# SEISMIC ANALYSIS AND DESIGN OF MULTISTOREY BUILDING IN DIFFERENT SEISMIC ZONES BY USING ETABS

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**Abstract -** *In India, multi-storied buildings area unit sometimes created because of high value and deficiency of land. Earthquake could be a phenomenon which might generate the foremost harmful forces on structures. Buildings ought to be created safe for lives by correct style and particularisation of structural members so as to possess a ductile sort of failure. To protect such civil structures from significant structural damage, the seismic response of these structures is analyzed along with wind force calculation and forces such as support reactions and joint displacement are calculated and included in the structural design for a vibration resistant structure. The primary objective is to make associate earthquake resistant structure by enterprise seismal study of the structure by static equivalent methodology of study and do the analysis and design of the building by using E-TABS software in both static and dynamic analysis. For this purpose, a G+10 residential building plan is considered. Seismic calculations are conducted for earthquake zone II, III, IV and V. The structural safety of the building is ensured by calculating all acting loads on the structure, including the lateral loads caused due to wind and seismic excitation.*

**Key Words: Base shear, displacement, story shear, story drift**

## 1. INTRODUCTION

### 1.1 EARTHQUAKE RESISTANT STRUCTURES

Earthquake-resistant structures are structures designed to protect buildings from earthquakes. While no structure can be entirely immune to damage from earthquakes, the goal of earthquake resistant construction is to erect structures that fare better during seismic activity than their conventional counterparts.

### 1.2 EARTHQUAKE ZONES OF INDIA:

The earthquake zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5) unlike its previous version, which consisted of five or six zones for the country. According to this partitioning map, Zone five expects the best level of seismicity whereas Zone a pair of is related to the bottom level of seismicity. Each zone indicates the results of Associate in Nursing earthquake at a specific place supported the observations of the affected areas and may even be represented employing a descriptive scale like Medvedev–Sponheuer–Karnik scale, could be a macro unstable intensity scale wont to valuate the severity of ground shaking on the idea of discovered effects in a part of the earthquake occurrence.

ZONE 5: Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity MSK IX (Destructive) or greater. The IS code assigns zone issue of zero.36 for Zone 5. Structural styleers use this issue for earthquake resistant design of structures in Zone five. The zone issue of zero.36 is indicative of effective (zero periods) level earthquake in this zone. It is mentioned because the terribly High injury Risk Zone.

ZONE 4:This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII (Damaging). The IS code assigns zone factor of 0.24 for Zone 4 at Jammu and Kashmir, Himachal Pradesh, Uttarakhand.

ZONE 3:This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII (very strong). And The IS code assigns zone factor of 0.16 for Zone 3.

ZONE 2:This region is liable to MSK VI (strong) or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of 0.10.

Fig 1.1 seismic zones at different areas in India

In this project, we are going to compare base shear, displacement, drift at different seismic zones by static and dynamic analysis.

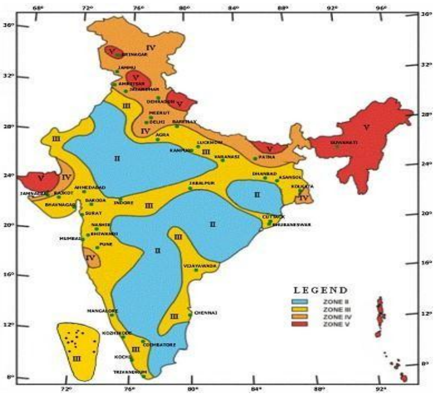



Fig 1.1 seismic zones at different areas in India

### 1.3 WIND

Wind could be a perceptible natural motion of air relative to earth surface, particularly within the sort of current of air processing in a very explicit direction. Wind blows with less speed in rough piece of ground and better speed in swish piece of ground. Terrain during which a particular structure stands shall be assessed as being one in all the subsequent piece of ground categories-

Category 1-Exposed open terrain with few or no obstructions and in which the average height of any object surrounding the structure is less than 3mts.

Category 2- Open terrain with well scattered obstructions having heights generally between 3mts to 10mts.

Category 3-Terrain with varied closely spaced obstructions having a size of building structures up to 10mts height with or while not a number of isolated tall structures.

Category 4 -Terrain with numerous large heights closely spaced obstructions.

### 1.4 SEISMIC ANALYSIS OF STRUCTURES

The seismic analysis ought to be dispensed for the buildings that have lack of resistance to earthquake forces. Seismic analysis can take into account dynamic effects thence the precise analysis typically become complicated. However, for simple regular structures equivalent linear static analysis is sufficient one, this type of analysis is carried out for regular and low-rise buildings. Seismic analysis of multi-storey building will be carried out for the building as specified by the code IS 1893-2002 (part 1). Dynamic analysis carried out either by response spectrum method or time history analysis method. The different analysis procedures are:-

i. Linear Static Analysis

ii. Linear Dynamic Analysis

iii. Non-Linear Static Analysis

iv. Non-Linear Dynamic Analysis

### 1.5 OBJECTIVES OF THE STUDY

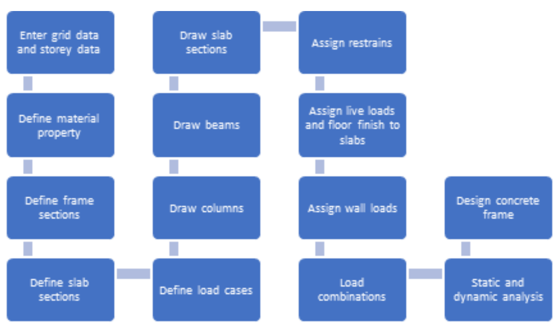
The objective of the present work is to study the seismic analysis and design of a multi-storeyed building(G+10) asymmetrical in plan, under earthquake load by adopting static analysis method to evaluate storey drift and displacements and other comparisons at zone II, III, IV and V.

Analysis of structure using static method and finding out maximum bending moment, drift at support, base shear, stiffness and shear force to understand the basic principles of structures by using Indian Standard Codes to understand the parameters of the design for beams, columns, slabs and other structural components to prepare the 3D model of the structure by using the E-TABS Software for detailed analysis and design how the seismic evaluation of a building should be carried out to study the behaviour of a building under the action of seismic loads and wind loads to compare various analysis results of building under zone II, III, IV and V using ETABS Software.

### 1.6 SCOPE OF THE STUDY

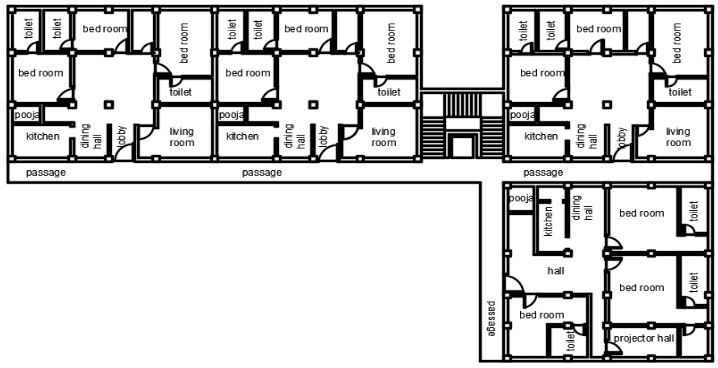
Based on project, study was undertaken with a view to determine the extent of possible changes in the seismic behaviour of multi-storey Building Model. The study highlights the effect of seismic zone factor in different zones that is in Zone II, III, IV and V which is considered in the seismic performance evaluation of buildings. The study emphasis and discusses the effect of seismic zone factor on the seismic performance of G+10 building structure. The entire process of modelling, analysis and design of all the primary elements for all the models are carried by using ETABS 15 version software.

### METHODOLOGY:




### 2 SPECIFICATIONS OF A BUILDING:

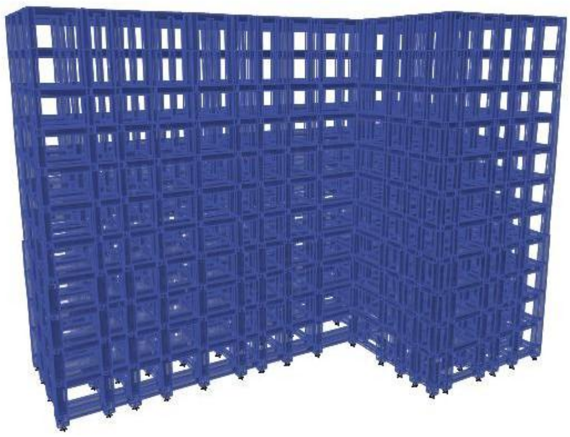
### 2.1 DEVELOPMENT OF PLAN IN AUTOCAD




### 2.2 BUILDING PROPERTIES

| Particulars | VALUES | Particulars | VALUES |
|---|---|---|---|
| Type of building | Multi-storey building | Size of Columns | 650 X 900 mm, 500 X 600 mm,450 mm X 450 mm |
| Plan dimension | 37 m X 24 m | Thickness of slab | 160 mm |
| Total height of building | 33m | Thickness of walls | 300mm |
| Height of each storey | 3m | Seismic Zone | V, IV, III, II |
| Size of beams | 350 X 600 mm,250 mm X 300 mm | Soil Condition | Type III |
| concrete grade | M30, M40 | Built-up area | 800 sq.m |

**Model generated in ETABS window:-**



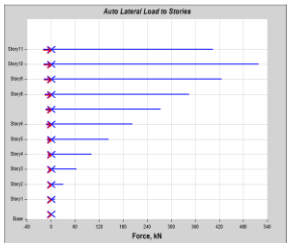
**STATIC ANALYSIS RESULTS**

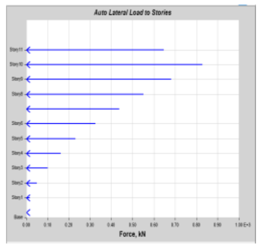
Lateral forces(kN) to stories for different seismic zones

| Zone | II | | III | | IV | | V | |
|---|---|---|---|---|---|---|---|---|
| Storey | X | Y | X | Y | X | Y | X | Y |
| 11 | 403.5 | 0 | 646.1 | 0 | 969.1 | 0 | 1134.5 | 0 |
| 10 | 518 | 0 | 829 | 0 | 1243.3 | 0 | 1455.4 | 0 |
| 09 | 425.4 | 0 | 681.3 | 0 | 1022 | 0 | 1196.3 | 0 |
| 07 | 273.3 | 0 | 437.4 | 0 | 656 | 0 | 768 | 0 |
| 05 | 144.1 | 0 | 230.9 | 0 | 346.8 | 0 | 405.3 | 0 |
| 03 | 63.2 | 0 | 101.7 | 0 | 152.1 | 0 | 178.7 | 0 |
| 01 | 10.1 | 0 | 16.6 | 0 | 24.50 | 0 | 28.5 | 0 |
| Plinth | 0.230 | 0 | 0.3689 | 0 | 0.553 | 0 | 0.64 | 0 |
| Base | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 9.1 Lateral Forces in Different Seismic Zones by Static Analysis

Graphs of lateral forces in various seismic zones in X and Y directions



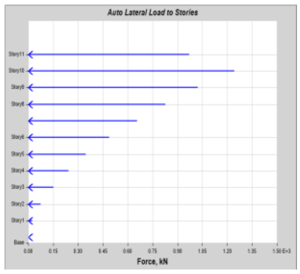




ZONE-II (X) Fig 9.1 lateral load at Zone 2(X) by Static Analysis

Fig 9.3 lateral Load at Zone 3(X) by Static Analysis

ZONE-IV (X)

ZONE-V(X)



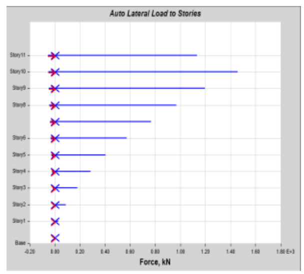




Fig 9.5 Lateral load at Zone 4 (X) by Static Analysis

Fig 9.7 Lateral Load at Zone 5 (X) by Static Analysis Storey Displacement (mm) at different seismic

| Zone | II | | III | | IV | | V | |
|---|---|---|---|---|---|---|---|---|
| Storey | X | Y | X | Y | X | Y | X | Y |
| 11 | 23.2 | 26.8 | 37 | 42.4 | 55.3 | 63 | 64.7 | 71 |
| 10 | 22.4 | 25.6 | 35.7 | 40.6 | 53.3 | 60 | 62.4 | 68.1 |
| 07 | 16.7 | 18.8 | 26.6 | 29.9 | 39.9 | 44 | 46.6 | 50.2 |
| 05 | 12 | 13.4 | 19.1 | 21.2 | 28.7 | 31 | 33.5 | 35.7 |
| 03 | 7.2 | 7.9 | 11.5 | 12.6 | 17.2 | 18 | 20.1 | 21.2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 02 | 4.9 | 5.4 | 7.9 | 8.6 | 11.8 | 12 | 13.9 | 14.5 |
| Base | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 9.2 Displacement in Different seismic zones by Static Analysis

Graphs of Displacement in various seismic zones by static analysis

ZONE-II ZONE-III

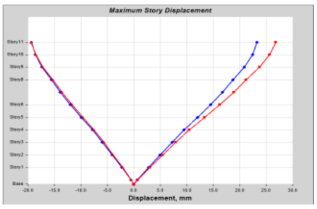



Fig 9.9 Displacement at Zone 2 by Static Analysis

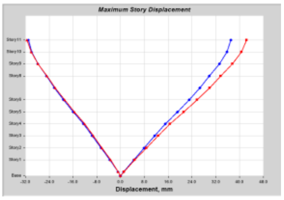



Fig 9.10 Displacement at Zone 3 by Static Analysis

ZONE-IV ZONE-V

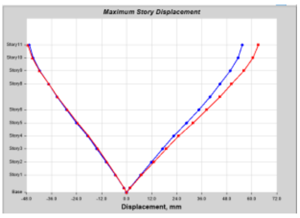



Fig 9.11 Displacement at zone 4 at by Static Analysis

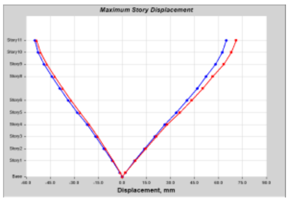



Fig 9.12 Displacement zone 5 by Static Analysis

ii.Storey Drift for different seismic zones

| Zones | II | | III | | IV | | V | |
|---|---|---|---|---|---|---|---|---|
| Storey | X | Y | X | Y | X | Y | X | Y |
| 11 | 0.00028 | 0.00038 | 0.00044 | 0.00059 | 0.00066 | 0.00086 | 0.00098 | 0.00127 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 08 | 066 | 079 | 0.00106 | 0.00124 | 158 | 184 | 236 | 275 |
| 05 | 0.00085 | 0.00097 | 0.00136 | 0.00154 | 0.00204 | 0.00230 | 0.00306 | 0.00344 |
| 03 | 0.00074 | 0.00083 | 0.00119 | 0.00132 | 0.00178 | 0.00198 | 0.00267 | 0.00296 |
| Base | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 9.3 Storey Drift values in Different Seismic Zones by Static Analysis

Graphs of Storey Drifts in various seismic zones

ZONE-II ZONE-III

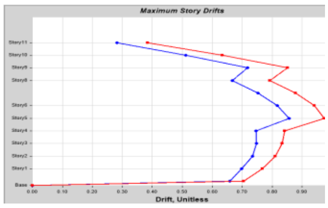



Fig 9.13 Storey Drift at zone 2 by Static Analysis

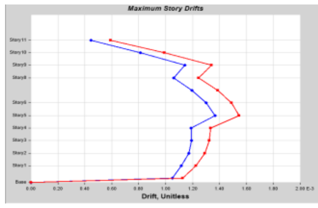



Fig 9.14 Storey Drift at zone 3 by Static Analysis

ZONE-IV ZONE-V

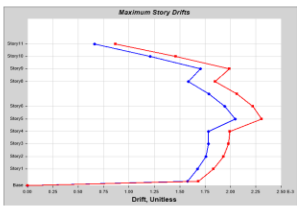



Fig 9.15 Storey Drift in Zone 4 by Static Analysis

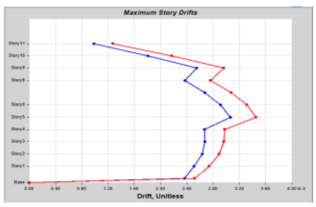



Fig 9.16 Storey Drift in Zone 5 by Static Analysis

## CONCLUSIONS:

1. From Static Analysis the base shear of structure increases as we go to higher seismic zones. For a similar building the

base shear value of ZONE II is 2520 KN and ZONE V is 9072 KN. This means base shear increases by more than 27.7% if seismic ZONE changes from II to V.

2. From Static Analysis the displacement of building models increases with the increasing of seismic Zones. The displacement is very high at roof and very low at the base. The displacement occur at the ZONE II is 23 mm and ZONE V is 64 mm. This means base shear increases by more than 27% if seismic ZONE changes from II to V.

3. The displacement of building models increases with the increasing of wind pressure. The displacement is very high at roof and very low at the base. The displacement occurs at the wind space 39 m/s is 10 mm and at the wind speed 44m/s is 12 mm. This means the displacement is increases by more than 79.5% from wind speed 39 m/s to 44m/s.

4. From the Static Analysis the storey drift is mainly occurred at the middle of the building structure. From table 9.3 and fig 9.13 to 9.16, it is concluded that the storey drift increases with the increasing of seismic zone factor and the maximum storey drift is available at ZONE V for the max. Load combo at 5th floor. The storey drift for ZONE II is 0.00097 and storey drift for ZONE V is 0.00344 at 5th floor. This means the storey drift is increases by more than 50% when compare to ZONE II to ZONE V.

5 .In Static Analysis from results it is observed that the Storey Shear is decreased as height of the building increased and reduced at top floor in all the building models subjected to seismic loads considered. The storey shear is maximum at the base and the storey shear value for the model in ZONE II is 3779 kN and ZONE V is 10619 kN. This means the storey shear is increases by more than 35% when compare to ZONE II to ZONE V.

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