DETAILED ANALYSIS BY ETABS OF A 530 SQUARE METER RESIDENTIAL BUILDING LOCATED AT DHAKA.

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This thesis is submitted to the **Department of Civil Engineering, Daffodil International University** in partial fulfilment of the requirements for the degree of **Bachelor of Science in Civil Engineering.**



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Declaration

The thesis "DETAILED ANALYSIS BY ETABS OF A 530 SQUARE METER RESIDENTIAL BUILDING LOCATED AT DHAKA" was completed under the supervision of Mardia Mumtaz, (Lecturer) Department of Civil Engineering, Daffodil International University, Dhaka, Bangladesh, and was approved in partial fulfillment of the requirement for the Bachelor of Science in Civil Engineering. To the best of our knowledge and belief, the capstone contains no previously published or written items, unless otherwise noted in the capstone.

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Abstract

This report has been composed as **"DETAILED ANALYSIS BY ETABS OF A 530 SQUARE METER RESIDENTIAL BUILDING LOCATED AT DHAKA"**. This six storied residential structure is an RCC structure. In this report we planned Column, Beam and Slab. We also calculated the required reinforcement of Column, Beam and Slab. We did all those things with the help of ETABS software and BNBC 1993 code and regulations. By utilizing ETABS software we computed wind load, Earthquake Load, Dead load and Live load.

List of Acronyms & Abbreviation

- \mathbf{P} = Axial Load of Column
- **V** = Shear Stress
- **h** = Slab Thickness
- \mathbf{b} = Width of Beam
- **d** = Effective Depth of Beam
- **a** = Equivalent Depth of Beam
- **Pcf** = Pound per Cubic feet
- **Psi** = Pound per Square Inch
- **ASTM** = American Standard for Testing Material
 - **ACI** = American Concrete Institute
- **BNBC** = Bangladesh National Building Code
- **DDM** = Direct Design Method
- **PWD** = Public Work Department
- **RCC** = Reinforcement Cement Concrete
- **USD** = Ultimate Strength Design
- **UBC** = Uniform Building Code
 - **LL** = live load
 - **DL** = Dead load
 - **PW** = partition wall
 - **FF** = Floor finish
 - **WL** = Wind load
- **EQL** = Earth quake load
 - Ag = Gross area
 - Ast = Area of steel
 - **V** = Shear Stress

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Chapter 1 : Introduction

1.1: Introduction:

It is well acknowledged that a basic understanding of particular design abilities and methods is insufficient for professional success. These techniques are prone to periodic modifications as new research becomes accessible and new design methodologies become available. To comprehend and stay current with these important changes, as well as to safely engage in innovative design, the engineer needs a detailed understanding of basic performance of converted and steel as constructions a cost-effective and safe method. As a result, knowledge with modern design techniques is important when using this basic idea as a basis.

1.2: Background of the Study:

For the sake of simplicity, the majority of structures in the world are built of reinforced concrete members, also known as RC members. The structural engineer's main job is to design structures. Strength must be both safe from collapse and usable in usage. The structure must be adequate for all loads that may operate on it in order to be safe. High rise buildings structural systems must handle vertical gravity loads, but lateral stresses such as those caused by wind and earthquakes must also be considered. Maximum 100-year interval wind forces vary greatly depending on location; at ground level, they are typically around 100 kilograms per square meter (20 pounds per square foot) at ground level. The major environmental stress for buildings is wind loading, which competes with seismic loading. Over a lengthy period of time, they have caused about equal quantities of harm. Large destructive earthquakes, on the other hand, are less common than strong wind storms. Is taking place somewhere on the planet, despite the fact that many storms are tiny and confined. Tropical cyclones (including hurricanes and typhoons) are created in the tropical waters, where the most severe of all wind occurs. When these storms hit inhabited coasts, the consequences may be disastrous. Many constructions have been damaged as a result of earthquakes. Bangladesh has seen an increase in the development of multistory structures in recent years. Almost all of these buildings are being built in Dhaka. This research compares the effects of lateral force on a residential structure. Although nature offers an adequate environment on our planet, it is usually perfectly appropriate to their requirements, convenience, and wants, the planning, design, and construction of structures is fundamentally as ancient as humans. Early people could possibly find natural caves made of hollow trees that would provide them with some protection from the weather, but they would have to be positioned correctly to fulfill their needs. As a result, the building of a structure was born. A concrete structure is often made up of a series of frames that are made up of vertical and horizontal components. It's for this reason that it's

called a frame structure. According to BNBC's definition, a low-rise building is any construction with a height of less than 20 meters. A medium rise building is one whose uppermost level does not surpass 70 feet and does not exceed 75 feet, with a maximum height of 8 storeys. Any structure whose uppermost level exceeds 70 feet or 75 feet, which is often more than 8 storeys, is classified as a high-rise building. The structural design of a structure is generally done with earthquake and wind loads in mind.

1.3 Objective:

- To study and compare the effects of lateral force on a residential structure by using ETABS software.
- To get a basic understanding of how to use basic ETABS software to design concrete buildings.
- Using of ETABS software to study and compare the effects of lateral force on a residential structure.
- To apply wind and earthquake load and analysis the model using ETABS software.

1.4 Scope of study:

The overall goal of this research is to use ETABS software to construct a given structure and analyze variations in building capacity. The software ETABS was used for structural analysis and design. The following codes were utilized for design and analysis: ACI code, UBC 1994, and BNBC 1993.

1.5 limitations:

Due to a lack of time, a thorough overall examination of the structure was not possible. Stairs and footings were not included in the design. Because the BNBC 1993 code was utilized, the study may be obsolete, and outdated software was used to comply with the BNBC 1993 code's suggestion. Because this research was done for a hypothetical circumstance, the structure's dimensions were mainly impractical. This research was carried out for a residential construction. Other structures were not studied since it would result in a lot of variety and take a lot of time. And for the last part there was no cost estimation in this investigation.

Chapter 2 : Review of literature

2.1 RCC Frame Structure:

The primary duty of a structural engineer is to design structures. The major aims of this thesis, from the structural engineer's perspective, are to distribute knowledge on the newest concepts, methodologies, and design data to structural engineers involved in the design of wind and seismic resistant structures. Recent advancements in seismic design, particularly those relating to structures in low and moderate seismic zones, are central to the argument. Wind and earthquake Resistant Buildings brings together the design features of steel, concrete, and composite structures in one book. The more a structure is higher, the more important it is to pick the right structural system.

The function of the building is a major factor that affects the structural system. Large open areas in modern office buildings are required, which may be split with lightweight partitioning to meet the demands of different tenants. As a result, the primary vertical components are typically placed around the perimeter of the design as much as possible, and internally ingroup around the elevator, stair, and service lifts. The floor spaces between the external and internal components are leveled, creating a wide column free area for office design. The services are arranged horizontally above the partitions in each floor and are generally hidden in the ceiling tiles. Because of the increased depth required by this area, an office building's usual story height is 3000 mm or more.

Shear walls for horizontal load resistance are a significant advancement in reinforced concrete height rise structural systems. This is the first in a series of important advancements in the structural system of concrete high-rise buildings, which will allow them to be free of the flat plate system. The broad availability of reinforcing bars and the constituents of concrete, stones, sand, and cement has allowed the height of concrete buildings to rise during construction due to the creation and refining of these new methods, as well as the development of greater strength concrete.

2.2 Dead Loads:

The weight of all materials, suspended loads (such as sanitary and electrical fixtures, linings, and fittings), and permanent equipment included into the building or other structure are all included. Its magnitude remains constant during the structure's lifetime. Permanent loads are a broader category that includes dead loads as well as force established by irreversible changes in structures over time, such as settlement, secondary effects of prestress, shrinkage, and creep incinerate. Walls, floors, ceilings, stairways, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural components, as well as the weight of cranes, are all examples of dead load. The term "dead load" refers to all permanent loads.

2.3 Live Loads:

A live load is a phrase used in civil engineering to describe a load that can vary over time. When individuals walk about in a building, the weight of the load is changeable or varies positions. Because it may be moved anywhere, anything in a building that is not attached to the structure might result in a live load.

So, Live loads are the maximum loads predicted for occupancy by the intended use, although they must never be less than the loads specified by this section.

2.3.1 Floor Live Loads:

These loads are to be considered as the minimum live loads in pounds per square foot of horizontal rejection to be used in building design for the occupancies mentioned, and loads at least equal to be presumed for applications not specified in this section but that produce or accommodate comparable loadings. The real live load shall be utilized in the design of such building or sections thereof when it can be ascertained in designing floors that the actual live load will be larger than the value. Machine and equipment load's require special consideration.

2.4 Wind Loads:

Every building or structure, and every component of it, must be built and constructed to withstand the wind effects determined in accordance with this division's criteria. The shielding effect of nearby structures will not result in any reduction in wind pressure. Buildings sensitive to dynamic effects, such as those with a height to width ratio greater than five, structures especially vulnerable to wind induced oscillations, such as vortex shedding or icing, and structures over 400 feet (121.9m) in height, must be designed in accordance with approved government standards, and all structures will have to be designed in accordance with approved national standards. Building and foundation systems in areas prone to erosion and water pressure due to wind and wave action are free from the restrictions of this section. Buildings and foundations exposed to such loads must be designed in accordance with the proved national standards.

2.5 Earthquake Loads:

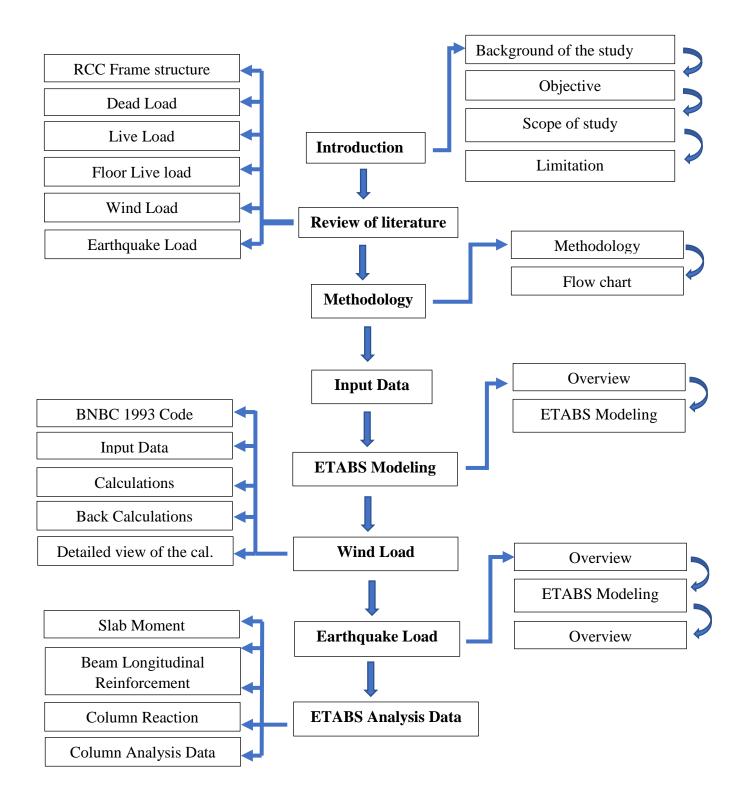
The earthquake provision is primarily intended to protect against severe structural collapses and loss of life, rather than to reduce damage or retain functionality. As a minimum, the structure and its components must be built and constructed to withstand the impacts of seismic ground movements as specified in this section.

Chapter 3: Methodology

3.1 General:

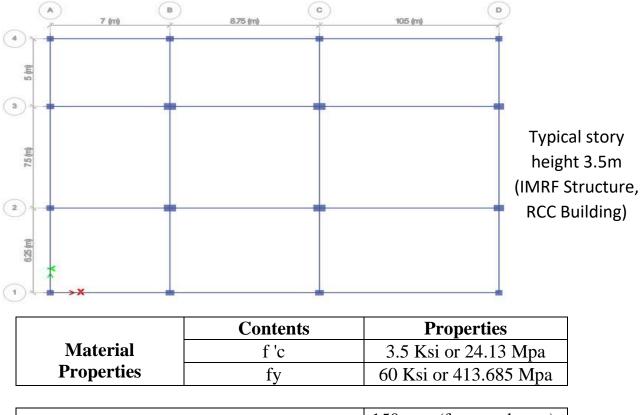
ETBAS has been used to create analysis and as a design tool. The calculations were made using the ACI, BNBC, and UBC codes, and the portal frame technique was utilized for analysis using the program ETABS. The building will be a six-story edge supported slab construction. Its elevation and plan have been drawn. Then, for the proposed structure in Dhaka, wind and earthquake loads were calculated on chosen beams and columns using BNBC, UBC 1994 CODE (coefficient, wind speed, seismic zone). To verify for variations, necessary comparisons were made.

3.2 Flow chart:



Chapter 4 : Input Data

4.1 Input data:



	150 mm (for membrane),
Slab thickness	125 mm (for bending)

Dead and Live	LL (Live Load)	3 KN/m ²
Loads	FF (Floor Finish)	1.5 KN/m ²
	PW (Partition Wall)	2.5 KN/m ²

Wind Load	Basic wind speed	238 Km/hr.
	Exposure condition	A (for odd groups)

Earthquake Load	Soil type	S_3 ((for odd groups)
	Zone	1 (for odd groups)

Table 4.1: General Information regarding the model

4.2 Column Layout:

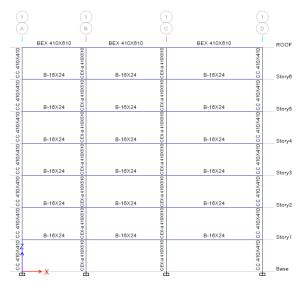


Fig 4.1: Grid 1A,1B,1C and 1D Column Position Layout



Fig 4.2: Grid 2A,2B,2C and 2D Column Position Layout

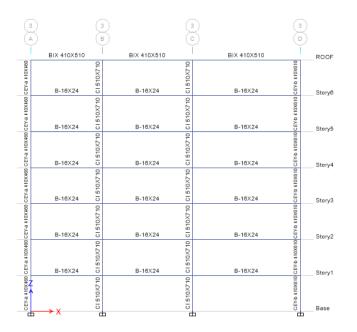


Fig 4.3: Grid 3A,3B,3C and 3D Column Position Layout

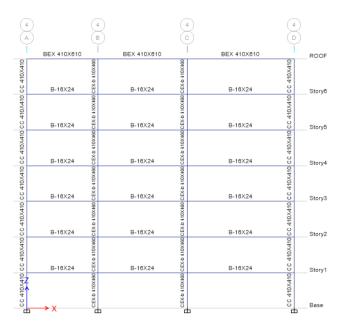


Fig 4.4: Grid 4A,4B,4C and 4D Column Position Layout

4.3 Beam Layout:

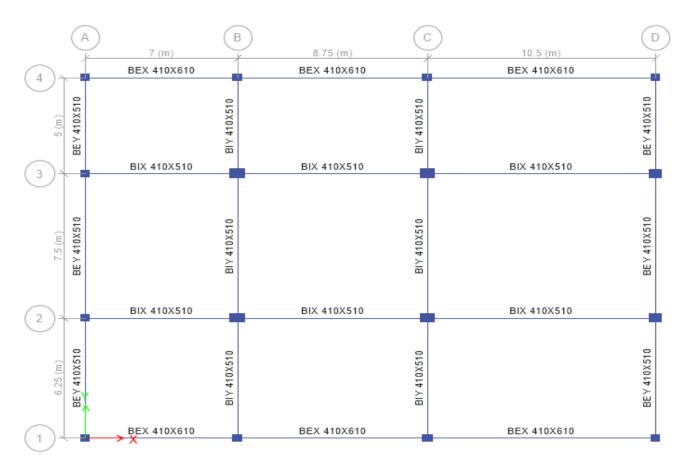


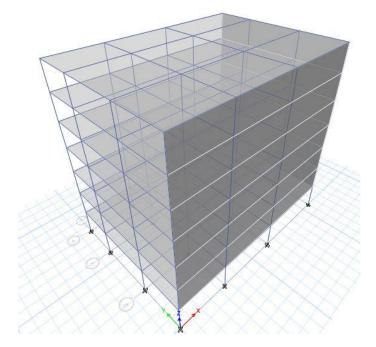
Fig 4.5: Beam Position Layout

Chapter 5: ETABS Modeling

5.1 Overview:

ETABS 9.6 is the PC software that is utilized in this proposal. ETABS is a fantastic tool that may help architects enhance their structural research and planning abilities. Part of this benefit comes from the diversity of possibilities available, while another aspect is that it is quite simple to use. The program's basic operation is straightforward. The customer utilizes seams, curves, linkages, and ligaments to create structural lines. and shells to compare grid lines to parent elements and gives these basic items base loads and characteristics (for example. Shell components can be distributed as area attributes; joint elements can be distributed as spring properties). Then, using the basic project and its objectives as a guide, complete the research, planning, and decomposition. The results are generated in the form of graphics or basic structures that may be printed or saved as documents for use in various projects.

5.2 ETABS Modeling:



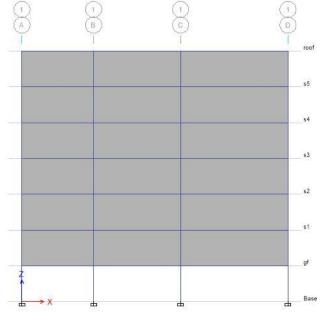


Fig 5.1: 3D view of the Building

Fig 5.2: Elevation view of the Building

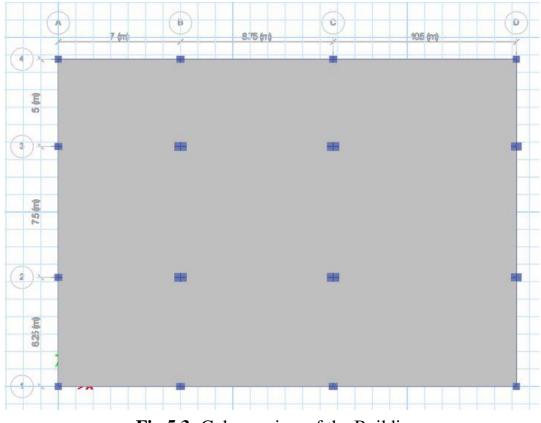
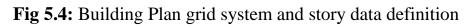


Fig 5.3: Column view of the Building

Number of Grid Lines in X Direction Number of Grid Lines in Y Direction Spacing of Grids in X Direction Spacing of Grids in Y Direction Spacing of Grids in Y Direction Specify Grid Labeling Options		7
Number of Grid Lines in Y Direction Spacing of Grids in X Direction Spacing of Grids in Y Direction Specify Grid Labeling Options Grid Labeling.	Typical Story Height	3.5 m
Spacing of Grids in X Direction Spacing of Grids in Y Direction Specify Grid Labeling Options Grid Labels.		
Spacing of Grids in Y Direction Specify Grid Labeling Options Grid Labels	Bottom Story Height	3.5 m
Specify Grid Labeling Options Grid Labels		
Custom Grid Spacing		
	O Custom Story Data	
Specify Data for Grid Lines Edit Grid Data	Specify Custom Story Data	Edit Story Data
Add Structural Objects		Two Way or Ribbed Slab



ind Syste	em Name			Story Ra	nge Option		Click to Modify.	/Show:		[
G1]	● De	efault - All Stories		F	eference Points			
ystem Or	Irigin			() Us	er Specified Top Story		R	eference Planes			
Global)	n		roof		Options			3	2 - 5 - 5 -
Global	Y)	n		Bottom Story		Bubble Size	1524	mm	2	
	ular Grids) Data as Ordinates	leg	Di	Base splay Grid Data as S	Spacing	Grid Color		Quick Sta	art New Rectangular	Grids
lectangu	ular Grids isplay Grid [leg) Di		Spacing	Grid Color		Quick Sta	art New Rectangular	Grids
ectangu O Di X Grid	ular Grids isplay Grid [Di Aisible		Spacing		Y Spacing (m)	Quick Sta Visible	art New Rectangular	Grids
ectangu O Di X Grid	ular Grids isplay Grid [Data	Data as Ordinates	V		splay Grid Data as S	Spacing Add	Y Grid Data	Y Spacing (m) 6.25			Grids
ectangu O Di X Grid	ular Grids isplay Grid [Data Grid ID	Data as Ordinates X Spacing (m)	v	/isible	splay Grid Data as S Bubble Loc	Add	Y Grid Data		Visible	Bubble Loc	Add
ectangu O Di X Grid	ular Grids isplay Grid [Data Grid ID A	Data as Ordinates X Spacing (m) 7	V	/isible Yes	splay Grid Data as S Bubble Loc End		Y Grid Data Grid ID 1	6.25	Visible Yes	Bubble Loc Start	

Fig 5.5: Define Grid Data

	Story	Height m	Elevation m	Master Story	Similar To	Splice Story	Splice Height m	Story Color
•	roof	3.5	24.5	No	s1	No	0	
	s5	3.5	21	No	s1	No	0	
	s4	3.5	17.5	No	s1	No	0	
	s3	<mark>3.5</mark>	14	No	s1	No	0	
	s2	3.5	10.5	No	s1	No	0	
	s1	3.5	7	Yes	None	No	0	
	gf	3.5	3.5	No	s1	No	0	
	Base		0					
Note: Rial	nt Click on Grid for Opti	ons						

Fig 5.6: Story Data

laterial Name and Type	
Material Name	3500Psi
Material Type	Concrete, Isotropic
esign Properties for Concrete Materia Specified Concrete Compressive S Lightweight Concrete Shear Strength Reduction Fac	trength, f'c 3500 lb/in²
ок	Cancel

Fig 5.7: input concrete strength (Defining material proparties)

Property Name	BEY 410X510]	
Material	3500Psi	~	2
Notional Size Data	Modify/Show Notional	I Size	• •
Display Color	Chang	ge	ĕ — ∔ ●
Notes	Modify/Show Note	es	• •
Shape			
Section Shape	Concrete Rectangular	~	
Section Dimensions Depth Width	508	mm mm	Modify/Show Modifiers Currently User Specified Reinforcement Modify/Show Rebar
	Show Section Properties	1	OK Cancel
	snow section Properties		Cancel

Fig 5.9: Defining Beam section proparty data

Material Name	A615Gr60		
Material Type	Rebar, Uniaxial		Į.
Design Properties for Rebar Materials			
Minimum Yield Strength, Fy	6000	D	lb/in²
Minimum Tensile Strength, Fu	9000	D	lb/in²
Expected Yield Strength, Fye	6600	D	lb/in²
Expected Tensile Strength, Fue	9900	0	lb/in ²

Fig 5.8: Input rebar strength (Defining material proparties)

Design Type	Rebar M	aterial			
O P-M2-M3 Design (Column)	Longit	Longitudinal Bars		A615Gr60 ~	
M3 Design Only (Beam)	Confir	Confinement Bars (Ties)		A615Gr60 ~	
Cover to Longitudinal Rebar Group	Centroid	Reinforcement /	Area Overwrit	es for Ductile Be	eams
Top Bars 87.5	mm	Top Bars at I	I-End	0	mm²
Bottom Bars 87.5	mm	Top Bars at	J-End	0	mm²
		Bottom Bars	at I-End	0	mm ²
		Bottom Bars	at J-End	0	mm²

Fig 5.10: Defining Beam section proparty reinforcement data.

	Rebar Material	
Design Type	Longitudinal Bars A	615Gr60 ~ 615Gr60 ~
Reinforcement Configuration @ Rectangular O Circular	Confinement Bars (Ties Spirals	Check/Design Reinforcement to be Checked Reinforcement to be Designed
Longitudinal Para		
dfiers Number of Longitudinal Bars Alon	ng 3-dir Face	62.5 mm 3 5
OK Number of Confinement Bars in 3	3-dir	V 129 mm² 152.4 mm 3 3
fy er	O M3 Design Only (Beam) Periforcement Configuration Rectangular Circular Longtudinal Bars Clear Cover for Confinement Bar Number of Longtudinal Bars Alo Number of Longtudinal Bars Alo Longtudinal Bars Size and Area Confinement Bar Size and Area Confinement Bar Size and Area Confinement Bar Size and Area Longtudinal Spacing of Confinement Bars in : 	M3 Design Only (Beam) Confinement Bars (Ties) Beinforcement Configuration Confinement Bars Image: Beinforcement Configuration Image: Beinforcement Configuration Image: Beinforcement Configuration Image: Beinforcement Configuration Image: Beinforcement Configuration Image: Beinforcement Bars Image: Beinforcement Configuration Image: Beinforcement Bars Image: Beinforcement Bars Image: Bars Image: Configuration Image: Bars

Fig 5.11: Defining Column section proparty data

Fig 5.12: Defining frame section proparty reinforcement data.

eneral Data			
Property Name	Slab 150mm]
Slab Material	3500Psi	~	•••
Notional Size Data	Modify/Show Notional	Size	
Modeling Type	Membrane	~]
Modifiers (Currently User Specified)	Modify/Show		
Display Color	Chan	ge	
Property Notes	Modify/Show		
Use Special One-Way Load Distrib	ution		
roperty Data			
Туре	Slab	~]
Thickness	150		mm

Fig 5.13: Defining slab section proparty data.

er Properties List	Click to:		
Type All ~	Import New Properties		
Filter Clear	Add New Property		
perties	Add Copy of Property		
ind This Property	Modify/Show Property		
EX 16X24			
3EX 16X24 3EY 16X20	Delete Property		
SIX 16X20 SIY 16X24	Delete Multiple Properties	- 🅎 Mass Source Data	
C 16X16 EX-A 16X20			Mass Multipliers for Load Patterns
EX-B 16X18 EY-A 16X18	Convert to SD Section	Mass Source Name	Load Pattern Multiplier
EY-B 18X24	Copy to SD Section	Mass Source	FF 1
		Element Self Mass	Live 1
		Additional Mass Specified Load Patterns	D
	Export to XML File		Mage Online
	Export to XML File	Adjust Diaphragm Lateral Mass to Move Mass Centroid by:	Mass Options
1/20/228	Export to XML File		

Fig 5.14: Frame proparties

Load Pat	em Name	Live	~
Uniform Load	3	kN/m²	Options Add to Existing Loads Replace Existing Loads
Direction	Gravity	~	O Delete Existing Loads

Fig 5.16: Assigning Live load Fig 5.17: Assigning FF load

Load Pattern Name	FF	~	
Uniform Load Load Direction Gravity	kN/m²	Options Add to Existing Loads * Image: The second se	
ОК	Close	Apply	

Fig 5.15: Defining mass source data.

Load Pattern	Name	PW	×
Uniform Load Load Direction	2.5 iravity ~] kN/m² (otions Add to Existing Loads Replace Existing Loads Delete Existing Loads

Fig 5.18: Assigning PW load

roo	216223	ory		abel		Unique Name	-
		27e8-eef1	F3	2da 540	15	7277	
40	io. eaus	2760-6611	-4301-3	300-34-31	24100	2377	
ect	Data						
Ge	ometry	Assignm	nents	Load	s		
~	Load P	attern: F	F				_
	Uniform			1.5 kN	/m²		
	Load P	attern: L	ive	3 kN/m	2		
		attern: P	w	3 KIN/m	D7		
	Uniform			2.5 kN	m²		

Fig 5.19: Slab Load Information

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Chapter 6: Wind Load

Height above

6.1 BNBC 1993 Code:

Height above		Coefficient, Cz (1)			
ground level, z (metres)	Exposure A	Exposure B	Exposure C		
0-4.5	0.368	0.801	1.196		
6.0	0.415	0.866	1.263		
9.0	0.497	0.972	1.370		
12.0	0.565	1.055	1.451		
15.0	0.624	1.125	1.517		
18.0	0.677	1.185	1.573		
21.0	0.725	1.238	1.623		
24.0	0.769	1.286	1.667		
27.0	0.810	1.330	1.706		
30.0	0.849	1.371	1.743		
35.0	0.909	1.433	1.797		
40.0	0.965	1.488	1.846		
45.0	1.017	1.539	1.890		
50.0	1.065	1.586	1.930		
60.0	1.155	1.671	2.002		
70.0	1.237	1.746	2.065		
80.0	1.313	1.814	2.120		
90.0	1.383	1.876	2.171		
100.0	1.450	1.934	2.217		
110.0	1.513	1.987	2.260		
120.0	1.572	2.037	2.299		
130.0	1.629	2.084	2.337		
140.0	1.684	2.129	2.371		
150.0	1.736	2.171	2.404		
160.0	1.787	2.212	2.436		
170.0	1.835	2.250	2.465		
180.0	1.883	2.287	2.494		
190.0	1.928	2.323	2.521		
200.0	1.973	2.357	2.547		
220.0	2.058	2.422	2.596		
240.0	2.139	2.483	2.641		
260.0	2.217 -	2.541	2.684		
280.0	2.910	2.595	2.724		
300.0	2.362	2.647	2.762		

Combined Height and Exposure Coefficient, Cz

Height above		Gh (2) and Gz	
ground level (metres)	Exposure A	Exposure B	Exposure C
0-4.5	1.654	1.321	1.154
6.0	1.592	1.294	1.140
9.0	1.511	1.258	1.121
12.0	1.457	1.233	1.107
15.0	1.418	1.215	1.097
18.0	1.388	1.201	1.089
21.0	1.363	1.189	1.082
24.0	1.342	1.178	1.077
27.0	1.324	1.170	1.072
30.0	1.309	1.162	1.067
35.0	1.287	1.151	1.061
40.0	1.268	1.141	1.055
45.0	1.252	1.133	1.051
50.0	1.238	1.126	1.046
60.0	1.215	1.114	1.039
70.0	1.196	1.103	1.033
80.0	1.180	1.095	1.028
90.0	1.166	1.087	1.024
100.0	1.154	1.081	1.020
110.0	1.114	1.075	1.016
120.0	1.134	1.070	1.013
130.0	1.126	1.065	1.010
140.0	1.118	1.061 1.057	1.008
150.0	1.111	1.057	1.005
160.0	1.104	1.053	1.003
170.0	1.098	1.049	1.001
180.0 190.0	1.092 1.087	1.046	1.000
190.0	1.067	1.045	1.000
200.0	1.082	1.040	1.000
220.0	1.073	1.035	1.000
240.0	1.065	1.030	1.000
260.0	1.058	1.026	1.000
280.0	1.051	1.022	1.000
300.0	1.045	1.018	1.000 ilding or struct

1 abie 6.2.11 Gust Response Factors, G_h and $G_z^{(1)}$

Gh (2) and Gz

Table 6.1: Combined height and exposure
 Coefficient C_z

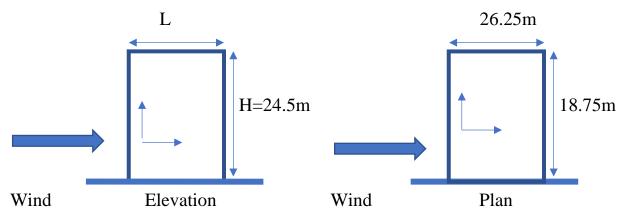
Table 6.2: Gust Response Factors, G_h and G_z

6.2 Input Data:

Earthquake Load					
Basic wind speed	238 Km/hr.				
Exposure condition	A (for odd groups)				

Exposure condition	Basic wind speed, V _b	Velocity to pressure coefficient, C _c	Structural importance coefficient Ci	Sustained wind pressure <i>q_z</i>	Gust coefficient C _G	Pressure, Pz-x	Pressure, Pz-y
1	238	47 x 10 ⁻⁶	1	2.67 C _z	1.37179	4.8426 Cz	5.53 C _z
	Km/hr.			KN/m ²			

6.3 Calculations:



Wind Pressure:

	Here,
$q_z = C_c C_z V_b^2$	$C_c = 47 \ge 10^{-6}$
=47 x 10^{-6} x 1 x C_z x 238 ²	$C_i = 1$
$= 2.67 \ C_z \ \mathrm{KN/m^2}$	Here, $C_c = 47 \ge 10^{-6}$ $C_i = 1$ $V_b = 238$ Km/hr.

Design Wind Pressure:

Pz-x =
$$C_G C_p q_z$$
Here,= 1.37179 x 1.32 x 2.67 C_z C_g =1.37179= 4.8426 C_z q_z =2.67 C_z H/B= 1.31 mL/B= 1.40 m

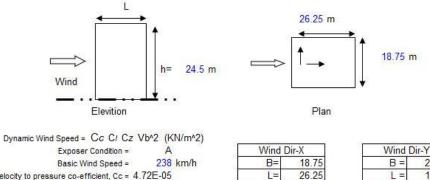
$Pz-y = C_G C_p q_z$	Here,
$= 1.37179 \text{ x } 1.51 \text{ x } 2.67 C_z$	$C_G = 1.37179$ Cp = 1.51 H/B=0.93 m
$=5.5300 C_z$	Cp = 1.51
	H/B=0.93 m
	L/B = 0.71

6.4 Back Calculations:

$$W_{x} = \left(\sqrt{\frac{\text{Given Value}}{\text{Etabs Value}}}\right) \text{ x Basic Wind Speed}$$
$$= \sqrt{\frac{301.7}{240.14}} \text{ X 147.886} = 165.761 \text{ Km/hr.}$$
$$W_{y} = \left(\sqrt{\frac{\text{Given Value}}{\text{Etabs Value}}}\right) \text{ x Basic Wind Speed}$$

$$= \sqrt{\frac{482.4}{384.59}} \times 147.886 = 165.627 \text{ Km/hr.}$$

6.5 Detailed view of the calculations:



h= L/B= h/B= Cp=

Exposer Condition =	A	
Basic Wind Speed =	238	km/h
Velocity to pressure co-efficient, Cc =	4.72E-05	
Structural Importance Co-efficient, CI =	1.0	
Sustained wind pressure, qz =	2.6736	Cz
Gust co-efficient, Cg =	1.37179	
pressure,Pz-x =	4.8426	Cz
pressure,Pz-y =	5.5300	Cz
1 KN =	0.2	Kip

Dir-X	Wind D	lir-Y
18.75	B =	26.25
26.25	L =	18.75
24.5	h =	24.5
1.40	L/B =	0.71
1.31	h/B =	0.93
1.32	Cp =	1.51

Wind Pressure Calculation:-

				X-dir				Y-dir			
Floor	Floor height	Height (m) from GL	Cz	P z-x (KN/m^2)	Pz-x (lb/ft^2)	Area (m^2)	Floor Level force (Kip)	Pz-y (KN/m^2)	Pz-y (lb/ft^2)	Area (m^2)	Floor Level force (Kip)
	0	0	8		4 ₁		8.	8		S	
1	3.500	3.500	0.5978	2.8949	60.4	65.6	38	3.3058	69.03	91.9	61
2	3.500	7.000	0.625	3.0266	63.2	65.6	40	3.4562	72.17	91.9	64
3	3.500	10.500	0.6522	3.1584	65.9	65.6	41	3.6067	75.31	91.9	66
4	3.500	14.000	0.6795	3.2906	68.7	65.6	43	3.7576	78.46	91.9	69
5	3.500	17.500	0.7067	3.4223	71.5	65.6	45	3.9080	81.60	91.9	72
6	3.500	21.000	0.725	3.5109	73.3	65.6	46	4.0092	83.71	91.9	74
7	3.500	24.500	0.7611	3.6857	77.0	65.6	48	4.2089	87.88	91.9	77

301.7

482.4

Fig 6.1: Detailed view of the calculations

Exposure and Pressure Coefficients		Wind Coefficients		
Exposure from Extents of Diaphragms		Wind Speed (mph)	147.886	
Exposure from Shell Objects		Exposure Type	В	~
Wind Exposure Parameters		Importance Factor	1	
Wind Directions and Exposure Widths	Aodify/Show	Exposure Height		
Windward Coefficient, Cq		Top Story	roof	~
Leeward Coefficient, Cq		Bottom Story	gf	~
		Include Parapet		
		Parapet Height		m

Fig 6.2: Wind Load pattern.

_ ∢	Base Reactions	🕨 🔰 Reload	Apply			
	Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m
•	Dead	-1.4712	0.2004	12147.2353	115472.8057	-154818.2304
	Live	-0.394	0.0762	3128.1498	29321.614	-40677.6925
	PW	-0.3283	0.0635	2606.7915	24434.6783	-33898.0771
	FF	-0.197	0.0381	1564.0749	14660.807	-20338.8462
	WX	-301.6998	-553.5742	0	1198.0938	-649.2736
	WY	-262.9096	-482.4	0	1044.0523	-565.7951
	EQX	-1.2018	24.3751	0	-32.686	-46.7571
	EQY	23.2025	72.4458	0	-155.8971	29.6008

Fig 6.3: Support Reactions.

Chapter 7: Earthquake Load

7.1 BNBC 1993 Code:

Basic Structural System ⁽¹⁾	Description of Lateral Force Resisting System	R (2)
a. Bearing Wall System	Light framed walls with shear panels i) Plywood walls for structures, 3 storeys or less ii) All other light framed walls Shear walls ii) Concrete iii) Masonry Light steel framed bearing walls with tension only bracing Braced frames where bracing carries gravity loads i) Steel ii) Concrete (3)	8 6 6 4 6
b. Building Frame System	iii) Heavy timber iii) Heavy timber iii) Plywood walls for structures 3-storeys or less ii) Plywood walls for structures 3-storeys or less ii) All other light framed walls ii) Concrete iii) Masonry Concentric braced frames (CBF) ii) Steel iii) Heavy timber	4 10 9 7 8 8 8 8 8 8 8
c. Moment Resisting Frame System	Special moment resisting frames (SMRF) 1) Steel ii) Concrete Ioncrete Ioncrete Iontermediate moment resisting frames (IMRF), concrete ⁽⁴⁾ Ordinary moment resisting frames (OMRF) i) Steel ii) Concrete ⁽⁵⁾	12 12 8 6 5
d. Dual System	Shear walls i) Concrete with steel or concrete SMRF ii) Concrete with steel OMRF iii) Concrete with concrete IMRF ⁽⁴⁾ iv) Masonry with steel OMRF v) Masonry with steel OMRF vi) Masonry with concrete IMRF ⁽³⁾ Steel EBF i) With steel SMRF ii) With steel SMRF ii) With steel OMRF ii) Steel with steel SMRF ii) Steel with steel SMRF ii) Steel with steel SMRF ii) Concrete with concrete SMRF ⁽³⁾	12 6 9 8 6 7 12 6 10 6 9 9 6
 Special Structural Systems 	See Sec 1.3.2, 1.3.3, 1.3.5	

Table 7.1: Response Modification Coefficient for structural System, R

a) Method A : For all buildings the value of T may be approximated by the following formula :

$$T = C_t (h_n)^{3/4} \tag{2.5.3}$$

where, $C_t = 0.083$ for steel moment resisting frames = 0.073 for reinforced concrete moment resisting frames, and eccentric braced steel frames = 0.049 for all other structural systems

Chart 7.1: Value of Ct for Method A

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Table 6.2.22 Seismic Zone Coefficients, Z		Table 6.2.23 Structure Importance Coefficients I, I'					
Seismic Zone (see Fig 6.2.10)							
			1	ľ			
1 2 3	0.075 0.15 0.25	Essential facilities Hazardous facilities Hi Special occupancy structures IV Standard occupancy structures V Low-risk Structures	1.25 1.25 1.00 1.00 1.00	1.50 1.50 1.00 1.00 1.00			

Table 7.2: Seismic zone coefficients and Structure Importance coefficients, I, I'

7.2 Input Data:

Earthq	uake Load
Soil type	S_3 ((for odd groups)
Zone	1 (for odd groups)

Time Period	Numerical	Seismic zone	Site Coefficient,	Importance
	Coefficient, Rw	factor, Z	S	Factor, I
Method A, 0.03	8	0.075	1.5	1

7.3 ETABS data input:

oads		C-KM-		Click To:	
Load	Туре	Self Wei Multipli		Add New Load	
Dead	Dead	√ 1	×.	Modify Load	
Dead	Dead	n n			
Live PW	Super Dead Super Dead	0		Modify Lateral Load	
FF		l o	10000000	Delete Load	
WX WY	Wind Wind	0	UBC 94 UBC 94	Delete Load	
EQX	Seismic	0	UBC 94		
EQY	Seismic	0	UBC 94		

Fig 7.1: Define static Load Case name

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Direction and Eccentricity				Seismic Coefficients		
🗹 X Dir		Y <mark>Dir</mark>		Seismic Zone Factor, Z		
X Dir + Eccentricity		Y Dir + Eccentricit	у	Per Code	0.075	~
X Dir - Eccentricity		Y Dir - Eccentricity	r	O User Defined		
Ecc. Ratio (All Diaph.)	6		14		non second	
mane come car mapping				Site Coefficient, S	1.5	~
Overwrite Eccentricities		Overwrite	-	Importance Factor, I	1	
Time Period				Story Range		
Method A	Ct (ft) =	0.03		Top Story	roof	~
Program Calculated	Ct (ft) =			Bottom Story	Base	~
O User Defined	⊤ =		sec		hi.	
Factors				-		
Numerical Coefficient, Rw		8		OK	Cance	

Fig 7.2: Seismic Load pattern for X direction (UBC 94)

X Dir + Eccentricity X Dir - Eccentricity		Y Dir Y Dir + Eccentricity Y Dir - Eccentricity		Seismic Coefficients Seismic Zone Factor, Z Per Code User Defined	0.075 ~	
Ecc. Ratio (All Diaph.) Overwrite Eccentricities		Overwrite,		Site Coefficient, S Importance Factor, I	1.5 1	~
Time Period				Story Range		
Method A	Ct (ft) =	0.03		Top Story	roof	~
O Program Calculated	Ct (ft) =			Bottom Story	Base	~
O User Defined	Τ =		sec			
Factors				01	C	
Numerical Coefficient, Rw		8		OK	Cancel	

Fig 7.3: Seismic Load pattern for Y direction (UBC 94)

Chapter–8 Analysis Data

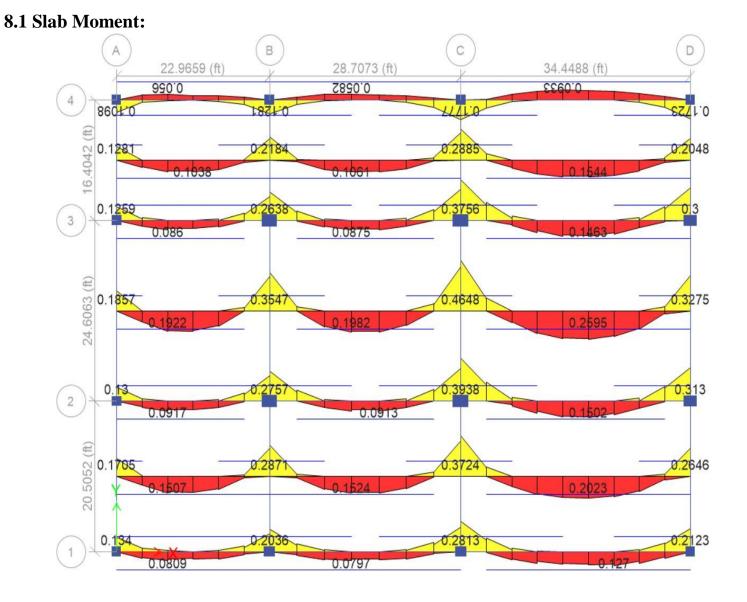


Fig 8.1: Moment Distribution in X Direction (Strip Method)

Max Top = 0.4648 *at* [51.6732, 32.8084]; *Max Bot* = 0.2595 *at* [70.8115, 32.8084]

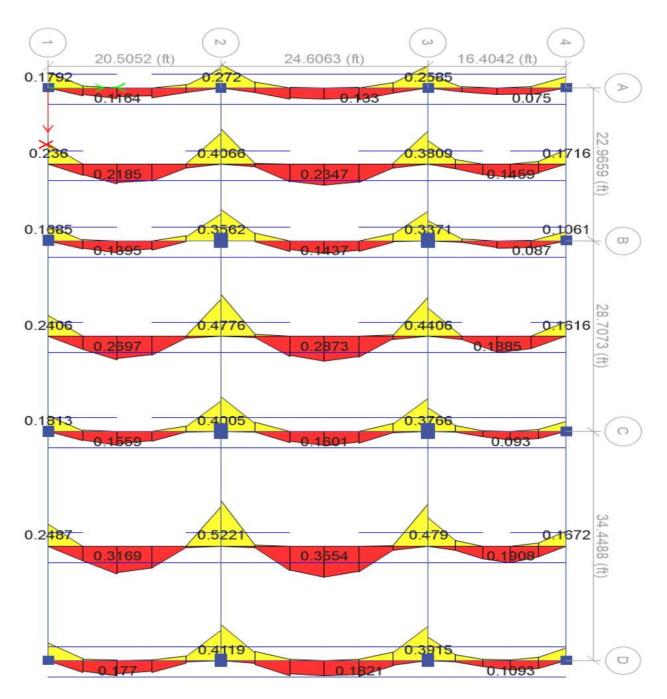


Fig 8.2: Moment Distribution in X Direction (Strip Method)

Max Top = 0.5221 at [68.8976, 20.5052]; Max Bot = 0.2595 at [68.8976, 32.8084]

8.2 Beam Longitudinal Reinforcement:

1 (A)) B		(1) (C)					
	0.2764 0.0609 0.1153	0.3579 0.0741 0.3572	l	0.4110	0.0935	0.4399		ROOF
2.5600	0.1325 0.2137 0.1351 0.5654 0.1254 0.1254	0.1683 0.2386 0.1679	3.2000	0.2283	0.4816	0.2133	2.5600	
2.5600	0.2711 0.2007 0.1906 0.7723 0.3264 1.0963	0.2176 0.2754 0.1709	3.2000	0.1773	0.3040	0.4004	4.1749	Story 5
2.5600	0.5805 1.0963 0.6566 0000 	0.9785 1.2644 1.0963	3.2000	1.3403	2.4287	1.1836	2.5600	Story 4
2.5600	0.5325 0.1496 0.1496 0.2765 0.2173 0.1930 0.3325 0.0810 0.1233	0.5113 0.1546 0.2631 0.2729 0.3299 0.2118 0.4069 0.0997 0.3695	3.2000	0.4606 0.2553 0.4618	0.2543 0.3962 0.1359	0.8731 0.4585 0.5670	2.5600	Story 3
2.5600	0.1645 0.1954 0.1248	0.2016 0.2444 0.1830	3.2000	0.2267	0.4238	0.2786	2.5600	Story 2
2.5600	0.1465 0.1821 0.0889 0.2206 0.0689 0.2396	0.2025 0.2514 0.1906	7.0370	0.2606	0.4086	0.2806	2.5600	Story 1 GF
2.5600	0.1162 0.1948 0.1257 99 99 99 99 99 99 99 99 99 99 99 99 99	0.2108 0.2554 0.2325	7.8459	0.3176	0.4448	0.2584	2.5600	-
_	→x							Base

Fig 8.3: Grid 1 Beam Longitudinal Reinforcement

2 A			2 C				2 D	
	0.1376 0.0538 0.2283	0.4594 0.0995 0.23	69	0.3303	0.1457	0.6233		ROOF
2.8800	0.1064 0.1952 0.1118 00 9.5	0.2188 0.2248 0.11	5.6000	0.1942	0.4344	0.3037	4.3200	
	0.4569 0.0980 0.0980	0.5635 0.1164 0.13		0.2482	0.1815	0.9840		Story 5
2.8800	0.2169 0.1355 0.1106	0.2044 0.2035 0.20	5.6000	0.1015	0.2393	0.4450	4.3200	
	1.0963 0.6858 2.1688	3.1874 1.0190 3.32		5.6417	1.2306	4.7462		Story 4
2.8800	1.0963 1.8379 1.0963	1.5078 2.6669 1.56	27 0000	2.5715	4.8242	2.4981	4.3200	Story 4
	0.4688 0.1328 0.1328	0.5941 0.1759 0.19		0.3838	0.3308	1.0644		Story 3
2.8800	0.2442 0.1723 0.1389 0000 0.1965 0.0501 0.2075	0.3144 0.3215 0.24	5.6000	0.3308	0.4023	0.5726	4.3200	5101 y 5
2.8800	0.0969 0.1768 0.1024	0.2224 0.2378 0.14	10.5469	0.1766	0.3766	0.3181	4.3200	Story 2
	0.2130 0.0538 0.2146	0.4372 0.1103 0.29	-	0.4408	0.1665	0.6612		Story 1
3.5320	0.1065 0.1698 0.1072	0.2187 0.2476 0.14	18.9174	0.2213	0.3703	0.3301	5.3207	65
3.9672	0.0957 0.1881 0.1302	0.2164 0.2564 0.19		0.2785	0.3968	0.3067	5.8863	GF
	→ X 🚽						_	Base

Fig 8.4: Grid 2 Beam Longitudinal Reinforcement

3 A) B		30				3 D	
	0.1402 0.0516 0.2213	0.4441 0.0951 0.2497		0.3383	0.1407	0.6092		ROOF
2.8800	0.1046 0.1956 0.1080 0.4469 0.0951 0.0951	0.2108 0.2233 0.1144	5.6000	0.1802	0.4279	0.2957	4.3200	
2.8800	0.2117 0.1384 0.1121 0000 0000 00000 00000	0.2546 0.2572 0.1875	5.6000	0.1747	0.2439	0.4286	4.3200	Story 5
2.8800	1.0963 0.6403 2.0170 1.0963 1.7231 1.0963 0.4589 0.1311 0.1311	2.9731 0.9527 3.0854 1.4123 2.4779 1.4631 0.5789 0.1728 0.2047	5.6000	5.2358 2.3724 0.4015	1.1395 4.3819 0.3193	4.3543 2.2940 1.0250	4.3200	Story 4
2.8800	0.2398 0.1765 0.1412	0.3073 0.3170 0.2345	5.6000	0.3193	0.4017	0.5519	4.3200	Story 3
2.8800	0.0990 0.1763 0.0999	0.2176 0.2373 0.1454	7.5058	0.1800	0.3745	0.3143	4.3200	Story 2
2.8800	0.1073 0.1706 0.1058	0.2153 0.2470 0.1513	14.8857	0.2257	0.3693	0.3248	4.3200	Story 1
2.8800	0.0967 0.1884 0.1295	0.2147 0.2561 0.1920	15.8527	0.2811	0.3971	0.3044	4.3200	GF
	→X 由							Base

Fig 8.5: Grid 3 Beam Longitudinal Reinforcement

4 A	4 B		(4) (C)				4 D	
	0.2812 0.0616 0.1222	0.3429 0.0789 0.3737	I.	0.4048	0.0960	0.4573		ROOF
2.5600	0.1345 0.2053 0.1238 0.5528 0.1208 0.1208	0.1615 0.2490 0.1768	2.8800	0.2277	0.4768	0.2158	2.5600	
2.5600	0.2638 0.1836 0.1703 00 80 80 80 80 80	0.1970 0.2739 0.1515	2.8800	0.1737	0.3167	0.3922	2.5600	Story 5
2.5600	0.7703 0.2913 1.0963 0.4884 1.0963 0.5856	1.3170 0.5465 1.7067 0.8602 1.1053 1.0963	2.8800	2.3682 1.1373	0.7443 2.0694	1.4990 1.0963	2.5600	Story 4
~	0.5243 0.1497 0.1497	0.4894 0.1530 0.3009	~	0.4637	0.2494	0.8525	~	Story 3
2.5600	0.2738 0.2105 0.1803	0.2645 0.3365 0.2017	2.8800	0.2569	0.4083	0.4486	2.5600	
2.5600	0.1660 0.1885 0.1152	0.1941 0.2469 0.1899	2.8800	0.2247	0.4226	0.2864	2.5600	Story 2
2.5600	0.2949 0.0743 0.1686 0.1476 0.1774 0.0844 0.2224 0.0716 0.2498	0.3939 0.1013 0.3990 0.1975 0.2526 0.2001 0.3970 0.1318 0.4662	4.6177	0.5210 0.2596 0.6132	0.1423 0.4102 0.1705	0.5707 0.2841 0.5017	2.5600	Story 1
2.5600	0.1173 0.1924 0.1309	0.2084 0.2560 0.2427	5.1628	0.3170	0.4464	0.2620	2.5600	GF
	→ X 👘							Base

Fig 8.6: Grid 4 Beam Longitudinal Reinforcement

8.3 Column Reaction:



Fig 8.7: Column Reaction

8.4 Column Analysis Data:

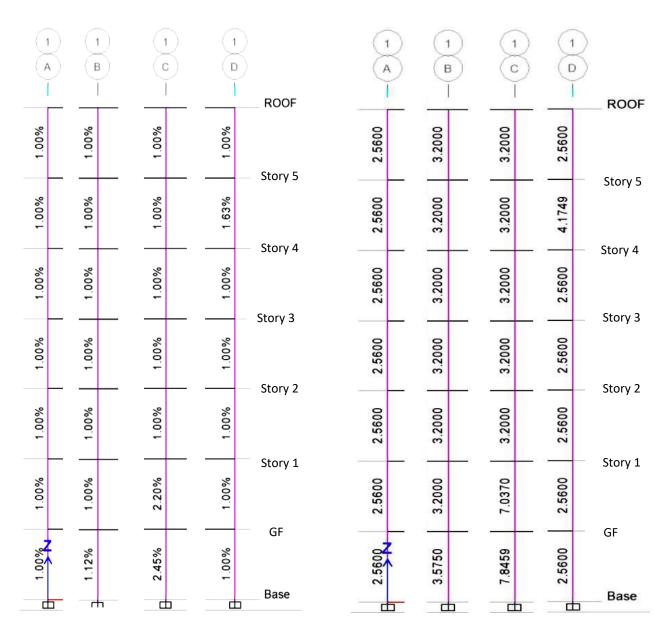


Fig 8.8: Grid 1 Rebar Percentage & Area

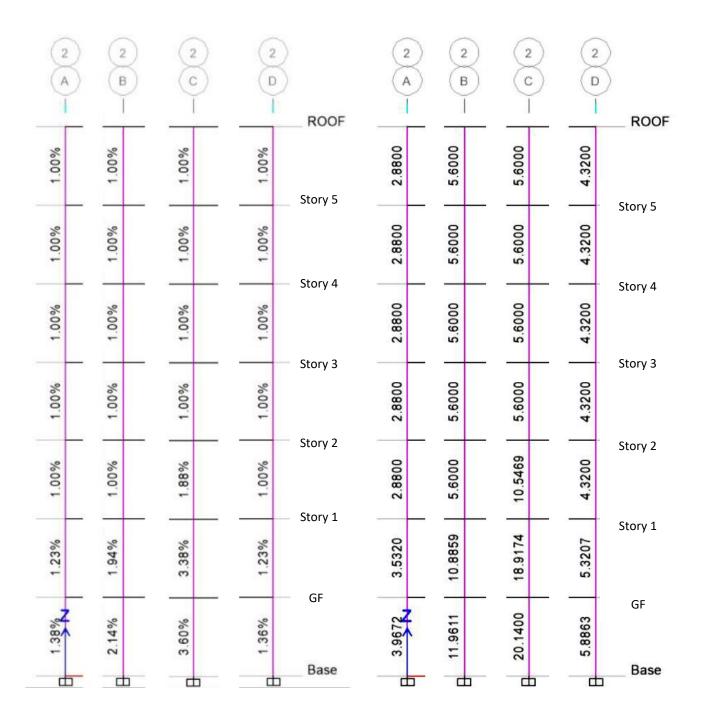


Fig 8.9: Grid 2 Rebar Percentage & Area

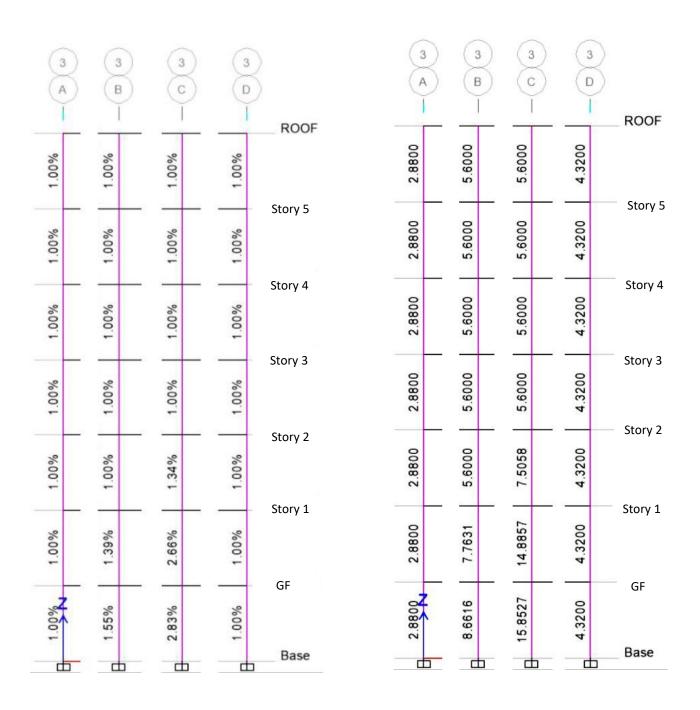


Fig 8.10: Grid 3 Rebar Percentage & Area



Fig 8.11: Grid 4 Rebar Percentage & Area

References

- Table 6.2.8 (Basic Wind Speeds for Selected Locations in Bangladesh), BNBC 1993
- 2.4.6.2 Sustained Wind Pressure formula (2.4.1) ,BNBC 1993
- Table 6.2.9 (Structu.re Importance Coefficients, C1 for Wind Loads) ,BNBC 1993
- Table 6.2.10 (Combined Height and Exposure Coefficient, Cz) ,BNBC 1993
- 2.4.6.3 Design Wind Pressure formula (2.4.2) ,BNBC 1993
- Table 6.2.11 (Gust Response Factors, Gh and Gz) ,BNBC 1993
- ▶ Fig. 6.2.10 Seismic Zoning Map of Bangladesh, BNBC 1993
- 2.5.6.1 Design Base Shear formula (2.5.1) ,BNBC 1993
- Table 6.2.22 (Seismic Zone Coefficients, Z) ,BNBC 1993
- Table 6.2.23 (Structure Importance Coefficients I, I') ,BNBC 1993
- 2.5.6.2 Structure Period formula (2.5.3) ,BNBC 1993
- Table 6.2.24 (Response Modification Coefficient for Structural Systems, R), BNBC 1993
- Table 6.2.25 (Site Coefficient, S for Seismic Lateral Forces) ,BNBC 1993
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Conclusion & Recommendation

Conclusion:

An initial design for a six story R.C.C building was done using BNBC 1993. Overall, the structure was completed as efficiently as possible, although it may require future revisions and may not entirely conform with the BNBC 1993 regulation. Because the structure was unlikely to be used in real life and the proportions were imagined, there were several problems that needed numerous changes and edits.

Only the basic planning and design of a six-story residential structure were completed and provided in this report. Due to a lack of time, the design of the staircase and foundation was ignored.

Recommendation:

Because this is only a model of an imaginary structure with hypothetical proportions, there may be several structural flaws. Furthermore, this research only included the preliminary and basic design, and the structure may require several changes and corrections. For the study to be more up to date and realistic, updated software and resources must be implemented. And as our group was the 5th one so because of that spacing between columns became huge, and for this the structure required more rebars than usual. So, using composite frames can bring down the column and beam size.