#### CHAPTER-1 INTRODUCTION

## 1.1 General:

What we have been exercising in our academic or professional carrier are based upon the western origin. Our careerists engineers, architects and planners are convinced of their research and investigations as a matter of disciplines, this is excellent, but we have a sacred duty to formulate a short of technology to fit into our merits.

In keeping this in mind, we tried to develop a short formula to find out moment with the relation of height and shape variations of building.

## **1.2 Importance of the study:**

The importance of the study for engineers are as follows:

- Should consider both wind and earthquake effects for designing the building.
- Should identify which floor govern maximum moment and design accordingly.
- Should understand the risk associated with high rise building.

## 1.3 OBJECTIVES OF THE STUDY:

To develop an empirical formula by which any engineer in home and abroad can easily find out relations between moment and height of various forms of the building.

## **1.4 ORGANIZATION OF THE THESIS OR METHODOLOGY:**

For the study of this project we chose the following types and shapes of six to ten storied residential building. Load calculation is performed according to code UBC 94. We considered wind load and earthquake load based on 3 zone in Bangladesh.

Туре-1	Туре-2
Type=L-48XB-32	Type=L-64XB-48
Type=L-64XB-32	Type=L-80XB-48
Type=L-80XB-32	Type=L-96XB-48

### Type & shape of building

## 1.5 BACKGROUND:

The history of high rise may be traced back to pyramids of Egypt about 48 stories in height and the tower of Babel.

People did not build tall structure again until the late 1600s, apart from a few roman apartment building of six or seven story tall. Tall building with iron skeletons began to be constructed in 1860s. In 1885 a ten story building was constructed in Chicago by William Le Baron Jenney.

#### CHAPTER-2 SOFTWARE REVIEW

#### 2.1 What is ETABS (Extended 3D Analysis of Building: System)?

The innovative and revolutionary new ETABS is the ultimate integrated software package for the structural analysis and design of buildings. Incorporating 40 years of continuous research and development, this latest ETABS offers unmatched 3D object based modeling and visualization tools, blazingly fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and easily decipher and understand analysis and design results.

From the start of design conception through the production of schematic drawings, ETABS integrates every aspect of the engineering design process. Creation of models has never been easier - intuitive drawing commands allow for the rapid generation of floor and elevation framing. CAD drawings can be converted directly into ETABS models or used as templates onto which ETABS objects may be overlaid. The state-of-the-art SAPFIRE 64-bit solver allows extremely large and complex models to be rapidly analyzed, and supports nonlinear modeling techniques such as construction sequencing and time effects (e.g., creep and shrinkage).

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

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

## 2.2 Analysis Software:

There is much finite element software for analyzing structure. ETABS is one of them. Every analysis is this thesis is done by using ETABS 16 package. In the following paragraph we will discuss some of its features.

## 2.3 History and advantage of ETABS:

Dating back more than 40 years to the original development of TABS, the predecessor of ETABS, it was clearly recognized that buildings constituted a very special class of structures. Early releases of ETABS provided input, output and numerical solution techniques that took into consideration the characteristics unique to building type structures, providing a tool that offered significant savings in time and increased accuracy over general purpose programs. As computers and computer interfaces evolved, ETABS added computationally complex analytical options such as dynamic nonlinear behavior, and powerful CAD-like drawing tools in a graphical and object-based interface. Although ETABS 2016 looks radically different from its predecessors of 40 years ago, its mission remains the same: to provide the profession with the most efficient and comprehensive software for the analysis and design of buildings. To that end, the current release follows the same philosophical approach put forward by the original programs, namely:

- Most buildings are of straightforward geometry with horizontal beams and vertical columns. Although any building configuration is possible with ETABS, in most cases, a simple grid system defined by horizontal floors and vertical column lines can establish building geometry with minimal effort.
- Many of the floor levels in buildings are similar. This commonality can be used to dramatically reduce modeling and design time.
- The input and output conventions used correspond to common building terminology. With ETABS, the models are defined logically floor-by-floor, column-by-column, bay-by-bay and wall- by-wall and not as a stream of non-descript nodes and elements as in general purpose programs. Thus the structural definition is simple, concise and meaningful.
- In most buildings, the dimensions of the members are large in relation to the bay widths and story heights. Those dimensions have a significant effect on the stiffness of the frame.
   ETABS corrects for such effects in the formulation of the member stiffness, unlike most general-purpose programs that work on center- line-to-centerline dimensions.
- The results produced by the programs should be in a form directly usable by the engineer. General purpose computer programs produce results in a general form that may need additional processing before they are usable in structural design.

## 2.4 An Integrated Approach:

ETABS is a completely integrated system. Embedded beneath the simple, intuitive user interface are very powerful numerical methods, design procedures and international design codes, all working from a single comprehensive database. This integration means that you create only one model of the floor systems and the vertical and lateral framing systems to analyze, design, and detail the entire building.

Everything you need is integrated into one versatile analysis and design package with one Windows-based graphical user interface. No external modules are required. The effects on one part of the structure from changes in another part are instantaneous and automatic. The integrated components include:

Drafting for model generation

Seismic and wind load generation

Gravity load distribution for the distribution of vertical loads to columns and beams when plate bending floor elements are not provided as a part of the floor system

Finite element-based linear static and dynamic analysis

Finite element-based nonlinear static and dynamic analysis (available in ETABS Nonlinear & Ultimate versions only) Output display and report generation

- Steel frame design (column, beam and brace)
- Concrete frame design (column and beam)
- Concrete slab design
- Composite beam design
- Composite column design
- Steel joist design
- Shear wall design
- Steel connection design including column base plates
- Detail schematic drawing generation

### 2.5 Modeling Features:

The ETABS building is idealized as an assemblage of shell, frame, link, tendon, and joint objects. Those objects are used to represent wall, floor, column, beam, brace, tendon, and link/spring physical members. The basic frame geometry is defined with reference to a simple three- dimensional grid system. With relatively simple modeling techniques, very complex framing situations may be considered. The buildings may be unsymmetrical and non-rectangular in plan. Torsional behavior of the floors and inter story compatibility of the floors are accurately reflected in the results. The solution enforces complete three- dimensional displacement compatibility, making it possible to capture tubular effects associated with the behavior of tall structures having relatively closely spaced columns.

Semi-rigid floor diaphragms may be modeled to capture the effects of in- plane floor deformations. Floor objects may span between adjacent levels to create sloped floors (ramps), which can be useful for modeling parking garage structures. Modeling of partial diaphragms, such as in mezzanines, setbacks, atriums and floor openings, is possible without the use of artificial ("dummy") floors and column lines. It is also possible to model situations with multiple independent diaphragms at each level, allowing the modeling of buildings consisting of several towers rising from a common base.

The column, beam and brace elements may be non-prismatic, and they may have partial fixity at their end connections. They also may have uniform, partial uniform and trapezoidal load patterns, and they may have temperature loads. The effects of the finite dimensions of the beams and columns on the stiffness of a frame system are included using end offsets that can be automatically calculated.

The floors and walls can be modeled as membrane elements within plane stiffness only or full shell-type elements, which combine both in- plane and out-of-plane stiffness. Floor and wall members may have uniform and non-uniform load patterns in-plane or out-of-plane, and they may have temperature loads. The column, beam, brace, floor and wall members are all compatible with one another.

#### 2.6 Analysis Features:

Static analyses for user specified vertical and lateral floor or story loads are possible. If floors with out-of-plane bending capability are modeled, vertical loads on the floor are transferred to the beams and columns through bending of the floor elements. Otherwise, vertical loads on the floor are automatically converted to span loads on adjoining beams, or point loads on adjacent columns, thereby automating the tedious task of transferring floor tributary loads to the floor beams without the need to explicitly model the secondary framing.

The program can automatically generate lateral wind and seismic load patterns to meet the requirements of various building codes. Three- dimensional mode shapes and frequencies, modal participation factors, direction factors and participating mass percentages are evaluated using eigenvector or Ritz vector analysis. P-Delta effects may be included with static or dynamic analysis. Response spectrum analysis, linear time history analysis, nonlinear time history analysis, and static nonlinear (pushover) analysis are all possible. The static nonlinear capabilities also allow you to perform incremental construction analysis so that forces that arise as a result of the construction sequence are included.

Results from the various static load cases may be combined with each other or with the results from the dynamic response spectrum or time history analyses. Output may be viewed graphically, displayed in tabular output, compiled in a report, exported to a database file, or saved in an ASCII file. Types of output include reactions and member forces, mode shapes and participation factors, static and dynamic story displacements and story shears, inter-story drifts and joint displacements, time history traces, and more.

Import and export of data may occur between third-party applications such as Revit and AutoCAD from Autodesk, or with other programs that support the CIS/2 or IFC data models.

ETABS uses the SAPFire<sup>™</sup> analysis engine, the state-of-the-art equation solver that powers all of CSI's software. This proprietary solver exploits the latest in numerical technology to provide incredibly rapid solution times and virtually limitless model capacity.

### 2.7 Design Features:

Design of steel frames, concrete frames, concrete slabs, concrete shear walls, composite beams, composite columns, and steel joists can be performed based on a variety of US and International design codes. Flexural, shear and deflection checks may all be performed depending upon the material and member type. Steel and concrete frame members may be optimized from auto select lists, and concrete sections are designed using reinforcing bar sizes chosen from US or International standards. Concrete slab design may be done using either design strips, or be based on the finite element method, and may include the effects of post-tensioning. Steel connection design automates the review of beam-beam and beam-column connections based on user specified bolt and shear plate preferences. Steel base plate design verifies the size, thickness, and anchorage of the connection.

### 2.8 Detailing Features:

Schematic construction drawings showing floor framing, column schedules, beam elevations and sections, steel connection schedules, and concrete shear wall reinforcing may be produced. Concrete reinforcement of beams, columns, and walls may be selected based on user-defined rules. Any number of drawings may be created, containing general notes, plan views, sections, elevations, tables, and schedules. Drawings may be printed directly from ETABS or exported to DXF or DWG files for fur- the refinement.

#### CHAPTER-3 STRUCTURAL MODELING AND ANALYSIS

### 3.1 Introduction:

To present the procedure of analysis and design of the RCC structures is consider a standard grid of 16'x16' and taken different shape from six to ten stored residential building. Dead load, Live load, Vertical load, Lateral load, Wind load, Seismic load are taken on the basis of contemporary trend performing by designers.

Given:

#### **Material Properties:**

Concrete Compressive strength, f'c = 4 ksi Yield Strength of Rebar, fy = 72.5ksi (500Mpa) Yield Strength of Shear Rebar, fy=40 ksi

#### Load:

Live Load= 40 psf Partition Wall=35 psf Floor Finish=25 psf

#### Beam and Column size:

Column=20"x20" Beam=12"x20" Beam=12"x21" All Slab 6" Thickness

#### 3.1.1 Methodology flow Diagram:



## 3.1.2 Plan:

#### Beam Column Layout (PLAN-XY)



Material Properties:

Concrete Compressive strength, f'c = 4 ksi Yield Strength of Rebar, fy = 72.5ksi (500Mpa) Yield Strength of Shear Rebar, fy=40 ksi

Beam and Column size: Column=20"x20" Beam =12"x20" Beam =12"x21" All Slab 6"

Load Patterns:

Dead: All the self wt of drawn members. Live: 40 psf on floor and roof slab, FF: Floor Finish 25 psf on all slabs PW: 35 psf on all floor slabs 500 plf on all beams

Load Combinations (a) 1.4xDead Loads (b) 1.2xDead Loads + 1.6xLive Loads`

#### Step

#### Action

#### 3.1.3 Start ETABS 2016: Menu Command: File>New Model.

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Initializati	ion Options		
0 <b>u</b>	Jse Saved User Default Settings		0
0 <b>u</b>	Jse Settings from a Model File		0
۵ پ	Jse Built-in Settings With:		
	Display Units	U.S. Customary	~ 1
	Steel Section Database	AISC14	$\sim$
	Steel Design Code	AISC 360-10	~ 1
	Concrete Design Code	ACI 318-08	~ 1

#### *New Model Quick Templates window* appears From **New Model Quick Templetes** window

Click on Custom Grid Spacing radio button

Click on Edit Grid Data... button

#### Grid System Data window appears

Click on O Display Grid Data as Spacing radio button

Click Add button to add an extra grid (Grid E) in X

Set the X Grid Data and Y Grid Data as follows

X Grid Data			١	' Grid Data
Grid ID	X Spacing (ft)		Grid ID	Y Spacing (ft)
A	16'		1	16'
В	16'		2	16'
С	16'		3	16'
D	16'		4	0
E	0			

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Grid System Name Story Range Option  Story Range Option  Default - All Stories  User Specified  Top Story			Click to Modify	/Show: Reference Points			RODE			
			Reference Planes			4				
Glo	ibal X 0	ft		Roof		Options	Options Bubble Size 60 in			
Glo	bal Y 0	ft	ft Bottom Story			Bubble Size				
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#### Click OK

Brings back to New Model Quick Templates window

#### SetSimple Story Data as below

Number of Stories	11	
Typical Story Height	10	ft
Bottom Story Height	7	ft





Me	nu Comman	d: Define>Material	Propertie	ete: es	
Det	fine Materia	Is Window appears			
Clie	CK Add New	Material			
Ad	d New Prop	erty Window appea	irs		
Sel	ect from the	dropdown list			
Reg	jion	User		<b>~</b>	
Mat	erial Type	Concrete		•	
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	General Data Material Na	me	Conc4000psi	1	
	Material Typ	Symmetry Type	Concrete	~	
	Material Dis	play Color	Isotropic	Change	
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	Weight per	Unit Volume		150	lb/ft <sup>3</sup>
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Clic	Modify/Sho	ow Material Property Design I	Data		
Mat	erial Property	Design Data Window	appears		
Set	Specified Concre	ete Compressive Strength, f'c	: 40	000 lb/in²	
Clic	кок				
Ket		a Property Data Windo	W		
Clic	K UK				
Ret	urns to <b>Define</b>	Materials Windowwith	i a new ma	trial in the list	
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	m the Define N	laterials window			
Froi					
From Clic	Add New I	Material			

Region	User	,
Material Type	Rebar	

OK Click

#### Material Property Data Window appears

Set Material Property Data window as follows

Material Name	Rebar72500psi	
Weight per Unit Volume	490	lb/ft <sup>3</sup>
Modulus of Elasticity, E	29E6	lb/in <sup>2</sup>
Coefficient of Thermal Expansion, A	6.5E-6	1/F
Material Property Data		$\times$

Material Name	Rebar72500p	>=i	
Material Type	Rebar		$\sim$
Directional Symmetry Type	Uniaxial		
Material Display Color		Change	
Material Notes	Modify	/Show Notes	
Material Weight and Mass			
Specify Weight Density	Spece	cify Mass Density	
Weight per Unit Volume		490	lb.∕ftª
Mass per Unit Volume		15.23	lb-s²/ft4
Mechanical Property Data			
Modulus of Elasticity, E		29000000	lb/in²
Coefficient of Thermal Expansion, A	*	0.0000065	1/F
Design Property Data			
Modify/Show M	Material Property	Design Data	
Advanced Material Property Data			
Nonlinear Material Data		Material Damping F	Properties
Time E	Dependent Prope	erties	
ок	C	Cancel	

## Material Property Design Data Window appears SetDesign Properties for Rebar Materials as follows

Selbesign Properties for Repar Materialsas 10110	NS	
Minimum Yield Strength, Fy	72500	lb/in <sup>2</sup>
Minimum Tensile Strength, Fu	83375	lb/in <sup>2</sup>
Expected Yield Strength, Fye	1.1*72500	lb/in <sup>2</sup>
Expected Tensile Strength, Fue	1.1*83375	lb/in <sup>2</sup>
Click OK		_
Deturne to Meterial Drenarty Date Window		

Returns to Material Property Data Window

OK Click

Returns to Define Materials Windowwith a new matrial in the list

#### 3.2.3 Define Material Properties of 40ksi Reinforcement (Rebar):

Follow the same procedure as above..

#### From the Define Materials Window

Click Add New Material...

#### Add New Property Window appears

Select from the dropdown list

Region	User 🗸
Material Type	Rebar 💌

Material Name		Rebar40000psi	
Weight per Unit Volume		490	lb/ft <sup>3</sup>
Modulus of Elasticity. E		29E6	lb/in <sup>2</sup>
Coefficient of Thermal Expansion	, A	6.5E-6	1/F
📭 Material Property Data			×
Material Name Material Type Directional Symmetry Type Material Display Color Material Notes Material Weight and Mass	Rebar 400000 Rebar Uniaxial Modify	Change //Show Notes ify Mass Density 490   lb. 15.23   lb. 29000000   lb. 0.0000065   1/	/ft <sup>3</sup> s <sup>2</sup> /ft <sup>4</sup> /in <sup>2</sup> /F
Advanced Material Property Data Nonlinear Material Data	terial Property	Design Data Material Damping Propertie	s

#### Material Property Design Data Window appears SetDesign Properties for Rebar Materials as follows

Minimum Yield Strength, Fy	40000	lb/in <sup>2</sup>
Minimum Tensile Strength, Fu	60000	lb/in <sup>2</sup>
Expected Yield Strength, Fye	1.1*40000	lb/in <sup>2</sup>
Expected Tensile Strength, Fue	1.1*60000	lb/in <sup>2</sup>

Click

Returns to Material Property Data Window

Click OK

Returns to Define Materials Window with a new matrial in the list

aterials	Click to:
A992Fy50	Add New Material
A615Gr60	Add Copy of Material
Conc4000psi Rabar72500psi	Modify/Show Material
Rebar40000psi	Delete Material
	OK Cancel

Returns to Main Window

#### 3.3.1 Define Frame Sections: Column 20"x20" with 8 Rebars:

Menu Command: Define>Section Properties>Frame Sections...

Click Delete Multiple Properties...

#### Delete Multiple Frame Section Properties Window appears

**Select** all the Frame Sections (Click the first item holding SHIFT key and Click the last item or simply click, hold and drag)

Click Delete Selected Frame Sections

Again Select all Frame Sections (Click the first item holding SHIFT key and Click the last item or simply click, hold and drag)

Click Delete Selected Frame Sections

Atleast one frame section must be present. Hence a massege box appears.

Click OK

Returns to Delete Multiple Frame Section Properties Window

Click OK

Retuns to Frame Properties Window

Click Add New Property...

Frame Property Shape Type Window appears

Click	Concrete Rectangular button
Frame Secti	on Property Data Window appears

Set General Data and Section Dimensions as follows

Property Name	Col20"x20"	
Material	Conc4000psi	
Depth	20	in
Width	20	in

Set the window as follows			
Longitudinal Bars	Rebar72500ps	ii 🗸 🗸	·] [
Confinement Bars (Ties)	Rebar40000ps	i 🗸	· · · · ·
Longitudinal Bars			
Clear Cover for Confinement Ba	ars	1.5	
Number of Longitudinal Bars Ale	ong 3-dir Face	4	
Number of Longitudinal Bars Ale	ong 2-dir Face	4	
Longitudinal Bar Size and Are	а	#7	
Comer Bar Size and Area		#7	
Confinement Bars		L	
Confinement Bar Size and Are	a	#3	
Longitudinal Spacing of Confine	ment Bars	6	
Number of Confinement Bars in	3-dir	2	
Number of Confinement Bars in	2-dir	2	
Frame Section Property Reinforcement D	ata		
Design Type P-M2-M3 Design (Column) M3 Design Only (Beam)	Rebar Material Longitudinal Bars Confinement Bars (Ties)	Rebar72500psi Rebar40000psi	~ . ~ .
Reinforcement Configuration   Rectangular   Circular	Confinement Bars     Ties     Spirals	Check/Design CReinforcement to be Reinforcement to be	Checked Designed
Clear Cover for Confinement Bars Number of Longitudinal Bars Along 3-dir I Number of Longitudinal Bars Along 2-dir I Longitudinal Bar Size and Area Comer Bar Size and Area	Face #7 #7	1.5 4 4 · · · · 0.6 · · · · 0.6	in
Confinement Bars Confinement Bar Size and Area Longitudinal Spacing of Confinement Bar Number of Confinement Bars in 3-dir Number of Confinement Bars in 2-dir	#3 rs (Along 1-Axis)	<ul> <li>0.11</li> <li>6</li> <li>2</li> <li>2</li> </ul>	in² in
	OK Cancel		
Click OK Retuns to Frame Section Prope Click OK Retuns to Frame Properties Wir Select W10x12 and Click	rty Data Window ndowwith a new item Delete Property		
Click Yes Dofine Frome Sectional Poor 1	2"~20"		
From Frame Properties Window	2 X2U V		
	1		

Set General Data and Section Dimer	nsions as follows	
Property Name	Beam12"x20"	
Material	Conc4000psi	
Depth	20	in
Width	12	in
Oliok Modify/Show Rebar		
Frame Section Property Reinforcem	nent Data Window app	ear
Click  M3 Design Only (Beam) ra	dio button	
SetRebar Material as below		
Rebar Material	[	
Confinement Bars (Ties)	Rebar72500psi	 
Set Cover to Longitudianl Rebar Gr	oup Centroid as below	
Top Bars		2.5 In
Frame Section Property Reinforcement Data		2.0
Design Type Reba	r Material	72500
M3 Design Only (Beam)     Co	onfinement Bars (Ties)	2500psi ~
Cover to Longitudinal Rebar Group Centroid	Top Bars at I-End	intes for Ductile Beams
Bottom Bars 2.5 in	Top Bars at J-End	0 in <sup>2</sup>
	Bottom Bars at I-End	0 in <sup>2</sup>
	Bottom Bars at J-End	0 in <sup>2</sup>
OF	< Cancel	
Click		
Retuns to Frame Section Property D	ata Window	
Returns to Frame Properties Window	with a new item	
Returns to France Properties Window		
Define Frame Sections: Beam 12"x2	21"	
From Frame Properties Window		
Select Beam12x20		
Select Beam12x20 Click Add Copy of Property		
Select Beam12x20 Click Add Copy of Property Frame Section Property Data Windo		
Select Beam12x20 Click Add Copy of Property Frame Section Property Data Windo Set General Data and Section Dimen	w appears	
Select Beam12x20 Click Add Copy of Property Frame Section Property Data Windo Set General Data and Section Dimen Property Name	ow appears nsions as follows Beam12	×21
Select Beam12x20 Click Add Copy of Property Frame Section Property Data Windo Set General Data and Section Dimen Property Name Material	ow appears nsions as follows Beam12 Conc400	x21 D0psi
Select Beam12x20 Click Add Copy of Property Frame Section Property Data Windo Set General Data and Section Dimer Property Name Material Depth	ow appears nsions as follows Beam12 Conc400 21	2x21 D0psi in

Filter Properties List       Click to:         Filter       Clear         Properties       Add New Property         Add Copy of Property       Add Copy of Property         Beam 12%20*       Delete Property         Delete Property       Delete Property         Colory to SD Section       Copy to SD Section         Copy to SD Section       Copy to SD Section         Copy to SD Section       Copy to SD Section         Click OK       Cance         Returns to main window       OK         Define Slab Sections: 6" thick floor and roof slab:         Menu Command: Define>Section Properties>Slab Sections         Slab Properties Window appears         Click       Add New Property         Slab Property Data Window appears         Set General Data and Property Data as follows         Property Name       Slab6"         Material       Conc4000psi	👔 Frame Properties	
Type       All       Import New Properties         Filter       Clear       Add New Property         Properties       Modify/Show Property       Modify/Show Property         Beam 12*x20**       Delete Property       Delete Property         Beam 12*x20**       Delete Multiple Properties       Convert to SD Section         Col20**x20**       Delete Multiple Properties       Convert to SD Section         Col20**x20**       OK       Cancel         Click       OK       Cancel         Click       OK       Cancel         Click       Convert to SD Section       Delete Multiple Properties         Click       OK       Cancel         Click       OK       Cancel         Click       OK       Cancel         Click       OK       Cancel         Slab Properties Window appears       Slab Property Data Window appears         Sci General Data and Property Data as follows       Property Name         Property Name       Slab6**         Material       Conc4000psi	Filter Properties List	Click to:
Filter       Clear       Add New Property         Properties       Modify/Show Property       Modify/Show Property         Beam 12*x20*       Delete Property       Delete Property         Beam 12*x20*       Delete Multiple Properties       Convert to SD Section         Color x20**       Convert to SD Section       Copy to SD Section         Color x20**       OK       Cance         Click       OK       Cance         Slab Properties Window appears       Slab         Click       Add New Property         Slab Property Data Window appears       Sectioners         Set General Data and Property Data as follows       Property Name         Property Name       Slab6*         Material       Conc4000psi	Type All ~	Import New Properties
Properties       Add Copy of Property         Pind This Property       Modify/Show Property         Beam 12*s20*       Delete Property         Delete Multiple Properties       Convert to SD Section         Cogo 's20''       OK         Cance       OK         Click       OK         Click       OK         Click       OK         Click       OK         Command: Define>Section Properties>Slab Sections         Slab Properties Window appears         Click       Add New Property         Slab Property Data Window appears         Set General Data and Property Data as follows         Property Name       Slab6''         Material       Conc4000psi	Filter	Add New Property
Find This Property       Modify/Show Property         Beam 12* x2 1°       Delete Multiple Properties         Col20* x20°       Convert to SD Section         Copy to SD Section       Copy to SD Section         Chick       CK         Returns to main window       OK         Define Slab Sections: 6° thick floor and roof slab:         Menu Command: Define>Section Properties>Slab Sections         Slab Properties Window appears         Click       Add New Property         Slab Property Data Window appears         Set General Data and Property Data as follows         Property Name       Slab6"         Material       Conc4000psi	Properties	Add Copy of Property
Image: Property 2000         Beam 12***20**         Delete Property         Delete Multiple Properties         Col20***20**         Delete Multiple Properties         Copy to SD Section         Export to XML File         OK         Click         OK         Returns to main window         Define Slab Sections: 6" thick floor and roof slab:         Menu Command: Define>Section Properties>Slab Sections         Slab Properties Window appears         Click       Add New Property         Slab Property Data Window appears         Set General Data and Property Data as follows         Property Name       Slab6"         Material       Conc4000psi	Find This Property	Modify/Show Property
Beam12*x20**       Delete Property         Col20**x20***       Delete Multiple Properties         Convert to SD Section       Copy to SD Section         Export to XML File       OK         Click       OK         Convert to SD Section       OK         Click       OK         Click       OK         Click       OK         Command:       Define Slab Sections: 6" thick floor and roof slab:         Menu Command:       Define>Section Properties>Slab Sections         Slab Properties       Window appears         Click       Add New Property         Slab Property Data Window appears       Set General Data and Property Data as follows         Property Name       Slab6"         Material       Conc4000psi	Beam12"x20"	
Delete Multiple Properties         Convert to SD Section         Copy to SD Section         Export to XML File         OK         Click         Property Data Window appears         Set General Data and Property Data as follows         Property Name       Slab6"         Material       Conc4000psi	Beam12"x20" Beam12"x21" C=120"-200"	Delete Property
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Click Click Returns to main window  Define Slab Sections: 6" thick floor and roof slab: Menu Command: Define>Section Properties>Slab Sections  Slab Properties Window appears Click Add New Property  Slab Property Data Window appears Set General Data and Property Data as follows Property Name Material		Convert to SD Section
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Export to XML File         OK         Click         Returns to main window         Define Slab Sections: 6" thick floor and roof slab:         Menu Command: Define>Section Properties>Slab Sections         Slab Properties Window appears         Click         Add New Property         Slab Property Data Window appears         Set General Data and Property Data as follows         Property Name       Slab6"         Material       Conc4000psi		
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Property Name Slab6" Material Conc4000psi		
Material Conc4000psi	Define Slab Sections: 6" thick floor and roof slab Menu Command: Define>Section Properties>Slab Slab Properties Window appears Click Add New Property Slab Property Data Window appears Set General Data and Property Data as follows	b: o Sections
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/	Define Slab Sections: 6" thick floor and roof slab Menu Command: Define>Section Properties>Slab Slab Properties Window appears Click Add New Property Slab Property Data Window appears Set General Data and Property Data as follows Property Name Material Type	b: <b>Sections</b> Slab6" Conc4000psi Slab

General Data				
General Data				
Bernet Nierre				
Property Name		Slab6"		
Slab Matenal		Conc4000psi		~
Notional Size Data		Modify/Show	Notional Siz	e
Modeling Type		Shell-Thin		~
Modifiers (Currently D	efault)	Modify	/Show	
Display Color			Change.	
Property Notes		Modify	/Show	
Property Data				
Туре		Slab		$\sim$
Thickness		[	6	in
	ОК	Cancel	-	
		Cancer		
Click OK				
Returns to Slab Properties	s Window			
Doturno to ETADS main 14	lindow			
Returns to ETADS main w	Indow			
Define: Load Patterns (De	ad, Live, FF. P	W)		
Menu Command: <b>Define&gt;I</b>	oad Dattorne	,		
Define Load Patterns Win	dow appears			
Set				
Land		T		Self Weight
LOAD		iype		Multiplier
FF	Super	Dead	- 0	
FF Click Add New Loa	Super l	Dead	- 0	1
FF Click Add New Loa		Dead	- O	1
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FF Click Add New Loa Adds FF(Superimposed De Again Set	super I ad ad Load) Load	Dead Pattern	<b>→</b> 0	l
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Click Add Default Design Combos Add Default Design Combinations Window appears Click Concrete Frame Design Add Default Design Combinations Select Design Type for Load Combinations Select Design Type for Load Combinations Select Design Type for Load Combinations Composite Beam Design Concrete Frame Design Concrete Shear Wall Design Concrete Shear Wall Design Concrete Slab Design	
Click Add Default Design Combinations Window appears Click Concrete Frame Design Add Default Design Combinations Select Design Type for Load Combinations Select Design Type for Load Combinations Select Design Type for Load Combinations Composite Beam Design Concrete Frame Design Concrete Shear Wall Design Concrete Slab Design Concrete Slab Design	
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Concrete Shear Wall Design Concrete Slab Design Convert to User Combinations (Editable)	
Concrete Slab Design Convert to User Combinations (Editable)	
Convert to User Combinations (Editable)	
Convert to User Combinations (Editable)	
UK Cancel	

## Returns to Load Combinations Window with 2 combinations

)Con1 )Con2	Add New Combo
	Add Copy of Combo
	Modify/Show Combo
	Delete Combo
	Add Default Design Combos
	Convert Combos to Nonlinear Cases
	OK Cancel

Returns to ETABS main Window

#### 3.5.1 Drawing all Beams:

Menu Command: Draw>Draw Beam/Column/Brace Objects> Draw Beam/Column/Brace (Plan/Elev,3D) Properties of Object window appear on left bottom Set Property as follows from the drop-down list Property Beam12"x20"

Beam12"x20" Beam12"x21" Col20"x20"  $\times$ 

Properties of Ob	ject
Type of Line	Frame
Property	Beam12"x20"
Moment Releases	Continuous
Plan Offset Normal, in	0
Line Drawing Type	Straight Line

Set Plan Drawing Mode to Similar stories:

Select One Stories from the drop-down list at bottom right corner

Similar Stories V Global V Units...

To Draw Beam:

Menu Command: Draw>Draw Line Object>Create Line in Region or at Clicks.

Set "Properties of Object" Beam 12"x20" and draw the beams like plan.

#### 3.5.2 Draw Column :

Draw Section: Set "All Stories" First.

Menu Command: Drow> Draw line object in Region or at click Set "Properties of Object"

Col20"x20"

And draw the Column.



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#### 3.5.3 Draw Floor Slab:

Draw Section: Set "Similar Stories" Menu Command: Draw→Draw area Object→Draw Areas Set "Properties of Object" Slab 6" Then draw the slab.

#### Now all slab are drawn:



From the plan view go to the base and select all points: At first Select everything Base Menu Command  $\rightarrow$ Assign $\rightarrow$ Joint/Points $\rightarrow$  Restraints Select "Fixed Support" then click Apply-Ok

Join	t Assignment - Restraints	×
	Restraints in Global Directions	
	✓ Translation X ✓ Rotation about X	
	✓ Translation Y ✓ Rotation about Y	
	Translation Z Rotation about Z	
	Fast Restraints	
	OK Close Apply	

### 3.6.1 Uniform Load Assign:

Menu Command: Select  $\rightarrow$  By wall/slab/deck sections>select slab 6" then click ok.

All floor slab has been selected.

Now, Menu Command: Assign → Shell/area loads → Uniform Set, Load Case Name-Live Load 40 Then click Ok.

Shell Load Assignment - Uniform

		210	
Jniform Load Load Direction G	40 ìravity `	lb/ft² ✓	Options Add to Existing Loads Replace Existing Loads Delete Existing Loads

Click on previous selection.

Menu Command: Assign→Shell/area loads→Uniform Set, Load Case Name-FF Load 25 Then click Ok.

Load Pattern Name	FF ~
Iniform Load	Options
Load 25 lb/ft²	<ul> <li>Add to Existing Loads</li> </ul>
	Replace Existing Loads
Direction Gravity ~	<ul> <li>Delete Existing Loads</li> </ul>

Click on previous selection Menu Command: Assign→Shell/area loads→Uniform Set, Load Case Name-PW Load 35 Then click Ok. Shell Load Assignment - Uniform

Iniform Load Load 35 lb/ft Direction Gravity ~	Options Add to Existing Loads Replace Existing Loads Delete Existing Loads

Now all slab load has been assigned.

Now Select Frame property:

Menu Command: Select → Select → Properties → Frame Sections and Select Beam

x

elect by Frame Prope	erty		×
Filter		Clears Ether	
Frame Properties			
Beam12"x20" Beam12"x21"			
Col20"x20" None			
Select	Deselect	Close	

#### 3.6.2 Distributed Frame Loads Assign:

Menu Command: Assign → Frame Loads → Distributed Now Load Patten = Select PW And Uniform Load=0.5 Kip/ft and Then click Frame Load Assignment - Distributed

Load Pa	attem Name		PW		~	
oad Type a	nd Direction			Options		
Forces		Moments		Ac	dd to Existing Loads	
Dimension	fland Analiantian	Constru		● Re	eplace Existing Load	ls
Direction o	r Load Application	Gravity	~	O De	elete Existing Loads	
rapezoidal l	Loads			-		
	1.	2.		3.	4.	
Distance	0	0.25	0.75		1	
Load	0	0	0		0	kip/ft
	Relative D	istance from End-I	0	Absolute D	istance from End-I	
Iniform Load	1					
	0.5	lain A		OK.	Classe	

Now click Apply then Ok

×



#### 3.6.3 Define Static Load Case:

Then Menu Command : Define> load Patterns: To set wind load For X Axis: Load-WLX, Type-Wind, Self weight multiplier-0, Auto lateral load-UBC94 Now click Add New Load.

To set wind load For Y Axis : Load-WLY, Type-Wind, Self weight multiplier-0, Auto lateral load-UBC94 Now click Add New Load

To set Earthquake load For X Axis: Load-EQX, Type-Seismic, Self weight multiplier-0, Auto lateral load-UBC94 Now click Add New Load

To set Earthquake load For Y Axis: Load-EQY, Type-Seismic, Self weight multiplier-0, Auto lateral load-UBC94 Now click Add New Load

				Click To:
Load	Туре	Self Weight Multiplier	Auto Lateral Load	Add New Load
Dead	Dead	~ 1	~	Modify Load
Live DW	Live Super Dead	0		Modify Lateral Load
FF	Super Dead Super Dead	0	LIBC 94	Delete Load
WLY	Wind Seismic	Ö	UBC 94 UBC 94	
EQY	Seismic	ŏ	UBC 94	
				UK Cancel
	modificlators	llood ontions	<u> </u>	
	moully latera		5 <b>7</b>	
indward Co	efficient,Cq	or Cp=1.28		
eward Coe	fficient, Cq=0	.0001		
ind Speed	(mph)=130			
nosure Tvr	ne=R			
postanca E	$\frac{1}{2}$			
arapet Heig	ht=3.5 ft			
ind Load Pattern - U	BC 94			
	Coefficients		Wind Coefficients	
Exposure and Pressure			Wind Speed (mph)	130
Exposure and Pressure <ul> <li>Exposure from E</li> </ul>	xtents of Diaphragms		Wind Opeca (inpri)	
Exposure and Pressure Exposure from E Exposure from S	xtents of Diaphragms hell Objects		Exposure Type	В ~
Exposure and Pressure     Exposure from E     Exposure from S     Wind Exposure Parameter	xtents of Diaphragms hell Objects eters		Exposure Type Importance Factor	B ✓ 1
Exposure and Pressure Exposure from E Exposure from S Wind Exposure Parame Wind Directions and	xtents of Diaphragms hell Objects eters Exposure Widths	Modify/Show	Exposure Type Importance Factor Exposure Height	B ~ 1
Exposure and Pressure Exposure from E Exposure from S Wind Exposure Parame Wind Directions and Windward Coefficier	xtents of Diaphragms hell Objects eters Exposure Widths t, Cq	Modify/Show 1.28	Exposure Type Importance Factor Exposure Height Top Story	B ~ 1 Roof ~
Exposure and Pressure Exposure from E Exposure from S Wind Exposure Parame Wind Directions and Windward Coefficient Leeward Coefficient	ktents of Diaphragms hell Objects eters Exposure Widths it, Cq Cq	Modify/Show 1.28 0.0001	Exposure Type Importance Factor Exposure Height Top Story Bottom Story	B ~ 1 Roof ~ GF ~
Exposure and Pressure Exposure from E Exposure from S Wind Exposure Parame Wind Directions and Windward Coefficient Leeward Coefficient	xtents of Diaphragms hell Objects eters Exposure Widths it, Cq Cq	Modify/Show 1.28 0.0001	Exposure Type Importance Factor Exposure Height Top Story Bottom Story Unclude Parapet	B ~ 1 Roof ~ GF ~

Now Click Modify/Show--→For X Axis Direction Angles, 0 Degree

	n as separator)		deg		
		Exposure Set 1 of	1: 0 deg		
Story	Diaphragm	Width	Depth ft	X Ordinate ft	Y Ordinate ft
1					
1 D Exposure Set Width is Auto	Calculated from Diaphysam B	Edents by the Program			
1 9 Exposure Set Width is Auto 2 Exposure Set Width is User	- Calculated from Diaphragm E	Extents by the Program			



or WLY Click modify lateral load of	options:	
Windward Coefficient ,Cq or Cp=1.5	6	
Leeward Coefficient, Cq=0.0001		
Wind Speed (mph)=130		
Exposure Type=B		
Importance Factor=1		
Parapet Height=3.5 ft		-
Wind Load Pattern - UBC 94		
Exposure and Pressure Coefficients	Wind Coefficients	
Exposure from Extents of Diaphragms	Wind Speed (mph)	130
O Exposure from Shell Objects	Exposure Type	в 🗸
Wind Exposure Parameters	Importance Factor	1
Wind Directions and Exposure Widths Modify/Show	Exposure Height	
Windward Coefficient, Cq 1.56	Top Story	Roof $\checkmark$
Leeward Coefficient, Cq 0.0001	Bottom Story	GF $\sim$
	Include Parapet	

Now Click Modify/Show-→For Y Axis Direction Angles, 90 Degree Wind Exposure Width Date

Story	Diaphragm	Width	Deoth	X Ordinate	YOrdinate
0.0.)	chop in og in	ft	ft	ft	ft

Click ok and again Click ok

For EQX Click modify lateral load options $ ightarrow$
Direction and Eccentricity→Only select X Dir
Select Program Calculated
And ct=0.03
Per code=0.15
Site Coefficient, S=1.5
Importance Factor,I=1
Numerical Coefficient,Rw=8
Story Range :
Top Story= Roof
Bottom Story= Base

35	Seismic L	oad Pattern	_	UBC 94
124	Seisinne i	oud i uttern		000004

X Dir		Y Dir		Seismic Zone Factor, Z	
X Dir + Eccentricity X Dir - Eccentricity Ecc. Ratio (All Diaph.) Overwrite Eccentricities		Y Dir + Eccentricity Y Dir - Eccentricity		<ul> <li>Per Code</li> <li>User Defined</li> <li>Site Coefficient, S</li> <li>Importance Factor, I</li> </ul>	0.15 ~ 1.5 ~ 1
me Period				Story Range	
<ul> <li>Method A</li> </ul>	Ct (ft) =			Top Story	Roof $\sim$
Program Calculated	Ct (ft) =	0.03		Bottom Story	Base ~
O User Defined	Τ=		sec		
actors Numerical Coefficient, Rw		8		ОК	Cancel

#### Click ok

For EQY Click modify lateral load options $\rightarrow$	
Direction and Eccentricity $\rightarrow$ Only select Y Dir	
Select Program Calculated	
And c <sub>t</sub> =0.03	
Per code=0.15	
Site Coefficient, S=1.5	
Importance Factor,I=1	
Numerical Coefficient,Rw=8	
Story Range :	
Top Story= Roof	
Bottom Story= Base	
Seismic Load Pattern - UBC 94	×

📲 Seismic Load Pattern - UBC 94

Direction and Eccentricity	Y Dir		Seismic Coefficients Seismic Zone Factor, Z	
X Dir + Eccentricity	Y Dir + Eccentricity		Per Code	0.15 ~
			O User Defined	
Ecc. Ratio (All Diaph.	)		Site Coefficient, S	1.5 ~
Overwrite Eccentriciti	es Overwrite		Importance Factor, I	1
Time Period			Story Range	
<ul> <li>Method A</li> </ul>	Ct (ft ) =		Top Story	Roof $\sim$
Program Calculated	Ct (ft) = 0.03		Bottom Story	Base $\checkmark$
O User Defined	Τ =	sec		
Factors				
Numerical Coefficient, Rw	8		ОК	Cancel

Click ok Returns to main window

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 $\times$ 

Mass Sources	Click to:
MsSrc1	Add New Mass Source
	Add Copy of Mass Source
	Modify/Show Mass Source
	Delete Mass Source
	Default Mass Source
	MsSrc1 ~

#### 3.7.1 Mashing and Define Mass Source:

Now Click Modify/Show Mass Source

Mass Source  $\rightarrow$  Select only Specified Load patterns

Mass Multiplies For load patterns

Dead x1 Click Add, Live x 0.25 Click Add, PW x1 Click Add ,FFx1 Click Add

Mass Source Name MsSrc1			Load Patte	ern Multiplier	
			Dead	~ 1	bbΔ
ss Source			Dead	1	
Element Self Mass			PW	1	Modify
Additional Mass			Live	0.25	Delete
Specified Load Patterns					
Adjust Diaphragm Lateral Mass to Move Mas	s Centroid by:		Mass Options		
This Ratio of Diaphragm Width in X Directio	n		Include Latera	l Mass	
This Ratio of Diaphragm Width in Y Directio	n		Include Vertica	al Mass	
		1	🗸 Lump Lateral I	llass at Story Levels	

## 3.7.2 Diaphragms:



Then Menu Command : All Slab Select →Assign→ Shell →Diaphragms→ Click

#### 3.7.3 **Design Stripe:**

Then Menu Command : Edit→Add/Edit Design Strips →Add Design Strips Now , Click include Middle Strips Grid Direction=X Strip Layer=A Click Apply Then Ok Add Design Strips

	11	$\sim$
Story	Roof	$\sim$
ptions		
Add Design Strips .	Along Cartesian Gri	d Lines
	os	
arameters		
Coordinate System	G1	~
Grid Direction	×	~
Strip Layer	A	$\sim$
Strip Width		
Fixed		

Then Menu Command : Edit→Add/Edit Design Strips →Add Design Strips Now , Click include Middle Strips Grid Direction=Y Strip Layer=B Click Apply then Ok Add Design Strips

Tower	T1	~
Story	Roof	$\sim$
)ptions		
Add Design Strips	Along Cartesian G	Grid Lines
Include Middle Strip	ps	
arameters		
Coordinate System	G1	$\sim$
Grid Direction	Y	$\sim$
Strip Layer	в	$\sim$
Strip Width		
Fixed		
Auto		

#### At Last The Diaphragms ===→



#### 3.7.4 Check Model:

Then Menu Command: Analyze->Check Model->Select All And Click ok

	0.1 in
oint Checks	
Joints/Joints within Tolerance	
Joints/Frames within Tolerance	
Joints/Shells within Tolerance	
rame Checks	
Frame Overlaps	
Frame Intersections within Tolerand	e
Frame Intersections with Area Edge	s
Shell Checks	
Shell Overlaps	
Other Checks	
Check Meshing for All Stories	
Check Loading for All Stories	
Check for Duplicate Self Mass	
ñx -	
Trim or Extend Frames and Move J	pints to Fix Problems
Joint Story Assignment	

No warning messages were generated.

📲 Warning

Model has been checked. No warning messages were generated.

×

 $\sim$ 

#### 3.7.5 Automatic Rectangular Mesh Setting For Floors:

Menu Command: Analyze $\rightarrow$ Automatic Rectangular Mesh Setting For Floors  $\rightarrow$  Then

Approximate Mesh Size =2 ft Click ok	$\times$
Mesh Options for Slabs <ul> <li>Rectangular Mesh</li> <li>Use Localized Meshing</li> <li>Merge Joints Where Possible</li> </ul>	
Approximate Maximum Mesh Size 2 ft	
Important Note These settings apply to all slab-type shell objects in the model that use auto meshing.	
OK Cancel	

#### 3.8.1 Run Analysis:

Then Menu Command: Analyze--> Run Analysis After Analysis:nalysis:



## 3.8.2 **Design Check:**

Datiels of Analysis: Menu Command :Design→Concrete Frame Design→Start Design Check: For Details:



#### Chapter-04 Load On Building

#### 4.1 WIND LOAD CALCULATION USING BNBC 1993:

Table 1: Exposure Category as per BNBC 1993 and UBC 1991 and afterward

BNBC 1993	UBC 1991 and afterward
<b>Exposure A:</b> Urban and sub-urban areas, industrial areas, wooded areas, hilly or other terrain covering at least 20 per cent of the area with obstructions of 6 meters or more in height and extending from the site at least 500 meters or 10 times the height of the structure, whichever is greater.	<b>Exposure B:</b> It has terrain with buildings, forest or surface irregularities 20 feet (6 meter) or more in height covering at least 20 percent of the ground level area extending 1 mile (1.61 km) or more from the site.
<b>Exposure B:</b> Open terrain with scattered obstructions having heights generally less than 10m extending 800 m or more from the site in any full quadrant. This category includes air fields, open park lands, sparsely built-up outskirts of towns, flat open country and grasslands.	<b>Exposure C:</b> It has terrain that is flat and generally open, extending <sup>1</sup> / <sub>2</sub> mile (0.81 km) or more from the site in any full quadrant.
<b>Exposure C:</b> Flat and unobstructed open terrain, coastal areas and riversides facing large bodies of water, over 1.5 km or more in width. Exposure C extends inland from the shoreline 400 m or 10 times the height of structure, whichever is greater.	<b>Exposure D:</b> It represents the most severe exposure in areas with basic wind speeds of 80 miles per hour (mph) (129 km/h) or greater and has terrain that is flat and unobstructed facing large bodies of water over 1 mile (1.61 km) or more in width relative to any quadrant of the building site. Exposure D extends inland from the shoreline ¼ mile (0.40 km) or 10 times the building height, whichever is greater.

Note: Exposure A, B and C in BNBC is similar to Exposure B, C and D in UBC respectively

#### Table 2: Design Wind Pressure as per BNBC and UBC

	BNBC 1993	UBC 1991 and afterward
where	velocity-to-pressure conversion coefficient = $47.2 \times 10^{-6}$ when velocity in km/h and pressure is in kN/m <sup>2</sup> = $0.00256$ when velocity in mph and pressure is in lb/ft <sup>2</sup> structure importance coefficient as given in Table 3 combined height and exposure coefficient as given in Table 4 basic wind speed obtained from Table 5 or Figure 1 or site specified value.	where combined height, exposure and gust factor coefficient pressure coefficient for the structure or portion of structure under consideration as given in wind stagnation pressure at the standard height of 33 feet = when velocity in mph and is in lb/ft <sup>2</sup> basic wind speed
where	gust coefficient as given in Table 4 pressure coefficient to be used for determination of wind loads on buildings and structures as set forth in sec <b>Error! Reference source not</b> <b>found.</b>	Importance factor. Structure importance is categorized in four categories and importance factors vary from 1.00 to 1.15. Low risk structure category is not included. Later wind importance factor is defined as and miscellaneous structure category included.

# **Table 3** Structure Importance Categories and Coefficients C<sub>1</sub> (BNBC 1993: Table 6.1.1 and Table 6.2.9)

Structure		Occupancy Type or Functions of Structure	Structure
Im	portance		Importance
Ca	tegory		Coefficients, C <sub>I</sub>
I)	Essential	Hospital and other medical facilities having surgery and	1.25
	Facilities	emergency treatment area.	
		Fire and police stations.	
		Tanks or other structures containing, housing or supporting water	
		or other fire-suppression materials or equipment required for the	
		occupancy structures	
		Emergency vehicle shelters and garages	
		Structures and equipment in emergency-preparedness centers	
		including cyclone and flood shelters.	
		Standby power-generating equipment for essential facilities.	
		Structures and equipment in government communication centers	
		and other facilities required for emergency response.	
II)	Hazardous	Structures housing, supporting or containing sufficient	1.25
	Facilities	quantities of toxic or explosive substances to be dangerous to the	
		safety of the general public if released.	
III)	Special	Covered structures whose primary occupancy is public assembly	1.00
	Occupancy	with capacity > 300 persons.	
	Structures	Buildings for schools through secondary or day-care centers with	
		capacity > 250 students.	
		Jails and detention facilities.	
		All structures with occupancy $> 5,000$ persons.	
		Structures and equipment in power-generating stations	
		and	
		other public utility facilities not included above, and required	
		for continued operation.	
		All structures having occupancies or functions not listed	
IV)	Standard	above.	1.00
	Occupancy		
	Structures		
V)	Low Risk	Buildings and Structures that exhibit a low risk to human life	0.80
	Structures	and property in the event of failure, such as agricultural	
		buildings, minor storage facilities, temporary facilities,	
		construction facilities, and boundary walls.	

Height	Height	(1)					Combined Coefficient				
above	above	Coefficient, <i>Cz</i> for			Coeffic	Coefficient, $C_G$ for			(1)(2) for exposure		
ground	ground	expo		egory	expo		egory		category	7	
(m)	(ft)	А	В	C	А	В	C	А	В	С	
0	0	0.368	0.801	1.196	1.654	1.321	1.154	0.609	1.058	1.380	
4.5	14.76	0.368	0.801	1.196	1.654	1.321	1.154	0.609	1.058	1.380	
6	19.68	0.415	0.866	1.263	1.592	1.294	1.140	0.661	1.121	1.440	
9	29.52	0.497	0.972	1.37	1.511	1.258	1.121	0.751	1.223	1.536	
12	39.36	0.565	1.055	1.451	1.457	1.233	1.107	0.823	1.301	1.606	
15	49.2	0.624	1.125	1.517	1.418	1.215	1.097	0.885	1.367	1.664	
18	59.04	0.677	1.185	1.573	1.388	1.201	1.089	0.940	1.423	1.713	
21	68.88	0.725	1.238	1.623	1.363	1.189	1.082	0.988	1.472	1.756	
24	78.72	0.769	1.286	1.667	1.342	1.178	1.077	1.032	1.515	1.795	
27	88.56	0.81	1.33	1.706	1.324	1.17	1.072	1.072	1.556	1.829	
30	98.4	0.849	1.371	1.743	1.309	1.162	1.067	1.111	1.593	1.860	
35	114.8	0.909	1.433	1.797	1.287	1.151	1.061	1.170	1.649	1.907	
40	131.2	0.965	1.488	1.846	1.268	1.141	1.055	1.224	1.698	1.948	
45	147.6	1.017	1.539	1.89	1.252	1.133	1.051	1.273	1.744	1.986	
50	164	1.065	1.586	1.93	1.238	1.126	1.046	1.318	1.786	2.019	
60	196.8	1.155	1.671	2.002	1.215	1.114	1.039	1.403	1.861	2.080	
70	229.6	1.237	1.746	2.065	1.196	1.103	1.033	1.479	1.926	2.133	
80	262.4	1.313	1.814	2.12	1.18	1.095	1.028	1.549	1.986	2.179	
90	295.2	1.383	1.876	2.171	1.166	1.087	1.024	1.613	2.039	2.223	
100	328	1.45	1.934	2.217	1.154	1.081	1.020	1.673	2.091	2.261	
110	360.8	1.513	1.987	2.26	1.114	1.075	1.016	1.685	2.136	2.296	
120	393.6	1.572	2.037	2.299	1.134	1.07	1.013	1.783	2.180	2.329	
130	426.4	1.629	2.084	2.337	1.126	1.065	1.010	1.834	2.219	2.360	
140	459.2	1.684	2.129	2.371	1.118	1.061	1.008	1.883	2.259	2.390	
150	492	1.736	2.171	2.404	1.111	1.057	1.005	1.929	2.295	2.416	
160	524.8	1.787	2.212	2.436	1.104	1.053	1.003	1.973	2.329	2.443	
170	557.6	1.835	2.25	2.465	1.098	1.049	1.001	2.015	2.360	2.467	
180	590.4	1.883	2.287	2.494	1.092	1.046	1.000	2.056	2.392	2.494	
190	623.2	1.928	2.323	2.521	1.087	1.043	1.000	2.096	2.423	2.521	
200	656	1.973	2.357	2.547	1.082	1.04	1.000	2.135	2.451	2.547	
220	721.6	2.058	2.422	2.596	1.073	1.035	1.000	2.208	2.507	2.596	
240	787.2	2.139	2.483	2.641	1.065	1.03	1.000	2.278	2.557	2.641	
260	852.8	2.217	2.541	2.684	1.058	1.026	1.000	2.346	2.607	2.684	
280	918.4	2.91	2.595	2.724	1.051	1.022	1.000	3.058	2.652	2.724	
300	984	2.362	2.647	2.762	1.045	1.018	1.000	2.468	2.695	2.762	

Table 4: Combined Height and Exposure Coefficient,  $C_Z$  and Gust Coefficient,  $C_G$ 

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

(2) Combined coefficient which is the same as Ce in UBC 1991 and afterward

Location	Basic Wind Speed (km/h)	Basic Wind Speed (mph)	Location	Basic Wind Speed (km/h)	Basic Wind Speed (mph)
Angarpota	150	93	Lalmonirhat	204	127
Bagerhat	252	157	Madaripur	220	137
Bandarban	200	124	Magura	208	129
Barguna	260	162	Manikganj	185	115
Barisal	256	159	Meherpur	185	115
Bhola	225	140	Maheshkhali	260	162
Bogra	198	123	Moulvibazar	168	104
Brahmanbaria	180	112	Munshiganj	184	114
Chandpur	160	99	Mymensingh	217	135
Chapai Nawabganj	130	81	Naogaon	175	109
Chittagong	260	162	Narail	222	138
Chuadanga	198	123	Narayanganj	195	121
Comilla	196	122	Narsinghdi	190	118
Cox's Bazar	260	162	Natore	198	123
Dahagram	150	93	Netrokona	210	130
Dhaka	210	130	Nilphamari	140	87
Dinajpur	130	81	Noakhali	184	114
Faridpur	202	126	Pabna	202	126
Feni	205	127	Panchagarh	130	81
Gaibandha	210	130	Patuakhali	260	162
Gazipur	215	134	Pirojpur	260	162
Gopalganj	242	150	Rajbari	188	117
Habiganj	172	107	Rajshahi	155	96
Hatiya	260	162	Rangamati	180	112
Ishurdi	225	140	Rangpur	209	130
Joypurhat	180	112	Satkhira	183	114
Jamalpur	180	112	Shariatpur	198	123
Jessore	205	127	Sherpur	200	124
Jhalakati	260	162	Sirajganj	160	99
Jhenaidah	208	129	Srimangal	160	99
Khagrachhari	180	112	St. Martin's Island	260	162
Khulna	238	148	Sunamganj	195	121
Kutubdia	260	162	Sylhet	195	121
Kishoreganj	207	129	Sandwip	260	162
Kurigram	210	130	Tangail	160	99
Kushtia	215	134	Teknaf	260	162
Lakshmipur	162	101	Thakurgaon	130	81

**Table 5:** Basic Wind Speeds for Selected Locations in Bangladesh (BNBC 1993:<br/>Table 6.2.8)



L/P				L/B	k z d		
N/D	0.1	0.5	0.65	1.0	2.0	≥ 3.0	
≤0.5	1.40	1.45	1.55	1.40	1.15	1.10	$\xrightarrow{\text{Wind}}$ $h$ $\longrightarrow$ $F_2$
10.0	1.55	1.85	2.00	1.70	1.30	1.15	
20.0	1.80	2.25	2.55	2.00	1.40	1.20	(b) Elevation
≥40.0	1.95	2.50	2.80	2.20	1.60	1.25	$\xrightarrow{\text{Wind}}$ $B$ $\longrightarrow$ $F_2$
<sup>(1)</sup> These coefficients are to be used with Method-2 given in BNBC							
Sec 2.4.6.6a (ii). Use $C_p = \pm 0.7$ for roof in all cases.							P7
<sup>(2)</sup> Linear interpolation may be made for intermediate values							(a) Plan
of h/B	and L/B			Rectangular Building			

 $\label{eq:constraint} \begin{array}{l} \mbox{Table 6: Overall Pressure Coefficients, Cp}_{(2)} \mbox{ for Rectangular Buildings with Flat} \\ \mbox{ Roofs (BNBC 1993: Table 6.2.15}_{(1)}) \end{array}$ 

## Interpolation for C<sub>p</sub> Value:

١	NLX			
INPUT				
L	64	ft		
В	48	ft		Wind
h	111	ft		
Output				
L/B	1.33			
h/B	2.31			
Сру				
Manual Interpolation				
Table For Check				Wind
h/P				
	0.65	1.33	1	
0.5	1.55	1.25714286	1.4	
2.31		1.28712406		
10	2	1.41428571	1.7	







Rectangular Building

1	WLY				
INPUT					
L	48	ft			
В	64	ft			
h	111	ft		2	~
Output				Wind	h
L/B	0.75				
h/B	1.73				
Сру					b) Elevation
Manual Interpolation Table For Check					Ţ
h /D		L/B		Wind	в
n/B	0.65	0.75	1		
0.5	1.55	1.50714286	1.4		
1.73		1.56004464			a) Plan
10	2	1.91428571	1.7		Rectangular Building

l

#### 4.2 EARTHQUAKE LOAD CANCULATION:

#### Equivalent Static Force Method

This method may be used for calculation of seismic lateral forces for all structures specified in Sec 2.5.5.1(a)

2.5.6.1 Design Base Shear : The total design base shear in a given direction shall be determined from the following relation :

$$V = \frac{ZIC}{R} W$$
(2.5.1)

where, Z = Seismic zone coefficient given in Table 6.2.22

I = Structure importance coefficient given in Table 6.2.23

- R = Response modification coefficient for structural systems given in Table 6.2.24 W
- = The total seismic dead load defined in Sec 2.5.5.2
- C = Numerical coefficient given by the relation :

$$C = \frac{1.25S}{T^{2/3}} \leq 2.5.2$$

S = Site coefficient for soil characteristics as provided in Table 6.2.25

T = Fundamental period of vibration in seconds, of the structure for the direction under consideration as determined by the provisions of Sec 2.5.6.2.

The value of C need not exceed 2.75 and this value may be used for any structure without regard to soil type or structure period. Except for those requirements where Code prescribed forces are scaled up by 0.375*R*, the minimum value of the ratio C/R shall be 0.075.

Table 6.2.22 Seismic Zone Coefficients, Z Table 6.2.23 Structure Importance Coefficients I, I'

**2.5.6.2 Structure Period** : The value of the fundamental period, *T* of the structure shall be determined from one of the following methods :

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

 $T = C \frac{(h)^{3/4}}{t n}$ (2.5.3)

where, Ct = 0.083 for steel moment resisting frames {0.034 when height in ft} = 0.073 for reinforced concrete moment resisting frames, and eccentric braced steel frames {0.030 when height in ft} = 0.049 for all other structural systems {0.020 when height in ft}

hn = Height in metres above the base to level n.

#### SEISMIC WEIGHT

Seismic weight, *W*, is the total dead load of a building or a structure, including partition walls, and applicable portions of other imposed loads listed below:

- a) For live load up to and including 3 kN/m<sup>2</sup>, a minimum of 25% of the live load shall be applicable.
- b) For live load above 3 kN/m<sup>2</sup>, a minimum of 50% of the live load shall be applicable.
- c) Total weight (100%) of permanent heavy equipment or retained liquid or any imposed load sustained in nature shall be included.

Where the probable imposed loads (mass) at the time of earthquake are more correctly assessed, the designer may go for higher percentage of live load.



Table 6.2.24 Response Modification Coefficient for Structural Systems,

Basic Structural	Description of Lateral Force Resisting System	R <sup>(2)</sup>
System <sup>(1)</sup>		
a. Bearing Wall	<ol> <li>Light framed walls with shear panels         Plywood walls for structures, 3 storeys or         i) less     </li> </ol>	8
Oystem	<ul><li>ii) All other light framed walls</li><li>2. Shear walls</li></ul>	6
	i) Concrete ii) Masonry	6 6
	<ul> <li>3.Light steel framed bearing walls with tension only bracing</li> <li>Braced frames where bracing carries gravity</li> <li>4. loads</li> </ul>	4
	i) Steel ii) Concrete <sup>(3)</sup>	6 4 4
b. Building Frame	iii) Heavy timber 1. Steel eccentric braced frame (EBF)	10
System	<ol> <li>Light framed walls with shear panels         Plywood walls for structures 3-storeys or         i)         loss     </li> </ol>	0
	<ul><li>ii) All other light framed walls</li><li>3. Shear walls</li></ul>	7
	i) Concrete ii) Masonry 4 Concentric braced frames (CBE)	8 8
	i) Steel ii) Concrete <sup>(3)</sup>	8 8
c Moment Resisting	iii) Heavy timber 1 Special moment resisting frames (SMRF)	þ
Frame System	i) Steel ii) Concrete	12 12
	Intermediate moment resisting frames (IMRF),     2. concrete     3. Ordinary moment resisting frames (OMRF)     i) Steel	<b>8</b> 6
	ii) Concrete <sup>(5)</sup>	D
d. Dual System	<ol> <li>Shear walls         <ol> <li>Concrete with steel or concrete SMRF</li> <li>Concrete with steel OMRF</li> </ol> </li> </ol>	12 6
	<ul> <li>iii) Concrete with concrete IMRF <sup>(4)</sup></li> <li>iv) Masonry with steel or concrete SMRF</li> <li>v) Masonry with steel OMRF</li> </ul>	9 8 6
	<ul> <li>vi) Masonry with concrete IMRF <sup>(3)</sup></li> <li>2. Steel EBF</li> <li>i) With steel OMDE</li> </ul>	7 12
	i) With steel SMRF ii) With steel OMRF 3. Concentric braced frame (CBF) i) Steel with steel SMRF	6 10 6
	II) Steel with steel OMRF	9
	iv) Concrete with concrete IMRF <sup>(3)</sup>	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. See Sec 2.5.6.6 for combination of structural systems, and Sec 1.3.5 for system limitations. (2)
- (3) Prohibited in Seismic Zone 3.
- Prohibited in Seismic Zone 3 except as permitted in Sec 2.5.9.3. (4)
- Prohibited in Seismic Zones 2 and 3. Sec 1.7.2.6. (5)

#### Table 6.2.25

#### Site Coefficient, S for Seismic Lateral Forces (1)

	Site Soil Characteristics	Coefficient,
		s
Type	Description	
51	A soil profile with either : a) A rock-like material characterized by a shear-wave velocity greater than 762 m/s or by other suitable means of classification, or b) Stiff or dense soil condition where the soil depth is less than 61 metres	1.0
s2	A soil profile with dense or stiff soil conditions, where the soil depth exceeds 61 metres	1.2
<b>√</b> 3	A soil profile 21 metres or more in depth and containing more than 6 metres of soft to medium stiff clay but not more than 12 metres of soft clay	1.5
S4	A soil profile containing more than 12 metres of soft clay characterized by a shear wave velocity less than 152 m/s	2.0
Note :	<ol> <li>The site coefficient shall be established from properly substantiated geotechnical data. In locations</li> </ol>	where the soil
	properties are not known in sufficient detail to determine the soil profile type, soil profile 33 shall	be used. Soil
	profile S4 need not be assumed unless the building official determines	
	that soil profile S4 may be present at the site, or in the event that soil profile S4 is establishe geotechnical data.	ed by

**2.5.6.3** Vertical Distribution of Lateral Forces : In the absence of a more rigorous procedure, the total lateral force, which is the base shear V, shall be distributed along the height of the structure in accordance with Eq (2.5.6), (2.5.7) and (2.5.8):

$$V = F_t + \sum_{i=1}^{n} F_i$$
(2.5.6)

where,  $F_i$  = Lateral force applied at storey level -i and

Ft = Concentrated lateral force considered at the top of the

building in addition to the force  $F_{n}$ .

The concentrated force,  $F_t$  acting at the top of the building shall be determined as follows:

$$F_t = 0.07 TV \le 0.25 V$$
 when  $T \ge 0.7$  second (2.5.7a)

$$Ft = 0.0$$
 when  $T \le 0.7$  second (2.5.7b)

The remaining portion of the base shear (V-Ft), shall be distributed over the height of the building, including level-*n*, according to the relation :

$$Fx = \frac{(V - F_{n-t})w}{\sum_{i=1}^{w} h_{i}} x^{h} x$$

At each storey level-x, the force  $F_{\chi}$  shall be applied over the area of the building in proportion to the mass distribution at that level.

(2.5.8)

### CHAPTER-05 RESULT AND DISCUSSIONS

#### 5.1 Data analysis:

#### 5.1.1 Finding Maximum Moment Value:

After checking deferent floor from analysis we found maximum moment on beam at:

	Beam Element Details (Summary)									
Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (in)	LLRF	Туре		
Floor2	B15	163	Beam12"x20"	DCon6	10	192	1	Sway Special		

Design Moment and Flexural Reinforcement for Moment, Mus								
	Design -Moment kip-ft	Design +Moment kip-ft	-Moment Rebar in²	+Moment Rebar in²	Minimum Rebar in²	Required Rebar in <sup>2</sup>		
Top (+2 Axis)	-215.7728		2.6146	0	0.5793	2.6146		
Bottom (-2 Axis)		107.8863	0	1.2078	0.5793	1.2078		

From above procedure we collect / found max moment with respect to grid type & level which is put on the graph as bellow:

## 5.1.2 Grid Type:

Туре-1	Туре-2
Type=L-48XB-32	Type=L-64XB-48
Type=L-64XB-32	Type=L-80XB-48
Type=L-80XB-32	Type=L-96XB-48

## 5.1.3 Graphs:

#### Graph is prepared with the relation of moment.

L= 48 Feet	Ratio - 1		
B= 32 Feet	Natio - 1		
			2
Height	Moment	L/R Patio	2 ب
(Variable)	Woment		
71	133.7917	1.5	Ĕ
81	157.3412	1.5	S <sup>1</sup>
91	181.4188	1.5	5
101	207.3381	1.5	
111	233.6817	1.5	
X	Y		

Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)



m=2.4978	
C=-44.583	

#### Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

L= 64 Feet	et Batio = 2.00								
B= 32 Feet	Katio = 2.0								
			250						
Height (Variable)	Moment	L/B Ratio	200 tu 0 150				y = 2.0114	4x - 23.866	•
71	119.3194	2.00	Ĕ						
81	138.8041	2.00	٥ <sup>100</sup>						
91	158.9158	2.00	50						
101	179.0526	2.00	0						-
111	199.765	2.00	0	20	40	60	80	100	120
X	Y		Height						
		-							

m=2.0114	
C=-23.866	



#### Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

C=1.608

# Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

	Datio = 1 22					
B= 48 Feet		Nacio - 1.55				
Height	Moment	L/B Ratio				
(Variable)						
71	123.9093	1.33				
81	145.4292	1.33				
91	168.2449	1.33				
101	192.4438	1.33				
111	216.4696	1.33				
Х	Y					

C=-41.944



L= 80 Feet	Datia - 1	Patio = 1.67						_		
B= 48 Feet	Ratio = 1.07		Moment Vs Height							
			200	•						
Height	Momont	L/P Patio	180					y = 1.7835	x - 19.697	*
(Variable)	woment		140							
71	107.4904	1.67	E 100					•		
81	124.4688	1.67								
91	142.1489	1.67	<b>2</b> 40							
101	159.9639	1.67	20							_
111	178.9154	1.67		0	20	40	60	80	100	120
Х	Y				- 1	Heigh	t			
	m=1.7835									

# Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

### Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

C=-19.697

L= 96 Feet	Datia - 3	00								
B= 48 Feet	Katio = 2.	Moment Vs He								
				180				v = 1 5262	7 7/12	•
Height	Momont	L/P Patio	L	140				y - 1.5202	×-1.1412	
(Variable)	Woment		ente	120				1	•	
71	101.746	2	Ĕ	100 80				•		
81	115.0202	2	- P	60						
91	130.434	2	6	40						
101	145.867	2		0						-
111	162.6307	2		0	20	40	60	80	100	120
X	Y					I	Heigh	nt		

m=1.5262
C=-7.7412

#### 5.1.4 Three Seismic Zone of Bangladesh:

## Earthquake zone of Bangladesh

 Zone 1:High Risk Mymensing,Sylhet,Rangpur,La Imonirhat, Kurigram etc.

Zone 2:Moderate Risk

Bogra, Dinajpur, Dhaka, Comilla, panchgar etc.

Zone 3:Low Risk

Khulna, jessor, Barisal, Patuakhali etc.



#### For Zone 1: (High Risk) Sylhet

	0 1 1		, , ,				
L= 64 Feet	t Ratio = 1.32			ht			
B= 48 Feet	Natio - 1			women	I vs neig	,iit	
			250				
Height	Mamant		200		1	r = 2.0258x - 31	.339
(Variable)	woment	L/ D Katio	tu 150			-	*
71	113.3629	1.33	Ĕ				
81	132.1956	1.33	₽ <sup>100</sup>				
91	152.1245	1.33	50				
101	173.2304	1.33					<b></b>
111	194.1364	1.33	D	20 40	60	80 1	00 120
X	Y				Height		
	m=2.0258						

Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

C=-31.339

#### For Zone 2: (Moderate Risk) Dhaka



Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

#### For Zone 3: (Low Risk) Khulna



Subject: Drawing Graph (Moment & L/B Ratio, Height Variable)

#### **Remarks:**

We chose 3 Locations Dhaka, Khulna and Sylhet of 3 separate Zones to assign lateral loads (both wind and seismic loads) to perform analysis of our project. But it is mentionable that for different Zones, Moment variations also different.

#### 5.2 Result:

Y=mx+C -----(1) nY=nmx+nc-----(2) [Multiply By n]  $\sum Y=m\sum x+nC$ -----(3)  $\overline{\Sigma}$ xY= $\overline{m\Sigma}$ x<sup>2</sup>+C $\Sigma$ x------(4) [Multiply By x]

x(Height) ft	x <sup>2</sup> (Height) ft <sup>2</sup>	Y(Moment) kip-ft	xY (kip-ft <sup>2</sup> )
71	5041	123.9093	8797.5603
81	6561	145.4292	11779.7652
91	8281	168.2449	15310.2859
101	10201	192.4438	19436.8238
111	12321	216.4696	24028.1256
∑x=455	∑ x²=42405	∑Y=846.4968	∑xY=79352.5608

Now, Putting the value in 3 & 4 No. Equation: 846.4968=m\*455+5\*C [Where n=5] 79352.5608=m\*42405+C\*455

C=-41.944

So, m=2.3214 [By Using Calculator]

Y=mx+C Y=2.3214\*101+(-41.944) [when, x=101 ft] =192.5174 kip-ft (Equation Proved)

## Moment Variation Follows a Straight Line.

## 6.1 Conclusions:

- Through this analysis it has been found that lateral loads (Wind, Earthquake) have considerable effect to grate extent in the design of a high rise building frame.
- For analysis the selected building frame we have used ETABS software. Which is the most common and accurate analysis procedure now a days.
- We found maximum moment on beam at 2<sup>nd</sup> and 3<sup>rd</sup> floor (Maximum Cases).

#### 6.2 FURTHER STUDIES:

From the above study the following recommendation can made for further study:

- The analysis can be performed by varying the number of story, height and number of spans of the building.
- The analysis involves finite element techniques with relatively coarse mesh. So accuracy of the result can be improved through using fine mesh.
- > This study can be compared between other approximate methods.

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