ANALYSIS OF MULTISTORIED BUILDING WITH DIFFERENT SLAB THICKNESS USING ETABS

A Project and Thesis submitted in partial fulfillment of the requirements for the award of Degree of
Bachelor of Science in Civil Engineering

by

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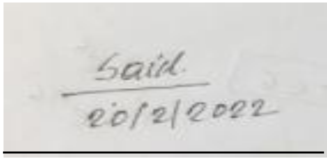
Certification

This is to certify that the student participants worked on the project and thesis "Analysis of Multistory Buildings with Different Slab Thickness Using ETABS" under my direct supervision and in the laboratories of the department of Civil engineering, faculty of engineering, Daffodil International University, in partial fulfillment of the requirements for the degree of bachelor of science in civil engineering. The presentation of the work was held on March 2022.

Signature of the candidates



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The project and thesis entitled "Analysis and Design of multistoried building with different slab thickness using ETABS**"** submitted by **Said Omar Ahmed**, ID No: 182-47-761. Session: summer 2018 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Civil Engineering** on March 2022.

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List of Abbreviations

f_c'	Compressive strength of concrete
f_y	Yield strength of steel
E_s	Modulus of Elasticity
ε_y	strain
γ	Density of Concrete
F1	Dead Load
F2	Live Load
F3	Floor Finish
SE1	Earthquake along X-axis
SE2	Earthquake along Y-axis
SW1	Wind load along X-axis
SW2	Wind load along Y-axis

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ABSTRACT

In this study RCC structural building is L-shape which is 384 m^2 in plan, with a Floor-to-Floor height of 3 meters. The major purpose of this study is to use ETABS to identify the smallest slab thickness that can safely support loads and hence reduce slab deflection in a concrete floor. A crucial element in the design process is the selection and computation of slab thickness. If a good technique for calculating slab thickness is followed, the design time will be significantly reduced, in addition to achieving a dependable and cost-effective slab thickness. The process of determining the behavior of a structure under specific load combinations is known as analysis. Design is the process of determining the structure's proper requirements. For design this L-shape Structure, I have applied different kind of gravity loads like live load of 4.8 kN/m^2, Floor finish 1.2 KN/m^2 and partial wall of 33% of live load as per BNBC 2020 code. Also earthquake loads have applied from base to top or roof of the building in Seismic Zone 2 by taking Zone factor(0.15), Type of soil (S1), Site coefficients, S (1.5), Numerical coefficient factor, Rw (8) and Ct(0.016,0.9) After making Twenty case study by change slab thickness and column size for check deflection under the limit. According to ACI 318-08-Table9.5 (ACI *318 Building Code Topic*, n.d.) for deflection limitation. I found that S5C6 which is slab thickness and column size of 600mm by 600 mm was suitable because of reveals in equation 4.1. It's observed that column size play vital role in this study and both slab thickness and column size has effect in this study.

CHAPTER 1

INTRODUCTION

1.1 General

The thickness of a concrete slab is determined by the loads and the slab's size. In general, a slab thickness of 6 inches (150mm) is used for residential and commercial buildings, BNBC 2020 (BNBC 2020) with reinforcement features as needed. The methods for determining slab thickness varied depending on the type of slab. For example, calculating the thickness of a one-way slab is different and easier than calculating the thickness of a two-way slab.

1.2 Importance of Slab Thickness

The slab may split under load and fail before its time if it is too thin. It expenses more than it should if the slab is excessively thick. Because slab thickness is a major determining factor in the cost of a concrete slab, there is often pressure to make the slab as thin as feasible.

1.3 Factors Effecting Slab Thickness

The thickness of the slab is an important consideration in the design and construction of a structure, and it has a direct impact on the structural system's cost. In a high-rise structure, for example, a 5mm increase in slab thickness results in a considerable increase in column axial loads. Then we'll have to raise the size of the columns, reinforcements, foundations, and so on. Finally, it has an impact on construction costs. As a result, we should keep the thickness of any structure within the design parameters (serviceability and ultimate limit state).
The following are some of the most important factors that influence slab minimum thickness.

i) Loads applied
ii) Strength of Concrete
iii) parameters for construction
iv) Length of the span
v) Number of Stories

vi) Types of Support

1.4 Scope of study

The major goal of our research is to determine the minimal slab thickness that can safely bear loads to prevent slab deflection of a concrete floor by utilizing ETABS ("ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.) with various slab thicknesses

1.5 Objective of this study

The main objective of this study is to analysis of multistoried building with different slab thickness using ETABS ("ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.) to get the suitable slab thickness.

1.6 Outline of Thesis

In chapter 1 Basic idea of the Slab, Factor effect slab thickness

In chapter 2 The next section mentions what has been done before and what kind of work has been used in the slab thickness effect

In chapter 3 What I have made modeling and specified the requirement data for analysis

In chapter we analyzed and how we accomplished & Evaluation results/analysis. The results such as Max Story displacement, Validation and deflections

In chapter 5: This chapter contains major findings of the research and recommendation for future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review summarizes what knowledgeable academics and experts have written about a certain topic. It's not uncommon to be asked to write one as a stand-alone piece of work, but it's more typical when it's part of a larger project like an article, research report, or thesis. In writing a literary review, the writer's purpose is to communicate to the reader what information and ideas they have about a subject, as well as their strengths and weaknesses. The purpose of a literature review is to serve as a guide for a certain topic. Literature reviews are a fantastic place to start if you just have a limited amount of time to conduct research. A good foundation for the study of a research report can also be found in literature reviews.

2.2 Overview

Through book reviews, the author should highlight what they have learned so far and what they plan to learn in the future. The reader should be persuaded after reading this chapter that the author's proposed study would be significant in furthering that discipline.

2.3 literature review

The papers below were published throughout the last few years by a variety of other authors.

(MacGregor, 1976) The origins of variability in reinforced concrete structures are discussed after a brief discussion of statistical definitions. The many methods for determining structural safety are discussed. A set of factors compliant with the 1975 National Building Code of Canada load factors are computed after a derivation of the processes used to determine load and factors. The new factors are lower than the present American and factors.

(Струков & Леванюк, 1983) Reinforced concrete slabs are subjected to intense stress testing at the Meppen test site under the impact of highly deformable projectiles. The approval of theoretically founded methods that are used to the treatment of aircraft impact load is one of the key goals of these tests. A dynamic, physically nonlinear technique is used to conduct comparative computational research. The majority of the parameter changes investigated at Meppen are related to structural design, namely the relationships between bending and shear bearing capacity.The proportion between bending and transverse shear deformations, as well as the quantity of overall displacements, are distinctly impacted by adjusting the bending and shear reinforcement. In the experiments, this translates to varying degrees of damage and crack formation. The results generally reveal a significant sensitivity to load conditions in the area of ultimate slab resistance. The impact velocity as well as the deformation behavior of the bullets have a significant impact on these.

(Kojima, 1991) A series of rocket impact loading on reinforced concrete slabs are described in this study. The study's main goal was to look into slab behavior on a local level. Steel missiles are launched at reinforced concrete slabs as part of the testing procedure. There were a total of 12 tests conducted, with different targets and missile settings. During the tests, the following results were discovered: (1) A soft-nosed missile causes less damage than a hard-nosed missile; (2) steel lining prevents flaking skin; (3) the impact strength of a double reinforced concrete slab is inadequate to that of a single reinforced concrete slab in the case of a hard-nosed missile, but nearly equal in the case of a soft-nosed missile.

(Huang & Ahmed, 1991) Concrete walls of various thicknesses exposed to the ASTM E119 fire course and the subsequent decay stage prescribed in the ISO 834 standard are assessed for fire safety. A mathematical model has been created and numerically solved to simulate the coupled heat and mass transfer in concrete walls under time-dependent boundary conditions. For various concrete wall thicknesses at varied depth thickness ratios, the results predict pore pressure, temperature, and moisture histories. Thinner slabs are more sensitive to damage and rupture during a fire than broader slabs, according to the findings.

(Ju & Lin, 1999) This project's main purpose is to compare and contrast rigid-floor and flexible-floor building studies. The finite-element approach is used to examine buildings with and without shear walls. Based on a variety of response-spectrum analyses, the rigid-floor model was found to be realistic enough for regular and nonregular buildings without shear walls. The difference between rigid and flexible floor studies in constructions with shear walls, on the other hand, could be significant. An error formula is developed using a regression analysis of rigid-floor and flexible-floor analyses from 520 rectangular, U-shaped, and T-shaped buildings. This formula can be used to calculate the structural error of a structure with shear walls when the rigid-floor assumption is adopted.

(Castro, Elghazouli, & Izzuddin, 2007) This study examines the behavior of composite beams, with an emphasis on the effective slab width, which is necessary for structural analysis and design. Current design codes propose effective width values that are largely a function of the beam span, ignoring the role of other crucial elements in the process. This work uses several 3D numerical simulations to highlight these parameters, and a new methodology for calculating the effective width is proposed as a result. When compared to other existing approaches based on stress integration, the suggested approach is easier to use and gives effective width values that result in a more reliable depiction of t he real beam state when simplified analysis is performed. The new method shows that the effective width is largely related to the actual slab width, and that the values produced can differ significantly from those specified in design rules in many circumstances. The new approach is validated by comparing simplified 2D models to results from a recent experimental study as well as more advanced 3D numerical simulations.

(Ajema & Abeyo, 2008) The cost of frames with ribbed slabs and solid slabs using HCB under seismic pressure is compared in this research article. Ribbed slabs are more efficient than solid slabs because their span limits are higher¬ In conclusion, even if the quantity of concrete in the Frame with Solid Slab is higher, the cost of HCB is higher in the Frame with Ribbed Slab, increasing the total cost of construction. Because a frame with a solid slab has less seismic weight than a frame with ribbed slab, the structure can have better shear, bending, and displacement resistance capacity

(Chen & May, 2009) The comparison of solid slab and ribbed slab structures is the basis for this research article. One of the structural components that can bear the most weight is the slab. This is due to the fact that it is flat, flexural, and covers a large surface area, all of which aids in the distribution of loads. The main issue raised in this study is that as loads have increased, slab weights have had to be increased to accommodate the increased loads. As a result, the authors of this study attempted to use lightweight concrete, which would aid in the reduction the Amount of dead load on the Concrete.

(Kaveh & Behnam, 2012) The optimum design of several floor systems, such as composite slabs, one-way waffle slabs, and concrete slab formwork, is conducted in this research using recently developed meta-heuristic algorithms, particularly the Charged System Search (CSS) and the Enhanced Charged System Search (ECSS) (E-CSS). CSS is a multi-agent strategy based on physics and mechanical concepts. Each agent, referred to as a Charged Particle (CP), is a sphere with a uniform charge density that can attract other CPs based on its own fitness. LRFD-AISC and ACI 318-05 are used to create the best designs. The cost function is the goal function for each structure. This function covers the structure's materials and building cost. The Improved Harmony Search (IHS) algorithm is used to optimize the structures in question, and the results are compared to the CSS results.

(Fernandez-Ceniceros, Fernandez-Martinez, Fraile-Garcia, & Martinez-De-Pison, 2013) Traditionally, the goal of flooring system design has been to reduce weight and save money. However, in recent years, this industry's attention has switched to enhancing the environmental performance of building materials and systems. We offer a decision-support approach for choosing design parameters for one-way floor slabs in this study. The goal of this research is to find environmentally acceptable and cost-effective solutions that take into account Spanish regulatory codes, materials, and manufacturing processes. To that purpose, we devised a criterion based on embodied CO_2 and the overall cost of one-way floor slabs. Three decision trees were built in order to come up with relevant principles for designing one-way floor slabs. Finally, the results of this case study in Spain show that embodied CO_2 emissions may be decreased by over 20% at a cost increase of less than 6%

(Wang & Adeli, 2014) The fields of mechanical, electrical, electronic, communication, acoustic, architectural, and structural engineering have all contributed to the advancement of environmentally friendly building design. The process involves managers, contractors, distributors, and building users. There has been a lot of talk about sustainable construction in recent years. The majority of published research focuses on reducing energy and water consumption, as well as making buildings more environmentally friendly by reducing carbon emissions, for example. This article looks at sustainable building design from the standpoint of structural engineering. We've created a list of all of the many strategies that have been suggested in the literature. Finally, the authors propose that intelligent structure technology, which includes hybrid systems, be the next significant step in sustainable construction.

(Salman, 2015) The purpose of this study is to examine the flexural behavior of reinforced concrete one-way slabs with openings and to reinforce them with CFRP strip. The size, shape, length, and width of the CFRP strip are the main characteristics investigated in this experiment. Three different square openings (150 mm, 200 mm, and 250 mm) are investigated, as well as two lengths of CFRP strip (500mm and 700mm) and two widths of CFRP strip (square, rectangular, and circular) (50mm and 100mm). These perforations are in the bending zone. Two series of tests are conducted during the experimental program. The first set of tests are conducted without CFRP strips, and the second set of tests are conducted once CFRP strips have been installed. There are nine test specimens in total: one reference specimen, five specimens without strengthening, and three specimens with strengthening. CFRP strips run the length of the openings and are secured with anchor bolts. Finally, test results are evaluated in order to determine the effectiveness of strengthening strategies.

(Sarita R. Khot, Himanshu V. Mahajan, Purval D. Shiram, Vishwajit V. Jadhav, Siddharth V. Tupe, & Kumar T. Bharekar, 2016) Waffle slabs are compared to regular RCC slabs and flat slabs in this study report. Concrete joints that are perpendicular to each other and have their heads at the column are used to construct waffle slabs. This is essential for shear stresses or for beam sections of column center lines with uniform depth. When compared to RCC and flat slabs, waffle slab construction helps to reduce the structure's dead load. The primary goal of this article is to compare waffle slabs to RCC and flat slabs in order to better understand the benefits of waffle slabs in infrastructure. The paper illustrates this with a case study in which waffle slabs were constructed using IS 456: 2000. Waffle slabs were created by the study's authors.

(Orvin & Amanat, 2018) The goal of this research is to figure out what the minimum slab thickness of an RC slab should be to avoid unwanted vibration. Although the American Concrete Institute (ACI) has a regulation for minimum slab thickness based on static deflection criteria, this may not be enough for dynamic serviceability. The natural floor vibration is investigated using finite element modeling of an RCC floor, which includes partition wall load. For many factors, the fluctuation of the floor vibration is investigated. Finally, for various span lengths and floor panel aspect ratios, the minimal slab thickness required that will not cause discomfort is graphically expressed.

(Oh, Glisic, Lee, Cho, & Park, 2019) This research proposes an ideal design model for producing reinforced concrete two-way slabs that is environmentally friendly. To obtain designs that minimize environmental effect, the model was used to several design situations of two-way slabs in residential, office, and commercial buildings. In respect to the material composition of concrete and steel in slabs, design parameters, and dominating design elements, the resulting designs were thoroughly compared to those of the conventional design approach in terms of sustainability and economic feasibility. The optimum sustainable design method achieved average CO_2 emission reductions of 4.94 percent, 11.40 percent, and 19.96 percent for residential, office, and commercial buildings, respectively, as compared to the conventional design method

(Feroz Sikandar, Zameeroddin, S, & Student, 2019) Grid floor systems are monolithic with slab and comprise of beams spaced at regular intervals in perpendicular directions. They are commonly used for architectural reasons in big rooms such as auditoriums, vestibules, theatre halls, and shop show rooms where column free space is a must. The void created in the ceiling, whether rectangular or square, can be used to conceal architectural lighting. The beams that run in perpendicular directions are normally kept the same size. A diagonal beam grid is used instead of a rectangular beam grid. The G+5 Building is considered in this challenge, and analysis and design are performed for both gravity and lateral (earthquake and wind) stresses. This is in comparison to the flat slab.

(Lokesh Nishanth, Sai Swaroop, Jagarapu, & Jogi, 2020) Design is the process of determining the structure's specifications. The examination and design of a structure by hand would take a long time. Any structure's study and design can be completed rapidly with the help of software. The main goal of this project is to analyze and design a commercial structure with various slab configurations, such as a conventional slab, a flat slab with drop panels, a grid/waffle slab, and a building with a load-bearing wall. A commercial building is one that uses at least 50% of its floor space for commercial purposes. ETABS software was used to examine the effects of seismic and wind pressures on structures with various slab layouts. Creating with A conventional slab is one that is supported by standard beams and columns. The load travels from the slab to the columns, the columns to the beams, and the beams to the foundation in a traditional slab. The term "flat slab" refers to a concrete slab that is supported directly by columns rather than using beams. In comparison to a flat slab without a drop panel, a flat slab with a drop panel is more effective. Flat slabs are simple to build and require minimal formwork. A grid/waffle slab is a reinforced concrete slab made out of beams that run in opposite directions. Grid slabs are commonly utilized in industrial and commercial structures. When compared to traditional slabs, it is employed where column spacing is greater and it can be built more quickly.

(Bocklenberg & Mark, 2020) The paper presents a test series consisting of four geometrically identical specimens of varying sizes, all of which were meant to explore the punching behavior of thick reinforced concrete slabs. The slab radius varies between 1.12 and 2.45 meters, and the thickness ranges from 300 to 650 mm. An novel test approach is used for experimental execution, and it has been modified for thick slabs. It takes the symmetry of specimens and divides them into quarters according to the symmetry grade. Geometrical dimensions and associated test loads are decreased by 75% using this strategy. The experiments show that the modified approach is adequate for punching testing of thick specimens on the one hand. On the other hand, the data show that multilayered, heavily reinforced slabs have a smaller size effect than single-layer slabs.

(Zhu, Zhou, Zhu, & Nie, 2021) In reinforced concrete slabs, the lateral restraint eccentricity and rotational restraint stiffness have a substantial impact on the compressive membrane action (CMA). However, these two aspects have received little attention and no analytical model that takes them into account has been developed. Furthermore, most analytical methods for determining CMA were developed for slabs of constant thickness, despite the fact that slabs of varying depth are relatively common in practice. As a result, this work proposes mathematical methods for predicting the load capacities of laterally restrained slabs while taking into account the impacts of lateral restraint eccentricity, rotational restraint stiffness, and slab depth variation. As long as the deflection at the load application site is available, the axial forces and bending moments may be calculated by solving equations based on compatibility requirements and force equilibrium.

(Menna Barreto, Timm, Passuello, Dal Molin, & Masuero, 2021) This research examines the impact of various concrete cover thicknesses on the life cycle of a reinforced concrete structure, taking into account construction costs, expected service life, and related environmental implications. Life Cycle Assessment (LCA) and Life Cycle Costs (LCC) are used to assess the environmental consequences and costs of a structural element (slab) as the concrete cover thickness is varied. Larger coverings consume more material (16.27 percent of steel reinforcement), have higher starting costs (up to 2.44 percent), and have negative environmental consequences (from 6.46% to 12.51%). However, the longer service life (durability) of the structure results in reduced annual expenditures (a reduction of 74.39 percent) and environmental impacts (up to 73.15 percent for ODP). The findings show that increasing the thickness of the concrete cover improves the structure's durability, lowers costs, and minimizes environmental impacts per year of expected service life contributing to reach more sustainable structures

2.4 Summary

Chapter and highlighted what has been done in the past. We have discussed the Analysis and Design of multistoried building with different slab thickness using ETABS also we have highlighted various factors that choosing slab thickness. As well as have shown some practical applications of slabs. We discussed some of the issues that will help us make decisions and help us to decide why important slab thickness effect.

CHAPTER 3

MODELING AND ANALYSIS

3.1 Introduction

Design is the process of determining the structure's specifications. The examination and design of a structure by hand would take a long time. Any structure's study and design can be completed rapidly with the help of software. The main goal of this project is to analyze and design a commercial structure with various slab configurations, such as a conventional slab, a flat slab with drop panels, a grid/waffle slab, and a building with a load-bearing wall. A commercial building is one that uses at least 50% of its floor space for commercial purposes. ETABS software ("ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.) was used to examine the effects of seismic and wind pressures on structures with various slab layouts. Creating with A conventional slab is one that is supported by standard beams and columns. The load travels from the slab to the columns, the columns to the beams, and the beams to the foundation in a traditional slab.

3.2 Building with Conventional Slab

In the figure 3.1: Shows the 2D plan view of 8 story L-shape Building which 32 m x 24 m and consist of slabs, beams and columns

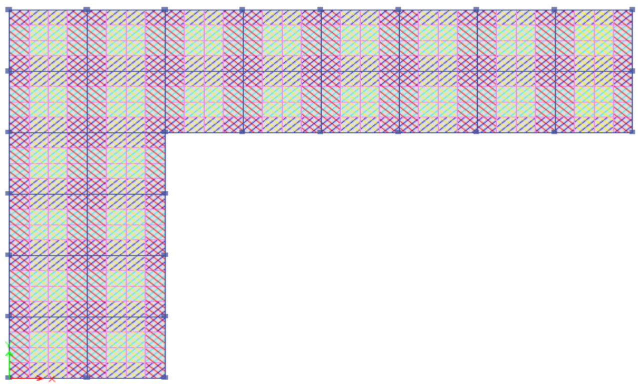

Figure 3.1: 2D Plan View of 8 Story L-shape Building

In the figure 3.2: Shows the 2D plan view of 8 story L-shape Building which Size 32 m x24m and consist of 8 Story and Floor to Floor height is 3 m with column spaced at 4 m from center to center.

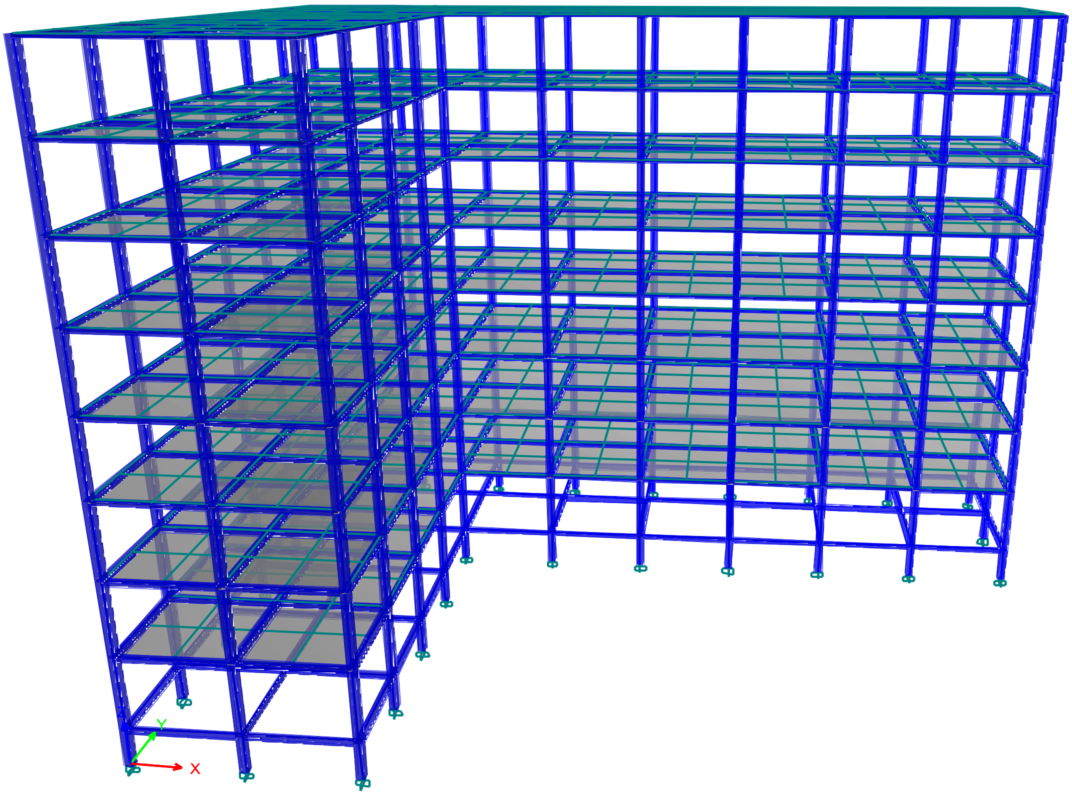

Figure 3.2: 3D View of 8 story L-shape Building

3.3 Computational FEA Package Detail

All of the structure modeling and analysis were done using ETABS Version v2016 ("ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.). The modeling was done in three dimensions, with linear elastic analysis instances. A graph from data analysis was also generated using Microsoft Excel ("Excel 2021 - Microsoft Lifecycle | Microsoft Docs," n.d.).

3.4 Description of the Building Model

In this RCC structural building, the building has an L-shape and is 32m x 24m in plan, with columns spaced at 4m from center to center. The dimension building is represented in the accompanying figure, with a Floor-to-Floor height of 3m.

3.4.1 Structural Dimensions of Building

In table 3.1 According to my building L-shape RCC building, there are 8 story building, from bottom to ground floor is 1.5 m and the typical story height is 3m.

Table 3.1 Structural Dimensions of Building

Parameters	**Dimension Size**
Length x Width	32m x 24m
No of Story	8
Story height	3 m
Beam	300mm x 150mm
Column	600mm x 600mm
Support Condition	Fixed

3.4.2 Material Specifications

Material Specifications refers to the material's description, which includes requirements, tolerances, shelf life, specifications, suppliers, and safety information.

In Table 3.2 its shows that the compressive strength of concrete that is denoted by fc 'which is compression strength of the material's capacity to withstand loads, yield strength of steel which is denoted by fy is the ultimate strength of steel and the density of concrete which is denoted by γ is a constant number which 25 N/mm3.

Table 3.2 Material Specifications

Material Specification	
Grade of Concrete M30	fc'=30 N/mm^2
Grade of Steel	fy=415 N/mm^2
Density of concrete	γ=25N/mm^3

3.4.3 Gravity Loads of the Building

Gravity loads include "dead," or permanent, loads, which are the weight of a structure's wall, floor tiles, surfaces, and mechanical systems, as well as "live," or transient, loads, which are the load of a structure's contents and people, including the weight of snow.

According to BNBC 2020 (BNBC, 2020) for industrial structure Specifies the minimum design forces including dead load and live load and Earthquake load on the building
In Table 3.3 describes gravity loads of the building as per BNBC 2020 (BNBC, 2020) provides different kind of loads for different type of building like commercial, residential and industrial building so our concentration is industrial building as per industrial building the loads are given in table 3.3.

Table 3.3 Gravity Loads of the Building

Parameters	**Loads**
Live Load	4.8 KN/m^2
Floor Finish	1.2 KN/m^2
Partition Wall	3.584 KN/m^2

3.4.4 Wind Load

The "load" exerted on a building by wind speed and air density is known as wind load. Low pressure zones form on the building as a result of high-velocity winds, creating suction pressure. Some are so powerful that they can lift a home's roof corner off.

In table 3.4 describes that the Wind load as we know Wind loads are typically determined by the wind velocity and the shape (and surface) of the building, which makes them difficult to anticipate. Any over- or under-pressure effects may be exacerbated by the building's form.
For My L- shape building I Considered the wind speed 237 kmph as dhaka city Lies in Zone 2 and exposure type is B, importance factor 1.

Table 3.4 Wind data for analysis

Parameter	**Value**
Wind speed (Km/hr.)	237
Exposure type	B
Importance factor	1
Story range	Ground floor to Roof story

3.4.5 Earthquake Loads

One of the fundamental ideas in earthquake engineering is seismic loading, which refers to the application of an earthquake-generated agitation to a structure. It occurs at a structure's contact surfaces with the earth, neighboring structures, or gravity waves from a tsunami.

Table 3.5 shows that the earthquake load is distributed from the base to the top or roof. There are three seismic zones: zone 1 has a value of 0.075, zone 2 has a value of 0.15, and zone 3 has a value of 0.25. I used zone 2 (0.15), and soil type S1 in our industrial building. The most significant element is 1, and R=8, which stands for numerical coefficient factor.

Table 3.5 Seismic data for analysis

Parameter	**Value**
Seismic zone	Zone 2
Zone factor	0.15
Type of soil	S_1
Site coefficients, S	1.5
Importance factor	1
Numerical coefficient factor, Rw	8
Ct	0.016,0.9
Story range	Bottom to Roof story

3.5 Load Combination

In order to ensure the structural safety under various maximum predicted loading situations, building codes often prescribe a number of load combinations as well as load factors (weightings) for each load type. As per BNBC 2020,(BNBC, 2020) “clause 2.7.3 assumptions” for “Combinations of Load effects for Strength Design Method” are followed, and as per clause 2.7.3.1 the load combinations are accounted.

No	Basic Combinations Lists
1	1.4F1
2	1.2F1+1.6F2
3	1.2F1+F2
4	1.2F1+0.8SE1
5	1.2F1-0.8SE1
6	1.2F1+0.8SE2
7	1.2F1-0.8SE2
8	1.2F1+1.6SW1+F2
9	1.2F1-1.6SW1+F2
10	1.2F1+1.6SW2+F2
11	1.2F1-1.6SW2+F2
12	1.2F1+SE1
13	1.2F1-SE1
14	1.2F1+SE2
15	1.2F1-SE2
16	0.9F1+1.6SW2
17	0.9F1-1.6SW1
18	0.9F1+1.6SW2
19	0.9F1-1.6SW2
20	0.9F1+SE1
21	0.9F1-SE1
22	0.9F1+SE2
23	0.9F1-SE2

3.6 Work flow chart

For this work flow chart summarize that what I have done throughout the whole work., Step-1: I choose my plan as L-shape building after that we follow the design code which BNBC2020. Step-2: I defined Material Property like beam, column, Slab section. Step 3: I applied the different kinds of loads then I analysis it then we put it our result in chapter 4.

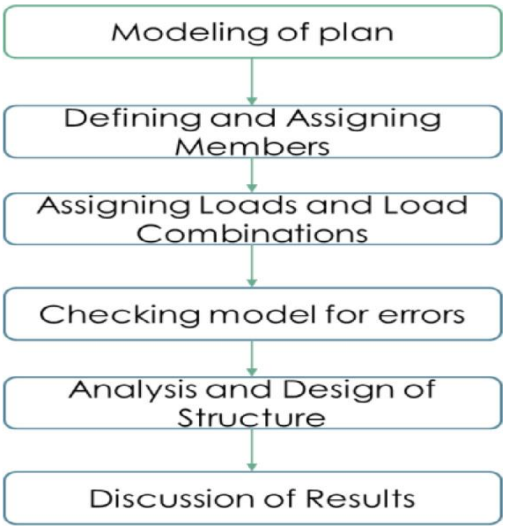

Figure 3.3: Work Flow Chart

3.7 Summary

In this chapter we have discussed introduction of modeling and analysis of building with conventional slab, Computer Software used for the design and analysis, Code followed, Description of the building modelling, Different kinds of loads that are applied to building and Work flow chart

CHAPTER 4

RESULT AND DISCUSIONS

4.1 Introduction

Following the analysis and design of the L-shape structure, I will present our findings in this chapter. The storey overturning moment changes inversely with storey height, according to the multi-story building's analysis. Furthermore, L-shape and I-shape buildings have nearly identical responses to the overturning moment. Storey drift displacement grew with storey height until the sixth storey, when it reached its maximum value, and then began to decline. Mode forms are obtained via dynamic analysis, and it may be determined that asymmetrical designs deform more than symmetrical layouts.

4.2 Evaluation the results/ Analysis

After making a lot of trial by change slab thickness and column size for check deflection under the limit. According to ACI 318-08-Table9.5 (ACI *318 Building Code Topic*, n.d.) for deflection limitation.

$$\textbf{Deflection Limitation} \leq \frac{\boldsymbol{Span}}{\mathbf{240}} \qquad (4.1)$$

For this L-building plan, slab span=4000m so According to equation (4.1)

After calculating the value of deflection, I got 16.667 mm. After the analysis, I find out the minimum and maximum deflection in each case and also Maximum Story displacement due to earthquake.

4.3 Maximum Storey Displacement and Deflection of slab

The maximum displacement of a node located on the top floor or roof of a building from its original location is known as maximum story displacement. According to BNBC 2020, the maximum permissible story displacement is L/500, where L is the building's overall height in inches. If the maximum story displacement is higher, the structure can be deemed less rigid

Table 4.1: Different Slab Thickness and Column size

Slab ID	Slab Thickness	Column ID	Square Column Size
S1	125 mm	C3	300mm x 300mm
S2	150 mm	C4	400mm x 400mm
S3	175 mm	C5	500mm x 500mm
S4	200 mm	C6	600mm x 600mm
S5	225 mm		

S1C3 stands for 125 mm slab thickness and 300 by 300 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.1. After analysis the deflection was found 51.715 mm which not satisfied equation 4.1

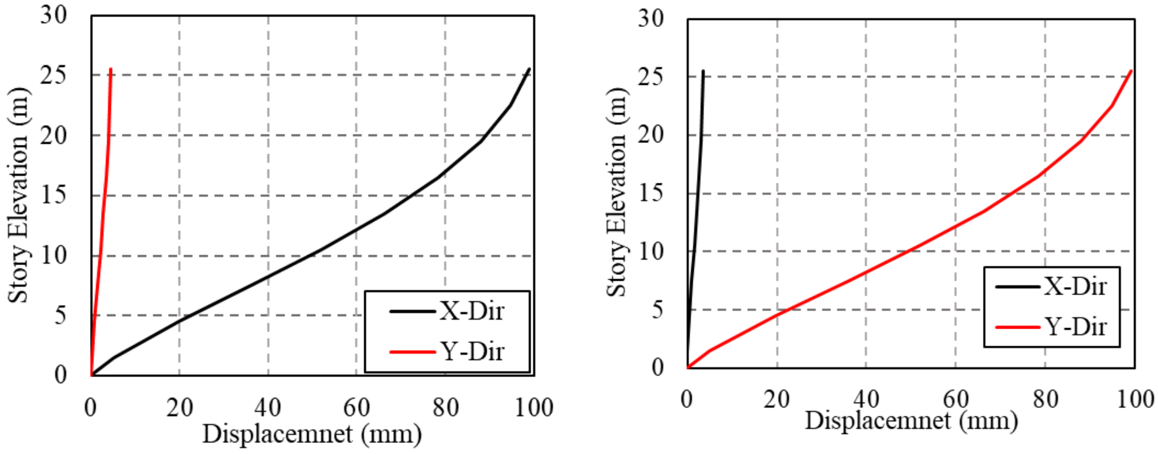

Figure 4.1: Earthquake Displacement Plot for S1C3

S1C4 stands for 125 mm slab thickness and 400 by 400 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.2. After analysis the deflection was found 42.406 mm which not satisfied equation 4.1.

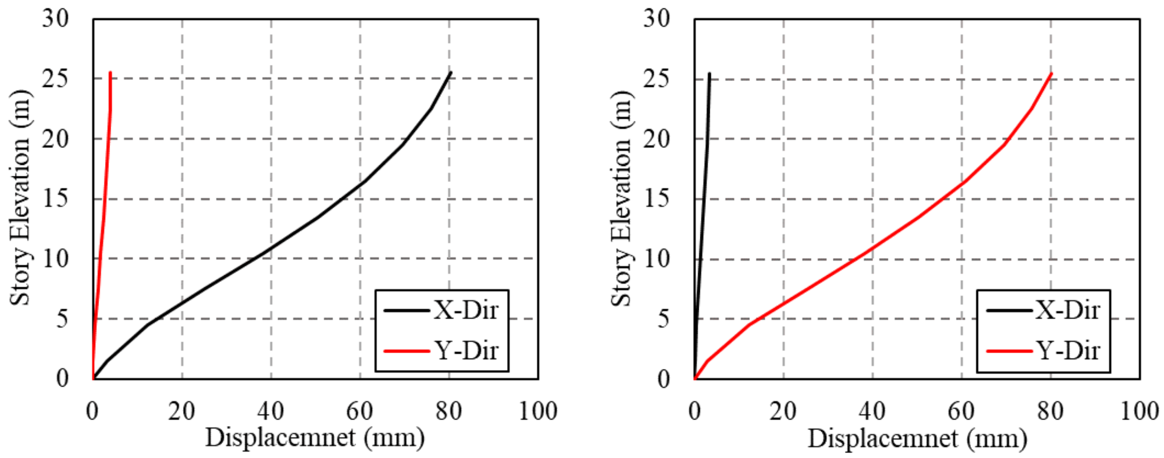

Figure 4.2: Earthquake Displacement Plot for S1C4

S1C5 stands for 125 mm slab thickness and 500 by 500 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.3. After analysis the deflection was found 22.569 mm which not satisfied equation 4.1.

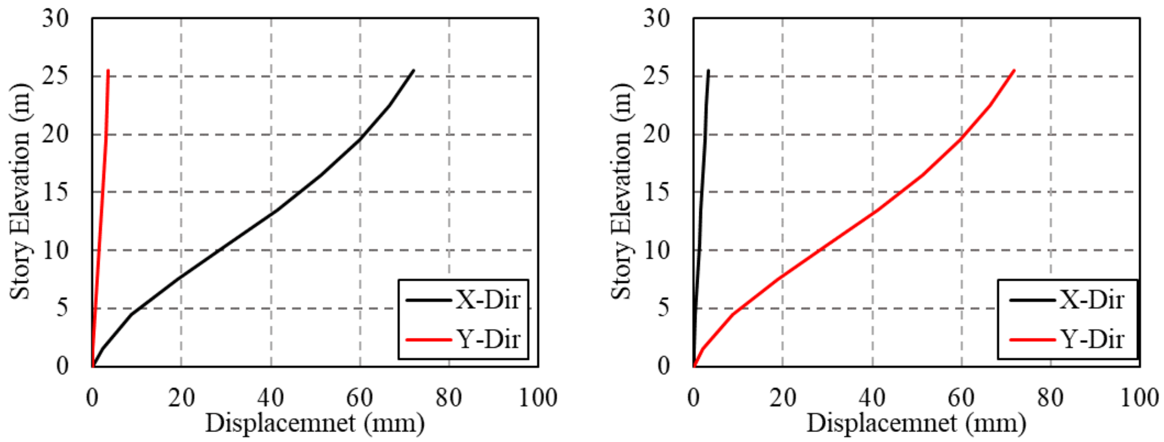

Figure 4.3: Earthquake Displacement Plot for S1C5

S1C6 stands for 125 mm slab thickness and 600 by 600 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.4. After analysis the deflection was found 21.672 mm which not satisfied equation 4.1.

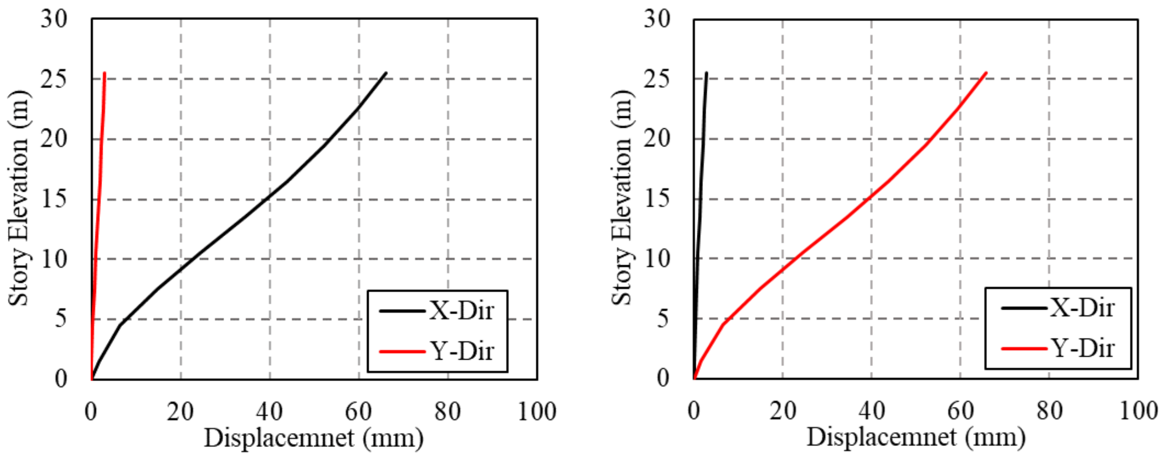

Figure 4.4: Earthquake Displacement Plot for S1C6

S2C3 stands for 150 mm slab thickness and 300 by 300 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.5. After analysis the deflection was found 42.042 mm which not satisfied equation 4.1

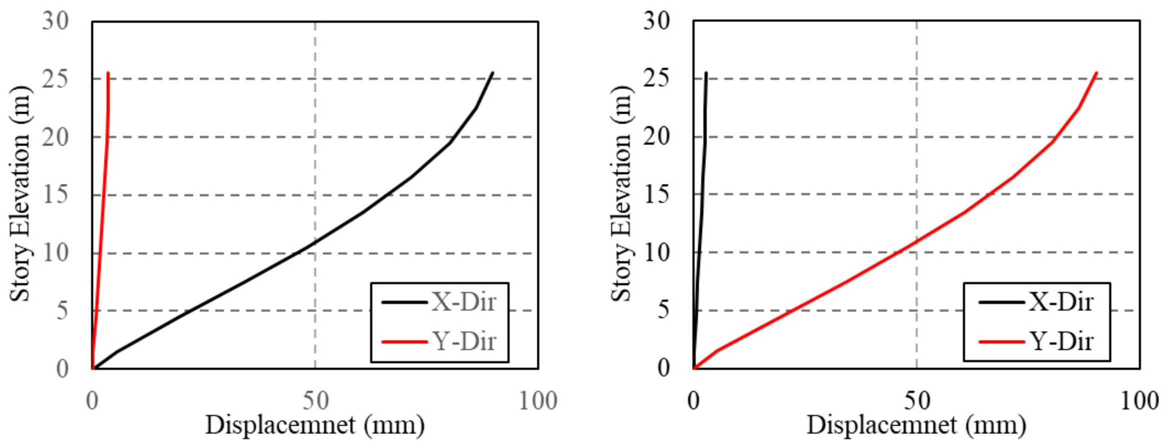

Figure 4.5: Earthquake Displacement Plot for S2C3

S2C4 stands for 150 mm slab thickness and 400 by 400 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.6. After analysis the deflection was found 33.07 mm which not satisfied equation 4.1

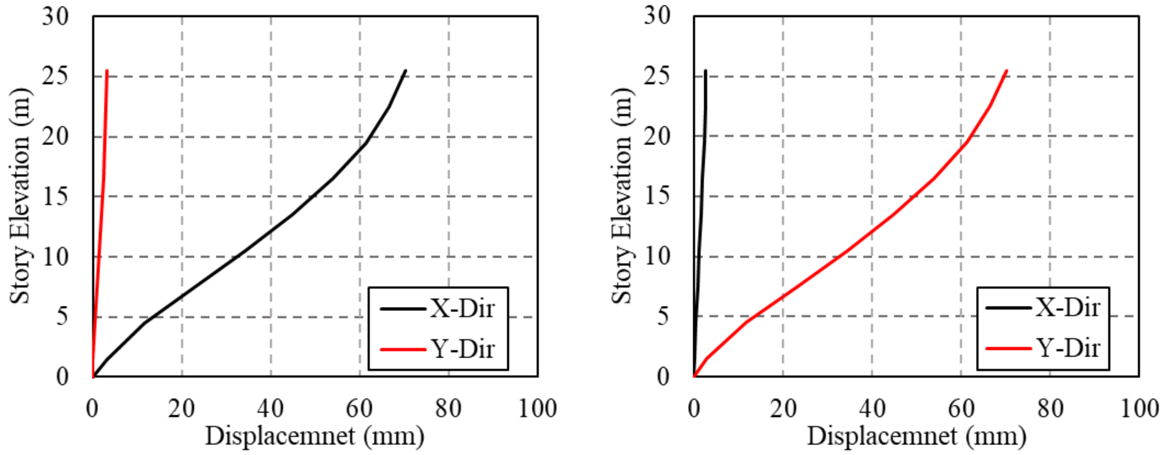

Figure 4.6: Earthquake Displacement Plot for S2C4

S2C5 stands for 150 mm slab thickness and 500 by 500 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.7. After analysis the deflection was found 33.07 mm which not satisfied equation 4.1

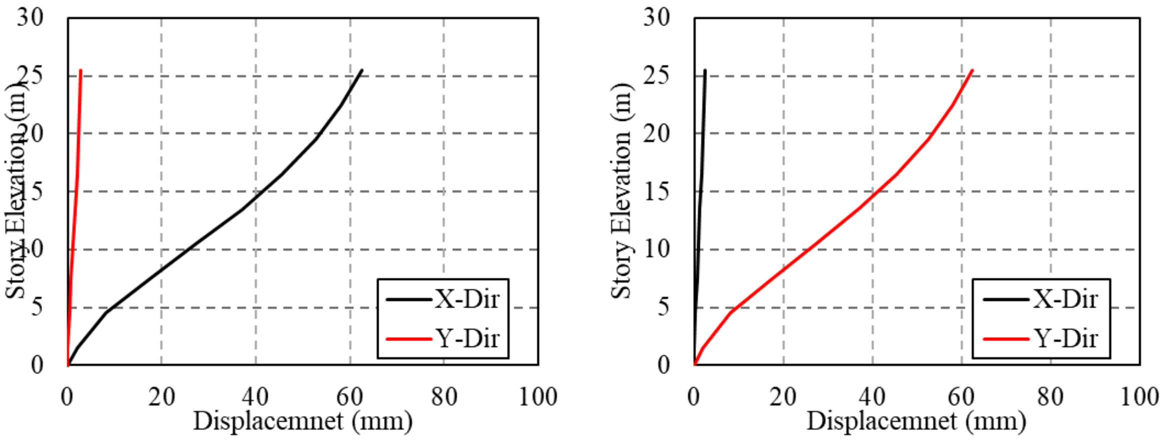

Figure 4.7: Earthquake Displacement Plot for S2C5

S2C6 stands for 150 mm slab thickness and 600 by 600 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.8. After analysis the deflection was found 27.713 mm which not satisfied equation 4.1.

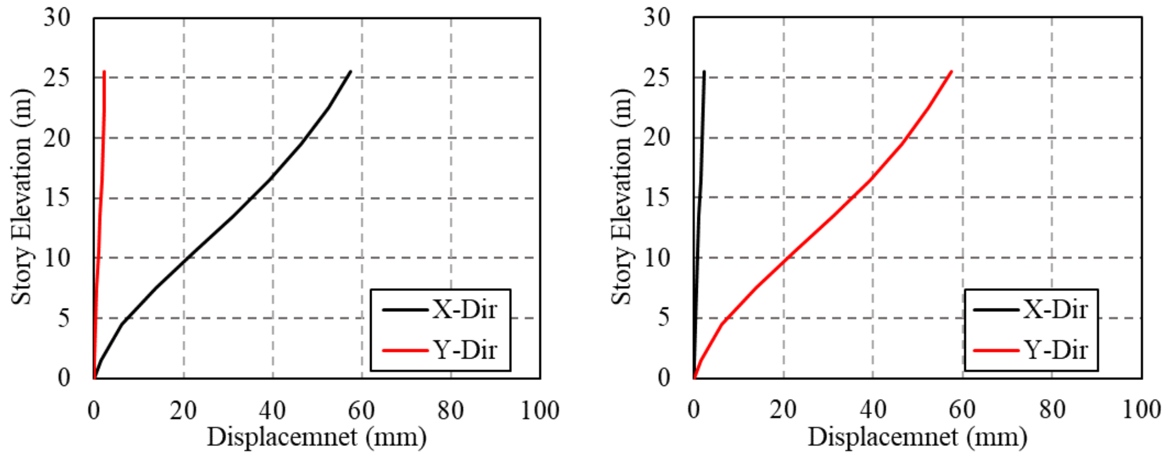

Figure 4.8: Earthquake Displacement Plot for S2C6

S3C3 stands for 175 mm slab thickness and 300 by 300 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.9. After analysis the deflection was found 35.933 mm which not satisfied equation 4.1

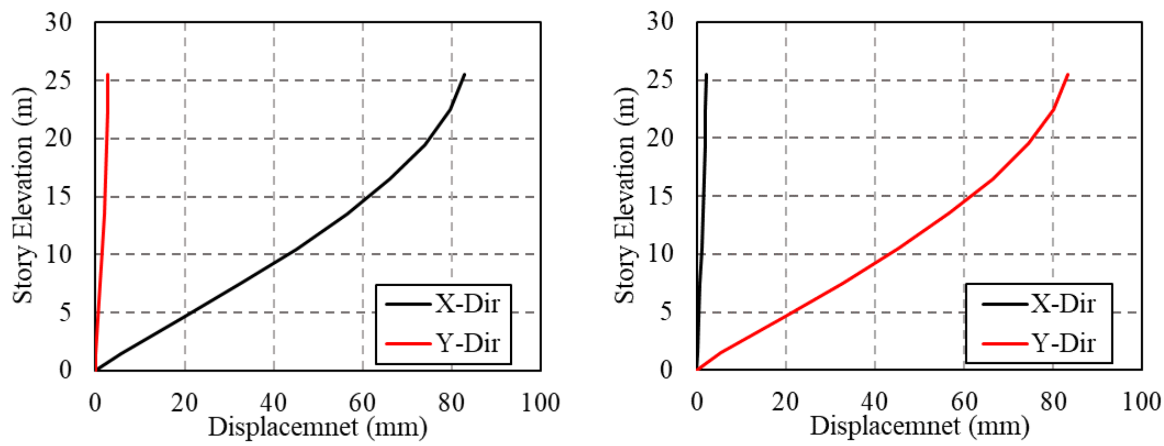

Figure 4.9: Earthquake Displacement Plot for S3C3

S3C4 stands for 175 mm slab thickness and 400 by 400 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.10. After analysis the deflection was found 27.173 mm which not satisfied equation 4.1.

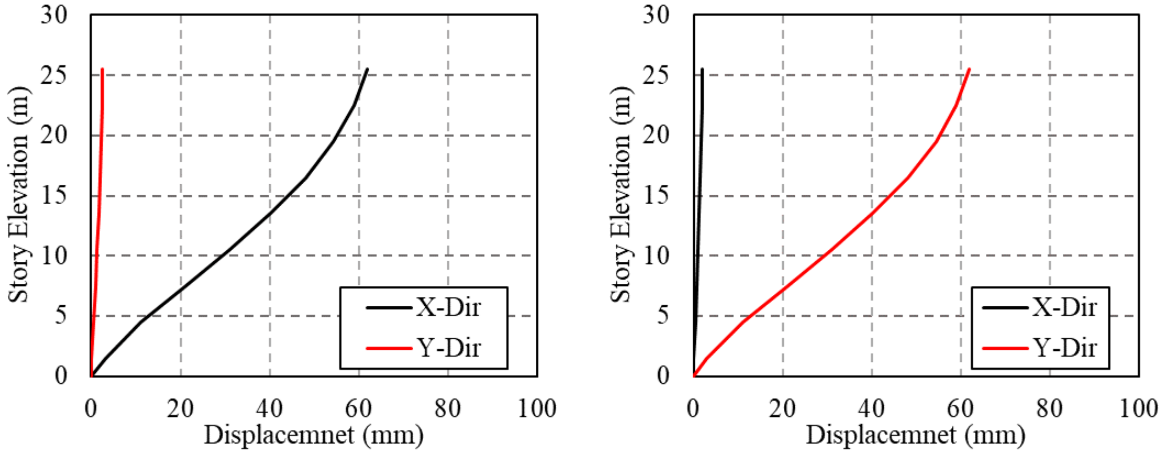

Figure 4.10: Earthquake Displacement Plot for S3C4

S3C5 stands for 175 mm slab thickness and 500 by 500 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.11. After analysis the deflection was found 23.325 mm which not satisfied equation 4.1

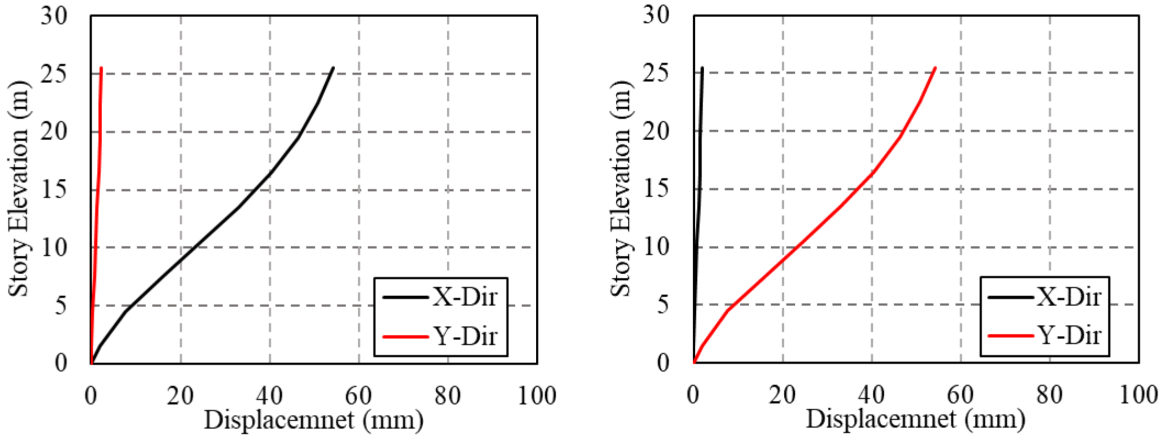

Figure 4.11: Earthquake Displacement Plot for S3C5

S3C6 stands for 175 mm slab thickness and 600 by 600 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.12. After analysis the deflection was found 21.39 mm which not satisfied equation 4.1.

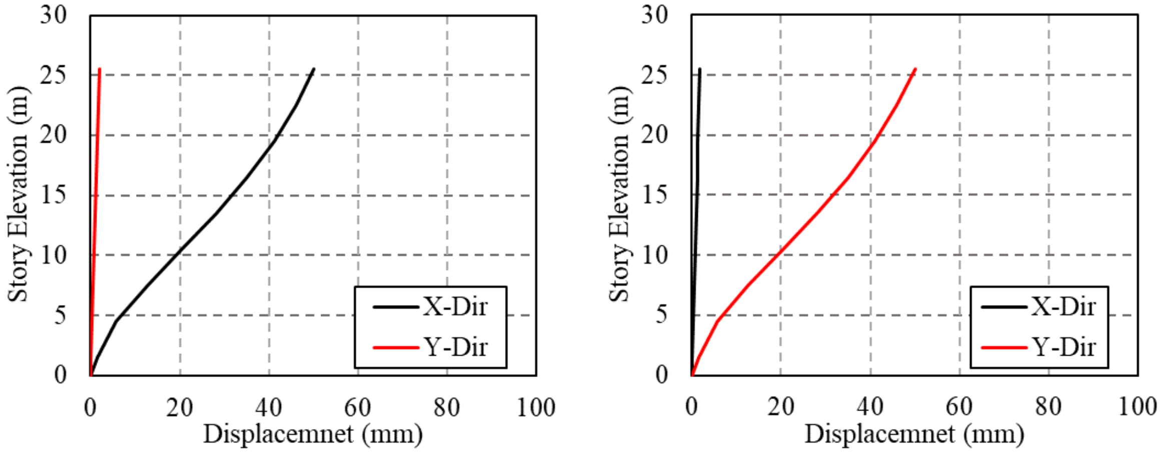

Figure 4.12: Earthquake Displacement Plot for S3C6

S4C3 stands for 200 mm slab thickness and 300 by 300 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.13 After analysis the deflection was found 39.943 mm which not satisfied equation 4.1.

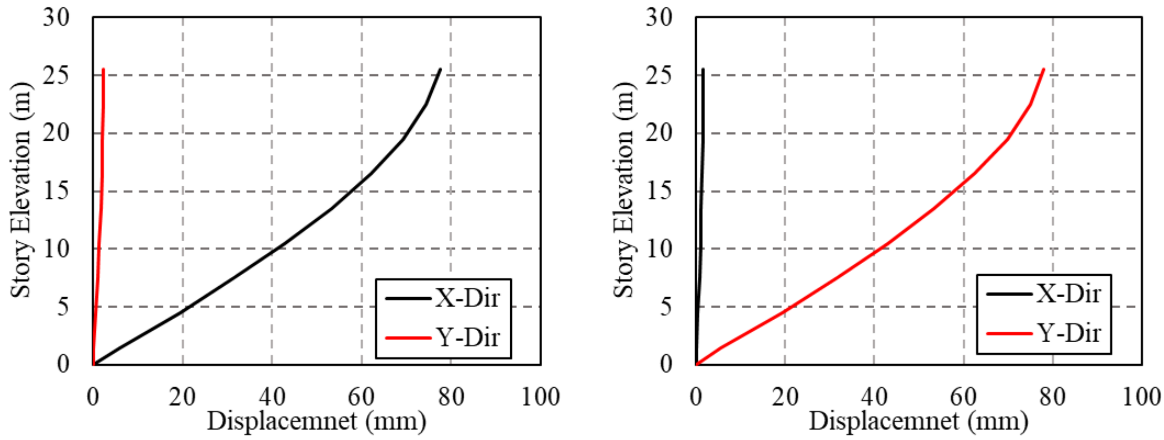

Figure 4.13: Earthquake Displacement Plot for S4C3

S4C4 stands for 200 mm slab thickness and 400 by 400 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.14. After analysis the deflection was found 23.296 mm which not satisfied equation 4.1.

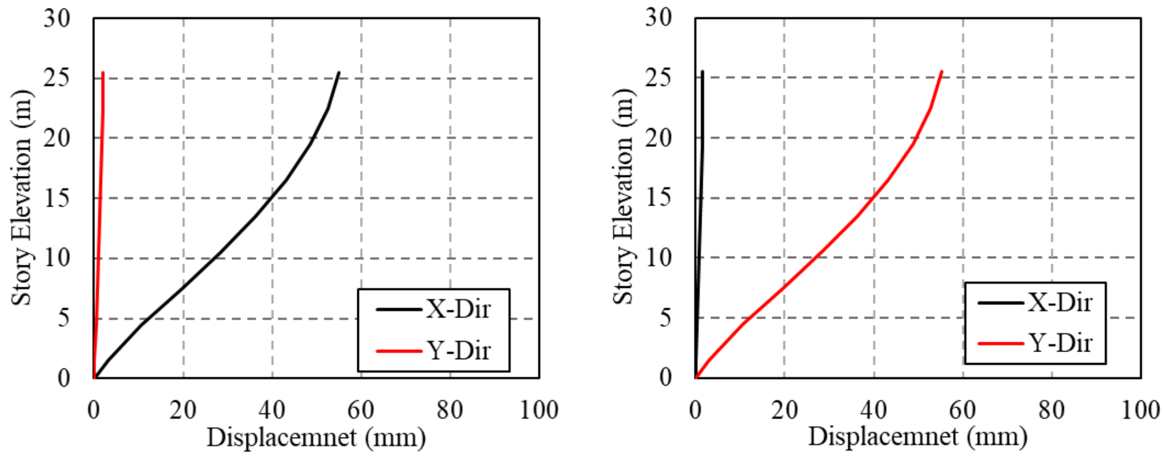

Figure 4.14: Earthquake Displacement Plot for S4C3

S4C5 stands for 200 mm slab thickness and 500 by 500 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.15. After analysis the deflection was found 19.421 mm which not satisfied equation 4.1.

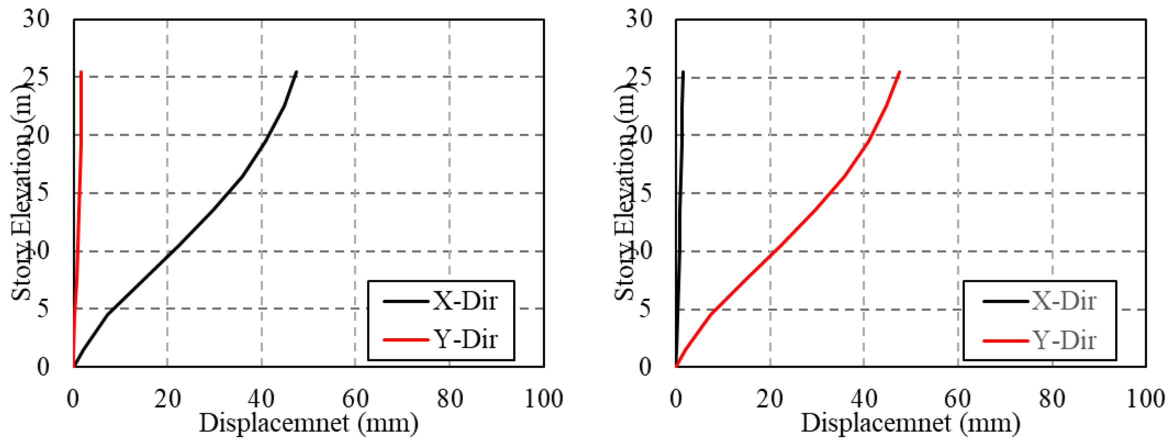

Figure 4.15: Earthquake Displacement Plot for S4C5

S4C6 stands for 200 mm slab thickness and 600 by 600 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.16. After analysis the deflection was found 17.422 mm which not satisfied equation 4.1.

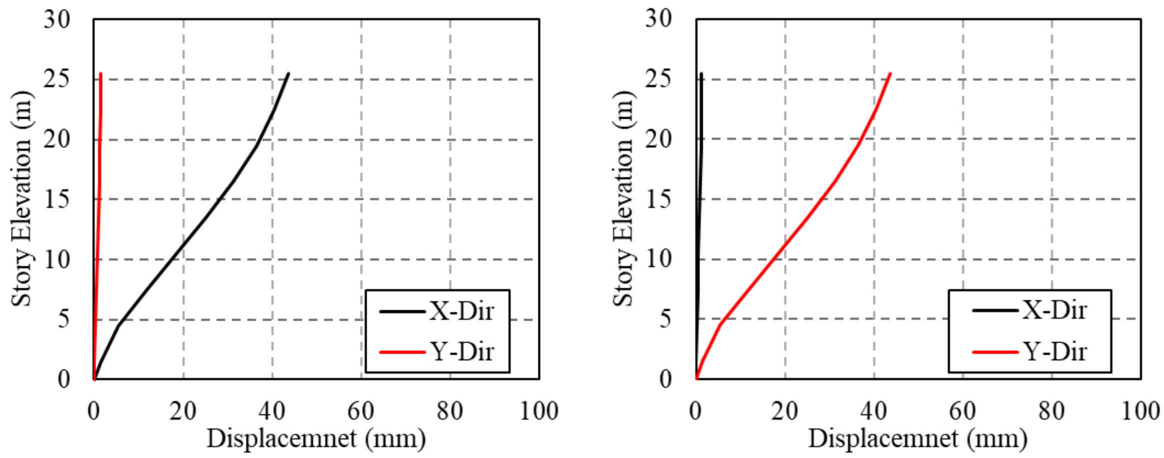

Figure 4.16: Earthquake Displacement Plot for S4C6

S5C3 stands for 225 mm slab thickness and 300 by 300 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.17. After analysis the deflection was found 29.216 mm which not satisfied equation 4.1.

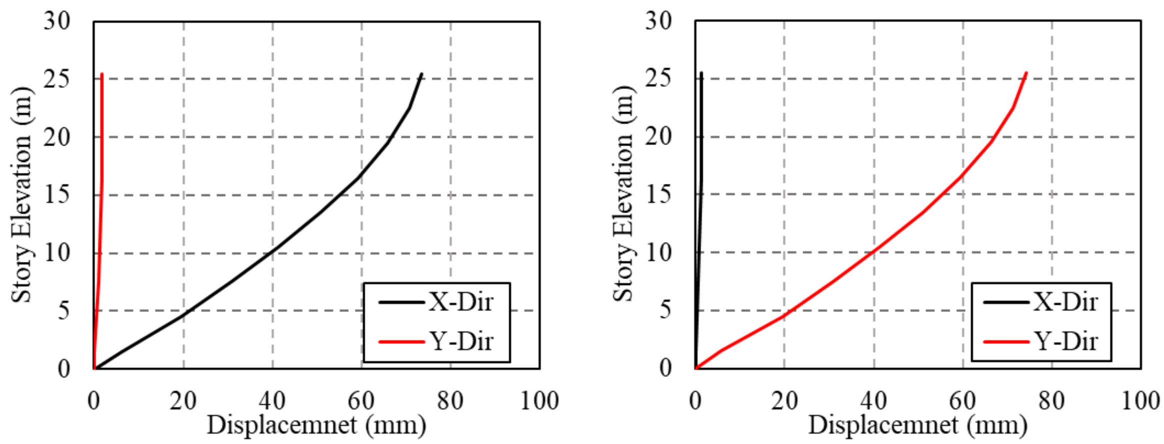

Figure 4.17: Earthquake Displacement Plot for S5C3

S5C4 stands for 225 mm slab thickness and 400 by 400 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.18. After analysis the deflection was found 20.701 mm which not satisfied equation 4.1.

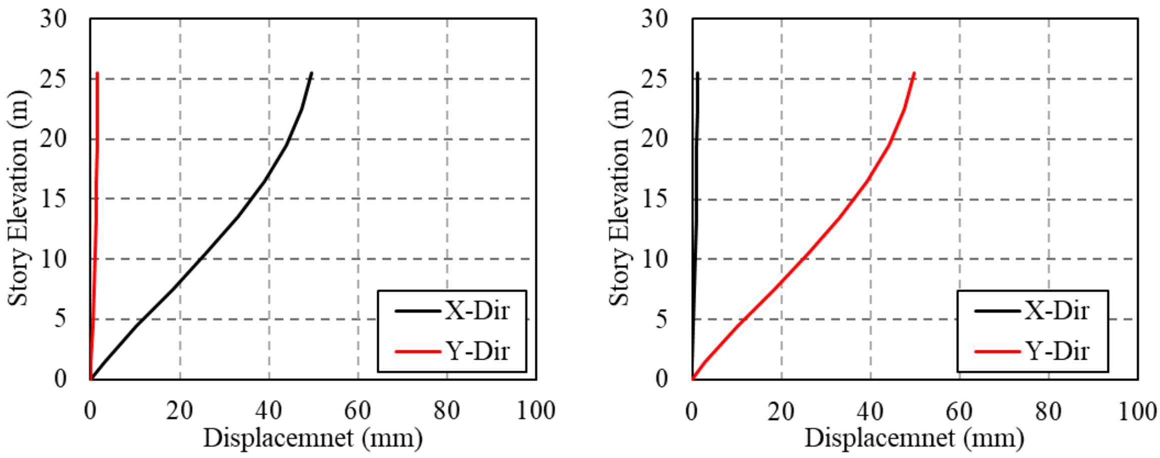

Figure 4.18: Earthquake Displacement Plot for S5C4

S5C5 stands for 225 mm slab thickness and 500 by 500 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.19. After analysis the deflection was found 16.768 mm which not satisfied equation 4.

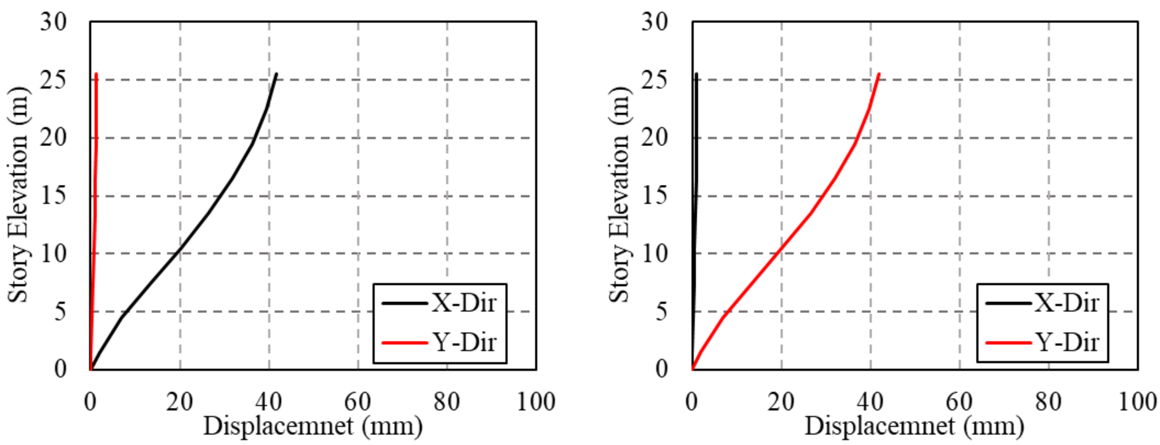

Figure 4.19: Earthquake Displacement Plot for S5C5

S5C6 stands for 225 mm slab thickness and 600 by 600 for cross section column, After Implement this in model, we found the earthquake response for both directions which one show below in the figure 4.20. After analysis the deflection was found 14.42 mm which satisfied equation 4.1. Finally, we can say that S5C6 which is a 225 mm slab thickness and 600 mm by 600 mm cross section of column is suitable for L-shape building to avoid any deflection failure.

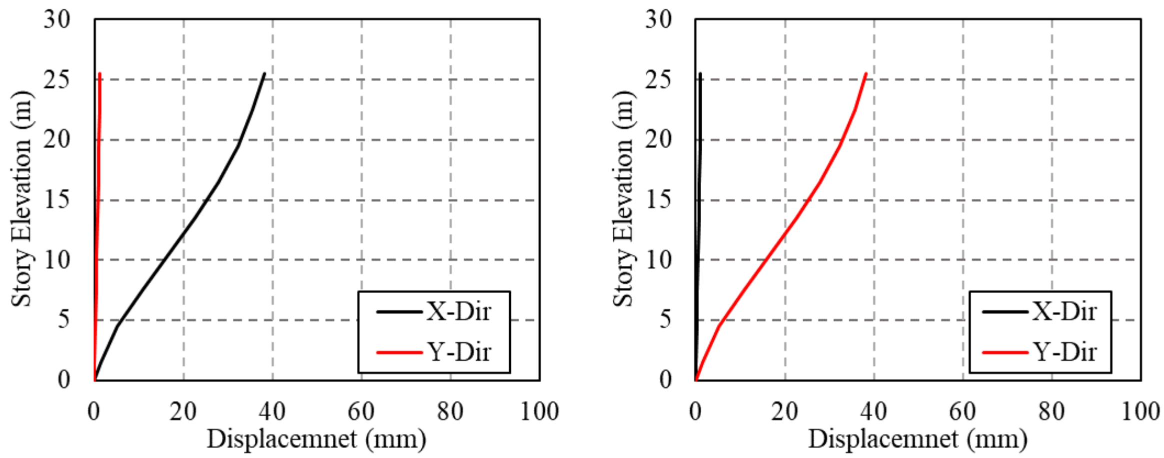

Figure 4.20: Earthquake Displacement Plot for S5C6

4.4 Summary

In this chapter I have discussed the results I have got after Analysis of modeling since my main goal of this project to find appropriate slab thickness so after making 20 trails by change slab thickness and column size so I found that that S5C6 which is a 225 mm slab thickness and 600 mm by 600 mm cross section of column is slab thickness is suitable for this building.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusions

After analysis of all this L-shape building is done using ETABS., in this study I considered two parameter which is Slab thickness and Column size. After comparison the results in the all cases we can say that:

- Among 125 mm to 225 mm of slab thickness, I found that 225 mm slab thickness satisfied the results as per 4.1equation.
- Slab thickness of 225 mm satisfied equation 4.1 only if the column size of this structure 600 mm x 600 mm.
- finally we can say that column plays an important role for satisfy this slab. So both effect of slab thickness and column size have in this study.

5.2 Future Recommendation

The people who are intending to perform research on this topic should consider the following aspects for further study:

1.Storey displacement is greatest for conventional slabs and least for load-bearing walls, and it rises with storey height.
2.The load bearing wall's storey displacement is 92.6 percent greater than the standard slab's.
3.Storey drift is greatest in a standard slab and least in a load-bearing wall. For a standard slab system, it reaches its maximum at the fourth level of a building, i.e. 0.00079 mm.
4.In both load combinations, base shear is smallest for Flat slab and largest for Load bearing wall type.
5.The load bearing wall type has a 44.5 percent higher base shear than the flat slab type.
6.Flat slabs require the least amount of concrete, while load bearing walls require the most.

7.The amount of concrete required for a load-bearing wall is 21% higher than for a flat slab.

8. Wind and earthquake loads are less likely to damage a load-bearing wall. However, when cost is a major consideration, When compared to other building slab layouts, grid slab is more cost-effective and safer.

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