ANALYTICAL STUDY ON MOMENT ROTATION CURVE FOR BEAM-COLUMN STEEL CONNECTION WITH END PLATE

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Abstract - *The structure connections should be studied carefully because it is always preferable for a structural part to break before a connection. It is always a brittle failure if the structural connection fails before the member, and the results will be disastrous. Present study is focused on determining the structural performance of various beam-column connections. The three-dimensional model of beam-column connection is made by using CATIA software. ANSYS software can predict the real behaviour of beam-to-column joints in steel sections subjected to point load is presented. It helps to study the behaviour of moment rotation curve for beam-column steel connection with end plate.*

Key Words: **CATIA, ANASYS, End plate, Rigid joint, Semi-rigid joint, Hinged joint.**

1. INTRODUCTION

The load distribution of structural frames is significantly influenced by connections between beams and columns. The primary purpose of these connections is to transfer the load from the floor system and beams to the columns. In its most basic form, the beam is thought to be simply supported and the connection is primarily employed to transfer the end reaction of the beam to the end reaction of the beam to the column. When constraints are present, the beams end rotations are limited, and the resulting end moments can be used to lower the beams maximum positive moment. Moment-resistant joints are a common term for such connections. Shear connections are those that are only capable of transmitting the beams reaction. Also of relevance is how the link between the beam and column affects the general behaviour of the frame. Bolting or welding can be used to create these connections. The flexibility of the joint can range from a hinged to a rigid joint condition depending on the type of joining technique and components utilize to construct the joint. Any joint that produces more than 90% of the ideal rigid joint moment is categorized as rigid, and any joint that produces less than 10% of the ideal rigid joints moment is categorized as a hinged joint. Joints that produce moments and rotations in between these two extremes are referred to as semi-rigid joints.

2. METHODOLOGY

2.1 Types of connections

a) Beam-column with end plate connection

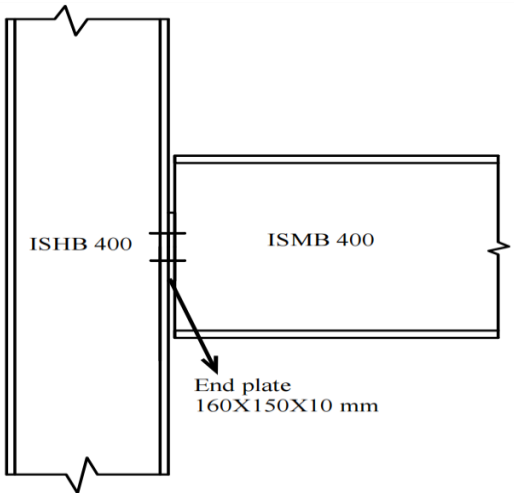

Fig -1: Beam-column with end plate connection

b) Beam-column with End plate and seat angle connection

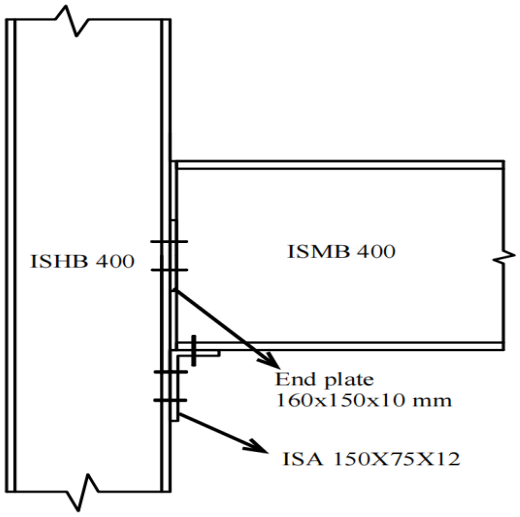

Fig -2: Beam-column with end plate and seat angle connection

c) Beam-column with seat angle and cleat angle connection

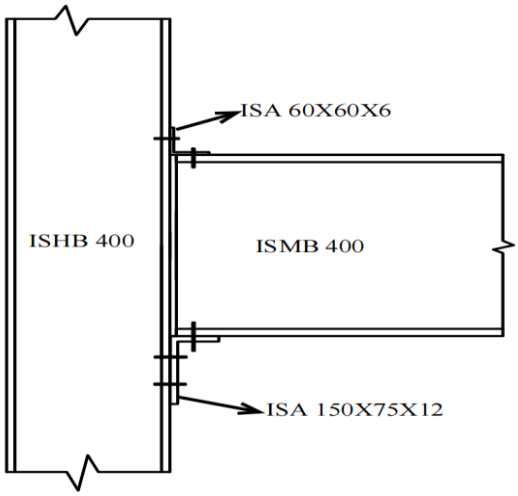

Fig -3: Beam-column with seat angle and cleat angle connection

Table -1: Section properties of Steel

Descriptions	Sizes
Column	ISHB 400
Beam	ISMB 400
End plate	160*150*10 mm
Cleat angle	60*60*6 mm
Seat angle	150*75*12 mm
Stiffeners	110*375*10 mm
Bolt	20 mm
Grade of bolt	4.6
Grade of steel	415 N/mm^2

Table -2: Material properties of Steel

Young's modulus of Steel (GPa)	206
Poisson's ratio of Steel (ν)	0.3
Density of Steel, (kg/m^3)	7850
Yield Stress (MPa)	415

2.2 CATIA models of the steel connections

The beam-column connections are modeled in CATIA software. CATIA stands for Computer Aided Three-Dimensional Interactive Application. CATIA is the industry-leading software for 3D CAD design excellence in engineering and product development. It is used to design, model, analyse and construct items.

a) Beam-column with end plate connection

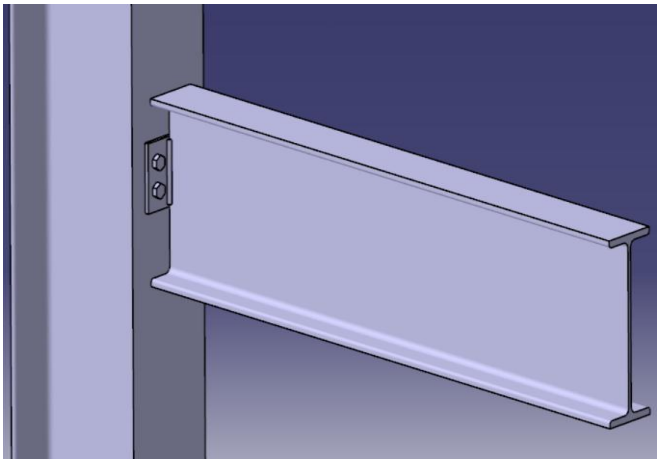

Fig -4: Beam-column with end plate connection

b) Beam-column with End plate and seat angle connection

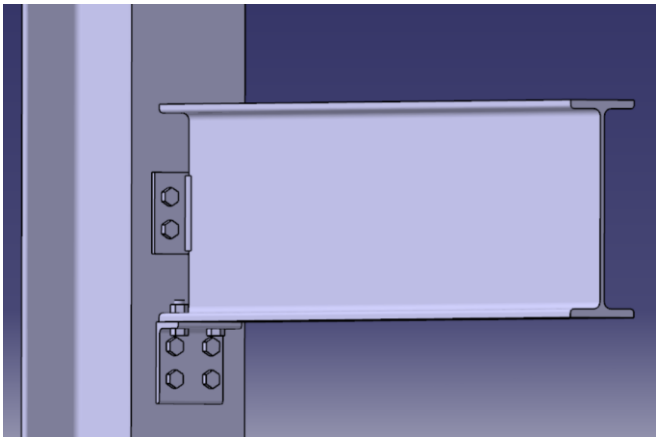

Fig -5: Beam-column with end plate and seat angle connection

c) Beam-column with top and seat angle connection

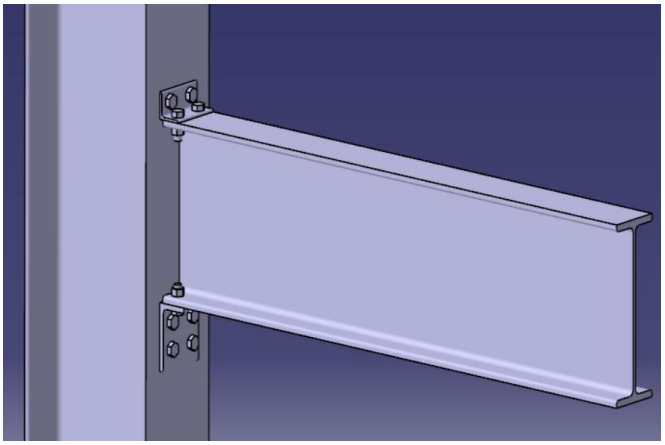

Fig -6: Beam-column with seat angle and cleat angle connection

2.3 Analysis of the steel connections in ANSYS software

a) Model 1: Beam-column with end plate connection

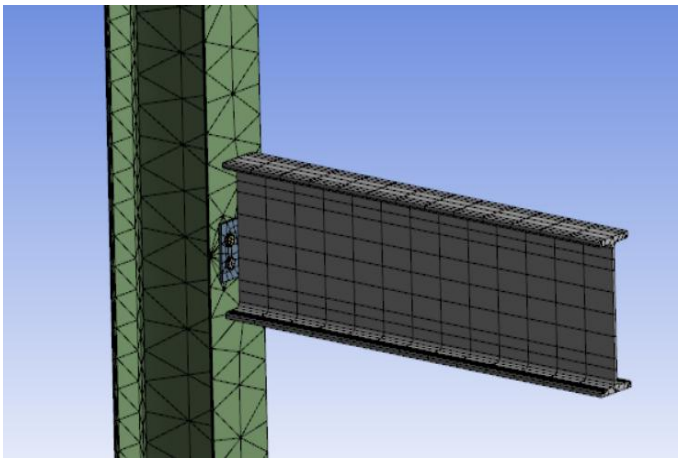

Fig -7: meshed steel beam-column connection

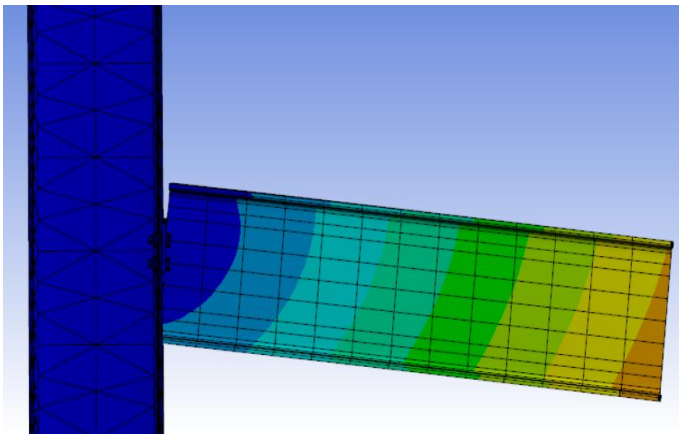

Fig -8: deflection of steel beam-column connection

b) Model 2: Beam-column with End plate and seat angle connection

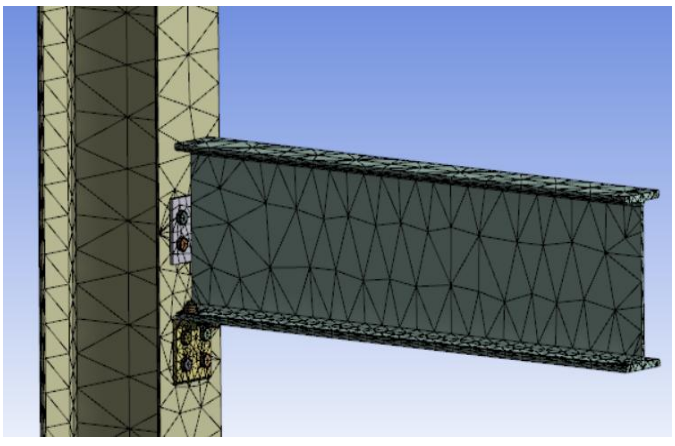

Fig -9: meshed steel beam-column connection

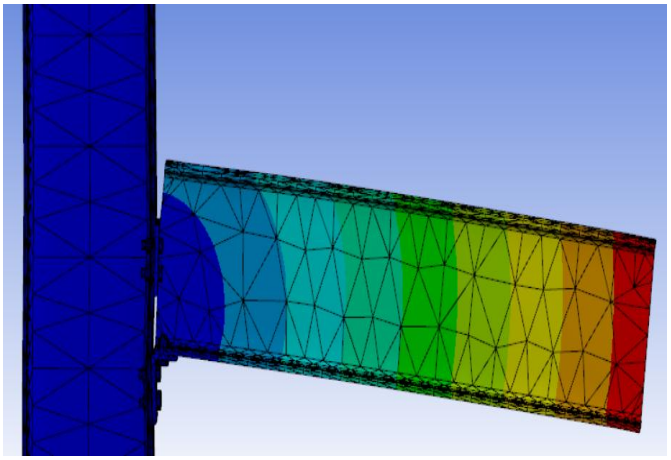

Fig -10: deflection of steel beam-column connection

c) Model 3: Beam-column with seat angle and cleat angle connection

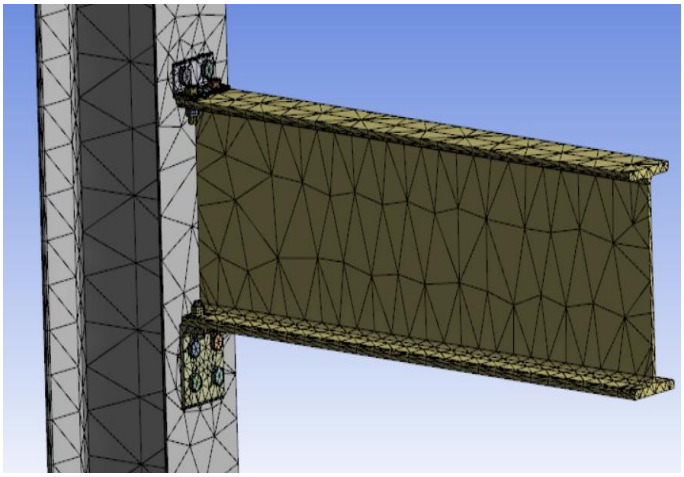

Fig -11: meshed steel beam-column connection

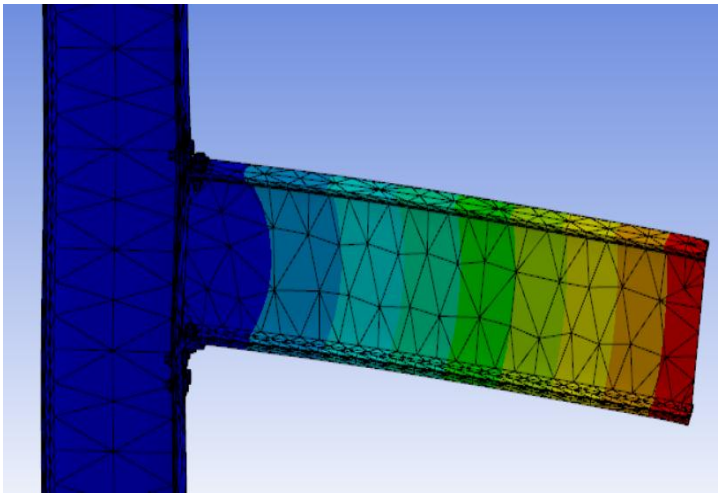

Fig -12: deflection of steel beam-column connection

3. Results from ANSYS software

Table -3: Analysis result of moment-rotation

Moment (kN-m)	Model 1	Model 2	Model 3
	Rotation (rad)	Rotation (rad)	Rotation (rad)
0	0	0	0
30	5.445	0.1738	0.0614
60	10.891	0.3476	0.1220
90	16.337	0.5214	0.1841
120	21.783	0.6952	0.2454
150	27.229	0.8690	0.3068
180	32.674	1.0429	0.3682
210	38.120	1.2167	0.4295
240	43.566	1.3905	0.4909
270	49.011	1.5643	0.5523
300	54.445	1.7382	0.6137
330	59.903	1.9120	0.675
360	65.348	2.0858	0.7364
390	70.794	2.2596	0.7978
420	76.240	2.4330	0.8591
450	81.686	2.6072	0.9205

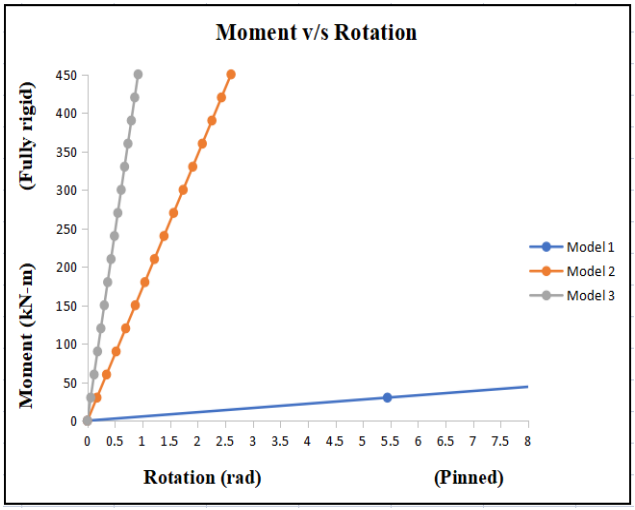

Chart -1: Combined moment v/s rotation graph

4. CONCLUSIONS

i. Relative rotation is maximum for model 1 (beam-column with end plate connection). Hence it has very less stiffness and it can be treated as pinned connection.

ii. Relative rotation is minimum for model 3 (beam-column with seat angle and cleat angle connection). Hence it has maximum stiffness compare to other connections and it can be treated as rigid connection.

iii. Relative rotation for model 2 (beam-column with end plate and seat angle connection) is in between model 1 (beam-column with end plate connection) and model 3 (beam-column with seat angle and cleat angle connection). Hence it can be treated as partially restrained or semi rigid connection.

iv. Moment in beam ends for model 1 (beam-column with end plate connection) is very less and hence it can be treated as pinned connection.

v. Moment in beam ends for model 3 (beam-column with seat angle and cleat angle connection) is more and hence it can be treated as rigid connection.

vi. Moment in beam ends for model 2 (beam-column with end plate and seat angle connection) is in between model 1 (beam-column with end plate connection) and model 3 (beam-column with seat angle and cleat angle connection). Hence it can be treated as semi rigid connection.

vii. The behaviour of connections can be studied in an attractive and detailed manner using ANSYS.

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BIOGRAPHIES

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