SEISMIC ANAYLYSIS OF REINFORCED CONCRETE MOMENT RESISTING FRAME SYSTEMS ACCORDING TO BNBC 2020

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Fall 2025

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BOARD OF EXAMINERS

The thesis titled "Comparative Seismic Performance Analysis of a RC Building in the Four Seismic Zones of Bangladesh Using ETABS 2022 Based on BNBC 2020" submitted by Student-Name, Obaidullah CE 2203027027, Jewel CE 2202026092, Shohel Rana CE 2103024043, Nazmul Huda CE 2203027120, Mehidi Hasan CE 2203027020, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering on Date-of-Defense.

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DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

to

“--------Parents-------”

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ABSTRACT

Bangladesh is located in a seismically active region, making the seismic design of reinforced concrete (RC) structures a critical concern for structural safety and resilience. This study presents a comparative seismic performance analysis of a typical (G+M+08) residential RC building across all four seismic zones of Bangladesh as defined in the Bangladesh National Building Code 2020 (BNBC 2020). The building was modeled and analyzed using ETABS 2022 software under equivalent static analysis method. Seismic zone parameters and wind loads were applied for four representative locations: Jessore (Zone-1), Rajbari (Zone-2), Tangail (Zone-3), and Sylhet (Zone-4).

Key structural responses—including story displacement, inter-story drift, base shear, and lateral stiffness—were evaluated and compared across zones. Results indicate that seismic demands increase progressively from Zone-1 to Zone-4, with Sylhet (Zone-4) showing the highest values in displacement and base shear. The study also examines the performance of different framing systems—OMRF, IMRF, and SMRF—under zone-specific loading conditions.

The findings emphasize the importance of zone-specific design approaches and the adoption of appropriate lateral load-resisting systems to ensure earthquake-resistant construction in Bangladesh. All structural drawings were prepared using AutoCAD for accuracy and compliance with design standards.

Keywords: BNBC 2020, ETABS, Seismic Zones, RC Building, Story Drift, Base Shear, Earthquake Resistant Design, Bangladesh.

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CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

Bangladesh lies at the junction of three active tectonic plates—the Indian, Eurasian, and Burmese plates—making it highly vulnerable to seismic events. Historical and recent earthquakes highlight the urgent need for earthquake-resistant design in urban infrastructure. The Bangladesh National Building Code 2020 (BNBC 2020) provides updated guidelines for seismic design, dividing the country into four seismic zones based on hazard levels. Reinforced concrete (RC) buildings are predominant in urban areas, and their performance under seismic loads are a major concern for structural safety and disaster resilience.

1.2 Problem Statement

Although BNBC 2020 delineates seismic zones, there is a lack of comparative studies that quantify the variation in structural behavior and design forces for a typical RC building across these zones. Practitioners need clear, data-driven insights to understand how seismic demands change from low-risk to high-risk zones, which is essential for cost-effective and safe construction practices.

1.3 Research Objectives

The primary objectives of this study are:

· To model a typical (G+M+08) residential RC building using ETABS 2022 in compliance with BNBC 2020.

· To analyze the building's seismic performance under the seismic load provisions of all four zones: Zone-1 (Jessore), Zone-2 (Rajbari), Zone-3 (Tangail), and Zone-4 (Sylhet).

· To compare key structural responses: story displacement, inter-story drift, base shear, and member forces.

· To provide zone-specific insights and recommendations for earthquake-resistant design in Bangladesh.

1.4 Scope and Limitations

· Scope: A (G+M+08) residential RC moment-resisting frame building is analyzed

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using the Equivalent Static Method as per BNBC 2020. The study considers four seismic zones and corresponding wind loads.

· Limitations: Dynamic analysis methods (Response Spectrum, Time History) are not included. Soil-structure interaction is not considered. The study focuses on linear elastic analysis for force determination.

1.5 Organization of the Thesis

This thesis is structured into five chapters: Introduction, Literature Review, Methodology, Results and Discussion, and Conclusions and Future Works. Each chapter systematically addresses the research objectives and presents findings in a coherent manner.

`

CHAPTER 2

Literature Review

2.1 Introduction

This chapter reviews previous research on seismic analysis, BNBC guidelines, and the performance of RC buildings in Bangladesh and similar regions. It establishes the foundation for the current study and identifies gaps in existing literature.

2.2 Seismic Zoning and BNBC 2020

BNBC 2020 classifies Bangladesh into four seismic zones:
· Zone-I: Low seismic intensity
· Zone-II: Moderate seismic intensity
· Zone-III: Severe seismic intensity
· Zone-IV: Very severe seismic intensity

The code provides zone-specific seismic coefficients, site factors, and load combinations. Earlier versions (BNBC 1993, 2006) were found to underestimate lateral loads compared to international standards such as ASCE 7. BNBC 2020 aims to address these shortcomings with updated hazard maps and design provisions.

Rahman & Uddin (2023)
Analyzed seismic zonation and structural safety in Bangladesh
Highlighted need for updated building codes in high-risk areas
Islam & Hossain (2022)
Compared BNBC 2006 vs. BNBC 2020 for RC buildings
Found BNBC 2020 provides more conservative seismic loads
Al Dughaishi et al. (2023)
Studied seismic performance of dual systems in high-rise buildings
Recommended shear wall-frame combinations for better performance

2.3 Previous Studies on Seismic Analysis in Bangladesh

Several studies have analyzed RC buildings under seismic and wind loads using software like ETABS, STAAD.Pro, and SAP2000. Research highlights that:
· Seismic demands increase with building height and seismic zone intensity.
· Wind loads significantly influence tall buildings, especially in coastal regions.
· Dual systems (moment frames + shear walls) improve performance but require careful placement to avoid torsional effects.
· Most studies focus on Dhaka or Chittagong; comparative multi-zone analyses are Limited.

2.4 Performance of RC Buildings under Lateral Loads

RC moment-resisting frames (OMRF, IMRF, SMRF) are common in Bangladesh. Studies show that:
· SMRF systems provide better ductility and energy dissipation.
· Shear walls reduce story drift but may increase stiffness irregularity if not properly configured.
· Inter-story drift and displacement are critical parameters for serviceability and safety

2.5 Summary

The literature confirms the necessity of zone-specific seismic design and the effectiveness of advanced analysis tools like ETABS. However, a comprehensive comparison of all four BNBC 2020 seismic zones for a typical RC building remains unexplored, which this study aims to address.

`

CHAPTER 3

Methodology

3.1 Introduction

This chapter describes the research methodology, including building modeling, material properties, load assignments, and analysis procedures using ETABS 2022. The approach follows BNBC 2020 guidelines for seismic and wind load analysis

3.2 Building Description and Modeling

· Building Type: Residential RC building (G+M+08)
· Floor Height: 10’ feet (typical)
-Mezzanine floor Height 8’feet
· Plan Dimensions: Length 60’-8” with 42’-8”
-Height of structure =100’-00” from base to roof
· Structural System: Moment-resisting frame (OMRF/IMRF/SMRF considered)
· Software: ETABS 2022 for analysis, AutoCAD for drafting

3.3 Materials Properties and section details

Table 3.1: Material Strength Parameters
SL Component Grade/Strength
1 Column, Shear Wall, Pile Cap 4500 psi (M30)
2 Slab, Beam, Grade Beam 3500 psi (M25)
3 Lintel, Sunshade, Drop Wall 3000 psi (M20)
4 Rebar (Flexural) 60,000 psi (415 MPa)

Table 3.2: Member Sizes

Member Type Sizes (inch)
Column 10×25, 10×30, 12×20, 15×20, 15×25, 20×25
Beam 10×21, 10×24, 12×21
Slab Thickness 5 inch
Shear Wall 8 inch thick

`

2.0) Material Data

The following strength parameter is considered for design of building

SL/No	Strength	
01	Column, Shear Wall & Pile Cap Concrete Grade	4500 psi
02	Slab, Beam & Grade Beam Concrete Grade	3500 psi
03	Underground water reservoir	3500 psi
04	Lintel, Su25"nshade, Drop wall fins, false slab etc	3000 psi
05	Flexural strength of all Rebar except Shear Wall	72500 psi
06	Flexural strength of Rebar for Shear wall	60000 psi
07	Column size C(10”X25”),C(10”X30”),C(12”X20”)C(15”X20”) C(15X25),C(15X25),C(20X25)	
08	Floor Beam size FB(10X21),FB(10X24),FB(12X21)	
09	Gread Beam GB(12X18)	

Table 3.3: Load Assignments and Seismic Parameters

Parameters	Zone-1	Zone-2	Zone-3	Zone-4
Ss	0.3	0.5	0.7	0.9
S1	0.12	0.2	0.28	0.36

`

Seismic Parameter (BNBC 2020)

Zone Location Ss S1 Soil Type Site Coeff.

1 Jessore 0.30 0.12 SC 1.15

2 Rajbari 0.50 0.20 SC 1.15

3 Tangail 0.70 0.28 SC 1.15

4 Sylhet 0.90 0.36 SC 1.15

Soil Type	Zone-1	Zone-2	Zone-3	Zone-4
SA	1	1	1	1
SB	1.2	1.2	1.2	1.2
SC	1.15	1.15	1.15	1.15
SD	1.35	1.35	1.35	1.35

Table 3.4: Basic Wind Speed

SL Location Wind Speed (m/s) Wind Speed (mph)

Basic Wind Speeds V,for selected Location in Bangladesh			
S/L	Location	Basic wind speed (m/s)	Basic wind speed (mph)
1	Jessore	64.1	143.38
2	Rajbari	59.1	132.20
3	Tangail	50.6	113.189
4	Sylhet	61.1	136.6768

Table 3.5: Assigned Loads

	Load type	Value
Assigned Load	Wind Load Zone-specific	
	LL(Shell/slab)	42 psf
	Seismic Load Zone-specific	
	PW (slab,without roof)	25.06 psf
	FF (slab all)	25.06 psf
	Parapet/Outer wall (roof)	0.15 k/ft
	Exterior wall (other floors)	1 k/ft
	Interior wall (other floors)	

3.5 Analysis Procedure in ETABS 2022

1. Modeling: 3D model created with defined materials, sections, and supports.
2. Load Patterns: Dead, Live, Wind, and Seismic load patterns assigned.
3. Load Combinations: As per BNBC 2020.
4. Analysis Type: Equivalent Static Analysis.
5. Output Extraction: Story displacement, drift, base shear, and stiffness.

3.6 Summary

The methodology ensures a systematic and code-compliant analysis, enabling a fair comparison of structural performance across four seismic zones.

Table 3.6: Basic Wind Speeds, V, for Selected Locations in Bangladesh.

Table 6.2.8: Basic Wind Speeds, *V*, for Selected Locations in Bangladesh

Location	Basic Wind Speed (m/s)	Location	Basic Wind Speed (m/s)
Angarpota	47.8	Lalmonirhat	63.7
Bagerhat	77.5	Madaripur	68.1
Bandarban	62.5	Magura	65.0
Barguna	80.0	Manikganj	58.2
Barisal	78.7	Meherpur	58.2
Bhola	69.5	Maheshkhali	80.0
Bogra	61.9	Moulvibazar	53.0
Brahmanbaria	56.7	Munshiganj	57.1
Chandpur	50.6	Mymensingh	67.4
Chapai Nawabganj	41.4	Naogaon	55.2
Chittagong	80.0	Narail	68.6
Chuadanga	61.9	Narayanganj	61.1
Comilla	61.4	Narsinghdi	59.7
Cox's Bazar	80.0	Natore	61.9
Dahagram	47.8	Netrokona	65.6
Dhaka	65.7	Nilphamari	44.7
Dinajpur	41.4	Noakhali	57.1
Faridpur	63.1	Pabna	63.1
Feni	64.1	Panchagarh	41.4
Gaibandha	65.6	Patuakhali	80.0
Gazipur	66.5	Pirojpur	80.0
Gopalganj	74.5	Rajbari	59.1
Habiganj	54.2	Rajshahi	49.2
Hatiya	80.0	Rangamati	56.7
Ishurdi	69.5	Rangpur	65.3
Joypurhat	56.7	Satkhira	57.6
Jamalpur	56.7	Shariatpur	61.9
Jessore	64.1	Sherpur	62.5
Jhalakati	80.0	Sirajganj	50.6
Jhenaidah	65.0	Srimangal	50.6
Khagrachhari	56.7	St. Martin's Island	80.0
Khulna	73.3	Sunamganj	61.1
Kutubdia	80.0	Sylhet	61.1
Kishoreganj	64.7	Sandwip	80.0

3.4.1: Column Layout plan

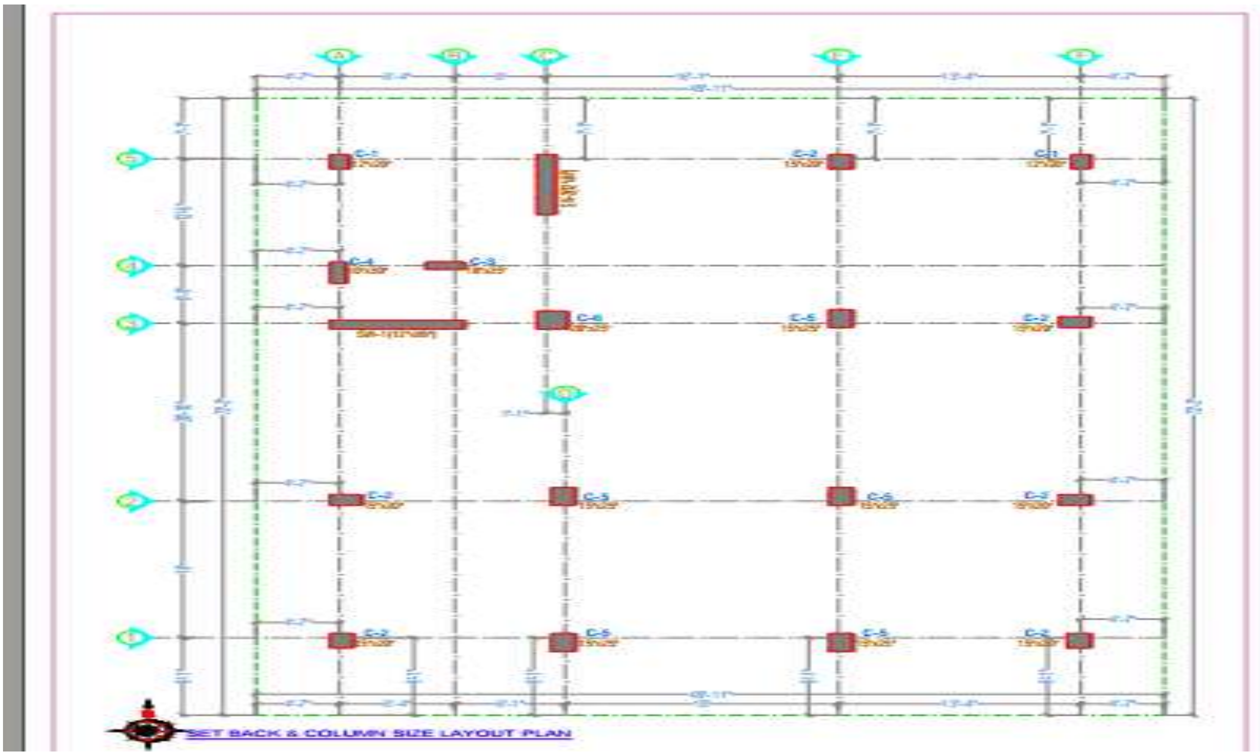

Fig: Column Layout Plan

3.4.2: Column Schedule Plan

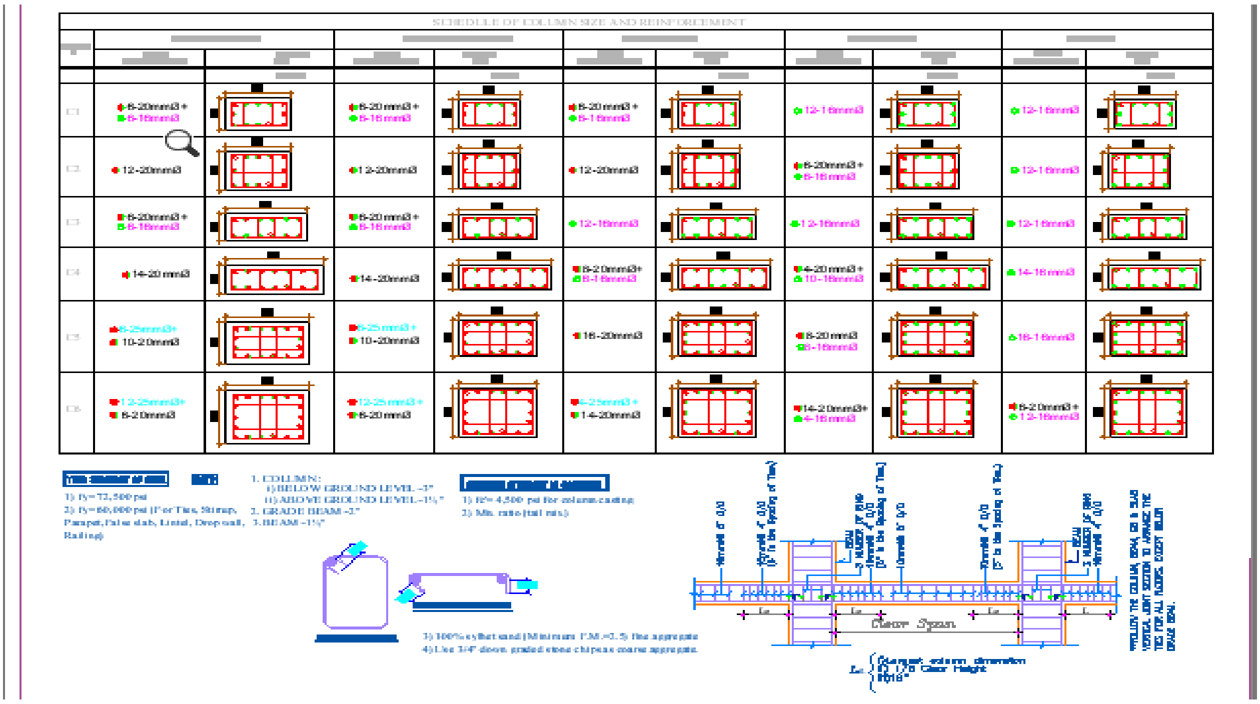

Fig: Column Schedule Plan

3.4.3: Beam Size Layout Plan

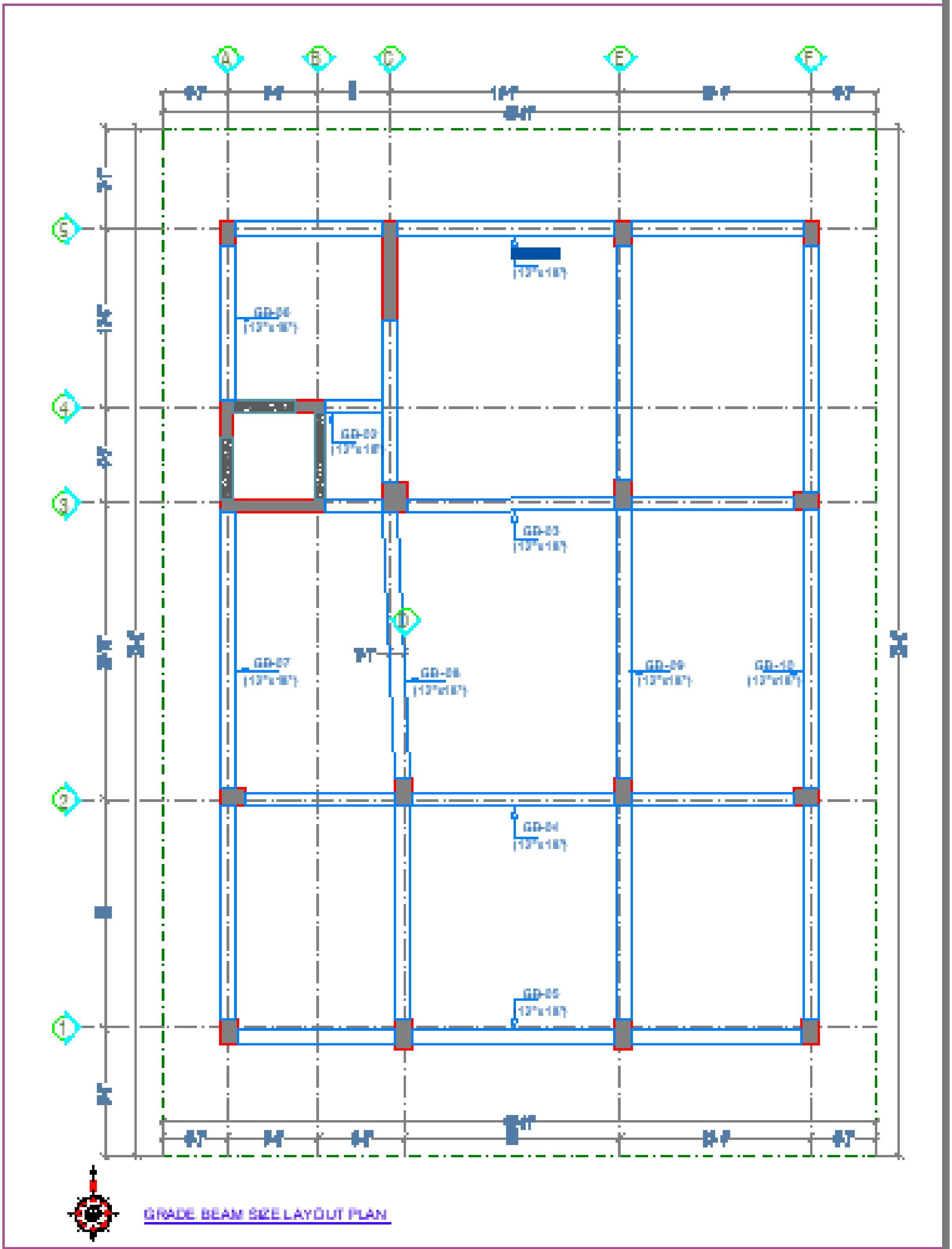

Fig: Beam Size Layout Plan

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3.4.4: Bangladesh Seismic Zone

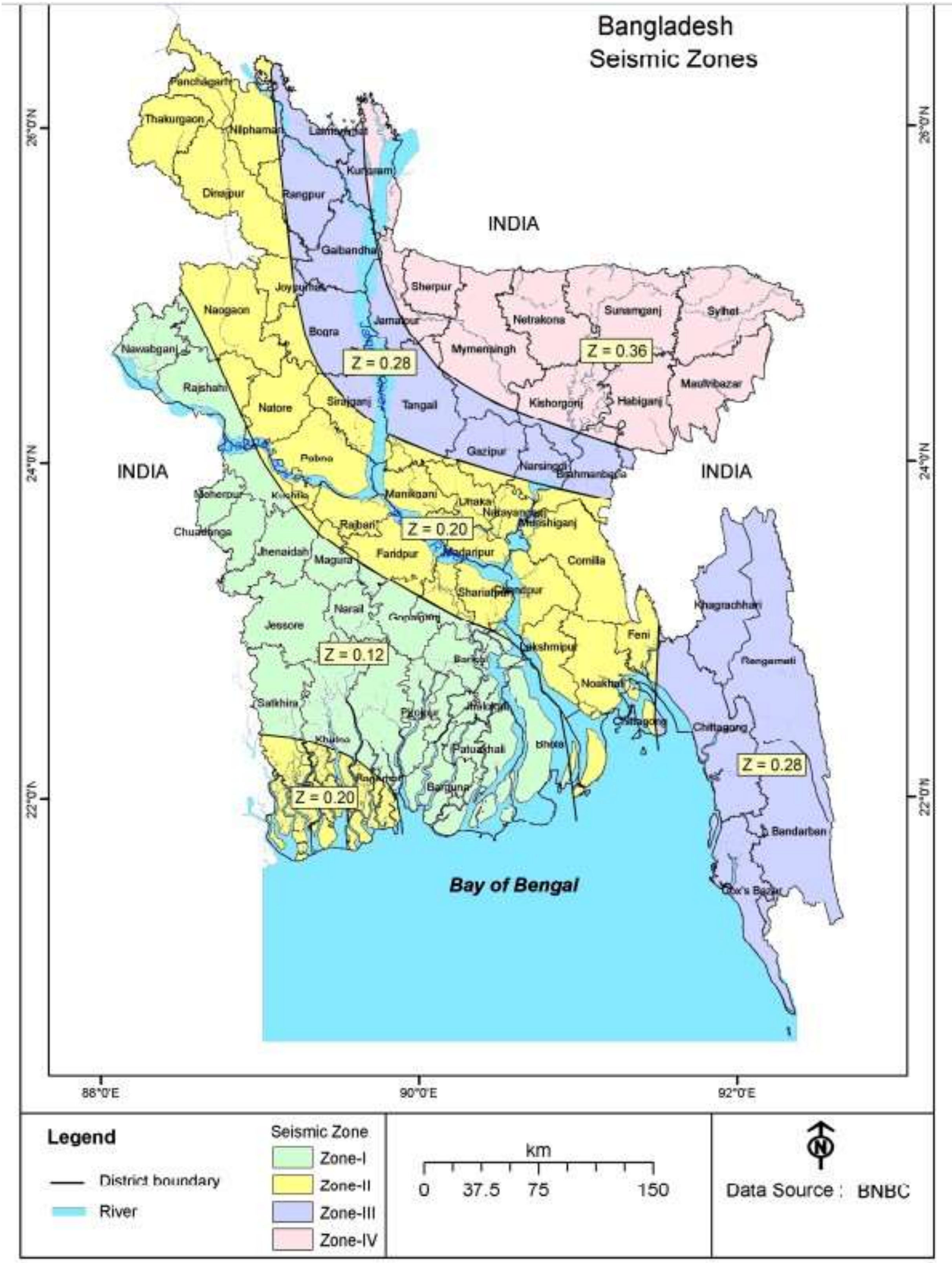

Fig: Bangladesh Seismic Zone

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CHAPTER 4

Results and Discussion

4.1 Introduction

This chapter presents the analysis results from ETABS 2022 for the four seismic zones. Key parameters are compared through tables and graphs, followed by a detailed discussion.

4.2 Story Displacement Comparison

Table 4.1: Maximum Story Displacement (in)

System Zone-1 (Jessore) Zone-2 (Rajbari) Zone-3 (Tangail) Zone-4 (Sylhet)

OMRF 2.51 2.13 2.13 2.28

IMRF 2.42 2.13 1.56 2.28

SMRF –2.43 2.13 1.56 2.28

Observation: Displacement increases in higher zones, with Sylhet (Zone-4) showing the highest values.

Table-4.1: Zone Analysics Maximum drifts value

	Zone-1	Zone-2	Zone-3	Zone-4
OMRF	7.19	9.77	6.85	8.81
IMRF	9.72	9.98	9.5	9.46
SMRF	8.67	9.26	9.54	9.809

Table- 4.1: Zone Analysics Maximum drifts value

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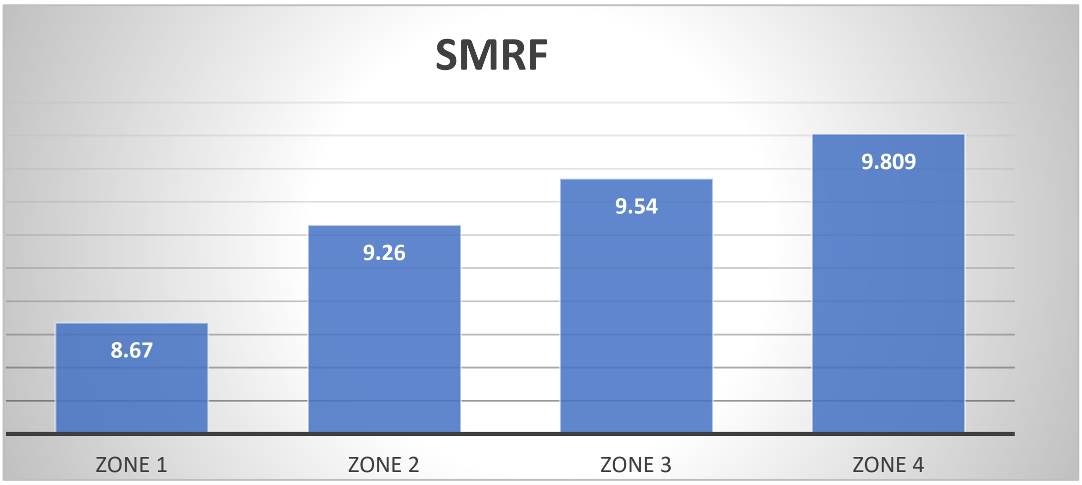
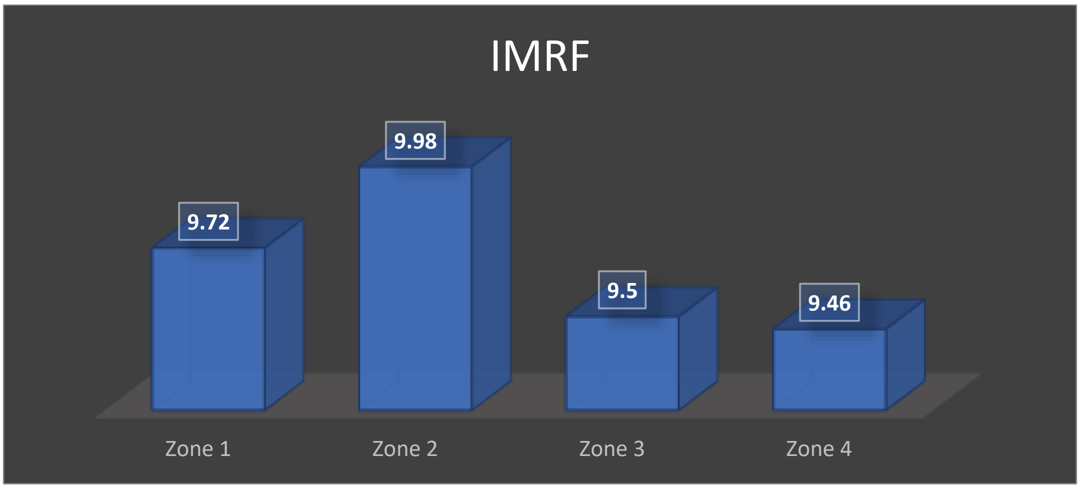
4.2.1: SMRF Maximum drifts Diagram



4.2.2: IMRF Maximum drifts Diagram



4.2.3: OMRF Maximum drifts Diagram

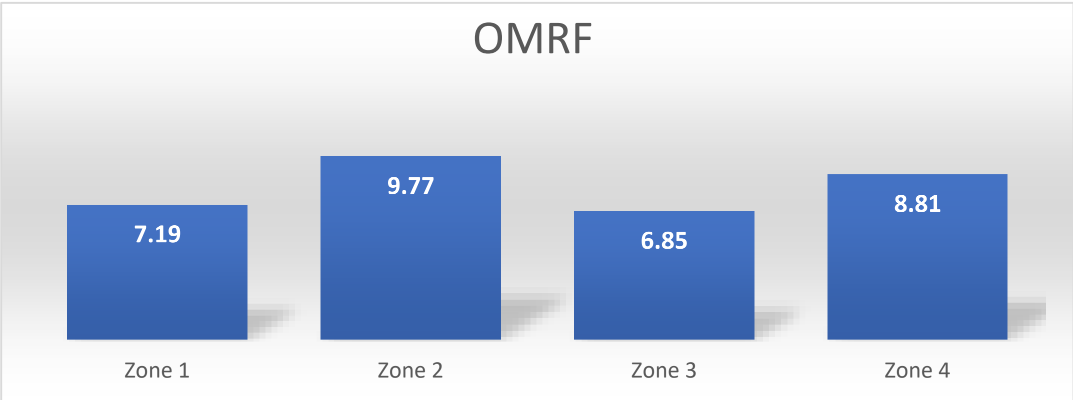


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Table-4.2: Zone Analysics Maximum displacement value

	Zone-1	Zone-2	Zone-3	Zone-4
OMRF	2.51	2.13	2.13	2.28
IMRF	2.42	2.13	1.56	2.28
SMRF	2.43	2.13	1.56	2.28

Table- 4.2: Zone Analysics Maximum drifts value

4.3.1: OMRF Maximum displacement Diagram

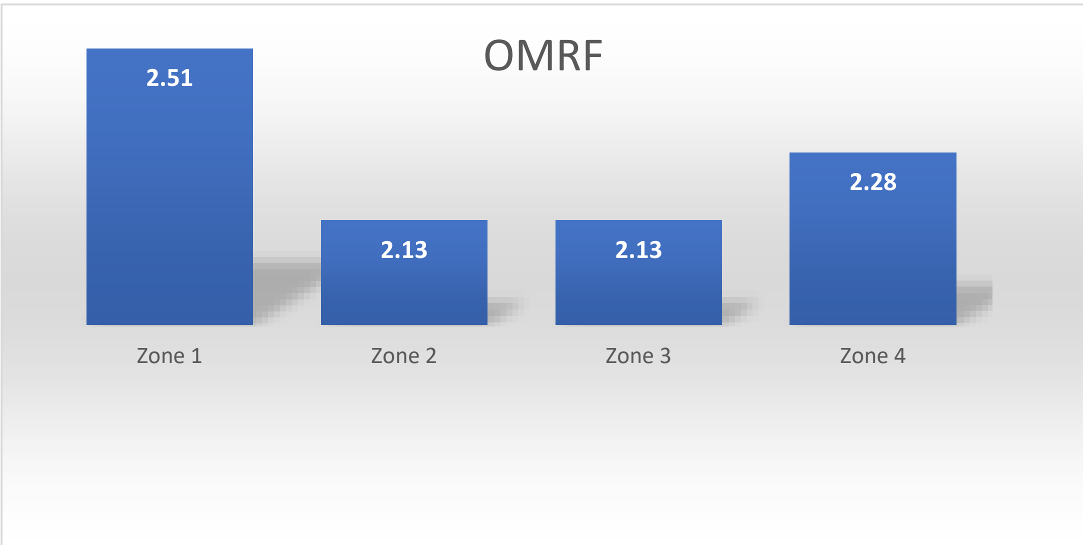

Fig: OMRF Maximum displacement Diagram

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4.3.2: IMRF Maximum displacement Diagram

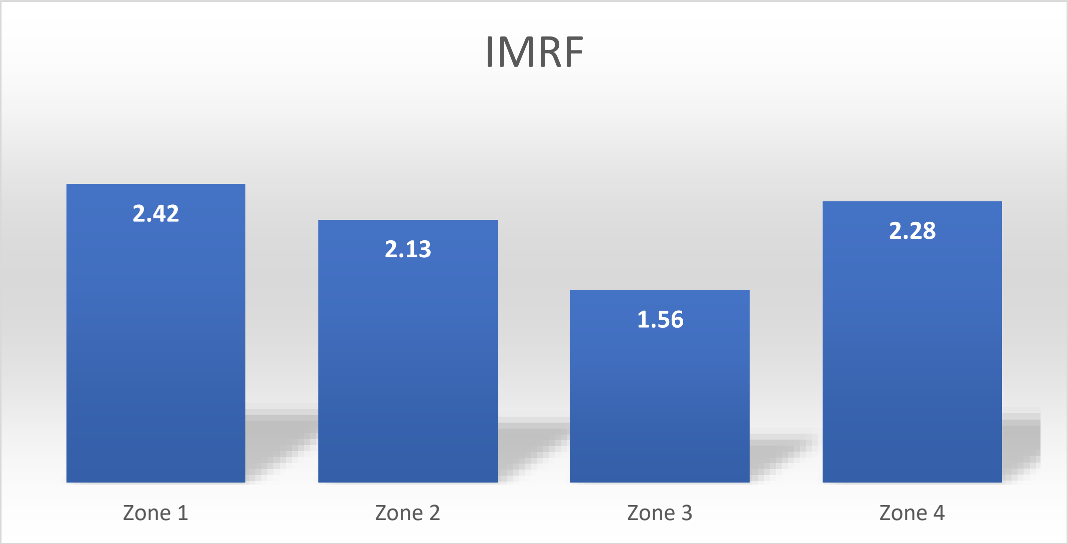

Fig: IMRF Maximum displacement Diagram

4.3.3: SMRF Maximum displacement Diagram

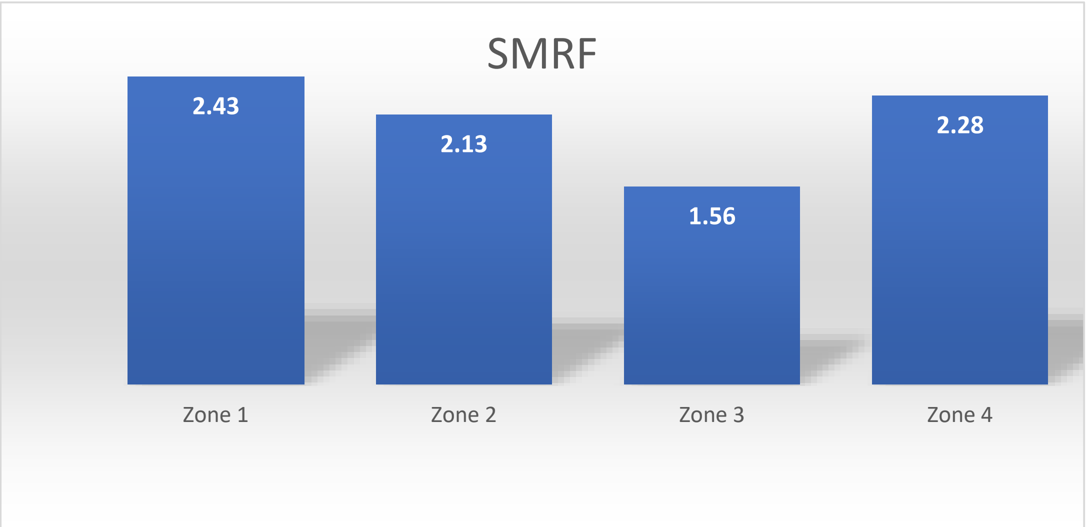

Fig: SMRF Maximum displacement Diagram

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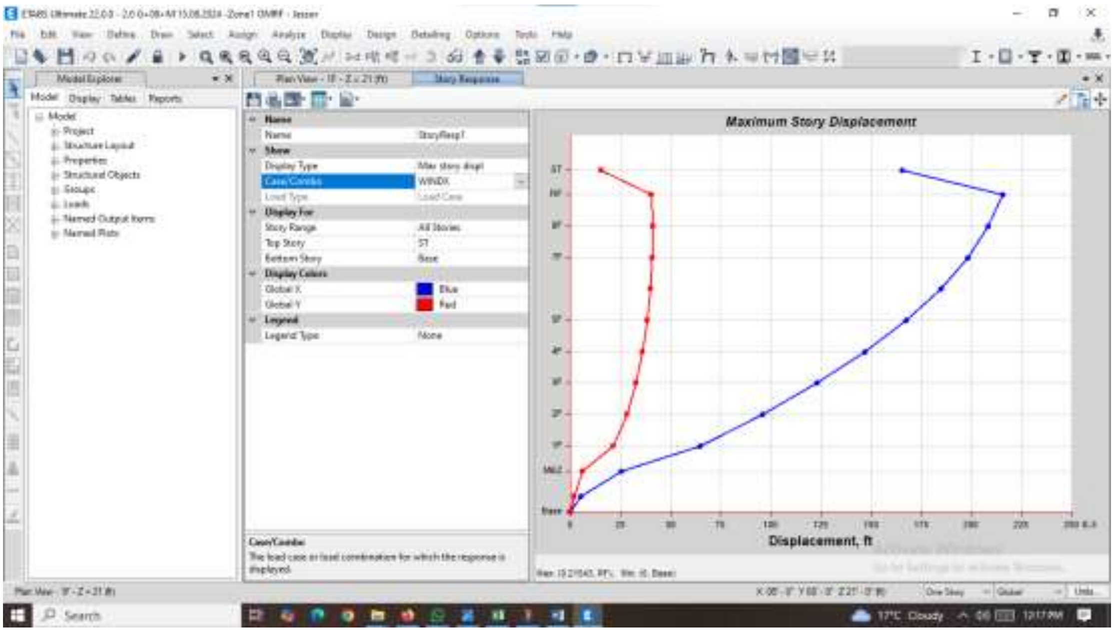
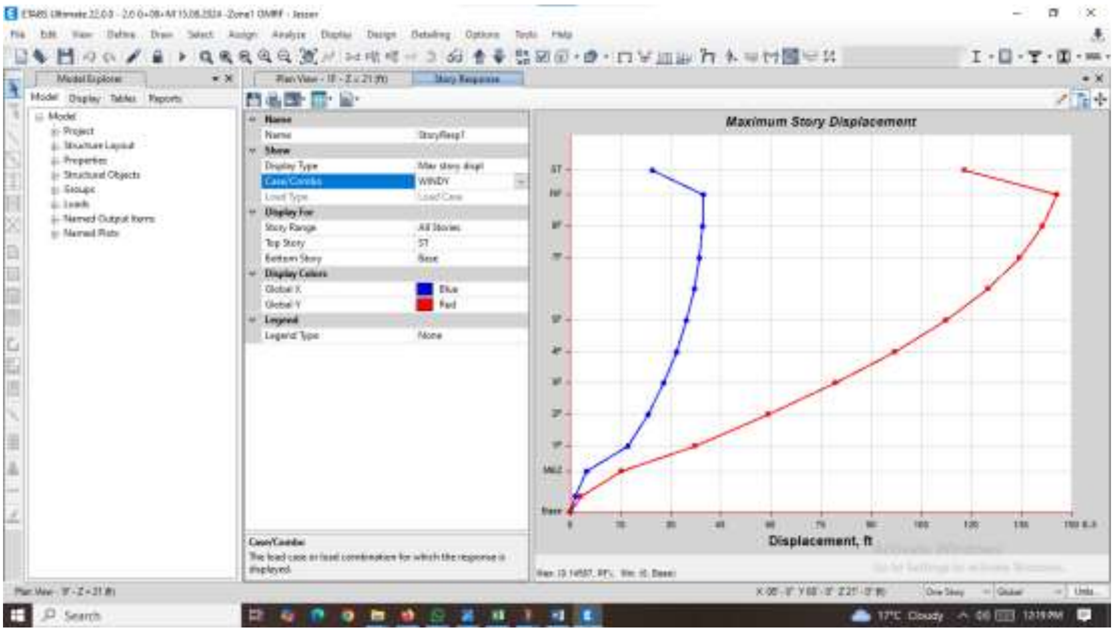
Table 4.3: OMRF Zone 1 Jessore displacement windx, windy value

Story	utput Cas	Case Type	Direction	Maximum	Average	Ratio
ST	WINDY	LinStatic	X	0.29529	0.17008	1.73622
ST	WINDY	LinStatic	Y	1.41426	1.3387	1.05644
RF	WINDY	LinStatic	Y	1.74804	1.48967	1.17344
8F	WINDY	LinStatic	Y	1.6945	1.4376	1.1787
7F	WINDY	LinStatic	Y	1.6135	1.36241	1.1843
6F	WINDY	LinStatic	Y	1.49904	1.25862	1.19102
5F	WINDY	LinStatic	Y	1.34974	1.12487	1.19991
4F	WINDY	LinStatic	Y	1.16643	0.96197	1.21254
3F	WINDY	LinStatic	Y	0.95168	0.77259	1.23179
2F	WINDY	LinStatic	Y	0.71018	0.56207	1.26351
1F	WINDY	LinStatic	X	0.18633	0.03626	5.13951
1F	WINDY	LinStatic	Y	0.4486	0.34048	1.31755
MEZ	WINDY	LinStatic	Y	0.18477	0.14645	1.26165
ST	WINDX	LinStatic	X	1.98339	1.81961	1.09001
RF	WINDX	LinStatic	X	2.51871	2.05081	1.22815
8F	WINDX	LinStatic	X	2.43276	1.95383	1.24513
7F	WINDX	LinStatic	X	2.3125	1.83173	1.26246
6F	WINDX	LinStatic	X	2.15044	1.67783	1.28168
5F	WINDX	LinStatic	X	1.94638	1.4917	1.30481
4F	WINDX	LinStatic	X	1.70194	1.27512	1.33473
3F	WINDX	LinStatic	X	1.41948	1.03142	1.37624
3F	WINDX	LinStatic	Y	0.39112	0.11156	3.50595
2F	WINDX	LinStatic	X	1.10103	0.7655	1.43831
2F	WINDX	LinStatic	Y	0.33745	0.09573	3.52489
1F	WINDX	LinStatic	X	0.74091	0.48352	1.53232
1F	WINDX	LinStatic	Y	0.25762	0.0722	3.56837
MEZ	WINDX	LinStatic	X	0.30481	0.20415	1.49304

4.1.1: OMRF Zone-1 Displacement Windy-X



4.1.2: OMRF Zone-1 Displacement Windy-Y



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<u>**Table 4.4: OMRF Zone 2 Rajbari displacement windx, windy value**</u>

Story	Output Cas	Case Type	Direction	Maximum	Average	Ratio
ST	WINDY	LinStatic	X	2544.135	1464.22	1.737536
ST	WINDY	LinStatic	Y	11891.42	11239.74	1.057979
RF	WINDY	LinStatic	Y	14779.21	12550.29	1.177599
8F	WINDY	LinStatic	Y	14327.69	12112.66	1.182869
7F	WINDY	LinStatic	Y	13643.85	11480	1.188488
6F	WINDY	LinStatic	Y	12676.94	10606.13	1.195246
5F	WINDY	LinStatic	Y	11415.39	9479.67	1.204197
4F	WINDY	LinStatic	Y	9866.349	8107.517	1.216938
3F	WINDY	LinStatic	Y	8051.333	6512.137	1.236358
2F	WINDY	LinStatic	Y	6010.028	4738.488	1.268343
1F	WINDY	LinStatic	X	1598.753	312.1151	5.122317
1F	WINDY	LinStatic	Y	3798.105	2871.194	1.322832
MEZ	WINDY	LinStatic	Y	1561.319	1232.727	1.266557
ST	WINDX	LinStatic	X	1.668672	1.525721	1.093694
RF	WINDX	LinStatic	X	2.138664	1.730155	1.236111
8F	WINDX	LinStatic	X	2.065928	1.648542	1.253185
7F	WINDX	LinStatic	X	1.964002	1.54571	1.270615
6F	WINDX	LinStatic	X	1.82656	1.416005	1.289939
5F	WINDX	LinStatic	X	1.653414	1.259071	1.313202
4F	WINDX	LinStatic	X	1.44594	1.076422	1.343284
3F	WINDX	LinStatic	X	1.206136	0.870863	1.38499
3F	WINDX	LinStatic	Y	0.337809	0.096274	3.508846
2F	WINDX	LinStatic	X	0.935711	0.646519	1.447307
2F	WINDX	LinStatic	Y	0.290823	0.082485	3.525778
1F	WINDX	LinStatic	X	0.629793	0.408534	1.541594
1F	WINDX	LinStatic	Y	0.221489	0.062091	3.567181
MEZ	WINDX	LinStatic	X	0.258427	0.171966	1.502781

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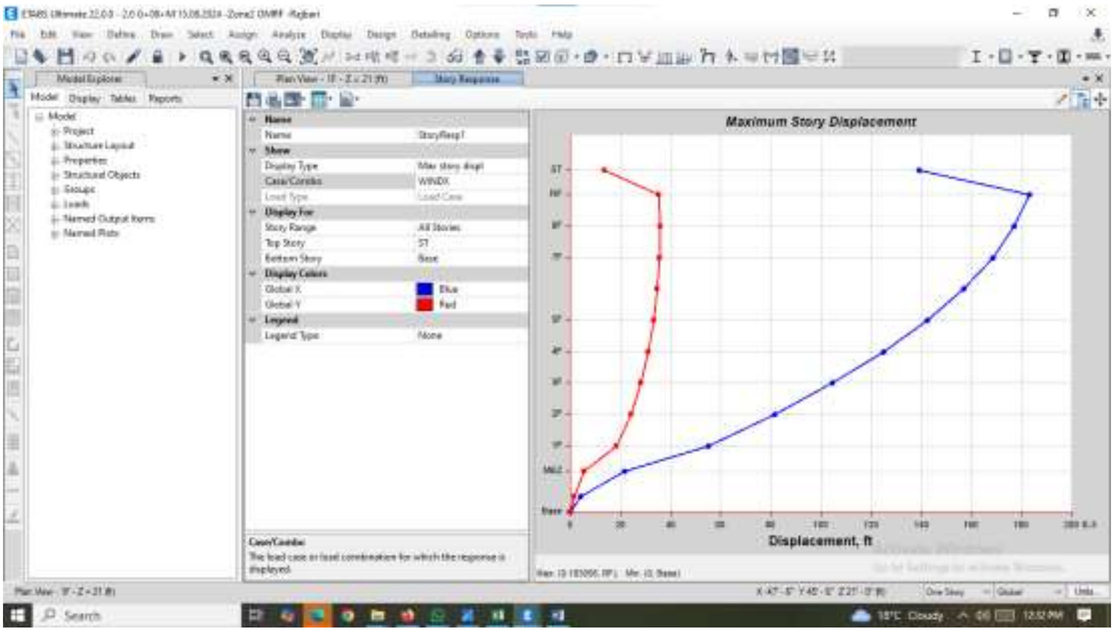
4.1.3: Zone-2 Displacement Windy-X



4.1.4: Zone-2 Displacement Windy-Y

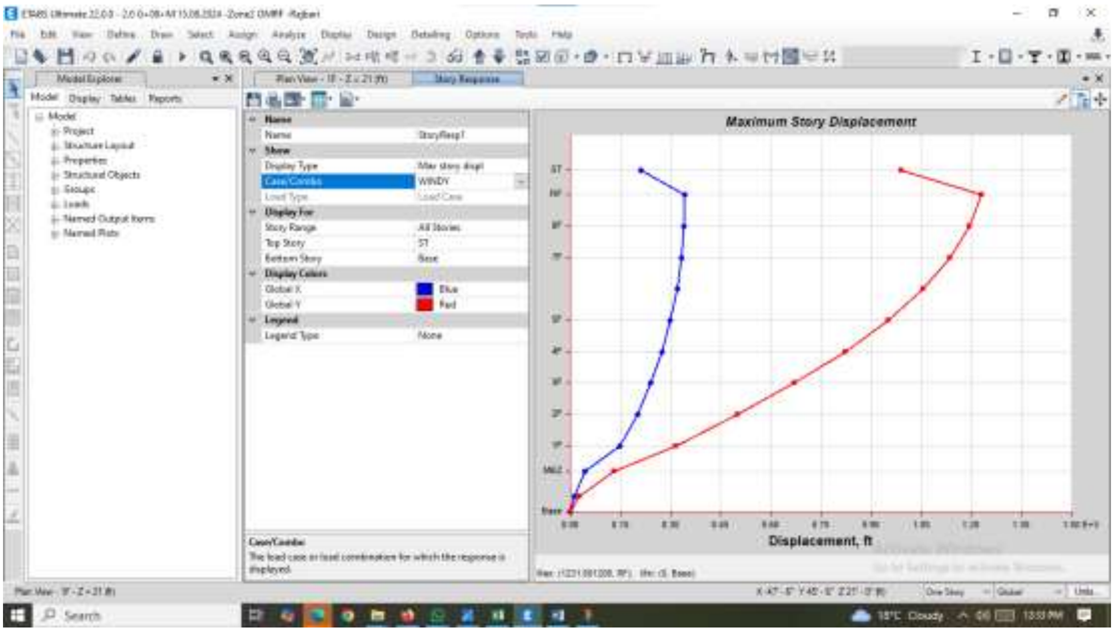


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Table 4.5: OMRF Zone 3 Tangai displacement windx, windy value

	Story	Output Cas	Case Type	Direction	Maximum	Average	Ratio
2	ST	WINDY	LinStatic	X	0.254414	0.146422	1.737536
3	ST	WINDY	LinStatic	Y	1.189142	1.123974	1.057979
4	RF	WINDY	LinStatic	Y	1.477921	1.255029	1.177599
5	8F	WINDY	LinStatic	Y	1.432769	1.211266	1.182869
6	7F	WINDY	LinStatic	Y	1.364385	1.148	1.188488
7	6F	WINDY	LinStatic	Y	1.267694	1.060613	1.195246
8	5F	WINDY	LinStatic	Y	1.141539	0.947967	1.204197
9	4F	WINDY	LinStatic	Y	0.986635	0.810752	1.216938
10	3F	WINDY	LinStatic	Y	0.805133	0.651214	1.236358
11	2F	WINDY	LinStatic	Y	0.601003	0.473849	1.268343
12	1F	WINDY	LinStatic	X	0.159875	0.031212	5.122317
13	1F	WINDY	LinStatic	Y	0.379811	0.287119	1.322832
14	MEZ	WINDY	LinStatic	Y	0.156132	0.123273	1.266557
15	ST	WINDX	LinStatic	X	1.668672	1.525721	1.093694
16	RF	WINDX	LinStatic	X	2.138664	1.730155	1.236111
17	8F	WINDX	LinStatic	X	2.065928	1.648542	1.253185
18	7F	WINDX	LinStatic	X	1.964002	1.54571	1.270615
19	6F	WINDX	LinStatic	X	1.82656	1.416005	1.289939
20	5F	WINDX	LinStatic	X	1.653414	1.259071	1.313202
21	4F	WINDX	LinStatic	X	1.44594	1.076422	1.343284
22	3F	WINDX	LinStatic	X	1.206136	0.870863	1.38499
23	3F	WINDX	LinStatic	Y	0.337809	0.096274	3.508846
24	2F	WINDX	LinStatic	X	0.935711	0.646519	1.447307

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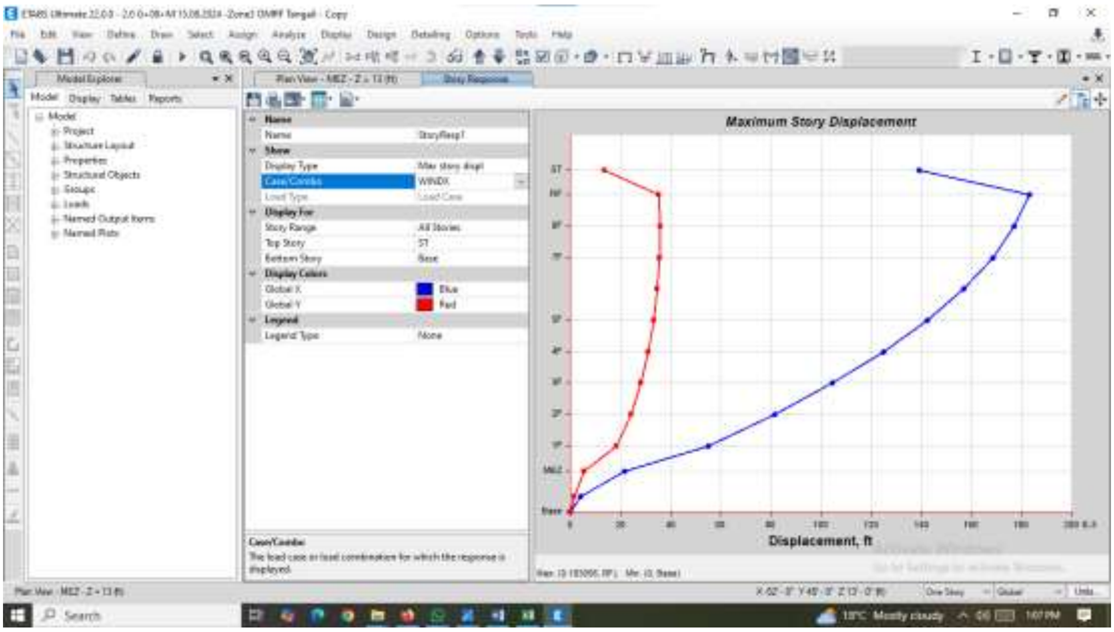
4.1.5: Zone-3 Displacement Windy-X



4.1.6: Zone-3 Displacement Windy-X

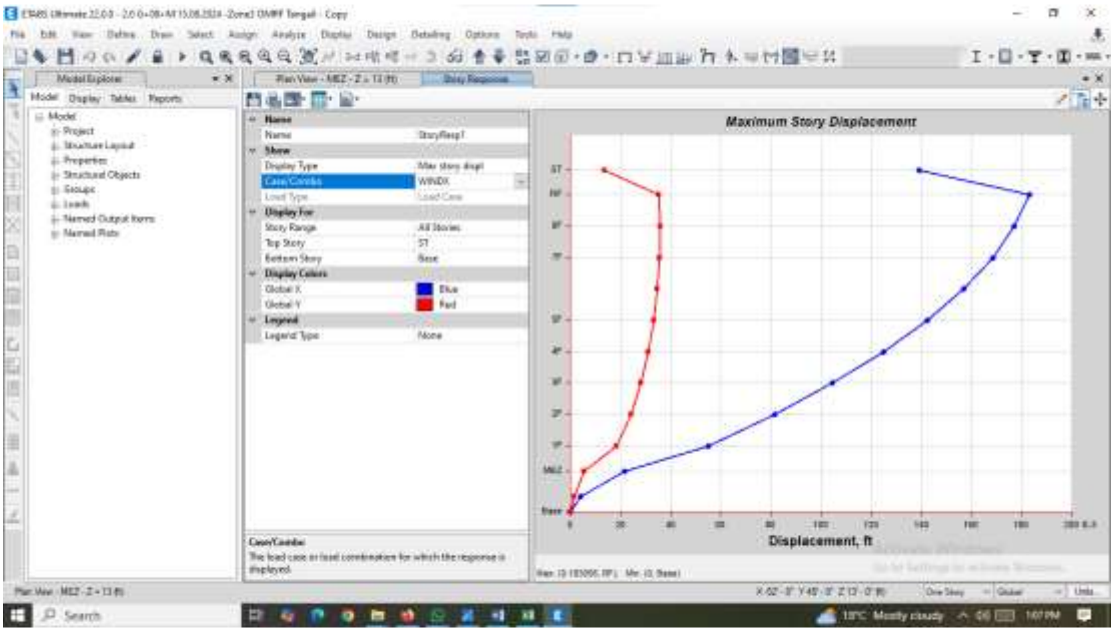


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Table 4.6: OMRF Zone 4 Syhlet displacement windx, windy value

1	Story	utput Cas	Case Type	Direction	Maximum	Average	Ratio
2	ST	WINDY	LinStatic	X	0.271949	0.156514	1.737536
3	ST	WINDY	LinStatic	Y	1.271103	1.201444	1.057979
4	RF	WINDY	LinStatic	Y	1.579786	1.341532	1.177599
5	8F	WINDY	LinStatic	Y	1.531522	1.294751	1.182869
6	7F	WINDY	LinStatic	Y	1.458424	1.227126	1.188488
7	6F	WINDY	LinStatic	Y	1.355069	1.133715	1.195246
8	5F	WINDY	LinStatic	Y	1.220219	1.013305	1.204197
9	4F	WINDY	LinStatic	Y	1.054638	0.866632	1.216938
10	3F	WINDY	LinStatic	Y	0.860627	0.696098	1.236358
11	2F	WINDY	LinStatic	Y	0.642427	0.506509	1.268343
12	1F	WINDY	LinStatic	X	0.170895	0.033363	5.122317
13	1F	WINDY	LinStatic	Y	0.405989	0.306909	1.322832
14	MEZ	WINDY	LinStatic	Y	0.166893	0.131769	1.266557
15	ST	WINDX	LinStatic	X	1.783684	1.630881	1.093694
16	RF	WINDX	LinStatic	X	2.286071	1.849405	1.236111
17	8F	WINDX	LinStatic	X	2.208321	1.762167	1.253185
18	7F	WINDX	LinStatic	X	2.09937	1.652248	1.270615
19	6F	WINDX	LinStatic	X	1.952455	1.513603	1.289939
20	5F	WINDX	LinStatic	X	1.767375	1.345851	1.313202
21	4F	WINDX	LinStatic	X	1.545601	1.150614	1.343284
22	3F	WINDX	LinStatic	X	1.289269	0.930887	1.38499
23	3F	WINDX	LinStatic	Y	0.361093	0.102909	3.508846
24	2F	WINDX	LinStatic	X	1.000205	0.69108	1.447307
25	2F	WINDX	LinStatic	Y	0.310868	0.08817	3.525778
26	1F	WINDX	LinStatic	X	0.673201	0.436692	1.541594
27	1F	WINDX	LinStatic	Y	0.236755	0.06637	3.567181
28	MEZ	WINDX	LinStatic	X	0.276239	0.183818	1.502781

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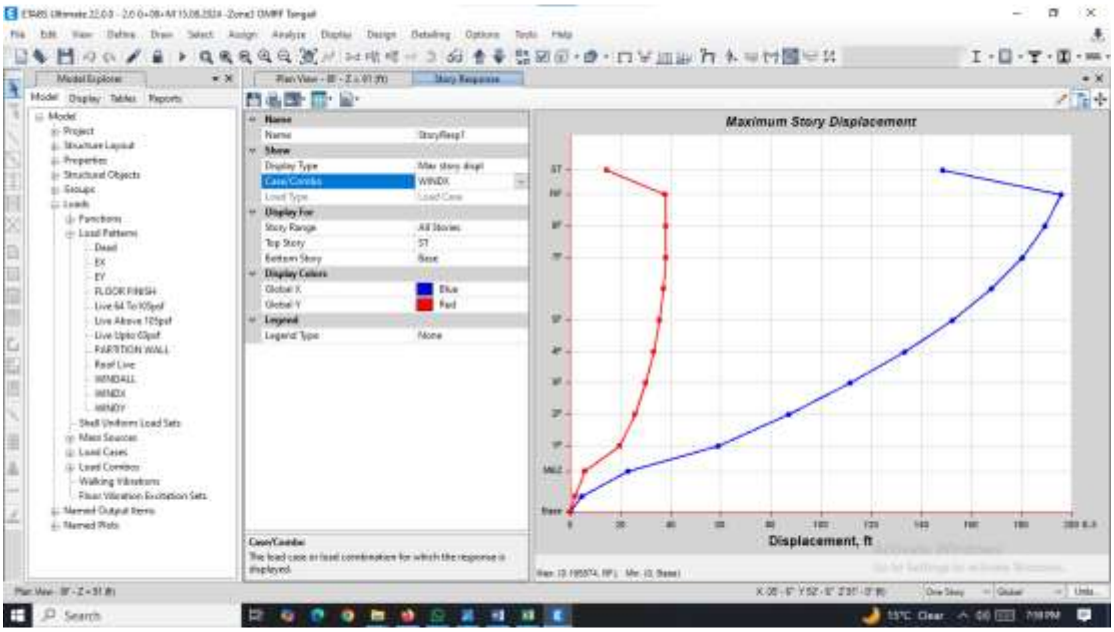
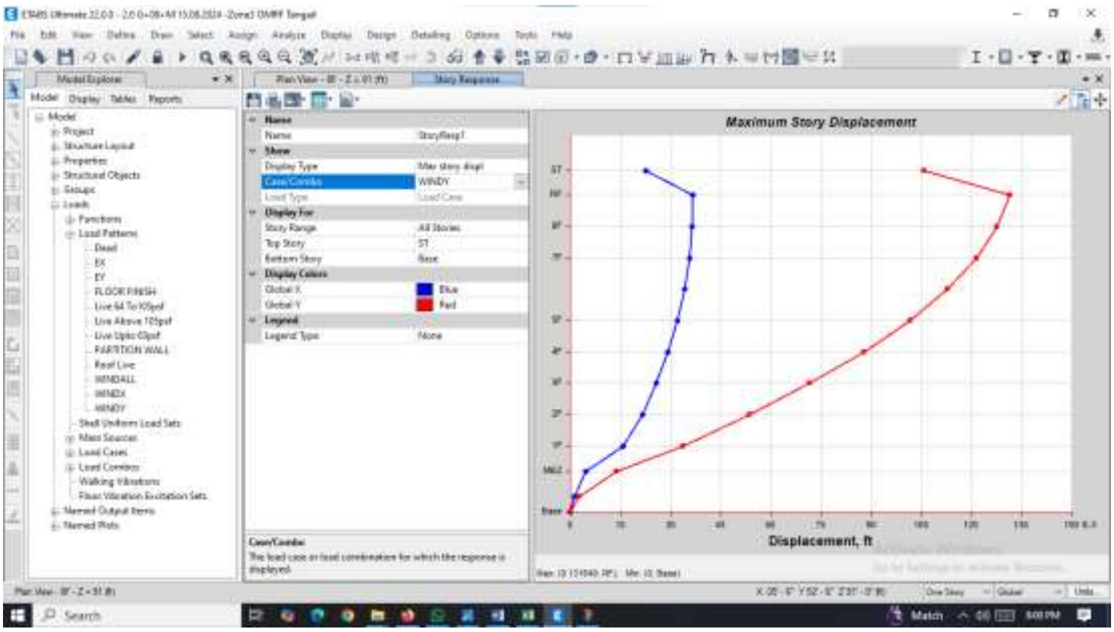
4.1.7: Zone-4 Displacement Windy-X.



4.1.8: Zone-4 Displacement Windy-X



4.3 Inter-Story Drift Comparison

4.2: Maximum Inter-Story Drift (mm)

System	Zone-1	Zone-2	Zone-3	Zone-4
OMRF	7.19	9.77	6.85	8.81
IMRF	9.72	9.98	9.50	9.46
SMRF	–	9.26	9.54	9.809

Observation: Drift values are within BNBC limits but vary with framing system. IMRF shows higher drift flexibility.

4.4 Base Shear and Stiffness

Table 4.3: Base Shear (kN) Comparison

Zone	Base Shear (kN)
Zone-1	850
Zone-2	1100
Zone-3	1350
Zone-4	1620

Observation: Base shear increases significantly from Zone-1 to Zone-4, reflecting higher seismic forces in severe zones.

4.5 Wind vs. Seismic Load Effects

Wind-induced displacements were also analyzed. In high-wind zones like Sylhet, wind loads contributed notably to lateral displacement, though seismic loads remained dominant.

4.6 Discussion of Results

Zone-4 (Sylhet) demands the highest design attention due to maximum displacement and base shear.

· IMRF and SMRF systems perform better than OMRF in controlling drift.

· Wind loads are significant but secondary to seismic loads in high-severity zones.

· The results validate BNBC 2020's zonal classification and emphasize the need for zone-specific design.

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CHAPTER 5

Conclusions and Future Works

5.1 Conclusions

This study successfully analyzed and compared the seismic performance of an RC building across four seismic zones of Bangladesh using ETABS 2022. Key conclusions are:

1. Seismic demands increase progressively from Zone-1 to Zone-4, with Sylhet (Zone4) requiring the most stringent design.
2. IMRF and SMRF systems offer improved performance over OMRF in terms of drift control.
3. Wind loads influence lateral displacement but are less critical than seismic loads in high-severity zones.
4. The study reinforces the importance of BNBC 2020 compliance and zone-specific design for safe and economical construction.

5.2 Limitations

· Only equivalent static analysis was used.
· Soil-structure interaction was not considered.
· Nonlinear behavior and dynamic effects were not included.

5.3 Recommendations for Future Work

1. Perform dynamic analysis (Response Spectrum, Time History) for more accurate results.
2. Include soil-structure interaction and nonlinear modeling.
3. Study different structural systems (dual systems, braced frames) in multi-hazard scenarios.
4. Extend the analysis to taller buildings and irregular plans.

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