Combined Effect of Lateral Loading System on RC Framed in Different Seismic Zones for Computing Percentage of Steel

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Abstract— Consideration of site specific lateral loading due to wind or earthquake loads along with vertical gravity loads is important for finding the behavior of the tall buildings. As the height of a building becomes taller, the amount of structural material required to resist lateral loads increases drastically. The design of tall buildings essentially involves a conceptual design, approximate analysis, preliminary design and optimization, to safely carry gravity and lateral loads. The design criteria are strength, serviceability and human comfort. The aim of the structural engineer is to arrive at suitable structural schemes, to satisfy these criteria. Safety of the structure is checked against allowable limits prescribed for base shear, roof displacements, inter-storey drifts, and accelerations prescribed in codes of practice and other relevant references in literature on effects of earthquake and wind loads on buildings. The present study mainly focuses on computation of percentage of steel in different seismic zones with combined lateral forces. The current Is code for seismic design i.e. IS 1893-2002 part 1 suggests that maximum reinforcement should be provided for higher seismic zones. In following work attempt is made to find the requirement of percentage of steel in different seismic zones and wind zones by using ETABS-2013(structural analysis software tool.

Key words: ETABS, Percentage Steel, Seismic Zones, Wind Zones, Base Shear

I. Introduction

A. Earthquake

An earthquake is a geological event that leads to vast destructions which occurs inside the earth due to the generation of strong vibrations.

Many reaches have been conducted on this topic and still it is in the process, because more we try to study more we can take control over the damages and save the lives. According to studies have been made on the seismology about 90% earthquake happens due to tectonics. Damage and loss of life sustained during an earthquake result from falling structures and flying glass and objects. Flexible structures built on bedrock are generally more resistant to earthquake damage than rigid structures built on loose soil. In certain areas, an earthquake can trigger mudslides, which slip down mountain slopes and can bury habitations below. A submarine earthquake can cause a tsunami, a series of damaging waves that ripple outward from the earthquake epicenter and inundate coastal cities.

Many study have been done and and still its going on because more we try to research more we learn and can reduce the damages caused the earth quakes.

If we stand for civil engineering point of view its our job to provide maximum safety in the structured designed and from economic point of view also.

B. Wind Analysis

Wind is air in the movement in respect to the surface of the earth. the expression "wind" indicates the flat wind, vertical winds are constantly recognized accordingly. The wind velocities are resolved with the instrument of anemometers or anemographs which are introduced at meteorological observatories at statures for the most part shifting from 10 to 30 meters over the ground. The traditional way to deal with the examination of element reaction of delicately damped structures is by determining the reaction into the common methods of vibration, portraying every ordinary mode as an arrangement of model parameters:

1) Model shape
2) Model mass
3) Model solidness

At the point when wind cooperates with a building, both + and - weights happen at the same time on the building. Load applied on the building are exchanged to the auxiliary framework and they thusly should be exchanged through the establishment into the ground, the size of the wind weight is an element of uncovered essential wind speed, topography, building tallness, inner weight, and state of the structures.

C. Objectives of the Study

The present proposition work is figuring and assessing nonexistent RC Framed structure wt considering the accompanying outlined targets.

- To study the conduct of structures because of seismic zones, wind designs and joined impact of both wind and seismic zones.
- Determination of variety in rate of steel from zone to zone.
- Determination of removal subjected to wind, quake and joined impact of both.
- To decide the base shear of structures at various wind and seismic zones.

II. Analytical Modeling and Methodology

A. Description of Sample Building

In this building, symetric models has been taken for all cases. The building has been divided into 3 categories:-

- Models with seismic zones
- Models with wind patterns
- Models with both wind & seismic zones

1) Model 1: Building does not have any masonry wall only gravity load is applied to the model

2) Model 2: seismic load is applied considering zone 2
3) Model 3: seismic load is applied considering zone 3
4) Model 4: seismic load is applied considering zone 4
5) Model 5: seismic load is applied considering zone 5
6) Model 6: wind load is applied considering zone 1
7) Model 7: wind load is applied considering zone 2
8) Model 8: wind load is applied considering zone 3
9) Model 9: wind load is applied considering zone 4
10) Model 10: wind load is applied considering zone 5
11) Model 11: wind load is applied considering zone 6
12) Model 12: Load is applied considering seismic zone 2 & wind zone 3
13) Model 14: Load is applied considering seismic zone 3 & wind zone 4
14) Model 15: Load is applied considering seismic zone 4 & wind zone 5
15) Model 16: Load is applied considering seismic zone 5 & wind zone 6

Numerous codal procurements on seismic and wind examination recommend that an investigation strategy relies on whether the building is customary or unpredictable fit as a fiddle. A large portion of the norms recommends the selection of direct static investigation for symmetrical structures and a portion of the unpredictable kind of structures. If there should arise an occurrence of sporadic building the codal principles endorses the appropriation of element examination strategy.

B. *Design Data*

1) *Material Properties*

- Young's modulus of (M30) concrete, E = 27.386x106 kN/m²
- Young's modulus of (M20) concrete, E = 22.360x106 kN/m²
- Density of Reinforced Concrete = 25kN/m³
- Assumed Live load = 4 KN/m2
- Assumed Floor finish = 1KN/m2

2) *Member Properties*

- Thickness of slab = 0.15m
- Column size (G+2) =0.30 x 0.60m
- Column size (remaing) =0.23 x 0.6m
- Beam size = 0.3 x 0.45m
- Thickness of wall =0.230m
- Type of structure =RCC framed structure
- Floor to floor height =3.5m
- Plinth height =2m
- Type of soil = Medium
- Seismic zones considered =2, 3, 4 & 5
- Wind zones considered =1,2, 3, 4 ,5&6

The layouts prepared for the study are shown on below figures.

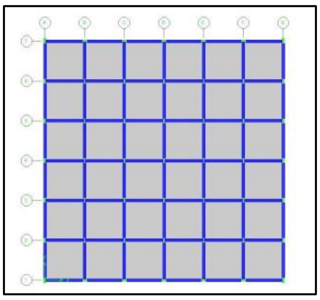

Fig. 1: Layout plan for 7 storyed building

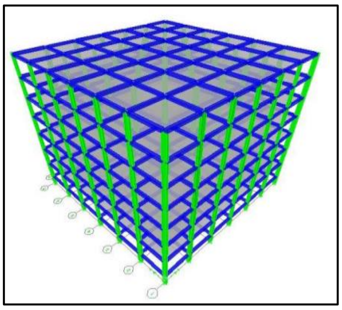

Fig. 2: 3D model of 7 storeyed Building

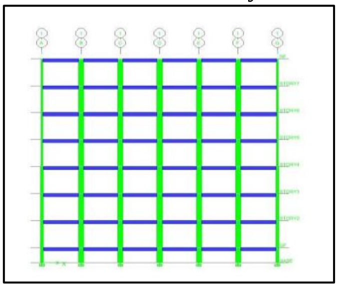

Fig. 3: Model elevation of 7 storeyed Building

III. RESULTS AND OUTCOMES

The following work carried out to study the percentage variation of steel in different seismic zones & wind zones of India by considering the combined effect. The study also includes various parameters which are studied such as base shear. The overall study is conducted by applying the all four seismic zones separately and wind zones separately and later on both zones been combined. In the present work fifteen symmetrical building models are used.

A. *Percentage of Steel*

Location of column	Gravity load	Zone2	Zone3	Zone4	Zone5
Outer column	0.8	0.8	0.8	0.8	0.8
Side column$_1$	1.04	1.04	1.04	1.22	1.78
Side column$_4$	1.03	1.03	1.03	1.32	1.93
Centre column	3.32	3.32	3.32	3.32	3.32

Table 1: Reinforcement percentage in columns for seismic zones

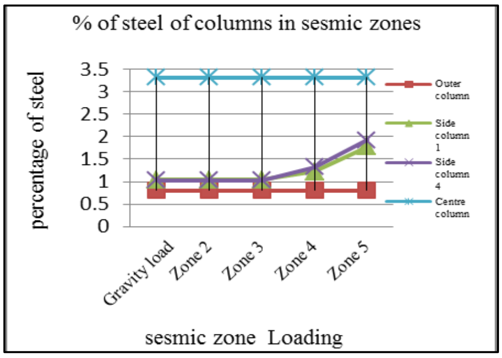

Fig. 4: Variation in reinforcement percentage in columns for seismic zones.

Location of column	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6

Outer column	0.8	0.8	0.8	0.8	0.8	0.8
Side column$_1$	1.04	1.04	1.04	1.04	1.04	1.04
Side column$_4$	1.03	1.03	1.03	1.03	1.03	1.25
Centre column	3.32	3.32	3.32	3.32	3.32	3.32

Table 2: Reinforcement Percentage in columns for wind zones

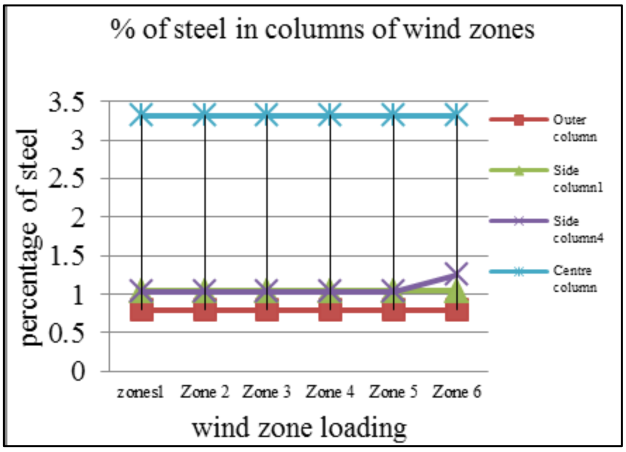

Fig. 5: Variation in reinforcement percentage in columns for wind zones.

Location of column	E2&W3	E3&W4	E4&W5	E5&W6
Outer column	0.8	0.8	0.8	0.8
Side column$_1$	1.04	1.04	1.22	1.787
Side column$_4$	1.03	1.03	1.32	1.32
Centre column	3.32	3.32	3.32	3.32

Table 3: Reinforcement Percentage in columns for combined zones of seismic & wind.

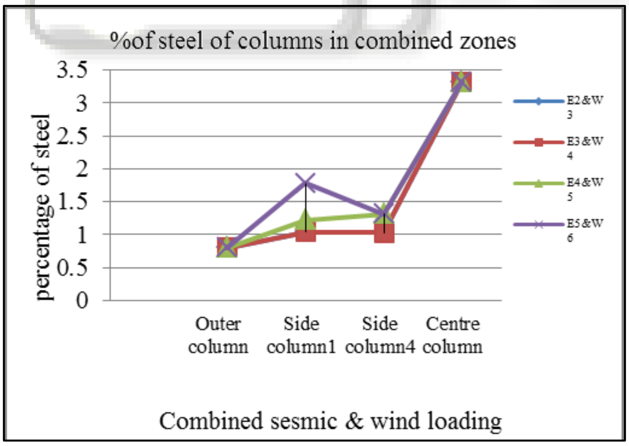

Fig. 6: Variation in reinforcement percentage in Columns for combined zones of seismic & wind.

Location of Beam	Gravity load	Zone 2	Zone 3	Zone 3	Zone 4
External beam	0.35	0.52	0.68	0.91	1.18
Internal beam	0.63	0.62	0.78	0.95	1.18

Table 4: Reinforcement Percentage in Beams for seismic zones.

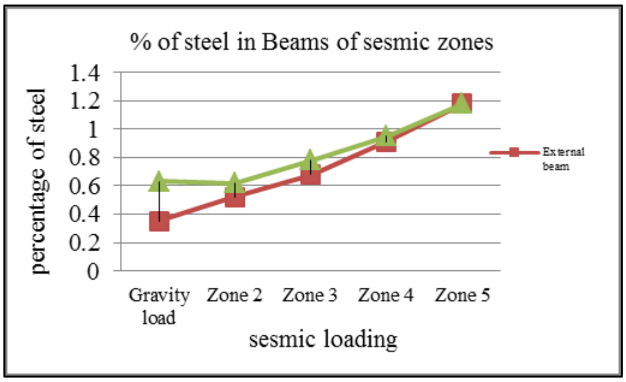

Fig. 7: Variation in reinforcement percentage in Beams for seismic zones

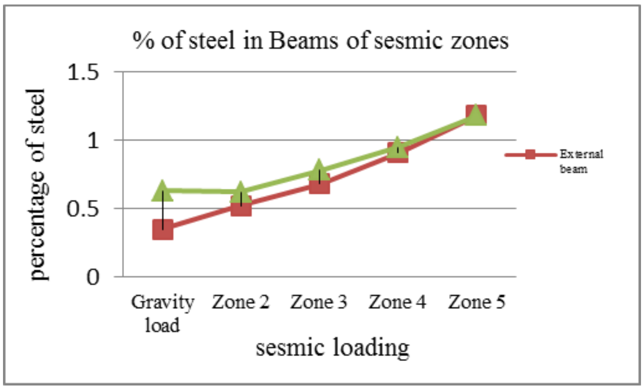

Fig. 8: Variation in reinforcement percentage in Beams for seismic zones

Location of Beam	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
External beam	0.47	0.55	0.63	0.69	0.76	0.88
Internal beam	0.63	0.67	0.74	0.79	0.84	0.93

Table 5: Reinforcement Percentage in Beams for wind zones

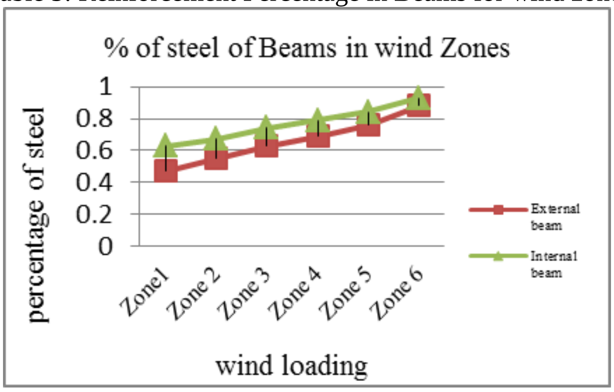

Fig. 8: Variation in reinforcement percentage in Beams for wind zones.

Location of BEAM	E2&W3	E3&W4	E4&W5	E5&W6
External beam	0.63	0.69	0.91	1.18
Internal beam	0.74	0.796	0.95	1.18

Table 6: Reinforcement Percentage in columns for combined zones of seismic & wind.

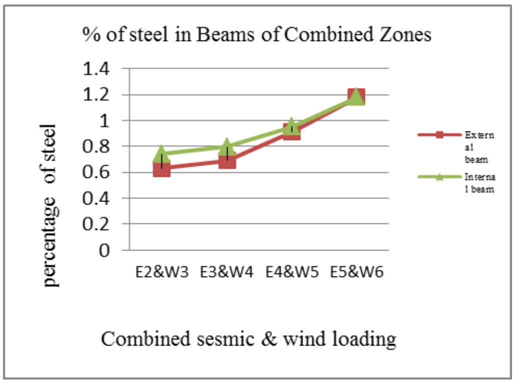

Fig. 9: Variation in reinforcement percentage in columns for combined zones of seismic & wind.

B. Base Shear

The base shear is the total lateral force design at the base of the building. The base shear is calculated depending on the vibration period of the building.

Base shear of seismic zones (KN)	
Model-1	Fx =00
	Fy =00
Model-2	Fx =523.76
	Fy =617.63
Model-3	Fx =838.02
	Fy =988.21
Model-4	Fx =1257.03
	Fy =1482.32
Model-5	Fx =1885.55
	Fy =2223.47

Table 7: Base Shear values with X and Y direction in seismic zones.

Base shear of wind zones (KN)	
Model-6	459.66
Model-7	642.01
Model-8	817.18
Model-9	932.41
Model-10	1055.24
Model-11	1276.84

Table 8: Base Shear values with X and Y direction in wind zones.

Base shear of both seismic zones and wind zones (KN)		
Model-12	Seismic Zone-2	Fx=523.76
		Fy=617.63
	Wind Zone-3	Fx=817.18
		Fy=817.18
Model-13	Seismic Zone-3	Fx=838.02
		Fy=938.21
	Wind Zone-4	Fx=932.41
		Fy=932.41
Model-14	Seismic Zone-4	Fx=15.46
		Fy=35.45
	Wind Zone-5	Fx=12.87
		Fy=25.28
Model-15	Seismic Zone-5	Fx=23.19
		Fy=53.17
	Wind Zone-6	Fx=15.57
		Fy=30.59

Table 9: Base Shear values with X and Y direction in combined seismic wind zones.

IV. CONCLUSIONS

- The total variation in percentage steel in columns for all the case for seismic zones increases mainly in side columns of front elevation and and middle elevation with zone to zone.
- The total variation in percentage steel in beams for all the case for seismic zones increases (0.35%-1.18%) for external beams & (0.63%-1.18%) for internal beams with zone to zone.
- The total variation in percentage steel in columns for all the case for wind zones increases mainly in side columns of front elevation and and middle elevation with zone to zone.
- The total variation in percentage steel in beams for all the case for seismic zones increases (0.47%-0.88%) for external beams & (0.63%-0.93%) for internal beams with zone to zone.
- The total variation in percentage steel in columns for all the case for combined zones increases mainly in side columns of front elevation and and middle elevation with zone to zone.
- The total variation in percentage steel in beams for all the case for seismic zones increases (0.63%-1.18%) for external beams & (0.74%-1.18%) for internal beams with zone to zone.
- In analysis the structure may not show the proper displacement and drift values if the total building weight is very high.
- In analysis if grade of concrete increases the area of reinforcement decreases.
- The reinforcement percentage in edge and interior columns are more compare to exterior columns.
- The percentage reinforcement in internal beams are more compare to external beams.
- In case of beams, the reinforcement percentage in bottom middle portion is same in all cases.
- The base shear in all the cases i.e. seismic, wind and combined. Increases as the zone loading increase.
- The displacement of structures is same in both X and Y direction and increased as the seismic zone wind zones and combination zone loading is applied.
- The drift of the structures is same in both X and Y direction and increased as the seismic zone & wind zone increase but there is bit noticeable variation can be seen in the combination models.
- The moments in building increases gradually according to seismic zones, wind zones and combination zones.

V. SCOPE OF FUTURE WORK

This study is directed by considering symmetrical structures and in plane ebb and flow, facilitate the study can be made on unsymmetrical structures and in bumpy and slant grounds with shear dividers, skimming sections furthermore by expanding the no of stories . In this study the bracings are not considered, in this manner consideration of various sorts of bracings can enhance the grasp on subject. Further brick work divider with n without infill's, center divider can likewise be utilized for the examination. The present study can be enhanced if composite structure marvel is utilized. The pliability proportion can like wise be ascertained as it results in the general conduct of structure. The other kind of examination other than equal investigation, for example, non-direct static, non-element can likewise be connected.

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