Retrofitting of RCC Beams using Steel Plates

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Abstract— Many of the building structure or any reinforcement concrete structure (super structure) damaged due to the extra load or frequent earthquakes. Retrofitting is used for small cracks and small damage of beams, columns, slabs and other RCC structures. Retrofitting prevent the complete replacement for existing structure using external materials. Mild steel plates with connection (bolt, rivet, welding) use in retrofitting, plates use 1,2and 3 layer in all face of beams The earthquake is serious problem for any structure. The building damages due to ground motion of soil by earthquake, settlement of foundation, improper maintenance, concrete related problems, increase loads at structure etc. The cost of complete replacement of building very high and if the building is historical reconstruction is not possible solution in this case we used retrofitting. For retrofitting design three beams. Cross section dimensions of beams are 100 mm ×150 mm. The total length of each beam is 1800 mm. Using M-25 grade of concrete. The mix ratio of M-25 is 1:1.4:2.95 of cement coarse sand, and coarse aggregate. The ratio of 20 mm and 10 mm coarse aggregates 60:40. The water ratio is 5.417 L for a beam. Fe-500, 2 numbers of 10 mm Ø steel bar provided in tension zone and 2 numbers 8 mm Ø bar in compression zone and also used Fe-415, 6 mm strips bar according to IS-456-2000. The strips bar provided 100 c/c in beams. The beams cast in wooden cost mould. The cast beams curing 28 days. The all beams tested in UTM applied point load. The load is applied until beam failure. After crack generated load from the specimen. Calculate the load and deflection and plot the graphs for each beam. Then used 12 mm thickness steel plate and 14 mm Ø bolts connection for retrofitting. In first retrofitting used one steel plate at bottom side and one plate at top of beam. In second retrofitting used two steel plates at bottom side and two plates at top of beam. In third retrofitting used one steel plate at front side and one plate at back side of beam no plates use at top and bottom side of beam. After retrofitting tested in UTM point load applied. Plot the graph between load and deflection.

Key words: RCC beam with simply supported, Mild steel plates, Bolts connection

I. INTRODUCTION

Retrofitting is used for the damaged structural elements. Building damaged due to many reason like earthquake, soil movement, improper maintenance, concrete related problem and increase the service loads and live load. Earthquake is major problem for soil movements at building foundation. Recently time earthquake have been occurred many time. Seismic retrofitting is provided in high seismic region for columns, beams and slabs. Seismic retrofitting used construction time. The earthquake is serious problem for any structure. The building damages due to ground motion of soil by earthquake, settlement of foundation, improper maintenance, concrete related problems, increase loads at structure etc. The cost of complete replacement of building very high and if the building is historical reconstruction is not possible solution in this case we used retrofitting. For retrofitting design three beams. The seismic retrofitting is already used in rcc building. The retrofitting is provided after damage structural elements. There are many type of local retrofitting techniques depend upon requirements of structure. The jacketing methods are reinforced concrete, steel plates, steel cable, fibre reinforced, glass fibre, carbon fibre, polymer etc. Steel plates jacketing techniques is local retrofitting techniques. This method is the most popular retrofitting for strengthening any structural elements. The steel plates are use number of layer at all direction of building damages section. Rivets, bolts and welding connection are used for the joint the section. Steel plates use for strengthening at section and number of layer use for more strengthening. Top and bottom side steel plates use in beams section for horizontal. For inclined beam section all provide steel plates all direction. For column retrofitting also provided in all direction. Jacketing of beams column joints depend upon the joint section retrofitting.

II. THEORY OF RETROFITTING OF BEAMS USING STEEL PLATES

In this retrofitting we are using steel plates with bolts and welding connections, The thickness of steels plates is depend upon load at the retrofitting element. The thickness of plates at least 6mm. If more strength required then increase the layer of steel plates or use the different steels section (rectangular, T, L etc.). Drill machine is use for drill in beams and steels plates.

III. METHODOLOGY

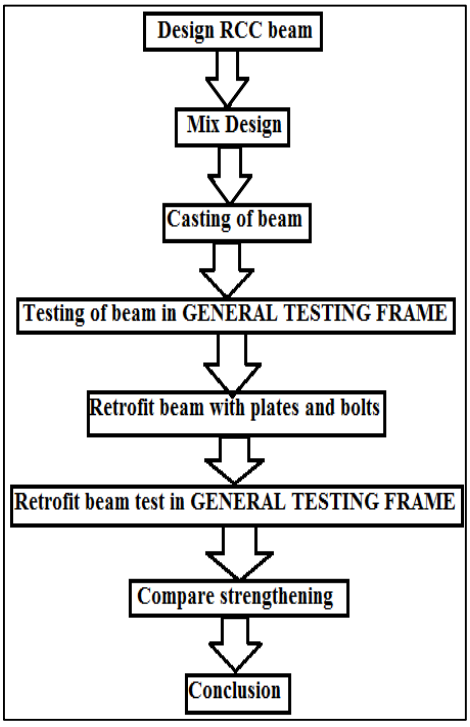

Fig. 1: Methodology

IV. MATERIAL USE IN RETROFITTING

In this retrofitting less material used as compare to other retrofitting methods. The material are writing below

- Steel plates
- Bolt and weld connections
- Drill machine
- Inject machine
- Slurry
- Skilled worker
- Temporary support
- General testing frame
- CTM

OPC of grade 43 was used. The initial setting time of cement is 30 minutes and the specific gravity of cement is 3.15. Fine aggregate used was clear sand passing through 4.75mm sieve with a specific gravity of 2.64. The grading zone of aggregate was zone III. Coarse aggregate used was angular crushed aggregate with a specific gravity of 2.6. Design concrete mix is M-25. MS steel plates of 10mm thickness are used for retrofitting of beams.

V. BEAM DESIGN

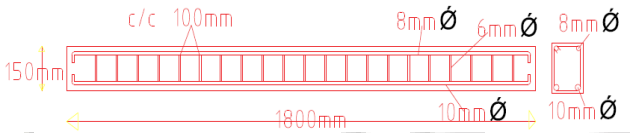

Fig. 2: Beam Design

VI. TESTING OF BEAM 1

The design beam test in general testing frame the deflection is measured by dial-gauge. The load applied by CTM. Beam one is retrofitted with one plates top and one plate bottom of the beam. The applied load is perpendicular to the width of plates.

Fig. 3: Retrofitted with one plates top and one plate bottom of the beam

Load KN	DEFLECTION	Retrofitting deflection
0	0	0
5	0.3	0.4
10	0.55	0.6
14	1.4	1.6
20	2.28	2.8
26	3.6	4.4
30	5.1	6
32	5.8	6.9
35	6.5	

Table 1:
The control specimen load, control beam deflection and retrofitting deflection values

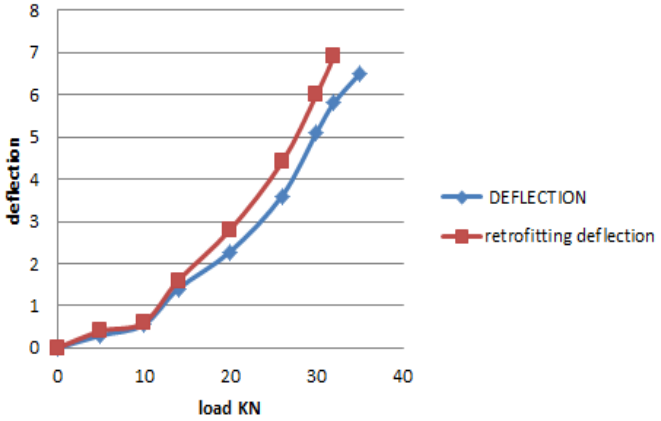

Fig. 4: The compare graph without retrofitting and with retrofitting single-single plate top and bottom

VII. TESTING OF BEAM 2

The design of beam-2 is same as beam-1. The beam test in general testing frame the deflection is measured by dial-gauge. The load applied by CTM. Beam two is retrofitted with double plates top and double plate bottom of the beam. The deflection is after the retrofitting steel plates. The applied load is perpendicular to the width of plates.

Fig. 5: Beam two is retrofitted with double plates top and double plate bottom of the beam

Load KN	DEFLECTION	Retrofitting deflection
0	0	0
5	0.27	0.28
10	0.42	0.44
15	1.11	1.18
20	2.8	3.1
25	4.5	4.8
27	5.1	5.5
29	5.9	6.6
31	6.2	

Table 2: The control specimen load, control beam deflection and retrofitting deflection values

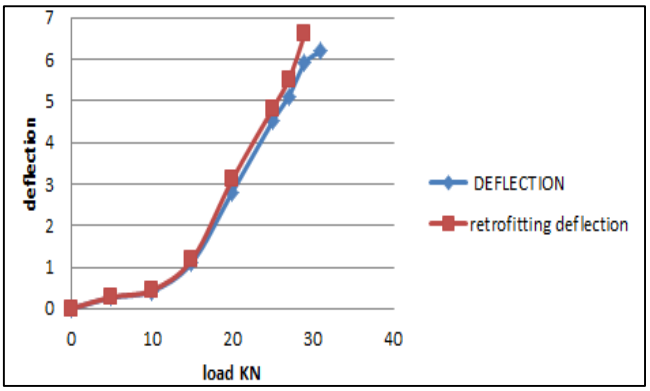

Fig. 6: The compare graph without retrofitting and with retrofitting double-double plates top and bottom

VIII. Testing of Beam 3

Beam one is retrofitted with one plate front and one plate backside of the beam. The applied load is parallel to the width of plates. Beam two is retrofitted with double plates top and double plate bottom of the beam.

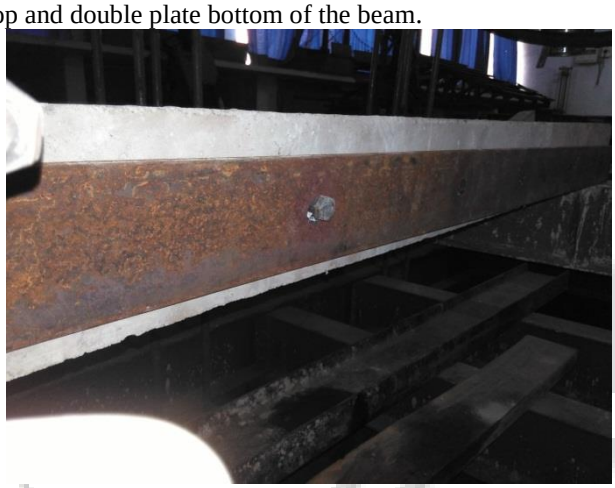

Fig. 7: Beam retrofitted with plates front and backside plate.

LOAD KN	DEFLECTION	RETROFITTING DEFLECTION
0	0	0
5	0.31	5
10	0.42	
15	1.23	
20	2.62	
25	4.01	
30	5.23	
35	6.75	

Table 3: The control specimen load, control beam deflection and retrofitting deflection values

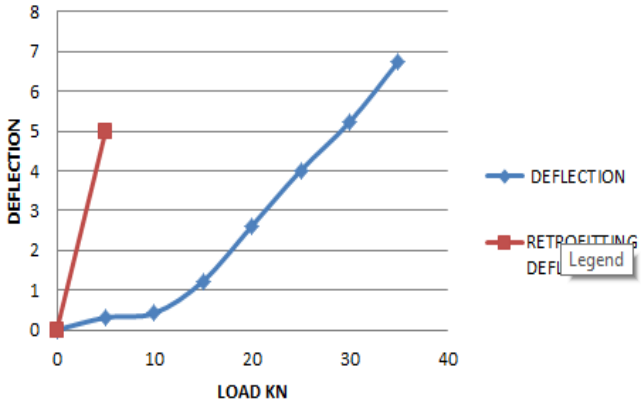

Fig. 8: The compare graph without retrofitting

IX. Result

Beam1 is retrofitted with one plates top and one plate bottom of the beam. The applied load is perpendicular to the width of plates. The strengthening is gain 91%.

Beam2 is retrofitted with one plates top and one plate bottom of the beam. The applied load is perpendicular to the width of plates. The strengthening is gain 94%.

Beam3 is retrofitted with one plate front and one plate backside of the beam. The applied load is parallel to the width of plates. The strengthening is very low 12% only because the load is not at plate only beams.

X. Conclusion

- The steel plates are useful for strengthening.
- The number of steel plates layer is also increases the gain strength but also increase the dead load.
- The applied load is parallel to the width of plates retrofitted with one plate front and one plate backside of the beam not useful.
- The applied load is perpendicular to the width of plates retrofitted with plates top and bottom of the beam is higher strengthening.

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