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Performance of Different Types of Multi-storied Frames During Earthquake

Prof. Kavita. K. Ghogare [1], Miss. Minakshi. B. Sonone [2]
[1, 2] *Department of Civil Engg , COET, Akola, SGB Amravati University*

Abstract: ***The principle objective of this project is to comparison between RCC and Steel Structure multi-storeyed building by using STAAD.Pro with same building dimension.The design involves load calculations and analyzing the whole structure. The design methods used is Limit State Design conforming to Indian Standard Code of Practice. Analysis the members due to Seismic load. The proposal structure is a 12 storied building with 3 m as the height of each floor. The overall plan dimension of the building is 24.0 m x 24.0m.***
Keywords: ***RCC frames structure, Steel structure***

I. INTRODUCTION

Earthquake is a natural phenomenon, which is generated in earth's crust. Duration of earthquake is usually rather short, lasting from few seconds to more than a minute or so. But thousands of people loose their lives due to earthquakes in different parts of the world.

A. Frame Structure

Initially there was no distinction between the supporting structure and protecting skin, however separation of supporting and protecting function leads to the framed system. A framed system may be defined as "A framed structure in any material is one that made stable by skeleton that is able to stand by itself as a rigid structure without depending on floors or wall to resist deformation." Material such as steel, reinforced concrete and wood, which are strong in both tension and compression, make best members for framing.

B. Material of Construction

Most of the framed buildings are constructed in reinforced cement concrete. RCC is composite material that is it made of concrete + steel. Concrete is obtained by mixing cement, sand, small stone, water in required proportion. Steel used is called reinforcement. They are round in shape and can twisted as per requirement. Reinforced take care of the weakness the concrete has and hence result in economical composite material. Frame build up of beam and columns

C. Steel & 2.Concrete

Resisting lateral load by bending of beam and columns. Provide lots of open interior space. Make building flexible.
Concrete frame structures are a very common or perhaps the most common type of modern building. This type of building consists of a frame or skeleton of concrete. Horizontal members of this frame are called beams and vertical members are called as columns. Humans walk on flat planes of concrete called slab. The column is the most important as it is the

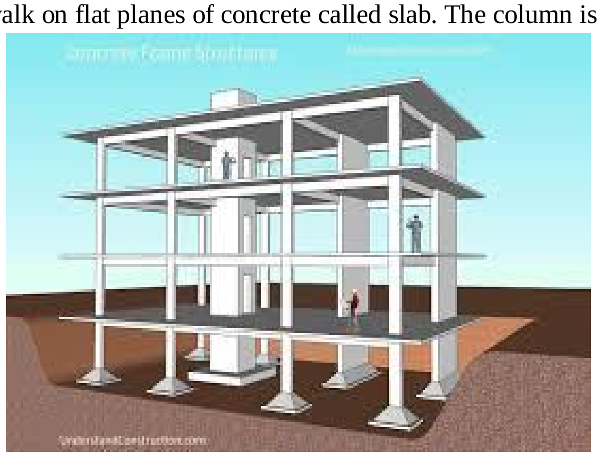

Fig. 1: RCC Frame structure

Fig. 2: Steel Frame structure

The role of steel structure is important in construction area. Steel have the some physical properties like as high strength per unit weight and ductility. Because of ductile nature steel structure gives the sufficient warning before failure by the way excessive deformation. These properties of steel are very important in case of seismic resistant design. The resistance to lateral loads from earthquake is the reason for the evolution of various structural systems.

D. Aim

Performance of Different Types of Multi-storied Frames During Earthquake.

E. Obectives

1) Study of different types of frame structure like RC frames and steel frames building and their performance during an earthquake
2) To analyse different types of frame structure multi-story buildings
3) Analysis is done with the use of STAAD.PRO software

F. Need

1) The behavior of structure changes with the material for construction due to its properties
2) To make building better resistances to collapse
3) Good deformation control
4) Perform well in earthquake prone zone
5) Good durability during an earthquake
6) Suitable for any number of stories

G. Scope

1) To study how analysis is to be carried out in STAAD pro.
2) It also includes the comparison of test result of various type of frames structure building during earthquake

II. METHODOLOGY

A. Different Phases of Methodology

1) *Phase- I*
a) Introduction: A general idea about the topic along with need and scope is stated.
b) Methodology: Total breakdown structure of line of work is given
2) *Phase-II*
a) Detailed study: Various types of seismic forces, various technique, various mathods, seismic consideration as per IS 1893:2002, IS 800:2007
b) Analysis for various types multi-story frame structure during earthquake
3) *Phase- III*
a) Observation: Observation obtained from the various analyses is done.
b) Results: results are derived on basis f the analysis.
c) Conclusion and limitation
d) Future Scope: future scope for work regarding this topic is stated.
e) References: various literatures

III.EXPERIMENTAL WORK

A. Case Study

A 12-story RCC and steel frames structure building has plan dimension as shown in fig. Determine the seismic forces shear at different floor levels. Manually and by using software for various case. The various cases analyzed are:

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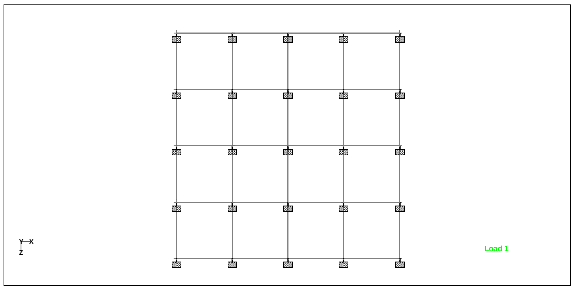

Fig. 3: Plan

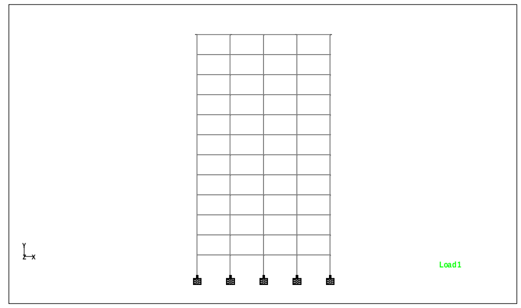

Fig. 4: Elevation

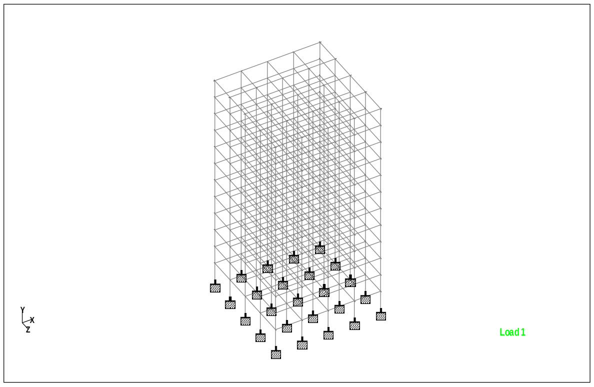

Fig. 5: 3D View

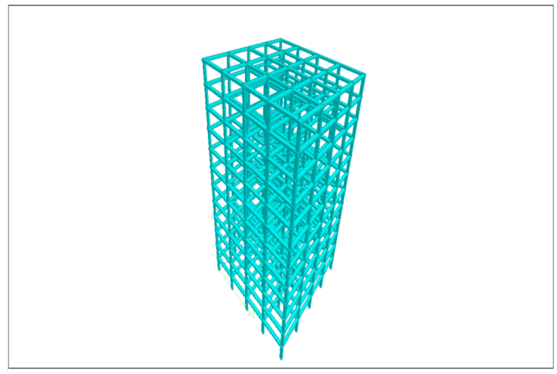

Fig. 6: 3D Rendered View

Table 1: Seismic load cases

Case I	RCC frame Structure subjected to seismic load for zone II
Case II	RCC frame structure subjected to seismic load for zone III.
Case III	RCC frame structure subjected to seismic load for zone IV
Case IV	RCC frame structure subjected to seismic load for zone V
Case V	STEEL frame structure subjected to seismic load for zone II
Case VI	STEEL frame structure subjected to seismic load for zone III.
Case VII	STEEL frame structure subjected to seismic load for zone IV
Case VIII	STEEL frame structure subjected to seismic load for zone V

Table 2: Frame detailing required for analysis

Particulars	RCC structure	Steel structure
No. of story	12	12
Plan dimension	24mx24m	24mx24m
Total height of building	36m	36m
Size of beam	300×600mm	Encased I section
Size of column	300×600mm	Encased I section
Slab thickness	120mm	120mm
Dead load	4KN/m^2	4KN/m^2
Live load	On each floor 3KN/m^2 On roof 1.5KN/m^2	On each floor 3KN/m^2 On roof 1.5KN/m^2
Seismic zone	II, III, IV, V	II, III, IV, V
Soil condition	Hard soil	Hard soil
Response reduction factor	3.0	5.0
Importance factor	1.0	1.0

IV. OBSERVATION

Table 3: CASE I Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	311	11:1.5(DL+EQX)	106.079	-6.773	-0.023	106.295	-0.000	0.000	-0.001
Min X	315	12:1.5 (DL-EQX)	-106.079	-6.773	-0.023	106.295	-0.000	-0.000	0.001
Max Y	306	1:EQX	70.601	1.381	-0.001	70.615	-0.000	0.000	-0.000
Min Y	288	6:1.5 (DL+LL)	0.000	-24.560	-0.036	24.560	-0.000	-0.000	-0.000
Max Z	303	13:1.5 (DL+EQZ)	0.000	-7.675	56.289	56.810	0.001	0.000	0.000
Min Z	323	14:1.5 (DL-EQZ)	0.000	-7.673	-56.336	56.856	-0.001	-0.000	0.000
Max Rx	103	13:1.5 (DL+EQZ)	0.000	-4.163	21.866	22.259	0.002	0.000	-0.000
Min Rx	123	14:1.5 (DL-EQZ)	0.000	-4.162	-21.892	22.284	-0.002	-0.000	-0.000
Max rY	305	11:1.5(DL+EQX)	105.567	-6.552	0.049	105.770	-0.000	0.000	-0.001
Min Ry	301	12:1.5 (DL-EQX)	-105.567	-6.552	0.049	105.770	-0.000	-0.000	0.001
Max Rz	105	12:1.5 (DL-EQX)	-43.804	-1.696	-0.015	43.837	0.000	0.000	0.003
Min Rz	101	11:1.5(DL+EQX)	43.804	-1.696	-0.015	43.837	0.000	-0.000	-0.003
Max Rst	313	11:1.5(DL+EQX)	105.973	-16.372	-0.024	107.230	0.000	0.000	-0.000

A. Reaction Summary

Table 4: Case I Reaction Summary

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	9	12:1.5 (DL-EQX)	102.880	3.31E 3	1.710	1.763	0.003	-161.484
Min FX	7	11:1.5(DL+EQX)	-102.880	3.31E 3	1.710	1.763	-0.003	161.484
Max FY	13	6:1.5 (DL+LL)	0.000	5.33E 3	0.079	0.157	0.000	-0.000
Min FY	6	1:EQX	-54.815	-368.968	0.621	0.502	-0.004	94.074
Max FZ	7	14:1.5 (DL-EQZ)	-0.562	3.27E 3	109.312	200.715	-0.004	0.533
Min FZ	17	13:1.5 (DL+EQZ)	-0.559	3.27E 3	-109.174	-200.476	0.004	0.531
Max MX	7	14:1.5 (DL-EQZ)	-0.562	3.27E 3	109.312	200.715	-0.004	0.533
Min MX	17	13:1.5 (DL+EQZ)	-0.559	3.27E 3	-109.174	-200.476	0.004	0.531
Max MY	25	14:1.5 (DL-EQZ)	-2.700	723.434	56.196	149.656	0.092	2.591
Min MY	21	14:1.5 (DL-EQZ)	2.700	723.434	56.196	149.656	-0.092	-2.591
Max MZ	7	11:1.5(DL+EQX)	-102.880	3.31E 3	1.710	1.763	-0.003	161.484
Min MZ	9	12:1.5 (DL-EQX)	102.880	3.31E 3	1.710	1.763	0.003	-161.484

Similarly reaction summary and bending moment are carried out for othe cases i.e. CASE II, CASE III, CASE IV, CASE V, CASE VI, CASE VII, CASE VII. And maximum shear force and bendin moment are carried out for outer and center frame at corner and middle beam and columns.

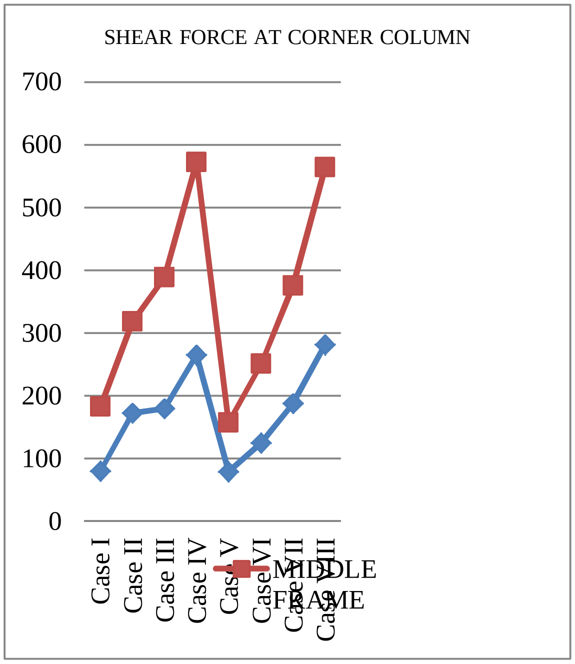

Fig. 7: Shear force at corner column

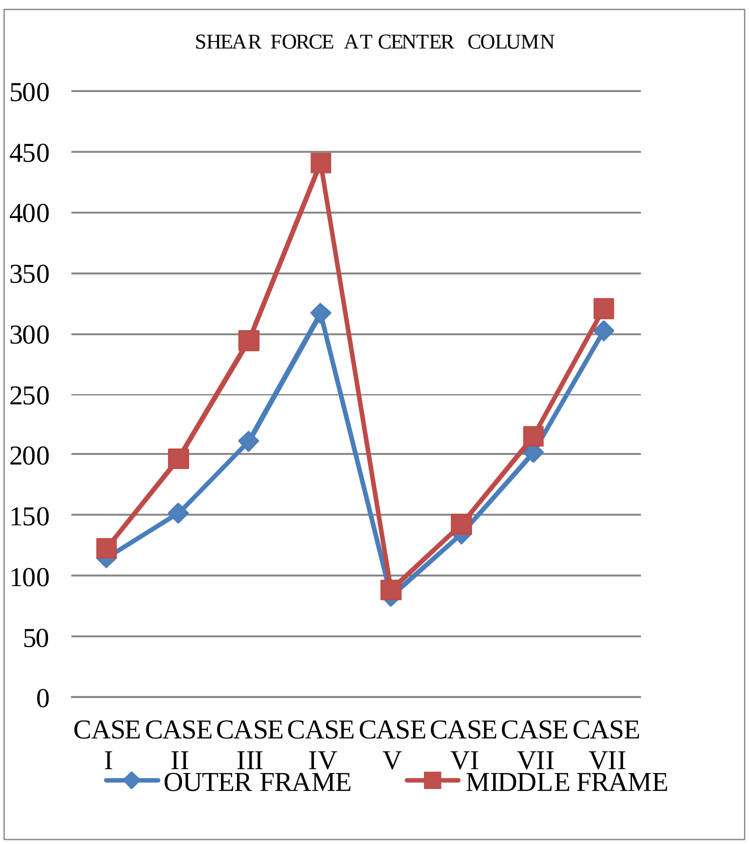

Fig. 8: Shear force at center column

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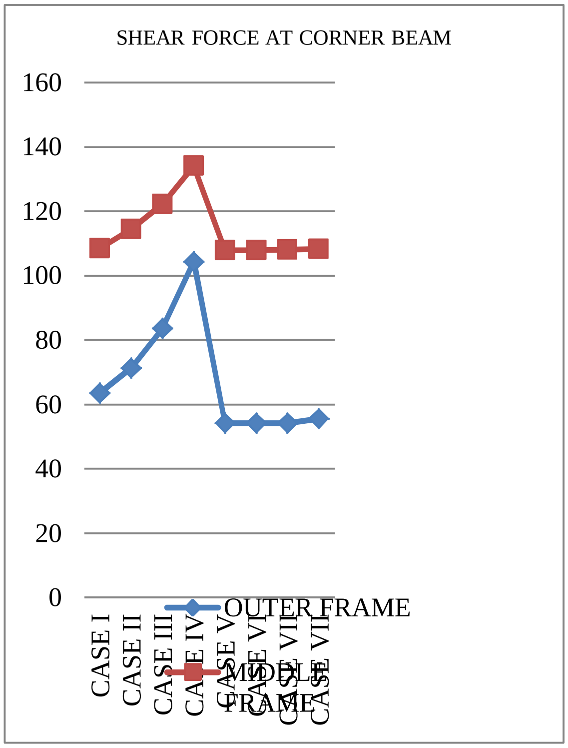

Fig. 9: Shear force at corner beam

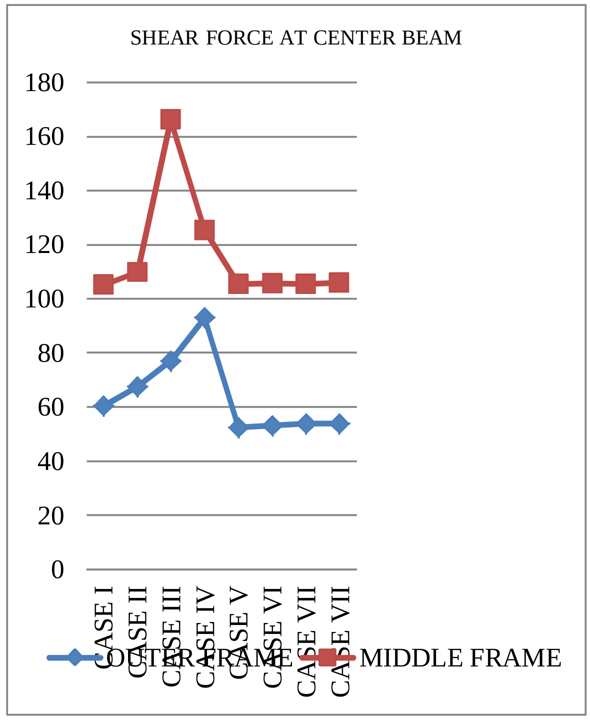

Fig. 10: Shear force at center beam

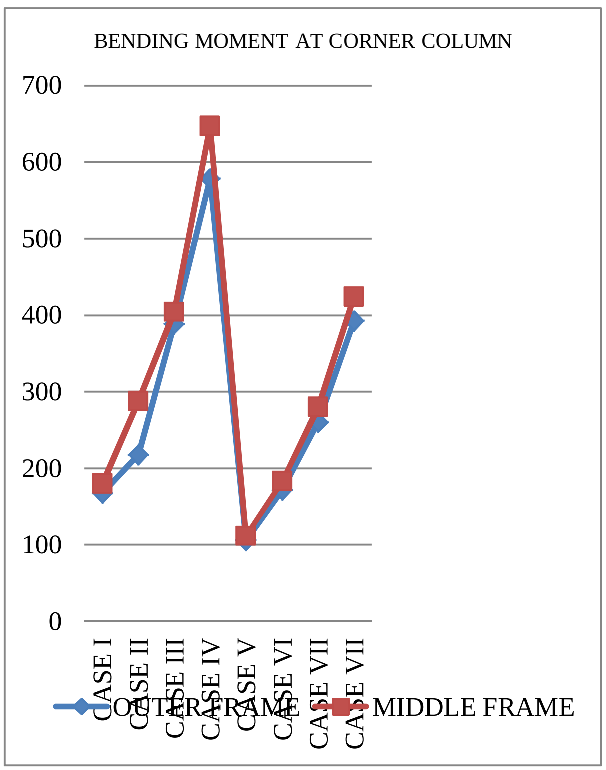

Fig. 11: Bending moment for corner column

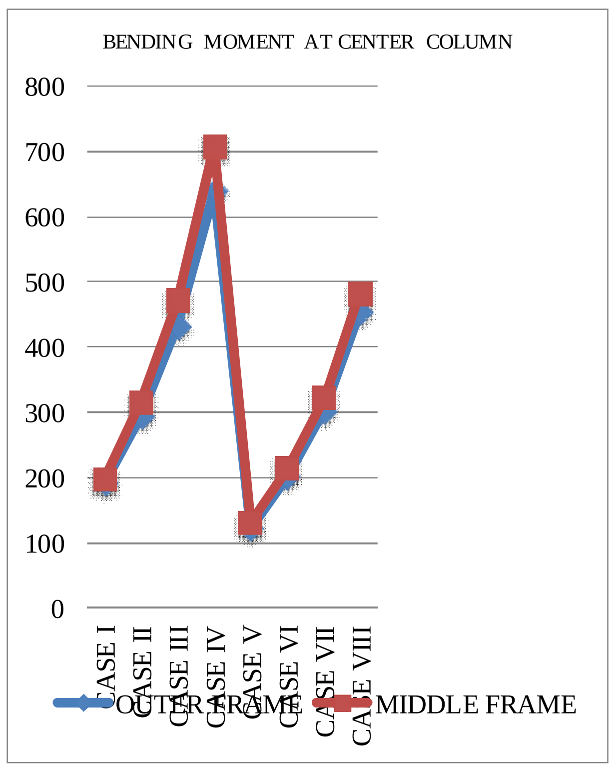

Fig. 12: Bending moment at center column

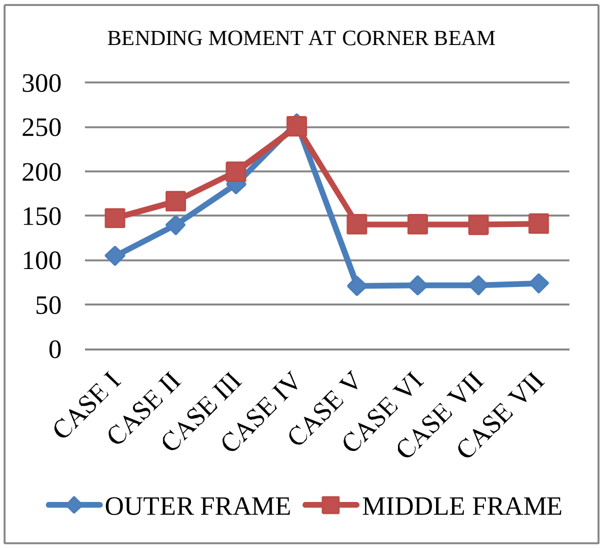

Fig.13: Bending moment at corner beam

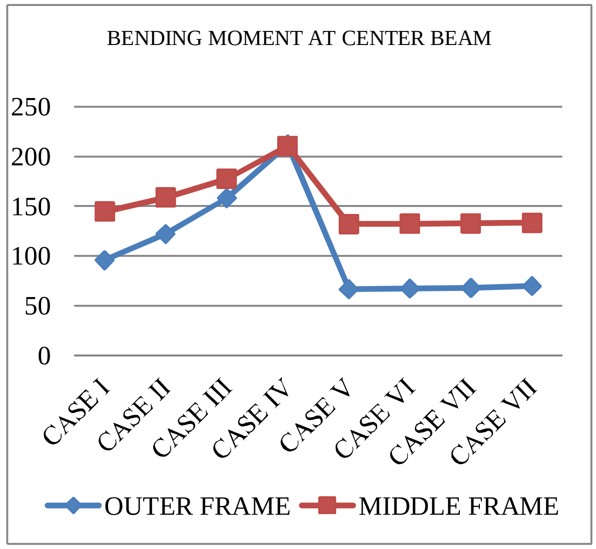

Fig. 14: Bending moment at center beam

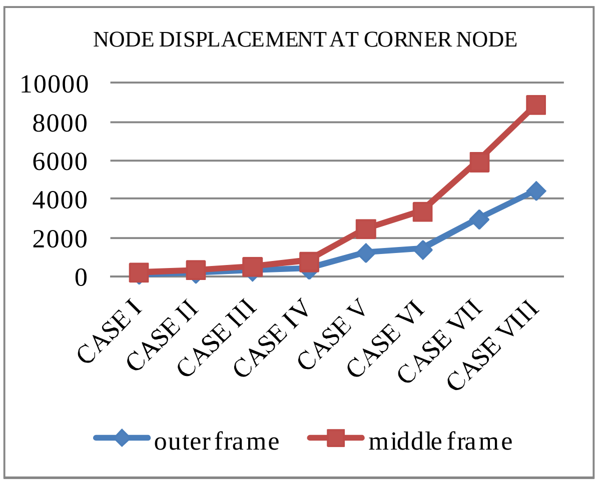

Fig. 15: Node displacement for corner node

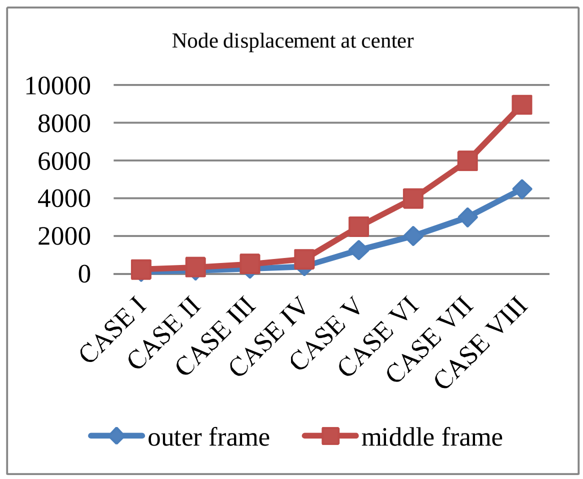

Fig. 16: Node displacement for center node

1) At time of seismic analysis by using software, considering the outer and middle frame with corner and middle columns, beams and nodes.
2) Analysis is done by using the software manly consider the effect of shear force, bending moment and node displacement.
3) Maximum shear force developed in middle frame as conpairing to the outer frame as well as is maximum at center column and beam for bothe RCC and steel with load combination of 1.5(DL-EQX) for RCC and 1.7(DL+EQX) for steel frame.
4) From the analysis bending moment is maximum for middle frame with column and beam, and miminum at outer frame with corner beam and column with load combination 1.5(DL+EQX) for RCC and 1.7(DL+EQZ) for steel frame
5) During seismic analysis maximum node displacement occurs at top node with load combination of 1.5(DL-EQX) for RCC and 1.7(DL+EQZ) for steel frame
6) From the whole analysis it is observed that difflaction is maximum for the middle frame at corner and center nodes in case of steel frame as compare to RCC frame As the Zone changes, the effect of shear force, bending moment and bisplacement increases.

V. CONCLUSIONS

In this paper the study is done for seismic analysis of RCC and steel building with the same building dimensions. During an earthquakes performance of the frames structure playes an important role in terms of stability,strength and resistive power. For finding the performance of a frame structure different types of frames are considered i.e. RCC frame structure and steel frame structure with considering the effect of seismic forces on outer frame and middle frame at corner and center point. IS 456:2000, IS 800:2007 and IS 1893:2002 (Part 1) are used. Seismic analysis critarea are given in IS 1893:2002 (Part 1) Maximum shear forces and bending moments are developed in middle frame at center point than corner point as compaired the outer frame, in case of RCC frame structure than steel frame. RCC carries maximum comparesive forces and steel carries maximum tensile forces. As per the observations RCC frame analysed by considering the maximum seismic effect and for that applying the IS Code provisions, due to this making the safe RCC frame structure. Steel is a ductile material and therefore performance is maximum of a steel frame structure. Steel frame is more resistive that RCC frame. And also from observations it is clear that maximum nodal displacement occurs in steel frame than RCC frame at the top level. From further study it is clear that, the seismic severity increases with different zones. From overall analysis results and observations, the final concusion is performance & stability of a multi-storied steel frame is more than multi-soried RCC frame. As per the property of steel and IS Code provisions. And finally both the steel and RCC frames are stable against earthquake forces.

VI. ACKNOWLEDGMENT

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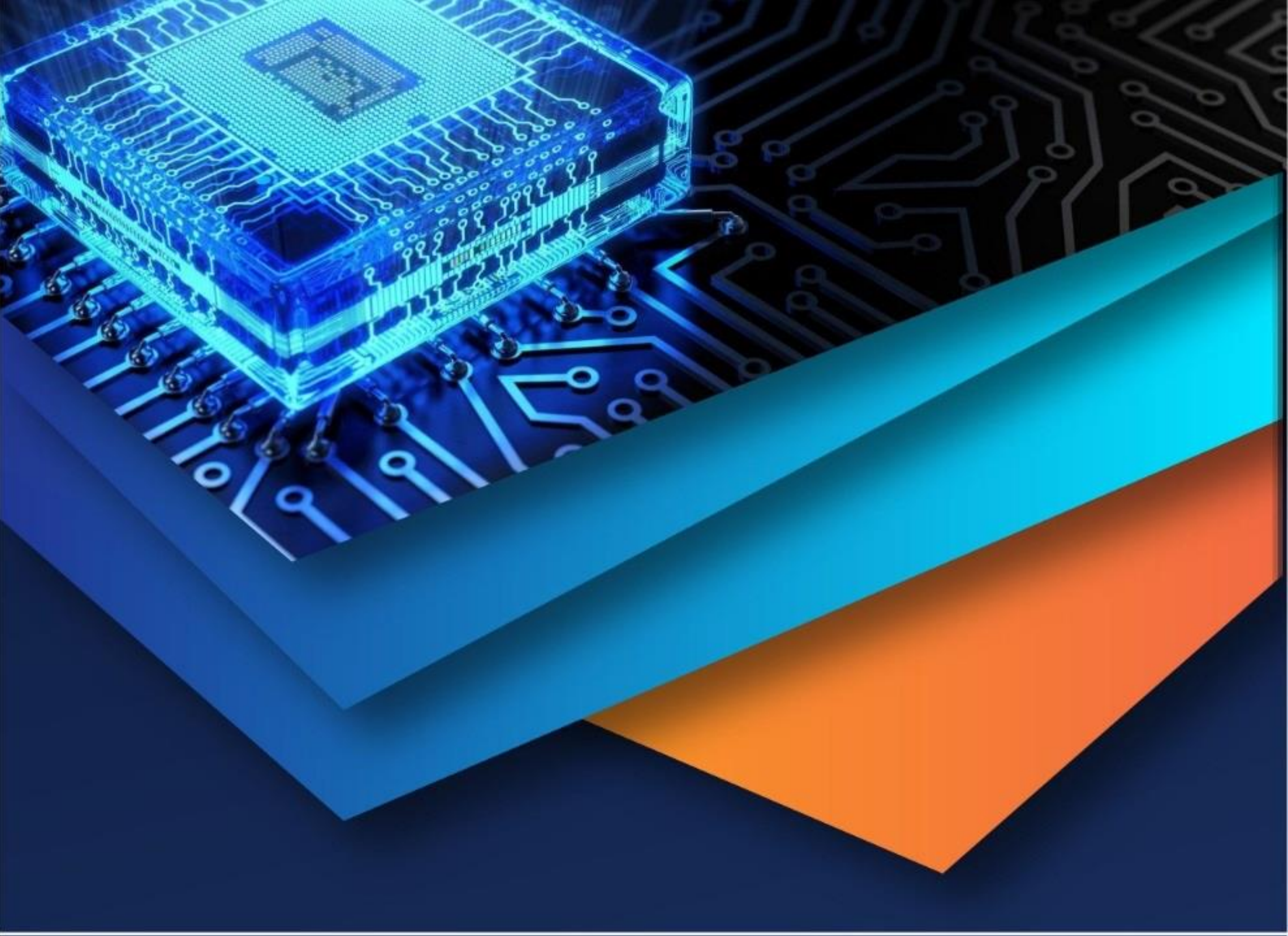

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