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Research Paper

Seismic Analysis of Double Basement + 28 Storied Residential Building (Case Study).

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ABSTRACT:*This paper focuses on Review of various Research Papers which are based on review of the seismic analysis of high rise structure with double basement (case study) (B+G+28) storey residential building by using the software, STAAD PRO along with the consideration of Indian Standard Code provisions. Due, to rapid increase in the population the horizontal space of the land is minimized and so to construct the structure using minimum land, the vertical space is used and high rise structures are introduced and constructed. One of the most destructive phenomena of the nature is an earthquake which leads to severe damage to the structure with terrible aftereffect. It is impossible to prevent the occurrence of an earthquake but the damage to the structures can be controlled through proper detailing and designing. It is necessary to do the seismic analysis of the structure against collapse. The building should be designed in such a way that causes minimum damage to the structure during an earthquake. This study mainly focused on understanding the seismic analysis of the structure through STAAD PRO software under Live load, Dead load, Wind load using various Indian Codes such as IS 456-2000, IS 1893-2016 6th edition, IS 875 Part 2 and 3.*

KEYWORDS: *Dead Load, Double Basement, Live Load, Staad Pro, Wind Load*

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I. INTRODUCTION

Buildings are the structures which are used by the people for shelter, living, working or storage. Due to rapid population growth and urbanization there is a shift of rural people to urban areas which leads to shortage of land space. Early, for construction horizontal spaces were utilized but due to rapid growth, to utilize minimum land vertical space were used and high rise structures were constructed. In this study the analysis and modelling is done for B+G+28 storey residential building. The building is to be constructed as Residential building with DOUBLE BASEMENT and 28 Floors i.e. "B+G+28" . The soil on which the building is constructed is Raft foundation. Pile foundation is also constructed from 1to 1.5m from the building area along with RCC wall is also constructed for preventing collapse of the soil. The total plot area is 45,000 Sq. Ft. and total slab area is 25,000 Sq. Ft. The excavation depth for Raft Foundation is 7m. The slab constructed is Normal Slab I.e. it contains a reinforced concrete structural element which is also known as RCC. The slab is provided with different thickness 300mm, 250mm, and 200mm.The steel grade used is Fe550D where 'D' implies "Ductility" which means that the steel bars have higher percentage of elongation. There are 28 floors and each floor contain 2 flats of 5 BHK and cost of 1flat is 6 crore and area of 1 flat is 6000-7000 Sq. Ft. The building contains 4 lifts. Overall cost of the building is 350 Crores (approximately). The Architect is SKA Consortium, Nagpur. The engineer under which we are doing our 1 year internship is Mr. Pravin Trimbke Sir.

Seismic analysis is a branch of structure analysis that involves calculating a building's earthquake reaction. In earthquake-prone areas, it is an element of structural design, earthquake engineering or structural evaluation and retrofit in regions where earthquakes are prevalent. From the figure, a building has a potential to 'wave' back-and-forth during an earthquake. This Is called 'fundamental mode' and is the lowest frequency of building response. Most buildings, however, have higher modes of response which are uniquely activated during earthquake. The figure just shows the second mode but there are higher 'shimming' (abnormal vibration) modes. Nevertheless, the first and second modes tend to cause the most damage in most cases.

Equivalent static method- As per this method, first, the design base shear Vb shall be computed for the building as a whole. Then this Vb shall be distributed to the various floor levels at the corresponding centres of mass. And finally this design seismic force at each floor shall be distributed to individual lateral load resisting elements through structural analysis considering the floor diaphragm action. This method shall be applicable for regular buildings with height less than 15m in Seismic Zone II.

Dynamic Analysis Method- Linear dynamic analysis shall be performed to obtain the design lateral force (design seismic base shear and its distribution to different levels along the height of the building and to various lateral load resisting elements) for all buildings, other than regular buildings lower than 15m in Seismic Zone II. The analytical model for dynamic analysis of buildings with unusual configuration should be such that it adequately represents irregularities present in the building configuration. Dynamic analysis may be performed by either the Time History Method or the Response Spectrum Method. The building to be constructed is "CIVIL LINES BHAGIRATHI TEXTILE".

II. LITERATURE REVIEW

Analysis of Tall Buildings subjected to Wind and Seismic loads.
By K. Rama Raju, M. I. Shereef, Nagesh. R. Iyer and S. Gopalkrishnan (2013), Chennai
In this research paper, the authors explain the importance of tall buildings in today's world. Since, due to increasing population and growing urbanization, people are shifting from rural areas to urban areas which leads to lack of horizontal spaces, the architects shift their mindset towards using of vertical space by constructing tall high rise buildings. In this research paper, the authors analyze tall building 3B+G+40 storied RCC residential building by 3D modelling in STAAD PRO by application of earthquake load and wind load using IS 1893 (Part 1) :2002 and IS 875 (Part 3) :1987 codes respectively. The safety of the structure is checked against the limits for inter storey drifts, base shear, accelerations and roof displacements in codes of practice and other literature for earthquake and wind.

Seismic Analysis of Building using STAAD PRO.
By Prof. Komal. S. Meshram, Samiksha Kumbhare, Sagar Thakur, Diksha Mate, Amit Moundekar, Raksha Waghmare (2019), Bhandara
In this research paper, the authors explain that the earthquake is one of the natural disaster which generates a lot of destructive forces of the structure as well as on the lives of the people and their safety. So, the building should be constructed and designed for the safety of the lives of people by proper design and detailing to prevent the structure from failure and to construct the structure against seismic power of multi storied working. In this research paper the author explains the need for seismic study and planning of structure for protection against earthquake. The goal of seismic resistance construction is to protect the structure better against seismic forces as compared To conventional methods. In this research paper the authors analyze and design the G+7 residential buildings situated in Zone II in India. The dead load and live load are applied and design of beam, column, slab and footing are obtained. The authors analyzed the whole structure using STAAD PRO software. There are many softwares used for analysis but STAAD PRO is one of the most common software used for analysis and design of the building considering earthquake forces. The authors also reviewed and studied behavior of multi storied building by using Equivalent Static Lateral Force method.

Analysis and Design of an Earthquake Resistant Structure using STAAD PRO.
By Akshay. R. Kohli, Prof. N. G. Gore (2016), Maharashtra
In this paper, the authors explain that the structural design is the concept of analyzing and designing any structure with ultimate strength, safety, serviceability and economy. In this paper, the authors analyze G+11 residential building situated in Mumbai for earthquake zone III. The authors used IS code for planning to meet the specified requirements required by the clients. Due to lack of land due to increasing population, the construction was constantly demanding the construction of high rise structures. Due to construction of multi storied structure, it gets vulnerable to external forces such as wind, static, earthquake etc. which leads to instability of structure. To prevent the structures from such instability, the structure is analyzed for all lateral forces using the software STAAD PRO. The principle objective of the paper is to construct earthquake resistant structure by analyzing the structure using equivalent method of analysis and design using the STAAD PRO software. The overall safety of the structure is ensured by calculating all the loads applied on the structure caused due to wind and seismic activity.

Analysis and Design of High Rise Building (G+30) using STAAD PRO.
By Borugadda Raju and Mr. R. Rattaiah (2015) , Petlurivaripalem
In this paper, the authors explain the design and analysis of high rise building (G+30) using STAAD PRO using Limit State Method. The authors explain that STAAD PRO is one of the software that features power analysis, visualization tools and modelling of the structure. Initially, the authors analyzed 2D frames and checked accuracy and then they analyzed and designed G+7 storey structure with all possible load combinations. After the successful analysis of G+7 building, the authors analyzed and designed more multi storied building 2D and 3D frames under various load combinations. Finally, the authors analyzed and designed G+30 3D RCC frame for various load combinations (dead, live, wind and seismic loads). The codes of practice were also considered and specified for design point of view with other important details. The authors also checked the deflection of various members under various load combinations.

Analysis and Design of High Rise Building frame using STAAD PRO.
By Tejashree Kulkarni, Sachin Kulkarni, Anjum Algur and M. H. Kollhar (2016), Karnataka
With increase in the population, the availability of land is minimized which caused greater responsibility on the shoulders of civil engineers to construct a structure using minimum space of land. Earlier the building was constructed considering the horizontal space but due to lack of land nowadays the buildings are constructed for vertical space. In this research paper, the authors analyze the multi storied buildings considering all forces acting on a structure of, it’s self weight as well as SBC. The authors explain, good quality of beam and column reinforcement should be used to encounter the external forces acting on the structure. The authors write that the soil beneath the structure should be hard enough to equally distribute the forces on the ground. In case of loose soil, deep foundations are considered. The authors explain that as the number of floors increases the chances of human errors. The main aim of this study explained by the authors are to analyze and design of multi storied G+30 building considering STAAD PRO software with load combinations such as seismic and wind load.

Seismic Analysis of Multi Storied Building using STAAD PRO Software.
By Ms. Kalpita. R. Chawhan, Er. Mithilesh Kapse, Dr. Snehal Abhyankar (2023), Nagpur
In this research paper, the authors describe that in the 21st century, the rise in population leads to decrease of areas in unit day by day. In early years due to minimum population people used to stay in horizontal system. But at the present situation, the rapid rise of population leads to people preferring vertical system (high rise building). In this paper, the authors explains us that while considering high rise building all the forces, building’s own weight and SBC are considered. STAAD PRO helps us in easy and accurate calculations of building without any error and helps in easy analysis and design of building. STAAD PRO also helps in better serviceability of building. The main aim of this project helps in finding better technique for creating geometry and defining the cross-sections for columns and beams.

Design and Analysis of Multi Storied Building (G+10) by using STAAD PRO.
By Mr. A. P. Patil, Mr. A. A. Choudhari, Mr. P. A. Mudhole, Mr. V. Patole, Ms. A. D. Dange, Ms. S. K. Chendake (2017), Peth
In this paper, the authors describe that in every stage of human civilization, structures are needed to live. Due to increasing population the land space is decreasing, so to fulfill the needs of human beings multi storied buildings are needed and constructed. The construction of high rise structures are complicated, time consuming and difficult to carry out the calculations using conventional manual methods. In this project, the authors used software STAAD PRO. Using STAAD PRO software is a platform which provides easy, efficient, fast and accurate calculations for analyzing and designing of structures. The main objective of the project explained by the authors were the comparative study of design and analysis of multi storied building (G+10) by using both STAAD PRO software as well as manual design of the structure. The authors in the project analysed multi storied building (G+10) for calculation of bending moment, shear force, deflections and components such as beam, columns and slab with economic and efficient design. They also described that standard problems can also be solved in STAAD PRO software for different cases. The method used by the authors in this project is Limit State Method and the design of the structure were confirmed using Indian Standard code of practice. The various loads which were applied on 33 m height of building were wind and seismic loads along with concrete and steel construction. The height of each floor of the G+10 storied were 3.00 m. The overall plan dimension of the building were 21.30x14.0 m.

Seismic Response Analysis of Tall Building using STAAD PRO Software.
By Sangeeta Uikey, Er. Rahul Satbhaiya (2020), M. P.
The aim explained by the authors in this research paper for the whole project was the seismic response analysis of the tall building using the STAAD PRO software. The authors in the project manually calculated the load

calculations and the analysis of the structure were done by using the STAAD PRO software. For analysis and designing of the whole structure in STAAD PRO the method used were Limit State Method along with the reference from Indian Standard code of practice. The authors reveal that the results obtained in STAAD PRO were precise and accurate. The authors analysed G+4, G+9, G+14 storey buildings along with all possible load combinations (dead load, live load, wind load and seismic loads). STAAD PRO has very user friendly interface which provides user to simply draw and apply the load values and dimensions on the frame. As per the criterion specified, the whole structure was analysed for different seismic zones according to the IS Code. For the analysis, the material were chosen and the geometric cross section were assigned for beam and column members, fixed supports were applied for the analysis of the whole structure. For the specific design purpose of the structure codal provision were followed. Finally, then STAAD PRO software were used for analyzing of the structure. It also helps in determining lateral forces, bending moment, shear force and axial force.

To study Analysis and Design of Multi Storey Building using STAAD PRO and Comparison with Manual Calculations.
By Rashmi Agashe, Marshal Baghele, Vaishnavi Deshmukh, Sharad Khomane, Gaurav Patle, Kushal Yadav (2020), Nagpur
The authors in this paper described that, structural planning is an art and science for designing economical, durable and practical structure. The authors explain that this project is based on theoretical design and analysis of the structure. The authors explained the importance of imagination, sound knowledge and thinking in civil engineering for complete process of structural planning and design required by the structure. At the initial stage, the authors analysed G+4 residential building with the reference of IS code. The authors first manually calculated and designed the structure and then verified it in the STAAD PRO. The method used in the Limit State Method which was used for design of slab, beam etc. The IS 456-2000 code was also used for reference along with it for application of different loads on the members IS 875-1987 (Part 1,2,3) were also considered.

Seismic Analysis of Multi Storey Building (G+9) by using STAAD PRO.
By Tejaswini Wagh, Disha Patel, Krupa Phakatkar, Dipti Yenegure, Prof. Miss. Tejashri. S. Gulve (2021), Pune
According to the authors, seismic analysis is the sunset of structural analysis and is the calculation of the building structure to earthquakes. The authors explain that earthquake is the natural phenomenon that has the capability to most of the structural disruption. As the preventive measure, the building should be constructed with proper safety of people by following adequate design and detailing of the components of the structure, the authors explain that the building should be ductile in the event of breakdown during earthquake preventing the structure from seismic force of the multi storied working. Proper seismic investigation and planning were considered one of the important factor for protection of structure during earthquake conditions. The main motive of the seismic resistance building is to construct the structures that can perform better in comparison to conventional counterparts during seismic activity. In this project, the authors analyzed and designed G+9 RCC building by applying dead load, live load. Designs of beam, slab, column and footing were also acquired. The whole structure was evaluated under STAAD PRO software. In this present conditions, explained by the authors a lot of new softwares were available in the market but STAAD PRO is considered as one of the most used software for earthquake analysis and design as well as behavior of multi storied buildings. The method used in this project by the authors for analysis and design was Equivalent Static Method. The authors concluded that STAAD PRO was one of the best software for multi storey structure designs.

Seismic Analysis and Design of Building Structures in STAAD PRO.
By Anoop Singh, Vikas Srivastava, N. H. Harry (2016), U. P.
The authors describe that structural analysis and seismic analysis of any structure were important factors required for structural designing before construction of any structure. They also explained that seismic analysis was the calculation of response of a structure subjected to earthquake excitation. Variety of earthquake data were required to carry out the earthquake analysis of the structures. In this the seismic analysis of the structure was carried out in the form of member forces, storey drift etc. The response was calculated for G+10 multi storied building using the STAAD PRO designing software. In this project the authors observed the reduction of cases ordinary moment resisting frame. For this project the authors considered earthquake zone II, response factor 3 for ordinary moment resisting frame and importance factor 1. The fundamental natural period calculated by STAAD PRO matched with calculation considered by IS 1893:2002. The projects maximum drift in the building was obtained as 2.077 cm which was safe as per IS 1893-2002.

Seismic Analysis and Design of Multi Storey Building in STAAD PRO for Zone II.
By Pushplata Armo, Mr. Bhavesh Kumar Jha (2022), Jagadalpur
The authors explain that earthquake is one of the natural disaster which when occurs causes a lot of disruption and destruction such as loss of life, property etc. It causes emotional, physical damage to mankind such as it makes people homeless. Many children lose their parents, women lose their husbands and become widow and the economy of the country also suffers. Earthquake release seismic waves and the economy of the country also suffers. Earthquake release seismic waves and when the buildings are subjected to seismic waves, the foundation on which the building stands begin to shake causing the whole structure to shake and collapse. Seismic analysis helps in finding and determining the structure's behavior under the event of an earthquake. Nowadays, due to shortage of area, vertical space is acquired and building are constructed as multi storeyed high rise structure both for residential and commercial purpose. But high rise structures were not be able to resist lateral force leading to structure's complete failure. In this project the authors analyzed G+4 structure to determine the ductility of the structure. The analysis of the building was performed using STAAD PRO software considering IS 1893:2002 code for seismic parameters.

Design and Analysis of High Rise Building using STAAD PRO.
By T. Dinesh Kumar, Mohammed Ismail Pasha Quadri, Mohammed Sohail Ali, Syed Abdul Rahman, Mohammed Akbar Khan (2019), Telangana
The authors explain the main principle objective of the project is to analyze and design a multi storied structure G+10, 3D frame using the software STAAD PRO. The method applied by the authors for analysis in STAAD PRO was Limit State Design Method conforming to Indian Standard code of practice. The authors also describe that STAAD PRO software is one such software which provides visualization tools, powerful analysis and design of the structure with advanced finite element and it also had dynamic analysis capabilities, state of the art user interface and many such features, type of software which performs model generation, analysis and design to visualization and result verification. The loads to be applied for design purpose for residential building were gravity load including dead and live loads, lateral load and only wind loads were included. The total height of building on which analysis and design were performed were 30m and the area of the residential building was around 9,048 sq. ft.

Seismic Analysis and Design of a Multi Storied Building of (G+15) by using STAAD PRO.
By Lakkala Harish Kumar, V. Siva Rajasekhar Reddy, N. Vijaya Kumar (2021), Andhra Pradesh
The authors in this paper first explains the concept of multi storied building. According to the authors a multi storied building was a building or structure that has many number of floors above the ground. The main and only one aim of multi storied building was to vertically increase the floor area saving the land and money. They explain that analysis of multi storied frames have a lot of complications and tedious calculations using conventional methods. Generally, such high rise structures may fail in bending moment and shear force applied on the various building components. To prevent such failure, beam, columns, footings to be constructed by considering maximum loads on members. In this project, the authors analyzed G+15 storey frame. The design of the structure was made using software on structural analysis design (STAAD PRO). The building was put through both vertical as well as horizontal loads. The vertical loads consisted of dead loads on components such as beams, columns, slabs etc. and live loads. The horizontal load consisted wind forces. Therefore, the whole building was designed for dead load, live load, wind load and seismic loads considering IS 875.The structure was designed for 2D vertical frame and it was analyzed for minimum and maximum bending moment and shear force using trial and error methods in reference with IS 456-2000.The whole analysis design and computation of loads, bending moment, shear force were applied and obtained using STAAD PRO software.

Study on Seismic Analysis of High Rise Building by using Software.
By Balchandra P. Alone, Dr. Ganesh Awchat (2017)
In this review paper the authors explained that high rise buildings are constructed everywhere in the world. The height and size of high rise buildings get larger and larger. The structural design of high rise building depends on dynamic analysis for earthquake. This paper addresses the case study on seismic analysis of high rise building system by STAAD PRO with application of IS Provisions. It tells that earthquake is one of the most frightening and destructive phenomena of nature and it's terrible after effect. It is impossible to prevent the earthquake but it's effect and damage can be controlled through proper design and detailing. So, it's important to do the seismic analysis and design of structure against collapse. The structure should be designed in such a way that it should reduce the damage during an earthquake which makes the structure quite uneconomical as the earthquake might or might not occur in it's lifetime and is a rare phenomenon. This review paper mainly explains the understanding of the results from the software under gravity load provision made in IS 456-2000.

Results shall satisfy the general criteria from being a failure, after analysis result to improve the accuracy as per code IS 1893:2002.

Seismic Analysis of High Rise Buildings (G+30) by using Software.
By Dr. K. Chandrashekhar Reddy and G. Lalith Kumar (2019)
In this paper, the software used for seismic analysis is ETABS. ETABS stands for Extended 3-D Analysis of Building System. The authors explain that in the present situation of construction industry, the buildings that were being constructed were gaining significance, those with best possible outcomes which were referred to members like beams and columns in multi storied RC structures. The software is mainly used for structures like high rise buildings, steel and concrete structures. This paper mainly focuses to analyze a high rise building of 30 floors by considering the seismic load, dead loads and live loads. The design criteria for high rise buildings are strength, serviceability and stability. In this paper, the authors were mainly determining the effects of lateral loads on moments, shear force, axial force, base shear, maximum displacement and tensile forces of structural systems which were subjected.

Dynamic Analysis of the Twin-Tower High Rise Structure with Basement.
By Jadav Bhavesh Bhanajibhai, N. B. Umravia (2020), Gujarat
In this paper, the authors explain that structural development in the metro city has rapidly increased as there were many high rise construction projects that have been carried out. Structural analysis was the fundamental part of the design of high rise structure with same height and geometry. The problems faced were vehicle parking and other basic enmities space. So, many structures were provided with multiple floors or underground basement parking. This paper, primarily focuses on the study on considering effects of influence parameters like height of the tower; connection with basement and depth of basement with two parallel towers having a common basement. The main objective to study the twin-tower in linear dynamics earthquake analysis have been considering on the behavior of structure G+20, G+25 and G+30 stories symmetrical twin-tower without an underground basement with 2 and 4 numbers of basement. The author also studied the seismic response of the superstructure by observing the variation of internal stress results such as base shear, storey displacement storey shear. The analysis results were obtained from all models which were performed by using various linear dynamic structure analysis such as ESEM, RSM and THA.

Analysis and Design of High Rise (G+25) Residential Building.
By Faraaz Siddiqui, Zaid Memon, Shaikh Khalid, Shaikh Abrar, Majeed Pathan (2021), Mumbai
In this review paper, the authors explain the analysis of high rise structures. High Rise Buildings are constructed everywhere in the world. The height and size of high rise buildings were increasing. The structural design of high rise buildings depends on dynamic analysis for winds and earthquakes. The analysis of buildings were performed on the computers using softwares like ETABS. In the present situation of construction industry, the buildings that were constructed were gaining importance. This software was mainly used for high rise buildings, steel and concrete structure. The paper aims to analyze the high rise buildings (G+25) with consideration of seismic, dead and live loads. The design criteria for high rise buildings were strength, stability and serviceability.

Seismic Performance evaluation of a tall building; Practical modelling of surrounding Basement Structures.
By Seung Yong Jeong. Thomas H-K Kang, Jang Keun Yoon, Ron Klemencie (2020)
In this review paper, the authors describe the performance evaluation of 49 storey residential building under construction. The building for this case study has an irregular plan and deep basement. A series of non linear time history analysis were carried for maximum considered earthquake (MCE) and Rare Earthquake (RE). The authors studied the effects of modelling methods of basement. Modelling of the surrounding underground structure included transfer of torsional modes, which can easily be amplified by high frequency components of ground motions and resulted in localized damage caused at the upper part of the building. The authors explain the analysis with the basement model surrounded by underground structures and non-soil structure interaction for the design.

Seismic Analysis and Design of G+9 RCC Residential Building in STAAD PRO.
By Rajat Srivastava and Sitesh Kumar Singh, Rajasthan
In this review paper, the authors explain that the tall structures have turned out to be overall engineering wonder. From past earthquakes it was identified that important number of structures were harmed because of earthquake and presently, it had turned out to be important to decide the seismic reactions over high rise structures. Structural Analysis; it’s a branch which includes the assurance of structures with a specific end goal

to see the reactions of genuine structures. Basic outlining required seismic examination of any structure before development. In general, it satisfied the prerequisite of the expanded populace in the constrained territory. To guarantee the wellbeing against seismic powers of multi storied working, it was necessary of the seismic examination study and planning for the protection of the structures against earthquake. The principle target of this paper was to think about the seismic investigation of structure for static and dynamic examination. The base necessities related to the basic security of structures were being secured by the method for setting out the base plan loads which must be accepted for dead loads, forced burden and other outside loadings. The total structure was analysed using STAAD PRO software.

Determination of Efficient Twin Tower, High Rise Building subjected to Seismic Loading.
By Surendra Chaurasiya and Sagar Jamle (2018), Indore
In this paper, the authors explain about the architectural vision of multi storied building design and its demanding growth. Various architectures used to make the structure with their own choice and it had been proved that the high rise building act as very vital role in new and modern cities. The problems faced for the construction by the area should be solved by the architectural view. With complex and different plan on the structural point of view. Such types of structures were twin-tower buildings used in this modern world. In this study, the comparison of results such as displacement and storey drift were obtained in terms of the multi storied building. Seismic effects were acting on the structure under 13 different cases and analysis with the help of STAAD PRO program.

Horizontally connected High Rise Buildings under Earthquake Loadings.
By Sayed Mahmoud (2019)
In this review paper author explains responses to lateral loads induced by wind and earthquakes were among the governing factors in structural design of the structures. In the recent situation adjacent tall buildings were being horizontally connected for different uses, such horizontal linkages potentially change the behavior of the structure, which limits the applicability of design codes. The research paper explains the response of linked high rise buildings, under earthquake loads, following the design code requirements. The building configurations were excited by a set of ground motion records with different ground accelerations were separately applied in two orthogonal directions and the responses to each connecting bridge location affects the dynamic load induced response of the building structures.

Earthquake Analysis of G+10 Buildings using Response Spectrum Method.
By Prakriti Chandrakar, Dr. P. S. Bokare (2017), Bhilai
In this paper, the authors describe about the earthquake occurrence in recent past indicated if structure were not properly designed and constructed may cause great damage to the structures. So, the authors explain the importance of safety against the dynamic force like earthquake force that are negatively impacting the structures and to determine seismic responses of such kind of buildings. THA was important technique for seismic analysis particularly when evaluated structural response was non linear. In present situation of construction an attempt had been made to study the dynamic behavior of G+10 multi storied building frame for the frames using RSM and THA. The study focuses to evaluate the important parameters such as base shear and maximum deflection. Analysis had been carried using ETABS software.

Study of Seismic Analysis and Design of Multi Storey Symmetrical and Asymmetrical Building.
By Pardeshi Sameer, Prof. N. G. Gorge (2016), Maharashtra
In this paper, the authors discuss the current version of the IS:1893-2002 that is suitable for practically all multi storied buildings be analyzed as three dimensional systems. Buildings may be considered as asymmetric in plan, in mass and stiffness along the storey, of the buildings. Mass and stiffness were two basic parameters to evaluate the dynamic response of the structural system. The authors explained that the multi storied buildings behave differently depending upon the various parameters like mass-stiffness distribution, foundation types and the soil conditions. This paper was concerned with the effects of various vertical irregularities on the seismic response of a structure.

Analysis and Design of G+19 Storied Building using STAAD PRO.
By D. R. Deshmukh, A. K. Yadav, S. N. Supekar, A. B. Thakur, H. P. S. Sonawane I. M. Jain (2016), Pune
In this research paper, the authors explain that the calculations of high rise structures were time consuming through conventional manual methods. Using STAAD PRO provides accurate, fast and efficient software for analysis and design of structures. The main objective of this project was for analysis and designing of multi storied building G+19 (3D frame) using STAAD PRO software. In this, the authors used G+19 multi storied building applying wind load, static load. The authors used Limit State Design method and Indian Standard code

of practice. The authors used various loads such as wind load, static load and earthquake load and the results were compared with the manual calculations.

III. METHODOLOGY

Step-1: Modeling:
With respect to the consideration of type of structure modeling has been done using CENTER LINE PLAN .

Step-2: Generation of Nodal Point:
As per the planning with respect to the positioning of column in building, their respective Nodal point has been created on that model.

Step-3: Property Definition:
Using General-Property command define the property as per size requirement to the Respective building on STAAD-Pro. So, beam and columns have been generated after Assigning to selected beam and columns.

Step-4: Create and Assign Support & Member Property:
After column definition at supports have been provided as fixed below each column by Selecting columns using Node Curser and its cross-section assigning based on load Calculations and property definition.

Step-5:3-DRendering:
After The dead load contains of the weight of walls, partitions floor finishes, false ceilings, floors and the other permanent standing construction in the buildings. The dead load loads are estimated from the dimensions of various members of building and their unit weights. The unit weights of plain concrete and reinforced concrete taken as 25kN/m3.The unit weight of masonry taken as 19kN/m3 As per IS:1893 (Part 1)-2016, the dead load have been assigned on the basis of member load, floor load, self-weight of the beams definition.

ii. Live Load
As per IS:875 (part 2)-1987, live load 2kN/m has been assigned to the members.

iii. Seismic Load
IS: 1893 (Part 1): 2016, the seismic load has been assigned with respect to +X, -X, +Z, and –Z directions with their respective appropriate seismic factor.

iv. Load combination
Required load combinations cases for seismic analysis have been assigned to the model based on specified loading combinations provided in the Indian standard CODES that are also available in STADD-Pro.

Step-6: Load Assignment:

i.Dead load
The dead load contains of the weight of walls, partitions floor finishes, false ceilings, floors and the other permanent standing construction in the buildings. The dead load loads are estimated from the dimensions of various members of building and their unit weights. The unit weights of plain concrete and reinforced concrete taken as 25kN/m3.The unit weight of masonry taken as 19kN/m3 As per IS:1893 (Part 1)-2016, the dead load have been assigned on the basis of member load, floor load, self-weight of the beams definition.

ii. Live Load
As per IS:875 (part 2)-1987, live load 2kN/m has been assigned to the members.

iii. Seismic Load
IS: 1893 (Part 1): 2016, the seismic load has been assigned with respect to +X, -X, +Z, and –Z directions with their respective appropriate seismic factor.

iv. Load combination
Required load combinations cases for seismic analysis have been assigned to the model based on specified loading combinations provided in the Indian standard CODES that are also available in STADD-Pro.

Step-7:Structural analysis on STADD-Pro.
After adding Analysis/Print, using Run Analysis Command, the structure is analyzed and detailed study of forces and bending moment is undertaken through the Post processing mode to recognize their shear forces, bending moment diagrams to it check is safe or not.

IV. NUMERYCAL STUDY

4.1 Description of Building Model

In the present study, CIVIL LINE BHAGRATHI TEXTILE 2B+G+27 Storeyed residential building model is taken for analysis The building is in NAGPUR The general features of the building model used in the building are given in Table 6.1. The grades of reinforcing steel and concrete used in the building are Fe500D and M25 respectively. The material properties used for concrete and steel are given in the Table 6.2.

4.2.1 General features of the model structure:

Table 6.1

1.	Length	40m
2.	Width	29m
3.	Height	84m
4.	Height (including basement)	90m
5,	Height of each basement	3m
6.	Height of each floor	3m
7.	Slab thickness	150mm
8.	Shear wall thickness	400mm
9.	Beam size	750x300mm
10.	Column size	2000x500mm

Table 6.2

1.	Property	Concrete	steel
2.	Density (kg/m3)	25	fe550D

4.2.2 The building is seismic analysis for the following parameters:

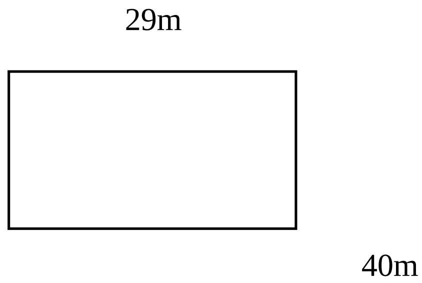
1. Seismic Zone – II
2. Type of the soil: Medium soil.
3. Response Reduction factor(R) = 3 for OMRC.
4. Floor Height = 3m
5. No. Of storey = 2B+29 nos.
6. External thickness of wall = 230mm
7. Internal thickness of wall = 150mm
8. Beam Size: 750x300 mm
9. Column Size: 2000x500
10. Slab Thickness: 150mm
11. Live Load: 2KN/m^2 as per IS 875 part 2 (table 1)
12. Earthquake Load = IS: 1893-2016
13. Grade of Concrete: M50
14. Grade of steel = fe550D
15. Damping ratio = 5 (cl.no. 7.2.4)
16. Importance factor (I) = 1.2 (table 8) cl.no. 7.2.3

17. Seismic zone factor Z = 0.10 (table 30 cl.no.6.42
18. seismic data as per requirement of IS: 1893 (Part 1): 2016, the seismic load has been assigned with respect to +X, -X, +Z, and –Z directions with their respective appropriate seismic factor.

From the analysis,

1) Calculation

   1. Height of story = 3m
   2. Height of structure = 84m
   3. No. of story = 28
   4. Design life of structure = 50 years assume
   5. Location of structure = Nagpur



6. Maximum dimension = 84m
7. Slab thickness = 150

1) Step 1

Design wind speed (Vz) (cl. No.6.3)
Vz = Vb*k1*k2*k3*k4
Vb = 44m/s (appendix A city Nagpur) (cl. No. 6.2)K1 = 1 (table 1) (cl.no. 6.3.1)
K3 = 1 (cl. No. 6.3.3)
K2 =1 (cl. No. 6.3.2)
K4 = 1 (cl. No. 6.3.4)

Category = 4 (table no. 2)Class

Height	K2
10	0.80
15	0.80
20	0.80
30	0.97
50	1.10
100	1.20

Vz =Vb*k1*k2*k3

Height	Vb	K1	K2	K3	Vz
10	44	1	0.80	1	35.2
15	44	1	0.80	1	35.2
20	44	1	0.80	1	35.2
30	44	1	0.97	1	42.68
50	44	1	1.10	1	48.4
100	44	1	1.20	1	52.8

1) Step 2 Design wind pressure (Pz) (cl. No. 7.2)

Pz =0.6*Vz (kN/m2)

Height	Vz	Pz = 0.6*Vz2
10	35.2	43.42
15	35.2	43.42
20	35.2	43.42
30	42.62	1002.94
50	48.2	1405.53
100	52.8	1672.70

1) Step 3 Design wind load (F)

F = Cf *Ae*Pz Cf (cl. No. 7.4)

Condition 1) h/b > 1 graph 4a

2) h/b < 1 4b

1) 84/40 = 2.1 h/b >1 (graph 4a)Cf = 2.1

2) Ae = 8.6*1m2 Ae = 8.6 m2

Height (m)	0-10	10-15	15-20	20-30	30-50	50-100
Intensity F(kN/m^2)	13.42	13.42	13.42	19.73	25.38	30.20

4.4 Load combinations as per IS 456:2000

Sr. No.	Load combination
1	1.5DL+1.5LL
2	1.2(DL+LL+EQX)
3	1.2(DL+LL-EQX)
4	1.2(DL+LL+EQY)
5	1.2(DL+LL-EQY)
6	1.5(DL+EQX)
7	1.5(DL-EQX)
8	1.5(DL+EQY)
9	1.5(DL-EQY)
10	0.9DL+1.5EQX
11	0.9DL-1.5EQX

12	0.9DL+1.5EQY
13	0.9DL-1.5EQY
14	1.2(DL+LL+WLX)
15	1.2(DL+LL-WLX)
16	1.2(DL+LL+WLY)
17	1.2(DL+LL-WLY)
18	1.5(DL+WLX)
19	1.5(DL-WLX)
20	1.5(DL+WLY)
21	1.5(DL-WLY)
22	0.9DL+1.5WLX
23	0.9DL-1.5WLX
24	0.9DL+1.5WLY
25	0.9DL-1.5WLY

4.5. Analysis model on STAAD-PRO:-

4.5.1 Introduction to Staad-Pro

Our paper involves analysis and design of multistoried (7-story) using a worldwide mostcommon used designing software STAAD-Pro.

i. Advantages of STAAD-Pro:

1. Confirmation with Indian standard Codes,
2. Versatile nature of solving any type of problem,
3. Easy to use interface,
4. Accuracy of the solution.

ii. Features:

1. STAAD-Pro features a user interface, visualization tools, powerful analysis and design appliance with advanced limited element and dynamic analysis efficiency

2. From model generation, analysis and design to output visualization and resultverification, STAAD-Pro is the specialist's best choice forconcrete, steel, aluminum, timber and cold-formed steel design of low and high-raised multistoried buildings, culverts, petrochemical plants, tunnels, bridge, piles andmuch more.

4.5.2 Getting Started

In this paper, methodology of structural analysis and design on STAAD-Pro and step by step procedure of has been explained with the help of diagrams. Further, load calculationshave been explained in depth/thickness and manual wind load calculations have also beenincluded in this report.

5. For development of the model following data is going to be assumed:-

1.Slab Thickness =125mm
2.Floor Finish = 1.5 KN/m^2
3.Live Load = 2 KN/m^2 as per IS 870 (Part 2)
4.Earthquake Load = Zone IV (assume so that effect can be visible)
5.Wind Load = 28m/s (Basic speed of wind IS 870 Part III).

V. ANALYTICAL STUDY

5.1 ANALYSIS RESULTS

Some of the sample analysis results have been shown below for beam number 64 which isat the roof level of top floor (28th Floor).

5.1.1 Column

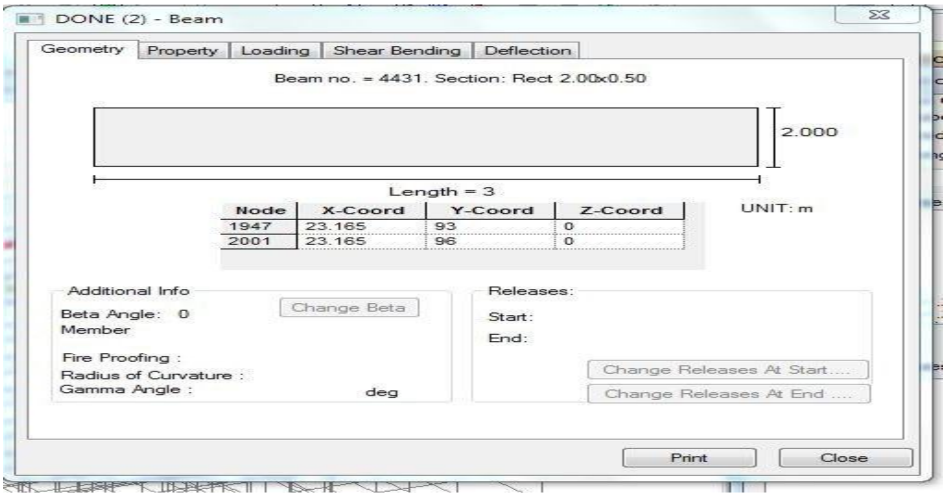


Fig No. 5.1 Geometry of Column

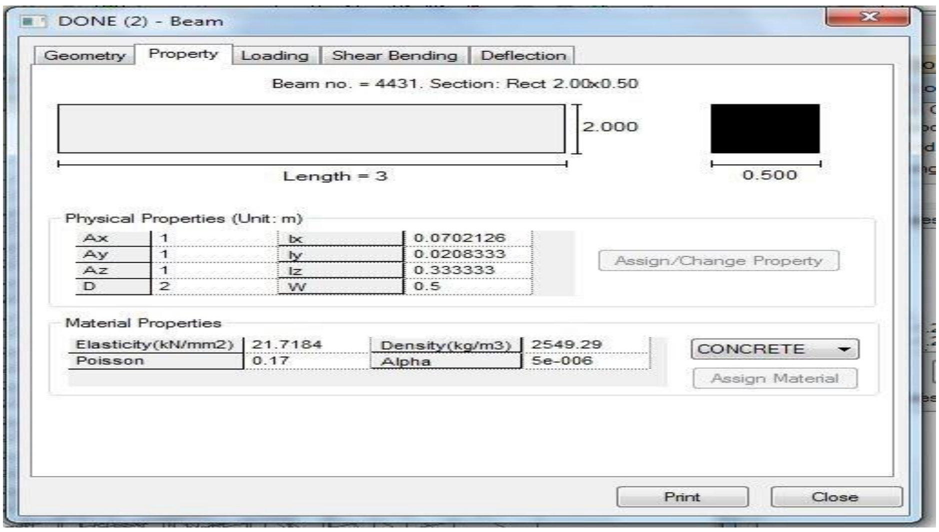


Fig No. 5.2 Property of Column

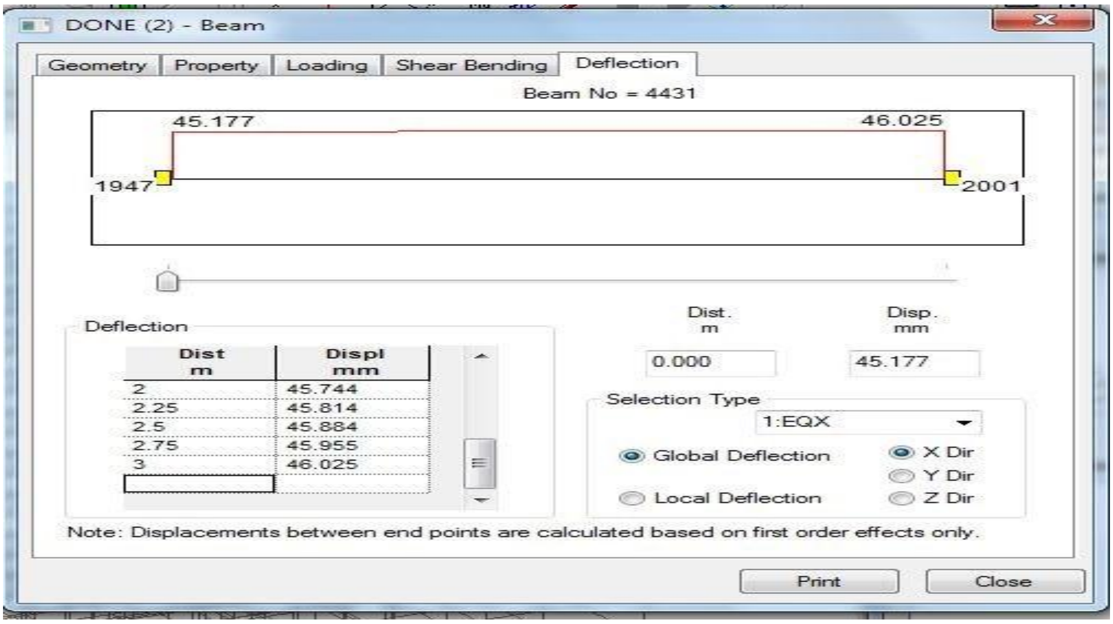


Fig No. 5.3 Deflection of Column

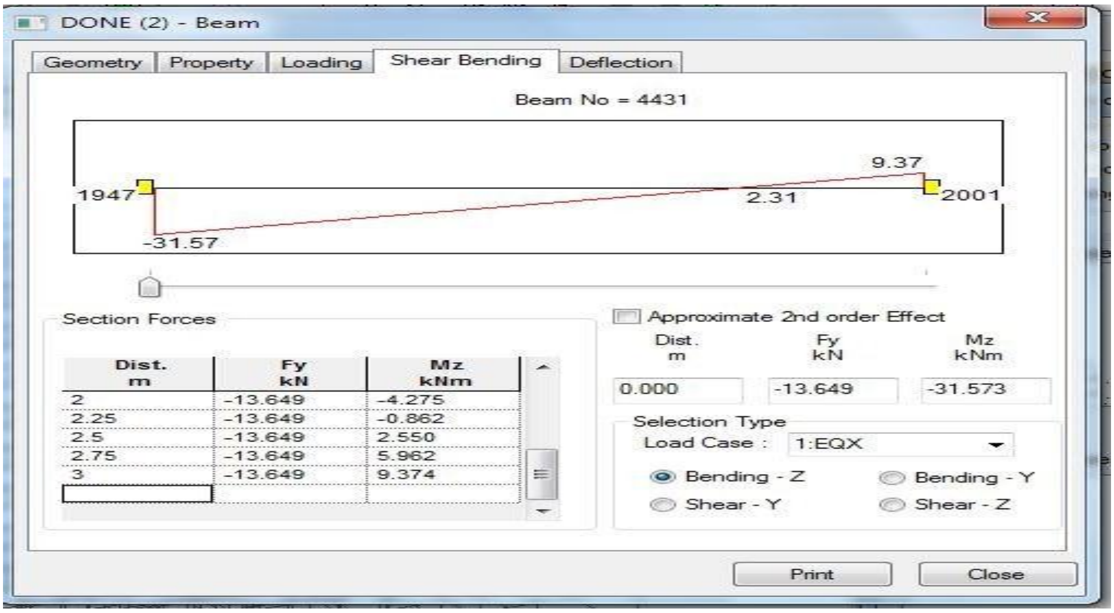


Fig No. 5.4 Shear Bending of Column

5.1.2 Beam

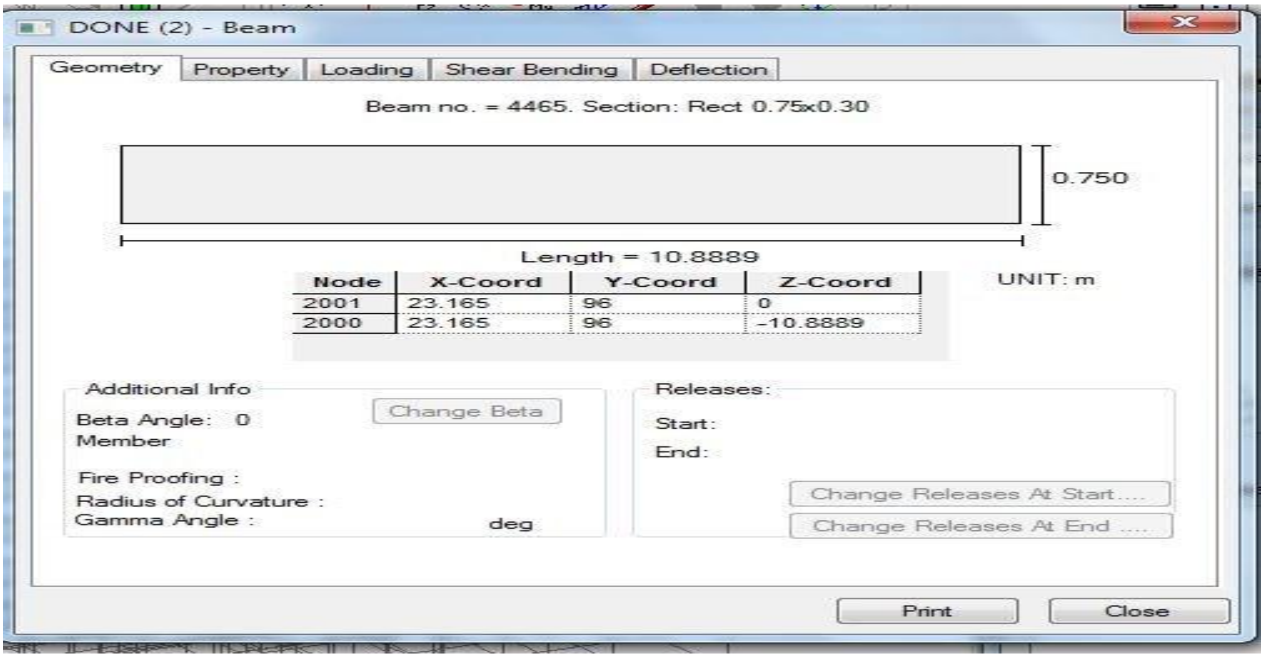


Fig No. 5.5 Geometry of Beam

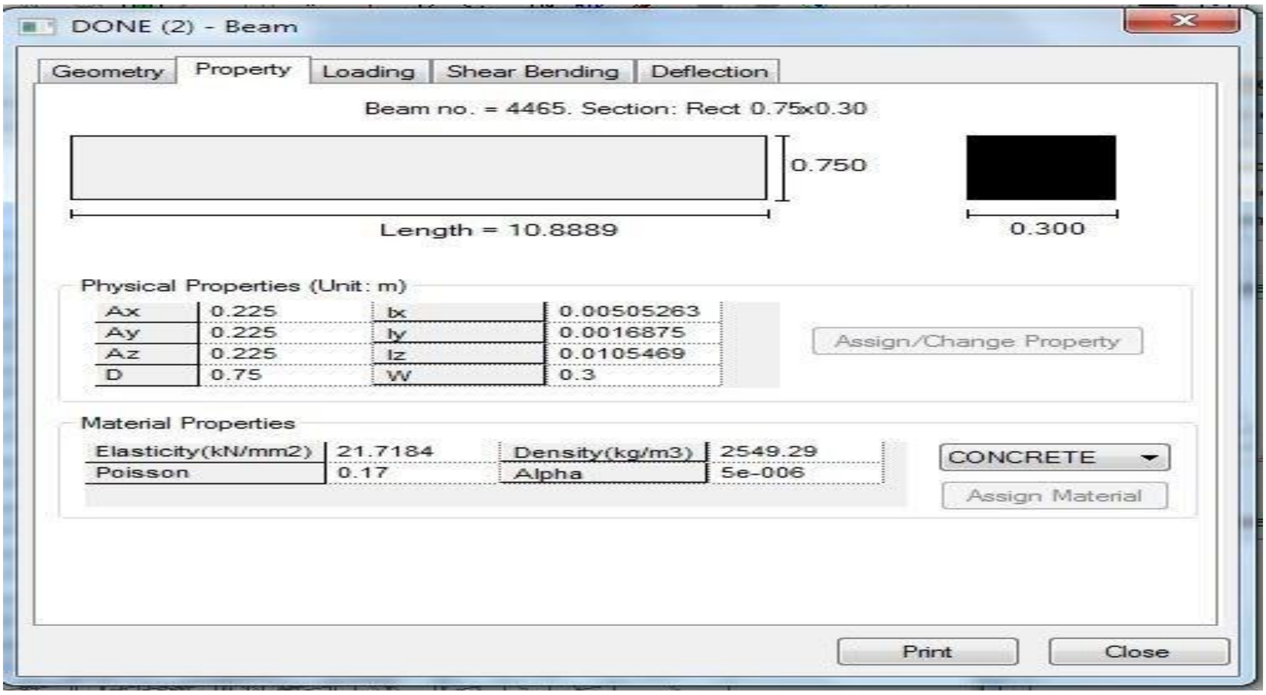


Fig No. 5.6 Property of Beam

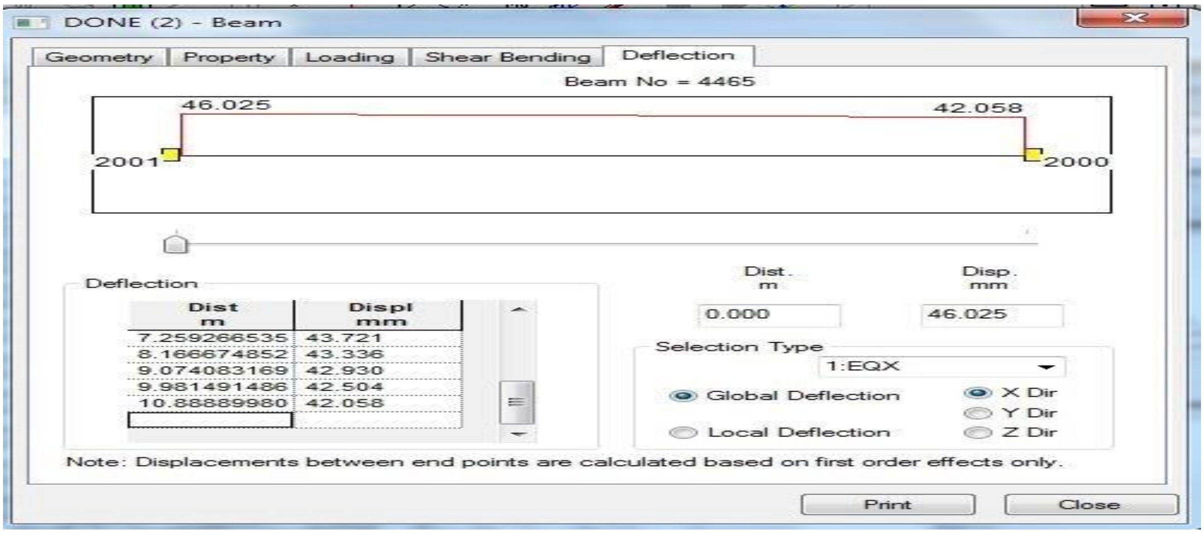


Fig No. 5.7 Deflection of Beam

5.2.3 Post Processing

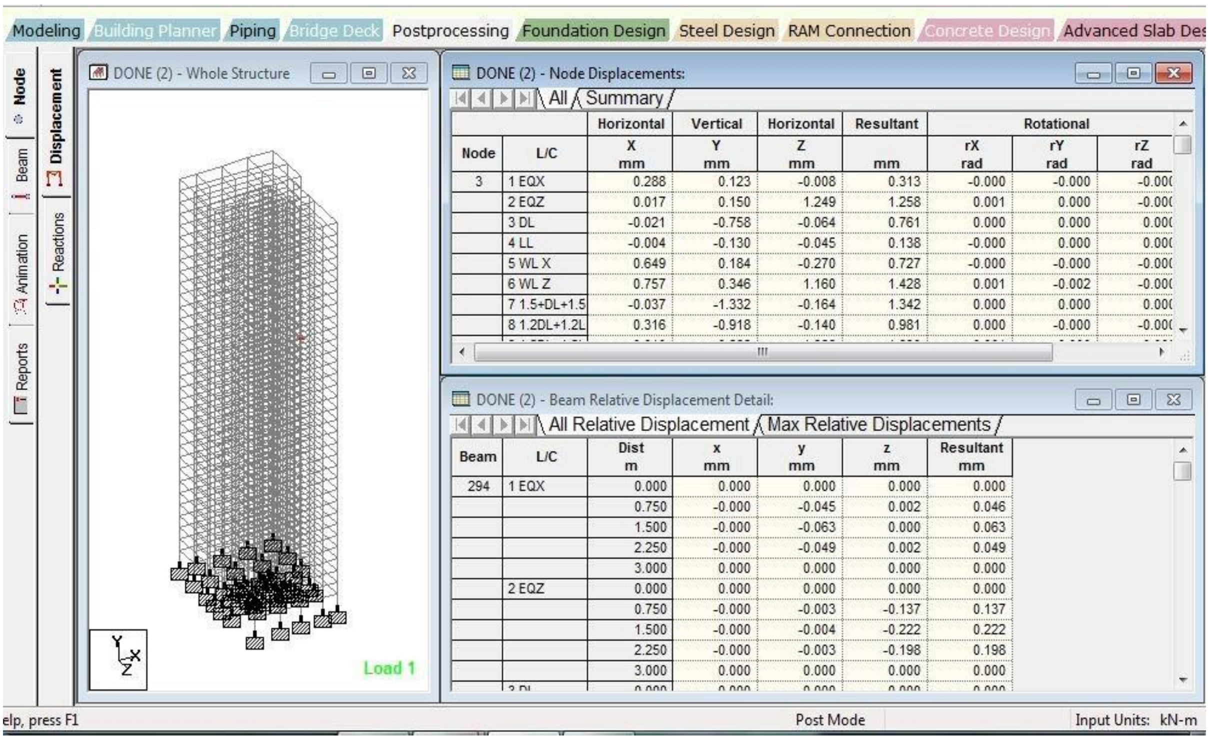


Fig No. 5.8 Post Processing mode in staad pro

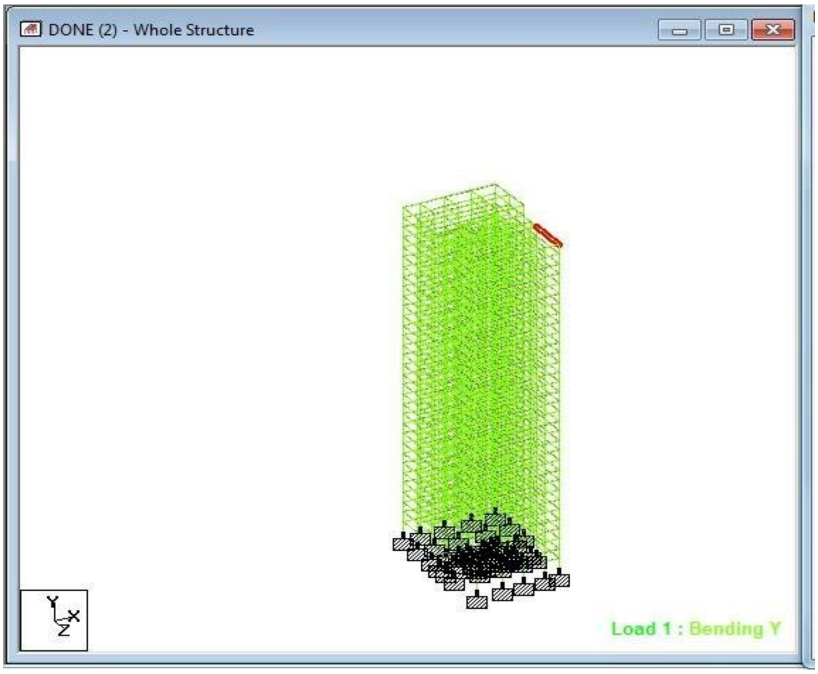


Fig No. 5.9 Bending in Y

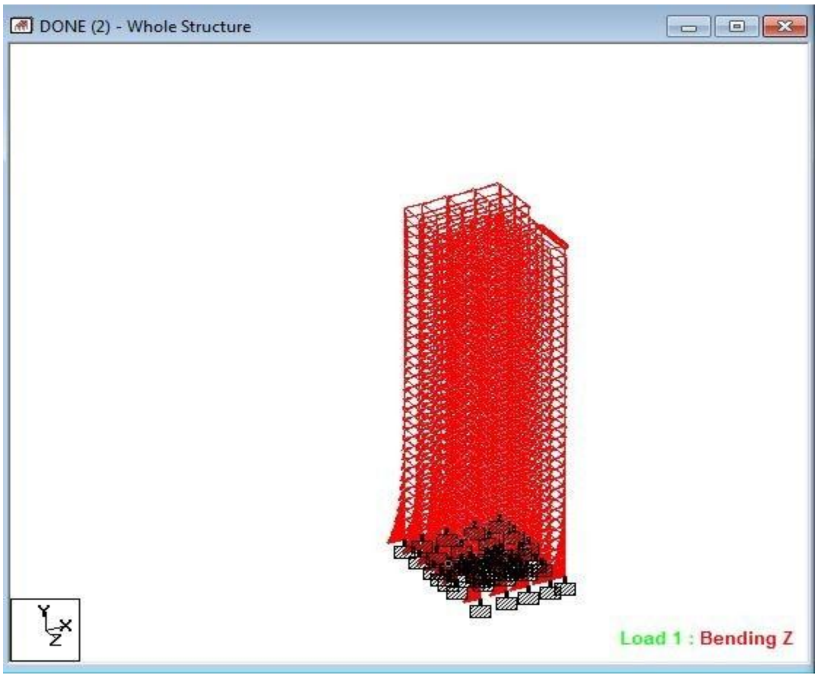


Fig No. 5.10 Bending in Z

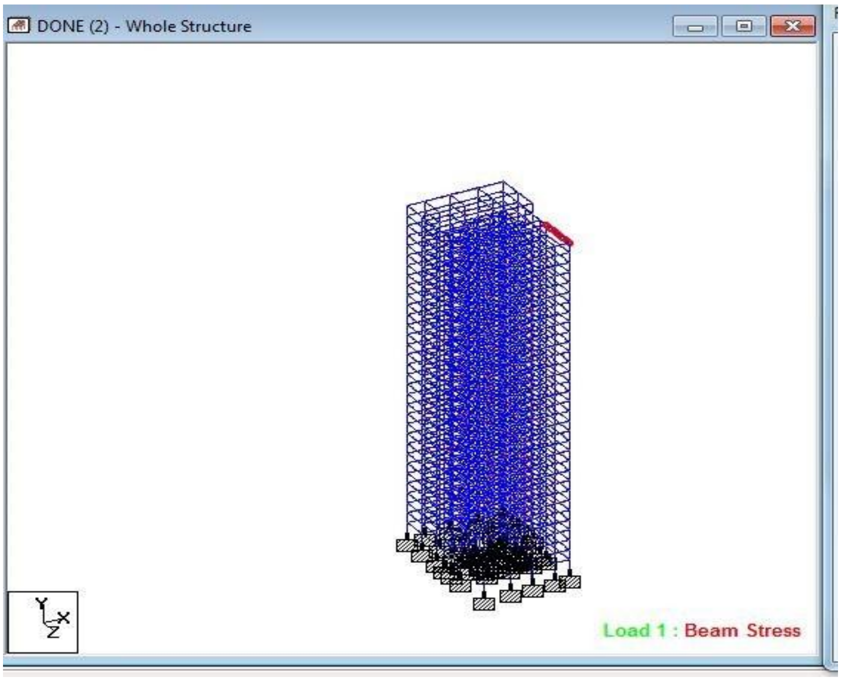


Fig No. 5.11 Beam Stress

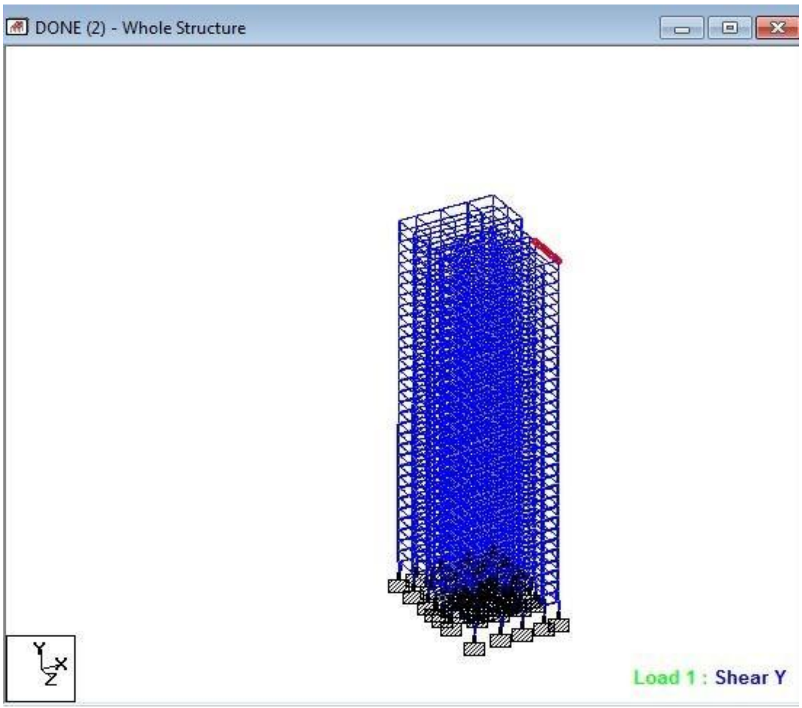


Fig No. 5.12 Shear Y

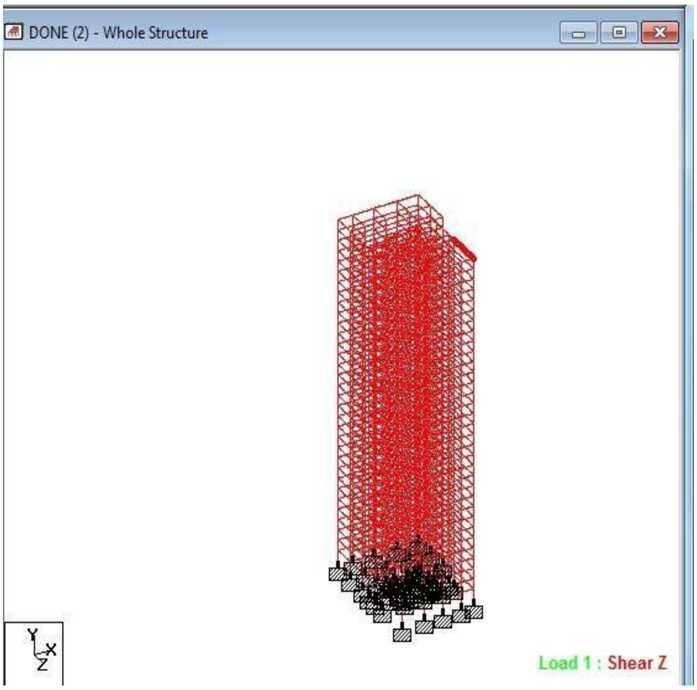


Fig No. 5.13 Shear Z

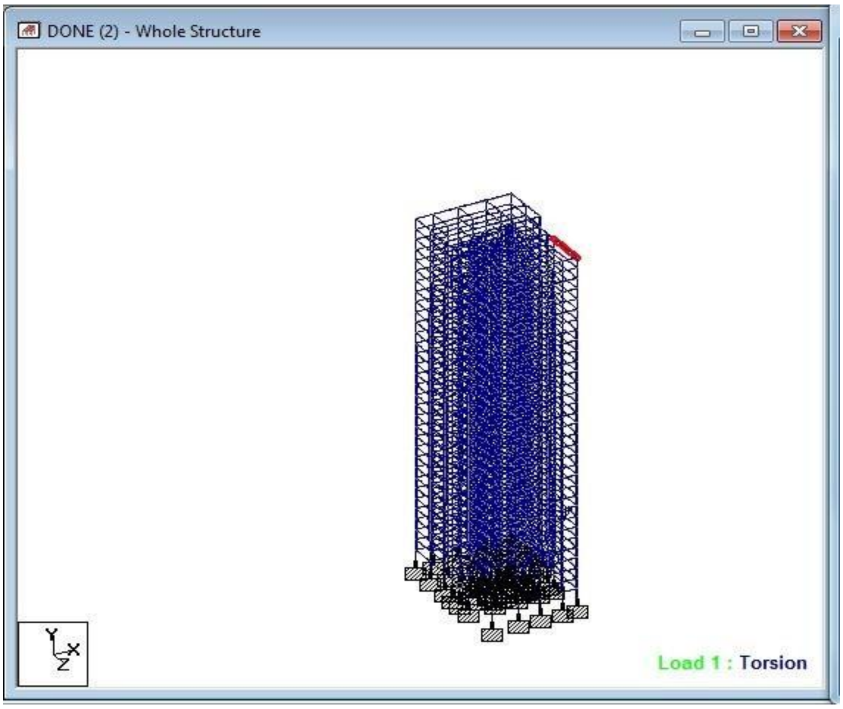


Fig No. 5.14 Torsion

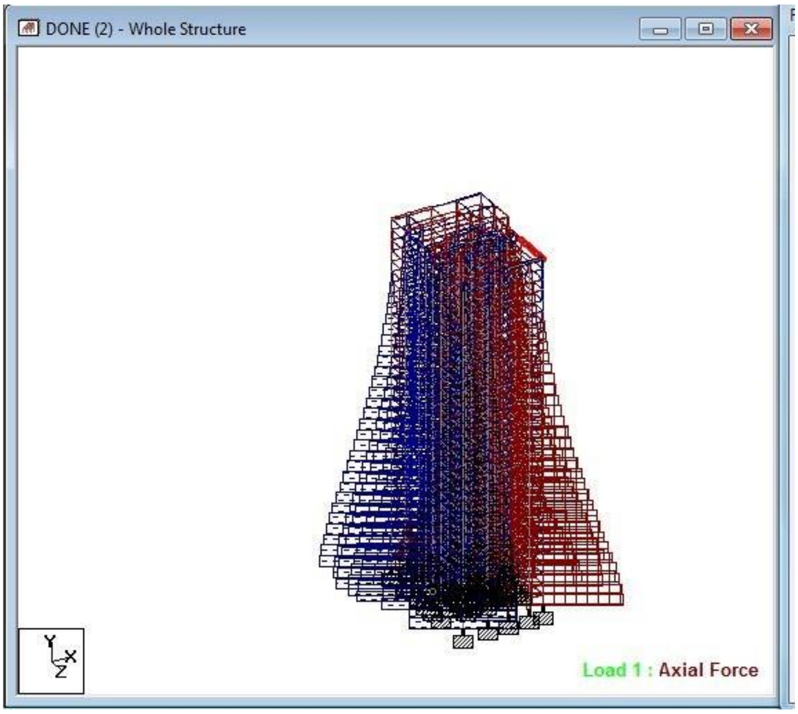


Fig No. 5.15 Axial Force

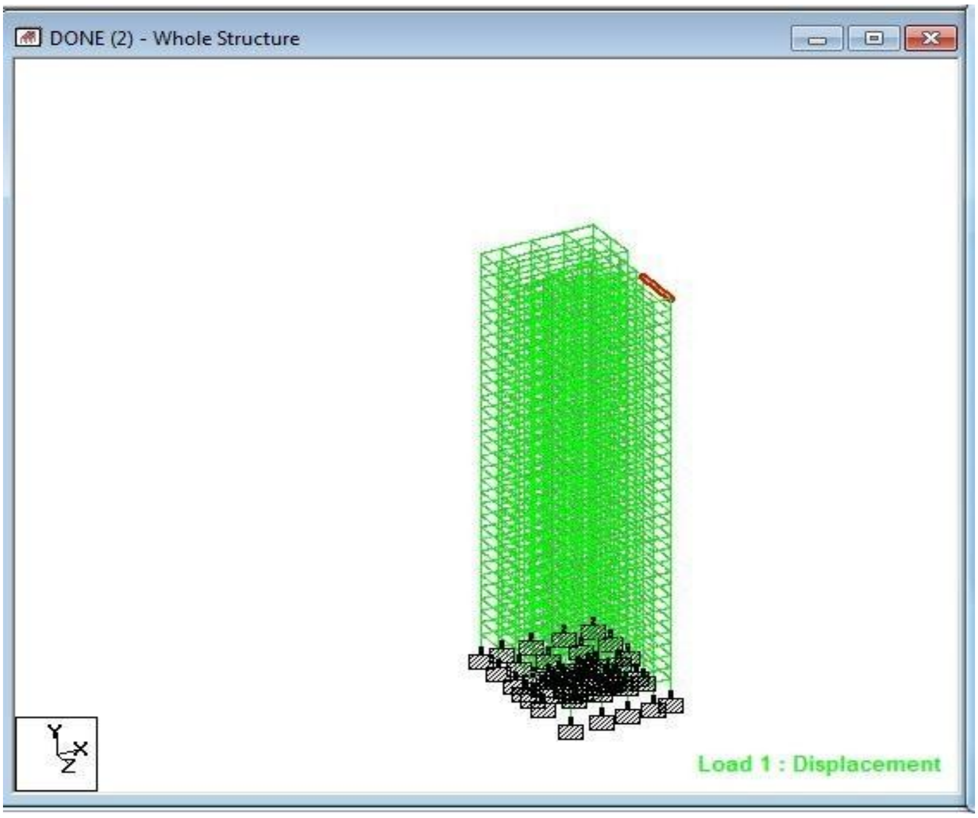


Fig No. 5.16 Displacement

VI. CONCLUSION

From the above, it is concluded that a lot of research have been carried on the Seismic Analysis and Design of High Rise Structures along with Double Basement using STAAD PRO SOFTWARE. The response of high rise structures under wind and seismic load as per INDIAN STANDARD

CODES OF PRACTICE WERE STUDIED. THE SEISMIC AND WIND LOAD ANALYSIS WERE STUDIED ON B+G+28 STOREY RESIDENTIAL BUILDING AS PER IS 456-2000, IS 1893-2016 6TH EDITION, IS 875 PART 2 AND 3.

REFERENCES

[1] Seismic Analysis of Multi Storied Building Frame using STAAD PRO , Volume 5, Issue 5, 202BOL

[2] Seismic Analysis and Design of Multi Storied Building in STAAD PRO for Zone II, Volume 11, Issue 05, 2022.

[3] Seismic Analysis and Design of a Multi Storied Building of (G+15) by using STAAD PRO, Volume 13, Issue 12, 2021.

[4] Analysis and Design of High Rise (G+25) Residential Building, Volume 8, Issue 5, 2021.

[5] Seismic Analysis of Multi Storey Building (G+9) by using STAAD PRO, 2021

[6] Seismic Response Analysis of Tall Buildings using STAAD PRO Software, Volume 3, Issue 1, 2020.

[7] To Study Analysis and Design of Multi Storey Building using STAAD PRO and Comparison with Manual Calculations, Volume 7, Issue 4, 2020.

[8] Dynamic Analysis of the Twin – Tower High Rise Structure with Basement, Volume 7, Issue 5, 2020.

[9] Seismic Performance Evaluation of a Tall Building; Practical Modelling of Surrounding Basement Structures, 2020.

[10] Seismic Analysis of Building using STAAD PRO, Volume 4, No. 5, 2019.

[11] Design and Analysis of High Rise Building using STAAD PRO, Volume 6, No. 6, 2019.

[12] Seismic Analysis of High Rise Buildings (G+30) by using Software, Volume 5, Issue 3, 2019.

[13] Horizontally Connected High Rise Buildings under Earthquake Loadings, Volume 10, Issue 1, 2019.

[14] Determination of Efficient Twin Tower High Rise Building Subjected to Seismic Loadi ng, Volume 8, No. 5, 2018.

[15] Analysis and Design of an Earthquake Resistant Structure using STAAD PRO, Volume 04, Issue 12, 2017.

[16] Design and Analysis of Multi Storied Building (G+10) using STAAD PRO, Volume 3, Issue 3, 2017.

[17] Earthquake Analysis of G+10 Buildings using Response Spectrum Method, Volume 6, Issue 5, 2017.

[18] Study on Seismic Analysis of High Rise Building by using Software, Volume 2, Issue 8, 2017.

[19] Analysis and Design of High Rise Building Frame using STAAD PRO Software, Volume 5, Issue 4, 2016.

[20] Seismic Analysis and Design of Building Structures in STAAD PRO, 2016.

[21] Study of Seismic Analysis and Design of Multi Storey Symmetrical and Asymmetrical Building, Volume 03, Issue 1, 2016.

[22] Analysis and Design of G+19 Storied Building using STAAD PRO, Volume 6, Issue 7,2016.

[23] Seismic Analysis and Design of G+9 RCC Residential Building in STAAD PRO, Volume 7, Issue 5, 2018.

[24] Analysis and Design of High Rise Building (G+30) using STAAD PRO, Volume 2, Issue 12, 2015.

[25] Analysis of Tall Buildings subjected to Wind and Seismic Loads, 2013.

[26] IS 456-2000.
[27] IS 1893-2016.

[28] IS 875.