International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 12, December-2018

EVALUATING THE SEISMIC RESPONSE OF FLAT PLATE MULTISTORIED STRUCTURAL SYSTEMS WITH THE INFLUENCE OF WEAK STOREYS

[1]Syed Shahbazuddin, [2]Mohammad Ismail Khan, [3]Mohammed Khaja Moinuddin

[1] *M. Tech Structures, Lords Institute of Engineering and Technology, Hyderabad, India*
[2] *Asst. Professor Lords Institute of Engineering and Technology, Hyderabad, India*
[3] *Asst. Professor Al Habeeb College of Engineering and Technology, Hyderabad, India*

ABSTRACT: ***Now a day's multistoried buildings are common in urban regions due to increase in human population and civilization towards urban regions, FSI(floor space index)permission is decreasing day by day in urban region due to that buildings are getting increase towards vertical. To fulfill the high head room requirements, flat plate or flat slab or beam less floor systems have come into existence and in multistoried building parking storey is common in ground floor which will lead to weak storey or sift storey formation and this soft storey is not much capable enough to transfer the inertia forces generated due to earthquake. Therefore in this particular study we consider G+12 storied building symmetrical about longitudinal and transverse direction, 7 different mathematical FEM 3D models have been generated in ETABS2015, an attempt is made in this study to nullify the soft storey effect by incorporating lateral resisting elements in the form of shear wall and steel bracings. To evaluate the seismic response two types of seismic analysis have been done via linear equivalent static and linear dynamic (response spectrum analysis) have been performed as per IS-1893-2002 and 2016. FEM modeling have been done by considering columns as frame element having 6DOF at each node, slab, shear wall and masonry infill panel haven been modeled as thin shell elements having 4 nodes and each node has 6 DOF and Lateral bracings are modeled as frame elements having 6DOF at each node with moment released at each nodal point. Finally a suitable building configuration is suggested for the practical implementation.***

I. INTRODUCTION

Tall buildings are the most complex built structures since there are many conflicting requirements and complex building systems to integrate. Today's tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high-rise buildings. Thus the impact of wind and seismic forces acting on them becomes an important aspect of the design. Improving the structural systems of tall buildings can control their dynamic response In the present practice of structural design in India, masonry infill panels are treated as non- structural element and their strength and stiffness contribution are neglected. In fact the presence of infill wall changes the behavior of the frame action in to truss action, thus changing the lateral load transfer mechanism. Performance of buildings in the past earthquakes clearly illustrates that the presence of infill walls has significant structural implications. Therefore, we cannot simply neglect the structural contribution of infill walls particularly in seismic regions where, the frame–infill interaction may cause significant increase in both stiffness and strength of the frame despite the presence of openings. Reinforced concrete (RC) structural walls, conventionally known as shear walls are effective in resisting lateral loads imposed by wind or earthquakes. They provide substantial strength and stiffness as well as the deformation capacity (capacity to dissipate energy) needed for tall structures to meet seismic demand. It has become increasingly common to combine the moment resisting framed structure for resisting gravity loads and the RC shear walls for resisting lateral loads in tall building structures. The consequence of the presence of a weak storey either in the ground storey or in the upper storey, may lead to a dangerous sway mechanism in the weak storey due to formation of plastic hinges at the top and bottom end of the columns, as these columns are subjected to relatively large cyclic deformations.

Fortified cement encircled structure in late time has a unique component i.e. the ground story is left open with the end goal of social and useful needs like vehicle stops, shops, gathering entryways, an expansive space for meeting room or a keeping cash hallway etc. Such The Indian code (provision no. 4.20) orders a delicate story as; it is one in which sidelong firmness is under 70 percent of that in the story above or under 80 percent of the normal horizontal solidness of the three stories above (IS 1893:2002). The delicate story can frame at any level of a tall structure to satisfy the required useful need and serve different.

As a rule, multi-storied structures in metropolitan urban areas require open taller first story for stopping of vehicles or for retail shopping, expansive space for meeting room or a managing an account corridor attributable to absence of level space and staggering expense. Because of this practical necessity, the primary story has lesser quality and solidness when contrasted with upper stories, which are solidified by stone work infill dividers. This normal for building development makes "frail" or "delicate" story issues in multi-story structures. Expanded adaptability of first story results in

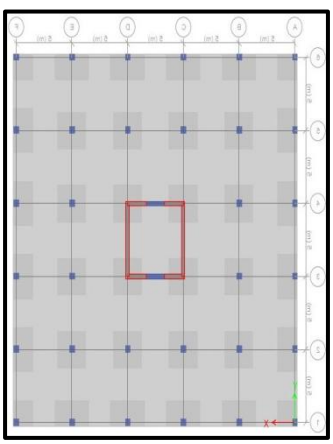
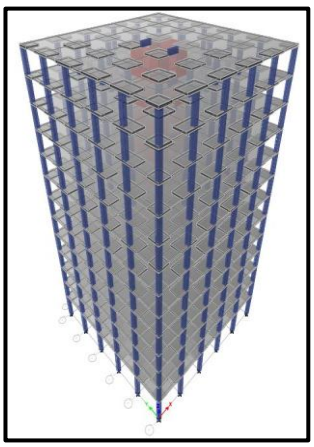
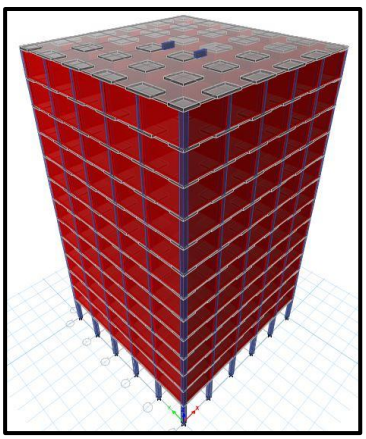
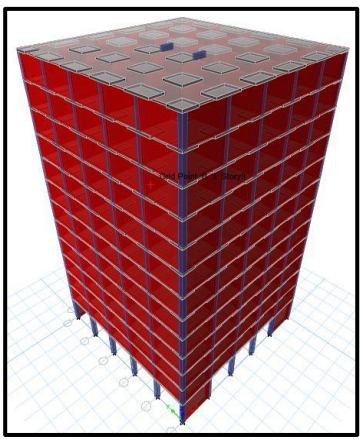
extraordinary avoidances, which thusly, prompts centralization of powers at second story associations joined by extensive plastic distortions. Also, most of the vitality created amid seismic tremor is scattered by segments of the delicate stories. In this procedure the plastic pivots are shaped at the closures of segments, which change the delicate story into an instrument. In such case the fall is unavoidable. It has been seen from the study that the harm is because of crumple and clasping of segments particularly where stopping places are not secured legitimately. Despite what might be expected, the harm is decreased impressively where the parking spots are secured enough. It is perceived that this sort of disappointment results from the mix of a few other troublesome reasons, for example, torsion, over the top mass on upper floors, p-Δ impacts and absence of flexibility in the base story.

The main Objectives of the present study is:

- To perform sidelong load examination for various building models according to the code.
- To examine the practices of level plate floor frameworks when subjected to gigantic seismic powers.
- To think about the impact of open ground story with level section floor frameworks.
- To think about the impact of center divider and corner shear dividers and bracings on the general conduct of building.

II. DESCRIPTION OF THE STRUCTURE

It is vital to building up a computational model on which direct/non-straight; static/powerful investigation is performed. The initial segment of this part displays a synopsis of different parameters characterizing the computational models, the fundamental presumptions and the geometry of the chose building considered for this examination. Exact exhibiting of the nonlinear properties of various assistant segments is essential in a nonlinear examination. Displaying a building includes the demonstrating an array of its different load-conveying components.
In this undertaking seismic examination of six distinct models is Analyzed utilizing ETABS-2015. The correlations of results are regarding Fundamental Time period, modes shapes, story shear, story dislodging, Story float, etc.
The models for analysis are as follows:
Model 1 - Bare edge display (Including weight of Brick mass of 230mm thick everywhere throughout the beams).All sections are demonstrated as edge components having 6 DOF at every hub, Slabs are demonstrated as thin Shell component having 6 DOF at every hub, and all shear dividers are displayed as thin shell component with Pier name. The floor plan is the level plate with drop section on each segment. Having a lift pipe of 2 C shape center shear dividers masterminded inverse way longitudinal way at Center of the building.
Model 2 – This model is same as Model 1, however, having the base story open without brickwork infill dividers and rest of every other story are having stonework infill board.
Model 3 – This model is precisely same as model 2 yet having RCC Planner (Rectangular shape) shear dividers up and down the 4 edges of the working longitudinal way, Shear dividers are displayed as 4 noded thin shell components.
Model 4 – This model is precisely same as model 2, however, having RCC Planner (Rectangular shape) shear dividers up and down the 4 edges of the working transverse way, Shear dividers are displayed as 4 noded thin shell components.
Model 5– This model is precisely same as model 2, however, having RCC Planner (Rectangular shape) shear dividers up and down the inside straight of the working in longitudinal and transverse bearing, Shear dividers are demonstrated as 4 noded thin shell components.
Model 6 – This model is precisely same as model 2, however, having sacrosanct round bracings as in rearranged V shapes up and down the middle inlet of the working in a longitudinal and transverse course, Bracings are demonstrated as 2 noded bar component having 6 DOF at each nodal point.
Model 7 – This model is precisely same as model 2, however, having sacred roundabout bracings as in rearranged X shapes up and down the middle narrows of the working in longitudinal and transverse bearing, Bracings are demonstrated as 2 noded bar component having 6 DOF at each nodal point.

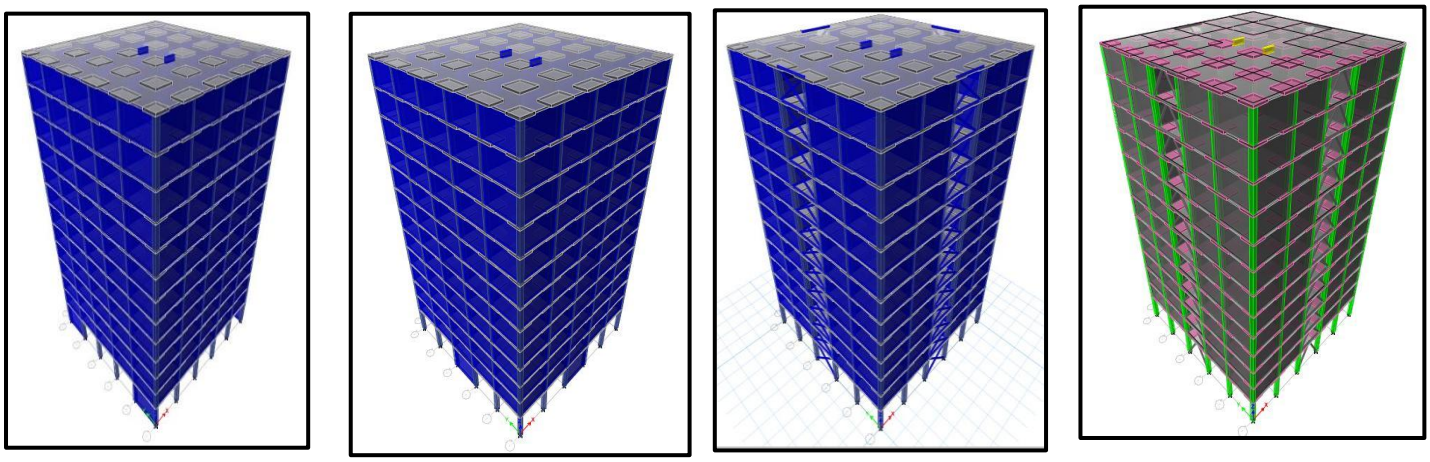


Figure 1: Plan and 3D view of all Models Considered in the Study

III. METHOD OF ANALYSIS:

MODAL ANALYSIS: Modal analysis includes the fundamental natural time period of the structure, Modal Mass participations, and Mode shapes. These results will elaborate the vibration analysis of the building systems and its response to seismic loadings.

Mode No	Time Period in Sec	Modal Mass Participation		
		UX	UY	RZ
1	2.494	0.00	0.00	80.94
2	1.953	74.88	0.00	0.00
3	1.818	0.00	69.61	0.00
4	0.787	0.00	0.00	10.47
5	0.555	15.18	0.00	0.00
6	0.434	0.00	0.00	4.08
7	0.414	0.00	18.25	0.00
8	0.285	0.00	0.00	2.02
9	0.275	4.43	0.00	0.00
10	0.206	0.00	0.00	1.08
11	0.177	0.00	6.47	0.00
12	0.175	2.20	0.00	0.00
TOTAL		**96.69**	**94.33**	**98.59**

Table 1: Modal analysis for Model-1

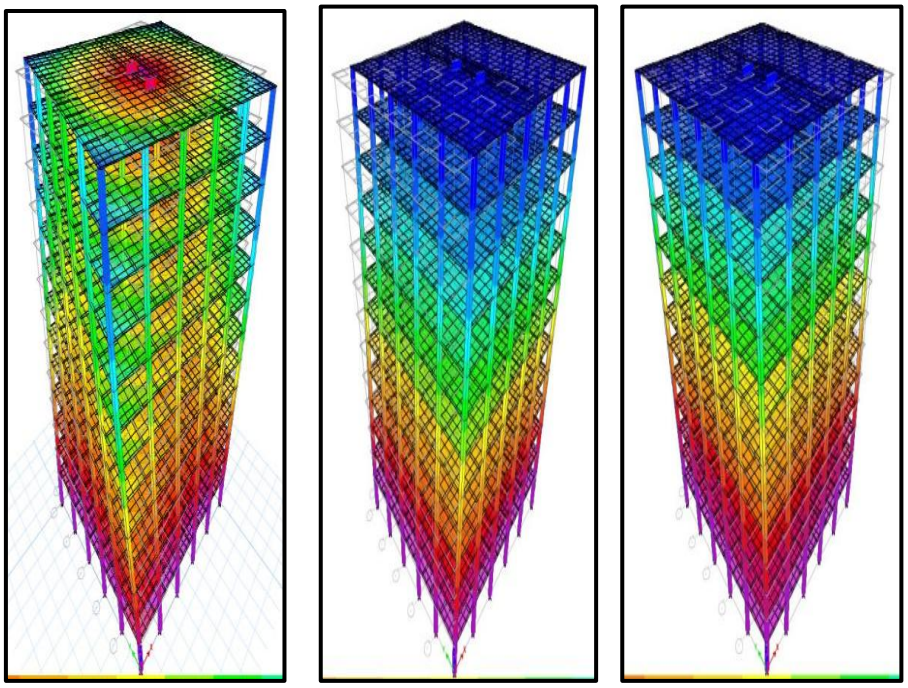


Figure 2: Mode Shapes of Model-1

Mode No	Time Period in Sec	Modal Mass Participation		
		UX	UY	RZ
1	0.721	0.00	0.00	0.00
2	0.437	94.48	0.00	100
3	0.401	0.00	94.48	0.00
4	0.112	5.52	5.52	0.00
5	0.102	0.00	0.00	0.00
6	0.008	0.00	0.00	0.00
7	0.005	0.00	0.00	0.00
8	0.005	0.00	0.00	0.00
9	0.004	0.00	0.00	0.00
10	0.003	0.00	0.00	0.00
11	0.003	0.00	0.00	0.00
12	0.003	0.00	0.00	0.00
TOTAL		**100**	**100**	**100**

Table 2: Modal analysis for Model-2

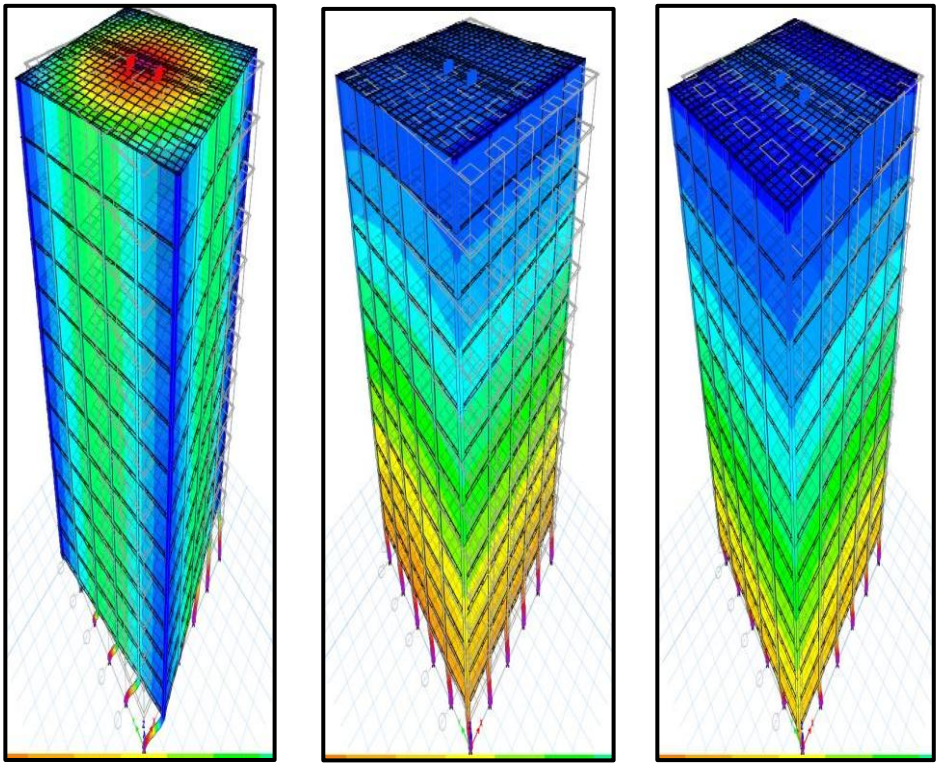


Figure 3: Mode Shapes of Model-2

Mode no	Time Period in Sec	Modal Mass Participation		
		UX	UY	UZ
1	0.282	28.2	97.07	0
2	0.237	23.7	0	0
3	0.148	14.8	0	100
4	0.069	6.9	2.93	0
5	0.059	5.9	0	0
6	0.007	0.7	0	0
7	0.005	0.5	0	0
8	0.005	0.5	0	0
9	0.004	0.4	0	0
10	0.003	0.3	0	0
11	0.003	0.3	0	0
12	0.002	0.2	0	0
TOTAL		**82.40**	**100**	**100**

Table 3: Modal analysis for Model-3

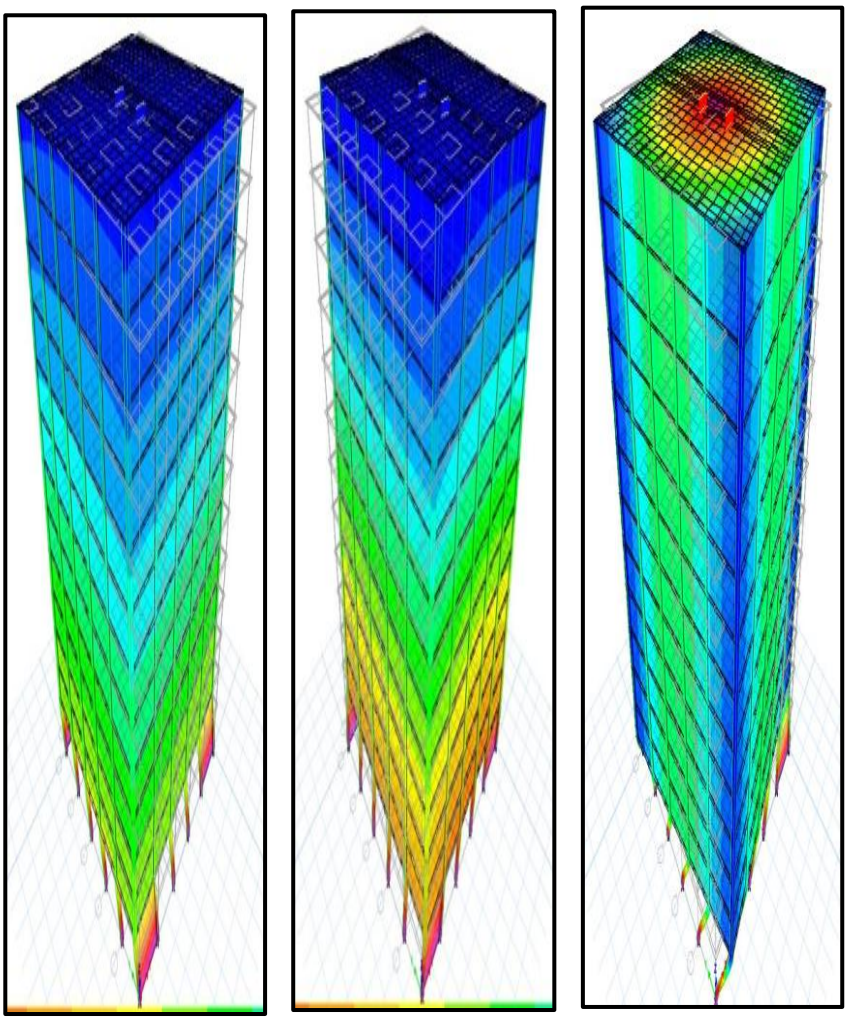


Figure 4: Mode Shapes of Model-3

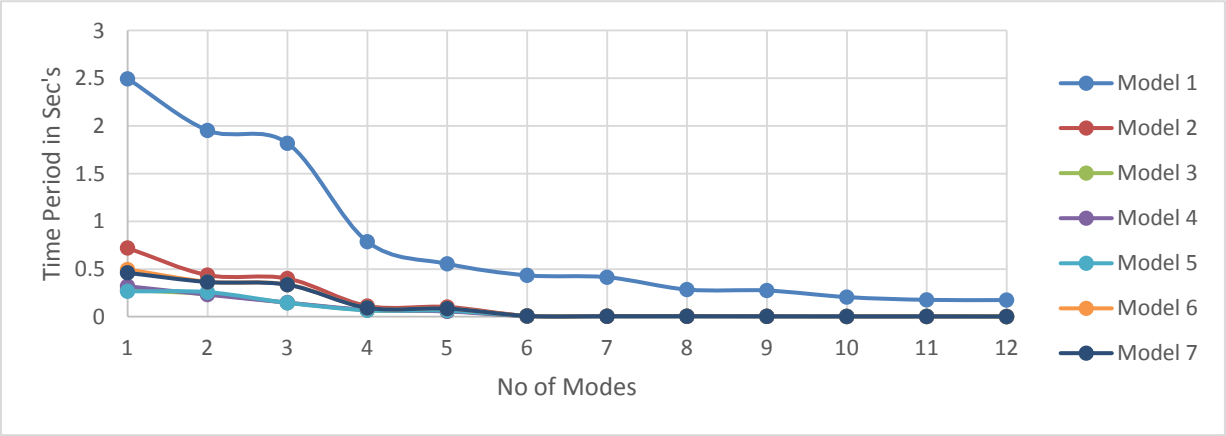


Chart 1: Showing the fundamental time period of the various models for all the considered modes.

The above shape modular examination the accompanying perception can be made as follows for the fine investigation 12 methods of vibration have been considered for each model.

Discussion:

When we have a correlation between models 3, 4 and 5 this specific model is somewhat adaptable however has great unique reaction record when contrasted and show 1 and mode 2.

STOREY DISPLACEMENTS: Story removal is the horizontal development of the structure caused by parallel power. The avoided state of a structure is most vital and most obviously noticeable purpose of correlation for any structure. No other parameter of examination can give a superior thought of conduct of the structure than the correlation of story relocation. Beyond what many would consider possible the removal must be inside the points of confinement as determined by codal arrangement, generally prompting disjoin harm to structures framework.

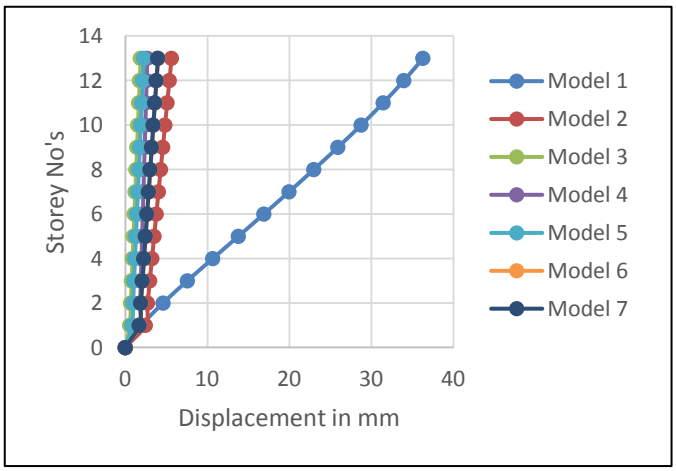


Chart 1: Displacements along longitudinal direction.

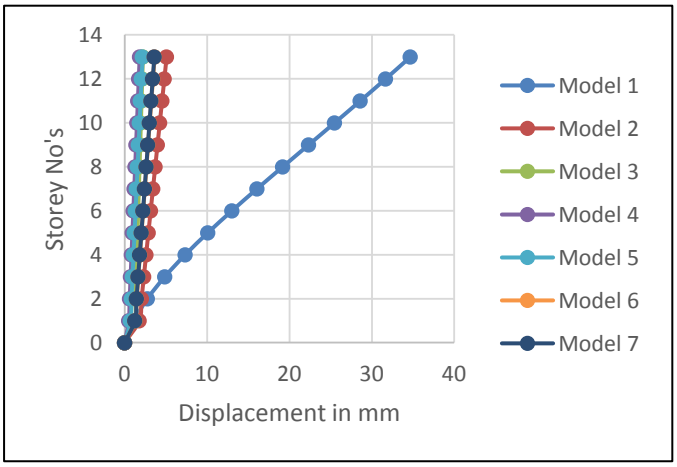


Chart2: Displacements along Transverse direction.

Discussion:

From the above removal examination, the Following perception can be made as follows.

- Lateral removals are most extreme at top stories and least at the base level for all the building models, the relocations esteem are inside as far as possible according to Seems to be Code.
- Model 1 demonstrates the most extreme relocations at top story level when contrast and all other building models, display 3 demonstrates the base measure of removals among every one of the models, When an examination is made model 1,3,4,5,6& 7, the rate decrements are 94.94%,67.4%,17.54%,53.94%, and 53.64%.
- When a sharp perception is made for working with delicate story, the uprooting is more at the delicate story and somewhat increments till the aggregate stature of the building.
- Introduction of parallel load opposing component as shear dividers bracings and brickwork dividers significantly decreases the horizontal removals.
- Conventional level chunk display is indicating very adaptable conduct among all the distinctive building models, subsequently multistoried must have parallel load opposing components.

STOREY DRIFT: Story float is the float of one level of a multistory building with respect to the level beneath. Bury story float is the distinction between the rooftop and floor removals of some random story as the building influences amid the seismic tremor, standardized by the story tallness. For instance, for a 10foot high story, a between story float of 0.10 demonstrates that the rooftop is uprooted one foot in connection to the floor underneath. The more noteworthy the float, the more noteworthy the probability of harm. Pinnacle entomb story float esteems bigger than 0.06 show extreme harm, while values bigger than 0.025 demonstrate that the harm could be not kidding enough to represent a genuine danger to human well-being. Qualities more than 0.10 show plausible building breakdown. As per I.S 1893 – 2002 admissible story float is equivalents to 0.004 times tallness of story.

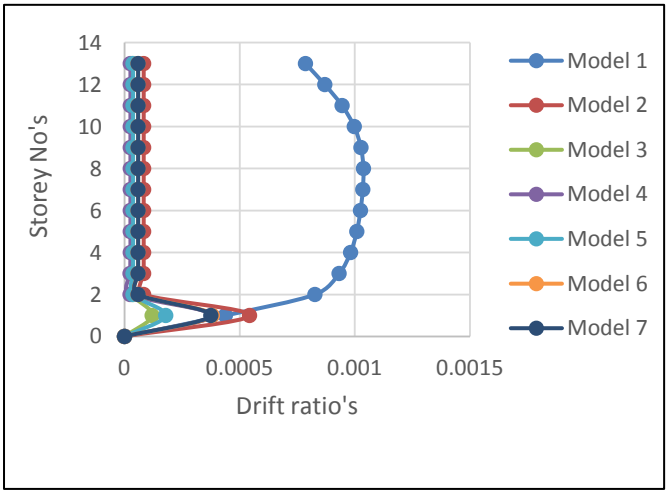


Chart 3: Storey drift ratio's along longitudinal direction.

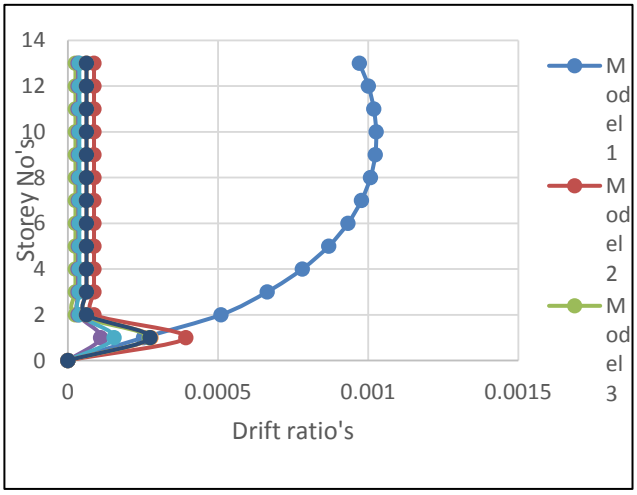


Chart 4: Storey drift ratio's along Transverse direction.

Discussion:

Story float is characterized as the proportion of best story removal less base story dislodging partitioned by story stature, the float proportions are inside as far as possible determined by IS-1893-2002 and 2016. From the above relocation examination the Following perception can be made as follows.

- Model-1 demonstrates the most elevated measure of story float proportions when contrasting and all other building models.
- Model 2 demonstrates the most flabbergasting measure of float proportion at story level-1 and float proportions are same for every other story, it very well may be seen that delicate story will prompt higher measure of float proportions, that is not reasonable for structures situated in seismic helpless areas, in this manner show 2 is one of the such model which won't exchange the seismic power securely to the ground level.
- Model-3 demonstrates the slightest sum if story float at story level-1, the level of decrements when contrasted and models 1,2,4,5,6 and 7 are 72.6%,77.9% 68.5%32.96%,68,5% and 68% individually, this shows shear dividers extensively decreases entomb story float proportions and improves quality and firmness of delicate story.

STOREY STIFFNESS:

Storey stiffness can be defined as lateral load per unit lateral drift at that storey.

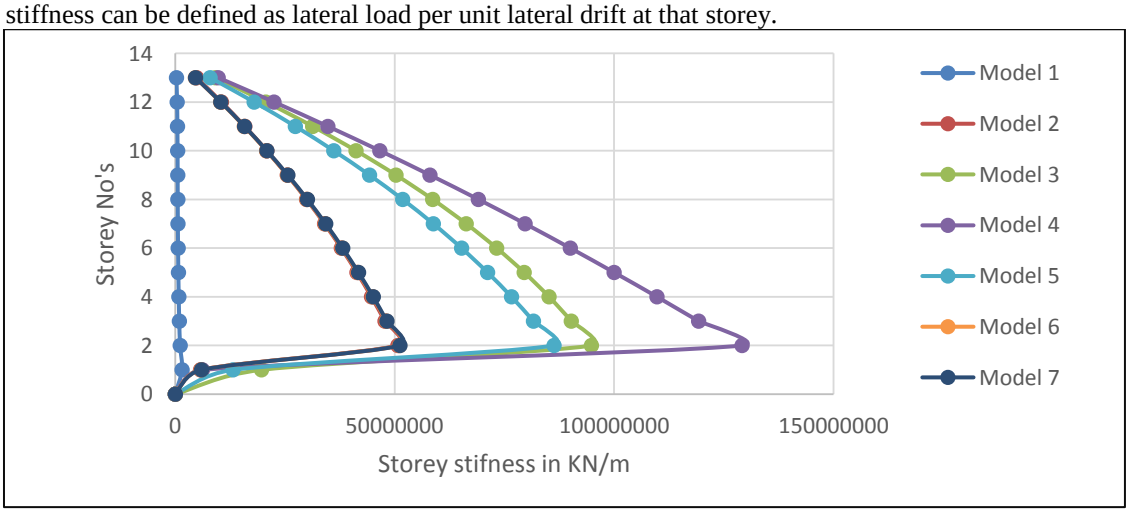


Chart 5: Storey Stiffness along the longitudinal direction for all the building models.

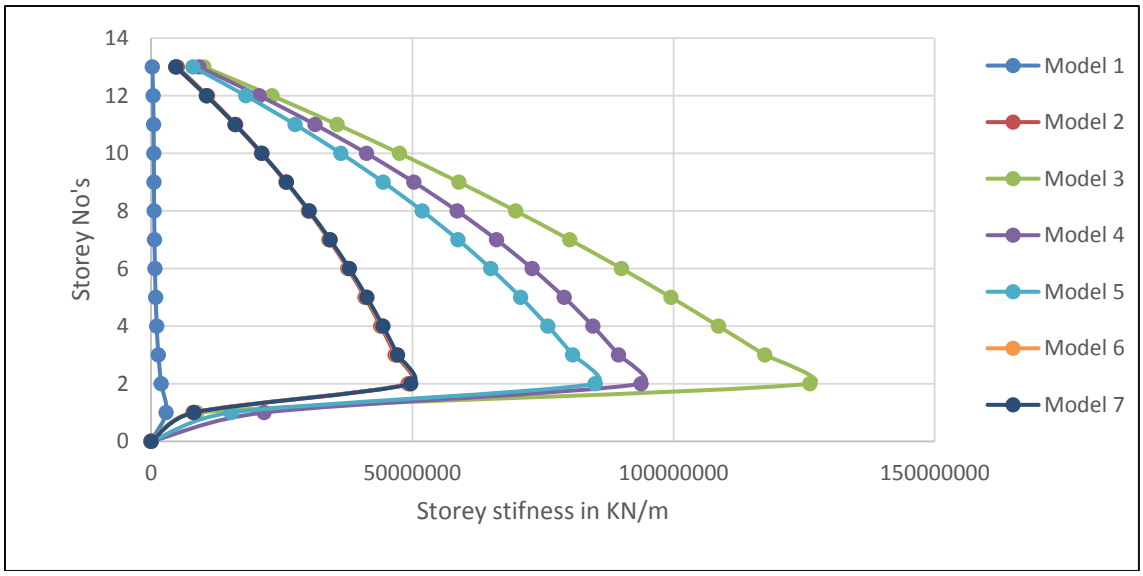


Chart 6: Storey Stiffness along the Transverse direction for all models.

Discussion:

From the above detail ponder the accompanying key perceptions can be made as follows

- Model-1 demonstrates the straight variety of story float all through the building stature; it shows that model-1 has the adaptable nature in seismic reaction.
- The presentation of delicate story wills extensively the story solidness as the above outcomes are obvious.
- Model-4 along longitudinal bearing demonstrates the most noteworthy measure of story solidness in every single separate story; consequently, it tends to presume that shear divider expands the horizontal firmness massively.
- Model-3 along transverse bearing demonstrates the most noteworthy measure of story solidness in every single separate story; consequently, it tends to presume that shear divider expands the horizontal firmness massively.
- Model-2 and Model-7 demonstrate the comparable conduct along longitudinal and transverse headings, in these manner parallel bracings will have the more prominent effect on seismic execution. ETABS2015 is the convenient device for assessing sidelong firmness at every story level.

STOREY SHEAR: Shear instigated at the base of working amid quake is called construct shear which depends with respect to the seismic mass and firmness of building the shear conveyed all through the stature of the building is called story Shear constrain, Base shear drive different models have been classified takes after.

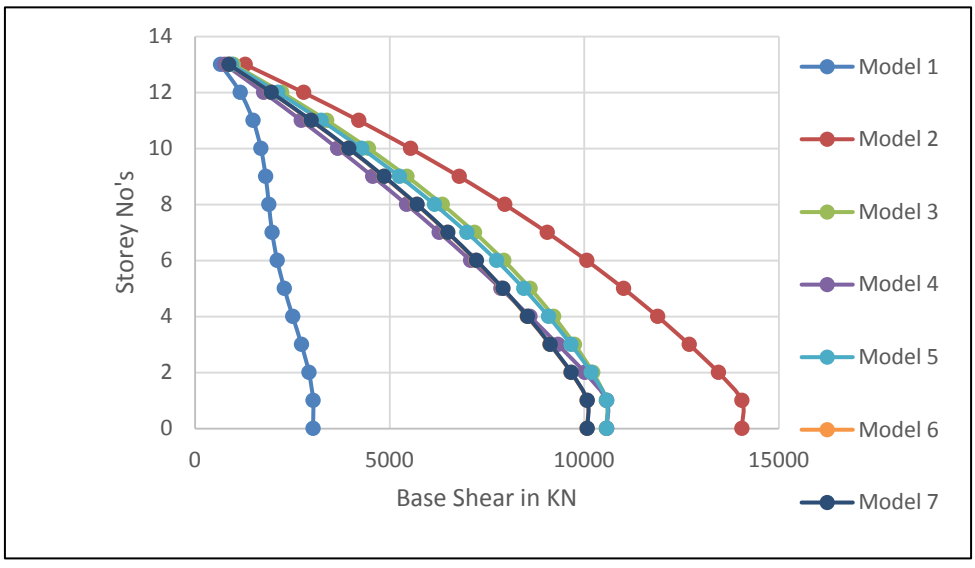


Chart 7: Storey Shear Force along the longitudinal direction.

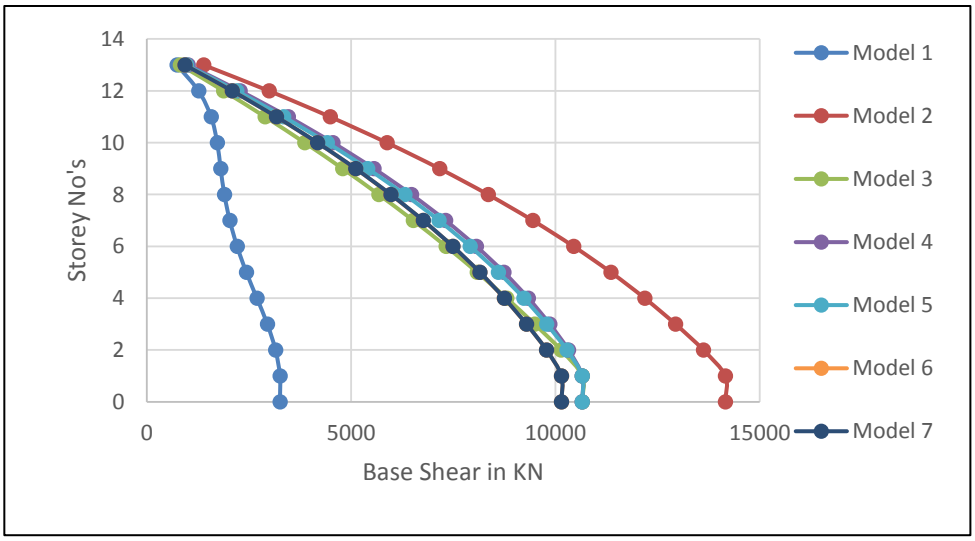


Chart 8: Storey Shear Force along the Transverse direction

Discussions: Story shear powers are produced because of vibration created by quakes, tremors powers will stream all through the building stature. From the above detail seismic investigation, the accompanying perceptions are made.

- Model-1 demonstrates the least measure of base shear constraint, this shows the model has got bring down seismic qualities against sidelong powers.
- Model-2 demonstrates the most elevated measure of base shear, it is a direct result of having ground delicate story, in this way the delicate story will seriously harm the structures and will in charge of the aggregate crumple of the structures.
- Model-3, 4,5,6 and 7 are demonstrating the comparative base shear and story shear powers with the low level of deviations. Along these lines, shear dividers and bracings impressively upgrade the seismic execution of the structures and make the legitimate stream of seismic powers in the aggregate stature of the building.

IV. CONCLUSION

From the above detail investigation, the accompanying closing comments can be made.

- Model 1: as the no of modes expands, the era is getting diminishing, initial 3 modes are thought to be principal modes, modular mass cooperation for this specific model for the first mode is around 80% that to be in torsion, and further second and third mode is parallel interpretation in x and y headings, in this way this setup of building model isn't that much sufficient to exchange the seismic powers appropriately.
- Model 2: this model shows 100% modular mass investment in torsion for first mode and staying two modes are sidelong interpretation in x and y bearing, having delicate story at ground level will seriously influence the dynamic conduct of structures, and basic day and age got lessen when contrasted and demonstrate 1, consequently considering the firmness of stone work dividers diminishes the key day and age of the structure and it will assume an essential job in seismic examination and outline.
- Model 3: this model shows gigantic seismic mass support parallel way in first and second modes and 100% torsion in the third method of vibration, this demonstrates the execution of the building significantly impacted by the presentation of planar shear dividers in x course, the dynamic conduct enormously changed and major day and age hugely got diminished when contrast and model 1 and mode 2.
- Model 4: this specific model is demonstrating the comparable conduct to display 3, however the dynamic reaction of this specific model is significantly superior to the model 3, on the grounds that planar shear dividers are set in y heading, seismic mass support is about 100 % for each of the 12 modes, first and second modes indicates sidelong interpretation with enormous mass investment and third one torsion with 100% modular mass cooperation's.
- Model 5: this specific model is demonstrating the comparative conduct to display 3 and model 4, however the dynamic reaction of this specific model is significantly superior to the model 1,2,3 and 4, in light of the fact that planar shear dividers are set in x and y heading at the middle inlet, seismic mass cooperation is almost 100 % for every one of the 12 modes, first and second modes indicates sidelong interpretation with tremendous mass investment and third one torsion with 100% modular mass interests.
- Model 6: presentation of steel bracings are significantly impacting the dynamic conduct of the building frameworks since this model demonstrates the 100% modular mass cooperation in the first crucial mode, and second and third mode are indicating over 90% modular mass interest in x and y heading..

- Model 7: presentation of steel bracings are impressively affecting the dynamic conduct of the building frameworks since this model demonstrates the 100% modular mass interest in the first central mode, and second and third mode are indicating over 90% modular mass cooperation in x and y heading.
- When we have an examination between models 3, 4 and 5 this specific model is marginally adaptable yet has great powerful reaction record when contrasted and display 1 and mode 2.
- Conventional level chunk demonstrate is indicating very adaptable conduct among all the diverse building models, hence multistoried must have horizontal load opposing components.
- when an examination is made between Model-2 and Mode1-1,3,4,5,6 and Model-7 the level of decline in base shears are 78.4%,24.8%,24.3%,28.3%,28% and 28.28% individually along longitudinal heading and the same perception is seen along the transverse course.
- Therefore the seismic execution of the level plate building can be upgraded with the base delicate story by presenting shear dividers and bracings as a path as from the focal point of the building.

REFERRENCES

[1] Dynamic Analysis of Soft Storey Building with Flat Slab by Ravindra B.N, Mallikarjun S. Bhandiwad.

[2] Parametric Study of Flat Slab Structure with Soft Storey against Earthquake Forcesby R. Balarami Reddy, K. Dhanasri.

[3] A Review on Non-linear Pushover Analysis of Flat Slab Building by Sayali Baitule and Tushar Dalawi.

[4]Seismic Effect of Masonry Infill with Open and Shear Wall on Flat Slab Structures by Janardanachar M. H, D. Prakash.

[5] Dynamic Analysis of Flat Slab System in Vertical Irregular Building with & without Shear Wall by Anshuman Nimade, Niraj Soni, Mahesh Patidar and Vikas Joshi.

[6] Comparison of Seismic Performance of RC Flat Slab with and without Drop Panel for Steel Bracing by Dakshayani S, Chaithra.

[7]Analytical Study of Different Types of Flat Slab Subjected to Dynamic LoadingbyR.S.More, V. S. Sawant, Y. R. Suryawanshi.

[8] Reinforced concrete design –S.unnikrishnapillai, Devdasmenon 7. R.C.C design S.Ramamrutham.

[9]Design of Earthquake Resistant Structures: Basic Theory of Seismic Stability" by S V Polyakov.

[10]Earthquake Resistant Design of Structures" by Shashikant K Duggal.

[11] IS 456: 2000. "Indian Standard Code of Practice for plain and reinforced Concrete", Bureau of Indian Standards, New Delhi.

[12]IS 1893(Part-I) 2002: Criteria for Earthquake Resistant Design of Structures, Part-I General Provision and Buildings (Fifth Revision). Bureau of Indian Standards, New Delhi.

[13]IS 4326, 1993, Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision).