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# Strengthening of RC Beam-Column Joints Using Steel Plates and Shear Connectors

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**Abstract:** The role of a beam-column joint is very vital in RCC framed structures. Most of the structural collapses due to earthquakes have been initiated by the failure of the beam-column joints and therefore understanding the behavior of beam-column joints is important. The beam column joint is a crucial area where loads from the beam and columns are transferred. It becomes the most critical part of the structure when poor detailing, unsafe design adopted in the region, overuse or lack of maintenance.

Large numbers of retrofitting techniques are being adopted worldwide to strengthen the beam-column joint.

Analytical modelling of interior and exterior beam-column joint has been modelled by using finite element analysis software ANSYS to validate the performance. In the proposed technique beam column joint were modeled using steel plate and steel plate with shear connectors. For structural safety, especially for reinforced concrete beam-column joints, strength of the joints has to be increased. The test results show that the performance of the joints was improved by using the proposed method.

**Keywords:** ANSYS, Steel plate, Beam-Column joint, Shear connector, Structural collapse

## I. INTRODUCTION

Most of the damages to existing reinforced concrete infrastructure are due to inadequate design, overuse and/or poor maintenance. Hence strengthening/retrofitting of such structures has become one of the most demanding construction activities. As far as RCC framed structures are concerned, the beam-column joints are crucial elements which are prone to failure. Arun Raj Ebanesar [3] They shows that experimental and analytical investigation improvement in seismic performance was found in the beam column joint by providing wire mesh and steel plate, which absorbs the lateral input energy more than the conventional joint. This method can be effectively used as new earthquake resistant construction. Sasmal and Voggu [20] Studied the quality of RC beam-column joints is considered by two variety of internal beam-column joints. The shear strength of the joints is tested analytically using the method of soft strut and tie. It is reflected by the analysis that subsequent energy dissipation per cycle drift offers a lot better perspective than the cumulative energy dissipation. The proposed technique Strengthening of Beam-Column joint using steel plates and shear connectors is introduced. Internal strengthening of beam column joint processing with parametric study. From the parametric study an optimum dimension for steel plates is obtained. The results proving that the joint performance improved by increased load carrying capacity of the joint and the failure location that also moved from the joint.

## II. OBJECTIVE

To perform nonlinear FEA of beam column joint with internal strengthening using steel plate under various parametric study subjected to monotonic loading.

- 1) Effect of plate length
- 2) Effect of plate Height
- 3) Effect of plate Thickness
- 4) No of plates (Single, Double)

## III. METHODOLOGY

The main goal of this project is to strengthen the Beam-Column joint using steel plate and shear connectors under various parameters and to investigate the performance of the joint by internal and external strengthening. The study's primary goal is to use the ANSYS WORKBENCH software to analyse and compare the performance and determine the ultimate load, deflection and the failure location.

**A. Modelling of Structure**

The Beam-Column joint specimen was modeled using ANSYS Workbench. The proposed conventional model is shown in fig 1. A monotonic displacement was applied to the beam to analyse the performance of joint and to identify the failure location. The grade of concrete in the frame members was M25 with the specified characteristic compressive strength of 25 MPa and the grade of reinforcement is Thermo-mechanically Treated(TMT) bars with the specified yield strength of 415 MPa. Modulus of Elasticity of concrete  $E_c = 15000\text{MPa}$ , Characteristic strength of concrete  $f_{ck} = 25\text{MPa}$ , Poisson's Ratio = 0.2, Modulus of Elasticity of steel  $E_s = 210000\text{MPa}$ . All columns of the study are chosen to be size 200mmx300mm and height 2300mm. whereas, the size of the beam sections is considered as 200mmx300mm and height 900mm. The design for shear reinforcement in beam and column sections was carried out as per IS 456:2000 design provisions. The FEM model of specimens is shown in Fig 1 to 2.

TABLE I

| MODEL  | DIMENSION(mm) | HEIGHT(mm) |
|--------|---------------|------------|
| Beam   | 200x300       | 900        |
| Column | 200x300       | 2300       |

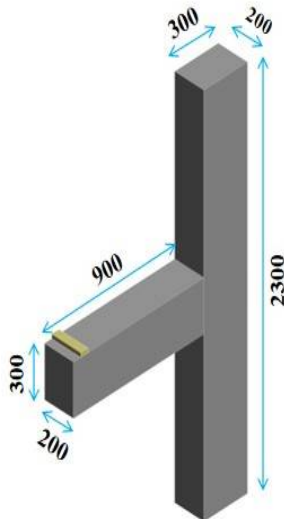


Fig -1(a)

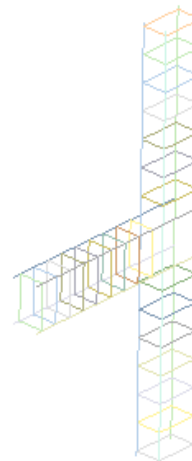


Fig -1(b)

Fig-1 : Modelled Beam-Column Joint a) geometry ; b) reinforcement details in model of conventional specimen(without steel plate for strengthening)

TABLE III

| Plate length (mm) |         | Plate Height (mm) | Plate Thickness (mm) | No. of Steel Plates | Steel Volume Constant (mm) |
|-------------------|---------|-------------------|----------------------|---------------------|----------------------------|
| 250               | -       | -                 | -                    | -                   | -                          |
| 300               | 250+50  | 100               | 5                    | 1                   | 150x100x5                  |
| 350               | 250+100 |                   |                      |                     |                            |
| 400               | 250+150 | 150               | 10                   | 2                   | 150x100x5                  |
| 450               | 250+200 | 200               | 15                   | 2                   | 300x100x2.5                |

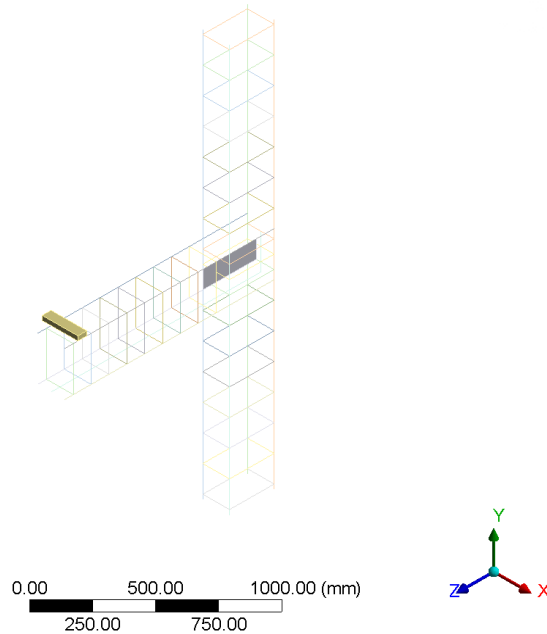


Fig-2 : Modelled Beam-Column Joint (steel plate is connected internally)

**B. Boundary conditions and loading**

The bottom and top end of the support is fixed . Loading plate is located at the end of beam. Load on the beam was applied monotonically. Corresponding deflection and load where noting for analysing the performance of joint under various parameters. The procedure was continued till failure of beam occurs.

**IV.RESULT AND DISCUSSION**

The model is subjected to nonlinear static analysis under monotonic loading with various parameters and Figure 3 to 13 represents the total deformation and plastic strain of the models.

A: SP-250X100X5  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 3.2 s

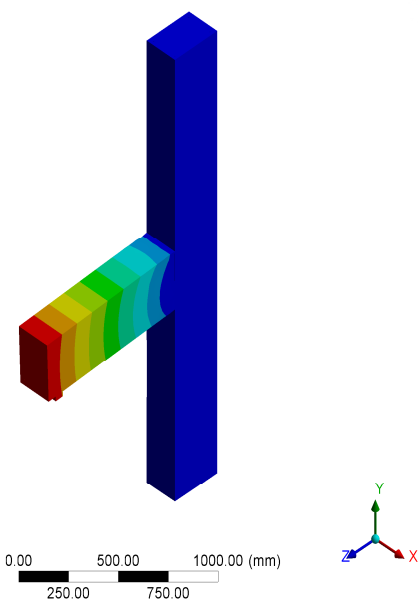
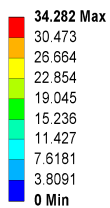


Fig 3- (a)

A: SP-250X100X5  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s

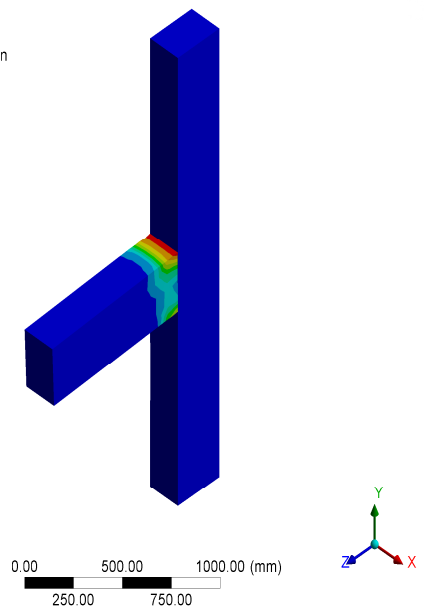
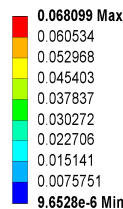


Fig 4- (a)

**B: SP-300(50) X100 X5**  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2.7625 s  
 1/28/2023 11:01 PM

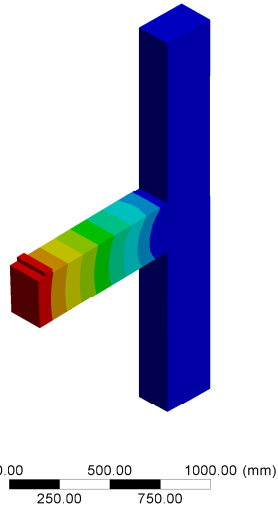
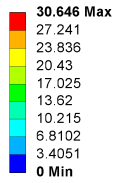


Fig 3- (b)

**B: SP-300(50) X100 X5**  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/28/2023 11:06 PM

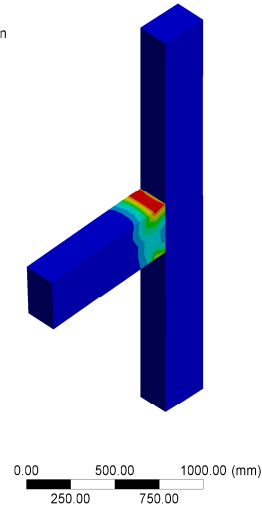
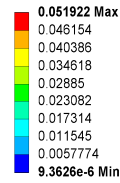


Fig 4- (b)

**C: SP-350(100) X100 X5**  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 3.4 s  
 1/28/2023 11:25 PM

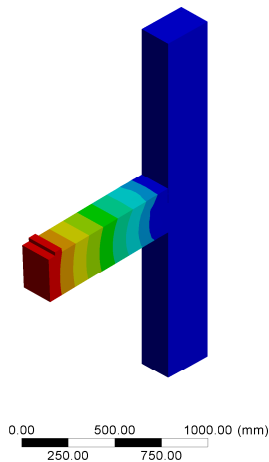
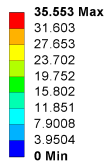


Fig 3- (c)

**C: SP-350(100) X100 X5**  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 2 s  
 1/28/2023 11:28 PM

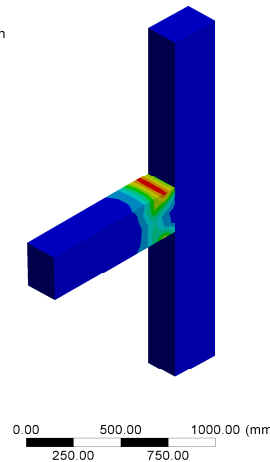
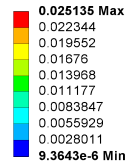


Fig 4- (c)

**D: SP-400(150) X100 X5**  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 1.9305 s  
 1/28/2023 11:33 PM

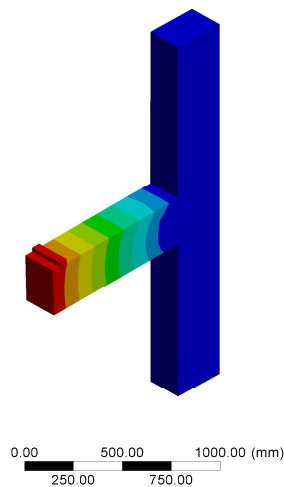
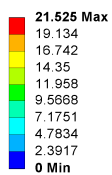


Fig 3- (d)

**D: SP-400(150) X100 X5**  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/28/2023 11:40 PM

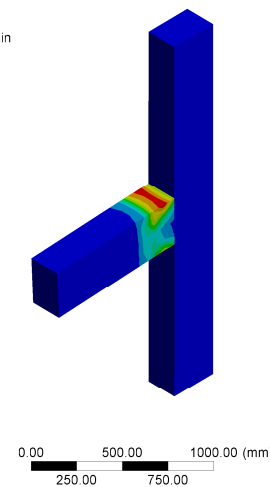
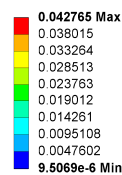


Fig 4- (d)

E: SP-450(200) X100 X5  
Total Deformation  
Type: Total Deformation  
Unit: mm  
Time: 2.2937 s  
1/28/2023 11:47 PM

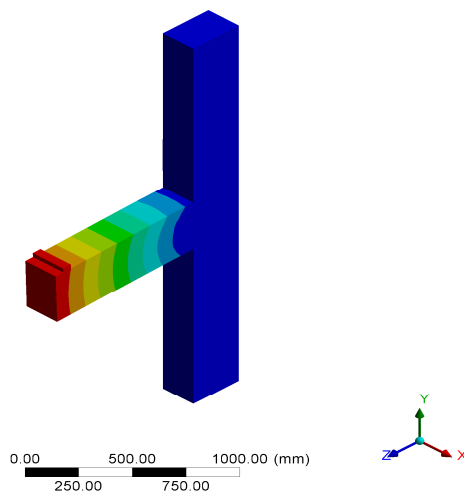
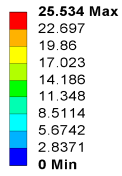


Fig 3- (e)

E: SP-450(200) X100 X5  
Equivalent Plastic Strain  
Type: Equivalent Plastic Strain  
Unit: mm/mm  
Time: 4 s  
1/28/2023 11:48 PM

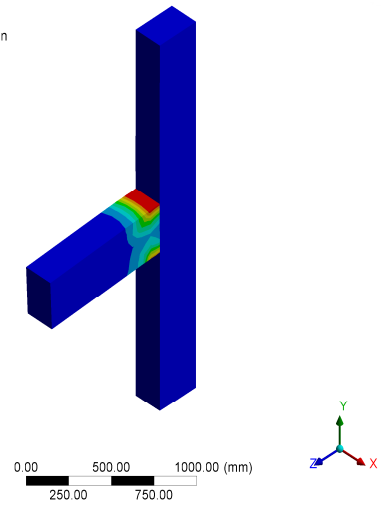
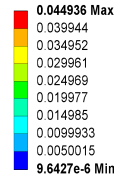


Fig 4- (e)

Fig-3 & 4 : Total Deformation and Plastic strain of Beam - Column Joint with steel plate having length 250, 300, 350, 400 & 450mm, height 100mm and thickness 5mm a) Plate length 250 ; b) Plate length 300mm ; c) Plate length 350mm ; d) Plate length 400mm ; e) Plate length 450mm.

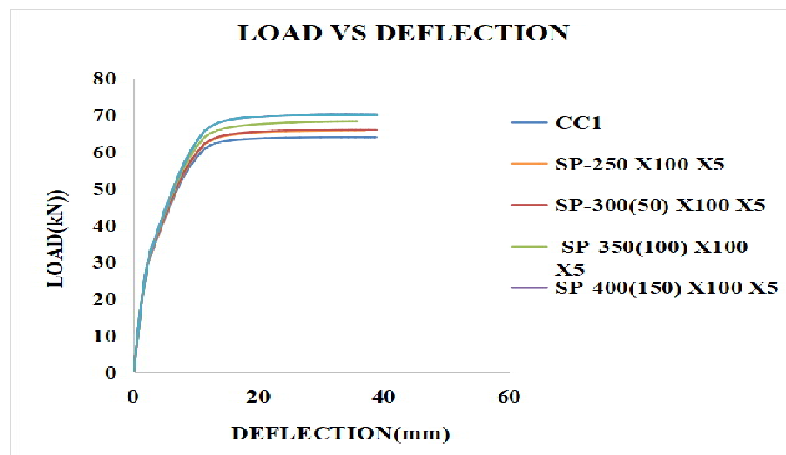


Chart 1 -: Load - Deflection Curve

| MODEL               | DEF(mm) | LOAD(KN) | LOAD(N) | % INCR IN L OAD |
|---------------------|---------|----------|---------|-----------------|
| CC1                 | 34.313  | 63.981   | 63981   | 1               |
| SP-250 X100 X5      | 34.282  | 65.741   | 65741   | 2.750           |
| SP-300(50) X100 X5  | 30.646  | 66.001   | 66001   | 3.157           |
| SP-350(100) X100 X5 | 35.553  | 68.308   | 68308   | 6.762           |
| SP-400(150) X100 X5 | 21.525  | 69.65    | 69650   | 8.860           |
| SP-450(200) X100 X5 | 25.534  | 69.931   | 69931   | 9.299           |

Table 3 : Analysis result of models having various plate length

D: SP-400(150) X100 X5  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 1.9305 s  
 1/28/2023 11:33 PM

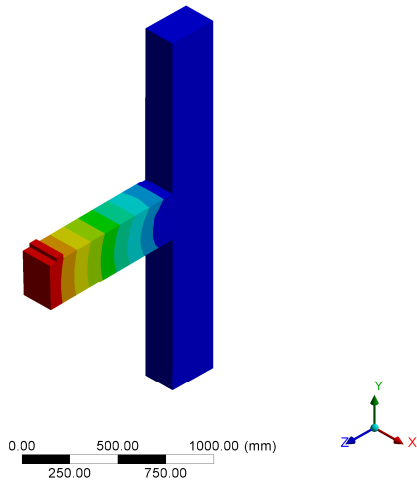
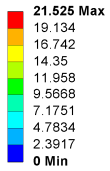


Fig 5- (a)

D: SP-400(150) X100 X5  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/28/2023 11:40 PM

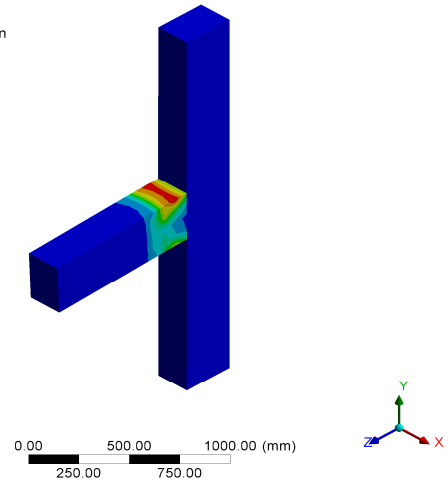
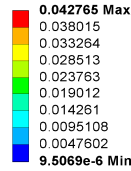


Fig 6- (a)

F: SP-400(150) X150 X5  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2.1925 s  
 1/29/2023 12:59 AM

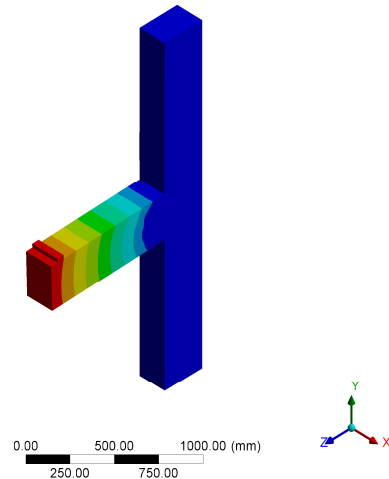
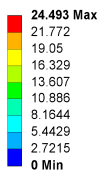


Fig 5- (b)

F: SP-400(150) X150 X5  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/29/2023 1:00 AM

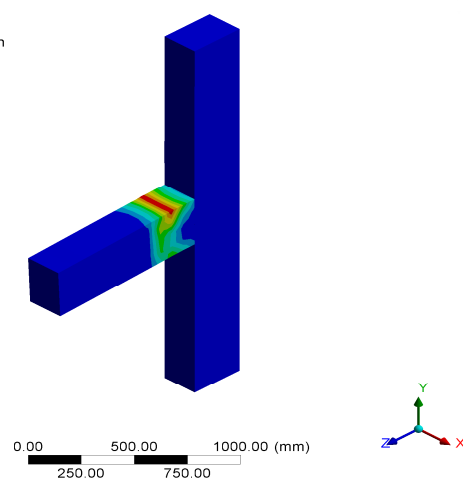
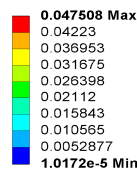


Fig 6- (b)

G: SP-400(150) X200 X5  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2 s  
 1/29/2023 12:55 AM

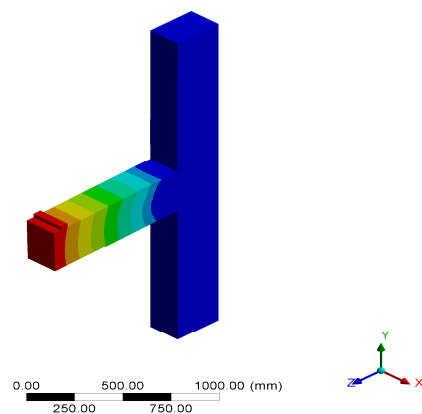
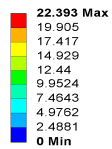


Fig 5- (c)

G: SP-400(150) X200 X5  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/29/2023 12:56 AM

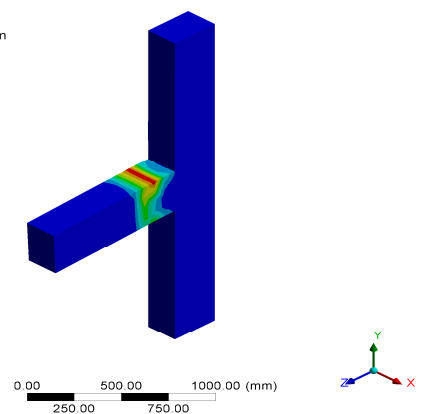
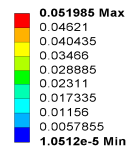


Fig 6- (c)

Fig-5 & 6 : Total Deformation and Plastic strain of Beam - Column Joint with steel plate having height 100 ,150 & 200mm, length 400mm and thickness 5mm a) Plate Height 100 ; b) Plate Height 150mm ; c) Plate Height 200mm.

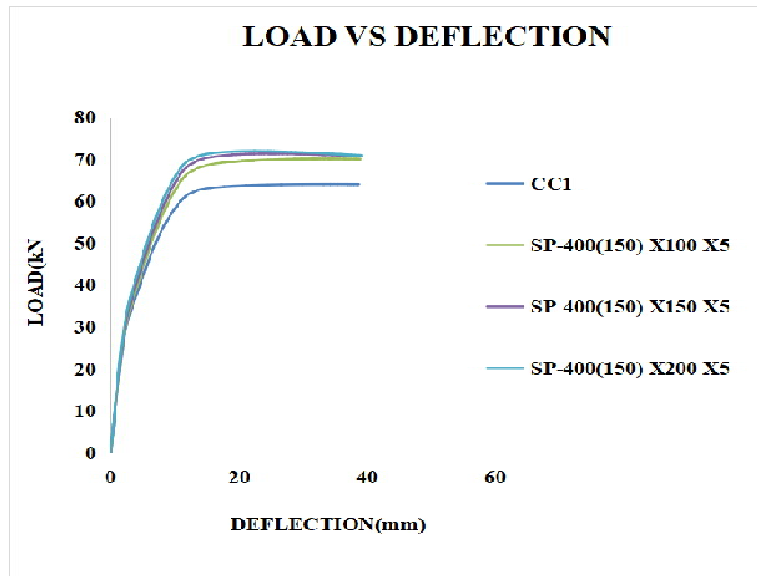


Chart 2 -: Load - Deflection Curve

| MODEL               | DEF(mm) | LOAD(KN) | LOAD(N) | % INCR IN LOAD |
|---------------------|---------|----------|---------|----------------|
| CC1                 | 34.313  | 63.981   | 63981   | 1              |
| SP-400(150) X100 X5 | 21.525  | 69.65    | 69650   | 8.860          |
| SP-400(150) X150 X5 | 24.493  | 71.296   | 71296   | 11.433         |
| SP-400(150) X200 X5 | 22.393  | 71.863   | 71863   | 12.319         |

Table 4 : Analysis result of models having various plate height

F: SP-400(150) X150 X5  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2.1925 s  
 1/29/2023 12:59 AM

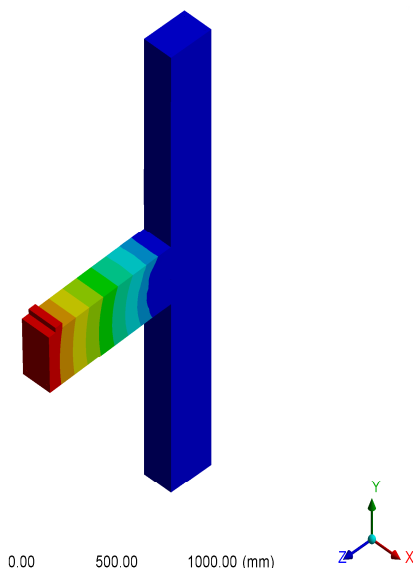
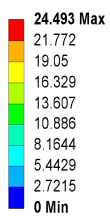


Fig 7- (a)

F: SP-400(150) X150 X5  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/29/2023 1:00 AM

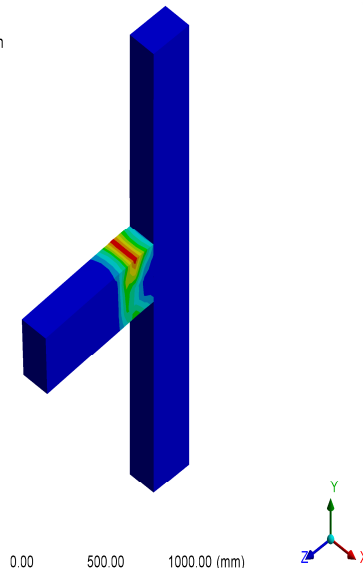
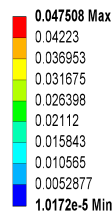


Fig 8- (a)



I: SP-400(150) X150 X10  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2.1225 s  
 1/29/2023 12:34 AM

23.734 Max  
 21.097  
 18.46  
 15.823  
 13.186  
 10.548  
 7.9113  
 5.2742  
 2.6371  
 0 Min

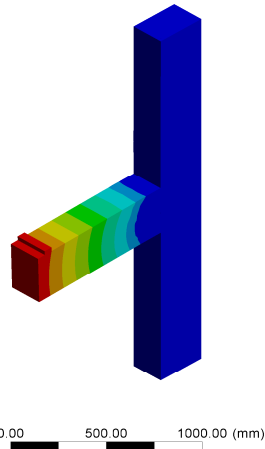


Fig 7- (b)

I: SP-400(150) X150 X10  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/29/2023 12:36 AM

0.052695 Max  
 0.046842  
 0.040988  
 0.035134  
 0.02928  
 0.023426  
 0.017572  
 0.011719  
 0.0058647  
 1.091e-5 Min

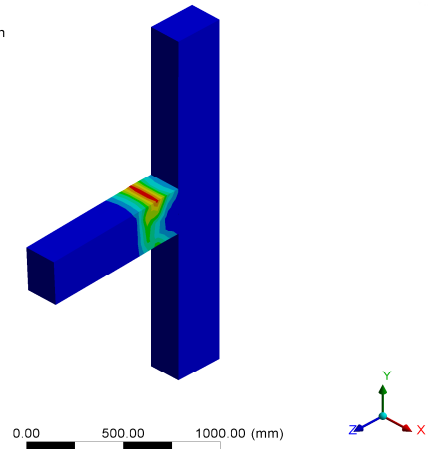


Fig 8- (b)

J: SP-400(150) X150 X15  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2.2 s  
 1/29/2023 12:39 AM

24.576 Max  
 21.846  
 19.115  
 16.384  
 13.654  
 10.923  
 8.1922  
 5.4614  
 2.7307  
 0 Min

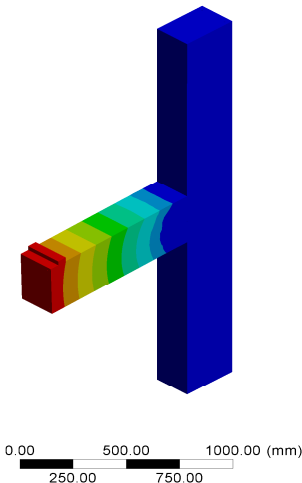


Fig 7- (c)

J: SP-400(150) X150 X15  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/29/2023 12:40 AM

0.047528 Max  
 0.042248  
 0.036969  
 0.031689  
 0.026409  
 0.021129  
 0.01585  
 0.01057  
 0.00529  
 1.0172e-5 Min

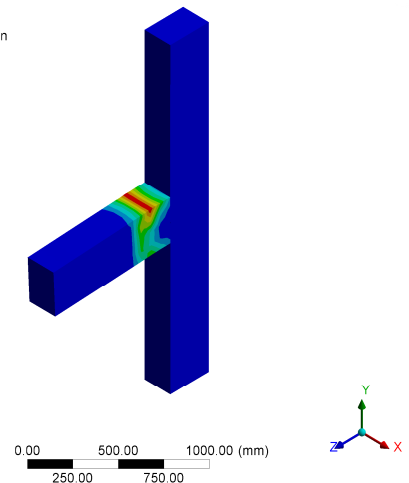


Fig 8- (c)

Fig-7 & 8 : Total Deformation and Plastic strain of Beam - Column Joint with steel plate having thickness 5,10 & 15mm, length 400mm and height 150mm a) Plate thickness 5mm ; b) Plate thicknrss 10mm ; c) Plate thickness 15mm.

**LOAD VS DEFLECTION**

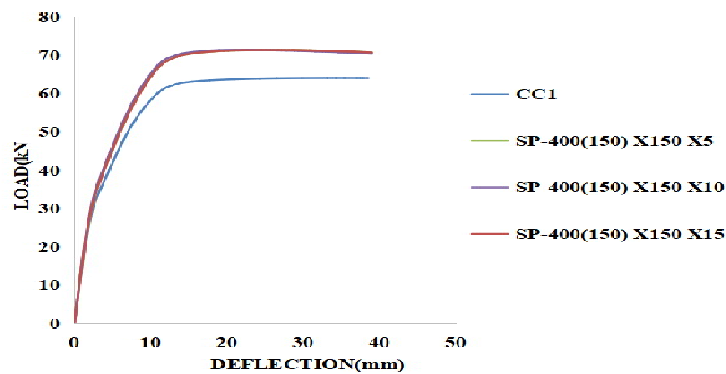


Chart 3 -: Load - Deflection Curve

| MODEL                | DEF(mm) | LOAD(KN) | LOAD(N) | % INCR IN LOAD |
|----------------------|---------|----------|---------|----------------|
| CC1                  | 34.313  | 63.981   | 63981   | 1              |
| SP-400(150) X150 X5  | 24.493  | 71.296   | 71296   | 11.433         |
| SP-400(150) X150 X10 | 23.734  | 71.307   | 71307   | 11.450         |
| SP-400(150) X150 X15 | 24.576  | 71.285   | 71285   | 11.415         |

Table 5 : Analysis result of models having various plate thickness

F: SP-400(150) X150 X5  
Total Deformation  
Type: Total Deformation  
Unit: mm  
Time: 2.1925 s  
1/29/2023 12:59 AM

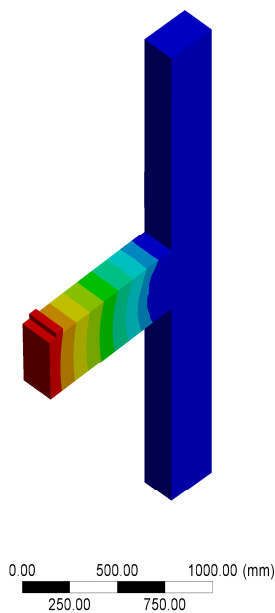
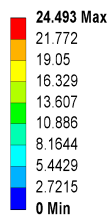


Fig 9- (a)

F: SP-400(150) X150 X5  
Equivalent Plastic Strain  
Type: Equivalent Plastic Strain  
Unit: mm/mm  
Time: 4 s  
1/29/2023 1:00 AM

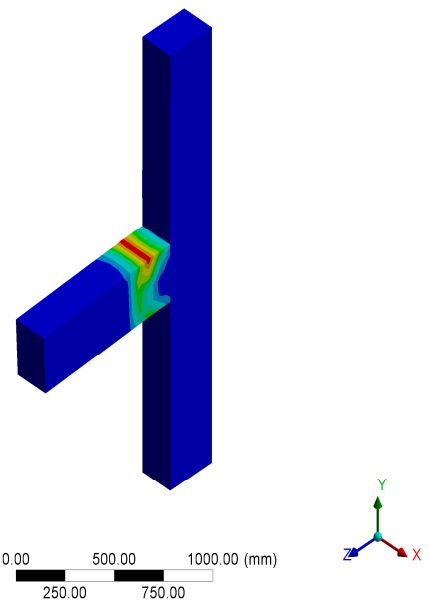
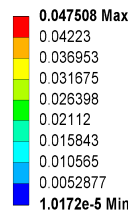


Fig 10- (a)

K: SP-400(150) X150 X5-2P  
Total Deformation  
Type: Total Deformation  
Unit: mm  
Time: 2.07 s  
1/29/2023 1:13 AM

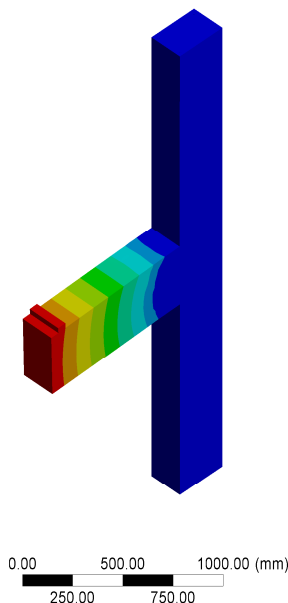
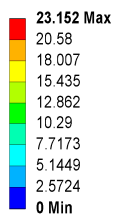


Fig 9- (b)

K: SP-400(150) X150 X5-2P  
Equivalent Plastic Strain  
Type: Equivalent Plastic Strain  
Unit: mm/mm  
Time: 4 s  
1/29/2023 1:16 AM

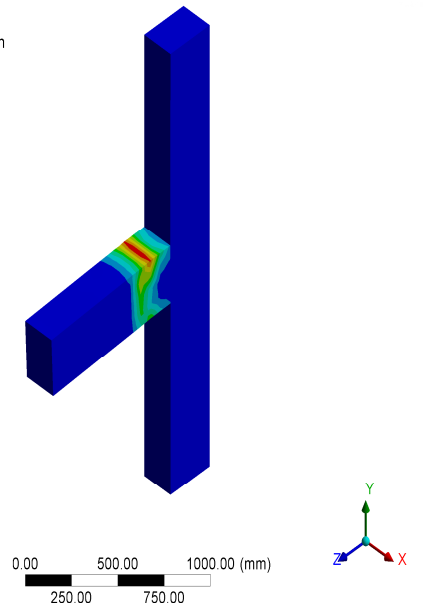
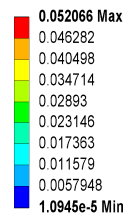


Fig 10- (b)

L: SP-400(150) X150 X5-3P  
 Total Deformation  
 Type: Total Deformation  
 Unit: mm  
 Time: 2 s  
 1/29/2023 1:18 AM

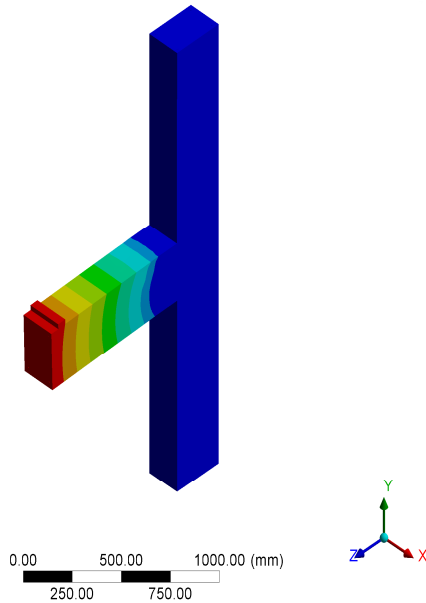
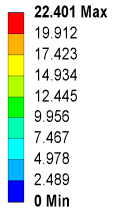


Fig 9- (c)

L: SP-400(150) X150 X5-3P  
 Equivalent Plastic Strain  
 Type: Equivalent Plastic Strain  
 Unit: mm/mm  
 Time: 4 s  
 1/29/2023 1:21 AM

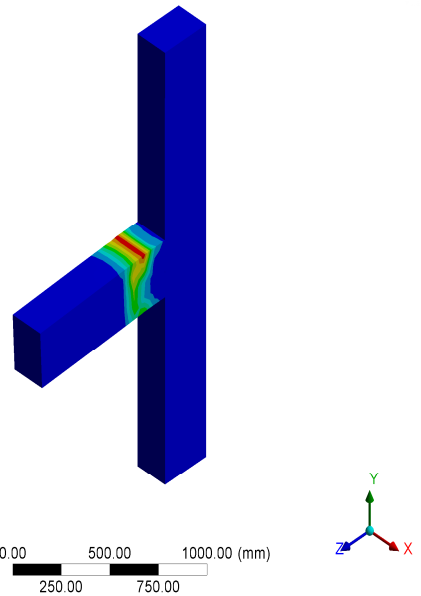
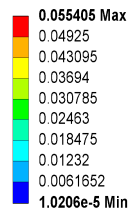


Fig 10- (c)

Fig-9 & 10 : Total Deformation and Plastic strain of Beam - Column Joint with steel plate having thickness 5,10 & 15mm, length 400mm and height 150mm a) Plate thickness 5mm ; b) Plate thicknrss 10mm ; c) Plate thickness 15mm.

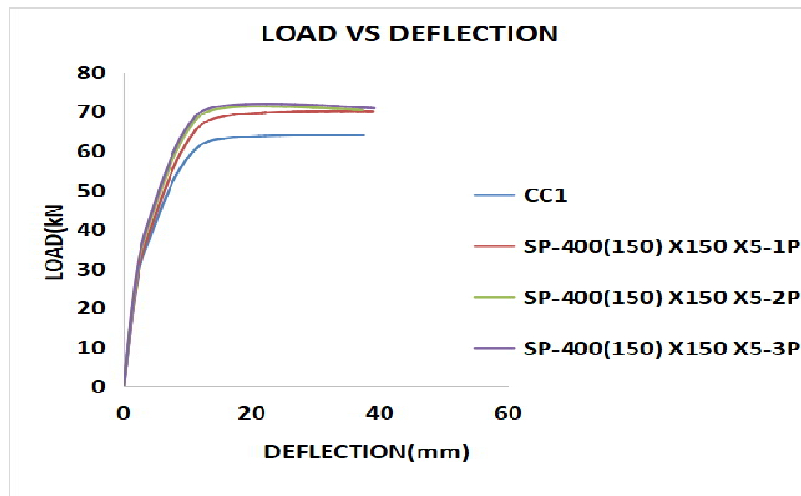


Chart 4 -: Load - Deflection Curve

| MODEL                  | DEF (mm) | LOAD (KN) | LOAD(N) | % INCR IN LOAD |
|------------------------|----------|-----------|---------|----------------|
| CC1                    | 34.313   | 63.981    | 63981   | 1              |
| SP-400(150) X150 X5-1P | 24.493   | 71.296    | 71296   | 11.433         |
| SP-400(150) X150 X5-2P | 23.152   | 71.265    | 71265   | 11.384         |
| SP-400(150) X150 X5-3P | 22.401   | 71.868    | 71868   | 12.327         |

Table 6 : Analysis result of models having various plate numbers

## V. CONCLUSIONS

A Beam column joint with steel plate is designed. Beam column joint with various length, height, thickness and different number of plates are modelled and they are allowed to testing under monotonic loading.

- 1) Steel plates having varying length 50mm, 100mm, 150mm and 200mm are studied. From this study it is observed that almost 9.29% of load is increased. Beyond 150mm the load carrying capacity is not very much improved. Hence 150mm is the effective length of steel plate can be used inside for the strengthening of beam-column joint.
- 2) Steel plates having varying height 100mm, 150mm and 200mm are studied. From this study it is observed that almost 12.4% of load is increased. Beyond 150mm the load carrying capacity is not very much improved. Hence 150mm is the optimum height of steel plate can be used inside for the strengthening of beam-column joint.
- 3) Steel plates having varying thickness 5mm, 10mm and 15mm are studied. From this study it is observed that almost 11.5% of load is increased. There is no much changes observed in load carrying capacity while doing the parametric study using changing the thickness. So minimum 5mm thickness is recommended for the improvisation of joint strengthening.
- 4) Placing the plate with different number, it is observed that upto 12% of load is increased. The optimum performance is observed on the plate with two numbers. Beyond two numbers, placing three plates has no significant improvement in performance. Hence the steel plate having 400(150)x150x5 with two number of plates are considered the optimum dimensions for internal strengthening of beam-column joint.
- 5) From the analysis the optimum dimension of steel plate is **400(150)x150x5**. Two number of steel plates having length 400mm, height 150mm and thickness 5mm is recommended for the Beam-Column joint strengthening.

## REFERENCES

- [1] Abbas, A. A., Syed Mohsin, S. M., & Cotsovos, D. M. (2014). "Seismic response of steel fibre reinforced concrete beam-column joints". Engineering Structures, 59, 261-283.
- [2] Alavi-Dehkordi, Davood (2019) "Exterior reinforced concrete beam column joint subjected to monotonic loading" Alexandria Engineering Journal Volume 57, Issue 4, December 2018, Pages 4133-4144
- [3] Arunraj Ebanesar, Hemalatha Gladston (2021) "Strengthening of RC beam-column joints using steel plate with shear connectors: Experimental investigation" Research Journal of The Institution of Structural Engineers. Structures Volume 35, January 2022, Pages 1138-1150
- [4] Ashraf A. Bahraq, Mohammed A (2021) "Numerical and analytical modeling of seismic behavior of beam-column joints retrofitted with ultra-high performance fiber reinforced concrete" Structures Volume 32, August 2021, Pages 1986-2003
- [5] Ataei, A., Bradford, M. A., & Liu, X. (2016). "Experimental study of flush end plate beam-to-column composite joints with precast slabs and deconstructable bolted shear connectors". Structures, 7, 43-58.
- [6] Attari Nassereddine, Youcef Youcef Si (2019), "Amziane Sofiane. Seismic performance of reinforced concrete beam-column joint strengthening by FRP sheets". Structures 2019;20:353-64.
- [7] Claudio Amadio, Chiara Bedon, Marco Fasan, Maria Rosa Pecce (2017). "Refined numerical modelling for the structural assessment of steel-concrete composite beam-to column joints under seismic loads". Eng Struct 2017; 138: 394-409.
- [8] Hamed Dabiri a, Ahmad Kaviani b.(2020) "Influence of reinforcement on the performance of non-seismically detailed RC beam-column joints" Journal of Building Engineering Volume 31, September 2020, 101333.
- [9] H. Behnam, J. Kuang, B. Samali (2018), "Parametric finite element analysis of RC wide beam-column connections", Comput. Struct. 205 (2018) 28-44.
- [10] Jing Zhang, Xiamin Hu (2021) "Experimental investigation of steel-concrete composite beam to reinforced-concrete column joints with single plate shear connection" Engineering Structures Volume 245, 15 October 2021, 112906.
- [11] J. Shayanfar, A. Hemmati, H.A (2019). Bengar, A simplified numerical model to simulate RC beam-column joints collapse, Bull. Earthq. Eng. 17 (2) (2019) 803-844.
- [12] K.Arash Karimi Pour (2022) "Experimental and numerical evaluation of steel fibres RC patterns influence on the seismic behaviour of the exterior concrete beam-column connections" Engineering Structures Volume 263, 15 July 2022, 114358
- [13] K.Sakthi murugan, K.Baskar (2021) "Experimental investigation on rcc external beam-column joints retrofitted with basalt textile fabric under static loading" Composite Structures Volume 268, 15 July 2021, 114001
- [14] M. Najafgholipour, et al.(2017), "Finite element analysis of reinforced concrete beam column connections with governing joint shear failure mode", Lat. Am. J. Solid. Struct. 14 (7) (2017) 1200-1225.
- [15] Mohamed H.Mahmoud, Hamdy M. Afefy (2014) "Strengthening of defected beam-column joints using CFRP" Journal of Advanced Research Volume 5, Issue 1, January 2014, Pages 67-77
- [16] P. Alaei, B. Li (2018), "Analytical investigations of reinforced concrete beam-column joints constructed using high-strength materials", J. Earthq. Eng. (2018) 1-29.
- [17] S. Mirzabagheri, A.A. Tasnimi, F. Issa (2018), "Experimental and numerical study of reinforced concrete interior wide beam-column joints subjected to lateral load", Can. J. Civ. Eng. 45 (11) (2018) 947-957.
- [18] S. Rajagopal, S. Prabavathy.(2015) "Investigation on the seismic behavior of exterior beam-column joint using T-type mechanical anchorage with hair-clip bar" Journal of King Saud University - Engineering Sciences Volume 27, Issue 2, July 2015, Pages 142-152
- [19] Said M.Allama, Hazem M.F.Elbakra, (2018) "Effects of high-strength reinforcing bars and concrete on seismic behavior of RC beam-column joints" Engineering Structures Volume 183, 15 March 2019, Pages 702-719
- [20] Saptarshi Sasmal, Srinivas Voggu (2019) "Performance evaluation of differently designed beam-column joints under cyclic shear-torsion loading". Engineering Structures Volume 197, 15 October 2019, 109447.



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