Improvement of Lateral Stability Of Peripheral Supported Structure In Severe Wind And Earthquake Zone

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***Abstract*:- Now a days due to globalization ,the fehmicas and demand in modern construction as been increased. The peripheral supported structure is being very much in demand due to no obstruction by inner column. The occupation area can be utilized in the most efficient way as possible. And it is also very much important to stabilize the building for earthquake and wind lateral forces. The improvement of frame structure against lateral loading can be achieved by providing shear wall and bracing. In the present study, the attempts are made to study the behavior of peripheral supported structure in severe Wind and Earthquakes zones of India and four models are analyzed, braced frame, with lateral resisting frame with inverted V bracing and shear wall. The models are analyzed using ETABS FE software by response spectrum method. The results of the analysis, in terms of displacements, storey drift, storey stiffness, base shear, time period, are obtained.**

Key Words: Peripheral supported structure, Bracing, Shear wall, Displacement, Time period, Base shear.

1. INTRODUCTION

Earthquake is the natural calamity known to mankind from many years which affects the human lives and also manmade structures. Building structures are one of the creations of mankind, due to sever earthquake the building collapse and cause direct loss to human lives. Numerous research works have been directed worldwide in last decades to investigate the cause of failure of different types of buildings under severe seismic and wind load. The behavior of a building during earthquake depends mainly on its overall shape, size and geometry in addition how moment resisting frames resist lateral forces during earthquake and how the earthquake forces are carried to the ground.

Now a days due to globalization and demand in modern construction as been increased. The peripheral supported structure is being very much in demand due to no obstruction by inner column. The occupation area can be utilized in the most efficient way as possible. And it is also very much important to stabilize the building for earthquake and wind lateral forces. It provide good architectural view to the building. The building has to be designed to offer lateral resistance to wind and earthquake force. The buildings are constructed by providing the columns at the periphery. Such building exhibit stiffness reduction of the lateral load resisting system in seismic zone. This reduction in stiffness causes higher stress to be concentrated to the columns leading to failure. Hence lateral stiffness is a major consideration in the design of building. The study focuses on the methods for evaluating the lateral resistance of individual assemblies of lateral force resisting system and the response of the whole building to lateral loads. In this study, the peripheral supported building (which is present in highly seismic area) has been analysed. Generally both shear wall and bracings will provide an effective lateral stiffness to the building. In this the performance of the shear wall, bracings and both shear wall and bracings are to be compared for better results between them. For this, the response spectrum method of analysis is performed with the help of Etabs Ultimate 17.0.1 software. And the results of bare frame, bracing, shear wall, and both shear wall and bracings are compared for better performance in lateral stiffness.

1.1 Inverted 'V' (Chevron) Bracings

In construction , chevron member is a system utilized to reinforce building structures in which the bracing member are connected to the top and coverage to a common point. Chevron bracing can increases a building capability to withstand seismic activity. Bracing is important earthquake resistant building because it helps to keep a structure standing. The member used in chevron bracings are designed for both compression and tension. It helps the building studier and more likely to withstand lateral forces. Inverted V bracing allows for doorways or corridors through the bracing lines in a structure. In the chevron brace connection the interaction of forces from a chevron above the beam and a chevron below that same beam are ignored. Each chevron brace connection is treated independently. Chevron bracing members use two types of connection first one is floor level connection may use a gusset plate much like the connection on X braced frames and type the bracing members are connected to beam/girder at the top and coverage to a common point. If gusset plates are used, it is important to consider that their size when laying out mechanical and plumbing systems that pass through braced bays.

1.2 Shear walls

Shear walls are vertical members that resist pseudo static (seismic) forces. These are provided along the height to resist the in-plane loads. Shear wall mainly experience the seismic and wind loads. Generally, the loads are transferred to walls by Diaphragm (The structural element which transverse the lateral load to the vertical resisting elements of a structure. These are mainly in horizontal, but can be in sloped in special case like ramp for parking the vehicle.) They may be wood, concrete stiffness to resist the lateral and masonry. Shear walls have high strength and forces. Shear wall are very important in high rise buildings in the seismic prone areas. Lateral displacement can be reduced by these shear wall. These are designed to resist both self-weight of the structure (gravity loads) and lateral forces. Natural calamities (Earthquakes, wind forces) force causes several kinds of stresses such as shear, tension, and torsion etc., the structure may experience Storey displacement or may collapse suddenly. Shear wall reduces the severity of lateral displacement of the structure and indicate the failure of the structure.

2. LITERATURE REVIEW

1) Dharanya, Gayathri and Deepika (2017): In this paper, a comparison study of shear wall and bracings under seismic loading in multi-storey residential building using ETABS software is made. In this study, a (G+4) storey residential RC building with soft storey was analyzed with cross bracings such as X bracing are provided at the outer periphery of the column and shear walls are provided at the corners of the buildings in zone 5. The main parameters are compared with lateral displacement, base shear, storey drift, shear force. It is concluded that shear wall could improve the lateral stability of the structure than the bracings.

2) Anes Babur and Chandan Kumar Patnailuni (2017): In this paper, the effect of steel bracings on RC framed structure using Etabs 2015 software are sudied. The models used are; model without steel bracings and shear wall, model with different bracings system, model with shear wall. Bracings and shear wall are placed in the middle bays. As a result the chevron type of Steel bracings is found to be more efficient in zone 2 and 5, Steel braced building reduces the lateral drift when compared with shear wall building in zone 4 and 5 X type of bracings is found to be more efficient.

3) Thorat and Salunke (2014): Analysised and observed the behavior of the structural systems under seismic effect and analyzed the dynamic behavior of reinforced concrete frame with and without shear wall and concrete braced frame. The position of bracings and shear wall considerably effect the seismic response of the structure if the shear wall is placed in the center reduces horizontal deflection and drift. Bare elements are very much capable of reducing lateral displacement of frame. The drift and horizontal deflection induced in braced frame are much less than that induced in shear wall and plane frame. Axial load on columns will be higher in bare frame than the shear wall frame. Hence bare frame structure is much more capable of resisting seismic force than the structure shear wall.

3. OBJECTIVES OF STUDY

The objective of the study are:
1) Learn and understand the Etabs Ultimate 17.0.1 software for a peripheral supported structure.
2) Learn and understand assigning of wind and earthquake load to multistory building by using prescribed IS codes in Etabs Ultimate 17.0.1 software.
3) And the main objective of this project work is to study the improvement of lateral stability of peripheral supported structure in sever wind and earthquake zone of India.
4) To evaluate displacement, base shear, storey drift of structure with bare frame, frame with shear wall, bracings and frame with both bracings and shear wall and compare them.
5) To understand the seismic behavior of peripheral supported building by using dynamic method of analysis.
6) Suggesting the improved lateral stability of peripheral supported structure using bracings and shear wall in sever wind and earthquakes zones of India.

4. METHODOLOGY

In the paper a peripheral supported structure is designed under severe seismic and wind loads. The (G+9) building is located in zone5. To improve the building stability against lateral loading an additional structural member such as shear wall is provided at each side in the middle, inverted 'V' (chevron braced) shaped bracing are provided at the outer periphery of the column and the shear wall at the corners and the bracing at the centre. The following four models are considered for the study.
Model 1: Bare Frame.
Model 2: Frame with bracing provide at the outer periphery of the column.
Model 3: Frame with shear wall provide at the each side of middle.
Model 4: Frame with shear wall provide at the corners and bracing at the each side of middle.
This models are analysed by using ETABS software.

4.1 MODEL DISCRIPTION

Table below represents the structural details of the models considered in the study

Item	**Building**
Plan	20m x 20m
Number of bays along X & Y direction	5
Spacing between girds in X & Y direction	4m
Storey height	27m
Live load intensity on each floor	2KN/m^2
Floor finish	1.5 KN/m^2
Soil type	Medium
Importance factor	1.2
Response reduction factor	5.0
Seismic zone	0.36
Damping ratio	5%
Grade of steel	Fe 500
Grade of concrete	M30 for columns M25 for beams
Beam size	230mm X 750mm
Column size	230mm X 750mm
Slab details	150mm thick throughout
Wall loads	15 KN/m
Bracings	ISMC150
Shear wall	230mm thick

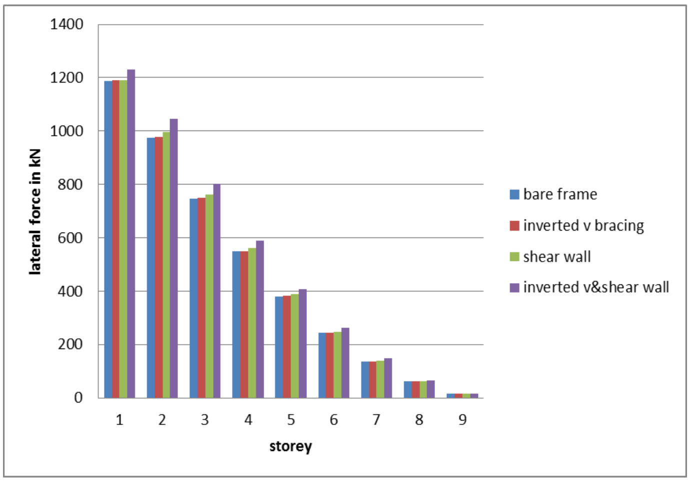
5. RESULTS

- In the present study the attempts are made to study the improvement lateral stability of peripheral supported building with additional structures like bracing and shear wall in sever wind and earthquakes zone of India.
- The analysis is done with Equivalent static method and Response spectrum method are tabulated and represented in the forms of graph.

- For modeling and analysis were performed using Etabs Ultimate 17.0.1 –Finite element software. The Results of analysis, in terms of Displacement, storey drift, base shear, stiffness are obtained.

5.1 Laternal loads

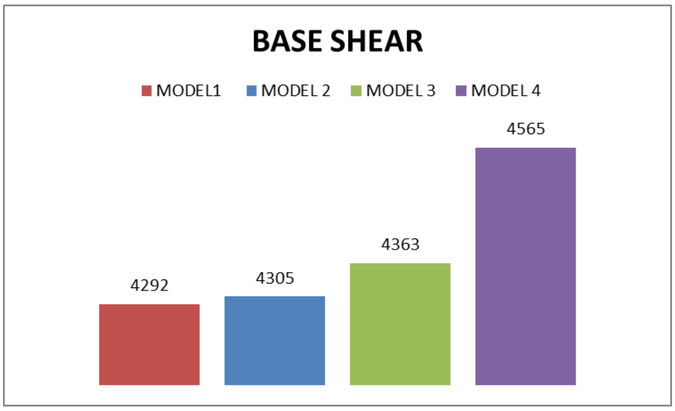
The base shear obtained in both X and Y direction is 4292 kN. The value of base shear the lateral force applied in each storey of the building was given in the figure below.



Variation of lateral force on building

The above graph for (G+9) storey building there is increase in lateral force for frame with both inverted 'V' bracing and shear wall . The lateral force is reduced for the bare frame. The maximum lateral force is obtained for the load combination 1.5DL+1.5LL+1.5RSX. By this we can conclude that the lateral force resisting system has well performed with placing bracing and shear wall.

5.2 Base shear

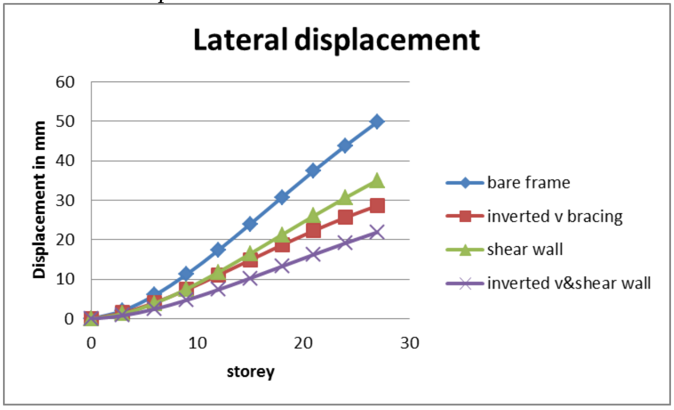


Variation of base shear

The above graph shows the variation of maximum base shear for building with shear wall and inverted 'V' bracing in RSPX and RSPY direction. For the model 1 the base shear is found to be minimum. For the model 4 the base shear is found to be maximum. The maximum base shear is obtained for the load combination 1.5DL+1.5LL+1.5RSX. The base shear is more for shear wall compared to inverted 'V' bracing. It has been observed that building with both shear wall and bracing the base shear percentage increase by 6% compared to bare frame..

From this we can conclude that base shear as improved for building with both shear wall and bracing.

5.3 Lateral displacement



Maximum displacement comparison

From the above table for (G+9) storied building, there is decrease in lateral displacement for both Shear wall and chevron bracing in RSPX and RSPY direction. The maximum lateral displacement is obtained for the load combination 1.5DL+1.5LL+1.5RSPX. For bare frame the displacement is 49.8mm ,the displacement percentage reduces by

Model 2 Inverted 'V' bracing (chevron bracing) = 42%
Model 3 Shear wall = 30%
Model 4 Both (Shear wall and chevron bracing) = 56%

For the model 4 the lateral displacement is minimum then the model 1. The lateral displacement is reduce for model 2 compared to the model 3. Hence the building with both shear wall and chevron bracing as least lateral displacement and the displacement of shear wall as minimum then compared to inverted v bracing.

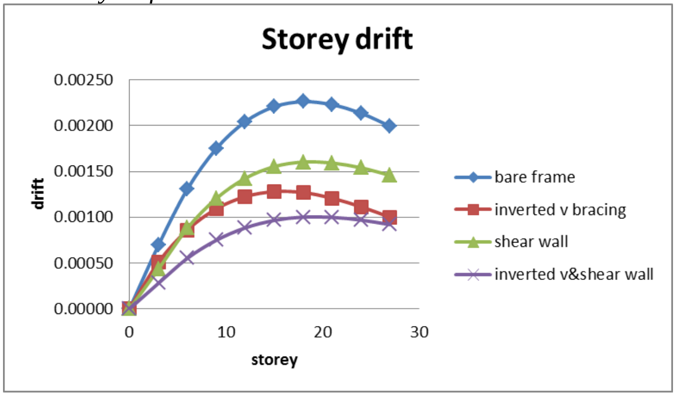
5.4 Storey stiffness

The above graph for (G+9) storied building, it is observed that there is an increase in storey stiffness for both Shear wall and Chevron bracing in RSPX and RSPY direction. The maximum storey stiffness is obtained for the load combination 1.5DL+1.5LL+1.5RSPX. The storey stiffness percentage increases by

Model 2 Inverted 'V' bracing (chevron bracing) = 88%
Model 3 Shear wall = 37%
Model 4 Both (Shear wall and chevron bracing) = 95%

For the model 4 the storey stiffness is more than the model 1. The storey stiffness is more for model 2 when compared to the model 3. Hence we can conclude that the stiffness is more for the building with both shear wall and bracing compared to the building with bare frame.

5.5 Storey drift



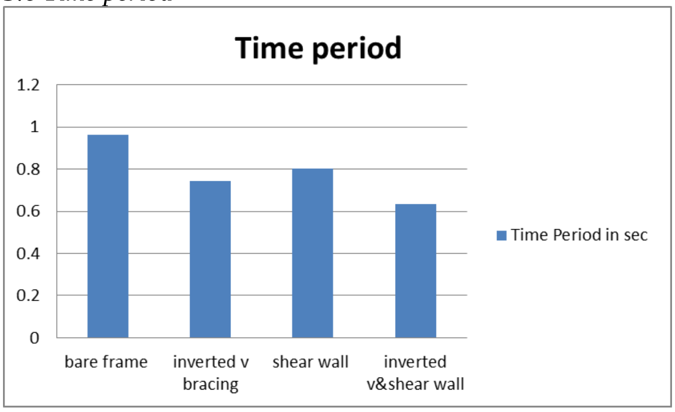
Storey drift comparison

From the above graph for (G+9) storied building, there is an decrease in storey drift for both Shear wall and Chevron bracing in RSPX and RSPY direction. The maximum base shear is obtained for the load combination 1.5DL+1.5LL+1.5RSPX. The storey stiffness percentage reduced by

Model 2 Inverted 'V' bracing (chevron bracing) = 49%
Model 3 Shear wall = 27%
Model 4 Both (Shear wall and chevron bracing) = 54%

For the model 4 the storey drift is less when compared to model 1. The storey drift is more for model 3 when compared to the model 2. Hence we can conclude that the storey drift is more for the building with both shear wall and bracing compared to the building with bare frame.

5.6 Time period



Time period comparison

From the above graph shows the variation of minimum time period for building with shear wall and inverted 'V' bracing in RSPX and RSPY direction. For the model 1 the time period is found to be maximum. For the model 4 the time period is found to be minimum. The maximum time period is obtained for the load combination 1.5DL+1.5LL+1.5RSX. The time period is reduced for the building with shear wall compared to the building with inverted 'V' bracing. It has been observed that building with both shear wall and bracing the time period percentage decreased by 34% compared to bare frame. From this we can concluded that base shear as improved of building with both shear wall and bracing. Which will improve the stability against earthquake and make the structure more stable.

6. CONCLUSIONS

- The lateral force resisting system has well performed well for building with shear wall and bracing.
- The maximum lateral displacement is reduced for the model 4(with both shear wall and chevron bracing) when compared to model 1 (with bare frame).
- The stiffness of the structure increases with addition of the shear wall and bracing.
- The stiffness is more for the structure with combining shear wall and chevron bracing.
- The storey drift of the structure decreases and improves the lateral stability of the structure.
- The natural time period of the structure has highly reduced after placing both bracing and shear wall, which will improve the stability against earthquake.

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