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RESPONSE SPECTRUM ANALYSIS OF G+13 MULTISTORIED BUILDING IN DIFFERENT SEISMIC ZONE BY USING STAAD PRO

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Abstract - *Today's multi storied buildings (G+13) are very common because of lack of land in India. Now a days Earthquake impacts on building in a massive way. Mainly earthquake is shaking of ground which induces vibration in the structure and causes massive damage. For example, The Nepal earthquake happened in the month of 25th April, 2015. The analysis of structures is a fundamental part of seismic design and assessment. It began more than a 100 years ago, when static analysis with lateral loads of about 10% of the weight of the structure was adopted in seismic regulations. For a long time seismic loads of this size remained in the majority of seismic codes worldwide. Dynamic analysis is a time dependent analysis and which is performed by two methods, one is Response spectrum method and another is Time history method. In this work, this topic is carried out by Response spectrum analysis of (g+20) building in different earthquake zone (II, III, IV and V) using Staad Pro v8i software. In comparison of four different zones, results of the analysis come out in terms of lateral deformation, displacement, peak storey shear, Axial force, and bending moment and which is imparted in the results.*

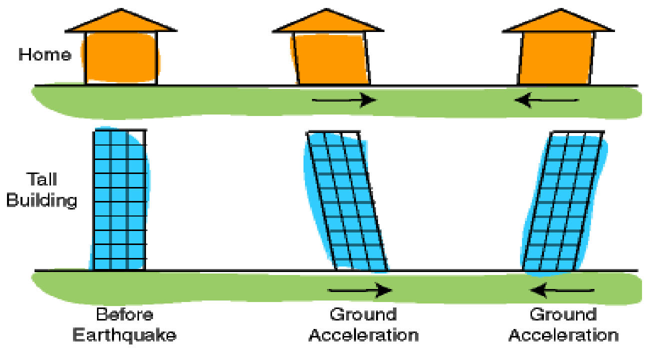
***Key Words*: Peak storey shear, Axial force, Displacement, Bending moment, Modal shapes**

1.INTRODUCTION

India is a developing country, now a day's modern construction is happened in our country. Huge and spectacular structures like monuments, high rise building indicates that growth of civilization and as well as wealth in our country. Modern construction takes less time, structural optimisation, more serviceability and durability in adverse condition. Today skyscraper building construction happened in metro cities (like Mumbai, Delhi, Kolkata) very frequently due to lack of area and increasing of population. In forthcoming years will not have enough space for build up structures, then vertical build up structures will be increased tremendously. Vertical structures have lots of stories, with the increase of stories some difficulties will come against earthquake and wind load impact. Also increase material consumption (cement, steel etc) and cost of project. That's why structural optimisation is needed, structural calculation in manually is very much time consuming. Software like Staad Pro, Etabs, Tekla structure helps to reduce time to calculate structural details, design, stability etc. This study helps to evaluate different lateral system, structural behaviour against seismic load in different zones.

1.1 Effect of Earthquake on Tall Building

Earthquake is a destructive natural calamity, which is does not predict from previously. In real world earthquake proof building does not exist. Earthquake resistance structure we have. 'Mass' of building in seismic design is related with building 'stiffness'. Earthquake induces 'inertia forces' which is proportional to 'Mass' of building. Earthquake forces increases direct proportional with ground acceleration and mass of the building. This implies that Newton's law, (F = ma); 'F' represents force, 'm' represents mass, 'a' represents acceleration.



Small buildings effected by high frequency wave (short and frequent wave). Tall buildings effected by long period or slow shaking. (F=1/T; F represents frequency; T represents time). Increasing the column height decreases the stiffness and decreases the oscillation or frequency.

1.2 Earthquake Zones of India

Based on previous seismic history and tectonic setup Bureau of India divides into four zones namely (zone-ii, zone-iii, zone-iv, zone-v) in India recently. (IS 1893:2002), where 1st and 2nd zone are unified. Previously earthquake zone divided into five zones with respect to severity of earthquake.

Zone V- This zone is highest risk of earthquake with high intensity. Zone factor is 0.36. Zone- v covers some parts of Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, North Bihar, Kutch ran in Gujrat and Andaman and Nicobar island.

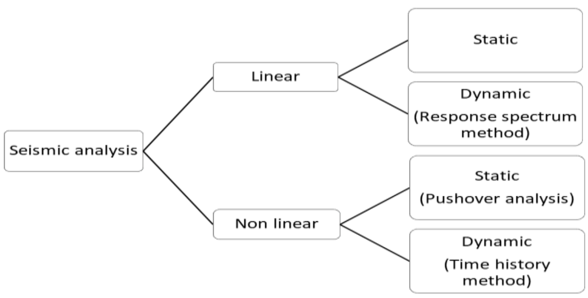
Zone IV- This zone is called High damage risk zone. Zone factor is 0.24. Zone iv covers remaining part of Jammu and Kashmir, Ladakh, Himachal Pradesh, Union Territory of Delhi, Sikkim, northern parts of Uttar Pradesh, Bihar and West Bengal, parts of Gujarat and small portions of Maharashtra near the west coast and Rajasthan.

Zone III- This zone is called as Moderate damage risk zone. Zone factor is 0.16. This zone covers remaining part of Uttar Pradesh, West Bengal, Gujrat, some parts of Punjab, Karnataka, Tamil Nadu, Orissa, Jharkhand, Maharashtra, Chhattisgarh, rest part of Bihar, Madhya Pradesh, Rajasthan, Kerala, Goa, Lakshadweep Island.

Zone II- This Zone is called Low damage risk zone. Rest part of India is included in this Zone.

1.3 Different Type of Seismic Analysis

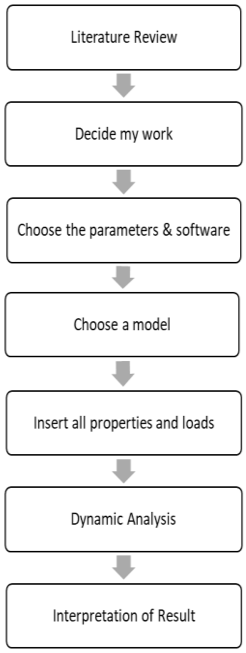
To determine seismic responses it is necessary to perform seismic analysis of the structure. The analysis can be done based on some factors like external action, the behaviour of structural materials, the type of model selected. Analysis can be classified as –



1.4 Objective of the Study

The objective of the work is to the analysis and study of the structural behaviour like (Displacement, peak storey shear, bending moment, axial force in different column) of G+13 multi storied building in different seismic zone (II, III, IV, V) by adopting of Dynamic analysis method (Response spectrum method) using STAAD Pro software.

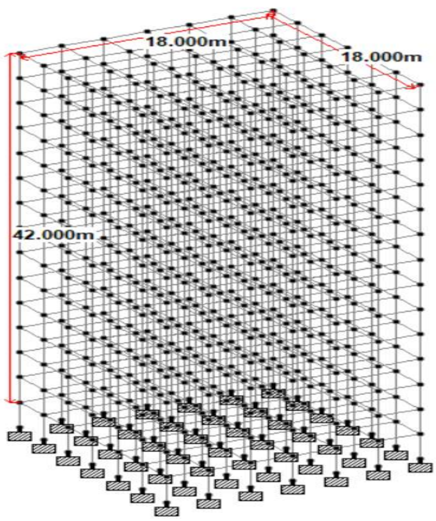
1.5 Methodology

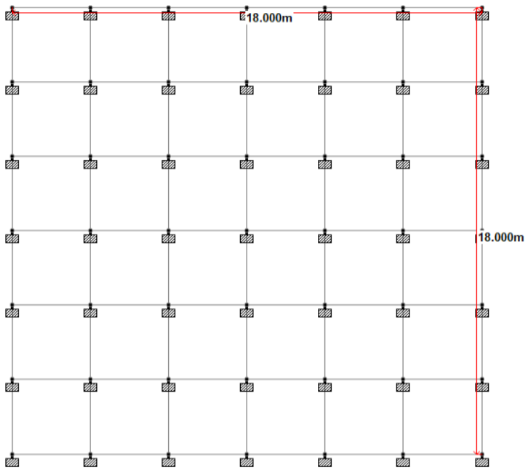


2. SPECIFICATION OF THE MODEL

2.1 Plan Details

The model length along X axis is 18m and width along Z axis is 18m and height along Y axis is 42m (G+13) storey with each floor height 3m. Model generated in Staad Pro software-





2.2 Table-1 Building Parameters

Length * breadth	18m * 18m
No of stories	14
Height of building	42 m
Storey height	3 m
Beam size	400 * 500 mm
Column size	800 * 700 mm
Slab thickness	130 mm
Depth of foundation	3.0 m
Outer wall thickness	230 mm
Inner wall thickness	150 mm
Parapet wall thickness	150mm

2.3 Table-2 Building Material Property

Brick	Standard
Steel	Fe500
Concrete	M25
Unit weight of brick	20N/mm^2
Unit weight of RCC work	25KN/m^3

2.4 Loads

1.Dead load (Table 2 as per IS 875(part1):1987)

Dead load as a floor self- load = 0.130 * 25 =3.25kn/m^2
Outer wall load = 0.230 * 20 * 2.5 = 11.5kn/m
Inner wall load = 0.150 * 20 *2.5 = 7.5kn/m
Parapet wall load = 0.150 * 20 * 0.9 = 2.7kn/m

2. Live load (Table 1 as per IS 875(part2):1987)

Live load in this model considered as 2.5kn/m

3.Seismic load

Select Zone II, zone III, zone IV, zone V as per (IS 1893:2002)
Type of structure- Special RC moment resisting frame (as per Table-7; IS 1893:2002)
Importance factor-1.5 (As per Table 6; IS 1893:2002)
Response reduction factor-5 (As per Table 7; IS 1893:2002)

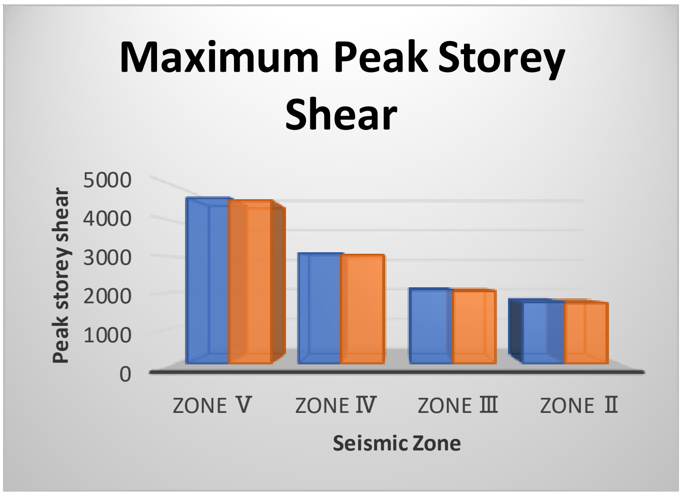
4. Table-3 Combination Load

1. 1.5(DL + LL)	8. 1.5(DL + EQZ)
2. 1.2(DL + LL + EQX)	9. 1.5(DL– EQZ)
3. 1.2(DL + LL – EQX)	10. 0.9DL + 1.5EQX
4. 1.2(DL + LL + EQZ)	11. 0.9DL - 1.5EQX
5.1.2(DL + LL – EQZ)	12. 0.9DL + 1.5EQZ
6. 1.5(DL + EQX)	13. 0.9DL – 1.5EQZ
7. 1.5(DL – EQX	

3.0 RESULT AND DISCUSSION

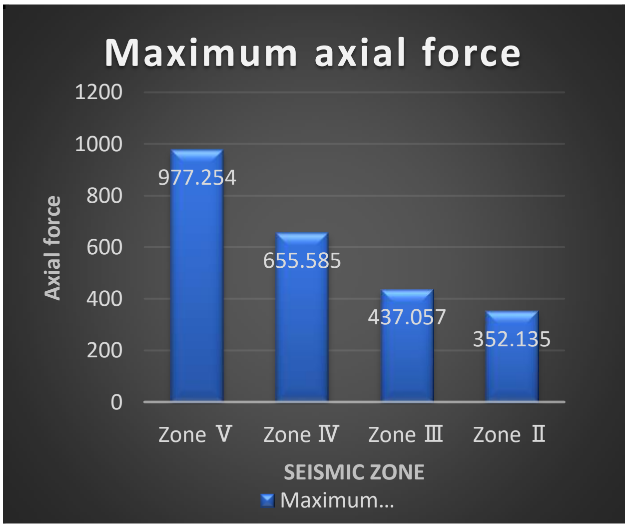
3.1 Table-4 Maximum peak shear force

ZONE	X	Z
V	4649.64 KN	4578.51 KN
IV	3099.76 KN	3052.34 KN
III	2066.51 KN	2034.89 KN
II	1722.09 KN	1695.74 KN



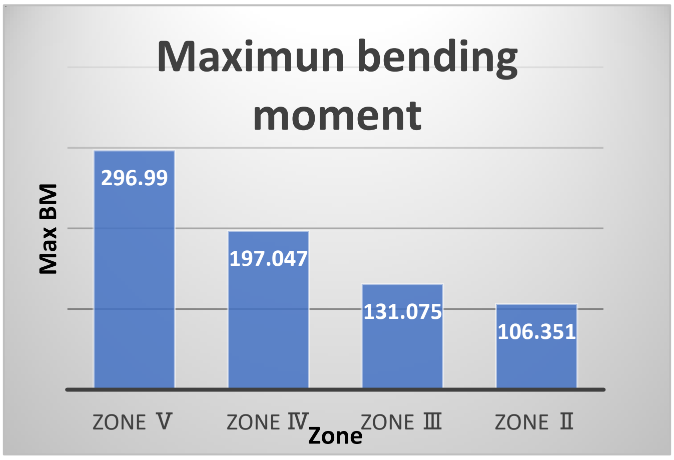
3.2 Table-5 Maximum axial force

ZONE	MAX AXIAL FORCE
V	977.254 KN
IV	655.585 KN
III	437.057 KN
II	352.135 KN



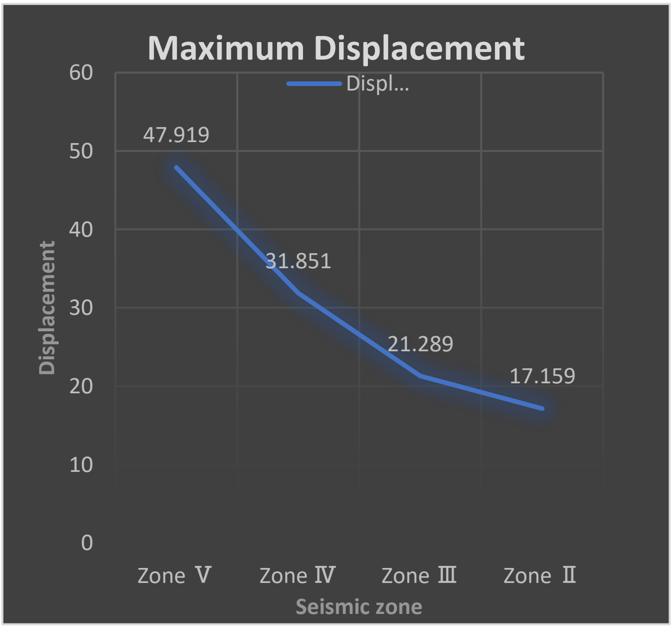
3.3 Table-6 Maximum Bending Moment

ZONE	MAX BENDING MOMENT
V	296.99 KN-m
IV	197.047 KN-m
III	131.075 KN-m
II	106.351 KN-m



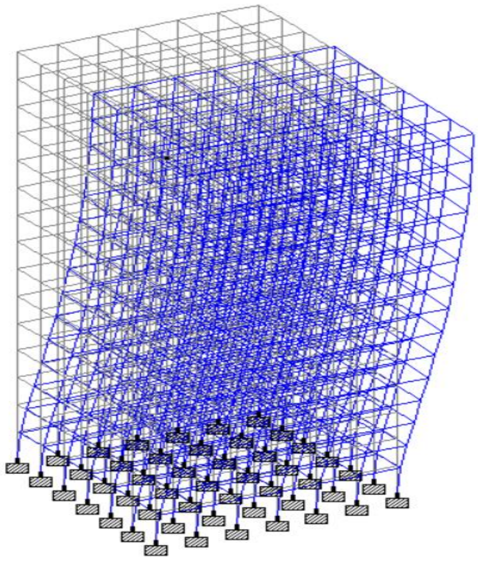
3.4 Table-7 Maximum Displacement

ZONE	MAX DISPLACEMENT
V	47.919 mm
IV	31.851 mm
III	21.289 mm
II	17.159 mm

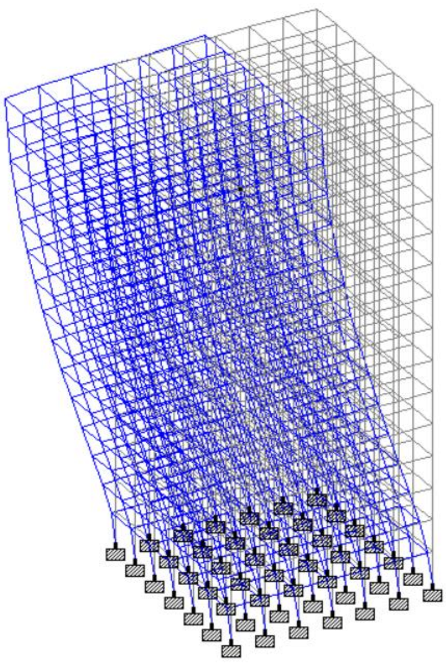


3.5 Modal Shapes of Building indifferent frequency

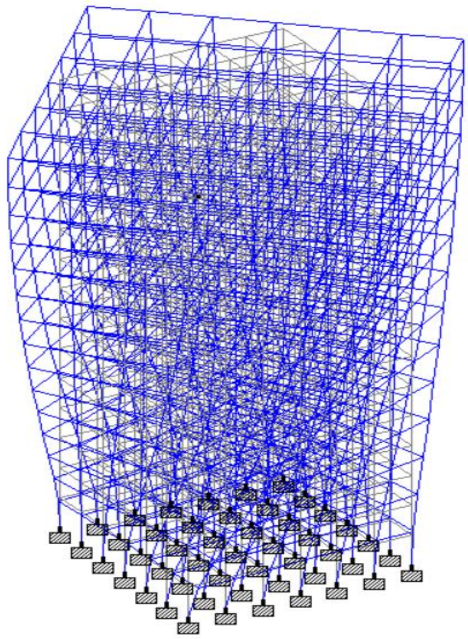
Mode-1 Translational along Z



Mode-2 Translational along X



Mode-3 Rotational



4.0 CONCLUSIONS

4.1 Peak Storey Shear Force

Peak storey shear decreases as the increase of storey. Max storey shear found in base of the model. In compare between zone II and zone III max shear storey about X is 1722.09Kn and 2066.51Kn respectively, where zone III increased by 20%. About Y axis is 1695.74kn and 2034.89kn respectively where zone III increased by 20%.In Zone IV max storey shear about X is 3099.76kn. In compare between zone II and zone IV, zone IV is increased by 79.9% almost and about Y axis max storey shear is 3052.34kn, where zone IV increased by 80%.In zone V max storey shear about X is 4649.64kn. In compare between zone II and zone V, zone V is increased by 169% and about Y axis max storey shear is 4578.51kn, where zone V increased by 170%.

4.2 Bending Moment

Bending moment decreases as the increase of storey. Max bending moment found in base of the model. In comparison of zone II and zone III maximum bending moment values are 106.351KN-m and 131.075KN-m. Zone III is increased by 23.2%. Maximum value in zone IV is 197.046KN-m. In comparison of zone II and zone IV, zone IV increased by 85.2%. Maximum bending moment value of zone V is 296.99KN-m. In comparison of zone II and zone V, zone V is increased by 179%.

4.3 Displacement

As the increase of storey increase the value of displacement in the model. Maximum displacement found in top storey of the model. Maximum displacement values of zone II and III are 17.159mm and 21.289mm. In comparison of zone II and zone III, zone III is increased by 24.06%.Maximum displacement value of zone IV is 31.851mm. In comparison of zone II and zone IV, zone IV is increased by 85%. Maximum displacement value of zone V is 47.919mm. In comparison of zone II and zone V, zone V is increased by 179.2%.

4.4 Axial Force

Axial force decreases as the increase of storey. Max bending moment found in base of the model. Maximum axial force values of zone II and III are 352.135KN and 437.057KN. In comparison of zone II and zone III, zone III is increased by 24.11%. Maximum axial force value of zone IV is 655.585KN. In comparison of zone II and zone IV, zone IV is increased by 86.17%. Maximum axial force value of zone V is 977.254KN. In comparison of zone II and zone V, zone V is increased by 177.5%.

4.5 Scope of the Future Work

1.This study uses Response spectrum analysis; it can be extended to pushover analysis. Pushover Analysis is an effective tool in analysis; brief analysis can be easily carried out with this method.

2. In this study simple R.C. Frame with slab is taken, other element like shear wall can be added to check effect etc.

3. In this study analysis is carried out for Steel structures can also be analyzed similarly.

4. Economical building can be design in minimalistic way.

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BIOGRAPHIES

Anirban Mandal, awarded B.Tech Degree with the specialization of Civil Engineering. And Pursuing M.Tech Degree with the specialization of Structural Engineering from Institute Of Science and Technology.