COMPARATIVE STRUCTURAL ANALYSIS IN ETABS OF A 45-STOREY MIXED-USE (RESIDENTIAL-COMMERCIAL) BUILDING USING BNBC 2006 AND BNBC 2020

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering.



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DECLARATION

We hereby declare that this report is my work and effort and it has not been submitted anywhere for any award. All the contents provided here are based on our labor dedicated to the completion of the experiment of the **"COMPARATIVE STRUCTURAL ANALYSIS IN ETABS OF A 45-STOREY MIXED-USE (RESIDENTIAL-COMMERCIAL) BUILDING USING BNBC 2006 AND BNBC 2020**" All the sources of information used in this report have been acknowledged and the necessary references included for further study.

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to

"PROF. SHAMIM ARA HASSAN"
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ABSTRACT

This thesis presents a comparative structural analysis of a 45-storey mixed-use (residential-commercial) reinforced concrete building, designed according to two versions of the Bangladesh National Building Code—BNBC 2006 and BNBC 2020. The building consists of commercial spaces at the front portion and residential units at the rear. The study aims to evaluate the structural design differences between the two codes, particularly in terms of seismic performance, load requirements, and overall safety. Using ETABS software, both models were analyzed with consistent building geometry, material properties, and load combinations. The results reveal that BNBC 2020 incorporates more rigorous seismic and structural guidelines, resulting in increased base shear, larger structural members, and potentially higher construction costs. Nevertheless, these changes significantly improve structural integrity and occupant safety. This research underscores the importance of adopting the updated code for the safe and efficient design of high-rise mixed-use buildings in Bangladesh.

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CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

- With the continuous advancement of urbanization worldwide, the demand for high-rise buildings is increasing significantly. Bangladesh is also experiencing this trend, especially in major cities like Dhaka, Chattogram, and others where the construction of multi-storied buildings has become more frequent. In such a scenario, following structural design codes or national building codes is essential to ensure a safe, durable, and economically viable design.
- The Bangladesh National Building Code (BNBC) 2006 and the latest version BNBC 2020 both provide crucial guidelines for building design in Bangladesh. BNBC 2006 was widely used for many years, but with the evolution of modern technologies, seismic characteristics, construction materials, and design philosophy, BNBC 2020 was introduced to align better with realistic needs and international standards.
- In this study, a 45-storey building was modeled and structurally analyzed separately using both BNBC 2006 and BNBC 2020. The primary objective is to analyze how the differences between the two codes affect the building design, including aspects like base shear, storey drift, reinforcement requirements, construction cost, and safety metrics.
- This thesis aims to present a practical comparative analysis that will help engineering students and professionals choose the appropriate code for future design-applications. Research Objectives and Overview

1.2 Objective of the study

The primary objective of this study is to perform a comparative structural analysis of a 45-storey mixed-use (residential-commercial) building based on the provisions of BNBC 2006 and BNBC 2020. The specific goals of the study are:

1. To assess the impact of updated seismic and load provisions on the overall structural performance of high-rise buildings.
2. To analyze how changes in the building code affect member sizing, base shear, and construction cost.
3. To determine whether BNBC 2020 enhances the structural safety and resilience of high-rise mixed-use buildings.
4. To encourage engineers and designers to adopt modern building code practices for safer and more sustainable design in Bangladesh.

1.3 Organization of the Thesis

This section should have a brief description of the thesis outline of the thesis. It should contain chapter no. with a title and brief descriptions of the content of each chapter: an example guide is provided below.

Chapter 1: Introduction and Objective: This chapter provides the background and motivations of the thesis. The overall objectives and expected outcomes are also described in this chapter.

Chapter 2: Literature: This chapter describes the Enhanced Seismic Load Provisions , Detailed Guidelines for Irregular Structures , Updated Wind Load Calculations , Revised Drift and Displacement Limits , Challenges in ETABS Analysis Under BNBC 2020 the related works in the topic.

Chapter 2: Methodology: This chapter describes the methodology adopted to carry out the research.

Chapter 4: Data Collection and Analysis: This chapter describes the Data Collection and Analysis.

Chapter 5: Result And Discussion: This chapter describes the Result And Discussion.

Chapter 5: Conclusion & Recommendation: This chapter describes conclusion & Recommendation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The Bangladesh National Building Code (BNBC) serves as the regulatory guideline for structural design in the country. BNBC 2006 had been the primary reference for building construction in Bangladesh for a long time. However, with the evolution of seismic behavior, construction methods, international standards, and increased risk of natural disasters, the BNBC 2020 edition was introduced. Summary.

1. Comparative Study of BNBC 2006 and BNBC 2020 Citatio (biswas, 2020)n:
Summary:

This study compares the structural and seismic design provisions in BNBC 2006 and BNBC 2020. The major differences include updated seismic zoning, new wind load maps, and more detailed structural classification. BNBC 2020 introduces stricter seismic and wind load regulations, increasing structural safety but also slightly raising construction costs. Since the proposed high-rise is in a dense urban area, compliance with BNBC 2020's updated seismic and wind load provisions ensures both safety and code accuracy.

2. Safety & Retrofitting in Nuclear Plant Zones Using BNBC (islam, 2023)

Summary:

Focused on retrofitting and safety measures, this study evaluated BNBC's role in nuclear-sensitive regions. It emphasized seismic detailing, emergency exits, and material specifications. BNBC 2020 includes provisions for specialized zones that require advanced structural detailing and emergency preparedness, unlike the 2006 version. Demonstrates how vertical buildings must also prepare for emergencies and structural resilience, even outside nuclear zones.

3. Impact of BNBC Code Updates on RC Frame Cost & Load (salahuddin, 2024)

Summary:

This study explored how code changes affected lateral loads (wind/seismic) and overall construction cost in reinforced concrete buildings. BNBC 2020 increased lateral load requirements by 7.4% to 59.78%, which also caused cost increments in

structural members. Important for structural budgeting and engineering analysis in high-rise development, especially for optimizing safety vs. cost.

4. Code Implementation and Enforcement Progress in Bangladesh (council, 2020)International Code Council (2020).

Summary:

The ICC reviewed Bangladesh's improvements in enforcing building codes, training engineers, and spreading code awareness after the introduction of BNBC 2020. Despite challenges, Bangladesh is progressing in adopting international standard practices, especially for vertical urban growth. Supports the feasibility of implementing a code-compliant high-rise in Bangladesh's evolving regulatory environment.

5. General Overview of BNBC 2020 (General Overview of BNBC 2020, 205)

Summary:

This presentation outlined major sections of BNBC 2020, including structural, fire, electrical, mechanical, and environmental aspects.

Highlights new guidelines for energy efficiency, fire-resilient design, greenarchitecture, and high-rise evacuation standards. Useful for integrating sustainability and fire safety features in a dense vertical residential building. Key Updates in BNBC 2020 for High-Rise Analysis in ETABS

2.2 Enhanced Seismic Load Provisions

Update: BNBC 2020 introduces more stringent seismic zoning and load calculations, leading to increased base shear values.

Implication: This necessitates more robust structural designs to accommodate higher seismic forces.

Reference: A study comparing BNBC 1993 and BNBC 2020 found that earthquake loads increased by 7.42% to 59.78% under the new code.

2.3 Detailed Guidelines for Irregular Structures

Update: BNBC 2020 provides specific considerations for buildings with irregular plans, such as L, T, U, and W shapes.

Implication: Irregular structures exhibit higher lateral displacements and story drifts, especially above the seventh story, making them more susceptible to seismic activities.

Reference: A study using ETABS v17 analyzed various plan configurations under BNBC 2020, highlighting the increased vulnerabilities of irregular structures.

2.4 Updated Wind Load Calculations

Update: The new code revises wind load computations, considering factors like terrain category and building height.

Implication: High-rise buildings may experience increased design wind pressures, affecting the sizing of structural elements.

Reference: Research indicates significant changes in wind force calculations under BNBC 2020 compared to previous codes.

2.5 Revised Drift and Displacement Limits

Update: Stricter limits on story drift and lateral displacements are set to enhance building performance during seismic events.

Implication: Designers must ensure that structures comply with these tighter criteria, potentially requiring additional stiffness or damping mechanisms.

Reference: Analyses show that irregular buildings often exceed these limits, emphasizing the need for careful design considerations.

2.6 Challenges in ETABS Analysis Under BNBC 2020

1. Complex Modeling Requirements

Challenge: Accurately modeling irregular geometries and incorporating updated load combinations demand advanced proficiency in ETABS.

Solution: Utilize ETABS features like diaphragm constraints and nonlinear analysis options to better simulate real-world behavior.

2. Increased Computational Effort Challenge: The enhanced requirements lead to more complex models, increasing analysis time and computational resources.

Solution: Optimize model complexity by focusing on critical structural components and using appropriate meshing techniques.

3. Design Optimization for Cost-Effectiveness

Challenge: Meeting the stringent criteria may lead to overdesign, impacting project budgets. Solution: Employ performance-based design approaches to balance safety.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this study, the structural analysis of a 45-storey mixed-use (residential-commercial) building was conducted using both BNBC 2006 and BNBC 2020 codes. Two separate models were developed one based on BNBC 2006 and the other on BNBC 2020. The primary objective was to examine how changes in the codes affect the structural behavior.

3.2 Methodology Overview

ETABS software was used for this analysis. It is a widely used and highly efficient finite element-based analysis software.

Building Details:

Total Stories: 45 with basement

Building Type: Residential-commercial

Foundation: Mat Foundation (assumed)

Structure: Concrete-frame+shear-wall-system

SlabType: Conventional-solid-slab.

3.3 Development of two separate building models

Generation of load combinations as per each code, Running structural analysis and design. Collection and comparison of results, Each step in this methodology was carefully observed to accurately identify how the differences in code provisions influence structural behavior.

Step 1: Soil test analysis

* (Ref. Drilled Shafts, Manual, Student Workbook, Volume-1, National highway Institute, US Department of Transportation. Page-501-502)

• (Ref. The theory and Practice of Foundation Design, N.N. Som & S.C. Das. Page-217.

Table No – 5: The unit allowable skin friction and the unit allowable tip resistance capacities for the bored cast-in-situ pile in ton per square feet (tsf) (F.S. = 3.00)

SPT Interval (ft)	Depth from EGL (ft)	Depth from EGL (m)	S.P.T.	Corrected S.P.T. Value = N-(N-15)/2	Average S.P.T.	Soil Type	Allowable unit skin friction, fsa (tsf)	Allowable unit end bearing capacity, qpa (tsf)
Boring No.- 01								
0.00	0.00	0.00	0	0.00	0.00		0.00	0.00
5.00	5.00	1.52	4	4.00	2.00	C	0.02	0.44
2.00	7.00	2.13	8	8.00	6.00	C	0.06	0.89
3.00	10.00	3.05	15	15.00	11.50	C	0.12	1.67
5.00	15.00	4.57	13	13.00	14.00	C	0.14	1.44
5.00	20.00	6.10	12	12.00	12.50	C	0.13	1.33
5.00	25.00	7.62	10	10.00	11.00	C	0.11	1.11
5.00	30.00	9.15	15	15.00	12.50	C	0.13	1.67
5.00	35.00	10.67	20	17.50	16.25	C	0.16	1.94
5.00	40.00	12.20	36	25.50	21.50	S	0.11	17.00
5.00	45.00	13.72	41	28.00	26.75	S	0.13	18.67
5.00	50.00	15.24	50	32.50	30.25	S	0.15	21.67
5.00	55.00	16.77	50	32.50	32.50	S	0.16	21.67
5.00	60.00	18.29	50	32.50	32.50	S	0.16	21.67
Boring No.- 02								
0.00	0.00	0.00	0	0.00	0.00		0.00	0.00
5.00	5.00	1.52	3	3.00	1.50	C	0.02	0.33
2.00	7.00	2.13	7	7.00	5.00	C	0.05	0.78
3.00	10.00	3.05	12	12.00	9.50	C	0.10	1.33
5.00	15.00	4.57	15	15.00	13.50	C	0.14	1.67
5.00	20.00	6.10	12	12.00	13.50	C	0.14	1.33
5.00	25.00	7.62	10	10.00	11.00	C	0.11	1.11
5.00	30.00	9.15	14	14.00	12.00	C	0.12	1.56
5.00	35.00	10.67	19	17.00	15.50	C	0.16	1.89
5.00	40.00	12.20	31	23.00	20.00	S	0.10	15.33
5.00	45.00	13.72	37	26.00	24.50	S	0.12	17.33
5.00	50.00	15.24	48	31.50	28.75	S	0.14	21.00
5.00	55.00	16.77	50	32.50	32.00	S	0.16	21.67
5.00	60.00	18.29	50	32.50	32.50	S	0.16	21.67
Boring No.- 03								
0.00	0.00	0.00	0	0.00	0.00		0.00	0.00
5.00	5.00	1.52	3	3.00	1.50	C	0.02	0.33
2.00	7.00	2.13	8	8.00	5.50	C	0.06	0.89
3.00	10.00	3.05	12	12.00	10.00	C	0.10	1.33
5.00	15.00	4.57	15	15.00	13.50	C	0.14	1.67
5.00	20.00	6.10	12	12.00	13.50	C	0.14	1.33
5.00	25.00	7.62	10	10.00	11.00	C	0.11	1.11

Figure: 3.1 boring nos information

SOIL TESTING LAB

WINNER BORING & SOIL EXPERT'S

(SUMMARY OF LABORATORY TEST RESULTS -)

LOCATION : DAG NO. R.S.5700(PART), M.S. - 12087(PART), MOUZA - WARI, P.S. - SUTRAPUR, DHAKA, BANGLADESH.

Bore Hole No		1		2		3	
Sample No		D-11	D-10	D-13	D-11	D-13	D-11
Depth (m)		55	45	60	55	60	55
Moisture Content (Natural) (%)			22.02	20.50		21.36	
Specific Gravity			2.6821	2.6825		2.6823	
Atterberg Limit	Liquid Limit (LL)						
	Plastic Limit (PL)						
	Plastacity Index(PI)						
Density	Wet Density (gm/cc)						
	Dry Density (gm/cc)						
Grain Size Analysis (Mechanical)	Sand (%)		80.52	82.52		84.65	
	Fines (%)		19.48	17.48		15.35	
Grain Size Analysis (Hydrometer)	Sand (%)						
	Silt (%)						
	Clay (%)						
Unconfined Compression Test	Unconfined Compression Strength, qu (tsf)						
	Strain At Failure (%)						
Direct Shear Test	Φ (Degree)	35.63			34.11		36.12
	Cohesion (TSF)	0			0		0
Result checked by Engr. Md. Saiful Islam							

Figure: 3.2 soil testing lab report

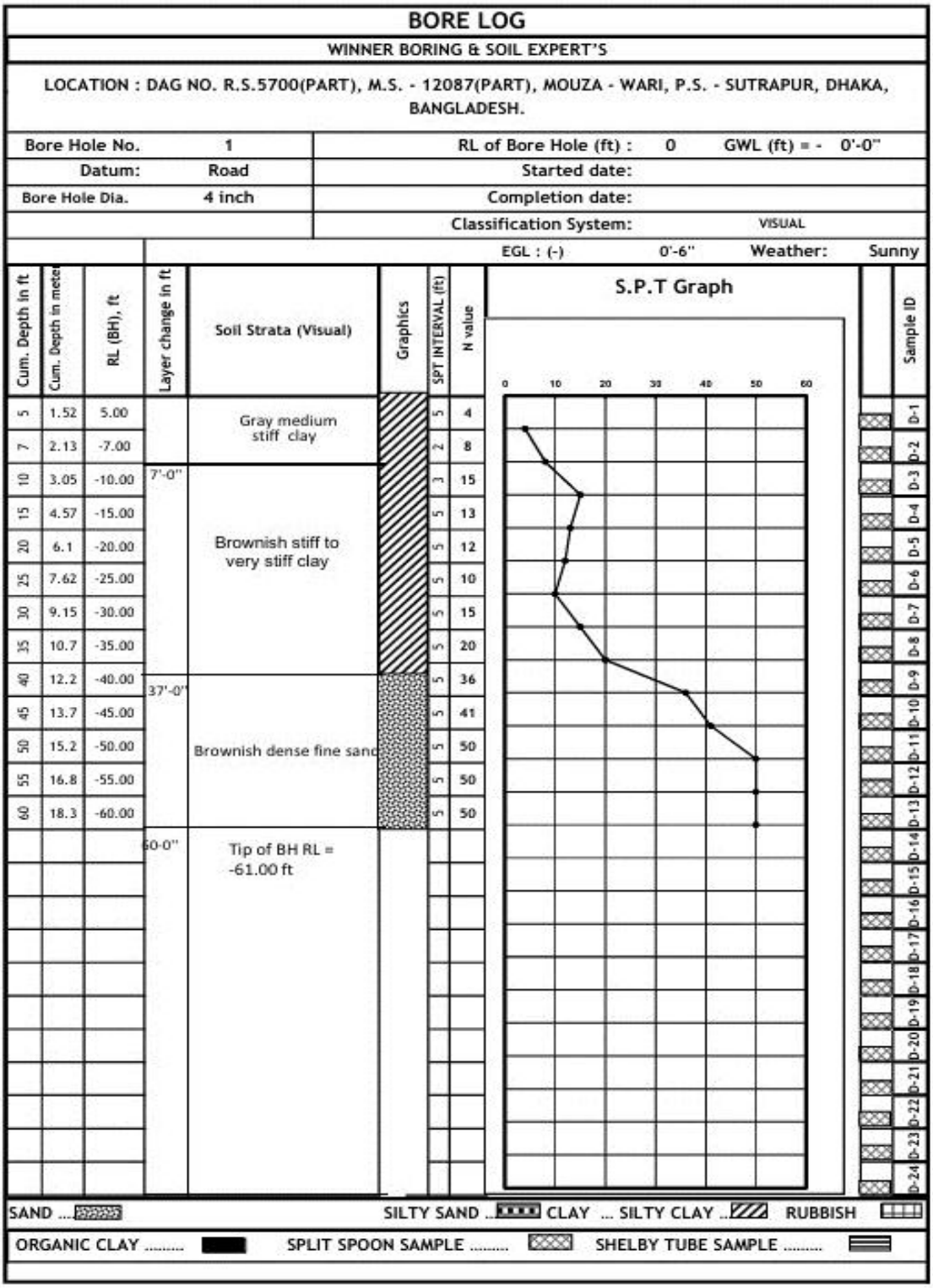


Figure: 3.3 bore log

Step 2: land calculation and making floor plan

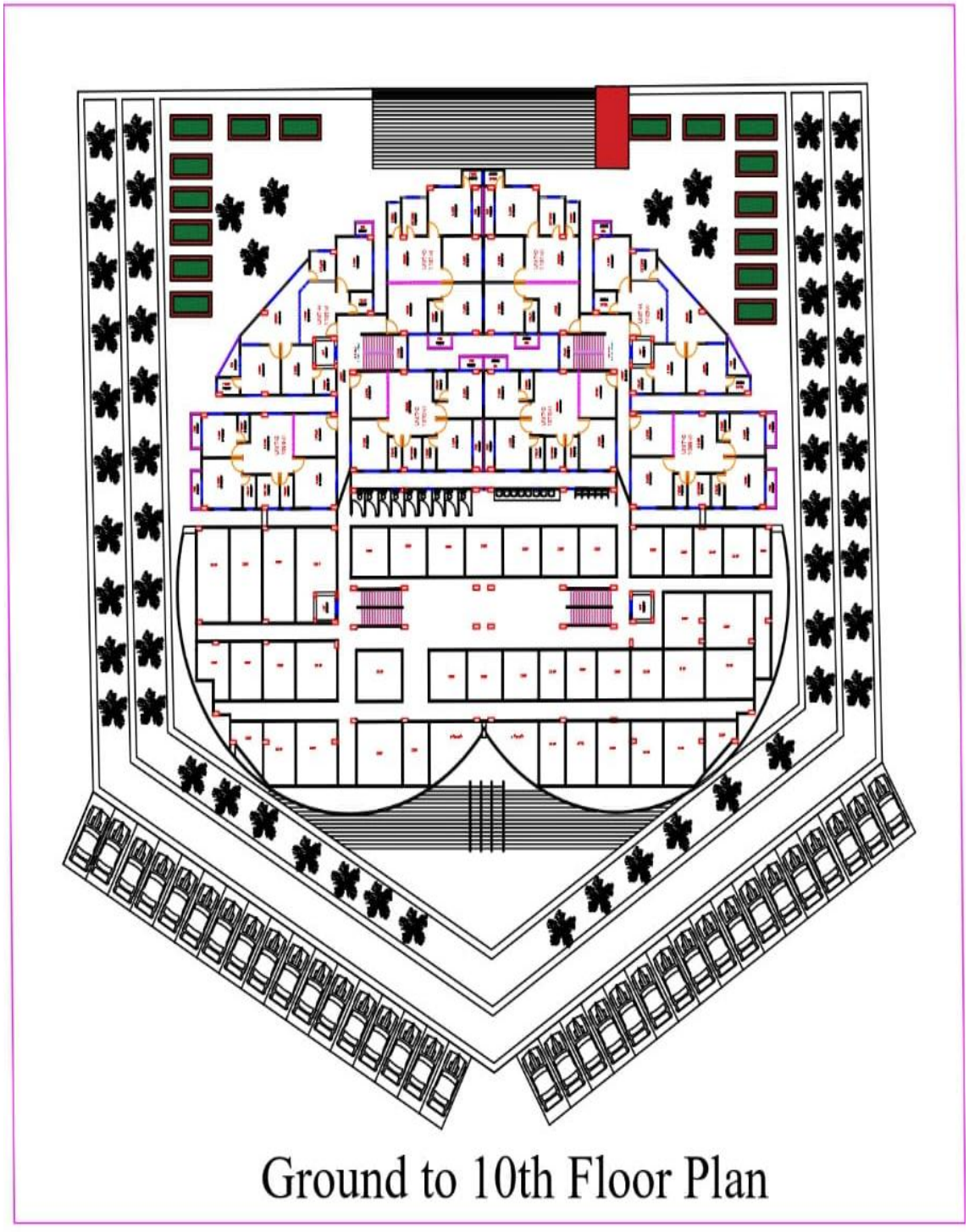


Figure: 3.4 ground to 10th floor plan

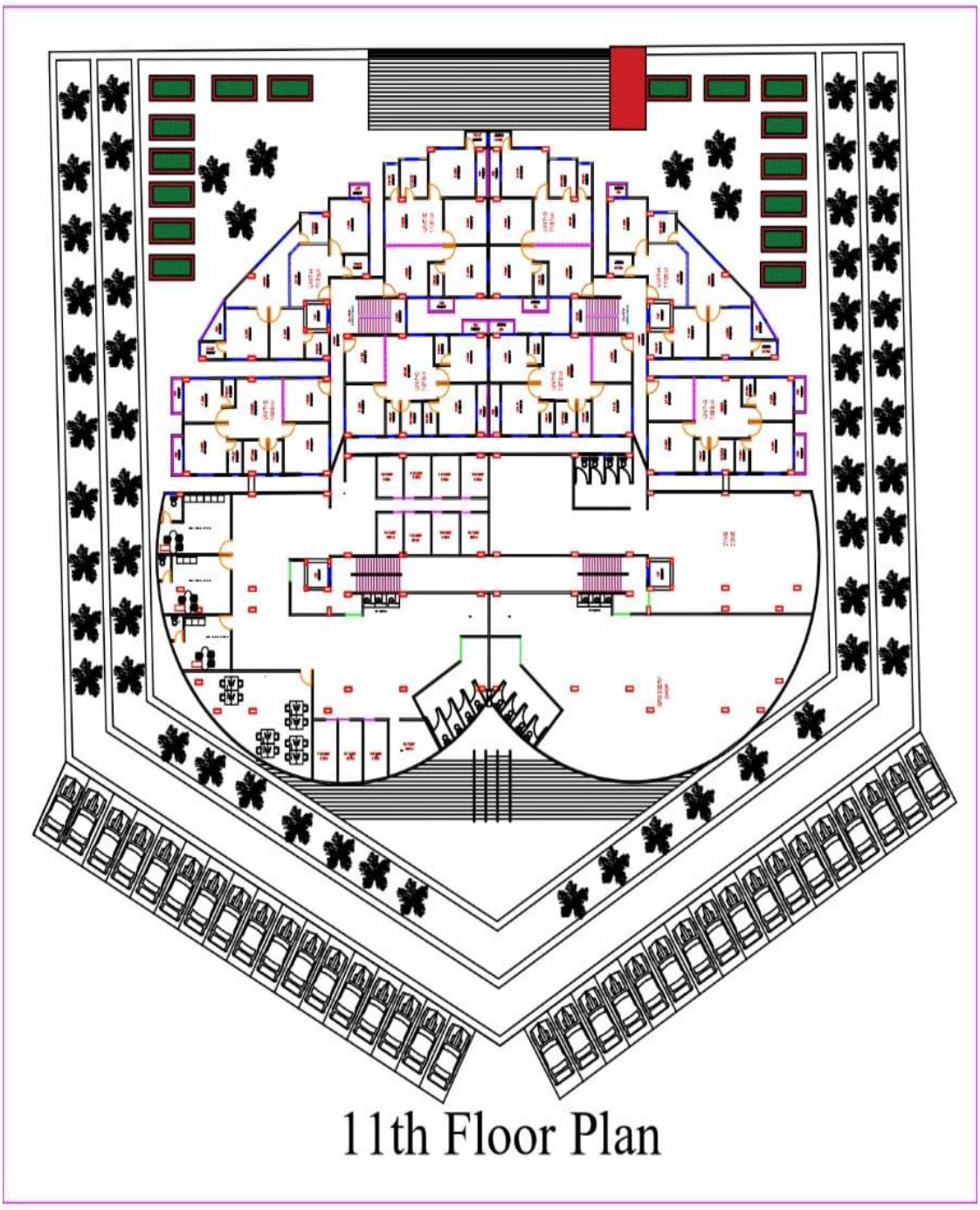


Figure: 3.5 only 11th floor plan

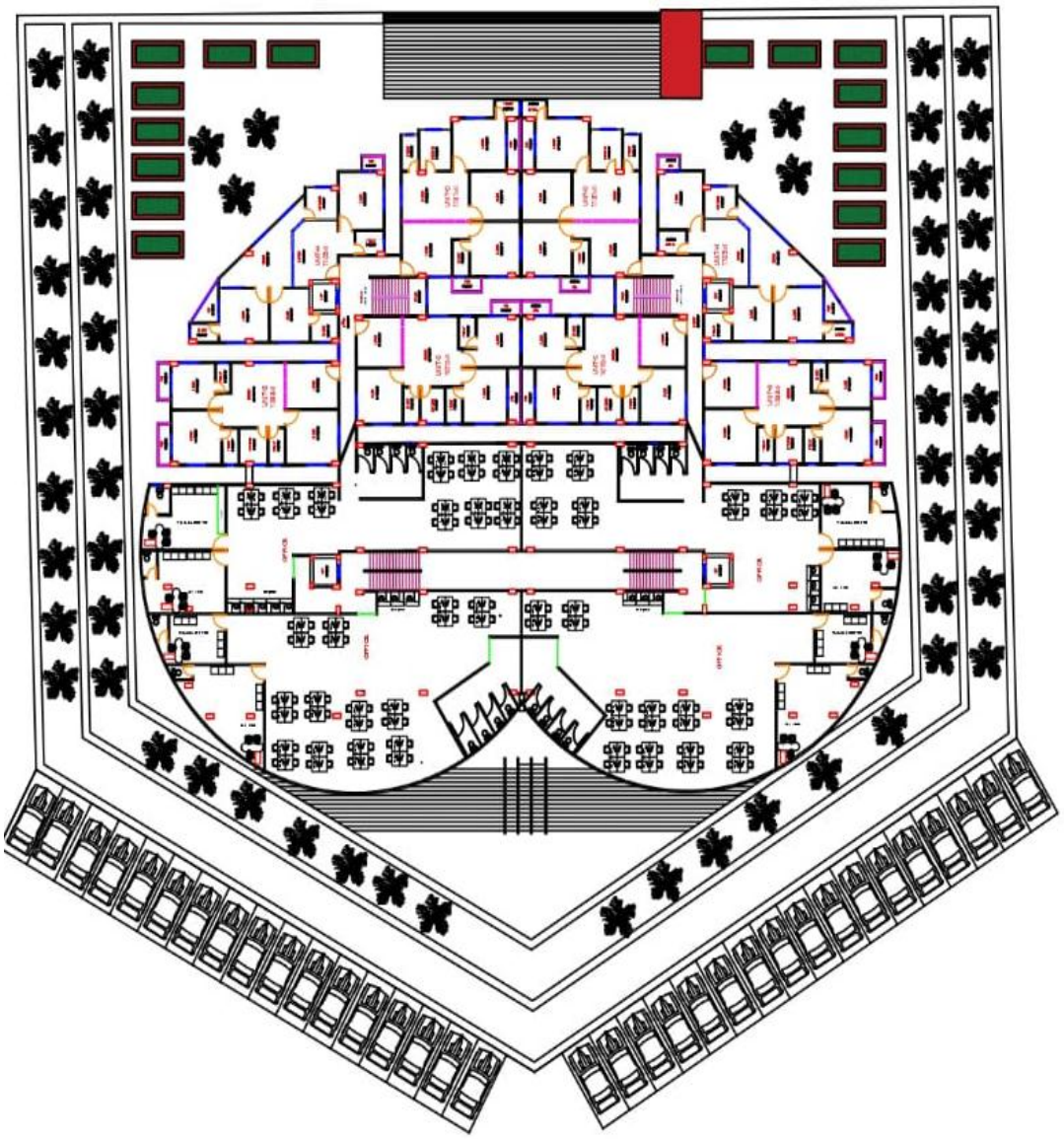


Figure: 3.6 12th to 40th floor plan

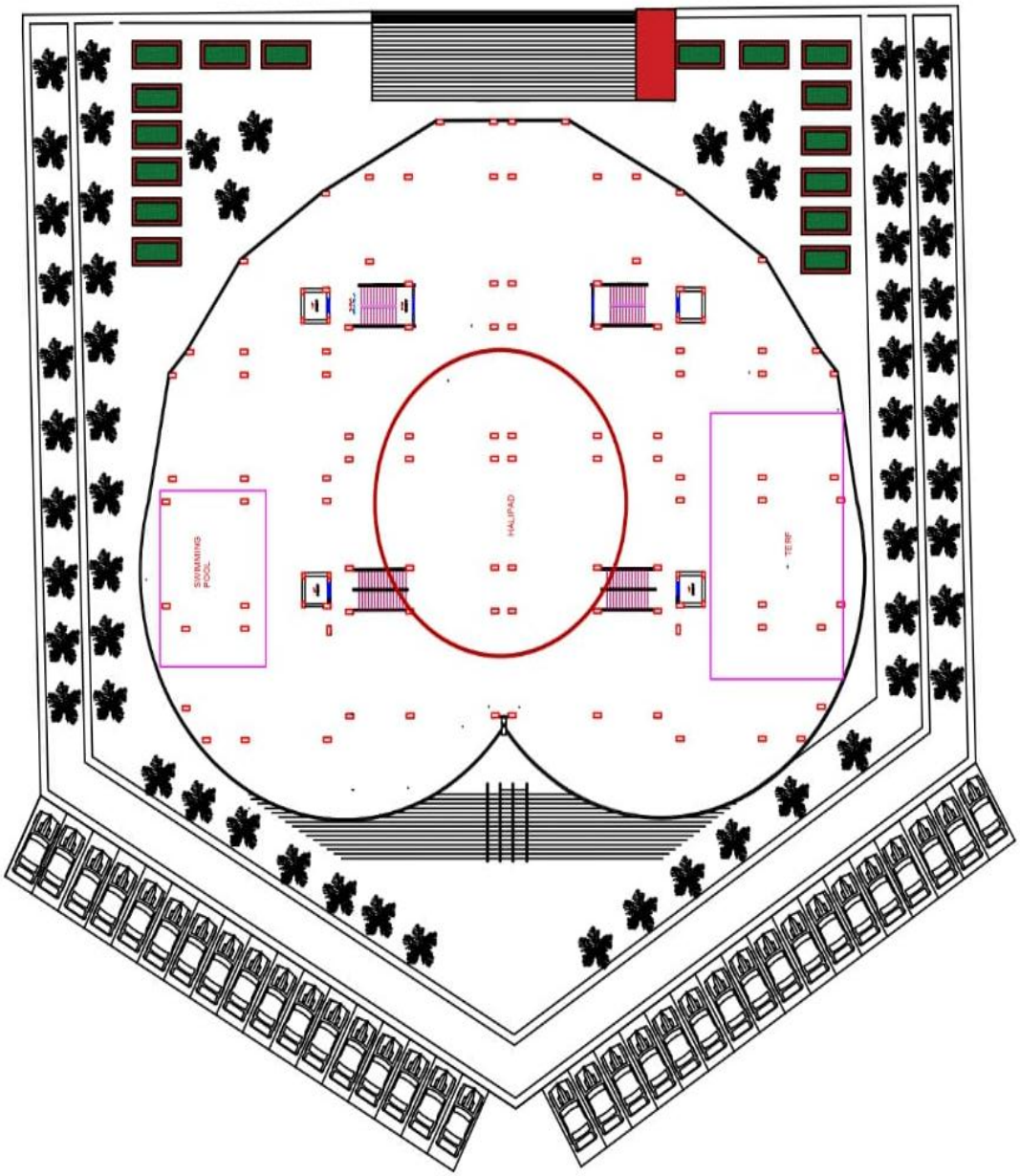


Figure: 3.7 Roof plan

Step: 3. Create three dimantional photo



Figure: 3.8. front view of commercial side.

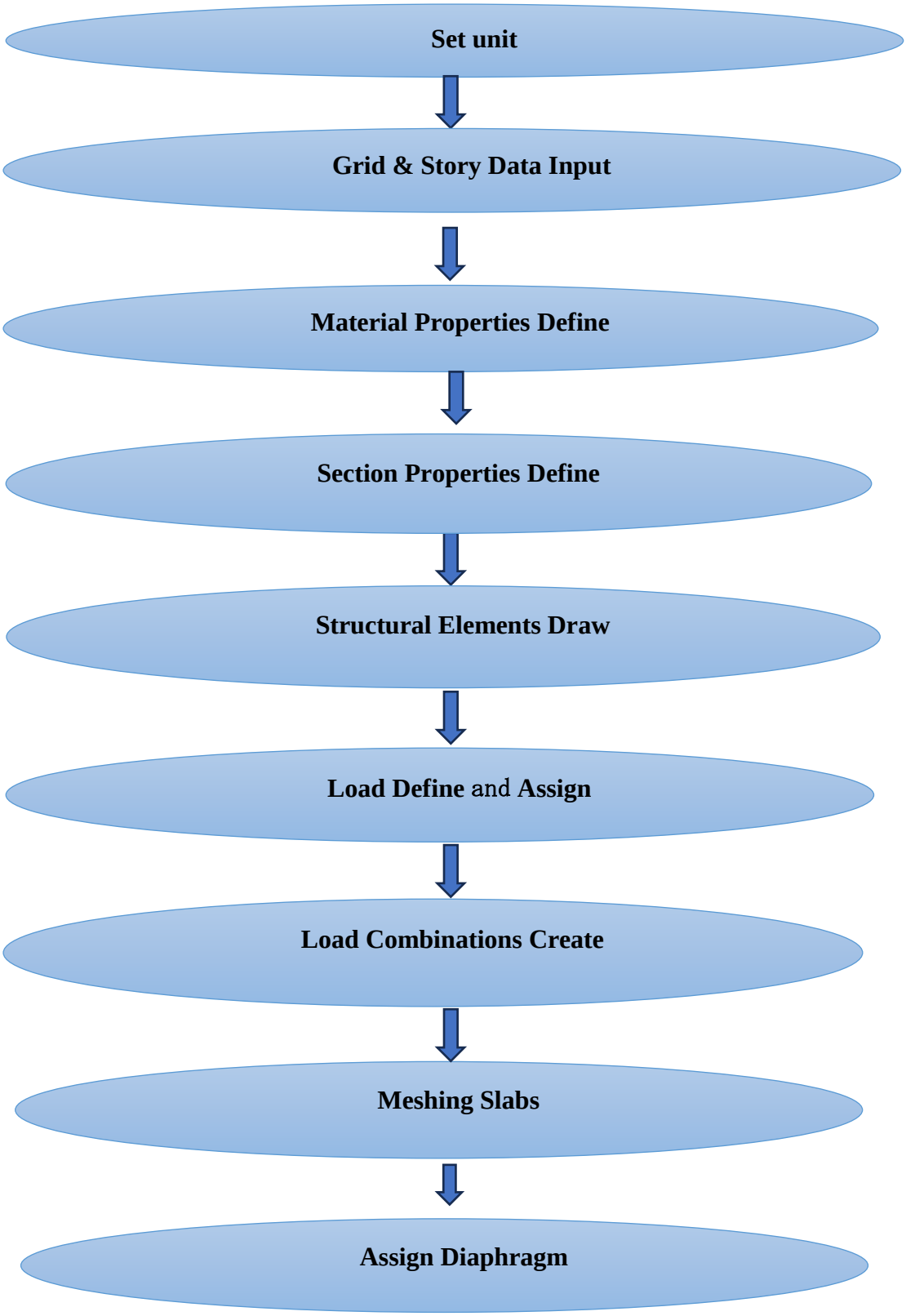


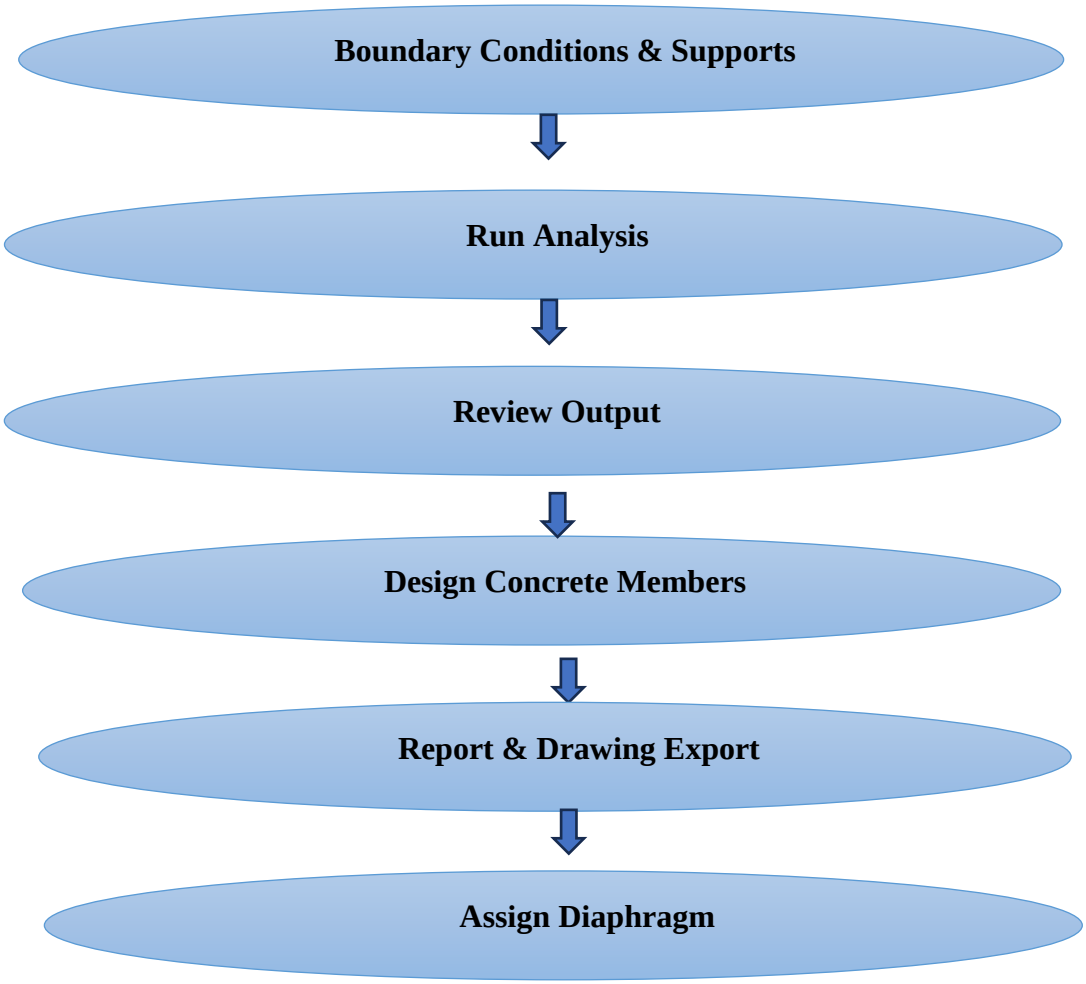
Figure: 3.9 front view of residential side



Figure: 3.10 Top view of our skyscraper

Step: 4. Steps Used for Etabs Analysis in BNBC 2006 and BNBC 2020




Boundary Conditions & Supports
Run Analysis
Review Output
Design Concrete Members
Report & Drawing Export
Assign Diaphragm

CHAPTER 4
DATA COLLECTION AND ANALYSIS

4. 1 Introduction

This chapter compares the results of the structural analysis in ETABS of the 45-storey building using BNBC 2006 and BNBC 2020 codes. The main results analyzed include base shear, story drift, story displacement, reinforcement requirements, and other structural parameters.

4.2 Data Collection and Analysis

Table: 4.1 steel strength for High Rise Building

Table: 4.1 Steel Strength (fy)

Code	Rebar Type	Yield Strength (fy)	Notes
BNBC 2006	Grade 60	413 MPa (60 Ksi)	Mild Steel or Grade 60
BNBC 2020	Grade 60+	500 MPa/ 550 MPa	High Strength TMT

Difference: In BNBC 2020 code ductility, bend test and seismic detailing are strict requirement

Table: 4.2 Base share difference.

Base Shear Difference: BNBC 2006 vs BNBC 2020

Formula BNBC 2006 V = Z I S_T W / (R T)	BNBC 2020: Formula: V = Cs × W Where, Cs = (SDS / (R / Ie))
Z = Seismic zone factor	SDS = Design spectral response acceleration
I = Importance factor	R = Response modification coefficient
S_T = Soil factor	Ie = Importance factor
W = Seismic weight	W = Effective seismic weight
R = Response reduction factor	
T = Time period of structure	

Table: 4.3. Load differences between BNBC 2006 and 2020

Differences between bnbc 2006 and 2020		
LOAD	**2006**	**2020**
Base share	2778 kN	20000 kN
Wind Load	112 mph	147 mph
Dead load	150 psf	150 psf
Live load	market -52 psf	Market (comercial-100 psf Residential- 100 psf Stair (residential)- 63 psf Comercial- 105psf Lift room - 28psf Helipad- 200 psf
Floor finish	20 psf	30 psf

Table: 4.4 Partial Safety Factors

Material	BNBC 2006	BNBC 2020
Concrete	1.5	1.5
Steel	1.15	1.15

Same But 2020 BNBC apply LRFD method, so load factor and combination is more conservative.

Table: 4.5 Concrete Strength (f'c) for High rise Building

Code Common Used f'c (MPa)

BNBC 2006	20 MPa (normal)	Usually f'c = 20 MPa or 28 MPa
BNBC 2020	25 MPa (minimum)	For structural elements, 25 MPa is minimum requirement in many cases

Difference:

IN BNBC 2020 for concrete strength minimum standard more for durability, strength, and earthquake performance.

Table: 4.6 changing between summary

BNBC 2020 every load use in (Dead = 1.2, Live = 1.6 etc.). BNBC 2006 not every load.

Subject	BNBC2006	BNBC 2020
Design Method	ASD	LRFD
Load Factors	Less defined	Clearly defined
Earthquake Load	Simple, often optional	Mandatory and detailed
Wind Load	Basic	Direction-sensitive combinations
Safety Margin	Moderate	Higher

Wind Load: The new code introduces more realistic wind load calculations by considering factors like exposure duration, building type, and terrain category.

2006	wind load combinations simple.
2020	wind direction (positive/negative) multiple combinations specially for tall structures.

Table: 4.7. Load Combinations:

BNBC 2020 provides updated load combinations that are more aligned with international standards like **ACI** and **UBC.**

Basic Format (LRFD vs ASD):

BNBC 2006	**BNBC 2020**
Mainly Allowable Stress Design (ASD).	Load and Resistance Factor Design (LRFD) system fully introduce in modern code. Load Combination (Factored Load):
• BNBC 2006 Example (ASD Style): • D + L • D + L + W • D + L + E • D + 0.75 (L + W + E) • Earthquake combinations comparatively simple and less conservative.	• BNBC 2020 Example (LRFD Style): • 1.4D • 1.2D + 1.6L + 0.5(Lr or R) • 1.2D + 1.0E + L + 0.2S • 0.9D ± 1.0E (For overturning cases) • For use this code factor apply only load, not stress — for more safety margin.

Table: 4.8 Earthquake Load Combinations:

BNBC 2006	earthquake combination is optional.
BNBC 2020	earthquake combination is more detailed and mandatory, especially for medium/high-rise building

ANALYSIS IN ETABS 2006

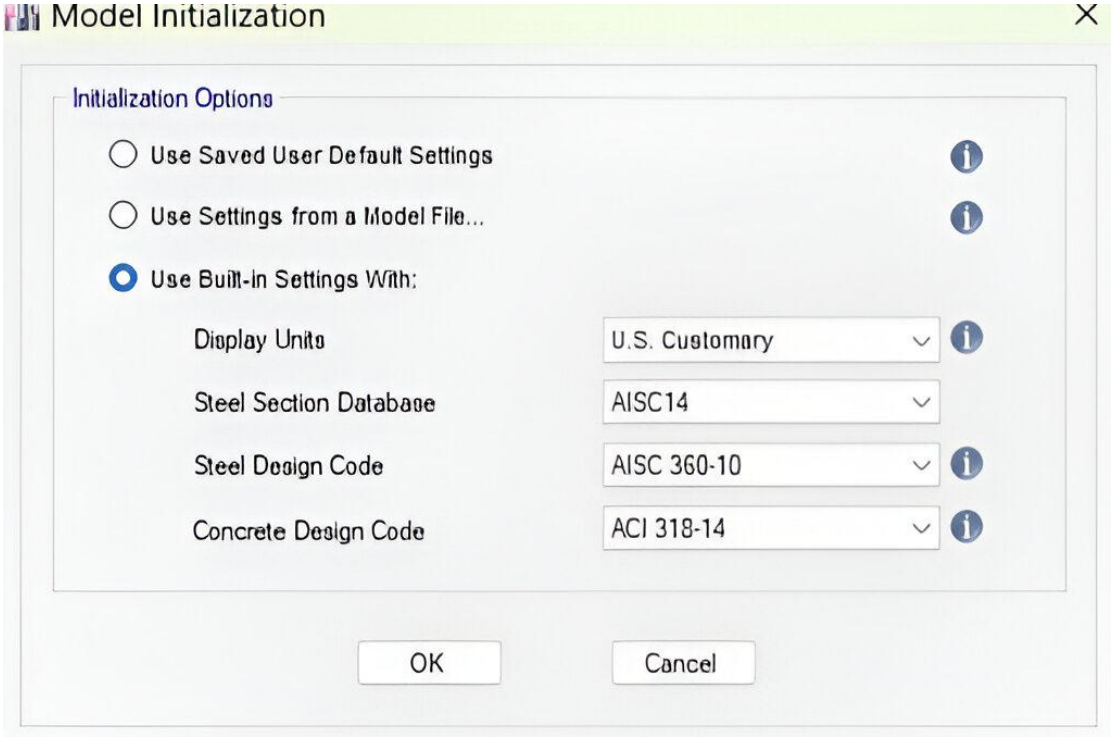


Figure: 4.16 Etabs modle Initializations

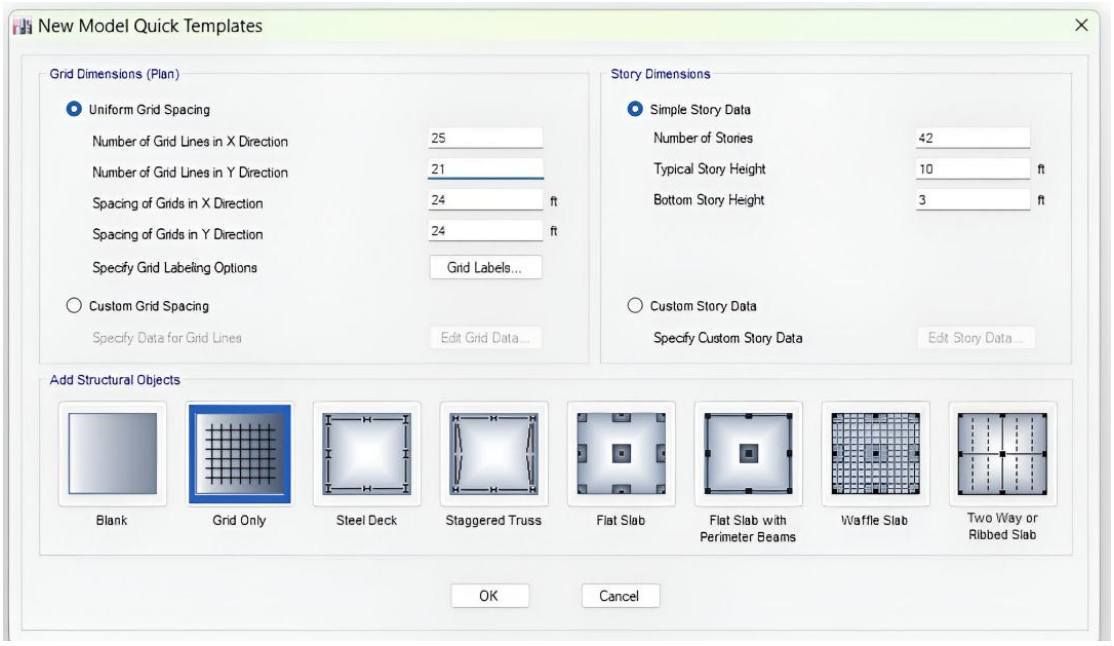


Figure: 4. 17 Select grid data and story data

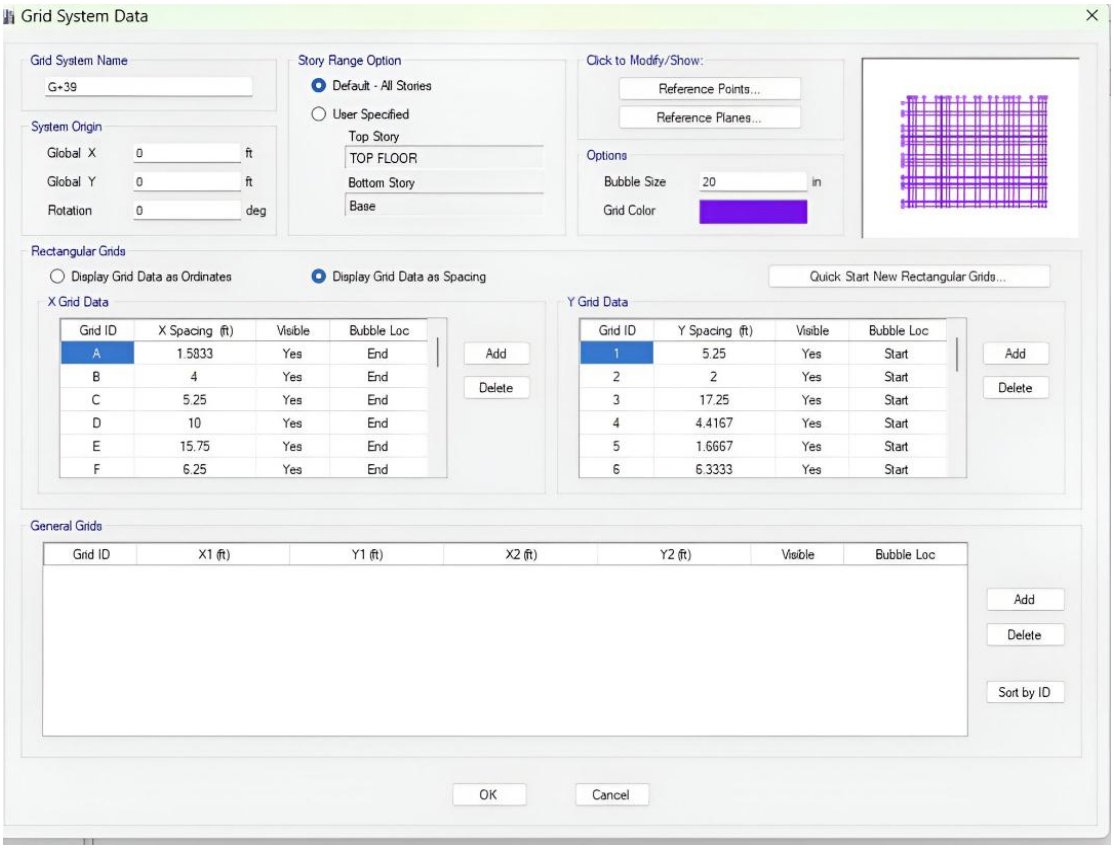


Figure: 4. 18 Modify grid data

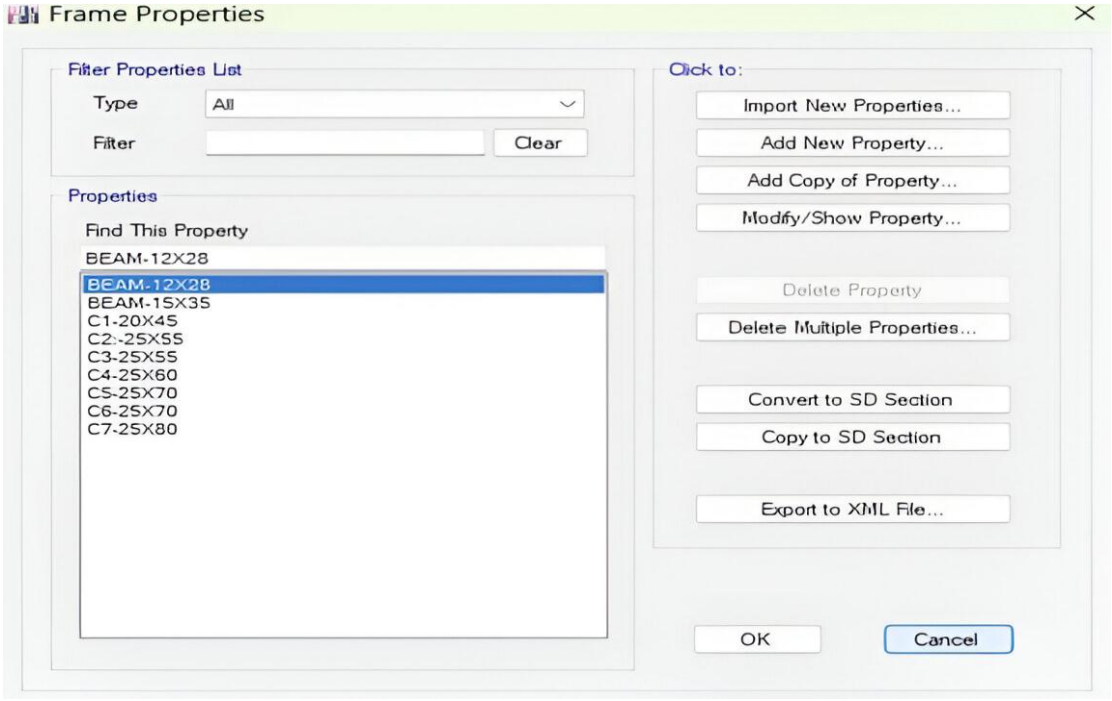


Figure: 19.4 Frame properties as per as bnbc 2006

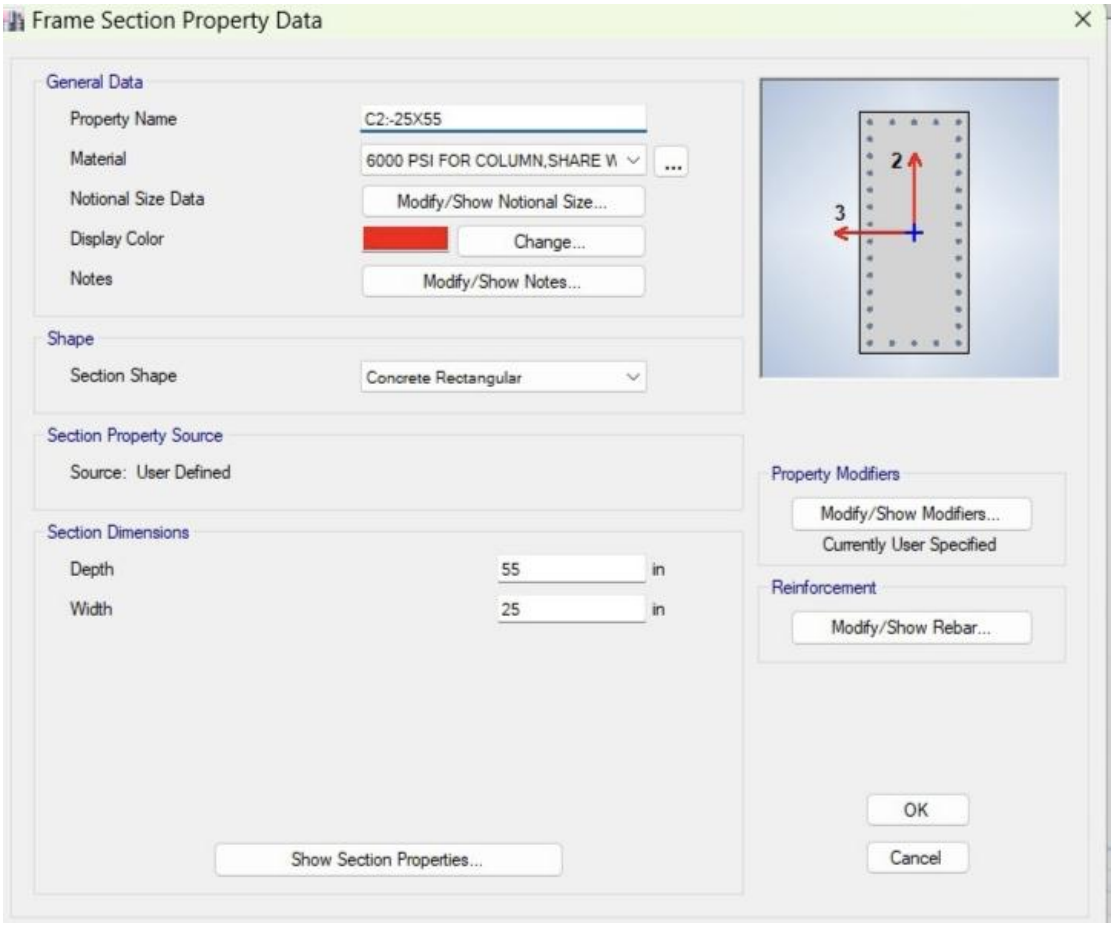


Figure: 4.20 Column size and reinforcement as bnbc 2006

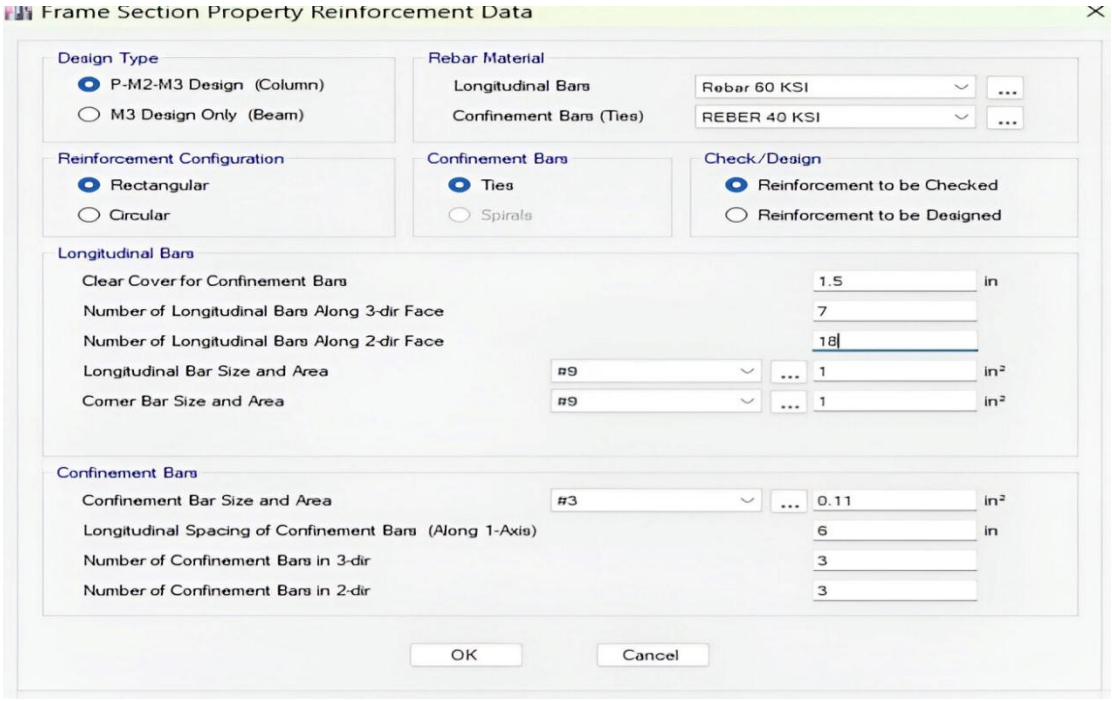


Figure: 4.21 Input reinforcement both code

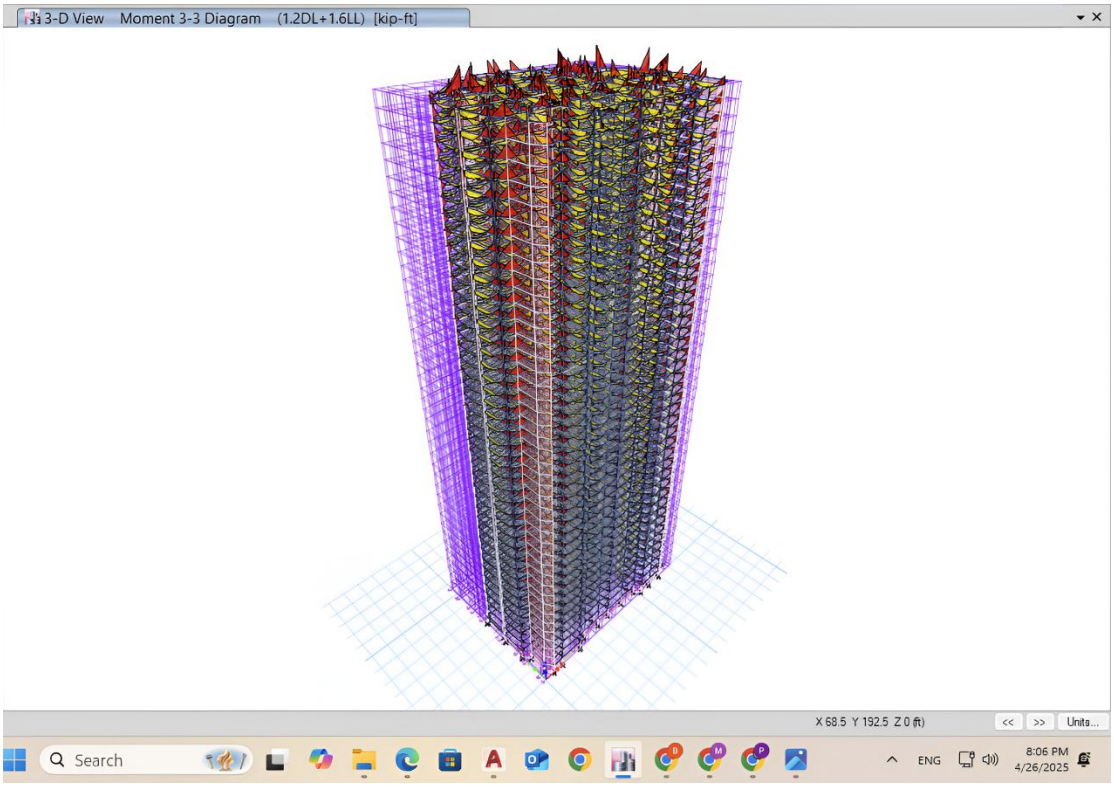


Figure: 4.22 Frame properties diagram as per as bnbc 2006

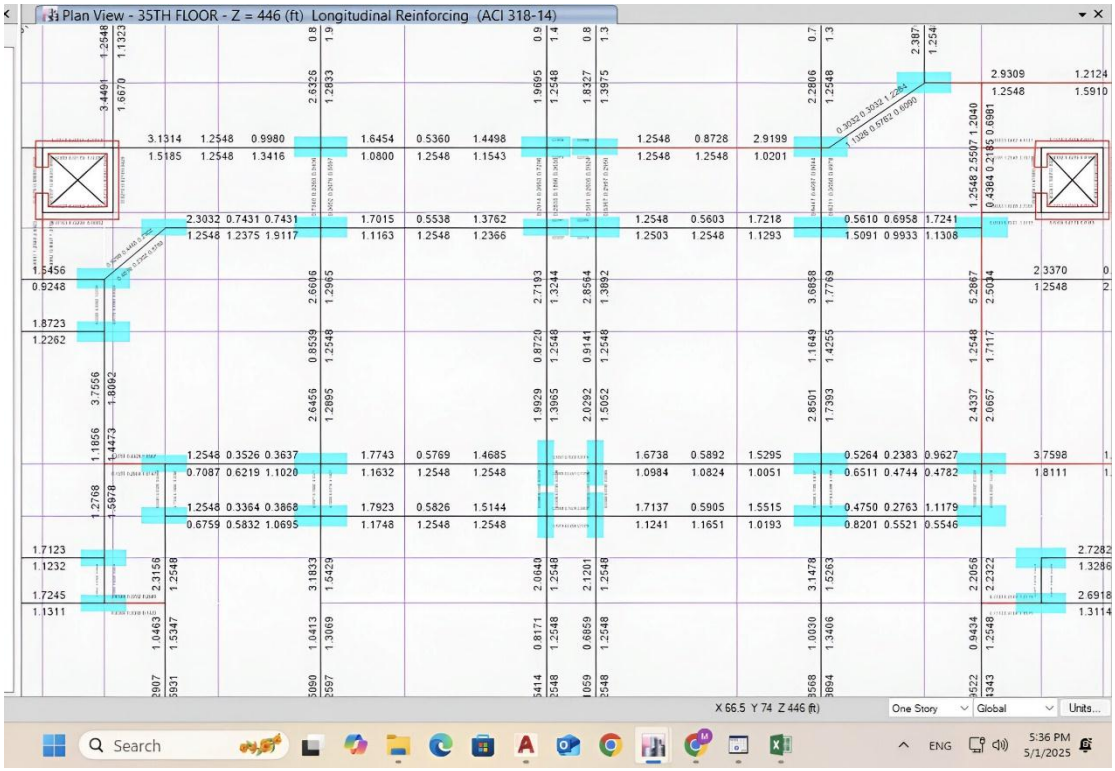


Figure: 4. 23 longitudinal reinfoecement 2006

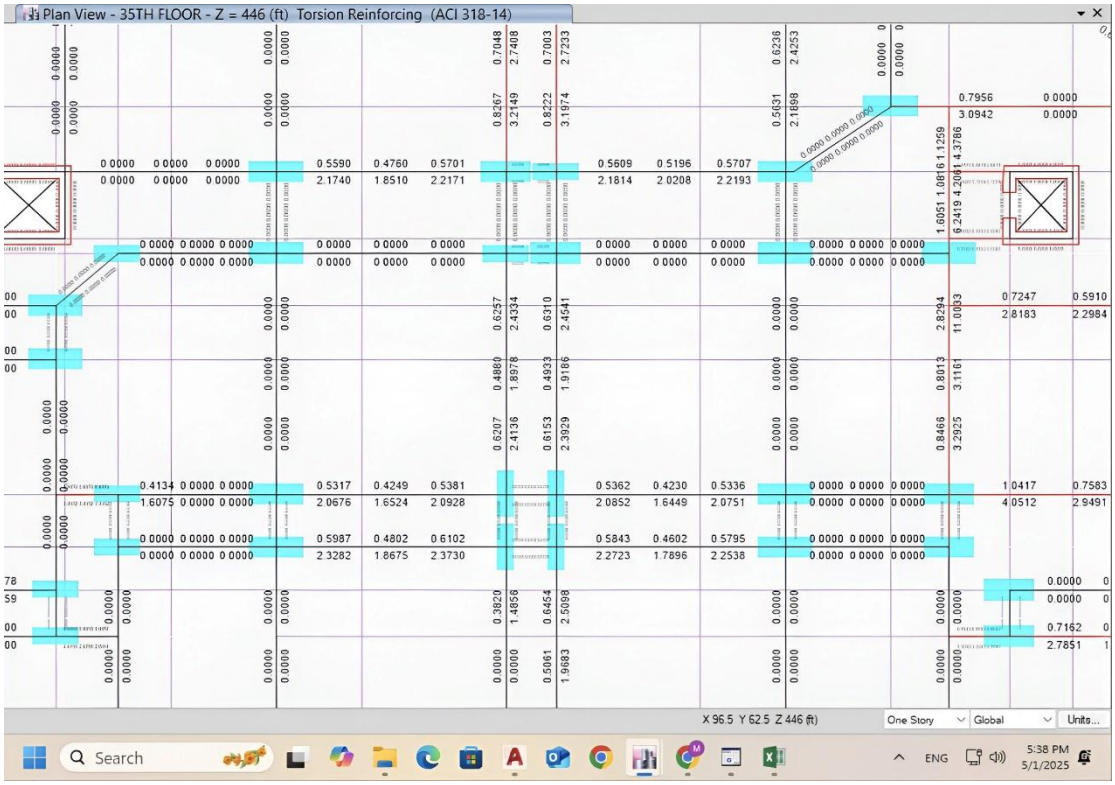


Figure: 4. 24 Torsional reinforcement

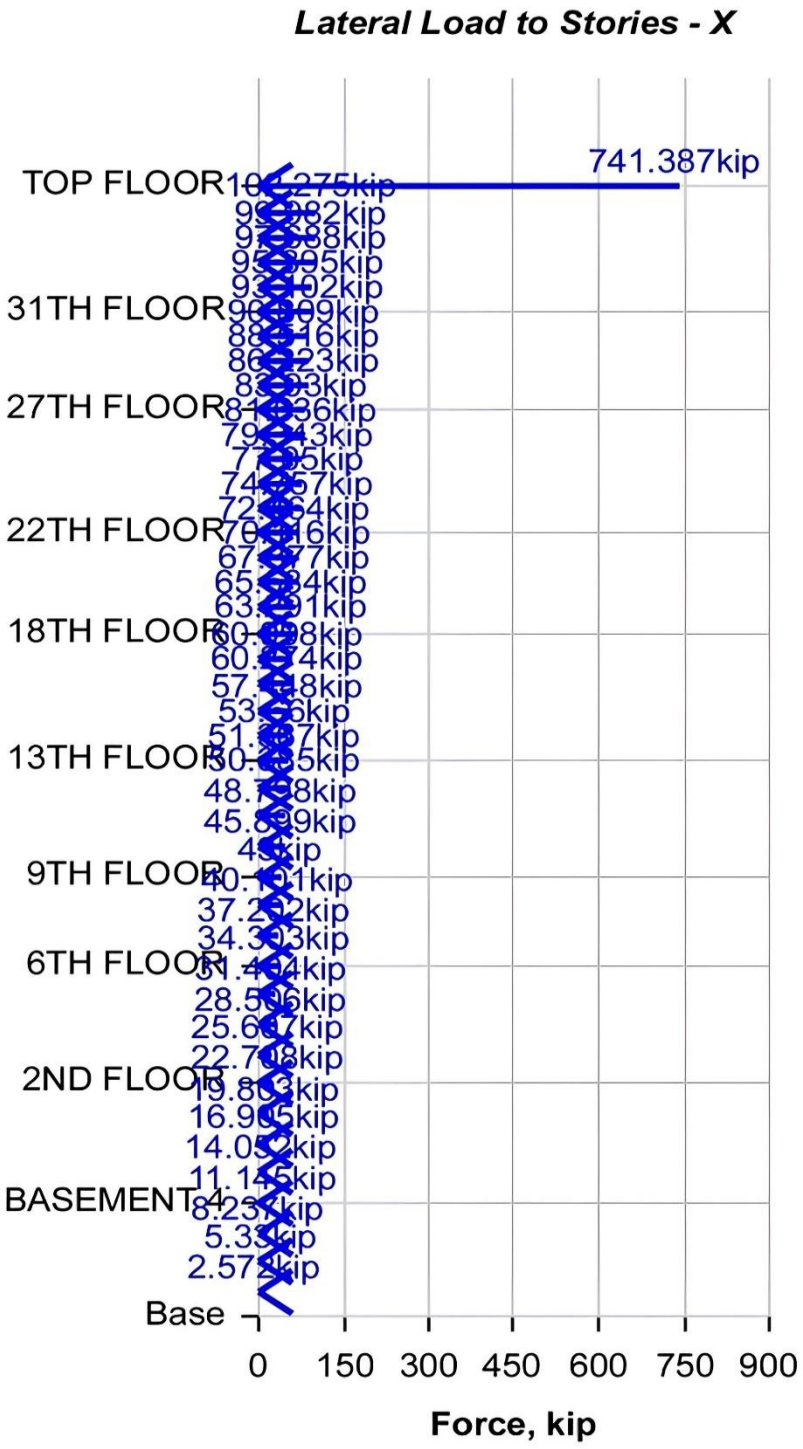


Figure: 4.25 Factoe load of column as per as bnbc 2006

UBC 94 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX according to UBC 94, as calculated by ETABS.

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = Method A

Coefficient, C_t		$C_t = 0.031ft$
Structure Height Above Base, h_n		$h_n = 456\ ft$
Approximate Fundamental Period, T [UBC Eq. 28-3]	$T = C_t (h)^{\frac{3}{4}}$	$T = 3.059\ sec$

Factors and Coefficients

Factor, R_w [UBC Table 16-N]	$R_w = 8$
Importance Factor, I [UBC Table 16-K]	$I = 1$
Seismic Zone Factor, Z [UBC Table 16-I]	$Z = 0.15$
Site Coefficient, S [UBC Table 16-J]	$S = 1.2$

Equivalent Lateral Forces

Base Shear Coefficient [UBC Eq. 28-2]	$=\frac{1.25S}{T^{\frac{2}{3}}}$
maximum	$= 2.75$
minimum	$= 0.075$
	$min \le V_{coeff} \le max$
Base Shear, V [UBC Eq. 28-1]	$V = \frac{ZIC}{R_w} W$

Calculated Base Shear

Direction	Period Used (sec)	V_{coeff}	W (kip)	V (kip)	F_t (kip)
X	3.059	0.711816	224861.8318	3001.1294	642.6405

Applied Story Forces

Figure: 4.26 Factoe load of column as per as bnbc 2006

Analysis Results

This Chapter Provides analysis results

Load Case/Combo	FX kip	FY kip	FZ kip	MX kip-ft	MY kip-ft	MZ kip-ft	X ft
Dead	0	-2.491E-05	163356.863	10029586	-14544371	-0.0024	0
Live	0	5.819E-06	50235.103	3027990.1471	-4417214	0.0006	0
FLOOR FINISH	0	0	24381.818	1497599.6874	-2178251	-0.0002	0
PERTION WALL	0	-2.142E-05	43979.972	2806928.7476	-3998474	-0.002	0
EQX	-3001.129	2.52E-05	0	-0.0125	-1027949	206750.146	0
EQY	-6.553E-05	-3001.13	0	1027949.9777	-0.0228	-295453.625	0
WQX 1	-1719.377	1.011E-05	0	-0.005	-431796.5646	117204.1836	0
WQX 2	-3.581E-05	-2254.949	0	566297.831	-0.0121	-201592.4158	0
WQY 1	-1719.377	1.011E-05	0	-0.005	-431796.5646	117204.1836	0
WQY 2	-3.581E-05	-2254.949	0	566297.831	-0.0121	-201592.4158	0
DL+LL	0	-4.222E-05	281953.756	17362104	-25138311	-0.0039	0
1.4DL+1.7LL	0	-5.737E-05	409805.789	25215343	-36518800	-0.0053	0
1.4DL	0	-6.726E-05	324406.114	20067760	-29009536	-0.0063	0
1.05DL+1.275LL+1.275WQX Max	-4.638E-05	-3.013E-05	307354.342	19633537	-27389100	149435.3301	0
1.05DL+1.275LL+1.275WQX Min	-2192.205	-2875.06	307354.342	18911507	-27939640	-257030.3341	0
1.05DL+1.275LL-1.275WQX Max	2192.205	2875.06	307354.342	18911507	-26838559	257030.3261	0
1.05DL+1.275LL-1.275WQX Min	4.494E-05	-5.592E-05	307354.342	18189478	-27389100	-149435.3381	0
1.05DL+1.275LL+1.275WQY Max	-4.638E-05	-3.013E-05	307354.342	19633537	-27389100	149435.3301	0
1.05DL+1.275LL+1.275WQY Min	-2192.205	-2875.06	307354.342	18911507	-27939640	-257030.3341	0
1.05DL+1.275LL-1.275WQY Max	2192.205	2875.06	307354.342	18911507	-26838559	257030.3261	0
1.05DL+1.275LL-1.275WQY Min	4.494E-05	-5.592E-05	307354.342	18189478	-27389100	-149435.3381	0
1.05DL+1.275WQX Max	-4.429E-05	-3.755E-05	243304.585	15772850	-21757152	149435.3293	0
1.05DL+1.275WQX Min	-2192.205	-2875.06	243304.585	15050820	-22307692	-257030.3348	0
1.05DL-1.275WQX Max	-4.429E-05	-3.755E-05	243304.585	15772850	-21757152	149435.3293	0
1.05DL-1.275WQX Min	-2192.205	-2875.06	243304.585	15050820	-22307692	-257030.3348	0
1.05DL+1.275WQY Max	-4.429E-05	-3.755E-05	243304.585	15772850	-21757152	149435.3293	0
1.05DL+1.275WQY Min	-2192.205	-2875.06	243304.585	15050820	-22307692	-257030.3348	0
1.05DL-1.275WQY Max	2192.205	2875.06	243304.585	15050820	-21206611	257030.3254	0
1.05DL-1.275WQY Min	4.702E-05	-6.333E-05	243304.585	14328790	-21757152	-149435.3388	0
0.9DL+1.3WQX Max	-4.538E-05	-3.009E-05	208546.787	13636890	-18648987	152365.4346	0
0.9DL+1.3WQX Min	-2235.19	-2931.433	208546.787	12900703	-19210323	-262070.1446	0
0.9DL-1.3WQX Max	-4.538E-05	-3.009E-05	208546.787	13636890	-18648987	152365.4346	0
0.9DL-1.3WQX Min	-2235.19	-2931.433	208546.787	12900703	-19210323	-262070.1446	0
0.9DL+1.3WQY Max	-4.538E-05	-3.009E-05	208546.787	13636890	-18648987	152365.4346	0
0.9DL+1.3WQY Min	-2235.19	-2931.433	208546.787	12900703	-19210323	-262070.1446	0
0.9DL-1.3WQY Max	2235.19	2931.433	208546.787	12900703	-18087652	262070.1364	0
0.9DL-1.3WQY Min	4.772E-05	-5.638E-05	208546.787	12164516	-18648987	-152365.4427	0
1.05DL+1.275LL+1.4EQX	-4201.58	-7.748E-06	307354.342	18911507	-28828229	289450.2003	0
1.05DL+1.275LL-1.4EQX	4201.58	-7.83E-05	307354.342	18911507	-25949971	-289450.2083	0
1.05DL+1.275LL+1.4EQY	-9.247E-05	-4201.582	307354.342	20350637	-27389100	-413635.079	0
1.05DL+1.275LL-1.4EQY	9.103E-05	4201.582	307354.342	17472377	-27389100	413635.071	0
1.05DL+1.4EQX	-4201.58	-1.517E-05	243304.585	15050820	-23196281	289450.1996	0
1.05DL-1.4EQX	4201.58	-8.572E-05	243304.585	15050820	-20318023	-289450.2091	0
1.05DL+1.4EQY	-9.038E-05	-4201.582	243304.585	16489950	-21757152	-413635.0797	0
1.05DL-1.4EQY	9.311E-05	4201.582	243304.585	13611690	-21757152	413635.0703	0

Figure:: 4.12 Base Reactions (Part 1 of 2)

Load Case/Combo	FX kip	FY kip	FZ kip	MX kip-ft	MY kip-ft	MZ kip-ft	X ft
0.9DL+1.43EQX	-4291.614	-7.205E-06	208546.787	12900703	-20118955	295652.7047	0
0.9DL-1.43EQX	4291.614	-7.927E-05	208546.787	12900703	-17179020	-295652.7128	0
0.9DL+1.43EQY	-4291.614	-7.205E-06	208546.787	12900703	-20118955	295652.7047	0
0.9DL-1.43EQY	4291.614	-7.927E-05	208546.787	12900703	-17179020	-295652.7128	0

Figure:: 4.13 Base Reactions (Part 1 of 2)

Load Case/Combo	Y ft	Z ft
Dead	0	0
Live	0	0
FLOOR FINISH	0	0
PERTION WALL	0	0
EQX	0	0
EQY	0	0
WQX 1	0	0
WQX 2	0	0
WQY 1	0	0
WQY 2	0	0
DL+LL	0	0
1.4DL+1.7LL	0	0
1.4DL	0	0
1.05DL+1.275LL+1.275WQX Max	0	0
1.05DL+1.275LL+1.275WQX Min	0	0
1.05DL+1.275LL-1.275WQX Max	0	0
1.05DL+1.275LL-1.275WQX Min	0	0
1.05DL+1.275LL+1.275WQY Max	0	0
1.05DL+1.275LL+1.275WQY Min	0	0
1.05DL+1.275LL-1.275WQY Max	0	0
1.05DL+1.275LL-1.275WQY Min	0	0
1.05DL+1.275WQX Max	0	0
1.05DL+1.275WQX Min	0	0
1.05DL-1.275WQX Max	0	0
1.05DL-1.275WQX Min	0	0
1.05DL+1.275WQY Max	0	0
1.05DL+1.275WQY Min	0	0
1.05DL-1.275WQY Max	0	0
1.05DL-1.275WQY Min	0	0
0.9DL+1.3WQX Max	0	0
0.9DL+1.3WQX Min	0	0
0.9DL-1.3WQX Max	0	0
0.9DL-1.3WQX Min	0	0
0.9DL+1.3WQY Max	0	0
0.9DL+1.3WQY Min	0	0
0.9DL-1.3WQY Max	0	0
0.9DL-1.3WQY Min	0	0
1.05DL+1.275LL+1.4EQX	0	0
1.05DL+1.275LL-1.4EQX	0	0
1.05DL+1.275LL+1.4EQY	0	0
1.05DL+1.275LL-1.4EQY	0	0

Figure::4.14 Base Reactions (Part 2 of 2)

Load Case/Combo	Y ft	Z ft
1.05DL+1.4EQX	0	0
1.05DL-1.4EQX	0	0
1.05DL+1.4EQY	0	0
1.05DL-1.4EQY	0	0
0.9DL+1.43EQX	0	0
0.9DL-1.43EQX	0	0
0.9DL+1.43EQY	0	0
0.9DL-1.43EQY	0	0

Figure::4.15 Base Reactions (Part 2 of 2)

ANALYSIS IN ETABS 2020

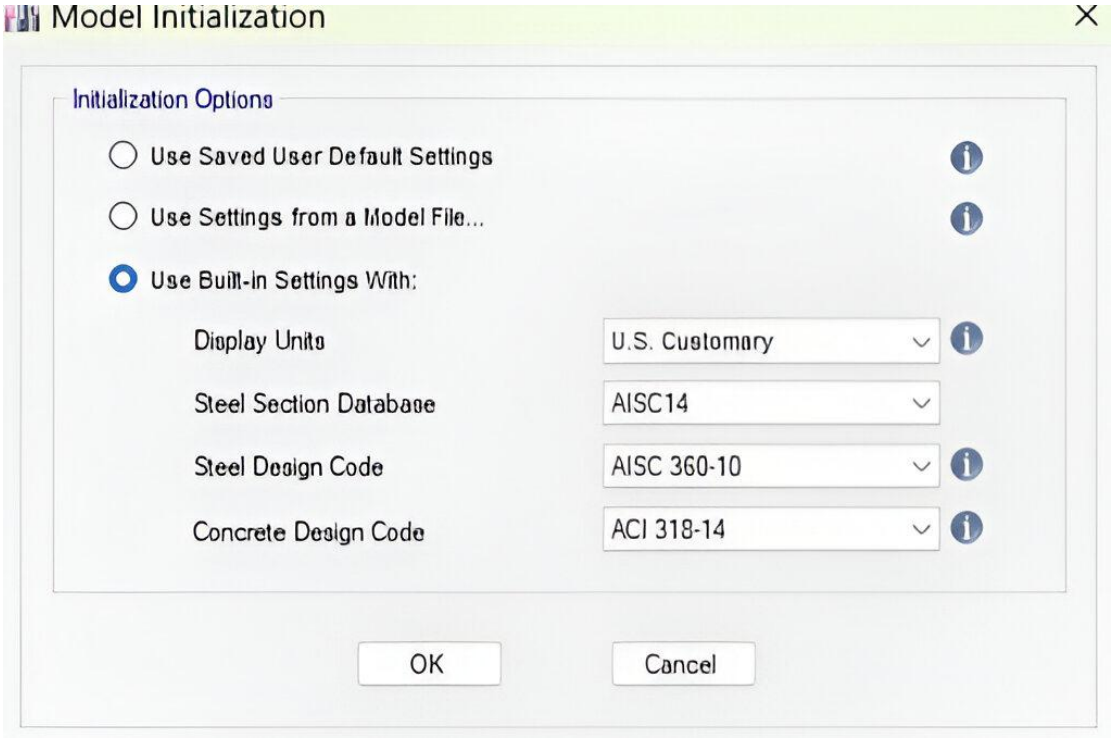


Figure: 4.27 Etabs modle Initializations

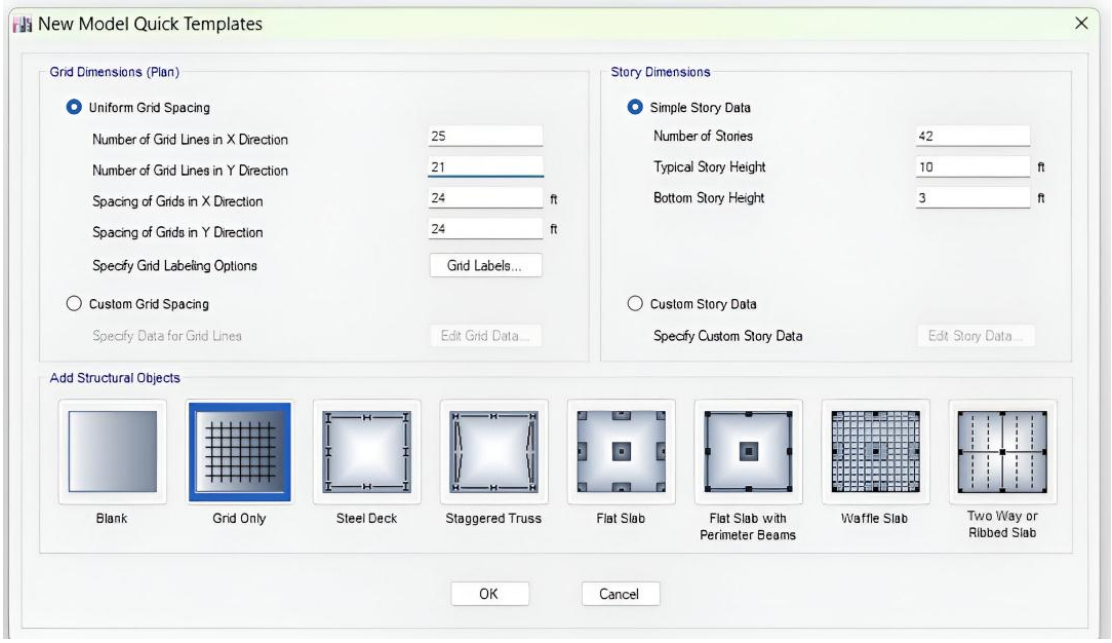


Figure: 4.28 Select grid data and story data

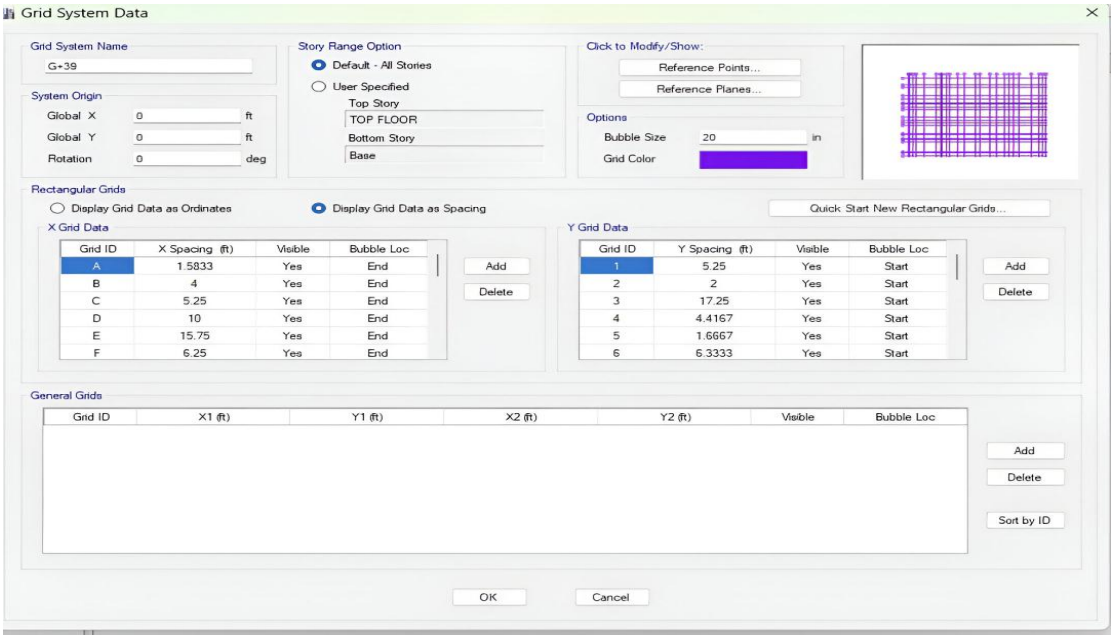


Figure: 4.29 Modify grid data

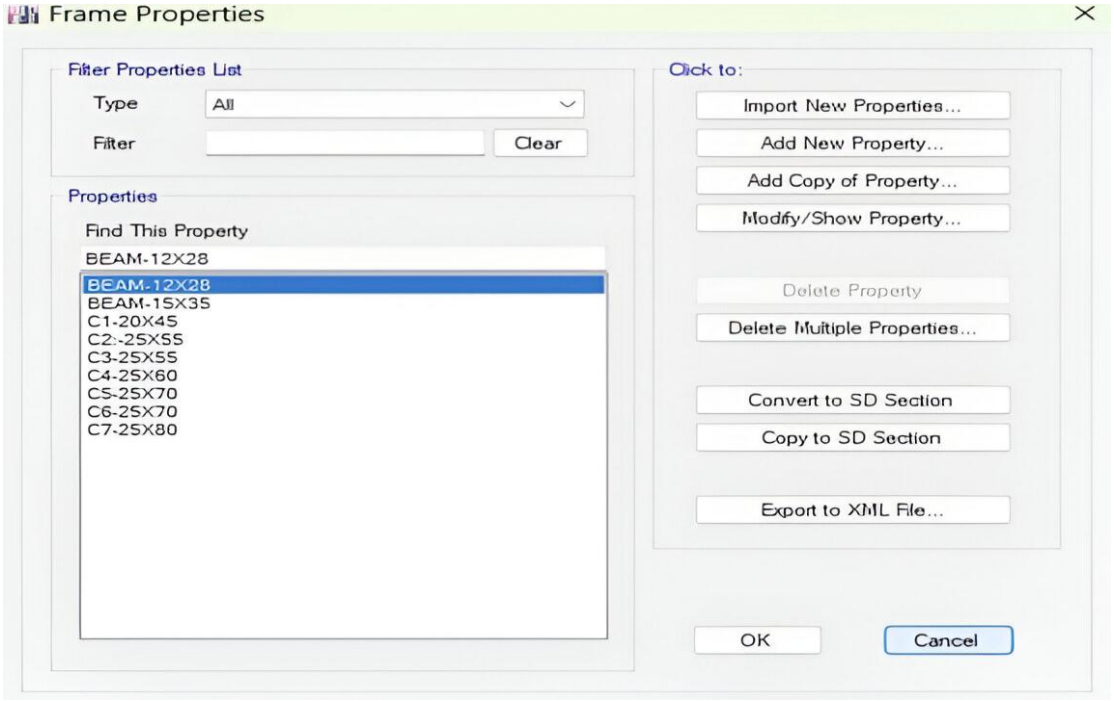


Figure: 4.30 Frame properties as per as bnbc 2020

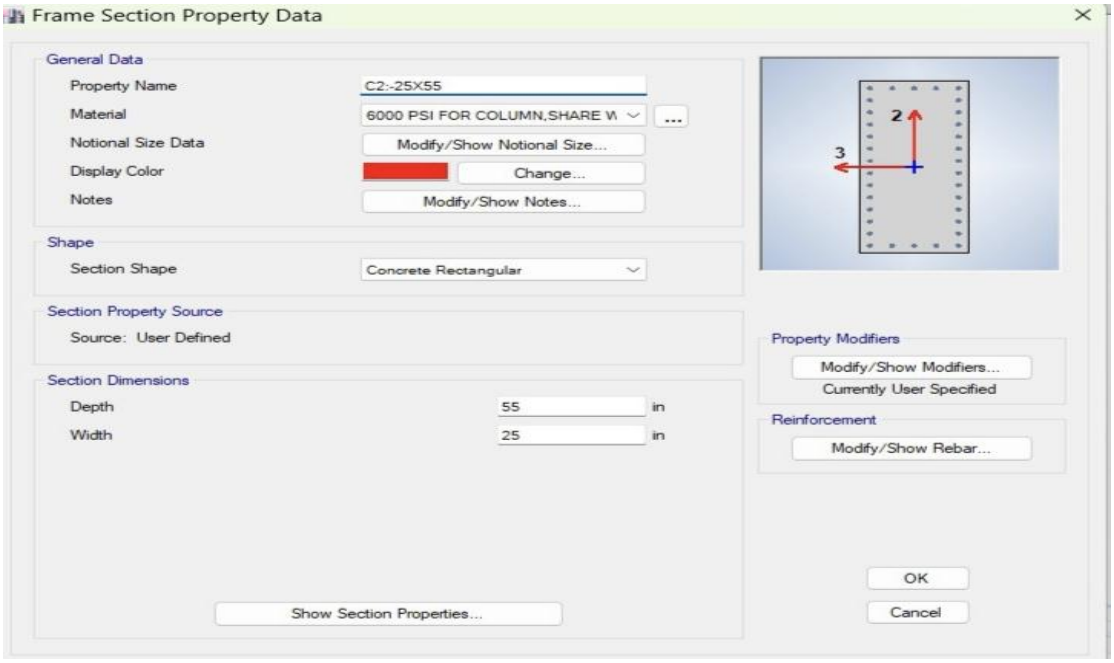


Figure: 4.20 Column size and reinforcement as bnbc 2020

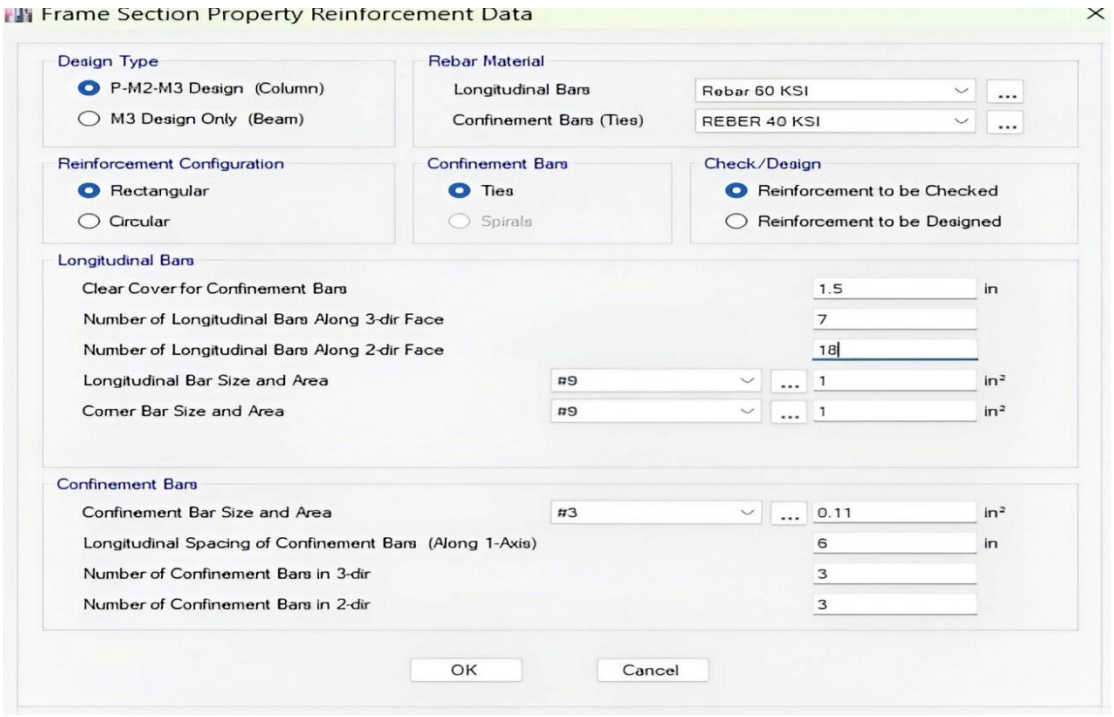


Figure: 4.21 Input reinforcement both code

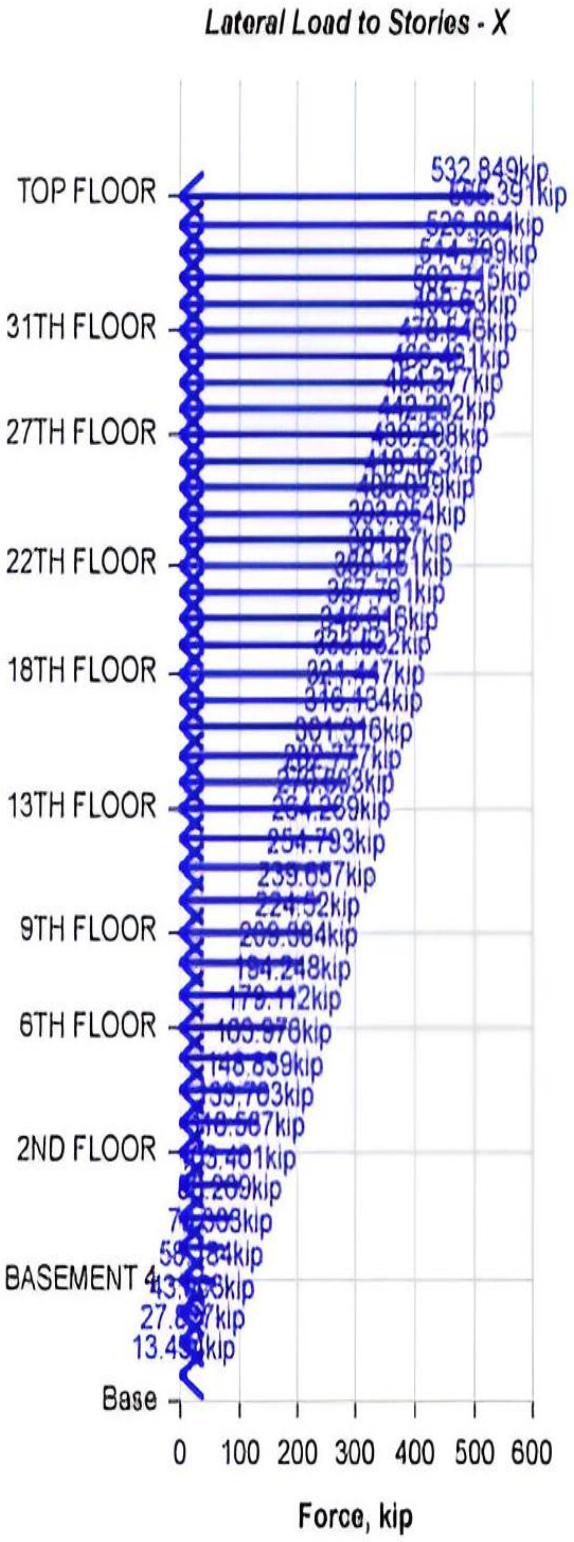


Figure:, 4.22 combined load 2020

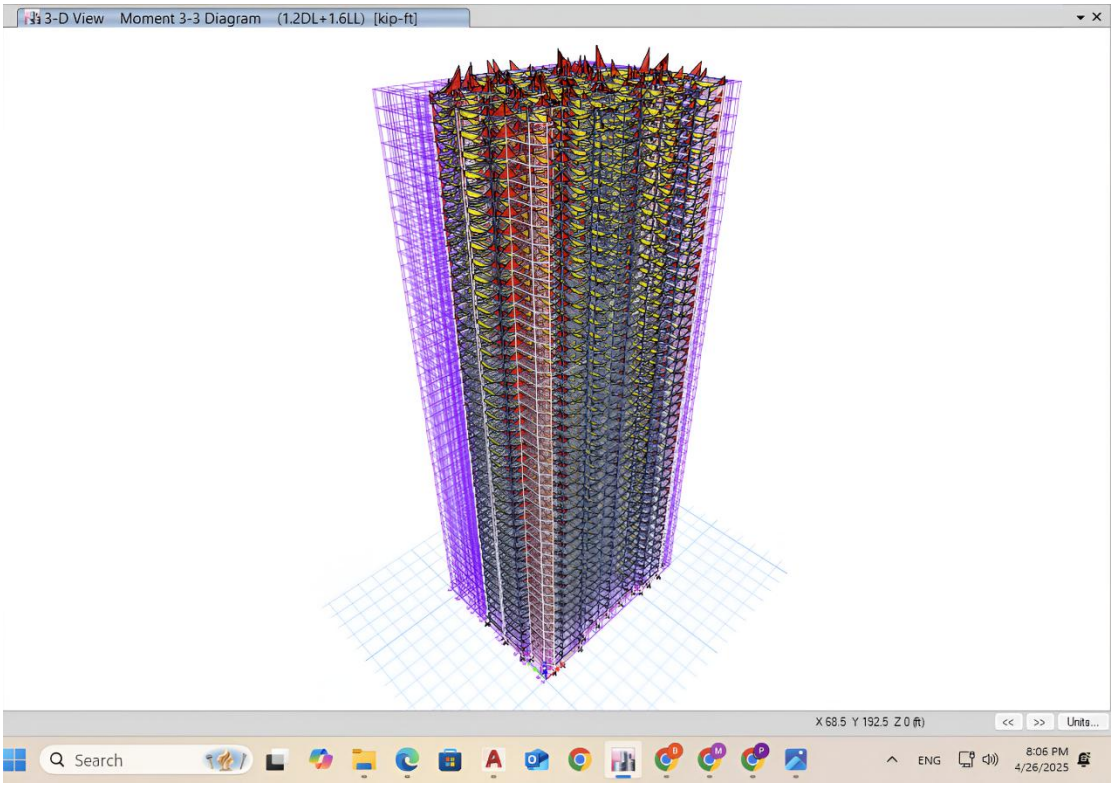


Figure: 4.23 Frame properties diagram as per as bnbc 2020

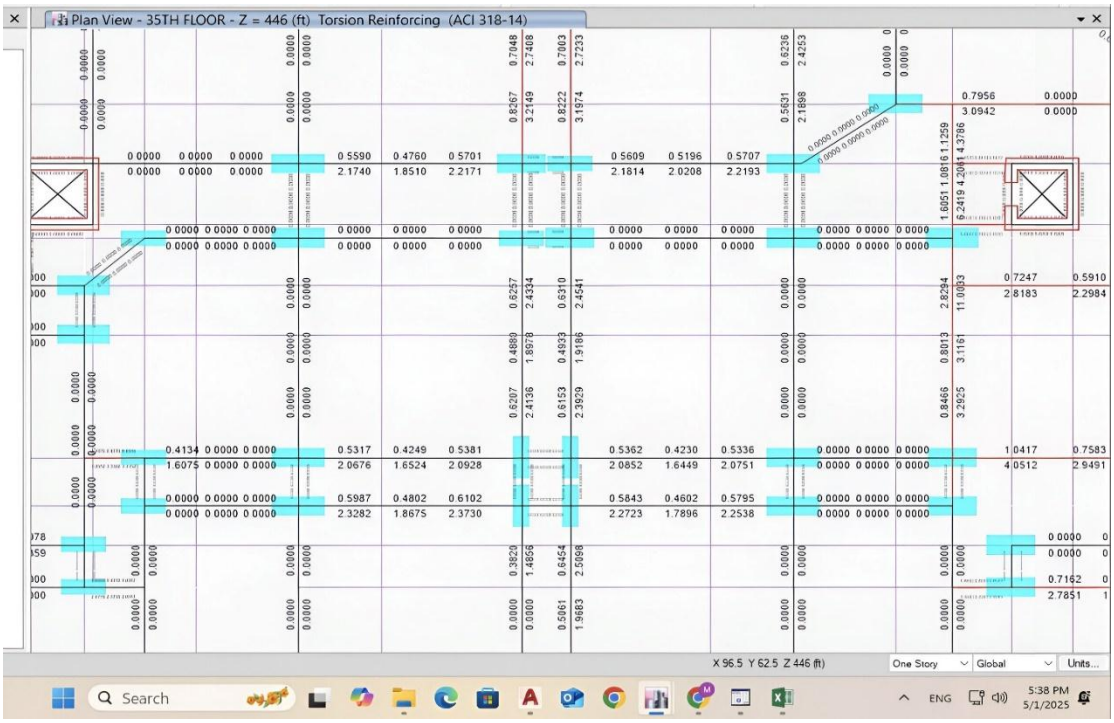


Figure: 4.24 longitudinal reinfoecement 2020

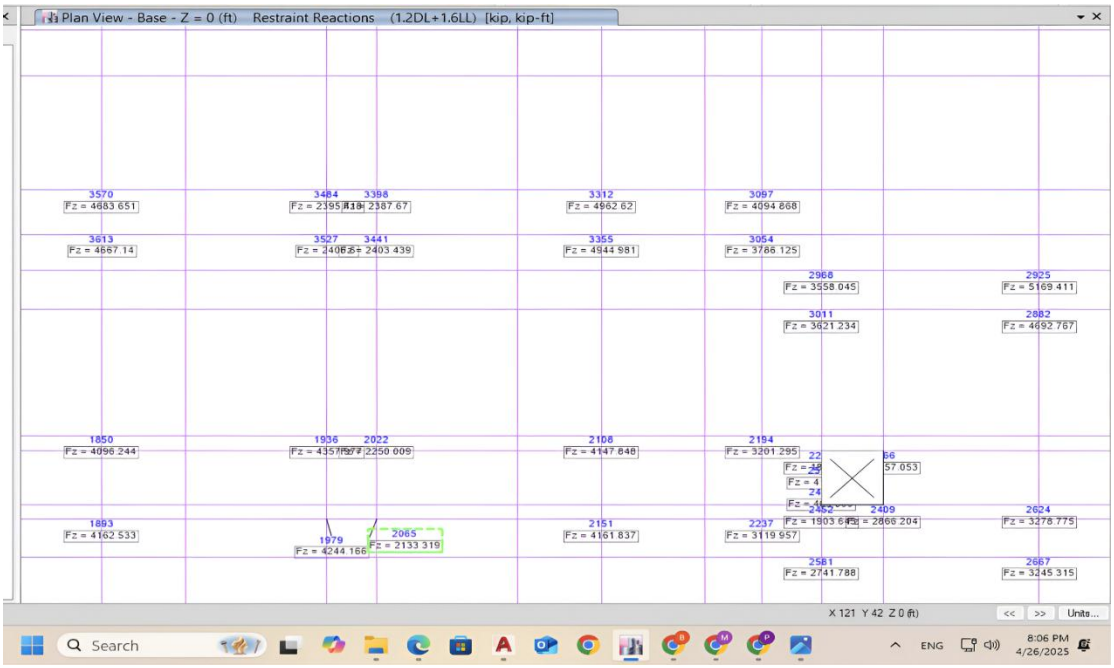


Figure: 4.25 restraint reaction 2020

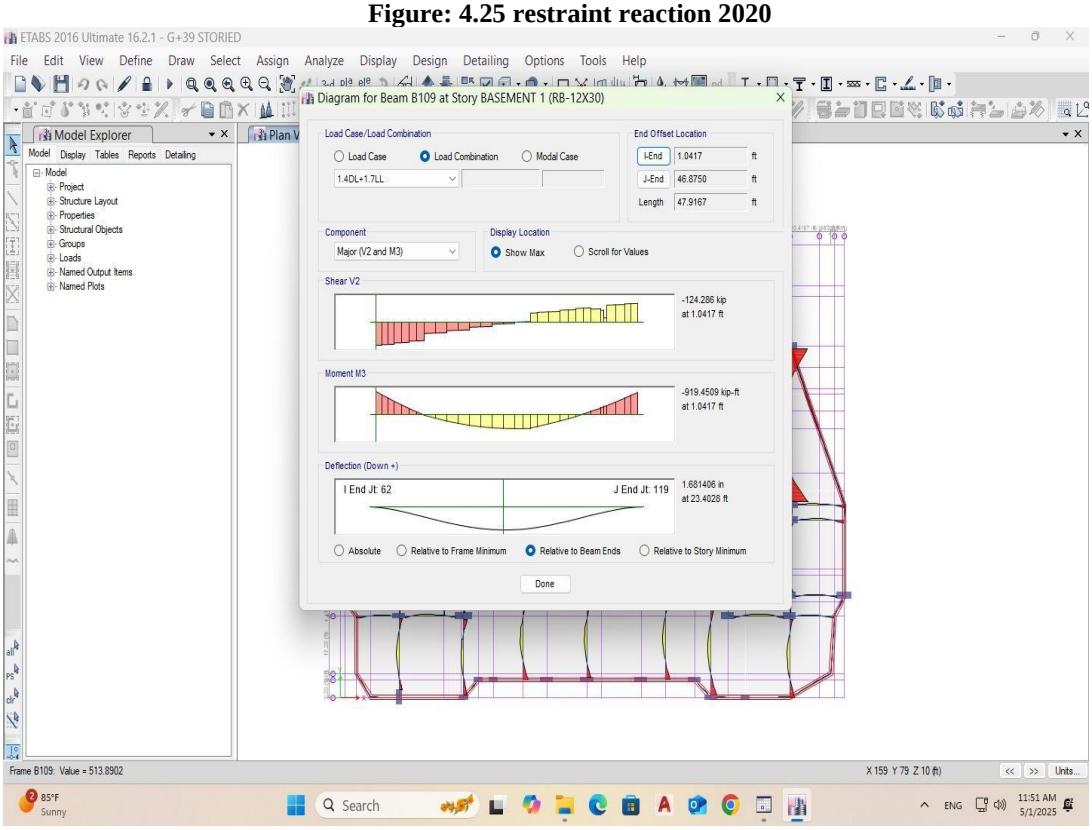


Figure: 4.26 beam diagram

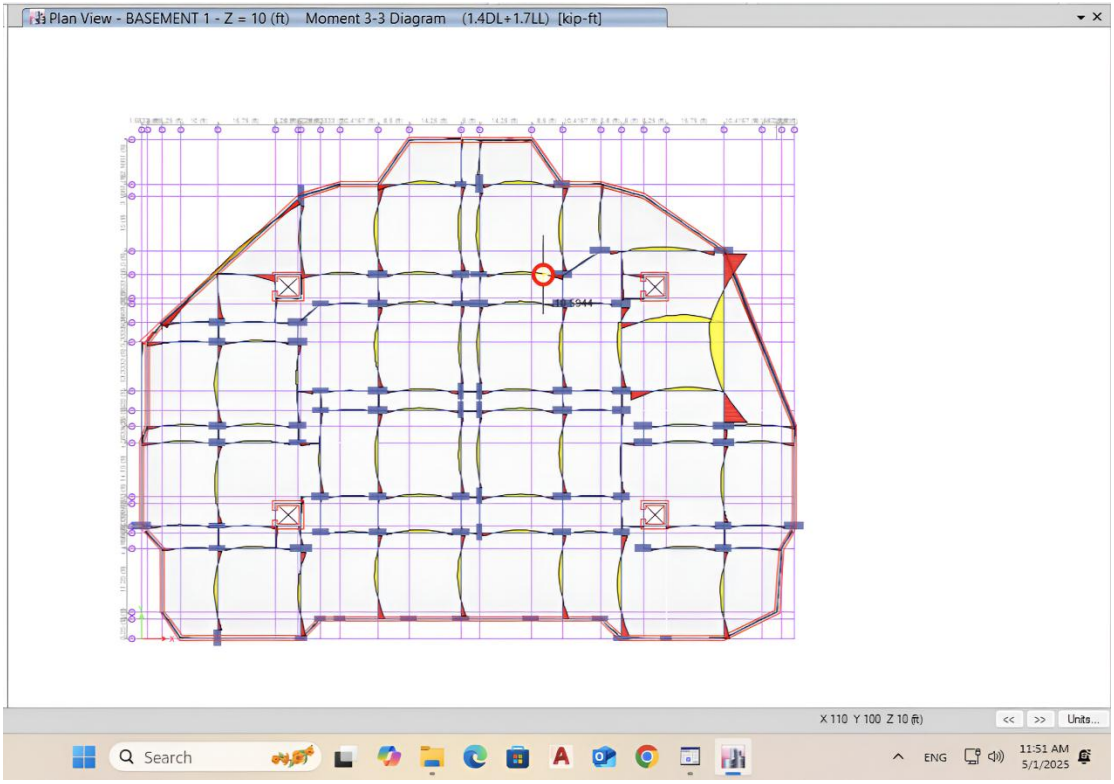


Figure: 4.27 model diagram 2020

Analysis Results

This Chapter Provides analysis results

Load Case/Combo	FX kip	FY kip	FZ kip	MX kip-ft	MY kip-ft	MZ kip-ft	X ft
Dead	0	-0.0001191	154852.224	9562882.0909	-13812763	-0.0126	0
Live	0	1.232E-05	50235.103	3027990.1447	-4417214	-3.109E-05	0
FLOOR FINISH	0	-1.207E-05	24381.818	1497599.6925	-2178251	-0.0014	0
PERTION WALL	0	-9.274E-05	43979.972	2806928.78	-3998474	-0.0095	0
ROOF LIVE LOAD	0	0	1074.179	67661.2236	-96200.9683	-0.0002	0
EQX	-12442.059	0.0003979	-1.366E-05	-0.1798	-3886256	856364.4469	0
EQY	-12442.059	0.0003979	-1.366E-05	-0.1798	-3886256	856364.4469	0
WQX 1	0	-5364.149	0	1381458.759	0.0043	-479554.9355	0
WQX 2	4090.111	-0.000106	0	0.0479	1053348.2588	-278809.2431	0
WQX 3	2.207E-05	-4023.112	0	1036094.0945	0.0119	-467566.0107	0
WQX 4	-1.786E-05	-4023.112	0	1036094.044	-0.0055	-251766.3926	0
WQX 5	3067.583	-0.0001123	0	0.0506	790011.1991	-271839.0219	0
WQX 6	3067.583	-4.668E-05	0	0.0212	790011.189	-146374.8428	0
WQX 7	-3067.583	-4023.112	0	1036094.0334	-790011.1909	-150559.2693	0
WQX 8	3067.583	-4023.112	0	1036094.1051	790011.1973	-568773.134	0
WQX 9	-2302.732	-3020.016	0	777761.2843	-593035.057	-241107.5033	0
WQX 10	-2302.732	-3020.016	0	777761.2244	-593035.0776	15067.8537	0
WQX 11	2302.732	-3020.016	0	777761.3382	593035.0824	-555046.7111	0
WQX 12	2302.732	-3020.016	0	777761.2783	593035.0618	-298871.3541	0
WQY 1	-5550.268	0.0001399	0	-0.0632	-1390351	378343.2702	0
WQY 2	0	-7279.133	0	1823435.0938	0.0056	-650754.5333	0
WQY 3	-4162.701	6.213E-05	0	-0.0282	-1042763	198630.204	0
WQY 4	-4162.701	0.0001477	0	-0.0665	-1042763	368884.7014	0
WQY 5	2.872E-05	-5459.35	0	1367576.3532	0.0156	-634485.6023	0
WQY 6	-2.37E-05	-5459.35	0	1367576.2874	-0.0072	-341646.1976	0
WQY 7	-4162.701	5459.35	0	-1367576	-1042763	771823.3526	0
WQY 8	-4162.701	-5459.35	0	1367576.273	-1042763	-204308.4473	0
WQY 9	-3124.801	4098.152	0	-1026594	-782767.4496	405567.4854	0
WQY 10	-3124.801	4098.152	0	-1026594	-782767.4767	753196.6413	0
WQY 11	-3124.801	-4098.152	0	1026593.9613	-782767.4434	-327182.119	0
WQY 12	-3124.801	-4098.152	0	1026593.8832	-782767.4705	20447.0369	0
1.4D	0	-0.0003135	312499.62	19414375	-27985284	-0.0329	0
DL+LL	0	-0.0002139	274523.296	16963062	-24502904	-0.0237	0
1.2DL+1.6LL	0	-0.0002527	349951.669	21593935	-31208851	-0.0286	0
1.2DL+1.6LL+0.5LR	0	-0.0002501	348770.072	21519508	-31103030	-0.0283	0
1.2DL+1.6LR+LL	0	-0.0002601	319810.607	19777141	-28558522	-0.0286	0
1.2DL+0.5LR+1.6WQX Max	6544.177	-0.0003445	268393.906	18885057	-22350130	24108.5376	0
1.2DL+0.5LR+1.6WQX Min	-4908.133	-8582.639	268393.906	16674723	-25299505	-910037.0427	0
1.2DL+0.5LR-1.6WQX Max	6544.177	-0.0003445	268393.906	18885057	-22350130	24108.5376	0
1.2DL+0.5LR-1.6WQX Min	-4908.133	-8582.639	268393.906	16674723	-25299505	-910037.0427	0
1.2DL+0.5LR+1.6WQY Max	4.853E-05	8734.96	268393.906	19592219	-24035487	1234917.3359	0
1.2DL+0.5LR+1.6WQY Min	-8880.428	-11646.613	268393.906	14486601	-26260048	-1041207	0
1.2DL+0.5LR-1.6WQY Max	8880.428	11646.613	268393.906	18862845	-21810926	1041207.2249	0
1.2DL+0.5LR-1.6WQY Min	-4.338E-05	-8734.96	268393.906	13757227	-24035487	-1234917	0
1.2DL+L+EQX	-12442.059	0.0001415	318091.92	19668883	-32290857	856364.4187	0

Figure: 4.28 Base reaction Part of 1 of 2

Load Case/Combo	FX kip	FY kip	FZ kip	MX kip-ft	MY kip-ft	MZ kip-ft	X ft
1.2DL+L-EQX	12442.059	-0.001	318091.92	19668883	-24518345	-856364.4751	0
1.2DL+L+EQY	-12442.059	0.0001415	318091.92	19668883	-32290857	856364.4187	0
1.2DL+L-EQY	12442.059	-0.001	318091.92	19668883	-24518345	-856364.4751	0
0.9DL+1.6WQX Max	6544.177	-0.0002762	200892.613	14691004	-16305183	24108.5448	0
0.9DL+1.6WQX Min	-4908.133	-8582.639	200892.613	12480670	-19254558	-910037.0355	0
0.9DL-1.6WQX Max	6544.177	-0.0002762	200892.613	14691004	-16305183	24108.5448	0
0.9DL-1.6WQX Min	-4908.133	-8582.639	200892.613	12480670	-19254558	-910037.0355	0
0.9DL+1.6WQY Max	4.788E-05	8734.96	200892.613	15398166	-17990540	1234917.3431	0
0.9DL+1.6WQY Min	-8880.428	-11646.613	200892.613	10292547	-20215101	-1041207	0
0.9DL-1.6WQY Max	8880.428	11646.613	200892.613	14668792	-15765979	1041207.2321	0
0.9DL-1.6WQY Min	-4.403E-05	-8734.96	200892.613	9563173.3571	-17990540	-1234917	0
0.9DL+EQX	-12442.059	0.0001963	200892.613	12480669	-21876796	856364.4258	0
0.9DL-EQX	12442.059	-0.001	200892.613	12480670	-14104284	-856364.468	0
0.9DL+EQY	-12442.059	0.0001963	200892.613	12480669	-21876796	856364.4258	0
0.9DL-EQY	12442.059	-0.001	200892.613	12480670	-14104284	-856364.468	0

Figure: 4.29 Base reaction Part of 1 of 2

Load Case/Combo	Y ft	Z ft
Dead	0	0
Live	0	0
FLOOR FINISH	0	0
PERTION WALL	0	0
ROOF LIVE LOAD	0	0
EQX	0	0
EQY	0	0
WQX 1	0	0
WQX 2	0	0
WQX 3	0	0
WQX 4	0	0
WQX 5	0	0
WQX 6	0	0
WQX 7	0	0
WQX 8	0	0
WQX 9	0	0
WQX 10	0	0
WQX 11	0	0
WQX 12	0	0
WQY 1	0	0
WQY 2	0	0
WQY 3	0	0
WQY 4	0	0
WQY 5	0	0
WQY 6	0	0
WQY 7	0	0
WQY 8	0	0
WQY 9	0	0
WQY 10	0	0
WQY 11	0	0

Figure: 4.30 Base reaction Part of 2 of 2

Story	Diaphragm	Load Case/Combo	UX in	UY in	RZ rad	Point	X ft	Y ft	Z ft
Base	D1	WQX 4	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 5	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 6	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 7	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 8	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 9	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 10	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 11	0	0	0	6590	93.9244	69.077	0
Base	D1	WQX 12	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 1	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 2	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 3	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 4	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 5	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 6	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 7	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 8	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 9	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 10	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 11	0	0	0	6590	93.9244	69.077	0
Base	D1	WQY 12	0	0	0	6590	93.9244	69.077	0
Base	D1	1.4D	0	0	0	6590	93.9244	69.077	0
Base	D1	DL+LL	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+1.6LL	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+1.6LL+0.5LR	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+1.6LR+LL	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR+1.6WQX Max	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR+1.6WQX Min	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR-1.6WQX Max	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR-1.6WQX Min	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR+1.6WQY Max	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR+1.6WQY Min	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR-1.6WQY Max	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+0.5LR-1.6WQY Min	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+L+EQX	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+L-EQX	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+L+EQY	0	0	0	6590	93.9244	69.077	0
Base	D1	1.2DL+L-EQY	0	0	0	6590	93.9244	69.077	0
Base	D1	0.9DL+1.6WQX Max	0	0	0	6590	93.9244	69.077	0
Base	D1	0.9DL+1.6WQX Min	0	0	0	6590	93.9244	69.077	0
Base	D1	0.9DL-1.6WQX Max	0	0	0	6590	93.9244	69.077	0
Base	D1	0.9DL-1.6WQX Min	0	0	0	6590	93.9244	69.077	0

Figure: 4.31 base mass displacement

Story	Diaphragm	Load Case/Combo	Y ft	Z ft
BASEMENT 1	D1	1.05DL+1.275LL+1.4EQX	68.7068	10
BASEMENT 1	D1	1.05DL+1.275LL-1.4EQX	68.7068	10
BASEMENT 1	D1	1.05DL+1.275LL+1.4EQY	68.7068	10
BASEMENT 1	D1	1.05DL+1.275LL-1.4EQY	68.7068	10
BASEMENT 1	D1	1.05DL+1.4EQX	68.7068	10
BASEMENT 1	D1	1.05DL-1.4EQX	68.7068	10
BASEMENT 1	D1	1.05DL+1.4EQY	68.7068	10
BASEMENT 1	D1	1.05DL-1.4EQY	68.7068	10
BASEMENT 1	D1	0.9DL+1.43EQX	68.7068	10
BASEMENT 1	D1	0.9DL-1.43EQX	68.7068	10
BASEMENT 1	D1	0.9DL+1.43EQY	68.7068	10
BASEMENT 1	D1	0.9DL-1.43EQY	68.7068	10
Base	D1	Dead	69.077	0
Base	D1	Live	69.077	0
Base	D1	FLOOR FINISH	69.077	0
Base	D1	PERTION WALL	69.077	0
Base	D1	EQX	69.077	0
Base	D1	EQY	69.077	0
Base	D1	WQX 1	69.077	0
Base	D1	WQX 2	69.077	0
Base	D1	WQY 1	69.077	0
Base	D1	WQY 2	69.077	0
Base	D1	DL+LL	69.077	0
Base	D1	1.4DL+1.7LL	69.077	0
Base	D1	1.4DL	69.077	0
Base	D1	1.05DL+1.275LL+1.275WQX Max	69.077	0
Base	D1	1.05DL+1.275LL+1.275WQX Min	69.077	0
Base	D1	1.05DL+1.275LL-1.275WQX Max	69.077	0
Base	D1	1.05DL+1.275LL-1.275WQX Min	69.077	0
Base	D1	1.05DL+1.275LL+1.275WQY Max	69.077	0
Base	D1	1.05DL+1.275LL+1.275WQY Min	69.077	0
Base	D1	1.05DL+1.275LL-1.275WQY Max	69.077	0
Base	D1	1.05DL+1.275LL-1.275WQY Min	69.077	0
Base	D1	1.05DL+1.275WQX Max	69.077	0
Base	D1	1.05DL+1.275WQX Min	69.077	0
Base	D1	1.05DL-1.275WQX Max	69.077	0
Base	D1	1.05DL-1.275WQX Min	69.077	0
Base	D1	1.05DL+1.275WQY Max	69.077	0
Base	D1	1.05DL+1.275WQY Min	69.077	0
Base	D1	1.05DL-1.275WQY Max	69.077	0
Base	D1	1.05DL-1.275WQY Min	69.077	0
Base	D1	0.9DL+1.3WQX Max	69.077	0
Base	D1	0.9DL+1.3WQX Min	69.077	0
Base	D1	0.9DL-1.3WQX Max	69.077	0
Base	D1	0.9DL-1.3WQX Min	69.077	0
Base	D1	0.9DL+1.3WQY Max	69.077	0
Base	D1	0.9DL+1.3WQY Min	69.077	0
Base	D1	0.9DL-1.3WQY Max	69.077	0
Base	D1	0.9DL-1.3WQY Min	69.077	0

Figure: 4.32 base mass displacement 2020

CHAPTER 5
RESULT AND DISCUSSION

5.1 Introduction

This research clearly demonstrates that BNBC 2020 is significantly more advanced, modern, and safety-focused compared to BNBC 2006. The structural analysis of the 45-storey building based on both codes revealed notable differences that provide relevant guidance for future structural designs.

5.2 Result

Safety and Stability:

Due to higher base shear and controlled story drift values under BNBC 2020, the overall stability of the building is improved. This makes the structure more secure during earthquakes or other natural disasters.

Structural Modification:

The increase in concrete and reinforcement quantities under BNBC 2020 leads to a stronger structural system, though it may increase construction costs. However, this ensures greater durability and sustainability of the building.

Design Flexibility:

With the inclusion of a performance-based design approach, BNBC 2020 allows for more flexibility, especially for future high-rise and complex buildings.

Real-Life Impact:

While BNBC 2020 may lead to higher initial construction costs, safety and life protection should be prioritized. The improved design standards support a more sustainable path for future urban development.

Table: 5.5 analysis result

Load Case/Combo	FX kip	FY kip	FZ kip	MX kip-ft	MY kip-ft	MZ kip-ft	X ft
Dead	0	-0.0001191	154852.224	9562882.0909	-13812763	-0.0126	0
Live	0	1.232E-05	50235.103	3027990.1447	-4417214	-3.109E-05	0
FLOOR FINISH	0	-1.207E-05	24381.818	1497599.6925	-2178251	-0.0014	0
PERTION WALL	0	-9.274E-05	43979.972	2806928.78	-3998474	-0.0095	0
ROOF LIVE LOAD	0	0	1074.179	67661.2236	-96200.9683	-0.0002	0
EQX	-12442.059	0.0003979	-1.366E-05	-0.1798	-3886256	856364.4469	0
EQY	-12442.059	0.0003979	-1.366E-05	-0.1798	-3886256	856364.4469	0
WQX 1	0	-5364.149	0	1381458.759	0.0043	-479554.9355	0
WQX 2	4090.111	-0.000106	0	0.0479	1053348.2588	-278809.2431	0
WQX 3	2.207E-05	-4023.112	0	1036094.0945	0.0119	-467566.0107	0
WQX 4	-1.786E-05	-4023.112	0	1036094.044	-0.0055	-251766.3926	0
WQX 5	3067.583	-0.0001123	0	0.0506	790011.1991	-271839.0219	0
WQX 6	3067.583	-4.668E-05	0	0.0212	790011.189	-146374.8428	0
WQX 7	-3067.583	-4023.112	0	1036094.0334	-790011.1909	-150559.2693	0
WQX 8	3067.583	-4023.112	0	1036094.1051	790011.1973	-568773.134	0
WQX 9	-2302.732	-3020.016	0	777761.2843	-593035.057	-241107.5033	0
WQX 10	-2302.732	-3020.016	0	777761.2244	-593035.0776	15067.8537	0
WQX 11	2302.732	-3020.016	0	777761.3382	593035.0824	-555046.7111	0
WQX 12	2302.732	-3020.016	0	777761.2783	593035.0618	-298871.3541	0
WQY 1	-5550.268	0.0001399	0	-0.0632	-1390351	378343.2702	0
WQY 2	0	-7279.133	0	1823435.0938	0.0056	-650754.5333	0
WQY 3	-4162.701	6.213E-05	0	-0.0282	-1042763	198630.204	0
WQY 4	-4162.701	0.0001477	0	-0.0665	-1042763	368884.7014	0
WQY 5	2.872E-05	-5459.35	0	1367576.3532	0.0156	-634485.6023	0
WQY 6	-2.37E-05	-5459.35	0	1367576.2874	-0.0072	-341646.1976	0
WQY 7	-4162.701	5459.35	0	-1367576	-1042763	771823.3526	0
WQY 8	-4162.701	-5459.35	0	1367576.273	-1042763	-204308.4473	0
WQY 9	-3124.801	4098.152	0	-1026594	-782767.4496	405567.4854	0
WQY 10	-3124.801	4098.152	0	-1026594	-782767.4767	753196.6413	0
WQY 11	-3124.801	-4098.152	0	1026593.9613	-782767.4434	-327182.119	0
WQY 12	-3124.801	-4098.152	0	1026593.8832	-782767.4705	20447.0369	0
1.4D	0	-0.0003135	312499.62	19414375	-27985284	-0.0329	0
DL+LL	0	-0.0002139	274523.296	16963062	-24502904	-0.0237	0
1.2DL+1.6LL	0	-0.0002527	349951.669	21593935	-31208851	-0.0286	0
1.2DL+1.6LL+0.5LR	0	-0.0002501	348770.072	21519508	-31103030	-0.0283	0
1.2DL+1.6LR+LL	0	-0.0002601	319810.607	19777141	-28558522	-0.0286	0
1.2DL+0.5LR+1.6WQX Max	6544.177	-0.0003445	268393.906	18885057	-22350130	24108.5376	0
1.2DL+0.5LR+1.6WQX Min	-4908.133	-8582.639	268393.906	16674723	-25299505	-910037.0427	0
1.2DL+0.5LR-1.6WQX Max	6544.177	-0.0003445	268393.906	18885057	-22350130	24108.5376	0
1.2DL+0.5LR-1.6WQX Min	-4908.133	-8582.639	268393.906	16674723	-25299505	-910037.0427	0
1.2DL+0.5LR+1.6WQY Max	4.853E-05	8734.96	268393.906	19592219	-24035487	1234917.3359	0
1.2DL+0.5LR+1.6WQY Min	-8880.428	-11646.613	268393.906	14486601	-26260048	-1041207	0
1.2DL+0.5LR-1.6WQY Max	8880.428	11646.613	268393.906	18862845	-21810926	1041207.2249	0
1.2DL+0.5LR-1.6WQY Min	-4.338E-05	-8734.96	268393.906	13757227	-24035487	-1234917	0
1.2DL+L+EQX	-12442.059	0.0001415	318091.92	19668883	-32290857	856364.4187	0

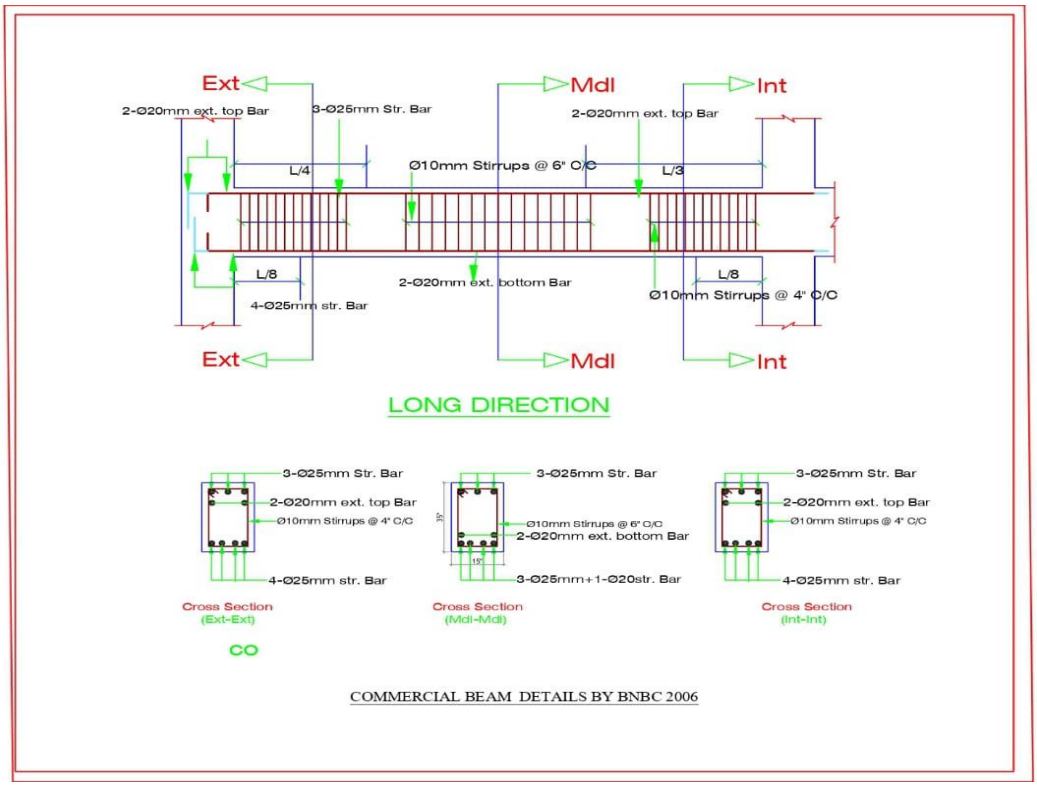


Figure: 5.1 Beam details BNBC 2006

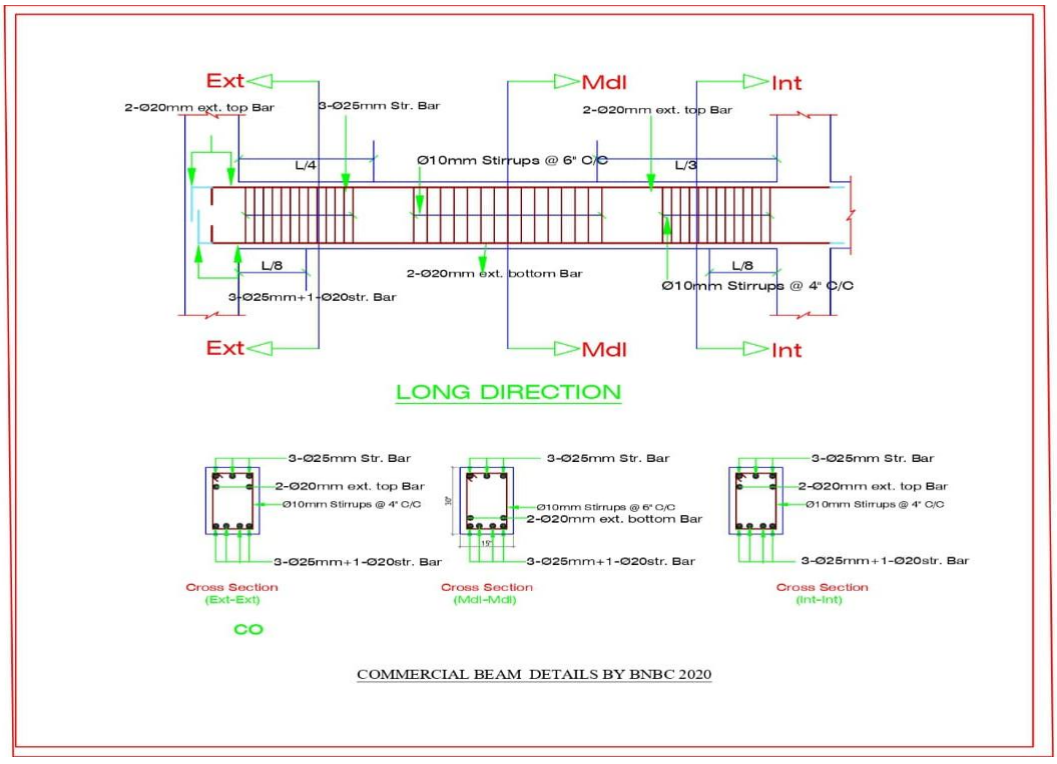


Figure: 5.2 Beam details BNBC 2020

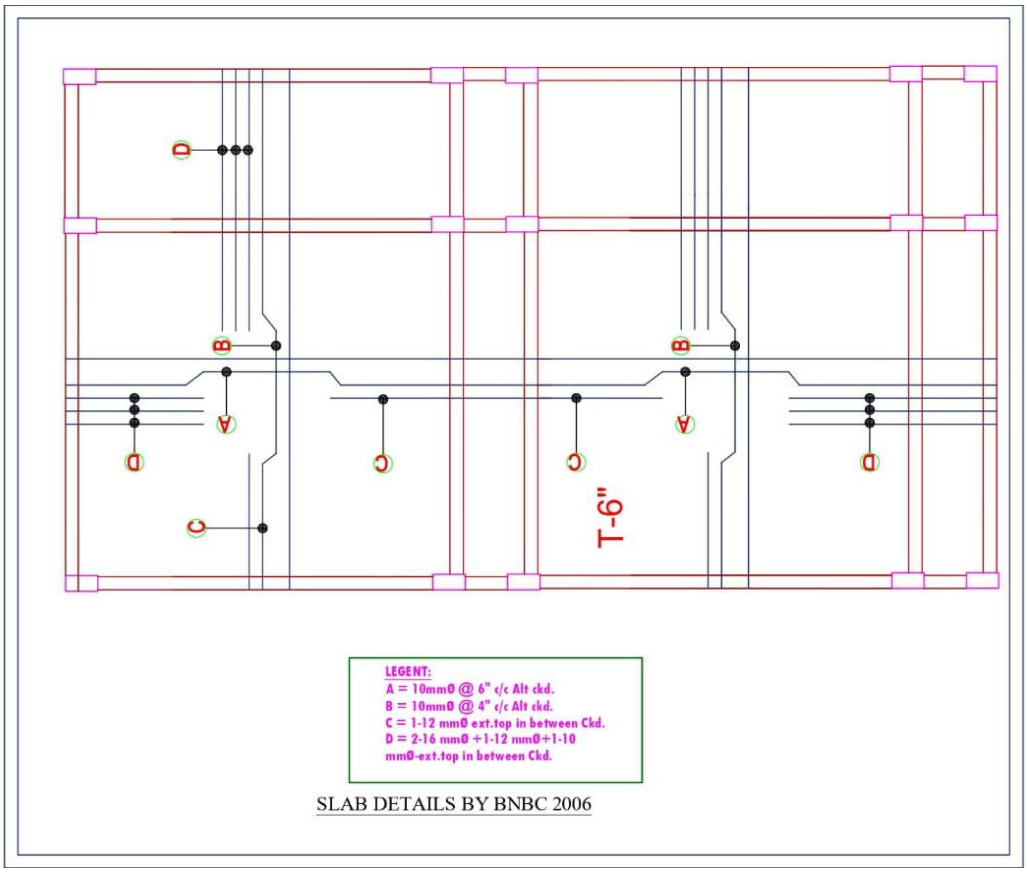


Figure: 5.3 slab datails BNBC 2006

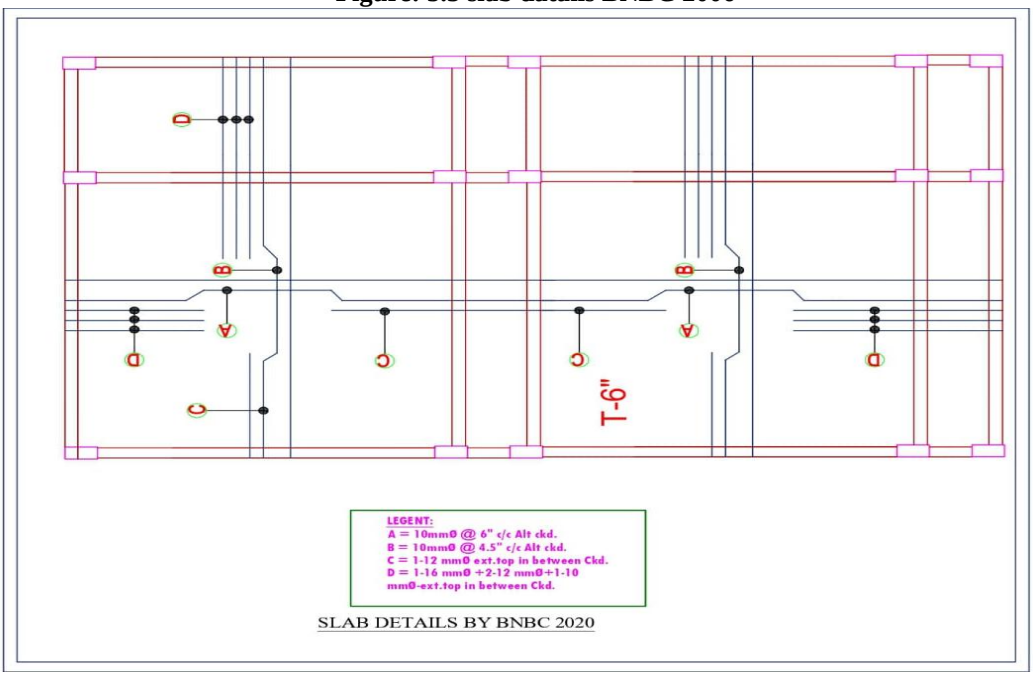


Figure: 5.4 slab datails BNBC 2020

5.3 Discussion

Base Shear:

Base shear is the total load applied at the base of the building during an earthquake. The BNBC 2020 code uses an improved method for seismic load calculation, resulting in higher base shear compared to the BNBC 2006 code. This ensures better safety for the building during seismic events.

Story Drift:

Story drift refers to the horizontal displacement between building stories. BNBC 2020 provides a more accurate calculation of this parameter, ensuring better stability of the building. The drift was found to be lower in the 2020 code, indicating better stability under seismic loads.

Story Displacement:

Story displacement refers to the horizontal shift of each floor of the building. Different load calculation methods for wind and seismic loads are used in both BNBC 2006 and 2020. In BNBC 2020, displacement values were lower, indicating that the building is more resilient and simplified in design.

Reinforcement Requirements:

The reinforcement requirements increased under BNBC 2020 due to the enhanced seismic load calculations. Additional reinforcement ensures the structural safety of the building under seismic forces.

Table: 5.1 steel strength

2. Steel Strength (fy)

Code	Rebar Type	Yield Strength (fy)	Notes
BNBC 2006	Grade 60	413 MPa (60 ksi)	Mild steel or Grade 60
BNBC 2020	Grade 60+	500 MPa/550 MPa	High strength TMT

Difference: In BNBC 2020 code- ductility, bend test and seismic detailing are strict requirement.

Construction Cost:

Following BNBC 2020 guidelines could potentially increase the construction cost due to the use of stronger materials and advanced safety features. However, the long-term safety and durability of the building justify this additional cost.

CHAPTER 6
CONCLUSION & RECOMMENDATION

6.1 Conclusion

This study analyzed the structural performance of a 45-storey building using BNBC 2006 and BNBC 2020 codes. The results show that BNBC 2020 is more advanced, realistic, and safety-oriented compared to the older version. Significant differences were observed in terms of base shear, story drift, displacement, and reinforcement. Buildings designed under the 2020 code are better suited to withstand seismic and other natural forces. Although the construction cost may increase slightly, it represents a sustainable investment for the future.

6.2 Recommendations

Engineers should fully comply with BNBC 2020 and develop a deep understanding of its provisions. Performance-based design methods should be more widely adopted in high-rise building designs. Awareness should be raised among building owners and contractors about the importance of following code.

provisions.

Special training or courses on BNBC 2020 should be introduced for engineering students. Government and private organizations should actively monitor the implementation of BNBC 2020. This study concludes that as building codes evolve, the principles of structural design must also adapt. With proper implementation, we can move toward a safer and more sustainable urban future.

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Summary: Analyzes seismic responses of various plan configurations, highlighting the vulnerabilities of irregular structures. Science Publishing Group+4ResearchGate+4Science Publishing Group+4

[9] Performance Assessment of Residential Building for Different Plan Configurations in Different Seismic Zones of Bangladesh Using ETABS, Authors: J. M. Raisul Islam Shohag, Kowshik Mozumder, Published: November 2022, DOI: 10.11648/j.jccee.20220705.12

Summary: Evaluates the impact of plan irregularities and seismic zoning on building performance. mySciencePG+2Science Publishing Group+2Science Publishing Group+2

[10] A Comparative Study of Lateral Load Analysis Considering Two BNBC Codes Using ETABS Software

Authors: Faruque Abdullah, Zahidul Islam, Mohammad Abu Turab Asif, Sumon Ali, Published: August 2021, DOI: 10.11648/j.ajce.20210904.13

Summary: Compares lateral load effects under BNBC 1993 and BNBC 2020, demonstrating increased demands in the latter.



End