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A COMPARATIVE STUDY ON MOMENT RESISTING STEEL FRAMES WITH & WITHOUT BRACINGS SUBJECTED TO DYNAMIC LOADS FOR HIGH RISE BUILDINGS

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Abstract -

Steel bracing is economically, easy to erect, occupies less space and has flexibility to design for meeting the requires strength and stiffness. In present study, the seismic performance of steel structure rehabilitated using concentric and eccentric bracing is investigated. The braces are provided for peripheral columns. A G+10 building is analysed for seismic zone IV as per IS 1893:2002 using Etabs 2013 version 13.1.5 software.

The effect of distribution of steel bracing along the height of the structure on seismic performance of rehabilitation is studied. The performance of the building is evaluated in terms of lateral displacements and inter storey drifts. The percentage reduction in these parameters is found out. It can be noted that X type of bracing followed by Inverted V type bracing significantly contributes the stiffness.

Key Words: *Bracing system, ETABS 2013, Equivalent static method, Time history analysis,*

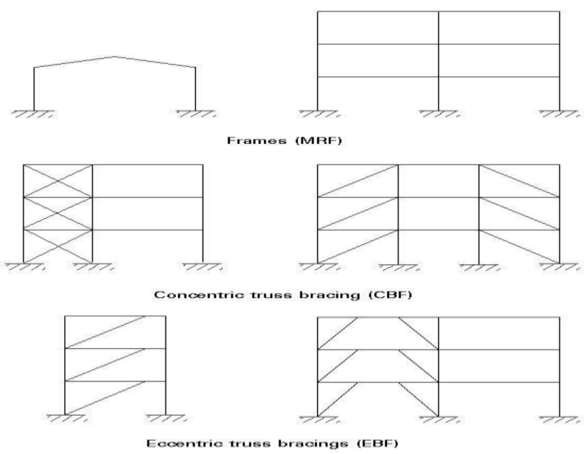
1. INTRODUCTION

1.1 General

A seismic tremor is a sudden movement or development of the world's covering, which begins normally at or underneath the surface. The word normal is critical here, since it prohibits stun waves made by atomic tests, man made blasts, and so forth. Around 90% of all quakes results from tectonic occasions, principally developments on the shortcomings. The remaining is identified with volcanism, the breakdown of underground pits or man made impacts. Tectonic tremors are triggered when amassed strain vitality close to the deficiencies surpasses the shearing quality of rocks.

1.2 Bracing System

These days High Rise Steel edge building is well setting up in metro urban areas. For development of elevated structure supporting are built for solidness and parallel burden resistance reason. Steel outline as a rule alludes to a building system with a "skeleton edge" of vertical steel segments and flat I-shafts, developed in a rectangular framework to bolster the floors, rooftop and dividers of a building which are all connected to the casing. The improvement of this method made the development of the high rise conceivable. Bracings are solid in pressure. Supporting with their encompassing casings must be considered for expansion in parallel burden opposing limit of structure. At the point when bracings are set in steel outline it carries on as corner to corner pressure strut and transmits pressure power to another joint. Varieties in the segment solidness can impact the method of displacement and sidelong firmness of the bracing.



2. METHODOLOGY

To find the basic components like lateral displacement and storey drifts this analysis has been carried using the software ETABS 2013 v 13.1.5. for the analysis purpose Equivalent static method and time history methods are adopted.

2.1 STRUCTURAL MODELING

A moment resisting steel framed structure with & without bracings frame works with 10 storey stature was utilized as a part of the examination to know the sensible conduct of steel building amid seismic tremor, Using E-Tabs Version 2013 13.1.5. The common floor tallness is 3m. Modular damping 5% is considered. For thought, diaphragm activity is taken out at every floor. Scientific displaying that incorporates all segments which impact the mass, strength and solidness. The impact of soil structure association is overlooked in investigation. The sections are thought to be altered at the ground level.

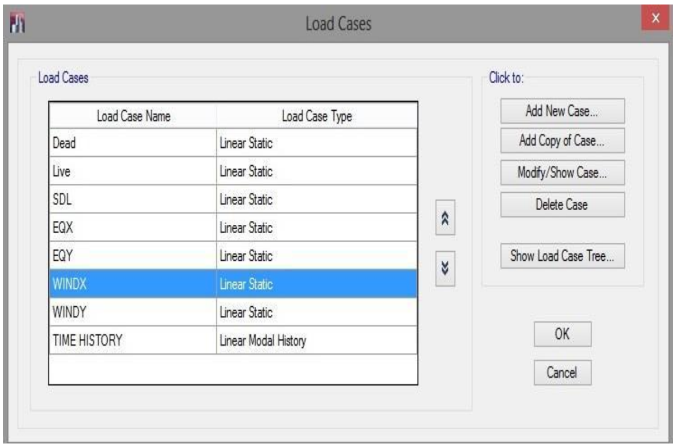
2.2 Structural Configuration

1. G +10 Steel confined structure without bracing (MRF).
2. G +10 Steel confined structure with diverse bracing examples, for example, X support, V support, Inverted V support, Diagonal support – Type and Diagonal support – Type 2.

2.3 Description of the Building:

Structure type	Steel Moment Resisting Frame (SMRF)
Earthquake zone	Zone 4
Zone factor	0.24 (severe)
Soil condition	Medium
Response reduction factor	5
Importance factor	1.5
Height of each storey	3m
Bottom storey height	5m
Beam type	ISWB400
Column type	BU-600
Bracings	Double Angle 200X200X25, ISWB400
Slab type	Deck 175mm thick
Slab material	Concrete, Solid slab

Table 2.1



2.4 OTHER LOAD PROPERTIES:

Live load (DECK)	4 KN/M2
SDL (DECK)	1.5 KN/M2
Glazing load (outer beams)	6 KN/M2
Wind load overwrite	Program defined

Table 2.2

For the wind load analysis of the structure, data from IS 875 (Part-3) -1987 has been chosen. Data such as Wind speed, Terrain category, Structure class, Risk coefficients and topography is taken into account.

2.5 Geometry of the Considered Model:

The geometry of the building of 10 storied building model are given in table below.

No. of Storeys	No. Bays in X direction	Bay width in X direction	No. of Bays in Y direction	Bay width in Y direction	Bottom Storey Ht	Storey Ht
10	8	5m	8	5 m	5 m	3m

Table 2.3

2.5 Plans and models

Plans and 3d models considered for the analysis purpose of the 10 Storey structure is shown in the figures.

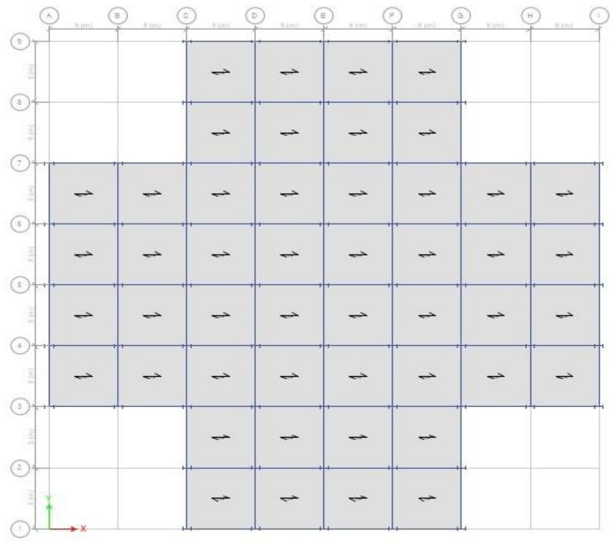


Fig 2.1: Plan of the G+10 building

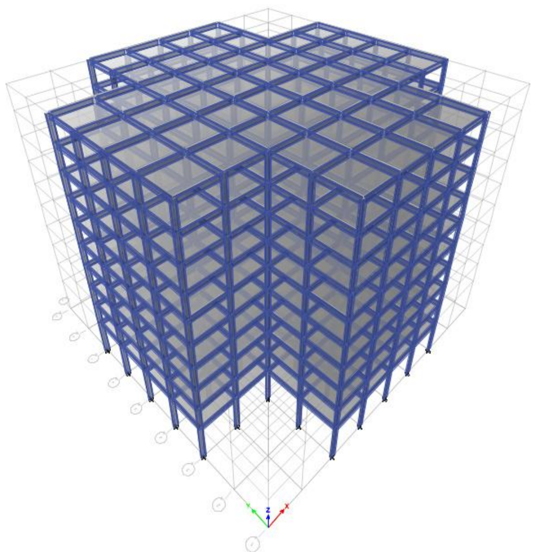
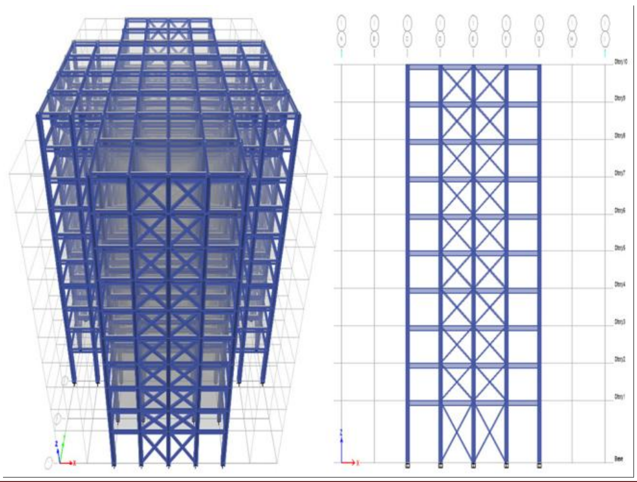


Fig 2.2: 3d model of the G+10 building



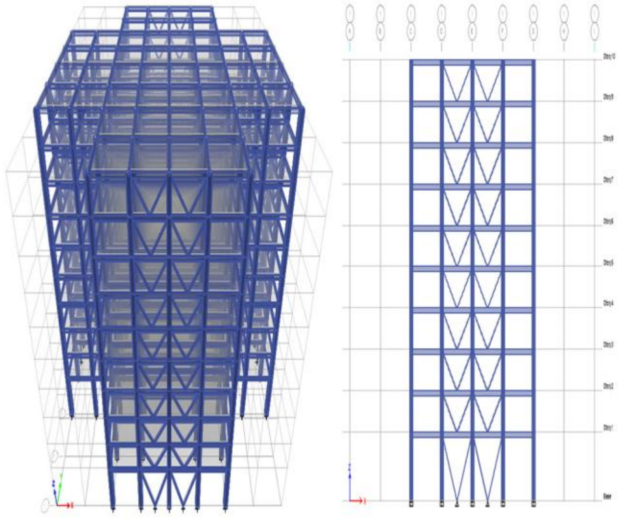


Fig 2.4: 10 Storey structure with V Bracings

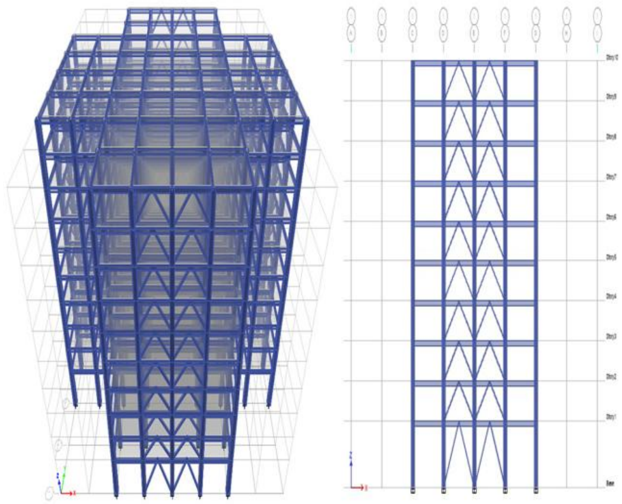


Fig 2.5: 10 Storey structure with Inverted V Bracings

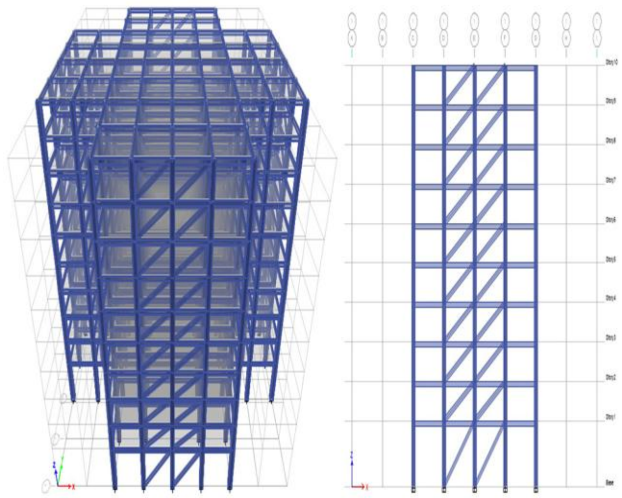


Fig 2.6: 10 Storey structure with Diagonal 1 Bracings

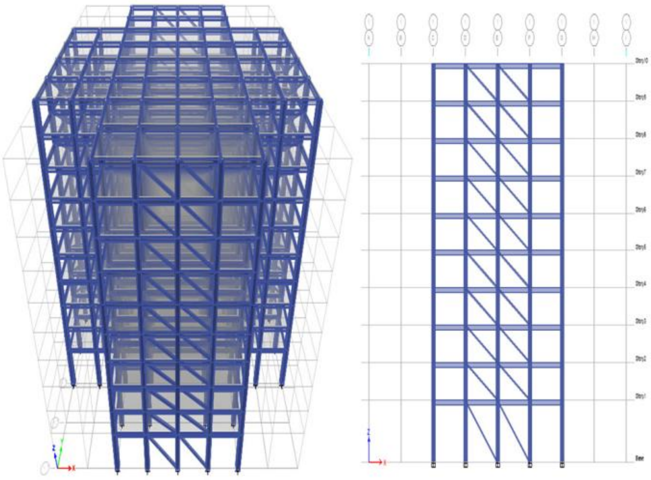


Fig 2.7: 10 Storey structure with Diagonal 2 Bracings

3. RESULTS & DISCUSSIONS

3.1 LATERAL DISPLACEMENT FOR G+10 STRUCTURE BY EQUIVALENT STATIC ANALYSIS

Lateral displacement for building models obtained from the equivalent static and time history methods are shown in figures for G+10.

Table 3.1: Lateral Displacement of 10 storey due to EQ in X direction

Storey level	Load Case	BM	X Bracings	V Bracings	Inv V	Dia 1	Dia 2
Storey10	EQX	53.6	22.9	25.5	22.6	31.8	26.4
Storey9	EQX	50.8	20.9	23.4	20.7	29.9	24.5
Storey8	EQX	47.1	18.6	21	18.6	27.5	22.2
Storey7	EQX	42.6	16.2	18.5	16.2	24.6	19.6
Storey6	EQX	37.2	13.7	15.8	13.8	21.4	16.8
Storey5	EQX	31.2	11.1	13	11.2	17.9	13.9
Storey4	EQX	24.8	8.6	10.3	8.7	14.3	10.9
Storey3	EQX	18.1	6.2	7.6	6.4	10.6	8
Storey2	EQX	11.6	4	5.1	4.2	7	5.3
Storey1	EQX	5.7	2	2.8	2.2	3.6	2.7
Base	EQX	0	0	0	0	0	0

Table 3.2: Lateral Displacement of 10 storey due to EQ in Y direction

Storey level	Load Case	Displacements (EqY) (mm)					
		BM	X Bracings	V Bracings	Inv V	Dia 1	Dia 2
Storey10	EQY	61.1	23.8	27.1	23.6	34.2	28.1
Storey9	EQY	58.6	21.8	24.9	21.7	32.3	26.2
Storey8	EQY	55	19.5	22.5	19.5	29.9	23.8
Storey7	EQY	50.2	17	19.8	17.1	26.9	21.1
Storey6	EQY	44.5	14.4	17	14.6	23.5	18.2
Storey5	EQY	37.9	11.7	14.1	12	19.9	15.1
Storey4	EQY	30.8	9.1	11.3	9.4	16.1	12.1
Storey3	EQY	23.4	6.6	8.5	7	12.2	9
Storey2	EQY	15.8	4.3	6	4.8	8.4	6.2
Storey1	EQY	8.5	2.3	3.5	2.7	4.7	3.4

Base	EQY	0	0	0	0	0	0

Table 3.3: Lateral Displacement of 10 storey due to Wind in X direction

Storey level	Load Case	Displacements (WIND X) (mm)					
		BM	X Bracings	V Bracings	Inv V	Dia 1	Dia 2
Storey10	WINDX	19.4	8	9.1	7.9	11.5	9.4
Storey9	WINDX	18.8	7.4	8.5	7.4	11	8.9
Storey8	WINDX	17.9	6.7	7.8	6.8	10.4	8.2
Storey7	WINDX	16.6	6	7	6.1	9.6	7.5
Storey6	WINDX	15	5.2	6.2	5.3	8.6	6.6
Storey5	WINDX	13	4.4	5.2	4.5	7.5	5.7
Storey4	WINDX	10.7	3.5	4.3	3.7	6.2	4.7
Storey3	WINDX	8.1	2.6	3.3	2.8	4.8	3.6
Storey2	WINDX	5.4	1.8	2.3	2	3.3	2.4
Storey1	WINDX	2.8	1	1.3	1.1	1.7	1.3
Base	WINDX	0	0	0	0	0	0

Table 3.4: Lateral Displacement of 10 storey due to Wind in Y direction

Storey level	Load case	Displacements WINDY (mm)					
		BM	X Bracings	V Bracings	Inv V	Dia 1	Dia 2
Storey10	WINDY	22.7	8.3	9.7	8.3	12.5	10.1
Storey9	WINDY	22.2	7.8	9.1	7.8	12.1	9.6
Storey8	WINDY	21.3	7.1	8.4	7.2	11.4	8.9
Storey7	WINDY	20.1	6.3	7.6	6.5	10.6	8.1
Storey6	WINDY	18.4	5.5	6.7	5.7	9.6	7.2
Storey5	WINDY	16.3	4.7	5.8	4.9	8.5	6.3
Storey4	WINDY	13.8	3.8	4.8	4	7.1	5.2
Storey3	WINDY	10.9	2.9	3.8	3.2	5.7	4.1
Storey2	WINDY	7.6	2	2.8	2.3	4.1	2.9
Storey1	WINDY	4.2	1.1	1.7	1.4	2.3	1.7
Base	WINDY	0	0	0	0	0	0

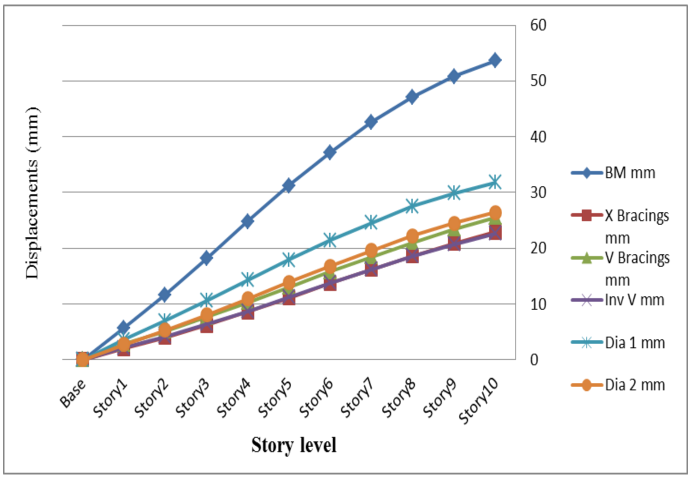


Fig 3.1: Displacement of 10 storey due to EQ in X direction

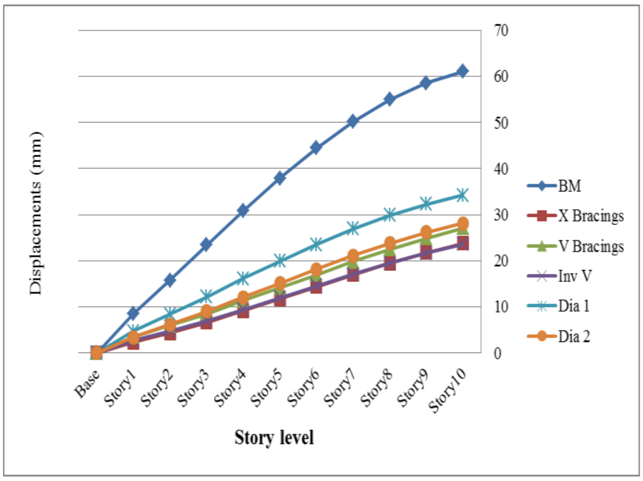


Fig 3.2: Displacement of 10 storey due to EQ in Y direction

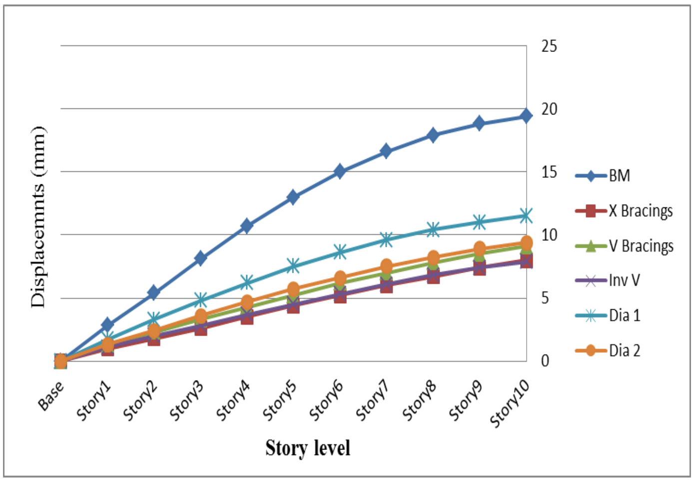


Fig 3.3: Displacement of 10 storey due to wind in X direction

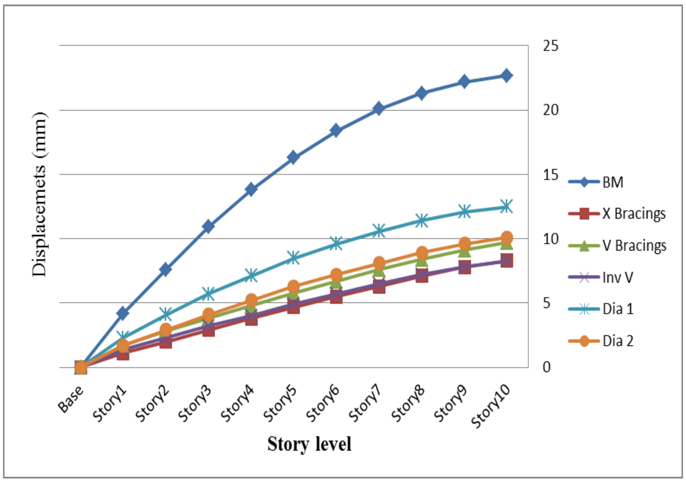


Fig 3.4: Displacement of 10 storey due to wind in Y direction

3.2 LATERAL DISPLACEMENT FOR G+10 BUILDING BY TIME HISTORY METHOD

Lateral displacement of 10 storey structure along X-direction & Y-direction (Time history analysis) as shown in table.

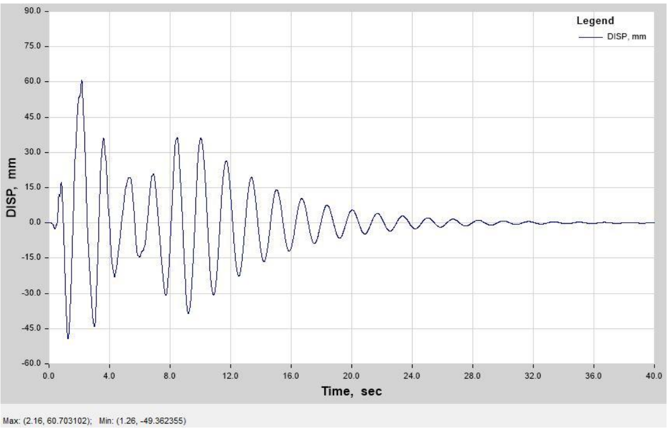


Fig 3.5: Displacement of 10 Storey structure without bracing

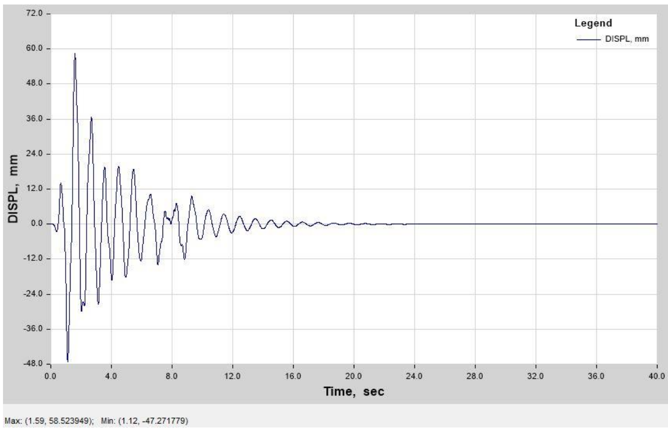


Fig 3.6: Displacement of 10 Storey structure with X bracing

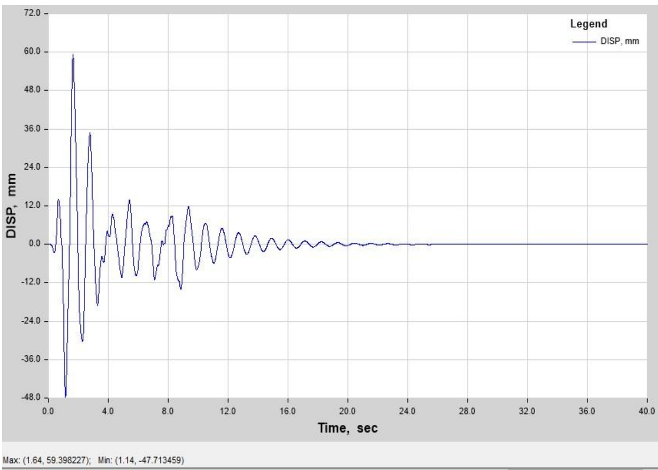


Fig 3.7: Displacement of 10 Storey structure with V bracing

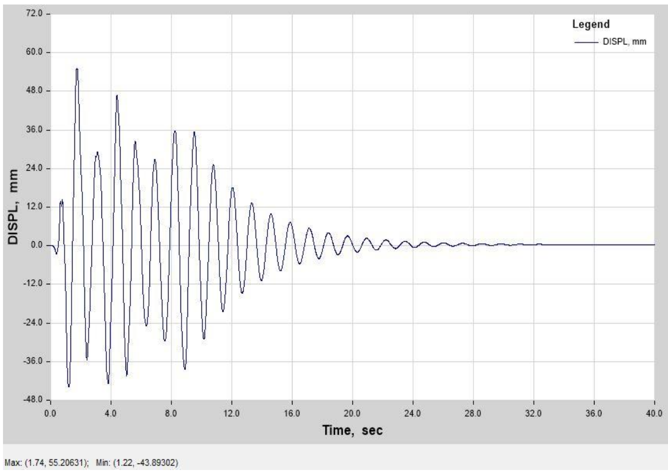


Fig 3.8: Displacement of 10 Storey structure with Diagonal 1 bracing

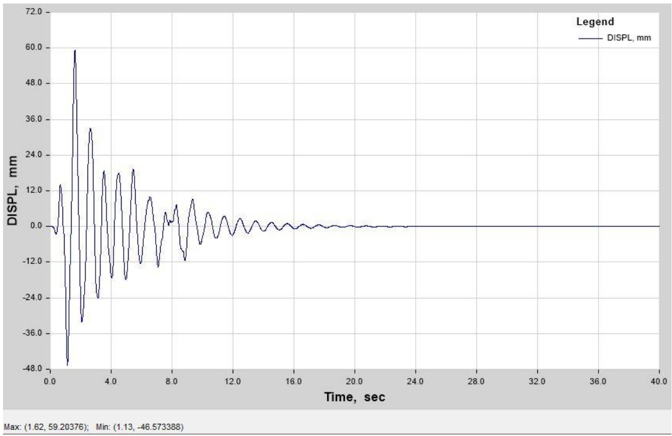


Fig 3.9: Displacement of 10 Storey structure with Inverted V bracing

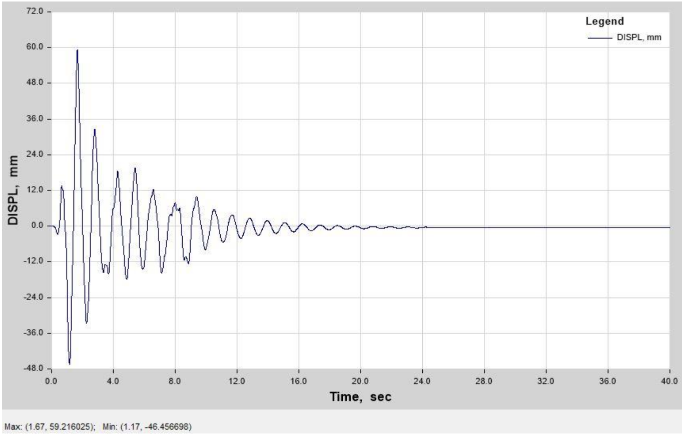
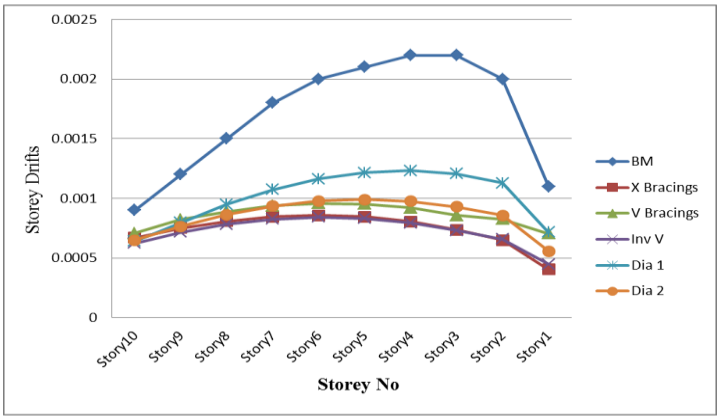


Fig 3.10: Displacement of 10 Storey structure with Diagonal 2 bracing

3.3 STOREY DRIFTS:

Storey level	Load Case	Storey drifts					
		BM	X Bracings	V Bracings	Inv V	Dia 2	Dia 3
Storey10	EQX/Y	0.0009	0.000668	0.000708	0.000624	0.00064	0.000648
Storey9	EQX/Y	0.0012	0.000751	0.000821	0.000714	0.000797	0.000764
Storey8	EQX/Y	0.0015	0.000809	0.00089	0.000782	0.00095	0.000863
Storey7	EQX/Y	0.0018	0.000845	0.000937	0.000824	0.001074	0.000935
Storey6	EQX/Y	0.002	0.000858	0.000958	0.000842	0.001163	0.000978
Storey5	EQX/Y	0.0021	0.000844	0.000952	0.000831	0.001215	0.000991
Storey4	EQX/Y	0.0022	0.000804	0.000919	0.000792	0.001231	0.000975
Storey3	EQX/Y	0.0022	0.000737	0.000858	0.000729	0.001207	0.00093
Storey2	EQX/Y	0.002	0.00065	0.000824	0.000659	0.001128	0.000856
Storey1	EQX/Y	0.0011	0.000404	0.000705	0.000446	0.000716	0.000557

Storey drifts of 10 storey model



Storey drifts of 10 storey model

3.4 SUMMARY

Lateral displacements of 10 Storey for the load cases EQX, EQY, WindX and WindY in X and Y directions are presented in above tables and graphs. The results are compared between the Base Model and buildings with different bracing patterns. It can be noted that building with bracings reduces lateral displacements significantly. Among them X type of bracing was found to be more useful. In Time history case (Fig 3.1-3.6) it can be observed that for a 10 storey building when braces are introduced the reduction in the displacement is not that significant. Diagonal 1 type of bracing was found to be effective compared to other types of bracings.

The inter storey drifts has been noted in the above tables. The values of storey drifts is plotted in a graph of storey numbers vs storey drifts. By observing the above figures it can be concluded that the building with bracing systems are having lesser inter storey drifts when compared to the building without bracing i.e Base Model.

4. CONCLUSIONS

The study on performance of 10, 20, 30 & 40 storey structures during earthquake was made by software approach. Different types of bracings were installed on the Base model (Structure) to find the variation in the performance of the structures. Comparision between the base model and braced models were made when analysed. The following are the conclusions obtained.

- Displacements with distinctive loadings (EQX, EQY, WINDX, WINDY) can be altogether lessened by utilizing different Bracing frameworks. Among them, X Bracing was discovered useful.
- X Bracing and optionally Inverted V type is discovered to be more powerful contrasted with other bracing examples.
- Time history analysis was made to conclude that different bracings behaved well during earthquake analysis.
- Storey drifts are essentially lessened by utilizing diverse bracings contrasted with Base Model.

REFERENCES

1. **Braz cezar M.T, Barros R.C.(2009)** 'Seismic performance of metallic braced frames by pushover analyses', Rhodes, Greece 22-24 June.
2. **Chime M.N and P Homani, Kharazmi (2012).** (Tarbiat Moallem) University, Tehran, Iran. 'Efficiency of bracing systems for seismic rehabilitation of steel structures'.
3. **Chui-Hsin Chen, Jiun-Wei Lai and Stephen Mahin (2008)'**Seismic Performance Assessment of Concentrically Braced Steel Frame Buildings' WCEE, October 12-17, China.
4. **C.Christopoulos, H. Choi J. Erochko and R. Tremblay (2008**)'Comparison of the Seismic Responseof Steel Buildings Incorporating Self-Centering Energy Dissipative Braces, BucklingRestrained Braced and Moment Resisting Frames'14th WCEE, October 12-17, Beijing, China.
5. **IS 1893 (part 1) – 2002**, 'Criteria for earthquake resistant design of structures, part -1 general provisions and buildings', fifth revision, Bureau of Indian Standards, New Delhi, India.
6. **IS 456:2000** – 'Plain and Reinforced concrete – Code of practice'. (Fourth revision) Bureau of Indian Standards, India.
7. **IS 875 (Part 3) – 1987**, (Wind Loads) 'Code of practice for design loads (other than earthquake) For buildings and structures', Bureau of Indian Standards, New delhi, India.
8. **Jain, A. and Goel, S., (1979)** July, 'Seismic response of eccentric and concentric braced steel frames with different proportions', UMEE 79R1, Dept. of Civil Engineering, Univ. of Michigan, Ann Arbor, 88 pages.
9. **L. Di Sarno & A.S. Elnashai (2008)** 'Bracing systems for seismic retrofitting of steel frames' Journal of Constructional Steel Research 452-465.
10. **Khatib, I. and Mahin, S.,(1987)** 'Dynamic inelastic behavior of chevron braced steel frames', Fifth Canadian Conference on Earthquake Engineering, Balkema, Rotterdam, pages 211-220
11. **K.K Sangle, K.M Bajoria, V.Mhalungkar, K.M Bajoria,(2012)** Mumbai. A Conference on 'Seismic analysis of high rise steel frame with and without bracings' LISBOA, Portugal.
12. **Nauman Mohammed & Islam nazrul (2013)** 'Behaviour of Multistorey RCC Structure with Different Type of Bracing System' December Vol 2, Issue 2.
13. **Ratnesh Kumar, Prof K.C Biswal (2014)** 'Seismic Analysis of Braced Steel Frames' NIT Rourkela, Orissa.

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