International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 7 ǁ July 2022 ǁ PP. 371-385

Analysis and Design of Multi-StoreyBuilding Using Etabs Software and Comparing With Different Zones

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ABSTRACT
When a structure is subjected to earthquake, it responds by vibrating. An earthquake force can be resolved into three mutually perpendicular directions-the two horizontal directions (x and y) and the vertical direction (z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. It is very essential to consider the effects of lateral loads induced from wind and earthquakes in the analysis of reinforced concrete structures, especially for high-rise buildings. The present study is limited to reinforced concrete (RC) multi-storied commercial building with FOUR different zones II, III, IV & V .The analysis is carried out the help of FEM software ETABS. The building model in the study has ten storeys with constant storey height of 3m. Different values of SEISMIC ZONE FACTOR are taken and their corresponding effects are interpreted in the results.
Keywords: *ETABS software, Storey displacement, Storey shear, Storey drift.*

Date of Submission: 02-07-2022 Date of acceptance: 13-07-2022

I. INTRODUCTION

GENERAL

Dynamic actions are caused on buildings by both wind and earthquakes. But, design for wind forces and for earthquake effects are distinctly different. The intuitive philosophy of structural design uses force as the basis, which is consistent in wind design, where in the building is subjected to a pressure on its exposed surface area; this is force type loading. However, in earthquake design, the building is subjected to random motion of the ground at its base, which induces inertia forces in the building that in turn cause stresses; this is displacement-type loading. Another way of expressing this difference is through the load deformation curve of the building – the demand on the building is force(i.e., vertical axis) in force-type loading imposed by wind pressure, and displacement(i.e., horizontal axis) in displacement type loading imposed by earthquake shaking. Wind force on the building has a non-zero mean component superposed with a relatively small oscillating component. Thus, under wind forces, the building may experience small fluctuations in the stress field, but reversal of stresses occurs only when the direction of wind reverses, which happens only over a large duration of time. On the other hand, the motion of the ground during the earthquake is cyclic about the neutral position of the structure. Thus, the stresses in the building due to seismic actions undergo many complete reversals and that to over the small duration of earthquake.

EARTHQUAKE:

Earthquake is a term used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth.

EARTHQUAKE RESISTANT STRUCTURES:

Earthquake-resistant structures are structures designed to protect buildings from earthquakes. Whileno structure can be entirely immune to damage from earthquakes, the goal of earthquake resistant construction is to erect structures that fare better during seismic activity than their conventional counterparts.

SEISMIC ZONES OF INDIA:

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

ZONE 2: This region is liable to MSK VI (strong) or less and is classified as the Low Damage RiskZone. The IS code assigns zone factor of 0.10.
ZONE 3: This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII (verystrong). And The IS code assigns zone factor of 0.16 for Zone 3.
ZONE 5: Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity MSK IX (Destructive) or greater. The IS code assigns zone issue of zero.36 for Zone 5. Structural styleers use this issue for earthquake resistant design of structures in Zone five. The zone issue of zero.36 is indicative of effective (zero periods) level earthquake in this zone. It is mentioned because the terribly High injury Risk Zone.
ZONE 4: This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII (Damaging). The IS code assigns zone factor of 0.24 for Zone 4 at Jammu and Kashmir, HimachalPradesh, Uttarakhand.

Table 1.1 Zone factor for different seismic zones

Seismic zone	II	III	IV	V
Seismic factor	0.1	0.16	0.24	0.36

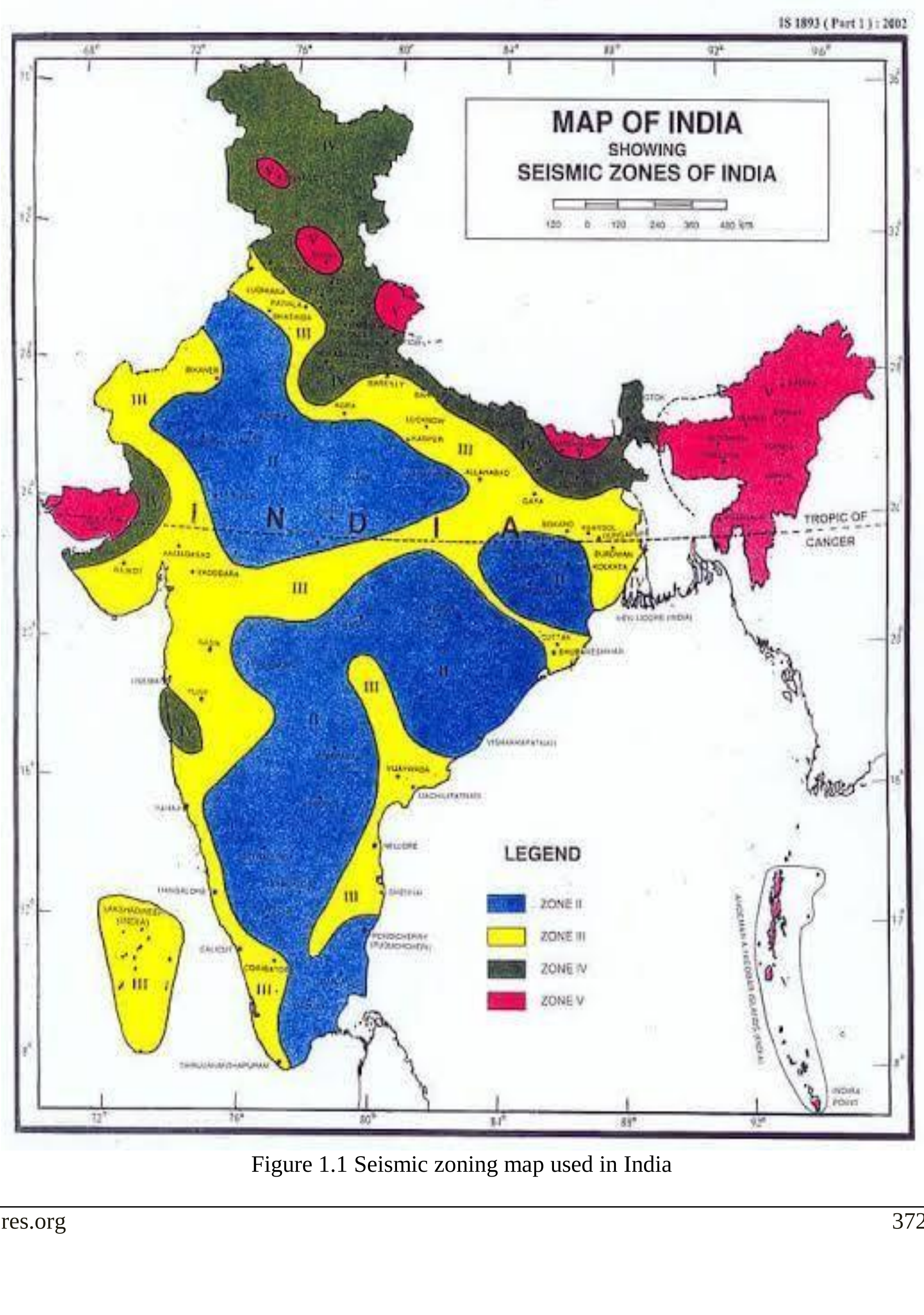


Figure 1.1 Seismic zoning map used in India

WIND:

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

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

Category 2- Open terrain with well scattered obstructions having heights generally between 3mts to10mts.

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

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

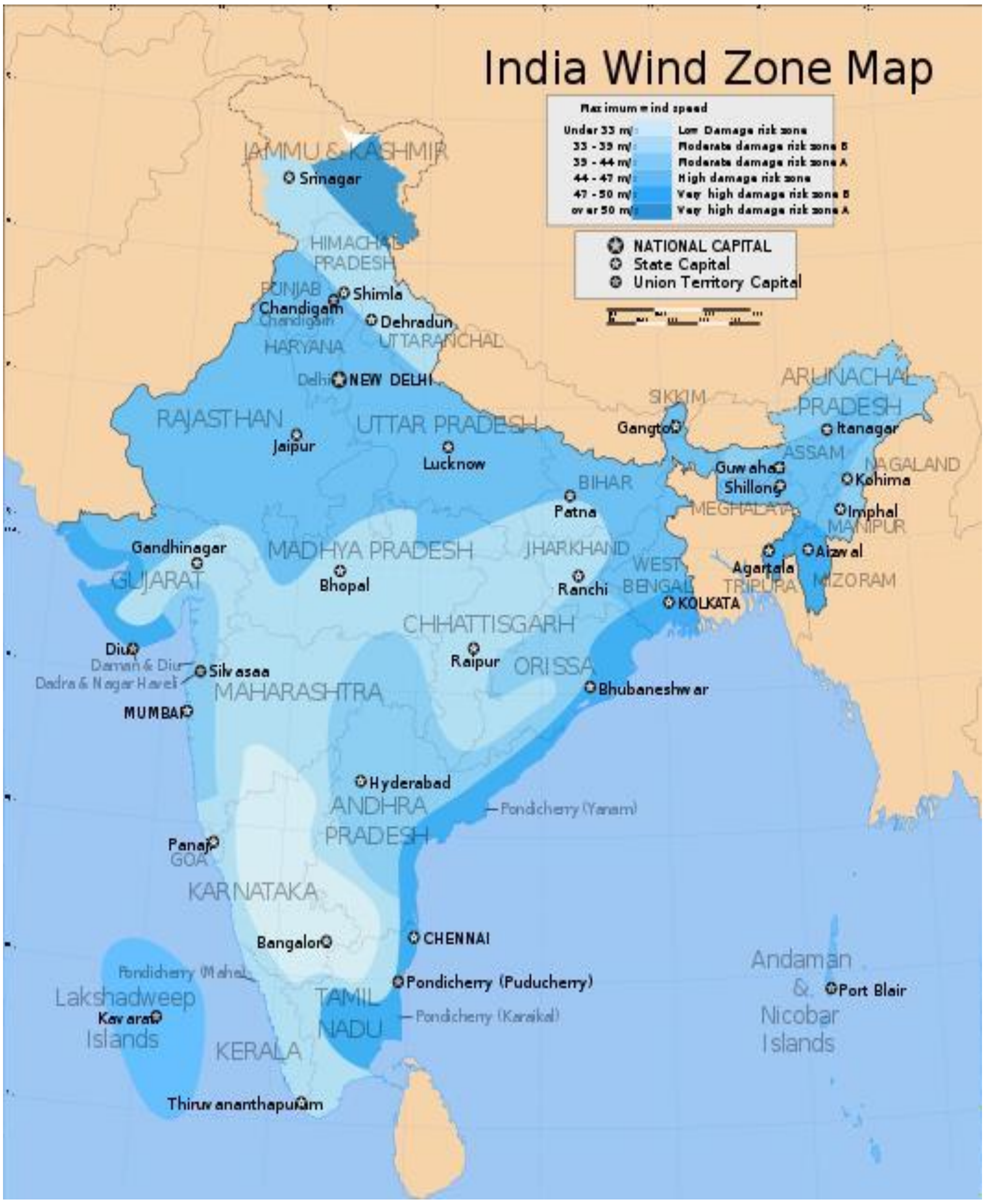


Figure 1.2 Wind zone map used in India

OBJECTIVES OF THE STUDY

The present work aims at the study of following objectives

How the seismic evaluation of a building should be carried out.

1. To study the behaviour of a building under the action of seismic loads and wind loads.
2. To compare various analysis results of building under zone II, III, IV and zone V using ETABSSoftware.
3. To know the displacement, storey drift and storey shear of the structure
4. The building model in the study has ten storeys with constant storey height of 3m. Four modelsare used to analyze with constant bay lengths and the number of Bays and the bay width alongtwo horizontal directions are kept constant in each model for convenience.
5. Different values of zone factor are taken and their corresponding effects are interpreted in the results.
6. Different values of wind speeds are taken for wind analysis and their corresponding effects ofbuilding structure are interpreted in the results

SCOPE OF THE STUDY

7. Based on project, study was undertaken with a view to determine the extent of possible changesin the seismic behaviour of RC Building Models.
8. RC framed buildings are firstly designed for gravity loads and then for seismic loads.
9. The study has been carried out by introducing symmetrical bare frame building models on different zones using equivalent static method and Response Spectrum Analysis.
10. The study highlights the effect of seismic zone factor in different zones that is in Zone II, ZoneIII, Zone IV and Zone V which is considered in the seismic performance evaluation of buildings.
11. The study emphasis and discusses the effect of seismic zone factor on the seismic performanceof G+10 building structure.
12. The entire process of modelling, analysis and design of all the primary elements for all the models are carried by using ETABS 16.2.1 version software.

ETABS INTRODUCTION

The software used for the present study is ETABS it is a product of Computers and Structures. It is a fully integrated program that allows Model creation, modification, execution of analysis, design optimization, and results review from within a single interface. ETABS is a standalone finite elementbased structural software for analysis and design of civil structures. It offers a powerful user interface with many tools to aid in quick and accurate construction of models, along with sophisticated technique to do most complex projects.

STOREY DISPLACEMENT

It is the absolute value of displacement of the storey under action of the lateral forces.

STOREY DRIFT

It is the difference of displacements between two consecutive stories divided by the height of that storey. Inter storey drift is the difference between the roof and floor displacements of any given storeyas the building sways during the earthquake, normalised by the storey height. The greater the drift thegreater likelihood of damage. Peak inter storey drift values larger than 0.06 indicates severe damage,while values larger than 0.025 indicate that the damage could be serious enough to pose a serious threatto human safety. Values in excess of 0.1 indicate probable building collapse.

STOREY SHEAR

It is an estimate of the maximum expected lateral force acting on a storey due to the forces such as seismic and wind force. It is calculated for each storey, changes from minimum at the top to maximumat the bottom of the building.

IMPORTANCE FACTOR

It is the factor used to obtain the design seismic force depending on the functional use of the structure, characterized by hazardous consequences of its 15 failure, its post-earthquake functional name, historicvalue, or economic importance. However the true purpose of is to provide an additional strength for risk critical facilities. Importance factor of a project will either be assigned as either a 1.0 or a 1.5.

II. LITERATURE REVIEW

GENERAL

The literature review was carried out under analysis and design of multi-storey building and comparing with different zones.

LITERATURE REVIEW ON ANALYSIS MULTI-STOREY BUILDING USING ETABS AND COMPARING WITH DIFFERENT ZONES

JagMohan Humar et al (2013):

Determination of seismic design forces by equivalent static load method. The base shear and overturning moment adjustments presented in this paper form the basis for the correspondingprovisions in the 2005 NBCC. The following conclusions are drawn from the results presented in thispaper:

1. The base shear adjustment factor Mv and the overturning moment reduction factor J are bothdependent on the characteristics of the lateral force resisting system. The factor Mv is largestfor a flexural wall system and smallest for a moment resisting frame. On the other hand, J is smallest for a flexural wall and largest for a moment resisting frame.
2. The factors Mv and J also depend on the first mode period Ta. Thus Mv increases with an increase in Ta, whereas J decreases with an increase in Ta.
3. The factors Mv and J strongly depend on the shape of the response spectrum. Compared with the western regions of Canada, the UHS for the eastern regions drops more rapidly with an increase in period. Thus the higher mode contribution is more predominant in the east; as a consequence, Mv values are larger and J values smaller for the eastern region.

Conrad PAULSON et al (2004):

Seismic versus wind design base shear forces in eastern and Midwestern United States. For low-rise structures, however, seismic design forces may at times be significant, even in the relatively low ground shaking design hazard of Chicago. Site soil classification has a significant influence as to whether seismic or wind controls the design base shear. For low-rise buildings on sites of soil in Chicago and New York City, seismic demands can dominate lateral strength proportioning. However, wind design usually governs strength proportioning for low-rise buildings on rock, particularly in areasof high wind exposure. On a practical basis, the effects of increased seismic demands on the economyof the lateral load system may not be significant. Particularly in Chicago, even though the strength requirement due to seismic design may be twice that of wind for some low-rise structures, both of these forces are relatively small in absolute force magnitude. Consequently, when the incremental increase of structure costs due to the seismic strength requirements is compared to the total cost of a structure, the change in total cost may not be significant. Other than the anomaly associated with the introduction of the soils coefficients in ASCE 7-95, which seems to have been rectified with the ASCE7- 98 edition, there appears to be no dramatic, overall increase in seismic design accelerations with thenewer editions of ASCE 7 for regions of low to moderate seismicity in the Midwestern and Eastern United States. In fact, the newest edition of ASCE 7 produces smaller design accelerations in Atlantaand New York City than the older editions.

AzlanAdnan, SuhanaSuradi et al (2008):

Comparison on the effect of earthquake and wind loads on the performance of reinforced concretebuildings.

J. P Annie Sweetlin (2016):

The present day scenario witnesses a series of natural calamities like earthquakes, tsunamis, floods etc. Of these the most damaging and recurrent phenomena is the earthquake. The Effective design and the construction of Earthquake resistant structure has gained greater importance all over the world. In this paper the earthquake resistance of a G+20 multi-storey building is analysed using Equivalent static method with the help of E-TABS 9.7.4 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The parameters studied were displacement, storey drift and storey shear. Seismic analysis was done by using E-TABS software and successfullyverified manually as per IS 1893:2002. Drift is within the limits for the building (0.004 times of the height of the storey) 0.004x3.2=12.8mm. Earthquake Base shear is greater than Wind Base shear. Complete guideline for the use of E-TABS 9.7.4 for seismic coefficient analysis is made available bythis paper.

Panchal D.R and Marathi P.M (2011):

The paper involves the comparative study of RCC, steel and composite (G+30) stories structures under the seismic effect. For the analysis equivalent static method has been used and modelling of structures has done by ETABS. From this study they conclude that the steel structures are better than RCC structures for low rise buildings but for high rise buildings the composite option is best suited among all three options. In addition, the reduction in self-weight of steel structure is 32% less than RCC structures and the self-weight of composite structure is 30% less than RCC structures. And also they suggest that, in steel structure the bending moment of secondary beam increased by average 83.3% and reduced by 48% in composite structure as compare to RCC.

Abhay Guleria (2014):

Abhay Guleria presents the analysis of the multi-storeyed building using ETABS reflected that the storey overturning moment varies inversely with storey height. Moreover, L-shape, I-shape type buildings give almost similar response against the overturning moment. Storey drift displacement increased with storey height up to 6th storey reaching to maximum value and then started decreasing. From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrical plans undergo more deformation than symmetrical plans. Asymmetrical plans should beadopted considering into gap.

Ali Kadhim Sallal (2018):

His main purpose of this software is to design and analysis multi-Storeyed building in a systematic process. This paper present a building where designed and analyzed under effect of earthquake and wind pressure by using ETABS software. In this case, (18m x 18m) and eight stories structure are modelled using ETABS software. Ten Storey is taken as (3m) height and making the total height of the structure (31m).

Pushkar Rathod and Rahul Chandrashekar (2017):

With the help of seismic analysis, the structure can be designed and constructed to withstand the high lateral movement of earth's crust during an earthquake. Any type of basic or a highly advanced structure which maybe under static or dynamic conditions can be evaluated by using ETABS. ETABSis a coordinated and productive tool for analysis and designs, which range from a simple 2D frames tomodern high-rises which makes it one of the best structural software for building systems.

Pardeshi Sameer and Prof. N. G. Gore (2016):

This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of regular and irregular RC building frames and Time HiStorey Analysis (THA) of regular RC building frames and carry out the ductility based design using IS 13920 corresponding to response spectrum analysis. Comparison of the results of analysis of irregular structures with regular structure is done.

Vijaya Bhaskar reddy. S et. al. (2015):

This paper presents illustration of a comparative study of static loads for 5 and 10 storey multi storeyedstructures. The significance of this work is to estimate the design loads of a structure. They conclude that deflection of the members is high with an increase in no. of floors. It can be observed that axial force is high in 10-storey compared to 5-storey building.

Abhay Guleria (2014):

The case study in this paper mainly emphasizes on structural behaviour of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modelling of 15- storeys R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximumshear forces, bending moments, and maximum storey displacement are computed and then compared for all the analyzed cases. The analysis of the multistore building reflected that the storey overturning moment varies inversely with storey height. From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrical plans undergo more deformation than symmetrical plans.

Varalakshmi v et.al (2014):

analyzed a G+5 storey residential building and designed the various components like beam, slab, column and foundation. The loads namely dead load and live load were calculated as per IS 875(Part I& II)-1987 and HYSD bars i.e. Fe 415 are used as per IS 1986-1985. They concluded that the safetyof the reinforced concrete building depends upon the initial architectural and structural configuration of the total building, the quality of the structural analysis, design and reinforcement detailing of the building frame to achieve stability of elements and their ductile performance.

Chandrashekar et.al (2015):

analyzed and designed thematic-storeyed building by using ETABS software. A G+5storey building under the lateral loading effect of wind and earthquake was considered for this study and analysis is done by using ETABS. They have also considered the chances of occurrence of spread of fire and theimportance of use of fire proof material up to highest possible standards of performance as well as reliability. They suggested that the wide chances of ETABS software which is very innovative and easier for high rise buildings so that time incurred for designing is reduced.

Balaji.U and Selvarasan M.E (2016)

Worked on analysis and design of multi-storeyed building under static and dynamic loading conditions using ETABS. In this work a G+13 storey residential building was studied for the earthquake loads using ETABS. They assumed that material property to be linear, static and dynamic analyses were performed. The non-linear analysis was carried out by considering severe seismic zones and the behaviour was assessed by considering type

II soil condition. Different results like displacements, baseshear were plotted and studied.

Geethu et.al (2016)

Made a comparative study on analysis and design of multi storied building by STAAD.Pro and ETABSsoftware's. They provided the details of both residential and commercial building design. The planning was made in accordance with the national building code and drafted using Auto CAD software. They concluded that while comparing both software results, ETABS software shows higher values of bending moment and axial force.

SACHIN METRE et.al (2017)

In this thesis 25 storey steel frame was analysed for the rectangular plan of 25x15 m by considering Z-II and Z-V for soil type-II. The analyses were done by using the ETABS 2016 software. In this papermodels are compared for different types of bracing such as X, inverted V and Single diagonal bracingby placing in different locations like Outer Edge, Inner Edge and at centre in X and Y-directions for the bracing angle ISA 130x130x8. Results are obtained by considering the parameters like storey displacement, storey drift and storey shear. It has been found that A bracing of the structure effectively reduces the lateral displacement and drift compared to other bracings.

SWATHI RANI et.al (2015)

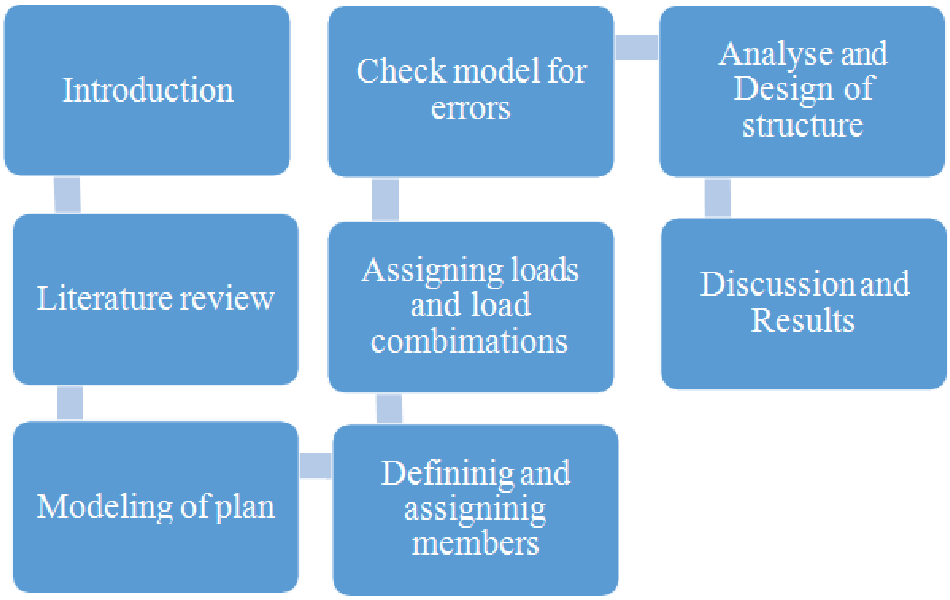
In this journal she discussed about the efficiency of using different types of bracings and concluded that lateral storey displacements of buildings are greatly reduced by the use of single diagonal bracingsarranged as diamond shape. Different parameters are compared for five models and it is found that as per displacement criteria bracings are good to reduce the displacement and the max reduction of 68.43% is observed in Single diagonal braces arranged as diamond shape in 3rd and 4th bay model compared to model without brace. The bending moment and shear force in columns are also reduced in braced models from which it can found that these are less in single diagonal braced model compareto other model

SUMMARY OF LITERATURE REVIEW

The above listed literature reviews have mainly discussed the comparison on the effect of earthquakeand wind loads on the performance of reinforced concrete buildings and different values of zone factorare taken and their corresponding effects are interpreted in the results and also different values of wind speeds are taken for wind analysis and their corresponding effects of building structure are interpreted in the results. By referring these literature reviews we have made the below mentionedobjective of the project.

III. METHODOLOGY AND PROCESS

METHODOLOGY



PROCESS OF ETABS

Step - 1: Initial setup of Standard Codes and Country codes Step - 2: Creation of Grid points & Generation of structure

After getting opened with ETABS we select a new model and a window appears where we had enteredthe grid dimensions and Storey dimensions of our building.

Step - 3: Defining of property
Here we had first defined the material property by selecting define menu material properties. We add new material for our structural components (beams, columns, slabs) by giving the specified details in defining. After that we define section size by selecting frame sections as shown below & added the required section for beams, columns etc.

Step - 4: Assigning of Property
After defining the property we draw the structural components using command menu. Draw line for beam for beams and create columns in region for columns by which property assigning is completed for beams and columns.

Step - 5: Assigning of Supports
By keeping the selection at the base of the structure and selecting all the columns we assigned supports by going to assign menu joint\frame Restraints (supports) fixed.

Step - 6: Defining of loads
In ETABS all the load considerations are first defined and then assigned. The loads in ETABSare defined as using static load cases command in define menu.

Step - 7: Assigning of Dead loads
After defining all the loads. Dead loads are assigned for external walls, internal walls in staad but in ETABS automatically taken care by the software.

Step - 8: Assigning of Live loads
Live loads are assigned for the entire structure including floor finishing.

Step - 9: Assigning of wind loads
Wind loads are defined and assigned as per IS 875: 1987 PART 3 by giving wind speed and wind angle. But since this is a G+3 Residential Building having total height less than 12 meters there is no need of assigning of wind loads or earth quake loads.

Step - 10: Assigning of Seismic loads
Seismic loads are defined and assigned as per IS 1893: 2002 by giving zone, soil type, and response reduction factor in X and Y directions. But since this is a G+3 residential building having total heightless than 12 meters there is no need of assigning Seismic loads.

Step - 11: Assigning of load combinations
Using load combinations command in define menu 1.5 times of dead load and live load will be taken.

Step - 12: Analysis
After the completion of all the above steps we have performed the analysis and checked for errors.

Step - 13: Design
After the completion of analysis we had performed concrete design on the structure as per IS 456:2000.ETABS performs the design for every structural element

IV. MODELING

BUILDING PARAMETERS

Table 4.1 Building parameters

Particulars	**Values**	**Particulars**	**Values**
Type of building	Multi-storey building	Size of column	450 mm X 450 mm
Plan dimension	12m X 12m	Thickness of slab	150mm
Total height ofbuilding	30m	Seismic zone	II, III, IV & V
Height of each storey	3m	Soil condition	Medium
Size of beam	250 mm X 300 mm	Concrete grade	M20, M25
Size of plinth beam	350 X 600 mm	Grade of steel	Fe 550

DEAD LOAD:

- Dead load on floor finishing: 0.8kN/sq. m. (Table 2 as per IS 875(part1):1987).

LIVE LOAD:

- Live load on floor: 2 kN/sq. m. (Table 1 as per IS 875(part2):1987)

SEISMIC ZONE:

- Seismic Zone: Zone-II; Zone-III; Zone-IV; Zone-V (As per IS 1893:2002(part1).
- Type of structure: Special RC moment-resisting frame (SMR) (Table 7 as per IS1893:2002(part1))
- Seismic Zone factor: 0.10 for Zone II; 0.16 for Zone III; 0.24 for Zone IV; 0.36 for Zone V (Table 2 as per IS 1893:2002(part1))
- Importance factor: 1.5 (Table 6 as per IS 1893:2002(part1))
- Response reduction factor: 5.0 (Table 7 as per IS 1893:2002(part1)).

WIND LOAD:

- Design wind speed: 33 m/s for Zone II; 39 m/s for Zone III; 46 m/s for Zone IV; 50 m/s for Zone V (clause 5.2 as per IS 875:1987(part 3)).

BUILDING CONFIGURATION:

Table 4.2 Building configuration data

PARAMETERS	ZONE II	ZONE III	ZONE IV	ZONE V
Seismic zone factor	0.10	0.16	0.24	0.36
Basic wind speed	33 m/s	39 m/s	46 m/s	50 m/s
Response factor	5	5	5	5
Importance factor	1.5	1.5	1.5	1.5
Soil type	Medium	Medium	Medium	Medium
Slab thickness	150 mm	150 mm	150 mm	150 mm
Size of plinth beam	350 mm X 600 mm	350 mm X 600 mm	350 mm X 600 mm	350 mm X 600 mm
Size of beam	250 mm X 300 mm	250 mm X 300 mm	250 mm X 300 mm	250 mm X 300 mm
Size of column	450 mm X 450 mm	450 mm X 450 mm	450 mm X 450 mm	450 mm X 450 mm
Dead load of plinth beam	5.25 kN/m	5.25 kN/m	5.25 kN/m	5.25 kN/m
Dead load of beam	1.875 kN/m	1.875 kN/m	1.875 kN/m	1.875 kN/m
Dead load of column	5.0625 kN/m	5.0625 kN/m	5.0625 kN/m	5.0625 kN/m
Dead load of slab	3.75 kN/m	3.75 kN/m	3.75 kN/m	3.75 kN/m
Live load	2 kN/m	2 kN/m	2 kN/m	2 kN/m
Earthquake load	1 kN/m	1 kN/m	1 kN/m	1 kN/m

LOAD COMBINATION:

Referring the IS 800:2007 and IS 1893:2000, following combinations were considered. COMBO 1 = 1.5DL + 1.5LL

COMBO 2 = 1.2DL + 0.5LL + 2.5EQXCOMBO 3 = 1.2DL + 0.5LL + 2.5EQYCOMBO 4 = 1.2DL + 0.5 LL – 2.5EQXCOMBO 5 = 1.2DL + 0.5LL – 2.5EQY COMBO 6 = 1.2DL + 1.2LL + 1.2WLXCOMBO 7 = 1.2DL + 1.2LL + 1.2WLYCOMBO 8 = 1.2DL + 1.2LL - 1.2WLXCOMBO 9 = 1.2DL + 1.2LL - 1.2WLY

PLAN AND 3D MODEL OF BUILDING

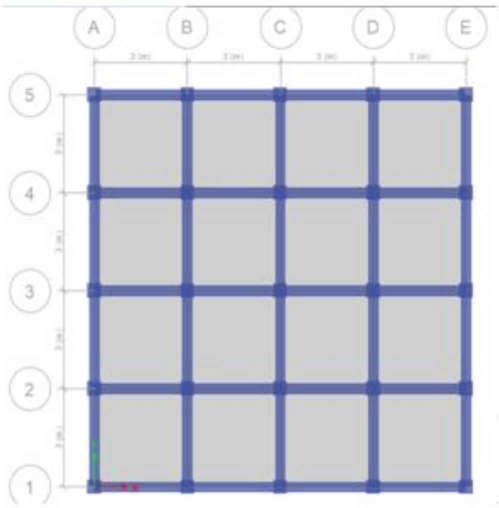


Figure 4.1 Plan

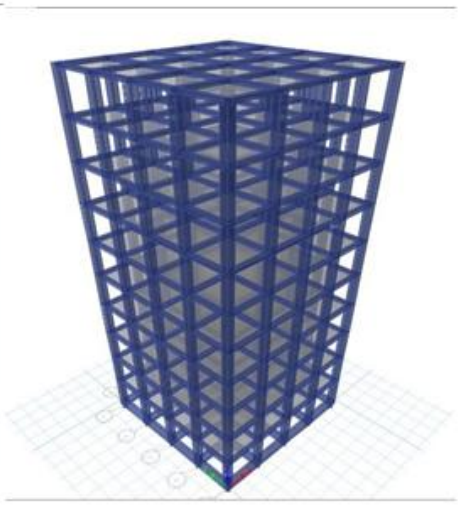


Figure 4.2 3D Model

V. RESULT AND DISCUSSION

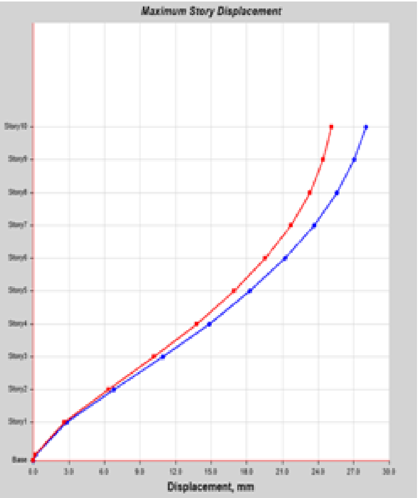
SEISMIC ZONE II

MAXIMUM STOREY DISPLACEMENT

Displacement value for 1.5DL + 1.5LL

Table 5.1 Displacement by Static Analysis

Storey	Elevation	Location	X-Dir	Y-Dir
	m		mm	Mm
Storey10	30.5	Top	28.054	25.143
Storey9	27.5	Top	27.028	24.433
Storey8	24.5	Top	25.593	23.312
Storey7	21.5	Top	23.667	21.698
Storey6	18.5	Top	21.223	19.566
Storey5	15.5	Top	18.26	16.912
Storey4	12.5	Top	14.802	13.76
Storey3	9.5	Top	10.913	10.171
Storey2	6.5	Top	6.766	6.309
Storey1	3.5	Top	2.805	2.603
PLINTH BEAM	0.5	Top	0.191	0.167
Base	0	Top	0	0

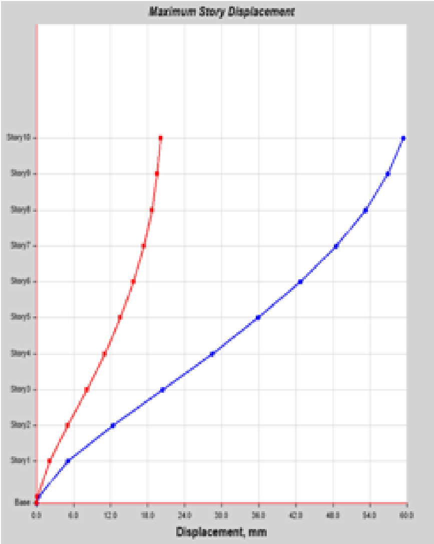


Graph 5.1

Displacement value for 1.2DL + 0.5LL + 2.5EQX

Table 5.2 Displacement by Static Analysis

Storey	Elevation	Location	X-Dir	Y-Dir
	m		mm	Mm
Storey10	30.5	Top	59.439	20.115
Storey9	27.5	Top	56.902	19.546
Storey8	24.5	Top	53.288	18.649
Storey7	21.5	Top	48.513	17.359
Storey6	18.5	Top	42.67	15.652
Storey5	15.5	Top	35.913	13.53
Storey4	12.5	Top	28.428	11.008
Storey3	9.5	Top	20.449	8.137
Storey2	6.5	Top	12.366	5.048
Storey1	3.5	Top	4.999	2.083
PLINTH BEAM	0.5	Top	0.328	0.133
Base	0	Top	0	0

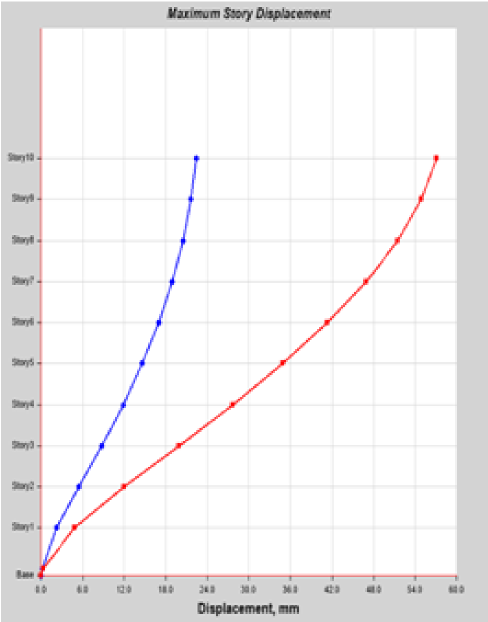


Graph 5.2

Displacement value for 1.2DL + 0.5LL + 2.5EQY

Table 5.3 Displacement by Static Analysis

Storey	Elevation	Location	X-Dir	Y-Dir
	m		mm	Mm
Storey10	30.5	Top	22.443	57.11
Storey9	27.5	Top	21.623	54.826
Storey8	24.5	Top	20.475	51.463
Storey7	21.5	Top	18.933	46.938
Storey6	18.5	Top	16.978	41.344
Storey5	15.5	Top	14.608	34.835
Storey4	12.5	Top	11.841	27.594
Storey3	9.5	Top	8.731	19.855
Storey2	6.5	Top	5.413	12.001
Storey1	3.5	Top	2.244	4.837
PLINTH BEAM	0.5	Top	0.153	0.309
Base	0	Top	0	0

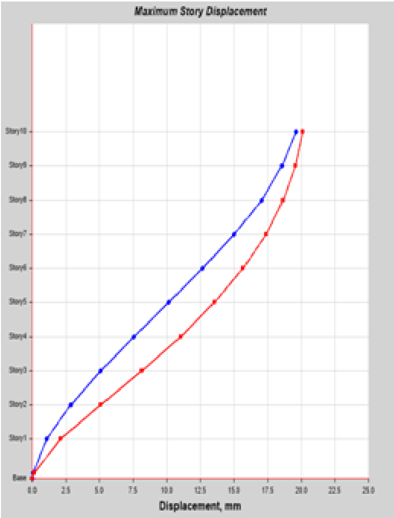


Graph 5.3

Displacement value for 1.2DL + 0.5 LL – 2.5EQ

Table 5.4 Displacement by Static Analysis

Storey	Elevation	Location	X-Dir	Y-Dir
	m		mm	Mm
Storey10	30.5	Top	19.607	20.115
Storey9	27.5	Top	18.566	19.546
Storey8	24.5	Top	17.023	18.649
Storey7	21.5	Top	15.009	17.359
Storey6	18.5	Top	12.654	15.652
Storey5	15.5	Top	10.114	13.53
Storey4	12.5	Top	7.538	11.008
Storey3	9.5	Top	5.068	8.137
Storey2	6.5	Top	2.845	5.048
Storey1	3.5	Top	1.057	2.083
PLINTH BEAM	0.5	Top	0.058	0.133
Base	0	Top	0	0



Graph 5.4

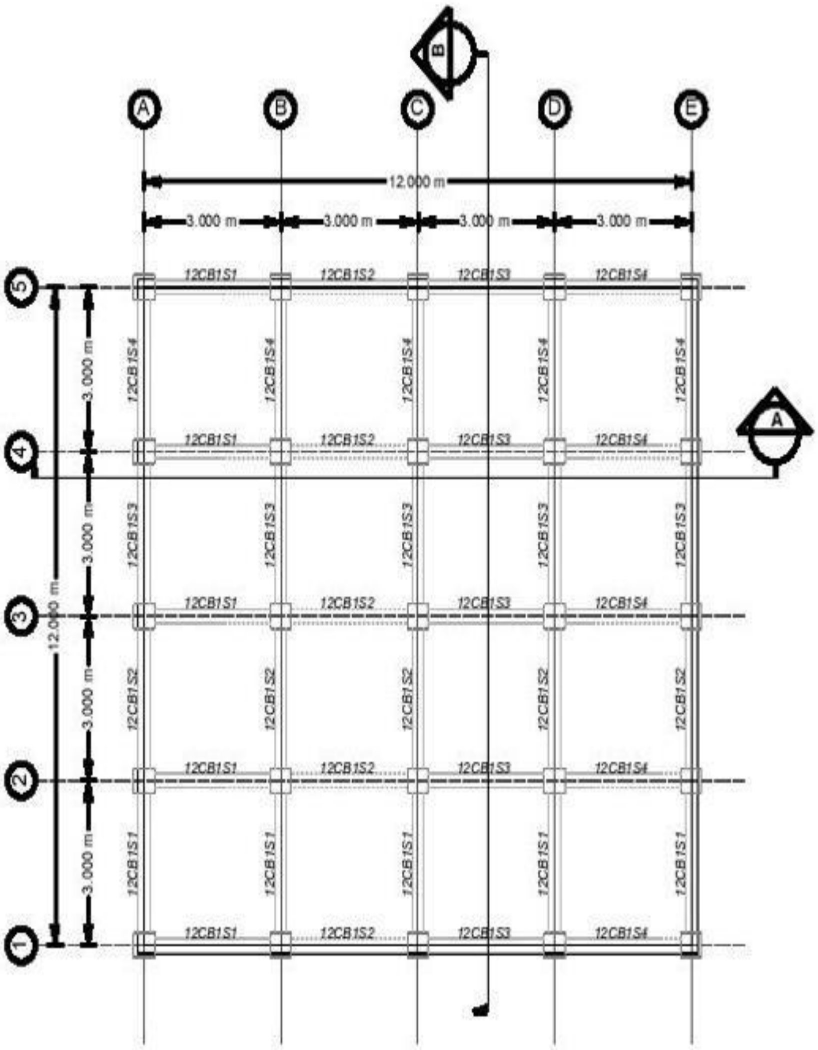


Figure 5.3 Beam layout

BEAM REINFORCEMENT DETAILS

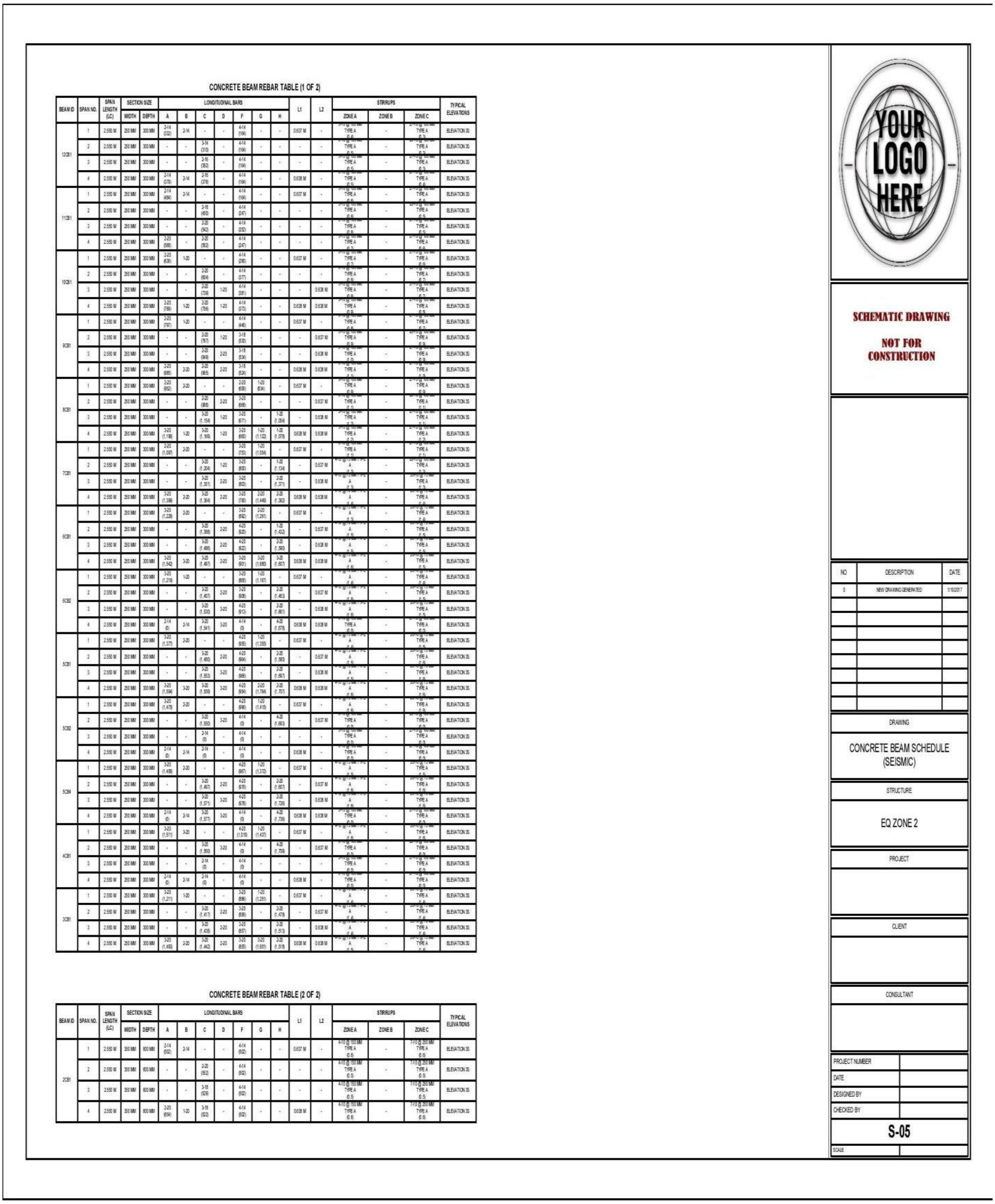


Figure 5.4 Beam reinforcement details

COLUMN LAYOUT

VI. RESULT AND DISCUSSIONS

1] Displacement for earthquake load: ZONE II is 59.439 mm at X direction, 20.115 mm at Y direction, ZONE III is 306.501 mm at X direction, 20.115 mm at Y direction, ZONE IV is 336.098 mm at X direction, 20.115 mm at Y direction and ZONE V is 373.104 mm at X direction, 19.583 mm at Y direction. This means the displacement increases by more than 628% if seismic ZONE changes from II to V. The displacement of building models increases with the increasing of seismic Zones. The displacement is very high at roof and very low at the base.

2] Displacement for wind load: The displacement occurs at the wind speed 33 m/s is 63.429 mm is at X direction, 20.115 mm at Y direction, wind speed 39 m/s is 68.939 mm at X direction, 20.115 mm atY direction, wind speed 46 m/s is 151.472 mm at X direction, 20.115 mm at Y direction, wind speed 50 m/s is 158.791 mm at X direction, 19.858 mm at Y direction. This means the displacement is increases by more than 250% from wind speed 33 m/s to 50 m/s. The displacement of building models increases with the increasing of seismic Zones. The displacement is very high at roof and very low atthe base.

3] Storey drift for earthquake load: The storey drift is maximum at storey 3. The storey drift for ZONEII is 0.002694 at X direction, 0.00103 at Y direction, ZONE III is 0.014907 at X direction, 0.00103 at Y direction, ZONE IV is 0.016178 at X direction, 0.00103 at Y direction and ZONE V is 0.017933 at X direction, 0.001017 at Y direction. This means the storey drift is increases by more than 666% whencompare to ZONE II to ZONE V. The storey drift increases with the increasing of seismic zone factor.And the maximum storey drift is available at ZONE V.

4] Storey drift for wind load: The value of storey drift at the wind speed 33 m/s is 0.003174 is at X direction, 0.00143 at Y direction, wind speed 39 m/s is 0.003501 at X direction, 0.001017 mm at Y direction, wind speed 46 m/s is 0.007575 at X direction, 0.00103 at Y direction, wind speed 50 m/s is 0.00773 is at X direction, 0.00103 at Y direction. This means the storey drift is increases by more than 541%. The storey drift increases with the increasing of wind pressure. And the maximum storey driftis available at ZONE V.

5] Storey shear for earthquake load: The storey shear for ZONE II is 737.5289 kN at X direction, 330kN at Y direction, ZONE III is 4582.0462 kN at X direction, 330 kN at Y direction, ZONE IV is 4908.0693 kN at X direction, 330 kN at Y direction and ZONE V is 5418.1774 kN at X direction, 330 kN at Y direction. The storey shear is increases by more than 735%. The Storey Shear is decreased asheight of the building increased and reduced at top floor in all the building models. The storey shear is maximum at the base.

6] Storey shear for wind load: The value of storey shear at the wind speed 33 m/s is 1011.4343 kN is at X direction, 330 kN at Y direction, wind speed 39 m/s is 1135.0973 kN at X direction, 330 kN at Ydirection, wind speed 46 m/s is 2370.9822 kN at X direction, 330 kN at Y direction, wind speed 50 m/s is 2408.7004 kN at X direction, 330 kN at Y direction. This means the storey shear is increases bymore than 238%. The Storey Shear is decreased as height of the building increased and reduced at top floor in all the building models. The storey shear is maximum at the base.

VII. CONCLUSION

1. The displacement increases by more than 628% if seismic ZONE changes from II to V. The displacement of building models increases with the increasing of seismic Zones. The displacement isvery high at roof and very low at the base.
2. The displacement is increases by more than 250% from wind speed 33 m/s to 50 m/s. The displacement of building models increases with the increasing of seismic Zones. The displacement isvery high at roof and very low at the base.
3. The storey drift is increases by more than 666% when compare to ZONE II to ZONE V. The storey drift increases with the increasing of seismic zone factor. And the maximum storey drift is availableat ZONE V.
4. The storey drift is increases by more than 541%. The storey drift increases with the increasing of wind pressure. And the maximum storey drift is available at ZONE V.
5. The storey shear is increases by more than 735%. The Storey Shear is decreased as height of the building increased and reduced at top floor in all the building models. The storey shear is maximumat the base.
6. The storey shear is increases by more than 238%. The Storey Shear is decreased as height of the building increased due to wind pressure and reduced at top floor in all the building models. The storey shear is maximum at the base.

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