# 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 od 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

**P =** Axial Load of Column
**V =** Shear Stress
**h =** Slab Thickness
**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 national standards that have been authorized.

## 2.5 Earthquake Loads:

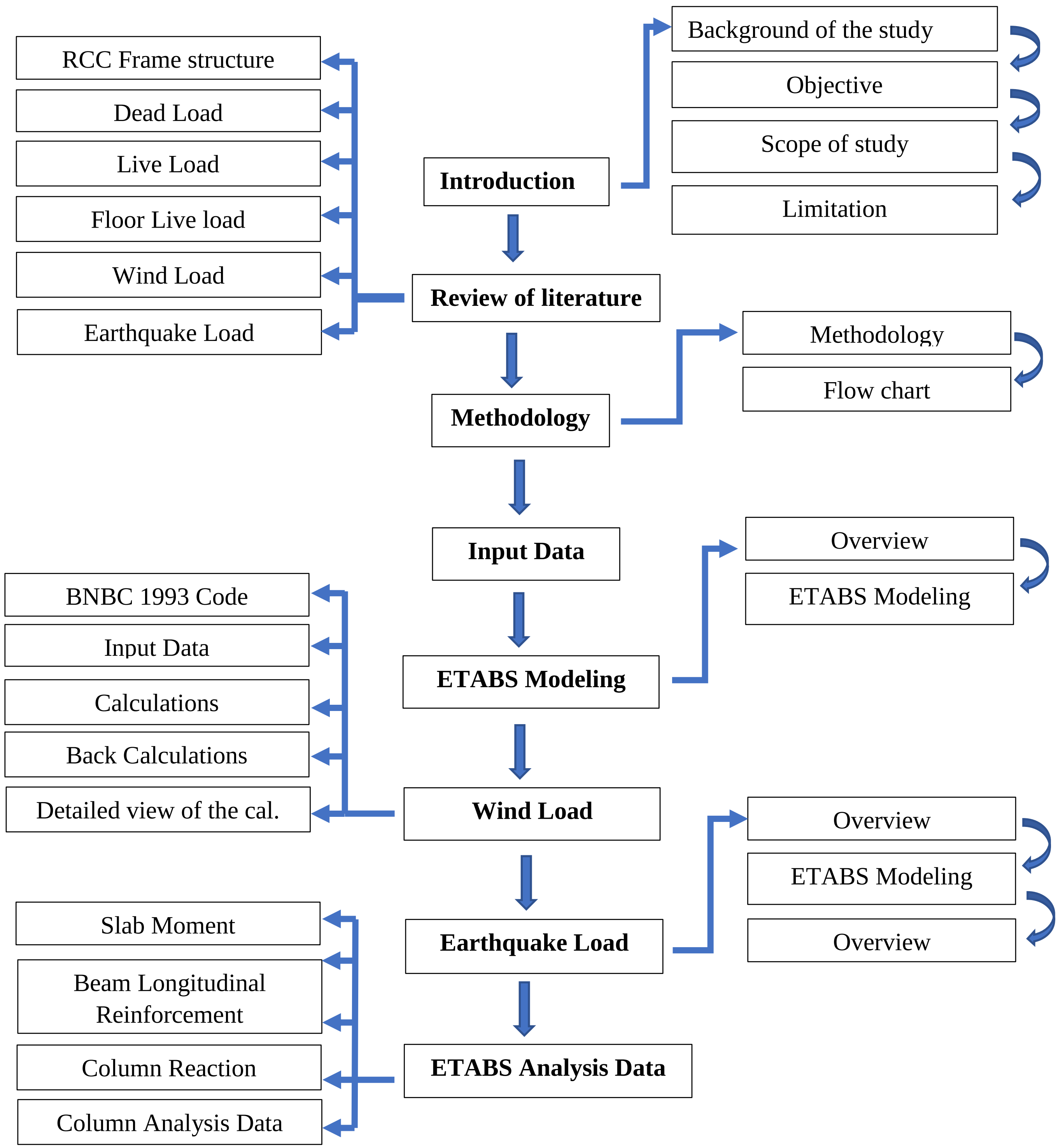
The earthquake provision is primarily intended to protect against severe structural collapses and loss of life, rather than to reduce damage or retain functionality. As a minimum, the structure and its components must be built and constructed to withstand the impacts of seismic ground movements as specified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

# Chapter 3: Methodology

## 3.1 General:

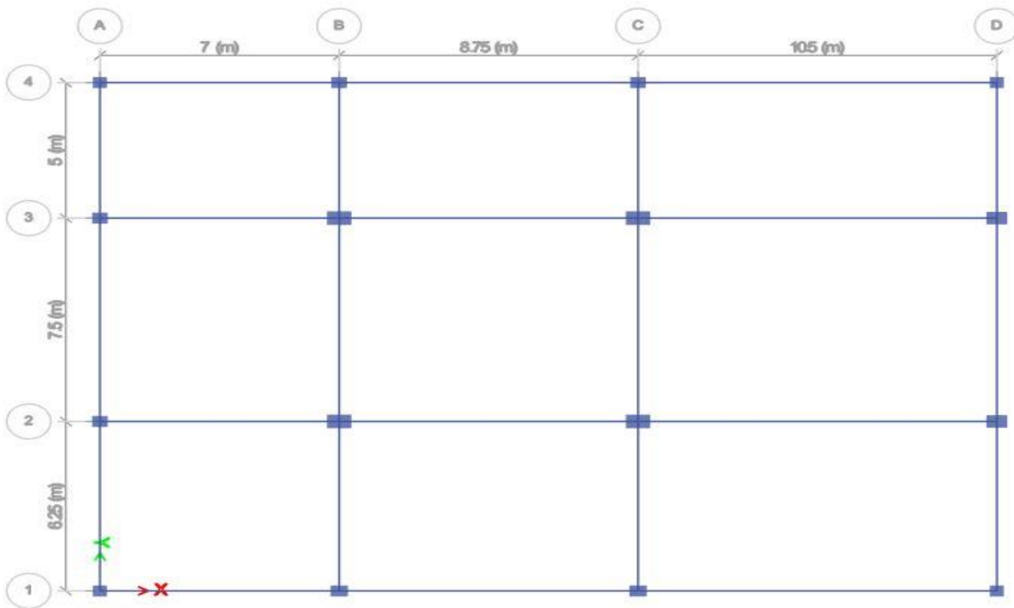
ETBAS has been used to create analysis and as a design tool. The calculations were made using the ACI, BNBC, and UBC codes, and the portal frame technique was utilized for analysis using the program ETABS. The building will be a six-story edge supported slab construction. Its elevation and plan have 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:




Typical story height 3.5m (IMRF Structure, RCC Building)

| | Contents | Properties |
|---|---|---|
| **Material Properties** | f 'c | 3.5 Ksi or 24.13 Mpa |
| | fy | 60 Ksi or 413.685 Mpa |

| | |
|---|---|
| **Slab thickness** | 150 mm (for membrane), |
| | 125 mm (for bending) |

| | | |
|---|---|---|
| **Dead and Live Loads** | LL (Live Load) | 3 $KN/m^2$ |
| | 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:

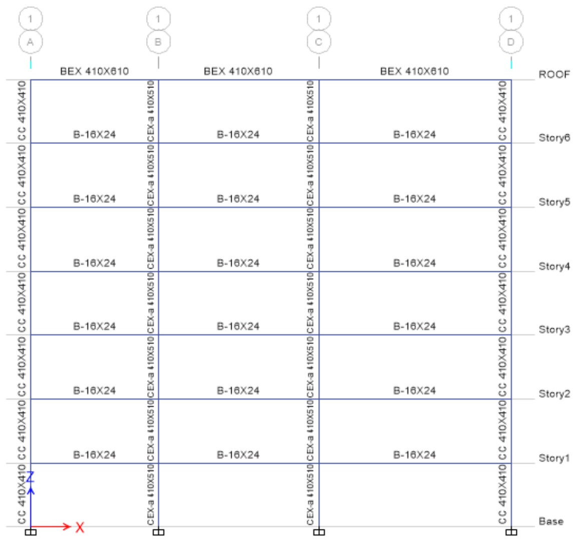



**Fig 4.1:** Grid 1A,1B,1C and 1D Column Position Layout


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

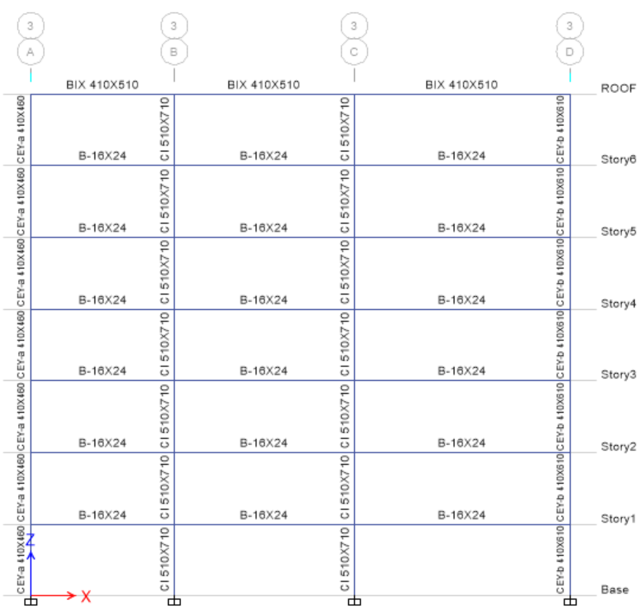



**Fig 4.3:** Grid 3A,3B,3C and 3D Column Position Layout

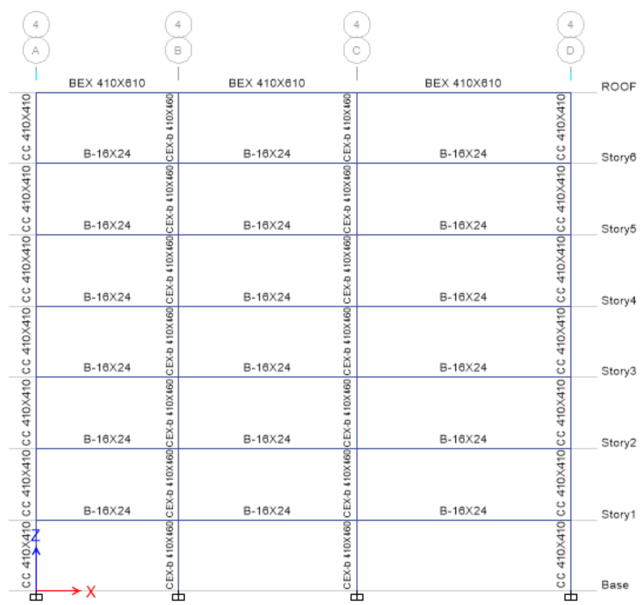



**Fig 4.4:** Grid 4A,4B,4C and 4D Column Position Layout

## 4.3 Beam Layout:

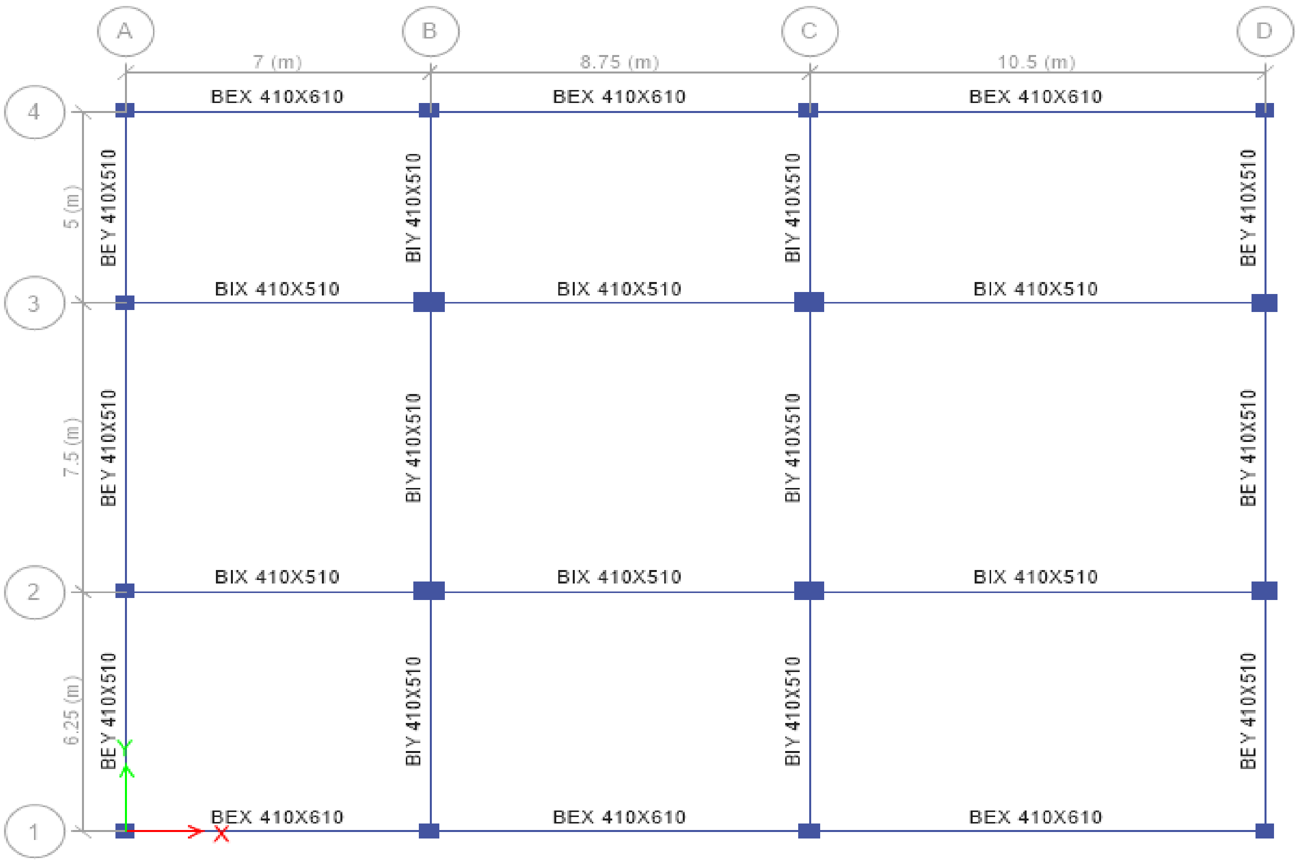



**Fig 4.5:** Beam Position Layout

# 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 cross-section or covering characteristics; frame elements 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:

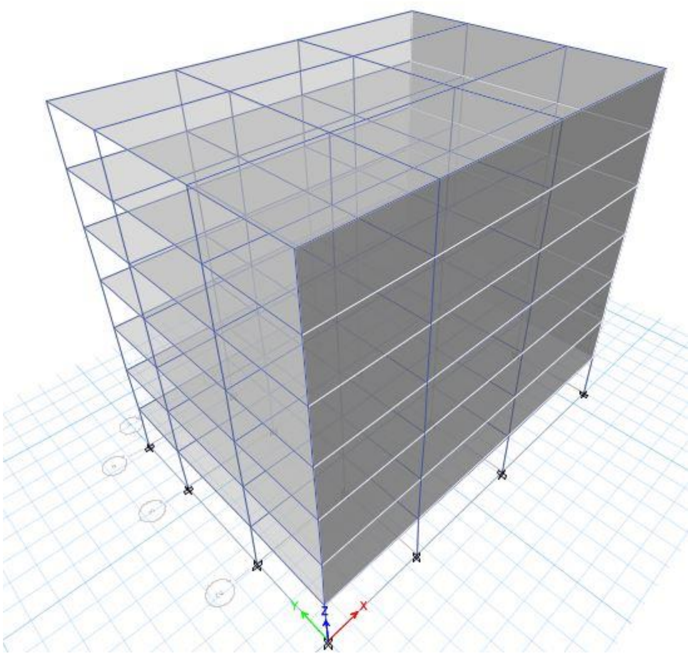



**Fig 5.1:** 3D view of the Building

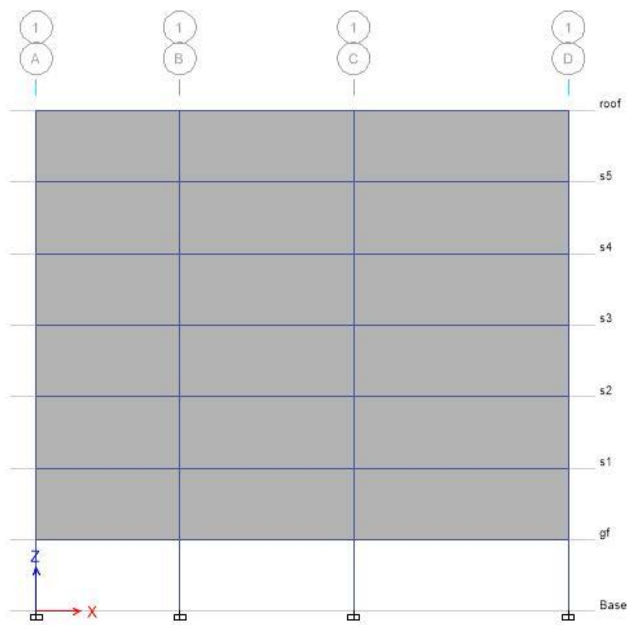



**Fig 5.2:** Elevation view of the Building

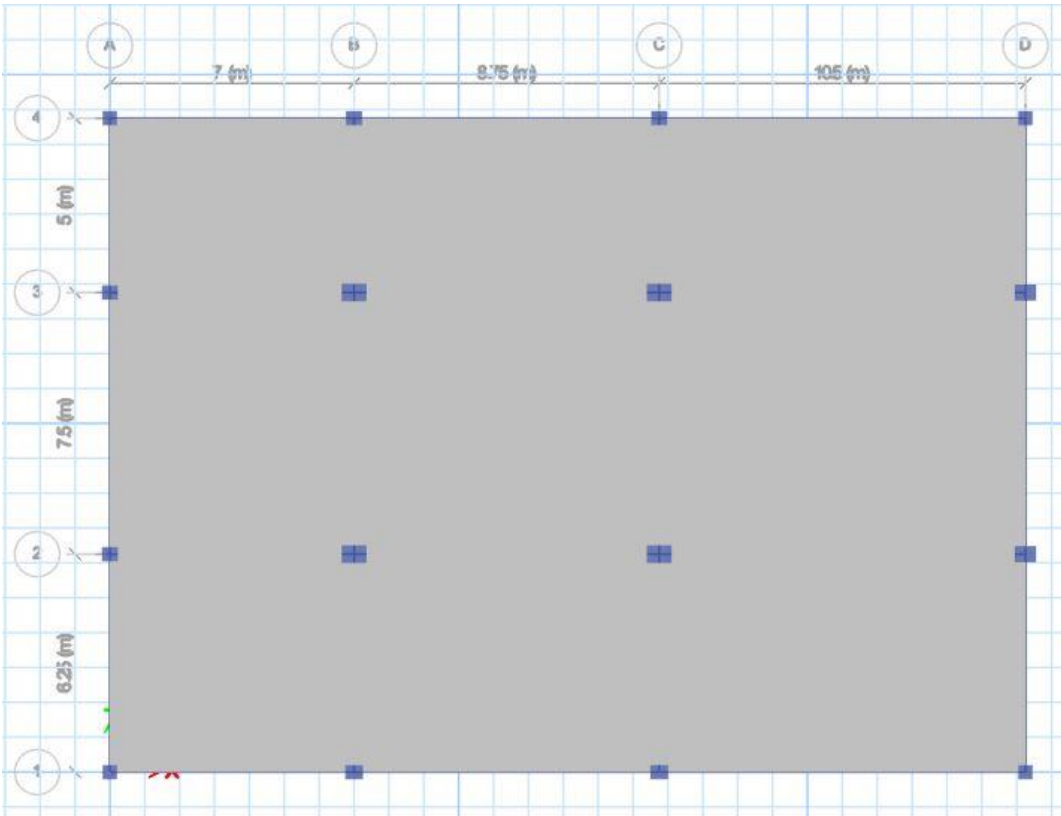



**Fig 5.3:** Column view of the Building

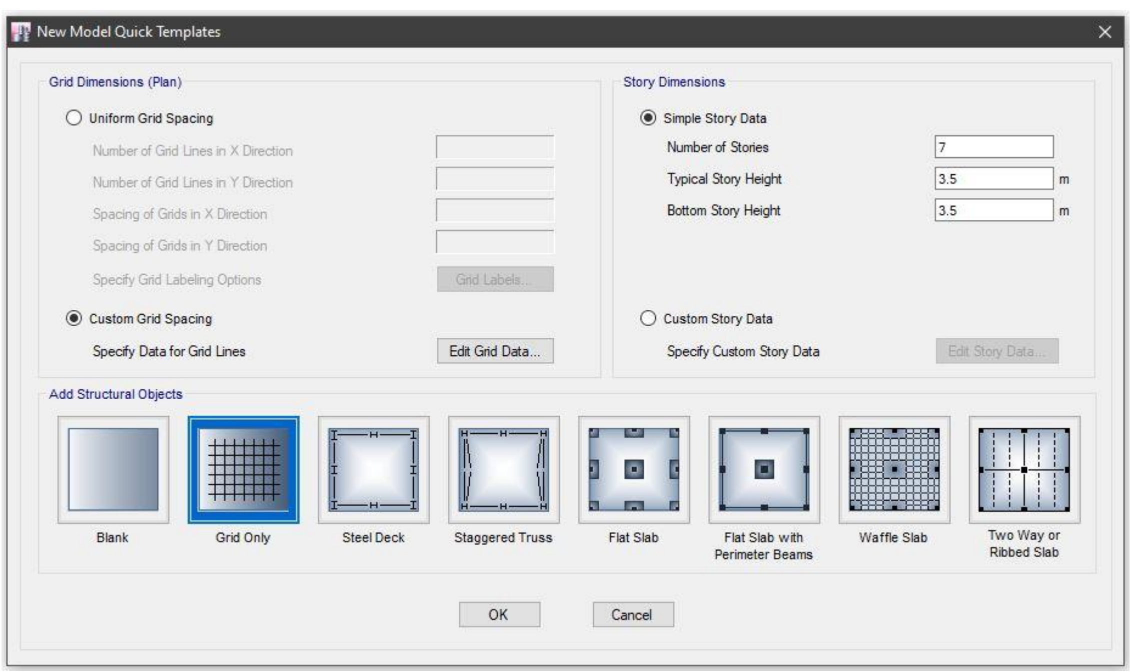



**Fig 5.4:** Building Plan grid system and story data definition

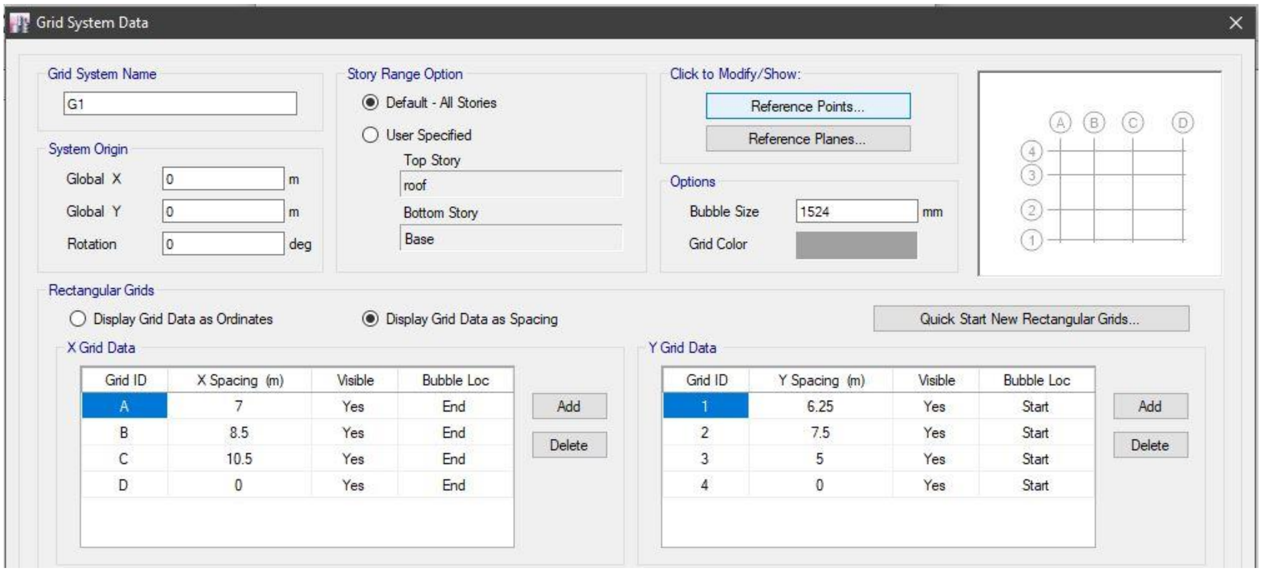



**Fig 5.5:** Define Grid Data

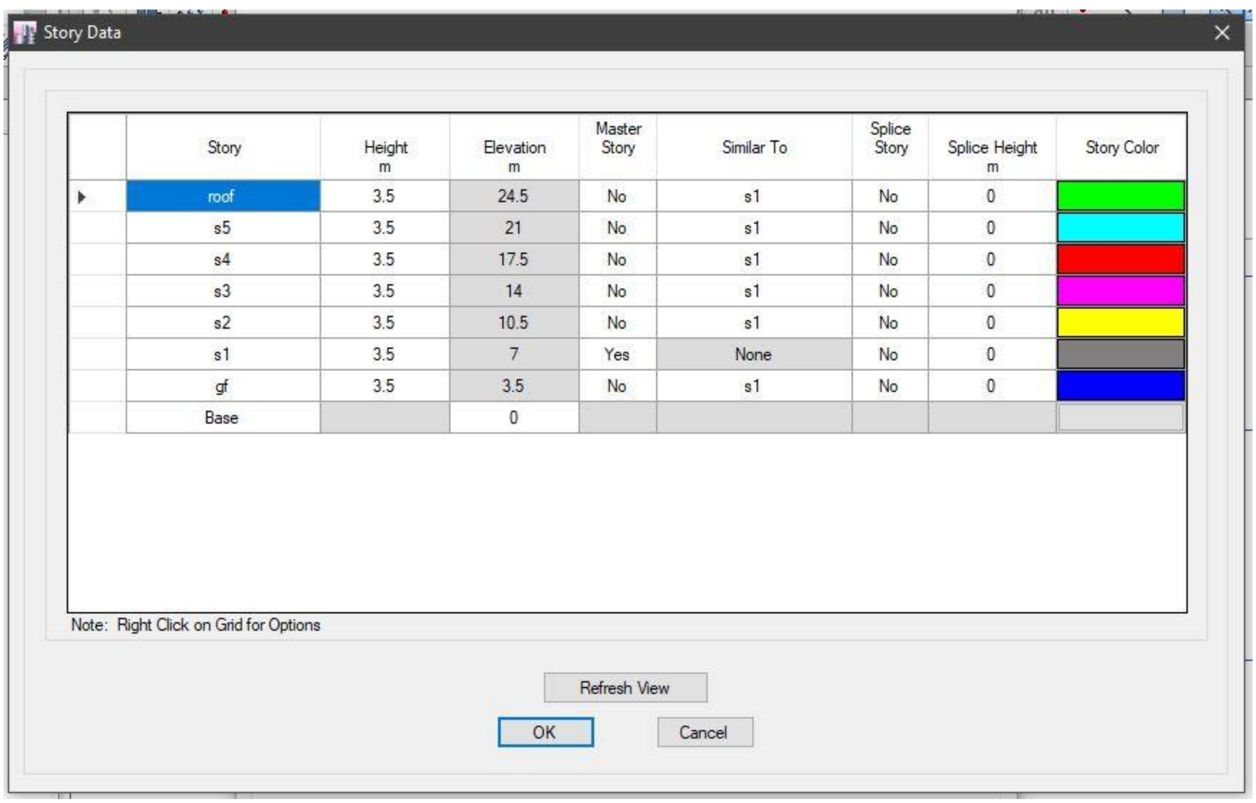
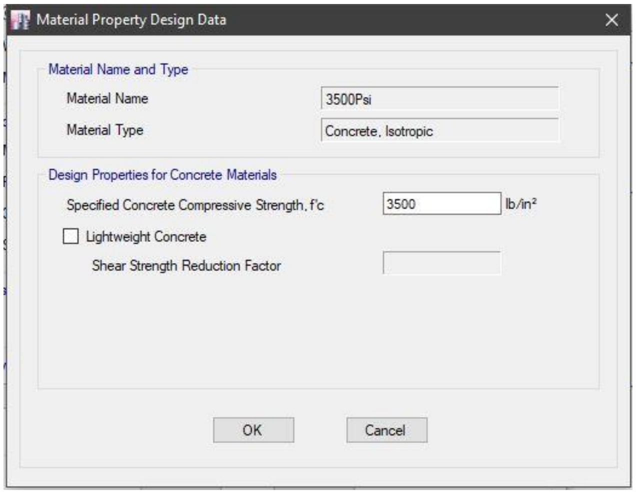



**Fig 5.6:** Story Data



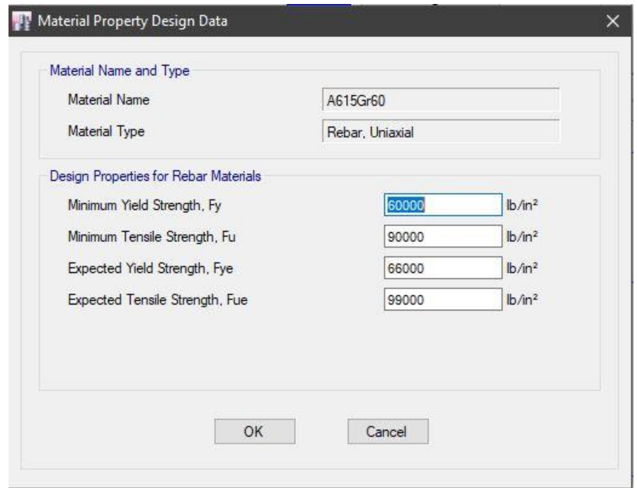




**Fig 5.7:** input concrete strength (Defining material properties)

**Fig 5.8:** Input rebar strength (Defining material properties)

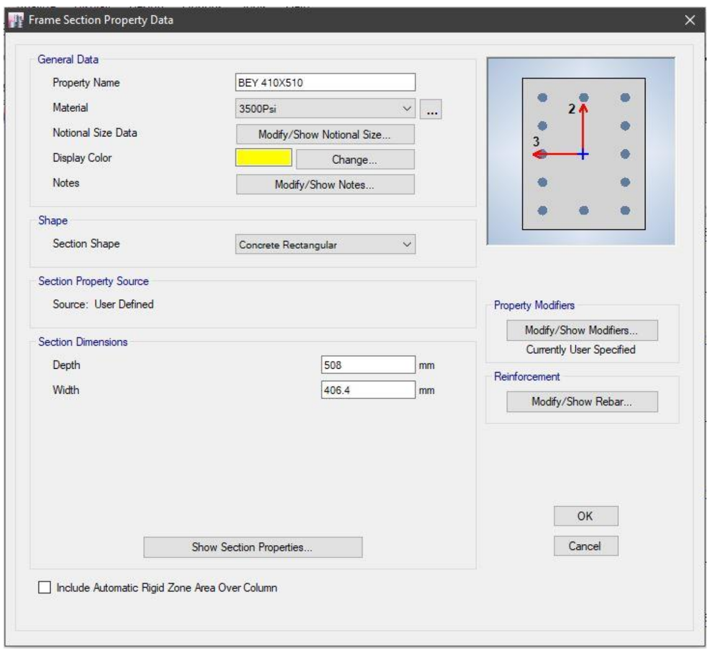



**Fig 5.9:** Defining Beam section proparty data

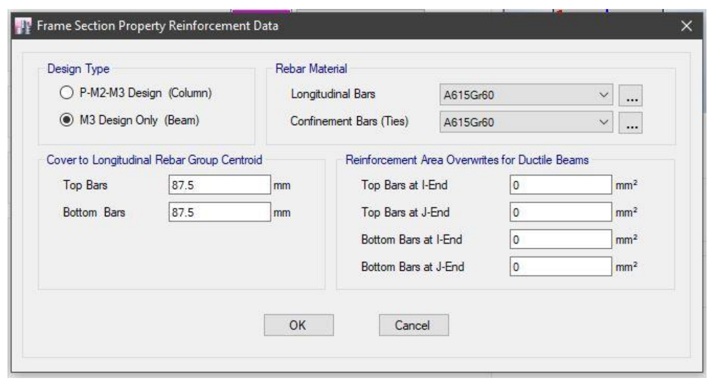
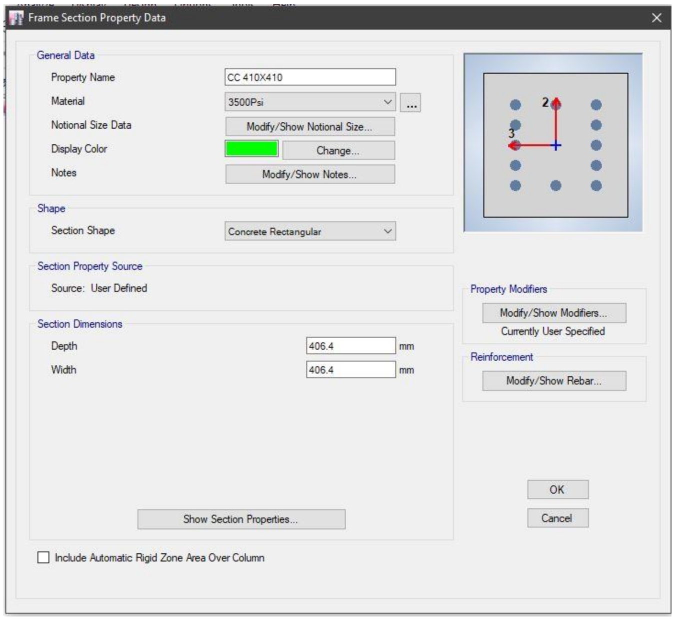



**Fig 5.10:** Defining Beam section proparty reinforcement data.



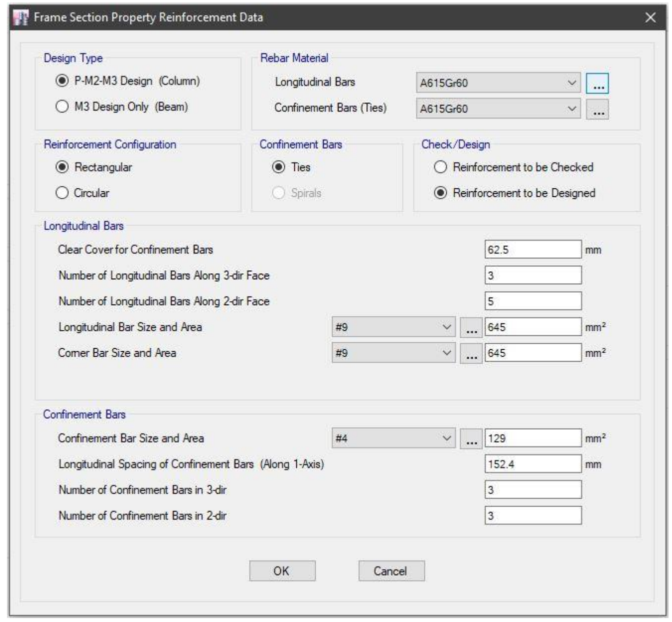




**Fig 5.11:** Defining Column section proparty data

**Fig 5.12:** Defining frame section proparty reinforcement data.

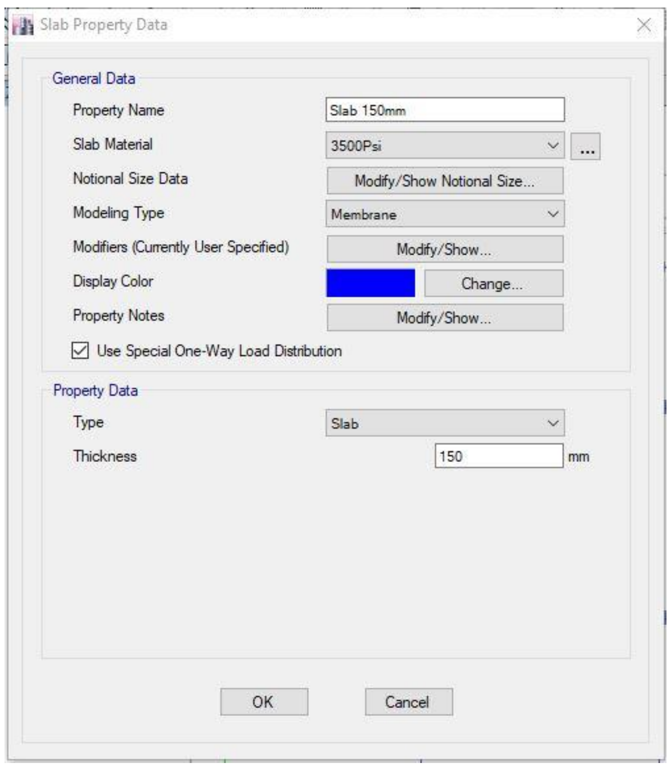



**Fig 5.13:** Defining slab section property data.

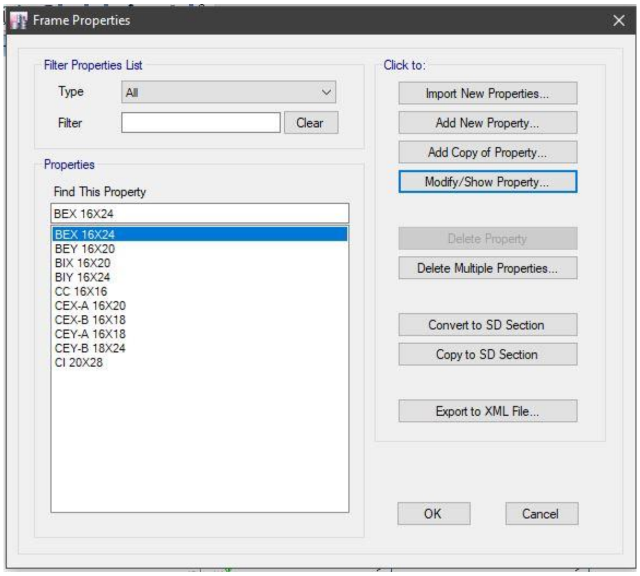



**Fig 5.14:** Frame properties

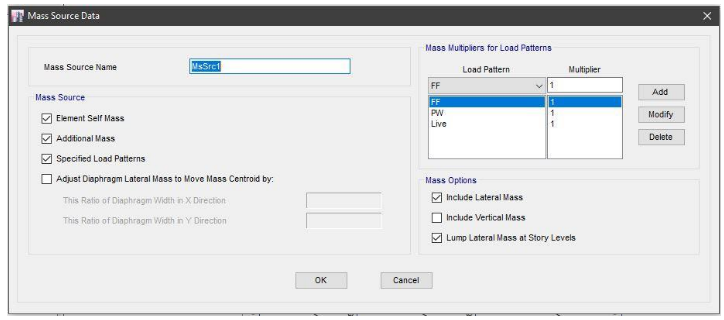



**Fig 5.15:** Defining mass source data.

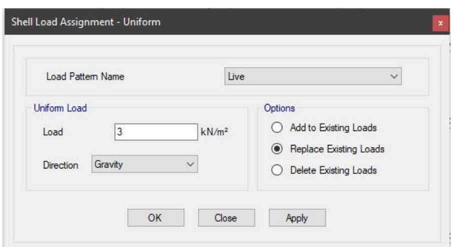



**Fig 5.16:** Assigning Live load

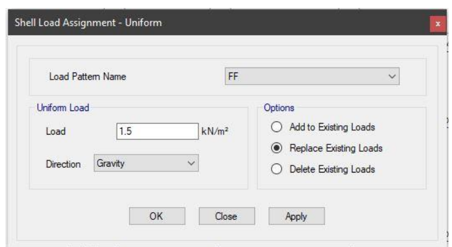



**Fig 5.17:** Assigning FF load

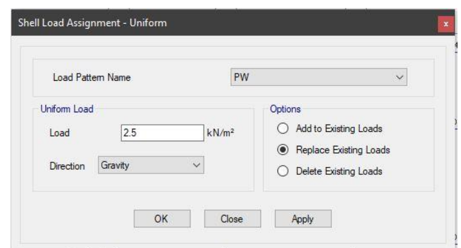



**Fig 5.18:** Assigning PW load

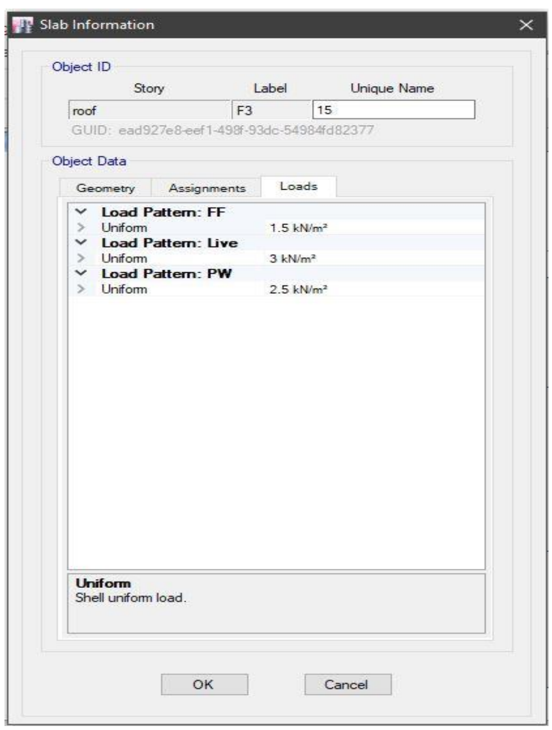



**Fig 5.19:** Slab Load Information

# Chapter 6: Wind Load

## 6.1 BNBC 1993 Code:

Combined Height and Exposure Coefficient, $C_z$

| Height above ground level, z (metres) | Coefficient, $C_z$ (1) | | |
|---|---|---|---|
| | 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 |

Note : (1) Linear interpolation is acceptable for intermediate values of z.

Table 6.2.11
Gust Response Factors, $G_h$ and $G_z$ (1)

| Height above ground level (metres) | $G_h$ (2) and $G_z$ | | |
|---|---|---|---|
| | 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 | 1.008 |
| 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 | 1.092 | 1.046 | 1.000 |
| 190.0 | 1.087 | 1.043 | 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 |

Note : (1) For main wind-force resisting systems, use building or structure height $h$ for z.
(2) Linear interpolation is acceptable for intermediate values of z.

**Table 6.1:** Combined height and exposure Coefficient $C_z$

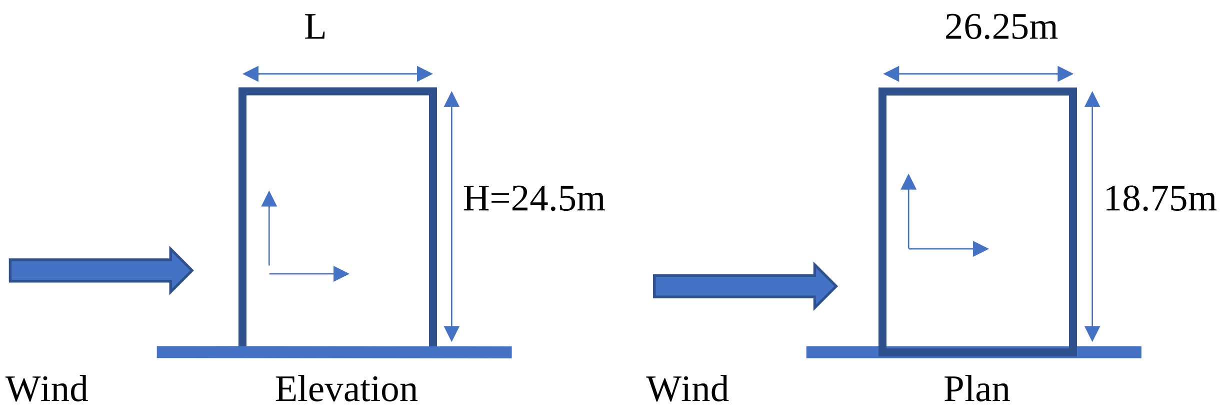
**Table 6.2:** Gust Response Factors, $G_h$ and $G_z$

## 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 $q_z$ | Gust coefficient $C_G$ | Pressure, Pz-x | Pressure, Pz-y |
|---|---|---|---|---|---|---|---|
| **1** | 238 Km/hr. | 47 x $10^{-6}$ | **1** | 2.67 $C_z$ KN/m$^2$ | 1.37179 | 4.8426 $C_z$ | 5.53 $C_z$ |

## 6.3 Calculations:




**Wind Pressure:**

$q_z = C_c\, C_z\, {V_b}^2$

$= 47 \text{ x } 10^{-6}\, x\; 1\; x\; C_z\; x\; 238^2$

$= 2.67\, C_z$ KN/m$^2$

Here,

$C_c = 47 \text{ x } 10^{-6}$

$C_i = 1$

$V_b$ = 238 Km/hr.

**Design Wind Pressure:**

Pz-x = $C_G\, C_p\, q_z$

= 1.37179 x 1.32 x 2.67 $C_z$

= 4.8426 $C_z$

Here,

$C_G$=1.37179

$C_p$=1.32

$q_z$=2.67 $C_z$

H/B= 1.31 m

L/B= 1.40 m

Pz-y = $C_G\, C_p\, q_z$

= 1.37179 x 1.51 x 2.67 $C_z$

=5.5300 $C_z$

Here,

$C_G$=1.37179

Cp = 1.51

H/B=0.93 m

L/B= 0.71

## 6.4 Back Calculations:

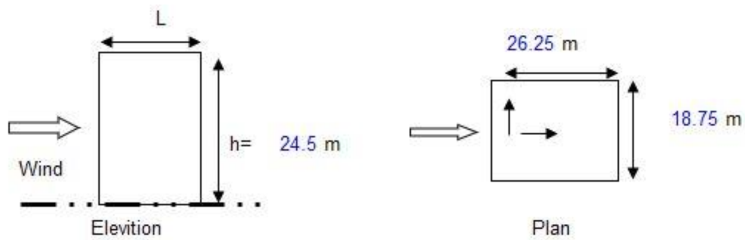
$$W_x = \left(\sqrt{\frac{\text{Given Value}}{\text{Etabs Value}}}\right) \text{ x Basic Wind Speed}$$

$$= \sqrt{\frac{301.7}{240.14}} \text{ X } 147.886 = 165.761 \text{ Km/hr.}$$

$$W_y = \left(\sqrt{\frac{\text{Given Value}}{\text{Etabs Value}}}\right) \text{ x Basic Wind Speed}$$

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

## 6.5 Detailed view of the calculations:




Dynamic Wind Speed = $C_c\ C_I\ C_z\ V_b$^2 (KN/m^2)
Exposer Condition = A
Basic Wind Speed = 238 km/h
Velocity to pressure co-efficient, $C_c$ = 4.72E-05
Structural Importance Co-efficient, $C_I$ = 1.0
Sustained wind pressure, qz = 2.6736 Cz
Gust co-efficient, $C_G$ = 1.37179
pressure,Pz-x = 4.8426 Cz
pressure,Pz-y = 5.5300 Cz
1 KN = 0.2 Kip

| Wind Dir-X | |
|---|---|
| B= | 18.75 |
| L= | 26.25 |
| | |
| h= | 24.5 |
| L/B= | 1.40 |
| h/B= | 1.31 |
| Cp= | 1.32 |

| Wind Dir-Y | |
|---|---|
| B = | 26.25 |
| L = | 18.75 |
| | |
| h = | 24.5 |
| L/B = | 0.71 |
| h/B = | 0.93 |
| Cp = | 1.51 |

**Wind Pressure Calculation:-**

| | | | | X-dir | | | | Y-dir | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Floor | Floor height | Height (m) from GL | Cz | Pz-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 | | | | | | | | | |
| 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

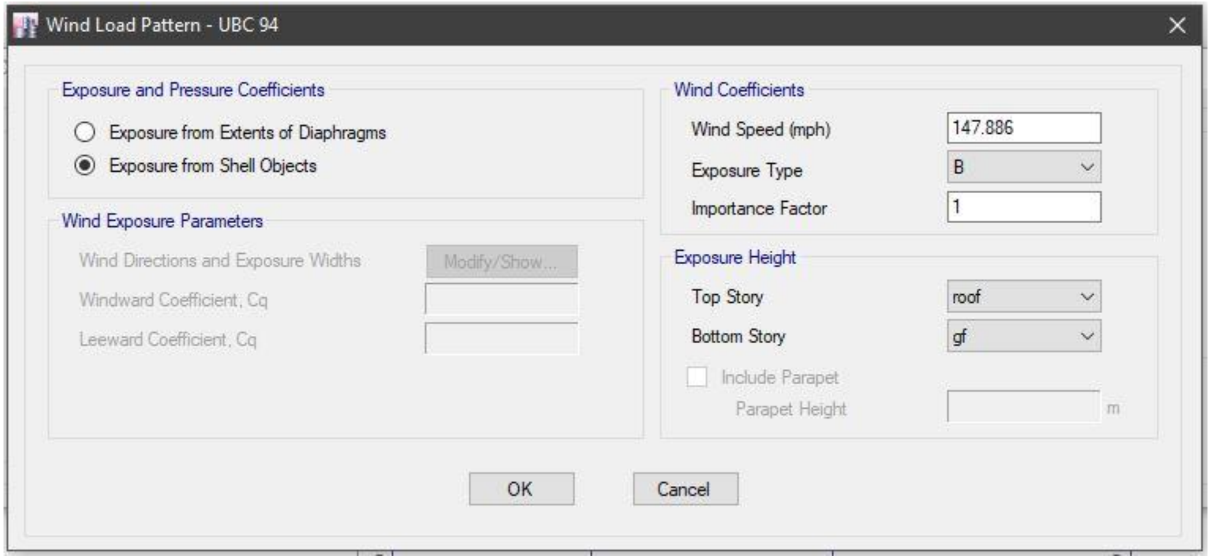



**Fig 6.2:** Wind Load pattern.

Base Reactions

1 of 8 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:

**Table 6.2.24**
**Response Modification Coefficient for Structural Systems, *R***

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

**Notes :**
(1) Basic Structural Systems are defined in Sec 1.3.2, Chapter 1.
(2) See Sec 2.5.6.6 for combination of structural systems, and Sec 1.3.5 for system limitations.
(3) Prohibited in Seismic Zone 3.
(4) Prohibited in Seismic Zone 3 except as permitted in Sec 2.5.9.3.
(5) Prohibited in Seismic Zones 2 and 3. Sec 1.7.2.6.

**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 :

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

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

Table 6.2.22
Seismic Zone Coefficients, Z

| Seismic Zone (see Fig 6.2.10) | Zone Coefficient |
|---|---|
| 1 | 0.075 |
| 2 | 0.15 |
| 3 | 0.25 |

Table 6.2.23
Structure Importance Coefficients *I*, *I'*

| Structure Importance Category (see Table 6.1.1 for occupancy) | | Structure Importance Coefficient *I* | *I'* |
|---|---|---|---|
| I | Essential facilities | 1.25 | 1.50 |
| II | Hazardous facilities | 1.25 | 1.50 |
| III | Special occupancy structures | 1.00 | 1.00 |
| IV | Standard occupancy structures | 1.00 | 1.00 |
| V | Low-risk Structures | 1.00 | 1.00 |

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

## 7.2 Input Data:

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

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

## 7.3 ETABS data input:

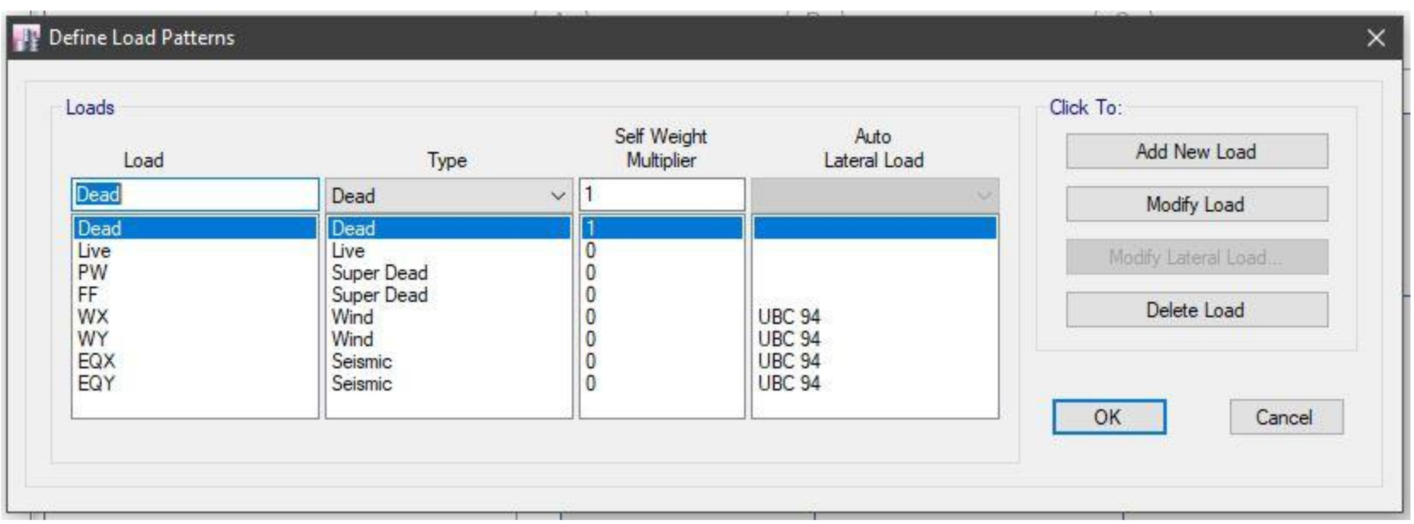



**Fig 7.1:** Define static Load Case name

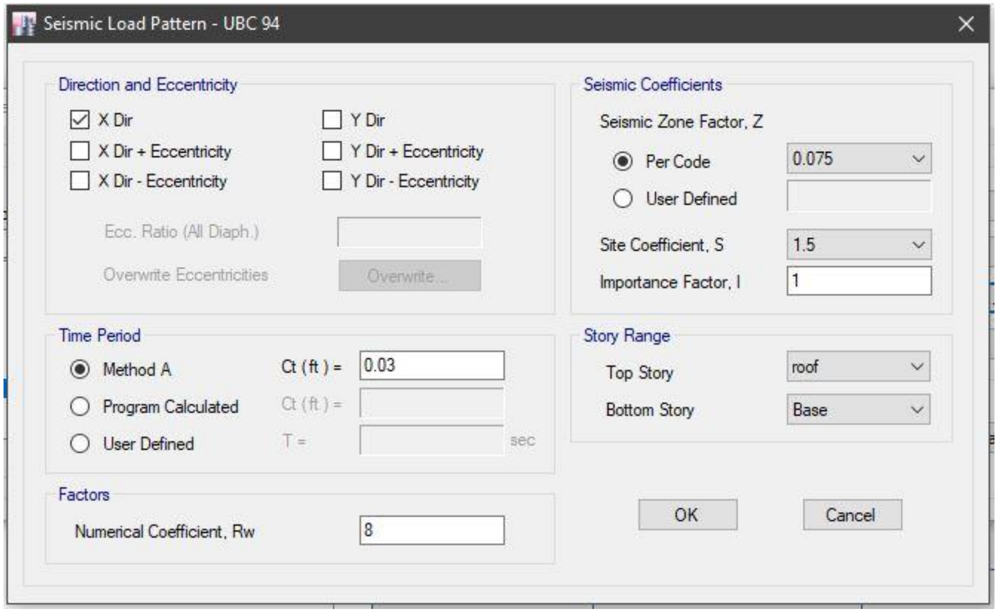



**Fig 7.2:** Seismic Load pattern for X direction (UBC 94)

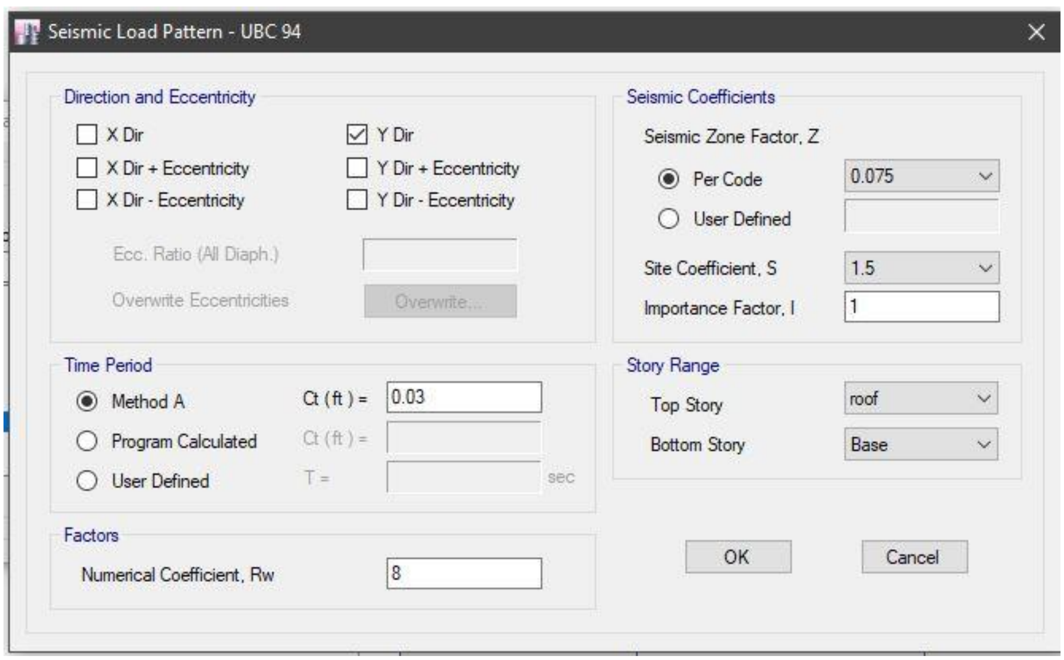



**Fig 7.3:** Seismic Load pattern for Y direction (UBC 94)

# Chapter–8 Analysis Data

## 8.1 Slab Moment:

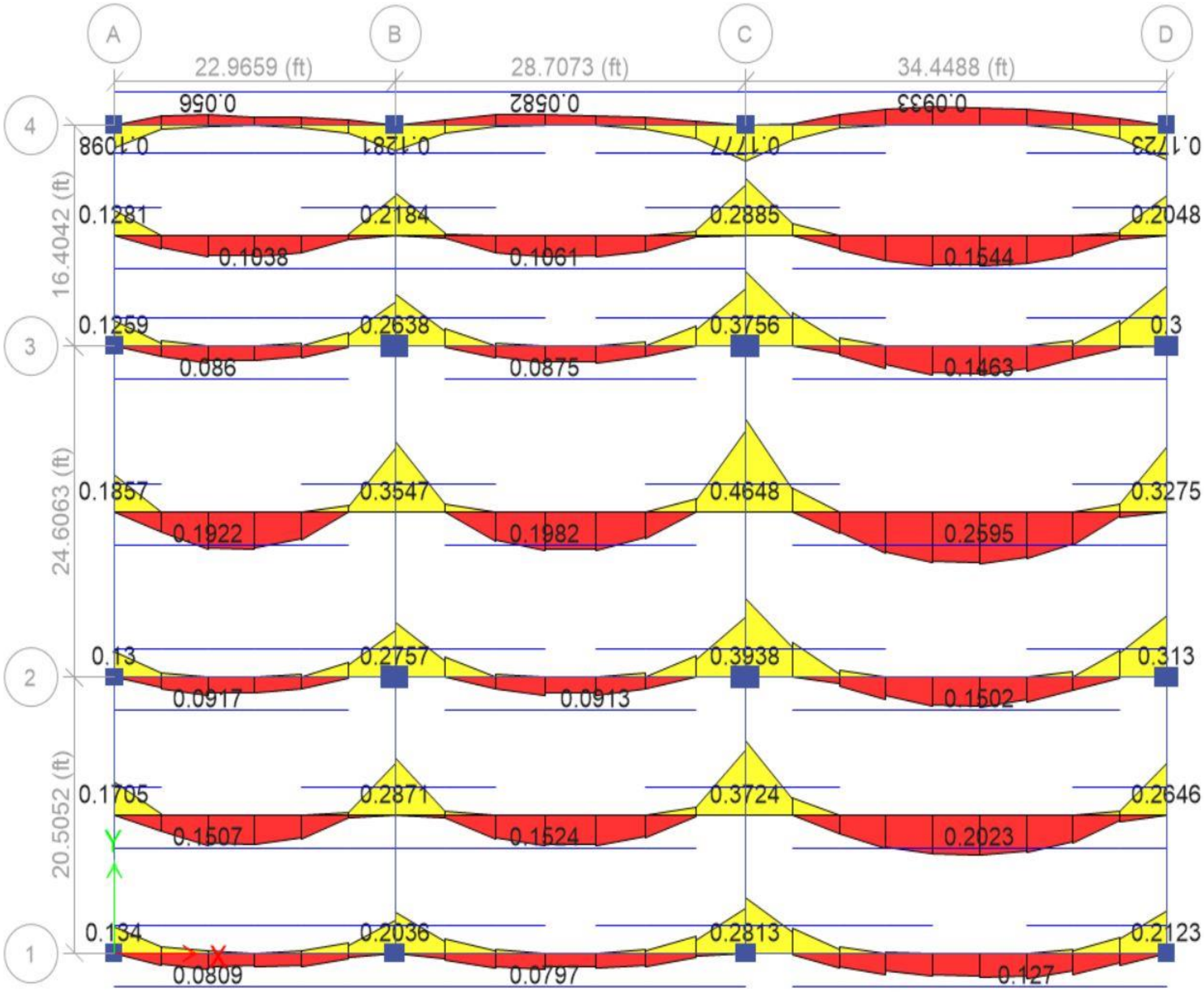



**Fig 8.1:** Moment Distribution in X Direction (Strip Method)

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

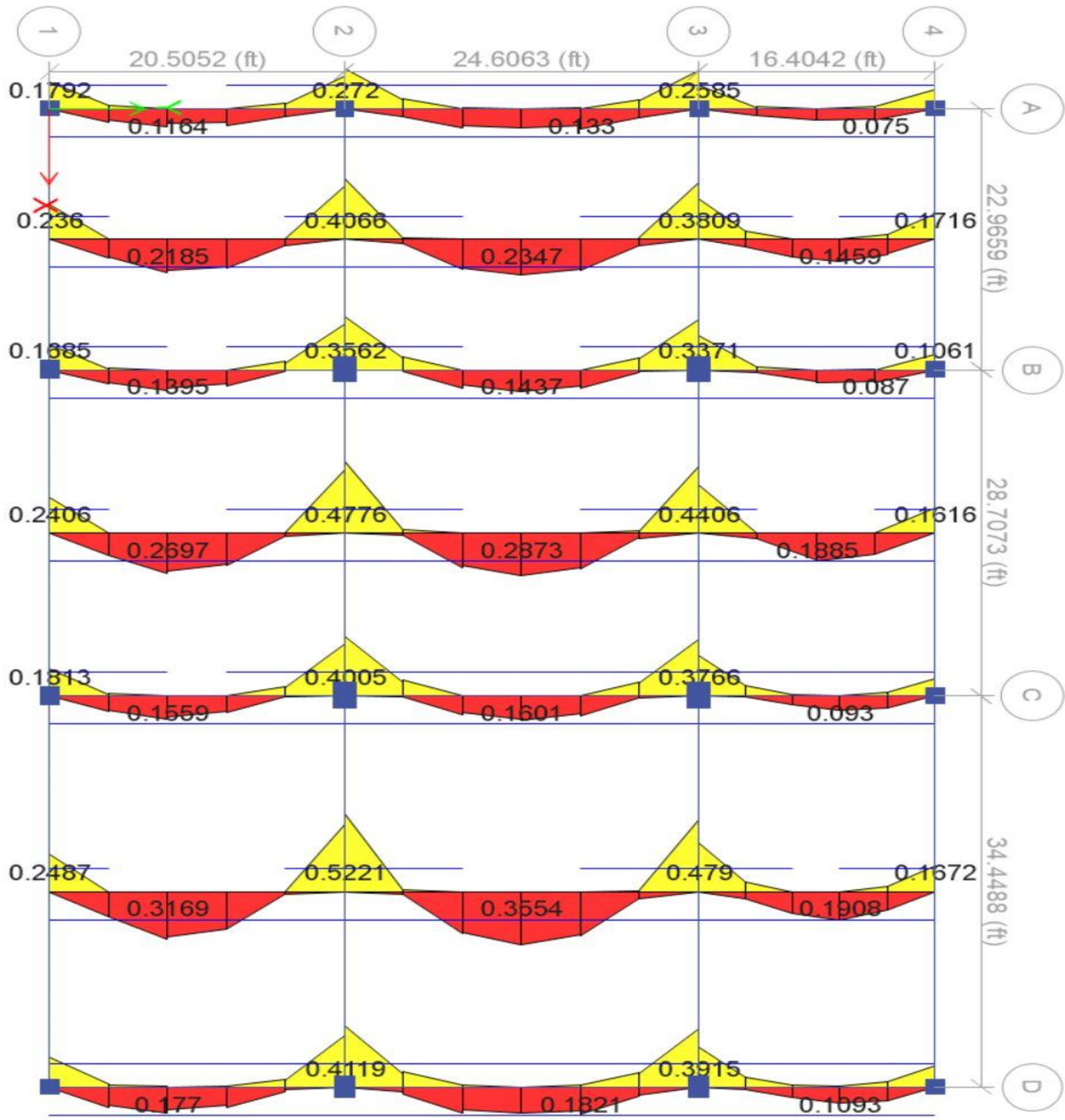



**Fig 8.2:** Moment Distribution in X Direction (Strip Method)

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

## 8.2 Beam Longitudinal Reinforcement:

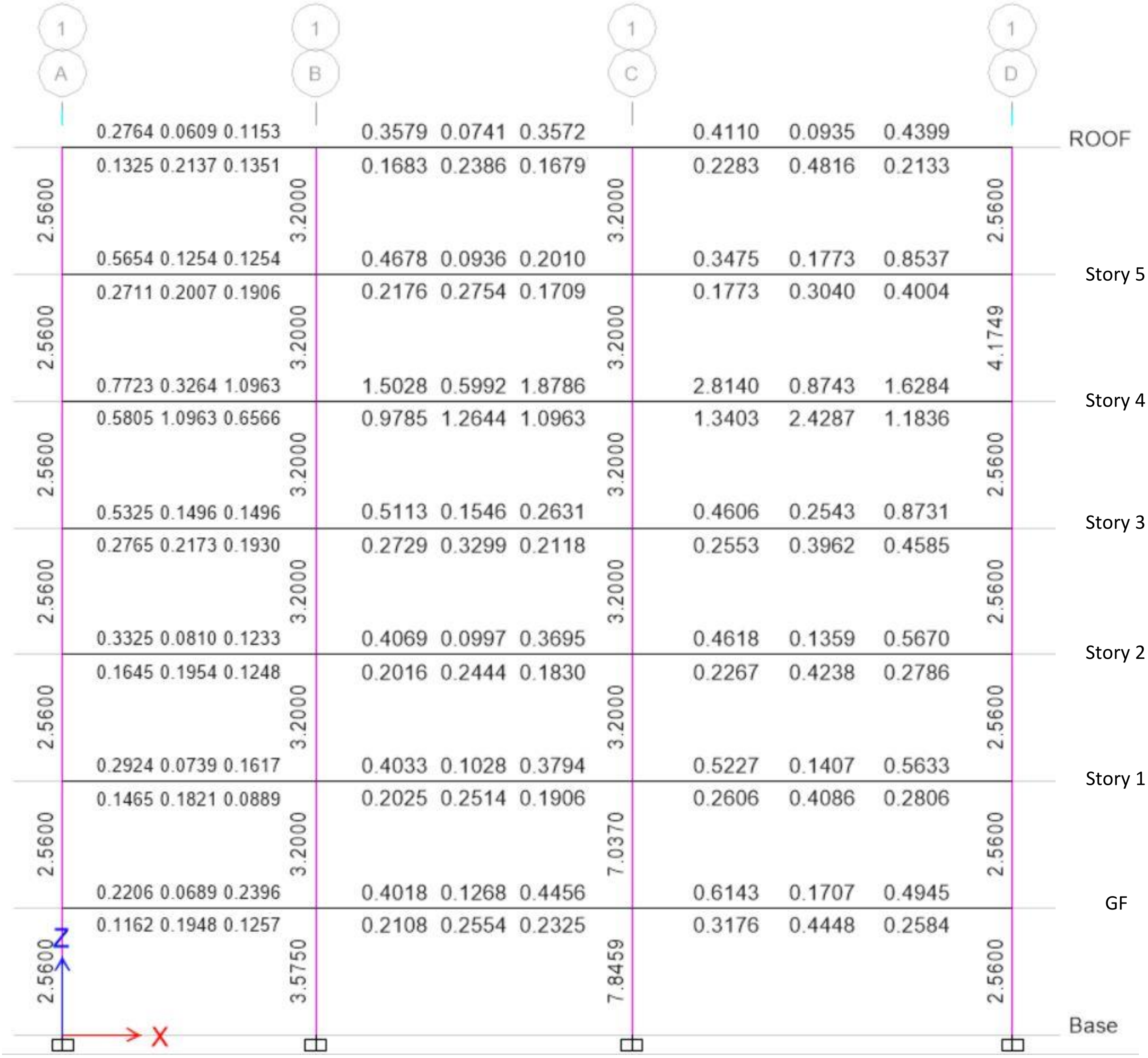



**Fig 8.3:** Grid 1 Beam Longitudinal Reinforcement

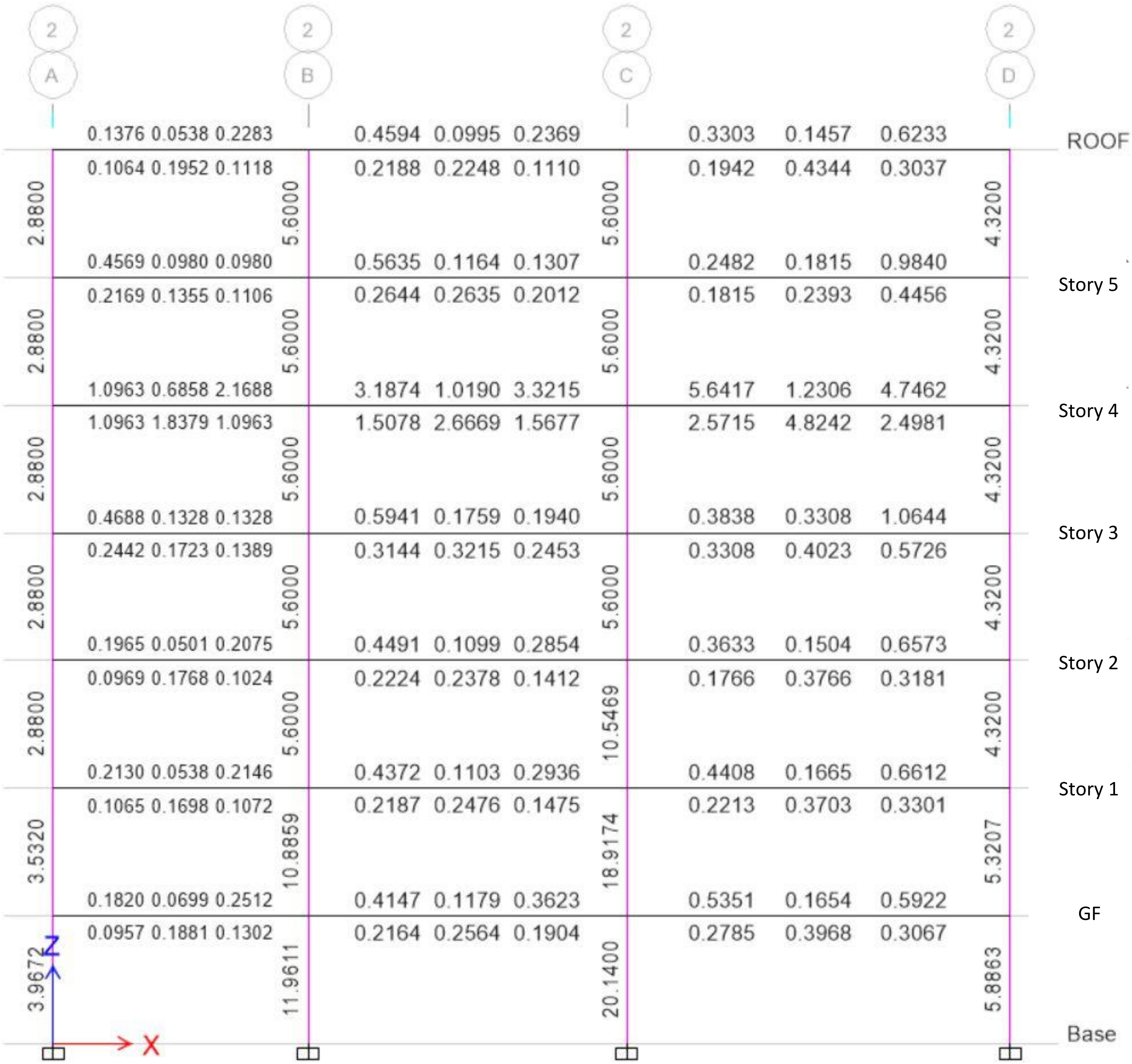



**Fig 8.4:** Grid 2 Beam Longitudinal Reinforcement

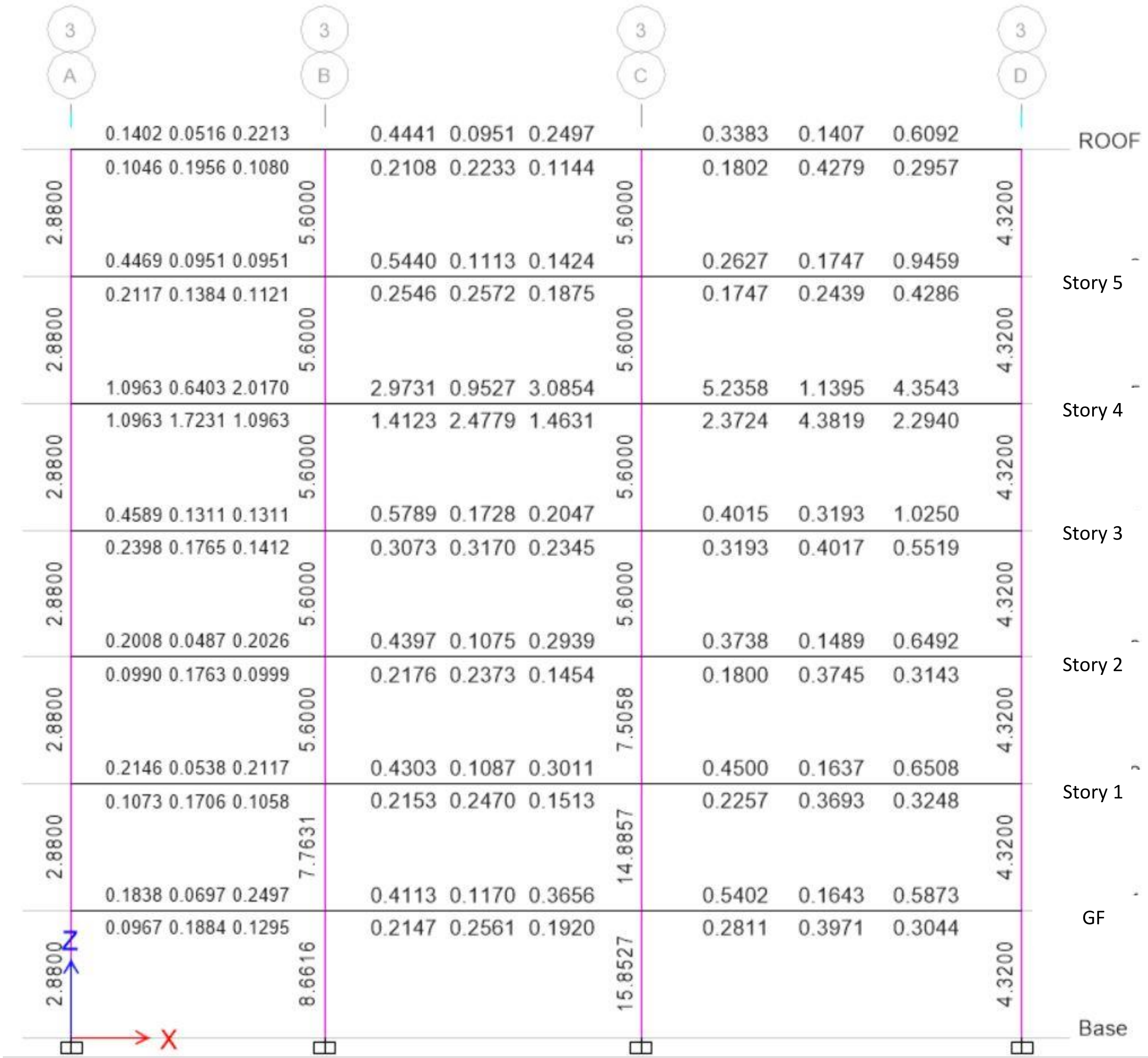



**Fig 8.5:** Grid 3 Beam Longitudinal Reinforcement

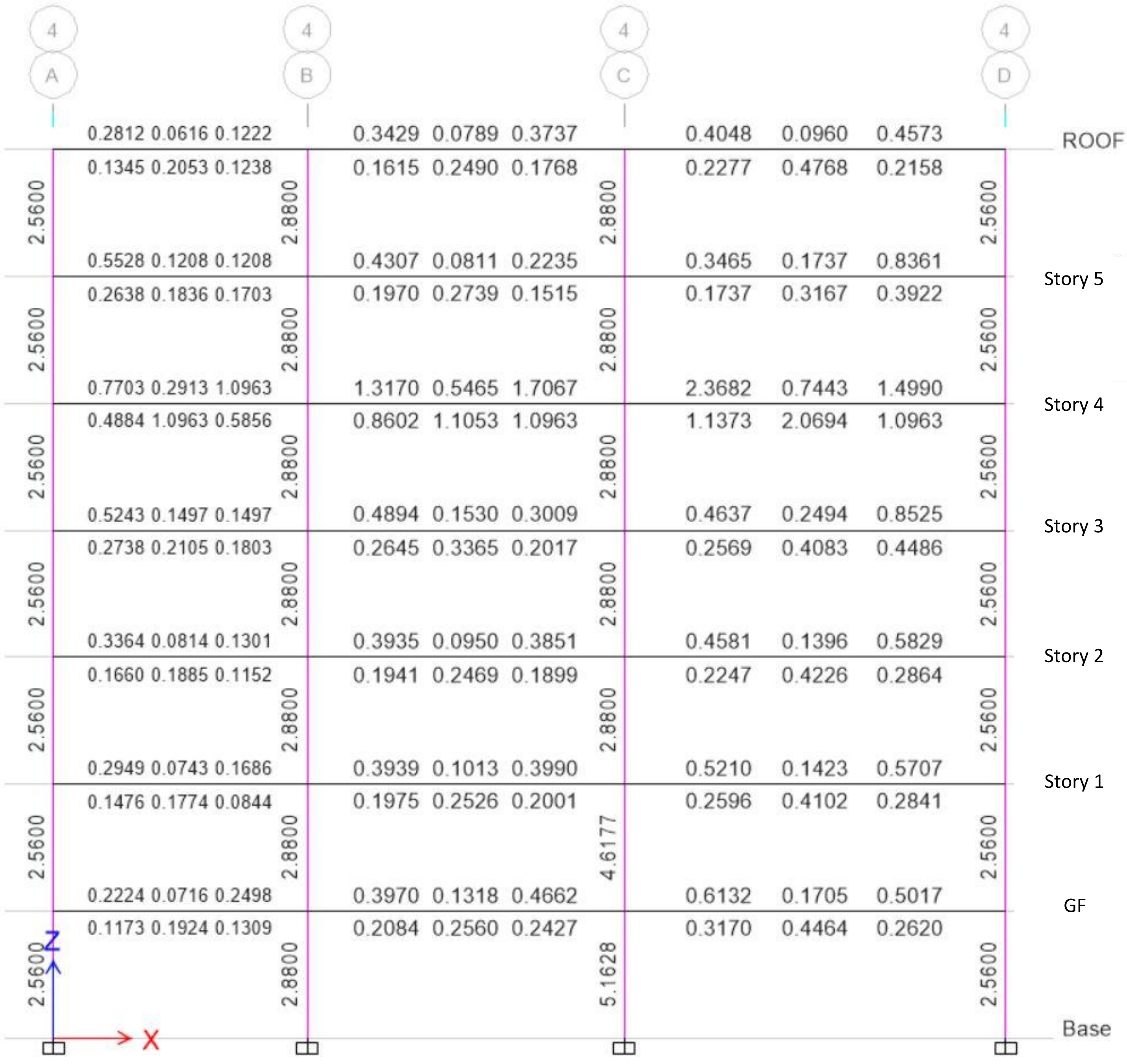



**Fig 8.6:** Grid 4 Beam Longitudinal Reinforcement

## 8.3 Column Reaction:


**Fig 8.7:** Column Reaction

## 8.4 Column Analysis Data:

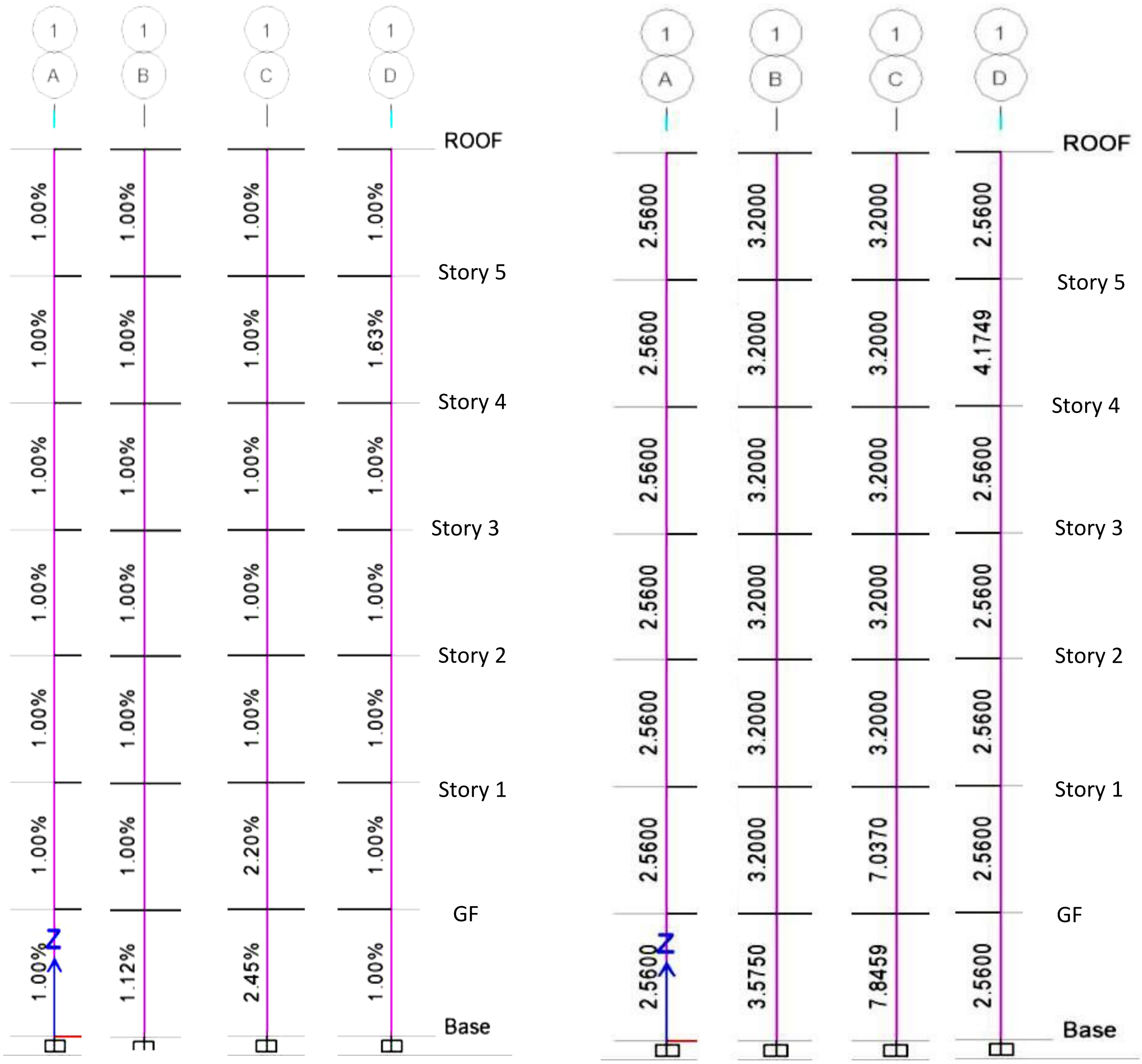



**Fig 8.8:** Grid 1 Rebar Percentage & Area

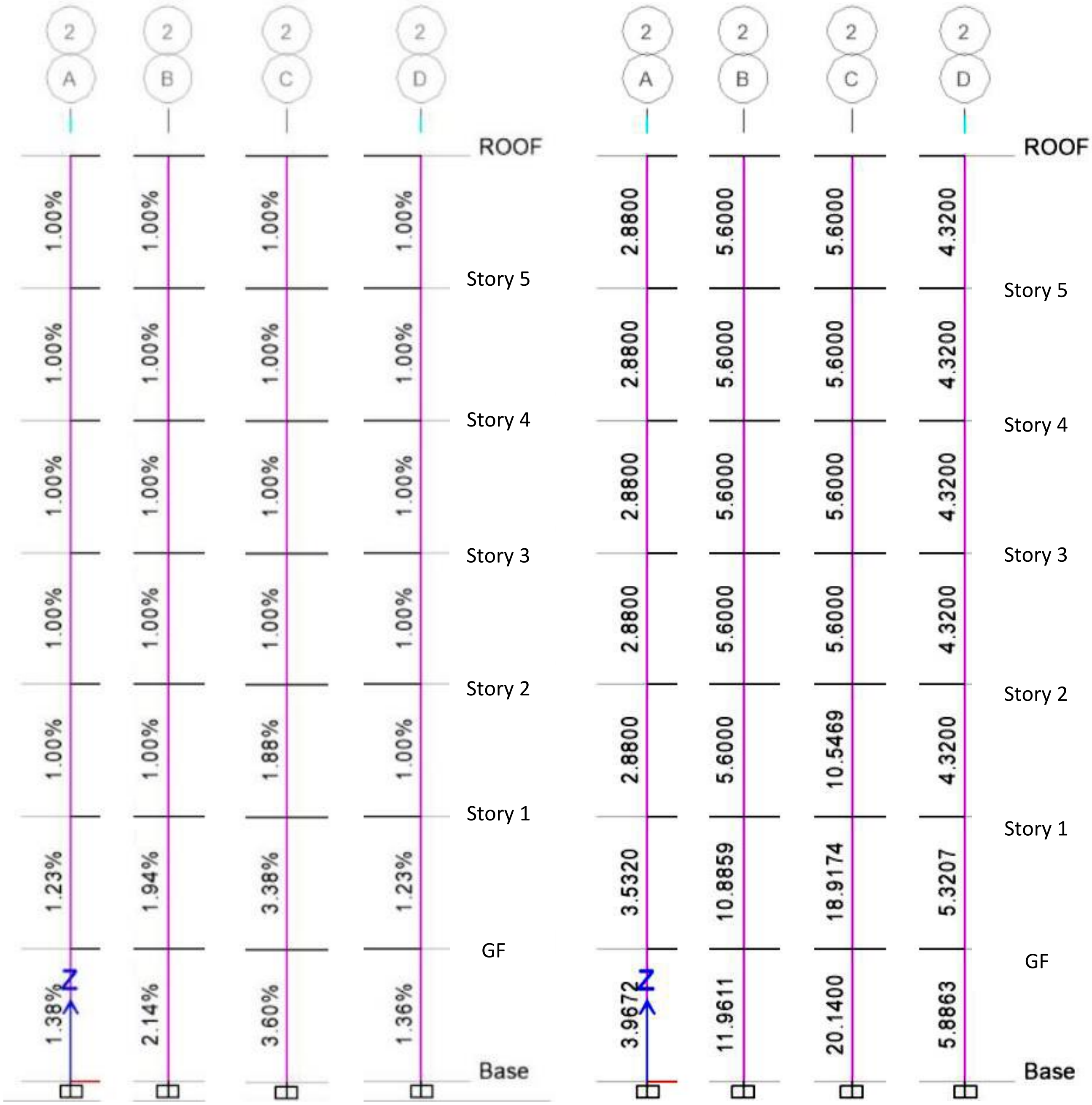



**Fig 8.9:** Grid 2 Rebar Percentage & Area


**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
- International edition of Design of Concrete structures (13th edition) by Arthur H. Nilsson, David Darwin and Charles W. Dolan

# 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 5$^{th}$ 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.