Effect of different lateral load resisting system on Seismic behavior of building

Abhishek Awasthi, 1st - PG Research Student,
Department of civil Engineering Uttarakhand Technical University, Dehradun

Mrs. Sangeeta Dhyani ,2nd- Assistant Professor,
Department of civil Engineering Uttarankhand Technical University, Dehradun

Abstract

Lateral loads on a structure are created either by wind or seismic tremors. Ordinarily, for tall structures within 20 storey range, earthquake is the representing horizontal power because of immense self-weight of the structure itself. These loads are opposed by the lateral load resisting system of any structure. The decision of parallel loads opposing framework should oversee the heap way lastly the configuration of building. A study was completed to contemplate the impact of lateral load on outline of a common RCC framed building. Although so many systems are use in filed numerous frameworks are utilized is field, this study is kept to three system to be specific Moment Resisting Frame (MRF), Special moment resisting fame (SMRF) and Shear wall(SW) shear. Two building height have been considered - five and ten storied building. The framing design plan is kept same for all the buildings. Floor to floor height is kept steady at 3 m. The analysis is done using computational programming software STAAD.ProV8i SS6.

Analysis is done with the help of moment resisting frame and special moment resisting frame with and without shear. Results demonstrate that for five and ten storied building MRF is more prudent contrasted with SW because of stiffer behavior. In the study also show the lateral drift of the building and base shear. Reactions and moments are also calculated on end columns, middle column and side columns.

It was found that ductile detailing give sparing outline contrasted with non-detailing design.

Keywords: Moment Resisting Frame (MRF), Special Moment Resisting Frame (SMRF), Shear Wall (SW), STAAD.ProV8i SS6.

I. Introduction

A. General

India at present is quickly developing economy which realizes requests in expansion of base infrastructure alongside the

development of population. The Interest of area in urban districts is expanding day by day. It is basic that land accessible for cultivating and agribusiness stays in place. To provide food the land request in these districts, vertical improvement is the main alternative. This kind of advancement brings difficulties to balance lateral loads due to wind and earthquake. This requests changes in the current structural framework which should be actualized to oppose these forces. Numerous exploration has been conveyed which depicts the reasonableness of different lateral load resisting system against misshapening and shear applied because of the earthquake and wind powers. Seismic zone assumes a critical part in the earthquake resistant design of building structures on the grounds that the zone variable changes as the seismic force changes from low to extremely serious. Another vital angle in the design of earthquake resistant structures is soil sort, as the soil sort changes the entire conduct and design of the structure changes. So to provide all the lateral loads, we have to plan the structure interestingly so that the structure can withstand for the most extreme era so that there is no damage to the general public.

Lateral load resisting system resist the loads of tall building easily. The greater part of the models for the examination of coupled shear wall structures depends on the continuum medium method. The guideline of the strategy is to supplant the impact of individual beams or slabs, which interconnect the walls at every floor, by ceaselessly disseminated shear forces, that agree to harden the auxiliary conduct.

B. Objective of the study:

a) To study the impact of lateral load resisting system.
b) To check the displacement of the building during seismic tremor.
c) To calculate base shear of moment resisting frame and special moment resisting with and without shear wall
d) To calculate reactions and moments on the all columns i.e. end columns, middle columns, and side columns.
e) Lateral drift and total use of steel are calculated for all the cases.

II. Methodology and building description

A. Methodology

It is vital to develop a computational model on which lateral load resisting system and ductility and non ductility is performed. For the examination of the structures, computational program STAAD Pro V8i software is utilized. Past scrutinizes have demonstrated that STAAD Pro V8i displaying is the most far reaching expository methodology for the conduct of point of confinement state strengthened. It demonstrates the 3D models era and multi-material design. It can be useful for the investigation of static, non-direct and a clasping examination. This can likewise be utilized for the dynamic investigation and seismic investigations. There are flowing methodologies adopted for the present study:

a) Select a current building model for the investigation.
b) Models are chosen of structures with and without shear wall. Structures are in square segment.
c) Lateral load resisting system is utilized for the present study.

Two height building models are chosen with various cases and comparative study of the result and design

B . Building Description

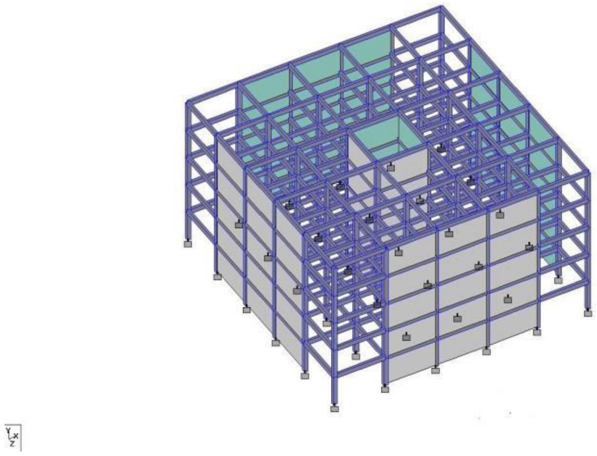
Two structures are considered for the analysis of the structure, there are 3-D framed models for a five storied and a ten storied structures are selected which are produced in STAADProV8i SS6.

The description of five storied building is following:

RRF	3(IS:456:2002)(MRF) 5(IS:13920:1993)(SMRF)
Plan size	3×6 m
Thickness of Shear wall	230 mm
Depth of Slab	150 mm
Floor to Floor height	3 m
Size of Column	450×450 mm
No. of floor	5
Maximum reinforcement	25 mm
Minimum reinforcement	16 mm
Grade of steel	M20
Seismic zone	IV

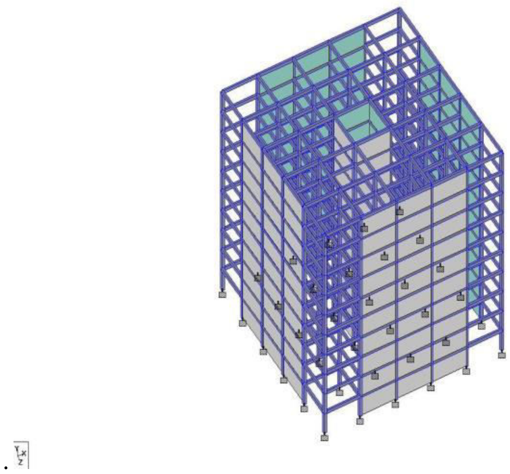
The descriptions of ten storied building are following:

RRF	3(IS:456:2002)(MRF) 5(IS:13920:1993)(SMRF)
Plan size	3×6 m
Thickness of Shear wall	230 mm
Depth of Slab	150 mm
Floor to Floor height	3m
Size of Column	450×450 mm
No. of floor	10
Maximum reinforcement	25 mm
Minimum reinforcement	16 mm
Grade of steel	M20
Seismic zone	IV



5-Storied With Shear Wall

10 Storied Building with Shear wall



III .Result and Conclusion

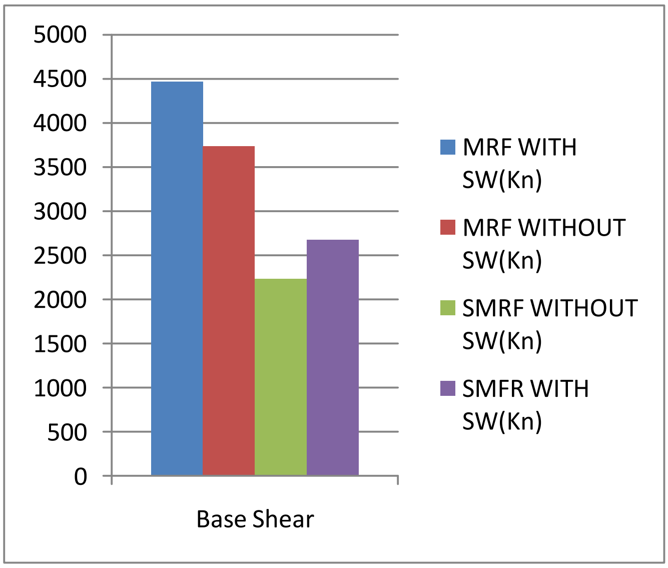
In the present concentrate, every one of the structures are outlined with the assistance of STAAD Pro V8i ss6. Two cases are considered for the present study moment resisting frame and special moment resisting frame with and without shear wall. At that point relative study is made between them. Shear wall opposes the vertical loads.

In this study, the contrast between the base shear, lateral drift, reactions and moments on all beams and columns are examined.

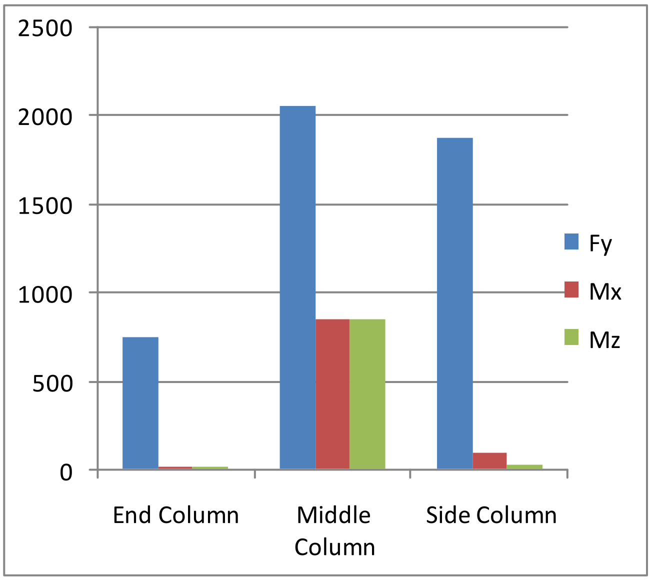
A .Analysis of 5-storied building: This building is designed for MRF and SMRF with and without shear wall. IS 456:2000 for MRF (RRF =3) and IS 13920:1993 for SMRF (RRF=5). The results obtained are as follows:

S. No.	Content	MRF With shear wall (IS 456:2000) (RRF=3)	MRF Without shear wall (IS 456:2000) (RRF=3)	SMRF (IS:13920:1993) Without shear wall (RRF=5)	SMRF (IS:13920:1993) With shear wall (RRF=5)
1.	Base Shear (V)	4462.258 kn	3732.019 kn	2239.211 kn	2677.355 kn
2.	Reactions and Moments	a)**End columns** F_y=747 kn M_y=16.647 kn M_z=-16.638 kn b)**Side columns** F_y=1878 kn M_x=-93.972 kn M_z=-27.623 kn c)**Middle columns** F_y=2063 kn M_x=852.549 kn M_z=852.573 kn	a)**End columns** F_y=768 kn M_X=17.522 kn M_z=-17.510 kn b)**Side columns** F_y=1151 kn M_x=-0.431 kn M_z=-18.64 kn c)**Middle columns** F_y=1531 kn M_x=-0.46 kn M_z=-0.45 kn	a)**End columns** F_y=768 kn M_x=17.522 kn M_z=-17.51 kn b)**Side columns** F_y=1151 kn M_x=-0.431 kn M_z=-18.641 kn c)**Middle columns** F_y=1531 kn M_x=-0.46 kn M_z=-0.45 kn	a)**End columns** F_y=747 kn M_x=16.647 kn M_z=-16.638 kn b)**Side columns** F_y=1878 kn M_x=93.647 kn M_z=-27.622 kn c)**Middle columns** F_y=2063 kn M_x=-852.552 kn M_z=852.547 kn
3.	Lateral Drift	**G.F**: x=0.204 mm, z=0.204 mm **1st floor**: x=0.374 mm, z=0.374 mm **2nd floor**: x=0.591 mm, z=0.591 mm **3rd floor**: x=0.804 mm, z=0.830 mm **4th floor**: x=0.973 mm, z=0.998 mm	**G.F:** x=11.047 mm, z=11.046 mm **1st floor**:x=29.093 mm, z=29.09 mm **2nd floor**:x=46.637 mm z=-46.626 mm **3rd floor**:x=60.492 mm, z=60.93 mm **4th floor**: x=-69.04 mm, z=-69.044 mm	**G.F**: x=6.653 mm, z=-6.529 mm **1st floor:** x=17.456m, z=-17.453 mm **2nd floor**:x=27.86 mmz=-27.974 mm **3rd floor**:x=36.30 mm z=36.302 mm **4th floor**: x=-41.508 mm, z=-41.505 mm	**G.F**: x=-0.147 mm, z=0.147 mm **1st floor**: x=0.238 mm, z=0.238 mm **2nd floor**: x=0.307 mm, z=0.370 mm **3rd floor**:x=0.524 mm, z=0.524 mm **4th floor**:x=0.623 mm, z=0.623 mm
4.	Design Total use of steel	36430.68 kg	52901.93 kg	41744.0366 kg	22425.891 kg

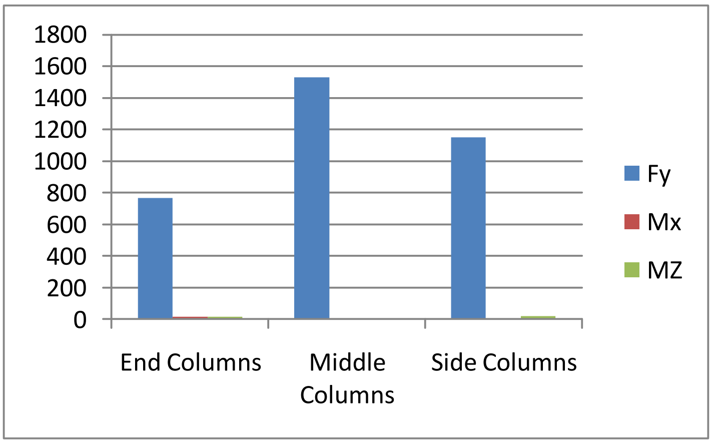
Base shear is the parallel force. It is more in moment resisting frame with shear wall when contrasted with special moment resisting frame with shear wall. The estimation of base shear is additionally more in moment resisting frame without shear wall when contrasted special moment resisting frame without shear wall as said in the above table. In this investigation the responses on end, side and center columns in moment resisting frame and special moment resisting frame with and without shear wall are same. It was additionally found that the moments are same in moment resisting frame and special moment resisting frame with and without shear wall. Lateral drift on the ground floor is more in moment resisting frame when contrasted with special moment resisting frame with and without shear wall. In investigation, it was found that on all the floors of the building, the lateral drift is more in moment resisting frame when contrasted with special moment resisting frame with and without shear wall.



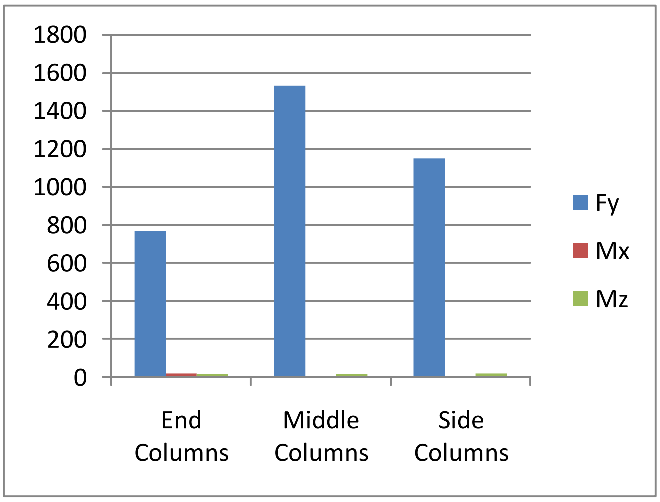
Base Shear



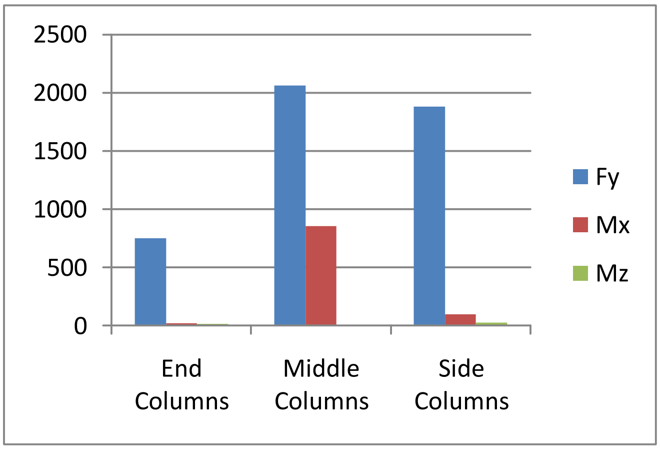
Reactions and Moments (MOMENT RESISTING FRAME WITH SHEAR WALL)
5 Storied Building



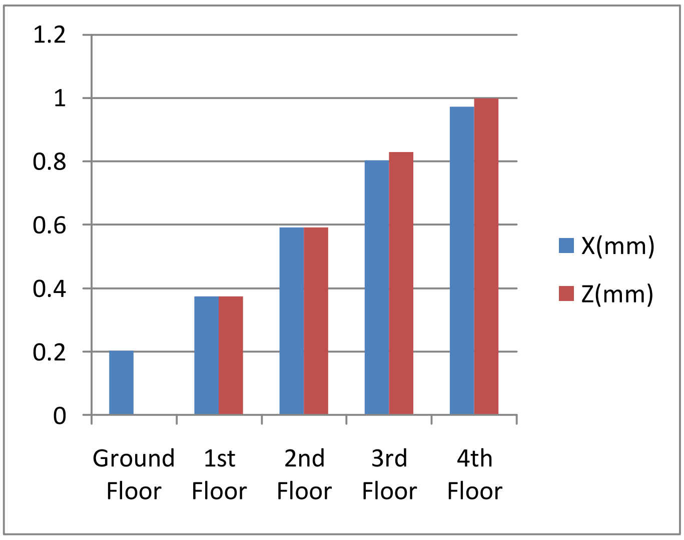
Reactions and Moments (Moment Resisting Frame without Shear Wall)
5 Storied Building



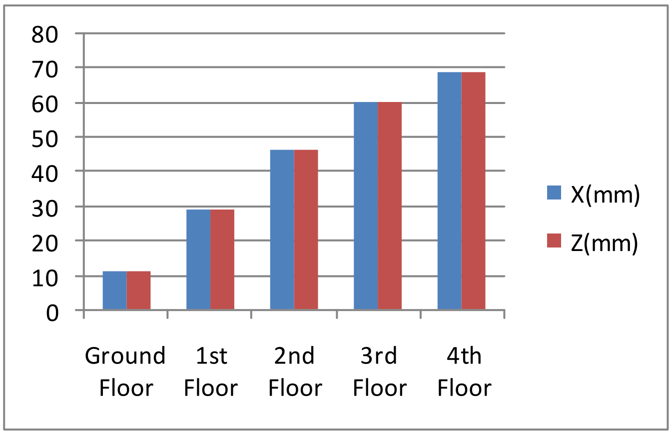
Reactions and Moments (Special Moment Resisting Frame without Shear Wall)
5 Storied Building



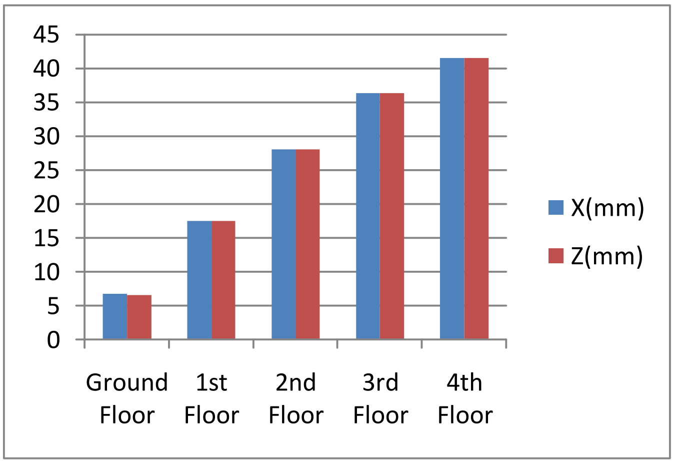
Reactions and Moments (Special Moment Resisting Without Shear Wall)
5 Storied Building



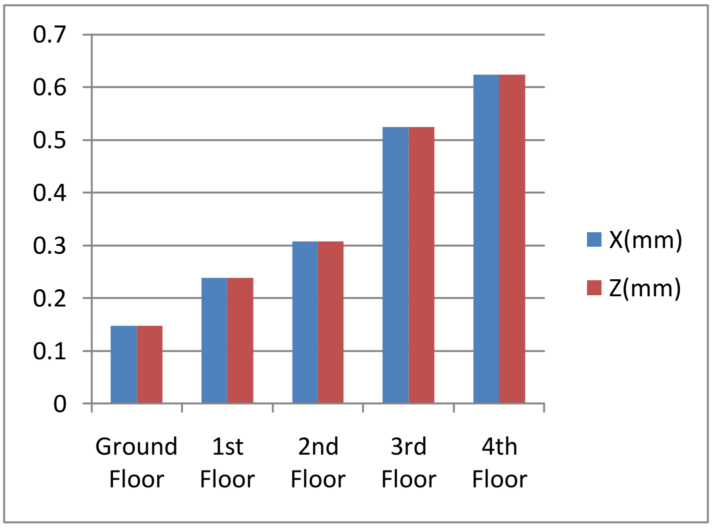
Lateral Drift (Moment Resisting Frame with Shear Wall)
5-Storied Building



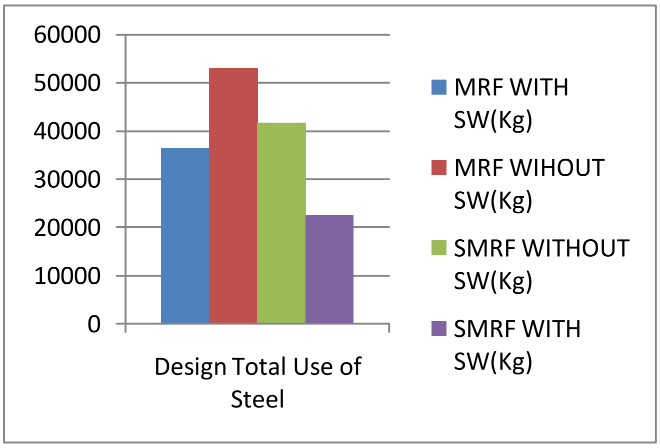
Lateral Drift (Moment Resisting Frame without SW)
5 Storied Building



Lateral Drift (Special Moment Resisting Frame without SW)
5 Storied Building



Lateral Drift (Special Moment Resisting Frame without SW)
5 Storied Building



Design Total Use of Steel
5 Storied Building

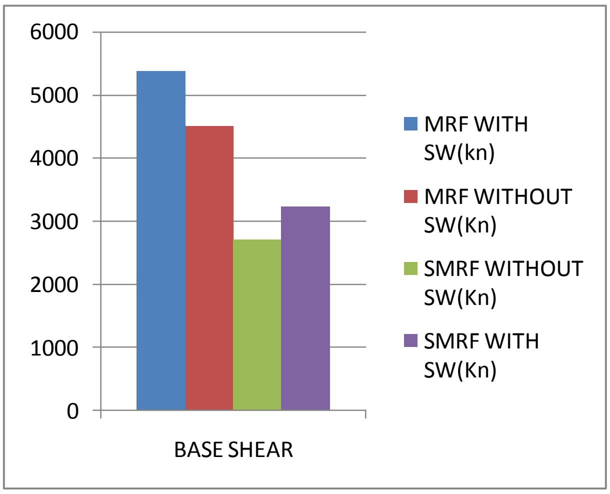
B. Analysis of 10-storied building: This building is designed for MRF and SMRF with and without shear wall. IS 456:2000 for MRF (RRF =3) and IS 13920:1993 for SMRF (RRF=5). The results obtained are as follows:

S. No.	Content	MRF With shear wall (IS 456:2000) (RRF=3)	MRF Without shear wall (IS 456:2000) (RRF=3)	SMRF (IS:13920:1993) Without shear wall (RRF=5)	SMRF(IS:13920:1993) With shear wall (RRF=5)
1.	**Base Shear (V)**	5382.266 KN	4513.86 KN	2708.316 KN	3229.360 KN
2.	**Reactions and Moments**	**a)End Column** F_y=1491 KN M_x=18.023 KN M_z=-18.023 KN **b) Side Column** F_y=4040 KN M_x=-100.709 KN M_z=-31.29 KN **c)Middle Column** F_y=4377 KN M_x=1811.2 KN M_z=1811.268 KN	**a)End Column** F_y=1674 KN M_x=17.885 KN M_z=-17.885 KN **b)Side Column** F_y=2394 KN M_x=-0.483 KN M_z=-18.983 KN **c)Middle Column** F_y=2394 KN M_x=-0.483 KN M_z=-18.983 KN	**a)End Column** F_y=1674 KN M_x=17.885 KN M_z=-17.885 KN **b)Side Column** F_y=2394 KN M_x=-0.469 KN M_z=-18.83 KN **c)Middle Column** F_y=3100 KN M_x=0.487 KN M_z=-0.487 KN	**a)End Column** F_y=1491 KN M_x=18.023 KN M_z=-18.03 KN **b)Side Column** F_y=1491 KN M_x=18.023 KN M_z=-18.03 KN **c)Middle Column** F_y=4377 KN M_x=1811.2 KN M_z=1811.268 KN

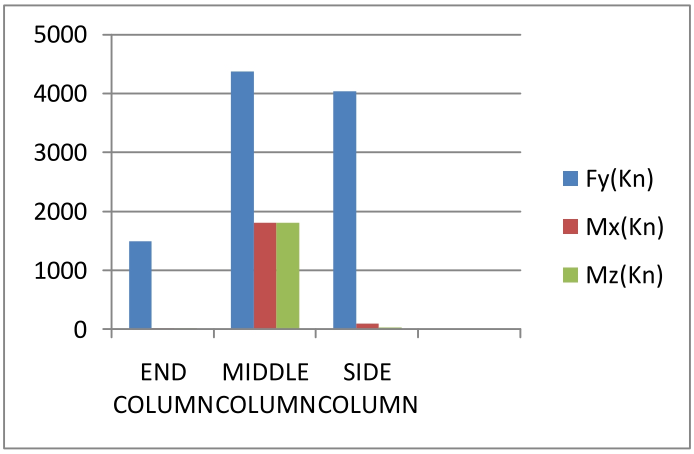
3.	**Lateral Drift**	**G.F**:x=.368 mm, z=.368 mm **1st Floor**: x=0.705 mm, z=0.705 mm **2nd Floor**: x=1.119 mm, z=1.119 mm **3rd Floor**: x=1.582 mm, z=1.582 mm **4th floor**: x=2.088 mm, z=2.088 mm **5th floor**: x=2.622 mm, z=2.622 mm **6th floor**: x=3.172 mm, z=3.172 mm **7th floor**: x=3.725 mm, z=3.725 mm **8th floor**: x=4.295 mm, z=4.295 mm **9th floor**: x=4.823 mm, z=4.823 mm	**G.F:** x=14.326 mm, z=14.326 mm **1st floor**: x=38.577 mm, z=38.577 mm **2nd floor**: x=64.519 mm, z=64.519 mm **3rd floor**: x=90.13 mm, z=90.13 mm **4th floor**: x=114.55 mm, z=114.55 mm **5th floor**:x=137.067 mm, z=137.067 mm **6th floor**: x=156.834 mm, z=156.834 mm **7th floor**: x=172.94 mm, z=172.94 mm **8th floor**: x=184.495 mm, z=184.495 mm **9th floor**: x=190.867 mm, z=190.867 mm	**G.F:** x=8.622 mm, z=8.622 mm **1st floor**: x=23.148 mm, z=23.148 mm **2nd floor**: x=38.714 mm, z=38.714 mm **3rd floor**: x=54.081 mm, z=54.081 mm **4th floor**: x=68.738 mm, z=68.738 mm **5th floor**: x=82.242 mm, z=82.242 mm **6th floor:** x=94.102 mm, z=94.102 mm **7th floor**: x=103.771 mm, z=103.771 mm **8th floor**: x=110.707 mm, z=110.707 mm **9th floor**: x=114.424 mm, z=114.424 mm	**G.F:**x=.272 mm, z=.272 mm **1st floor**: x=0.423 mm, z=0.475 mm **2nd floor**: x=0.726 mm, z=0.726 mm **3rd floor**: x=0.998 mm, z=0.998 mm **4th floor**: x=1.294 mm. z=1.294 mm **5th floor**: x=1.606 mm, z=1.606 mm **6th floor**: x=1.928 mm, z=1.928 mm **7th floor**: x=2.255 mm, z=2.255 mm **8th floor**: x=2.605 mm, z=2.605 mm **9th floor**: x=2.938 mm, z=2.938 mm
4.	**Total use of steel**	73098.77 kg	112342.099 kg	93471.865 kg	42368.603 kg

In this investigation, the base shear in MRF is more when contrasted with SMRF with shear wall and base shear in MRF is likewise more when contrasted with SMRF without shear wall as can be found in the above table. In this investigation, the responses on end, side and middle columns in moment resisting frame and special moment resisting frame with and without shear wall are same. It was likewise found that the moments are same in moment resisting frame and special moment resisting frame with and without shear wall.

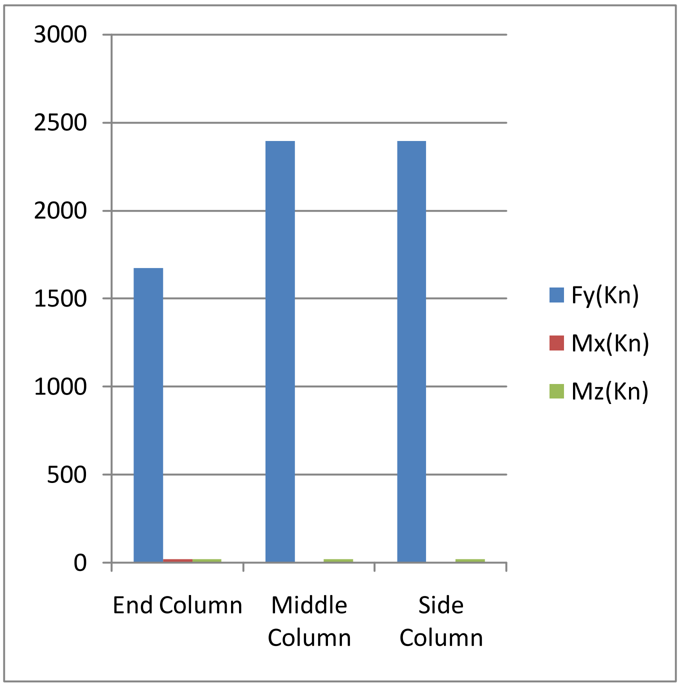
Structures are more drift in moment resisting frame when appeared differently in relation to special moment resisting frame with and without shear wall. In brake down, on all the floors of the building, drift is more in moment resisting frame when diverged from special moment resisting frame with and without shear wall.



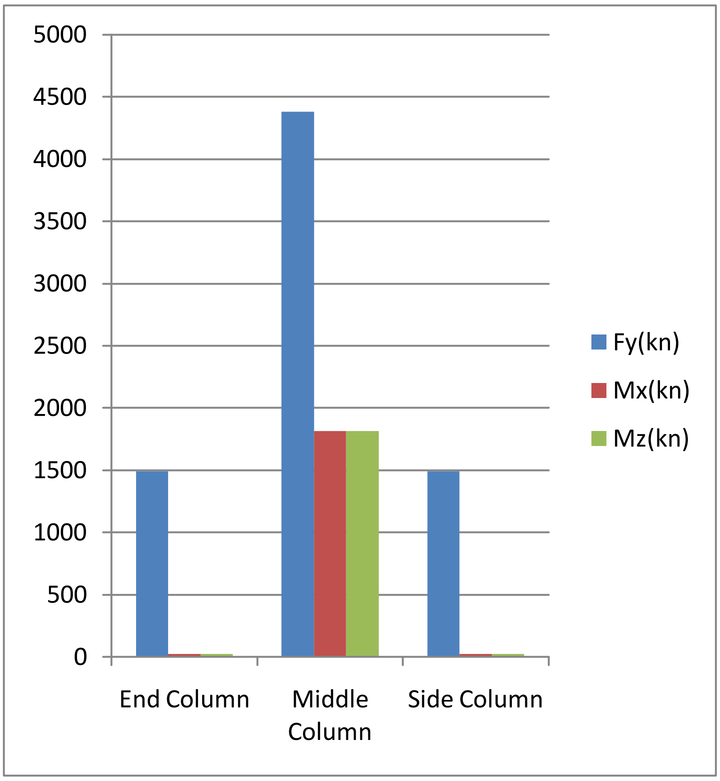
BASE SHEAR (Kn)
10 Storied Building



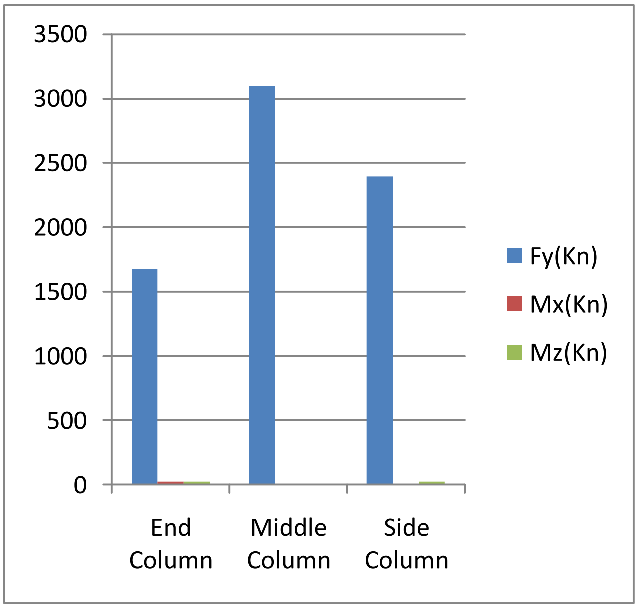
Reaction and Moments (Moment Resisting Frame with SW)
10 Storied Building



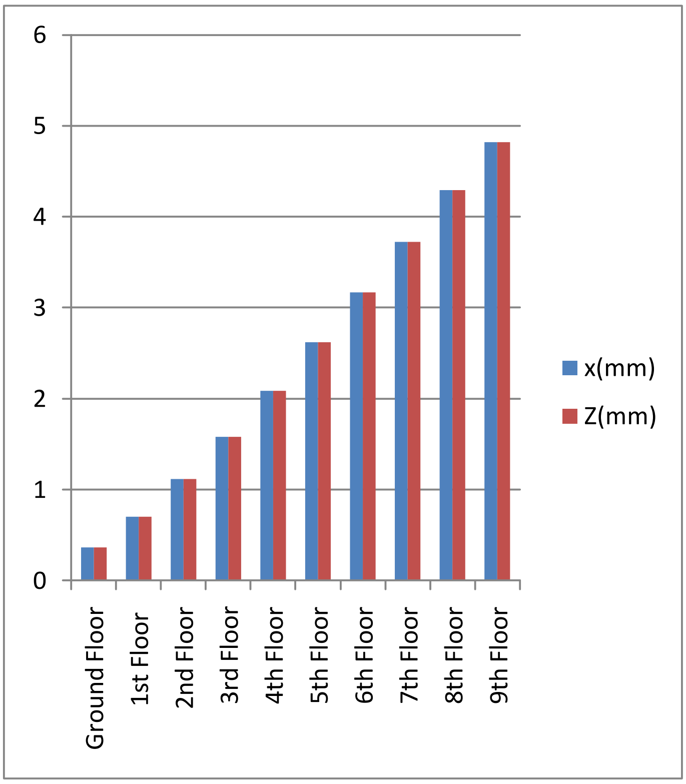
Reactions and Moments (Moment Resisting Frame without SW)
10 Storied Building



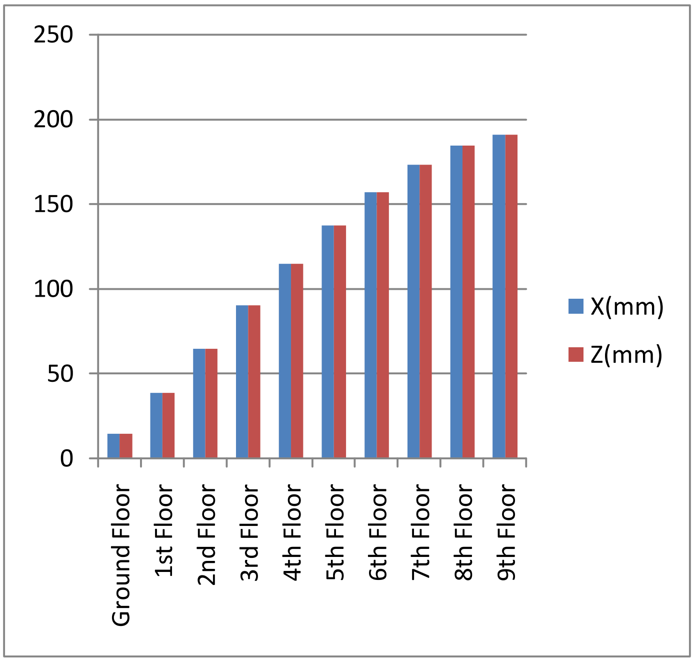
Reactions and Moments (Special Moment Resisting Frame with SW)
10 Storied Building



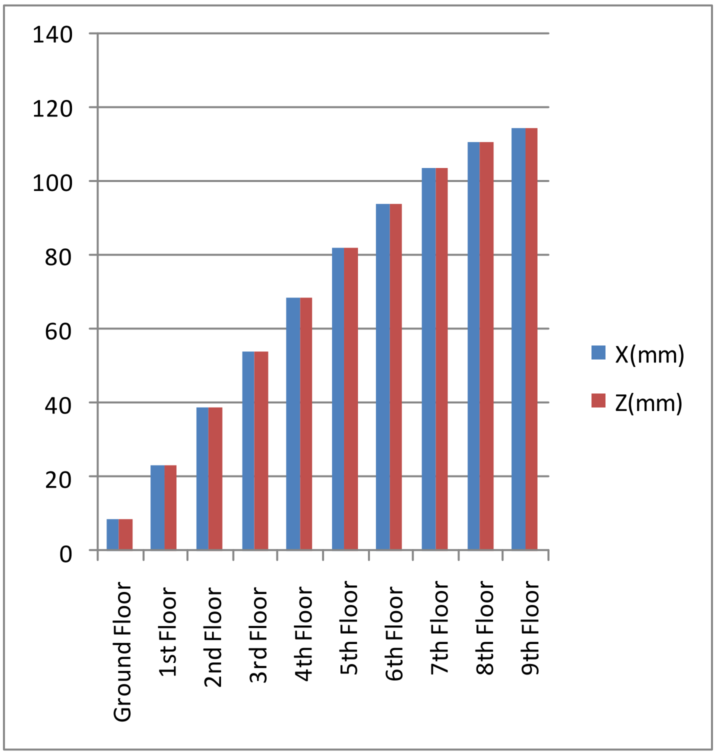
Reactions and Moments (Special Moment Resisting Frame without SW)
10 Storied Building



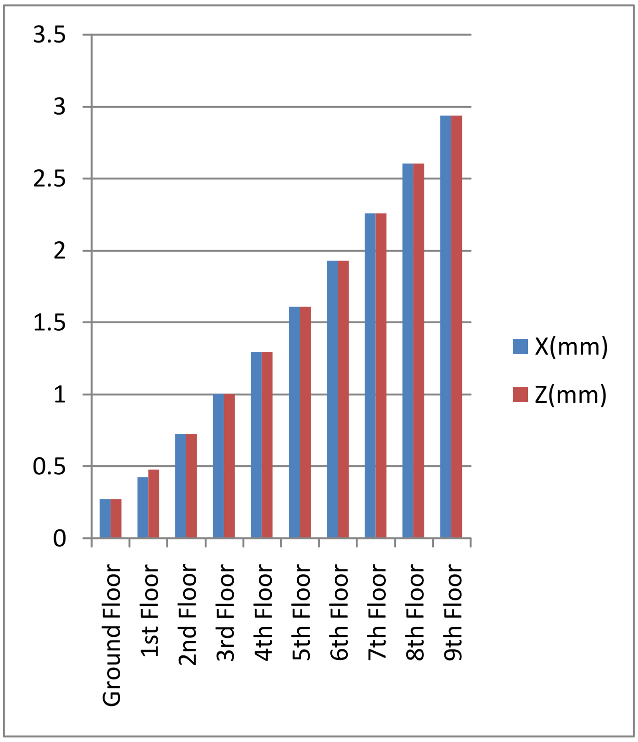
Lateral Drift (Moment Resisting Frame with SW)
10 Storied Building



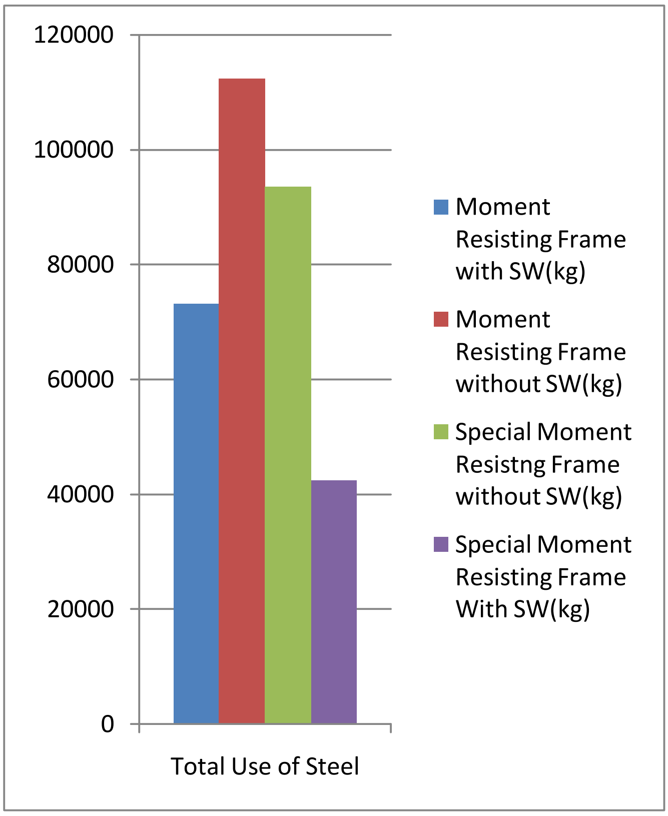
Lateral Drift (Moment Resisting Frame without SW)
10 Storied Building



Lateral Drift (Special Moment Resisting Frame without SW)
10 Storied Building



Lateral Drift (Special Moment Resisting Frame with SW)
10-Storied Building



Total Use of Steel (10 Storied Building)

C. Conclusion

The present study conclude that on five story and ten story fabricating the base is more in moment resisting frame with shear wall as contrasted special moment resisting frame with and without shear wall and shear wall likewise base shear is more in moment resisting frame without shear wall when contrasted with special moment resisting frame outline without shear without shear wall.

Reactions and moments in MRF with SW and SMRF with shear wall are same on all columns i.e. end columns, middle columns and side columns. Also reactions and moments are same in MRF without SW and SMRF without SW.

Building are more drift in MRF with and without SW when contrasted with SMRF with and without SW.Total utilization of steel is more in MRF without SW.In present study conclude that the MRF is more economical with SW.Also reason that the utilization of steel is more in moment resisting frame without shear wall.

Acknowledgements

I might want to express my most profound appreciation to my supervisor Mrs.Sangeeta Dhyani, HOD &Assistant Professor for her incredible supervision, help and persistence. She has not just furnished me with this chance to enhance my insight additionally upheld me completely through my studies. She has encouraged me amid my exploration residency with the most ideal assets. She has given greatest conceivable time to my work inside her bustling calendar and has dependably been willing and inviting.

REFERENCES

[1]. Dr. Valsson Varghese (et al) (2013) **“**Comparative Study of SMRF Building over OMRF Building with Seismic and Wind Effect” International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 3, Issue 3, May-Jun 2013, pp.1501-1503.

[2]. Mahesh Tandon (2005),“ECONOMICAL DESIGN OF EARTHQUAKE-RESISTANT BRIDGES”, ISET Journal of Earthquake Technology, *Paper No. 453, Vol. 42, No. 1, March 2005, pp. 13-20*2 5th ISET Annual Lecture.

[3]. Devesh ojha (et al) (2014), “Low Cost Earthquake Resistant Housing Construction in India”, Volume-4, Issue-5, October-2014, ISSN No.: 2250-0758 International Journal of Engineering and Management Research, Page Number 18-20.

[4]. Dalal Sejal P, Vasanwala S A and Desai A K “Performance based seismic design of structure: A review” INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 1, No 4, 2011. ISSN 0976 – 4399.

[5]. Tzong-Ying Hao“Energy of Earthquake Response Recent Developments” ISET Journal of Earthquake Technology, Paper No.416, Vol.39, No.1-2 March June 2002, PP 21-53

[6]. E. Pavan Kumar (et al) (2014) “Earthquake Analysis of Multi Storied Residential Building - A Case Study, Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 11(Version 1), November 2014, pp.59-64.

[7]. Eric L. Geist “RAPID TSUNAMI MODELS AND EARTHQUAKE SOURCE PARAMETERS: FAR-FIELD AND LOCAL APPLICATIONS” ISET Journal of Earthquake Technology, Paper No. 460, Vol. 42, No. 4, December 2005, pp. 127-136.

[8]. Mohammad Adil Dar, Prof (Dr) A.R. Dar , Asim Qureshi ,Jayalakshmi Raju (2013) “A Study on Earthquake Resistant Construction Techniques”, American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-12, pp-258-264 www.ajer.org.

[9]. A.Paul, M.L.Sharma and V.N.Singh “Estimation of focal parameters for utarkashi earthquake using peak ground horizontal acceleration”, ISET Journal of Earthquake Tech. Paper No. 1-3, March-Sept. 1998,pp 1-8.