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"ANALYSIS AND DESIGN OF COMMERCIAL BUILDING IN ZONE II AND ZONE IV BY SOFTWARE ETABS"

Submitted by

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CHAPTER 1

1.1 INTRODUCTION

Actions causing movement in dwellings occur due to both winds and seismic events. Nevertheless, designing structures takes into account unique considerations related specifically to wind pressures and seismic impacts. Structural design based on intuition relies on forces acting consistently under windy conditions, where internal structures experience tension near their exposed surfaces due to external pressures. However, during seismic construction planning, structures must account for natural ground motion beneath their foundation, leading to inertial effects inside them causing stress variations; this type involves displacements as loads. An alternative method for conveying this contrast involves examining the stress-strain relationship exhibited during construction—whereby forces exerted vertically correspond to the applied wind pressures along an upward direction, while displacements horizontally represent loads caused by seismic tremors acting downwardly. The wind velocity above the structure exhibits both an average nonzero directional influence alongside a distinct fluctuating element. Consequently, during windy conditions, structures could experience slight variations in stress levels due to these movements; yet, such changes occur most readily when winds shift direction abruptly, an event typically occurring after considerable periods have passed. Despite this motion occurring continuously during an earthquake, it oscillates around the neutral function of the building's foundation. Consequently, within buildings subjected to seismic movements due to earthquakes, stress cycles frequently reverse their direction across short time intervals.

1. The building consists of the main block and a service block connected by expansion joint and is therefore structurally separated (Figure 1). Analysis and design for main block is to be performed.
2. The building will be used for exhibitions, as an art gallery or show room, etc., so that there are no walls inside the building. Only external walls 230 mm thick with 12 mm plaster on both sides are considered. For simplicity in analysis, no balconies are used in the building.
3. At ground floor, slabs are not provided and the floor will directly rest on ground. Therefore, only ground beams passing through columns are provided as tie beams. The floor beams are thus absent in the ground floor.
4. Secondary floor beams are so arranged that they act as simply supported beams and that maximum number of main beams get flanged beam effect.
5. The main beams rest centrally on columns to avoid local eccentricity.
6. For all structural elements, M30 grade concrete will be used.
7. The floor diaphragms are assumed to be rigid.
8. Centre-line dimensions are followed for analysis and design. In practice, it is advisable to consider finite size joint width.
9. Preliminary sizes of structural components are assumed by experience.
10. For analysis purpose, the beams are assumed to be rectangular so as to distribute slightly larger moment in columns. In practice a beam that fulfils requirement of flanged section in design, behaves in between a rectangular and a flanged section for moment distribution.
11. Seismic loads will be considered acting in the horizontal direction (along either of the two principal directions) and not along the vertical direction, since it is not considered to be significant.
12. All dimensions are in mm, unless specified otherwise.

EARTHQUAKE AND SYSMIC ZONES OF INDIA

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. While no 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 its previous 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 Risk Zone. 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 (very strong). And The IS code assigns zone factor of 0.16 for Zone 3.

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, Himachal Pradesh, Uttarakhand.

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 stylers 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.

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

IS 1893 (Part 1) : 2016

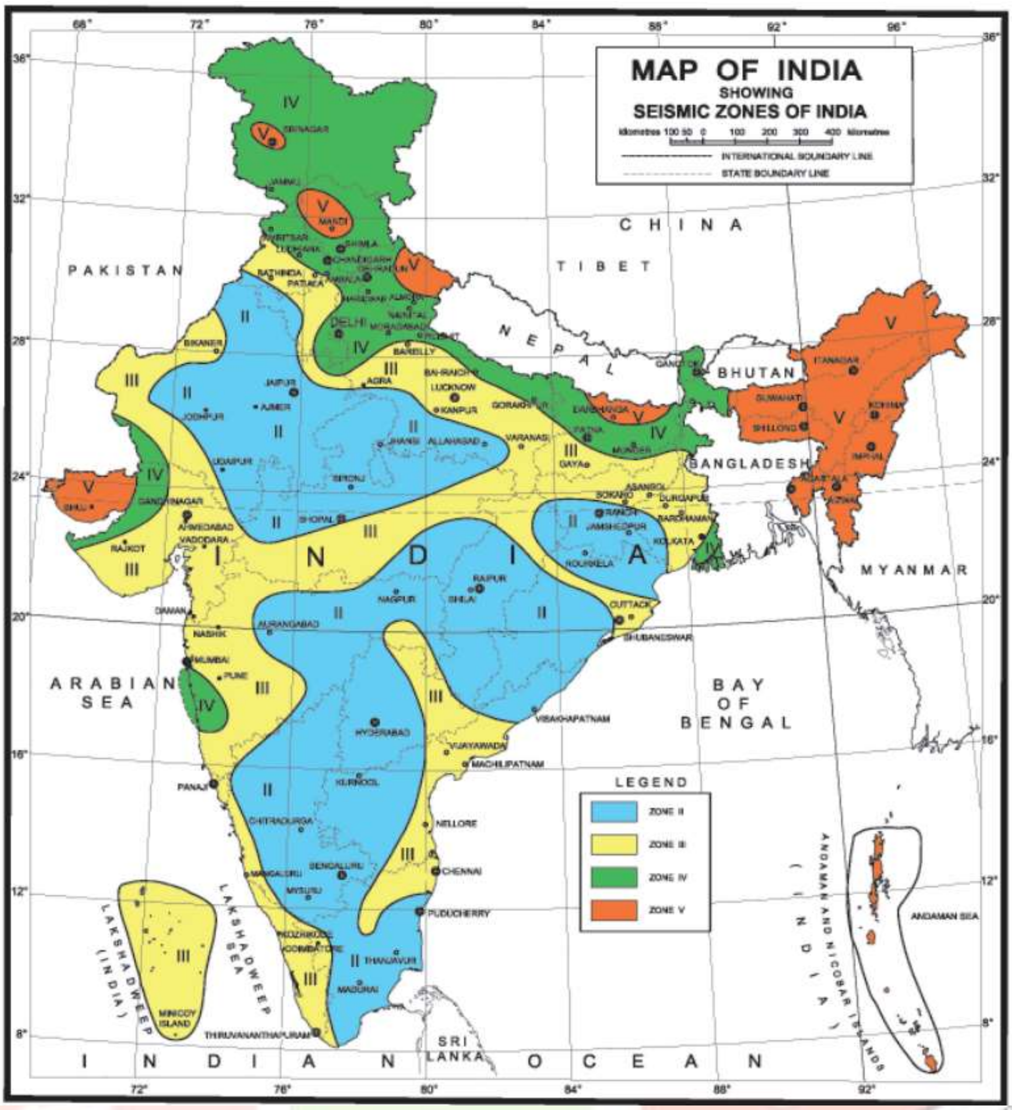


Figure 1.1 Seismic zoning map used in India

WIND:

Wind could be a perceptible natural motion of air relative to earth surface, particularly within the sort of current of air processing in a very explicit direction. Wind blows with less speed in rough piece of ground 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 to 10mts.

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.

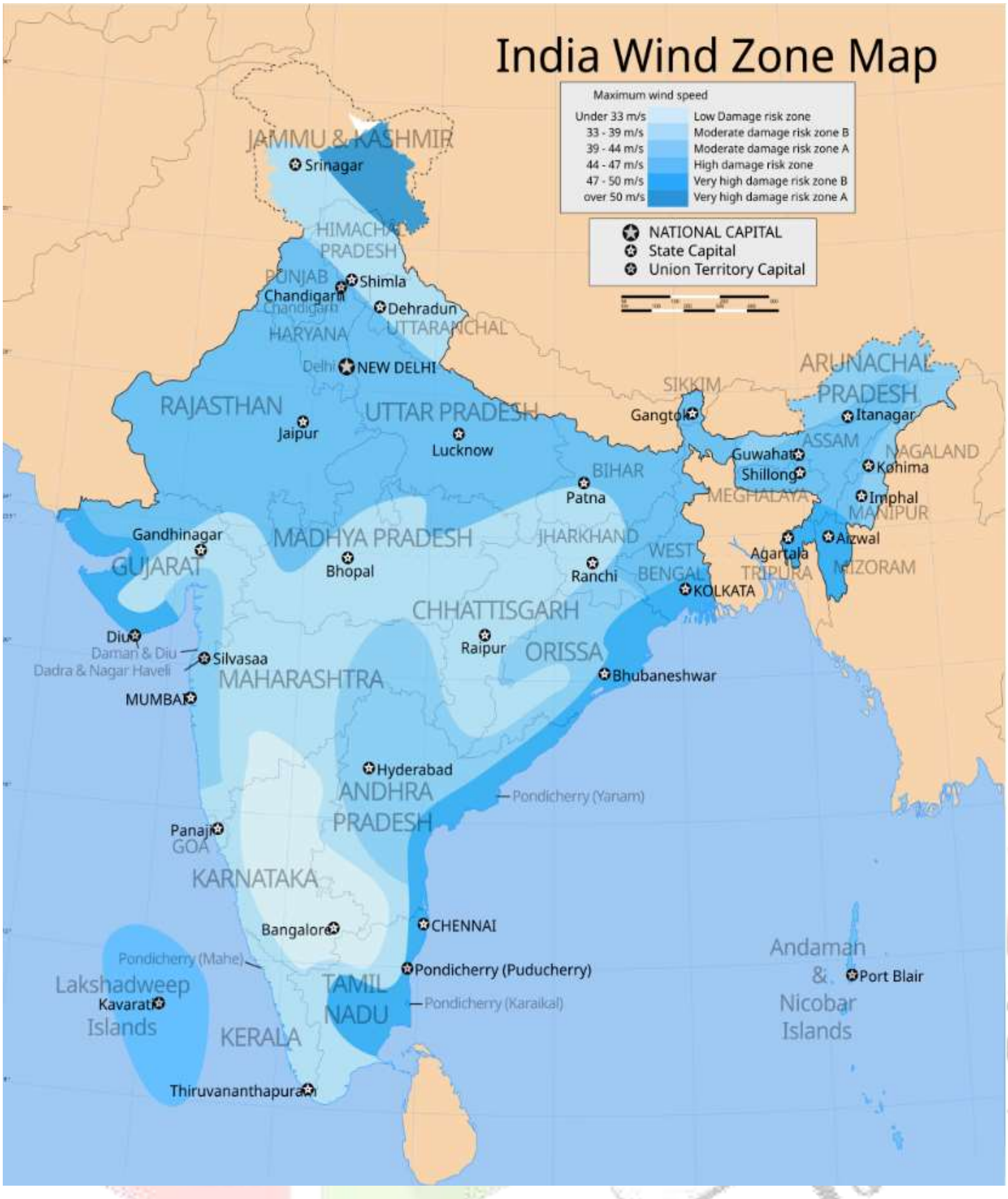


Figure 1.2 Wind zone map of India

ABOUT ETABS SOFTWARE

ETABS offers an advanced tool designed exclusively for analyzing and designing construction projects efficiently. The latest version of ETABS, released in 2018, boasts both user-friendly graphics along with superior modelling capabilities, alongside advanced analysis tools, detailed designs, and comprehensive documentation seamlessly linked through a shared data base system. Despite being efficient for basic designs, ETABS is capable of managing large-scale projects involving intricate geometries and various non-linear behaviours, thus becoming an indispensable resource for architects working within construction sectors.

ETABS stands out as an outstandingly advanced comprehensive tool designed specifically for analyzing and constructing structures in architecture. Drawing on over four decades of dedicated R&D efforts, this most recent version of ETABS boasts unparalleled 3D modelling and visualisation features, coupled with lightning-fast computational abilities in both static and dynamic analyses, extensive material handling functionalities, advanced design options catering to diverse applications, and intuitive graphical outputs facilitating quick comprehension of outcomes.

Throughout the initial stages of designing up until creating detailed schematics, ETABS seamlessly incorporates all elements of the construction planning cycle. Model creation is now much simpler than ever before – users can quickly generate floor and elevation drawings using straightforward command tools. CAD files can easily transform into ETABS formats by direct conversion or serve as references for overlaying ETABS elements on them. SAP's advanced Fire 64-bit solution enables efficient analysis of vast, intricate model scenarios through its support for sophisticated modelling methods like sequence planning during construction and accounting for factors like material deformation over time (for instance, due to temperature changes and contraction/expansion).

Design of steel and concrete frames (with automated optimization), composite beams, composite columns, steel joists, and concrete and masonry shear walls is included, as is the capacity check for steel connections and base plates. Models may be realistically rendered, and all results can be shown directly on the structure. Comprehensive and customizable reports are available for all analysis and design output, and schematic construction drawings of framing plans, schedules, details, and cross-sections may be generated for concrete and steel structures.

ETABS provides an unequalled suite of tools for structural engineers designing buildings, whether they are working on one-story industrial structures or the tallest commercial high- rises. Immensely capable, yet easy-to-use, has been the hallmark of ETABS since its introduction decades ago, and this latest release continues that tradition by providing engineers with the technologically-advanced, yet intuitive, software they require to be their most productive.

1.2 OBJECTIVE 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.
2. To compare various analysis results of building under zone II and IV using ETABS Software.
3. To know the displacement, storey drift and storey shear of the structure in zone II and zone IV.
4. The building model in the study has G+7 storeys with storey height of 4m. Four models are used to analyze with constant bay lengths and the number of Bays and the bay width along two 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. To know the rebar percentage difference in column and beam.

1.3 SCOPE OF THE STUDY

1. Based on project, study was undertaken with a view to determine the extent of possible changes in the seismic behaviour of RC Building Models.
2. RC framed buildings are firstly designed for gravity loads and then for seismic loads.
3. The study has been carried out by introducing symmetrical bare frame building models on zone II and zone IV Response Spectrum Analysis.
4. The study highlights the effect of seismic zone factor in different zones that is in Zone II and Zone IV which is considered in the seismic performance evaluation of buildings.
5. The study emphasis and discusses the effect of seismic zone factor on the seismic performance of G+7 building structure.
6. The entire process of modelling, analysis and design of all the primary elements for all the models are carried by using ETABS 18.0.2 version software.

CHAPTER 2

LITERATURE REVIEW

2. LITERATURE REVIEW

GENERAL

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

Analysis and Design of Commercial Building using ETABS June 2024 | IJIRT | Volume 11 Issue 1 | ISSN: 2349-6002

This study details the analysis and design of a G+8 commercial building using ETABS, adhering to Indian standards. The structure, intended for mixed office and retail use, was modelled in 3D, incorporating realistic material properties.

Analysis of g+20 RC building in different zones using ETABS 2022 IJCRT | Volume 10, Issue 8 August 2022 | ISSN: 2320-2882

Comparing the ETABS software findings for different buildings in zones II, III, IV, & V.

International research journal of Engineering and Technology (IRJET) volume: 07 issue 08 | August 2020

Analysis and design of g + 3 building in different seismic zones using E-tabs the objectives of the current work is to study the behaviour of a multi storey building subjected to earthquake load by adopting response spectrum analysis.

International Research Journal of engineering and technology (IRJET) volume: 06 Issue: 05 | May 2019

Analysis and design of g+6 building in different zones by using software. The principal objective of this project is to analyse and design of g + 6 building in different seismic zones and in different soil types by using ETABS.

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).

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 paper models are compared for different types of bracing such as X, inverted V and Single diagonal bracing by 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.

International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 06 June-2017

Studied Analysis and Design of Commercial Building Using ETABS Our project “Analysis and Design of residential building using ETABS software” is an attempt to analyse and design a residential building using ETABS. A G+20 storey building is considered for this study. Drawing and detailing are done using Auto CAD.

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 successfully verified 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 by this paper.

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 earth quake 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, base shear were plotted and studied.

GEETHU ET.AL (2016)

Made a comparative study on analysis and design of multi storied building by STAAD.Pro and ETABS software'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.

CHANDRASHEKAR ET.AL (2015)

Analysed and designed the multi-storeyed building by using ETABS software. A G+5 storey 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 the importance 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.

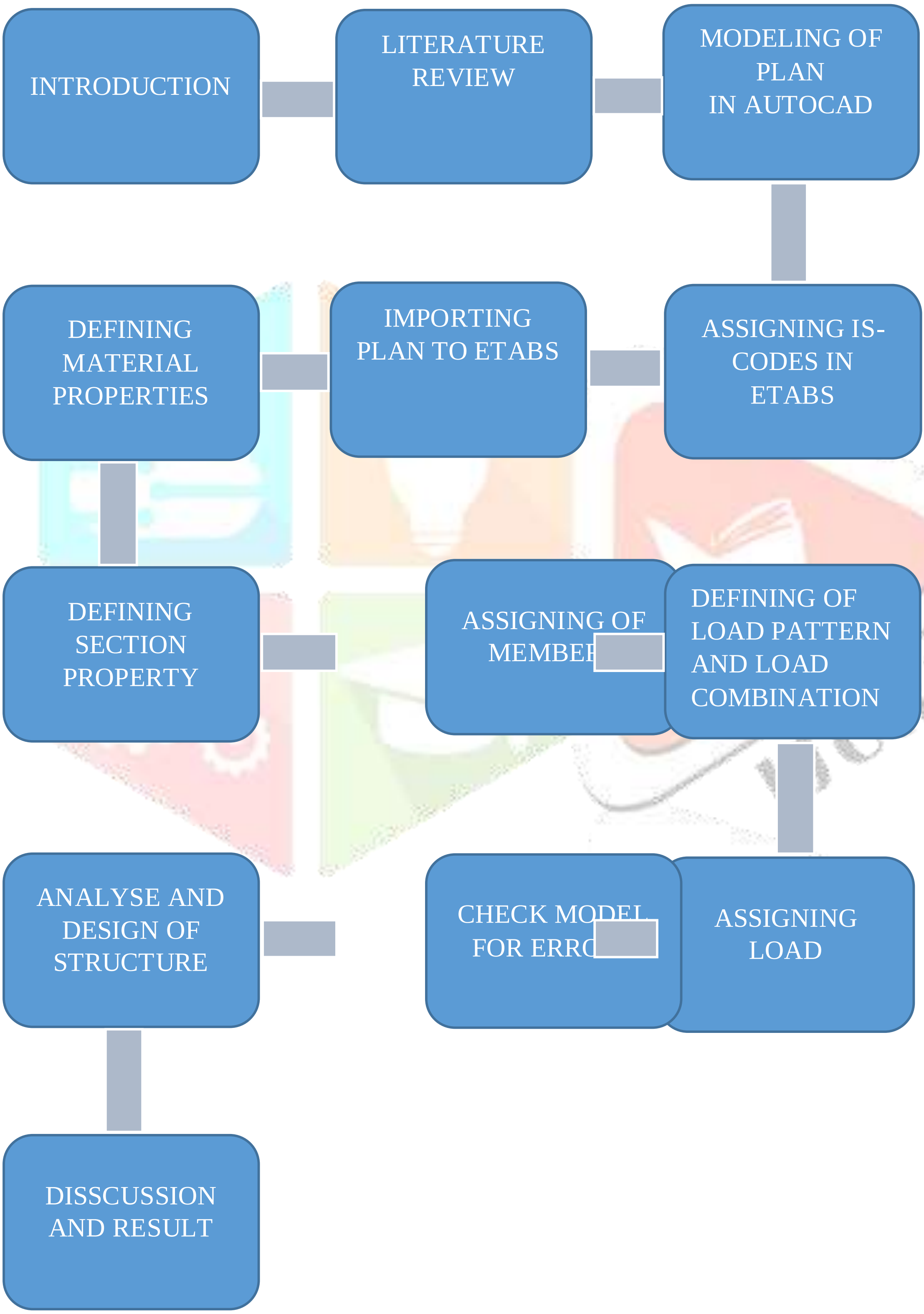
VARALAKSHMI V ET.AL (2014)

Analysed 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 safety of 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.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 RESEARCH METHODOLOGY



3.2 GENRAL DATA OF THE BUILDING

Live load	: 4.0 kN/m2 at typical floor
	: 1.5 kN/m2 on terrace
Floor finish	: 1.0 kN/m2
Wind load	: As per IS: 875-Not designed for wind load, since earthquake loads exceed the wind loads.
Earthquake load	: As per IS-1893 (Part 1) - 2002
Depth of foundation below ground	: 2.5 m
Type of soil	: Type II, Medium as per IS:1893
Storey height	: Typical floor: 4 m, GF: 2.5 m
	Parapet wall: 1.2 m
Floors	: G.F. + 7 upper floors.
Walls	: 230 mm thick brick masonry walls only at periphery.

3.3 GENRAL DATA OF ZONE FOR SEISMIC ANALYSIS

TABLE 3.1

PARAMETERS	ZONE II	ZONE IV	IS CODE	TABLE NO.
Seismic zone factor	0.16	0.24	**IS 1893-PART 1-2016**	**Table 3(clause 6.4.2)**
Response factor, R	3	3	**IS 1893-PART 1-2016**	TABLE (CLAUSE 7.2.6)
Importance factor, I	1.5	1.5	**IS 1893-PART 1-2016**	**Table 8 (clause 7.2.3)**
Site type	II(Medium)	II(Medium)	**IS 1893-PART 1-2016**	

Member self-weight:

Weight calculation of brick missionary wall.

Brick wall (230 mm thick)

0.23 x 19 (wall) + 2 x 0.012 x 20 (plaster)

=4.9 kN/m^2 x 3.5

= 17.15 kN/m^2

Terrace parapet (height 1.2 m)

1.1 x 4.9 = 5.92 kN/m^2

3.4 Modelling of plan

Preparation of Plan in AutoCAD

The architectural layout of the building was initially drafted using AutoCAD. The plan includes key structural elements such as columns, beams, slabs, and walls. Accurate dimensions and grid lines were maintained to facilitate proper modelling in ETABS.

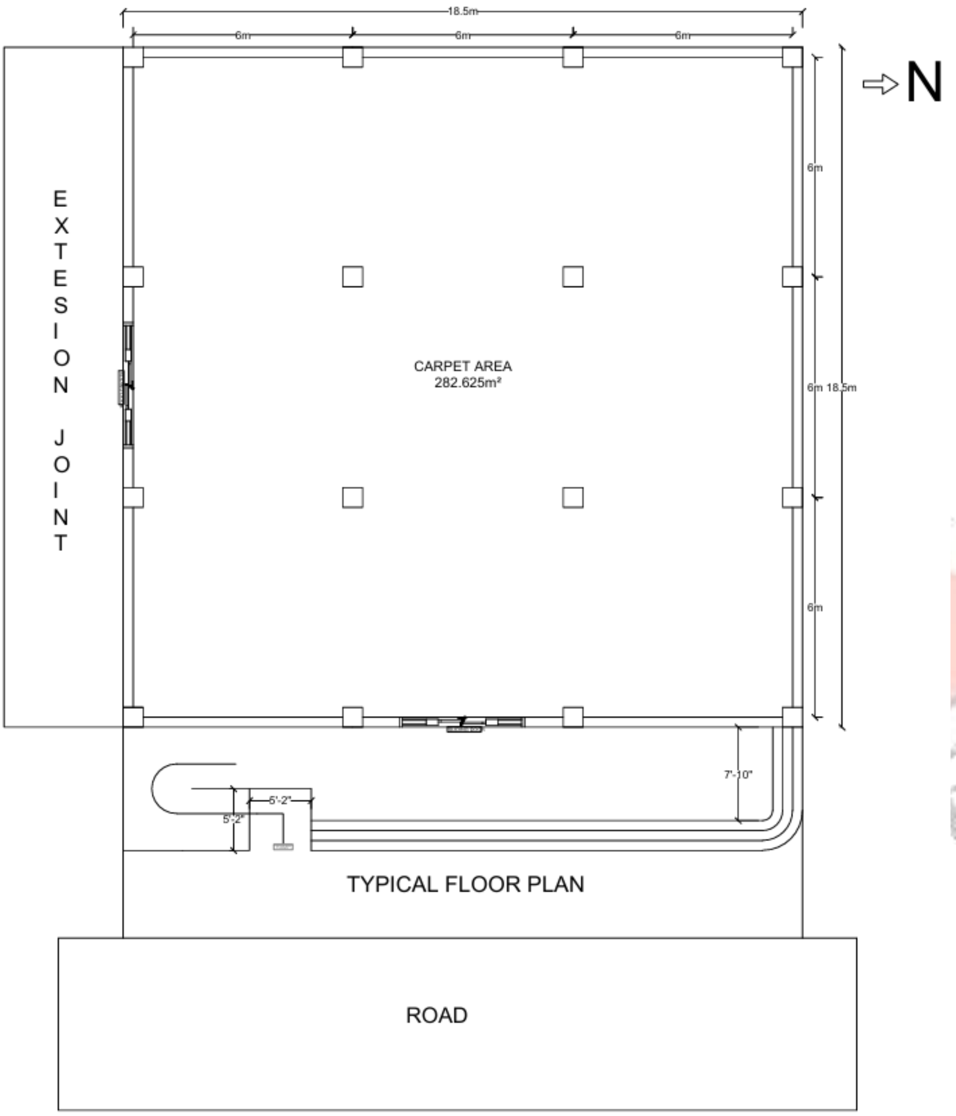


Figure 3.4 (a) Architectural plan of the project.

3.4.1 ASSIGNING OF CODES

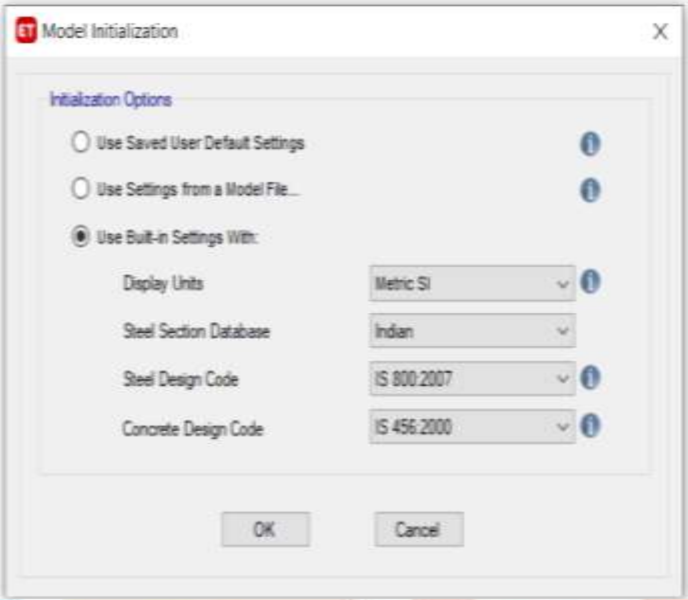


Figure 3.4(b) Architectural plan of the project.

In ETABS codes are assign just before starting of new project. For design of steel is code is 800:2000 has been used. Code for concrete is 456:2000 is used.

3.4.2 IMPORTING PLAN TO ETABS

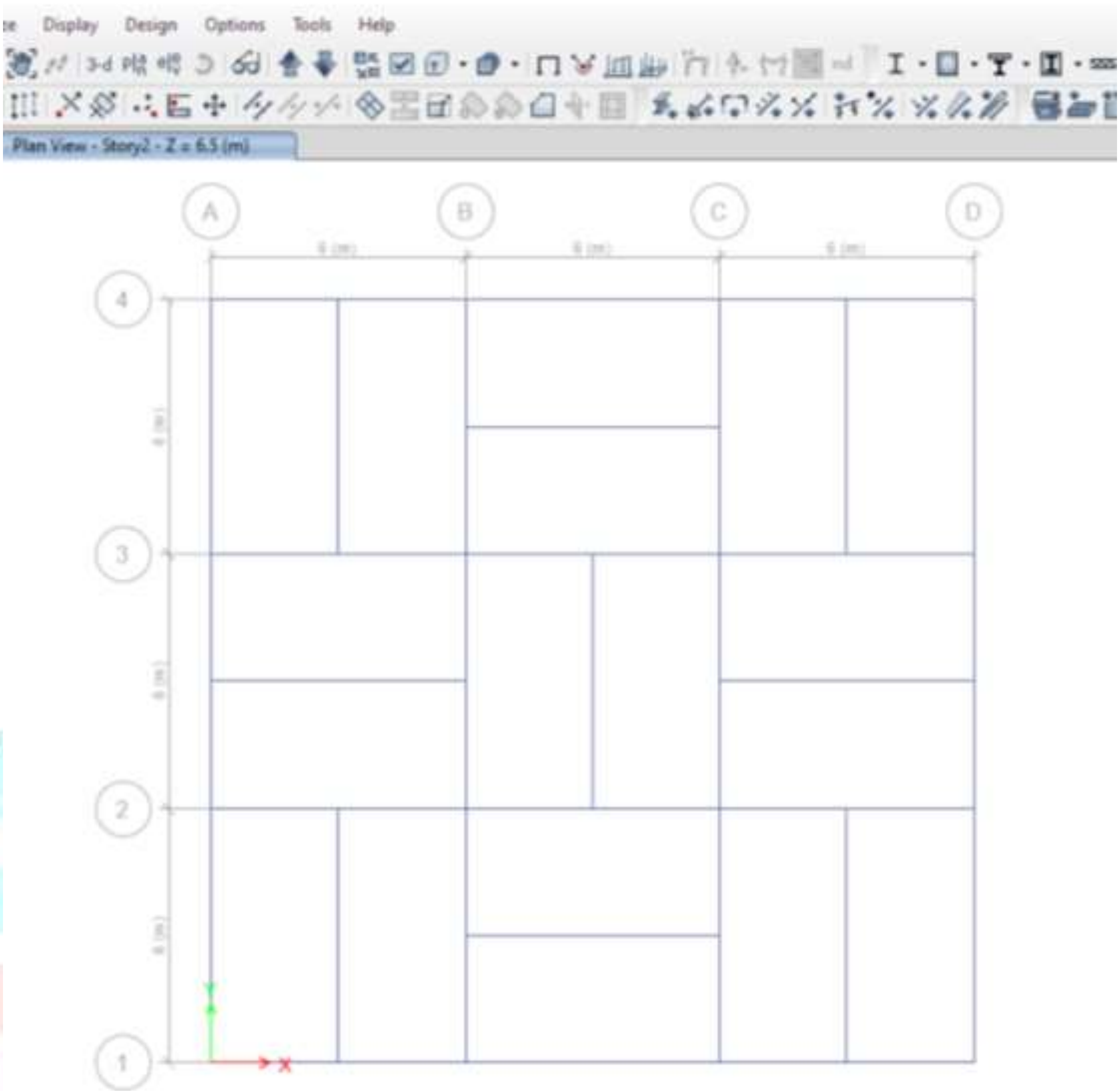


Figure 3. (c) Grid line imported in Etabs.

The plan developed in AutoCAD was exported and imported into ETABS using the DXF file format. This step ensured seamless integration between drafting and structural modelling.

3.4.3 DEFINING MATERIAL PROPERTY

Concrete and reinforcement steel properties will be defined in ETABS as per the specifications of IS 456:2000. Grades of materials used (e.g., M30 concrete and Fe550 steel) were assigned to appropriate structural elements.

CONCRETE

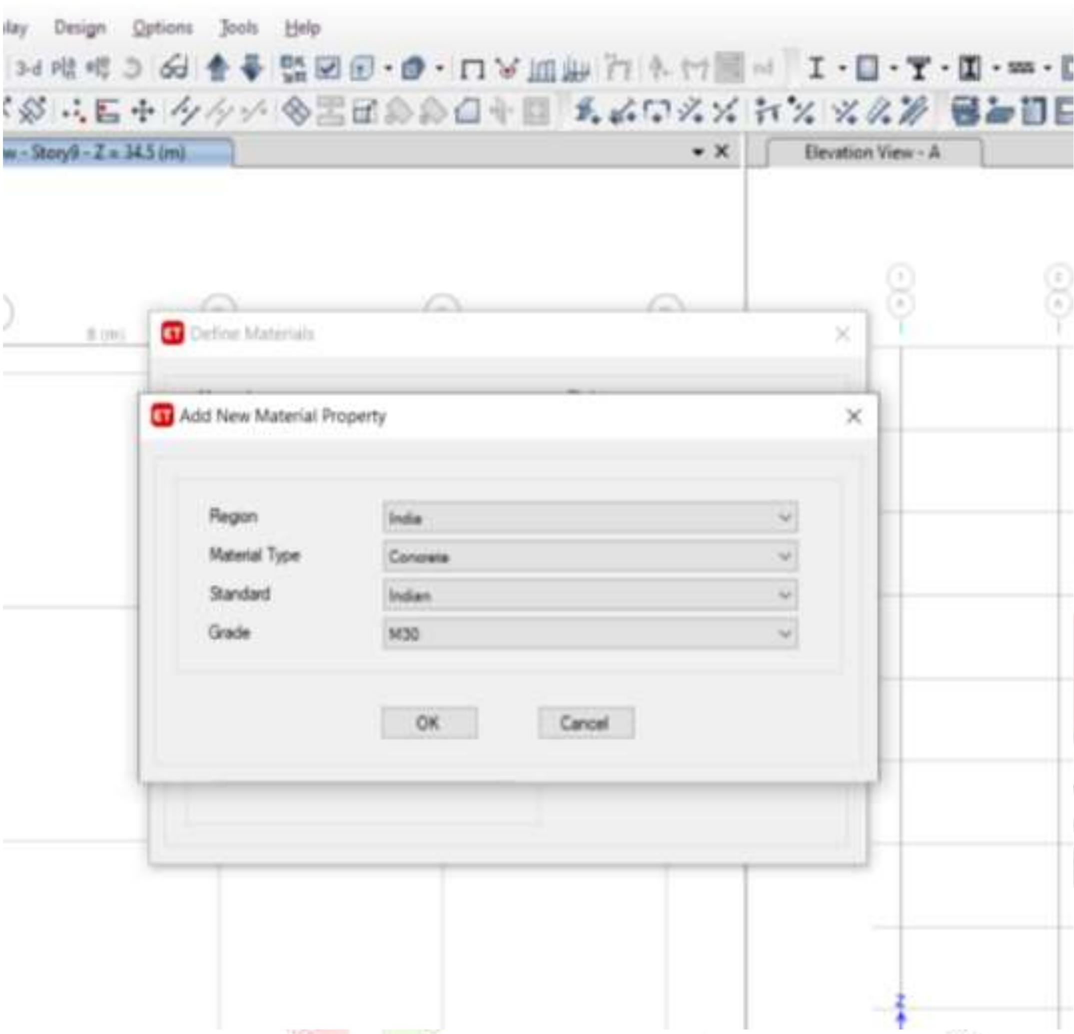


Figure 3.4 (d) Concrete properties M30 defined.

All components unless specified in design: M30 grade all

E_c= 5 000$\sqrt{f_{ck}}$ N/mm^2 = 5000$\sqrt{f_{ck}}$ MN/m^2

= 27386 N/mm^2 = 273856 MN/ m^2

STEEL

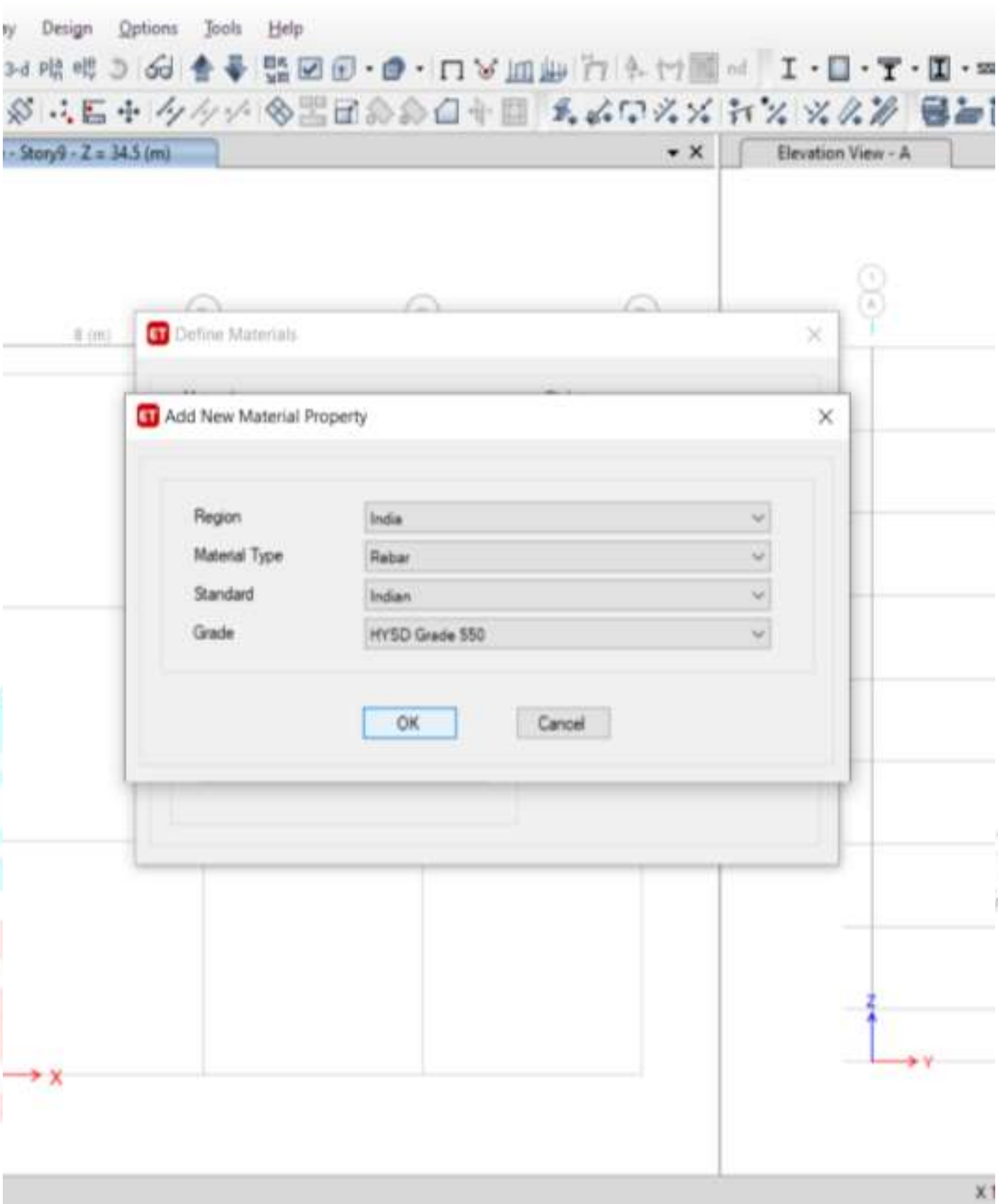


Figure 3.4 (e). Rebar property Fe550 defined.

HYSD reinforcement of grade Fe 550 confirming to IS: 1786 is used throughout.

3.4.4 DEFINING SECTION PROPERTY

COLUMN 500X500

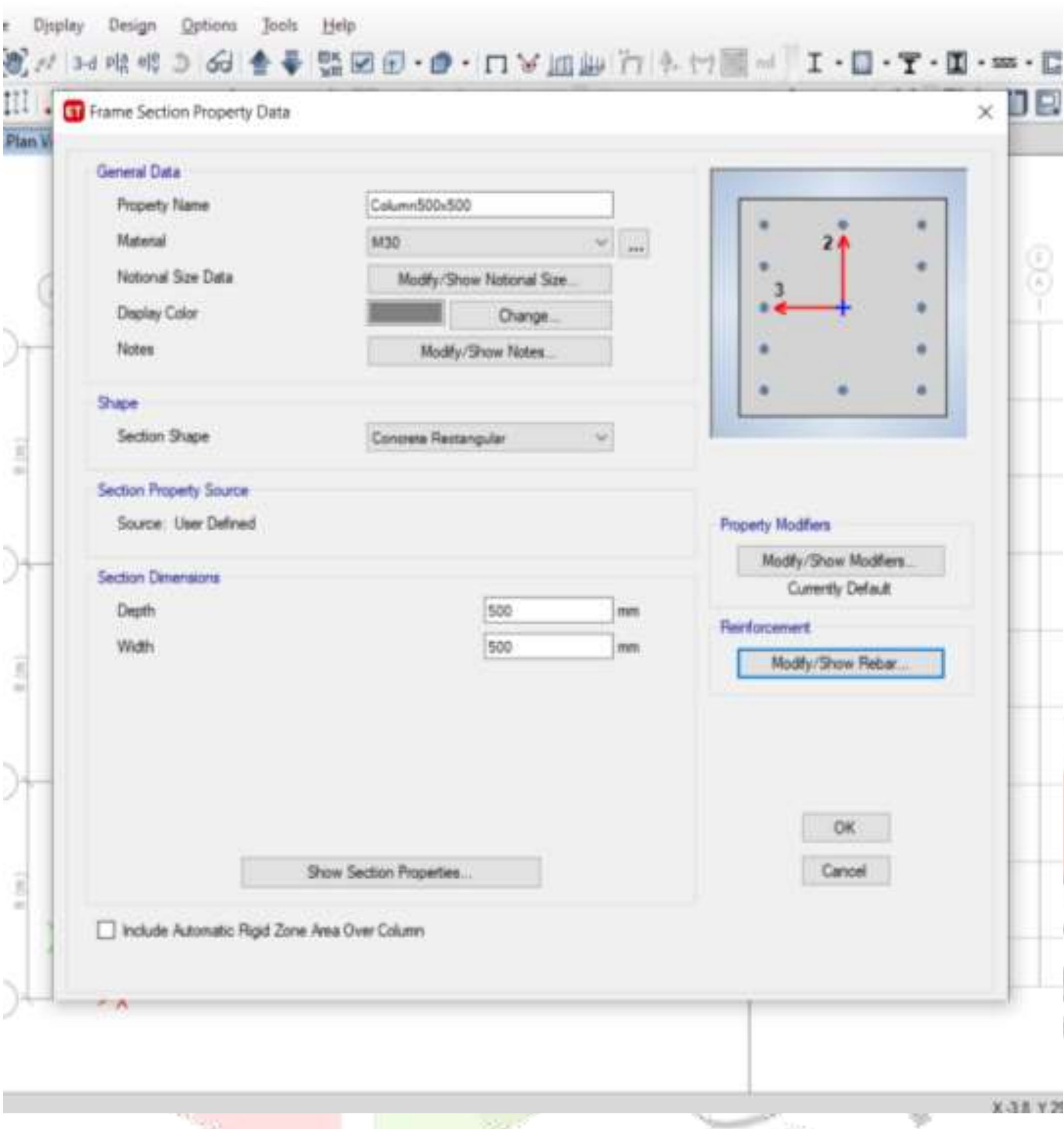


Figure 3.4(f). Column section 500x500mm defined.

Column size 500x500 was used in all floors. Preliminary sizes of structural components are assumed by experience.

MAIN BEAM 300X550

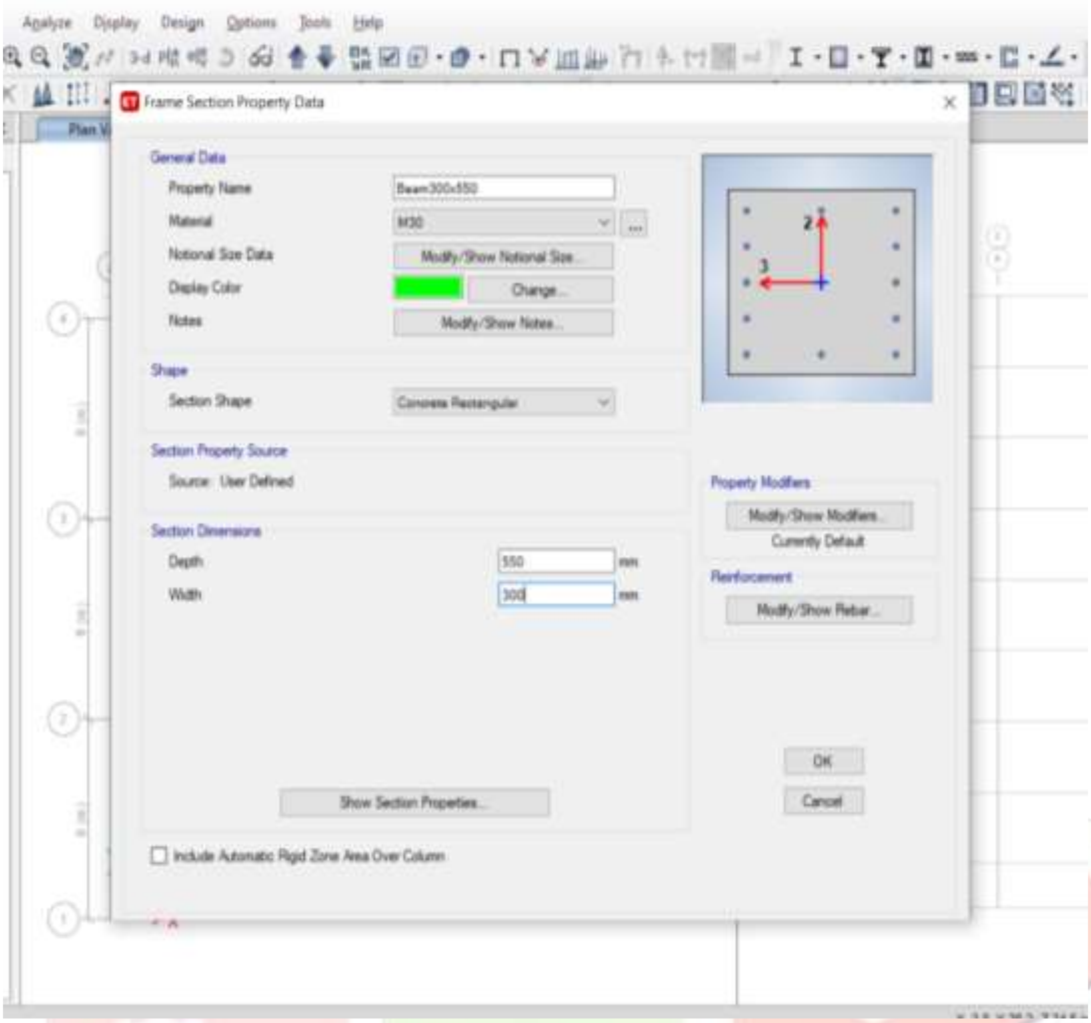


Figure 3.4(g). Main beam 300x550mm property defined.

SECONDARY BEAM 250X400

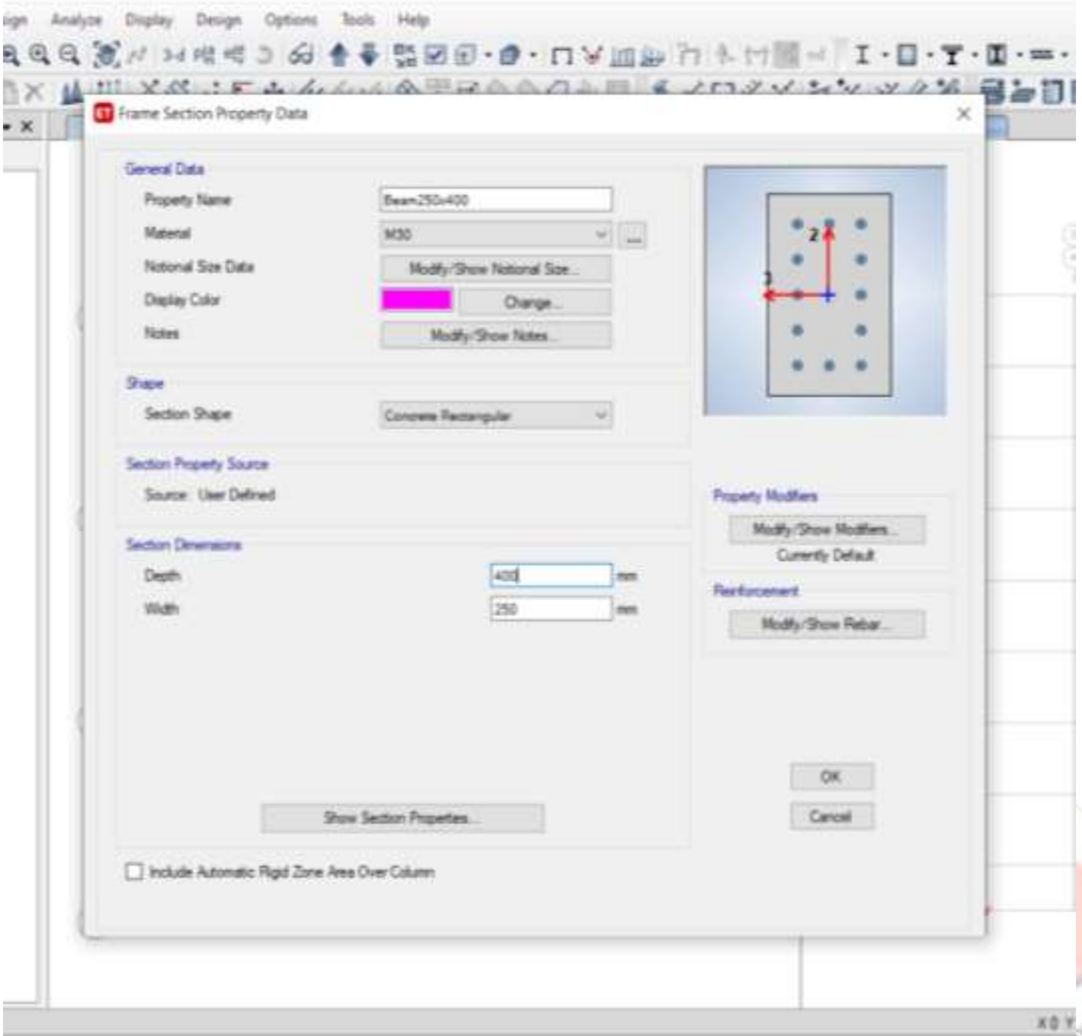


Figure 3.4(h). Secondary beam 250x400 mm property defined.

SLAB 125 MM

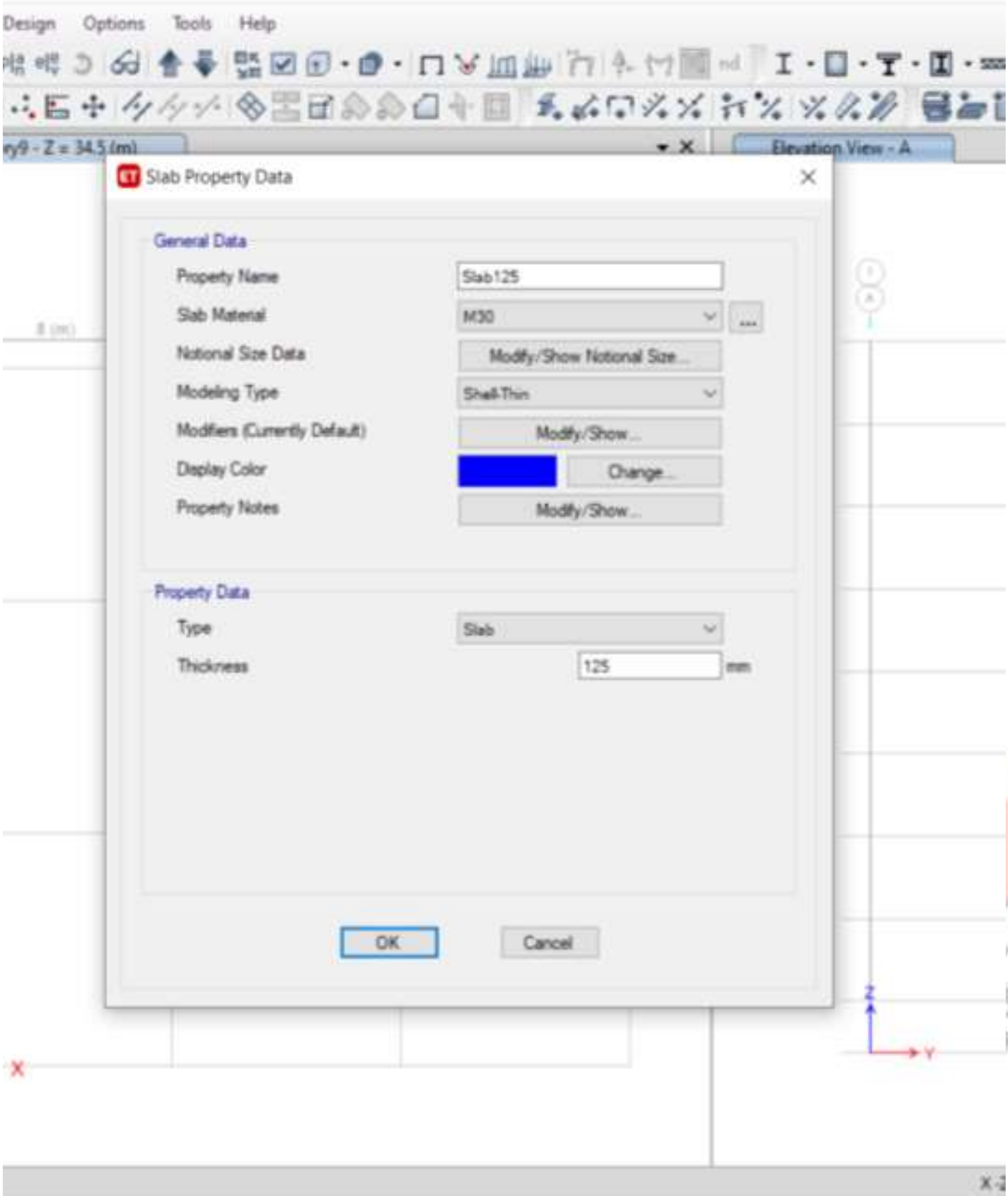


Figure 3.4(i). Slab property 125mm defined.

3.4.5 ASSIGNING OF MEMBERS

FIRST MAIN BEAM WAS ASSIGNED TO ALL THE FLOORS

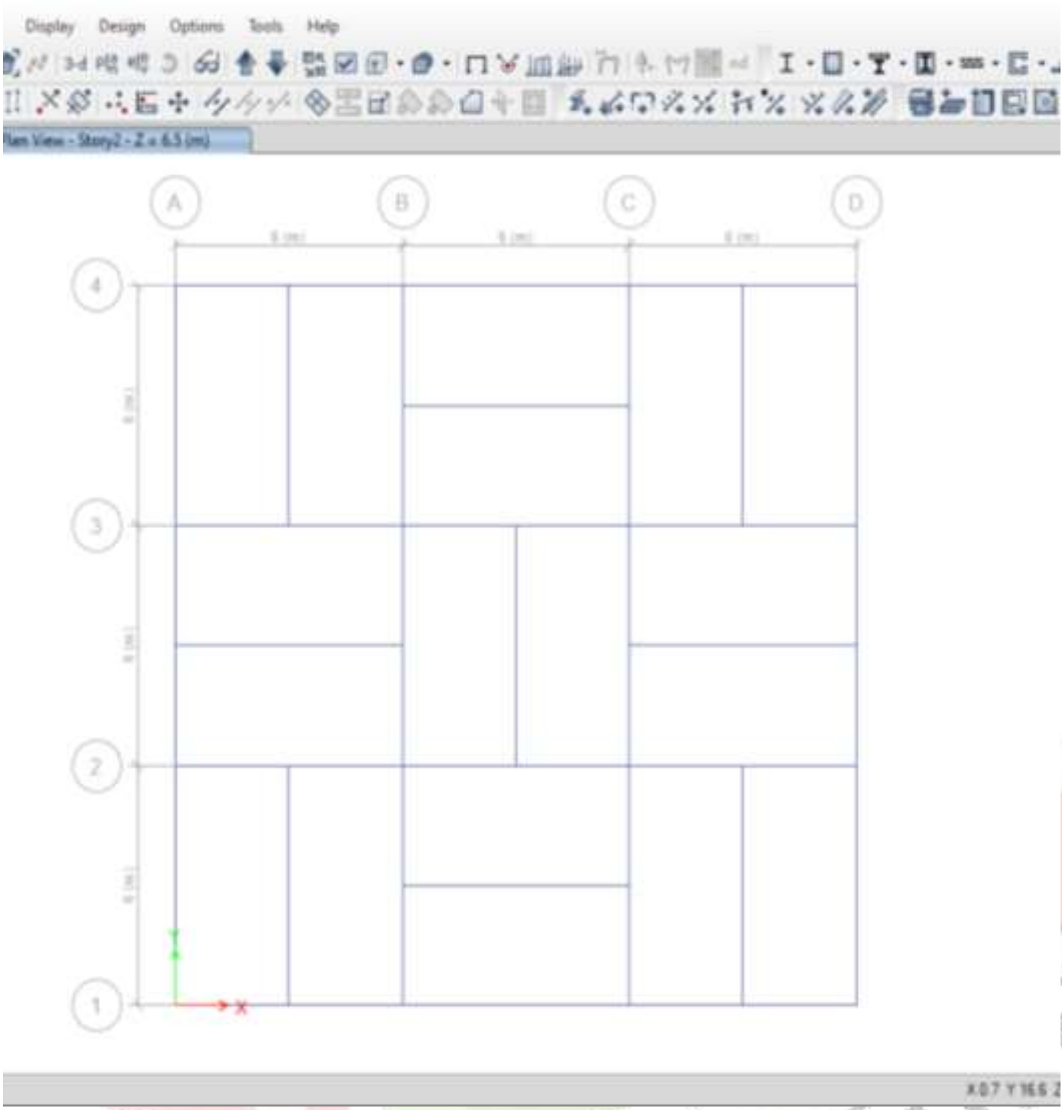


Figure 3.9(a) Main beam and secondary beam assigned as per plan.

COULUMN (500X500) ASSIGNED TO ALL FLOORS.

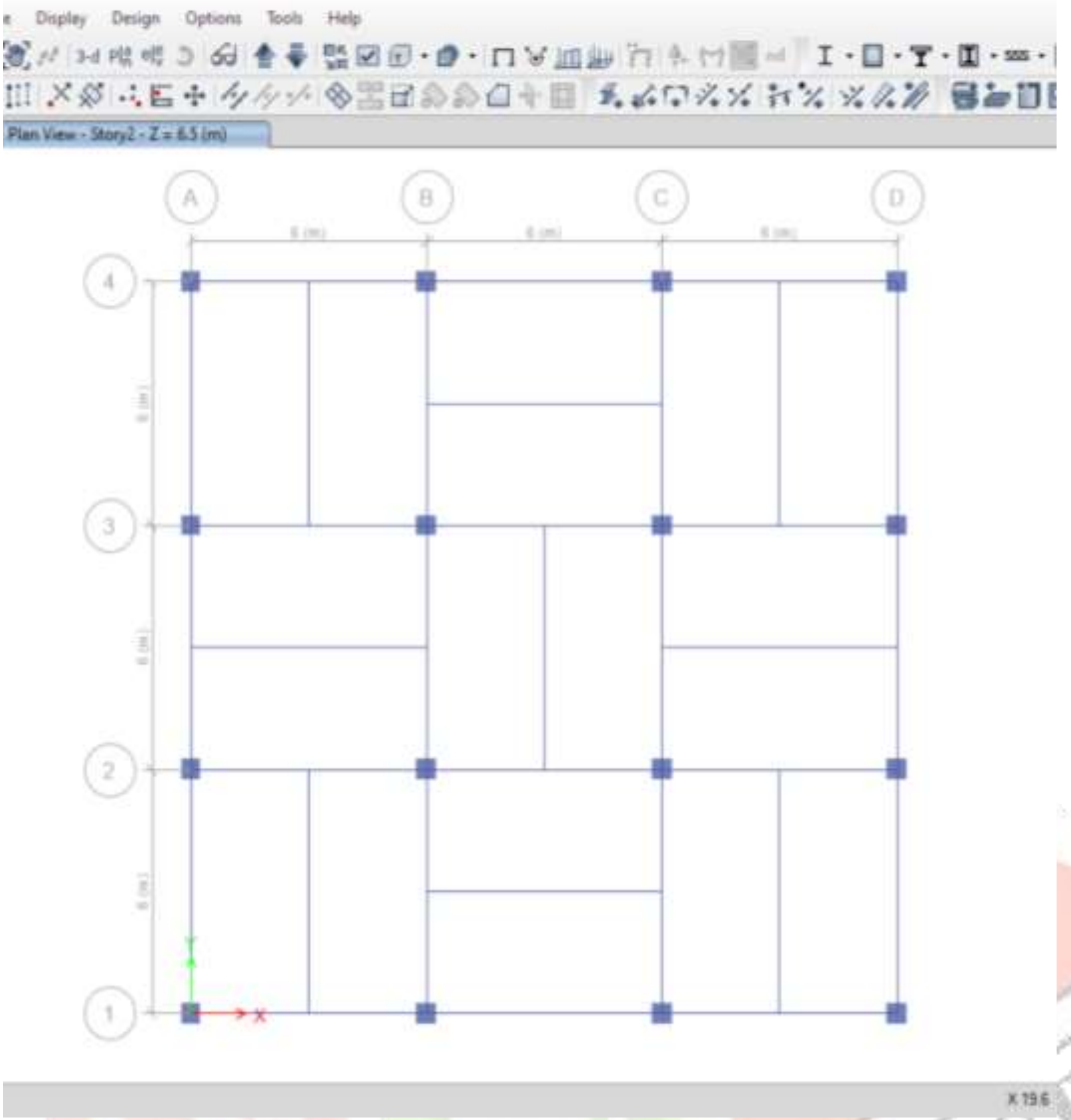


Figure 3.9(b) Column assigned as per plan.

SLAB 125 MM ASSIGNED TO ALL FLOORS.

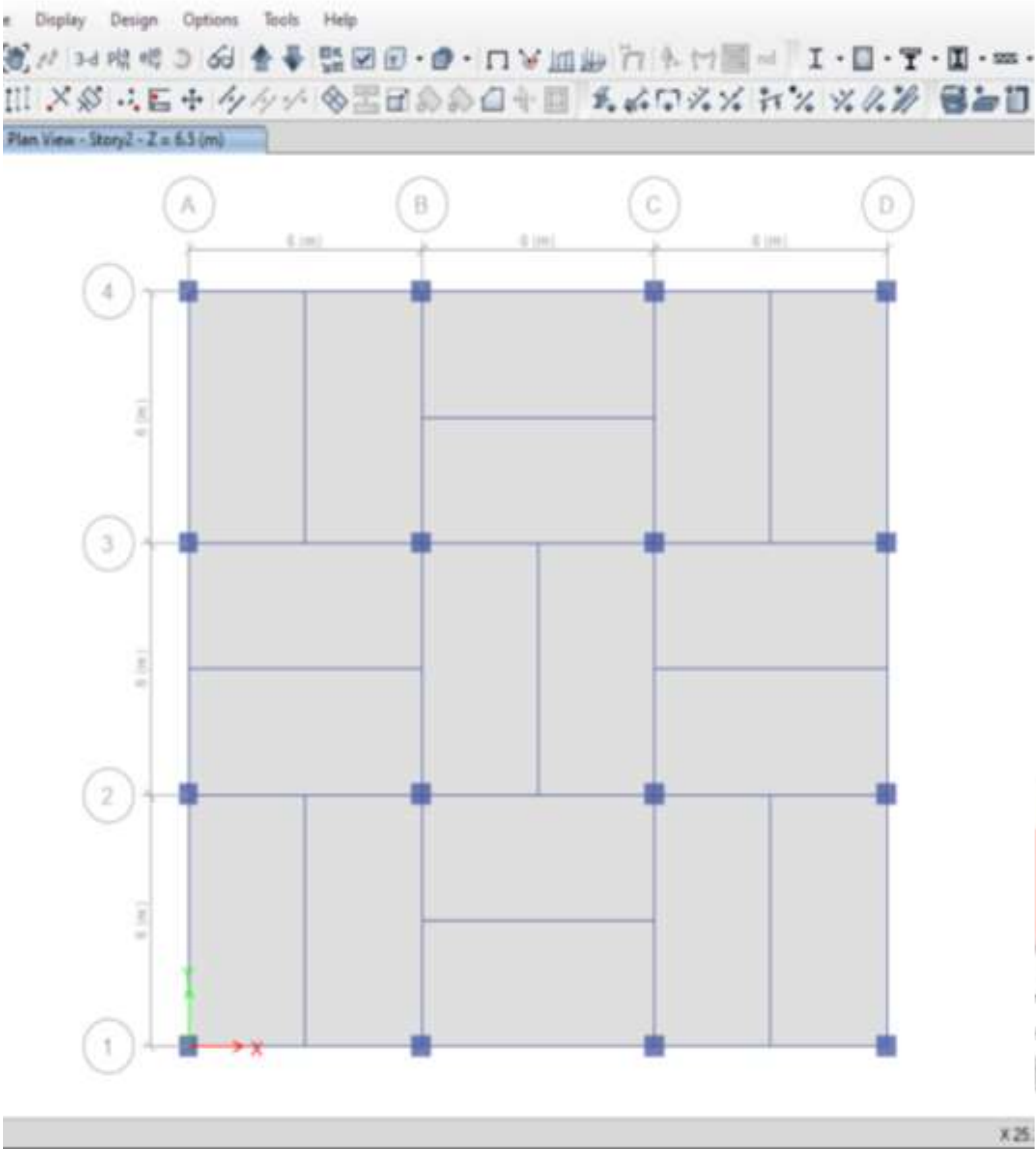


Figure 3.9(c) 125mm thick slab assigned.

3D VIEW OF THE STRUCTURE

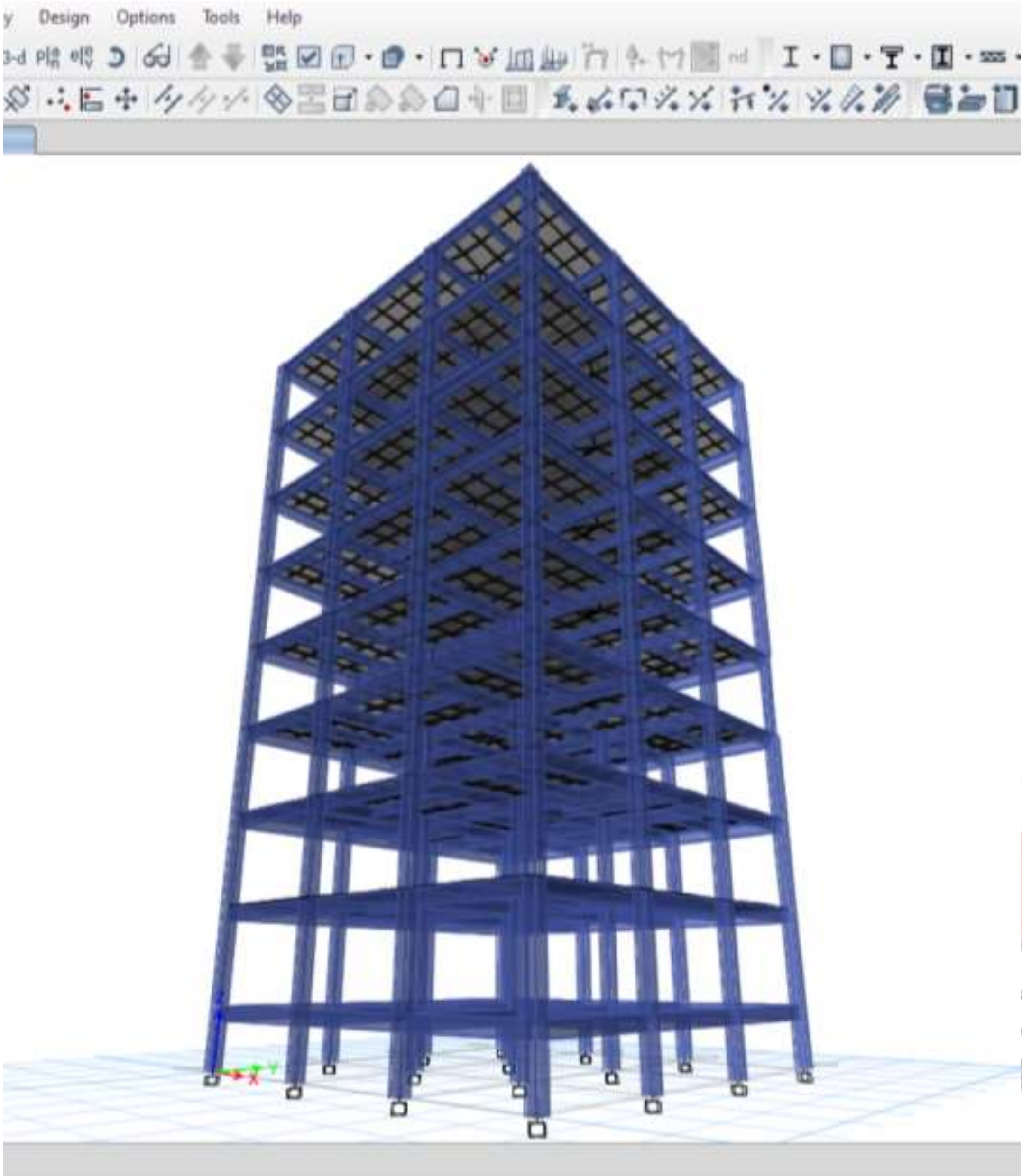


Figure 3.9 (d) 3D view of the structure.

3.4.6 ASSIGNING OF FIXED JOINT

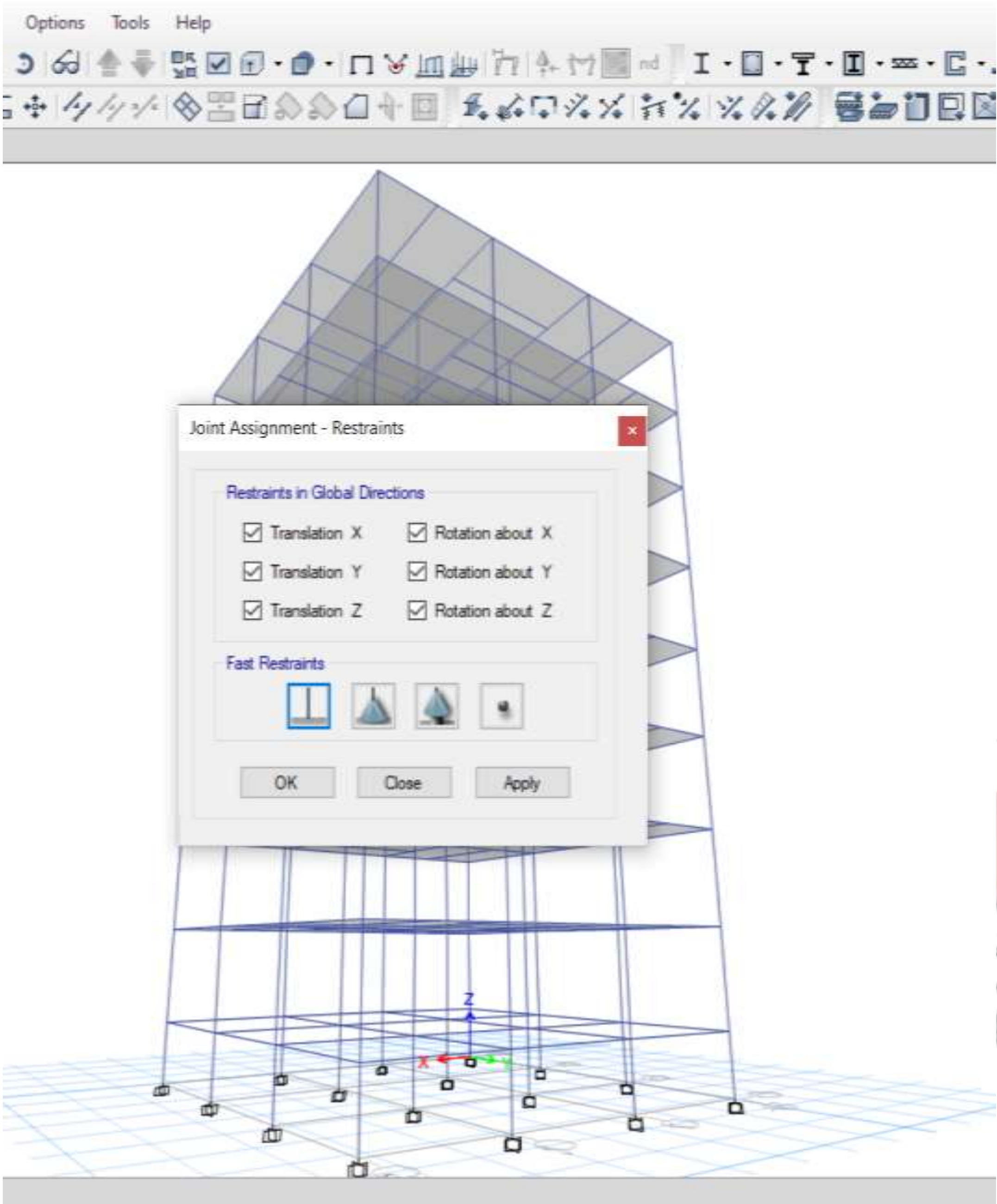


Figure 3.10 (a) fixed support at the base of structure.

3.5 DEFINING OF LOAD PATTERN

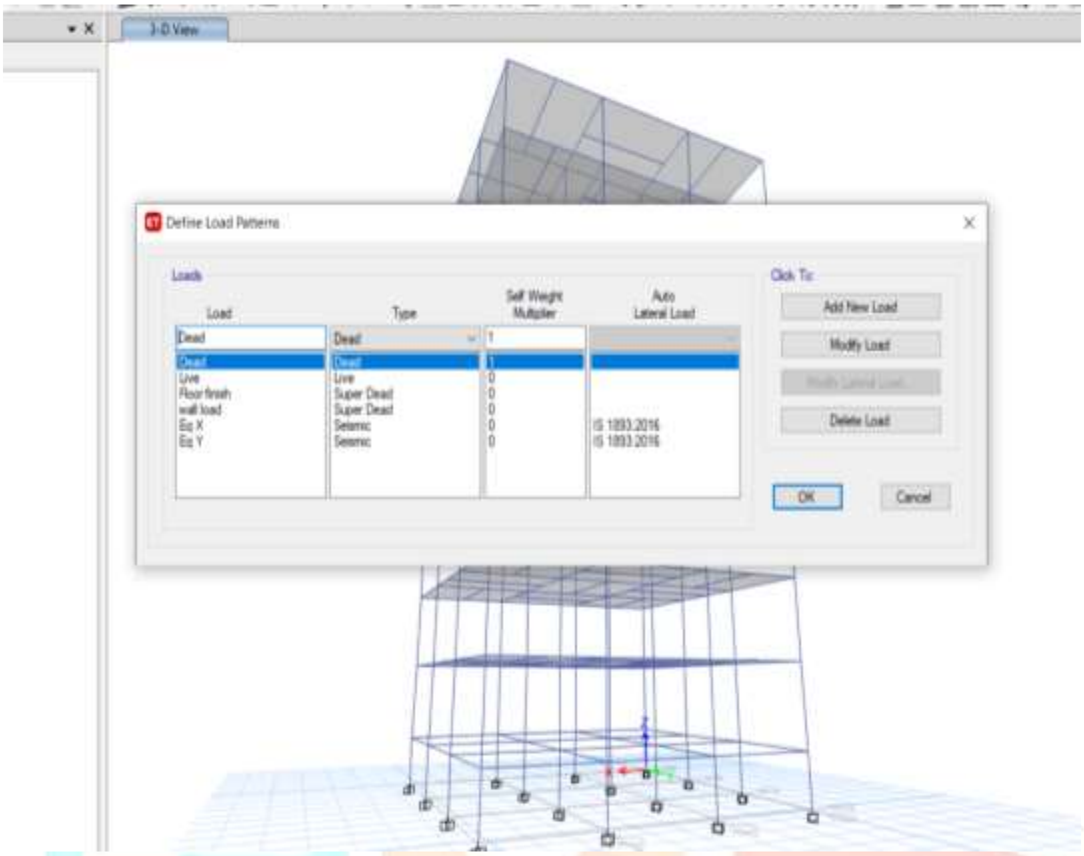


Figure 3.5(a). Defining all loads in load pattern.

Dead load in ETABS is self-multiplied. Seismic load is defined here in load pattern as per requirement.

3.6 DEFINING EARTHQUAKE PROPERTIES

FOR ZONE II

FIRST EARTHQUAKE IS DEFINED IN X-DIRECTION.

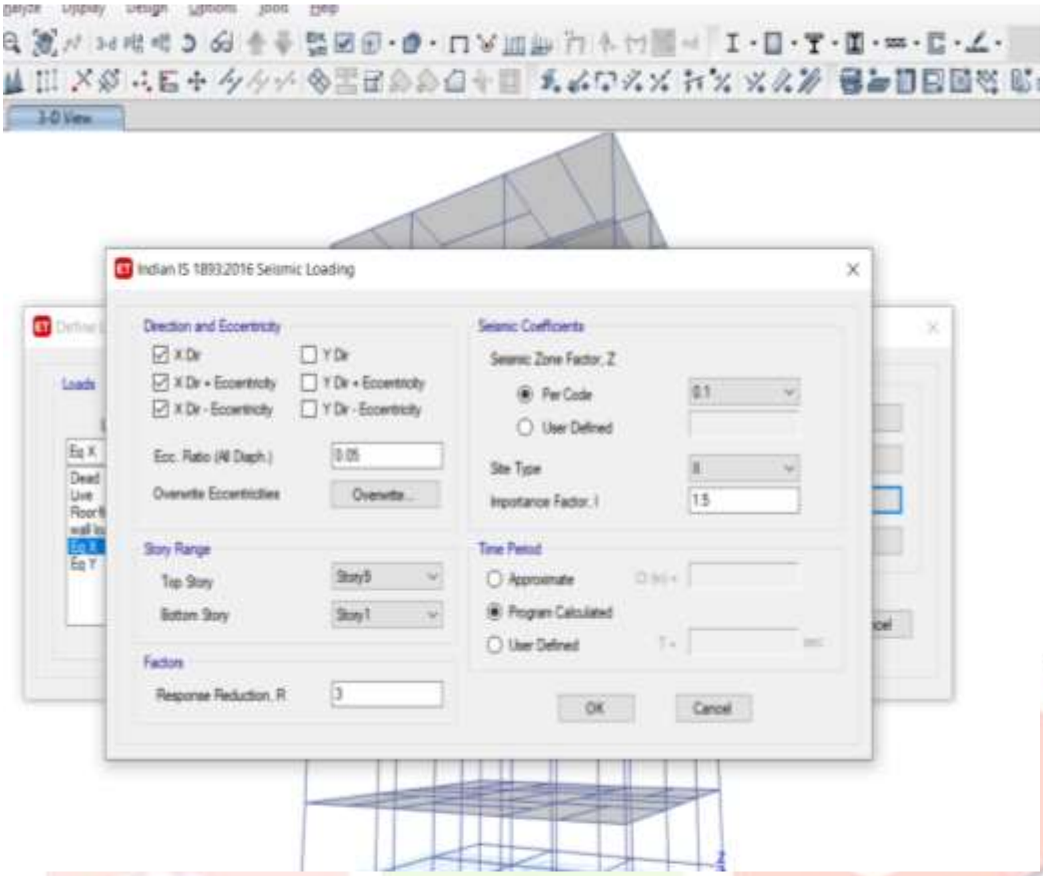


Figure 3.6 (a). Defining seismic load and eccentricity in y-direction.

FIRST EARTHQUAKE IS DEFINED IN Y-DIRECTION.

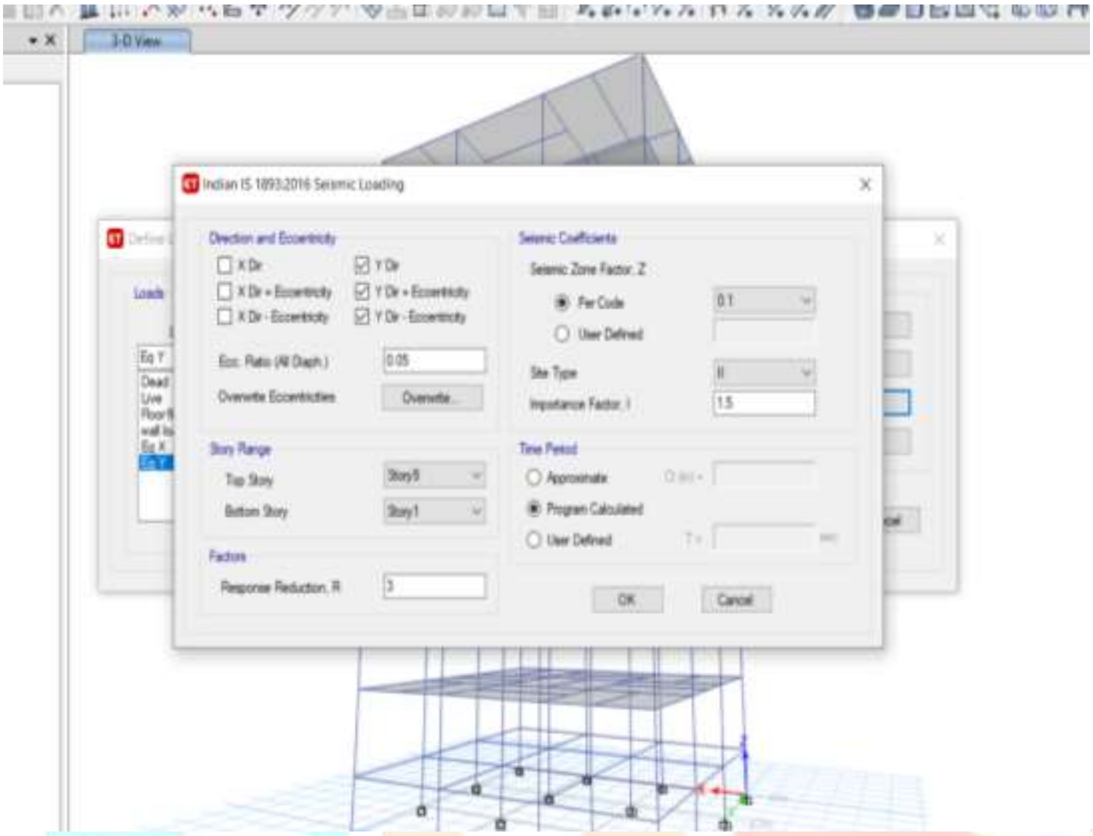


Figure 3.6 (b). Defining seismic load and eccentricity in y-direction.

DEFINING EARTHQUAKE PROPERTIES FOR ZONE IV

FIRST EARTHQUAKE IS DEFINED IN X-DIRECTION.

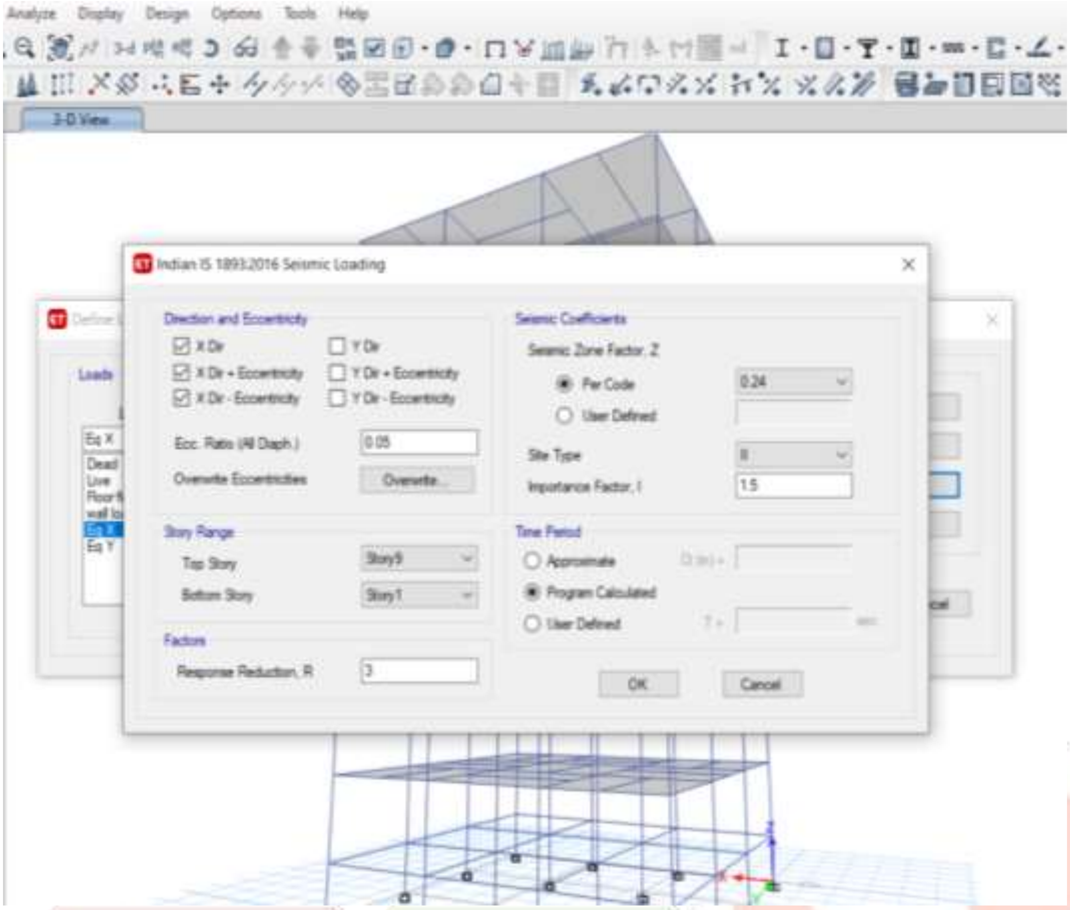


Figure 3.6(c). Defining seismic load and eccentricity in x-direction.

FIRST EARTHQUAKE IS DEFINED IN Y-DIRECTION.

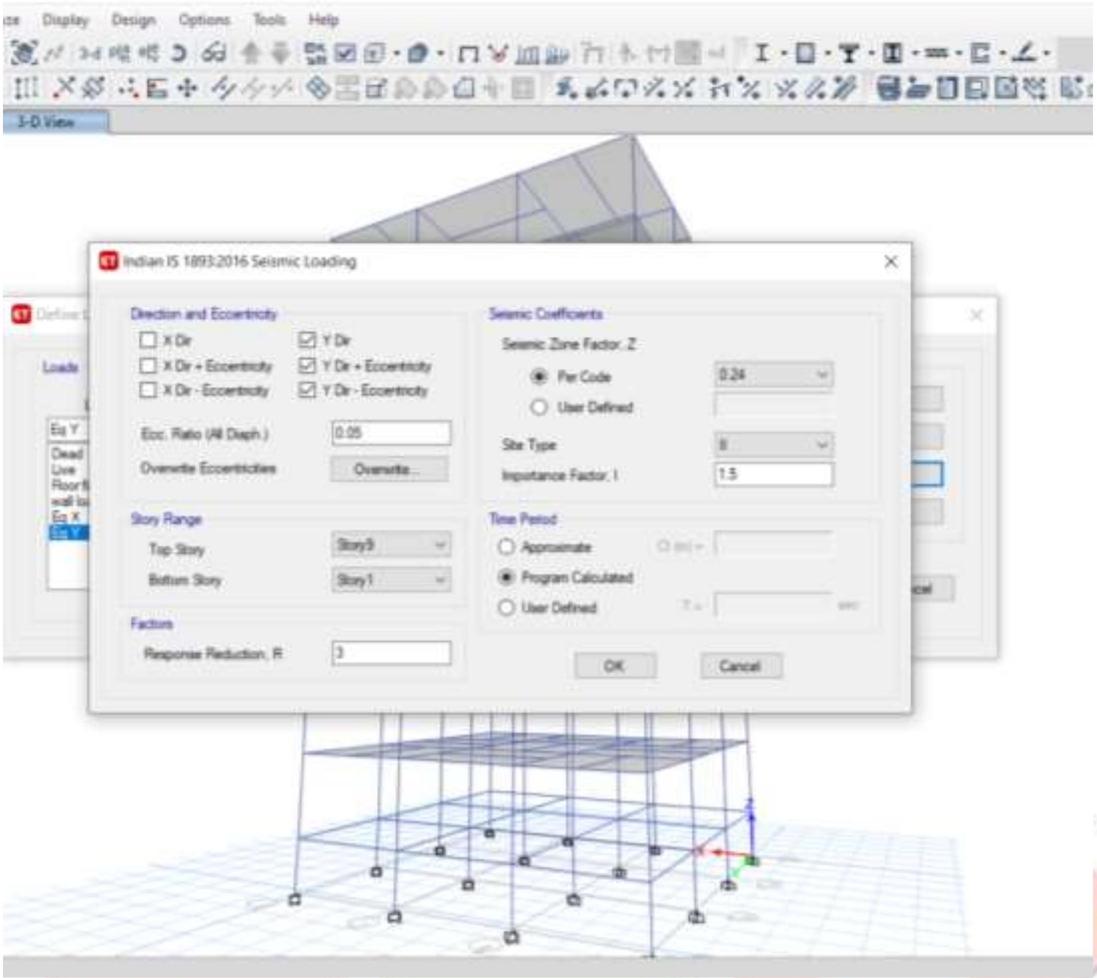


Figure 3.6(d). Defining seismic load and eccentricity in y-direction.

1. Importance factor, I is as per IS code 1893 Part-1:2016. Table no.8 (clause 7.2.3).

2. Response reduction factor is as per IS code 1893 Part-1:2016. Table no.9 (clause 7.2.6).

3. Zone value is as per IS code 1893 Part-1:2016. Table no.3 (clause 6.4.2).

3.7 DEFINING OF LOAD COBINATION

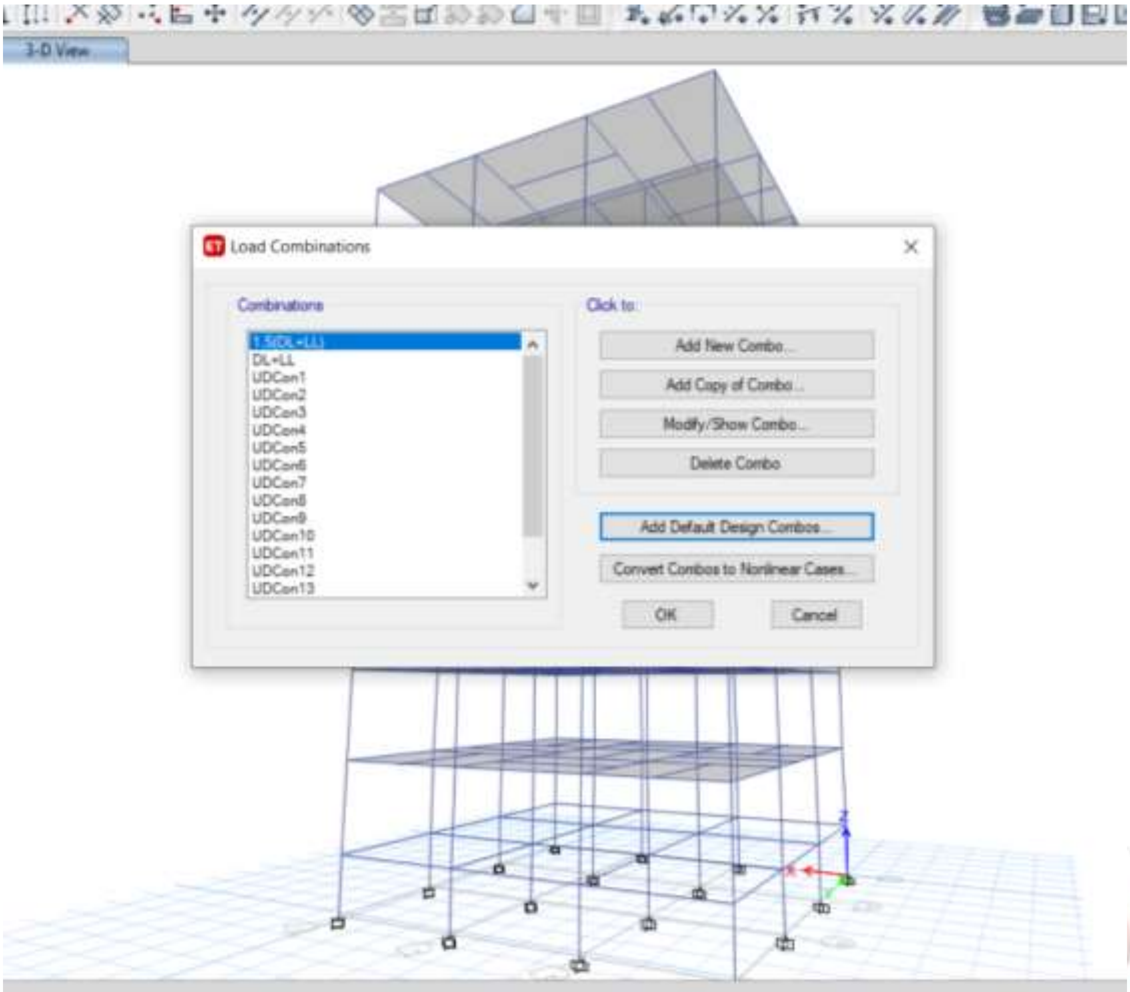


Figure 3.7(a). Default design combos.

TABLE 3.2 Default Combos generated by system

Default combos name	
UDCon1	**1 Dead + 1 Live + 1 Floor finish + 1 Wall load**
UDCon2	**1.5 Dead + 1.5 Live + 1.5 Floor finish + 1.5 Wall load**
UDCon3	**1.5 Dead + 1.5 Floor finish + 1.5 Wall load**
UDCon4	**1.5 Dead + 1.5 Live + 1.5 Floor finish + 1.5 Wall load**
UDCon5	**1.2 Dead + 1.2 Live + 1.2 Floor finish + 1.2 Wall load + EQX**
UDCon5	**1.2 Dead + 1.2 Live + 1.2 Floor finish + 1.2 Wall load - EQX**
UDCon6	**1.2 Dead + 1.2 Live + 1.2 Floor finish + 1.2 Wall load + EQY**
UDCon7	**1.2 Dead + 1.2 Live + 1.2 Floor finish + 1.2 Wall load - EQY**
UDCon8	**1.5 Dead + 1.5 Floor finish + 1.5 Wall load + EQX**
UDCon9	**1.5 Dead + 1.5 Floor finish + 1.5 Wall load - EQX**
UDCon10	**1.5 Dead + 1.5 Floor finish + 1.5 Wall load + EQY**
UDCon11	**1.5 Dead + 1.5 Floor finish + 1.5 Wall load - EQY**
UDCon12	**1.5 Dead + 1.5 Floor finish + 1.5 Wall load + EQX**
UDCon13	**0.9 Dead + 0.9 Floor finish + 0.9 Wall load + 1.5 EQX**
UDCon14	**0.9 Dead + 0.9 Floor finish + 0.9 Wall load - 1.5 EQX**
UDCon15	**0.9 Dead + 0.9 Floor finish + 0.9 Wall load + 1.5 EQY**
UDCon116	**0.9 Dead + 0.9 Floor finish + 0.9 Wall load - 1.5 EQY**

ASSIGNING OF DIAPHRAGM

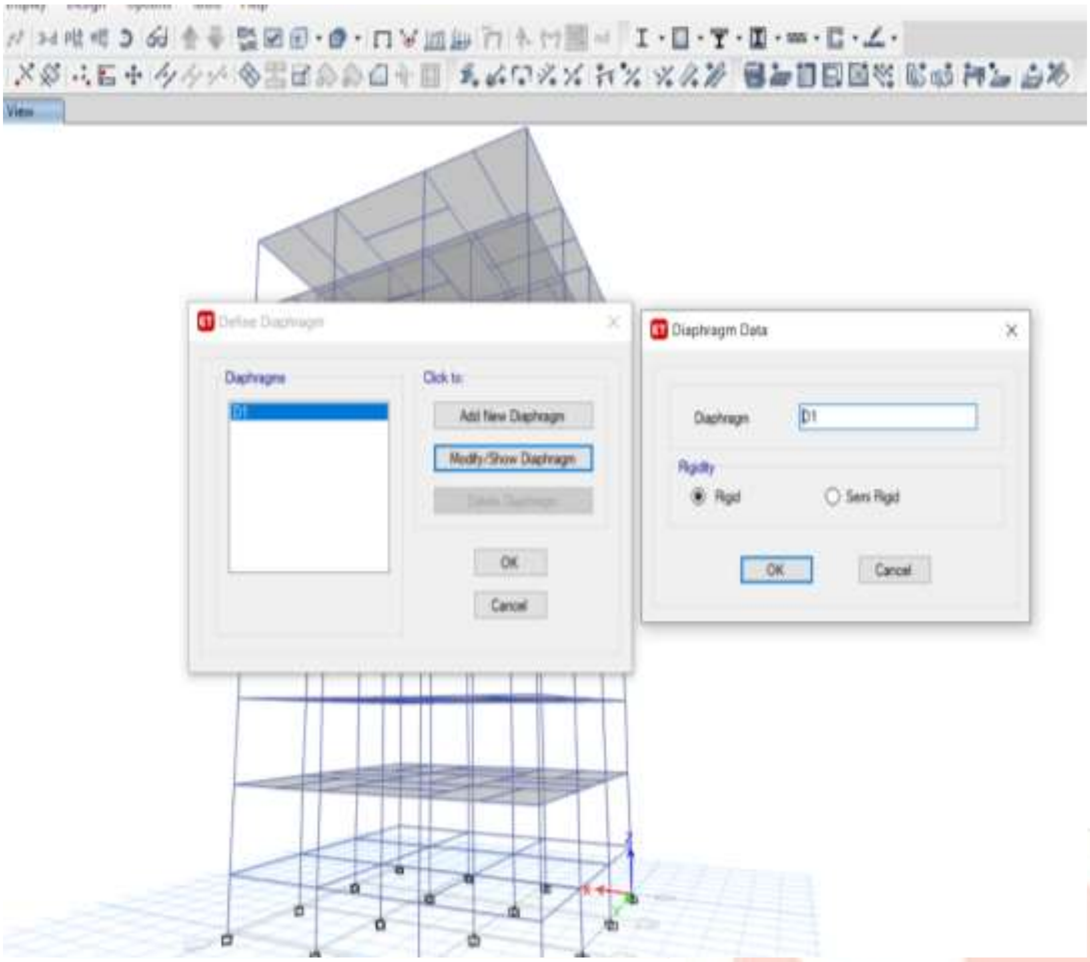


Figure 3.7(b) Rigid Diaphragm.

3.8 ASSIGNING LOADS AS PER IS 456:2000

Dead load

Floor finish

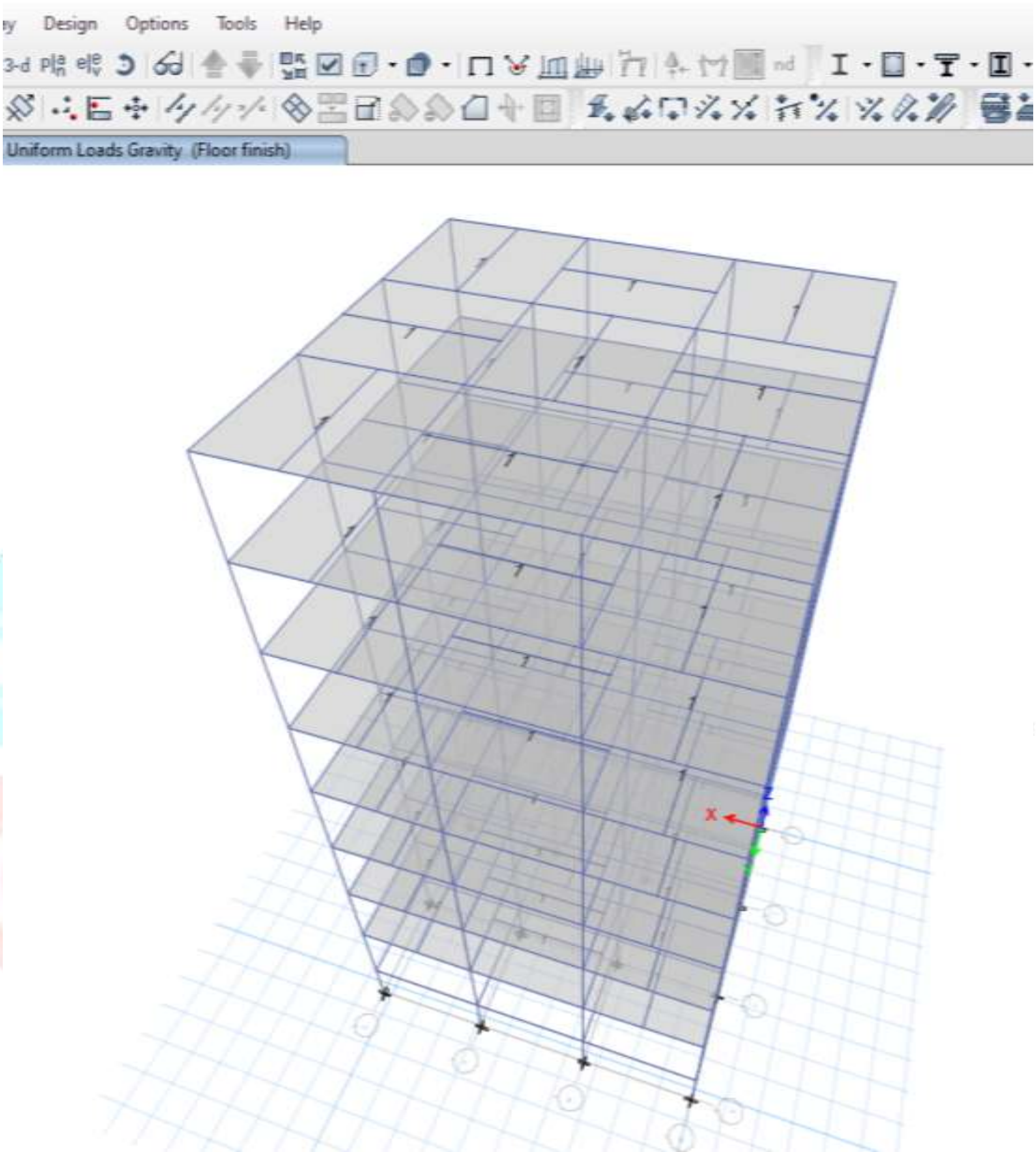


Figure 3.8(a). Floor finish load on slab

Frame load

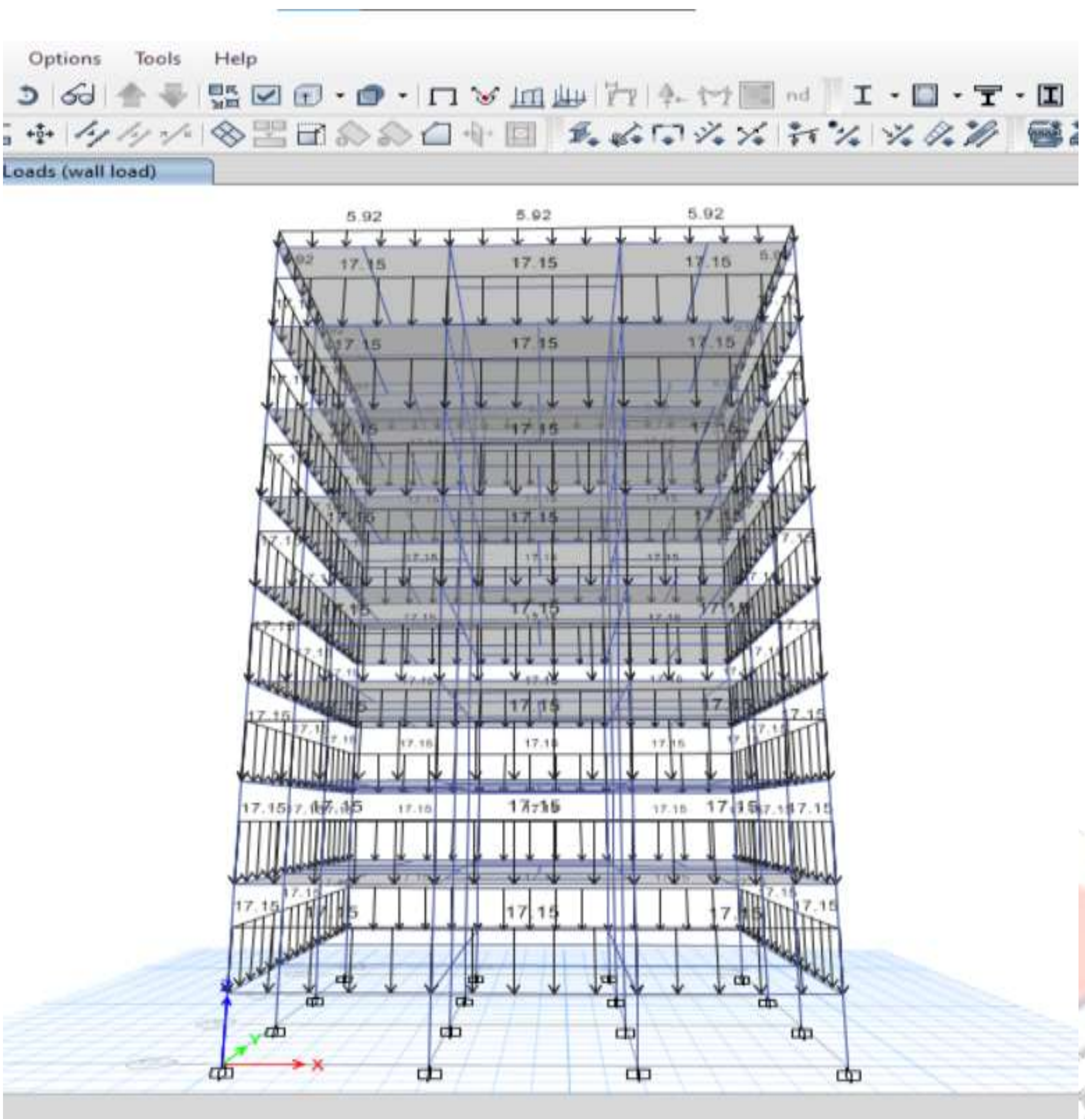


Figure 3.8(b). Wall load on slab

Member self-weight:

Weight calculation of brick missionary wall.

Brick wall (230 mm thick)

0.23 x 19 (wall) + 2 x 0.012 x 20 (plaster)

=4.9 kN/m^2 x 3.5

= 17.15 kN/m^2

Terrace parapet (height 1.2 m)

1.1 x 4.9 = 5.92 kN/m^2

LIVE LOAD

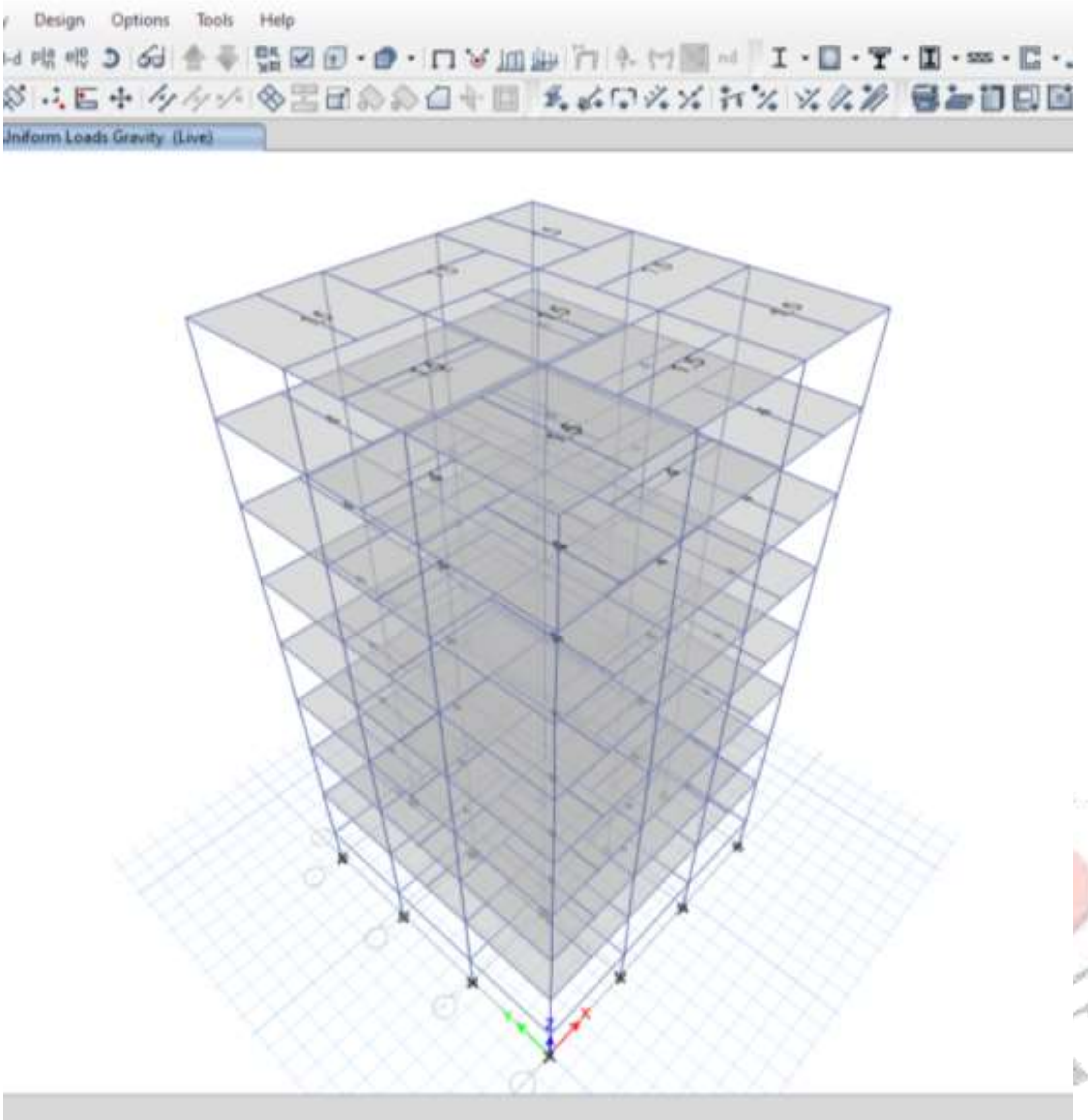


Figure 3.8(c). Wall load on slab

Dead loads, live loads, and other applicable loads will be applied based on guidelines provided in IS 875 (Part 1 & 2) and IS 456:2000. Load combinations will be generated as per code recommendations to simulate realistic loading conditions.

3.9 CHECK MODEL FOR ERRORS

LENGTH TOLERANCE 1MM

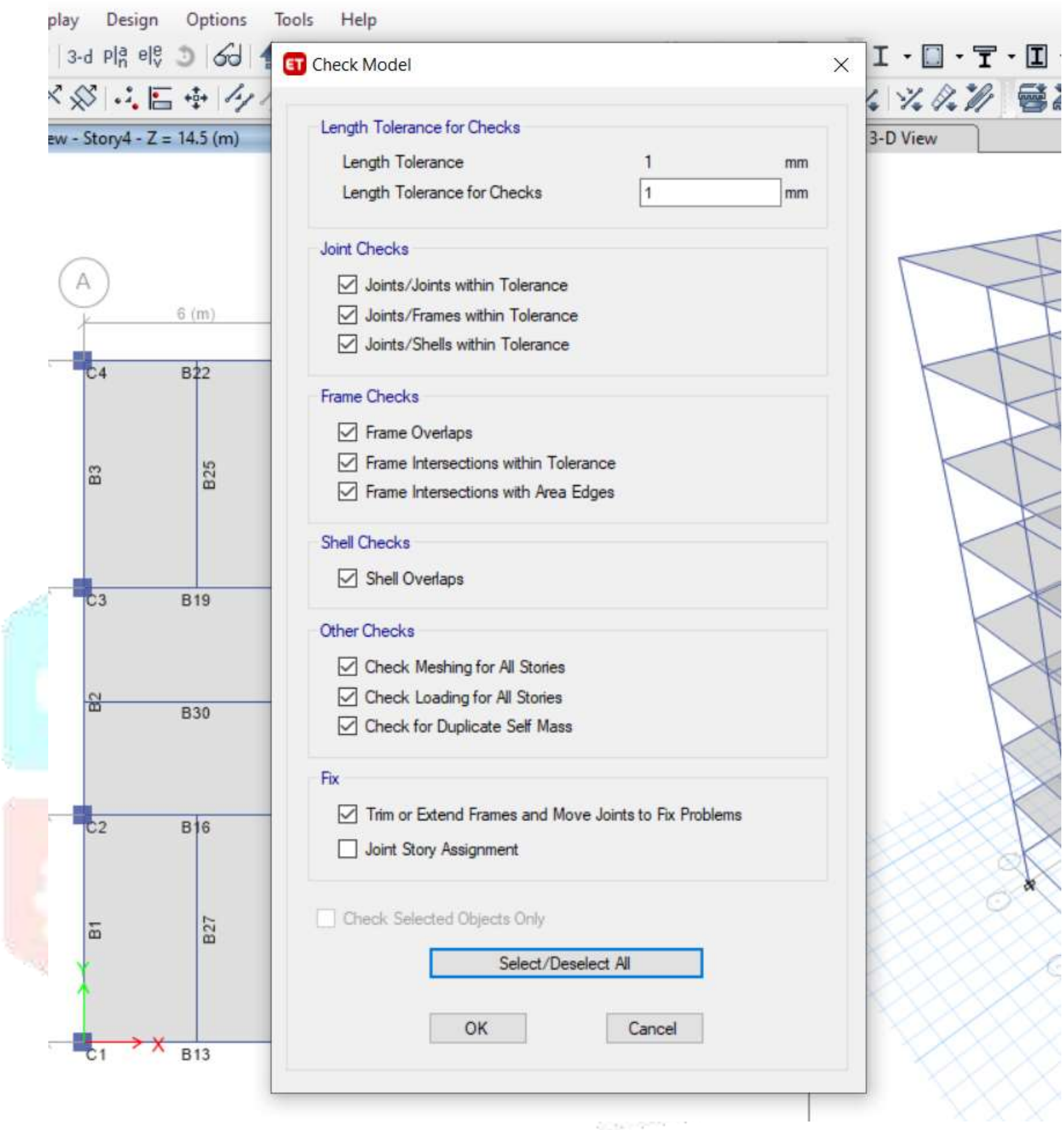


Figure 3.9(a). Check model for error.

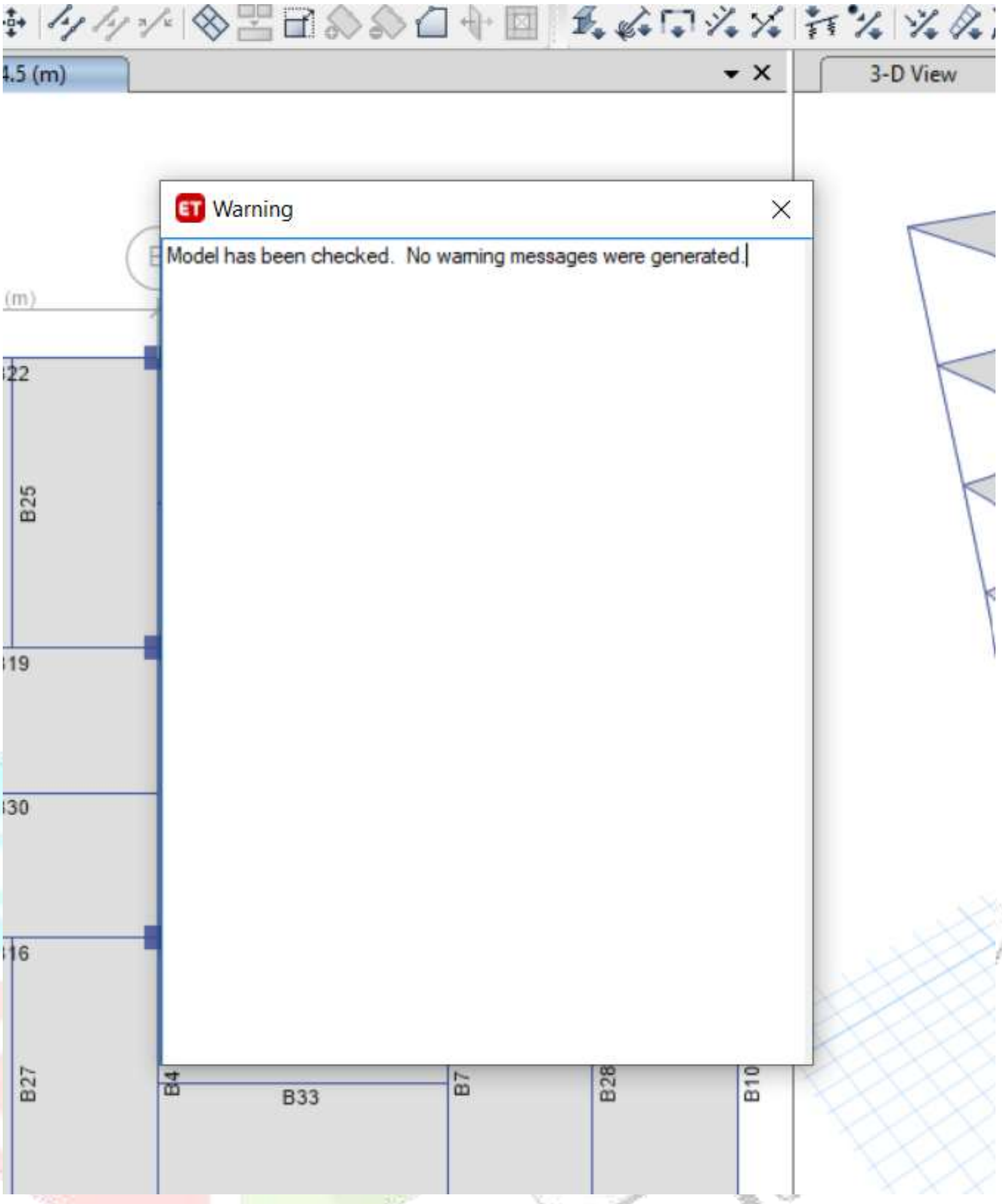


Figure 3.9(b). Showing no warning generated.

.

3.10 DESIGN OF STRUCTURE

START DESINGN CHECK

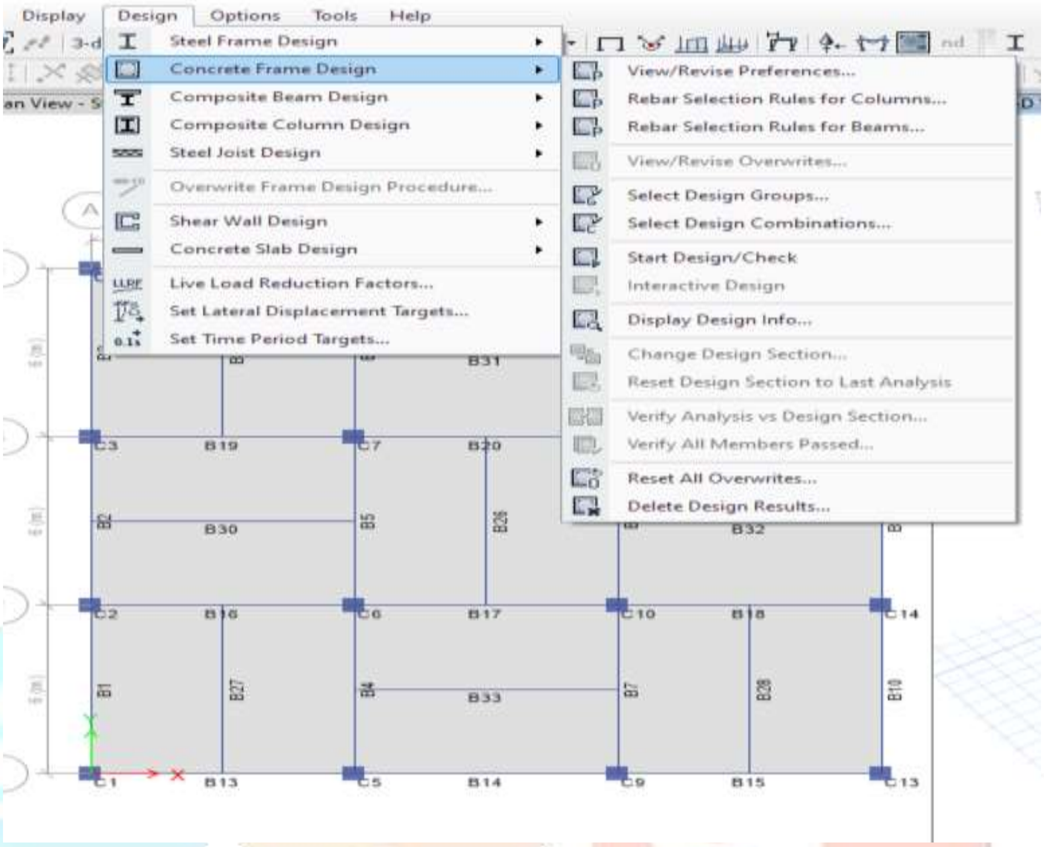


Figure 3.10(a). Concrete frame design check started.

VERIFY ALL MEMBER PAASED

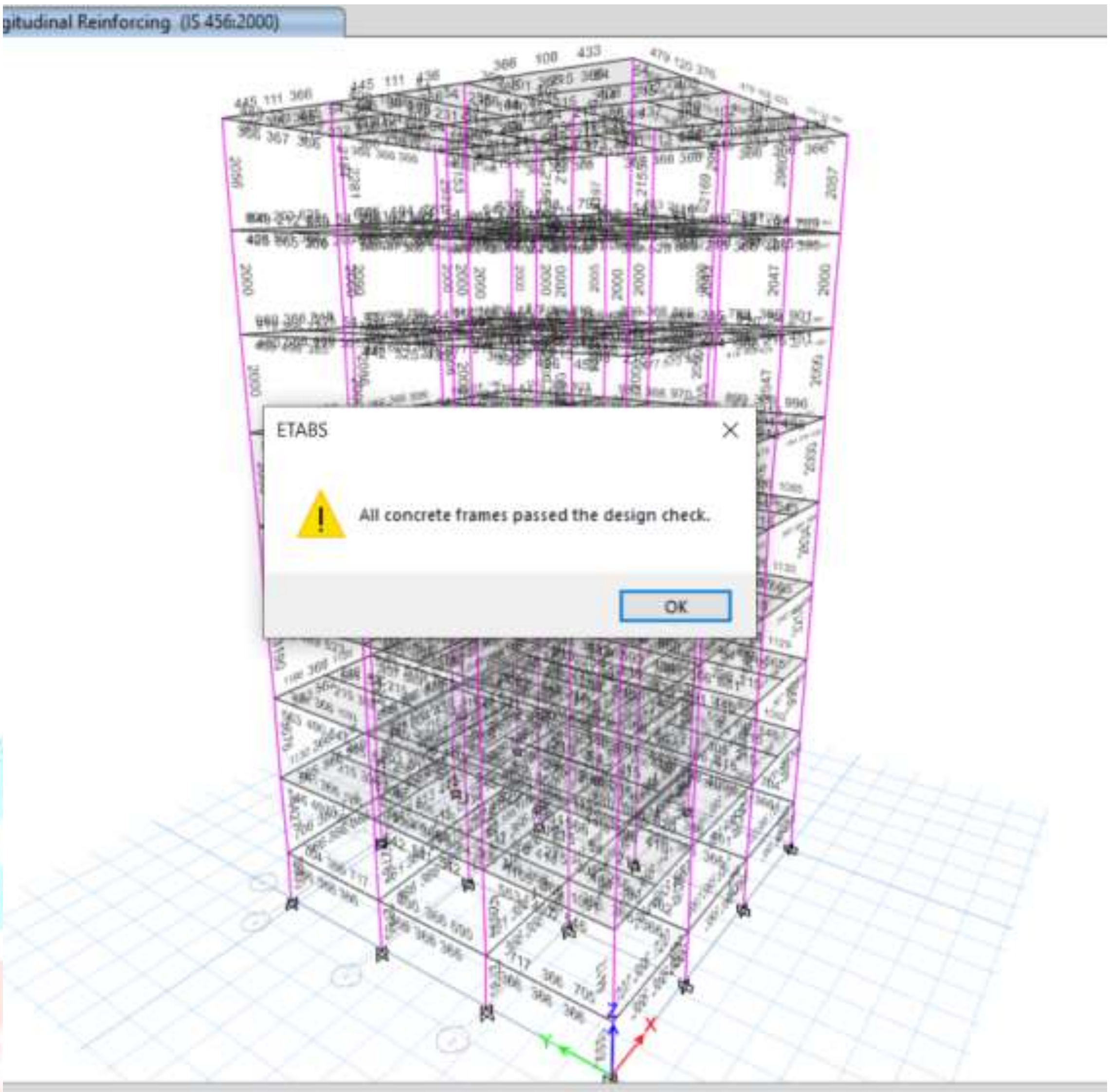


Figure 3.10(b). All the frame passed design check.

CHAPTER - 4

RESULT

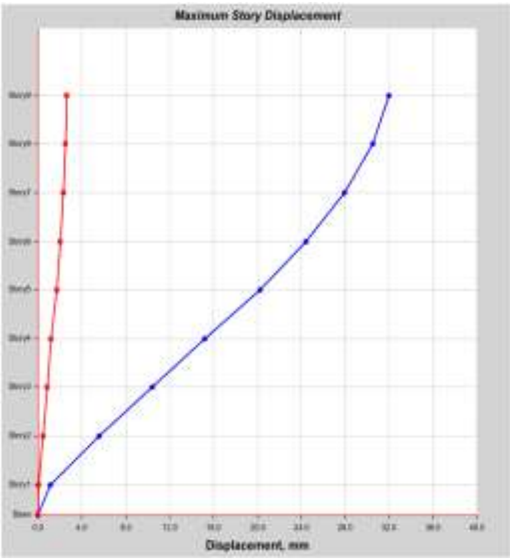
4.1 RESULT

ZONE II RESULT FOR MAX STORY DISPLACEMENT

DISPLACEMENT VALUE FOR EQ- X

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story9	34.5	Top	31.965	2.657
Story8	30.5	Top	30.501	2.549
Story7	26.5	Top	27.917	2.35
Story6	22.5	Top	24.392	2.075
Story5	18.5	Top	20.202	1.743
Story4	14.5	Top	15.222	1.216
Story3	10.5	Top	10.394	0.833
Story2	6.5	Top	5.542	0.444
Story1	2.5	Top	1.153	0.093
Base	0	Top	0	0

Table 4.1

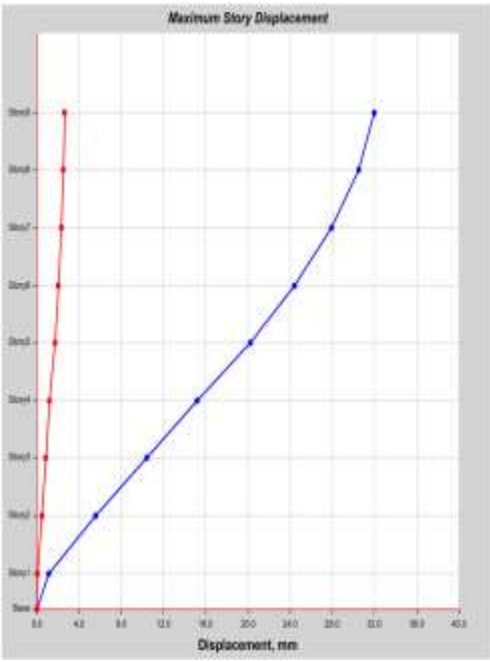


Graph 4.1

DISPACEMENT VALUE FOR EQ-Y

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story9	34.5	Top	2.575	31.843
Story8	30.5	Top	2.467	30.375
Story7	26.5	Top	2.268	27.788
Story6	22.5	Top	1.992	24.26
Story5	18.5	Top	1.669	20.092
Story4	14.5	Top	1.227	15.218
Story3	10.5	Top	0.835	10.394
Story2	6.5	Top	0.445	5.545
Story1	2.5	Top	0.094	1.154
Base	0	Top	0	0

Table 4.2



Graph 4.2

DISPLACEMENT VALUE FOR 1.5 DL + 1.5 FF + 1.5 WL - 1.5 EQ-X

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story9	34.5	Top	44.035	0.925
Story8	30.5	Top	42.019	0.813
Story7	26.5	Top	38.463	0.704
Story6	22.5	Top	33.609	0.595
Story5	18.5	Top	27.832	0.507
Story4	14.5	Top	21.031	0.042
Story3	10.5	Top	14.35	0.018
Story2	6.5	Top	7.651	0.008
Story1	2.5	Top	1.632	0.026
Base	0	Top	0	0

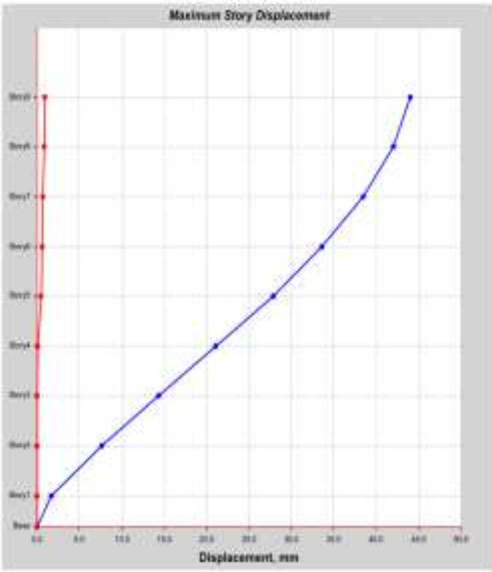


Table 4.3

Graph 4.3

MAX STORY SHEAR ZONE II FOR 1.2 Dead + 1.2 Live + 1.2 Floor finish + 1.2 Wall load + EQX

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story9	34.5	Top	-159.4447	0
		Bottom	-159.4447	0
Story8	30.5	Top	-341.3366	0
		Bottom	-341.3366	0
Story7	26.5	Top	-474.9715	0
		Bottom	-474.9715	0
Story6	22.5	Top	-567.7734	0
		Bottom	-567.7734	0
Story5	18.5	Top	-627.0071	0
		Bottom	-627.0071	0
Story4	14.5	Top	-660.3147	0
		Bottom	-660.3147	0
Story3	10.5	Top	-675.1631	0
		Bottom	-675.1631	0
Story2	6.5	Top	-678.8751	0
		Bottom	-678.8751	0
Story1	2.5	Top	-678.8751	0
		Bottom	-678.8751	0
Base	0	Top	0	0
		Bottom	0	0

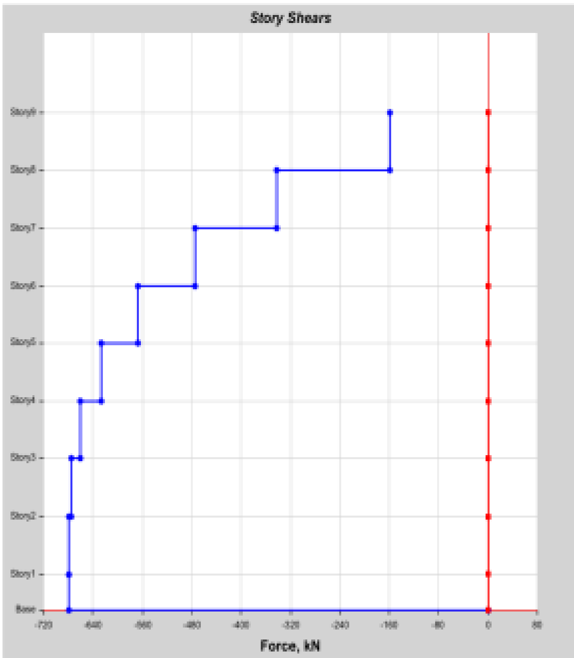


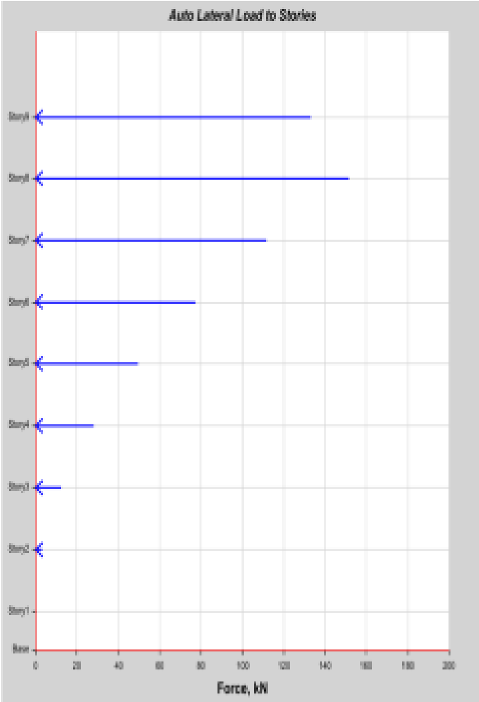
Table 4.4

Graph 4.4

AUTO LATERAL LOAD TO STORIES IN X- DIRECTION

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story9	34.5	Top	132.8706	0
Story8	30.5	Top	151.5766	0
Story7	26.5	Top	111.3624	0
Story6	22.5	Top	77.335	0
Story5	18.5	Top	49.3614	0
Story4	14.5	Top	27.7564	0
Story3	10.5	Top	12.3736	0
Story2	6.5	Top	3.0934	0
Story1	2.5	Top	0	0
Base	0	Top	0	0

Table 4.5



Graph 4.5

AUTO LATERAL LOAD TO STORIES IN Y- DIRECTION

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story9	34.5	Top	0	133.0948
Story8	30.5	Top	0	151.8323
Story7	26.5	Top	0	111.5502
Story6	22.5	Top	0	77.4654
Story5	18.5	Top	0	49.4446
Story4	14.5	Top	0	27.8032
Story3	10.5	Top	0	12.3945
Story2	6.5	Top	0	3.0986
Story1	2.5	Top	0	0
Base	0	Top	0	0

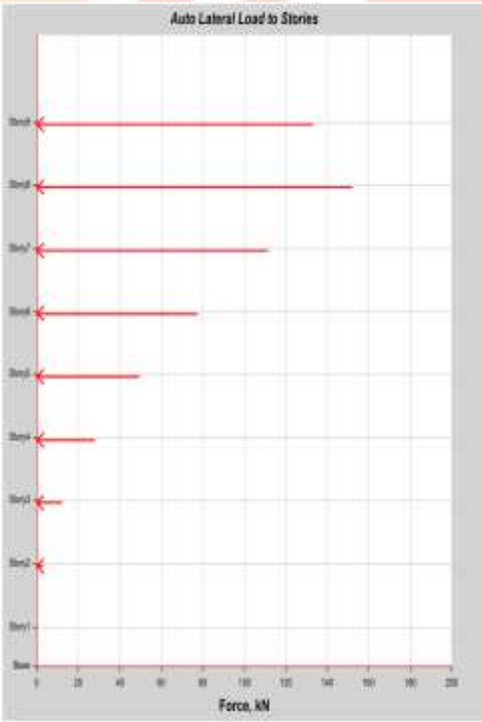


Table 4.6

Graph 4.6

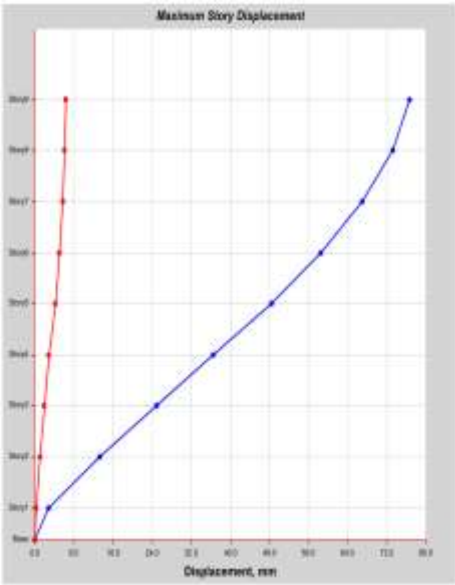
ZONE IV

MAX STORY DISPLACEMENT

DISPLACEMENT VALUE FOR EQ-X

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story9	34.5	Top	76.717	6.376
Story8	30.5	Top	73.203	6.118
Story7	26.5	Top	67.002	5.641
Story6	22.5	Top	58.541	4.98
Story5	18.5	Top	48.486	4.184
Story4	14.5	Top	36.534	2.918
Story3	10.5	Top	24.945	2
Story2	6.5	Top	13.3	1.066
Story1	2.5	Top	2.766	0.224
Base	0	Top	0	0

Table 4.7

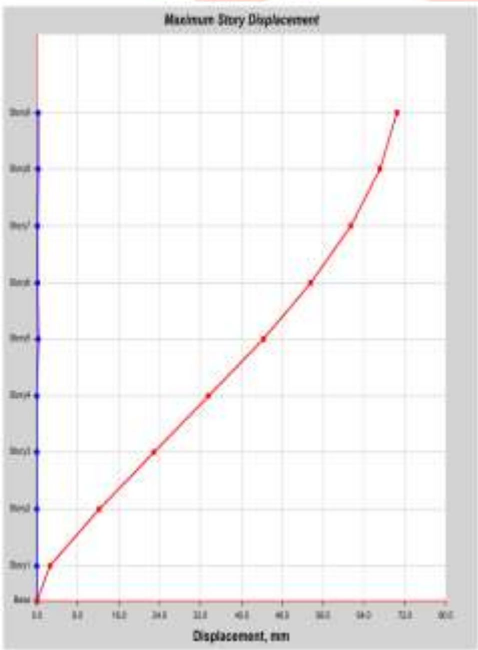


Graph 4.7

DISPLACEMENT VALUE FOR EQ-Y

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story9	34.5	Top	0.209	70.393
Story8	30.5	Top	0.201	67.122
Story7	26.5	Top	0.194	61.384
Story6	22.5	Top	0.192	53.573
Story5	18.5	Top	0.219	44.353
Story4	14.5	Top	0.027	33.604
Story3	10.5	Top	0.008	22.951
Story2	6.5	Top	0.004	12.243
Story1	2.5	Top	0.003	2.576
Base	0	Top	0	0

Table 4.8

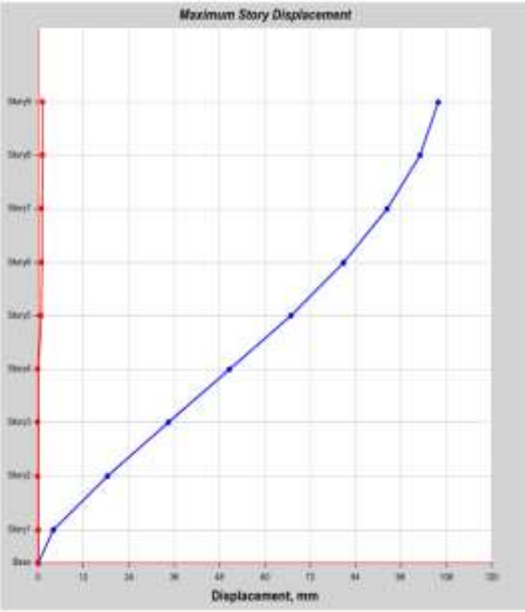


Graph 4.8

DISPLACEMENT VALUE FOR 1.5 DL + 1.5 FF + 1.5 WL - 1.5 EQ-X

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story9	34.5	Top	105.878	1.239
Story8	30.5	Top	101.008	1.133
Story7	26.5	Top	92.436	1.03
Story6	22.5	Top	80.752	0.929
Story5	18.5	Top	66.864	0.85
Story4	14.5	Top	50.451	0.049
Story3	10.5	Top	34.434	0.025
Story2	6.5	Top	18.359	0.012
Story1	2.5	Top	3.882	0.026
Base	0	Top	0	0

Table 4.9



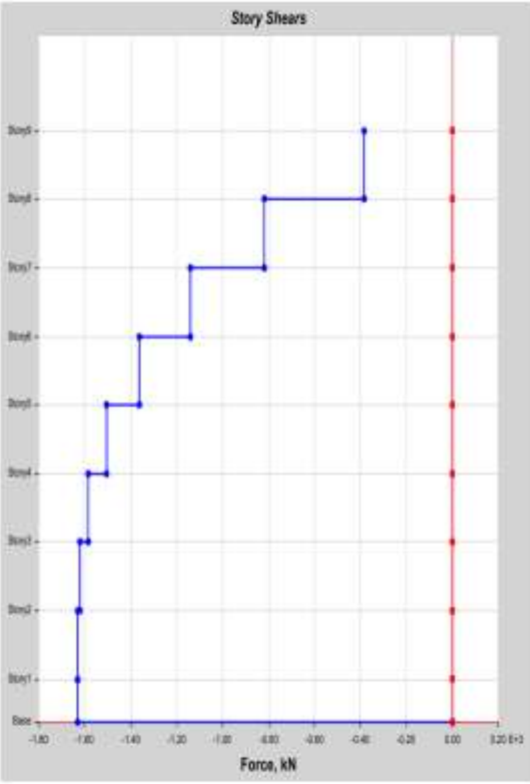
Graph 4.9

MAX STORY SHEAR ZONE IV FOR 1.2 DEAD LOAD +1.2LIVE LOAD + 1.2 WALL LOAD +FLOOR FINISH+ 1.2 X

Story Response Values

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story9	34.5	Top	-382.6674	0
		Bottom	-382.6674	0
Story8	30.5	Top	-819.2079	0
		Bottom	-819.2079	0
Story7	26.5	Top	-1139.9315	0
		Bottom	-1139.9315	0
Story6	22.5	Top	-1362.6562	0
		Bottom	-1362.6562	0
Story5	18.5	Top	-1504.8169	0
		Bottom	-1504.8169	0
Story4	14.5	Top	-1584.7554	0
		Bottom	-1584.7554	0
Story3	10.5	Top	-1620.3914	0
		Bottom	-1620.3914	0
Story2	6.5	Top	-1629.3003	0
		Bottom	-1629.3003	0
Story1	2.5	Top	-1629.3003	0
		Bottom	-1629.3003	0
Base	0	Top	0	0
		Bottom	0	0

Table 4.10

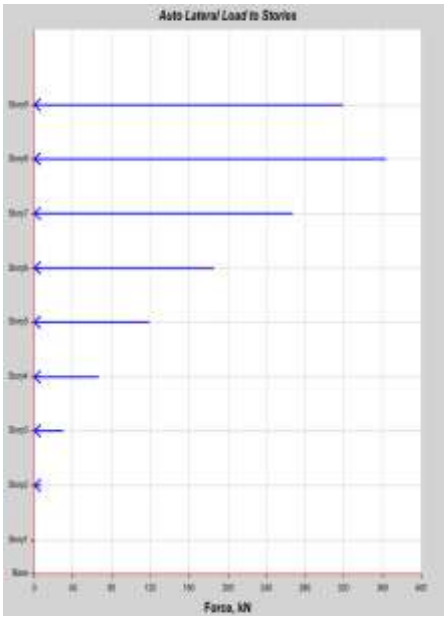


Graph 4.10

AUTO LATERAL LOAD TO STORIES IN X- DIRECTION

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story9	34.5	Top	318.8895	0
Story8	30.5	Top	363.7837	0
Story7	26.5	Top	267.2697	0
Story6	22.5	Top	185.6039	0
Story5	18.5	Top	118.4672	0
Story4	14.5	Top	66.6154	0
Story3	10.5	Top	29.6966	0
Story2	6.5	Top	7.4242	0
Story1	2.5	Top	0	0
Base	0	Top	0	0

Table 4.11

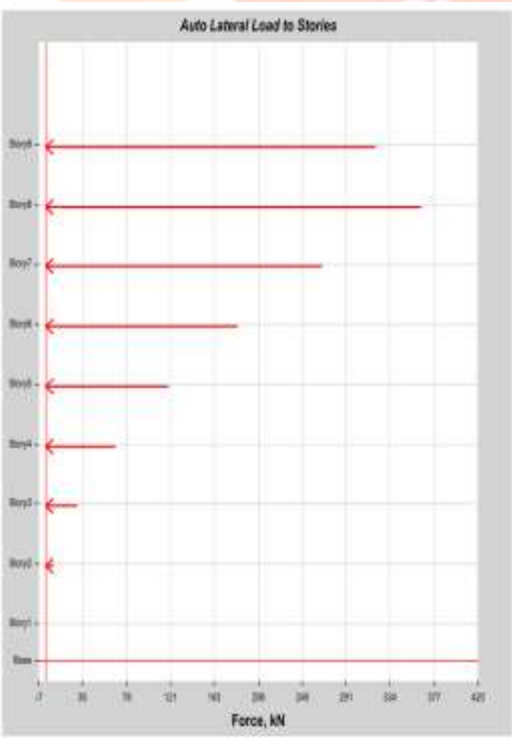


Graph 4.11

AUTO LATERAL LOAD TO STORIES IN Y- DIRECTION

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story9	34.5	Top	0	319.4275
Story8	30.5	Top	0	364.3975
Story7	26.5	Top	0	267.7206
Story6	22.5	Top	0	185.9171
Story5	18.5	Top	0	118.6671
Story4	14.5	Top	0	66.7278
Story3	10.5	Top	0	29.7467
Story2	6.5	Top	0	7.4367
Story1	2.5	Top	0	0
Base	0	Top	0	0

Table 4.12



Graph 4.12

COMPARISON OF MAX DISPLACEMENT VALUE FOR 1.5 DL + 1.5 FF + 1.5 WL - 1.5 EQ-Y FOR ZONE II AND ZONE IV

TABLE - 4.13

Story	Elevation	Location	X-Dir	Y-Dir	Elevation	Location	X-Dir	Y-Dir
			Zone II				Zone IV	
	m		mm	mm	m		mm	mm
Story9	34.5	Top	44.035	0.925	34.5	Top	105.878	1.239
Story8	30.5	Top	42.019	0.813	30.5	Top	101.008	1.133
story7	26.5	Top	38.463	0.704	26.5	Top	92.436	1.03
Story6	22.5	Top	33.609	0.595	22.5	Top	80.752	0.929
Story5	18.5	Top	27.832	0.507	18.5	Top	66.864	0.85
Story4	14.5	Top	21.031	0.042	14.5	Top	50.451	0.049
Story3	10.5	Top	14.35	0.018	10.5	Top	34.434	0.025
Story2	6.5	Top	7.651	0.008	6.5	Top	18.359	0.012
Story1	2.5	Top	1.632	0.026	2.5	Top	3.882	0.026
Base	0	Top	0	0	0	Top	0	0

AXIAL FORCE IN COLUMN OF STORY – 1 OF ZONE II AND ZONE IV

TABLE-4.14

Story	Label	Unique Name	Section	ZONE II	ZONE IV
				PkN	PkN
1	1	49	Column 500x500	1730.8216	3092.9247
1	2	50	Column 500x501	3817.1556	3764.6364
1	3	51	Column 500x502	3815.2423	3766.2674
1	4	52	Column 500x503	1147.5371	3102.1192
1	5	53	Column 500x504	3808.0621	3035.0906
1	6	54	Column 500x505	4618.0718	4618.0718
1	7	55	Column 500x506	4629.9775	4629.9975
1	8	56	Column 500x507	3838.6253	3081.4857
1	9	57	Column 500x508	3805.8792	3034.7900
1	10	58	Column 500x509	4624.2986	4624.2986
1	11	59	Column 500x510	4649.0087	4649.0087
1	12	60	Column 500x511	3740.8164	2969.6851
1	13	61	Column 500x512	1732.7699	3095.4282
1	14	62	Column 500x513	3820.4668	3767.4959
1	15	63	Column 500x514	3890.8381	3791.5058
1	16	64	Column 500x515	1132.6093	3027.9429

REBAR PERCENTAGE OF COLUMN AT STORY -1 OF ZONE II AND ZONE IV

TABLE-4.15

Story	Label	Section	ZONE II	ZONE IV
1	C1	Column 500 X 500	0.80%	1.79%
1	C2	Column 500 X 500	1.12%	2.13%
1	C3	Column 500 X 500	1.11%	2.13%
1	C4	Column 500 X 500	0.80%	1.79%
1	C5	Column 500 X 500	1.10%	1.91%
1	C6	Column 500 X 500	2.06%	2.06%
1	C7	Column 500 X 500	2.07%	2.07%
1	C8	Column 500 X 500	1.15%	1.95%
1	C9	Column 500 X 500	1.10%	1.91%
1	C10	Column 500 X 500	2.06%	2.06%
1	C11	Column 500 X 500	2.10%	2.10%
1	C12	Column 500 X 500	2.01%	1.85%
1	C13	Column 500 X 500	0.80%	1.75%
1	C14	Column 500 X 500	1.12%	2.13%
1	C15	Column 500 X 500	1.16%	2.15%
1	C16	Column 500 X 500	0.84%	1.71%

CHAPTER 5

CONCLUSION AND REFERENCES

CONCLUSION

1. The displacement increases by more than 140% if seismic ZONE changes from II to IV. 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. 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. The displacement occur at the ZONE II is 44.035 mm and ZONE IV is 105.8788 mm in x-direction. By using shear walls, dampers, rubber pads, spring we can reduce damage of seismic effect of an R C building resting on high seismic zone.
3. The maximum story shear forces in ZONE IV are consistently and significantly higher than those in ZONE II for all stories. This aligns with seismic zoning, where Zone 4 represents a higher earthquake hazard/seismic intensity than Zone 2.
4. At Story 1 (Elevation 2.5 m), the shear force is approximately 1629 kN in ZONE IV, compared 679 kN in ZONE II.
5. The total lateral force at the base is approximately 2.4 times greater in Zone 4 1629.3 kN than in Zone 2 678.9 kN.
6. From results it is observed that the Storey Shear is decreased as height of the building increased and reduced at top floor in all the building models subjected to seismic loads considered. The storey shear is maximum at the base. And the storey shear value for the model in ZONE II is151.29 and ZONE IV is 544.65.This means the storey shear is increases by more than 27% when compare to ZONE II to ZONE IV.
7. Requirement of rebar in column increase 80% to 110% in ZONE IV compared to ZONE II.

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