ANALYSIS OF MULTISTORIED BUILDING WITH AND WITHOUT FLOATING COLUMN 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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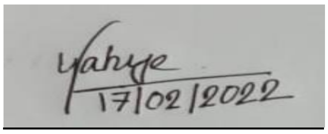
Certification

This is to certify that the student participants worked on the project and thesis "Analysis of multistory buildings with and without floating column 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. In March 2022

Signature of the candidates



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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
C1	Dead Load
C2	Live Load
C3	Floor finish
CW1	Wind load Along x-axis
CW2	Wind load Along y-axis
CE1	Earthquake Along x-axis
CE2	Earthquake Along y-axis

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I would want to thank our amazing family for their constant support, as well as their inspiration and encouragement, throughout our stay at this university.

ABSTRACT

In today's scenario, buildings with floating columns are a common feature in modern multi-story construction in the world. These floating columns are presented to the building so that it can be used for both commercial and residential purposes, and they begin at the story level where the building should be used as a residential building. The influence of floating columns of an RC frame structure for G+8 story at zone 2 in Bangladesh was investigated in this study, as well as the effect of floating column position at different locations in the considered plan. In this study I make three cases by removing column for different side, after analysis I make a list for taking the column that are not similar according all three cases, in this study, I found that, whenever you remove a column then the building column size increased due to removed column, so after analysis the building in first case I found that the maximum columns size was 400X550mm in second case the maximum was 500X700mm and finally in the third case it was 400x950mm so as we can see whenever we remove column then the column size increased due to applied load. The repeatedly column that I have seen in all three cases is column C19. Finally, analysis results in the building such as finding the maximum and minimum size of the column, repeatedly column were discussed in this study.

CHAPTER 1

INTRODUCTION

1.1 General

"A column is a vertical member that starts at the foundation level and transfers the load to the ground, and the term "Floating Column" refers to a vertical element that rests at its lower level on a beam that is a horizontal member."

In figure 1.1: shows the elevation of 8 story industrial building where some columns are removed from second to third floor to get space, the floating column transfer the load the near beam.

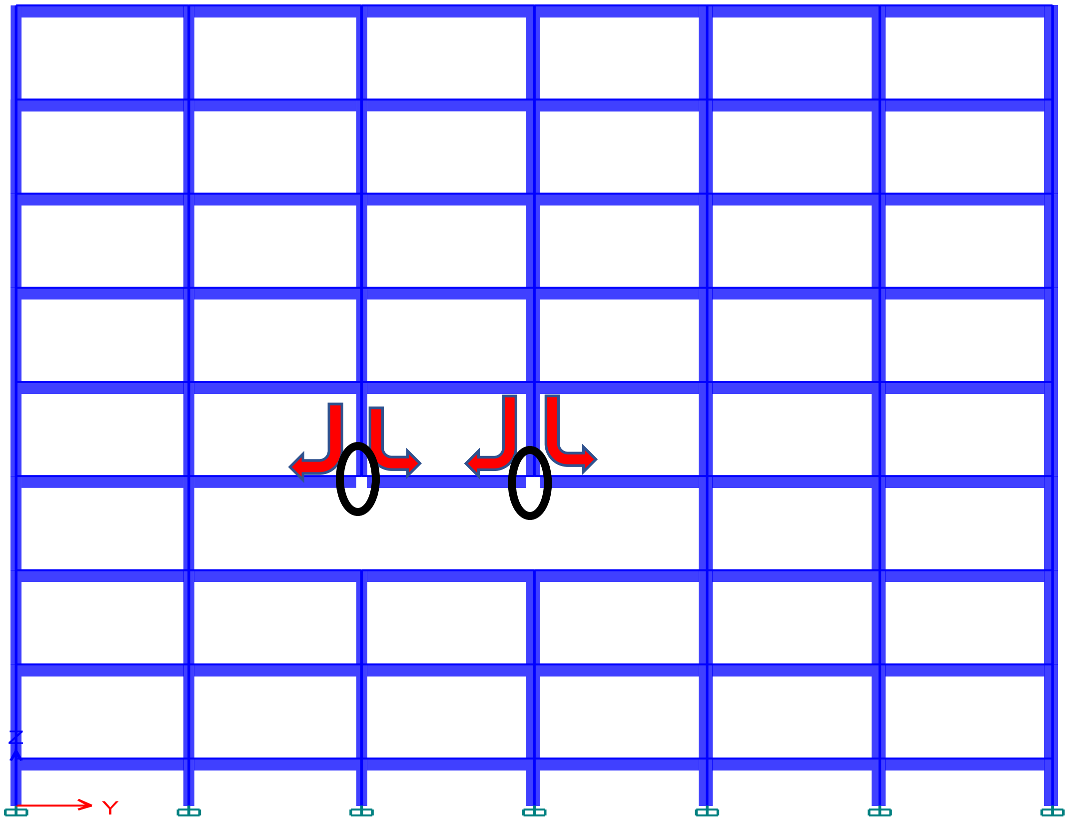

Fig. 1.1: Building with a Floating Column

Floating columns have already been utilized in several Bangladeshi buildings, notably above the ground level when transfer beams are used, to generate more empty area on the ground level, which may be needed for a venue or parking.

The column is placing a lot of pressure on the beam that's currently sustaining it. As a consequence,

In seismic zones, structures constructed with these kinds of discontinuous parts are at risk. As a consequence, For architectural perspectives and site circumstances, the floating column is used Staad Pro(*STAAD.Pro Help Documentation - RAM | STAAD Wiki - RAM | STAAD - Bentley Communities*, n.d.), ETABS("ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.), and SAP2000 ("SAP2000 - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.) can all be used to evaluate these types of structures, all of these things can be utilized to analyze it. However, I used FEA packages to examine this building.

1.2 Earthquake Resistant Design

These floating column structures are typically built for impact load and seem to be protected under lateral load, but they are not designed to withstand earthquake loads. As a result, in earthquake-prone areas, these structures are dangerous. As a result, the goal of this study is to educate the public about all of these issues in seismically multi-story buildings with floating columns.

There are four virtues of Earthquake Resistant Design: seismic structural configuration, lateral stiffness, lateral strength and ductility

1.3 Advantages and Disadvantages

The advantages of Floating Column:

i) Floating columns are primarily used to satisfy a structure's architectural requirements.

ii) They actually be useful when building soft storeys.

iii) The plan on each floor can be varied due to removing columns.

iv) The rooms can be divided and a portion of the area raised without the entire area being raised.

The disadvantages of Floating Column:

i) Floating Columns increase the structure's storeys displacement.

ii) Floating Columns tends to attract a lot of Load.

1.4 Scope of study

The following factors are being reviewed in this project.

1) Using (“ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base,” n.d.), model a multi-story building with and without a floating column.

2) When the floating column is visible at the same floor and various locations in the building, a comparative study is conducted between the multi-story building with and without floating column in different zones.

3) A comparative study of variations in the structure's structural response as a result of earthquake action is also carried out.

4) Because buildings with floating columns are more likely to fail during seismic excitations, recommendations for earthquake-resistant design of the buildings under consideration are modelled and analyzed.

5) The study's main goal is to provide an economical and safe design of a building with a floating column in seismic zones, as well as some design recommendations, because there is no specific requirement or magnification factor for this type of irregularity in BNBC2020 codes.

1.5 Objective of this study

The main purpose of our study is to analyze the behavior of multistoried Floating Column.

The study uses FEA packages to model the behavior of multi-story buildings with floating columns in Zone 2 as per BNBC2020 (BNBC, 2020)

1.6 Outline of Thesis

In chapter 1 Basic idea of the Floating Column that has been done under this research.

In chapter 2 The next section mentions what has been done before and what kind of work has been used in the Floating Column.

In chapter 3 What we analyzed and how we accomplished.

In chapter 4 We verification of Model & Evaluation results/analysis. The results such as Different cases considered based on positioning and removal of columns in the building.

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 highlights what competent academics and specialists have published on a certain issue. It's not rare to be asked to write one as a stand-alone piece of work, but it's more common in the context of an article, research report, or thesis. The writer's goal in writing a literary review is to express to their reader what knowledge and opinions have been established about a subject, as well as their strengths and faults. Literature reviews are used as a guide for a specific topic. If you just have a limited amount of time to conduct research, literature reviews can be a good place to start. Literature reviews also serve as a solid foundation for the study of a research report.

2.2 Overview

Through book reviews, the author must discuss what they've learned so far and what they plan to learn in the future. The reader should be convinced after reading this chapter that the author's suggested research will be vital to the growth of the discipline.

2.3 literature review

The research articles and journals that were studied for understanding the work to be done are discussed in this study, and these papers are presented in this chapter according to the study's references.

(Mulgund & Kulkarni, 2011) This study investigates on the behavior of RC frames with the arrangement various shaped infill walls and are when subjected to earthquake dynamic loading. The results obtained are verified and concluded as per IS1893(2002) code book. Thus, the results obtained when analyzed using the software FEMA-356 2000, are as follows. The introduction of infill panels in the RC frames reduces the time period of bare frames and also enhances the stiffness of the structure.

(M. K. Wakchaure & Ped, 2012) This study deals with effect of masonry walls on high rise buildings, when a time history analysis is applied to the models and are analyzed using the software ETABS. The results are obtained by considering the base shear, storey displacements, storey drifts, and also it is observed that how the infill walls reduce displacements, time periods and increases the base shear.

(M. R. Wakchaure, Shirish, & Nikam, 2012) This study aims at description of plan irregularities by analytical method during seismic events. Analyses have been done to estimate the seismic performance of high-rise buildings and the effects of structural irregularities in stiffness, strength, mass and combination of these factors
are going to be considered.

(Onkar V. Sapate(2012) “Inter Relationship Between Moment Values Of Columns In A Building With Different Architectural Complexities And Different Seismic Zones” In this study a G+15 storied high rise building with different architectural complexities is analyzed for various earthquake zones using the software STAAD Pro. And the results thus obtained are concluded as follows.

(International Journal, 2012) In this study a G+15 storied high rise building with different architectural complexities is analyzed for various earthquake zones using the software STAAD Pro. And the results thus obtained are concluded as follows. It is concluded that the moment values considered in the cases modelled and analyzed are found to be increased significantly in higher earthquake zones when compared with lower seismic zones.

(Chandurkar & Pajgade, 2013) This study mainly highlights the solution for shear wall location and effectiveness in multi-storied building with the help of four different models. Where modal one is bare frame structural system and the other three are dual type systems and these are analyzed for the seismic zones from II to V. The results obtained are concluded by considering the factors like lateral displacements and story drifts and also total cost required for ground floor calculated for replacing column with shear walls.

(Kumar, Sreenivasa, Kumar, & Sekhar, 2013) This study considers that the present version of IS 1893-2002 code book requires the analysis to be performed for the multistoried building in three dimensional systems, This study includes the seismic vulnerability of a RC building without shear wall, shear wall at center, shear wall at diagonal corners, shear wall at mid along X- direction, Y-direction, and shear wall at mid along X & Y-directions. Thus in this study, an effort is made to evaluate the effect of shear wall at all floors of all the models. So for analysis and design of each five cases as described in the problem statement is carried out with the help of structural analysis software “ETABS”.

(College, 2014) This study aims as entitled and the analysis is observed using the ETABS software, and the results obtained are observed on the analysis of shear force, bending moment and torsion. This study deals with effect of seismic loading on placement of different shapes of shear walls in high rise buildings by considering a frame and dual system. The effectiveness of the shear wall has been studied with the help of considering seven different shapes of shear walls and also which are located at different locations.

(G.S Hiremath, 2014) In this study a 25 storey building in seismic zone IV with shear walls for it is presented to reduce the effect of earthquake response of the building. The main aim of providing shear wall in the building is to improve the rigidity and is found to be economical and effective design. This study highlights on the effect of shear wall at different location and configurations where the thickness of the shear wall is varied by analysing the structure for push-over analysis using the ETABS software, and the results obtained are as discussed.

(Udhav S., A.N., & Ravi G., 2015) This paper is titled "SEISMIC ANALYSIS OF MULTI-STOREY BUILDING WITH FLOATING COLUMN" in which the ETABS analysis is carried out for 2D and 3D multi-Storey frames with and without floating columns, studying the responses of the structure with different seismic excitations, where the RC frames are factors as constants with varying frequencies, and highlighting with alternative measures involving stiffness balance to reduce the irregularity introduced by the floating columns in the first and second storeys.

(Ashish R.Akhare, Tejas R. Wankhade[18],(2014) 2015) Structures can be heavily damaged by earthquakes. Future earthquakes will wreak havoc on the structures that have already been built.Structure damage results in deaths, injuries, economic losses, and the loss of functions. Ground acceleration causes damage to the structure. This can be reduced by increasing the structure's strength. It is not always possible to improve the structure's strength indefinitely.As a result, using seismic improvement techniques, it should be tried to increase the structure's capacity.

(Ashish R.Akhare, Tejas R. Wankhade(2014) “Seismic Performance Of RC Structure Using Different Base Isolator” The primary purpose of this study is to make it easier for structural and non-structural components to remain operational and safe during an earthquake. Since a result, the base isolation technique is utilized to limit the influence of earthquakes on such structures, as it is the best alternative seismic proactive system and is used in the study.

(Govind. M, Kiran.K Shetty, K.Anil Hedge(2014) “Seismic Evaluation Of High rise Regular And Irregular Structure Using Push-Over Analysis”This paper study the behaviour of G+20 storied R.C frame buildings that are rectangular and H-shaped in plan which are subjected to earthquake in seismic Zone III and are the displacement control pushover analysis is carried out using the software ETABS, and the conclusions drawn from the results are that the pushover analysis is simple method to investigate the non-linear behavior of the buildings, the structural plan configurations have a significant impact on the structural response.

(Pratyush Malaviya, Saurav(2014) “Comparative Study of Effect Of Floating Columns On The Cost Analysis Of A Structure Designed On Staad Pro V8i”. In this paper the structure is analyzed using the software STAAD Pro, where the floating columns are provided and the finite element formulation is considered. There are various types of structures considered in this study where floating columns are provided in the structure at different positions and are compared with the structure with no floating Column.

(Sharma, 2016) this study refers to the response of 10-storey frame to lateral loads for mass and stiffness irregularities. This 10-storey building frame is considered with five different types of irregularities as per IS1893-part1:2002 and the analysis is being carried out by ETABS software. And hence the results obtained by considering storey displacements and storey drifts where in this paper various frames are analyzed with different irregularities but with same dimensions and are the regular frame shows the least story drifts when compared with floating column frame and hence is a vulnerable to damages under seismic loading and the other irregularities frames showed unsatisfactory results. The frame with floating column is the weakest among the other.

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(Wahidi & Rama Seshu, 2016) this paper is titled “SEISMIC RESPONSE OF COMPLEX BUILDINGS WITH FLOATING COLUMN FOR ZONE II AND ZONE V” and it examines the seismic response of buildings with floating columns and other complexities for ten-story buildings in various locations, as well as for low to high zones. Alternative measures involving stiffness balance of the storey where floating column is provided and the storey above when other irregularities are also introduced in the stories are presented in this study.Finally, the study compares analysis results such as storey drifts, storey displacements, and storey shears of the high-rise building using the software(“ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base,” n.d.).

(Bhusnar et al., 2016) The conclusion is that the steel braced system improves structural stiffness and decrease maximum inter story drift and lateral displacement in R.C.C buildings. When comparing the deflection of the bare frame to the other cases, the bare frame has a really large deflection. It is also indicated that the steel structure in the model has a significant impact on the seismic behavior of the model by increasing the structure's stiffness. The Cross of steel bracing system at the bottom storey also has a lower torsion influence.

(Abhinay, Rao, & Ghorpade, 2017) this paper is titled "SEISMIC ANALYSIS OF A NORMAL BUILDING AND FLOATING COLUMN BUILDING" . As a result, the study examines whether structures with floating columns are safe or unsafe in seismically active areas, as well as whether the structure is cost-effective or not. When excited to lateral loads, this paper investigates the behavior of the G+5 storey building with all columns, which is a normal building, and the other building without edge columns in the ground floor, which is a floating column building. After comparing the buildings, it was discovered that the G+5 without edge columns is not safe in seismic zones because the lateral displacement of a floating column building is greater than

that of a normal building, making the floating column building unsafe in seismic zones. When the lateral stiffness of both buildings is compared, it is clear that the building with floating columns will suffer from a severe soft storey effect, whereas the normal building will be free of this effect completely.

(Irjet Journal, n.d 2020.) The effect of the floating column under earthquake excitation was investigated for various soil conditions, and a linear dynamic analysis for the 2D frame of the multi-story building was performed , to achieve the frame's response with and without floating column in order to design a structure that is both safe and cost-effective when subjected to such excitations , This paper study the effect of a floating column under earthquake excitation for various soil conditions where for the purpose of analysis two different models are considered.

(Thakur & Khatun, 2022) This paper mainly deals with the study of architectural drawing and framing drawing of the building having floating columns. In this study a existing G+7 residential building is selected for the equivalent static analysis of load distribution on floating columns and various effects due to it are presented using STAAD Pro V8i. Thus the main objective of this paper is to find the various analytical properties of the structure and also understand a very systematic and economical design of the structure.

2.4 Summary

Chapter and highlighted what has been done in the past. We have discussed the Floating Column and also we have highlighted various advantages and disadvantages of Floating Column. As well as have shown some practical applications of using Floating Column.
We discussed some of the issues that will help us make decisions and help us to decide why we use Floating Column.

CHAPTER 3

MODELING AND ANALYSIS

3.1 Introduction

Computers and software are powerful tools for design engineers today, but they require precise input to produce reliable results. There are a number of building modeling acceptances that influence the lateral stiffness of a given structure. Many of these assumptions were described in the literature review, including sources of deformation, beam column joint modeling, composite action, non-structural components, and second order effects. The calculations were made using the ACE-318(“318 Building Code Topic,” n.d.), BNBC2020 (BNBC, 2020), and (UBC) codes, and the portal frame method was used for analysis using the software (“ETABS Features | BUILDING ANALYSIS AND DESIGN,” n.d.).

3.2 Industrial Building without floating Columns

In the figure 3.1 shows that the 3D view of C-Shape Industrial Building which consist of 8 story and Slabs, beams and columns, each floor height is 3m.

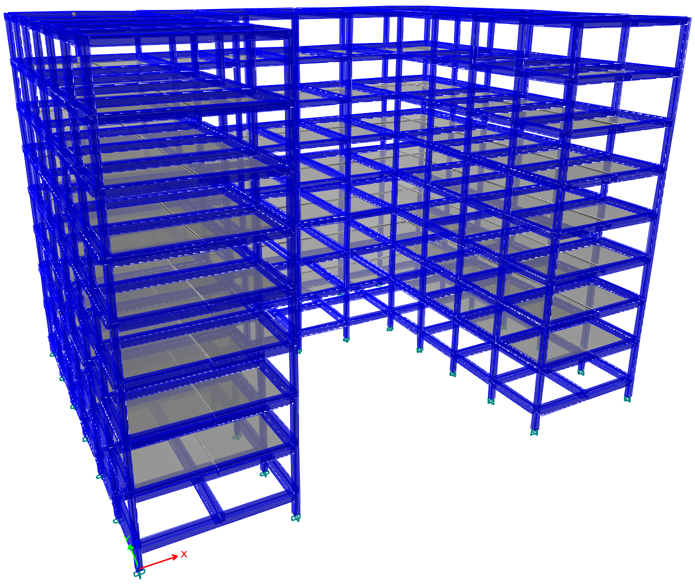


Figure. 3.1: 3D view of C-Shape Industrial Building

3.3 Computational FEA package detail

All of the building modeling and analysis were done with ETABS ("ETABS Features | BUILDING ANALYSIS AND DESIGN," n.d.). The analysis cases were linear elastic and the modeling was done in three dimensions.

3.4 Description of the Building model

In this Industrial building the building shape is C Shape The structure is 32m x 24m in plan with columns spaced at 4m from center to center in this industrial building, which has a C form. It is expected that the floor to floor height is 3 meters. The following image depicts the architectural plan for all of the examples.

3.4.1 Structural Dimensions of the building

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

Intermediate moment frames (IMRF) are expected to endure limited inelastic deformations in their members and connections when subjected to stresses arising from the design earthquake's motions. The IMRF must meet the requirements in this section.

Table 3.1: Description of the building model

Description of the building model	
Number of stories	8
Bottom story height	3m
Each Story height	3m
Building frame system: Intermediate moment resisting frames (IMRF)	Industrial

3.4.2 Gravity Loads of Building

The vertical forces acting on a structure are known as gravity loads. The structure's weight, human occupancy, and snow are all examples of loads that require a complete load path to the ground. The induced gravity load is supported by a floor slab.

According to BNBC2020 (BNBC, 2020) Loads on Buildings and Structures , the minimum design forces including dead load, live load, wind and earthquake loads.

In Table 3.2 describes that Industrial 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 3.2.

Table 3.2: Gravity Loads of Building

Parameter	**Loads**
Live Load	4.8 KN/m^2
Floor Finish	1.2 KN/m^2

3.4.3 Material Specification:

Written release specifications and testing instructions, as stated in the Master Batch Documentation or as otherwise mutually accepted in writing by the Parties, are examples of Material Requirements.

In Table 3.3 its shows that the compressive strength of concrete that is denoted by f_c'which is compression strength of the material's capacity to withstand loads, yield strength of steel which is denoted by f_y is the ultimate strength of steel and the density of concrete which is denoted by γ is a constant number which 25 N/mm^3

Table 3.3: Material Specification

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

3.4.4 Earthquake Load:

Earthquake loads (E) should be computed according to the relevant code of the country in which the plant is located; nevertheless, UBC is the most prevalent code for earthquake loads for buildings, while AISC 7-10 ("ASCE 7-10 : MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES," n.d.) is favored for industrial structures because it concentrates on industrial structures.

In table 3.4 describes that the earthquake load as we know the earthquake starts from base to Top or Roof, for seismic zone we know that there are three zone, zone 1 value is 0.075, Zone 2 value is 0.15 and Zone 3 is 0.25. In our industrial building we use zone 2 which is 0.15 and soil type is S1, important factor is 1, R=8, R means that Numerical coefficient factor.

Table 3.4: Seismic data required 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, R	8
C_t	0.016,0.9
Story range	Bottom to Roof story

3.4.5 Wind Load:

The word 'Wind Load' refers to any stresses or forces exerted by the wind on a structure or building. There are three different types of wind forces that can be applied to a structure. In table 3.5 describes that the Wind load as we know the wind load starts from Ground to Top or Roof or Wind load as a part of lateral load is very important concern in structural analysis for our C shape building, I used that the wind speed 147mph as Dhaka city lies in zone 2 and our exposure type is B and we consider it importance factor as 1.

Table 3.5: Wind data required for analysis

Parameter	Value
Wind speed	147
Exposure type	B
Importance factor	1
Story range	Ground floor to roof

3.4.6 Load Combinations:

As per 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,

Basic Combinations

1. 1.4C1
2. 1.2C1+1.6C2
3. 1.2C1+C2
4. 1.2C1+0.8CW1
5. 1.2C1-0.8CW1
6. 1.2C1+0.8CW2
7. 1.2C1-0.8CW2
8. 1.2C1+1.6CW1+C2
9. 1.2C1-1.6CW1+C2
10. 1.2C1+1.6CW2+C2
11. 1.2C1-1.6CW2+C2
12. 1.2C1+CE1
13. 1.2C1-CE1
14. 1.2C1+CE2
15. 1.2C1-CE2
16. 0.9C1+1.6CW1
17. 0.9C1-1.6CW1
18. 0.9C1+1.CW2
19. 0.9C1-1.6CW2
20. 0.9C1+CE1
21. 0.9C1-CE1
22. 0.9C1+CE2
23. 0.9C1-CE2

3.5 Work Flow Chart:

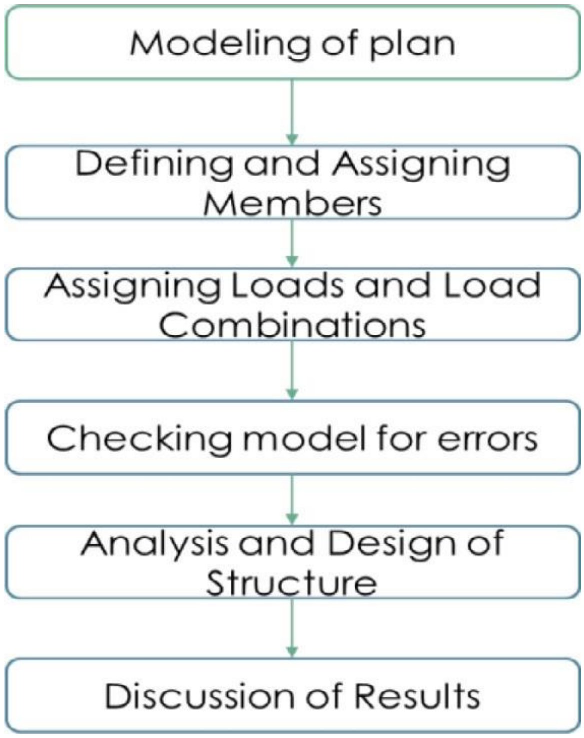
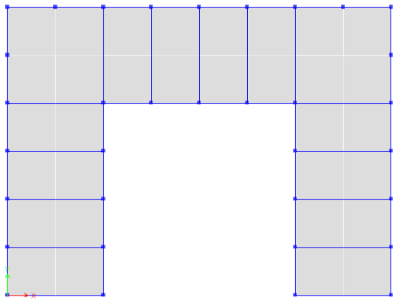


Figure 3.2: Work Flow Chart

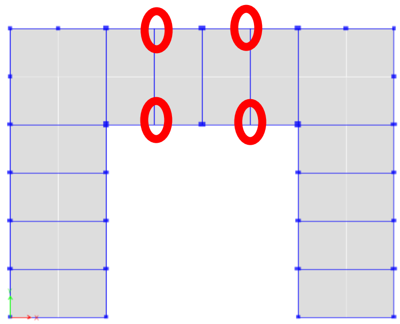
For this work flow chart summarize that what we did in our ETABS building design, at first we choose our plan as C shape building after that we follow the design code which BNBC2020. We draw our modeling in ETABS then we go define option and we choose it beam, column, Slab section. Finally, we applied the different kinds of loads then we analysis it then we put it our result in chapter 4.

3.6 Different Floating cases

in the below four figures it showing that the 2D plan of industrial building for removing different positions of the columns.



a



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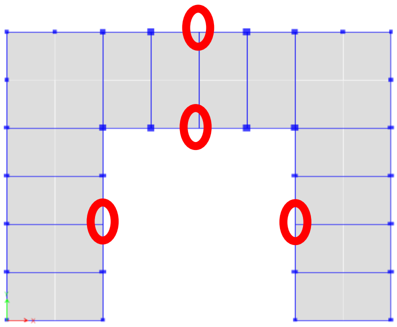

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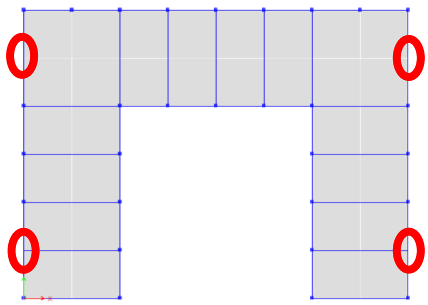


d

a) Building has no floating Column

b, c, d) Removing only 4 columns in the 2nd To 3rd floor

Figure 3.3 different cases of column positioning 2D plan

3.7 Summary:

In this chapter we have discussed Introduction, normal building without floating Colum, computer software Used, Code followed, Description of the building model, work flow chart and Different cases considered based on positioning and removal of columns in the building.

CHAPTER 4

RESULT AND DISCUSIONS

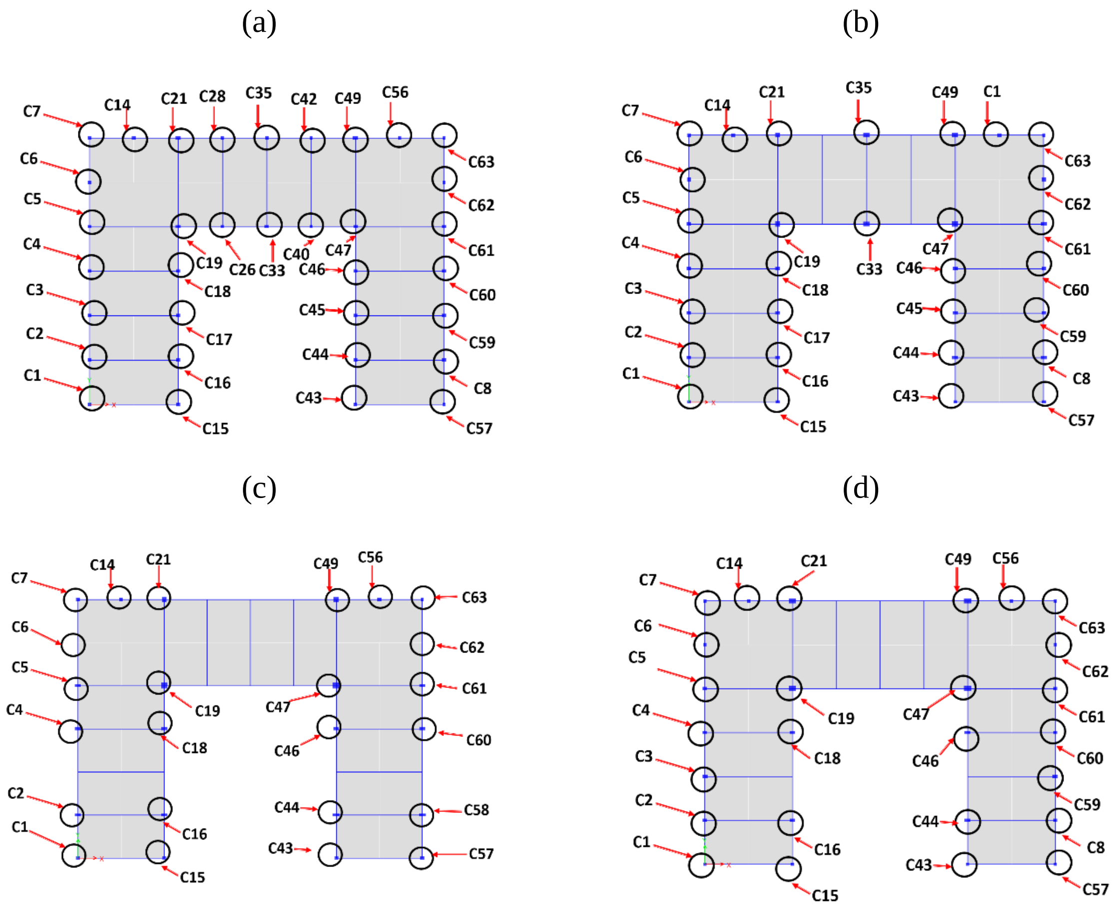
4.1 Introduction

The structural response of a building with floating columns in "parallel locations, at one edge column" is investigated in depth, position and in the middle section," as determined by criteria such as maximum displacements in the building, story drifts, and the maximum displacements in the building at each floor the deformation limitations have been exceeded. As a result, in extreme earthquake zones, such a floating column building is more likely to fail, and certain recommendations are made to analyze the building's behavior in that event. For the analysis of the building under these conditions, shear walls, infill walls, steel bracings, and the planned frame is a moment resisting frame were used. As a result, the findings are described and displayed below.

4.2 Evaluation the results/ Analysis

At various zones mentioned in BNBC2020 (BNBC, 2020), a comparison study and analysis is undertaken between a normal column building with all regular columns and other structural and non-structural components, and a floating column building with all regular columns and other structural and non-structural members. The structural response of the floating column building at "parallel positions, one edge column position, and at the center portion," as observed from parameters such as maximum displacements in the building at each floor, story drifts, and the results obtained are beyond the deformation limits, is investigated in depth, after completing all processes, we finally reached analysis part. After the analysis, we find out Comparison of the results observed in the a below models that is Column dimensions.

In the below four figures illustrated that the 2D plan of industrial building that I did for ETABS ("ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base," n.d.)in the first figure a illustrates that plan view from ground floor to roof without removing columns , in figure b c and d its removed by columns for different positions then we name it each column after analysis.



a) Building has no floating Column

b, c, d) Removing only 4 columns in the 2nd To 3rd floor

figure 4.1 Column specimen ID for all four cases

4.2.2 Column ID

Table 4.1: Differentiate between all three cases at Roof

Column ID	Case 1	Case 2	Case 3
C2	300X350	300X350	**300X450**
C3	300X350	**300X400**	**300X300**
C4	300X350	300X350	**300X400**
C5	300X350	300X350	**300X450**
C16	**300X350**	300X450	300X450
C17	**300X350**	300X300	300X300
C18	**300X350**	300X400	300X400
C19	300X450	**400X500**	**300X350**
C21	300X500	**400X600**	**300X450**
C26	300X650	**300X600**	300X650
C28	300X300	**300X600**	**400X400**
C33	300X300	300X300	300X300
C35	**300X350**	300X300	300X300
C40	300X300	**300X600**	**300X650**
C42	300X300	**300X600**	**400X400**
C44	**300X350**	300X450	300X450
C45	**300X350**	300X300	300X300
C46	**300X350**	300X400	300X400
C47	300X450	**400X500**	**300X350**
C49	300X500	**400X600**	**300X450**
C58	300X350	300X350	**300X450**
C59	300X350	**300X400**	**300X300**
C60	300X350	300X350	**300X400**
C61	300X350	300X350	**300X450**

From table 4.1 I found that the maximum Column size is 400X600 mm on C21 that means the width of the column is 400mm and the depth of the column is 600mm, C21 Column number 21, and the minimum size of the Column is 300X300mm on C33.

From table 4.2 I found that the maximum Column size is 400X500 mm on 19 that means the width of the column is 400mm and the depth of the column is 500mm, C19 Column number

From table 4.2 I found that the maximum Column size is 400X500 mm on 19 that means the width of the column is 400mm and the depth of the column is 500mm, C19 Column number 19, and the minimum size of the Column is 300X300mm on C26

Table 4.2: Differentiate between all three cases at 7th Floor

Column ID	Case 1	Case 2	Case 3
C2	300X350	300X350	**300X400**
C3	300X350	**300X400**	**300X300**
C4	300X350	300X350	**300X450**
C5	300X350	300X350	**300X450**
C16	300X350	**300X400**	**300X450**
C17	**300X350**	300X300	300X300
C18	300X350	300X400	**300X400**
C19	400X400	400X500	400X400
C21	**300X450**	**400X550**	400X450
C26	300X300	**300X400**	300300
C28	**300X300**	300X350	300X350
C33	300X450	**300X350**	**300X300**
C35	**300X500**	300X300	300X300
C40	300X300	**300X400**	300X300
C42	**300X300**	300X350	300X350
C44	300X350	**300X300**	**300X450**
C45	**300X350**	300X300	300X300
C46	**300X350**	300X400	300X400
C47	400X400	**400X500**	400X400
C49	**300X450**	400X450	400X450
C58	300X350	300X350	**300X400**
C59	300X350	**300X400**	**300X300**
C60	300X350	300X350	**300X450**
C61	300X350	300X350	**300X450**

From table 4.3 I found that the maximum Column size is 400X600 mm on C21 that means the width of the column is 400mm and the depth of the column is 600mm, C21 Column number 21, and the minimum size of the Column is 300X300mm on C33 and C35

Table 4.3: Differentiate between all three cases at 6th Floor

Column ID	Case 1	Case 2	Case 3
C2	300X400	300X400	**300X500**
C3	300X350	**300X400**	**300X300**
C4	300X350	300X350	**300X450**
C5	300X400	300X400	**300X500**
C16	**300X400**	300X500	300X500
C17	300X350	300X350	**300X300**
C18	**300X400**	300X450	300X450
C19	400X400	**400X450**	400X400
C21	400X400	**400X600**	400X400
C26	300X300	**300X600**	**400X600**
C28	300X300	**300X650**	**400X650**
C33	**300X500**	300X300	300X300
C35	**300X450**	300X300	300X300
C40	300X300	**300X600**	**400X600**
C42	300X300	**300X650**	**400X650**
C44	**300X400**	300X500	300X500
C45	**300X350**	300X300	300X300
C46	**300X400**	300X450	300X450
C47	400X400	**400X550**	400X400
C49	400X400	**400X600**	400X400
C58	300X400	300X400	**300X500**
C59	300X350	**300X400**	**300X300**
C60	300X350	300X350	**300X450**
C61	300X400	300X400	**300X500**

From table 4.4 I found that the maximum Column size is 400X600 mm on C21 that means the width of the column is 400mm and the depth of the column is 600mm, C21 Column number 21, and the minimum size of the Column is 300X300mm on C33, C35 and C,36

Table 4.4: Differentiate between all three cases at 5th Floor

Column ID	Case 1	Case 2	Case 3
C2	300X350	**300X400**	**300X300**
C3	300X400	**300X450**	**300X300**
C4	300X400	300X400	**300X500**
C5	300X400	300X400	**300X500**
C7	300X300	300X300	**300X350**
C16	300X350	**300X450**	**300X500**
C18	300X400	**300X450**	**300X500**
C19	400X400	**400X600**	**400X550**
C21	400X400	**500X550**	**400X700**
C26	**300X300**	300X350	300X350
C33	**400X400**	300X300	300X300
C35	**400X400**	300X300	300X300
C40	**300X300**	300X350	300X350
C44	300X350	**300X450**	**300X500**
C45	**300X400**	300X300	300X300
C46	300X400	**300X450**	**300X500**
C47	400X400	**400X600**	**400X550**
C49	400X400	**500X550**	**400X700**
C58	300X350	**300X400**	**300X500**
C59	300X400	**300X450**	**300X300**
C60	300X400	300X400	**300X500**
C61	300X300	**300X400**	**300X500**
C63	300X300	300X300	**300X350**

From table 4.5 I found that the maximum Column size is 400X700 mm on C47 that means the width of the column is 700mm and the depth of the column is 600mm, C47 Column number 21, and the minimum size of the Column is 300X300mm on C7,

Table 4.5: Differentiate between all three cases at 4th Floor

Column ID	Case 1	Case 2	Case 3
C2	**300X400**	**300X450**	400X450
C3	**300X400**	**300X500**	300X350
C4	300X400	300X400	**400X450**
C5	300X400	300X400	**400X400**
C6	**300X350**	300X300	300X300
C7	300X300	300X300	**300X350**
C16	300X400	**300X500**	**400X450**
C17	**300X400**	300X300	300X300
C18	300X400	**300X500**	**400X450**
C19	400X550	**300X300**	**400X700**
C21	400X450	**400X550**	**400X600**
C26	300X300	**300X650**	**500X850**
C28	300X300	**300X700**	**500X850**
C33	**400X450**	300X300	300X300
C35	**400X400**	300X300	300X300
C40	300X300	**300X650**	**300X850**
C42	300X300	**300X700**	**300X850**
C44	300X400	**300X500**	**400X450**
C45	300X400	**300X500**	**300X300**
C46	300X400	**300X500**	**400X450**
C47	400X450	**500X500**	**400X700**
C49	400X450	**400X550**	**400X600**
C58	300X400	**300X450**	**400X450**
C59	300X400	**300X500**	**300X350**
C60	300X400	300X400	**400X450**
C61	300X400	300X400	**400X400**
C62	300X350	**300X300**	**300X500**
C63	300X300	300X300	**300X350**

From table 4.6 I found that the maximum Column size is 500X700 mm on C21 that means the width of the column is 500mm and the depth of the column is 700mm, C21 Column number 21, and the minimum size of the Column is 300X300mm on C7, C14, C56 And C63. As we see in the table in C3 there is no case 3 because we remove a column there.

Table 4.6: Differentiate between all three cases at 3rd Floor

Column ID	Case 1	Case 2	Case 3
C2	300X400	300X400	**400X450**
C3	300X400	**300X500**	
C4	300X400	300X400	**400X450**
C5	300X450	**300X400**	**400X450**
C7	300X300	300X300	**300X400**
C14	300X300	300X300	**300X350**
C16	300X400	**300X500**	**400X450**
C18	300X400	**300X500**	**400X450**
C19	400X550	**500X650**	**500X700**
C21	400X450	**500X700**	**400X950**
C44	300X400	**300X500**	**400X450**
C45	300X400		
C46	300X400	**300X500**	**400X450**
C47	400X550	**500X650**	**500X700**
C49	400X450	**500X700**	**400X950**
C56	300X300	300X300	**300X350**
C58	300X400	300X400	**400X450**
C59	300X400	**300X500**	
C60	300X400	300X400	**400X450**
C61	300X450	**300X400**	400X450
C63	300X300	300X300	300X340

From table 4.7 I found that the maximum Column size is 500X500 mm on C19 that means the width of the column is 500mm and the depth of the column is 500mm, C19 Column number 21, and the minimum size of the Column is 300X300mm on C63. As we see in the table in C3 there is no case 3 because we remove a column there.

Table 4.7: Differentiate between all three cases at 2nd Floor

Column ID	Case 1	Case 2	Case 3
C2	300X500	300X500	**300X600**
C3	300X450	**300X500**	
C4	300X450	**300X500**	**300X550**
C5	300X500	300X500	300X500
C16	300X500	**300X550**	**300X600**
C18	**300X450**	300X550	300X550
C19	**500X500**	500X600	500X600
C21	**400X500**	500X500	500X500
C44	300X500	**300X550**	**300X600**
C46			300X550
C47	**500X500**	500X600	500X600
C49	**400X500**	500X500	500X500
C58	300X500	300X500	**300X600**
C59	300X450	**300X500**	
C60	300X450	**300X500**	**300X550**
C61	300X500	300X500	**300X550**
C63			300X300

From table 4.8 I found that the maximum Column size is 400X600 mm on C21 that means the width of the column is 400mm and the depth of the column is 600mm, C21 Column number 21, and the minimum size of the Column is 300X300mm on C14, C14, C26, C40 and C57

As we see in the table in C3 there is no case 1 because we remove a column there.

Table 4.8: Differentiate between all three cases at 1st Floor

Column ID	Case 1	Case 2	Case 3
C3		300X450	**300X400**
C4	300X400	300X400	**300X500**
C5	300X450	300X450	**300X500**
C6	300X350	300X350	**300X300**
C14	300X300	300X300	**300X350**
C16	300X400	**300X500**	**400X400**
C17	**300X400**	300X350	300X350
C18	**300X400**	300X500	300X500
C19	**400X550**	500X600	500X600
C21	400X400	**400X550**	**400X600**
C26	300X300	300X300	**300X350**
C28	**300X300**	300X350	300X350
C33	300X450	**400X400**	300X450
C35	**300X450**	300X400	300X400
C40	300X300	300X300	**300X350**
C42	**300X300**	300X350	300X350
C44	300X400	**300X500**	**400X400**
C45	**300X400**	300X350	300X350
C46	**300X400**	300X500	300X500
C47	**400X550**	500X600	500X600
C49	400X400	**400X550**	**400X600**
C56	300X300	300X300	**300X350**
C57	300X300	300X300	
C58			400X400
C59	300X400	**300X450**	
C60	300X400	300X400	**300X500**
C61	300X450	300X450	**300X500**
C62	300X350	300X350	**300X300**

From table 4.9 I found that the maximum Column size is 500X600 mm on C19 that means the width of the column is 500mm and the depth of the column is 600mm, C19 Column number 21, and the minimum size of the Column is 300X300mm on C2, C4, C60, C46 and C33. As we see in the table in C61 there is no case 1 because we remove a column there.

Table 4.9: Differentiate between all three cases at GB Floor

Column ID	Case 1	Case 2	Case 3
C2	300X300	**300X350**	**300X450**
C4	300X300	300X300	**300X450**
C5	300X350	**300X300**	**300X450**
C16	**300X300**	300X450	300X450
C18	300X300	**300X400**	**300X450**
C19	400X550	**400X700**	**500X600**
C21	**300X450**	400X550	400X550
C33	**400X400**	300X300	300X300
C35	**400X400**	300X300	300X300
C44	**300X300**	300X450	300X450
C46	300X300	**300X400**	**300X450**
C47	400X550	**400X700**	**500X600**
C49	**300X450**	400X550	400X550
C58	300X300	**300X350**	**300X450**
C59	300X300	**300X350**	300X300
C60	300X300	300X300	**300X450**
C61		300X300	**300X450**

4.3 Summary

In this chapter I have discussed the results I have got after analysis like Differentiate between all the three cases, all the Column position and the minimum and maximum dimension of each floor.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusions

This study focuses on the distinctions between a conventional column building and a floating column building, as well as recommendations for a safe and cost-effective design of a floating column building, which can be categorized as an earthquake-resistant design, and the findings of the analysis.

- ❖ After analysis I found that the maximum column size is 400X950 in case 3.
- ❖ Also, I found that as well the minimum column size is 300X300 in case 1.
- ❖ The maximum column size found in C21 column ID and the minimum column size is C2, C4, C60, C46 and C33 Column ID.
- ❖ Maximum Number of Variation was found at 3rd floor of this building.
- ❖ Finally, it was observed that the C2, C3, C14, C16, C18, C19, C26, C33, C28, C40, C42, C47, C49, C59, column is the repeatedly in most of the cases.

5.2 Future Recommendation

The present study is limited to maximum G+8 storied building with floating column in the present study three cases (Case 1, Case2, Case3) are compared in which failure checked by moments, deflection and column shear.

1) In general, if a structure is intended to withstand any damage during a big earthquake shaking, it becomes more expensive.
2) In this study, it was discovered that normal column construction is more efficient than alternative models, such as floating column construction.

3) Based on the findings, it can be concluded that buildings with floating columns in Zones 2 and 3 can be made safe by increasing the beam and column size, however in Zones 4 and 5, the Recommendations must eventually be followed in the design.

4) As a result, recommendations such as shear walls, infill walls, and bracings are taken into account in the modeling and analysis, and it is discovered that they can be designed as earthquake resistant up to a certain extent, such that the addition of floating columns to RC frames extends the time period of bare frames due to stiffness reduction.

5) When the findings from each model are examined, it can be shown that the buildings with normal columns had less displacements and story drifts than the floating column models.

Finally, the floating column building will result in an increase in the dimensions of the members in the structure to increase stiffness and for the earthquake resistant design of the building, with various recommendations taken into account that are more expensive than a standard building cost of construction. Even if the building is built in a high seismic zone, sticking to sustainable practices and recommendations may result in an earthquake-resistant design.

Reference

. D. A. C. (2015). Seismic Performance of Structure With Fixed Base, Base Isolated Structure and Structure With Viscous Damper. *International Journal of Research in Engineering and Technology*, *04*(09), 158–166. https://doi.org/10.15623/ijret.2015.0409028

318 Building Code Topic. (n.d.). Retrieved February 14, 2022, from https://www.concrete.org/topicsinconcrete/topicdetail/318 Building Code?search=318 Building Code

Abhinay, Y., Rao, H. S., & Ghorpade, V. G. (2017). *Comparison of Seismic Analysis of a Floating Column Building and a Normal Building*. *12*(3), 421–431.

ASCE 7-10 : MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES. (n.d.). Retrieved February 14, 2022, from https://global.ihs.com/doc_detail.cfm?rid=BSD&document_name=ASCE 7-10

Bhusnar, D. L., Pise, C. P., Mohite, D. D., Pawar, Y. P., Kadam, S. S., & Deshmukh, C. M. (2016). Seismic Behavior of Multi-Storey Building With Soft Storey Considering Different Infill Materials: A Review. *Int. Journal of Engineering Research and Application Www.Ijera.Com*, *6*(10), 23–26.

BNBC. (2020). Bangladesh National Building Code (BNBC) 2020. *House Building Research Institute*, (2).

Chandurkar, P. P., & Pajgade, P. S. (2013). Seismic Analysis of RCC Building with and Without Shear Wall. *International Journal of Modern Engineering Research (IJMER)*, *3*(3), 1805–1810.

College, J. (2014). *Optimum Location of Different Shapes of Shear Walls in Unsymmetrical High Rise Buildings*. *3*(9), 1099–1106.

ETABS - Documentation - Computers and Structures, Inc. - Technical Knowledge Base. (n.d.).

ETABS Features | BUILDING ANALYSIS AND DESIGN. (n.d.). Retrieved February 14, 2022, from https://www.csiamerica.com/products/etabs/features

G.S Hiremath, M. S. H. (2014). Effect of Change in Shear Wall Location with Uniform and Varying Thickness in High Rise Building. *International Journal of Science and Research (IJSR)*, *3*(10), —. Retrieved from https://www.ijsr.net/archive/v3i10/T0NUMTQ4.pdf

Journal, International. (2012). *Inter-Relationship between Moment Values of Columns in a Building with Different Architectural Complexities and Different Seismic Zones*. *5*(2), 55–59.

Journal, Irjet. (n.d.). *IRJET- SEISMIC ANALYSIS OF MULTISTOREY BUILDING WITH DIFFERENT POSITIONING OF FLOATING COLUMNS SEISMIC ANALYSIS OF MULTISTOREY BUILDING WITH DIFFERENT*.

Kumar, C. M. R., Sreenivasa, M. B., Kumar, A., & Sekhar, M. V. (2013). *Seismic Vulnerability Assessment Of Rc Buildings With Shear Wall*. *3*(3), 646–652.

Mulgund, G. V, & Kulkarni, a B. (2011). Seismic Assesement of Rc Frame Buildings With

Brick. *International Journal of Advanced Engineering Sciences and Technologies*, (2), 140–147.

No, C., & Services, C. (2020). *BNBC and Building Code Implementation Module 2: BNBC 2020 Implementation and Enforcement*.

Pdf file for STAAD.Pro Help Documentation - RAM | STAAD Wiki - RAM | STAAD - Bentley Communities. (n.d.).

SAP2000 - Documentation - Computers and Structures, Inc. - Technical Knowledge Base. (n.d.).

Sharma, A. (2016). *" Study of Structurally Irregular Building Frames Subjected To Seismic Excitations ."* (142651).

Thakur, A., & Khatun, A. (2022). Comparative Seismic Analysis of Multi-storied Building with and Without Floating Columns. *Lecture Notes in Civil Engineering*, *196*(October 2014), 863–872. https://doi.org/10.1007/978-981-16-6557-8_70

Udhav S., B., A.N., S., & Ravi G., M. (2015). Analysis of Multistorey Building with Floating Column. *International Journal of Engineering Research*, *4*(9), 475–478. https://doi.org/10.17950/ijer/v4s9/902

Wahidi, A., & Rama Seshu, D. (2016). Seismic analysis of multistorey building with floating columns. *Asian Journal of Civil Engineering*, *17*(8), 1077–1085. https://doi.org/10.22214/ijraset.2019.3028

Wakchaure, M. K., & Ped, S. P. (2012). Earthquake Analysis of High Rise Building with and Without In filled Walls. *Nternational Journal of Engineering and Innovative Technology (IJEIT)*, *2 (2)*(2), 89–94.

Wakchaure, M. R., Shirish, A., & Nikam, R. (2012). Study of plan irregularity on high-rise structures. *International Journal of Innovative Research & Development*, *1*(8), 269–281.