the structural member.
3. Depending on the size of the column how much size has to be increased.
4. Depending on the strength required column has to be reconstructed by providing suitable diameter of the bar.
5. Use of the shuttering on the all four sides or two sides depending on the column size.
6. Use of the concrete or the Microconrete for the filling of the column shuttering.
7. Test should be conducted on the column for check in the increase of the strength.

TABLE1: Rebound Hammer Test Results Before The Structural Strengthening On Column

Sl. No	Structural Members	Position	Rebound Hammer Number	Average Rebound Hammer Number	Probable Strength Of Concrete in N/mm²	Remarks
BULIDING BLOCK						
1	Column – C1	Top	28	28	15	Medium
		Middle	27			
		Bottom	29			
		Top	27			
		Middle	29			
		Bottom	28			
2	Column-C2	Top	26	27	15	Medium
		Middle	27			
		Bottom	29			
		Top	27			
		Middle	27			
		Bottom	28			

Table 2: Ultrasonic Pulse Velocity Test Results Before The Structural Strengthening On Column

Sl. No	Structural Members	Position	Ultrasonic Pulse Velocity in Km/sec	Average Velocity Km / sec	Probable Strength of Concrete in N/mm²	Remarks Ref chart
BUILDING BLOCK						
1	Column – C1	Top	3.23	3.24	15	Medium
		Middle	3.21			
		Bottom	3.48			
		Top	3.18			
		Middle	3.18			
		Bottom	3.21			
2	Column – C2	Top	3.23	3.33	15	Medium
		Middle	3.51			
		Bottom	3.48			
		Top	3.18			
		Middle	3.38			
		Bottom	3.21			

Table3: Rebound Hammer Test Results After The Structural Strengthening On Column

Sl. No	Structural Members	Position	Rebound Hammer Number	Average Rebound Hammer Number	Probable Strength Of Concrete in N/mm²	Remarks
BULIDING BLOCK						
1	Column – C1	Top	38	40	30	GOOD
		Middle	40			
		Bottom	39			
		Top	38			
		Middle	41			
		Bottom	40			
2	Column – C2	Top	38	39	28	GOOD
		Middle	38			
		Bottom	39			
		Top	38			
		Middle	40			
		Bottom	38			

Table4: **Ultrasonic Pulse Velocity Test Results After The Structural Strengthening On Column**

Sl. No	Structural Members	Position	Ultrasonic Pulse Velocity in Km/Sec	Average Velocity Km / Sec	Probable Strength of Concrete in N/mm²	Remarks Ref chart
BUILDING BLOCK						
1	Column – C1	Top	3.89	4.19	30	GOOD
		Middle	4.10			
		Bottom	4.4			
		Top	4.67			
		Middle	3.88			
		Bottom	4.14			
2	Column – C2	Top	3.99	4.2	30	GOOD
		Middle	3.90			
		Bottom	3.89			
		Top	4.12			
		Middle	4.00			
		Bottom	3.99			

3. COMPARISON OF REBOUND NUMBER BEFORE AND AFTER STRENGTHENING

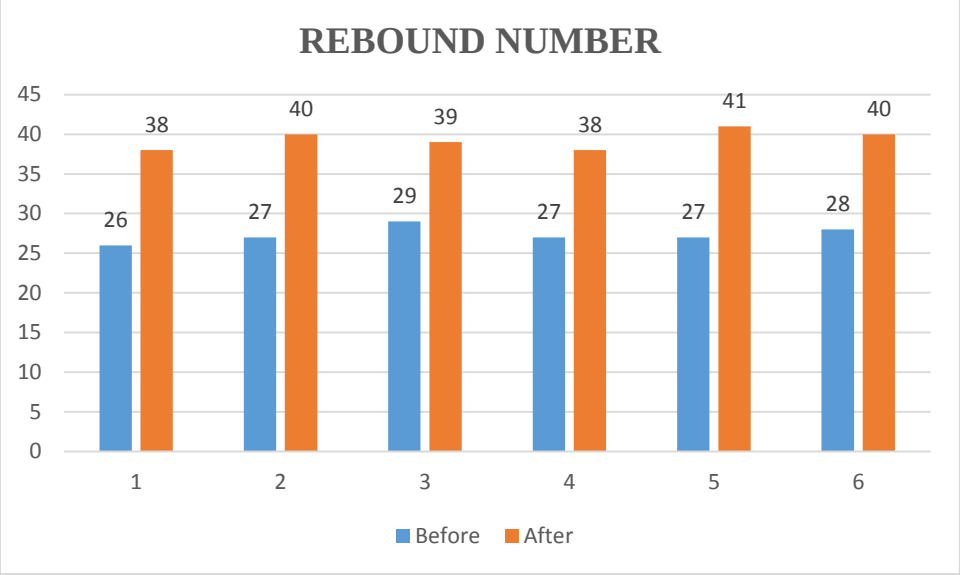

Fig 2: Showing comparison of rebound number

The above fig 2.shows value of the rebound number is increased. As we have to increase the strength of the structural member after testing of columns initially we have got lower rebound number which indicates the compressive strength of the column is also low. After the jacketing of column and structural strengthening .The rebound number is increased which shows the change in the compressive strength of column. change in Probable Strength of Concrete is 15 N/mm² to 30 N/mm².

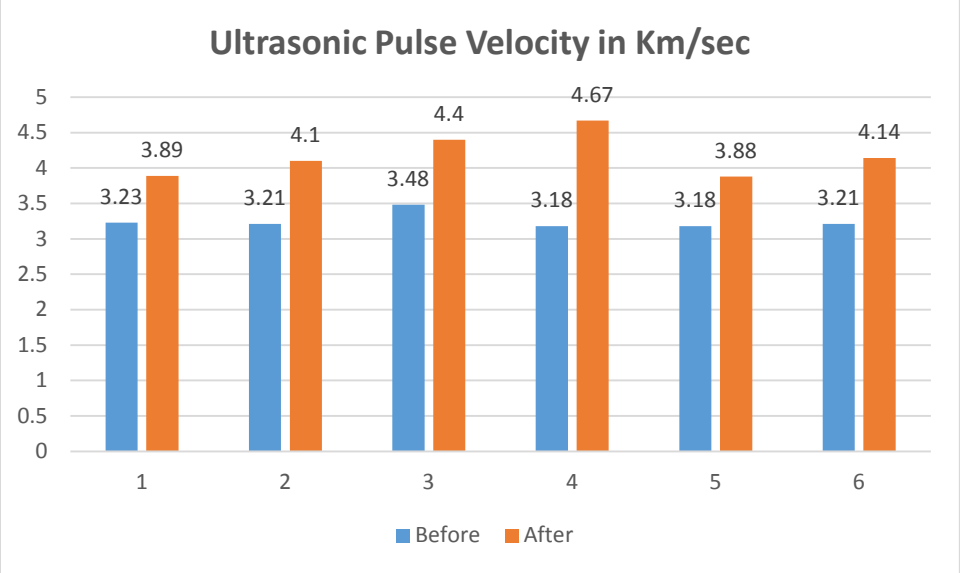

Fig 3: Showing comparison of UPV

The above fig3. shows the value of the UPV is increased. As we have to increase the strength of the structural member after testing of columns initially we have got lower UPV which indicates the compressive strength of the column is also low . After the jacketing of column and structural strengthening. The UPV is increased which shows the change in the compressive strength of column, change in Probable Strength of Concrete is 15 N/mm² to 30 N/mm²

4. CONCLUSIONS

The strengthened column will increase the axial load carrying capacity of the column. The major errors in the construction site is due to the unskilled labour and the use of the lower grade materials for the construction and improper supervision of the construction due to lack of attention on the site supervision.

1. Error in the designs during the construction.
2. Sudden increase in the storey height.
3. Due to use of unskilled labours.
4. Lack of knowledge about the materials used.
5. Improper marking of the columns.

5. FUTURE SCOPE FOR THE WORK:

Project work has focused on strengthening the RCC buildings. There is an large scope to create an awareness in the occupants residents of the buildings those may have completed the service period and or will probably be completing the service period

in short future. All such buildings in and all the metro cities in the state and country can be retrofitted with suitable technique to save the lives and property.

REFERENCES

[1] Marc Badoux and James O "Steel Bracing Of RC Frames For Seismic Retrofitting"ASCE, J Structural Engineer, 1990,116(1):p55-74.
[2] Vistasp M.Karbhari,Member,ASCE "Materials Considerations In FRP Rehabilitation Of Concrete Structures"J.Mater.Civil.Engineer,,2001,13(2):99-97.
[3] Yan Xiao, M.ASCE and Hui Wu "Retrofit of reinforced concrete columns using partially stiffened steel jackets"J,Structural ,2003,129(6):725-732.
[4] M.A.Ismaeil,A.E.Hassaballa "Seismic retrofitting of a RC building by adding steel plates shear walls",ISOR-JMCE,Volume 7,Issue 2,2013,pp49-62.
[5] EI-Amoury abd Ghobarah "Retrofit of RC rrames using FRP jacketing or steel bracing"JSEE,2005,vol.7No.2/83.
[6] ES Julio,F Branco and V D SILVA fctuc,combira ,portugalIST,Lisboa,Portugal "Structural rehabilitation of the columns with reinforced concrete jacketing"Prog Structure Engineer Matter,2003,5:29-37.
[7] Majid Sadoughi YARANDI,Murat SAATCIOGLU "Rectangular concrete columns retrofitted by external prestressing for the seismic shear resistance "World conference on earthquake Engineering,2004,paper No 2720.
[8] Ganansekaran kaliyaperumal"Seismic Retrofit of columns in buildings for flexurale using concrete jacket" 2009,ISET Journal of Earthquake Technology Vol No 505,No.2,pp 77-107.
[9] Shri.Pravin B.Waghmare "Materials and jacketing techniques for the retrofitting of structures"IJAERS,/Vol.1/2011/15-19.
[10] Kai Qian,A.M.ASCE "Strengthening and retrofiiting of RC Flat slabs To mitigate progressive collapse by externally bonded CFRP Laminates",Journals Of Composites For construction,2013,17(4):554-565.
[11] Minakshi V.Vaghani,Sandip A.Vasanwala and Atul K.Deasi "Advanced retrofitting techniques for RC buildings :Astatebof an art review",IJCET,2014,vol.No.2.
[12] IS: 13311 (part 1): 1992 – Non – Destructive Testing of Concrete: Methods of Test, Part 1 – Ultrasonic Pulse Velocity Test (First print September 1996).
[13] IS: 13311 (part 2): 1992 – Non Destructive Testing of concrete: Methods of Test, Part 2 – Rebound Hammer (first reprint June 1995)
[14] Properties of Concrete by A.M. Neville, Fourth edition, 1996, reprint 2003, ELBS, Long man Publications, England.

BIOGRAPHIES

GURUPRASAD BIRADAR
M.Tech (Structural Engineering) Student
Department of Civil Engineering
Global Academy of Technology,
Bengaluru-560098.

C H PRAKASH
CEO, NISHICON INFRASTRUCTURES ,
317/19,1st G Cross, Subbana Garden, R P C Layout,
(W) Extension, Vijaynagar,
Bangaluru- 560 040

DHAVALA SURESH
Assistant Professor
Department of Civil Engineering
Global Academy of Technology,
Bengaluru-560098.

SHIVA KUMAR KS
Assistant Professor
Department of Civil Engineering
Global Academy of Technology,
Bengaluru-560098.