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SEISMIC ASSESSMENT OF STEEL FRAMES USING DIFFERENT BRACING SYSTEMS

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Abstract : Structures having sufficient strength and stiffness able to withstand deflection and collapse during earthquake. Strength and stiffness can be increased by adding bracings in the structure. In the present study typical G+6, G+8 and G+ 10 storied steel frames are modeled and analyzed. In the present study bare frame and frames with X bracing, Diagonal bracing, V bracing, and Inverted V bracing are studied. In the present study, R factor is calculated for steel frames. For the analysis non-linear static pushover analysis is used. SAP2000 V19 software is used to carry out pushover analysis. In this study results are compared in terms of base shear, pushover curve and R factor. The factors called over strength factor, ductility factor, redundancy and damping factor affects the R factor. The result of this study shows that the R factor is affected by the type of bracing system and the height of the structure.

Index Terms **- Strength, stiffness, bracings, Response Reduction Factor, Pushover analysis, Pushover curve.**

I.INTRODUCTION

Earthquake resistant structures are designed to resist lateral loads occurred during earthquakes in addition to gravity loads. Many design procedures depend on an elastic analysis of structure which does not consider the nonlinear behavior of structure. Researches have shown that a structural system designed elastically can take larger loads than the design loads. The nonlinear response of structure is not incorporated in design process but its effect is integrated by using a reduction factor called R factor.

The structure will fail only when large amount of plastic hinges are formed in the structure. Even though a plastic hinge is formed at one end, when non-linear behavior of certain structural elements is taken into account it will continue to take load beyond its elastic capacity as the member was designed for deformations greater than demand. For making the structure safer, durable and economic, an engineer has to implement reduction factors in the design to reduce the forces acting on the structure.

Steel bracing is economical, occupies less space, easy to erect and flexible to attain the required strength and stiffness. Braced systems are effective due to their strength and stiffness. Diagonal members take axial load and give more stiffness against the horizontal shear. Hence Braced frames are most economical lateral load resisting systems used in the building.

There are mainly two types of bracings concentric and eccentric. In this study concentric bracings are used as they form a truss and create a stiff frame.

II. BUILDING MODELLING AND DETAILS

A six, eight and ten storied steel frame structure having four bays in X direction and three bays in Y direction have been considered for the analysis. The building elevation is shown in fig 2.2. for 6, 8 &10 storey. The columns are fixed at the ground. Building is modeled with and without bracings in SAP2000V19. Bracings are used at the corners to increase the stiffness. Different types of bracings are considered such as X bracing, Diagonal bracing, V bracing and Inverted V bracing shown in fig 2.3, fig 2.4 & fig 2.5 for 6, 8 & 10 storey structure respectively.

All the detailing of six, eight and ten storied structure is given below.

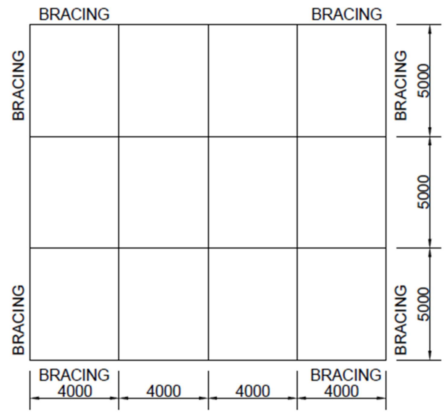

Fig-2.1: Typical floor plan

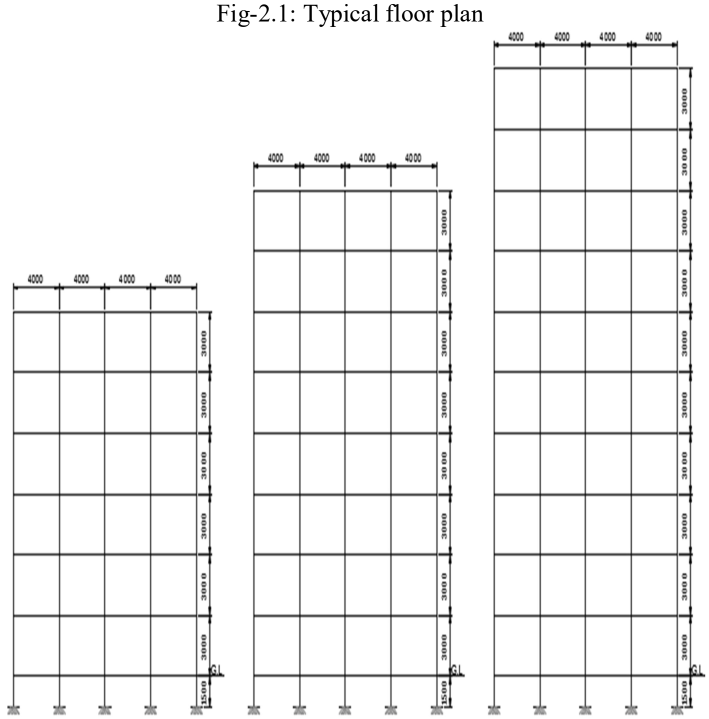

Fig-2.2: Elevation of 6, 8 & 10 storey bare frame structure

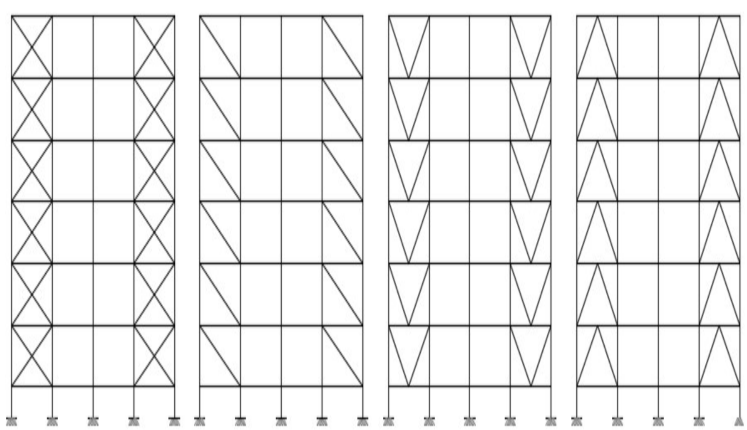

Fig-2.3: Elevation of 6 storey braced frame structure

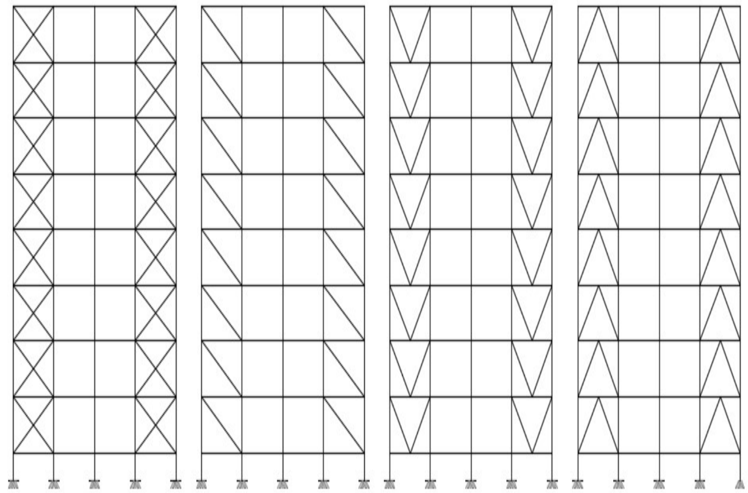

Fig-2.4: Elevation of 8 storey braced frame structure

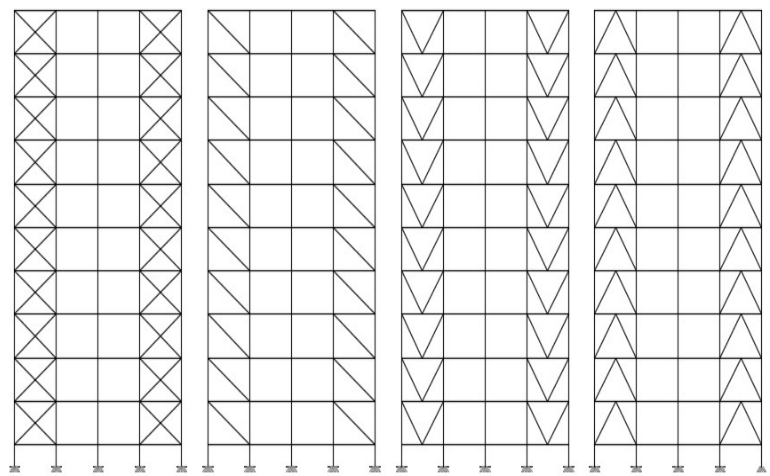

Fig-2.5: Elevation of 10 storey braced frame structure

Table-2.1: Building Details

Sr.No	Description	Details
1	Type of structure	Steel
2	Bays along X direction	4 numbers
3	Bays along Y direction	3 numbers
4	Storey height	3 meter
5	Bay width along X direction	4 meter
6	Bay width along Y direction	5 meter
7	Live load	3 kN/m^2
8	Live load (Roof)	1.5 kN/m^2
9	Floor finish	1.5 kN/m^2
10	Floor finish (Roof)	2.5 kN/m^2
11	Seismic zone	Zone III
12	Importance factor	1
13	Response reduction factor	4
14	Soil type	Medium
15	Damping	5%

The material properties of the structural steel are as follows:

Table-2.2: Material properties

Sr.No	Description	Value
1	Weight per unit volume	7850 kg/m3
2	Modulus of elasticity (E)	2.1x105 N/mm2
3	Poisson's ratio (μ)	0.3
4	Minimum yield stress (Fy)	250 N/mm2
5	Minimum tensile stress (Fu)	410 N/mm2

Table -2.3: Section size used in model for analysis

Sr. No	Member	Top and bottom flange width	Top and bottom flange thickness	Depth	Web thickness
		m	m	m	m
1	Beam (I-section)	0.125	0.0125	0.25	0.0069
	Member	**Width**	**Depth**	**Thickness**	
2	Column(Box section)	0.3	0.3	0.01	
	Member	**1st leg width**	**2nd leg width**	**Thickness**	
3	Bracing (Angle section)	0.1	0.1	0.01	

III. Analysis

For Fifteen models of steel frame non-linear static pushover analysis is carried out using software SAP2000. Gravity loads are applied and then calculated lateral loads using IS code load pattern. Lateral load is applied to the structure. Hinge properties are assigned to the column, Beam, and Bracings according to FEMA-356. Model is run for the analysis. After running the analysis we get Pushover curve from display option. Pushover curve shows lateral displacement values on X-axis and corresponding base shear values on the Y-axis. Same procedure is followed for without bracing, diagonal bracing, X bracing, V bracing and inverted V bracing structures. Required values are recorded from pushover curve and then calculated R factor for all the Frames.

IV. RESULTS

4.1 Base shear

The values of base shear calculated for different type and height of the structures are shown in tabulated format given below

Table -4.1: Base shear values

Type of structure	Base shear					
	6 Storey		8 Storey		10 Storey	
	Vbx	vby	Vbx	Vby	Vbx	Vby
Without bracing	829.58	829.58	1053.58	1028.58	1068.32	1034.39
Diagonal bracing	831.49	831.49	1056.12	1030.16	1070.87	1036.87
'X' bracing	838.14	838.14	1058.66	1032.63	1073.42	1039.34
'V' bracing	832.23	832.23	1057.10	1031.12	1071.86	1037.83
Inverted 'V' bracing	832.23	832.23	1057.10	1031.12	1071.86	1037.83

4.2 Pushover curve

Combined graph of static pushover curve of without bracing, X bracing, diagonal bracing, V bracing & inverted V bracing structure with different height is shown in fig 4.1 to fig 4.5.

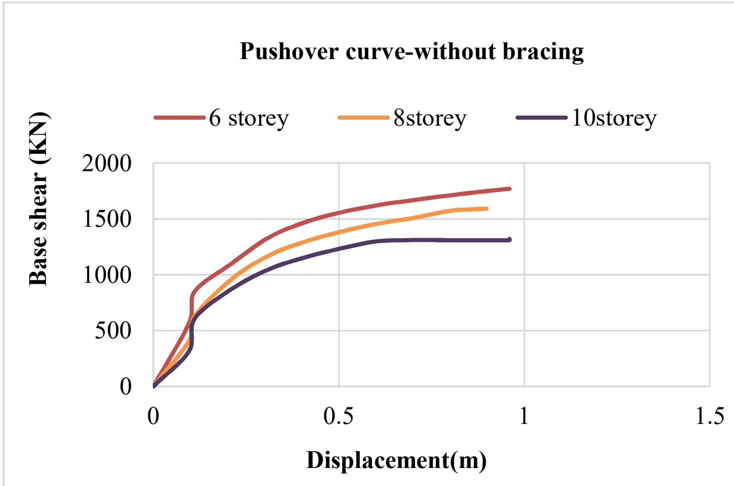

Fig-4.1: Pushover curve for without bracing structures.

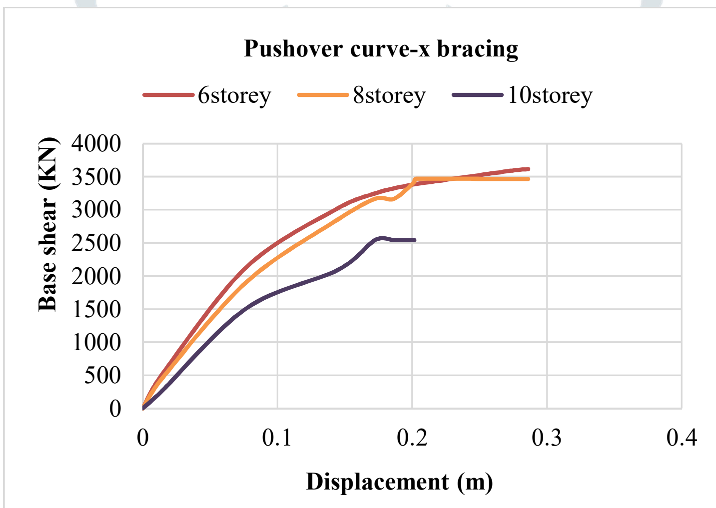

Fig-4.2: Pushover curve for X braced structures.

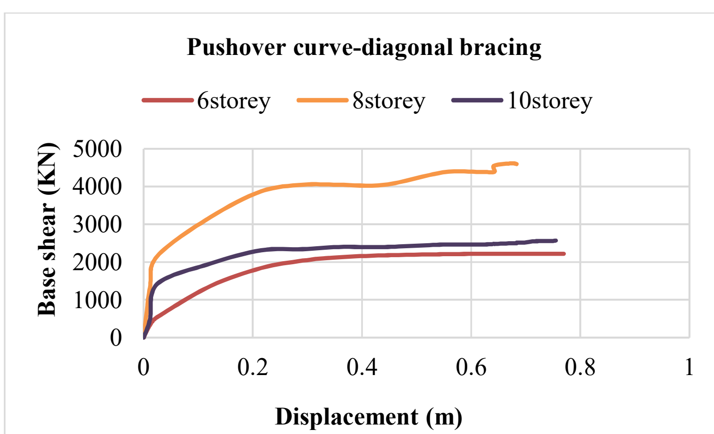

Fig-4.3: Pushover curve for Diagonal braced structures.

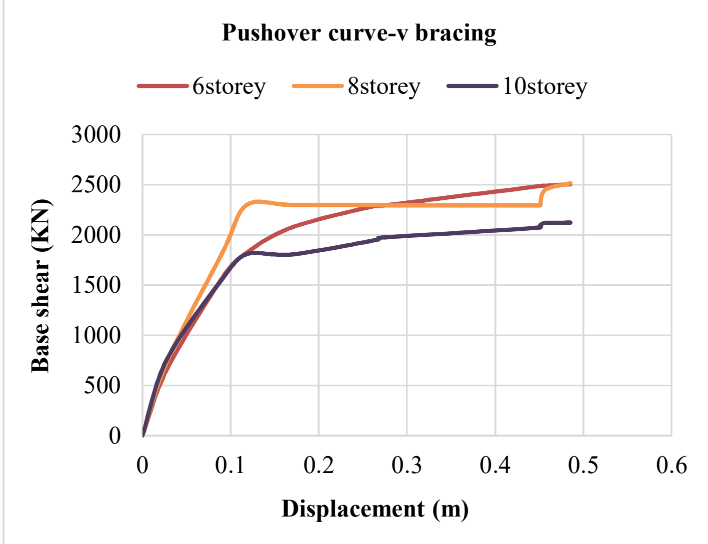

Fig-4.4: Pushover curve for V braced structures.

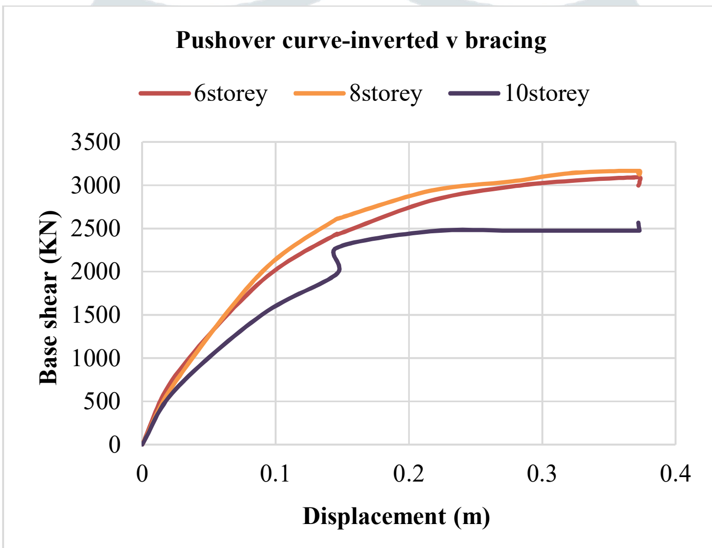

Fig-4.5: Pushover curve for Inverted V braced structures.

From the above graph it is seen that the displacement is less in X bracing structure than without bracing, diagonal bracing, V bracing and Inverted V bracing structure.

V. RESPONSE REDUCTION FACTOR

Response reduction factor is calculated using the formula given below.

$R = R_S R_\mu R_\xi R_R$

Where,

R_S= Over Strength factor

R_μ= Ductility Factor

R_ξ= Damping factor (taken 1)

R_R= Redundancy factor (As per ASCE7 1)

Ductility factor, over strength factor and R factor is calculated from the pushover curve for all the structures separately then cumulative result for each structure is shown in tabular form

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Table -5.1: 'R' factor parameters of the frame

Storey	Frame	Load pattern	Rµ	R_S	R_R	R_ξ	R
6	without Bracing	IS Code	3.40	1.33	1	1	4.51
	X bracing	IS Code	5.76	3.30	1	1	18.98
	Diagonal Bracing	IS Code	6.67	2.04	1	1	13.61
	V Bracing	IS Code	5.26	2.29	1	1	12.06
	Inverted V Bracing	IS Code	5.67	2.40	1	1	13.59
8	without Bracing	IS Code	2.91	1.16	1	1	3.38
	X bracing	IS Code	6.04	3.09	1	1	18.66
	Diagonal Bracing	IS Code	8.35	1.51	1	1	12.58
	V Bracing	IS Code	5.25	2.09	1	1	10.95
	Inverted V Bracing	IS Code	5.65	2.22	1	1	12.51
10	without Bracing	IS Code	2.89	0.96	1	1	2.79
	X bracing	IS Code	3.64	2.98	1	1	10.83
	Diagonal Bracing	IS Code	7.02	1.46	1	1	10.27
	V Bracing	IS Code	4.76	1.83	1	1	8.70
	Inverted V Bracing	IS Code	5.11	1.98	1	1	10.10

Fig 5.1 to Fig 5.3 shows graphical representation of R value for different type of bracings for Six, eight and ten storied steel frame structure.

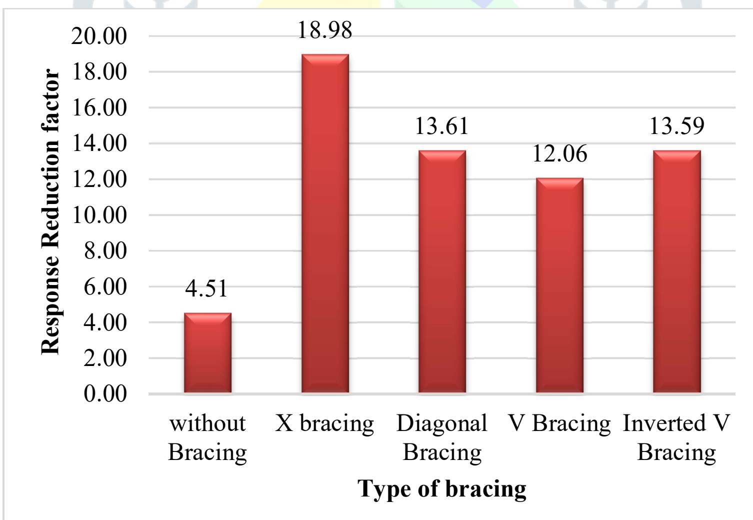

Fig-5.1: Comparison of R factor with type of bracing for 6 storey structure.

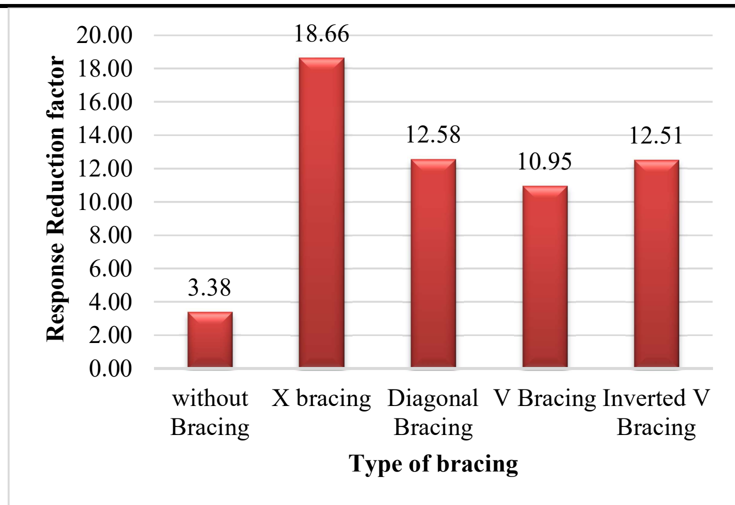

Fig-5.2: Comparison of R factor with type of bracing for 8 storey structure.

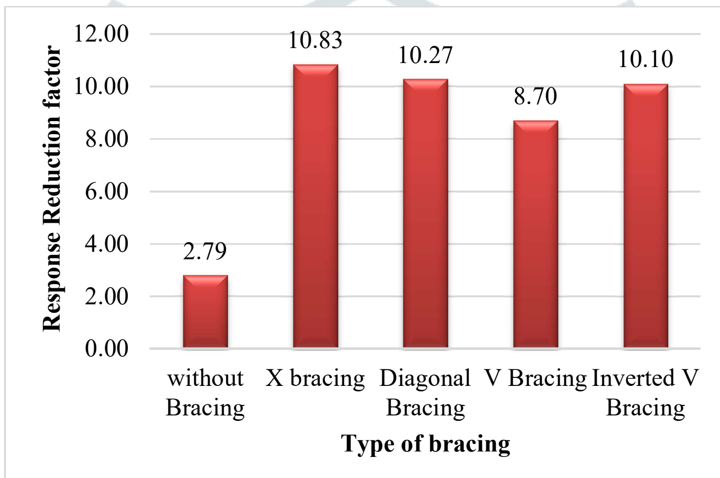

Fig-5.3: Comparison of R factor with type of bracing for 10 storey structure.

VI. CONCLUSIONS

Conclusions have been drawn from the results of static pushover curves are summarized as follows

1. As per table no 4.1 value of base shear for X braced structure is maximum for 6, 8 and 10 storey structures than diagonal braced, V braced and inverted V braced structures.
2. R factor varies with the type of bracing and height of the structure.
3. As per table no 5.1, Parameters of R factor are not same for all the bracing system, it changes with the type of bracing.
4. Ductility factor for X braced structure is higher comparative to diagonal, v and inverted v braced structures shown in table no 5.1.
5. X bracing gives maximum value of R factor than diagonal, V & inverted V bracing as shown in fig 5.1, fig 5.2 & fig 5.3.
6. It is observed that as the number of storeys increases the value of R factor tends to decreases. The shorter frames give higher value of R than taller frames.

REFERENCES

[1] A. Mondal, S. Ghosh, G. Reddy (2013), ‘Performance evaluation for ductile RC frames’, Engineering Structures,Vol-56,Pages 1808-1819.
[2] D. Patil, K. Sangle(2015), ‘Seismic behaviour of different Bracing systems in high rise 2-D building’, Engineering structures, Vol.3,Page no-282-305.
[3] M. Maheri, R. Akbari (2003), ‘Sesmic behaviour factor, R for steel X-braced and knee-braced RC buildings’, Engineering structures, Vol.25, page 1505-1513.
[4] A. Vijay, K. Vijayakumar (2013), ‘Performance of Steel Frame by Pushover Analysis for Solid and Hollow Section’, International Journal of Engineering Research and Development, Volume 8, Issue 7 (September 2013), PP. 05-12.
[5] M. Khan, K. Khan(2014), ‘Seismic Analysis of Steel Frame with Bracings using Pushover Analysis’, International Journal of Advanced Technology in Engineering and Science, Volume No.02, Issue No. 07, July 2014.