iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** III **Month of publication:** March 2023

DOI: https://doi.org/10.22214/ijraset.2023.49798

Advancement Study in Jumbo Beam-Column Connection Using Tubular Flange Cut and Web Cut Reduced Beam Section

Rinsa Febin[1], Anjusha R[2]
[1]*Post graduate student (M.Tech Structural Engineering),* APJ Abdul Kalam Technological University, *Vedavyasa Institute of Technology, Kerala, India*
[2]*Assistant Professor, Vedavyasa Institute of Technology, Kerala, India*

Abstract: There is an increasing demand for jumbo shapes in the construction of high-rise buildings. Super jumbos are very heavy rolled wide flange sections with up to 140 mm flange thickness and weigh up to 1377 kg/m. However, there is a lack of knowledge of the behavior of these types of construction, especially under seismic loading. In this paper, a tubular reduced section (RBS) is designed.
A tubular reduced beam section (RBS) is made by replacing a part beam with a steel tube at a suitable location of the beam plastic hinge.
The main objective of this paper is to study the behavior of the jumbo section with and without implementing tubular RBS in beam-column connection and understand the seismic performance. A finite element tubular RBS is modeled and compared with without RBS. It is expected that using this method can improve seismic capabilities. The result showed that on introducing tubular flange RBS, the seismic performance of the jumbo section increased and the plastic hinge has been relocated. The complete analytical model and Extensive parametric studies have been carried out using ANSYS software.
Keywords: ANSYS, Jumbo shapes, Reduced beam section, Tubular flange reduced beam section

I. INTRODUCTION

The RBS connection is one of the most admired and feasible moment-resisting connection types amongst post-Northridge and Kobe earthquakes. RBS is mainly used to relocate the plastic hinge. The most commonly used RBS is flange cut RBS, which means a part of the flange had been removed to relocate the plastic hinge, but this method causes premature failures. Therefore, a new method called tubular RBS is introduced. Tubular RBS means a part of the beam has been removed and replaced by a steel tube at the desirable location of the beam plastic hinge.

The "strong column - weak beam" design concept was analyzed by the SAC Joint Venture, which was hired by FEMA. It is best used in conjunction with ArcelorMittal's RBS connection, which was released from patent in 1995. AISC successfully evaluated the technique, which was then incorporated into the FEMA 350 and 355 documents. [3,4]. AISC 358 [4] restricts the use of the RBS connection in special and intermediate moment frames based on the parameters used in previous tests. To address these issues, a combined experimental and analytical study was conducted to study the behavior of RBS connections with jumbo shapes and examine ways to improve their ductility [5].

II. OBJECTIVE

A. To study the performance of jumbo structures with and without implementing tubular RBS in beam-column connection.
B. To investigate the performance of different types of tubular RBS to optimize the plastic hinge relocation and premature failure.

III. METHODOLOGY

The main goal of this study is to enhance the seismic performance of jumbo beams and columns. For that, a tubular RBS is first modeled, and results are compared with no RBS. The study's primary goal is to use the ANSYS WORKBENCH software to compare the performance of several types of Tubular RBS to reduce premature failure and plastic hinge relocation.

A. *Modelling of Frames*

An exterior RBS moment connection specimen was modeled using ANSYS Workbench. The proposed RBS is shown in fig 1. as shown, in a limited zone near the column face the beam web is replaced by vertical tubular RBS By using complete joint penetration, the beam is connected to the column face. A monotonic displacement was applied to the beam to achieve a story drift angle of up to 4%. The beams were A992 Grade 50 steel (fy = 345 MPa) and has Young's Modulus 200 GPa and Poisson's ratio as 0.3. Columns were A913 Grade 65 steel (fy = 450 MPa) and has Young's Modulus 200 GPa and Poisson's ratio as 0.3. The plate material was A572 Grade 50 steel (fy = 345 MPa). Dimensional details of the jumbo section are shown in Table 1. The FEM model of specimens is shown in Fig 1 to 4.

TABLE I

specim en	Beam (mm)	Column (mm)	RBS dimension (a,b,e) (mm)
SP3	W920 x 420 x 1377	W360 x 410 x 1299	354.75, 384, 547

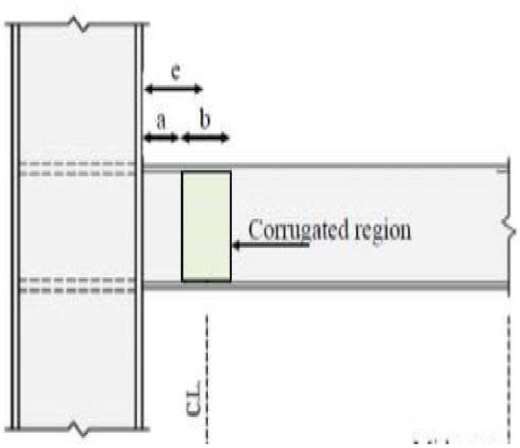


Fig -1: Tubular RBS

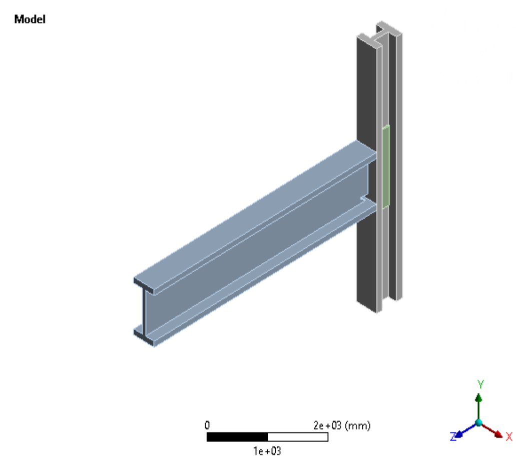


Fig -2: Without RBS

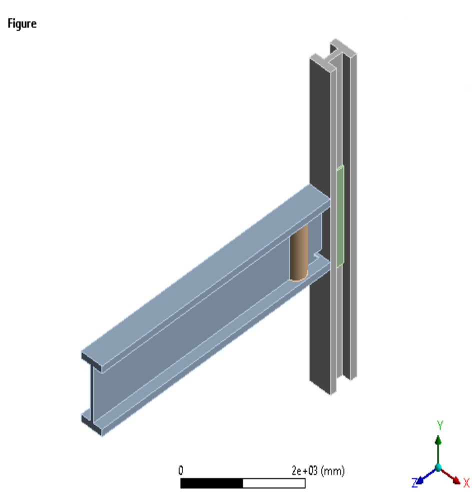


Fig -3: Tubular web cut RBS

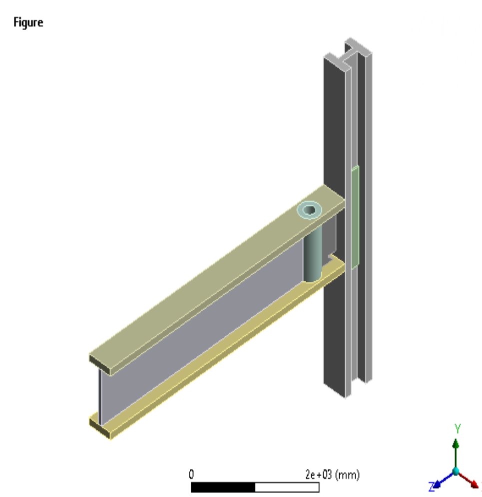


Fig -4: Tubular flange cut RBS

B. Boundary Condition and Loading

The left end of the column was restrained against translation in all three directions (i.e. pin support) while the other three supports for the column were simulated by restraining translation in one direction only (i.e. rollers). A monotonic displacement was applied to the beam -to achieve a story drift angle of up to 4%.

IV. RESULT AND DISCUSSION

The model is subjected to nonlinear static analysis and Figure 5 to 13 represents the total deformation and plastic strain.

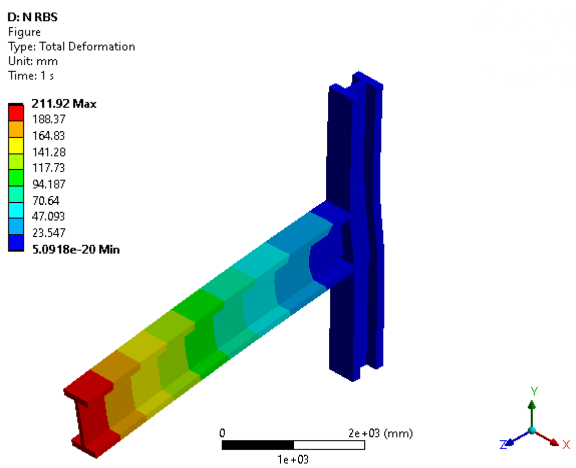


Fig -5: Total Deformation (no RBS)

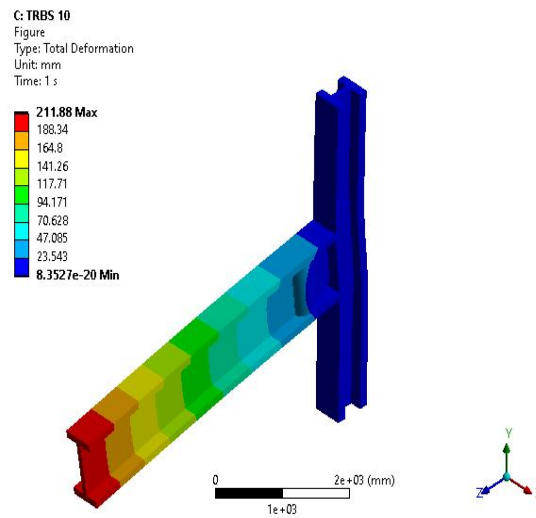


Fig -6: Total deformation (TBRBS10mm thick)

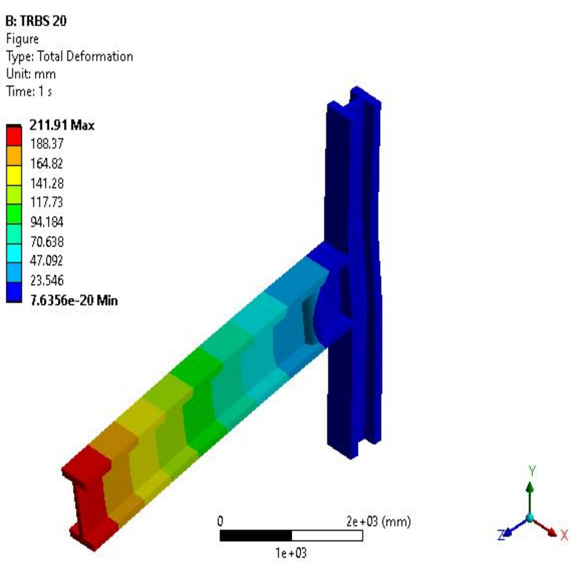


Fig -7: Total deformation (TBRBS20mm thick)

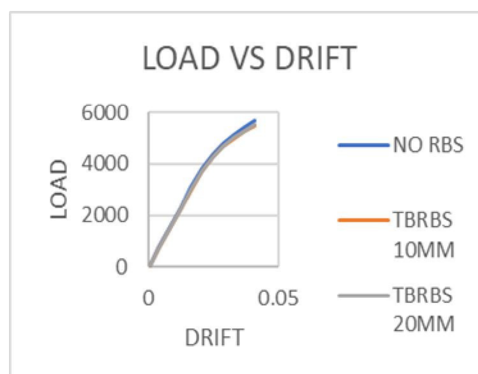


Chart -1: Load -Drift Curve

The study shows that tubular web RBS with 10mm and 20mm do not show a sufficient reduction in stress and also the plastic hinge is not relocated. Therefore, a tubular flange cut has to be designed. Almost 10 models was designed.

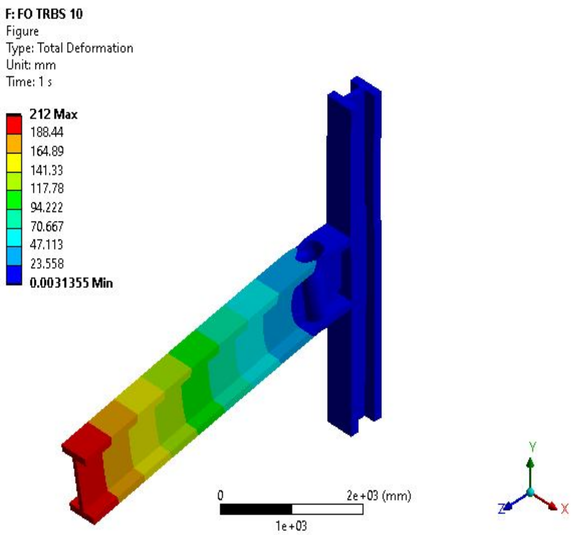


Fig -8: Total Deformation (FC TBRBS 10mm)

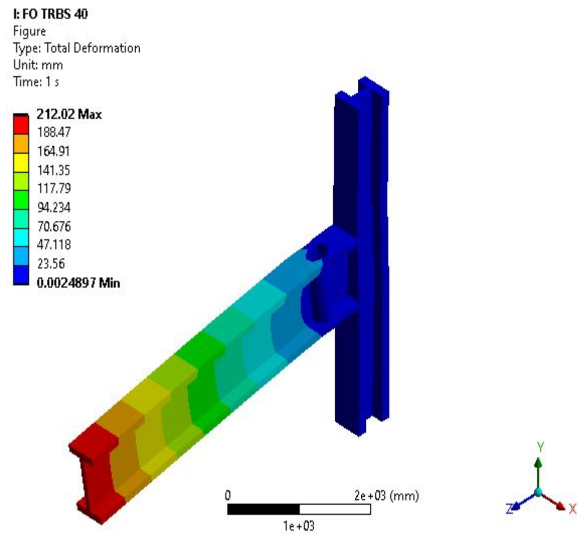


Fig -9: Total Deformation (FC TBRBS 40mm)

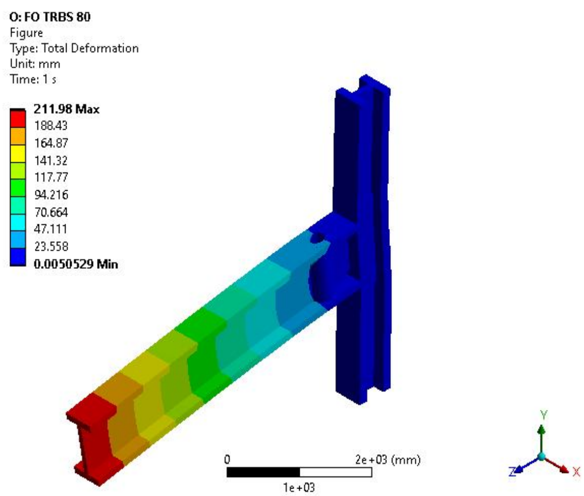


Fig -10: Total Deformation (FC TBRBS 80mm)

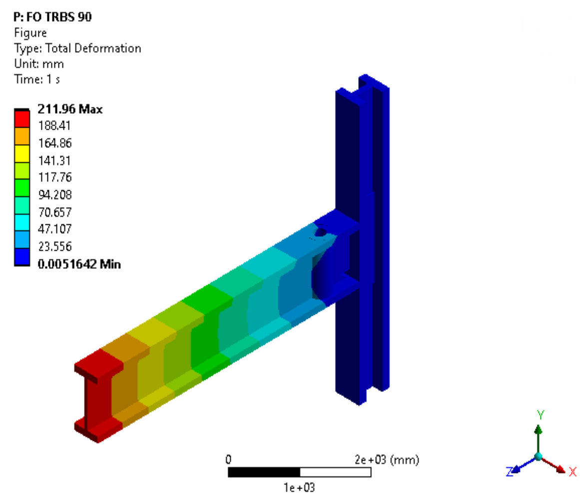


Fig -11: Total Deformation (FC TBRBS 90mm)

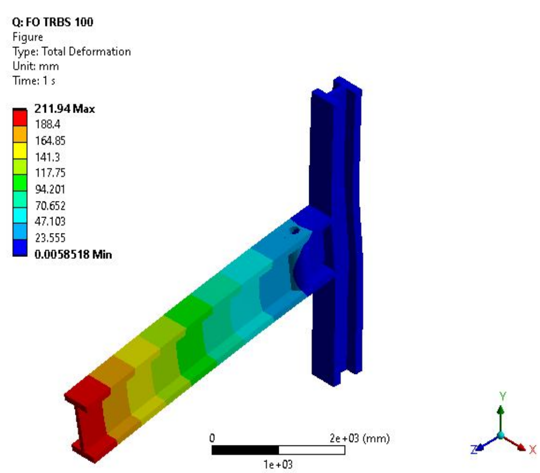


Fig -12: Total Deformation (FC TBRBS 100mm)

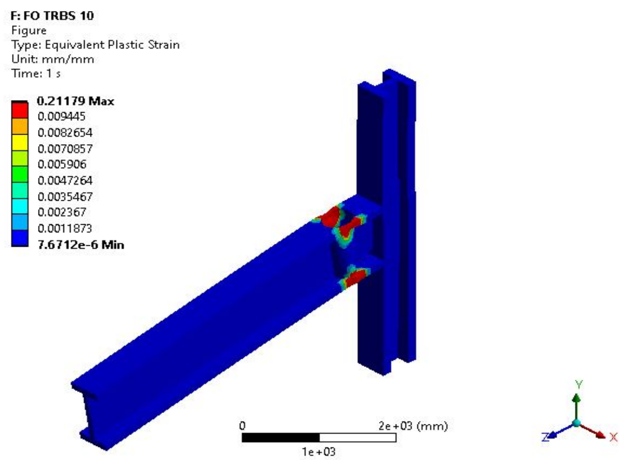


Fig -13: plastic strain (FC TBRBS 10MM)

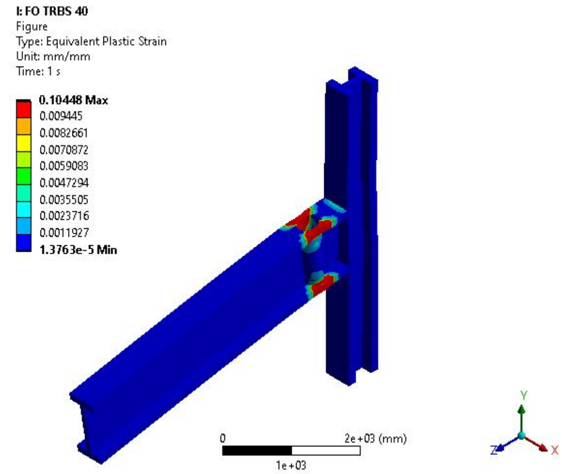


Fig -14: plastic strain (FC TBRBS 40MM)

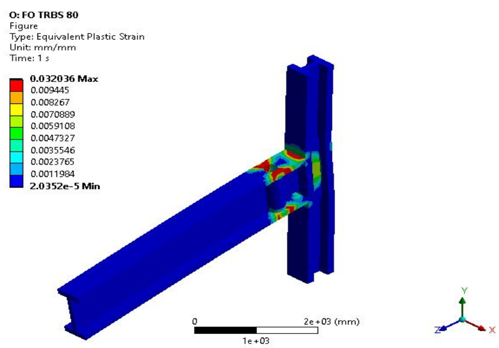


Fig -15: plastic strain (FC TBRBS 80MM)

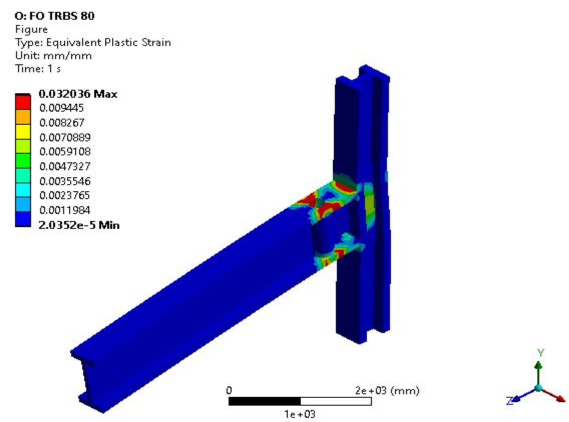


Fig -16: plastic strain (FC TBRBS 90MM)

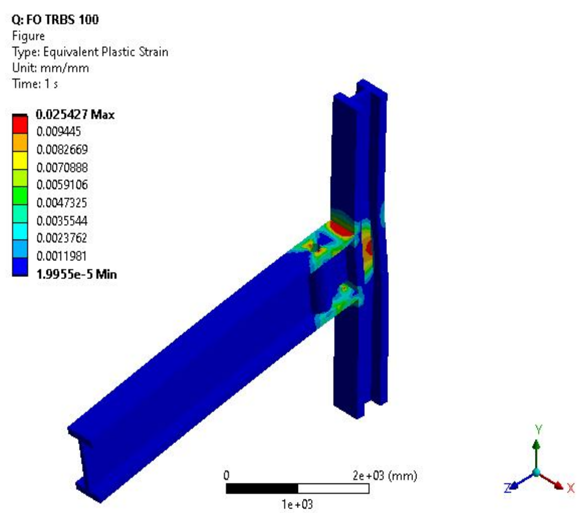


Fig -17: plastic strain (FC TBRBS 100MM

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue III Mar 2023- Available at www.ijraset.com

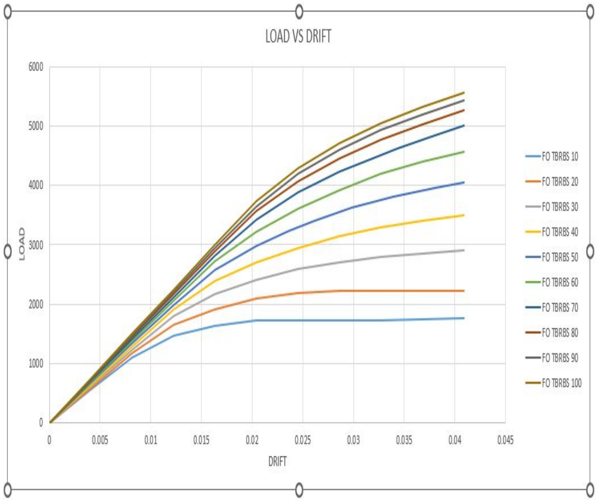


Chart -2: Load -Drift Curve

MODEL	DRIFT %	LOAD(KN)	BEAM STRESS	COLUMN STRESS	%	BEAM STRAIN	COLUMN STRAIN	%
NO RBS	4	5666.3	549.8	598	1	0.0238	0.01	1
FC TBRBS 10	4	1765.9	579.18	231.8	61.2375	0.0029	0.0012	87.999
FC TBRBS 20	4	2220.9	579.52	281.06	53	0.0029	0.0014	85.91
FC TBRBS 30	4	2897.4	579.83	361.63	39.5268	0.0029	0.0019	81.395
FC TBRBS 40	4	3498.6	579.88	435.82	27.1204	0.0029	0.0022	77.659
FC TBRBS 50	4	4052.2	579.93	470.23	21.3662	0.0029	0.0024	76.191
FC TBRBS 60	4	4569.7	579.96	491.43	17.8211	0.0029	0.0025	75.427
FC TBRBS 70	4	4998.5	579.93	519.33	13.1555	0.0029	0.0026	74.032
FC TBRBS 80	4	5268.8	579.96	544.43	8.9582	0.0029	0.0027	72.776
FC TBRBS 90	4	5432.4	579.97	564.68	5.5719	0.0029	0.0028	71.764
FC TBRBS 100	4	5554.1	579.96	581.42	2.7726	0.0254	0.0097	2.722

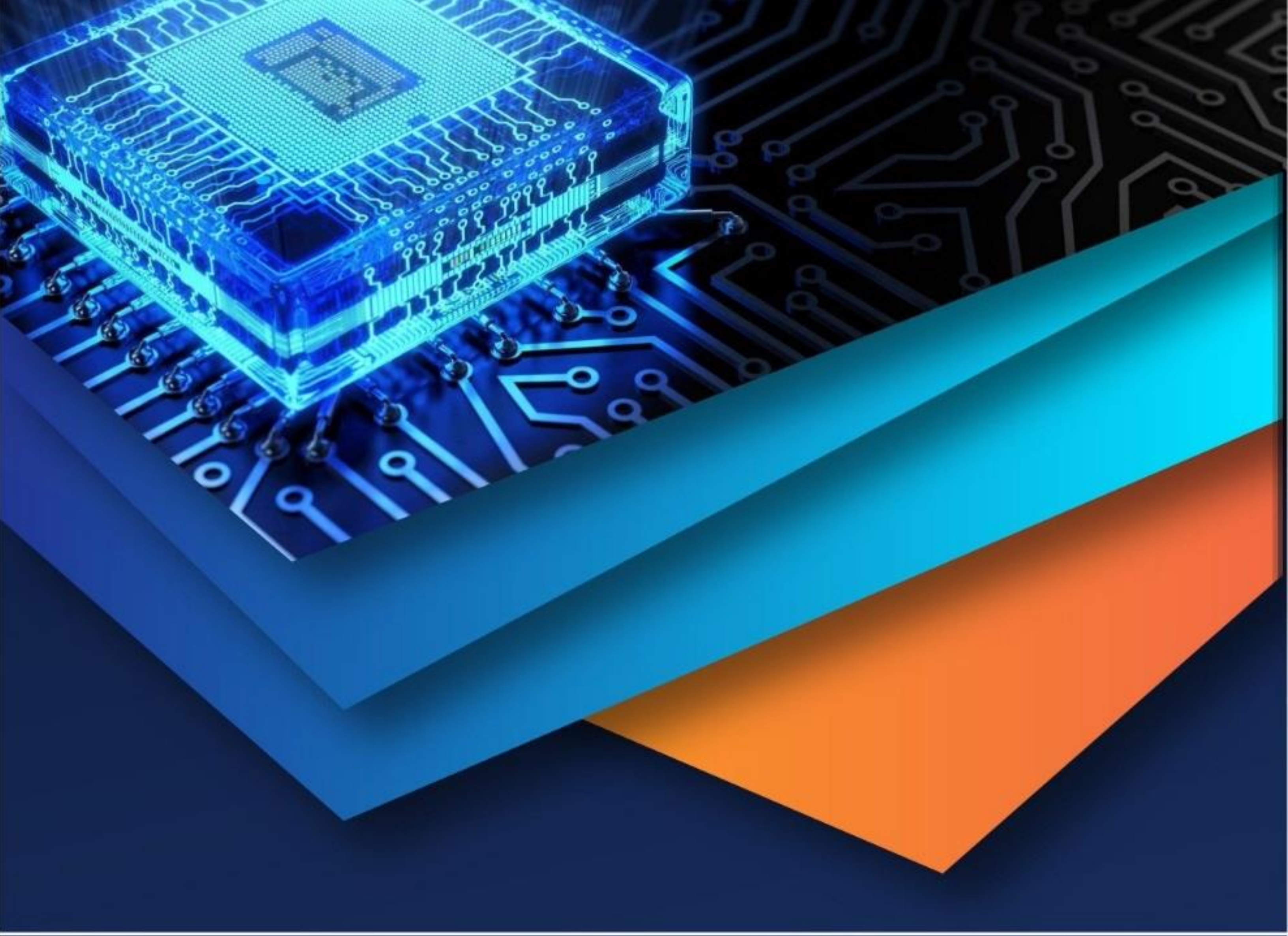
Table-2: performance of jumbo section

V. CONCLUSIONS

A tubular reduced section (RBS) is designed. A tubular reduced beam section (RBS) is made by replacing a part beam with a steel tube at a suitable location of the beam plastic hinge. The main objective of this paper is to study the behavior of the jumbo section with and without implementing tubular RBS in beam-column connection and understand the seismic performance. In tubular flange cuts RBS stress concentration is reduced on comparing to other types. Therefore “strong column - weak beam” design concept is satisfied and also up to 4% drift there is no failure in the structure hence it shows that it has seismic stability. There are 10 models of tubular flange cut RBS out of them tubular RBS of 80,90,100 mm thickness shows almost the same load-carrying capacity compared to no RBS. And out of three, 90mm tubular flange cut RBS shows the strain concentration as 72% than no RBS, and when we are looking to 100mm thickness column stress again increased than beam stress, As a result, we may say that the tubular RBS of 90mm thickness is the ideal section.

REFERENCES

[1] Liangjie Qi, Roberto T. Leon, Matthew R. Eatherton, Jonathan L. Paquette b, ‘‘Parametric investigation on the design of RBS moment connections with jumbo beams and columns” J. Struct. Engg, vol.122, 2021, pp 1292– 1299.
[2] P Cimagala, “Optimization of Reduced Beam Sections (RBS) for Ductile Detailing of Seismic Joint Connections Using Finite Element Analysis (FEA)” J. Constr. Steel Res., vol. 42, pp 49– 69, 2021.
[3] FEMA, Recommended seismic design criteria for steel moment-frames buildings, FEMA 350, 2000 (Washington, DC).
[4] FEMA, State of the art report on base metals and fracture, FEMA 355A, 2000, (Washington, DC).
[5] J. Paquette, “Experimental Investigation of Reduced Beam Section Moment Connections for Jumbo Steel Wide Flange Sections” Virginia Tech, 2018.
[6] Reshma Raveendran, Geetha P.R. “Evaluation of Sloped Tubular Web RBS Moment Connections under” (2019)
[7] Mubeena T S1, Bindu Sebastian “Seismic and premature failure enhancement study in Jumbo beams and columns under RBS concept” PG student, Dept. of Civil Engineering (2022)



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY