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Comparison of Shear wall Building and Core wall Building

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Abstract:
Background*:Shear wall and core wall are components applied in the high story structures to resist lateral force in high seismic zones, now utilized in zone II and also zone III to restrain against earthquake loads. Shear wall and core wall both are similar. Shear wall is considered as a linear wall which is provided at the edges of buildings. Core wall is provided at the center of the building. Core wall is combination of shear walls.*
Materials and Methods: *In this paper study of 10 story, 15 story and 20 story building analyzed with different lateral resistance applied with similar structural parameters and dimensions with linear static method and comparison of analysis results with shear wall, core wall and concrete frame building.*
Results:*The mean difference is in terms of maximum story displacement, story drift in each model. The variation of results can be seen core wall in the middle has less deformation compared to other models.*
Conclusion: *Core wall provided in the center of model is more convenient with compare to shear wall at the edge of the model.*
Key Word: *Shear Wall, Core Wall, Optimum Location*

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I. Introduction

The rapid increase in population, limited space, land price and importance of tall buildings are the creation and development of tall buildings. Development of long brick building to limit the horizontal expansion of buildings in cities tall buildings are current craze for construction. Certain walls like are used in tall buildings for resistance of lateral force like wind, seismic loads. The first concrete wall was used by Pere for the construction of his own apartment located I Paris in 1903.In the last decades, the conviction of earthquake flexibility towards the structural system has become popular in which lateral resisting system considered as a viable option for any building for earthquake resistance. Different lateral resisting systems like rigid jointed moment resisting frames, braces frames and shear walls.[4] The braced system is the cheapest and most efficient but it blocks the building in one bay, the rigid moment resisting frame is the most expensive in which every beam column joint required to detail as moment resistant connection.[1] Shear wall is intermediate, which block the building in one bay but that is provided where there is no problem of blocking, based on the suitability the lateral resisting systems are used in building.[8]

Shear wall is structural member used to resist lateral forces which are parallel to wall. Shear walls vertical elements to resist horizontal forces.Shear walls are provided in building to prevent the failure in shear due to weight of structure and occupants, creates torsional forces and also resist against forces caused by wind, earthquake and uneven settlement of loads. Shear walls are generally constructed from materials like concrete and masonry. Shear walls construction required as per locality and earthquake zones for multistory building. For building with lesser stories, neither Shear walls required in the construction nor required to check by design by knowing the estimated wind force and earthquake force of the location.Shear wall construction is quick and does not require any extra plastering and finishing as the wall itself provides high level of precision. [5] Shear forces can be also resisted by steel braced frames which can be very effective towards lateral forces.

Torsional forces are created to shear wall by lateral pressure, but shear wall which acts as one member and produces compression member at one corner and tension member at another corner. When the lateral force is applied from the opposite direction, a coupled reversed that shows that both sides of the shear wall need to be capable both types of forces.Torsional forces are created to shear wall by lateral pressure, but shear wall which acts as one member and produces compression member at one corner and tension member at another corner. [9]When the lateral force is applied from the opposite direction, a coupled reversed that shows that both sides of the shear wall need to be capable both types of forces.

Core walls are originated with combination of wall and arranged like a core located at the geometric center of the building. It is a type of shear wall simply the combination of shear wall. Core wall is constructed from the foundation and it is raised up to the building. In this type of building, the wall itself acts as a column. Core is used to install lifts, stair case, step wells and accommodate services.**[**6**]** Core wall is constructed from the

foundation and it raises up to the height of the building. In this type of wall, the wall itself acts as a column. Core wall is built to carry the lateral force exerted on the structure due to wind, earthquake or any other lateral load. Lift core wall is most widely used as a core in multistory building with open section, which defends against lateral seismic loads. Core acts as circulation core include staircase, elevators, pipelines through which people are allowed to move between the floors of the building [7].

The most efficient and suitable lateral load resisting system is shear wall system in that different types are used like RC core wall, concrete block, and steelshear wall. For multistory building core wall system is applied in building, shear wall criteria are poles apart from core wall. Core may be referred as circulation core or service core, include staircase, elevators, electrical cables and water pipes.Core allows people to move between the floors of the building and assign the services decisive to the floors. In the study, 9 models are prepared to achieve the least deformation 10, 15 and 20 floors models are analyzed with same parameters and similar zone.To check out the performance the effect of core wall and shear wall on concrete frame building. It is obtained that walls decreases displacement and story drift in plans as height increases.[2]

As described earlier that core wall are provided in centre of the building and support the building to resist lateral loads, horizontal loads which are wind load, seismic load. the effect of core wall is top to bottom sequence to prevent overturning the structure. Core wall provided in the middle beahve as column to resist all the loads of the structure without spreading in surrounding column. Thus, it takes whole loads of the structure. Core wall is more convient than otherr types of shear walls and lateal resisting system including braced frames. The thickness of core wall is based on the height of the structure. [6]

II. Modelling of Structure

This comparative study was carried out on different lateral restraining systems contenting core wall and shear wall. Different story of models of symmetrical plans are analyzed in ETABS software through static linear by using Indian Standard codes of seismic resistance.

Study Design: Analysis of shear wall building and core wall building comparison.

Model profile: To check the Effect of Shear wall and Core Shear Wall on the relative drift of tall buildings with concrete frame system in the regular plan on the function of buildings Reinforce Concrete Core Shear Walls, three buildings with a concrete frame system in different heights of 10, 15 and 20 floors were considered. [3] Then the mentioned buildings were analyzed and designed with the static linear method in ETABS software. To study the effect of irregularities on the performance of shear wall and Core Shear Wall, three different concrete frame buildings with 10, 15 and 20 with symmetrical plans were considered in which the relative drifts and maximum displacement obtained in the X axis and the Y axis. Both the axis showed their different deformed shapes accordingly for particular seismic load.5)
Drawn figures and comprising the outputs are obtained fromanalysis results. The building has 5 openings with 4meters length along the x axis and 5 openings with 4 meters length along the y axis.To check out the performance the effect of core wall and shear wall on concrete frame building some calculations were required as per Indian Standard[10].

Calculation related to seismic force application is required including time period, response reduction factor and importance factor.

Reinforced concrete frame building, with shear wall and with core wall are shown in figure 1, 2 and 3.

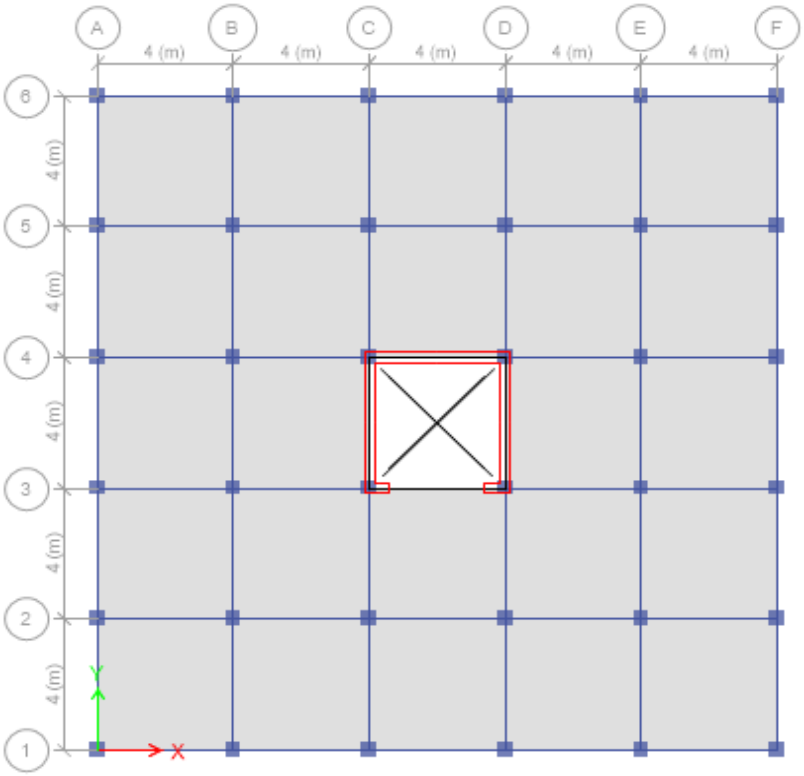

Figure.1 Reinforced concrete building withcore wall

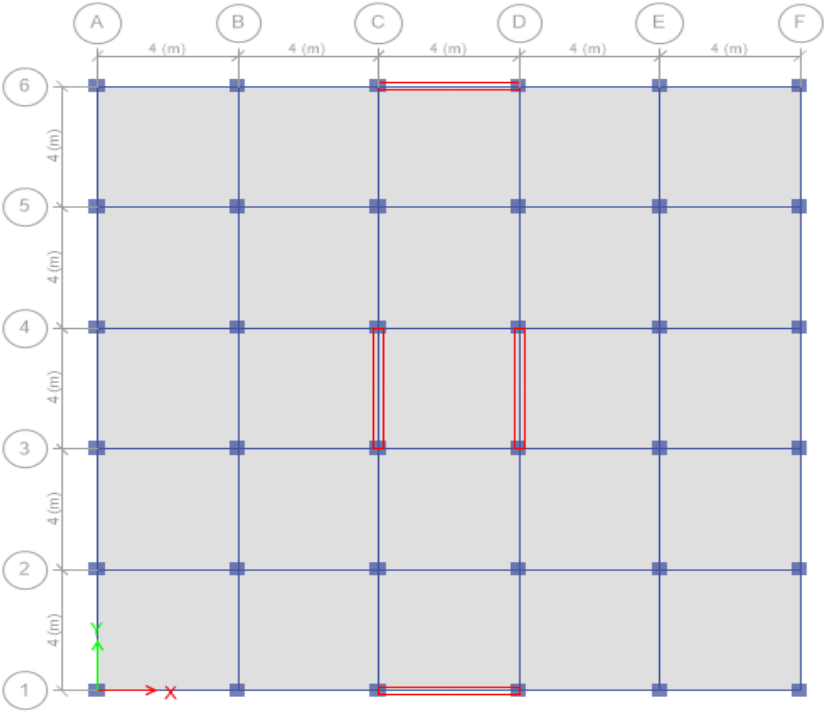

Figure.2 Reinforced concrete building with shear wall

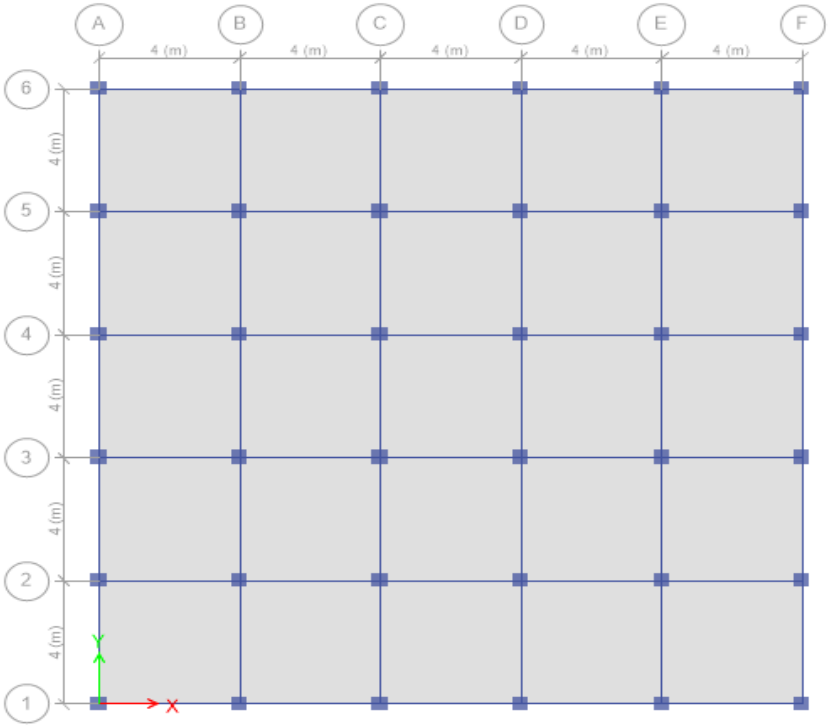

Figure.3 Reinforced concrete building

Criteria: The table given below indicates the building parameters and structural members dimension for symmetrical plan of model.

Table-1Geometric parameters and properties considered

SrNo.	Parameters	10 Floors	15 Floors	20 Floors
1	Plan	20×20	20×20	20×20
2	Height of each story	3.5m	3.5m	3.5m
3	Ground level	3.5m	3.5m	3.5m
4	Height of basement	4m	4m	4m
5	Total height of building	32.4m	49.9m	67.4m
6	Size of beams	450×600mm	450×600mm	450×600mm
7	Size of column	450×450mm	450×450mm	450×450mm
8	Slab thickness	150mm	150mm	150mm
9	Live load	2.0 kN/m^2 4.0 kN/m^2 7.0 kN/m^2	2.0 kN/m^2 4.0 kN/m^2 7.0 kN/m^2	2.0 kN/m^2 4.0 kN/m^2 7.0 kN/m^2
10	Floor finish	1.5 kN/m^2 2.0 kN/m^2	1.5 kN/m^2 2.0kN/m^2	1.5 kN/m^2 2.0 kN/m^2
11	Seismic zone	III	III	III
12	Soil condition	Medium soil	Medium soil	Medium soil
13	Importance factor	1	1	1
14	Response reduction factor	5	5	5
15	Time period	1.01	1.48	1.76
16	Wall Thickness	300mm	300mm	300mm

Statistical analysis

Data isanalyzed usingETABS (17.0.1) student version to learn the significance differences between shear wall and core wall. In addition only concrete frame building was also analyzed in software to check the performance with the effects of core wall and shear wall.[8] [9] [10]All the models were analyzed with shear wall, core wall and only concrete frame building and found out result in forms of deformation;maximum displacement and relative story drift diagrams.

III. Result

After analysis of models following results were found out and obtained results were compared shear wall building, core wall building in terms of maximum displacement and relative drift. From acquired value of software graphs were drawn and also following results.

Following graphs are drawn from obtained result of ETABS graphs represents the maximum displacement and relative drift of 20 floors model with core wall, shear wall and concrete frame building accordingly and comparison as shown in comparison tables for 10, 15 and 20 floors model with core wall, shear wall and only concrete frame building model. The table shows the value of displacement and maximum drifts. The results graphs are plotted for maximum stories in height to understand the height raise also increase deformation.

In the following figure 4 maximum displacementsare 77.171 mm in X- direction and 72.024 mm in Y-direction.The graph in figure 5 shows the maximum drift for X and Y- direction.

The maximum displacement for concrete frame building with shear wall is 82.276 mm and 72.309 mm for X-direction and Y- direction respectively. Figure 6 shows the concrete frame building having displacement of 112.069mm in both X and Y directions.

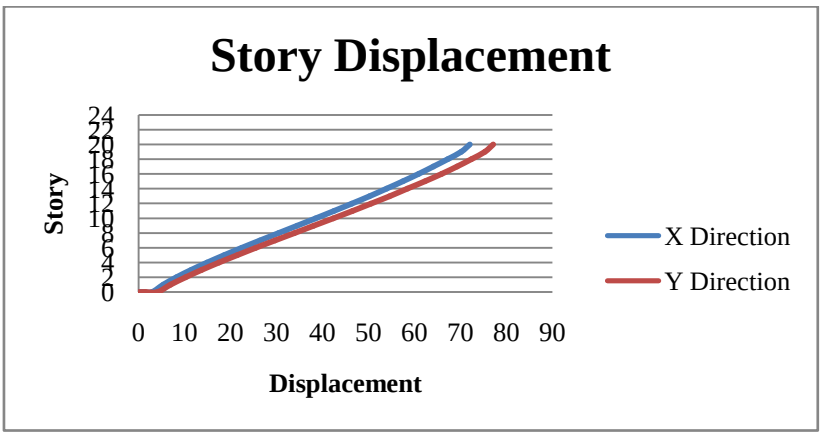

Figure.4Maximum displacement of 20 stories height Core wall building

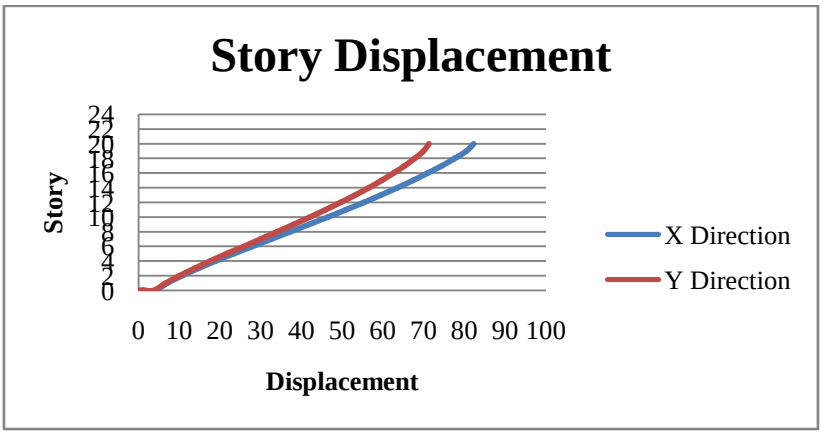

Figure.5Maximum displacement of 20 stories height Shear wall building

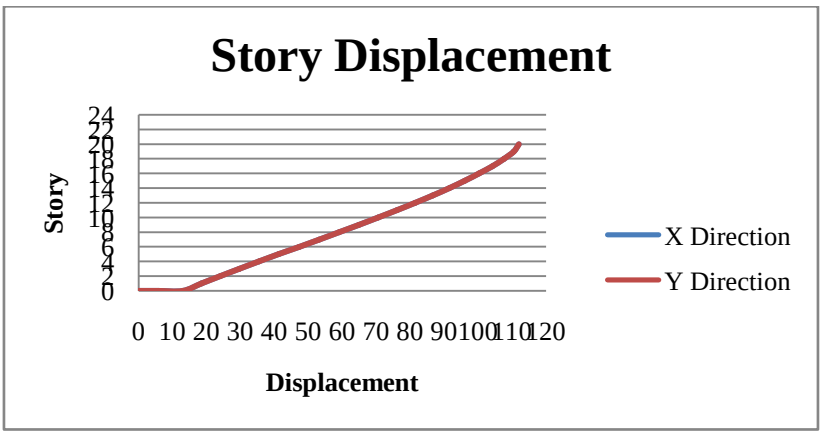

Figure.6Maximum displacement of 20 stories concrete frame building

Following figures shows the maximum relative story drift for 20 stories height building. The maximum drift is 0.001207 in X- direction and 0.001154 for Y- direction accordingly with core wall concrete frame building as shown in figure 7 for building with core wall.

Figure 8 indicates the maximum story drift for 20 stories height building with shear wall story drift is 0.001327 in X- direction and 0.001176 in Y- direction.

Graph shown in figure 9 is story drift for 20 stories height concrete frame building without provision of core wall at center and without shear wall. The maximum drift is 0.001809 in X- direction and also for Y- direction.

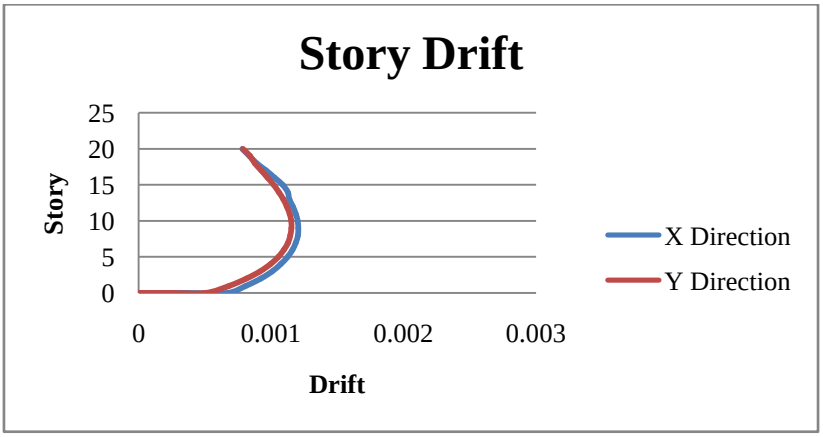

Figure.7Relative story drift of 20 stories height core wall building

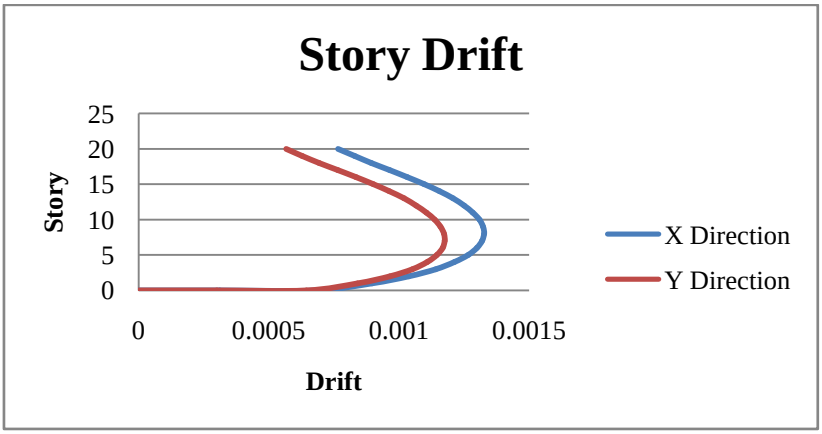

Figure.8Relaive story drift of 20 stories height shear wall building

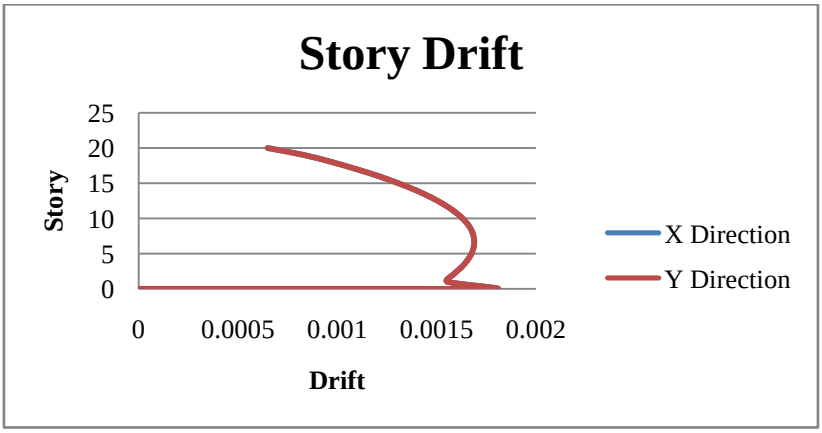

Figure.9Relative story drift of 20 stories concrete frame building

Comparisons of 10, 15 and 20 stories maximum displacement and story drift values with core wall concrete building, shear wall concrete building and concrete frame building.

Table-2Maximum displacement for different stories height building in X- direction

Building type	Core wall	Shear wall	Concrete frame
10 Floors	25.234	27.59	57.12
15 Floors	44.359	45.066	93.141
20 Floors	77.171	82.276	112.069

Table-3Maximum displacement for different stories height building in Y- direction

Building type	Core wall	Shear wall	Concrete frame
10 Floors	20.203	25.84	53.92
15 Floors	40.633	41.304	93.141
20 Floors	72.024	112.069	112.069

Following figure 10 indicates the information for 10, 15 and 20 stories height building with core wall, shear wall and concrete frame building without any lateral resisting walls. Where 1, 3, 5 are for X- direction and 2, 4, 6 are for Y- direction.

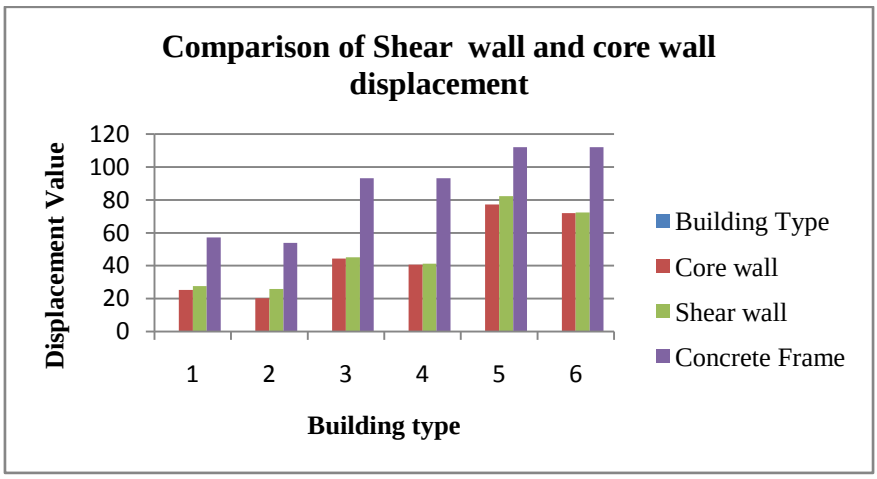

Figure.10Comparison of Shear wall and core wall Displacement

Comparison for relative maximum drift of 10, 15 and 20 stories drift for core wall, shear wall and concrete frame building are shown in table 4 and 5 below.

Following tables are shows the maximum values for building type with different stories. Story drift for different heights and different lateral load response walls and without any wall provisions. After table there is comparisons of all type of buildings with different stories heights are compare in terms of drift value where graphs is plotted as shown in figure

Table-4 Relative drift of different stories height building in X- direction

Building type	Core wall	Shear wall	Concrete frame
10 Floors	0.000731	0.000827	0.001991
15 Floors	0.000907	0.000948	0.002212
20 Floors	0.001207	0.001327	0.001809

Table-5Relative drift of different stories height building in Y- direction

Building type	Core wall	Shear wall	Concrete frame
10 Floors	0.000655	0.000781	0.001879
15 Floors	0.000849	0.000864	0.002212
20 Floors	0.001154	0.001176	0.001809

Following figure 11 shows the comparison of maximum story drift of different stories height building with increment and decrement of drift between stories for different lateral resistance through structural walls in

X- direction and Y- direction. Where column 1, 3 and 5 indicates the value of maximum story drift for earthquake X- direction and 2, 4 and 6 shows the maximum story drift of Y- direction.

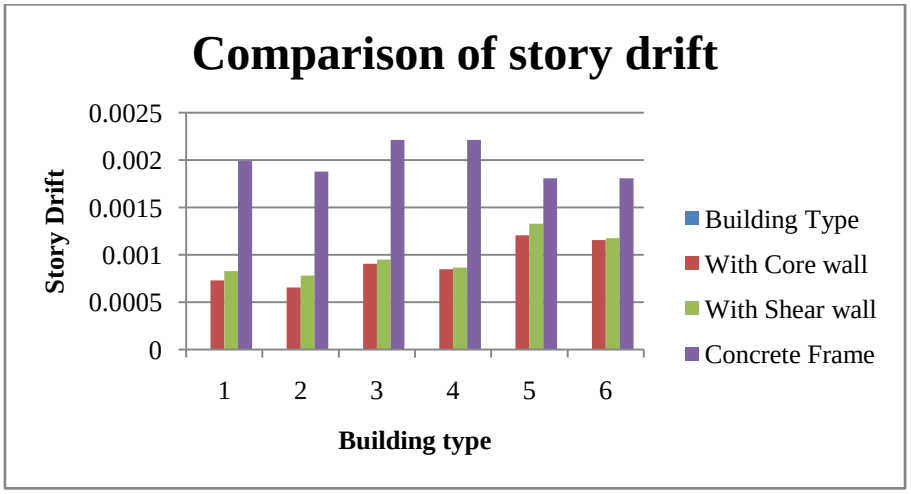

Figure.11Comparison of shear wall and core wall drift

IV. Discussion

Comparative study of different story of models are with height difference same symmetrical plan. The comparison of study includes different lateral load resisting structural walls as well only concrete frame building. Structural walls like shear wall and core walls are placed in similar plans in different stories of 10 stories, 15 stories and 20 stories. The study leads to optimum location of core wall in only 20 story building with static linear method.

After analysis, the responses of buildings are obtained in terms maximum story displacement, relative story drift. Firstly, all story models are compared for different response against lateral force and analyzed. Secondly, all models are compared with different load resistance applied and without applying any resistance for same story height.

V. Conclusion

1. Core wall is more effective for reducing displacement and drift other than shear wall.
2. As height of building increase, displacement, drift also raises. But for core wall models have less value in comparison of only concrete frame models.
3. For location of core wall, it is preferable to locate at the cenre of the building for convenient response of lateral loads.

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