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## Earthquake Analysis of Multi Storied G+10 RCC Building

Yogesh B. Chauhan<sup>1</sup>, Rikesh S. Bisen<sup>2</sup>, Vikas B. Gaherwar<sup>3</sup>, Sakshi H. Meshram<sup>4</sup>, Heena S.

Bawanthade<sup>5</sup>, Pratiksha A. Gondane<sup>6</sup>, Swati M. Lilhare<sup>7</sup>, Prof. Parag Koche<sup>8</sup>

B.E 8th Semester Student, Department of Civil Engineering, Madhukarrao Pandav College of Engineering, Bhandara,

Nagpur, Maharashtra, India<sup>1234567</sup>

Assistant Professor, Department of Civil Engineering, Madhukarrao Pandav College of Engineering, Bhandara,

Nagpur, Maharashtra, India<sup>8</sup>

**ABSTRACT:** In India with a seismic moderate zone, the equivalent static force method to estimate the seismic force, subsequent vulnerability and behaviour o RC building under seismic load is inadequate. From past seismic tremors, it is seen that on the off chance that the structures are not appropriately examined and developed with required quality, then it may lead to great destruction and loss to human lives. It has been demonstrated that numerous structures are completely or halfway harmed because of the quake. This reality was never disregarded while plan of multi-story structures by the basic specialists, scientists to guarantee wellbeing against tremor powers while erection. In this Project seismic reaction of a private G+10 RC outline building is breaking down by the direct examination methodologies of Equivalent Static Lateral Force and Response Spectrum techniques utilizing Stadd Pro Ultimate software according to the Seems to be 1893-2002-Part-1. These analyses are carried out by considering different seismic zones. A substitute response like lateral force, story drift, displacements, base shear are plotted to think about the consequences of the static and dynamic investigation.

**KEYWORDS**: Earthquake, Seismic Zones, Multi-Storey Building, Response Spectrum techniques, Lateral Force, STAAD Pro

#### I. INTRODUCTION

A seismic tremor might be characterized as the arrival of versatile vitality by sudden slip on a blame and coming about ground shaking and transmitted brought about by slip. Tremors are one of the most exceedingly bad among the cataclysmic events. Around 1 lakh tremors of extent in excess of three hit the earth each year. As indicated by a preservationist gauge of in excess of 15 million, human lives have been lost and harm worth hundred billion of dollars have been dispensed in the written history due to these. In present scenario, transformation of India due to urbanization, modernization &industrialization represents the level of development of our country. Rapid development indicates the scarcity of land and increases the demand of high-rise buildings. In today's era of modernization, major share in infrastructures are occupied by high-rise building structure and increases the demand of engineers & architect to plan & construct high-rise structures with more and more complex individual plan and elevation. The Indian subcontinent has suffered some of the greatest earthquakes & have most active seismic zone in the world. Prior decade, consideration of earthquake forces in structural design was neglected but today its consideration is significant one. Even though there is early advancement in field of seismic safety, moderate earthquakes in India are still became reason of thousands of people deaths and major property loss, representing the poor seismic performance of the existing infrastructure. There is a necessity: to build a more specialized environment for planning, analysing, designing, detailing and constructing earthquake resistant high- raised multi-storeyed structure by following seismic codal provisions. An earthquakeresistant high- raised multi-storeyed building has features like Good Structural Configuration, Lateral Strength, Adequate Stiffness, Good Ductility which required adequate knowledge and experience to achieve in different zones of India. Bureau of Indian Standards [IS 1893 (part 1):2002] has grouped INDIA into four seismic zones and same structure in different zone have different behaviour under seismic load and have varying requirements for effective seismic designs of high-raised structure because of categorisation of zone as per intensities or magnitude of earthquake. Structural Analysis determines behaviour of structures so as to predict the responses of actual structures under the upgrading of predictable loading & outside environment during the service lifespan of structure. The present research describes the behaviour of (G+10) symmetrical high-rise multi-storey building structure under seismic analysis to



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withstand earthquake forces, which it will be subjected during an earthquake. Analysing the effect of Indian seismic zones mainly (Zone II (Mumbai) & Zone IV (Nagpur)) ONSAME (G+ 10) high-rise multi-storey building structure by the direct examination methodologies of static (Equivalent static lateral Force) and Dynamic (Response Spectrum techniques) is examined. The present analysis is done using STADD.Pro (V8i) which provides a much faster approach to structural analysis and designing with chances of minimum error according to the code 1893-2002-Part-1. the software being used gives the calculation of support reactions, shear forces, axial force, bending moment, Base shear, seismic forces and displacement, stress, strain & deformation or deflection for a structural components of building (such as Beams, columns & slabs)The main parameters consider in this study to compare effect of Indian seismic zones(Zone II (Mumbai) & Zone IV (Nagpur)) on the seismic performance of (G+ 10) high rise multi-storey building structure with methods of seismic analysis. Analytical results are compared to achieve the most suitable earthquake resisting & economic structure against the lateral forces.

#### **II. OBJECTIVES OF THE STUDY**

- Analysis and Design of Earthquake resistant of multistoryRCC building.
- To analyse the seismic response of a structure with the help of software STAAD.Pro 2000.
- Analysis of simple 2-dimensional reinforced concrete frames and as such both static loads(dead, live and load combinations) and dynamic load (Earth quake load).
- Ductility design and detailing.

#### **III. EARTHQUAKE STUDY**

#### **3.1 GENERAL**

The portion accomplishes a prologue to the fundamental qualities of the tremor safe plan of structures with an extraordinary accentuation on related extra highlights in contrast with structural building plan. It is essential for Planning of Earthquake Resistant Structures constantly, tremors end the thousands of people life's, and wreck belongings value billions. It is essential that structures are proposed to contradict seismic tremor forces, to diminish the loss of life. additional structure assumes a critical job. Here, various tips and methods utilized in planning Earthquake Resistant structures are talked about. A seismic tremor is a sudden; A seismic tremor is the shaking of the surfaces of the Earth, coming about in view of the unexpected entry of imperativeness in the Earth's lithosphere that makes seismic waves. Shakes can keep running in size from those that are feeble to the point that they can't be felt to those savage enough to fling people around and demolish whole urban networks. The seismicity or seismic activity of a domain insinuates the repeat, type and size of tremors experienced over some stretch of time. At the Earth's surface, seismic tremors show themselves by shaking and a portion of the time development of the ground.

#### Table 1 : List of natural and man-made earthquake sources

Natural Source	Man-made Source
Tectonic Earthquakes	Controlled Sources (Explosives)
Volcanic Earthquakes	Reservoir Induced Earthquakes
Rock Falls/Collapse of Cavity	<ul> <li>Mining Induced Earthquakes Cultural</li> </ul>
Microseism	• noise (Industry, Traffic, etc)

#### **3.2 Protection from Earthquakes**

For a structure to remain safe in the midst of seismic tremor trembling, The earthquake- resistant bracing has been designed for homes with a mullion-and-transom design, and connects the horizontal beams with the vertical submit. when exposed to wind or tremors, the connectors need to be rigid sufficient to maintain deformation to a minimal – but additionally elastic sufficient to resist strong earthquakes. If deformation does occur, it does now not cause important pressure – in other words, the constructing sways, but does now not fall apart.

#### 3.3 Design philosophy of Earthquake Resistant Building

a) Beneath minor but visit shaking, the primary individuals from the structures that bring vertical and horizontal powers ought not to be harmed; besides structures parts that do not deliver load may additionally aid repairable damage.



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- b) under mild yet incidental shaking, the principle individuals might also aid repairable harm, whilst unique elements that don't deliver load may hold repairable harm.
- c) Beneath stable/tough however unusual shaking, the number one people may additionally aid critical damage, yet the structure ought not fall.
- d) whereas, a notable part of the abrupt are caught up within the pressure driven liquids and simply little is transmitted above to the undercarriage of the car. on the point when seismic energy is transmitted thru them, dampers ingest a few part of it, and consequently soggy the motion of the structure.

#### 3.4 Analysis of the Structure

The building was divided into portal frames. The structure was partitioned into gateway Outlines and these casing have been investigated utilizing the STAAD.Pro.2000 Programming. The Ten-story gateway was ruined down for live load, dead load and Earthquake load combinations. The examination gave the force rising in the individuals, to be specific transverse

beam and sections, because of the above burdens and these individuals were intended for the severest of force acquired because of the load combination.

#### 3.5 Seismic Zone of India

The changeable topography at various areas in the nation infers that the probability of harming seismic tremors occurring at various areas is having different seismic zone values for different locations. In this way, a seismic region map is essential so structures and different structures situated in various areas can be intended to withstand distinctive dimension of ground shaking. The current zoning of map divided into four zones in India II, III, IV and V.

Based on the past seismic history, Bureau of Indian Standards grouped the country into four seismic zones namely Zone-II, Zone-III, Zone-IV and Zone-V. Of all these four zones, Zone-V is the most seismic active region whereas Zone-II is the least.

Seismic Zone	Intensity on M.M Scale
Zone-II (Low-Intensity Zone)	6 (or less)
Zone-III (Moderate Intensity Zone)	7
Zone-IV (Severe Intensity Zone)	8
Zone-V (Very Severe Intensity Zone)	9 (and above)

#### Table 2 : Seismic Zone Intensity in MM Scale

#### 3.6 Regions that fall under the Earthquake (seismic) Zones in India

**Zone-V** covers entire northeastern India, some parts of Jammu and Kashmir, some parts of Ladakh, Himachal Pradesh, Uttarakhand, Rann of Kutch in Gujarat, some parts of North Bihar and Andaman & Nicobar Islands.

**Zone-IV** covers remaining parts of Jammu & Kashmir, Ladakh and 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** comprises of Kerala, Goa, Lakshadweep islands, remaining parts of Uttar Pradesh, Gujarat and West Bengal, parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Odisha, Andhra Pradesh, Tamil Nadu and Karnataka.

Zone-II covers remaining parts of the country

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(Figure 1: Earthquake (seismic) Zones in India (Map))

#### **IV. LITERATURE REVIEW**

**Gaikwad et al[1]** The essential objective of earthquake engineers is to fashion and build a shape in such the only manner that injury to the structure and its structural element all through the earthquake is minimize. For the evaluation purpose models of G + 9 stories of RCC and metal with unsymmetrical plan is think about. The evaluation is by carried by means of victimization F.E primarily based more often than not software program package deal. numerous parameter like lateral force, base shear , story glide , tale shear are frequently determined .For dynamic evaluation time records approach or reaction spectra technique is hired .Dynamic analysis have to be accomplished for symmetrical furthermore as unsymmetrical building. Dynamic evaluation are frequently within the style of complete nonlinear dynamic time records analysis .If the RCC and steel constructing rectangular measure unsymmetrical, Torsional result are going to be turn out in each the building and so square measure compared with one another to see the economical building underneath the result of torsion.

**UmamaheswaraRao et.al [2]** In this study model of G+7 Structure is analysed under seismic load by using STAAD.Pro software in different seismic zones (II, III, IV, V) of India. Consideration is done for all the basic parameters of earthquake responsible to affect Multi-storey building and analysed with Different Load combinations and try to fill the void of IS:1893-2002 doesn't provide the variations in steel quantity from zone to zone. Result shows comparison of Base shear, Floor Displacements, support Reactions and variation of steel quantity by zone to zone. Result declare that Base shear, Displacements, support reactions and steel quantity are Depends on zone factor, so these values are more in zone-v, zone-V is critical for the G+7 structure. Support reactions zone-V as higher value as compare to zone-II, zone-III, zone-IV. 6. Steel quantity of seismic zone-V is higher than 53.84%, 13.89% and 8.31% as compared to zone II, zone-III and zone-IV.

**Pavan Kumar et.al [3]** In these research the residential building of G+ 15 storey structure is analyse for seismic load by using method of static and dynamic analysis by considering ordinary moment resisting frame and special moment resisting frame in zone II. Equivalent static analysis and response spectrum analysis are the methods used in structural seismic analysis. The total structure were analyzed by using STAAD.PRO software. The result shows that response reduction of cases ordinary moment resisting frame and special moment resisting frame values with deflection diagrams in static and dynamic analysis. The special moment of resisting frame structured is good in resisting the seismic loads. Final result concludes that the results of static analysis in OMRF & SMRF values are low when comparing to that of dynamic analysis in OMRF & SMRF values. Hence the performance of dynamic analysis SMRF structure is quiet good in resisting the earthquake forces compared to that of the static analysis OMRF & SMRF.



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#### V. INTERFACE OF STAAD PRO SOFTWARE

#### 5.1 GENERAL

In each part of human development we required structures to live in or to get what we need. In any case, it isn't just structure structures however to fabricate proficient structures with the goal that it can satisfy the principle reason for what it was made for. Here comes the job of structural designing and all the more exactly the job of investigation of structure. There are numerous established strategies to take care of plan issue, and with time new programming's additionally becoming an integral factor. Here in this undertaking work dependent on programming named Staad professional has been used. Few standard issues likewise have been unraveled to demonstrate how Staad star can be utilized in various cases. These ordinary issues have been settled utilizing essential idea of stacking, examination, condition according to IS code. These essential strategies might be discovered helpful for further investigation of issues .Examination of the structure intends to assurance of the inside powers like hub pressure bowing minute, shear constrain and so on in the segment part for which the part are to be planned under the activity of given outside burden. The plan is procedure of segment percussion from the examination results by utilizing appropriate investigation method. The point of configuration is to accomplishment of a satisfactory likelihood that structures being planned will perform agreeably amid their proposed life.

#### 5.2 STAAD PRO

STAAD or (STAAD.Pro) is a structural analysis and design software application originally developed by Research Engineers International in 1997. In late 2005, Research Engineers International was bought by Bentley Systems. STAAD.Pro is one of the most widely used structural analysis and design software products worldwide. It supports over 90 international steel, concrete, timber & aluminium design codes.It can make use of various forms of analysis from the traditional static analysis to more recent analysis methods like p-delta analysis, geometric non-linear analysis, Pushover analysis (Static-Non Linear Analysis) or a buckling analysis. It can also make use of various forms of dynamic analysis methods from time history analysis to response spectrum analysis. The response spectrum analysis feature is supported for both user defined spectra as well as a number of international code specified spectra.Additionally, STAAD.Pro is interoperable with applications such as RAM Connection, AutoPIPE, SACS and many more engineering design and analysis applications to further improve collaboration between the different disciplines involved in a project. STAAD can be used for analysis and design of all types of structural projects from plants, buildings, and bridges to towers, tunnels, metro stations, water/wastewater treatment plants and more.

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(Figure 7.1 : STAAD PRO working Interface)

#### 5.2.1 Advantages of STAAD PRO software

- i) Flexible modeling environment
- ii) Availability of wide ranges for designing code
- iii) Open architecture
- iv) All feature of structural engineering
- v) Report and documentation
- vi) Quality assurances
- vii) International code

Investigation of structure of different components of structure.

i) Planning of different parts of a structure with section situating



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ii) Introduction of STAAD.Pro

iii) Modeling of the structure in the STAAD.Pro giving all limit conditions

- (Underpins, stacking and so on)
- iv) Analysis and Design of different basic parts of the modular structure
- v) Study of investigation Data of the product
- vi) Detailing of shafts, segments, piece with area proportioning and fortification.

#### 5.2.2 Aim of STAAD PRO

This undertaking goes for relearning of idea of basic plan with the assistance of PC helps. Quickly we have experienced finishing calls attention to of the venture work

- i) Comprehension of plan and itemizing idea.
- ii) Main goal for example learning of STAAD.Pro programming bundle.
- iii) Learning of examination and plan procedure which can be valuable in the field.
- iv) Understanding of seismic tremor obstruction plan idea.
- v) Approach for expert practice in the field of basic designing



(Figure 7.2: Seismic Analysis of 10 Storey RCC Building Using Staad Pro V8i)

#### VI. PROPOSED METHODOLOGY

#### **6.1 MODEL OF THE PROJECT**

Building type	G+10 Residential Building
Plan area	26.5(m)*26.7(m)
Beam size	300(mm)*400 (mm)
Column size	500(mm)*500 (mm)
Bam clear cover to Longitudinal Rebar Group centroid	60 mm
Column clear cover to confinement Bars	40 mm
Slab thickness	150 mm
Typical storey height	3 m
Bottom storey height	4 m
Live load, LL	3kN/m <sup>2</sup>
External Wall load	11.44kN/m
Partition and floor finishing load, FL	2kN/m2
Earthquake Direction	X and Y
Seismic Zone	II, III, IV and V
Soil type	Type II (Medium Soil)
Materials	M30 and Fe415



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#### 6.2 ANALYSIS OF BUILDING ELEMENTS IN STAAD PRO

The modeling analysis is done in the STAAD PRO.



(Figure 8.7 :3d modeling view )

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(Figure 8.8 :Beams representation)



(Figure 8.9 :3D rendering view)



(Figure 8.10 : Bending moment diagram)

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(Figure 8.12 : Axial force diagram)



(Figure 8.13 :Footing analysis )



(Figure 8.14 : mode shape in dynamic analysis )

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#### VII. RESULTS

The result below is after analyzing by using Staad Pro

DSET

Table 9.3 shows the base shear in Tx and Tz

#### VIII. CONCLUSION

- To conclude, STADD. Pro is versatile software having the ability to determine the reinforcement required for any concrete section based on its loading and determine the nodal deflections against lateral forces.
- Stadd.Pro& ETABS (version 2017) gives hardly any variation in results compared to the results computed manually.
- Irregular configuration of structure is more susceptible to earthquake load than regular shaped buildings.
- The variation of seismic load, wind load, shear force and bending moment with the height is showing a direct relationship
- Seismic zone-V have more value of Zone Factor and show critical behaviour during seismic analysis of G+10 structure. Steel quantity required for seismic zone-V is higher than 53.84%, 13.89% and 8.31% as compared to zone II, zone-III and zone-IV
- The behavior of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces were carried to the ground
- Stadd.Pro allows you to follow the criteria of several design codes for eg. The Indian standards relating to loads, designs, analysis etc.
- Stadd.Pro is a much easier and faster way of analysing and designing a structure when compared to manual computation.
- Stadd.Pro is a user-friendly way to analyse the structure as its GUI is very easy to work with and the software is quite versatile.

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