



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 7, July 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569



# Seismic Analysis of Regular RCC G+10 Framed Building

Pooja Hatewar<sup>1</sup>, Prof. Girish Sawai<sup>2</sup>

PG Student, Department of Civil Engineering, V M Institute of Engineering & Technology, Nagpur,  
Maharashtra, India<sup>1</sup>

Assistant Professor, Department of Civil Engineering, V M Institute of Engineering & Technology, Nagpur,  
Maharashtra, India<sup>2</sup>

**ABSTRACT:** The performance of a multi-storey framed building during sturdy earthquake motions depends on the distribution of mass, stiffness, and strength in both the horizontal and vertical planes of the building. In multistoreyed framed buildings, smash up from earthquake ground motion generally initiates at locations of structural weaknesses present in the lateral load resisting frames. In some cases, these weaknesses may be produced by discontinuities in stiffness, strength or mass between adjoining storeys. Such discontinuities between storeys are often allied with sudden variations in the frame geometry along the height. A common type of discontinuity is vertical geometrical irregularity arising from the rapid drop of the height. This work shows the performance & behavior of regular & vertical geometric irregular RCC framed structure under seismic motion. All building frames are modeled & analyzed in software Staad.Pro V8i. Various seismic responses like shear force, bending moment, storey drift, storey displacement, etc. are obtained. The seismic analysis is done according to IS 1893:2002 part (1). Seismic zone IV & medium soil strata are taken for all the cases. The change in the different seismic response is observed along different height.

**KEYWORDS:** STAAD PRO, Earthquake, Regular building, Seismic response parameters, Response Method

## I. INTRODUCTION

Irregular buildings constitute a large portion of the modern urban infrastructure. The group of people involved in constructing the building facilities, including owner, architect, structural engineer, contractor and local authorities, contribute to the overall planning, selection of structural system, and to its configuration. This may lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building. When such buildings are located in a high seismic zone, the structural engineer's role becomes more challenging. Therefore, the structural engineer needs to have a thorough understanding of the seismic response of irregular structures. In recent past, several studies have been carried out to evaluate the response of irregular buildings. This paper is an attempt to summarize the work that has been already done pertaining to the seismic response of vertically irregular building frames. Vertical irregularities are characterized by vertical discontinuities in the geometry, distribution of mass, rigidity and strength. Setback buildings are a subset of vertically irregular buildings where there are discontinuities with respect to geometry. However, geometric irregularity also introduces discontinuity in the distribution of mass, stiffness and strength along the vertical direction. The structures having this discontinuity are termed as Irregular structures. There is a need of more work to be done in this regard. So this research work is an attempt to reach on more accurate conclusion to reduce their effect on the structure. We observe that real structures are frequently irregular as perfect regularity is an idealization that rarely occurs in the practice. Regarding buildings, for practical purposes, major seismic codes across the globe differentiate between irregularity in plan and in elevation, but it must be realized that irregularity in the structure is the consequence of a combination of both types. It is seen that irregular structural configurations either in plan or in elevation were often recognized as one of the major causes of collapse during precedent earthquakes. Irregular structures contribute a large portion of urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with soft storey were the most notable structures which collapsed. So, the effect of vertically irregularities in the seismic performance of structures becomes really important. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the regular building.



The word earthquake is used to express any seismic occurrence whether natural or caused by humans that can produce seismic influence around any particular area. Earthquakes are caused generally by rupture of geological faults inside the earth, but also by other events such as volcanic movement, landslides, mine blasts, and atomic tests. Vertical irregularities are characterized by vertical discontinuities in the geometry, distribution of mass, rigidity and strength. Setback buildings are a subset of vertically irregular buildings where there are discontinuities with respect to geometry. However, geometric irregularity also introduces discontinuity in the distribution of mass, stiffness and strength along the vertical direction. Majority of the studies on setback buildings have focused on the elastic response. The behavior of these types of building is something different. There is a need of more work to be done in this regard. So this research work is an attempt to reach on more accurate conclusion to reduce their effect on the structure.

We observe that real structures are frequently irregular as perfect regularity is an idealization that rarely occurs in the practice. Regarding buildings, for practical purposes, major seismic codes across the globe differentiate between irregularity in plan and in elevation, but it must be realized that irregularity in the structure is the consequence of a combination of both types. It is seen that irregular structural configurations either in plan or in elevation were often recognized as one of the major causes of collapse during precedent earthquakes.

**Earthquake:**

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	• Mining Induced Earthquakes Cultural
• Microseism	• noise (Industry, Traffic, etc)

At the point when the focal point of a vast quake is found seaward, the seabed might be movement adequately to cause a wave. Seismic tremors can likewise trigger destruction of property, landslide, and at times volcanic movement injury of people and even kills. For a gigantic number of years, the powers of tectonic plates have mold the Earth as the enormous plates that structure the Earth's surface move progressively finished. A seismic tremor's purpose of introductory burst is called its focus or hypocenter. The focal point is the point at ground level straightforwardly over the hypocenter.

The dynamic response of structure to seismic tremor ground development is the most basic explanation behind shudder incited mischief to structures. The mischief that a structure suffers essentially depends not upon its removing, anyway after accelerating. While dislodging is the genuine detachment the ground and building may move in the midst of a shudder, stimulating is an extent of how quickly they change speed as they move. The standard method to manage seismic tremor safe arrangement of structures depends on outfitting the structure with quality, solidness and inelastic twisting limits which are incredible to withstand a given component of shudder formed drive.



### 1.2.5 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.
- 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.

#### 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.

#### 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.

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

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

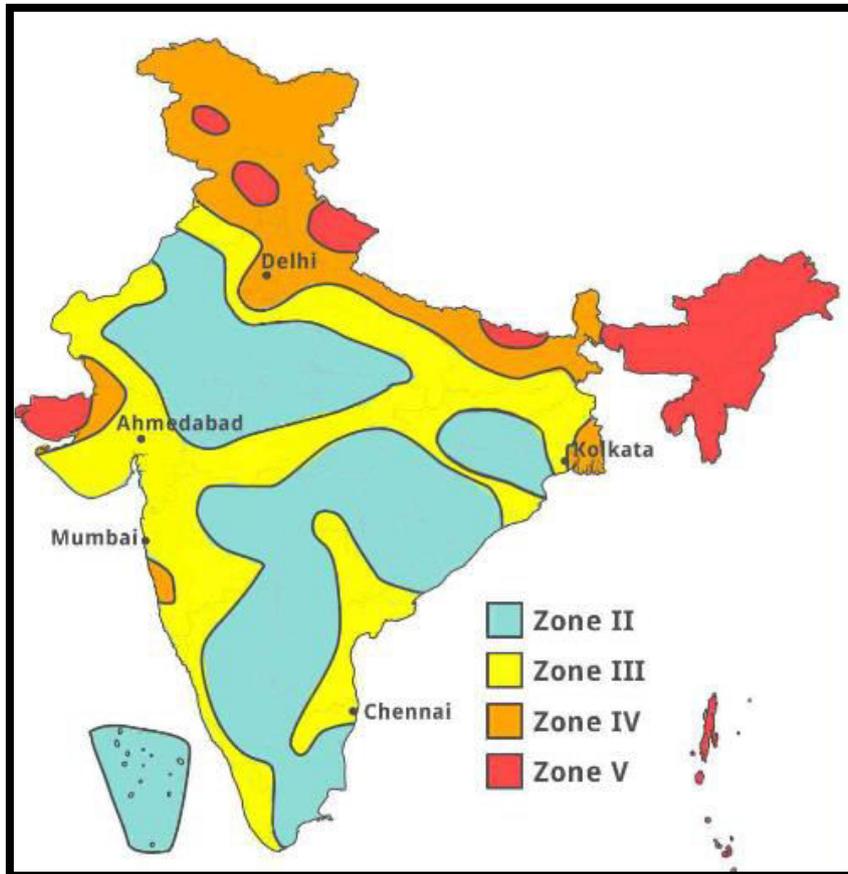
#### Regions that fall under the Earthquake (seismic) Zones in India:

**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



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

**Effect of Earthquakes on High Rise Buildings:**

Precisely when a building is shown to the seismic tremor vibrations its establishment will move to and from with the ground. These vibrations can be incredibly marvelous, making stresses and deformation all through the structure making the upper edges of the building swing from a few mms to different inches' reliant on their stature size and mass. This is reliably material for structures everything being equivalent, paying little heed to whether single storied or multi-storied in high-chance seismic tremor zones. A building ought to be barely versatile and have fragments, which can withstand or counter the nerves caused in various bits of the working as a result of level advancements realized by tremors. It was seen that structures of various sizes and statures vibrated with various frequencies. Where these were made nearby each other they made stresses in both the structures and subsequently weakened each other and when in doubt caused the failure of both the structures. Master of Indian Standards gives in its code IS 4326 that a Separation Section is to be given between structures. Division Section is portrayed as an opening of demonstrated width between neighboring structures or parts of a comparative building, either left uncovered or verified fittingly to enable improvement to avoid beating considering the seismic tremor. Further, it communicates that for structures of height more vital than 40 meters, it will charm total model or dynamic examination of the structures to figure the buoy at each story, and the opening width between the adjoining structures won't be not actually the total of their dynamic evasions at any measurement.

Therefore, it is urged to give a tasteful opening between two structures more unmistakable than the sum of the typical bowing of both the structures taking care of business, with the objective that they have enough space to vibrate. This circumstance is likewise intensified when the section estimation of one building is close to the mid-estimation of the dividers and parts of the neighboring building, the dividers and segments are typically not proposed for taking this extra

shear propel acknowledged by the measurement control starting from the neighboring piece. This causes catching of the areas and dividers every so often of over the best stresses at the mid centers (amiability your neighboring building) and thusly the breakdown of the structures onto each other starting a chain reaction. Since one can't predict how one's neighbor is going to build his home at the period of plan it is more intelligent to stay away from potential hazard, for instance, keeping up a hole. On record of high rise, multi storied private and business structures advancement joints are given when the length of the building outperforms a length controlled by code.

This augmentation joint is suited moderating anxieties caused in view of advancement or pressure of improvement material inferable from temperature changes. Presently, the structures are totally separated and a gap of 1 to 2" is outfitted which is stacked up with a versatile material. In any case, this is causing an essential issue for instance the shirking of these self-sufficient structures during the seismic tremor is significantly more in raised structures than the expansion joint and since now these structures are detached and of the varying size, they would swing and hammer with each other and cripple the structures. Assistant fragments around the augmentation joint would be truly hurt and there will be a chain reaction of forces in the complete structure for which the structure has not been arranged. In regions where highpower tremors are depended upon the wellbeing measures are to be taken: Due to bowing/development, Expansion joints legitimate hole as required in two pieces of the working, because of quake gave in all structures.

At the season of authorizing of building plan, we should submit basic illustrations and declaration from the authorized auxiliary specialist.

These should give refinements of

- a) soil condition and bearing point of confinement.
- b) Seismic tremor zone for which the building has been organized.
- c) I.S. Codes utilized for structure

No relaxations ought to be allowed, and no progressions made that auxiliary structure after authorization. Accommodation of Structural authentication from the architect to the overseeing city body subsequent to throwing of establishments and at each floor level ought to be made necessary. At the season of assent This should express that the support and R.C.C standing have been confirmed and are according to his basic structure submitted to the body. the ordinary shape must be favored at the Common divider framework between abutting structures should be completely abrogated distortion.

### **Important of Seismic Design Codes:**

Ground vibrations during earthquake cause forces and deformations in structures. Structures should be planned withstand such powers and disfigurements. Seismic codes help to improve the conduct of structures so that may withstand the quake impact without huge death toll and property. Nations around the globe have techniques laid out in the seismic code to help configuration builds in the arranging, planning, enumerating and developing of structures.

#### ***a. A tremor safe has four ethics in it, specifically:***

- i) Good Structural Configuration: its size, shape and a basic framework conveying loads are to such an extent that they guarantee an immediate and smooth stream of latency powers to the ground.
- ii) Lateral Strength: The most extreme sidelong (even) compel that it can oppose is with the end goal that the harm initiated in it doesn't result in breakdown.
- iii) Adequate Stiffness: Its sidelong burden opposing framework is to such an extent that the seismic tremor – in fact distortions in it don't harm its substance under low-to-direct shaking.
- iv) Good Ductility: Its ability to experience extensive disfigurements under extreme seismic tremor shaking even in the wake of yielding is improved by positive structure and itemizing procedures.

#### **b. Indian Seismic Codes:**

Seismic codes are extraordinary to an area or nation. They think about the nearby seismology, acknowledged dimension of seismic hazard, structures typologies, and materials and strategies utilized in development.

***The Bureau of Indian Standards (BIS) the accompanying Seismic Codes:***

- IS 1893 (PART 1) 2002, Indian Standard Criteria for Earthquakes Resistant of Design Structures (5th update).
- IS 4326, 1993, Indian Standard Code of training for Earthquake Resistant Design and Construction of Buildings. (second update).
- IS 13827, 1993, Indian Standard Guidelines for improving Earthquake Resistant of Earthen structures.
- IS 13828, 1993 Indian Standard Guidelines for improving Earthquake Resistant of Low Strength Masonry Buildings.
- IS 13920, 1993, Indian Standard Code for training for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces. The directions in these gauges don't guarantee that structures endure no harm amid the tremor of all greatness. In any case, to the degree conceivable, they guarantee that structures can react to tremor shaking of moderate forces without auxiliary harm and of substantial powers without all out breakdown.

**OBJECTIVES: -**

- To calculate the design lateral forces on regular buildings using response spectrum analysis and to compare the results of different structures.
- To propose the best suitable building configuration on the existing condition and Analysis of Regular RCC G+10 Framed Building.

**II. LITERATURE REVIEW**

Prakash Sangamnerkaret. al. has done the comparative study on the static and dynamic behavior of reinforced concrete framed regular building. Comparison of static and vibrant behavior of a six storey's structure is considered in this paper and it is analyzed by using computerized solution available in all four seismic zones i.e. II, III, IV and V. It is observed that parameters like base shear, nodal displacements and beam ends forces varies in the same ratio as described above, hence it is very important conclusion derived in the analysis.

Mohit Sharma et. al. considered a G+30 storied regular reinforced concrete framed building. Dynamic analysis of multistoried Building was carried out. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parameters for the design as per the IS-1893- 2002-Part-1 for the zones- 2 and 3. It was concluded that not much difference in the values of Axial Forces as obtained by Static and Dynamic Analysis.

Anwaruddin M. et. al. carried out the study on non linear Static Pushover Analysis of G plus 3 medium rise reinforced cement concrete structure with and without vertical irregularity. It was seen that irregularity in height of the building reduces the performance point of structure. There was reduction in displacement or deformation of the RCC building also. They concluded seeing that the no of bays reduces upright, the lateral load carrying capacity increases with decline in lateral displacement.

Sarkar et. al. proposed a new method of quantifying irregularity in vertical geometric irregular building frames, which deals with the dynamic characteristics i.e. stiffness and mass. This paper discusses some of the important issues regarding analysis and design of stepped buildings. They proposed a fresh method for quantifying the irregularity in stepped building. This approach is found to execute better than the existing procedures to quantify the irregularity. The total 78 stepped frames with varying irregularity and height were taken in this study. They proposed a correction factor to the empirical code formula for fundamental period, to provide it applicable for vertical geometric stepped buildings.

Sujit Kumar et. al (2014) studied the effect of sloping ground on structural performance of rcc building under seismic load. The seismic analysis of a G+4 storey RCC building on varying slope angles i.e., 7.50 and 150 is carried and compared with the same existing on the flat ground. The seismic loadings are as per IS: 1893-2002. STAAD Pro v8i is used in this study to see the effect of sloping ground on building performance during earthquake. Seismic analysis has been done using equivalent Linear Static method. The analysis is carried out to estimate the effect of sloping ground on structural forces. The bending moment, horizontal reaction in footings and axial force in columns are critically analyzed to enumerate the effects of various sloping ground.

Athanassiadou (2008) concluded that the effect of the ductility class on the cost of buildings is negligible, while performance of all irregular frames subjected to earthquake appears to be equally satisfactory, not inferior to that of the regular ones, even for twice the design earthquake forces. DCM frames were found to be stronger and less ductile than the corresponding DCH ones. The over strength of the irregular frames was found to be similar to that of the regular ones, while DCH frames were found to dispose higher over strength than DCM ones. Pushover analysis seemed to underestimate the response quantities in the upper floors of the irregular frames.

Rakesh K. Goel and Anil K. (1997) studied the period formulas for momentresisting frame buildings. Based on analysis of the available data for the fundamental vibration period of 27 RC MRF buildings and 42 steel MRF buildings, measured from their motions recorded during earthquakes different formulas were used for estimating, conservatively, the period of RC and steel buildings; respectively .Regression analysis was done to obtain the coefficient of empirical formula for fundamental period.

M. S. Aainawalaet. al. done the comparative study of multistoried R.C.C. Buildings with and without Shear Walls. They applied the earthquake load to a building for G+12, G+25, G+38 located in zone II, zone III, zone IV and zone V for different cases of shear wall position. It was observed that Multistoried R.C.C. Buildings with shear wall is economical as compared to without shear wall.

VishwajeetDeshmukh et al (2016) in this study find the effect of masonry infills on four story reinforced concrete frame for seismic response of a four story. Seismic analysis is to be done by using the Response Spectra Method for different reinforced concrete frame building models that 6 are bare frame without opening and in-filled frame with opening and for analyzing the results of these are concluded by using ETABS 2015 for all frame model. The masonry infill are helpful in reducing the displacement of structure and may be used to limit drift of structure and the base shear of infill frame is more than in in-filled frame with opening and bare frame and also the time period of in-filled frame is less as compared to in-filled frame with opening and bare frame.

### III. PROPOSED METHODOLOGY

#### INTERFACE OF STAAD PRO SOFTWARE:

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.

#### 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.

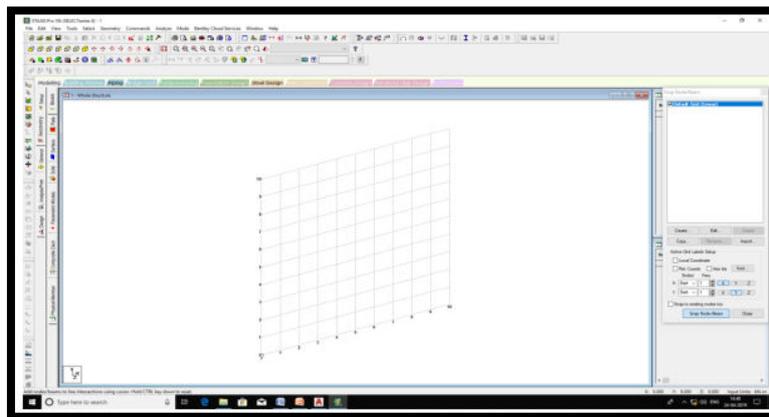
It can make use of various forms of analysis from the traditional static analysis to more recent analysis methods like p-delta analysis, geometric non-linear analysis, Pushover analysis (Static-Non Linear Analysis) or a buckling analysis. It



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.

The STAAD.Pro Graphical User Interface: it's wont to generate the model, which might then be analyzed mistreatment the STAAD engine. Once analysis and style are completed, the user interface also can be wont to read the results diagrammatically. The STAAD analysis and magnificence engine: it is a general calculation engine for structural analysis and integrated Steel, Concrete, Timber and metal vogue. To begin with we've got resolved some sample problems practice STAAD skilled and checked the accuracy of the results with manual calculations. The results were to satisfaction and were correct. With the initial section of our project we've got done calculations concerning loadings on buildings and conjointly thought of seismal and wind masses. Structural analysis contains the set of physical laws and arithmetic needed to review and predicts the behavior of structures. Structural analysis may be viewed additional abstractly as a way to drive the engineering style method or prove the soundness of a style while not a dependence on directly testing it. To perform associate in nursing correct analysis a structural engineer should confirm such data as structural masses, geometry, support conditions and material properties. The results of such Associate in nursing analysis generally embrace support reactions, stresses and displacements. This data is then compared to criteria that indicate the conditions of failure. Advanced structural analysis might examine dynamic response, stability and non-linear behavior. The aim of style is that the accomplishment of an appropriate likelihood that structures being designed can perform satisfactorily throughout their supposed life. With Associate in nursing applicable degree of safety, they ought to sustain all the masses and deformations of traditional construction and use and have adequate sturdiness and adequate resistance to the results of seismal and wind. Structure and structural elements shall normally be designed by Limit State Method. Account should be taken of accepted theories, experiment and experience and the need to design for durability. Design as well as style for sturdiness, construction and use in commission ought to be thought of as a full. The belief of style objectives needs compliance with clearly outlined standards for materials, productions, accomplishment and additionally maintenance and use of structure in commission. The planning of the building depends up on the minimum necessities as prescribed within the Indian customary codes. The minimum necessities relating the structural safety of building square measure being coated by manner of egg laying down minimum style (design) loads that got to be assumed for dead loads, obligatory loads and different external loads, the structural would be needed connected. Strict conformity to loading standards recommended in this code, it is hoped, will not only ensure the structural safety of the buildings which are being designed.



(Figure2 : STAAD PRO working Interface)

### 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

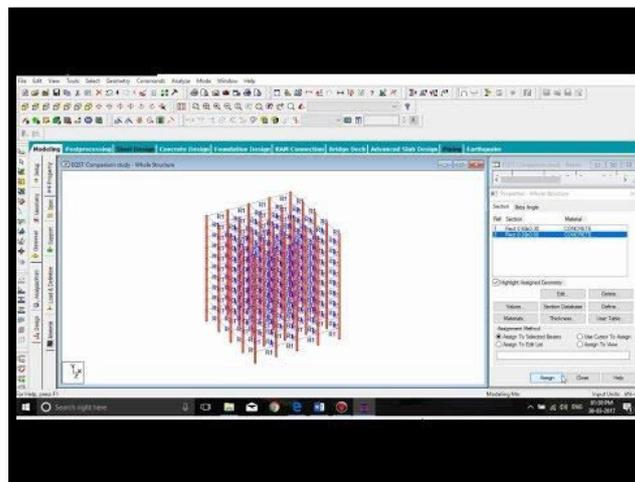
Investigation of structure of different components of structure.

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

### 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 3: Seismic Analysis of 10 Storey RCC Building Using Staad Pro V8i)

### METHODS OF ANALYSIS:

The most commonly used methods of analysis for determining the design seismic forces acting on a structure as a results of ground shaking are based on the approximation that the effects of yielding can be accounted for by linear analysis of the building, using the design spectrum for inelastic systems. Forces and displacements due to each horizontal component of ground motion are separately determined by analysis of an idealized building having one lateral degree of freedom per floor in the direction of the ground motion component being considered. Such analysis may be carried out by the equivalent static procedure (static method) or response spectrum analysis procedure (dynamic method). Both the equivalent static and response spectrum analysis procedures lead directly to lateral forces in the

direction of the ground motion component. The significant difference between linear static and linear dynamic analysis is the level of the forces and their distribution along the height of the structure. The equivalent static method is mainly suited for preliminary design of the building. The preliminary design of the building is then used for response spectrum analysis or any other refined method such as the elastic time history method. For this study, seismic analysis is carried out by linear static analysis and response spectrum analysis.

#### **Equivalent Static Analysis:**

It is one of the method for calculating the seismic loads. The high rise structures are not considered for the design simple static method. In practical as it does not take into account all the factors that are the importance of the foundation condition. The equivalent static analysis is used to design only for the small structures. In this method only one mode is considered for each direction. The earthquake resistant designing for the low rise structures the equivalent static method is enough. Tall structures are needed more than two modes and mass weight of each story to design earthquake resistant loads. This is not suitable to design those structures and dynamic analysis method to be used for high rise structures.

#### **Response Spectrum Analysis:**

The seismic forces strikes the foundation of a structure will move with the ground motion. It shows that structure movement is generally more than the ground motion. The movement of the structure as compared to the ground is referred as the dynamic amplification. It depends on the natural frequency of vibration, damping, type of foundation, method of detailing of the structure. The response "design acceleration spectrum" which refers to the max acceleration called spectral acceleration coefficient  $S_a/g$ , as a function of the structure for a specified damping ratio for earthquake excitation at the base for a single degree freedom system. The revised IS 1893-2002 uses the dynamic analysis by response spectrum.

*In this method takes into account all the five important engineering properties of the structures.*

- i. The fundamental natural period of vibration of the building (  $T$  in seconds)
- ii. The damping properties of the structure
- iii. Type of foundation provided for the building
- iv. Importance factor of the building
- v. The ductility of the structure represented by response reduction factor.

#### **Response Spectrum Method by using STAAD Pro:**

This is accurate method of analysis. The design lateral force at each floor in each mode is computed by STAAD Pro in accordance with IS: 1893 (Part 1)-2002. The software provides result for design values, modal masses and storey wise base shear.

Methodology: The design lateral shear force at each floor in each mode is computed by STAAD in accordance with the IS: 1893 (Part 1) -2002 following equation.

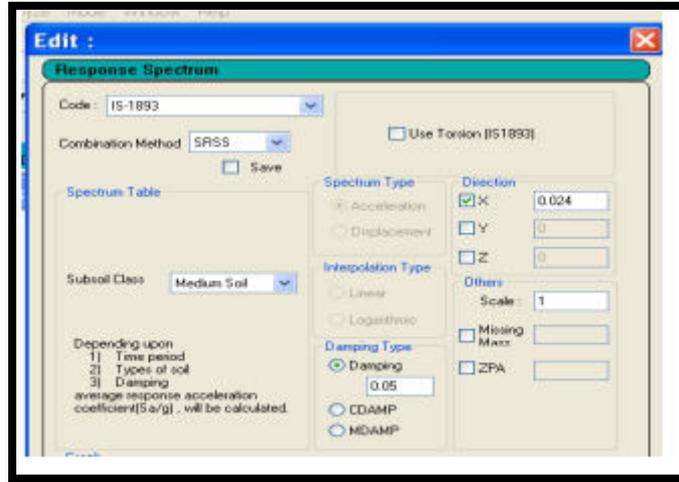
$$Q_{ik} = A_k * f_{ik} * P_k * W_k \text{ and } V_{ik} = Q_{ik}$$

*STAAD utilizes the following procedure to generate the lateral seismic loads*

1. User provides the value for  $Z/2 * I/R$  as factors for input spectrum.
2. Program calculates time periods for first six modes or as specified by the user.
3. Program calculates  $S_a/g$  for each mode utilizing time period and damping for each mode.
4. The program calculates design horizontal acceleration spectrum  $A_k$  for different modes.
5. The program then calculates design mode participation factor for different modes.
6. The peak lateral seismic force at each floor in each mode is calculated.
7. All response quantities for each mode are calculated.
8. The peak response quantities are then combined as per method (CQC or SRSS or ABS or TEN or CSM) as defined by the user to get the final results.

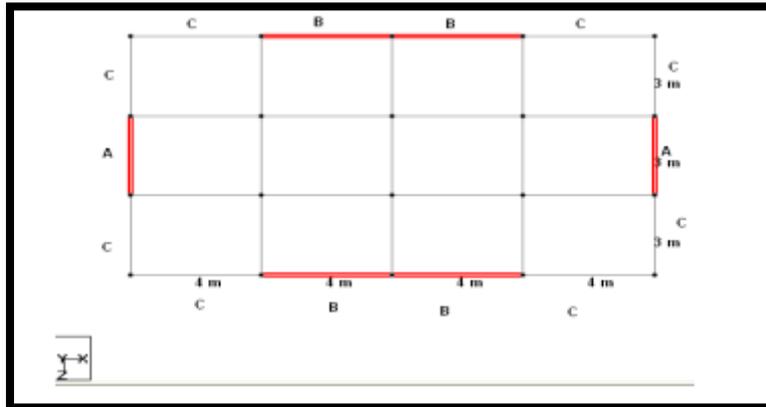
#### **Analysis of Building With Response Spectrum Method:**

Seismic Analysis of high-rise building having following data is analyzed for different models of lateral load resisting systems.



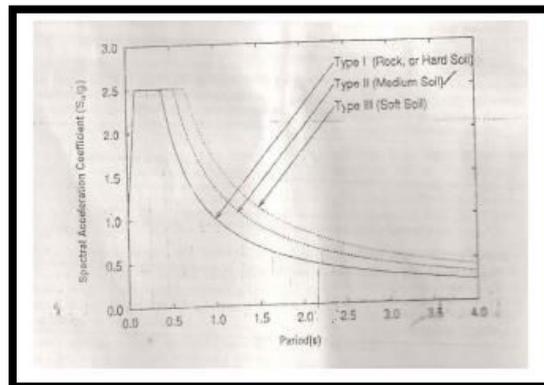
(Figure 4: Response Spectrum data specification)

For present work response spectrum method as per IS:1893-2002 is carried out for reinforced concrete moment resisting frame having (G+10) storey situated in zone IV. The floor to floor height of the building is 3m. The total height of building is 45m.

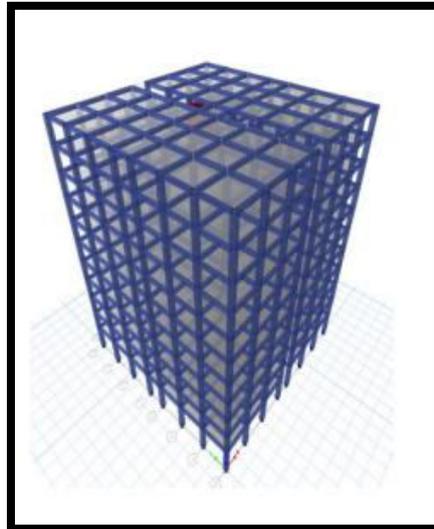


(Figure 5: Plan of building showing location of braced frame & shear wall frame)

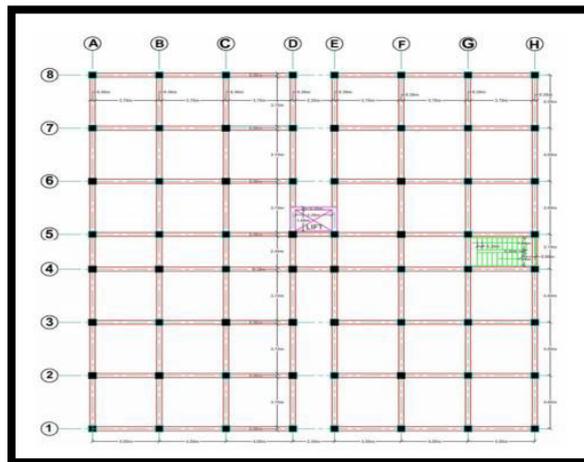
*Design Parameters: The design spectrum used is of medium soil as per IS 1893 Part I (2002).*



(Figure 6: Response spectrum for soil as per IS 1893 Part I (2002))



(Figure 7: 3D Model)



(Figure8 : Model Layout)

**WORKING WITH STAAD.PRO:**

**INPUT GENERATION-**

The graphical user interface (or user) communicates with the STAAD analysis engine through the STAAD INPUT file. That computer file could be a document consisting of a series of commands that sequentially measure dead consecutive. The commands contain either directions or knowledge concerning analysis and/or design (style). The STAAD computer file may be created through a text editor or the graphical user interface modeling facility. In general, any text editor is also utilized to edit/create the STAAD computer file. The graphical user interface modeling facility creates the computer file through Associate in using interactive menu-driven graphics homeward-bound procedure.

**TYPES OF STRUCTURES:**

A Structure is often outlined as an assemblage of components. STAAD is capable of analyzing and planning structures consisting of frame, plate/shell and solid components. Virtually any style of structure is often analyzed by STAAD. A SPACE structure, that may be a 3-dimensional framed structure with hundreds applied in any plane, is that the most general. A PLANE structure is sure by a worldwide X-Y frame of reference with hundreds within the same plane. A TRUSS structure consists of truss members who might have solely axial member forces and no bending within the members. A FLOOR structure may be a 2 or 3-dimensional structure having no horizontal (global X or Z) movement of the structure [FX, FZ & MY square measure restrained at each joint]. The ground framing

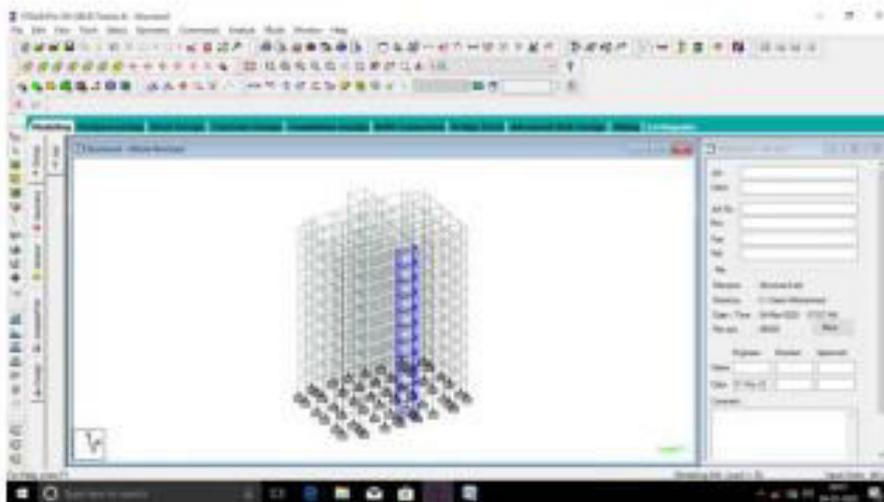


(in worldwide X-Z plane) of a building is a perfect example of a FLOOR structure. Columns also can be sculptural with the ground during a FLOOR structure as long because the structure has no horizontal loading. If there's any horizontal load, it should be analyzed as an area structure.

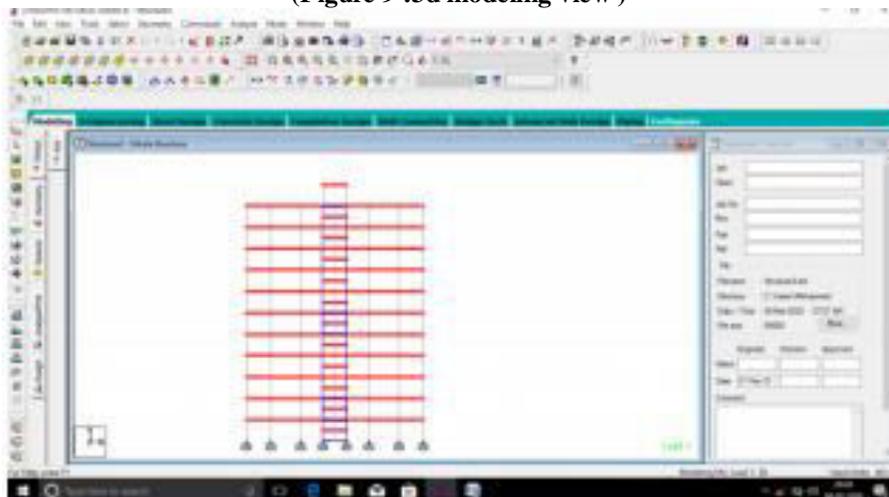
**GENERATION OF THE STRUCTURE :** The structure could also be generated from the computer file or mentioning the co-ordinates within the graphical user interface. The figure below shows the graphical user interface generation technique. E structure.

**MATERIAL CONSTANTS:** The material constants are: modulus of elasticity (E); weight density (DEN); Poisson's ratio (POISS); co-efficient of thermal enlargement (ALPHA), Composite Damping Damping Ratio, and beta twelve angle (BETA) or coordinates for any reference (REF) purpose. E value for members should be provided or the analysis won't be performed. Weight density (DEN) is employed only self-weight of the structure is to be taken under consideration.

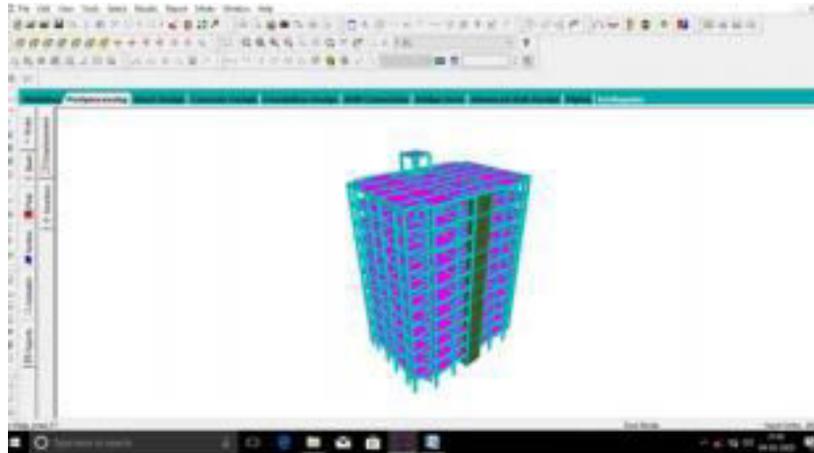
**ANALYSIS OF BUILDING ELEMENTS IN STAAD PRO-**  
*The modeling analysis is done in the STAAD PRO.*



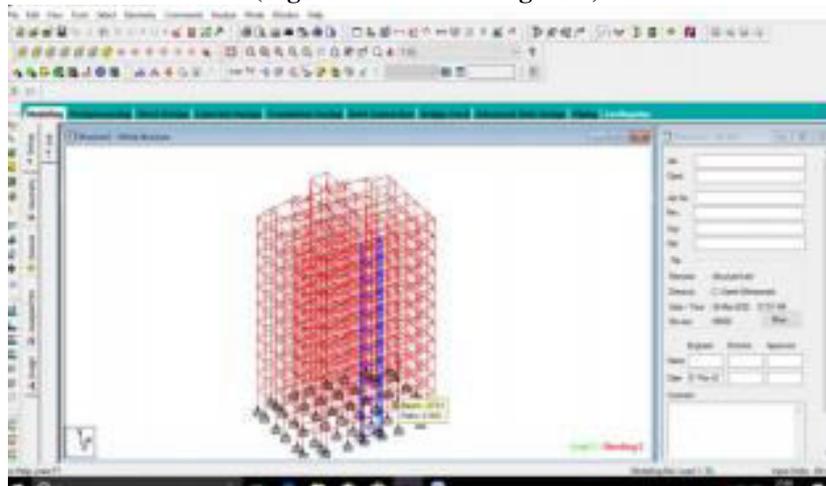
(Figure 9 :3d modeling view )



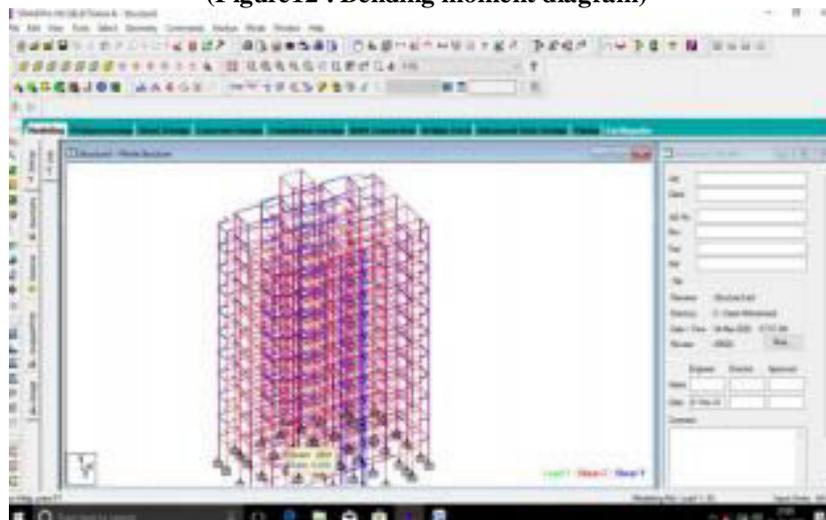
(Figure10 :Beams representation)



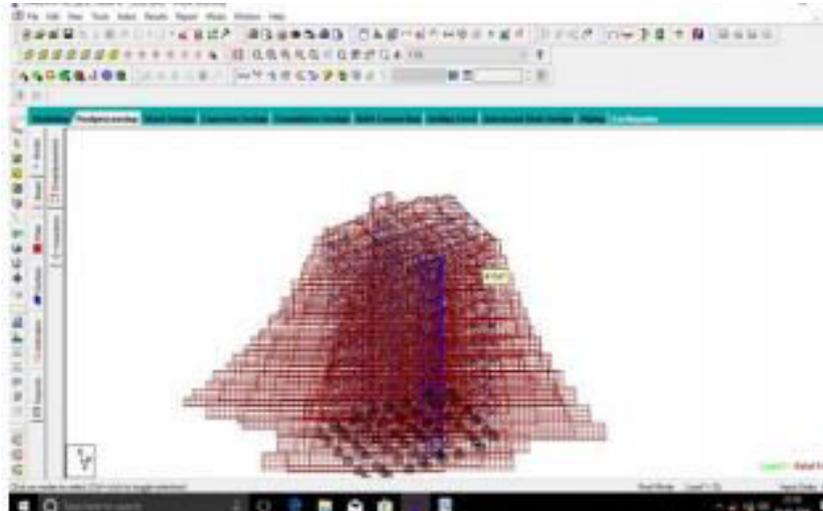
(Figure11 :3D rendering view)



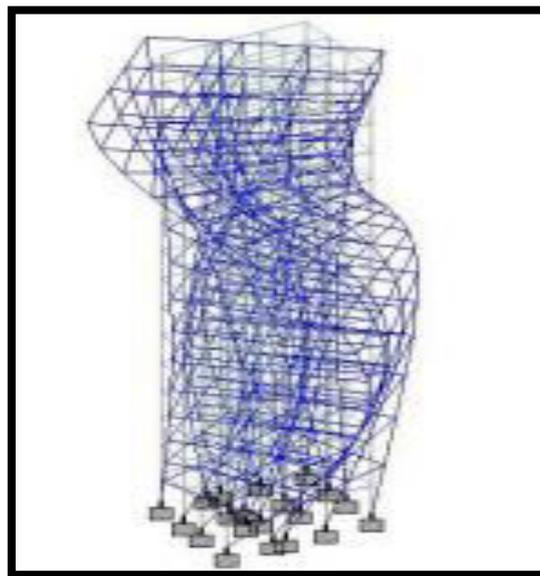
(Figure12 : Bending moment diagram)



(Figure13 :Shear force diagram)



(Figure14 :Axial force diagram)



(Figure15 : mode shape in dynamic analysis )

**Results:**

The result below is after analyzing by using Staad Pro  
Table 3 shows the base shear in Tx and Tz



```
*****
*
* TIME PERIOD FOR X 1893 LOADING = 0.38300 SEC *
* SA/G PER 1893= 2.500, LOAD FACTOR= 1.000 *
* VB PER 1893= 0.0600 X 74365.16= 4461.91 KN *
*
*****
*
* TIME PERIOD FOR Z 1893 LOADING = 0.49200 SEC *
* SA/G PER 1893= 2.500, LOAD FACTOR= 1.000 *
* VB PER 1893= 0.0600 X 74365.16= 4461.91 KN *
*
*****
```

#### IV. 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.

#### ACKNOWLEDGMENTS

The authors are grateful to the V M INSTITUTE OF ENGINEERING & TECHNOLOGY, NAGPUR, MAHARASHTRA, INDIA, for providing guidances and resources to carry out this work.

#### REFERENCES

1. DileshwarRana, Prof.JunedRaheem (2015) Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building
2. Achyut S Naphade, Prof Grpatil(2015), “Push over analysis of RCC building with soft storey at different levels” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
3. SuchitaHirde Ganga Tepugade(2014), “Seismic performance of multistorey building with soft storey at different level with RC shear wall”International Journal of Current Engineering and Technology
4. Devendra Dohare1, Dr.Savita Maru2(2014) “Seismic Behaviour of soft Storey Building : A Critical Review” International Journal of Engineering Research and General Science Volume 2, Issue 6, October-November, 2014

5. Akshay V. Raut<sup>1</sup>, Prof. RVRK Prasad<sup>2</sup>(2014) “Pushover Analysis of G+3 Reinforced Concrete Building with soft storey” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
6. Bhattacharjee, B. and ASV, N., 2007. Computer aided analysis and design of multi-storeyed buildings (Doctoral dissertation).
7. Saatcioglu, M. and Humar, J., 2003. Dynamic analysis of buildings for earthquake resistant design. Canadian Journal of Civil Engineering, 30(2), pp.338-359.
8. Duan, X.N. and Chandler, A.M., 1993. Inelastic seismic response of code-designed multistorey frame buildings with regular asymmetry. Earthquake engineering & structural dynamics, 22(5), pp.431-445.
9. Fu, F., 2010. 3-D nonlinear dynamic progressive collapse analysis of multi- storey steel composite frame buildings—Parametric study. Engineering Structures, 32(12), pp.3974-3980.
10. Mwafy, A.M. and Elnashai, A.S., 2001. Static pushover versus dynamic collapse analysis of RC buildings. Engineering structures, 23(5), pp.407-424.
11. BIS, IS 456:2000, — Plain and reinforced concrete code of practice Bureau of Indian Standards, Fourth revision.
12. BIS, IS-875 (Part-1): (1987) Dead Loads- Unit weights of building materials and stored materials
13. BIS, IS-875 (Part-2): (1987) Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures
14. Agarwal P. and Shrikhande M, Earthquake Resistant Design of Structures, PHI Publication, 2004.
15. Duggal S.K, Earthquake Resistant Design of Structures Second edition Oxford Publications, 2007
16. A.K Chopra "Dynamic of structures theory and Earthquake Engineering" fourth edition, Prentice Hall, 2012
17. Anirudh Gottala, Kintali Sai Nanda Kishore and Dr. Shaik Yajdhani “Comparative Study of Static and Dynamic Seismic Analysis of a Multistoried Building” International Journal of Science Technology & Engineering, Volume 2, Issue 01, July 2015
18. B. Srikanth and V.Ramesh "Comparative Study of Seismic Response for Seismic Coefficient and Response Spectrum Methods", International Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 3, Issue 5, Sep-Oct 2013, pp.1919-1924
19. Pankaj Agarwal, Manish Shrikhande "Earthquake Resistant Design Of Structures” Prentice Hall of India private limited, 2006
20. Sayed Mahmoud and Waleed Abdallah Saudi Arabia "Response Analysis of Multi-Story RC Buildings under Equivalent Static and Dynamic Loads according to Egyptian Code ", International Journal of Civil and Structural Engineering Research, ISSN 2348-7607 (Online), Vol. 2, Issue 1, pp: (79-88), Month: April 2014 - September 2014
21. S.K. Duggal “Earthquake Resistant Design of structures” Oxford university Press, 2007
22. D.R. Deshmukh, A.K. Yadav, S. N Supekar, A. B. Thakur, H. P Sonawane, I. M. Jain, “Analysis and Design of G+19 Storied Building Using Staad-Pro”, Pg. 17-19, ISSN: 2248-9622, Vol. 6, Issue 7, (Part-1) July 2016.
23. Ankit Purohit, Lovish Pamecha “Seismic Analysis of G+12 Multistory Building Varying Zone and Soil Type SSRG” , International Journal of Civil Engineering ( SSRG – IJCE ) – Volume 4 Issue 6 – June 2017.
24. Patil S.S. (2013), “ Seismic Analysis of High-Rise Building by Response Spectrum Method”, International Journal Of Computational Engineering Research (Ijceronline.Com) Vol. 3 Issue. 3.
25. E. Pavan Kumar, A. Naresh , M. Nagajyothi, M. Rajasekhar “ Earthquake Analysis of Multi Storied Residential Building - A Case Study”, Int. Journal of Engineering Research and Applications [www.ijera.com](http://www.ijera.com) ISSN : 2248-9622, Vol. 4, Issue 11( Version 1), November 2014.
26. Prof. Komal S. Meshram, Samiksha Kumbhare, Sagar Thaku, Diksha Mate, Amit Moundekar, Raksha Waghmare, “Seismic Analysis of Building Using Staad-Pro”, International Journal of Innovations in Engineering and Science, Vol. 4, No. 5, 2019.
27. Sangeeta Uikey, Er. Rahul Satbhay, “Seismic Response Analysis of Tall Building Using STAAD Pro Software”, Journal of Earthquake Science and Soil Dynamics Engineering Volume 3 Issue 1, (2020) DOI: <http://doi.org/10.5281/zenodo.3685732>
28. Siddhartha S. Ray, Alkesh S. Bhalerao, Rahul Chandrasekhar, “Earthquake Analysis of Multistory Building”, International Journal of Advanced Science and Technology Vol. 29, No. 4, (2020), pp.7650-7658, ISSN: 2005 - 4238 IJAST Copyright @2020 SERSC



**Impact Factor:  
7.569**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details