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Behaviour of Moment Resisting Frame and Shear wall –Frame Structure

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Abstract:-
The rapid growth of urban population and limited land space have considerably influenced the developments of high-rise structures. Lateral loads are important consideration as the building height increase. It is necessary to choose a structural system such a way that it can resist lateral loads effectively. It is required to understand the behaviour of structural systems in teams of stiffness and stability. In this paper two structural systems i.e. moment resisting frame and wall-frame structure is compared in teams of time period, deflection and drift. The analysis of 30 story RC building is carried out in ETABS. The results shows that top deflection and time period is reduced for wall-frame structure. Wall-frame structure can resist lateral loads effectively than frame structure for high rise buildings.

Keywords: Moment Resisting frame, Shear wall- frame structure, structural systems, shear racking behaviour, top deflection, drift

I. INTRODUCTION:

Structural development of high rise buildings is necessary for the rapid growth of urban population and development of civil engineering world. Taller the building, lateral loads should be effectively consider in design of structures. The taller and slender the building, the more important structural factors and more necessary to choose an appropriate structural system. Structural system is an arrangement of major structural members such a way that structure can resist lateral loads effectively. With loading on a tall building acts not only a very large building surface, but also with greater intensity at the greater heights and with a larger moment arm about the base than on a low rise building [2]. There are structural systems for tall buildings i.e. Moment resisting frame, Braced frame, shear-wall frame, Outrigger system, Bundled tube system. Concrete is widely used construction material to construct high rise structures. Behaviour of different structural systems is unique and each system is having different load transferred mechanism. Generally in case of high-rise structures, stiffness requirement in terms of inter storey drift and top storey displacements are important criteria to control. Therefore selected structural system should be such that the design requirement should satisfy along with the full utilization of the structural elements. In this paper behaviour of two different structural systems under the action of lateral loading is discussed.

II. MOMENT RESISTING FRAME (MR FRAME):

MR frame is a skeleton of beams and columns which connected parallels or orthogonally to each other with MR joints. Resistance to lateral loading is provided by bending resistance of columns, girders and joints. Rigid frame gives advantage in terms of simplicity in design and unobstructed space from bracing and structural walls. The horizontal stiffness of a rigid frame is governed mainly by the bending resistance of the girders, the columns and their connection. The shear causes the story height columns to bend in double curvature with points of contra-flexure at mid height of the column [fig.2][2]. And due to overall moment the frame is subjected to tension on windward side and compression on leeward sides of structure. That causes extension and shortening of columns [fig. 3][2]. As the building height increases, the story drift due to overall bending will increase. Story drift of frame members in high rise building can controlled by stiffness rather than strength.

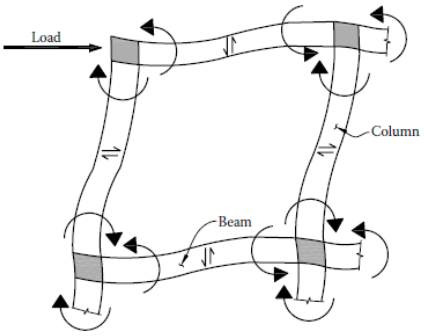

Figure 1: Behaviour of beam and column of frame structure [2]

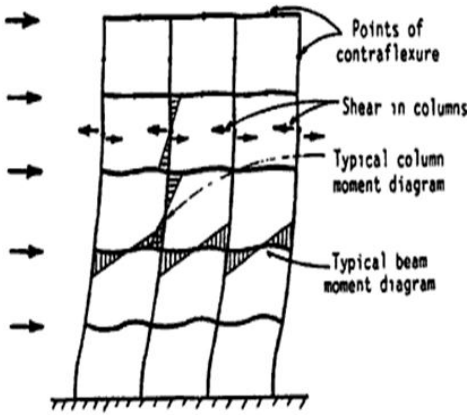

Figure 2: Shear racking behaviour of frame structure [2]

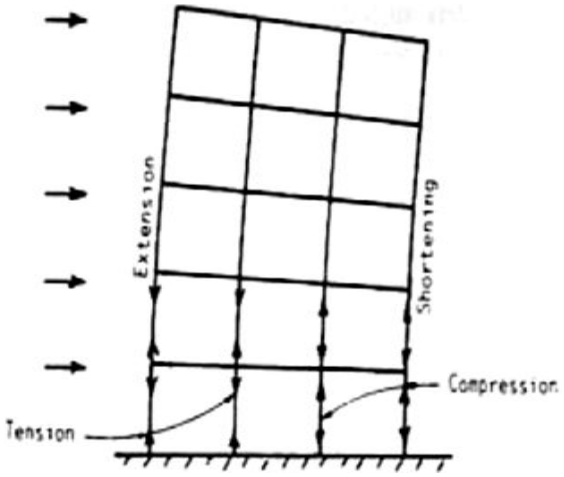

Figure 3: Overall bending behaviour of Frame structure [2]

III. WALL- FRAME STRUCTURE

Wall-frame structure is structural system having combination of rigid frame and shear wall. Shear wall is constructed as a part of central elevator or service core, and frames are arranged in plan in conjunction with the wall. This structural system can resist lateral loads effectively by producing interaction between shear walls and frames. Consider the behaviour of shear wall as central core and frame separately having same height. When lateral load acts on structure, the shear wall is deflected individually in flexural shape and frame is deflected in shear shape. Because the top flexibility of core, behave as flexural cantilever which behave as proportional to cube of height. And flexibility of frame behave as shear cantilever which directly proportional to height. When wall and frame connected with pin-end joints, the behaviour of wall-frame structure during subjected to horizontal loading, the deflected shape of structure is flexure profile at lower part and shear profile at upper part. Due to interaction force in connecting links causes the shear wall resist the structure near the base and frames will resist the structure near the top in teams of deflection and drift.

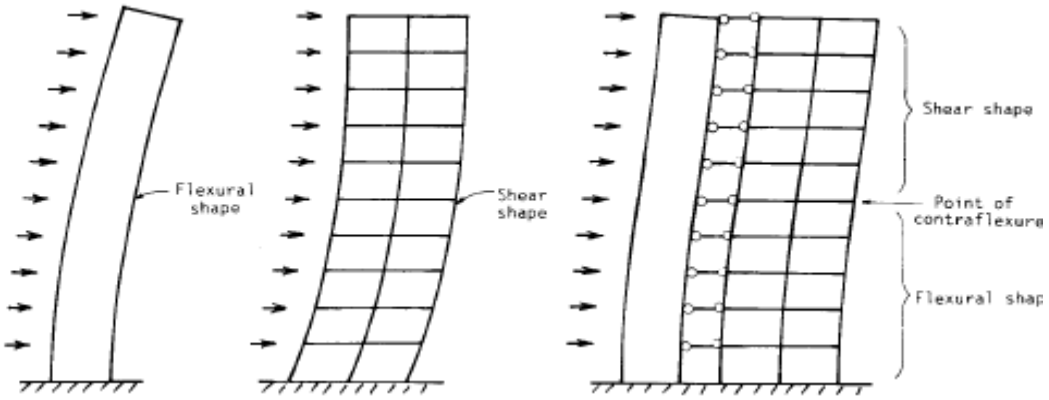

Figure 4: Behaviour of Wall-Frame structure [2]

IV. PARAMETRIC STUDY:

In case of High-rise building it is very important that the structural system should satisfy the strength and stiffness requirement. The response of the different structural system is depends upon its behaviour and load transfer mechanism. In this paper the comparison of the Moment Resisting Frame and Shear-Wall Frame is presented. Analysis is carried out in ETABS.

Analysis results for 30 storey building with two different structural systems are compared. The comparison of the Time period, Top storey displacement and Maximum storey drift for the Moment Resisting Frame, Shear-Wall Frame are presented.

For MR frame the building geometry is shown in fig. 5

Building data:

Number of story: 30

Height of building- 96 meter

Plan dimension: 24 x 24 meter

Size of beams- 0.3 x 0.3 meter

Size of column- 0.8 x 0.8 meter

Slab thickness-150mm

Live load- 3 kN/m^2

Floor finish- 1 kN/m^2

Zone factor- V

Importance factor- 1.5

Response reduction factor- 5

Concrete Grade- M30

Steel grade- Fe415

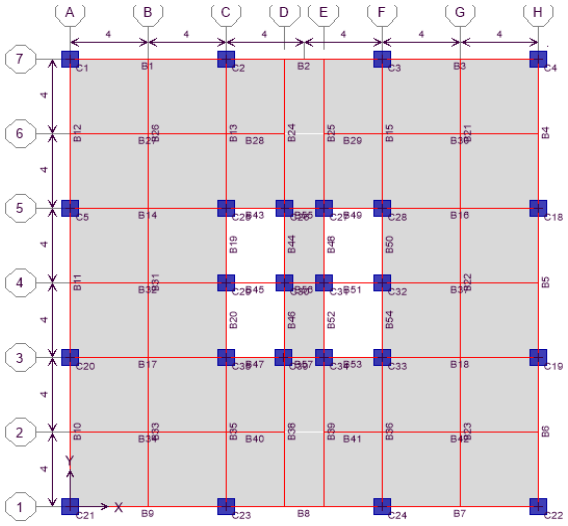

Figure 5: Plan of MR frame structure

Wall- frame structural system building as shown in fig.6 other dimension and seismic data are same as MR frames. Shear wall is provided at service core of the building throughout the height as shown in fig.

Thickness of the shear wall is 0.3 meter.

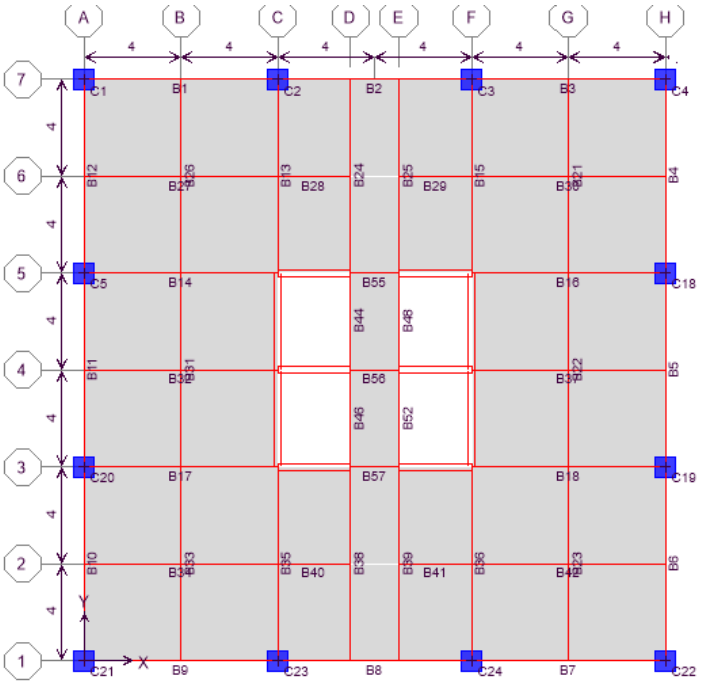

Figure 6: Plan of shear wall-frame structure

V. MODELLING IN ETABS

Both structures has been modelled in ETABS and analysed for load combinations as per IS:456-2000[7]. 3D model of structure is shown in figure7. Seismic data are taken as per IS:1893(part-1)-2002.[8]

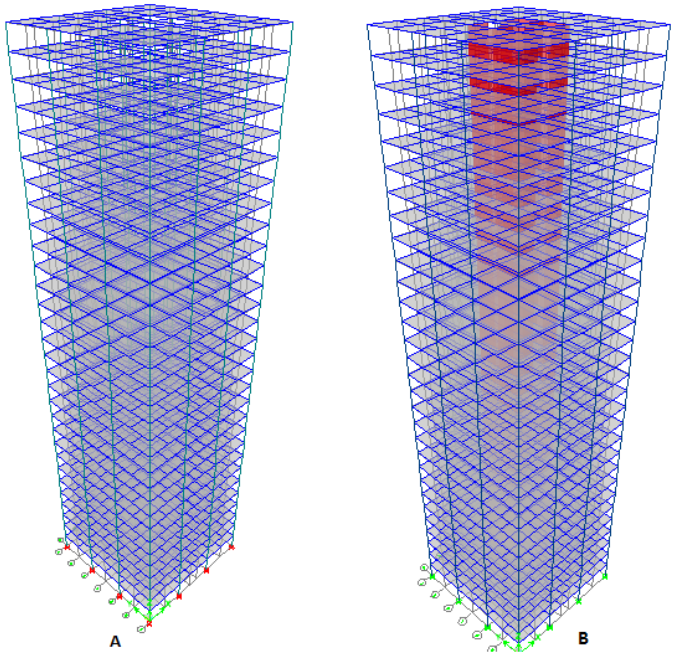

Figure 7: 3D model of structure in ETABS A) MR frame B) Shear wall-frame structure

VI. ANALYSIS RESULTS

After analysis in ETABS software result shows that in wall-frame structure Time period is effectively reduced also Top story displacement and Maximum drift is reduced.
Results are shown in table.1

Table 1: Analysis results of MR frame and Wall-frame structure

Parameters		Moment resisting frame	Shear wall- frame system
Time period (Sec)		4.37	3.66
Top displacement (meter)	X-dir	0.1254	0.1045
	Y-dir	0.1241	0.1071
Max. Drift (mm)	X-dir	1.564	1.33
	Y-dir	1.54	1.37

Comparison results of lateral displacement for MR frame and shear wall frame structure is shown in table 2.

***T*able 2: Comparison results of lateral displacement for MR frame and shear wall frame structure**

Story	Lateral Displacement (m)			
	Frame Structure		Wall-Frame Structure	
	X-direction	Y direction	X direction	Y direction
STORY30	0.1254	0.1241	0.1045	0.1071
STORY29	0.1225	0.1215	0.101	0.1034
STORY28	0.1194	0.1186	0.0974	0.0997
STORY27	0.116	0.1154	0.0937	0.0959
STORY26	0.1125	0.112	0.09	0.092
STORY25	0.1087	0.1083	0.0861	0.088
STORY24	0.1047	0.1045	0.0822	0.0839
STORY23	0.1005	0.1004	0.0782	0.0798
STORY22	0.0961	0.0962	0.0741	0.0756
STORY21	0.0916	0.0918	0.0699	0.0713
STORY20	0.087	0.0873	0.0657	0.067
STORY19	0.0822	0.0826	0.0615	0.0626
STORY18	0.0774	0.0779	0.0572	0.0582
STORY17	0.0725	0.0731	0.053	0.0538
STORY16	0.0675	0.0682	0.0487	0.0494
STORY15	0.0625	0.0633	0.0445	0.045
STORY14	0.0575	0.0584	0.0403	0.0407
STORY13	0.0525	0.0535	0.0362	0.0364
STORY12	0.0476	0.0486	0.0321	0.0322
STORY11	0.0427	0.0437	0.0282	0.0282
STORY10	0.0378	0.0389	0.0244	0.0242
STORY9	0.0331	0.0342	0.0208	0.0205
STORY8	0.0284	0.0295	0.0173	0.0169
STORY7	0.024	0.025	0.0141	0.0136
STORY6	0.0196	0.0206	0.011	0.0105
STORY5	0.0155	0.0164	0.0083	0.0078
STORY4	0.0116	0.0123	0.0058	0.0053
STORY3	0.0079	0.0085	0.0037	0.0033
STORY2	0.0045	0.0049	0.0019	0.0017
STORY1	0.0016	0.0017	0.0006	0.0006

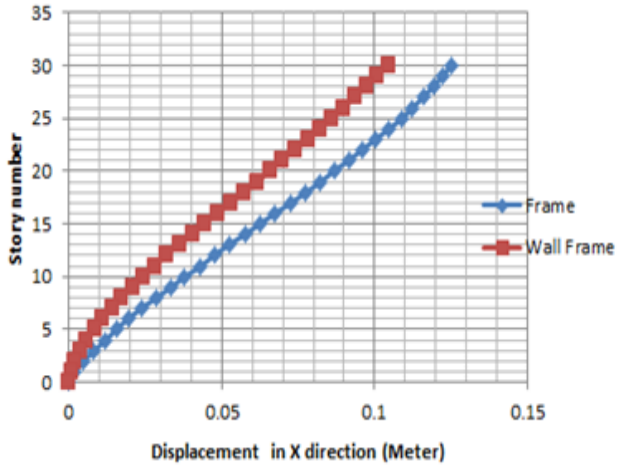

Figure 8: Comparison Graph of deflection in X direction

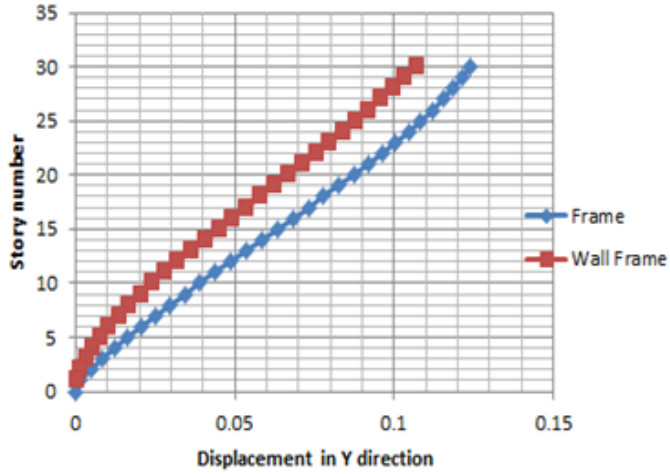

Figure 9 Comparison Graph of deflection in Y direction

Comparison results of lateral drift for MR frame and shear wall frame structure is shown in table 3.

Table 3 Comparison results of lateral drift for MR frame and shear wall frame structure

Story	Lateral Story Drift (m)			
	Frame Structure		Wall-Frame Structure	
	X-direction	Y direction	X direction	Y direction
STORY30	0.000896	0.000825	0.001093	0.001146
STORY29	0.000976	0.000908	0.001121	0.001172
STORY28	0.00105	0.000989	0.001148	0.001193
STORY27	0.001121	0.001067	0.001176	0.001217
STORY26	0.001188	0.001139	0.001204	0.001242
STORY25	0.001251	0.001206	0.001231	0.001268
STORY24	0.001308	0.001267	0.001256	0.001293
STORY23	0.00136	0.001322	0.001278	0.001316
STORY22	0.001407	0.001371	0.001298	0.001336
STORY21	0.001448	0.001413	0.001313	0.001353
STORY20	0.001483	0.00145	0.001324	0.001366
STORY19	0.001512	0.00148	0.001331	0.001375

STORY18	0.001534	0.001504	0.001333	0.001379
STORY17	0.001551	0.001522	0.00133	0.001377
STORY16	0.001561	0.001534	0.001321	0.001369
STORY15	0.001564	0.00154	0.001307	0.001355
STORY14	0.001561	0.001539	0.001286	0.001334
STORY13	0.001551	0.001533	0.001259	0.001306
STORY12	0.001535	0.00152	0.001226	0.001271
STORY11	0.001512	0.001502	0.001185	0.001227
STORY10	0.001482	0.001478	0.001137	0.001174
STORY9	0.001445	0.001448	0.001082	0.001112
STORY8	0.001401	0.001412	0.001018	0.001041
STORY7	0.00135	0.00137	0.000946	0.000958
STORY6	0.001291	0.001323	0.000865	0.000864
STORY5	0.001225	0.001269	0.000774	0.000758
STORY4	0.001148	0.001207	0.00067	0.000638
STORY3	0.001055	0.001125	0.00055	0.000503
STORY2	0.000909	0.000978	0.000401	0.000352
STORY1	0.000511	0.000543	0.000192	0.000172

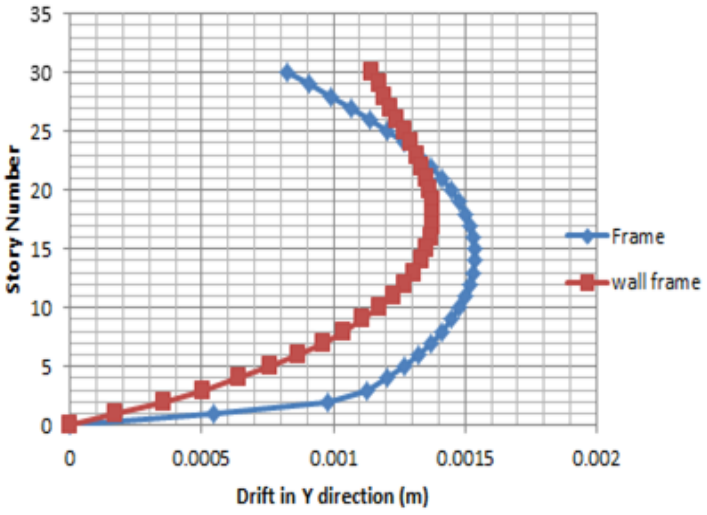

Figure 10: Comparison Graph of Drift in Y direction

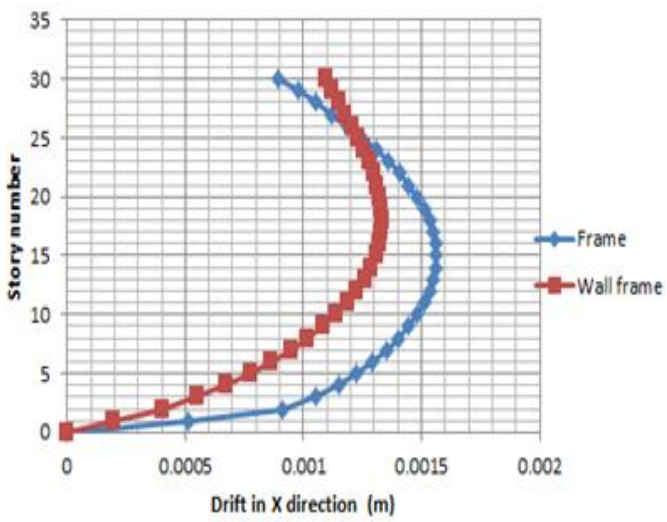

Figure 11: Comparison Graph of drift in X direction

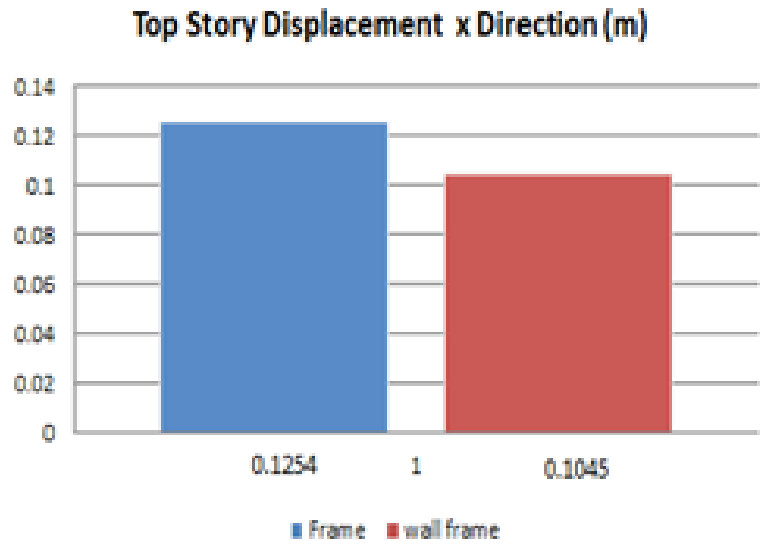

Figure 12 Comparison graph of Top storey displacement in X direction

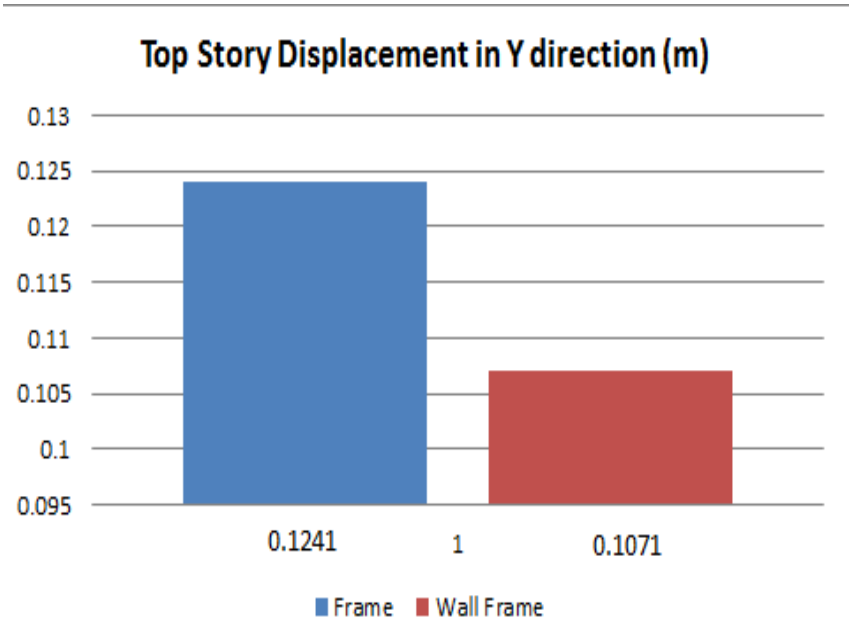

Figure 13: Comparison graph of Top storey displacement in Y direction

VII. CONCLUSION:

The comparison of moment resisting frame and wall-frame structure is carried out in terms of time period, top deflection and maximum storey drift. Analysis is carried out with ETABS software. Results show that for the wall frame structure, time period is effectively reduced. Also the top story displacement and Maximum drift is reduced than frame structure. Concluded that Wall Frame structure is more effective and stiff than frame system so it can resist lateral loads effectively.

VIII. ACKNOWLEDGMENT

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IX. REFERENCES:

[1] Mir M. Ali and Kyoung Sun Moon, "Structural Development in Tall Building Current Trends and Future Prospects", Invited Review Paper, School of Architecture 2007"
[2] Alex Coull and Bryan Stafford Smith "Tall buildings structures: Analysis and Design". Rigid-frame Structures and Wall-frame structures.
[3] Bryan Stafford Smith and Young –Soo Yoon , "Estimating Seismic Base Shears of Tall Wall Frame Building", Journal of structure Engineering Vol. 117 1991, ASCE.
[4] Fouad R. Moudarres and Alex Coull, "Stiffening of Linked Shear Walls", Journal of Engineering Mechanics vol.112 1986,ASCE
[5] Avigdor Rutenberg, Itai Leviathan and Moshe Decalo "Stability of Shear –Wall Structures" Journal of Structure Engineering Vol. 114 1988, ASCE.
[6] M .HalisGunel, H.EmreIlgin, "A proposal for the classification of Structural systems of tall buildings", Science direct, 2006 .
[7] IS: 456-2000, Code of Practice for Plain and Reinforced Concrete, Fourth revision, Bureau of Indian Standards, New Delhi, 2000.
[8] IS: 1893-2002(Part-I), Criteria for Earthquake Resistant Design of Structures, Fifth revision, Bureau of Indian Standard, New Delhi.