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DESIGN OF G+4 EXISTING SCHOOL BULIDING BY RETROFITTING JACKETING OF COLUMN

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Abstract - *Retrofitting is the process of adding something to the existing building using different methods to increase the strength of building, remove defects or design error, to add more stories to the building, etc. It is a building involves changes in system or structure after its initial construction. This process can improve the performance of building. This process also makes the building structure seismic resistance structure or building. Retrofitting process saves time after construction and also reduces the cost of construction.*

Key Words: Retrofitting, Existing Building, Strength of building, design error, Seismic resistance.

1.INTRODUCTION

In this project we are going to design G+4 building (existing G+2) by providing retrofitting jacketing to the column on G+2 existing building. Without reconstructing the whole building or adding stories directly on the constructed building can leads to failure of the building. To avoid failure we can use Retrofitting process.

1.1 Problem Statement

A G+2 already constructed building, for adding 2 more stories on that building by providing retrofitting jacketing of column. We can increase the strength of building so that it can capable to bare the load which comes from additional stories.

1.2 Objectives

1. To increase the strength of building so that it can bared load of stories to be added on building.
2. To make the building earthquake resistance.
3. To reduce the cost of construction.

1.3. RC Jacketing

It is a technique of retrofitting and as the name suggest jacketing is the process in which additional materials are to structural components to increase their strength and durability. Means giving protective layer to the component is called as RC jacketing. RC Jacketing of structural column and beams is widely known method and is the most popularly used for strengthening building. The process of jacketing is an ideal solution for seismic retrofitting structure.

Fig -1: RC Jacketing

1.4. Procedure of providing RC jacketing on Column

Step 1: Cleaning and roughening the surface.

Step 2: Installing dowels for fastening the stirrups.

Step 3: Installing dowels for fastening the lower main steel.

Step 4: Installing dowels for fastening the upper main steel.

Step 5: Installing the new stirrups and steel bars.

Step 6: Coating the surface with epoxy.

Step 7: Pouring the new concrete layer.

2. MATERIALS

- Steel plates
- Steel reinforced concrete
- Ordinary Portland cement Concrete and Mortar:
- Bonding Agent
- Anti-corrosive Agent
- Bricks

2.1 Materials Properties

1) Anticorrosive Coating:

- Mix and apply Fosroc Nitozinc Primer/equivalent, two components, zinc rich, epoxy primer to the exposed rebars all around in two coats and allowed to fully dry.

- The applied surface shall not be exposed to open sky for a long time and should be reinstated with micro concrete or polymer modified concrete immediately.

2) Bonding Agent:

- After providing anti corrosive protection, the structural elements surface shall be prepared suitably using an epoxy based bond coat, so that the jacketed concrete may bond well with existing/ old concrete.
- The bonding agent shall be an epoxy based two component resin system like Nitobond EP/equivalant. The base and hardener of the epoxy jointing compound shall be mixed mechanically using a slow speed heavy duty drilling machine strictly following the manufactures guidelines.

3. CASE STUDY

A base shear using seismic coefficient method:
Given:

- Overall Plan dimension = 20000mmx12000mm
- Height of building =15000mm
- Height of each floor = 3000mm
- Size of Beam = 350mmx500mm
- Size of column = 400mmx500mm
- Slab thickness = 200mm
- Ext. Wall thickness = 300mm
- Int. wall thickness =150mm

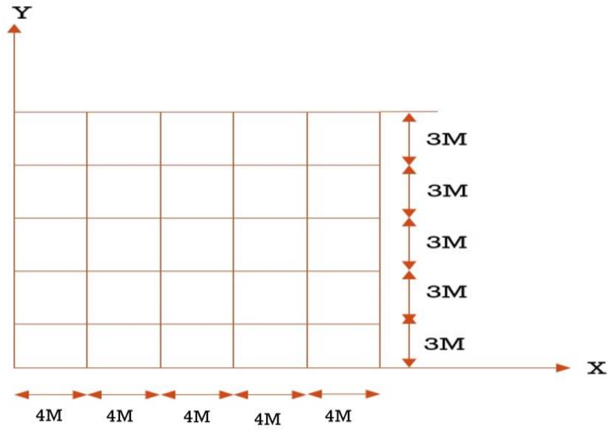

Fig -2: Design Lateral Force

Step1: **Calculation of various design parameter**

As per IS 1893-2016 as the building located in Amravati which is in the zone 2.
Z= 0.10
Importance factor=1.5 (for institutional building)
Response reduction factor: Assume given building as special RC moment resisting frame(SMRF)
R= 5

Step 2: Calculation of time period

$$T_a = \frac{0.09h}{\sqrt{d}}$$

$$T_{ax} = \frac{0.09h}{\sqrt{d}} \qquad T_{ay} = \frac{0.09h}{\sqrt{d}}$$

$$T_a = \frac{0.09*15}{\sqrt{20}} \qquad T_{ay} = \frac{0.09*15}{\sqrt{12}}$$

=0.30 =0.39

As per clause 6.4.5 IS 1983-2016

$$\frac{Sa}{g} = 2.5$$

Step 3: Calculation of design horizontal seismic coefficient

Using clause 6.4.2

$$A_h = \frac{z*I*Sa}{2*R*g} = 0.04$$

Step 4: Calculation of seismic weight

- Self weight of slab = (20x12)x0.15x25 = 900KN
- Self weight of beam = (0.35x0.5)x4x25x38 = 798KN
- Self wt. of column = (0.4x0.5)x3x25x24 = 360KN
- Dead Load of roof slab = 900+798+360/2 = 1878KN
- Dead load on each floor = 900+798+360 = 2058KN
- Live load on roof slab = (20x12)(3.5x50/100) = 420KN
- Live on each floor = (20x12)(2x25/100) = 120KN

Seismic wt. of building

On each floor =2058+420=2478KN
On roof slab= 1878+120=1998KN
Total seismic weight W= 11910KN
Seismic base shear V_B=0.04x11910=476.4KN

Determination of design lateral force

$$Q = V_B \times \frac{w*h^2}{\in wh^2}$$

Storey	w (KN)	h(M)	wh^2	$\frac{w*h^2}{\in wh^2}$	Q_x	Q_y
5	1998	15	449550	0.4019	191.45	191.45
4	2478	12	356832	0.3180	151.96	151.96
3	2478	9	200718	0.1792	85.48	85.48
2	2478	6	89208	0.0797	37.99	37.99
1	2478	3	22302	0.0199	9.49	9.49
			∈= 1118610			

Table -1:

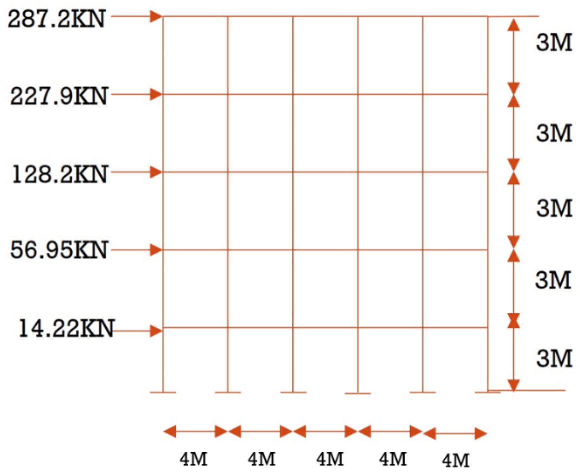

Fig -3: Design Lateral Force

3.1 Design of RC Column Jacketing Using Is 15988: 2013

The firs Details of existing column are as follows:
Height of the Column=3000mm,
Cross-Section= (400x500) mm,
Effective Cover=40mm Grade of Concrete =20 N/mm2 and Grade of steel=415 N/mm2 Load, =2478 KN,
Reinforcement provided=8-16mmØ bars

Procedure:

$$P_u=0.4 \times f_{ck} \times A_c+0.67 \times f_y \times A_{sc}$$

According to the provisions provided in to 8.5.1.2 (a) of IS 15988: 2013, Concrete strength shall be at least 5 MPa greater than the strength of the existing concrete.

Thus, taking value of f_{ck} =25 N/mm2 and assuming
A_{sc} = 0.8% A_c

$2478 \times 10^3 = 0.4 \times 25 \times A_c + 0.67 \times 415 \times (0.8\ \%\ A_c)$
$2478 \times 10^3= 12.22\ A_c$
A'_c =202782.32 mm².

According to 8.5.1.1 (e) of IS 15988:2013,
A_c =1.5 A'_c
Thus, **A_c =304173.48mm²**
Assuming the cross sectional details as:
B=500mm D=304173.48/500=600mm
Jacketing details of cross section:

B = (500-400)/2=50mm, D = (600-500)/2=50mm

700mm

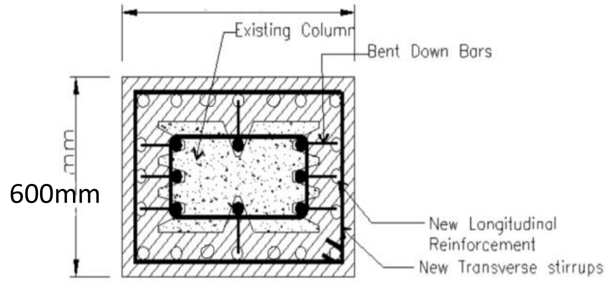

Fig -4: Reinforcements

However, according to the code specified above, Minimum jacket thickness shall be 100 mm as per 8.5.1.2 (c) of IS 15988:2013
Thus, New size of the column:
B = 400+100 +100=600mm, D =500 +100 +100=700mm

New concrete area=600x700=420000mm² > A_c =304173.48mm²
Area of steel, =0.8% x 600x700=3360mm2

But according to 8.5.1.1 (e) IS 15988:2013, $A_c = (4/3) A'_c$
A_c = (4/3) x 3360=4480 mm²
Assuming 16mm Ø bars,
Thus, number of bars, N =4480 x 4/ (π x 16²) = 20 bars
Provide 20 NO. -16mm Ø bars for jacketed section.
Therefore, revised jacketed section will be 600mm x700 mm.
The details of RC Jacketing are provided in Fig.

3.2 Design of Lateral Ties

As per 8.5.1.2 (e) of IS15988: 2013, Minimum diameter of ties shall be 8 mm and not less than one-third of the longitudinal bar diameter.
Diameter of bar =1/3 of Ø of largest longitudinal bar = 1/3x 16 = 6mm .... take 8mm Spacing of ties as per 8.5.1.1 (f) of IS 15988:2013- The code suggests that the spacing, s of ties to be provided in the jacket in order to avoid flexural shear failure of column and provide adequate confinement to the longitudinal steel along the jacket is given as:

$$s=\frac{fy*dh*dh}{\sqrt{fck*tj}}$$

Where,
f_y= yield strength of steel, f_{ck}= cube strength of concrete,
d_h= diameter of stirrup t_j= thickness of jacket

$$s=\frac{415*16*16}{\sqrt{25*200}} \qquad s= 110mm$$

Provide 8mm Ø @110mm c/c.
However, 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.

4. PROJECT RESULT

Load carrying capacity (Pu) when constructed
For a column of size 400×500mm with 0.8% steel reinforcement,

Ag = 400×500
= 200000mm2
Asc = 1600 mm2
Ac = 200000-1600
=198400mm2
Pu = 0.4×25×198400 + 0.67×415×1600
Pu = 2408.96 kN

- COMPARATIVE STUDY OF PERCENTAGE INCREASE IN STRENGTH

Percentage increase in strength after jacketing
Maximum condition - (0.8% steel)
Providing 100mm jacketing on all sides
Area of jacket = (600×700) – (400×500)
= 220000mm2
As = 0.8 % of Ag
= 0.8%×220000= 1760 mm^2
Ac = 220000 - 1760 =218240 mm^2

Pu” = Pu + Pu’
= 2408.96 + { (0.4×25×218240) + (0.67×415×1760) }
Pu” = 5080.73 KN
Percentage increase in strength (original)
= { (5080.73 – 2408.96)/2408.96 } × 100 = 110.9%

5. CONCLUSIONS

- For future expansion of building we can provide the column jacketing to strengthen the column.
- If building is found deterioted or damaged, then we can have carried out non-destructive technique.
- Due to providing RCC retrofitting jacketing is significant improvement in axial load carrying capacity in column.
- RCC structures can be strengthen by using micro-concreting and additional reinforcement with epoxy resin agent.
- We can add such type concrete which is self-compacting, high strength and high durability.

5.1 DISSCUSSION

- The purpose of this project was to assess the analysis of an existing RC structure and to provide retrofitting in case the members fail.
- In this project the age of the building is 20years old, G+2 R.C.C Structure.
- Structural audit has been completed on the building. The plan and reinforcement details of the building were provided.
- Analysed the building using STAAD pro software for the increment of live load, the present building strength is calculated.
- In this audit slabs, beams and footings are safe, but few beams and columns are unsafe.
- Hence it is found that few extra RCC jacketing is required for structural purpose use.

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