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Behavior of strengthened RCC Beam using steel plates

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Abstract-*Most structures need to be strengthened when their performance is not satisfactory. This has been a problem in civil construction industry. It could be as a result of change in design codes and hence a newer codes and limit to be implemented in order to satisfy the required capacity checks. In addition, there may be application mistakes during the construction of the structure. This could arise as a result of the skills implemented in the construction site. Problems may later arise, which could be a poor concrete grade, some missing transverse reinforcement, longer spans and lower sizes of some structural members. when some parts of the structure have started wearing, there is a tendency that the building will lose its ability to carry load. This can be restored by firstly repairing and shortly followed by strengthening. Also, there may be a need to strengthen structures due to high vulnerability to seismic motions.*

Keywords : Repairs, Strenghetning, RC beams, Design Codes.

I. INTRODUCTION

Structures may be required to improve the structural behaviour and repair of damaged structures to restore structural performance for economical reasons. Generally, reinforced concrete beams fail in two modes: flexure and shear failure. Shear failure of reinforced concrete beam is sudden and brittle in nature and gives no advance warning prior to failure. Shear failure is more dangerous than flexural failure. Hence, reinforced concrete beam must be designed to develop their full flexure capacity. Many reinforced concrete structures have shear problems for various reasons, like improper detailing of the shear reinforcement, mistakes in design calculations, poor construction practices and reduction of the shear reinforcement steel area due to corrosion in service environment etc. The shear strength of reinforced concrete beam can be affected by concrete properties, beam size, beam shape and reinforcement details. Nowadays, strengthening of reinforced concrete beam by using steel plates, fiber reinforced polymer (FRP), ferrocement is a common task for concrete structures maintenance. Strengthening using materials can be done by two techniques, namely external bonding (EB) and near surface mounting (NSM). The external bonding technique involves adding strengthening material to the external surface of concrete using adhesives whereas NSM technique involves fixing of strengthening material in the pre-cut grooves using adhesives. In both techniques, two component epoxy materials are generally used as adhesives. Near surface mounting technique is proven to have many advantages over the external bonded method such as reduced surface preparation during installation, less chances of deboning and better protection to material due to less exposure to external conditions. External steel plating is a common strengthening and repair technique in RC beams. The ease of application, isotropic property, low prices of the materials used in the process, and limited disruption to the use of the structure are among the factors rendering external plating a relatively convenient method for improving the flexural behaviour and increasing or restoring the load carrying capacities of RC beams compared with other strengthening or repair methods, including the addition of a new concrete layer and reinforcement to a concrete beam.

1.1 Need of study

Structures may be required to improve the structural behaviour and repair of damaged structures to restore structural performance for economical reasons. Steel plates are one of the most common materials for strengthening of reinforced concrete beams; it is very effective for increasing the flexural and shear capacity of reinforced concrete beam. From various studies it was understood that web bonded steel plates affects the crack patterns of the beams significantly and the position of web bonded steel plates significantly influences the stiffness and flexural capacity of plated beams. The critical gap in research is to study the flexural capacity of RC beam with web bonded steel plates by varying the plate thickness and to find the effective thickness of steel plate based on flexural capacity and crack pattern and to study the flexural capacity and crack pattern of RC beam strengthened with web bonded steel plates having effective plate thickness by varying plate depth. The control specimen and the beam with web bonded steel plates of 10, 12, 14 mm thick, and 16 mm thick were tested by using loading frame. The results are compared based

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on the parameters ultimate load, deflection, and load at first crack and the effective thickness of steel plates is found out and beams strengthened with web bonded steel plates of various widths are studied based on the same parameters. The test results confirmed the effectiveness of web bonded continuous steel plates for strengthening of RC beams.

1.2 Reasons for Strengthening

Most structures need to be strengthened when their performance is not satisfactory. This has been a problem in civil construction industry. It could be as a result of change in design codes and hence a newer codes and limit to be implemented in order to satisfy the required capacity checks. In addition, there may be application mistakes during the construction of the structure. This could arise as a result of the skills implemented in the construction site. Problems may later arise, which could be a poor concrete grade, some missing transverse reinforcement, longer spans and lower sizes of some structural members.

Another reason for strengthening is the change of the use of the structure (increment of the live load). This will lead to an increase in the load that will be carried by the structure. Also, there may be a need to strengthen structures due to high vulnerability to seismic motions.

Therefore, the aim of strengthening is to reduce the effect of the internal forces as a result of flexure, shear, torsional and axial. This can be achieved when the magnitude of their forces are reduced to bare minimum or by establishing additional structural member in order to resist them. Thus, care should be taking when strengthening building in order to see that the best method for strengthening is used and for which the total cost including maintenance cost does not exceed the cost of raising a new building and safer as the economy is considered.

II. METHODOLOGY

Strengthened of beam with and without steel plates in ABAQUS software is explained. Results are obtained for displacement at ultimate load of beam and for ultimate load carrying capacity of beam. In which analysis the beam and find out the ultimate load carrying capacity of beam in ABAQUS.

- Analyse and design R.C.C beam with Steel plates and C Sections.
- Predict the behaviour of RCC beam with steel plates and C Sections under consideration by finite element analysis.
- The analyse study the strengthening of beam using steel plates and its effects as retrofit for damaged beams.
- The validate the results optimize damaged beams by using the retrofit.
- Concluded the strengthening of beam compare the behaviour of RCC beam with and without Steel plates.

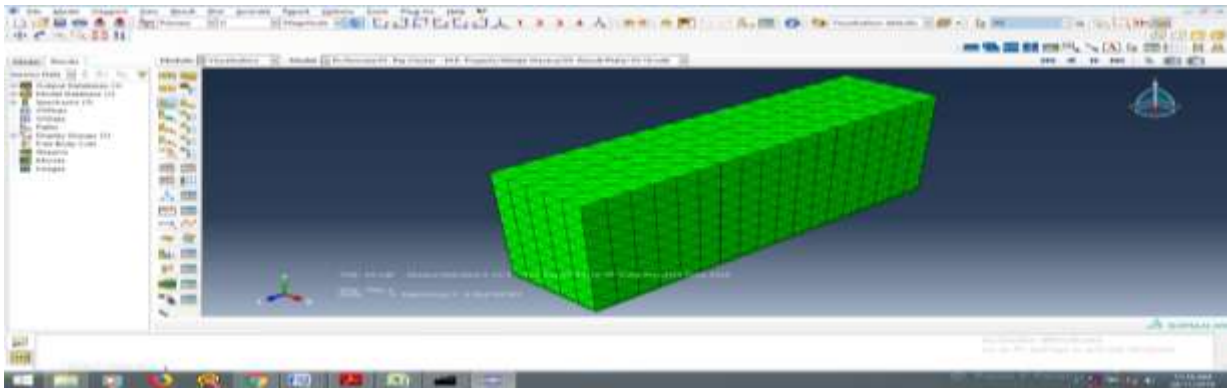

Figure No 1: Analysis and visualization of model

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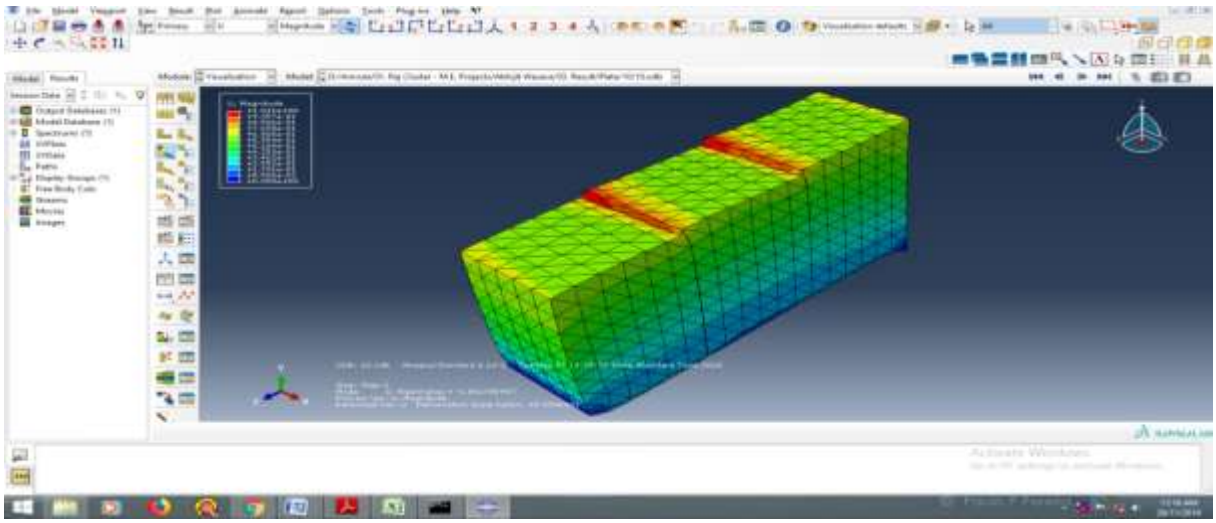

Figure No 2 : Visualization of stress generated model

III. RESULTS AND DISCUSSION

3.1 RCC beam without Steel and with steel plate

The table shows load vs. percentages difference as well as the ratio of load carrying capacity of different size of steel plates. In which Basic steel plate load carrying capacity is 131.2 KN is caparison with others steel plate's loads, the maximum capacity of 16mm plate is 159.74 KN & minimum capacity of 10mm is 155.58 KN.

Table No.
3.1 Load Vs Percentage Difference

Details	Basic	(10mm)	(12mm)	(14mm)	(16mm)
load carrying capacity(KN)	131.2	155.58	157.18	158.76	159.74
Percentage Difference		18.58	19.80	21.01	21.76
Ratio		6.76	5.69	4.93	4.34

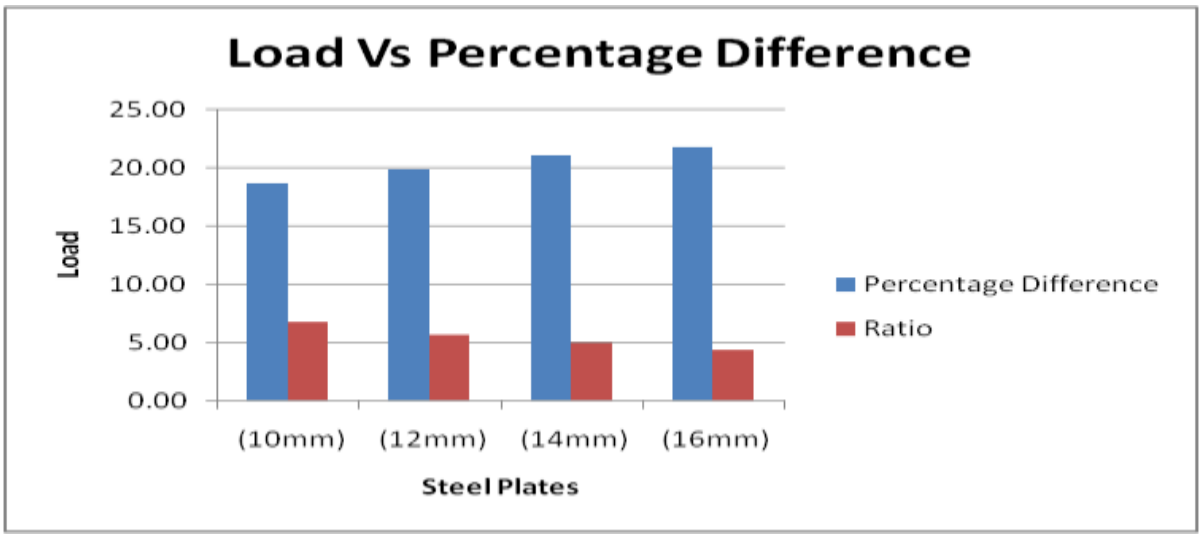

Figure No 3.1 Load Vs Percentage Difference of Steel plates

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The Figure shows load vs. percentages difference as well as the ratio of load carrying capacity of different size of steel plates. In which the maximum capacity of 16mm plate is 159.74 KN & minimum capacity of 10mm is 155.58 KN.

3.2 RCC beam with and without C shape steel plate

The table shows load vs. percentages difference as well as the ratio of load carrying capacity of different size of C Sections. In which Basic C section load carrying capacity is 131.2 KN is caparison with others C Sections loads, the maximum capacity of 16mm plate is 164.07 KN & minimum capacity of 10mm is 158.46 KN.

Table No

3.2 Load Vs Percentage Difference

Details	Basic	(10mm)	(12mm)	(14mm)	(16mm)
load carrying capacity(KN)	131.2	158.46	160.86	162.59	164.07
Percentage Difference		20.78	22.61	23.92	25.05
Ratio		6.89	5.83	5.05	4.46

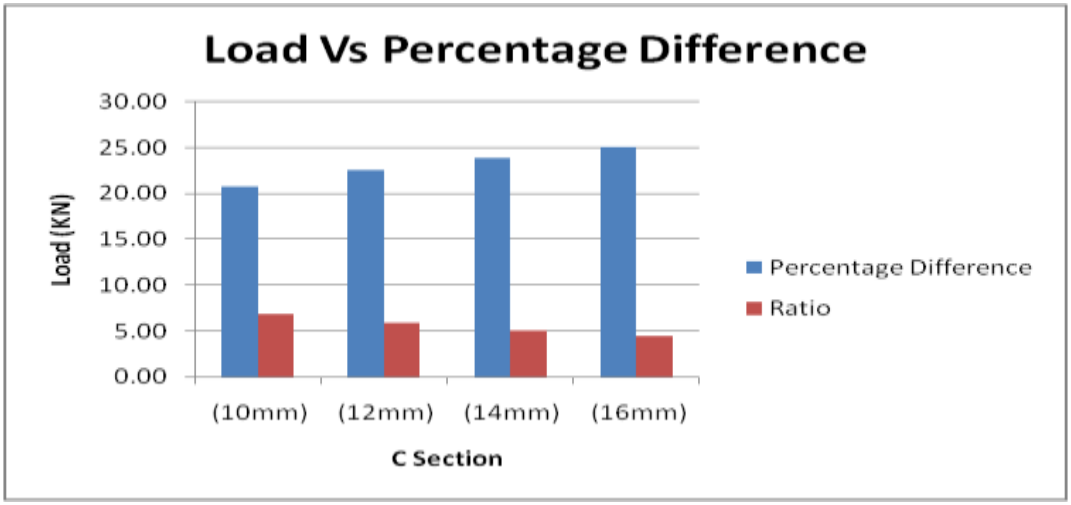

Figure No 3.2 Load Vs Percentage Difference of C Section

The Figure shows load vs. percentages difference as well as the ratio of load carrying capacity of different size of C Sections. In which the maximum capacity of 16mm plate is 164.07& minimum capacity of 10mm is 158.46.

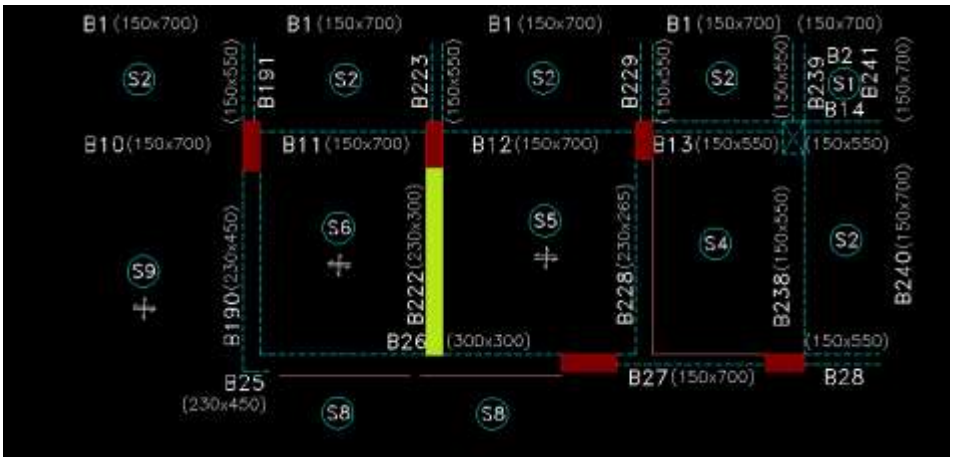

Figure No 3.3 Beam No 222 Analysis for strengthening

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Table 3.3
Actual Beam Model

Beam No.	Size	Without Steel plate	With Steel Plate 14mm Thick	With C Steel Plate 14mm Thick
B222	230X300	107.63	124.50	130.26
Percentage Difference			15.67%	21.03%

The Table shows load vs. percentages difference as well as the ratio of load carrying capacity of different steel plate strengthening on existing beam. In which the maximum capacity of 14 mm plate was seen in the element analysis. The strengthening technique of steel plate increases load carrying capacity by 15.67% for plain plate and 21.03% for C shape plate. The load carrying capacity of c shape steel plate is 4.63% more than plain steel plate.

IV. CONCLUSION

- It has been confirmed that externally bonded longitudinal steel plates can improve the ultimate load carrying capacities of RC damaged beams and can enhance their flexural strength as compared to reference beams.
- The strengthening technique of steel plate increases load carrying capacity by 15.67 % for plain plate and 21.03% for c shape plate. The load carrying capacity of C shape steel plate is 4.63 % more than plain steel plate.
- While adding steel plates to RCC beam the maximum load capacity is found for 16mm plate which is 159.74 KN & minimum capacity is found for 10mm which is 155.58 KN
- While adding C shape steel plates to RCC beam the maximum load capacity is found for 16mm plate which is 164.07 KN & minimum capacity is found for 10mm which is 158.46 KN.

REFERENCES

[1] Anandhi.L, Ramamoorthy.S And Dr.K.Dhanasekar, " Strengthening Of Rc Beam With Steel Plate As Shear Reinforcement" International Journal Of Engineering Research & Technology (Ijert), Volume 6, Issue 02, 2018
[2] Alessandra Aprile, Enrico Spacone And Suchart Limkatanyu, "Role Of Bond In Rc Beams Strengthened With Steel And Frp Plates" J. Struct. Eng., Vol No -.127 Pp. No -1445-1452, 2001.
[3] Bengi Aykaç, Eray Özbek, Rahim Babayani, Mehmet Baran And , Sabahattin Aykaç "Seismic Strengthening Of Infill Walls With Perforated Steel Plates" Engineering Structures Vol No - 152 Pp. No- 168–179, 2017
[4] Byung Hwan Oh, M.Asce Jae Yeol Cho And Dae Gyun Park," Static And Fatigue Behavior Of Reinforced Concrete Beams Strengthened With Steel Plates For Flexure" Vol- 129, Pp No-527-535, 2003.