FINITE ELEMENT ANALYSIS ON STRENGTHENING OF FULLY PREFABRICATED STEEL FRAME UNDER SEISMIC BEHAVIOUR

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Abstract - *All the structural members were prefabricated in the factory and assembled on site. This paper presents evaluate the strength using single reduced beam in cantilever portion. Reduced beam sections (RBS) is we cut the flange of the beam away from the connection at a particular radius. Then various retrofitting techniques are adopted checking the strength of the frames. Modeling is done by using ANSYS 16.0. Reduced beam with different geometries were modeled.*

***Key Words*: Reduced beam section, Retrofitting**

1. INTRODUCTION

Prefabricated buildings whose members are fabricated in factories and assembled together on site have relatively better construction quality and faster construction speed. All the structural members were prefabricated in the factory and assembled on site. The aim of the study is to evaluate the strength using single reduced beam in the cantilever portion. Reduced beam section s we cut the flange of the beam away from the connection at a particular radius. This radius of cut depends on the geometrical shape of the section.

This reduced capacity of the beam section should be greater than the moment demand due to seismic demands as well as the gravity loading. By doing this, in case of an earthquake, the plastic hinge in the beam is forced away from the beam column joint. Higher ductility demand can be achieved and possible brittle failure because of uncertainties is eliminated. Thus the reduced beam section is useful in order to achieve higher ductility of the seismic system and improve the performance of the structure under earthquake.

When analyzing the structure, stiffness of the beam should be reduced to an RBS equivalent stiffness so that a software program will be able to capture more drifts and deformations in the structure. Drifts are generally control a moment frame structure, thus this becomes an important issue especially when beams contribute more to the overall stiffness of the moment frame. RBS connections also have a number of advantages in design practice. Compared to reinforced connections, their use leads to reduced demands for continuity plates, panel zone reinforcement, and strong column- weak-beam requirements.

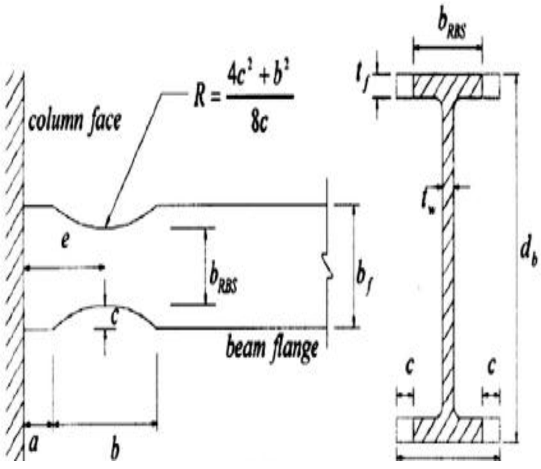

Fig -1: Reduced beam section

2. SCOPE AND OBJECTIVES OF THE STUDY

To develop a finite element model with high accuracy, good stabilization, and acceptable computational costs. Flexible building creations. Reducing the frictional loss in plates. Increasing the strength of the beam using retrofits operation by plates and ribs. The objectives of the work are summarized as follows.

- To study the single reduced beam.
- Optimize the single reduced cantilever beam by placing plates in major stress concentration area.
- To place the web or rib in the maximum stress concentration area to protect the entire beam.
- To place the bolt connections in the maximum stress concentration area to protect the entire beam.
- Checking different load conditions. Such as Rotation, Displacement.
- Find out the suitable profile of cantilever beam.

2. NUMERICAL INVESTIGATION USING ANSYS WORKBENCH 16.0

The ANSYS 16.0 WORKBENCH, a finite element software was used to model the specimen for nonlinear analysis. The dimensions and material properties of all the models in two conditions are same and it is given in table 1.The fundamentals assumptions made to idealize steel mechanical properties are including: Young's modulus of 2 x 10^5 MPa, Poisson's ratio of 0.3. Every model was meshed using 20 noded hexahedron element [Solid 186] to achieve better accuracy in nonlinear analysis.

Table -1: Geometry of Sections

Member	Depth d (mm)	Web thickness t_w (mm)	Flange width b_f (mm)	Flange thickness t_f (mm)
Column	162	8	154	11.5
Beam	200	5.6	100	8.5

RBS dimensions(mm)			
a	b	c	R
60	160	25	140.5

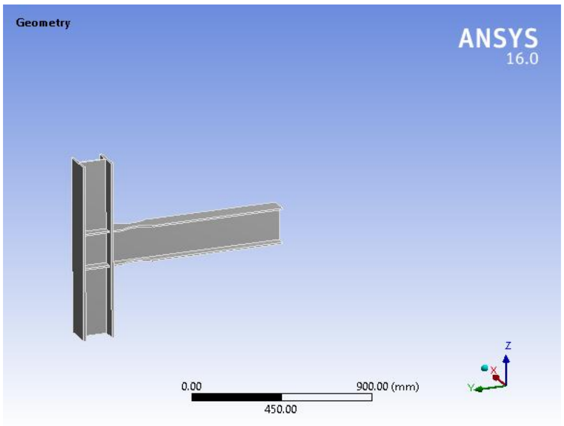

Fig -2: Modelled view of reduced beam.

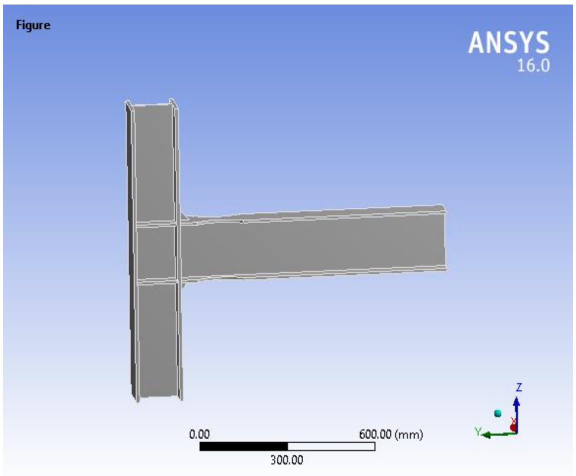

Fig -3: Modelled view of reduced beam with ribs.

Boundary conditions were assigned in two conditions is displacement and rotations. The Displacement were applied in the free end of the beam. Where the rotations in the x directions. The column was assigned in two conditions as fixed supported at the both ends. The retrofitting techniques, reduced beam with ribs and bolted connections were placing in major stress concentration areas in two conditions. The bolts are used 16mm diameters.

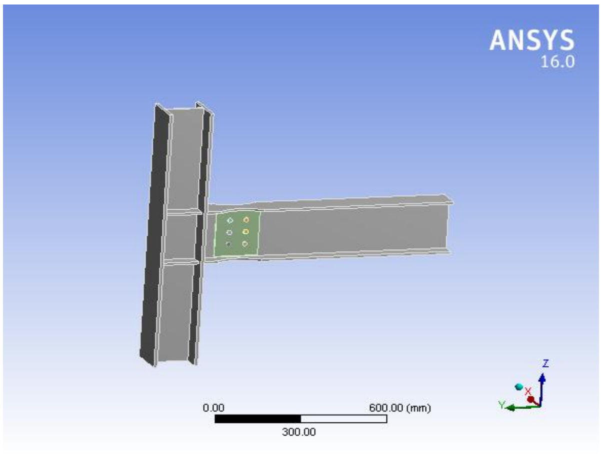

Fig -4: Modelled view of reduced beam with bolted connection.

4. RESULTS AND DISCUSSIONS

The force and corresponding displacements of reduced beam with different geometries were obtained. The force vs deflections graph of reduced beam and reduced beam with bolted connections were shown below in figure 5 and 6.

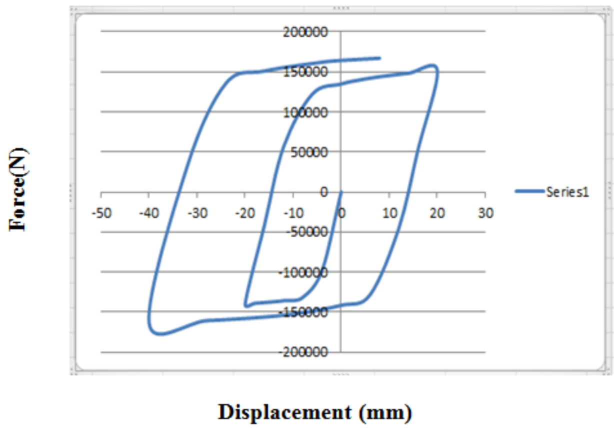

Fig -5: Force vs deflection graph of RBS with bolted connection in displacement condition.

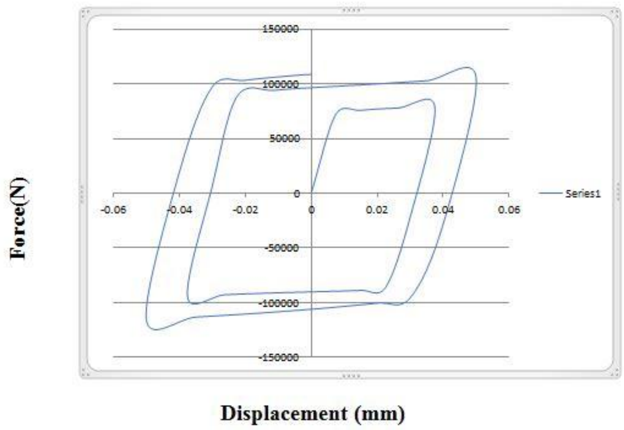

Fig -6: Force vs deflection graph of RBS with bolted connection in rotations.

Figure 7 to Figure 8 shows the total deformation of all the models obtained from ansys. Figure 9 to Figure 10 shows the equivalent von mises stress of all the models from ansys in displacement conditions.

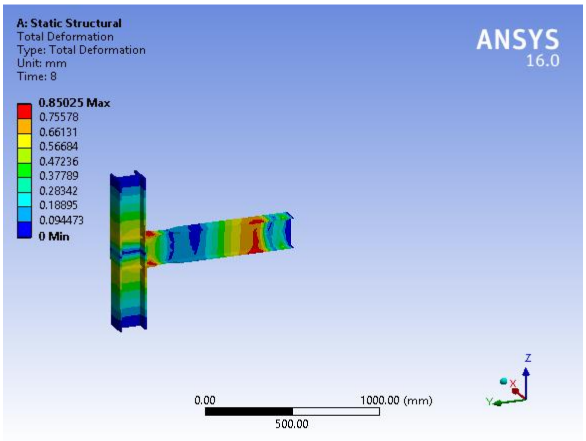

Fig -7: Total deformation of rduced section.

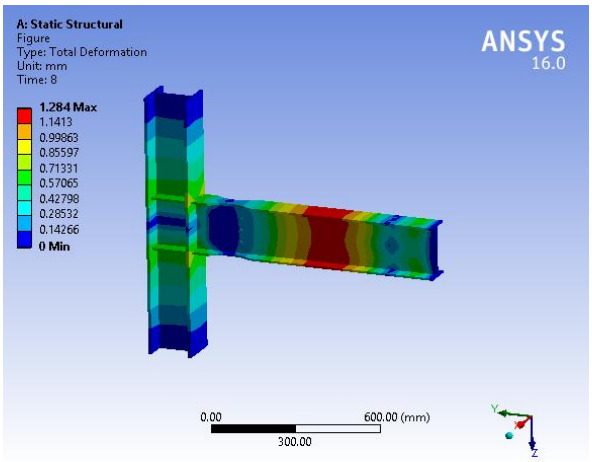

Fig -8: Total deformation of rbs with bolt connection.

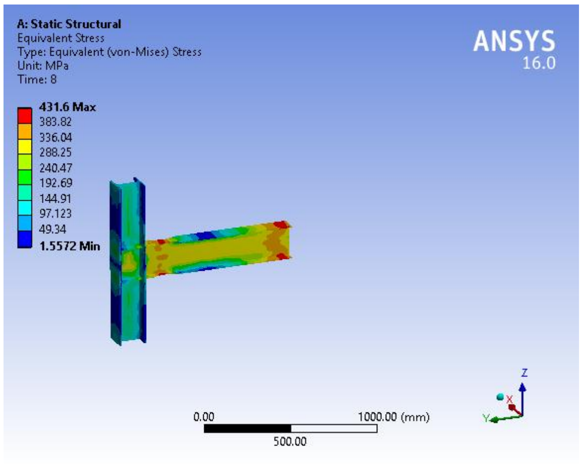

Fig -9: Equivalent von mises stress of reduced beam section.

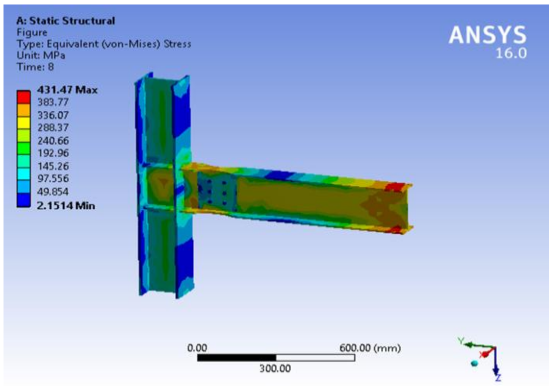

Fig -10: Equivalent von mises stress of rbs with bolt connection.

Figure 11 to Figure 12 shows the total deformation of all the models obtained from ansys. Figure 13 to Figure 14 shows the equivalent von mises stress of all the models from ansys in rotations.

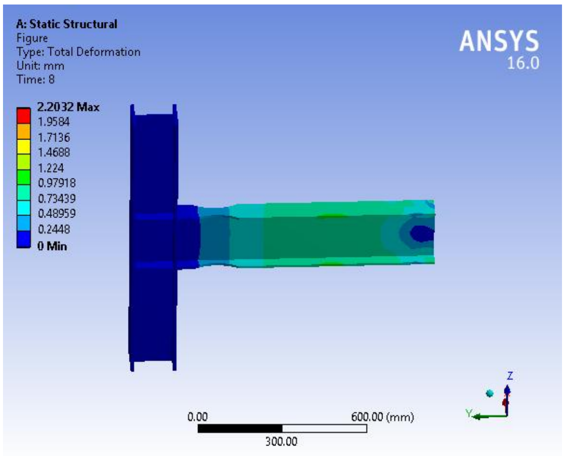

Fig -11: Total deformation of rduced section.

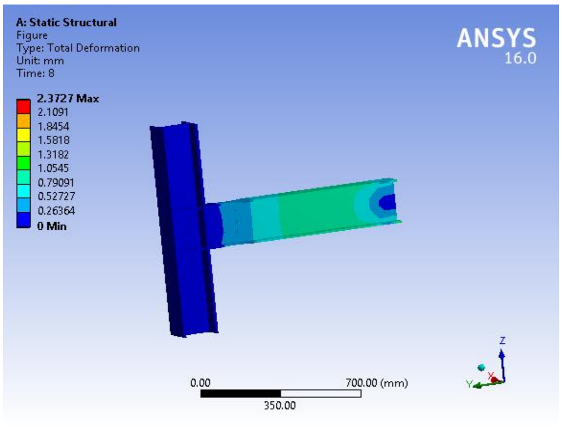

Fig -12: Total deformation of rbs with bolt connection

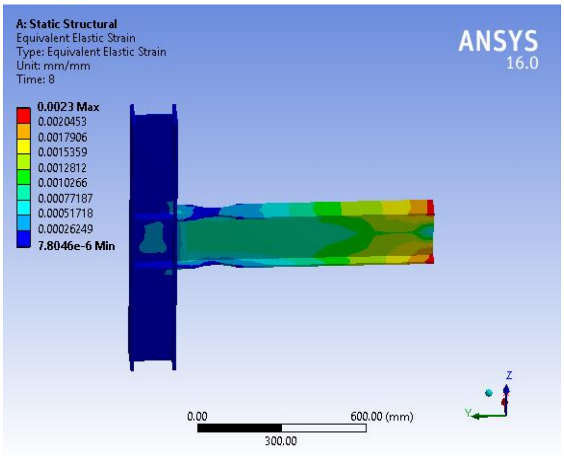

Fig -13: Equivalent von mises stress of reduced beam section.

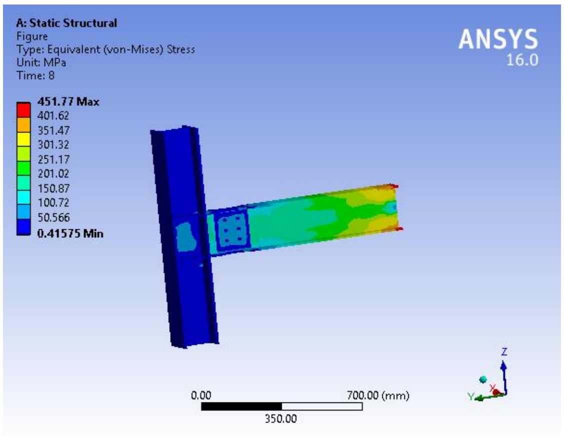

Fig -14: Equivalent von mises stress of rbs with bolt connection.

Table representing reduced stress and force reactions in different loadings.

Table -2: Reduced stress and force reactions in displacement conditions

Model	Reduced beam	RBS with ribs	RBS with bolt connection
Reduced stress	392.87	401.16	326.1
Force reactions	$1.665x10^5$	$1.6784x10^5$	$1.71634x10^5$

Table -3: Reduced stress and force reactions in rotations.

Model	Reduced beam	RBS with ribs	RBS with bolt connection
Reduced stress	153.01	159.05	64.878
Force reactions	$1.016x10^5$	$1.0212x10^5$	$1.0215x10^5$

5. CONCLUSIONS

Reduced beam sections(RBS) connections was much superior to the connection without reduced beam sections. Thus the reduced beam section is useful in order to achieve higher ductility of the seismic system and improve the performance of the structure under earthquake. RBS connections also have a number of advantages in design practice. RBS connection with differenet loadings ,bolted connections was better results in other retrofitting's techniques.

- Among reduced beam with different retrofittings, best results are exhibited by reduced beam with bolted connections in displacement conditons.
- Among reduced beam with different retrofittings, best results are exhibited by reduced beam with bolted connections in rotations.
- It shows the maximum force reaction.
- Since the reduced beam with bolted connections is used it has higher in strength.

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