Study on Steel Beam Column Joint with Different Types of Connections

Abishek P, Karthikeyan G

Abstract: ***A wide theoretical and experimental study was made on different types (welded and bolted) of beam-to-column connections has been made using Reduced Beam Section (RBS) concept. The beam is reduced on the flange with specified radii on both sides of the section. Totally 6 different models have been analysed ANSYS. Single and Double stiffeners are additionally provided in order to increase the time taken for deformation thereby avoiding sudden collapse in the structure. Total deformation is the main parameter considered in the study. Comparing the results from the ANSYS software and thereby choosing the critical section. Then the critical section is developed into a 3 storey frame for which push over analysis is performed using E-TABS. Performance of the building is observed at different stages of hinge formation and push over curve is plotted.***

Keywords: ***Reduced Beam Section, Stiffener, Bolted Connection, Welded Connection, Notch.***

I. INTRODUCTION

Reduced Section Adopted Observation from the literature review gives an idea that RBS with radius cut has good behavior under all loading conditions. The geometric characteristics of RBS is given in Table 1. A typical reduced section with radius cut is shown below (fig.I)

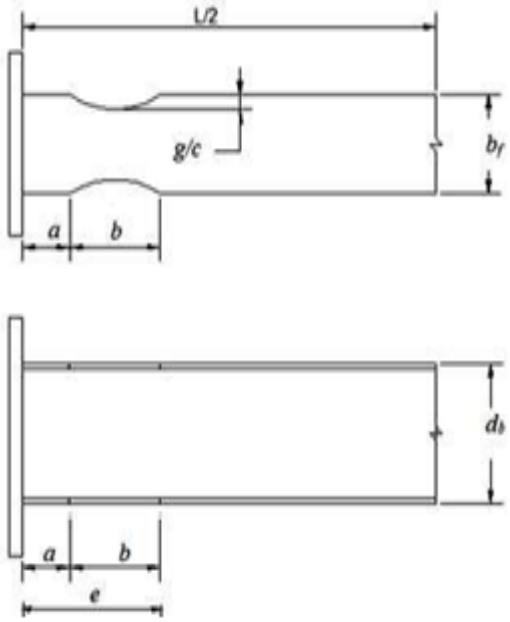

Figure 1.Radius cut with Geometry

FEMA350-2000	EC8, Part 3	AISC 358-05
$a = (0.5 \text{ to } 0.75)\ b_f$	$a = 0.6\ b_f$	$a = (0.5 \text{ to } 0.75)\ b_f$
$b = (0.65 \text{ to } 0.85)\ d_b$	$b = 0.75\ d_b$	$b = (0.65 \text{ to } 0.85)\ d_b$
$c \leq 0.25\ b_f$	$g = c \leq 0.25\ b_f$	$0.1\ b_f \leq c \leq 0.25\ b_f$
$s = a + b/2$	$s = a + b/2$	--
$r = (4c^2 + b^2)/8c$	$r = (4c^2 + b^2)/8g$	--

Table I Geometric Characteristics of RBS with Radius cut

Member	ISMB250
Depth(mm)	250
Web Thickness(mm)	6.9
Flange Width(mm)	125
Flange Thickness(mm)	12.5
Moment of Inertia(mm^4)	5131.6×10^4

Table II Section Properties

II. TYPES OF CONNECTIONS USED

A. Analytical Study

Notched without stiffener (Bolted & Welded), Notched with single stiffener (Bolted & Welded), Notched with double stiffener (Bolted & Welded), Cyclic loading in Notched Double Stiffener (Bolted & Welded)

B. Experimental Study

Notched without stiffener (Bolted & Welded), Notched with double stiffener (Bolted & Welded).

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C. Performing Analytical Study

The beam-column junction is analyzed using FEM Software. A frame is constructed using a beam-column joint based upon the results obtained from FEM software and it is analyzed using ANSYS Software.

D.ANSYS Modelling

A beam-column joint is designed using ANSYS workbench 16.1. Totally 8 models were created.

E.ETABS Modelling

A three storey frame is designed from the most critical section available from the above 8 models. The model which is selected is "Notched double stiffener bolted connection with Cyclic Loading". Fig III represents the ansys model for RBS section with double stiffener bolted connection.

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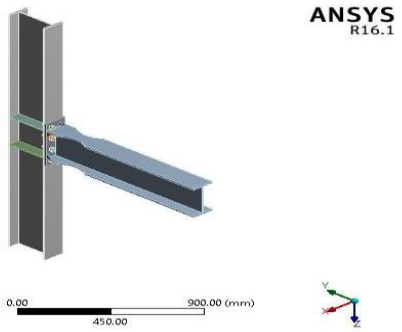


Figure 2 ANSYS Model of RBS with double stiffener (Bolted)

Fig 4. represents the RBS section with double stiffener welded connection modelled in ansys software.

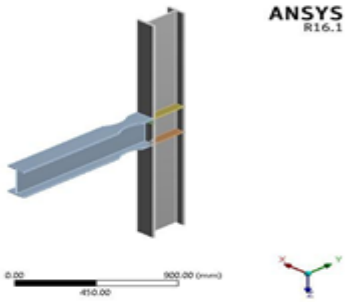


Figure 3 ANSYS Model of RBS with double stiffener (Welded)

III. RESULTS AND DISCUSSION

A. Analytical Study

The results which are required based upon the requirements which are determined using both ANSYS and ETABS software From ANSYS

On performing analysis of all the section the critical section is choosed based upon the performance of the total deformation. The deformation at the joint is shown in fig V and VI.

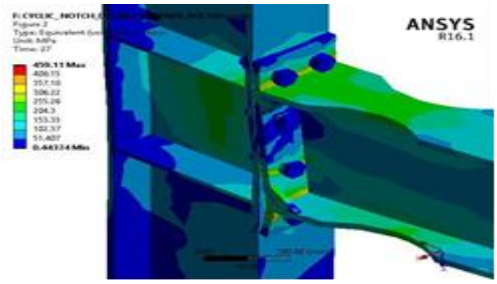


Figure 4 Deformation for Bolted Connection

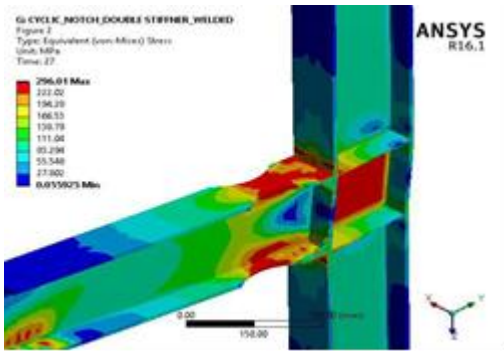


Figure 5 Deformation for Welded Connection

Two of those sections were choosed and cyclic Loading is given in order to obtain Hysteresis Loop to check and compare the critical section. Fig VII shows the hystersis lop for moment and angle.

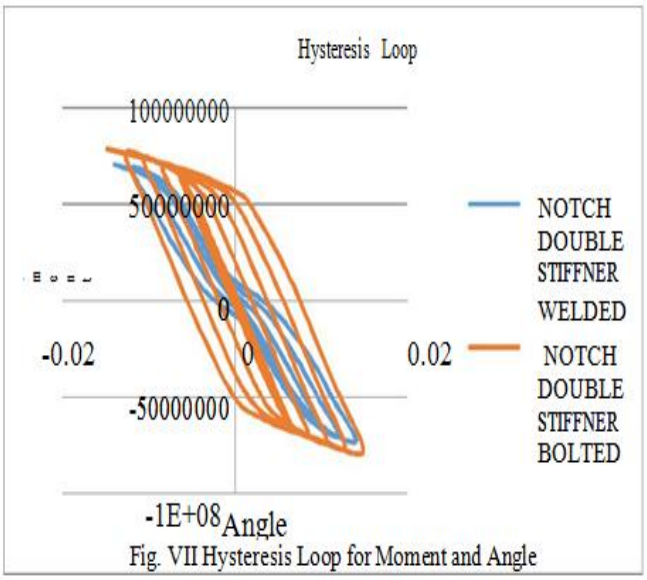


Figure 6 Hysteresis Loop for Moment and Angle

Fig VIII shows the hysteresis loop for load and deflection.

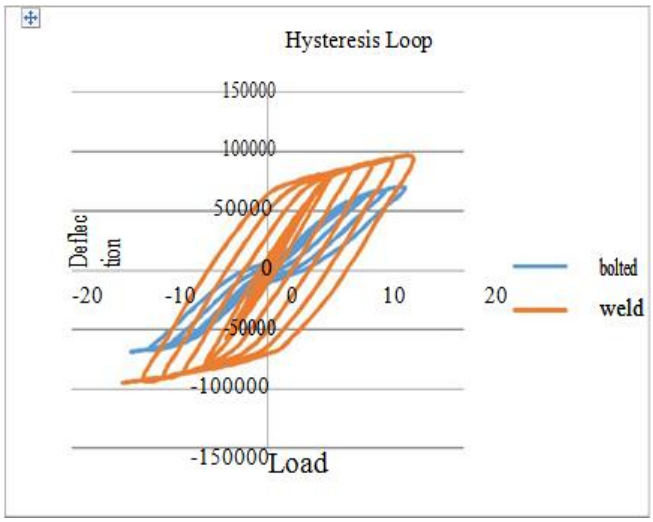


Fig. VIII Hysteresis Loop for Load and Deflection

B. Experimental study

For comparison all the models were fabricated as in design and the test is performed in lab. Experimental test setup is shown in fig IX and X.

Figure 8 Notched Bolted ConnecFig. X Loading Cell of Beam Column JointFrom ETABS

In the design of frame the model selected is from ANSYS is "Cyclic Loading in Notched section with Double Stiffener(bolted)". It is the crictial section where the grade of the bolts and thickness of the end plate is altered compared to other section in order to achieve deformation in the notch of the section.

Figure By performing push over analysis both push over curve and performance of the building is determined. The results are as follows. The Hinge formation is observed and performnace of the building at different stages which are analysed in e-tabs are shown in the fig XII, XIII and XIV.

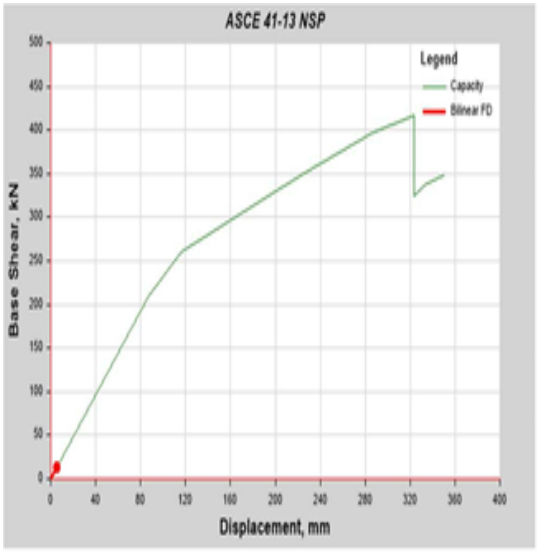
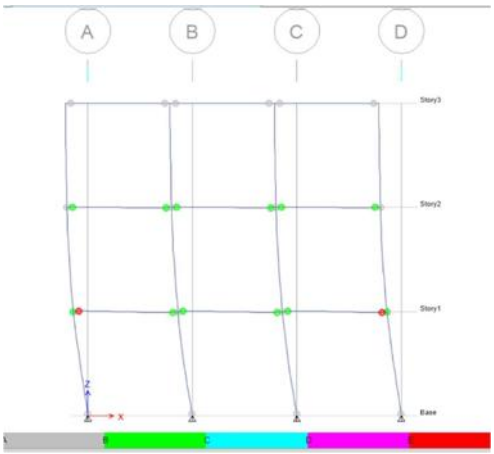


Figure 10 Push over Curve



Performance of the Building

Figure 11 Performance of Building Stage 2

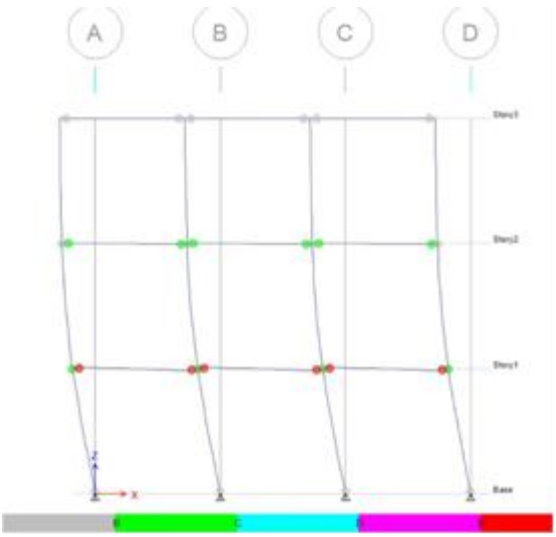


Figure 12 Performance of Building Stage 2

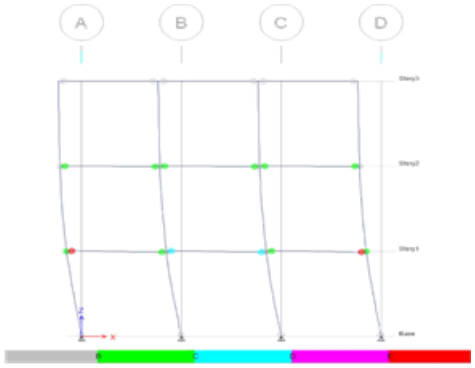


Figure 13 Performance of Building Stage 3

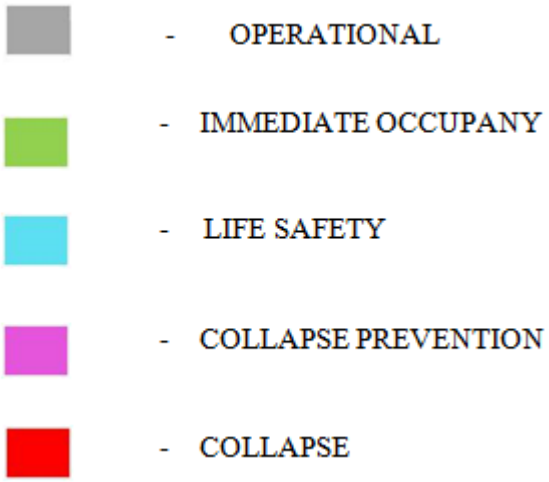


Figure 14 Different Stages in Performance of Buildings

IV. CONCLUSION

From the above results obtained from the analysis, the various comparisons are made with the types of connection and with conventional joint which is also designed. From that, the following conclusions are made,

Reduced beam section is much effective in welded joint when compared bolted joint since there is no deviation in results between Notched and Un notched bolted connection.

On optimizing the Hysteresis Loop, the bolted connection tends to attain its original position but when compared to welded connection it does attain its original position as it is a rigid connection. Push over analysis is performed on Notched double stiffener bolted connection under cyclic loading. On performing this analysis, the frame is subjected to seismic loading and performance of the building is determined. On doing analysis the frame reaches collapse at Stage 3 due to failure in Storey 1. Hence it is optimum when compared to other connection used in practice.

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