"COMPARATIVE STUDY ON HIGH RISE BUILDING WITH EARTHQUAKE AND WIND LOADING USING WITH AND WITHOUT SHEAR WALL AT DIFFERENT LOCATIONS"

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ABSTRACT*:* *Earthquake is a natural calamity and it is observed it behaviour fatal in today's time. Now a days due to the enormous effect of earthquake, collapse of structures and the construction practices play a tremendous role in the death; therefore special attentions are required to resolve the seismic performance of multi storied buildings. For this a concrete shear walls are extensively used for buildings to resist lateral loads due to earthquake, wind etc. in high rise building. In this study, modelling and analysis is done with equivalent static method on Staad-Pro software for the assessment of the relative effectiveness of the various lateral load resisting systems. Five models were used, one for moment resisting frame & four models each for the lateral load resisting systems (Shear wall combined with column). Each model consists of G+15 storied building with different types Shear wall combining with column analysed with seismic and wind forces having total height of 58.0 m. The parameters like maximum storey displacement, storey drift ratio, moment and axial force in column are considered to locate the effective location of shear wall from the analysis results of RC buildings with different shear wall locations.*

Keywords: Earthquake, Shear Wall, Storey Displacement, Storey Drift Ratio, Seismic and Wind Forces

1. INTRODUCTION

The word earthquake is employed to explain any seismic event whether natural or caused by humans that generate seismic waves. It's caused mostly because of rupture of geological faults, but also by other events like volcanic activity, landslides, mine blasts, and nuclear tests. But because of preparedness and safe building construction practices we will certainly reduce the extent of injury and loss. Thanks to earthquake shaking generated inertia forces in building are proportional to the overall building mass. Since most of the building mass is present at floor levels, earthquake-induced inertia forces primarily develop at the ground levels. These forces travel downwards - through slabs and beams to columns and walls, then to the foundations from where they're dispersed to the bottom. Thanks to shear shut in high rise building is employed to resist lateral force of earthquake and wind. Lateral loads can develop high stresses, produce sway movement or cause vibration. Now every day it's vital for the structure to possess sufficient strength against vertical loads along with adequate stiffness to resist lateral forces thanks to wind and earthquake effect this could be resisted by Frame action, Shear Walls, or Dual System.

Shear wall is vertical plate-like RC walls additionally to slabs, beams and columns. These concrete walls generally start at foundation level and are continuous throughout the building height. It will be thickness of 200mm, or as high as 400mm in high rise buildings. Properly designed and detailed buildings with shear walls have shown superb performance in past earthquakes. Shear walls are like vertically-oriented wide beams that carry earthquake loads downward to the inspiration. It provides large strength and stiffness to the full buildings within the direction of their orientation, which significantly reduces lateral sway of the building thanks to wind effect and earthquake and there by reduces damage to the structure and its contents.

2. MODELLING

In this study RC building of G+15 with 3.5m height for each story, regular in plan is modelled. These buildings were designed in compliance to the Indian Code of Practice for Seismic Resistant Design of Buildings. The buildings are assumed to be fixed at the base. The sections of structural elements are rectangular. The buildings are modelled using Staad-Pro software. Five different models were created and studied with different positioning of shear wall in building given in Table 1. Models are studied in seismic zone III.

Table 1: Model Reference

Model	Description
Model 1	Model without shear wall
Model 2	Model with shear wall at corner location
Model 3	Model with shear wall on each side at middle
Model 4	Model with shear wall on middle portion
Model 5	Model with shear wall on intermediate Side

Following figure shows modelling of structure with shear wall and without shear frame.

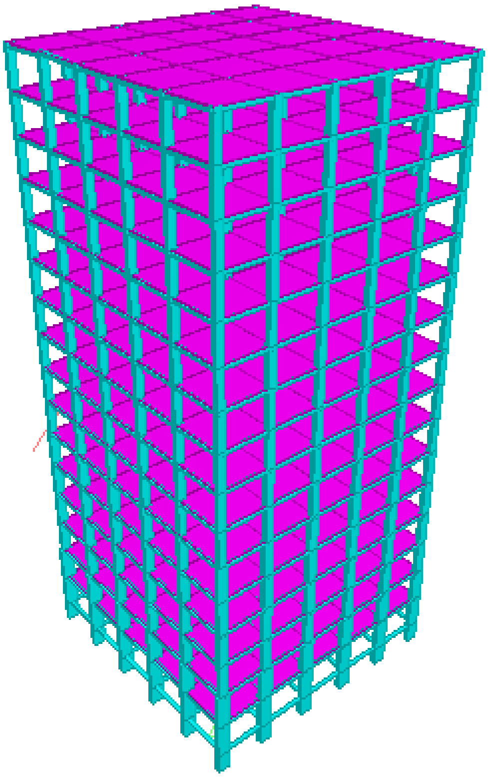


Figure 1: Model 1

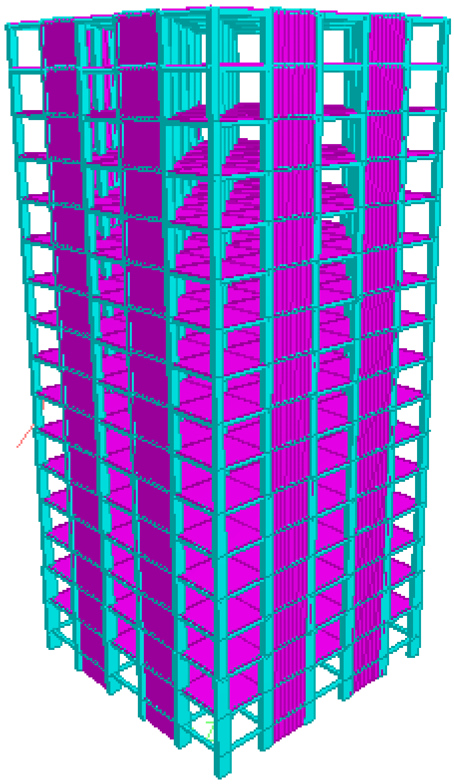


Figure 3: Model 3

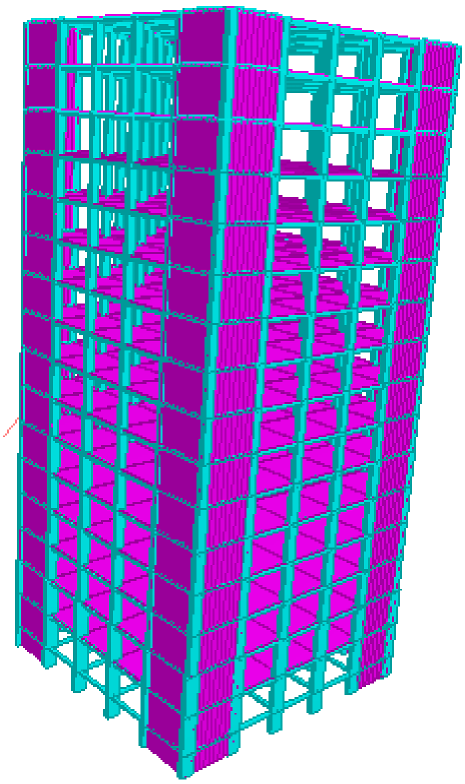


Figure 2: Model2

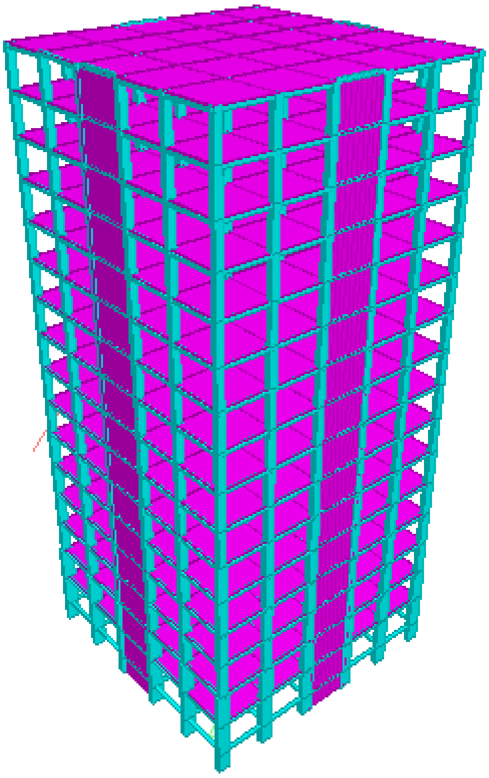


Figure 4: Model 4

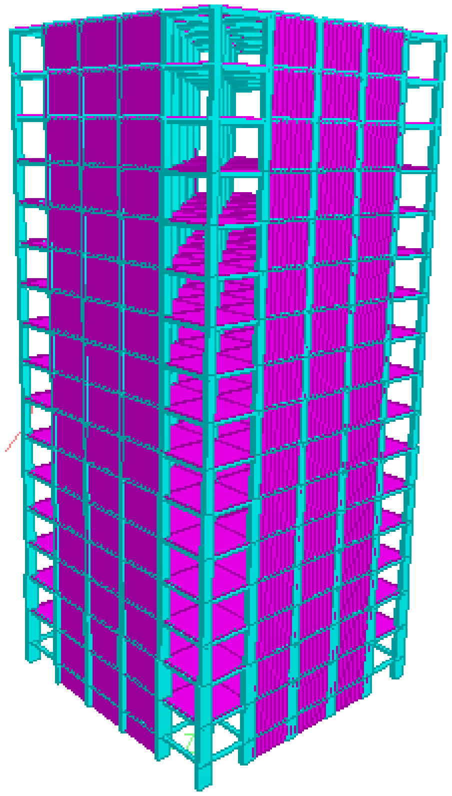


Figure 5: Model 5

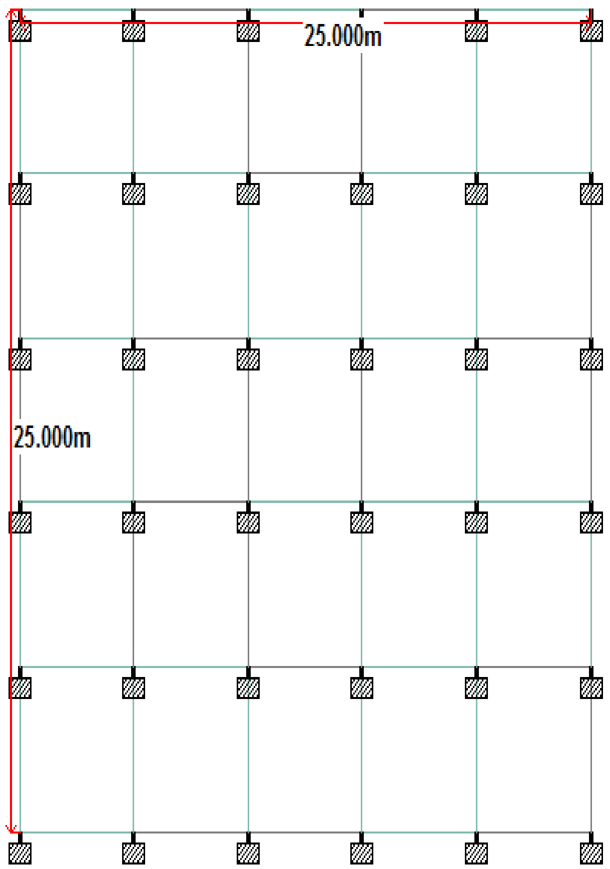


Figure 6: Plan of Structure

Table 2: Description of Structure.

Types of Structure	SMRF
No. Of stories	G+15
Storey Height	3.5 m
Material property	
Grade of concrete	M25
Grade of Steel	Fe 415
Member Properties	
Thickness of slab	0.150 m
Beam Size	0.27 x 0.3 m
Column Size from	1.2 x 0.50 m
Column Size from 2nd	0.8 x 0.50 m
Column Size from sixth	0.6 x 0.50 m
Load Intensities	
Seismic Zone	III
Location	Mumbai
Height of building	58 m
Live load	3 KN/M^2
Roof load	1.5 KN/M^2
Shear wall Thickness	0.200 m
Importance factor	1
Terrain category	3
Risk coefficient	1
Permeability opening	0.5

Table 3: Method used for Analysis of the Building

Analysis	Method
Earthquake Analysis	Equivalent Static Method
Wind Analysis	Force Coefficient Method

Static Analysis

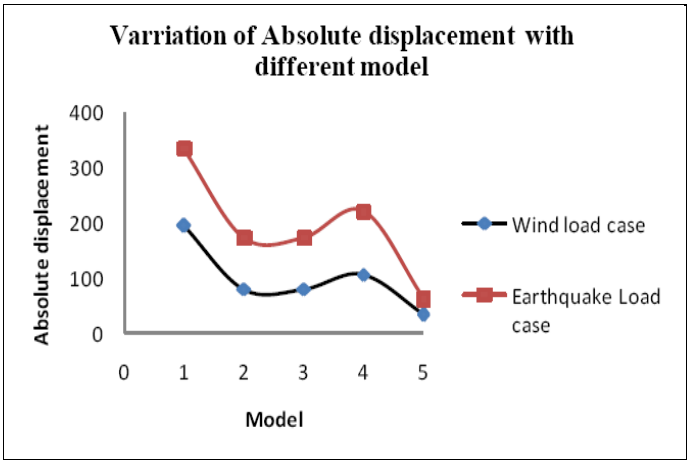
It is known as equivalent static force method. The base shear is calculated from the weight of building. Earthquake forces are calculated in normalized way. In most codes of practice for regular, low- to medium-rise buildings it is permitted. It begins with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Tall buildings (over, say, 75 m), where second and higher modes can be important, or buildings with torsional effects, are much less suitable for the method and require more complex methods to be used in these circumstances.

Force Coefficient - A non-dimensional coefficient such that the total wind force on a body is the product of the force coefficient, the dynamic pressure of the incident design wind speed and the reference area over which the force is required.

3. RESULTS

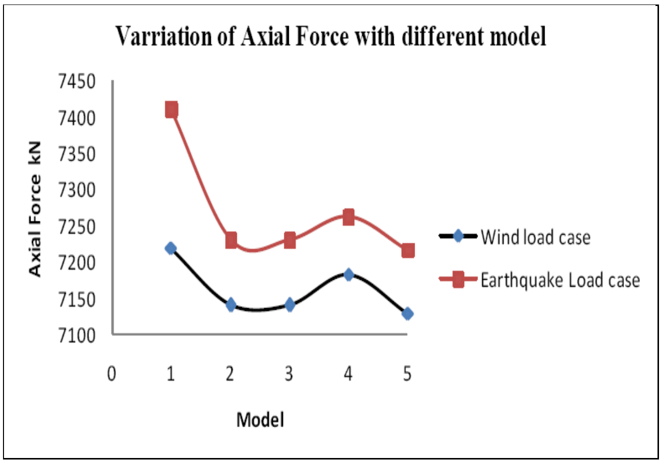
The following analysis are carried out as per IS: 1893-2002(Part-I) for G+15 storied building models. For the analysis, Seismic zone-III is considered. According to IS: 1893-2002 (Part-I) Zone Factor, Z=0.16, Importance factor, I=1.00, Response reduction factor, R=5.00, are Considered during analysis. Wind forces are calculated using code IS-875 (PART-3). Also comparison is done here in between earthquake load case and wind load case.

1) Variations of maximum absolute displacement in (mm) with different types of model



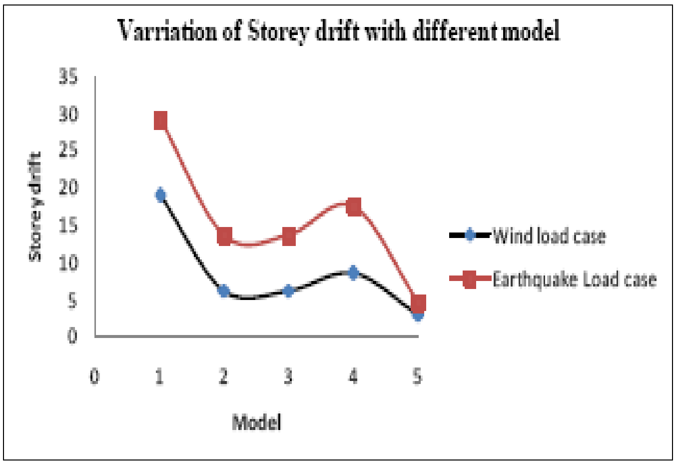
- The Absolute displacement in without shear wall system is the greatest among all lateral load resisting systems investigated. Amongst the absolute displacement in dual frames, shear wall provided at intermediate side is the least while other frames have higher values in earthquake and wind load case.
- Fig indicates that the maximum absolute displacement in wind load case is lesser than earthquake load case.
- In earthquake and wind load cases value of absolute displacement is maximum at top level and below is lesser means increasing order.

2) Variations of maximum axial force in (KN) with different types of model.



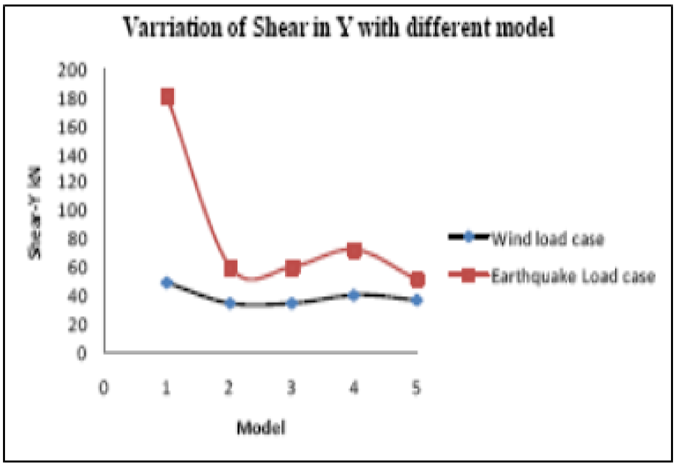
- In earthquake and wind load cases value of axial force is greatest in without shear wall system as compared to other model and minimum in shear wall provided at intermediate side.
- In earthquake and wind load cases value of axial force is maximum at below level and top is lesser means decreasing order.
- Fig indicates that the maximum axial force in wind load case is lesser than earthquake load case.

3) Variations of maximum storey drift with different types of model



- Model without shear wall shows maximum storey drift as compared to other model in wind and earthquake load case.
- Fig indicates that the maximum Storey drift in wind load case is lesser than earthquake load case.
- Storey drift is maximum in 7th storey in earthquake load case.
- Storey drift is maximum in 3rd storey in wind load case.

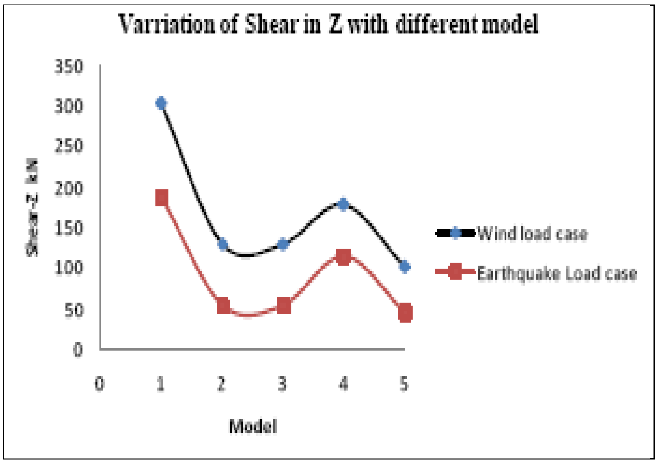
4) Variations of maximum shear Y in (KN) with different types of model.



- In earthquake and wind load case value of shear in Y is greatest in without shear wall system as compared to other model and minimum in shear wall provided at intermediate side.

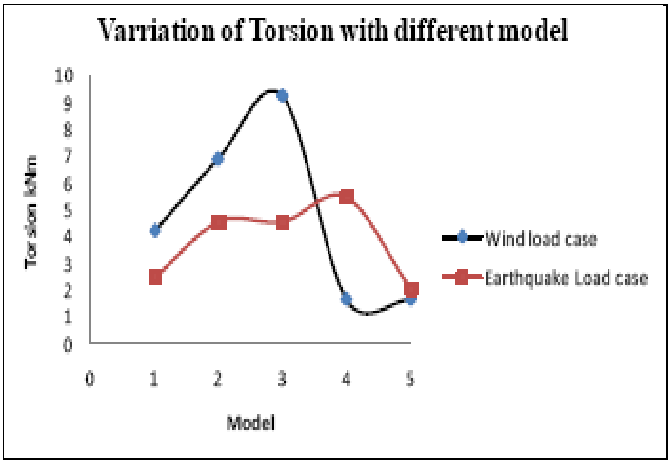
- Fig indicates that the maximum shear in Y in wind load case is lesser than earthquake load case.

5) Variations of maximum shear Z in (KN) with different types of model.



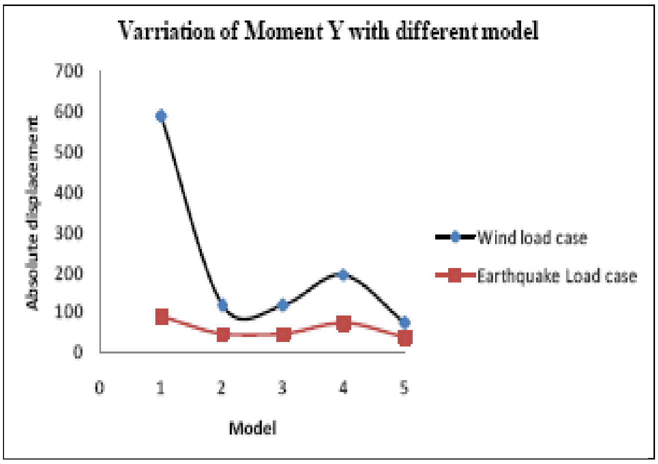
- In earthquake and wind load case value of shear in Z is greatest in without shear wall system as compared to other model and minimum in shear wall provided at intermediate side.
- Fig indicates that the maximum Shear in Z in wind load case is higher than earthquake load case.

6) Variation of maximum torsion in (KN) with different types of model



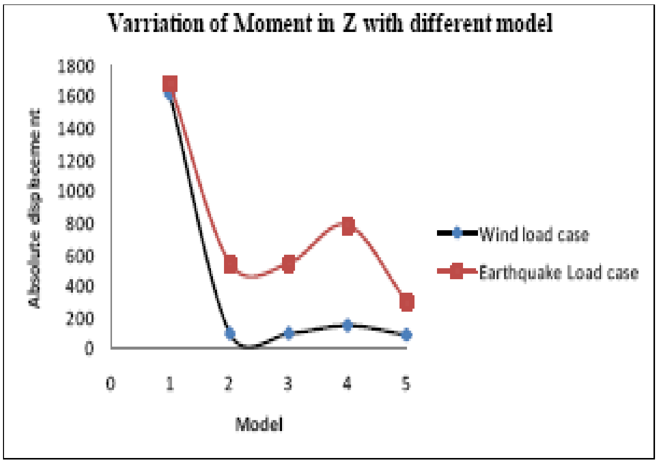
- In earthquake and wind load case, torsion is minimum in shear wall provided at intermediate side.
- In model I, II, III torsion is higher in wind load case than earthquake load case and in model IV; V torsion is higher in earthquake load case than wind load case.

7) Variation of maximum moment Y in (KNm) with different types of model.



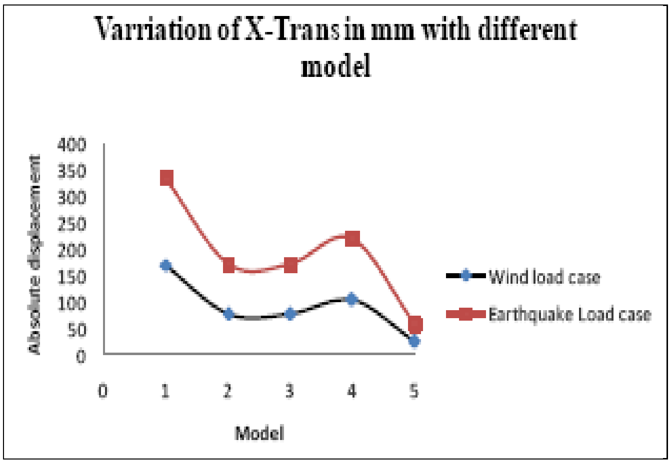
- In earthquake and wind load case, moment in Y is maximum in without shear wall system and less in shear wall provided at intermediate side.
- Maximum moment in Y in wind load case is higher than earthquake load case.

8) Variation of maximum moment Z in KN.m with different types of model



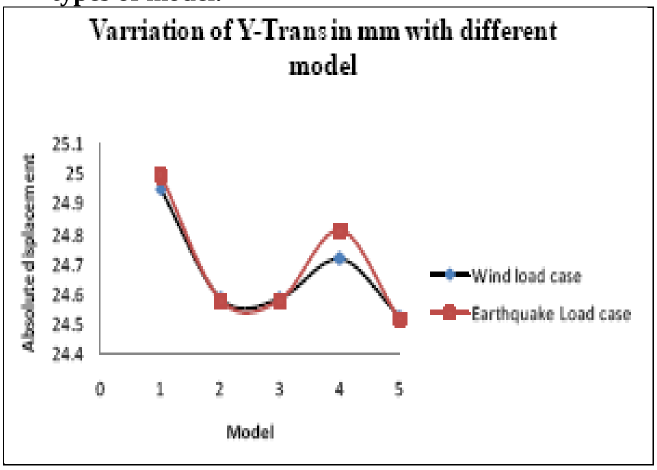
- In earthquake and wind load case, moment in Z is maximum in without shear wall system and less in shear wall provided at intermediate side.
- Maximum moment in Z in wind load case is lesser than earthquake load case.

9) Variation of maximum X-trans mm with different types of model



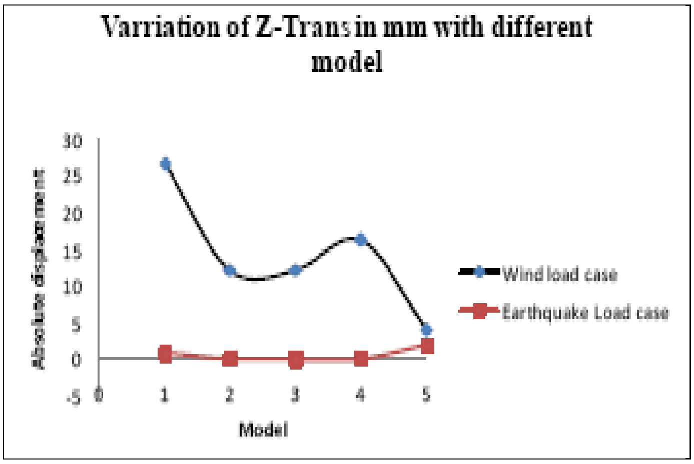
- The X-Trans in without shear wall system is the greatest among all lateral load resisting systems and least in shear wall provided at intermediate side are investigated in earthquake and wind load case.
- In earthquake and wind load case value of X-Trans in mm is maximum at top level and below is lesser means increasing order.
- Fig indicates that the Maximum X-Trans in wind load case is lesser than earthquake load case.

10) Variation of maximum Y-Trans mm with different types of model.



- The Y-Trans without shear wall system is the greatest among all lateral load resisting systems and least in shear wall provided at intermediate side are investigated in earthquake and wind load case.
- In earthquake and wind load case value of Y-Trans in mm is maximum at top level and below is lesser means increasing order.
- Fig indicates that the maximum Y-Trans in wind load case is lesser than earthquake load case.

11) Variation of maximum Z-Trans mm with different types of model



- The Z-Trans in shear wall provided at intermediate side is the greatest among all model in earthquake load case and in wind load case shear wall provided at intermediate side is the least while other frames have higher values.
- In wind load case value of Z-Trans in mm is maximum at top level and below is lesser means increasing order.
- Fig indicates that the maximum Z-Trans in wind load case are higher than earthquake load case.

CONCLUSION

1. The Absolute displacement, axial force, storey drift, moment and storey shear in moment frame without shear wall is the greatest among all lateral load resisting systems as compare to the shear wall models. Shear wall provided at intermediate side gives the least while other frames have higher values in earthquake and wind load case.
2. In earthquake and wind load cases value of axial force is greatest in without shear wall case as compared to other model and minimum in Shear wall provided at intermediate side. Hence when shear wall provided in moment resisting frame it will help to reduce axial force significantly in moment resisting frame.
3. Torsion in without shear wall is the greatest among all lateral load resisting systems and least in Shear wall provided at intermediate side are investigated in earthquake and wind load case.
4. Shear wall shows least deflection as compare with other models. Hence RC shear wall can be considered as displacement and drift, damage control structural element that may occur due to wind and earthquake forces and it is found most effective in resisting lateral forces induced by earthquake and wind.
5. Good preliminary design and optimization leads to better fabrication and erection costs, and better construction. The cost of systems depends on their total structure weight; efficient initial design also leads to a better foundation design, even in difficult soil conditions.
6. Absolute displacement, axial force, Storey drift, and moment in wind load case are lesser than earthquake

load case. So it is considered that in comparison wind load case is better than earthquake load case .Hence wind load is less predominant than earthquake load case.

7. If all the parameters are taken into consideration to choose a safe, laterally stiff and economical frame then, Shear wall provided at intermediate side of dual system is the most efficient solution. Means Shear wall combining with column is best appropriate system.

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