Seismic Analysis of Positioning of Shear Walls

Shruthishri H M [1], Mrs. Manjula K[2], Bharath H K[3]

[1]*Mtech student,* [2]*Assisant Professor,* [3]*Assistant Professor, Department of Civil Engineering, BGS Institute of Technology*[1]

[1,2]*BGS Institute of Technolog,*[3]*JITS, Narsampet, Telegana, India*[3]

Abstract: Shear walls are structural members used to elongate the strength of R.C.C. structures. These shear walls will be construct in each level of the structure, to form an effective box structure. Equal length shear walls are placed symmetrically on opposite sides of outer walls of the building. Shear walls are added to the building interior to provide more strength and stiffness to the building when the exterior walls cannot provide sufficient strength and stiffness. It is necessary to provide these shear walls when the tolerable span- width ratio for the floor or roof diaphragm is exceeded. The present work deals with a study on the improvement location of shear walls in symmetrical high rise building. Position of shear walls in symmetrical buildings has due considerations. In symmetrical buildings, the center of gravity and center of rigidity coincide, so that the shear walls are placed symmetrically over the outer edges or inner edges (like box shape). So, it is very necessary to find the efficient and ideal location of shear walls in symmetrical buildings to minimize the torsion effect. In this work a high rise building with different places of shear walls is considered for analysis. The multi storey building with 5 storey's is analyzed for its displacement, strength and stability using ETABS software. For the analysis of the building for seismic loading) is considered. The analysis of the building is done by using equivalent static method. The results from the analysis obtained and the results are compared using graphical form.

Keywords: ETABS, SHEAR WALL, AUTO CAD, IS 456-2000, IS1893-2002.

I. INTRODUCTION

1.1 General

Increment in the development of tall buildings both private, business and the cutting-edge drift is towards more tall structures. The impacts of lateral loads like wind loads, seismic tremor loads and impact powers are accomplishing expanding significance. because of this, and relatively every fashioner is looked with the issues of giving satisfactory strength and dependability against horizontal loads. Likewise, because of the real quakes in the current pasts the codal arrangements changed and actualizing more weightage on seismic tremor outline of structure. The structure might be as yet harmed because of a few or the other reason amid quakes. Conduct of structure amid tremor movement relies upon circulation of weight, stiffness and strength in both flat and vertical planes of building.

In the seismic outline of buildings, strengthened cement basic dividers, or shear dividers, go about as significant tremor resisting individuals. Auxiliary dividers give a proficient supporting framework and offer extraordinary potential for sidelong load protection. The properties of these seismic shear dividers rule the reaction of the buildings, and in this way, it is imperative to assess the seismic reaction of the dividers suitably. Shear divider are one of the brilliant methods for giving seismic tremor protection from multi storied strengthened solid building.

1.2 Shear Walls

Supportedrobust buildings as frequently as possible have upright plate like RC walls called Shear Walls not enduring pieces, shafts and portions. These walls generally start at underpinning level and are boundless all through the building height. Their breadth can be 150mm, height 400mm in overwhelming structures. Shear walls are for the most part given along both length and width of buildings. Shear walls look like vertically-orchestrated wide column. Truly formed and point by point buildings with shear walls have shown awesome execution in past seismic tremors. The psyche boggling accomplishment of buildings with shear walls in resisting strong seismic tremors is packed in the announcement:

"We can't remain to make strong buildings expected to contradict genuine seismic tremors without shear walls." by Mark Fintel, a noticeable advising engineer in USA.

Shear walls in tall seismic areas levy in frequent hypothesizing. Be that as it may, in past tremors, even buildings with adequate measure of walls that were not extraordinarily definite for seismic execution (but rather had enough very much disseminated support) were spared from fall. Shear divider buildings are a prominent decision in numerous seismic tremor inclined nations, like Japan, Chile, New Zealand and USA. Shear walls are anything but difficult to develop, because support enumerating of walls is generally straight-forward and in this way effectively executed at site. Shear walls are proficient, both as far as development cost and adequacy in limiting quake harm in auxiliary and non-basic components (like glass windows and building substance) that convey tremor loads downwards to the establishment.

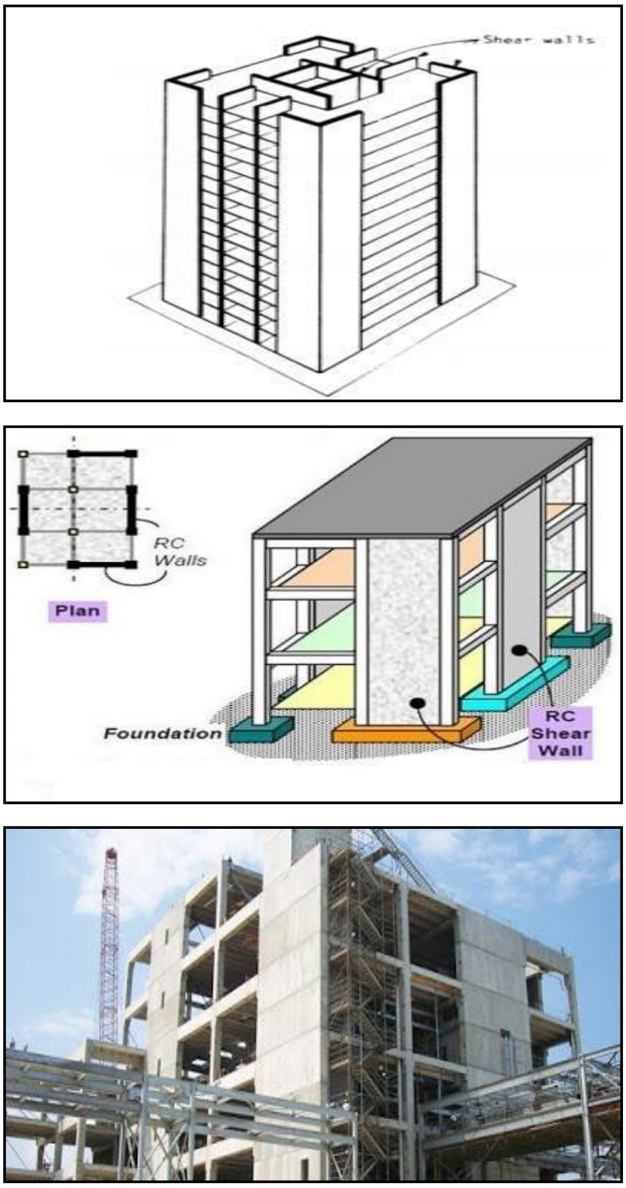


Figure 1.1: Buildings with shear wall.

II. LITERATURE REVIEW

A few analysts considered the impact of situating the shear divider in multi-story strengthened bond solid structures. A short survey of past examinations on impact of situating and opening in shear walls on seismic conduct of strengthened bond solid structures is introduced in this area and past endeavours most firmly identified with the requirements of the present work.

P Chandurkar and Pajgade (2013), performed 'Seismic Analysis of RCC Building with and Without Shear Wall' in this investigation, a quake compel is connected to ten story building situated in zone II, III, IV and V. Viability of shear divider is contemplated with four unique models. Demonstrate one is an uncovered casing structure and other three models are double write Structure framework. The primary focal point of study was to decide the answer for the models. Parameters like parallel uprooting, story float and aggregate cost required for the ground floor are figured in both the cases supplanting segment with shear divider. It is seen that changing the situation of shear divider influence the fascination of powers, so the divider must be appropriately set. Giving the shear divider at satisfactory area generously lessens the dislodging because of seismic tremor.

AnshulSud,Raghav Singh Shekhawat, Poonam Dhiman(2014), in their examination 'best position of shear walls In a RCC space outline in view of seismic reaction', they have considered five edges with various shear divider arrangements viz. uncovered edge, shear divider symmetrically put at outside coves midway , at centre and contiguously set in outside of the building are viewed as and is investigated in view of examination it is presumed that Shear walls are unquestionably great component for sidelong loads relief, yet the arrangement of shear walls ought to be made sensibly. In the present case, shear walls at mid-sides supposedly performs better in significant number of cases.

Romy Mohan and Prabha (2011),in their investigation 'Dynamic examination of RCC buildings with shear divider', they considered two multi story building, one of six and other of eleven stories have been demonstrated utilizing programming SAP2000 for seismic tremor zone V in India. Six unique kinds of shear divider with its variety fit as a fiddle are considered for concentrate their adequacy in resisting parallel powers. It additionally manages the variety of building height on the auxiliary reaction of shear divider. They have presumed that; square shape shear divider is the best and L formed is slightest compelling.

M R Suresh, Ananth ShayanaYadav (2015),in their investigation 'the ideal area of shear divider in skyscraper R.C buildings' under horizontal stacking led the seismic examination of unpredictable arrangement of building and is finished by both static tremor and static wind examination and furthermore correlation is finished by furnishing shear divider at four edges with without shear divider in the sporadic arrangement to decide the ideal position of shear divider. The arrangement without shear divider gives greater dislodging and more float contrast with design with shear divider along four edges. Thus, by giving shear divider along four edges we can lessen story removal, story float, story shear and furthermore we can expand strength and stiffness of the structure.

III. METHODOLOGY AND OBJECTIVE

3.1 Objective

The most important objectives of present study include:

1. To determine the optimum position of shear wall by considering plan of a multi storey building.
2. To conduct Equivalent static analysis based on the

Indian Standard code for Earthquake IS: 1893-2002.

3. To determine parameters such as base shear, lateral displacement, Storey stiffness, time period.
4. To compare the parameters obtained among different positions and determining the advantageous position of shear wall in the structure by comparing the results of analysis.

3.2 Methodology

The following steps are implemented for the analysis:

1. Plans of the multi storey buildings are considered to carryout equivalent static analysis.
2. Model is created in Auto cad software and is imported to ETABS
3. All the required properties of the building are defined in ETABS
4. Numbers of models are created by providing different positions of shear wall based on structure of the building.
5. Equivalent static analysis is carried out for all the different replicas
6. Results of the analysis are compared by plotting graphs for parameters of analysis such as base shear, storey stiffness, storey force and maximum displacement.
7. By comparing the results beneficial position of shear wall is determined for the building under seismic loading.

Detailed steps including in analysis of the two multi storey building are as follows:

3.3.Building

3.3.1 Plan of the multi-storeyedifice

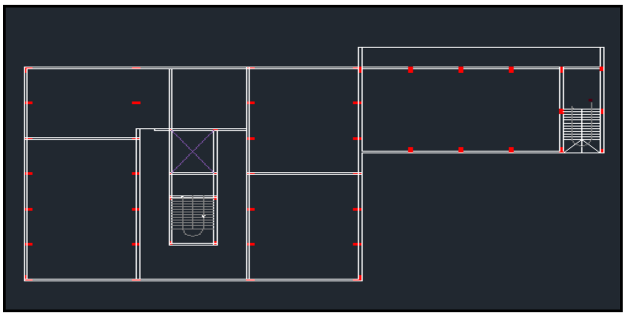


Figure 3.3.1 Plan of the multi storey building in AUTOCAD.

3.3.2. Plan of the multi-storey building modelled in Auto cad to export into ETABS.

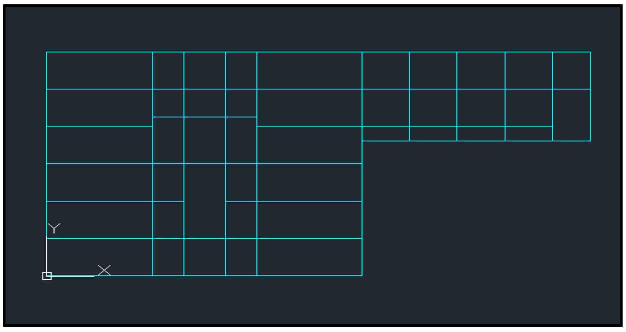


Figure 3.3.2. Plan view of the building after centreline method.

Defining assets of the building.

i. Define Storey statistics like storey elevation, no. of storey etc.

ii. Import the demonstrated plan view of a multi-storeybuilding from AutoCAD to ETABS Select Code preference from option and then define:

a) Material propertiescountingassets of concrete, masonry and rebar.

b) Sectional properties including,Frame Sections i.e. column and beam,Slab sections i.e. one-way slab and two-way slab and Wall sections i.e. wall and shear wall by providing suitable data.

iii. Draw building Fundamentals from draw menu according to plan of the building in respective positions.

iv. Give Support Circumstances

v. Define Load cases and loadblends (The load to be applied on the building are based on the Indian standards as per IS 875: part I and part II)

vi. Assign Load such as live load, floor finish, and wall load.

Model Data:

A. Geometrical Data:

1. Type of Building: Commercial building.
2. Typical storey loftiness: 3.5m
3. No of Storey= G+4
4. Beam size= 0.50×0.375m
5. Column size = 0.530m x 0.30m and 0.230m×0.230m
6. Slab thickness= 0.150m
7. Shear wall thickness= 0.30m
8. Wall thickness =0.30m

B. Earthquake Data:

(Based on Indian seismic code, IS 1893-2002)

1. Seismic zone: (Zone 4)

2. Importance Factor: 1.5

3. Response Reduction Factor: 5

4. Type of Soil: Medium (Type 2)

C. Material Data:

1. Grade of concrete =M30

2. Grade of steel =Fe500

3. Density of Reinforced Concrete =25 KN/m³

4. Density of Brick Masonry =22 KN/m³

D. Loading Data:

1. Live load : On floor = 4 KN/m², on roof = 1 KN/m²

2. Floor Finish: 1.5 KN/m²

3. Earthquake load in X and Y direction i.e. EQX and EQY.

4. Wall load = wall thickness(floor height-depth of the beam)×density

=0.30(3.5-0.5) ×22

=19.8KN/m

Load combinations based on IS 1893-2002,

1. 1.5(DL + LL)

2. 1.2 (DL + LL ± EQX)

3. 1.2 (DL + LL ± EQY)

4. 1.5 (DL ± EQX)

5. 1.5 (DL± EQY)

6. 0.9 DL ± 1.5 EQX

7. 0.9 DL ± 1.5 EQY

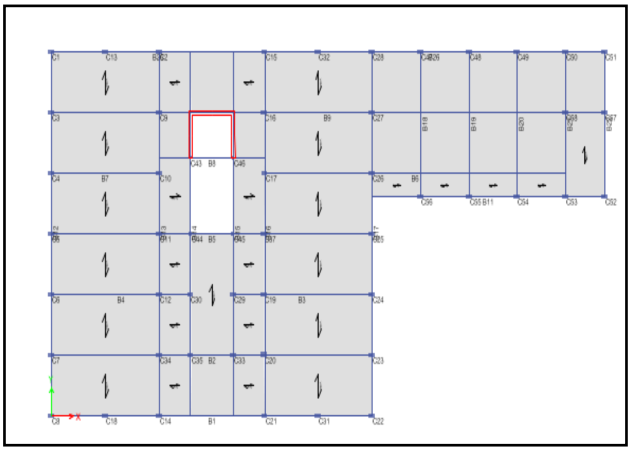
3.3.4 Positioning of shear wall

Depending upon the structural requirements of the building four different positions of shear walls are chosen and models are created, they are as follows:

MODEL 1: Bare frame

MODEL 2: Shear wall provided along x direction

MODEL 3: Shear wall provided along y direction



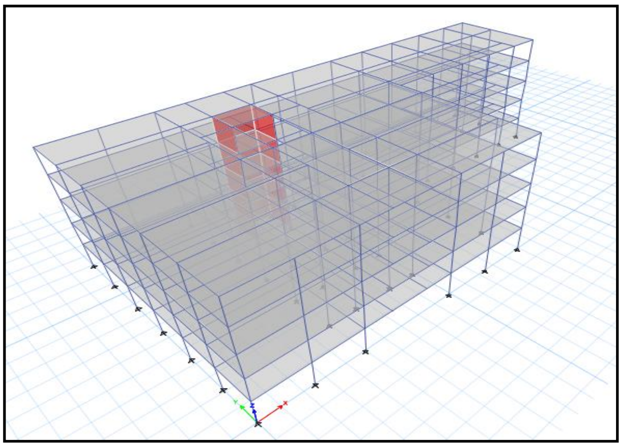
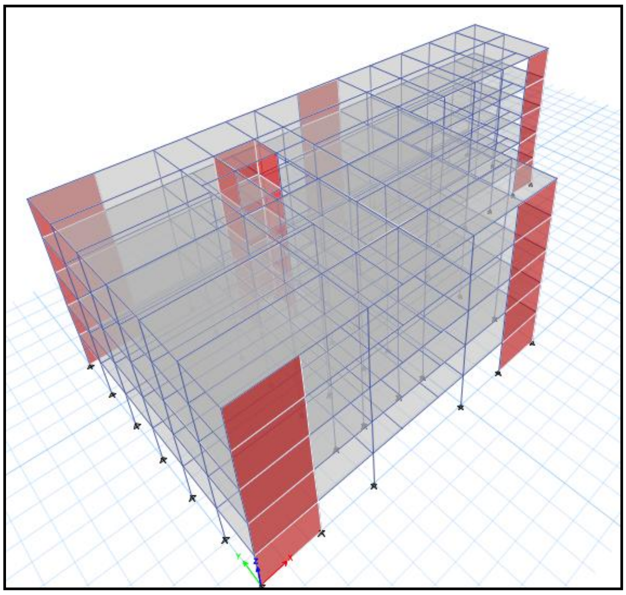


Figure 3.3.3 Model 1: bare frame

MODEL 4: L shaped shear wall provided diagonally named L1

MODEL 5: L shaped shear wall provided diagonally named L2



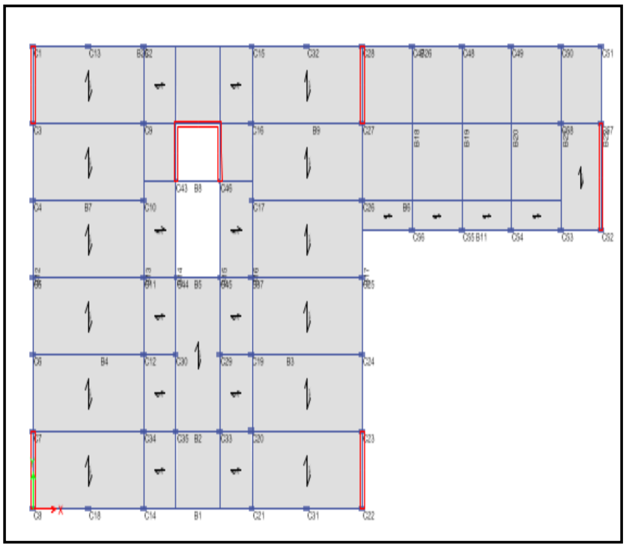
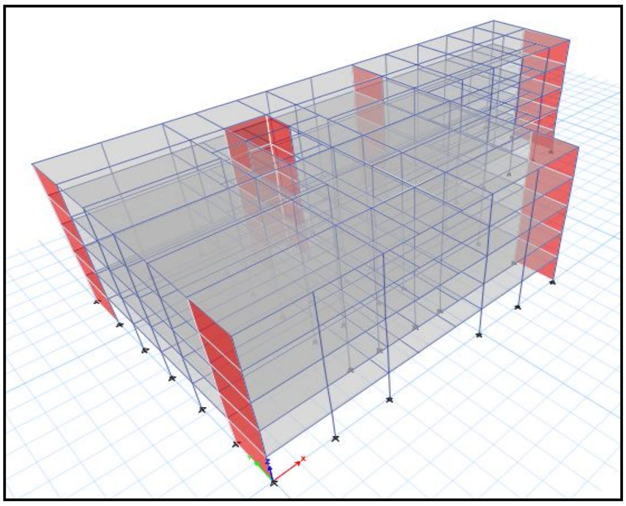


Figure 3.3.4 Model 2: shear walls along X direction.



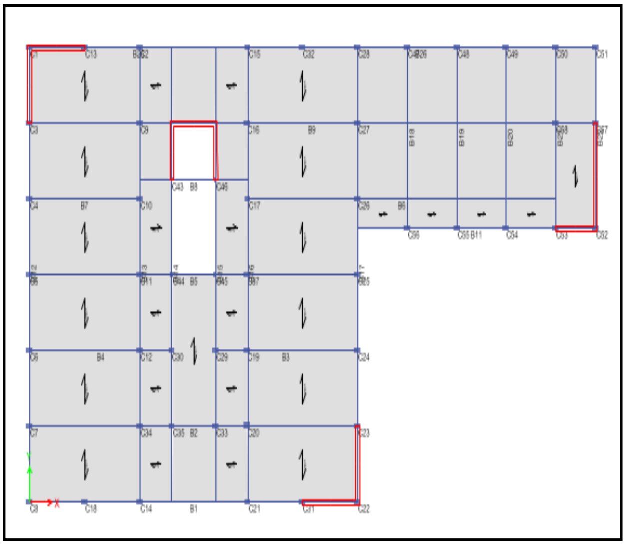
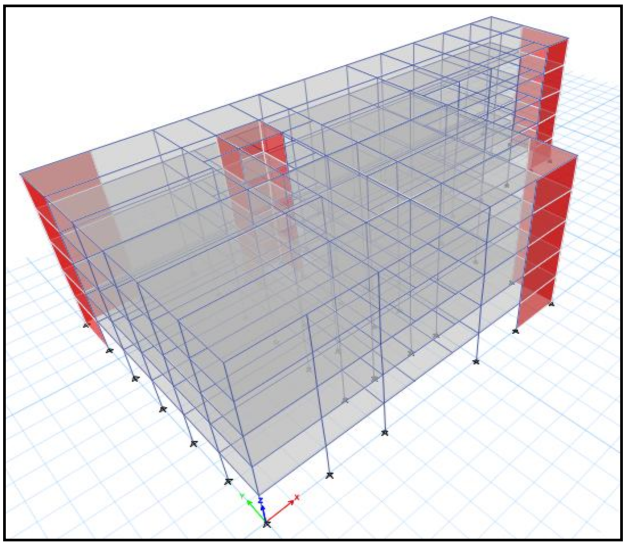


Figure 3.3.5 Model 3: shear wall along Y axis



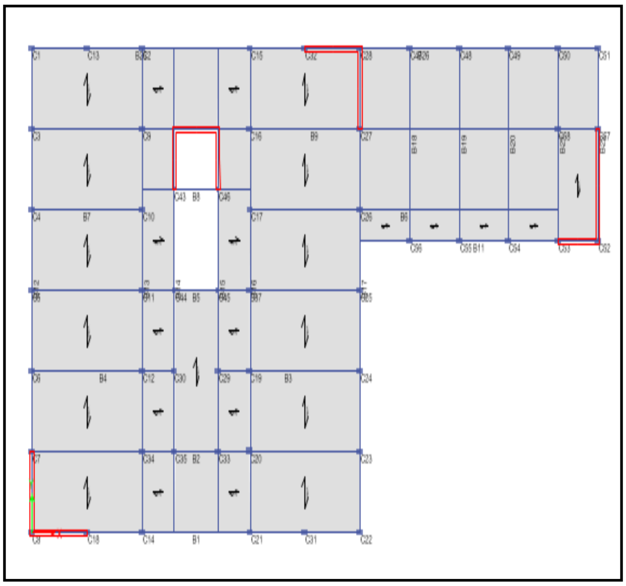
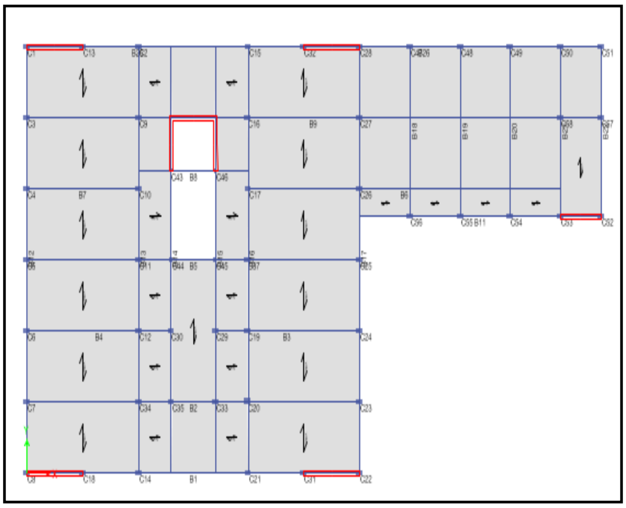


Figure 3.3.6 Model 4: Diagonally placed L shaped shear wall-L1



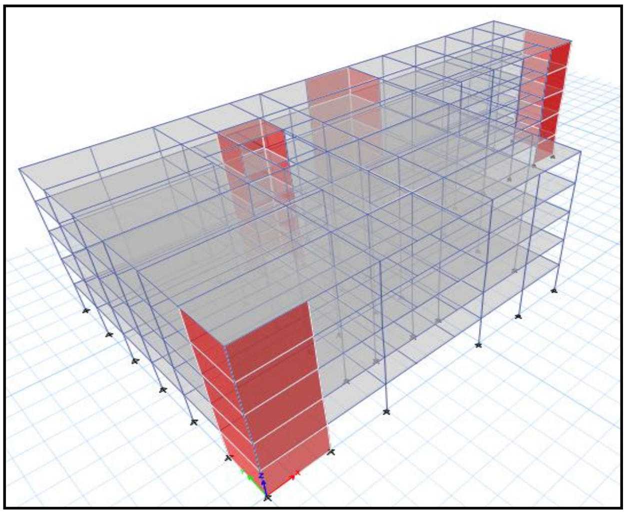


Figure 3.3.7 Model 5: Diagonally placed L shaped shear wall -L2

IV. RESULTS AND DISCUSSION

Equal static inquiry is completed and the strictures, for example, base shear, story toughness, most exciting dislodging and day and age are resolved. Quantities of charts are plotted and comes about are analysed.

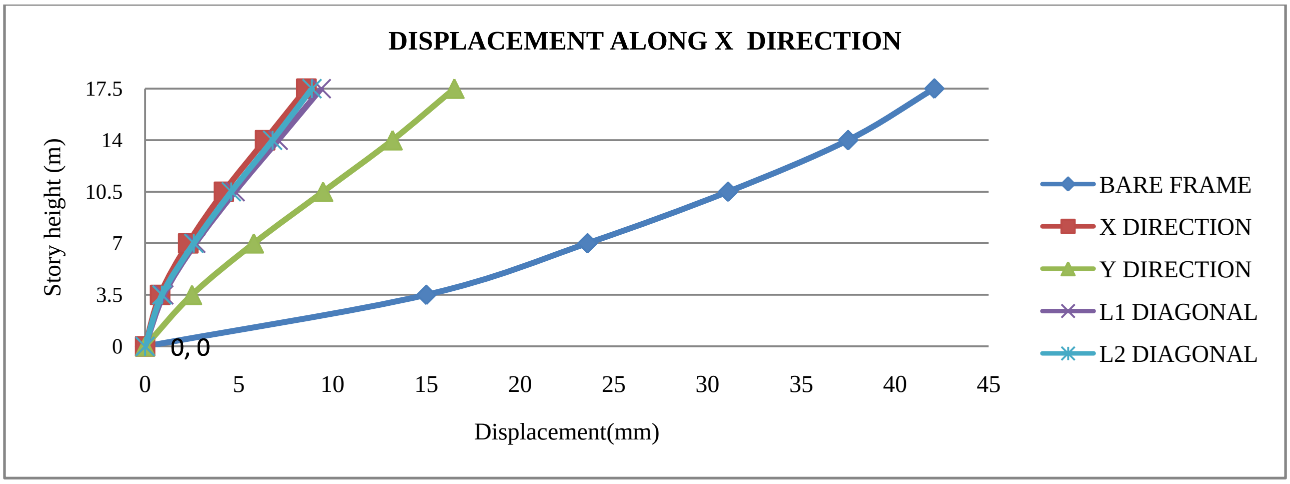
4.1 Building No.2

4.1.1 Maximum Displacement:

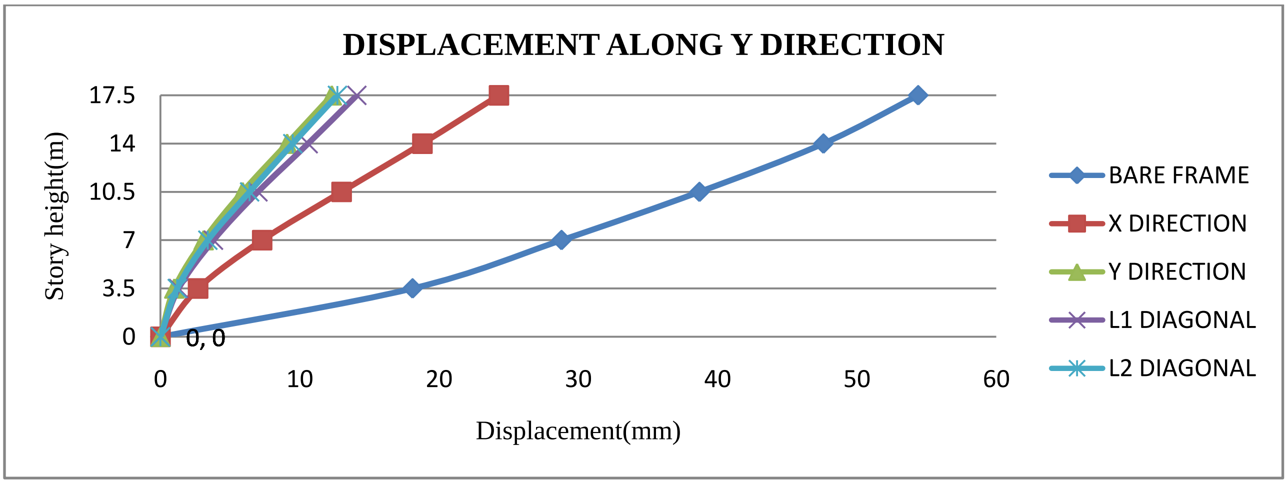
The scrutinyoutcomes for displacement of the building in X path i.e. for EQX is as follows:

Table no.4.1.1 Displacement along X direction.

From chart No.4.1.1 we can infer that building No.2 with no shear divider i.e. demonstrate No.1 exposed edge indicates greater dislodging. This demonstrates giving shear divider offers protection against uprooting under seismic stacking. The slightest relocation is appeared by show No.2 and model No.5. Demonstrate No.2 indicates minimum removal in x heading as shear walls are given in x course.



Graph no 4.1.1: Displacement along X- direction.



Graph 4.1.2: Displacement along Y direction.

Chart No.4.1.2 demonstrates that model No.1 i.e. exposed casing demonstrates greater removal and slightest dislodging is appeared by display no.3 and show no.5. Display no.3 demonstrates minimum removal in y bearing as shear walls are given in y heading.

From the examination consequence of uprooting we can see show no.5 that is L formed shear divider put corner to corner - L2 offers slightest removal among all the 5 models.

Storey	Storey height	Bare frame	X drtn	Y drtn	L1	L2
	(m)	(mm)	(mm)	(mm)	(mm)	(mm)
S5	17.5	42.1	8.6	16.5	9.4	8.9
S4	14	37.5	6.4	13.2	7.1	6.8
S3	10.5	31.1	4.2	9.5	4.8	4.6
S2	7	23.6	2.3	5.8	2.7	2.6
S1	3.5	15	0.8	2.5	1	0.9
Base	0	0	0	0	0	0

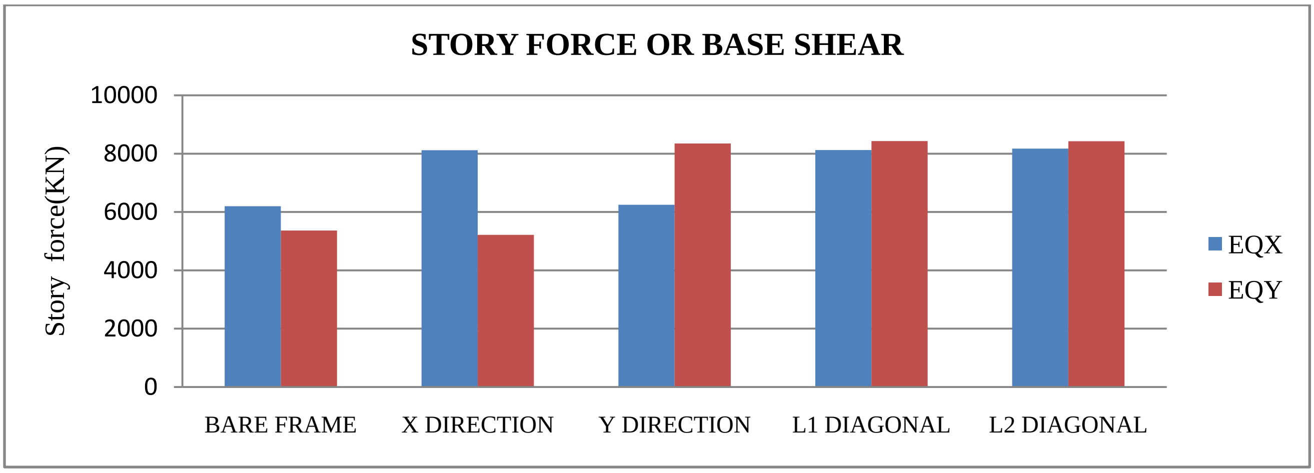
4.1.2 Storey Force or Base Shear:

Base shear is a device of the most extreme predictable lateral influence that will materialize since of seismic ground movement at the sordid of a structure or the seismic power at base of the building is known as the base shear. Quake frequently evils buildings at this level. Weightiness of the working above breaking is the shear constrain that broke the building. Ordinarily seismic tremor harm happens at base of building.

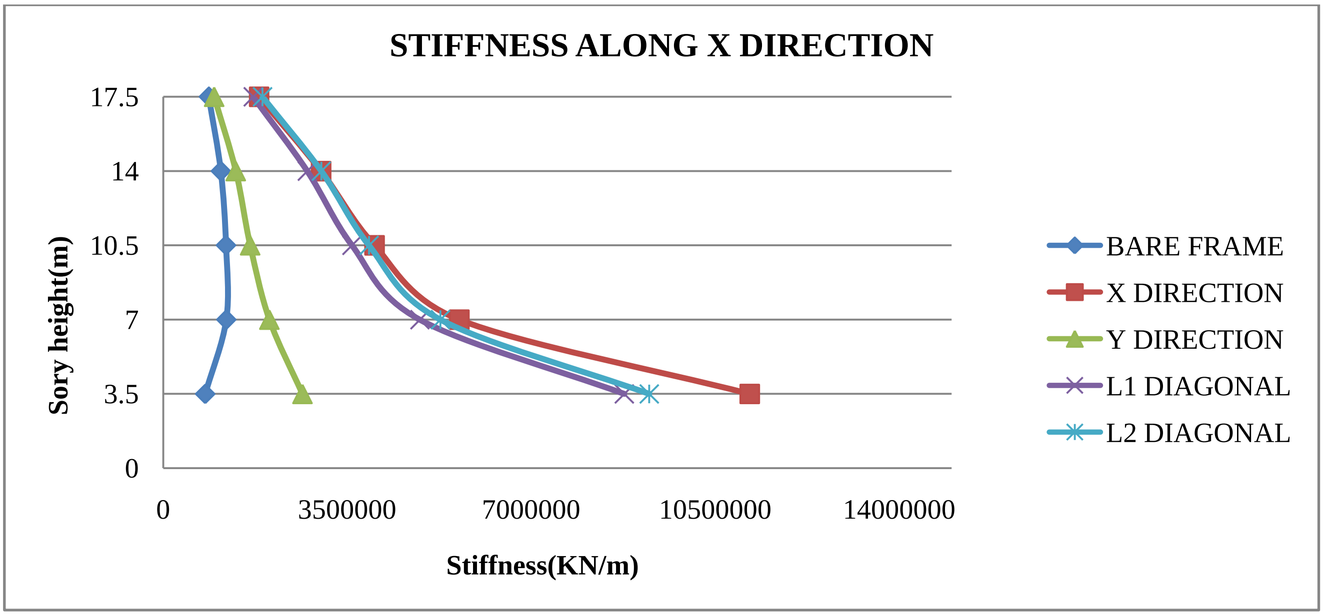
Higher the story drive higher is the stiffness of the building. The base shear is expanded by expansion of shear divider because of increment in seismic weight. From diagram Model No.4 and 5 demonstrates high story constrain which demonstrates that L moulded shear divider gave askew gives more stiffness at base of the building contrasted with other 5 show.

4.1.3 Storey Stiffness:

Diagram demonstrates that Model No.1 i.e. exposed edge has minimum stiffness and Model No. 2 and 5 demonstrates more stiffness in X bearing and model No. 3 and 5 demonstrates more stiffness in Y heading. From this outcome we can presume that model no.5 i.e. L moulded shear divider put corner to corner indicates more stiffness against seismic stacking.

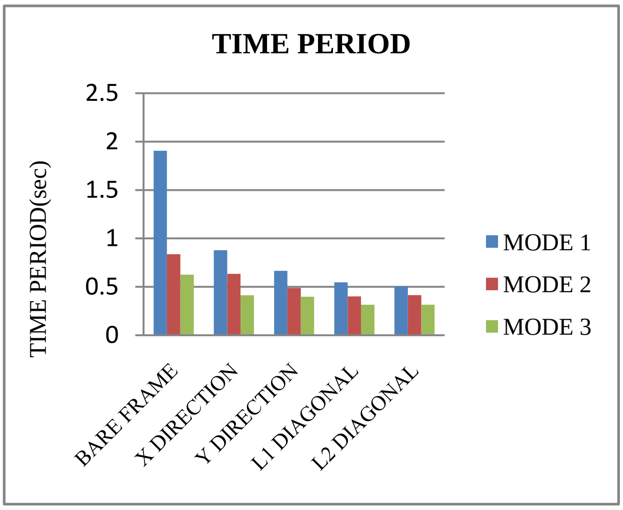


Graph 4.1.2: Storey force or base shear.



Graph 4.1.3: Stiffness along X direction.

4.1.4 Time Period:



Graph 4.1.4: Time period.

From graph model No.1 i.e. bare frame shows more time period. As the stiffness increases time period decreases. Model No.5 i.e. L shaped shear wall placed diagonally: L2 shows least time period.

V. CONCLUSION

1. Bare casing indicates greater uprooting contrasted with models with shear divider. Least removal is appeared by demonstrate no.5 i.e. Slanting put L moulded shear divider: L2.

2. Model no.5 i.e. Corner to corner put L molded shear divider: L2 have more stiffness, story constrain in both X and Y bearing.

3. Time period is slightest for Model no.5 i.e. Corner to corner put L moulded shear divider: L2.

4. From this we can infer that model no.5 i.e. L formed shear divider gave corner to corner is the favourable position of shear divider for building.

VI. SEISMIC ZONING

The point of the seismic zoning is to speak to the districts having a similar objective power of ground movement in a nation, and to give the rules to the arrangement of satisfactory tremor protection in the development offices as a stage to overcome alleviation. The plan of the structure with a base standard to shield the structure against the quake is administered by the social, efficient, and political contemplations. The most grounded power of the ground movement depends on the monetary idea of 'worthy hazard', and to a social inquiry 'How safe will be sufficiently sheltered'. The most grounded powers of the ground movement depend on the over two imposers. As per the unadulterated financial hypothesis the seismic tremor causes two sorts of misfortune known as essential misfortune and the auxiliary misfortune. The misfortune which is gone and brings about loss of human life because of seismic tremor is called as essential misfortune. Auxiliary misfortune is misfortune which can recoup every different misfortune happened because of the seismic tremor. The base standard gave in the code is to withstand the total fall of the structure amid the seismic tremor so it doesn't make any impact human life.

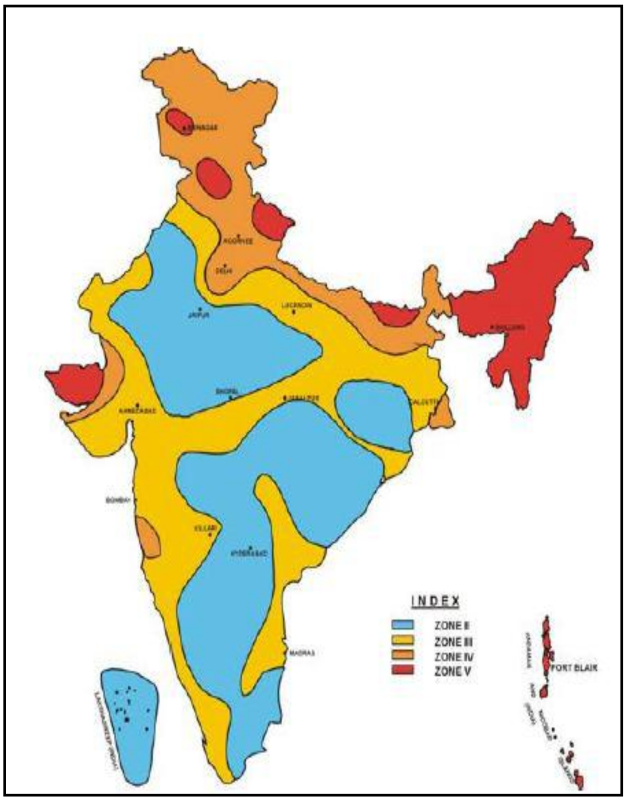


Figure Representation of seismic zones of India.

This requires an estimation of the most grounded force ground movement at a specific site amid the life of the structure. The estimation of the quickening, speed, dislodging, recurrence substance and length of expected greatest solid ground movement for a site is required. The seismic zoning guide of a nation partitions the different territories of the nation with a similar sanity of most extreme force of ground movement. At the point when the structure is planned according to the codal arrangements the likelihood of the fall of the structure is less notwithstanding when the tremor happens at the higher power. Subsequently the structure planned with the code arrangement will make harm both the basic and the non-auxiliary write. The harm can be repaired and the financial essentialness isn't justified.

REFERENCE

[1] P PChandurkar and Pajgade (2013), 'Seismic Analysis of RCC Building with and Without Shear Wall'

[2] AnshulSud,Raghav Singh Shekhawat, Poonam Dhiman(2014), 'Best Placement of Shear Walls In an RCC Space Frame Based on Seismic Response'

[3] Romy Mohan and Prabha (2011), 'Dynamic analysis of

RCC buildings with shear wall'.

[4] M R Suresh, Ananth ShayanaYadav(2015), 'The optimum location of shear wall in high rise R.C buildings under lateral loading'.

[5] SuchitaTuppad, R.J.Fernandes(2015), 'Optimum location of shear wall in multi-storey building subjected to seismic behaviour using genetic algorithm'.

[6] A Murali Krishna,AArunakanti.(2014), 'Optimum location of different shapes of shear wall in unsymmetrical highrise buildings'.

[7] IS:875(Part 1) – 1987 (Reaffirmed 2003), Code of Practice for Design Loads (Other than Earthquake) For Buildings and Structures (Second Revision)

[8] IS: 875(Part 2) – 1987 (Reaffirmed 2003), Code of Practice for Design Loads (Other than Earthquake) For Buildings and Structures (Second Revision).

[9] IS: 456-2000 (Reaffirmed 2005), Indian Standard Code of Practice for Plain and Reinforced Concrete (Fourth Revision), Bureau of Indian Standards, New Delhi.

[10] IS: 1893-2002, Indian Standard Recommendations for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.

AUTHOR PROFILE

Shruthishri H M received the D.C.E in SJBGS Polytechnic BG Nagar, Mandya dist B.E Degree in Civil Engineering from NDRK Institute of Technology (Hassan) in 2013 to 2016. Pursuing M. Tech specialization Structural Engineering in BGS Institute of Technology BG Nagar, Nagamangala 571448, Mandya dist

Email-id:shruthishree.71@gmail.com