Study of Displacement and Lateral Load Variation of RC Frame Building in different Seismic Zones

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Abstract: **When the structure is affected to seismic activity the seismic waves can be affecting in three mutually perpendicular directions, two horizontal and one vertical direction. By this the structure starts to vibrate in all the three directions. The main direction the seismic waves affect the structure is from the horizontal direction. It is essential to consider the lateral load for designing the reinforced concrete frames especially in tall structures. Designing buildings are to behave like elastically during earthquakes without damaging the building. The project is done on the reinforced concrete building and it is analyzed for various zone factors keeping the soil medium and other required data constant.**

KEYWORDS**- Seismic Zones, Displacement, Lateral Load.**

I. INTRODUCTION

The seismic zones are mainly classified into four different zones from zone II, zone III, zone IV and zone V. Zone V has the areas of having the highest risks zone which suffers maximum earthquake intensities andhaving 0.36 zone factor.The zone IV is called as high damage risk region and having 0.24 zone factor. Zone III is categories as moderate damage risk region and the code assigned is 0.16. Zone II categories as low damage risk region it is assigned as 0.1. The structural designers will use these factors as earthquake resistant while designing the structures.

II. A] DIFFERENT SEISMIC ZONES IN INDIA:

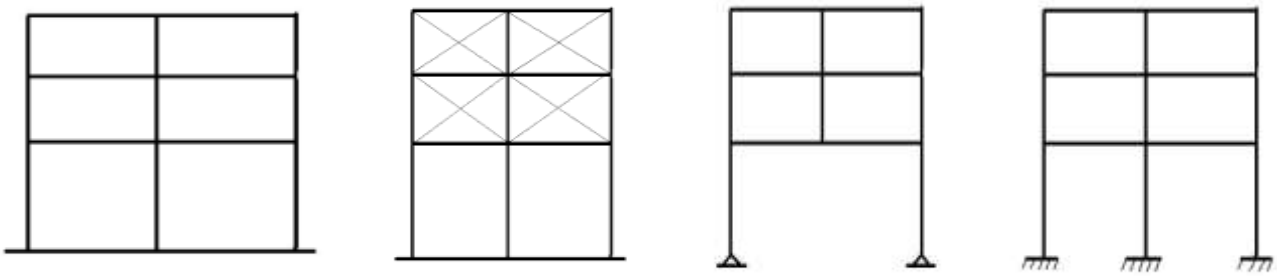
Based on the intensity of the earthquake which is happened in the previous time, the zones are revised from time to time and the new codes are added to it. Previously, there were V seismic zones in India that were used; later zone I is merged with the zone II. Therefore, zone I will not be used while designing the structures.

Fig 1.1: Seismic Zones in India

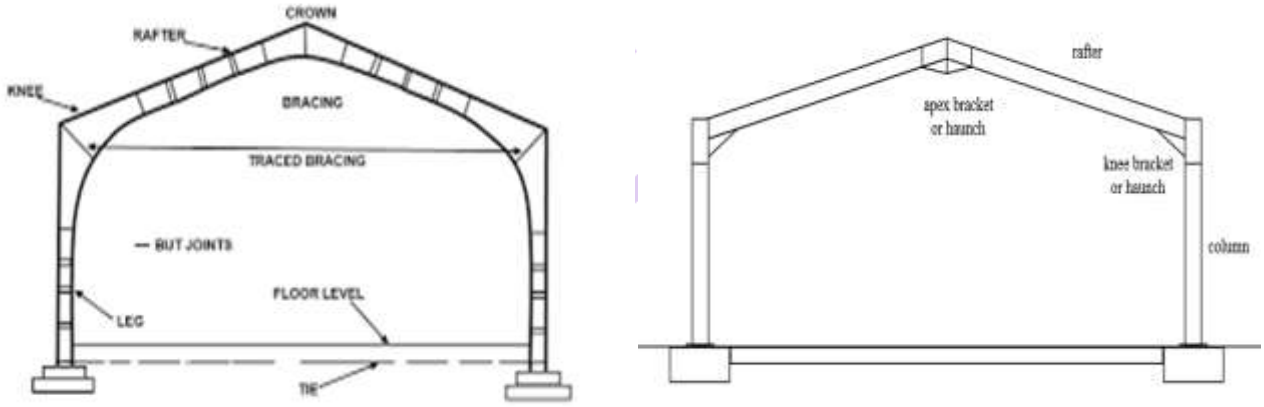
B] TYPES OF RC FRAMES:

1. Rigid Frames: These are assembled with the members which are interconnected mostly by rigid connections which will later resist the movement.
2. Braced Frames: Mainly composed of steel bracing connections, they designed primarily to resist the wind load and the seismic forces. These types of frames are developed to work in tension and compression of a truss.
3. Pin Ended Frame: These are the type of frames in which the members of the columns are connected by pins and are considered as non-rigid if they would collapse then the supports are removed.

4. Fix Ended Frame: These are the type of structures in which the frames are generally used and ends are fixed to the ground.
5. Gabbled Frame: These types of framed structures which are similar to the tail rafter and the bottom sides of the rafter are slightly heavy when compared to top side of the rafter, mainly found in region with heavy rainfall.
6. Portal Frame: These methods which are used in the construction using steel or prefabricated steel and reinforced concrete. The connections between the columns and frames are deigned to resist the moments.



Rigid **Braced** **Pin-Ended** **Fixed**



Gabbled **Portal**

Fig 1.2: Types of Frames

C] RESPONSE SPECTRUM METHOD:*IS 1893 (part 1):2002*
Dynamic analyses are implemented in the design seismic force for the various levels among the height of the building. the base shear value and calculated using the fundamental period. If the base shear values are less than the design base shear value then all the response quantities should be multiplied by the values which are obtained from the base shear and design base shear value. The reduction values for the building are taken as 2 and 5 percent which are critical for the purpose of the dynamic analysis for reinforced concrete and steel buildings respectively.

1. Regular Buildings: For these types of buildings, the height should be greater than 40m which are located in zone IV and zone V regions and for those buildings whose height is greater than 90m then it should be located in zone II or zone III regions.

2. Irregular Buildings: For these types of buildings, the height should be greater than 12m then it should be located in zone IV or zone V regions and for the buildings whose height is greater than 40m then it should be located in zone II or zone III regions.

III FACTORS USED TO DETERMINE THE SEISMIC COEFFICIENT:
1. Zone Factors, Z: This factor is used to obtain in the design seismic force depending upon the functional use of the structure. The zone factors which are included in this standard are reasonable for the estimate of effective ground acceleration.

Table 1.1: List of Zones Factor

Zones	Intensity	Zone Factor
Zone II	Least Active Seismic Zone	0.1
Zone III	Moderate Seismic Zone	0.16
Zone IV	High Seismic Zone	0.24
Zone V	HighestSeismic Zone	0.36

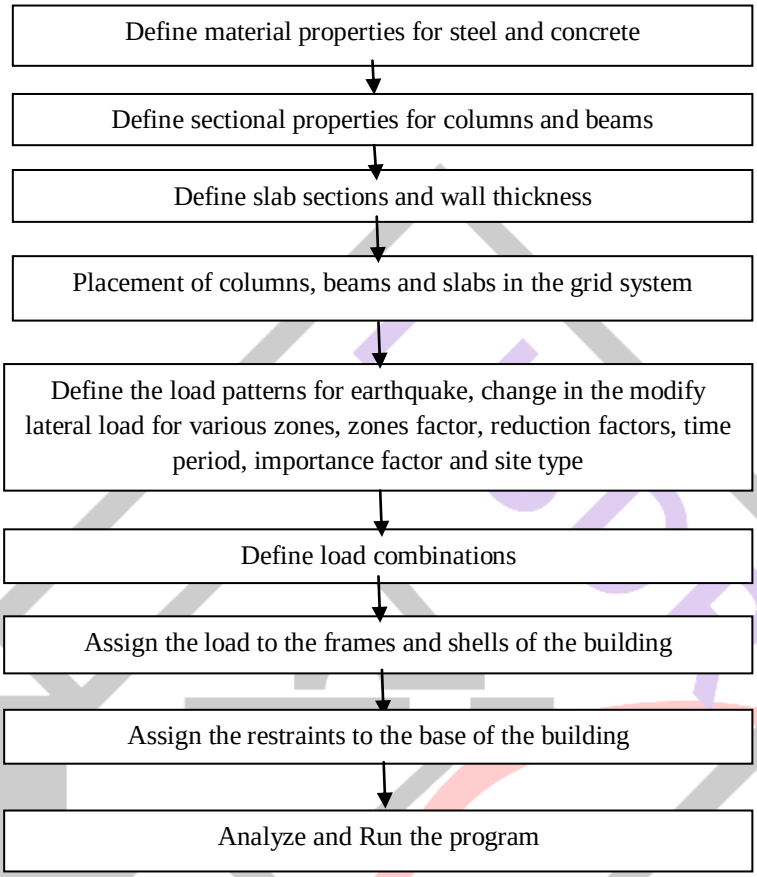
2. Importance Factor, I: It is used to obtain from the design loads for building and other structures and it is based on the occupancy of the category. It is used to calculate flood, wind, snow, earthquakes and ice loads etc., the importance factor can be used as a multiplier that increases or decreases the base design loads.

3. Response Reduction Factor, R: The factor caused due to reflect the ability of the structure to be the elastic behavior. This depends on the seismic damage of the structure characterized by ductile deformation.
4. Average Response Acceleration Coefficient, S_a/g: According to IS 1893 (part 1): 2002, the seismic activity depends on the area of zone factor and the average coefficient acceleration of the soil response and it will reorganize depends upon the type of foundation.

IV. OBJECTIVES OF THE PROJECT

1. Analysis of RC frame building by for all the earthquake zones.
2. Comparison of the models for different parameters like lateral load and storey displacementby developing graphs and tables.

V. METHODOLOGY



Steps for Methodology:

1. Modeling Phase
2. Analysis Phase (Response spectrum)

1. Modeling Phase

It is stage to analyze properly whether the building is comes in which seismic zone before constructing. The present study has been planned to check for the same height of the building comes for the various seismic zones and has been analyzed using etabs software.

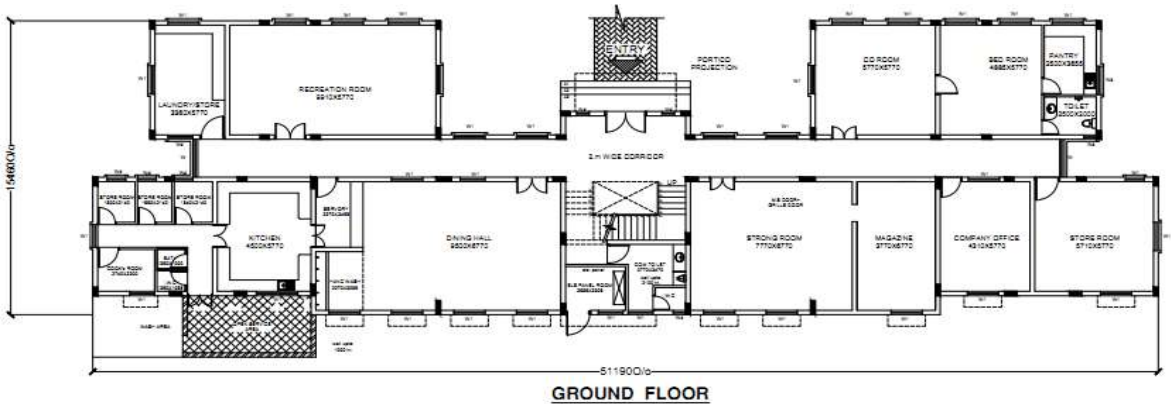


Fig 1.3: Architectural plan of ground, first, typical, fourth floor

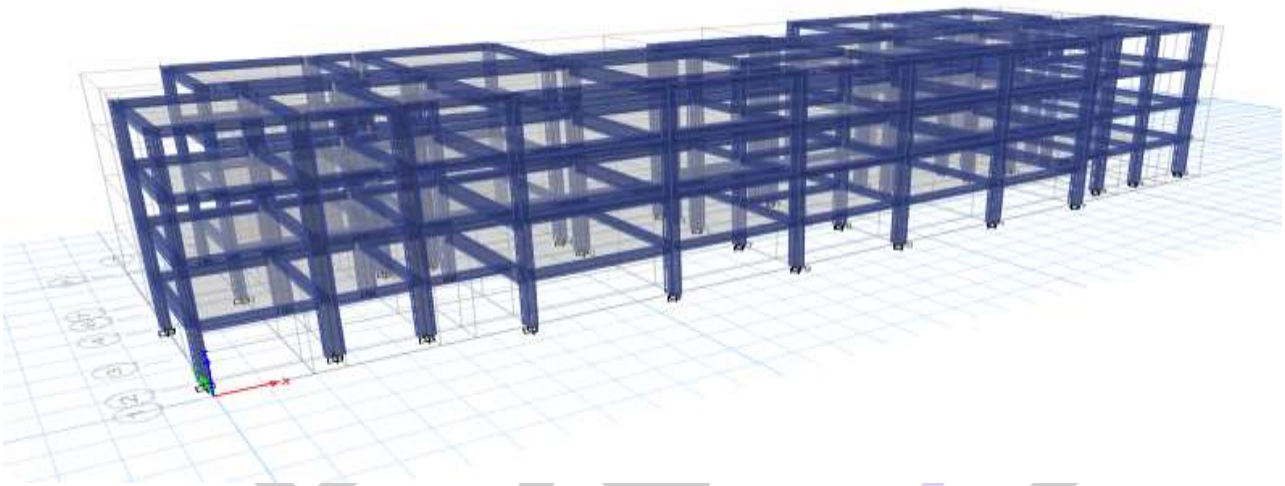


Fig 1.4:Modeling and Extrudified view of the Building

2. Analysis Phase

In this phase the Loads which are applied on slabs and frames are analyzed by using E-tabs software. In this phase, all bending moment, Shear Force, axial forces are obtained at each and every point of element and also its maximum value. Following data should be considered for the analysis of this Structure

- Gravity Analysis Data –
  - Live Load – 2 KN/Sqm (On Slabs)
  - Floor Finish Load – 1 KN/Sqm (On Slabs)
  - Partition Wall Load – 1 KN/Sqm (On Slabs)
  - Peripheral Wall Load – 5 KN/m (On Beams)
  - Bearing Capacity of Soil – 250 KN/Sqm
- Seismic Analysis Data -
  - Zone Factor = Z = 0.10
  - Type Of Soil = Hard Soil
  - Period = Program calculated
  - Importance Factor = I = 1.0
  - Response Reduction Factor = R = 3.0

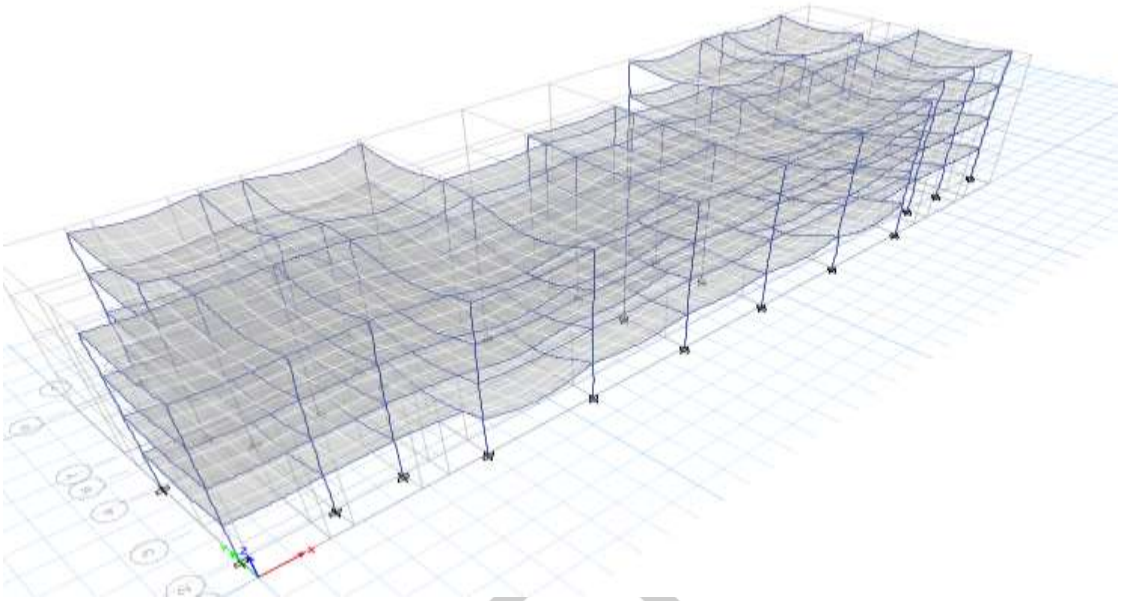


Fig1.5:Deformed shape of the structure

VI RESULTS:

A] DISPLACEMENT: Displacement is the critical factor considered in dynamic analysis for any multistory building;it is also called as drift due to lateral loads occurring in the building. In the present study from different zonal conditions drift have been evaluated by using ETABS.

Table 1.2: Displacement (mm) Values in X-Axis

Storey	Zone II	Zone III	Zone IV	Zone V
Base	0	0	0	0
Storey 1	2.5	4.2	6.1	11.2
Storey 2	6.5	11	15.8	29.1
Storey 3	10	16.9	24.3	44.8
Storey 4	12.3	20.9	30.1	55.4

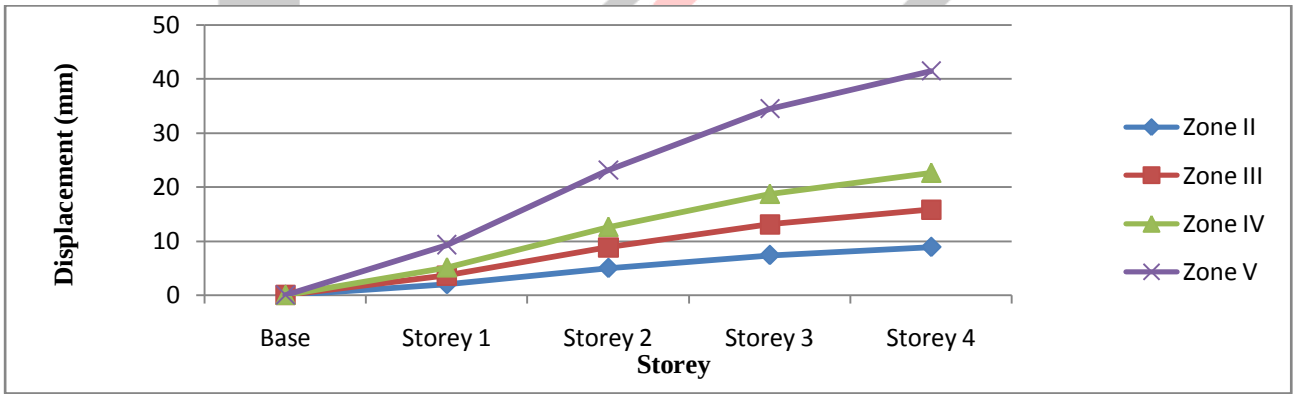


Fig 1.6: Displacement in X-direction for different zones

Table 1.3: Displacement (mm) Value in Y-Axis

Storey	Zone II	Zone III	Zone IV	Zone V
Base	0	0	0	0
Storey 1	2.5	4.2	6.1	11.2
Storey 2	6.5	11	15.8	29.1
Storey 3	10	16.9	24.3	44.8
Storey 4	12.3	20.9	30.1	55.4

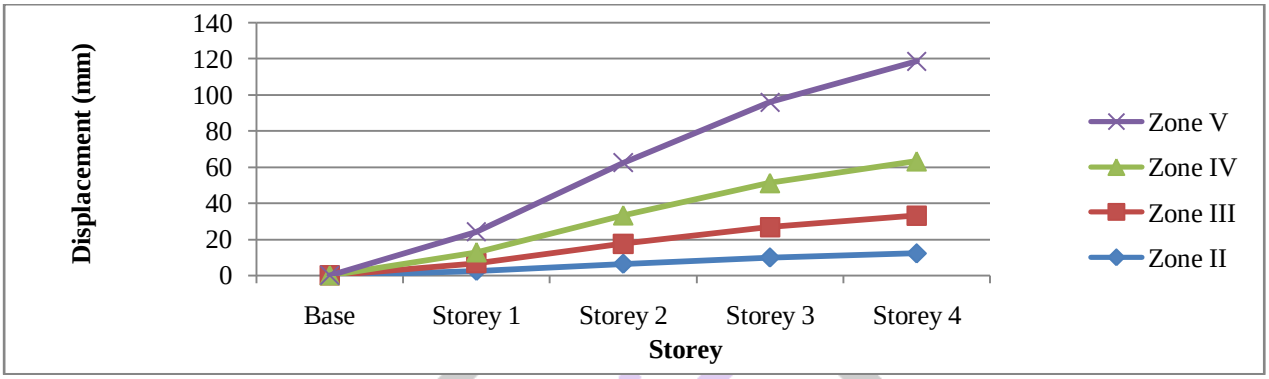


Fig 1.7: Displacement in Y-direction for different zones

- **DISCUSSIONS:** From the above tabular columns, the maximum values for X & Y - direction for all the regions is taken and mentioned separately in the above table and the graph is plotted and it is seen that, the displacements will be more as the height of the building increases and the displacements will be vary more from zone II to zone V. The displacement increases from base to storey. The obtained displacement vales are within the limitations prescribed by Bureau of Indian Standards.

B]LATERAL LOADS: Lateral loads may be considered as earthquake loading from different directions. In the present study these lateral loads have been considered in the analysis for different zones for the building and results are obtained.

Table 1.4: Lateral Load (kN) to the Storey's for various Zones

Storey	Zone II	Zone III	Zone IV	Zone V
Base	0	0	0	0
Storey 1	36.5296	52.4005	78.6007	117.9011
Storey 2	145.9575	210.6435	315.9562	473.9479
Storey 3	329.7477	476.0181	714.0271	1071.041
Storey 4	558.2748	801.5411	1202.312	1803.468

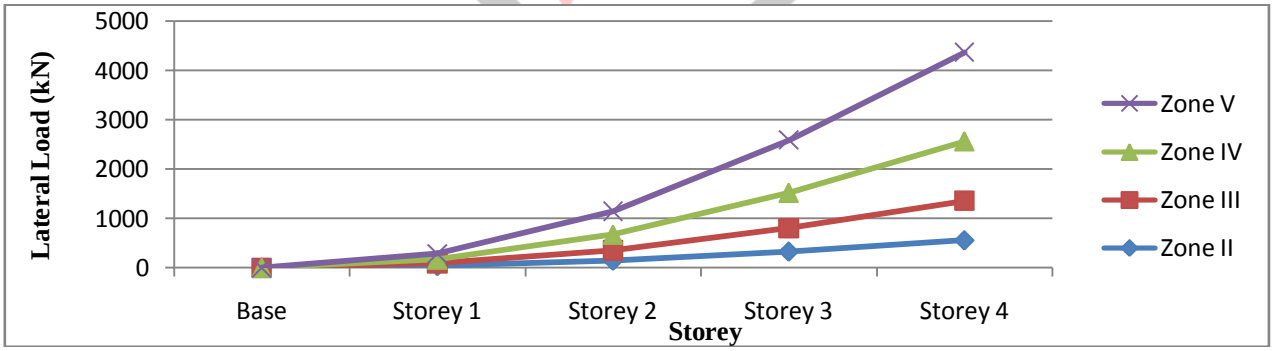


Fig 1.8: Lateral Load to the Stories for Different Zones

- **DISCUSSIONS:** The lateral load occurs to all the storeys from base to storey 4, as the number of storey's increases from bottom to top the lateral load also increases. The lateral load varies from zone II to zone V.

VIICONCLUSION:

The present study can conclude the displacement and lateral load parameters in the different zone are considered with RC Framed structure and the conclusions are given below,

1. The displacement of the building is high at the top floor and low at the bottom. The displacement of the building increases as the seismic zone factor increases.

2. The lateral load is low at the base of the building as the number of stories increases the lateral load also increases. The lateral load is increased as the zone factor increases.
3. From the models it is seen that the values for the bending moments and the shear force in the region zone 2, zone 3 and zone 5 are comparatively less when compared to the zone 4 region.

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