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**COST COMPARISON FOR THREE DIFFERENT
FLOORS IN TALL BUILDINGS**

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Master's Thesis

Supervisor

Prof.Dr. Zeki HASGUR

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ABSTRACT

COST COMPARISON FOR THREE DIFFERENT FLOORS IN TALL BUILDINGS

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The aim of the research is to compare three different types of floor systems (Conventional, Flat, Waffle) from an economic perspective for tall buildings. For the purpose of this study, three models of a typical 25-story RC building structure with different spans length will be utilized. These models have all been checked and analysed under the influence of gravity loads and lateral loads. Three different models were compared. According to the comparison of materials costs for each model with different floor systems, it has been found that conventional floor systems are more cost-effective in tall buildings with intermediate span lengths, waffle floors are more economical for buildings with longer spans, and flat floor are the most expensive in both cases.

Keywords: Cost, Floor System, Conventional Floor, Flat Floor, Waffle Floor, Tall Building.

TABLE OF CONTENTS

	<u>Pages</u>
ABSTRACT	v
LIST OF TABLES.....	ix
LIST OF FIGURES.....	xii
1. INTRODUCTION	1
1.1 FACTORS EFFECT ON COST	1
1.1.2 Labour Cost.....	2
1.2 ESTIMATING PROCESS.....	2
1.3 METHODS OF COST ESTIMATION	3
1.3.1 Detailed Estimate	3
1.3.2 Assembly Estimating	3
1.3.3 Parametric Estimates.....	3
1.3.4 Model Estimating.....	4
1.3.5 Square-Foot Estimates	4
1.3.6 Project Comparison Estimates	4
1.4 PROBLEM STATEMENT.....	4
2. LITERATURE REVIEW	6
2.1 TALL BUILDINGS.....	6
2.1.1 Wind Loads Effect	7
2.1.2 Seismic Loads Effect	8
2.2 FLOOR SYSTEM.....	9
2.2.1 Conventional Floor System.....	10
2.2.2 Flat Floor System.....	11
2.2.3 Waffle Floor System.....	12
2.2.4 Comparison between Three Different Floor Systems.....	14
3. METHODOLOGY	17
3.1 GENERAL.....	17

3.2 ANALYSIS BY USING COMPUTER PROGRAMS	17
3.3 METHODOLOGY	17
3.4 MODEL DESCRIPTION	18
3.5 LOADS	18
3.5.1 Gravity Loads.....	18
3.6 LATERAL LOADS	19
3.6.1 Seismic Loads	19
3.6.2 Wind Loads	23
3.7 RESPOND SPECTRUM ANALYSIS	24
4. MODELLING AND CASE STUDY	27
4.1 CASE STUDY (1) CONVENTIONAL FLOOR FOR MODEL (6.3-5.5-5.2)	27
4.1.1 Checking Critical Case	28
4.1.2 Checking Building under Lateral Forces Effect	29
4.1.3 Floor Design.....	29
4.2 CASE STUDY (2) FLAT FLOOR FOR MODEL (6.3-5.5-5.2).....	39
4.2.1 Checking Critical Case	39
4.2.1.2 Wind loads	40
4.2.2 Checking Building under Lateral Forces Effect	41
4.2.3 Floor Design.....	41
4.3 CASE STUDY (3) WAFFLE FLOOR (6.3-5.5-5.2).....	48
4.3.1 Checking Critical Case	48
4.3.2 Checking Building Under Lateral Forces Effect	50
4.3.3 Floor Design.....	50
4.4 CASE STUDY (4) CONVENTIONAL FLOOR (8.3-7.5-7.2)	57
4.4.1 Checking Critical Case	57
4.4.2 Checking Building under Lateral Forces Effect	59
4.4.3 Floor Design.....	59
4.5 CASE STUDY (5) FLAT FLOOR FOR MODEL (8.3-7.5-7.2).....	67

4.5.1 Checking Critical Case	67
4.5.2 Checking Building under Lateral Forces Effect	69
4.5.3 Floor Design.....	69
4.6 CASE STUDY (6) WAFFLE FLOOR (8.3-7.5-7.2).....	75
4.6.1 Checking Critical Case	75
4.6.2 Checking Building under Lateral Forces Effect	77
4.6.3 Floor Design.....	77
5. RESULTS AND DISCUSION	82
5.1 COST RESULTS COMPARISON.....	82
5.1.1 Cost for Medium Length Span Model (6.3-5.5-5.2).....	82
5.1.2 Comparison of Floors Cost of Medium Length Span Model (6.3-5.5-5.2)	83
5.1.3 Cost for Long Length Span Model (8.3-7.5-7.2).....	85
5.1.4 Comparison of Floors Cost of Long Length Span Model (8.3-7.5-7.2)	87
5.1.5 Cost Comparison between Medium Length Span and Long Length Span	89
5.2 STRUCTURAL RESULTS COMPARISON OF FLOORS	91
5.2.1 Floor Displacement.....	91
5.2.2 Floor Drift	91
5.2.3 Time Period.....	92
5.2.4 Base Shear.....	93
6. CONCLUSION	94
REFERENCES	96
APPENDIX A.....	100
A.1 WIND CALCULATIONS AND RESULTS.....	100
A.2 SEISMIC FORCE CALCULATIONS.....	102
A.3 UNITE PRICE CALCULATION.....	132
A.4 MODEL (6.3-5.5-5.2) MATERIAL CALCULATIONS.....	133
A.5 MODEL (8.3-7.5-7.2) MATERIAL CALCULATIONS.....	141

LIST OF TABLES

	<u>Pages</u>
Table 3.1: Material Properties for Concrete C30 and Steel fy.	18
Table 3.2: Dead Loads Values.....	19
Table 3.3: Seismic Load Combinations.....	19
Table 3.4: Seismic Effect Parameters.....	22
Table 3.5: Load Combination of Wind.....	24
Table 3.6: Response Spectrum Curve Parameters.....	25
Table 4.1: Case Study 1 Parameters for Model (6.3-5.5-5.2).....	27
Table 4.2: Critical Case for Seismic and Wind Loads Effect Model (6.3-5.5-5.2).....	28
Table 4.3: Steel Area of Beams (B&B2&B3) Model (6.3-5.5-5.2).	32
Table 4.4: Deflection Values for Conventional Floor Model (6.3-5.5-5.2).	35
Table 4.5: Steel Reinforcement Table for Panel (6.3x5.5) for Conventional Floor (6.3-5.5-5.2).....	37
Table 4.6: Flat Floor Model Parameters & Properties Model (6.3-5.5-5.2).....	39
Table 4.7: Critical Case for Seismic and Wind Loads Effect for Flat Floor.	40
Table 4.8: Parameters of Columns (C1&C2) of Flat Floor Case Model (6.3-5.5-5.2).	43
Table 4.9: Short Term Deflection& Long Term Deflection Model (6.3-5.5-5.2).....	44
Table 4.10: Steel Reinforcement Table For Panel; (6.3x5.5) For Flat Floor Model (6.3-5.5-5.2).....	46
Table 4.11: Waffle Floor Model Parameters & Properties Model (6.3-5.5-5.2).....	48
Table 4.12: Critical Case for Seismic and Wind Loads Effect for Waffle Floor Model (6.3-5.5-5.2).	49

Table 4.13: Parameters of Columns (C1&C2) of Waffle Floor Case Model (6.3-5.5-5.2).	53
Table 4.14: Short Term & Long Term Deflection for Waffle Floor Model (6.3-5.5-5.2).	53
Table 4.15: Steel Reinforcement Table for Panel; (6.3x5.5) for Waffle Floor Model (6.3-5.5-5.2).	55
Figure 4.16: Steel Reinforcement details for Waffle Floor System Case Model (6.3-5.5-5.2).	56
Table 4.17: Conventional Floor Parameters & Properties for Model (8.3-7.5-7.2).	57
Table 4.18: Critical Case for Seismic and Wind Loads Effect for Model (8.3-7.5-7.2).	58
Table 4.19: Deflection Values for Conventional Floor for Model (8.3-7.5-7.2).	63
Table 4.20: Steel Reinforcement Table for Panel (8.3x7.5) for Conventional Floor (8.3-7.5-7.2).	65
Table 4.21: Flat Floor Model Parameters & Properties for Model (8.3-7.5-7.2).	67
Table 4.22: Critical Case for Seismic and Wind Loads Effect for Flat Floor for Model (8.3-7.5-7.2).	68
Table 4.23: Parameters of Columns (C1&C2) of Flat Floor Case.	70
Table 4.24: Short Term Deflection& Long Term Deflection Model (8.3-7.5-7.2).	71
Table 4.25: Steel Reinforcement Table for Panel; (8.3x7.5) for Flat Floor for Model (8.3-7.5-7.2).	73
Table 4.26: Waffle Floor Model Parameters & Properties for Model (8.3-7.5-7.2).	75
Table 4.27: Critical Case for Seismic and Wind Loads Effect for Waffle Floor for Model (8.3-7.5-7.2).	76
Table 4.28: Parameters of Columns (C1&C2) of Waffle Floor Case for Model (8.3-7.5-7.2).	78

Table 4.29: Short Term Deflection& Long Term Deflection Model (8.3-7.5-7.2) for Waffle Floor.	78
Table 4.30: Steel Reinforcement Table for Panel (8.3x7.5) for Waffle Floor for Model (8.3-7.5-7.2).	80
Table 5.1: Shown Total Cost Conventional Floor for Model (6.3-5.5-5.2).	82
Table 5.2: Shown Total Cost in Flat Floor for Model (6.3-5.5-5.2).....	82
Table 5.3: Shown Total Cost in Waffle Floor for Model (6.3-5.5-5.2).....	83
Table 5.4: Shown Total Cost of Conventional Floor for Model (8.3-7.5-7.2).	85
Table 5.5: Shown Total Cost in Flat Floor for Model (8.3-7.5-7.2).....	86
Table 5.6: Shown Total Cost in Waffle Floor for Model (8.3-7.5-7.2).....	86

LIST OF FIGURES

	<u>Pages</u>
Figure 2.1: Diagram of Buildings World's Highest Building.	6
Figure 2.2: Wind Effect on Different Sides of Structure.....	7
Figure 2.3: Diagram Shown Relation between Number of Stories and Materials Quantities.	10
Figure 2.4: Diagram Showing One-Way and Tow-Way of Conventional Slab.....	11
Figure 2.5: Diagram Showing (a) Flat Slab System without Column Head (b) Flat Slab System with Column Head.....	12
Figure 2.6: Diagram Showing Typical Waffle Slab.....	13
Figure 3.1: Shown Iraq Regions for S1&SS.....	20
Figure 3.2: Design Response Spectrum Curve.....	26
Figure 4.1: Conventional Floor Model Isometric & Plan View Model (6.3-5.5-5.2).	27
Figure 4.2: Showing Internal Beams of Conventional Floor (B1, B2, B3) Model (6.3-5.5- 5.2).....	30
Figure 4.3: Showing Moment Diagram for Internal Beams (B1, B2, B3) model (6.3-5.5-5.2).	31
Figure 4.4: Show Steel Reinforcement Details for Span 6.3 m Beams Model (6.3-5.5-5.2).	33
Figure 4.5: Show Steel Reinforcement Detail for Beam (B1&B2&B3) Model (6.3-5.5-5.2).	33
Figure 4.6: (a) Show Long-Term Deflection, (b) Show Immediate- Term Deflection.	35
Figure 4.7: Bending Moment Diagram for The Convention Floor Model (6.3-5.5-5.2). ...	36

Figure 4.8: Middle Strip Steel Reinforcement Details for Panel (6.3x5.5) model (6.3-5.5-5.2).....	38
Figure 4.9: Column strip Steel Reinforcement Details for Panel (6.3x5.5) Model (6.3-5.5-5.2).....	38
Figure 4.10: Flat Floor Model Isometric & Plan View Model (6.3-5.5-5.2).....	39
Figure 4.11: Framework Plan for Flat Floor Model (6.3-5.5-5.2).....	42
Figure 4.12: (a) Show Immediate Deflection, (b) Show Long- Term Deflection Model (6.3-5.5-5.2).	44
Figure 4.13: Showing Bending Moment Diagram for Panel (6.3×5.5) for Flat Floor (6.3-5.5-5.2).....	45
Figure 4.14: Middle Strip Steel Reinforcement for Panel (6.3x5.5) of Flat Floor (6.3-5.5-5.2).....	47
Figure 4.15: Column Strip Steel Reinforcement for Panel (6.3x5.5) of Flat Floor (6.3-5.5-5.2).....	47
Figure 4.16: Waffle Floor Model Isometric & Plan View Model (6.3-5.5-5.2).....	48
Figure 4.17: Show Framework Plan for Waffle Floor Model (6.3-5.5-5.2).....	52
Figure 4.18: (a) Show Immediate Deflection, (b) Show Long- Term Deflection for Waffle Floor.	53
Figure 4.19: Showing Bending Moment Diagram for Panel (6.3×5.5) of Waffle Floor Case.	54
Figure 4.20: Steel Reinforcement details for Waffle Floor System Case Model (6.3-5.5-5.2).....	56
Figure 4.21: Conventional Floor Model Isometric & Plan View (6.3-5.5-5.2).....	57
Figure 4.22: Showing Moment Diagram for Internal Beams Model (8.3-7.5-7.2).	60

Figure 4.23: (a) Show The Steel Reinforcement for Beams (B2&B3) (Section A). (b) Show The Steel Reinforcement for Beams (B2&B3) (Section B) for Model (8.3-7.-57.2).....	61
Figure 4.24: Conventional Floor Model Isometric & Plan View for Model (8.3-7.5-7.2).	62
Figure 4.25: (a) Show Immediate Deflection, (b) Show Long- Term Deflection for Conventional Floor Model (8.3-7.5-7.2).	63
Figure 4.26: Bending Moment Diagram for The Convention Floor for Model (8.3-7.5-7.2).	64
Figure 4.27: Middle Strip Steel Reinforcement for Panel (8.3x7.5) for Model (8.3-7.5-7.2).	66
Figure 4.28: Column Strip Steel Reinforcement for Panel (8.3x7.5) for Model (8.3-7.5-7.2).	66
Figure 4.29: Flat Floor Model Isometric & Plan View.	67
Figure 4.30: Flat Plate Model Isometric & Plan View for Model (8.3×7.5x7.2).	70
Figure 4.31: (a) Show Immediate Deflection, (b) Show Long- Term Deflection Model (8.3×7.5x7.2).....	71
Figure 4.32: Showing Bending Moment Diagram for Panel (8.3x7.5) for Flat Floor (8.3-7.5-7.2).....	72
Figure 4.33: Column Strip Steel Reinforcement for Panel (8.3x7.5) of Flat Floor (8.3-7.5-7.2).....	74
Figure 4.34: Middle Strip Steel Reinforcement for Panel (8.3x7.5) of Flat Floor (8.3-7.5-7.2).....	74
Figure 4.35: Waffle Floor Model Isometric & Plan View.	75
Figure 4.36: Showing Bending Moment Diagram for Panel (8.3x7.5) of Waffle Floor (8.3-7.5-7.2).	79

Figure 4.37: (a) Steel Reinforcement for Panel (8.3-7.5-7.2) for Waffle Floor (b) Section A Showing Steel Waffle Floor for Model (8.3-7.5-7.2).....	81
Figure 5.1: Concrete Cost Comparison for Model (6.3-5.5-5.2).....	83
Figure 5.2: Framework Cost Comparison for Model (6.3-5.5-5.2).....	84
Figure 5.3: Steel Rebar Cost Comparison for Model (6.3-5.5-5.2).....	84
Figure 5.4: Overall Cost Comparison for Model (6.3-5.5-5.2).	85
Figure 5.5: Concrete Cost Comparison for Model (8.3-7.5-7.2).....	87
Figure 5.6: Framework Cost Comparison for Model (8.3-7.5-7.2).....	87
Figure 5.7: Steel Rebar Cost Comparison for Model (8.3-7.5-7.2).....	88
Figure 5.8: Overall Cost Comparison for Model (8.3-7.5-7.2).	88
Figure 5.9: Concrete Cost Comparison between Medium Length Span and Long Length Span.	89
Figure 5.10: Framework Cost Comparison for Medium Length Span and Long Length Span.	89
Figure 5.11: Steel Rebar Cost Comparison for Medium Length Span and Long Length Span.	90
Figure 5.12: Overall Cost Comparison for Medium Length Span and Long Length Span.	90
Figure 5.13: Shown Floor Displacement for Medium Length Span and Long Length Span.	91
Figure 5.14: Shown Floor Drift VS Stories.....	92
Figure 5.15: Shown Time period for Medium Length Span and Long Length Span.....	92
Figure 5.16: Shown Base Shear for Medium Length Span and Long Length Span.....	93

1. INTRODUCTION

Managing a construction project is challenging due to the high cost of labour and materials. Cost control is one of the most important factors in managing a construction project. Today, the importance of cost control is increasing in the construction industry. Cost estimation is an integral part of project planning. This involves estimating the quantity, cost, and price of resources needed to complete a project [1].

The most important factors in a feasibility study for a real estate project are usually construction costs and income. The decision to embark on a project is rarely accompanied by any detailed descriptions of how the project will proceed, and there is rarely enough information to verify that the projected costs are accurate [2].

High-rise buildings and structures are becoming increasingly important as the population grows. As a result of this, land will be insufficient to accommodate them. A high-rise building is constructed to solve this problem. Several modifications are made to improve the efficiency of the process. Building tall buildings and structures requires modern construction techniques and skilled labour. As a consequence, when constructing high-rise buildings and structures, the cost of various structural elements, including columns, beams, walls, and slabs, must be considered [3].

1.1 FACTORS EFFECT ON COST

1.1.1 Material Cost

Materials costs include both direct and indirect costs, with the exception of labour and installation equipment, which are not included in the cost of materials. Among the additional factors to consider are the cost of transport, sales taxes, and shipping. Reinforced concrete is commonly used as a building material in modern buildings. The term "concrete mix" refers to a mixture of cement, sand, and particles mixed with water to form a "manufactured stone" [8].

1.1.2 Labour Cost

The labour cost includes base wages and additives such as payroll taxes and fringe benefits. There are also crew foremen who receive hourly wages in addition to the actual workers [9].

An indirect labour cost refers to wages and labour cost additives paid to contractors whose effort cannot be directly attributed to a specific task. The indirect labour costs (overhead) include personnel such as superintendents, engineers, clerks, and site clean-up labourers. [9].

1.2 ESTIMATING PROCESS

Estimation step process according to Larly Aaron [10] as following:

Project Initiation: This stage occurs when there is motivation or justification for considering a resource project. The first requirement is to determine if the cost is justified.

Scope Definition: Scope Definition answers the "Why?" and "How?" questions concerning the project and its accompanying estimate. The estimator must also consider structural needs.

Pre-Estimated Planning: assessing approaches, structures, processes, or formats, or assessing cost-time trade-offs

Quantity Take-Offs: During this step, quantity take-offs (QTOs) are performed. All scope items should be included on the estimate detail sheets.

Data Sources and Costing: Money is the subject of this step. In the process of obtaining data from data sources and costing it, there are two types of money involved.

Direct Cost Totals: All costs associated with installation, direct supervision, start costs, contractors' fees, insurance, taxes, etc. that are necessary to complete the installation.

Documentation and Checking: Documentation or assumptions that support the estimate, such as lists of applicable drawings and specifications.

Estimate Issue and Filing: Since estimates contain an extensive amount of project-related information, estimates are usually numbered and placed in a known location.

1.3 METHODS OF COST ESTIMATION

There are several types of cost estimation methods:

1.3.1 Detailed Estimate

Using this method, each project item must be broken down into its component parts and estimated accordingly. Quantities and prices must be determined. It includes materials, labour, equipment, insurance, bonds, and overhead, as well as a profit forecast [7].

1.3.2 Assembly Estimating

Instead of bidding on each component individually, an assembly is constructed by grouping them together. Additionally, the assembly of components may involve more than one trade or may be limited to a single trade. A home lightweight switch with a single-gang box and a single-pole switch demonstrates simple assembly. [7].

Assembly estimating can also be applied to preliminary and conceptual estimations. An estimate for a complete building can be created quickly with wide assemblies [4].

1.3.3 Parametric Estimates

Estimates based on metric equations indicate the statistical relationship between construction costs and building parameters. Parameters such as the floor area, the number of rooms, and the type of construction can be considered.

In comparison to square foot estimates, parametric estimates utilize more complicated equations, such as logarithmic functions, parameter scaling, and parameter multiplication. Parameter estimation is useful for developing conceptual estimates based on assumptions, according to Dagostino and Peterson [7].

In his study, Hollmann (1997) identifies parametric estimation as a technique that produces a random parameter or independent variable (that is, the parameter is usually an indirect estimate or conjecture about an object not measured in order to obtain a numerical value).

1.3.4 Model Estimating

Model-based estimation is a method of generating estimates using computer software based on the responses provided by the estimator in order to produce estimates using the model. The estimator only needs to provide a smaller amount of information when estimating a model compared to an assembly estimate, according to [7].

1.3.5 Square-Foot Estimates

When estimating square footage, square footage is multiplied by price per square foot and adjusted for variations in height, perimeter length, and other factors. Building dimensions may also be measured using other units than square footage. For example, parking spaces can be used to determine the size of a garage. It is useful for the owner to estimate the square footage of a proposed project to determine whether it fits within their budget [7].

1.3.6 Project Comparison Estimates

Project comparison estimates are prepared by comparing the costs of proposed and completed projects [4].

Starting with a comparable project, the estimator adjusts for project variances. As an example, an estimate of the structure of an apartment project may be made based on a similar project constructed in a nearby city the previous year using the same plans. Consequently, the pricing for the completed project must be adjusted, labour availability and costs must be adjusted, and city regulations must be followed to modify the plans. The significant variances in site conditions usually require the use of another method to calculate the site.

1.4 PROBLEM STATEMENT

In this study, the amount of materials required for three different floors (conventional, flat, and waffle) of a high rise building model was determined, and the total cost of each floor was compared to determine which floor would be more cost-effective. In order to model the structure, ETABS & Software are used. Analysis and design of the structure are done, followed by a comparison of the results generated by these two software programs, and finally a conclusion is drawn.

The main objective of the research is:

To develop models of three types of floors (Waffle floor, conventional floor, flat floor) in a tall building for analysis and design by finite element method using the software ETABS.

To evaluate Materials quantities (concrete, steel, and formwork) of the three types of High Rise Building floors (Waffle floor, conventional floor, flat floor).

To compare the total cost between the three types of High Rise Building floors (Waffle floor, conventional floor, flat floor).



2. LITERATURE REVIEW

2.1 TALL BUILDINGS

Modern high-rise buildings can be regarded as prototypes for ancient tall structures, such as Egyptian pyramids and Mayan temples, both of which were known as high-rises in ancient times.

Defining a tall building does not seem to be a widely accepted definition. There is no consensus on what constitutes a tall building, what height, how many floors, or what proportion can be used to define a tall building. It may be appropriate to draw a line between statics and structural dynamics when designing structures. The structural design considers buildings tall if they are subject to lateral loads. This includes the sway resulting from such loads [11].

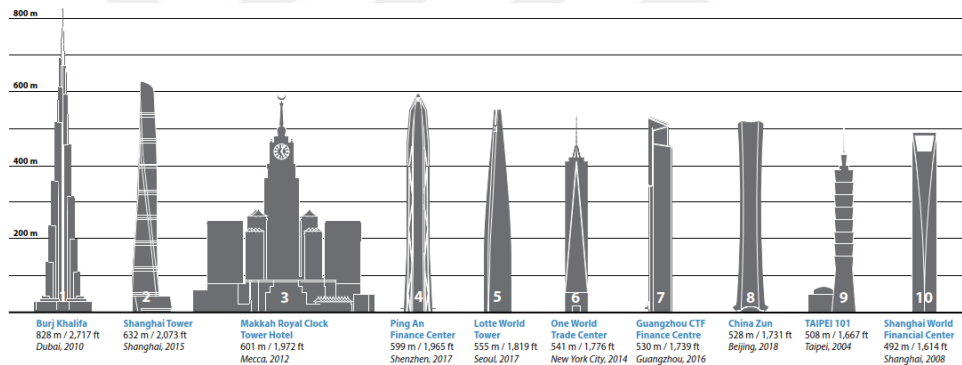


Figure 2.1: Diagram of Buildings World's Highest Building.

A tall building's design is mainly based on analytical investigations and scaled model tests, which are largely based on fundamental mechanics and years of research and experience. Most tall buildings are designed to provide adequate strength and stiffness against wind and earthquake loads [13].

The main reasons for building tall can be summed up as economic gain in areas with high land prices. Building a denser city Publicity, Fascination. Bryan & Alex [12] divide the factors that affect the growth of tall building construction into socioeconomic problems and industrialization, new construction technology, and new materials allowed to develop lightweight skeleton.

2.1.1 Wind Loads Effect

Wind is a complicated phenomenon due to the numerous flow situations produced by wind interaction with structures. As this process continues, the structure will encounter multiple impacts in a variety of directions. [14]

Positive direct pressure is applied to surfaces oriented in the wind's direction. In this process, the air mass exerts maximum force directly on the structure. Leeward sides of towers usually have negative pressure or suction (opposite to the wind). A surface parallel to a wind's direction is subject to drag effects. The drag effect increases the overall force on the tower in addition to the pressure on the building surfaces. These three factors together determine the total force of the tower [15].

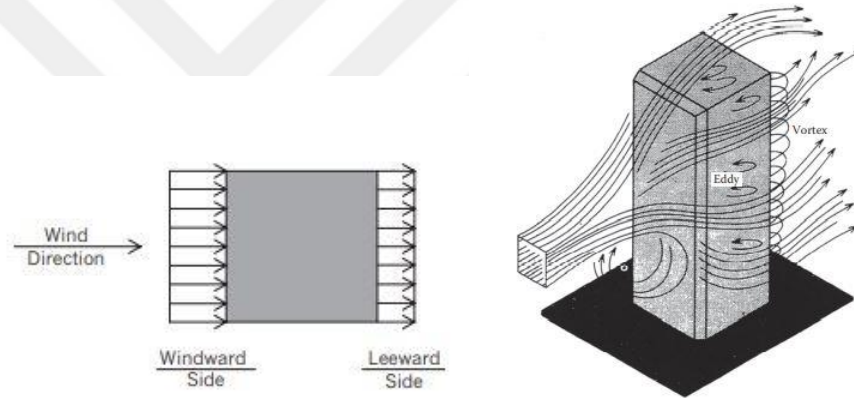


Figure 2.2: Wind Effect on Different Sides of Structure.

The dynamic characteristics of tall or slender structures can amplify forces. Cross-wind or lift is common for these structures. Tall structures often follow this behaviour. Even at low wind speeds, dynamic effects can occur if the vortex shedding of the wind generates force pulses that coincide with the structure's natural vibration period. [15].

As a consequence of wind interaction with structures, there are a number of scenarios that may complicate the flow of wind. Although wind characteristics are characterized as follows: Variation of wind velocity with building height, Turbulence of wind, Possibility of vortex shedding, dynamic behaviour of wind–structure interaction [12].

The building's response to earthquake shaking occurs over the time of a few seconds. During this time, several types of seismic waves are combined to shake the building in ways that are

different in detail for each earthquake. The characteristics of each building are different, whether in size, configuration, material, structural system, age, or quality of construction: each of these characteristics affects the building response. Despite the complexity of the interactions between the building and the ground during the few seconds of shaking, there is a broad understanding of how different building types will perform under different shaking conditions. Tall building design_ steel, concrete, and composite systems [16].

2.1.2 Seismic Loads Effect

During an earthquake, the building responds within a few seconds to the shaking of the ground. It is at this time that a number of seismic waves combine to cause the building to vibrate according to a particular pattern specific to each earthquake. Structure response is influenced by a number of factors, including size, design, materials, structural system, and age. Even though the interactions between the building and the ground during a shaking event are complex, different types of buildings are generally understood how they will perform under different shaking conditions. Tall building design_ steel, concrete, and composite systems [16].

Tall buildings are subject to seismic forces based on the equation $\text{force} = \text{mass} \times \text{acceleration}$. The calculation of mass can be performed directly but the calculation of acceleration is more complex. Ground movement and various mechanical factors affect the response of tall buildings to seismic movements. If the building is rigid to infinity, it will be influenced by the maximum acceleration in the direction of movement (PGA). This means the building's mass will move in accordance with the ground movement during an earthquake but if the building is very flexible, there is no stiffness, and then it does not move. In general, all structures can be classified into these categories. Designing tall buildings - structure as architecture [16].

There are also other factors, such as the nature of the soil, the ductility of the structure, and the damping ratio, that can affect the response of structures to seismic waves. In the event of an earthquake, soft soil will contribute to an increase in earth movement. Structures with a high degree of ductility may be able to dissipate energy more effectively during a seismic event. Furthermore, damping influences the force exerted by a structure in proportion to the amount of acceleration. In general, the more damping there is inside a structure, the less

likely it is to be subjected to forces. It is also important to consider the base period, which is the length of time it takes for the structure to go through a full cycle. Designing tall buildings structure as architecture [16].

2.2 FLOOR SYSTEM

In tall buildings, the floor system plays a very significant role. In addition to resisting gravity loads, it also transmits lateral forces to lateral resistance systems from the cladding. Thus, the connection between floors and other elements should be adequate to resist shear. Floor systems used in tall buildings are similar to those used in lower buildings, with the following differences: the weight of the floor should drop as the building rises, and the floor system should resist loads during construction [16]

Gravity floor framing is essentially the same for low- and high-rise structures; no matter if the floor is framed at the second level of a low-rise building or on the 50th level of a high-rise building, the required quantities remain the same. In floor framing, material quantity is determined by the span between columns, not by the building height. Nevertheless, the number of columns and walls required to support the vertical gravity system increases by the ratio $(n + 1)/2$, where n equals the number of floors. The reason is that these elements are designed not just to handle loads from the floor itself but also to handle loads from above. Lateral loads begin to be more important at about 50 stories and become increasingly important with greater height [11].

The cost of a floor slab in a building project can range from 13 to 16 percent of the total cost of the structure. The minimum amount of material required for gravity loads in steel buildings is 49 kg/m², 0.1 m³/m² (concrete)* 4.8 kg/m² (rebar)* Reinforced concrete building: 32 kg/m² (rebar) 0.34 m³/m² (concrete) Designing [17].

Around 50 stories, lateral loads dominate and become more critical as height increases. For buildings over 50 stories, horizontal bracing is crucial for minimizing additional material requirements [17].

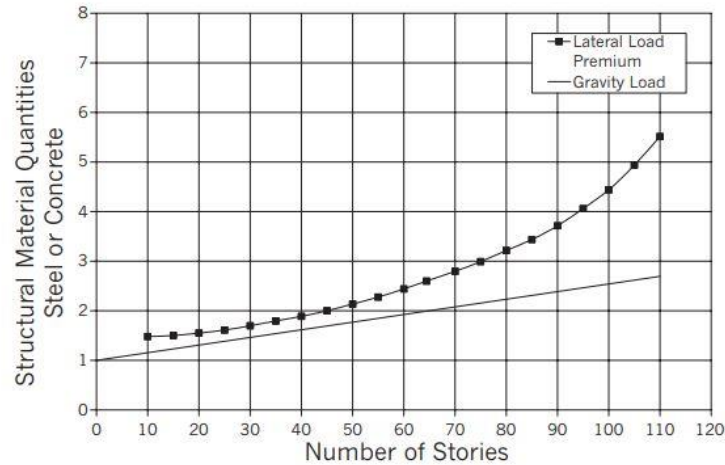


Figure 2.3: Diagram Shown Relation between Number of Stories and Materials Quantities.

2.2.1 Conventional Floor System

A conventional slab is one that is supported by walls or beams. It is common for conventional floors in the construction industry to be rectangular in shape, however other shapes can also be used, including triangular, circular, trapezoidal, etc. [18]. According [18], the slabs are supported by beams and columns, which is called beam-slab construction.

A conventional slab structure transfers its load first to beams, then to columns. This results in an increase in structure weight, as well as more expensive and complicated formwork compared to a flat slab structure. Due to their thin thicknesses, these slabs require more formwork than flat slabs since beam depths are large while slab thicknesses are small. Dead loads are higher in this type of slab than in flat slabs and ceilings have to be flat to be attractive [19].

There are two types of conventional slabs: one-way slab and two-way slab. Whenever there is a large difference between the length and width of a slab, then the slab is considered to be one-dimensional. $L/B > 2$ for a one-way slab. If the $L/B < 2$ then it is called two-way slab [20].

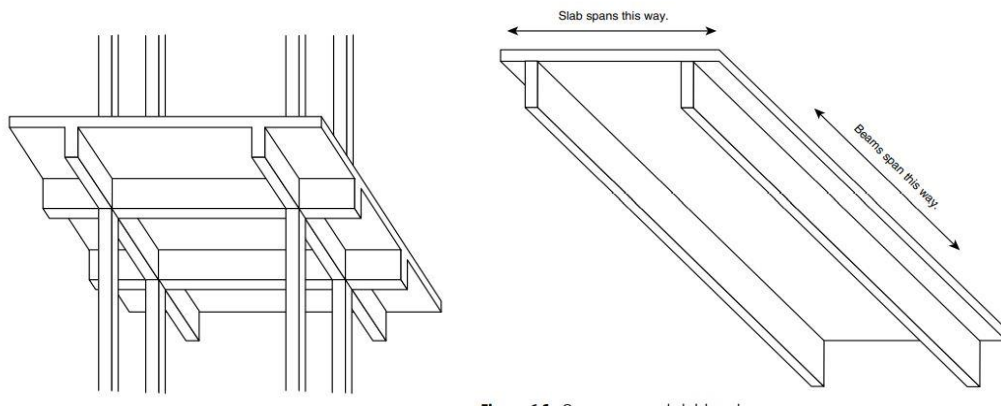


Figure 2.4: Diagram Showing One-Way and Two-Way of Conventional Slab.

2.2.2 Flat Floor System

Flat slabs were developed in the year 1906 in USA. Load tests were conducted on many slabs in the United States during the period 1910-20. Nicholas proposed a method in 1914 of analysing and supporting slabs by beams and beams by columns. But the effective ceiling height is reduced by this type of construction. Due to the fact that there are no beams in flat plates or slabs, they are more economical as they reduce the height of the floor by 10-15%. Due to the fact that beams can be avoided, room height can be increased. As a result, slabs are placed directly on columns for aesthetic and architectural reasons where the loads are directly transferred to the columns. These slabs are called flat slabs [21].

The slabs are supported directly by columns without the use of beams. Shear strength and negative reinforcement in the support area are usually enhanced by thickening the slab near the column. In flat slab system, the column no longer provides direct support, therefore the load is transferred directly to the foundation and column [22].

Unlike beam structures, flat slabs are directly supported by concrete columns. There are two types of flat slabs: single-sided slabs with the total load concentrated on a support column, and rectangle slabs known as "drop panels" [23].

The use of drop panels increases the overall performance and robustness of underfloor vertical load systems and also increases cost efficiency. In addition to reducing shearing stresses, drop panels provide an increase in moment resistance where the column is most

likely to punch through the slab [24] .A drop panel typically has a height twice that of the slab.

It is recommended that flat slabs be used for many architectures, as well as for asymmetrical column layouts and sloped floors [23]

There are several Advantages of using flat floor [21].

Reduce the height between floors .There is a reduction in working time due to table formwork. It gives flexibility in the design of the dimensions of spaces and partitions

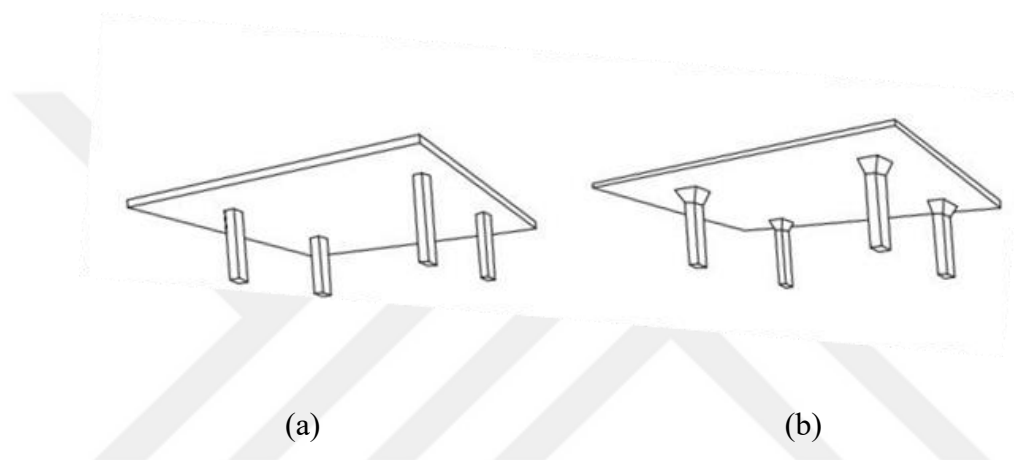


Figure 2.5: Diagram Showing (a) Flat Slab System without Column Head (b) Flat Slab System with Column Head.

2.2.3 Waffle Floor System

As a result of their economic benefits, waffle slabs are becoming more and more popular. Fig. 1 illustrates a pattern of orthogonal ribs regularly spaced, topped by a thin slab. The slab is supported at various points by several columns, with solid sections assisting with the transfer of weight [25].

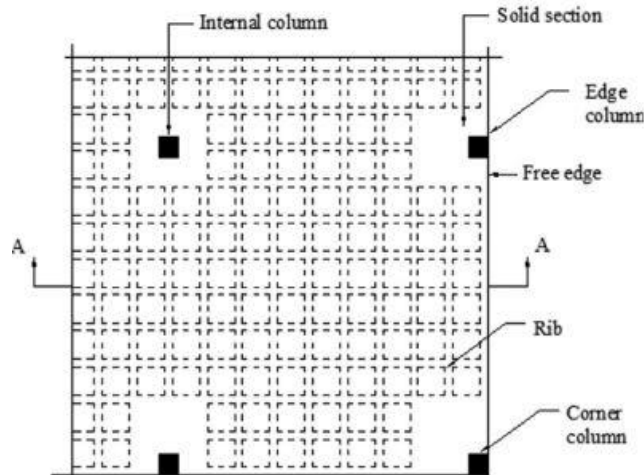


Figure 2.6: Diagram Showing Typical Waffle Slab.

A waffle slab is formed by arranging concrete joists perpendicular to each other with solid heads at columns and solid wide beam sections at column centres. This will ensure that the depth of the slab is uniform throughout. Due to its short span between the joists, waffle slabs allow a substantial reduction in dead load versus conventional flat slabs [26].

As the intermediate beam spacing of two-way beam column floor systems is usually less than about 3 meters, they can be considered waffle slab floor systems. This type of floor resembles a one-way joist floor, except the joists run in two directions [27].

There are a number of advantages to having waffle floors:

Structures with large column-to-column spans can be constructed with waffle floor systems. A waffle floor is the ideal choice for users who require level surfaces because of its high stiffness.

Conventional floors transfer loads uniformly from the slab to the beams and columns. The frame (made up of beams and columns) resists lateral forces in this floor system, whereas, in a flat floor system, there is no frame and the slab and column connection is vulnerable. As a result, punching failures of flat slabs are often caused by the transfer of shearing forces and unbalanced moments between slab and column [21].

2.2.4 Comparison between Three Different Floor Systems

There are several reinforced concrete slab types that exist in building construction., the most common ones, namely a two-way slab with beams, ribbed, waffle and flat slab types, will be. A Two-way slab with beams (columns anchored with beams) provides high diaphragm rigidity, adequate lateral displacement, and durability. Therefore, these types of slab systems are recommended for buildings located in earthquake prone areas .Ribbed and waffle slab types have many advantages. Due to the presence of voids in these slabs, the dead weight will decrease; consequently, the concrete below the neutral axis will also decrease [40].

At the connection between the slab column and the slab, the transfer of lateral displacement generates a moment. Since flat plate buildings are flexible, in high seismic regions they must be combined with a stiffer lateral force resisting system. [28].

It is demonstrated in [29] that the value of shell stresses of the flat slab is lower than that of conventional structures. According to [28] flat slab buildings exhibit superior flexibility in comparison to conventional buildings because of their thicker slabs. The stiffness of a flat slab building is higher than that of a conventional building but the ductility of the conventional building is greater. Shear and displacement are generated more frequently by flat slab construction. Conventional buildings perform better than flat slab buildings in terms of seismic performance [28].

According to [1], the flat plate system has the highest economic efficiency because it is not supported by beams. Thus, it is possible to reduce the floor height by 10-15 percent. In comparison to solid slabs, one-way ribbed slabs, and two-way ribbed slabs, the flat plate system can reduce construction costs by 7%, 4%, and 3.33%, respectively.

Compared to conventional slab structures, flat slab structures are quite lightweight. Therefore, Flat slab structure is more economical. Flat slab structures cost 15.8% less than conventional structures [18].

Uludağ evaluated RC buildings with varying slabs, spanning of 5, 6, and 7 meters as well as three different site classes. For seismically prone areas, a two-way slab with beams was recommended. A flat slab was associated with higher vibrations. Since this slab type has a

large concrete volume and a low rigidity, it is not recommended for spans greater than 5 meters. Two-way slabs with beams require less concrete than flat slabs [40].

Waffle slabs can suffer punching shear failures similar to flat slabs. To reduce punching shear with waffle slabs. In order to increase the load transfer capacity between columns and waffle slabs, one can increase the solid portion at the slab–column joint, increase the slab thickness, increase the rib width, reduce the spacing between ribs and add shear reinforcement. [30].

A waffle slab deflection is higher than that of a slab system. Thus, waffle slab systems have a greater degree of flexibility than solid slab systems. The values of deflection and steel reinforcement are increased when seismic actions are considered in the analysis. As compared to a solid slab system, a waffle slab system offers a number of advantages, including the advantage of providing a lighter and more economical slab subject to both gravitational and seismic forces, and the use of more flexible columns (columns with a smaller cross-section), as well as a greater degree of flexibility in the connection between the columns and the waffle slab [27]. Among the benefits of waffle slabs are their high stiffness and small deflection, which are necessary for structures carrying heavy loads and having long spans. Void sections within ceilings minimize load and are used for concealed architectural structures. [31]

M. Lonare [36] has stated that waffle slab systems are significantly more cost effective and lighter than solid slab systems in terms of achieving an economical, lighter structure. Additionally, research indicates that constructing a residence from a solid slab requires approximately 5.5-12% less material than one constructed from a solid slab. In comparison to the solid slab system, the waffle slab system saves 20% of concrete volume and 27% of steel reinforcement.

The waffle slab has a significantly smaller slab depth than a flat slab and other slabs, such as conventional slabs. Therefore, it is more practical to provide Waffle Slabs instead of Flat Slabs due to this decrease in slab depth. Nonetheless, Waffle Slabs would also be more convenient for execution compared with Flat Slabs. Although waffle slabs require more formwork, it can be reused many times, and the construction process is quicker. Accordingly,

Waffle Slabs are more suitable for large spans of slabs than Conventional RCC Slabs, Flat Slabs [32].

The most economical slab type for buildings with 6-m spans was a two-way slab with beams. Waffle slab was the most economical slab for buildings with 7.5 and 9-meter spans. In all cases, flat slab was found to be the most expensive type of slab in high seismic Istanbul [40].

In (4) conclude. The storey drift is minimum for waffle slab arrangement and maximum for conventional slab. The maximum storey shear force for a waffle slab system is 47.4% more than the flat slab system and 31% for the similar dimensional area of the building [41].



3. METHODOLOGY

3.1 GENERAL

The purpose of this study is to analyse the design of a 25-story building. Computer analysis is required to complete this task. In order to develop a computer model, all the geometry, properties of the elements, and the load on the structure need to be determined.

3.2 ANALYSIS BY USING COMPUTER PROGRAMS

In order to construct a high-rise building, three phases must be followed. Conceptual design entails identifying multiple concepts and selecting appropriate subsystems and configurations. Initial conceptual models are developed during the preliminary design stage. Detailed design phases conclude with the development of a complete solution for all subsystems, as well as the preparation of final drawings for the architecture, structural, electrical, and mechanical systems.

Although computer programs can be used to analyse, the engineer must still create a model that is based on input data and the input data. In addition, it is important to select the appropriate analysis procedure and type, as well as arrange the outputs in a timely manner. For large buildings or three-dimensional structures, it is often difficult to calculate the analysis calculation, and it may not be possible at all. In order to achieve a close-to-exact or reasonable value, hand-on calculations require more iterations. Software uses the same method as hand calculations but iterates or uses geometric stiffness which is nearly exact. The hand computation method differs from software that performs analysis in the following ways: Hand computation methods are suitable for small problems or structures. Even medium-sized problems are difficult to analyse. Three-dimensional analysis is nearly impossible. Error probability increases with structure size [39].

3.3 METHODOLOGY

All three cases of buildings are modelled and analysed by using ETABS software, which enables gravity loads and lateral loads (seismic) to be analysed in various combinations. According to ASCE 7-16 and ACI 318-14, both gravitational and lateral loads are measured. All calculated loads are presented in table (3.2). The amount of reinforced steel and concrete

required for the floor structure has been determined for the three cases presented in forth chapter.

3.4 MODEL DESCRIPTION

The numerical models have been developed for three cases of 25-story buildings, with a main plan model of area 27.7x27.7 meters and a secondary plan model of area 37.7x37.7 proposed for construction in Baghdad city, Iraq. . The geometrical model is identical in all cases except the floor system. In addition to an RC beam-column slab and frame system, the model also includes a core wall for access between floors. This building has a ground floor height of 4 meters and 3.5 meters, and a building height of 88.5 meters. This building structure is made of reinforced concrete and the properties of concrete and steel rebar are shown below.

Table 3.1: Material Properties for Concrete C30 and Steel fy.

Material	Young's Modulus, E (kN/mm ²)	Poisson's ratio μ	Density (KN/m ³)
Concrete C30	25.49	0.2	25
Concrete C45	31.52	0.2	25
Steel	200	0.2	76.9729

3.5 LOADS

The design loads for tall buildings may be classified as sustained or transient. The self-weight of the structure is permanent and has the highest degree of certainty, whereas superimposed loads differ based on the system. Gravity is considered sustained, whereas wind, seismic, temperature, and snow are considered temporary.

3.5.1 Gravity Loads

3.5.1.1 Live loads

Live loads in the tall building depend on the service of the building according to the ASCE 7-16 code Table 4.3-1 show live loads for different live load for the model. (L.L=2.40) for offices and this load.

3.5.1.2 Dead loads

The dead load includes Self weights of slabs columns beams, walls, partitions floor finishes.

Table 3.2: Dead Loads Values.

Load description	Value
Self-weight	Depends on the Case
floor finishes	1.25 kN/m ²
240 mm thick external wall	2 kN/m ²
125 mm thick internal wall	1 kN/m ²

3.6 LATERAL LOADS

3.6.1 Seismic Loads

Table 3.3: Seismic Load Combinations.

Num	Case of Combinations	Num	Case of Combinations
1	1.2D+.5L.L+EQX	13	0.9D+EQX
2	1.2D+.5L.L-EQX	14	0.9D-EQX
3	1.2D+.5L.L+EQY	15	0.9D+EQy
4	1.2D+.5L.L-EQY	16	0.9D-EQy
5	1.2D+.5L.L+(EQX+ecc)	17	0.9D+(EQX+ecc)
6	1.2D+.5L.L-(EQX+ecc)	18	0.9D-(EQX+ecc)
7	1.2D+.5L.L+(EQX-ecc)	19	0.9D+(EQX-ecc)
8	1.2D+.5L.L-(EQX-ecc)	20	0.9D-(EQX-ecc)
9	1.2D+.5L.L+(EQY+ecc)	21	0.9D+(EQy+ecc)
10	1.2D+.5L.L-(EQY+ecc)	22	0.9D-(EQY+ecc)
11	1.2D+.5L.L+(EQY-ecc)	23	0.9D+(EQY-ecc)
12	1.2D+.5L.L-(EQY-ecc)	24	0.9D-(EQY-ecc)

For Vertical seismic load effect

According to ASCE7-16 (12.4.2.2) [33] Vertical load effect calculate from the Equation

$$E_v = 0.2 S_{DS} D \quad (3.1)$$

This modification must apply to combination cases (5&7)

$$(1.2 + 0.2 S_{DS}) D + E + L \quad (3.2)$$

$$(0.9 - 0.2 S_{DS}) D + E \quad (3.3)$$

Equivalent Lateral Force Procedure

Find S_s & S_1 for Baghdad city from Iraqi Seismic code 2017 for Zones (III) & (II) as shown below:

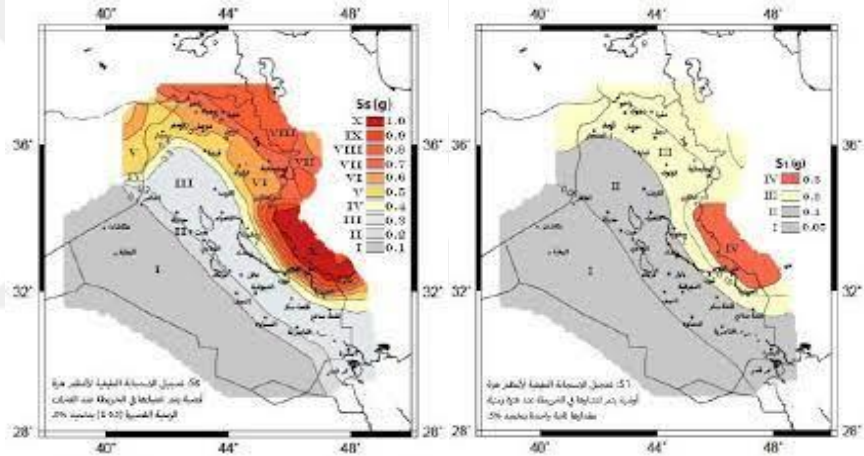


Figure 3.1: Shown Iraq Regions for S_1 & S_s .

Find Site Coefficient, F_a & F_v from Tables (11.4-2 & 11.4-1) at [33] Shown in Table

Calculate S_{DS} & S_{D1} From Equation as shown below

$$S_{DS} = \frac{2}{3} F_a S_s \quad (3.4)$$

$$S_{D1} = \frac{2}{3} F_v \quad (3.5)$$

Find R from table value shown at Table 12.2-1 [33]

Find Risk Category of the model from Table 1.5-1[33]

Find Seismic Design Category of model from table 11.61&11.6-2[33]

Find Approx. period Parameter C_t & x from Table 12.8-1[33]

Calculate value of T_a from Equation:

$$T_a = C_1 H^x \quad (3.6)$$

Find C_u from Table 12.8-1 value shown in the table

Calculate value of T_{max} from Equation:

$$T_{max} = C_u T_a \quad (3.7)$$

Check for Fundamental period " T " (s) & T_{max} to find Period time

Find C_s Factor from the Equation

$$C_s = \frac{SD_s}{\left(\frac{R}{I_e}\right)} \quad (3.8)$$

Check for C_s max & C_s min according to the Equations (12.8-3&12.86) at [33]

Calculate Seismic Base Shear

$$V = C_s W \quad (3.9)$$

Calculate Values of C_{vx} & F_x

$$F_x = C_{vx} V \quad (3.10)$$

$$C_{vx} = \frac{W_x h_x^k}{\sum_{i=1}^n W_i h_i^k} \quad (3.11)$$

Table 3.4: Seismic Effect Parameters.

Coefficient	Definition	Value
F_a	Site Coefficient	1.2
F_v	Site Coefficient	1.7
S_s		0.3
S_1	maximum considered earthquake spectral response acceleration parameter	0.1
S_{D1}	the design spectral response acceleration parameter at a period of 1.0 s	0.1
S_{DS}	The design response acceleration parameter at short period	0.26
R	Response Modification Coefficient depend on structure	5
I_e	Seismic Importance factor	1
C_t		0.047
X		0.75
T_a	The approximate fundamental period.	1.408
C_u		1.7
T_{max}		2.394
C_s	Seismic Response Coefficient	0.052
CS_{max}		0.01
CS_{min}		0.011
K	an exponent related to the structure period	1.97

3.6.2 Wind Loads

There are several Steps to find Wind pressure According to ASCE7-16[33].

Find Basic Wind Speed Form (Wind Distribution Map of Iraq) $V=31\text{m/s}$. According to ASCE7-16 the Wind speed loads should be under ultimate load depend on the return period category form the building location in Iraq risk category (II) then return period is (700 year) by applying the equation below

$$\frac{V_T}{V_{50}} = (0.36 + 0.1 \ln 12T) \quad (3.12)$$

Then find $V_T = 39.07\text{m/s}$

Find directionality factor K_d from Table 26.6-1, $K_d = 0.85$

Find Exposure Category chosen as Exposure B (Roughness B: Urban and suburban areas) Section 26.7.3 at [33]

Find topographic factor from $K_{zt} = (1 + K_1 K_2 K_3) = 1$

Find Ground Elevation factor $K_e = 1$

Find gust effect factor from section 26.11.4 $G = 0.884$ see calculation in appendix (A.1)

Enclosure classification, Building considered to be enclosed

Find internal pressure coefficient from table 26.13-1. $GC_{pi} = (+0.18, -0.18)$

Find the velocity pressure coefficient from section 26.10-1 K_z, K_h

Calculate the velocity pressure $q_z = 0.613 K_z K_{zt} K_d K_e V^2$

Find External wind coefficient (C_p) from figure 72.3-1 [33].

$L/B=1$

Windward Wall $C_p = 0.80$

Leeward Wall $C_p = -0.50$

Side Walls $C_p = -0.70$

Calculate wind pressure:

$$p = q_z G C_p - q_i (G C_{pi}) \quad (3.13)$$

Table 3.5: Load Combination of Wind.

NUM	Combination
1	1.2D+0.5LL+W
2	1.2D+0.5LL+W
3	0.9D+W
4	0.9D-W

3.7 RESPOND SPECTRUM ANALYSIS

Find Maximum considered earthquake (MCE_g) spectral response acceleration parameters

$$S_{MS} = F_a S_s \quad (3.14)$$

$$S_{M1} = F_y S_1 \quad (3.15)$$

Design spectral acceleration parameters

$$S_{DS} = \frac{2}{3} S_{MS} \quad (3.16)$$

$$S_{D1} = \frac{2}{3} S_{M1} \quad (3.17)$$

Design response spectrum curve

For T less than T₀, Sa Values find from

$$S_a = S_{DS} = (0.34 + 0.6 \frac{T}{T_0}) \quad (3.18)$$

For T greater than T_s and less or equals to T_l from

$$S_a = \frac{S_{D1}}{T} \quad (3.19)$$

T greater than Ts find S_a by equation

$$S_a = \frac{S_{D1}T_L}{T^2} \quad (3.20)$$

$$T_0 = 0.2\left(\frac{S_{D1}}{S_{DS}}\right) \quad (3.21)$$

$$T_S = \frac{S_{D1}}{S_{DS}} \quad (3.22)$$

From Equation above table show the value of the parameters

Table 3.6: Response Spectrum Curve Parameters.

Parameter	Definition	Value
S_a	The design Spectral response Acceleration	In figure
S_{DS}	The design Spectral response Acceleration parameter at short period	0.1
S_{D1}	The design Spectral response Acceleration parameter at 1-s period	0.26
S_{MS}	MCE_g - spectral response acceleration parameters at short period	0.39
S_{M1}	MCE_g spectral response acceleration parameters at 1-s period	0.15
T_0	From equation above	0.077
T_S	From equation above	0.385
T_L	Long period transition periods	5
T	The fundamental period of the structure	

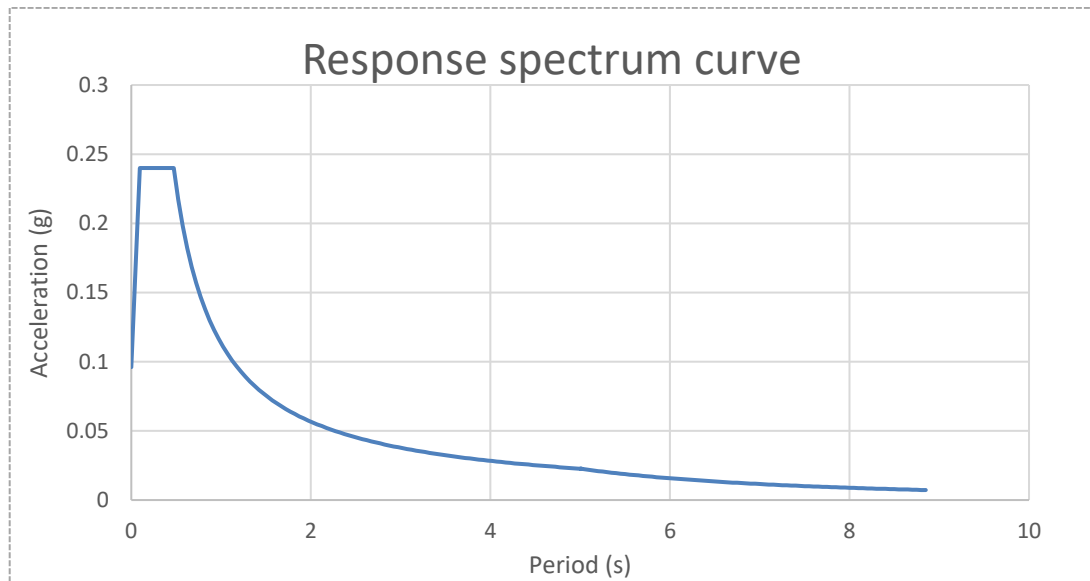


Figure 3.2: Design Response Spectrum Curve.

4. MODELLING AND CASE STUDY

4.1 CASE STUDY (1) CONVENTIONAL FLOOR FOR MODEL (6.3-5.5-5.2)

The building modelled for all three cases of spans (6.3-5.5-5.2) m with configuration of columns dimensions (1200x700mm) and outer beams dimensions (800x500mm) shear wall thickness (360mm).

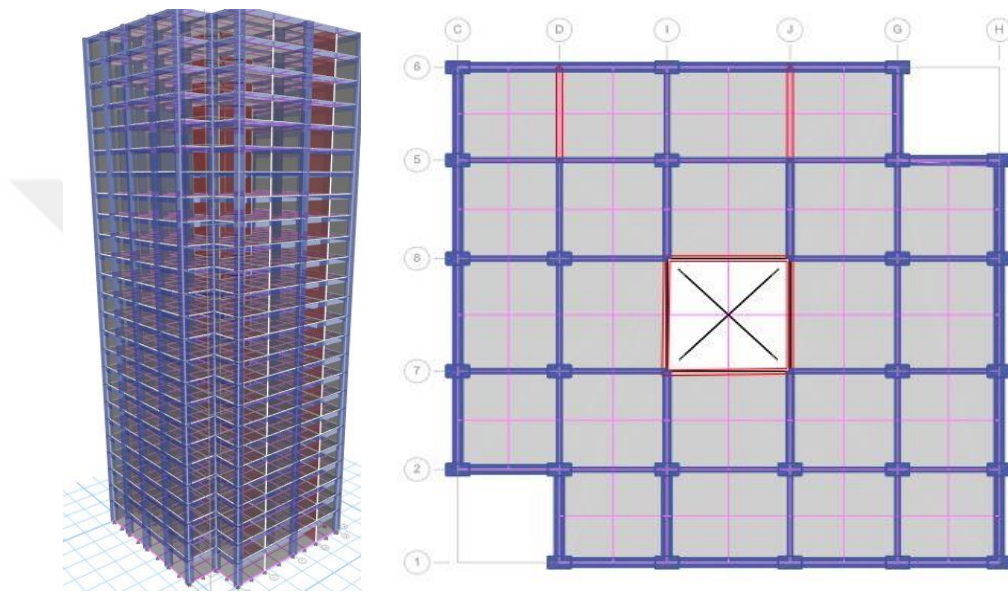


Figure 4.1: Conventional Floor Model Isometric & Plan View Model (6.3-5.5-5.2).

Table 4.1: Case Study 1 Parameters for Model (6.3-5.5-5.2).

Building weight "W" (KN)	248320.5814	
Height (m)	88.5	
Cu	1.7	ASCE Table 12.8-2
T _{max}	2.394	TaxCu
Cs	0.058	ASCE Section 12.8.11
Cs _{max}	0.009	
Fundamental period "T" (s) X-direction (sec)	4.285	
Fundamental period "T" (s) Y-direction(sec)	3.741	

4.1.1 Checking Critical Case

4.1.1.1 Seismic loads

By applying the procedure shown in the section (3.6.1) steps (1-15) and using the table (4.1) for Case-1 data, the seismic loads force calculated in (X&Y) Direction the results shown in the Appendix (A.2.1) where maximum seismic force is {302 KN} at story 24.

Since $T_{max} < T_{used}$ use T_{max} And used $C_s_{max} < C_s_{used}$

4.1.1.2 Wind loads

By applying the procedure shown in the section (3.6.2) steps (1-13) and find K_z for different height. See Appendix (A.1) Comparing the effect of the Wind forces and seismic loads to find critical case for the lateral forces

Table 4.2: Critical Case for Seismic and Wind Loads Effect Model (6.3-5.5-5.2).

Case	Base reaction (Fy)	Base reaction (Fx)
	KN	KN
Seismic in -x (EX)	-2840.7875	0
Seismic in -y (EY)	0	-2840.7875
Wind1	-2470.79	0
Wind2	0	-2470.79
Wind3	-1853.09	0
Wind4	-1853.09	0
Wind5	0	-1853.09
Wind6	0	-1853.09
Wind7	-1853.09	1853.09
Wind8	-1853.1	-1853.09
Wind9	-1391.06	1391.06
Wind10	-1391.06	1391.06
Wind11	-1391.06	-1391.06
Wind12	-1391.06	-1391.06

4.1.2 Checking Building under Lateral Forces Effect

4.1.2.1 Checking story drift

As shown in Appendix (A.2.2) the drift & displacement were calculated for each story All Values satisfied with allowable drift value. Where maximum displacement (126.8mm).

4.1.2.2 Checking rigidity of structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity from Appendix (A.2.3) all Values of Eccentricity Ratio are less than 15%, therefore the building are satisfied allowable ratio where maximum eccentricity ratio (5.1%).

4.1.2.3 Checking for Amplification of accidental torsional moment & torsional irregularity

Torsion amplification were calculated for each story and as shown in Appendix (A.2.4) where values that exceed ($A_x > 1$) at Story (1&2) in Y- direction, modification factor for these cases must be considered: For Story 1 =1.5, For Story 1 =1.8 .From section (12.8.7) at ASCE7-16 [33] where A_x not exceed 1.2 don't consider torsion irregularity.

4.1.2.4 P-Delta effects

From Appendix (A.2.5) stability coefficient (θ) were calculated for each story and as shown in table below where ($1 < \theta < \theta_{max}$) in each direction therefore, P-Delta Effects should be consider in design $\theta_{max}=0.111$.

4.1.3 Floor Design

Design for selected panels (6.3x5.5) in story 10 as shown in figure bellow

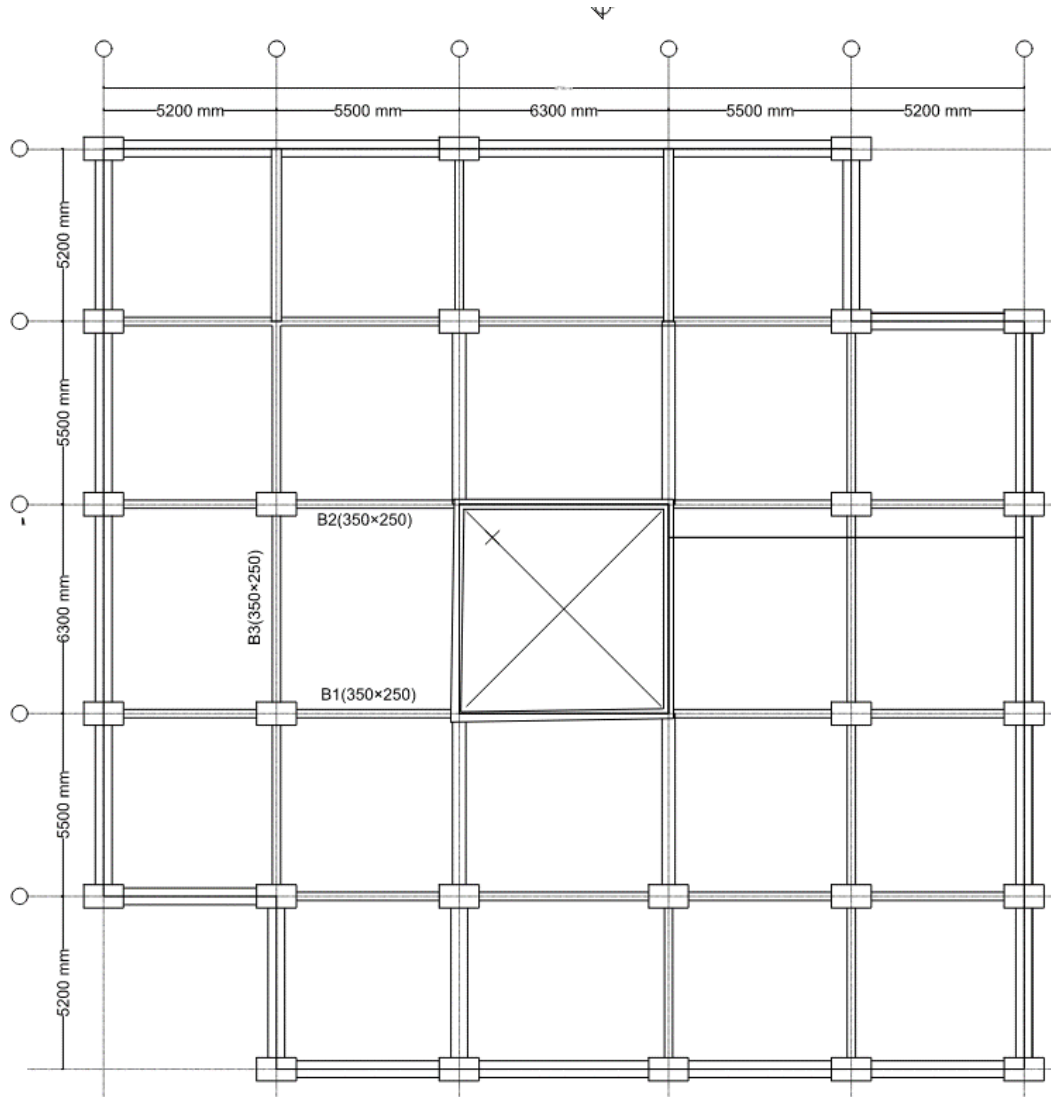


Figure 4.2: Showing Internal Beams of Conventional Floor (B1, B2, B3) Model (6.3-5.5-5.2).

4.1.3.1 Design for internal beams

Check the minimum beam depth requirement of ACI 318-14 [35] (Table 9.3.1.1)

$$h_{\min} = \frac{L_n}{18.5} = \frac{6.3}{18.5} = 340.5 \approx 350 \text{ mm} \quad (4.1)$$

$h_{\min} = 500 \text{ mm}$ for span 6.3 m

$b_{\min}$ between $(1/2 b_{\min}, 2/3 b_{\min})$

Take $b_1 = 250 \text{ mm}$ & $b_2 = 400 \text{ mm}$ for beam span 6.3 m

Beams dimensions B1&B2 &B3 (350x250)

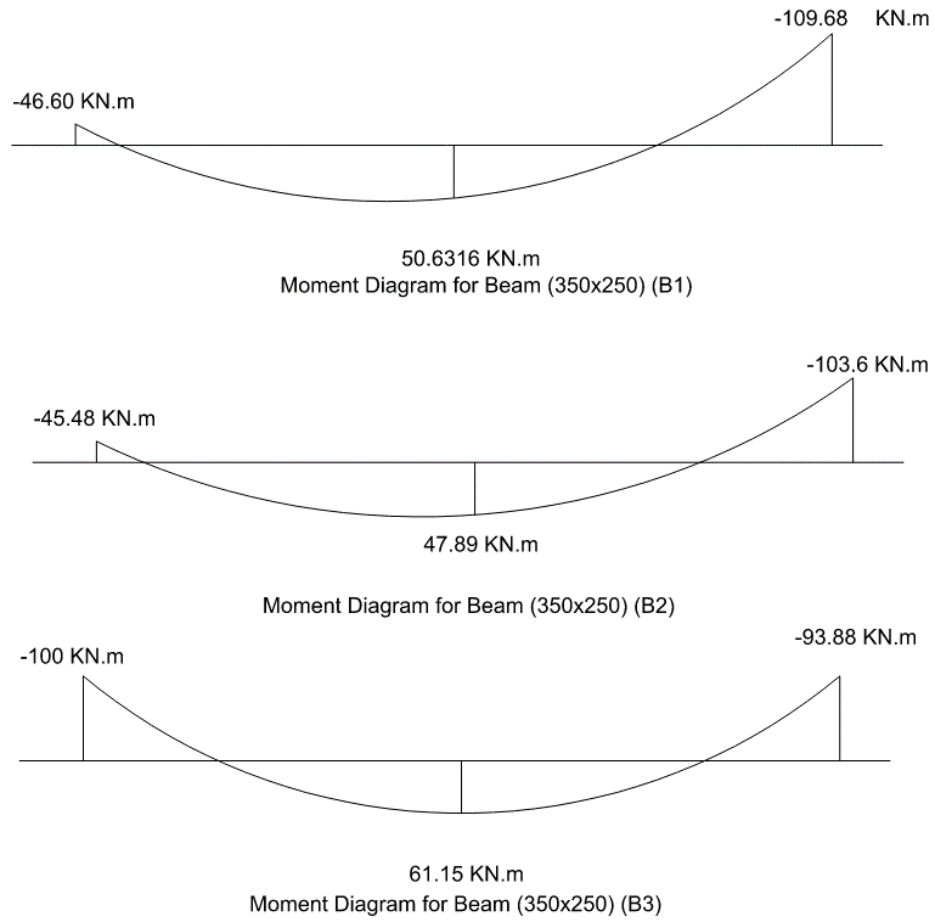


Figure 4.3: Showing Moment Diagram for Internal Beams (B1, B2, B3) model (6.3-5.5-5.2).

From ACI 318-14 (Table 20.6.1.3.1).

Find $d = h - (c.c + \text{strup} + D_b/2)$ Take $\phi = 0.9$, $j d = 0.889 \times d$

$$A_s = \frac{M_u}{\phi \times f_y \times j d} \quad (4.2)$$

$$a = \frac{A_s \times f_y}{f_c \times b} \quad (4.3)$$

$$\beta = 0.85 - \frac{0.05(f_c - 28)}{7} \quad (4.4)$$

$$c = \frac{a}{\beta}, \epsilon_t = \left(\frac{d-c}{c}\right) 0.003 \quad (4.5)$$

$$M_d = A_s \phi \times f_y \times \left(d - \frac{a}{2}\right) \quad (4.6)$$

Moment values of Beams for Story-10

Therefore Check $M_d = \phi Mu$

$$A_{s_{min}} = \frac{0.25 \times \sqrt{f_c}}{f_y} \times b \times d \quad (4.7)$$

$$A_{s_{min}} = \frac{1.4}{f_y} \times b \times d \quad (4.8)$$

Table 4.3: Steel Area of Beams (B&B2&B3) Model (6.3-5.5-5.2).

B1(350x250)	Location	MU	Md	a	β	c	A _s
Top	M(-)	45.47	51.23	30.17	0.84	33.11	420
	M(-)	10.33	16.77	16.47	0.84	19.71	250
	M(-)	103.80	116.94	74.45	0.84	89.08	1130
Bottom	M(+)	20.67	28.61	16.47	0.84	19.71	250
	M(+)	47.89	53.98	31.89	0.84	38.16	484
	M(+)	10.83	16.77	16.47	0.84	19.71	250
B2(350x250)	Location	MU	Md	a	β	c	AS
Top	M(-)	46.50	51.34	30.24	0.8357	36.18	459
	M(-)	27.40	30.94	17.85	0.8357	21.36	271
	M(-)	109.68	115.06	73.06	0.8357	87.43	1109
Bottom	M(+)	27.42	30.94	17.85	0.8357	21.36	271
	M(+)	50.63	57.14	33.86	0.8357	40.52	514
	M(+)	54.84	61.82	36.83	0.8357	44.07	559
B3(350x250)	Location	MU	Md	a	β	c	AS
Top	M(-)	100.00	112.89	71.48	0.8357	85.53	1085
	M(-)	25.00	28.61	16.47	0.8357	19.71	250
	M(-)	93.88	105.94	66.48	0.8357	79.54	1009
Bottom	M(+)	50.00	56.40	33.40	0.8357	39.97	507
	M(+)	62.70	70.75	42.56	0.8357	50.93	646
	M(+)	48.94	52.92	31.23	0.8357	37.37	474

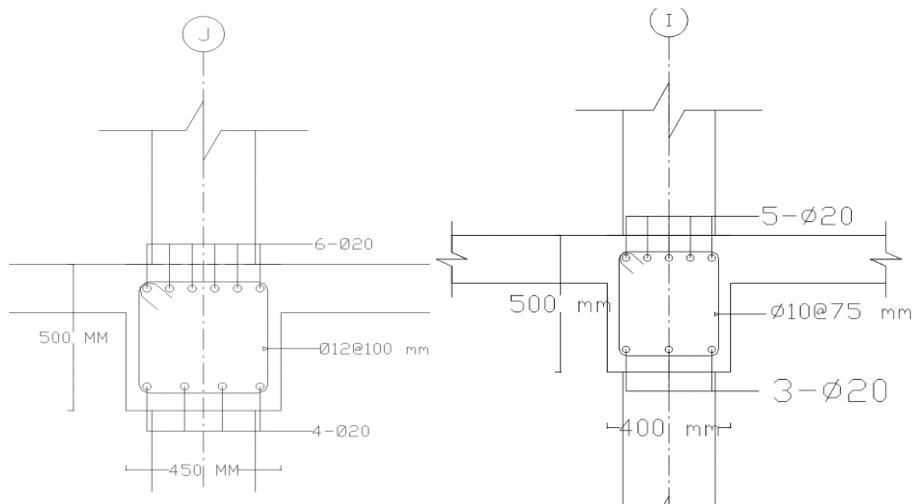


Figure 4.4: Show Steel Reinforcement Details for Span 6.3 m Beams Model (6.3-5.5-5.2).

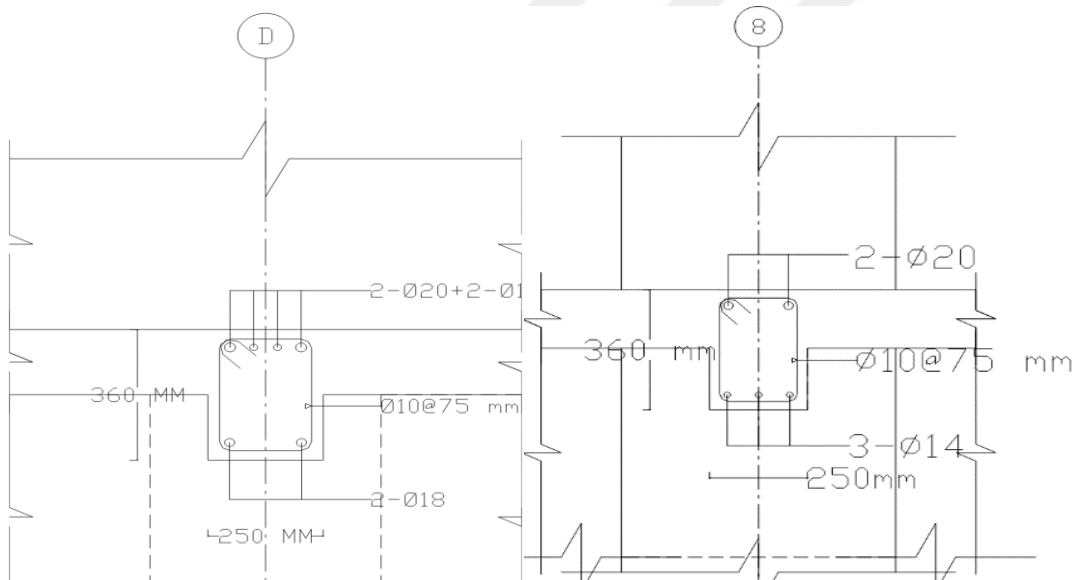


Figure 4.5: Show Steel Reinforcement Detail for Beam (B1&B2&B3) Model (6.3-5.5-5.2).

4.1.3.2 Design slab

Check slab thickness for panel (6.3×5.2)

Find

$$\alpha_f = \frac{E_{cb} I_b}{E_{cs} I_s} \quad (4.9)$$

$$\alpha_{fm} = \frac{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}{4} \quad (4.10)$$

Check if $0.2 < \alpha_{fm} < 2$

Find minimum slab thickness from ACI-14 Table 8.3.1.2

$$\beta = \frac{L_{Long}}{L_{short}} = \frac{6.3}{5.2} = 1.21 \quad (4.11)$$

$\alpha_{fm} > 2$ then

$$h_{min} = \frac{Ln(0.8 + \frac{f_y}{1400})}{36 + 9\beta} \geq 90mm \quad (4.12)$$

To check for panel (6.5×5.5) maximum deflection has been consider to determine the slab thickness

Slab thickness has been increased to (h=165mm) consider to be most economical solution

Divide the slab to column strip & field strip as shown below

Width of strips

$$\text{Width of column strip} = \frac{L_s}{2} = \frac{5.2}{2} = 2.6m$$

$$\text{Width of field strip -Long direction} = L_s - \frac{L_s}{2} = 5.2 - \frac{5.2}{2} = 2.65m$$

$$\text{Width of field strip -Short direction} = L_l - \frac{L_s}{2} = 6.3 - \frac{5.3}{2} = 3.55m$$

4.1.3.3 Check deflection

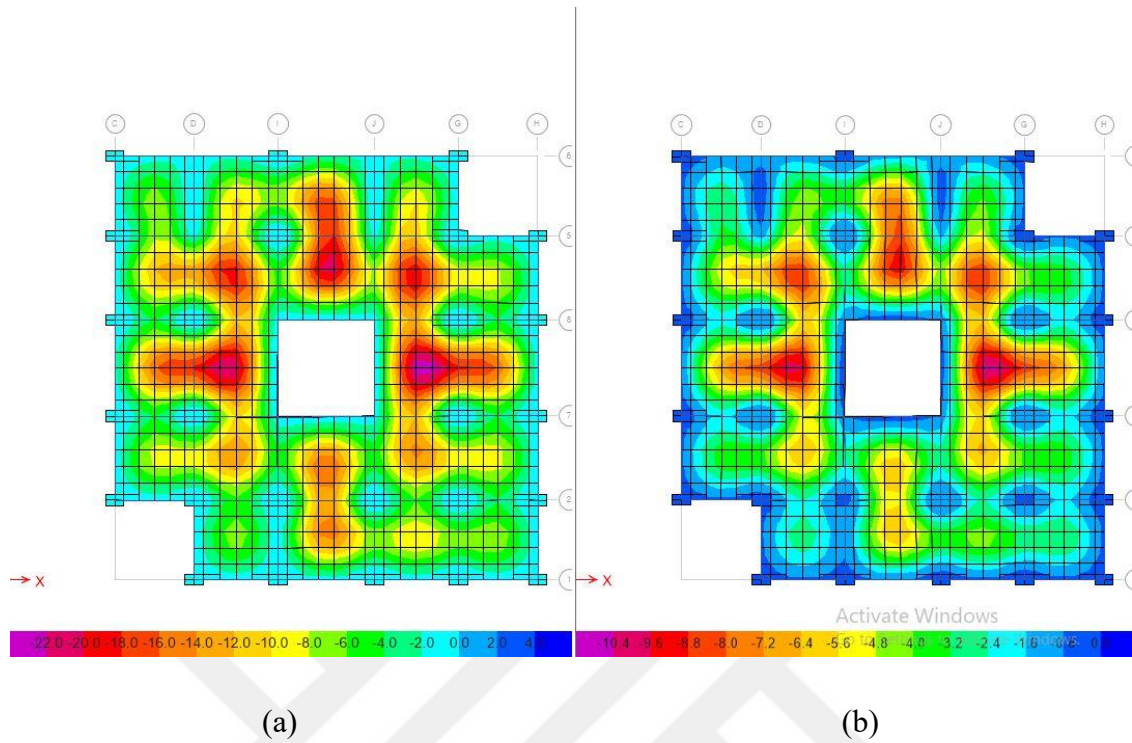


Figure 4.6: (a) Show Long-Term Deflection, (b) Show Immediate- Term Deflection.

Figure shown values of immediate and Long-term deflection and comparing to the allowable values

$$\frac{L}{360} \text{ For immediate deflection}$$

$$\frac{L}{240} \text{ For Long-term deflection}$$

Table 4.5: Deflection Values for Conventional Floor Model (6.3-5.5-5.2).

	Floor deflection(mm)	Allowable deflection(mm)
Short term deflection(mm)	-10.4	-17.6
Long term deflection(mm)	-22	-26.25

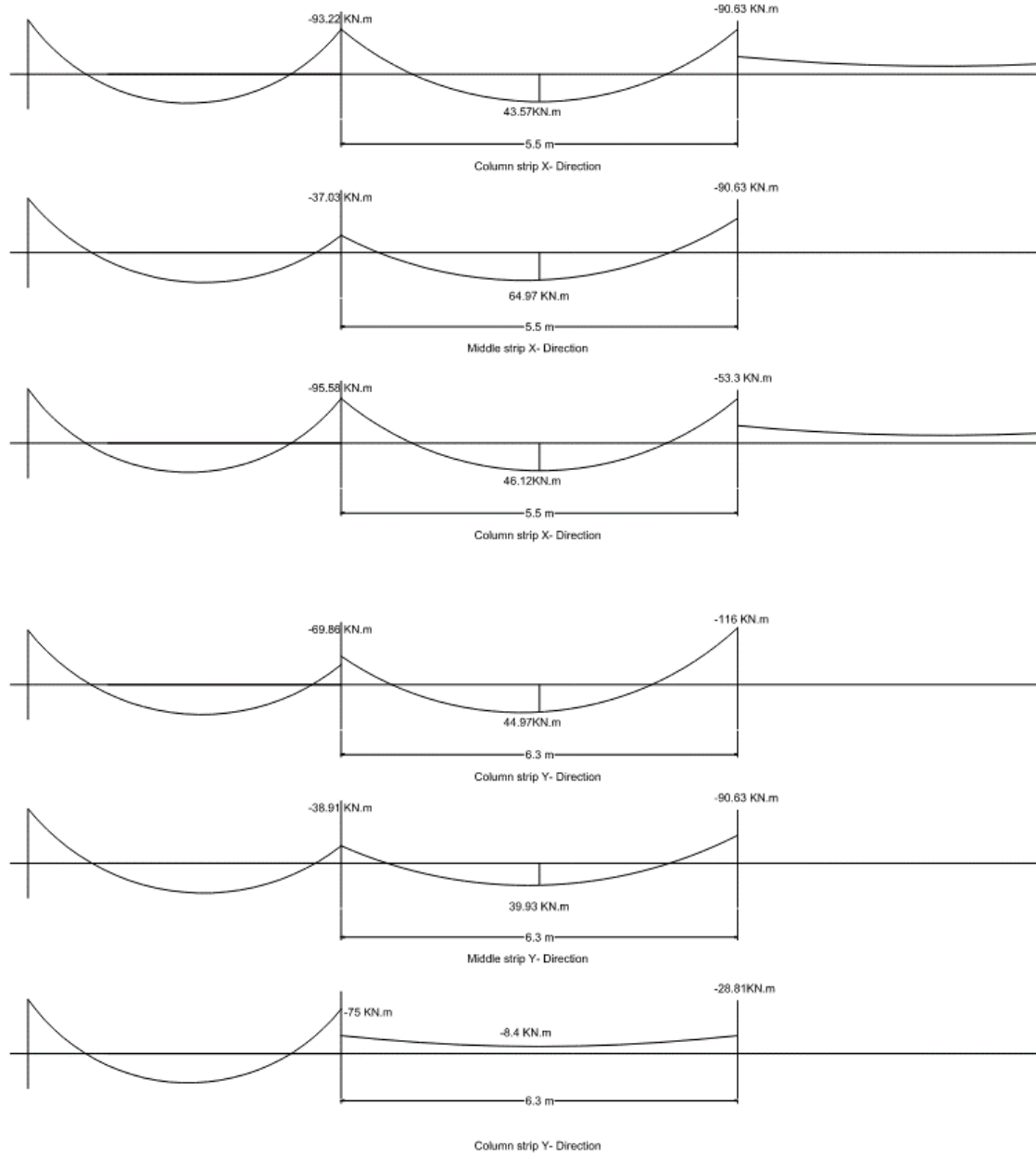


Figure 4.7: Bending Moment Diagram for The Convention Floor Model (6.3-5.5-5.2).

4.1.3.4 Design for the panel (6.3m x5.5m)

$$A_{s \min} = 0.002 \times 1000 \times d = 280 \text{ mm}^2 \quad (4.13)$$

$$\rho_{\min - \text{long}} = \frac{280}{97} = 0.0028 \quad (4.14)$$

$$\rho_{\min - \text{long}} = \frac{280}{97} = 0.0025 \quad (4.15)$$

$$R_u = \frac{Mu}{\phi bd^2} \quad (4.16)$$

$$\rho = \frac{1}{m} \left[1 - \sqrt{1 - \frac{2R_u m}{f_y}} \right] \quad (4.17)$$

$$m = \frac{f_y}{0.85 \times f_c} \quad (4.18)$$

$$A_s = \rho \times bd \quad (4.19)$$

Table 4.6: Steel Reinforcement Table for Panel (6.3x5.5) for Conventional Floor (6.3-5.5-5.2).

Span	Cross-section	Location	Moment	RU	p	A _s	Reinforcement	Additional
span 5.5 m	Column strip	M(-)	93.22	3.85104765	0.00999125	1639	Ø18@400	Ø18@400
		M(+)	43.57	1.79993720	0.004448537	730	Ø14@270	
		M(-)	90.63	3.74405116	0.009687227	1589	Ø18@350	Ø18@400
	Middle strip	M(-)	37.03	1.52976072	0.00375863	300	Ø10@270	
		M(+)	64.97	2.68400092	0.006767666	1110	Ø12@190	
		M(-)	90.63	3.74405116	0.009687227	2150	Ø16@270	
	Column strip	M(-)	95.68	3.95267367	0.01028171	4667	Ø18@400	Ø18@500
		M(+)	46.12	1.90528124	0.004719841	774	Ø14@270	
		M(-)	53.3	2.20189701	0.005490907	901	Ø16@350	Ø10@350
span 6.3 m	Column strip	M(-)	111	4.58556414	0.012129657	4913	Ø18@400	Ø18@500
		M(+)	55.97	2.31219842	0.0057804	948	Ø14@350	
		M(-)	116	4.79212109	0.01274818	4885	Ø18@350	Ø18@350
	Middle strip	M(-)	52.1	2.15232335	0.00536129	993	Ø16@350	
		M(+)	38.3	1.58222618	0.003891947	638	Ø12@300	
		M(-)	50.3	2.07796285	0.005167432	889	Ø16@350	
	Column strip	M(-)	75.1	3.10248529	0.007900959	1296	Ø18@350	Ø18@350
		M(+)	8.4	0.34701566	0.000831927	136	Ø10@350	
		M(-)	29.81	1.23149249	0.003006568	493	Ø10@350	Ø18@350

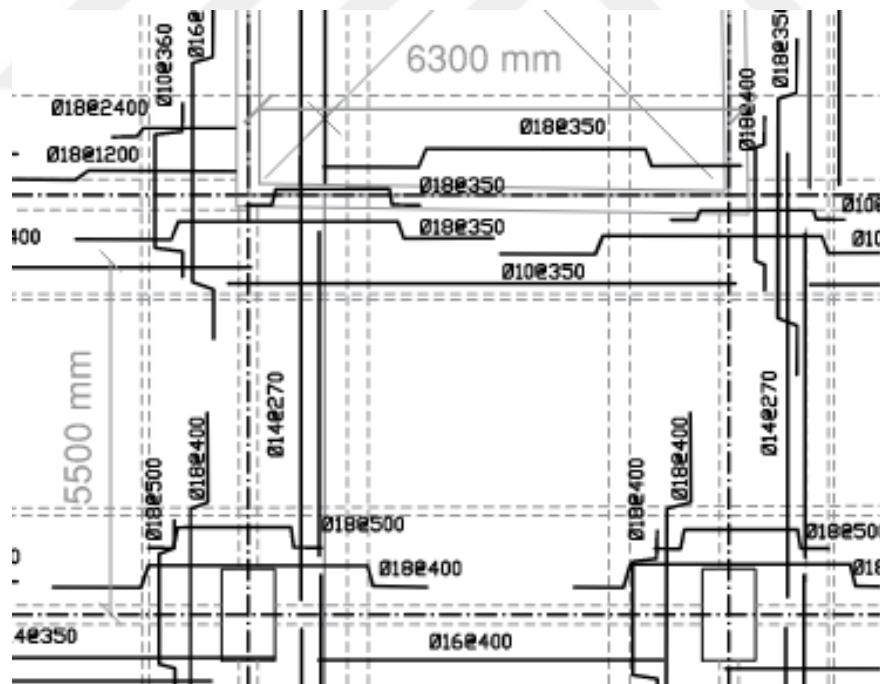
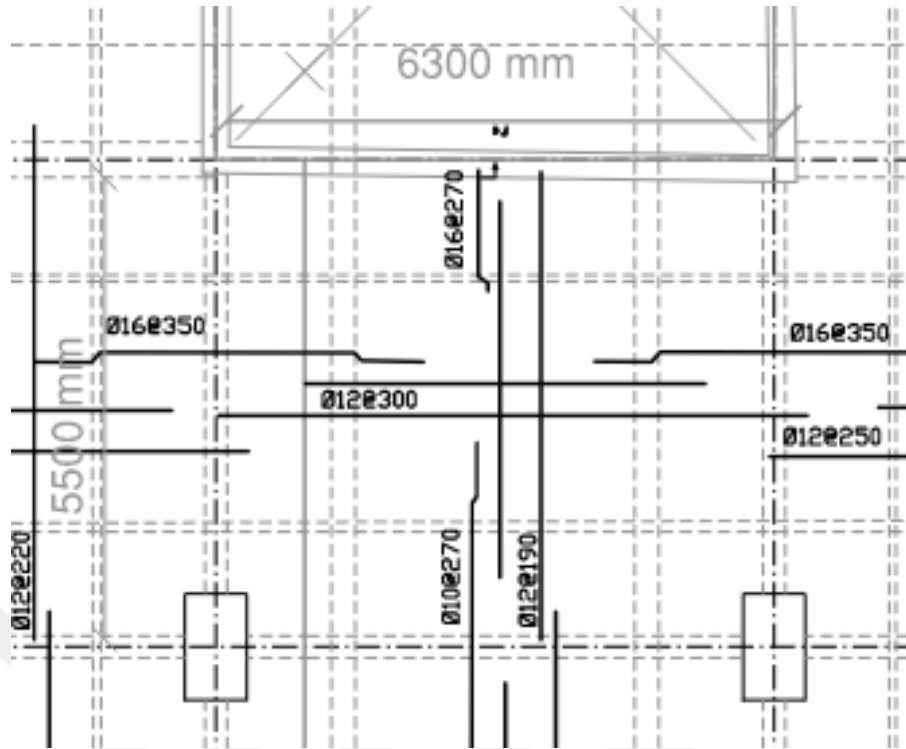


Figure 4.9: Column strip Steel Reinforcement Details for Panel (6.3x5.5) Model (6.3-5.5-5.2).

4.2 CASE STUDY (2) FLAT FLOOR FOR MODEL (6.3-5.5-5.2)

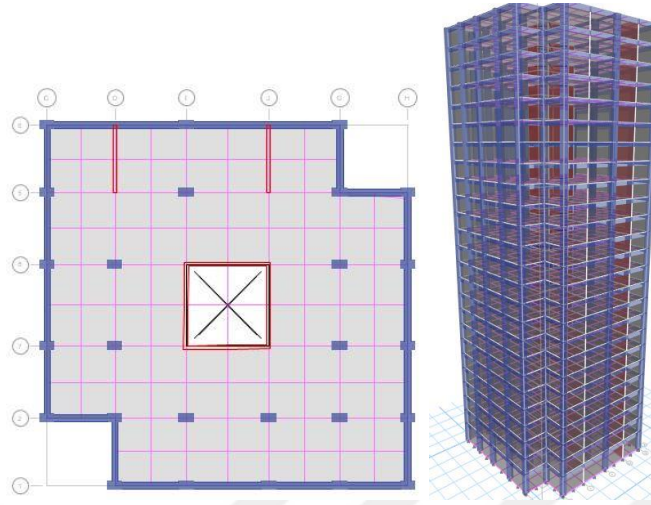


Figure 4.10: Flat Floor Model Isometric & Plan View Model (6.3-5.5-5.2).

Table 4.7: Flat Floor Model Parameters & Properties Model (6.3-5.5-5.2).

Building weight "W" (KN)	250148.6978	
Height (m)	88.5	
Upper limit period Parameter "Cu"	1.7	ASCE Table 12.8-2
T _{max}	2.394	T _a × Cu
Seismic response coefficient "Cs"	0.052	ASCE Section 12.8.11
Maximum Seismic response coefficient Cs _{max}	0.008	ASCE Eq.12.8-3
Fundamental period "T" (s) X-direction (sec)	4.49	
Fundamental period "T" (s) Y-direction(sec)	4.17	
Approximate fundamental period "Ta"	1.408	

4.2.1 Checking Critical Case

4.2.1.1 Seismic loads

By applying the procedure shown in the section (3.6.1) steps (1-15) and using the table (4.2) for Case-2 data, the seismic loads force calculated in (X&Y)Direction the results shown in the Appendix(A.2.1)where maximum seismic force is{300 KN) at story 24

Since $T_{max} < T_{used}$ use T_{max} And used $C_s_{max} < C_s_{used}$

4.2.1.2 Wind loads

By applying the procedure shown in the section (3.6.2) steps (1-13). See Appendix (A.1)

Comparing the effect of the Wind forces and seismic loads to find critical case for the lateral forces

Table 4.8: Critical Case for Seismic and Wind Loads Effect for Flat Floor.

Case	Base reaction (Fy)	Base reaction (Fx)
	KN	KN
seismic in -x (EX)	-2861.7011	0.00
seismic in -y (EY)	0.00	-2861.7011
Wind1	-2470.79	0.00
Wind2	0.00	-2470.78
Wind3	-1853.09	0.00
Wind4	-1853.09	0.00
Wind5	0.00	-1853.09
Wind6	0.00	-1853.09
Wind7	-1853.09	1853.09
Wind8	-1853.09	-1853.09
Wind9	-1391.06	1391.05
Wind10	-1391.06	1391.05
Wind11	-1391.06	-1391.05
Wind12	-1391.06	-1391.05

4.2.2 Checking Building under Lateral Forces Effect

4.2.2.1 Checking story drift

As shown in Appendix (A.2.2) the drift & displacement were calculated for each story All Values satisfied with allowable drift value. Where maximum displacement (139.3mm).

4.2.2.2 Checking rigidity of structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity from Appendix (A.2.3) all Values of Eccentricity Ratio are less than 15%, therefore the building are satisfied allowable ratio where maximum eccentricity ratio (5.85%).

4.2.2.3 Checking for amplification of accidental torsional moment & torsional irregularity

Torsion amplification were calculated for each story and as shown in Appendix (A.2.4) where values that exceed ($A_x > 1$) at Story (1&2) , in Y- direction, modification factor For Story 1 =1.5, For Story 2 =1.71 ,in X- direction, modification factor For Story 1 =1.14 From section (12.8.7) at ASCE7-16 [33] where A_x not exceed 1.2 don't consider torsion irregularity.

4.2.2.4 P-Delta effects

From Appendix (A.2.5) stability coefficient (θ) were calculated for each story and as shown in table below where ($1 < \theta < \theta_{max}$) in each direction therefore, P-Delta Effects should be consider in design $\theta_{max}=0.111$.

4.2.3 Floor Design

Determine the slab thickness

From ACI 318-14 (Table 8.3.1.1) [35]

$$h = \frac{Ln}{33} = \frac{5.7}{33} = 172 \approx 195mm \quad \text{Thickness increased to cope with Punching shear failure}$$

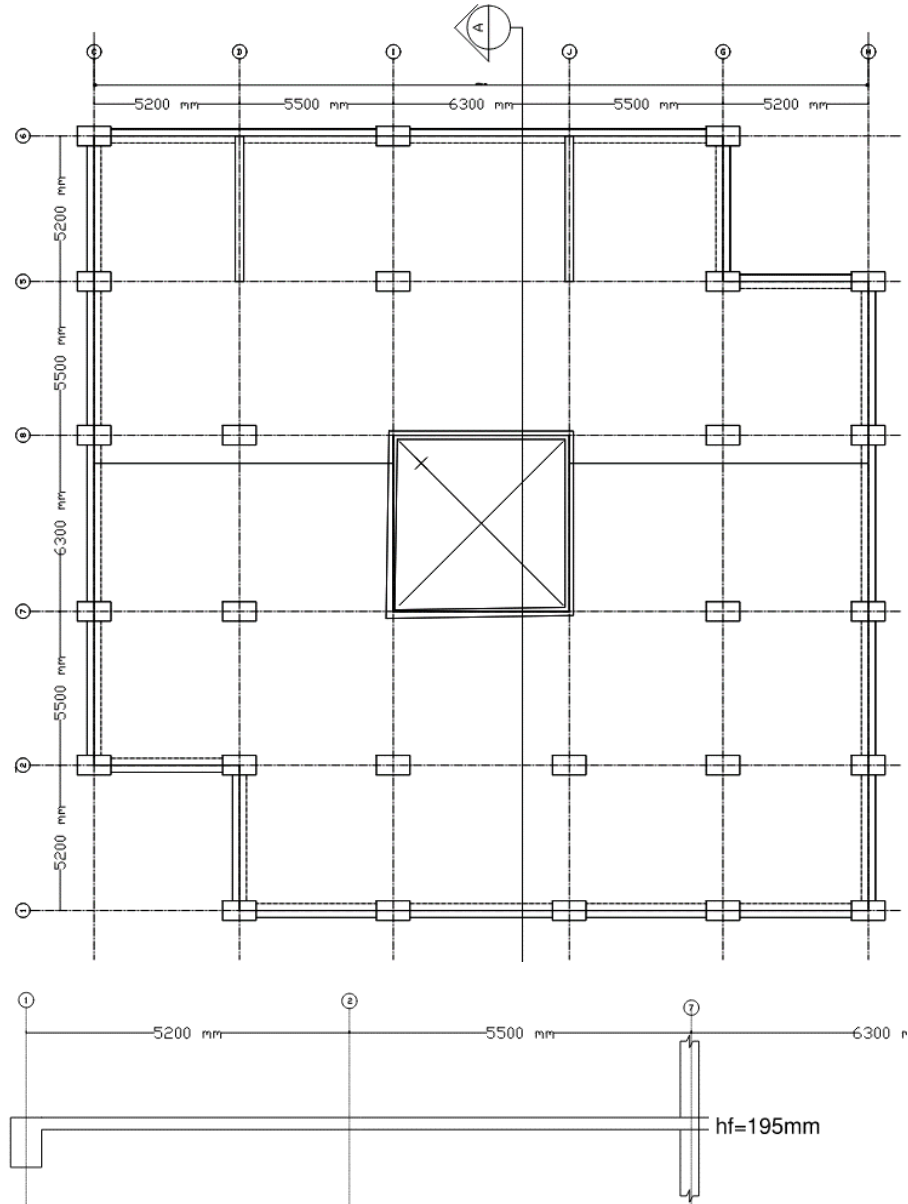


Figure 4.11: Framework Plan for Flat Floor Model (6.3-5.5-5.2).

4.2.3.1 Slab shear strength – check for punching

The applied shear stress is calculated as

$$v_u = \frac{V_u}{b_0 d} \pm \frac{\gamma_1 M_{u1} C_1}{J_{C1}} \pm \frac{\gamma_2 M_{u2} C_2}{J_{C2}} \quad (4.20)$$

M_u =unbalanced moment

J_C =an effective polar moment

b_0 =Effective shear Perimeter

d =Effective slab thickness

Slab shear strength (V_c) taken smallest value of equations below ACI 318-14 (Table 22.6.5.2(a))

$$V_c = 0.33\sqrt{f_c}b_0d \quad (4.21)$$

$$V_c = 0.17 \left(1 + \frac{2}{\beta}\right)\sqrt{f_c}b_0d \quad (4.22)$$

$$V_c = 0.083 \left(2 + \frac{d}{b_0}\alpha_s\right)\lambda\sqrt{f_c}b_0d \quad (4.23)$$

β = Ratio of long side to short side of columns

α_s = Column coefficient depend on the Exterior or Interior columns

Table 4.9: Parameters of Columns (C1&C2) of Flat Floor Case Model (6.3-5.5-5.2).

Column	Mu1 KN.m	Mu2 KN.m	γ_1	γ_2	I1 cm4	I2 cm4	Vu MPa	Vc Mpa	Vu/Vc %
C1	20.46	1.15	0.34597	0.45657	889437.5	17845313	0.98	1.15	0.85
C2	25.56	16.62	0.34597	0.45657	889437.5	17845313	1	1.15	0.87

4.2.3.2 Checking deflection

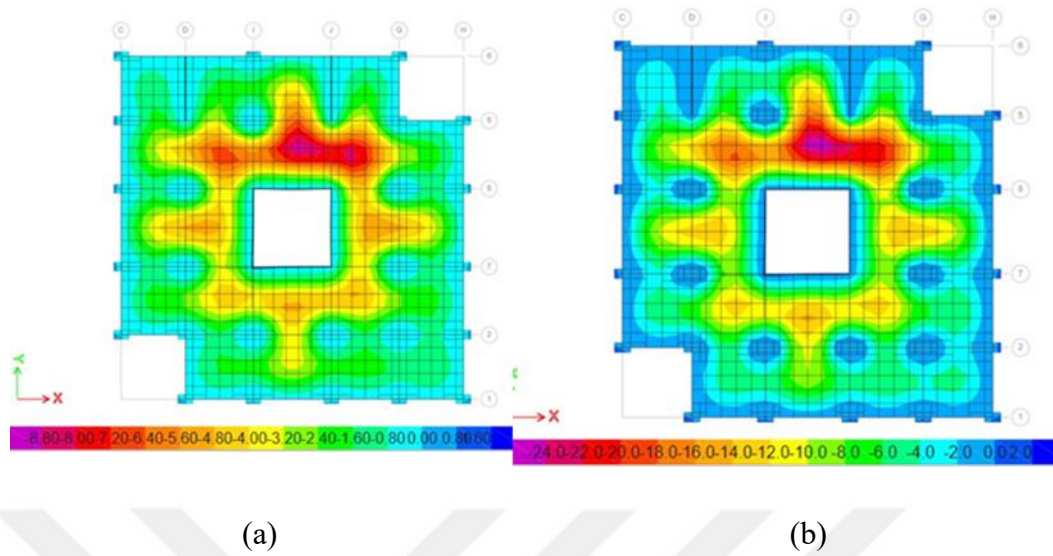


Figure 4.12: (a) Show Immediate Deflection, (b) Show Long- Term Deflection Model (6.3-5.5-5.2).

Figure shown values of immediate and Long-term deflection and comparing to the allowable values. From same values in section (4.1.3.3).

Table 4.10: Short Term Deflection& Long Term Deflection Model (6.3-5.5-5.2).

	Floor deflection(mm)	Allowable deflection(mm)
Short term deflection(mm)	-8.72	-17.5
Long term deflection(mm)	-25.59	-26.25

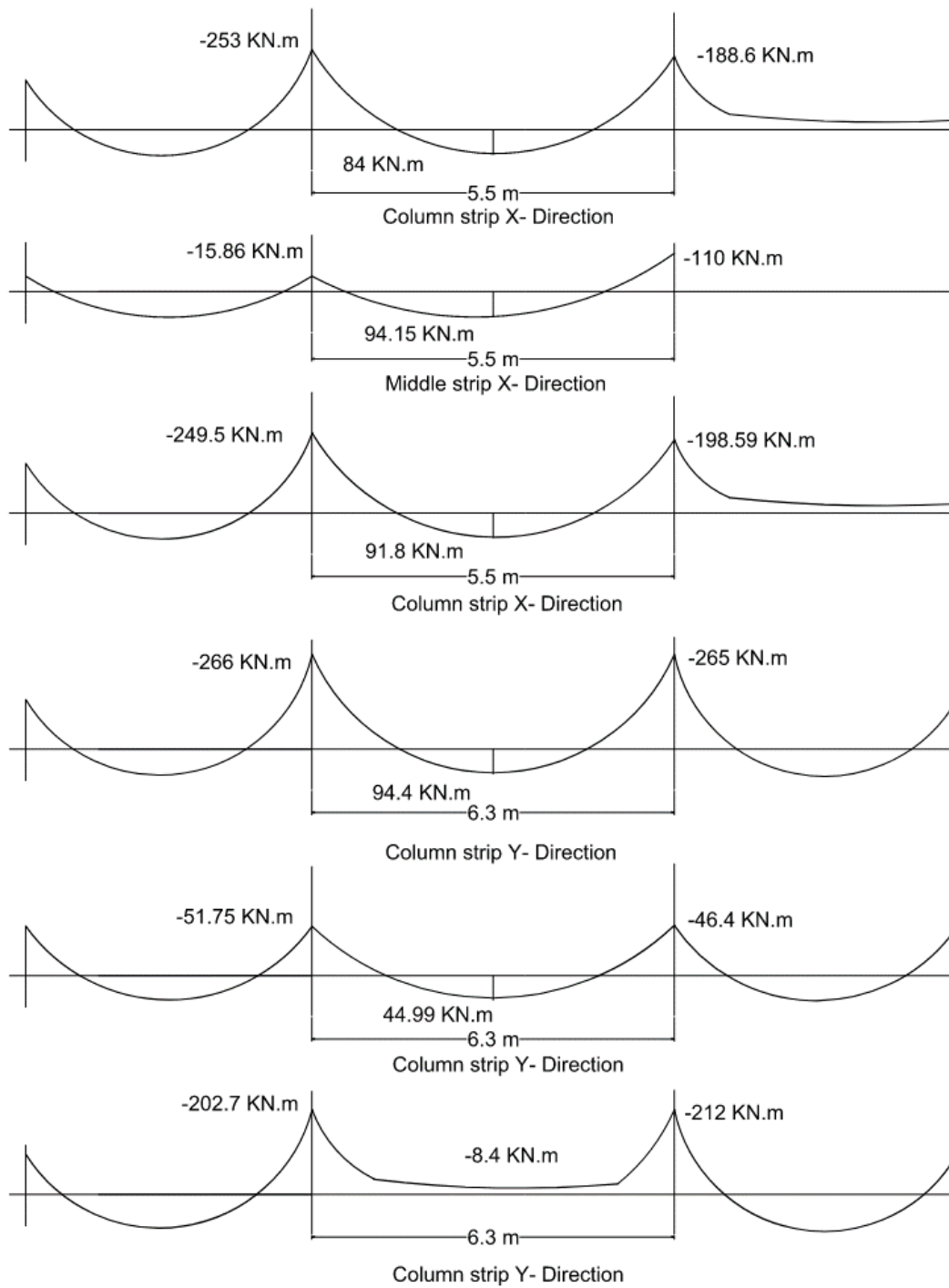


Figure 4.13: Showing Bending Moment Diagram for Panel (6.3×5.5) for Flat Floor (6.3-5.5-5.2).

4.2.3.3 Design for the panel (6.3m x5.5m)

Same procedure as section (4.1.3.4)

Table 4.11: Steel Reinforcement Table For Panel; (6.3x5.5) For Flat Floor Model (6.3-5.5-5.2).

Span	Cross-section	Location	Moment	RU	p	AS	Reinforcement	Additional
span5.5 m	Column strip	M(-)	253	10.45178	0.034937	5730	Ø18@270	Ø18@240
		M(+)	84	3.470157	0.008917	1462	Ø16@220	
		M(-)	188.6	7.791328	0.022851	3748	Ø18@220	Ø18@220
	Middle strip	M(-)	15.86	0.655199	0.001581	259	Ø10@300	
		M(+)	94.15	3.889467	0.010101	1657	Ø12@150	
		M(-)	110	4.544253	0.012007	1969	Ø12@130	
	Column strip	M(-)	249.6	10.31132	0.034161	5602	Ø18@240	Ø18@220
		M(+)	91.8	3.792385	0.009824	1611	Ø16@220	
		M(-)	198.59	8.204029	0.024461	4012	Ø18@220	Ø18@270
span6.3 m	Column strip	M(-)	266.2	10.99709	0.038202	9530	Ø18@220	Ø18@220
		M(+)	94.4	3.899795	0.01013	1661	Ø16@220	
		M(-)	265	10.94752	0.037886	6213	Ø18@220	Ø18@220
	Middle strip	M(-)	51.5	2.127537	0.005297	869	Ø16@300	
		M(+)	44.99	1.858599	0.004599	754	Ø12@270	
		M(-)	46.4	1.916848	0.00475	779	Ø14@300	
	Column strip	M(-)	202.7	8.373818	0.025144	4124	Ø18@160	Ø18@360
		M(-)	8.4	0.347016	0.000832	136	Ø18@160	
		M(-)	212	8.758014	0.026742	4386	Ø18@160	Ø18@360

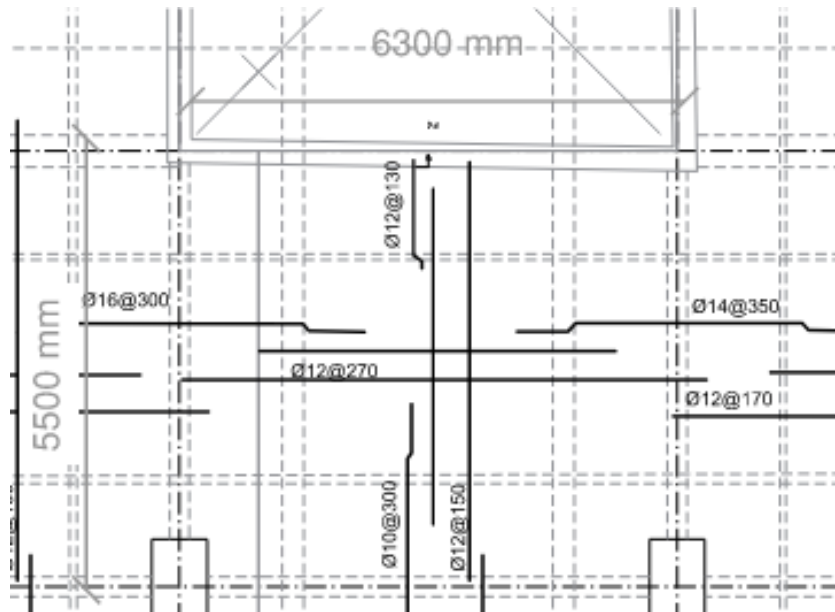


Figure 4.14: Middle Strip Steel Reinforcement for Panel (6.3x5.5) of Flat Floor (6.3-5.5-5.2).

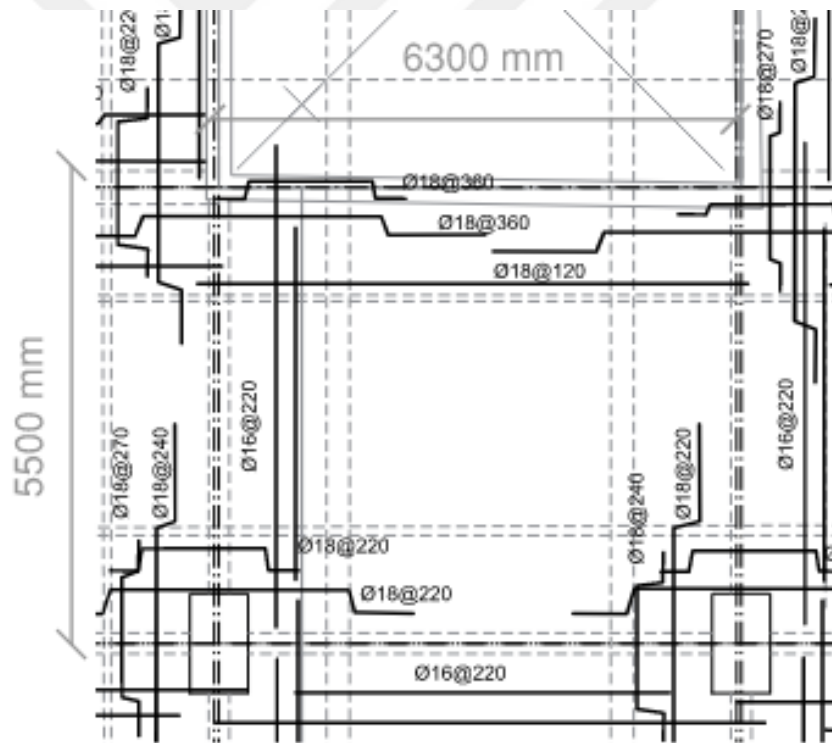


Figure 4.15: Column Strip Steel Reinforcement for Panel (6.3x5.5) of Flat Floor (6.3-5.5-5.2).

4.3 CASE STUDY (3) WAFFLE FLOOR (6.3-5.5-5.2)

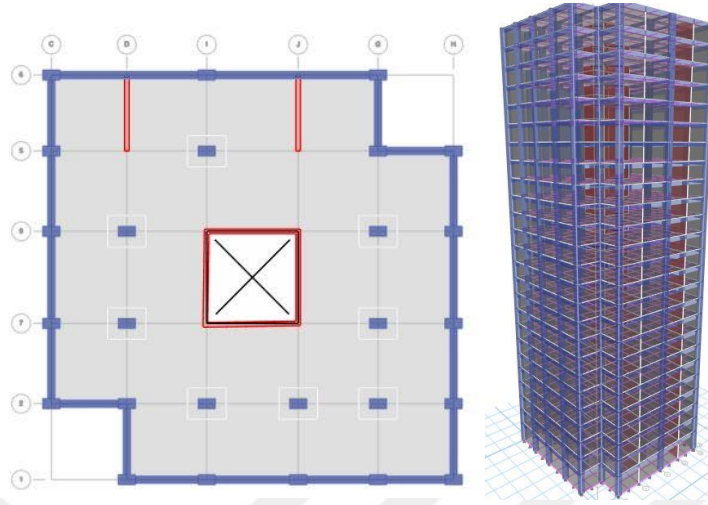


Figure 4.16: Waffle Floor Model Isometric & Plan View Model (6.3-5.5-5.2).

Table 4.12: Waffle Floor Model Parameters & Properties Model (6.3-5.5-5.2).

Building weight "W" (KN)	259553.9922	
Height (m)	88.5	
Upper limit period Parameter "Cu"	1.7	ASCE Table 12.8-2
T_{max}	2.394	$T_a \times C_u$
Seismic response coefficient "Cs"	0.052	ASCE Section 12.8.11
Maximum Seismic response coefficient $C_{s_{max}}$	0.008	ASCE Eq.12.8-3
Fundamental period "T" (s) X-direction (sec)	4.41	
Fundamental period "T" (s) Y-direction(sec)	4.115	
Approximate fundamental period "Ta"	1.408	

4.3.1 Checking Critical Case

4.3.1.1 Seismic loads

By applying the procedure shown in the section (3.6.1) steps (1-15) and using the table (4.2) for Case-2 data, the seismic loads force calculated in (X&Y)Direction the results shown in the Appendix(A.2.1) where maximum seismic force is {281 KN} at story 24.

Since $T_{max} < T_{used}$ use T_{max} And used $C_s_{max} < C_s_{used}$

4.3.1.2 Wind loads

By applying the procedure shown in the section (3.6.2) steps (1-13) and See Appendix (A.1)

Comparing the effect of the Wind forces and seismic loads to find critical case for the lateral forces

Table 4.13: Critical Case for Seismic and Wind Loads Effect for Waffle Floor Model (6.3-5.5-5.2).

Case	Base reaction (Fy)	Base reaction (Fx)
	KN	KN
Seismic in -x (EX)	-2974.6918	0
Seismic in -y (EY)	0	-2974.6917
Wind1	-2470.7861	0
Wind2	0	-2470.7861
Wind3	-1853.0896	0
Wind4	-1853.0896	0
Wind5	0	-1853.0896
Wind6	0	-1853.0896
Wind7	-1853.0896	1853.0896
Wind8	-1853.0896	-1853.0896
Wind9	-1391.0526	1391.0526
Wind10	-1391.0526	1391.0526
Wind11	-1391.0526	-1391.0526
Wind12	-1391.0526	-1391.0526

4.3.2 Checking Building Under Lateral Forces Effect

4.3.2.1 Checking story drift

As shown in Appendix (A.2.2) the drift & displacement were calculated for each story All Values satisfied with allowable drift value. Where maximum displacement (133.4mm).

4.3.2.2 Checking rigidity of structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity from Appendix (A.2.3) all Values of Eccentricity Ratio are less than 15%, therefore the building are satisfied allowable ratio where maximum eccentricity ratio (6.5%).

4.3.2.3 Checking for amplification of accidental torsional moment & torsional irregularity

Torsion amplification were calculated for each story and as shown in Appendix (A.2.4) where values that exceed ($A_x > 1$) at Story (1&2). In Y- direction, modification factor For Story 1 =1.4, For Story 2 =1.68. From section (12.8.7) at ASCE7-16 [33] where A_x not exceed 1.2 don't consider torsion irregularity.

4.3.2.4 P-Delta effects

From Appendix (A.2.5) stability coefficient (θ) were calculated for each story and as shown in table below where ($1 < \theta < \theta_{max}$) in each direction therefore, P-Delta Effects should be consider in design $\theta_{max}=0.111$.

4.3.3 Floor Design

Determine the slab thickness

From ACI 318-14 (Table 8.3.1.1)

Rip Width $b_{Rip}=200mm \geq 100mm$

$$Rip\ depth = \frac{LL}{36} = \frac{6.3}{36} = 160mm \leq 3.5 \times b_{Rip} \quad (4.24)$$

Increase Rip depth to resist flexural & shear failure

Take Slab thickness $h_w=120mm \geq 50mm$

Overall depth = $t_{\text{Rip}} + t_w = 280\text{mm}$

Space between two ribs (S_{Ribs}) = $550\text{mm} \leq 750\text{ mm}$ the space reduced to (550mm to resist flexural failure)

Design for drop panel

Min Drop Length = $LL/6 = 1.05$

For both direction drop Width = 2.1 m

For both direction drop length = (drop Width-column length – column width) = 2.6m

Drop Depth = 280 mm



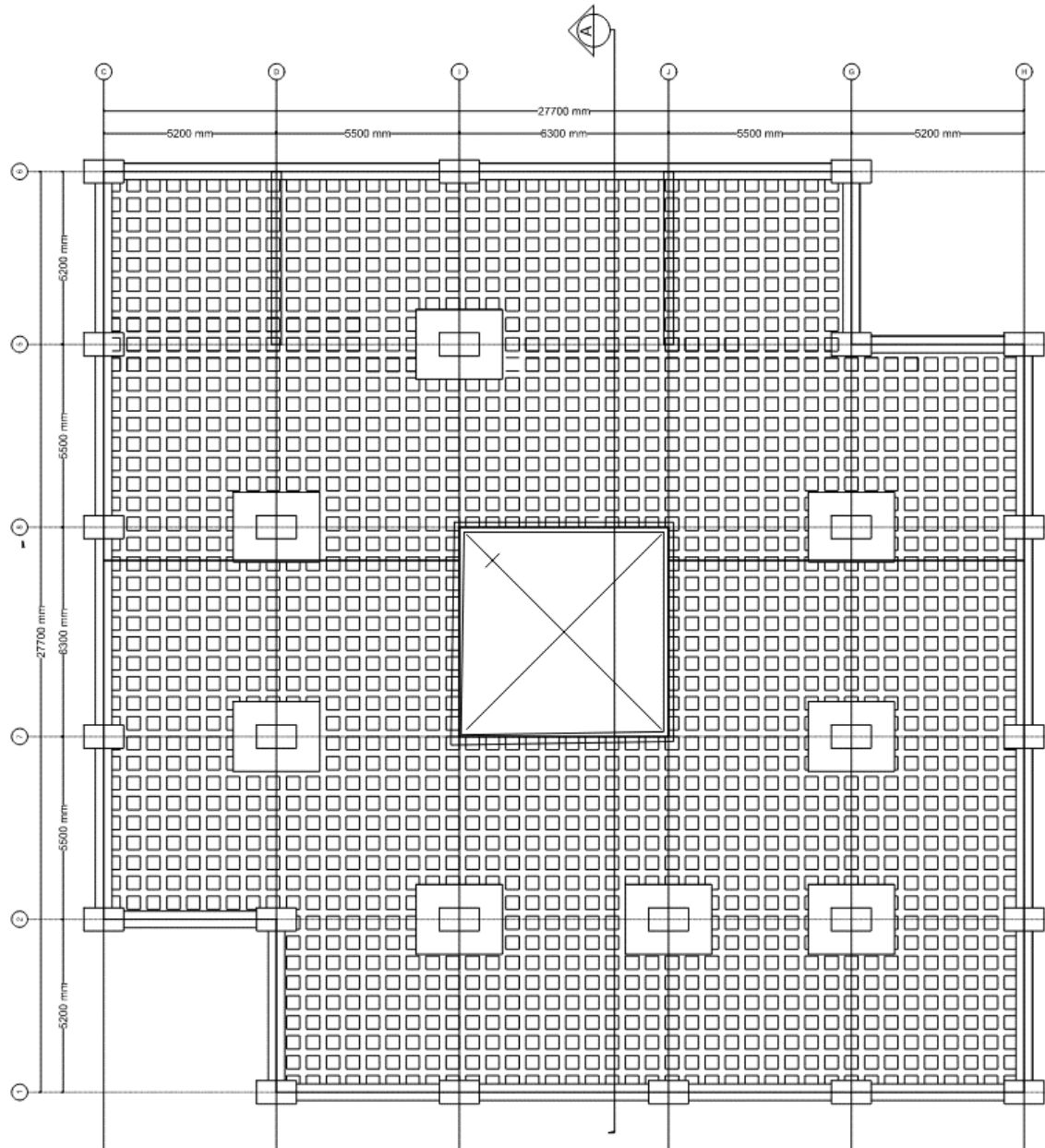


Figure 4.17: Show Framework Plan for Waffle Floor Model (6.3-5.5-5.2).

4.3.3.1 Slab shear strength – check for punching

Table 4.14: Parameters of Columns (C1&C2) of Waffle Floor Case Model (6.3-5.5-5.2).

Column	Mu1 KN.m	Mu2 KN.m	γ_1	γ_2	I1 cm4	I2 cm4	Vu MPa	Vc Mpa	Vu/Vc %
C1	15.6	49.25	0.349945	0.452234	18407836	34968177	0.68	1.36	0.5
C2	38.65	46.82	0.349945	0.452234	18407836	34968177	0.69	1.36	0.5

4.3.3.2 Checking deflection

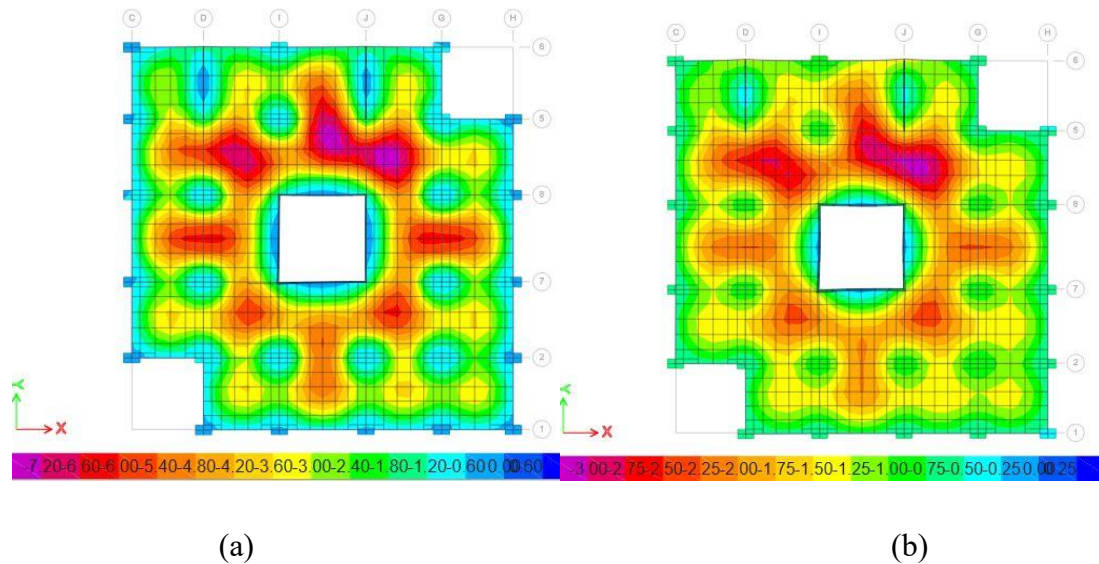


Figure 4.18: (a) Show Immediate Deflection, (b) Show Long- Term Deflection for Waffle Floor.

Allowable values of immediate and Long-term deflection from section (4.1.3.3).

Table 4.15: Short Term & Long Term Deflection for Waffle Floor Model (6.3-5.5-5.2).

	Floor deflection(mm)	Allowable deflection(mm)
Short term deflection(mm)	-3.12	-17.5
Long term deflection(mm)	-7.53	-26.25

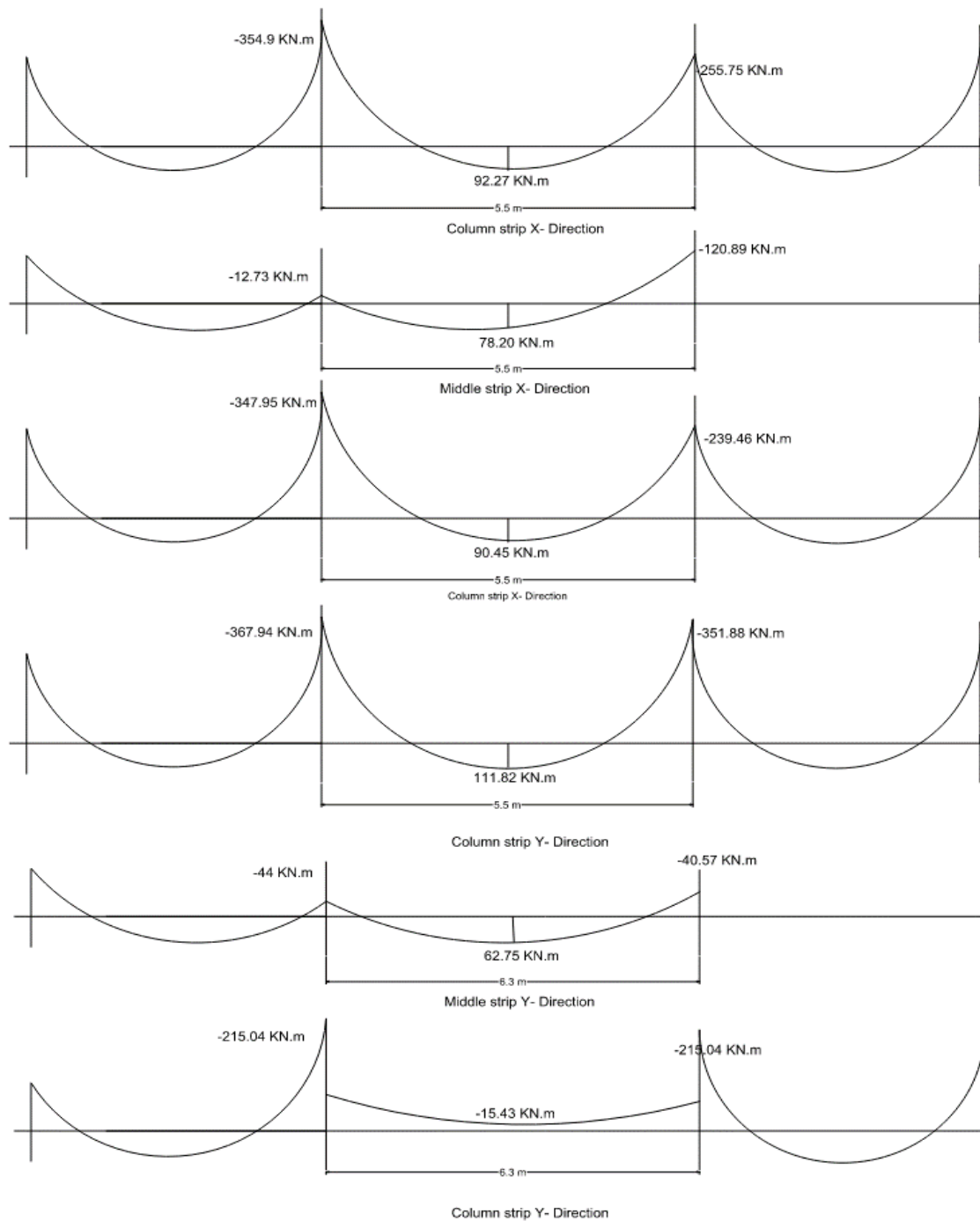


Figure 4.19: Showing Bending Moment Diagram for Panel (6.3x5.5) of Waffle Floor Case.

4.3.3.3 Design for the panel (6.3m x5.5m)

For concrete strength $f_c' = 30 \text{ Mpa}$, steel rebar strength $f_y = 400 \text{ Mpa}$, $d = 95 \text{ mm}$.

$\emptyset 8$ at top Spacing $\emptyset 8 @ 300 \text{ mm}$

Same procedure as section (4.2.3.1.2)

Table 4.16: Steel Reinforcement Table for Panel; (6.3x5.5) for Waffle Floor Model (6.3-5.5-5.2).

Span	Cross-section	Location	Moment	RU	p	AS
span5.5 m	Column strip	M(-)	354.9	12.55846	0.053273	8737
		M(+)	92.27	2.71705	0.006856	1124
		M(-)	255.75	5.544815	0.015073	2472
	Middle strip	M(-)	12.73	0.525894	0.001265	208
		M(+)	78.2	3.230551	0.008253	1353
		M(-)	120.89	4.994134	0.013361	2191
	Column strip	M(-)	347.95	12.34934	0.049951	8192
		M(+)	90.45	2.813884	0.007117	1167
		M(-)	239.466	6.820097	0.019309	3167
span6.3 m	Column strip	M(-)	367.94	12.72143	0.05784	9486
		M(+)	111.83	4.619853	0.012232	2006
		M(-)	351.88	12.47108	0.051734	8484
	Middle strip	M(-)	44	1.817701	0.004494	737
		M(+)	39.8	1.644193	0.00405	664
		M(-)	40.57	1.676003	0.004131	677
	Column strip	M(-)	215	8.881949	0.027273	4473
		M(-)	98	4.048516	0.010557	1731
		M(-)	215.04	8.883601	0.02728	4474

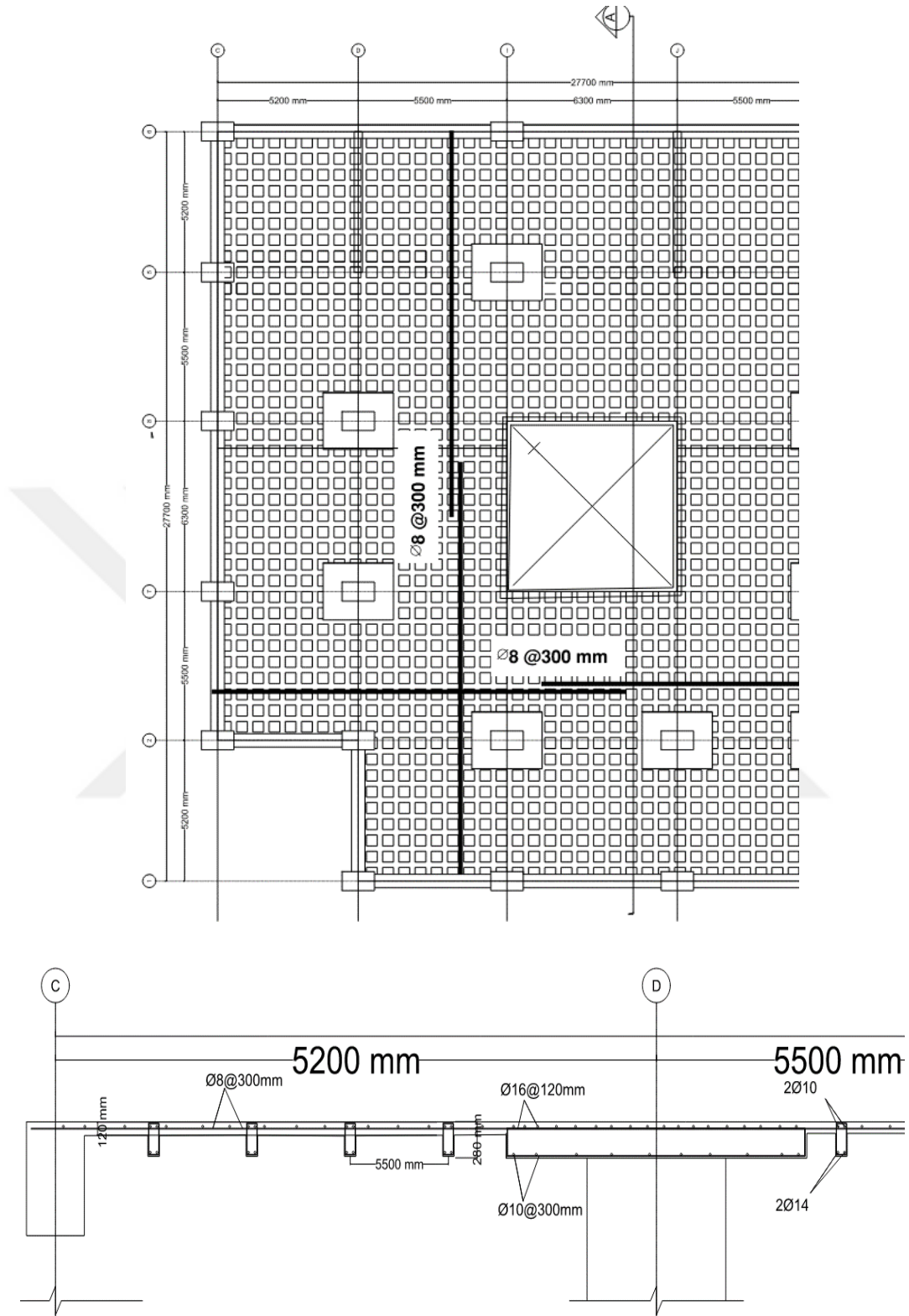


Figure 4.20: Steel Reinforcement details for Waffle Floor System Case Model (6.3-5.5-5.2).

4.4 CASE STUDY (4) CONVENTIONAL FLOOR (8.3-7.5-7.2)

The building modelled by ETABS as configuration for spans length (8.3-7.5-7.2m) ,outer columns (1200x1200 mm) and all outer beams (850x600), inside columns (1300x1200) ,shear wall thickness (360mm).

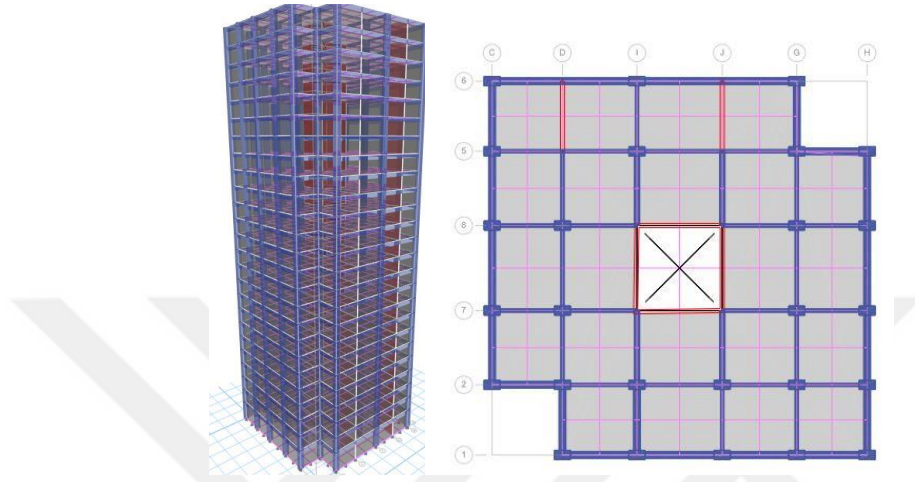


Figure 4.21: Conventional Floor Model Isometric & Plan View (6.3-5.5-5.2).

Table 4.17: Conventional Floor Parameters & Properties for Model (8.3-7.5-7.2).

Building weight "W" (KN)	521462.367	
Height (m)	88.5	
Cu	1.7	ASCE Table 12.8-2
T _{max}	2.394	TaxCu
Cs	0.011	ASCE Section 12.8.11
Cs _{max}	0.009	
Fundamental period "T" (s) X-direction (sec)	4.325	
Fundamental period "T" (s) Y-direction(sec)	3.972	

4.4.1 Checking Critical Case

4.4.1.1 Seismic loads

By applying the procedure shown in the section (3.6.1) steps (1-15) and using the table (4.17) for Case-4 data, the seismic loads force calculated in (X&Y) Direction the results shown in the Appendix (A.2.1) where maximum seismic force is {626 KN} at story 24.

Since $T_{max} < T_{used}$ use T_{max}

And used $Cs_{max} < Cs_{used}$

4.4.1.2 Wind load

By applying the procedure in the section (3.6.2) steps (1-13) See Appendix (A.1)

Comparing the effect of the Wind forces and seismic loads to find critical case for the lateral forces

Table 4.18: Critical Case for Seismic and Wind Loads Effect for Model (8.3-7.5-7.2).

Case	Base reaction (Fy)	Base reaction (Fx)
	KN	KN
seismic in -x (EX)	-5965.5296	0
seismic in -y (EY)	0	-5965.5296
Wind1	-3362.7667	0
Wind2	0	-3362.7667
Wind3	-2522.075	0
Wind4	-2522.075	0
Wind5	0	-2522.075
Wind6	0	-2522.075
Wind7	-2522.075	2522.075
Wind8	-2522.075	-2522.075
Wind9	-1893.2377	1893.2377
Wind10	-1893.2377	1893.2377
Wind11	-1893.2377	-1893.2377
Wind12	-1893.2377	-1893.2377

4.4.2 Checking Building under Lateral Forces Effect

4.4.2.1 Checking story drift

As shown in Appendix (A.2.2) the drift & displacement were calculated for each story All Values satisfied with allowable drift value. Where maximum displacement (126.8mm) and maximum drift (0.0014) while allowable drift (0.088).

4.4.2.2 Checking rigidity of structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity from Appendix (A.2.3) all Values of Eccentricity Ratio are less than 15%, therefore the building are satisfied allowable ratio where maximum eccentricity ratio (5%).

4.4.2.3 Checking for amplification of accidental torsional moment & torsional irregularity

Torsion amplification were calculated for each story and as shown in Appendix (A.2.4) where values that not exceed ($A_x > 1$), In Y- direction, modification factor For Story 1 =2.1, For Story 2 =1.95, From section (12.8.7) at ASCE7-16 [33] where A_x not exceed 1.2 don't consider torsion irregularity.

4.4.2.4 P-Delta effects

From Appendix (A.2.5) stability coefficient (θ) were calculated for each story and as shown in table below where ($1 < \theta < \theta_{max}$) in each direction therefore, P-Delta Effects should be consider in design $\theta_{max}=0.111$.

4.4.3 Floor Design

4.4.3.1 Design for internal beams

Design for selected panel model (8.3x7.5) in story 10

Design for Internal Beams

Check the minimum beam depth requirement from section (4.1.3.1)

$$h = 500 \text{ mm}$$

Take $b = 350 \text{ mm}$

From section (4.1.3.1) procedure find beam dimensions and reinforcement

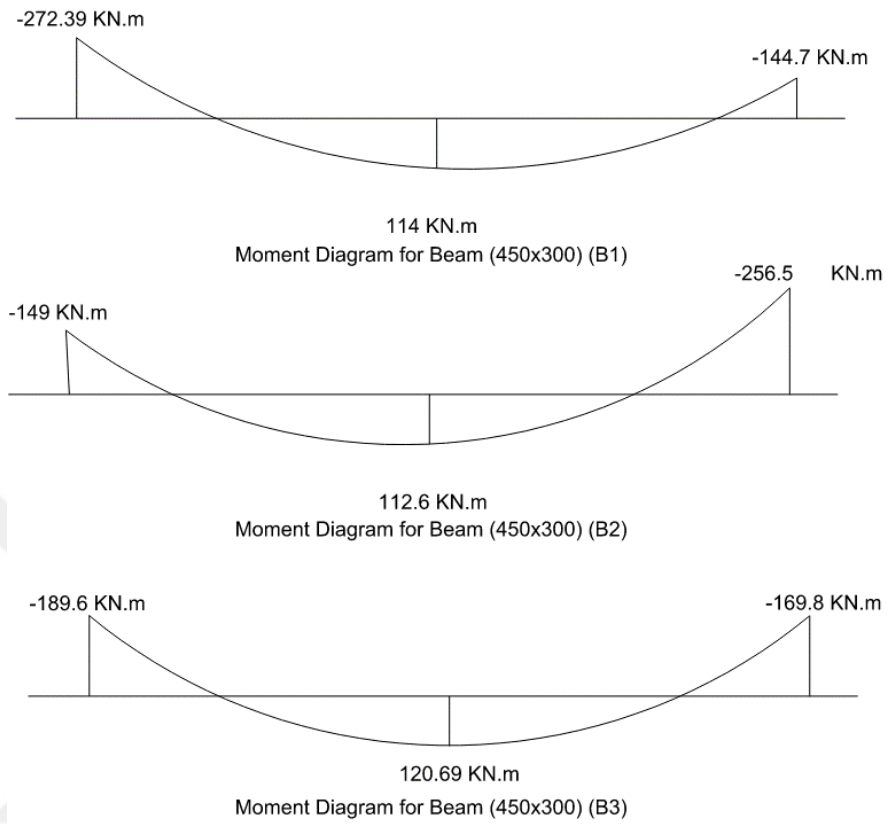


Figure 4.22: Showing Moment Diagram for Internal Beams Model (8.3-7.5-7.2).

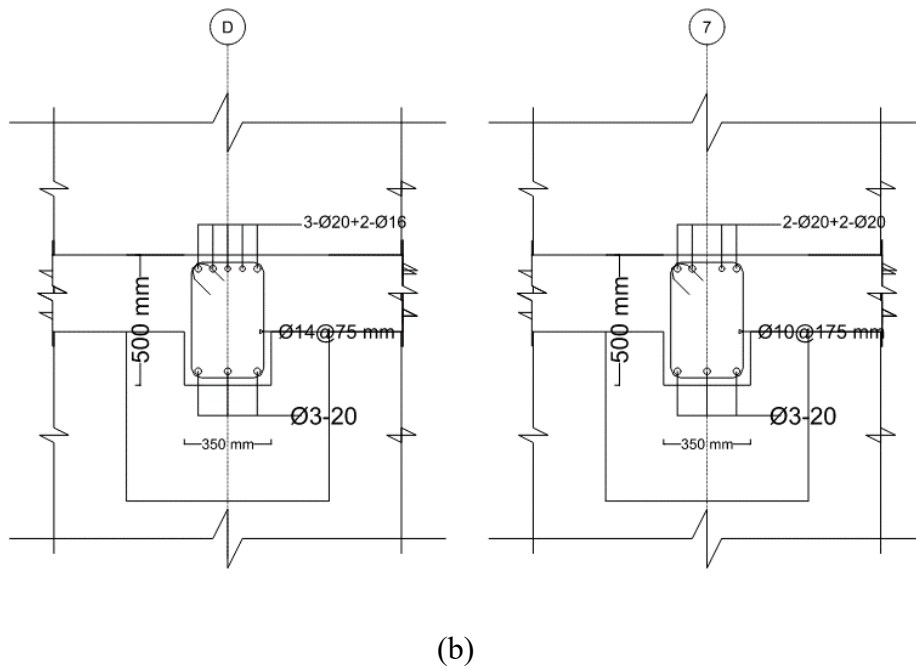
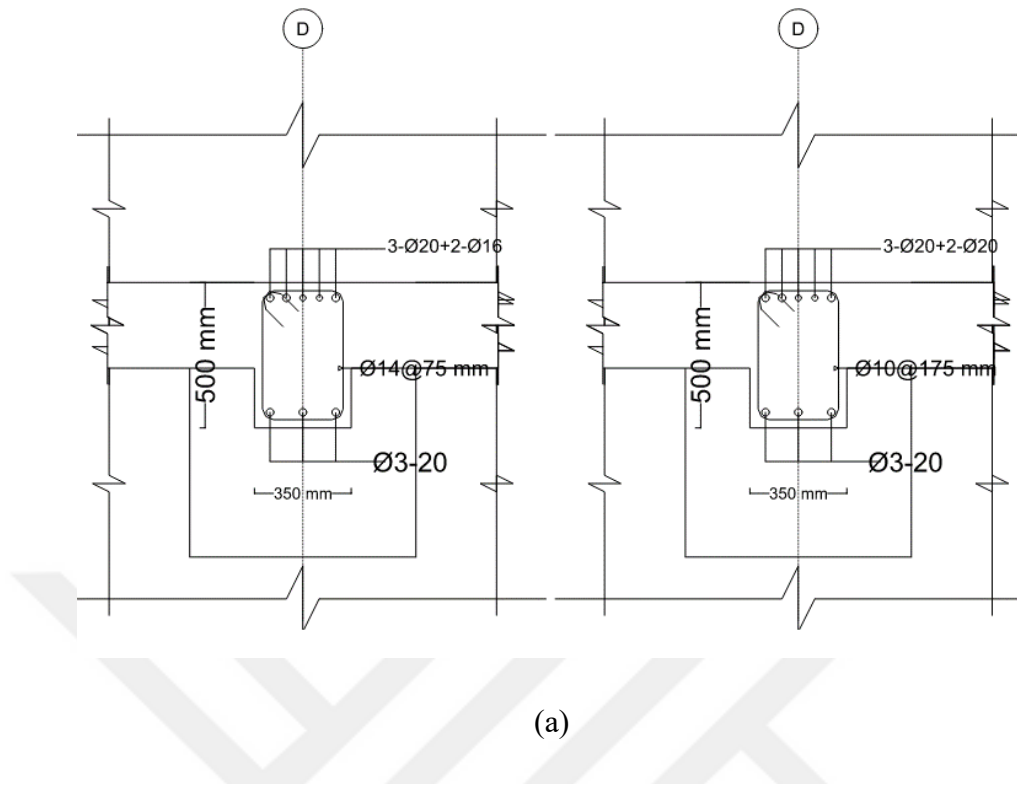


Figure 4.23: (a) Show The Steel Reinforcement for Beams (B2&B3) (Section A). (b) Show The Steel Reinforcement for Beams (B2&B3) (Section B) for Model (8.3-7.-57.2).

4.4.3.2 Design floor

From section (4.1.3.2) find Floor thickness

$h=260\text{ mm}$

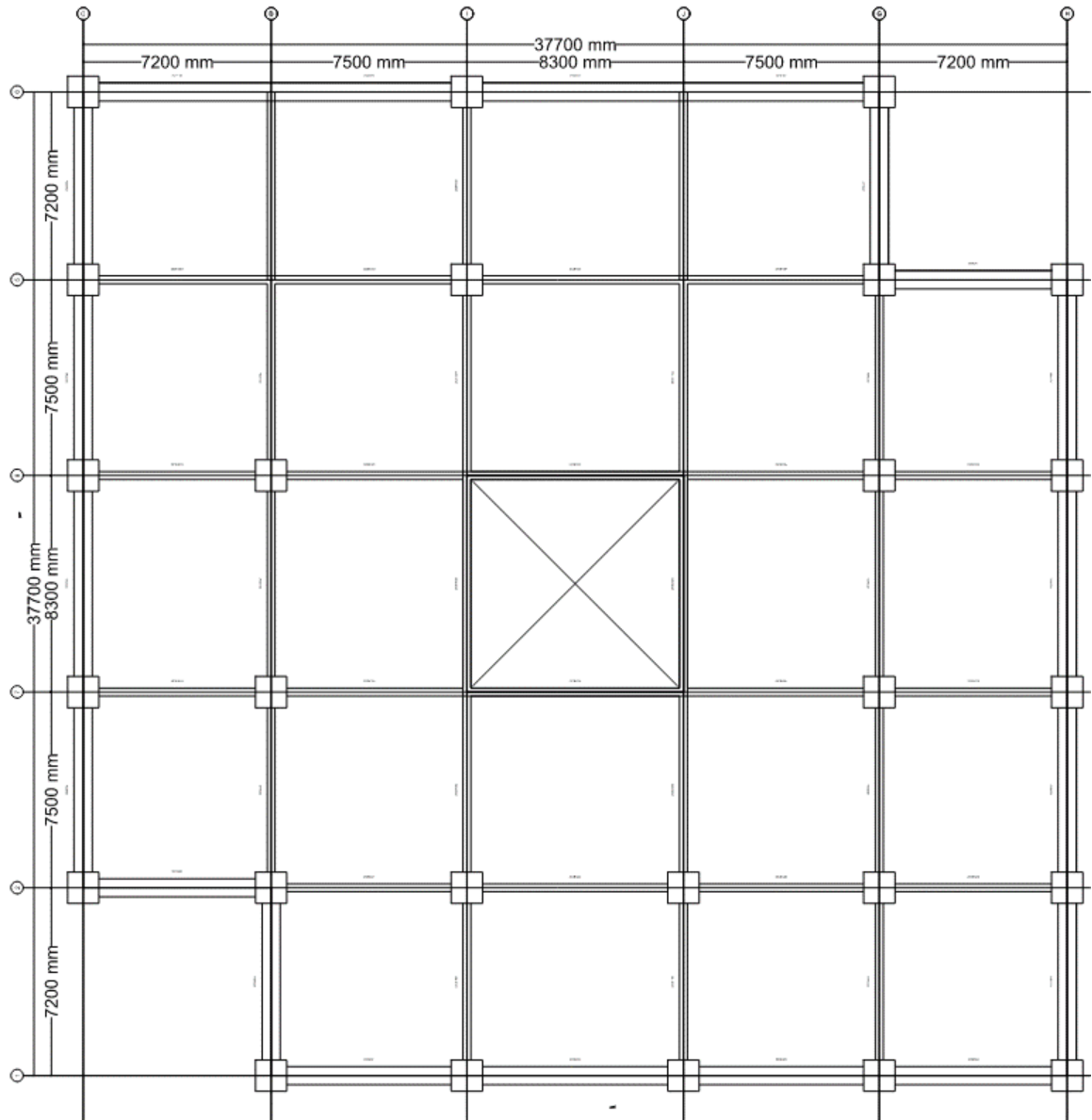


Figure 4.24: Conventional Floor Model Isometric & Plan View for Model (8.3-7.5-7.2).

4.4.3.3 Check deflection

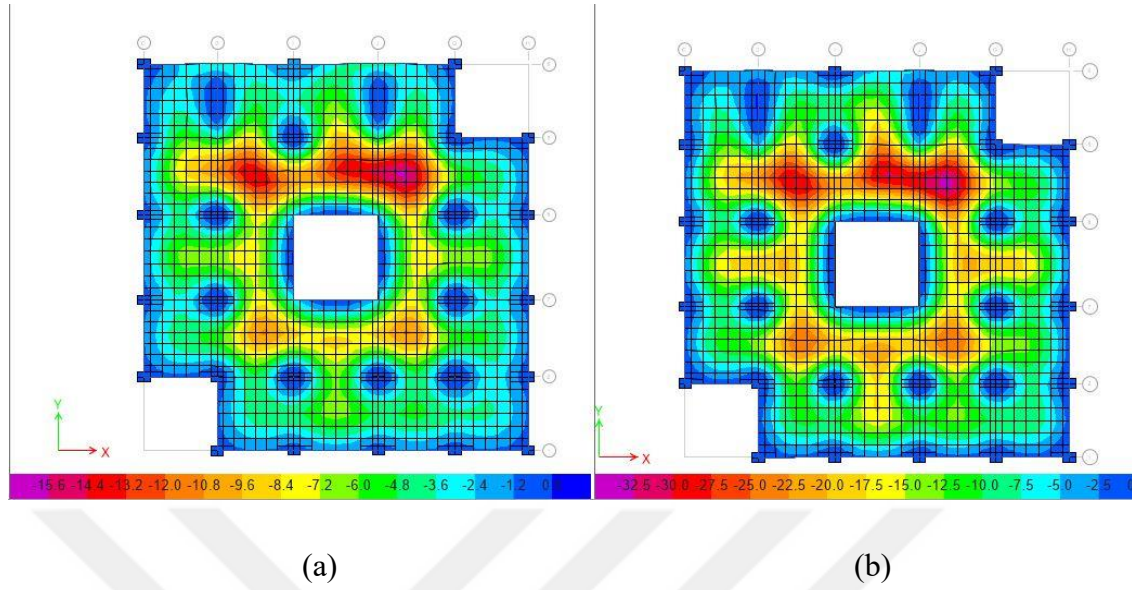


Figure 4.25: (a) Show Immediate Deflection, (b) Show Long- Term Deflection for Conventional Floor Model (8.3-7.5-7.2).

Table 4.19: Deflection Values for Conventional Floor for Model (8.3-7.5-7.2).

	Floor deflection(mm)	Allowable deflection(mm)
Short term deflection(mm)	-14.6	-20.2
Long term deflection(mm)	-32	-34.5

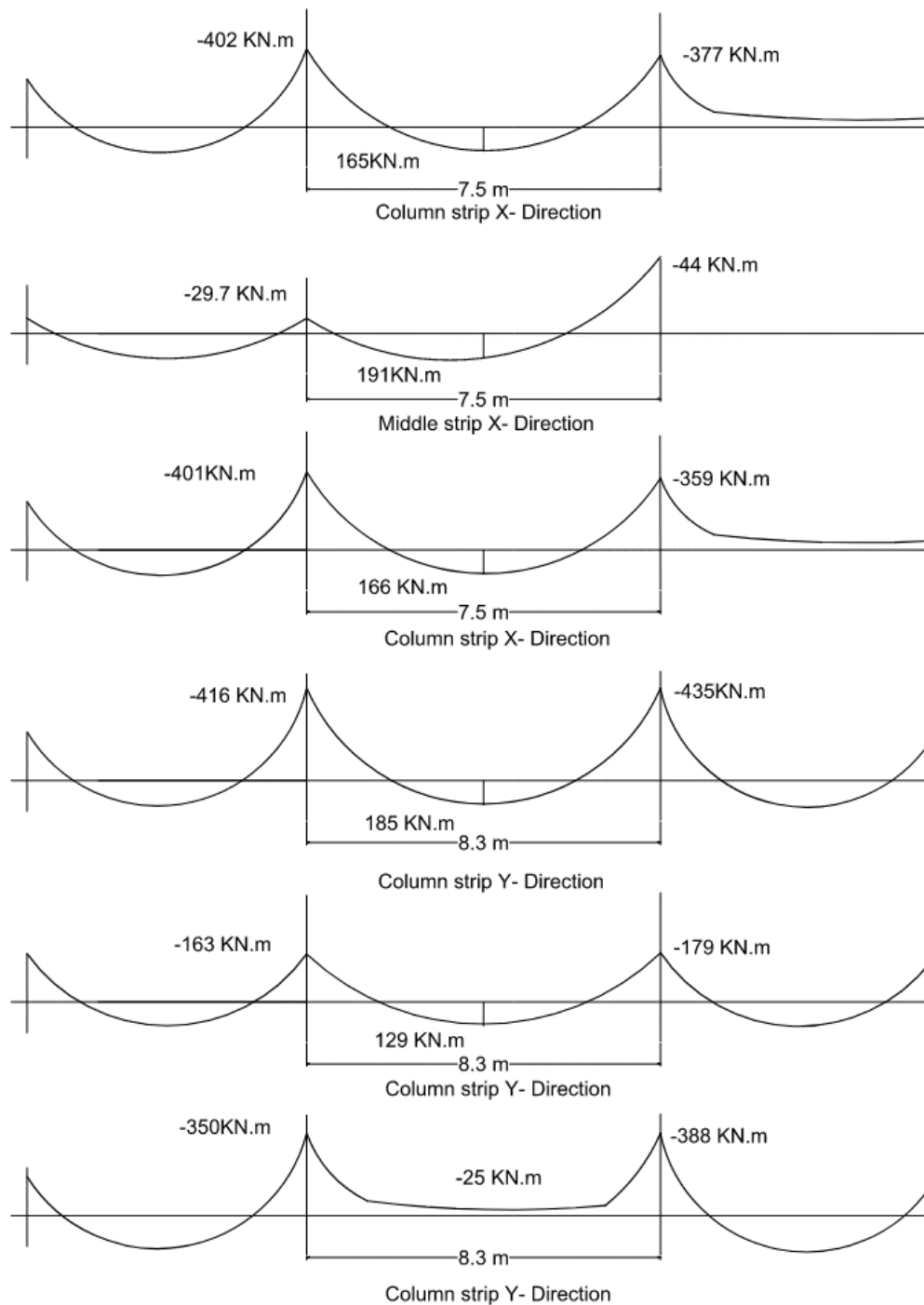


Figure 4.26: Bending Moment Diagram for The Convention Floor for Model (8.3-7.5-7.2).

4.4.3.4 Design for the panel (8.3m x7.5m)

Table 4.20: Steel Reinforcement Table for Panel (8.3x7.5) for Conventional Floor (8.3-7.5-7.2).

Span	Cross-section	Location	Moment	RU	p	As	Reinforcement	Additional
Span 7.5 m	Column strip	M(-)	402	7.346491	0.021189	5085	Ø18@170	Ø18@170
		M(+)	165	3.18287	0.008121	1949	Ø16@300	
		M(-)	377	7.272377	0.020919	4688	Ø18@300	Ø18@300
	Middle strip	M(-)	141	2.719907	0.006864	1647	Ø14@300	
		M(+)	191	3.684414	0.009519	2284	Ø12@160	
		M(-)	466	8.796296	0.026905	5707	Ø16@120	
	Column strip	M(-)	401	7.73534	0.022638	5433	Ø18@300	Ø18@300
		M(+)	166	3.20216	0.008174	1962	Ø14@270	
		M(-)	359	6.925154	0.019677	4722	Ø18@330	Ø18@330
Span 8.3 m	Column strip	M(-)	416	8.024691	0.023753	5701	Ø18@250	Ø18@250
		M(+)	185	3.568673	0.009193	2206	Ø16@220	
		M(-)	435	8.391204	0.025215	5999	Ø18@250	Ø18@250
	Middle strip	M(-)	163	3.14429	0.008016	1924	Ø16@250	
		M(+)	129	2.488426	0.006246	1499	Ø12@230	
		M(-)	179	3.452932	0.008869	2129	Ø16@270	
	Column strip	M(-)	350	6.751543	0.01907	4577	Ø18@280	Ø18@280
		M(+)	25	0.482253	0.001159	278	Ø10@350	
		M(-)	388	7.484568	0.021697	5207	Ø18@350	Ø18@350

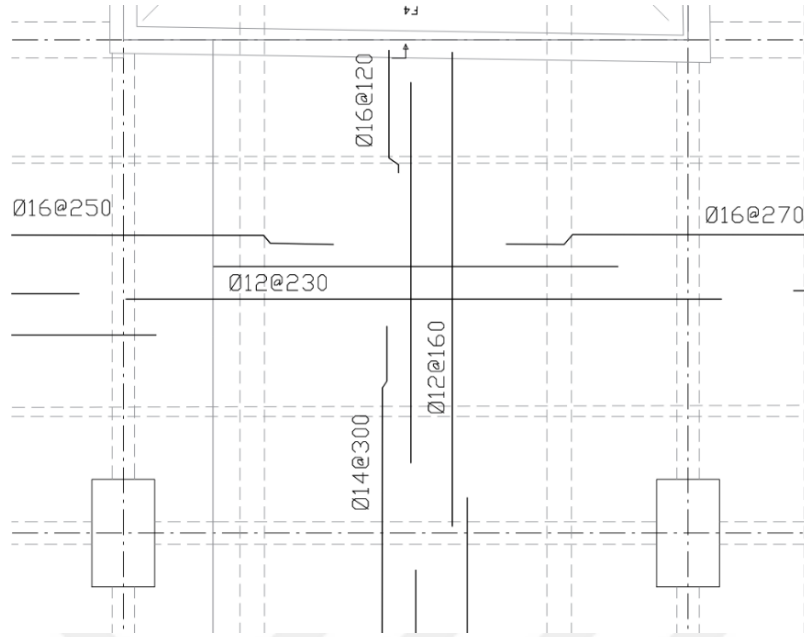


Figure 4.27: Middle Strip Steel Reinforcement for Panel (8.3x7.5) for Model (8.3-7.5-7.2).

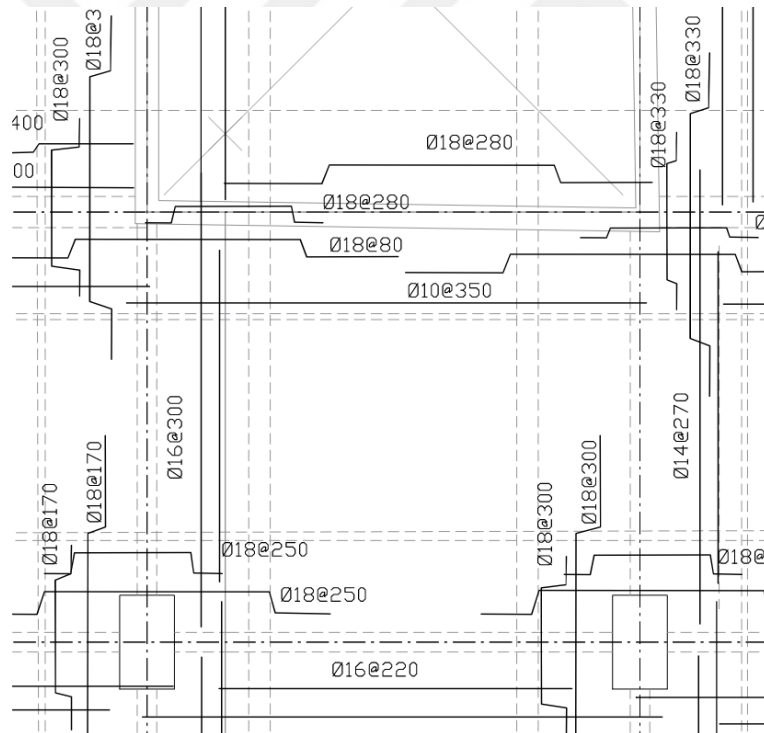


Figure 4.28: Column Strip Steel Reinforcement for Panel (8.3x7.5) for Model (8.3-7.5-7.2).

4.5 CASE STUDY (5) FLAT FLOOR FOR MODEL (8.3-7.5-7.2)

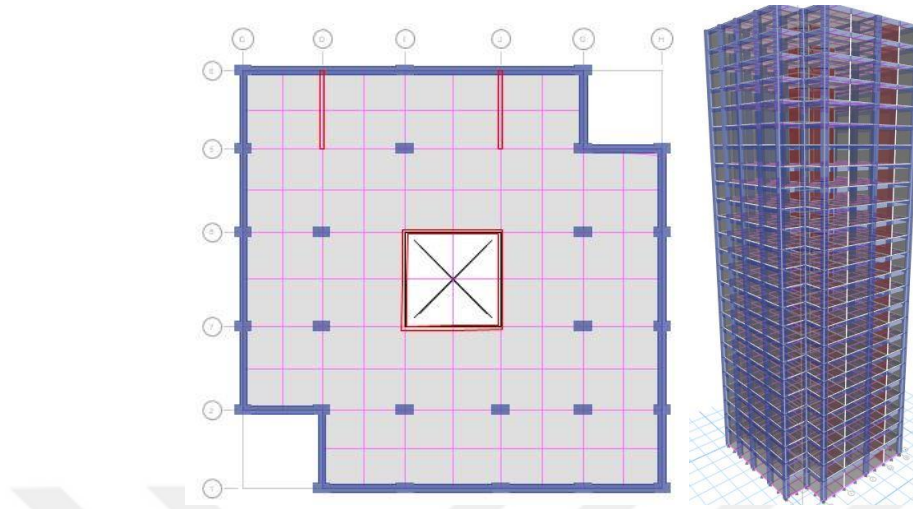


Figure 4.29: Flat Floor Model Isometric & Plan View.

Table 4.21: Flat Floor Model Parameters & Properties for Model (8.3-7.5-7.2).

Building weight "W" (KN)	510087.4962	
Height (m)	88.5	
Upper limit period Parameter "Cu"	1.7	ASCE Table 12.8-2
T_{max}	2.394	$T_a \times C_u$
Seismic response coefficient "Cs"	0.052	ASCE Section 12.8.11
Maximum Seismic response coefficient Cs_{max}	0.008	ASCE Eq.12.8-3
Fundamental period "T" (s) X-direction (sec)	4.502	
Fundamental period "T" (s) Y-direction(sec)	4.095	
Approximate fundamental period "Ta"	1.408	

4.5.1 Checking Critical Case

4.5.1.1 Seismic loads

By applying the procedure shown in the section (3.6.1) steps (1-15) and using the table (4.21) for Case-5 data, the seismic loads force calculated in (X&Y)Direction the results shown in the Appendix(A.2.1) where maximum seismic force is {598 KN} at story 24.

Since $T_{max} < T_{used}$ use T_{max}

And used $C_{s_{max}} < C_{s_{used}}$

4.5.1.2 Wind loads

By applying the procedure shown in the section (3.6.2) steps (1-13) and See Appendix (A.1)

Comparing the effect of the Wind forces and seismic loads to find critical case for the lateral forces

Table 4.22: Critical Case for Seismic and Wind Loads Effect for Flat Floor for Model (8.3-7.5-7.2).

Case	Base reaction (Fy)	Base reaction (Fx)
	KN	KN
seismic in -x (EX)	-5835.4011	0
seismic in -y (EY)	0	-5835.4011
Wind1	-3362.7667	0
Wind2	0	-3362.7667
Wind3	-2522.075	0
Wind4	-2522.075	0
Wind5	0	-2522.075
Wind6	0	-2522.075
Wind7	-2522.075	2522.075
Wind8	-2522.075	-2522.075
Wind9	-1893.2377	1893.2377
Wind10	-1893.2377	1893.2377
Wind11	-1893.2377	-1893.2377
Wind12	-1893.2377	-1893.2377

4.5.2 Checking Building under Lateral Forces Effect

4.5.2.1 Checking story drift

As shown in Appendix (A.2.2) the drift & displacement were calculated for each story All Values satisfied with allowable drift value. Where maximum displacement (145mm) and maximum drift (0.012) while allowable drift (0.088).

4.5.2.2 Checking rigidity of structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity from Appendix (A.2.3) all Values of Eccentricity Ratio are less than 15%, therefore the building are satisfied allowable ratio where maximum eccentricity ratio (4.8%).

4.5.2.3 Checking for amplification of accidental torsional moment & torsional irregularity

Torsion amplification were calculated for each story and as shown in Appendix (A.2.4) where values that exceed ($A_X > 1$) at Story (1&2) , in Y- direction, modification factor For Story 1 =1.5, For Story 2 =1.92 ,in X- direction, modification factor For Story 1 =2 From section (12.8.7) at ASCE7-16 [33] where A_X not exceed 1.2 don't consider torsion irregularity.

4.5.2.4 P-Delta effects

From Appendix (A.2.5) stability coefficient (θ) were calculated for each story and as shown in table below where ($1 < \theta < \theta_{max}$) in each direction therefore, P-Delta Effects should be consider in design $\theta_{max}=0.111$.

4.5.3 Floor Design

Determine the slab thickness

From ACI 318-14 (Table 8.3.1.1)

$$h = \frac{Ln}{33} = \frac{7.1}{33} = 220mm \approx 280mm$$
 Thickness increased to cope with punching share and with deflection

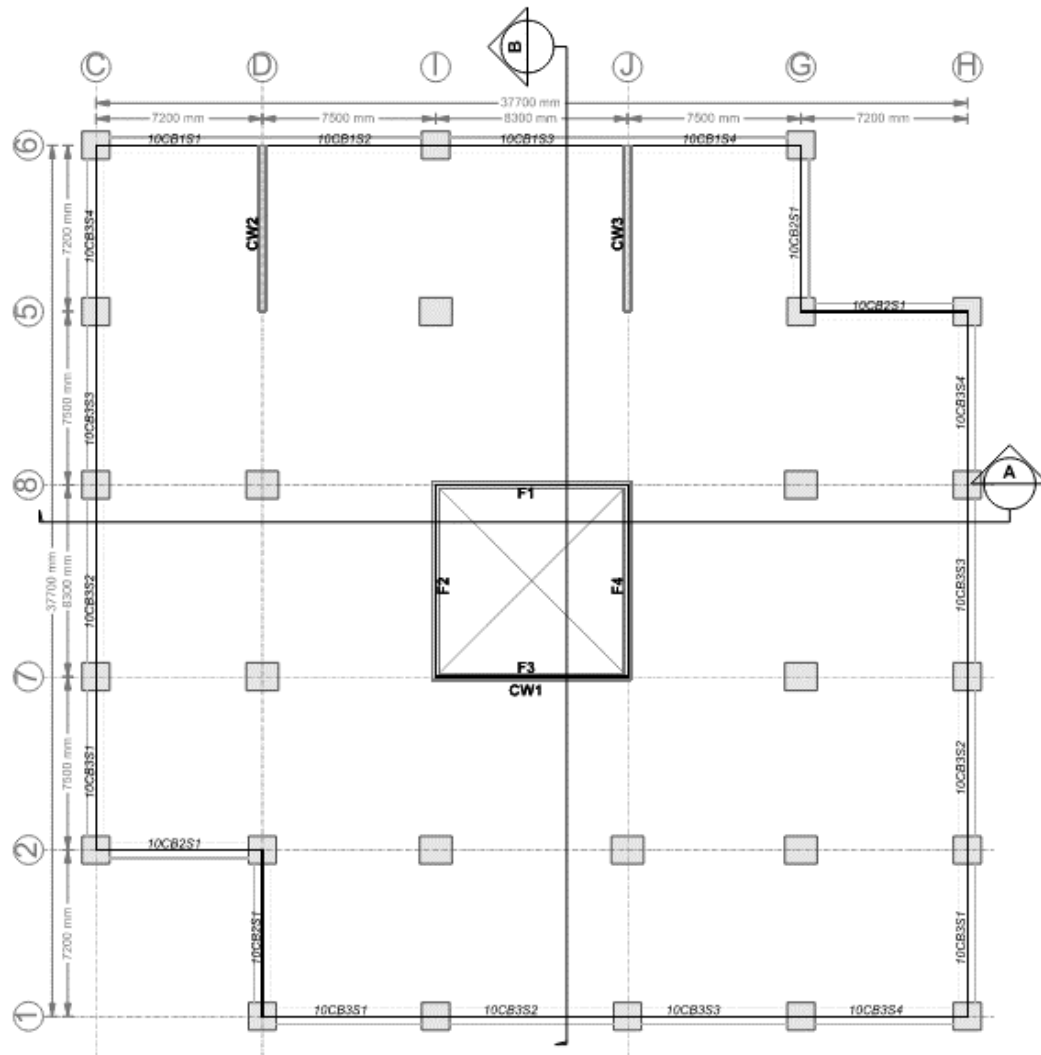


Figure 4.30: Flat Plate Model Isometric & Plan View for Model (8.3x7.5x7.2).

4.5.3.1 Slab Shear strength – check for punching

From section 4.2.3.1.1 punching shear checked

Table 4.23: Parameters of Columns (C1&C2) of Flat Floor Case.

Column	Mu1 KN.m	Mu2 KN.m	γ_1	γ_2	I1 cm4	I2 cm4	Vu MPa	Vc Mpa	Vu/Vc %
C1	16.44	24.117	0.3447	0.415734	52097095	63323297	1.07	1.21	0.89
C2	17.56	32.08	0.3447	0.415734	52097095	63323297	1.1	1.21	0.91

4.5.3.2 Checking deflection

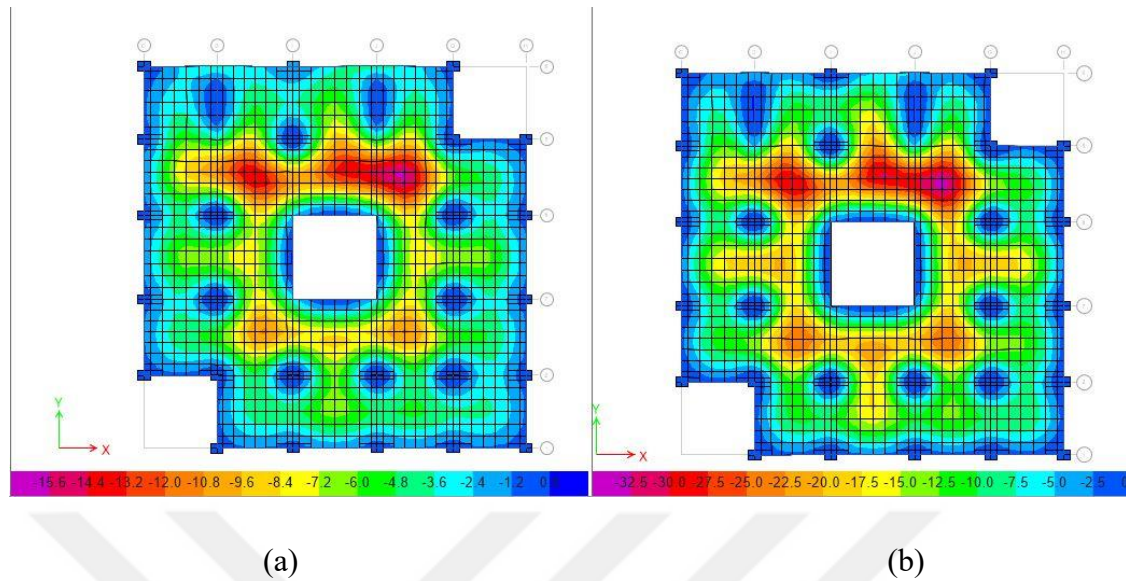


Figure 4.31: (a) Show Immediate Deflection, (b) Show Long- Term Deflection Model (8.3×7.5x7.2).

Table 4.24: Short Term Deflection& Long Term Deflection Model (8.3-7.5-7.2).

	Floor deflection(mm)	Allowable deflection(mm)
Short term deflection(mm)	-15.72	-20.2
Long term deflection(mm)	-32.59	-34.5

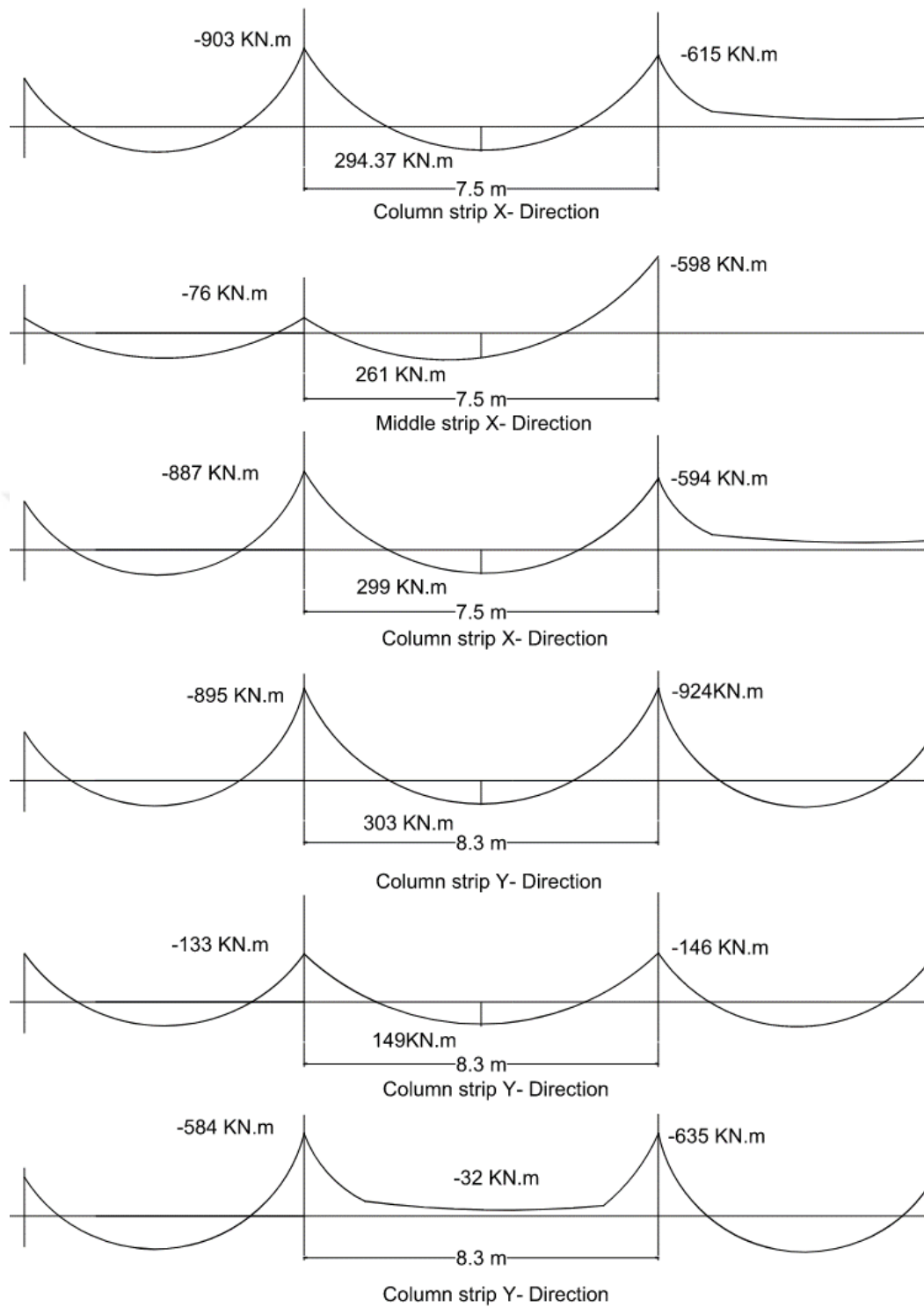


Figure 4.32: Showing Bending Moment Diagram for Panel (8.3x7.5) for Flat Floor (8.3-7.5-7.2).

4.5.3.3 Design for the panel (8.3m x7.5m)

Table 4.25: Steel Reinforcement Table for Panel; (8.3x7.5) for Flat Floor for Model (8.3-7.5-7.2).

Span	Cross-section	Location	Moment	RU	p	AS	Reinforcement	Additional
Span 7.5 m	Column strip	M(-)	903	10.45178	0.034937	10847	Ø18@150	Ø18@150
		M(+)	294	3.470157	0.008917	3167	Ø16@160	
		M(-)	615	7.791328	0.022851	7146	Ø18@220	Ø18@350
	Middle strip	M(-)	76	0.655199	0.001581	845	Ø12@200	
		M(+)	261	3.889467	0.010101	2472	Ø12@200	
		M(-)	598	4.544253	0.012007	8910	Ø16@100	
	Column strip	M(-)	887	10.31132	0.034161	10633	Ø18@150	Ø18@150
		M(+)	299	3.792385	0.009824	4330	Ø16@150	
		M(-)	594	8.204029	0.024461	6887	Ø18@220	Ø18@350
Span 8.3 m	Column strip	M(-)	895	10.99709	0.038202	11925	Ø18@240	Ø18@240
		M(+)	303	3.899795	0.01013	4730	Ø16@150	
		M(-)	924	10.94752	0.037886	12367	Ø18@120	Ø18@120
	Middle strip	M(-)	133	2.127537	0.005297	1598	Ø16@350	
		M(+)	149	1.858599	0.004599	1882	Ø16@300	
		M(-)	146	1.916848	0.00475	1782	Ø14@300	Ø12@300
	Column strip	M(-)	584	8.373818	0.025144	7376	Ø18@270	Ø18@350
		M(-)	32	0.347016	0.000832	679	Ø18@200	
		M(-)	635	8.758014	0.026742	8073	Ø18@200	Ø18@200

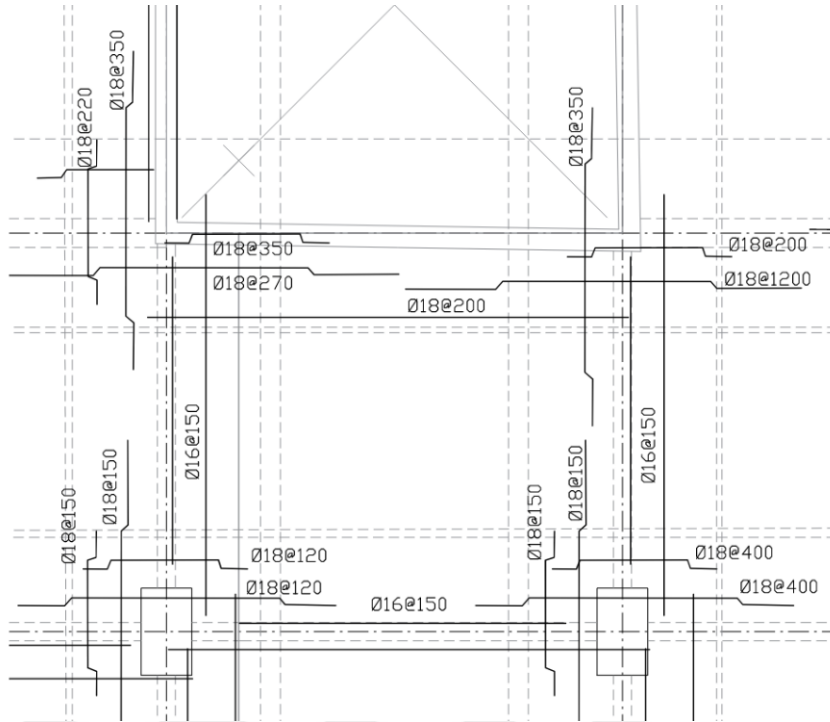


Figure 4.33: Column Strip Steel Reinforcement for Panel (8.3x7.5) of Flat Floor (8.3-7.5-7.2).

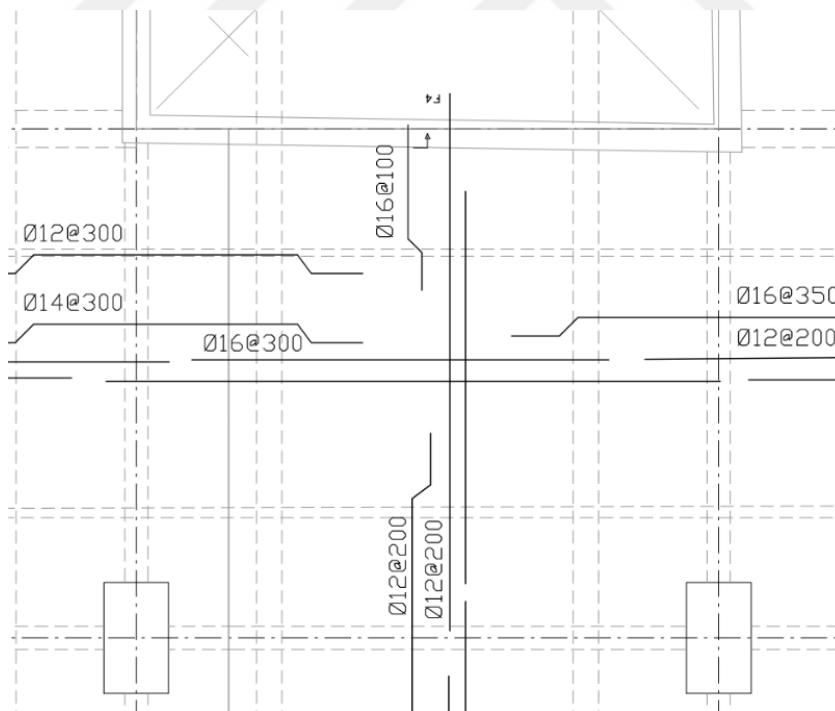


Figure 4.34: Middle Strip Steel Reinforcement for Panel (8.3x7.5) of Flat Floor (8.3-7.5-7.2).

4.6 CASE STUDY (6) WAFFLE FLOOR (8.3-7.5-7.2)

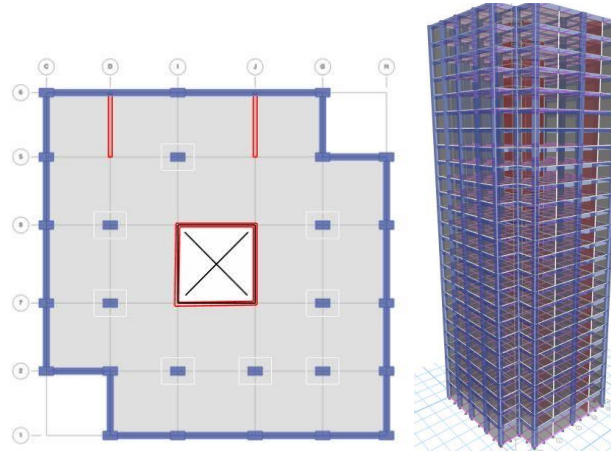


Figure 4.35: Waffle Floor Model Isometric & Plan View.

Table 4.26: Waffle Floor Model Parameters & Properties for Model (8.3-7.5-7.2).

Building weight "W" (KN)	505448.6098	
Height (m)	88.5	
Upper limit period Parameter "Cu"	1.7	ASCE Table 12.8-2
T_{max}	2.394	$T_a \times C_u$
Seismic response coefficient "Cs"	0.052	ASCE Section 12.8.11
Maximum Seismic response coefficient $C_{s_{max}}$	0.008	ASCE Eq.12.8-3
Fundamental period "T" (s) X-direction (sec)	4.372	
Fundamental period "T" (s) Y-direction(sec)	4.026	
Approximate fundamental period "Ta"	1.408	

4.6.1 Checking Critical Case

4.6.1.1 Seismic loads

By applying the procedure shown in the section (3.6.1) steps (1-15) and using the table (4.26) for Case-6 data, the seismic loads force calculated in (X&Y)Direction the results shown in the Appendix(A.2.1) where maximum seismic force is {589 KN} at story 24.

Since $T_{max} < T_{used}$ use T_{max}

And used $C_{s,max} < C_{s,used}$

4.6.1.2 Wind loads

By applying the procedure shown in the section (3.6.2) steps (1-13) and. See Appendix (A.1)

Comparing the effect of the Wind forces and seismic loads to find critical case for the lateral forces

Table 4.27: Critical Case for Seismic and Wind Loads Effect for Waffle Floor for Model (8.3-7.5-7.2).

Case	Base reaction (Fy)	Base reaction (Fx)
	KN	KN
seismic in -x (EX)	-5782.3322	0
seismic in -y (EY)	0	-5782.3322
Wind1	-3362.7667	0
Wind2	0	-3362.7667
Wind3	-2522.075	0
Wind4	-2522.075	0
Wind5	0	-2522.075
Wind6	0	-2522.075
Wind7	-2522.075	2522.075
Wind8	-2522.075	-2522.075
Wind9	-1893.2377	1893.2377
Wind10	-1893.2377	1893.2377
Wind11	-1893.2377	-1893.2377
Wind12	-1893.2377	-1893.2377

4.6.2 Checking Building under Lateral Forces Effect

4.6.2.1 Checking story drift

As shown in Appendix (A.2.2) the drift & displacement were calculated for each story All Values satisfied with allowable drift value. Where maximum displacement (136mm) and maximum drift (0.0085) while allowable drift (0.088).

4.6.2.2 Checking rigidity of structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity from Appendix (A.2.3) all Values of Eccentricity Ratio are less than 15%, therefore the building are satisfied allowable ratio where maximum eccentricity ratio (4.8%).

4.6.2.3 Checking for amplification of accidental torsional moment & torsional irregularity

Torsion amplification were calculated for each story and as shown in Appendix (A.2.4) where values that exceed ($A_X > 1$) at Story (1&2). In Y- direction, modification factor For Story 1 =2, For Story 2 =1.9. From section (12.8.7) at ASCE7-16 [33] where A_X not exceed 1.2 don't consider torsion irregularity.

4.6.2.4 P-Delta effects

From Appendix (A.2.5) stability coefficient (θ) were calculated for each story and as shown in table below where ($1 < \theta < \theta_{max}$) in each direction therefore, P-Delta Effects should be consider in design $\theta_{max} = 0.111$.

4.6.3 Floor Design

Determine the slab thickness

From ACI 318-14 (Table 8.3.1.1)

Rip Width (b_{Rip}) = 200mm $\geq$ 100mm

Rip depth = 175mm $\approx$ 200mm $\leq$ $3.5 \times b_{Rip}$ Increase Rip depth to resist flexural & shear failure

Take Slab thickness t_w = 140 mm $\geq$ 50mm

Overall depth = $t_{Rip} + t_w = 340\text{mm}$

Space between two ribs (S_{Ribs}) = $550\text{mm} \leq 750\text{ mm}$ the space reduced to (400mm to resist flexural failure & shear failure)

Design for drop panel

Min Drop Length = 1380 mm

For both direction drop Width = 2800 mm

For both direction drop length = (drop Width-column length – column width) = 2800 mm

Drop Depth = 340 mm

4.6.3.1 Slab shear strength – check for punching

Table 4.28: Parameters of Columns (C1&C2) of Waffle Floor Case for Model (8.3-7.5-7.2).

Column	Mu1 KN.m	Mu2 KN.m	γ_1	γ_2	I1 cm ⁴	I2 cm ⁴	Vu MPa	Vc Mpa	Vu/Vc %
C1	27	52	0.385051	0.415138	73734290	889512467	0.89	1.32	0.68
C2	20.67	46.6	0.349945	0.452234	18407836	34968177	0.89	1.23	0.68

4.6.3.2 Checking deflection

Table 4.29: Short Term Deflection& Long Term Deflection Model (8.3-7.5-7.2) for Waffle Floor.

	Floor deflection(mm)	Allowable deflection(mm)
Short term deflection(mm)	-7.72	-20.2
Long term deflection(mm)	-26.59	-34.5

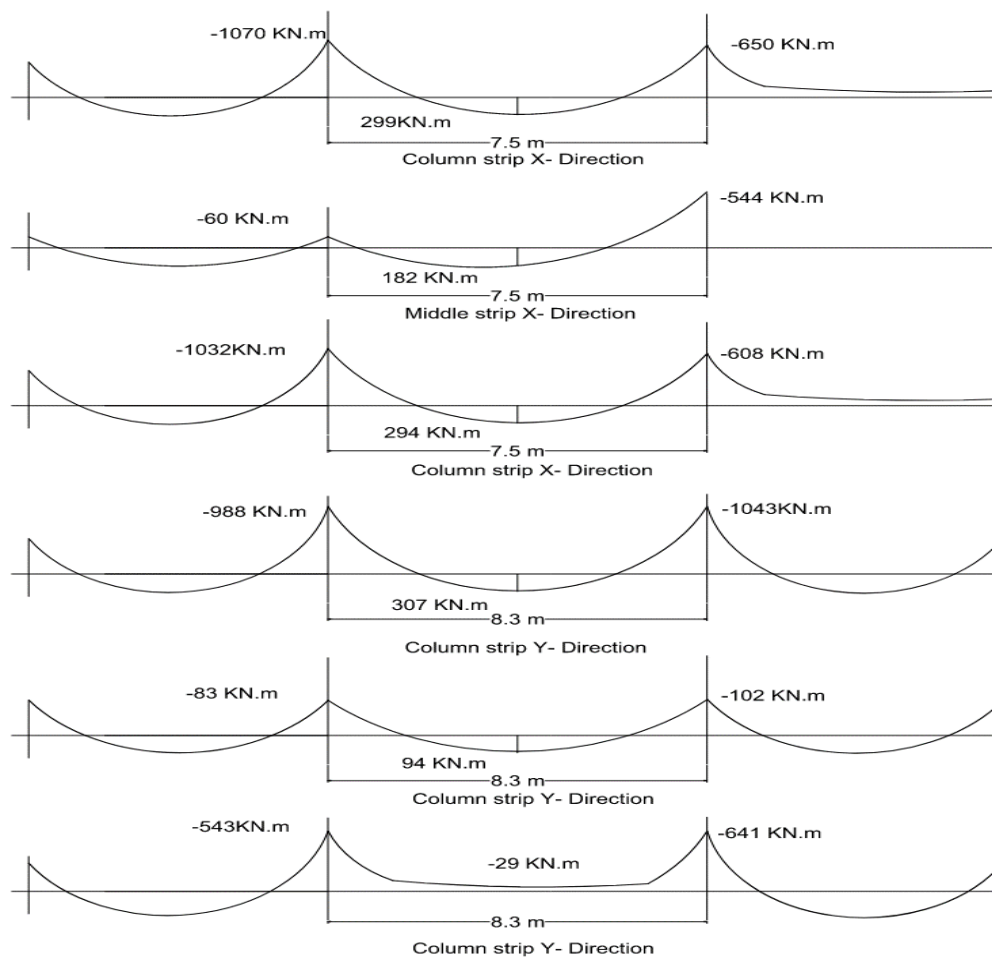


Figure 4.36: Showing Bending Moment Diagram for Panel (8.3x7.5) of Waffle Floor (8.3-7.5-7.2).

4.6.3.3 Design for the panel (8.3m x7.5m)

For Concrete Strength $f_c' = 30 \text{ Mpa}$, Steel Rebar Strength $f_y = 400 \text{ Mpa}$, $d = 120 \text{ mm}$

For $\emptyset 8$ at top Spacing $A_s / A_{s_{\emptyset 8}}$, $\emptyset 8 @ 300 \text{ mm}$

Same procedure as section (4.2.3.1.2)

Table 4.30: Steel Reinforcement Table for Panel (8.3x7.5) for Waffle Floor for Model (8.3-7.5-7.2).

Span	Cross-section	Location	Moment	RU	p	AS
Span 7.5 m	Column strip	M(-)	1070	12.55846	0.053273	10583
		M(+)	299	2.71705	0.006856	2472
		M(-)	650	5.544815	0.015073	8232
	Middle strip	M(-)	60	0.525894	0.001265	664
		M(+)	182	3.230551	0.008253	2191
		M(-)	544	4.994134	0.013361	6645
	Column strip	M(-)	1032	12.34934	0.049951	10161
		M(+)	294	2.813884	0.007117	3167
		M(-)	608	6.820097	0.019309	7606
Span 8.3 m	Column strip	M(-)	988	12.72143	0.05784	10331
		M(+)	307	4.619853	0.012232	2572
		M(-)	1043	12.47108	0.051734	10992
	Middle strip	M(-)	83	1.817701	0.004494	1009
		M(+)	94	1.644193	0.00405	1731
		M(-)	102	1.676003	0.004131	1240
	Column strip	M(-)	543	8.881949	0.027273	7390
		M(-)	29	4.048516	0.010557	664
		M(-)	641	8.883601	0.02728	8987

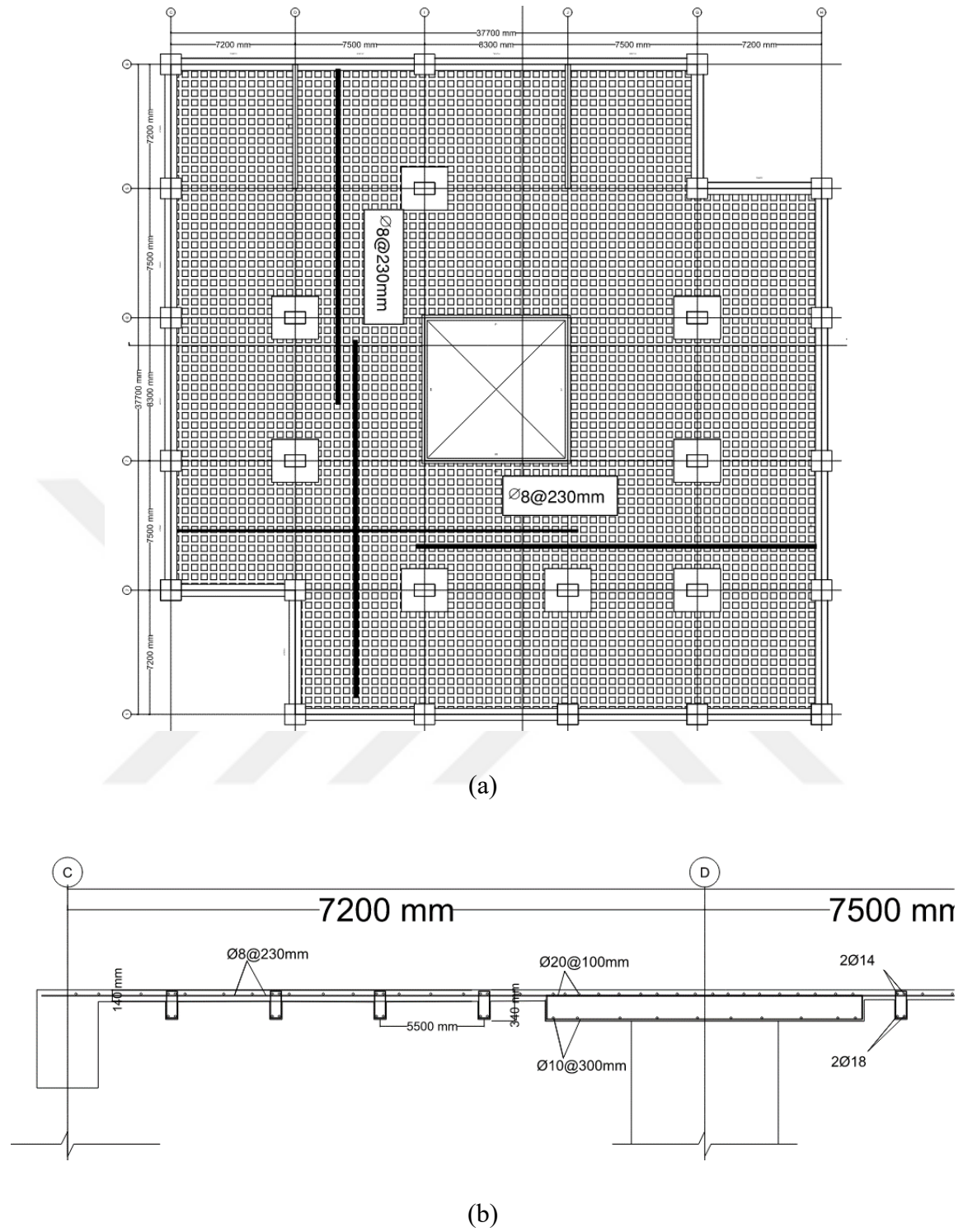


Figure 4.37: (a) Steel Reinforcement for Panel (8.3-7.5-7.2) for Waffle Floor (b) Section A Showing Steel Waffle Floor for Model (8.3-7.5-7.2).

5. RESULTS AND DISCUSION

5.1 COST RESULTS COMPARISON

5.1.1 Cost for Medium Length Span Model (6.3-5.5-5.2)

From section (A.4.1) concrete quantities shown in table (A.37), Framework quantities shown in table (A.38), from figure (A.1, A.2) rebar quantities shown in table (A.39).

Table 5.1: Shown Total Cost Conventional Floor for Model (6.3-5.5-5.2).

Item	Unite	QTY	Rate (\$/Unite)	Amount (\$)	Percentage (%)
Concrete	m ³	120.48	120.00	14457.906	39%
Framework	m ²	696.04	21.6	15034.356	39%
Steel Rebar	ton	11.1	783	8691.3	22%
total cost					\$ 38,450.91

From section (A.4.2) concrete quantities shown in table (A.40), Framework quantities shown in table (A.41), from figure (A.3, A.4) rebar quantities shown in table (A.42).

Table 5.2: Shown Total Cost in Flat Floor for Model (6.3-5.5-5.2).

Item	Unite	QTY	Rate (\$/Unite)	Amount (\$)	Percentage (%)
Concrete	m ³	131.34	120	15760	40%
Framework	m ²	673.52	21.6	14548	37%
Steel Rebar	ton	11.54	783	9035.8	23%
total cost					\$ 39,344.22

From section (A.4.3) concrete quantities shown in table (A.43), Framework quantities shown in table (A.44), and from figure (4.20) rebar quantities shown in table (A.45).

Table 5.3: Shown Total Cost in Waffle Floor for Model (6.3-5.5-5.2).

Item	Unite	QTY	Rate (\$/Unite)	Amount (\$)	Percentage (%)
Concrete	m ³	134.12	120	16094.592	38%
Framework	m ²	673.52	21.6	14548.032	35%
Steel Rebar	ton	13.19	783	10805.4	26%
Waffle mold	num	1998	0.3	599.4	1%
total cost					\$ 42,011.78

5.1.2 Comparison of Floors Cost of Medium Length Span Model (6.3-5.5-5.2)

From tables and values of section (A.4) compare between floor materials for (6.3-5.5-5.2)

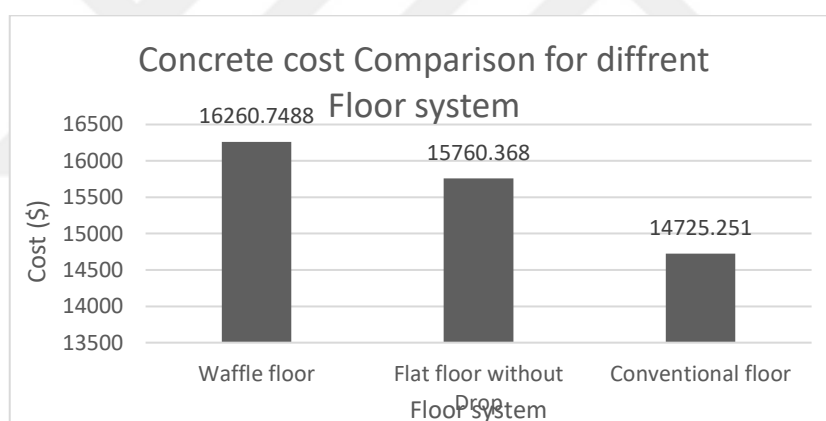


Figure 5.1: Concrete Cost Comparison for Model (6.3-5.5-5.2).

The results in the figure above show that concrete costs for Conventional floor are less expensive than other floor systems. In Conventional floor, the cost is less than waffle floors by 10%, it is less than flat floor with drop by 7%.

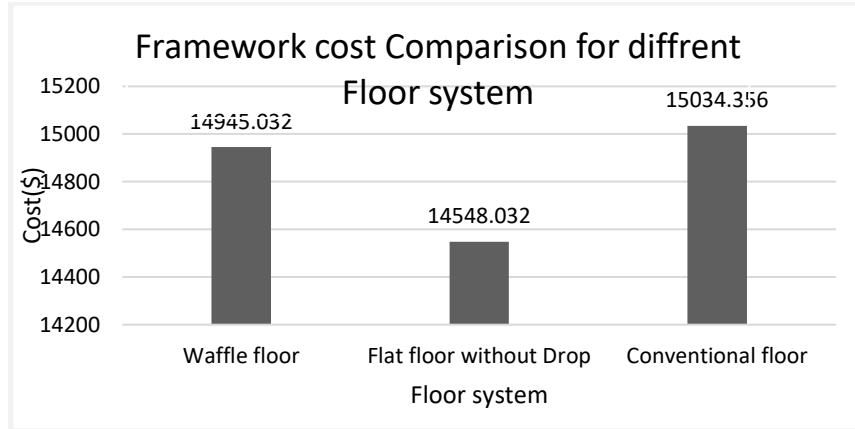


Figure 5.2: Framework Cost Comparison for Model (6.3-5.5-5.2).

This figure indicates that framework costs for flat floor are lower than other floor systems based on the results. There is a 2.7% reduction in cost for flat floor when compared to waffle floor, a 4% reduction in cost for conventional floor.

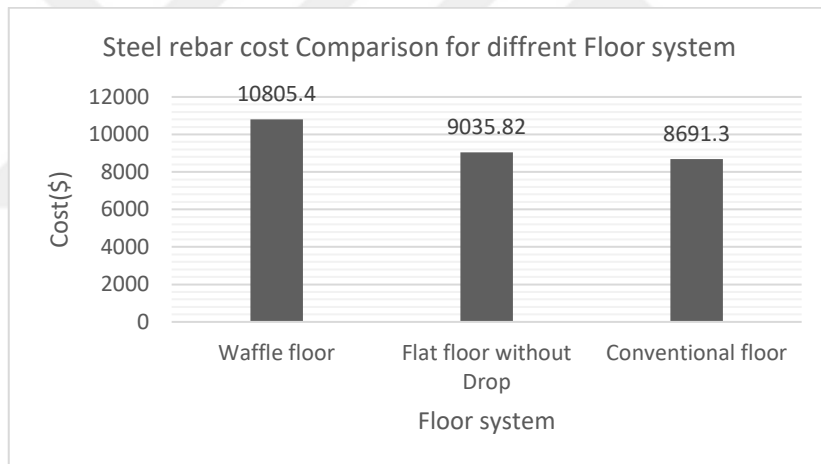


Figure 5.3: Steel Rebar Cost Comparison for Model (6.3-5.5-5.2).

This figure illustrates that steel rebar cost of conventional is less than that of other floor systems for one floor. A conventional floor costs 4% less than a flat floor, and it costs almost 16% less than a less than waffle floor. A conventional floor is more economically viable than all other floor systems when compared to the total floor cost.

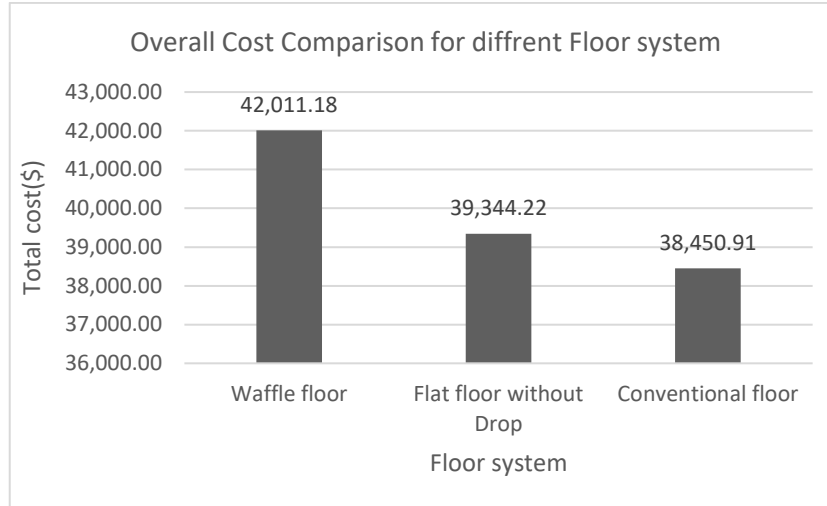


Figure 5.4: Overall Cost Comparison for Model (6.3-5.5-5.2).

The results in the figure above show that overall costs for conventional floors are less expensive than other floor systems. In conventional floor, the cost is less than waffle floors by 9.3%, it is less than and flat floors by 2.6%, flat floor less than waffle floor by 7%.

5.1.3 Cost for Long Length Span Model (8.3-7.5-7.2)

From Appendix section (A.5.1) concrete quantities shown in table (A.46), Framework quantities shown in table (A.47), rebar quantities shown in table (A.48).

Table 5.4: Shown Total Cost of Conventional Floor for Model (8.3-7.5-7.2).

Item	Unite	QTY	Rate (\$/Unite)	Amount (\$)	Percentage (%)
Concrete	m ³	343.95	120.00	41274.432	37%
Framework	m ²	1281.55	21.6	27681.5232	26%
Steel Rebar	ton	53.1	783	41577.3	37%
total cost					\$110,533.26

From Appendix section (A.5.2) concrete quantities shown in table (A.49), Framework quantities shown in table (A.50), rebar quantities shown in table (A.51).

Table 5.5: Shown Total Cost in Flat Floor for Model (8.3-7.5-7.2).

Item	Unite	QTY	Rate (\$/Unite)	Amount (\$)	Percentage (%)
Concrete	m ³	349.64	120	41957	35%
Framework	m ²	1248.72	21.6	26972	22%
Steel Rebar	ton	65.1	783	50973	43%
total cost					\$ 119,902.64

From section (A.5.3) concrete quantities shown in table (A.52), Framework quantities shown in table (A.53), and from figure (4.37) rebar quantities shown in table (A.54)

Table 5.6: Shown Total Cost in Waffle Floor for Model (8.3-7.5-7.2).

Item	Unite	QTY	Rate (\$/Unite)	Amount (\$)	Percentage (%)
Concrete	m ³	306.95	120	36834	38%
Framework	m ²	1248.72	21.6	26972.352	28%
Steel Rebar	ton	42	783	32886	34%
Waffel mold	num	3868	0.3	1160.4	1%
total cost					\$97,852.75

5.1.4 Comparison of Floors Cost of Long Length Span Model (8.3-7.5-7.2)

From tables of section (A.5) this section compare between floor materials for (8.3-7.5-7.2)

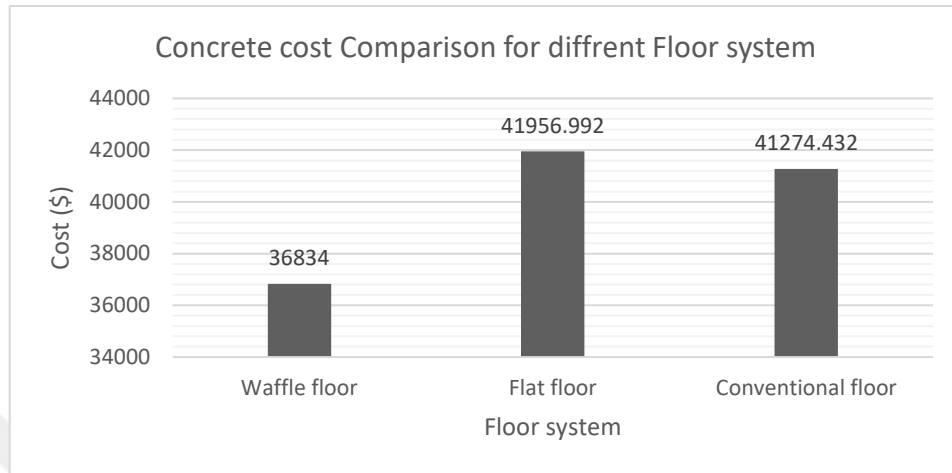


Figure 5.5: Concrete Cost Comparison for Model (8.3-7.5-7.2).

The results in the figure above show that concrete costs for Waffle floor are less expensive than other floor systems. In waffle floor, the cost is less than conventional floors by 3%, it is less than flat floor by 6%.

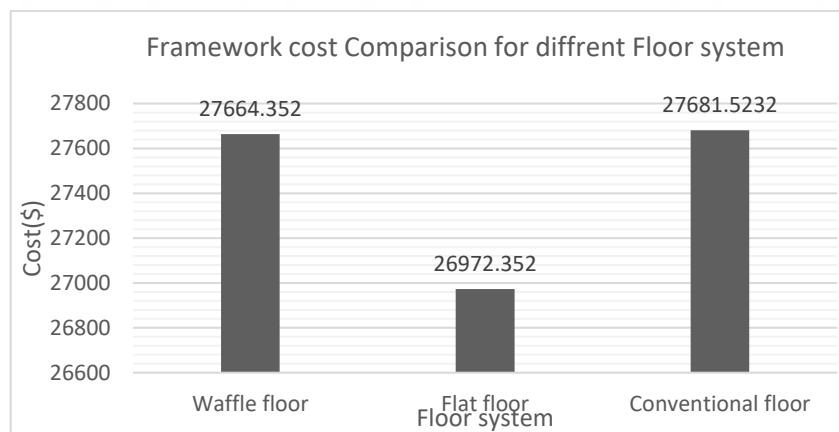


Figure 5.6: Framework Cost Comparison for Model (8.3-7.5-7.2).

The results in the figure above show that framework costs for flat floor s are less expensive than other floor systems. In flat floor, the cost is less than waffle floors by 2.7%, it is less than and conventional floors by 3.3%.

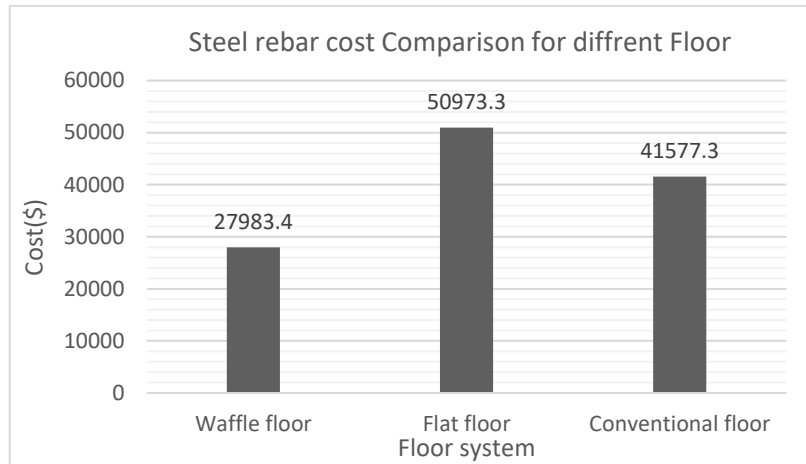


Figure 5.7: Steel Rebar Cost Comparison for Model (8.3-7.5-7.2).

This figure indicates that steel rebar costs are lower for waffle floor panels than other floor systems based on the results. There is a 22% reduction in cost for waffle floor when compared to flat floor, a 15% reduction in cost for conventional floor.

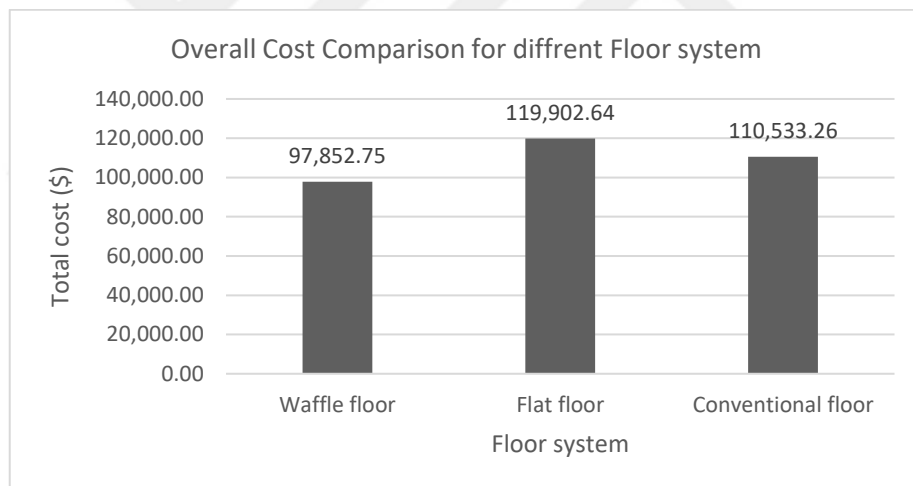


Figure 5.8: Overall Cost Comparison for Model (8.3-7.5-7.2).

This figure illustrates that the overall cost of a waffle is less than that of other floor systems for one floor. A waffle costs 21% less than a flat floor, and it costs almost 13% less than a conventional floor. A Waffle floor is more economically viable than all other floor systems when compared to the total floor cost.

5.1.5 Cost Comparison Between Medium Length Span and Long Length Span

A comparison is made between the model (6.5-5.5- 5.2) in and the model (8.3- 7.5- 7.2)

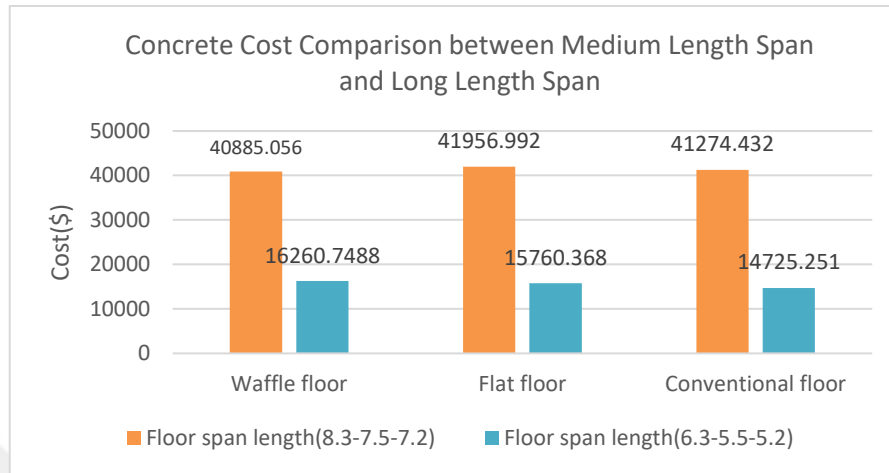


Figure 5.9: Concrete Cost Comparison between Medium Length Span and Long Length Span.

The figure above shows that concrete costs for waffle floors are less expensive than other floor systems in long length span while flat floor cost most. While in medium length span conventional floor consider to be less concrete cost and waffle floor cost the most.

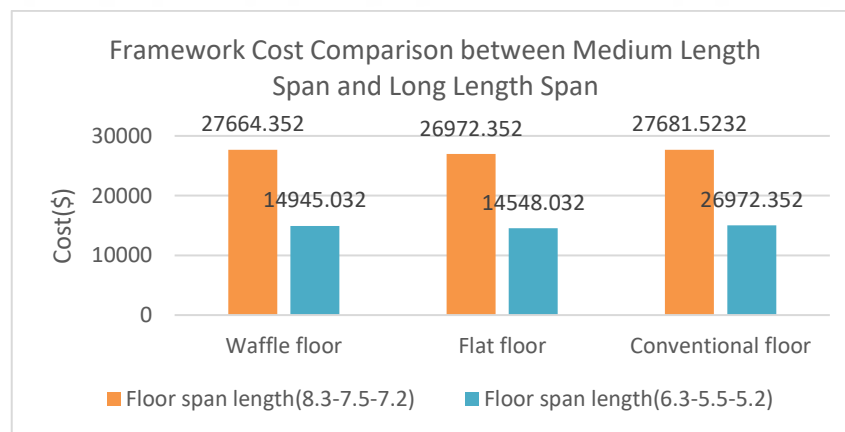


Figure 5.10: Framework Cost Comparison for Medium Length Span and Long Length Span.

The results in the figure above show that framework costs for Long length span model and medium length span model are more economical for flat floor where is less than others by 3% in long span and 4% in medium length.

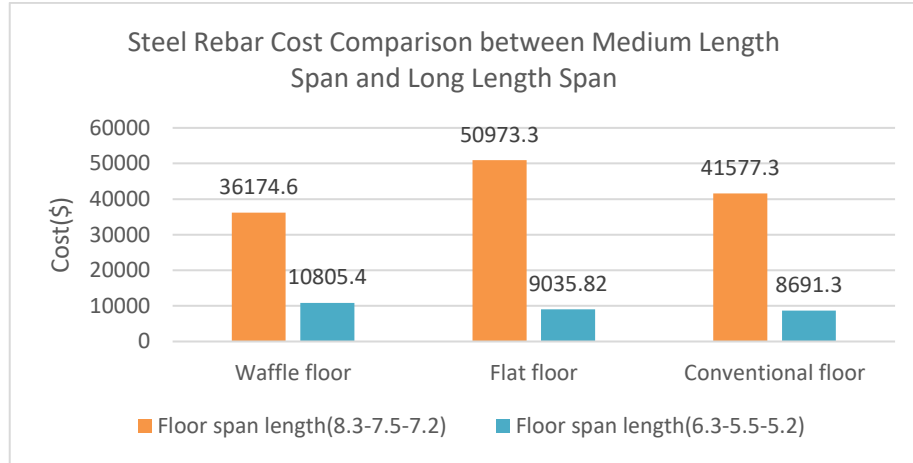


Figure 5.11: Steel Rebar Cost Comparison for Medium Length Span and Long Length Span.

This figure indicates that steel rebar costs are in model span (8.3, 7.5, 7.2) that Waffle floors cost less than other floor systems based on the results. While Conventional floor is cost less than others in (6.3, 5.5, 5.2) model.

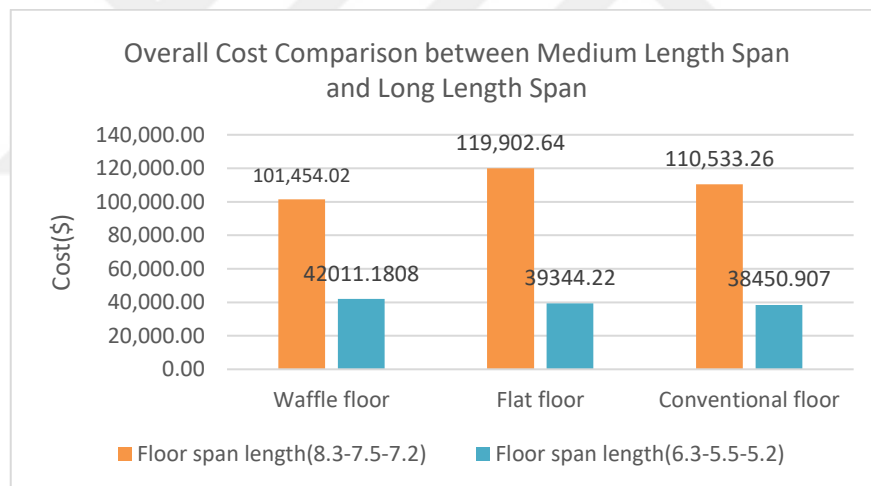


Figure 5.12: Overall Cost Comparison for Medium Length Span and Long Length Span.

This figure illustrates Compares of overall cost of model span (8.3-7.5-7.2) with (6.3-7.5-7.2) model. Accordingly, waffle floor has a span (8.3- 7.5- 7.2) that is lower than similar floor systems by 18% and 9% for flat floor with drop and conventional floor. While conventional floor consider to the economical vital option in model (6.3-5.5-5.2) and waffle floor is less economical choice.

5.2 STRUCTURAL RESULTS COMPARISON OF FLOORS

5.2.1 Floor Displacement

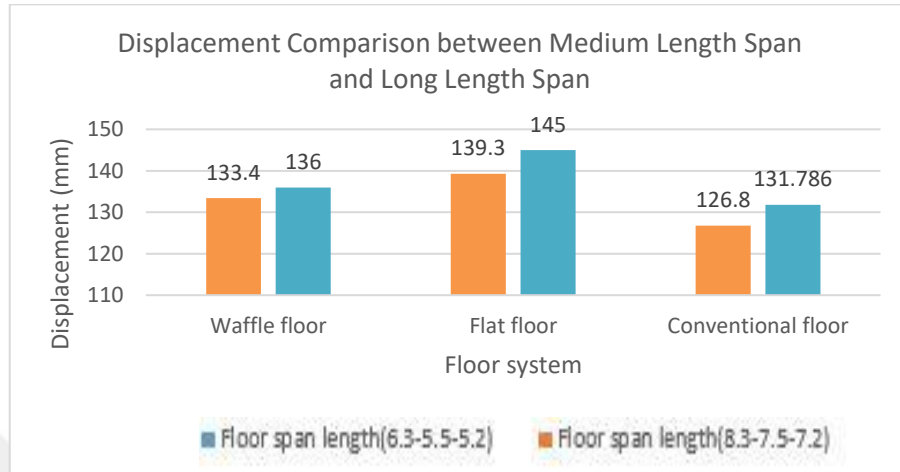


Figure 5.13: Shown Floor Displacement for Medium Length Span and Long Length Span.

As can be seen in the figure above, flat floor has a higher displacement value at storey 25 than other floor systems in both models. The results also show that waffle floor has a smaller displacement value in model (6.3-5.5-5.2) increase by 2% in model (8.3-7.5-7.2), while increase in conventional floor by 4%.

5.2.2 Floor Drift

According to the curve in figure shown below, flat floor drift higher at different stories in both long and medium length span. According to the results of the study, waffle floors tend to drift higher than conventional floor in both models (6.3-5.5-5.2) and (8.3-7.5-7.2),

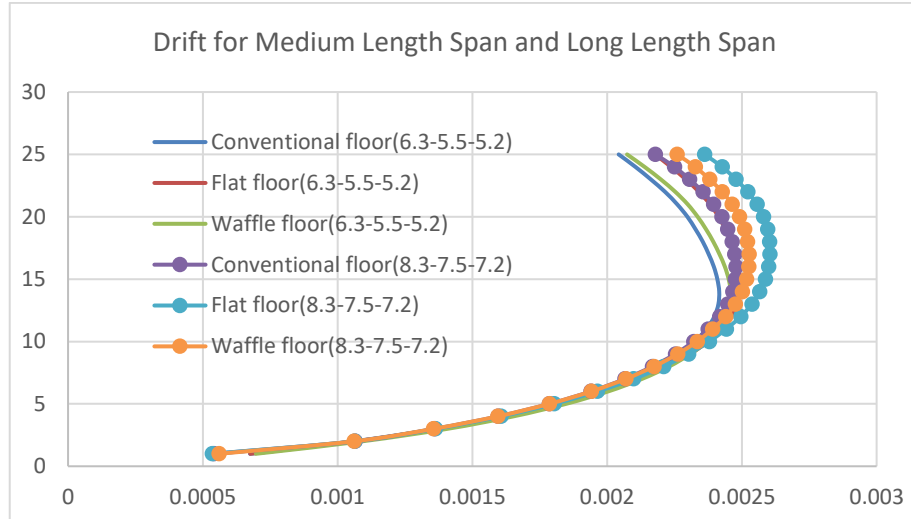


Figure 5.14: Shown Floor Drift VS Stories.

5.2.3 Time Period

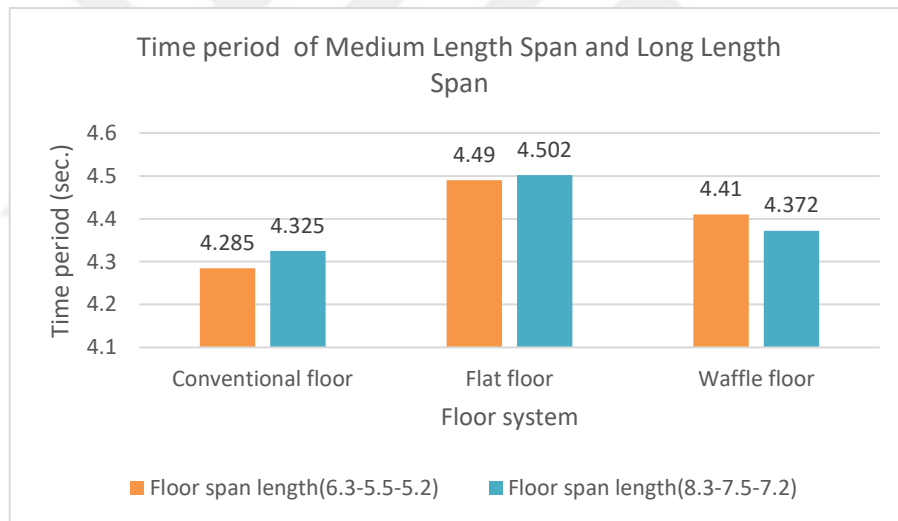


Figure 5.15: Shown Time period for Medium Length Span and Long Length Span.

This figure illustrates time period span of models (8.3-7.5-7.2) and (6.3-7.5-7.2). Accordingly, time period for flat floor higher than other floors in both models while conventional floor has less time period than other two models in both cases.

5.2.4 Base Shear

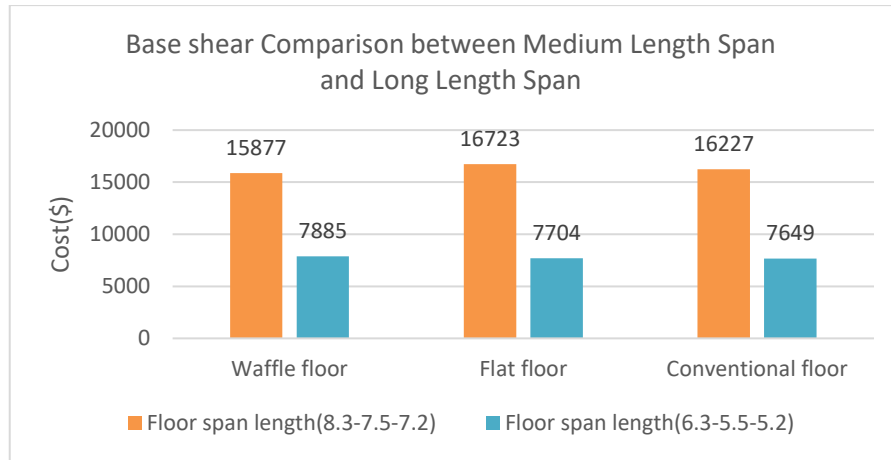


Figure 5.16: Shown Base Shear for Medium Length Span and Long Length Span.

This figure illustrates time period span of models (8.3-7.5-7.2) and (6.3-7.5-7.2). Accordingly, base shear flat floor higher than other floors in both models while conventional floor has less base shear than other two models in medium span length and waffle floor lower than other in long span length.

6. CONCLUSION

This study evaluated the total cost of three different floor systems (conventional floor, flat floor, and waffle floor) for tall buildings with the same peripheral beams, walls, and columns selected for comparison. Analysis and design of the building models were conducted in accordance with the requirements of ACI 318-14 and ASCE-16, which consist of 25 storeys and a storey dimension of 27.7x27.7 meters for main model with spans length (6.3m-5.5m-5.2m) model and secondary model with dimensions 37.7x37.7 meters with span length (8.3m-7.5m-7.2m) .

The analysis indicates that conventional floor system are more cost-effective for tall buildings with intermediate span lengths, whereas waffle floor systems and flat plate systems are more costly. It has been shown that waffle floors are more efficient and economical over long length spans, and flat plates are the most expensive floor system.

Based on the findings of this case study, the following conclusions can be drawn:

According to economic considerations, conventional floor system are more economical for intermediate span lengths model while waffle floors systems consider best economical option for long span buildings.

For medium length span models, conventional floor systems cost less concrete than other floor systems. In contrast, waffles require less concrete in long span models.

In comparison to other types of floor systems, flat floors are cost-effective due to their lower framework costs in both cases

Conventional floor have a lower cost of steel rebar than other floor systems in medium length floor system but in long length span system waffle floor consider to be more economic

According to the results of the research, a conventional floor has a lower drift and displacement value than other floors, whereas a flat floor has a higher drift and displacement value.

Buildings with flat floors experience more time than other floor systems for both models

A building with a flat floor system shows a higher base shear for a long span length, while a building with a waffle floor system shows a higher base shear for a medium span length.



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APPENDIX A

A.1 WIND CALCULATIONS AND RESULTS

Table A.1: Wind Calculation Parameters.

Parameter	Value	Definitions
$z(\text{bar})$	174.21	Equivalent height
$Iz(\text{bar})$	0.227	Intensity of turbulence
$Lz(\text{bar})$	557.19	Integral length scale of turbulence
gq	3.4	Peak factor of background responds
gv	3.4	Peack factor of wind respond
gr	3.896	Peack factor of resonant respond
Q	0.818	background respond factor
β	0.035	Damping Ratio
C_t	0.047	Period Coefficient
T	3.278	Approximate fundamental period
f	0.305	Natural frequency

Table A.2: Gust (G) factor calculation Parameters

Parameter	Value	Equation
$V(\text{bar}, z\text{bar})$	85.04	Eq.26-16
N_1	1.999	Eq. 26-14
R_n	0.089	26.9-13
μ_h	4.792	
R_h	0.187	Eq26.9-15a
μ_b	1.44	
R_B	0.467	Eq26.9-15a,b
h_d	4.822	
R_L	0.186	Eq26.9-15a,b
R	0.371	Eq26.9-12
G_f	0.884	The gust effective factor
G_{Use}	0.884	Eq.26.9-10

Table A.3: Wind Force Distribution.

Story	Height (m)	Force (KN)
Story25	88.5	258.5286
Story24	85	280.1701
Story23	81.5	258.1604
Story22	78	237.0269
Story21	74.5	216.7716
Story20	71	197.3967
Story19	67.5	178.9046
Story18	64	161.2977
Story17	60.5	144.5785
Story16	57	128.7497
Story15	53.5	113.8143
Story14	50	99.7753
Story13	46.5	86.6359
Story12	43	74.3999
Story11	39.5	63.071
Story10	36	52.6533
Story9	32.5	43.1516
Story8	29	34.568
Story7	25.5	26.9168
Story6	22	20.196
Story5	18.5	14.416
Story4	15	9.5857
Story3	11.5	5.7161
Story2	8	2.8212
Story1	4.5	0.9596

A.2 SEISMIC FORCE CALCULATIONS

A.2.1 Vertical Distribution of Seismic Forces

Find vertical Distribution of Seismic from section (3.6.1).

Table A.4: Vertical Distribution of Seismic Forces in Conventional Floor for Model (6.3-5.5-5.2).

Level	Weight (KN)	Height (m)	h_k	C_{vx}	F_x (KN)
Story25	8,714	88.5	7,832	0.098	282
Story24	10,112	85	7,225	0.105	302
Story23	10,112	81.5	6,642	0.096	278
Story22	10,112	78	6,084	0.088	254
Story21	10,112	74.5	5,550	0.081	232
Story20	10,112	71	5,041	0.073	211
Story19	10,112	67.5	4,556	0.066	190
Story18	10,112	64	4,096	0.059	171
Story17	10,112	60.5	3,660	0.053	153
Story16	10,112	57	3,249	0.047	136
Story15	10,112	53.5	2,862	0.042	120
Story14	10,112	50	2,500	0.036	105
Story13	10,112	46.5	2,162	0.031	90
Story12	10,112	43	1,849	0.027	77
Story11	10,112	39.5	1,560	0.023	65
Story10	10,112	36	1,296	0.019	54
Story9	10,112	32.5	1,056	0.015	44
Story8	10,112	29	841	0.012	35
Story7	10,112	25.5	650	0.009	27
Story6	10,112	22	484	0.007	20
Story5	10,112	18.5	342	0.005	14
Story4	10,112	15	225	0.003	9
Story3	10,112	11.5	132	0.002	6
Story2	10,112	8	64	0.001	3
Story1	10,512	4.5	20	0.000	1

Table A.5: Vertical Distribution of Seismic Forces in Flat Floor for Model (6.3-5.5-5.2).

Level	Weight (KN)	Height (m)	h^k	C_{vx}	FY (KN)
Story25	8,648	88.5	7,832	0.0979	280
Story24	10,046	85	7,225	0.1049	300
Story23	10,046	81.5	6,642	0.0964	276
Story22	10,046	78	6,084	0.0883	253
Story21	10,046	74.5	5,550	0.0806	231
Story20	10,046	71	5,041	0.0732	209
Story19	10,046	67.5	4,556	0.0661	189
Story18	10,046	64	4,096	0.0595	170
Story17	10,046	60.5	3,660	0.0531	152
Story16	10,046	57	3,249	0.0472	135
Story15	10,046	53.5	2,862	0.0415	119
Story14	10,046	50	2,500	0.0363	104
Story13	10,046	46.5	2,162	0.0314	90
Story12	10,046	43	1,849	0.0268	77
Story11	10,046	39.5	1,560	0.0226	65
Story10	10,046	36	1,296	0.0188	54
Story9	10,046	32.5	1,056	0.0153	44
Story8	10,046	29	841	0.0122	35
Story7	10,046	25.5	650	0.0094	27
Story6	10,046	22	484	0.0070	20
Story5	10,046	18.5	342	0.0050	14
Story4	10,046	15	225	0.0033	9
Story3	10,046	11.5	132	0.0019	5
Story2	10,046	8	64	0.0009	3
Story1	10,445	4.5	20	0.0003	1

Table A.6: Vertical Distribution of Seismic Forces in Waffle Floor for Model (6.3-5.5-5.2).

Story	Weight (KN)	Height (m)	Cvx	Fx (KN)
Story25	7,366	88.5	0.096	239
Story24	8,764	85	0.105	262
Story23	8,764	81.5	0.097	241
Story22	8,764	78	0.089	221
Story21	8,764	74.5	0.081	201
Story20	8,764	71	0.073	183
Story19	8,764	67.5	0.066	165
Story18	8,764	64	0.060	149
Story17	8,764	60.5	0.053	133
Story16	8,764	57	0.047	118
Story15	8,764	53.5	0.042	104
Story14	8,764	50	0.036	91
Story13	8,764	46.5	0.031	78
Story12	8,764	43	0.027	67
Story11	8,764	39.5	0.023	57
Story10	8,764	36	0.019	47
Story9	8,764	32.5	0.015	38
Story8	8,764	29	0.012	31
Story7	8,764	25.5	0.009	24
Story6	8,764	22	0.007	18
Story5	8,764	18.5	0.005	12
Story4	8,764	15	0.003	8
Story3	8,764	11.5	0.002	5
Story2	8,764	8	0.001	2
Story1	9,164	4.5	0.000	1

Table A.7: Vertical Distribution of Seismic Forces in Conventional Floor for Model (8.3-7.5-7.2).

Story	Weight (KN)	Height (m)	Cvx	Force (KN)
Story25	8,714	88.5	0.098	584
Story24	10,112	85	0.105	626
Story23	10,112	81.5	0.096	575
Story22	10,112	78	0.088	527
Story21	10,112	74.5	0.081	481
Story20	10,112	71	0.073	436
Story19	10,112	67.5	0.066	394
Story18	10,112	64	0.059	355
Story17	10,112	60.5	0.053	317
Story16	10,112	57	0.047	281
Story15	10,112	53.5	0.042	248
Story14	10,112	50	0.036	216
Story13	10,112	46.5	0.031	187
Story12	10,112	43	0.027	160
Story11	10,112	39.5	0.023	135
Story10	10,112	36	0.019	112
Story9	10,112	32.5	0.015	91
Story8	10,112	29	0.012	73
Story7	10,112	25.5	0.009	56
Story6	10,112	22	0.007	42
Story5	10,112	18.5	0.005	30
Story4	10,112	15	0.003	19
Story3	10,112	11.5	0.002	11
Story2	10,112	8	0.001	6
Story1	10,512	4.5	0.000	2

Table A.8: Vertical Distribution of Seismic Forces in Flat Plate Floor for Model (8.3-7.5-7.2).

Story	Weight (KN)	Height(m)	Cvx	Force (KN)
Story25	8,714	88.5	0.098	581.765
Story24	10,112	85	0.105	598.6337
Story23	10,112	81.5	0.096	551.606
Story22	10,112	78	0.088	506.4503
Story21	10,112	74.5	0.081	463.1713
Story20	10,112	71	0.073	421.7734
Story19	10,112	67.5	0.066	382.2617
Story18	10,112	64	0.059	344.6413
Story17	10,112	60.5	0.053	308.9178
Story16	10,112	57	0.047	275.0968
Story15	10,112	53.5	0.042	243.1846
Story14	10,112	50	0.036	213.1877
Story13	10,112	46.5	0.031	185.1132
Story12	10,112	43	0.027	158.9687
Story11	10,112	39.5	0.023	136.7226
Story10	10,112	36	0.019	115.7762
Story9	10,112	32.5	0.015	94.8833
Story8	10,112	29	0.012	76.0157
Story7	10,112	25.5	0.009	59.1857
Story6	10,112	22	0.007	44.4078
Story5	10,112	18.5	0.005	31.6985
Story4	10,112	15	0.003	21.0775
Story3	10,112	11.5	0.002	12.5687
Story2	10,112	8	0.001	6.2033
Story1	10,512	4.5	0.000	2.0903

Table A.9: Vertical Distribution of Seismic for Flat Floor in X-direction for Model (8.3-7.5-7.2).

Story	Weight (KN)	Height (m)	Cvx	Force (KN)
Story25	1832789.42	88.5	0.101	571.6319
Story24	2042111.67	85	0.104	589.276
Story23	2042111.67	81.5	0.096	542.9834
Story22	2042111.67	78	0.088	498.5336
Story21	2042111.67	74.5	0.080	455.931
Story20	2042111.67	71	0.073	415.1803
Story19	2042111.67	67.5	0.066	376.2863
Story18	2042111.67	64	0.059	339.254
Story17	2042111.67	60.5	0.053	304.0888
Story16	2042111.67	57	0.047	270.7965
Story15	2042111.67	53.5	0.041	239.3832
Story14	2042111.67	50	0.036	209.8552
Story13	2042111.67	46.5	0.031	182.2196
Story12	2042111.67	43	0.027	156.4837
Story11	2072091.32	39.5	0.023	134.5583
Story10	2102070.98	36	0.019	114.0203
Story9	2102070.98	32.5	0.016	93.3886
Story8	2102070.98	29	0.012	74.8185
Story7	2102070.98	25.5	0.010	58.2536
Story6	2102070.98	22	0.007	43.7147
Story5	2102070.98	18.5	0.005	31.2132
Story4	2102070.98	15	0.003	20.7504
Story3	2102070.98	11.5	0.002	12.3763
Story2	2102070.98	8	0.001	6.1083
Story1	2170442.95	4.5	0.000	2.0593

A.2.2 Story Drift

From section (12.8.6) ASCE7-16 define drift ratio as follow:

$$\delta_x = \frac{C_d \delta_{xe}}{I_e} \quad \text{Where}$$

δ_{xe} Elastic displacement

C_d Amplified displacement, and comparing to value in table (12.12-1) ASCE7-16, showing in tables for three floors cases

Table A.10: Drift & Displacement Values of Case in Conventional Floor for Model (6.3-5.5-5.2).

Story	Displacement (δ_i)	Story height	(Δi) Story Drift Ratio (%)	Allowable Story Drift Ratio (Δa)
	m	m		
Story25	126.872	3.5	0.00112	0.088
Story24	122.049	3.5	0.001153	0.088
Story23	117.104	3.5	0.001183	0.088
Story22	112.024	3.5	0.001218	0.088
Story21	106.788	3.5	0.001254	0.088
Story20	101.384	3.5	0.001289	0.088
Story19	95.811	3.5	0.001323	0.088
Story18	90.078	3.5	0.001352	0.088
Story17	84.197	3.5	0.001377	0.088
Story16	78.189	3.5	0.001396	0.088
Story15	72.079	3.5	0.001407	0.088
Story14	65.9	3.5	0.00141	0.088
Story13	59.685	3.5	0.001405	0.088
Story12	53.475	3.5	0.001389	0.088
Story11	47.315	3.5	0.001363	0.088
Story10	41.254	3.5	0.001325	0.088
Story9	35.345	3.5	0.001274	0.088
Story8	29.646	3.5	0.00121	0.088
Story7	24.219	3.5	0.001132	0.088
Story6	19.131	3.5	0.001037	0.088
Story5	14.456	3.5	0.000926	0.088
Story4	10.27	3.5	0.000796	0.088
Story3	6.661	3.5	0.000645	0.088
Story2	3.722	3.5	0.00047	0.088
Story1	1.575	4	0.000212	0.100

Table A.11: Drift & Displacement Values of Flat Floor Case for Model (6.3×5.5×5.2).

Story	Displacement (δ_i)	Story height	(Δi) Story Drift Ratio (%)	Allowable Story Drift Ratio (Δa)
	mm	m		
Story25	139.313	3.5	0.007049571	0.088
Story24	133.83	3.5	0.007203857	0.088
Story23	128.227	3.5	0.007373571	0.088
Story22	122.492	3.5	0.007576714	0.088
Story21	116.599	3.5	0.007790143	0.088
Story20	110.54	3.5	0.008004857	0.088
Story19	104.314	3.5	0.008206714	0.088
Story18	97.931	3.5	0.008390571	0.088
Story17	91.405	3.5	0.008544857	0.088
Story16	84.759	3.5	0.008663143	0.088
Story15	78.021	3.5	0.008737714	0.088
Story14	71.225	3.5	0.008763429	0.088
Story13	64.409	3.5	0.008732571	0.088
Story12	57.617	3.5	0.00864	0.088
Story11	50.897	3.5	0.008479286	0.088
Story10	44.302	3.5	0.008246571	0.088
Story9	37.888	3.5	0.007931571	0.088
Story8	31.719	3.5	0.007533	0.088
Story7	25.86	3.5	0.007043143	0.088
Story6	20.382	3.5	0.006453	0.088
Story5	15.363	3.5	0.005758714	0.088
Story4	10.884	3.5	0.004948714	0.088
Story3	7.035	3.5	0.004014	0.088
Story2	3.913	3.5	0.002916	0.088
Story1	1.645	4	0.001850625	0.100

Table A.12: Drift & Displacement Values of Waffle Floor Case for Model (6.3-5.5-5.2).

Story	Displacement (δ_i)	Story height	(Δi) Story Drift Ratio (%)	Allowable Story Drift Ratio (Δa)
	mm	m		
Story25	122.036	3.5	0.005632	0.088
Story24	117.108	3.5	0.005774857	0.088
Story23	112.055	3.5	0.005908571	0.088
Story22	106.885	3.5	0.006056	0.088
Story21	101.586	3.5	0.006210286	0.088
Story20	96.152	3.5	0.006362286	0.088
Story19	90.585	3.5	0.006502857	0.088
Story18	84.895	3.5	0.006626286	0.088
Story17	79.097	3.5	0.006726857	0.088
Story16	73.211	3.5	0.006797714	0.088
Story15	67.263	3.5	0.006836571	0.088
Story14	61.281	3.5	0.006836571	0.088
Story13	55.299	3.5	0.006792	0.088
Story12	49.356	3.5	0.006701714	0.088
Story11	43.492	3.5	0.006557714	0.088
Story10	37.754	3.5	0.00636	0.088
Story9	32.189	3.5	0.006100571	0.088
Story8	26.851	3.5	0.005777143	0.088
Story7	21.796	3.5	0.005384	0.088
Story6	17.085	3.5	0.00492	0.088
Story5	12.78	3.5	0.004373714	0.088
Story4	8.953	3.5	0.003745143	0.088
Story3	5.676	3.5	0.003021714	0.088
Story2	3.032	3.5	0.002194286	0.088
Story1	1.112	4	0.001112	0.100

Table A.13: Drift & Displacement Values of Case 1 for Model (8.3-7.5-7.2).

Story	Displacement (δ_i)	Story height	(Δi) Story Drift Ratio (%)	Allowable Story Drift Ratio (Δa)
	m	m		
Story25	131.786	3.5	0.00112	0.088
Story24	126.48	3.5	0.001153	0.088
Story23	121.03	3.5	0.001183	0.088
Story22	115.455	3.5	0.001218	0.088
Story21	109.738	3.5	0.001254	0.088
Story20	103.875	3.5	0.001289	0.088
Story19	97.869	3.5	0.001323	0.088
Story18	91.731	3.5	0.001352	0.088
Story17	85.479	3.5	0.001377	0.088
Story16	79.134	3.5	0.001396	0.088
Story15	72.724	3.5	0.001407	0.088
Story14	66.281	3.5	0.00141	0.088
Story13	59.841	3.5	0.001405	0.088
Story12	53.444	3.5	0.001389	0.088
Story11	47.136	3.5	0.001363	0.088
Story10	40.967	3.5	0.001325	0.088
Story9	34.982	3.5	0.001274	0.088
Story8	29.238	3.5	0.00121	0.088
Story7	23.795	3.5	0.001132	0.088
Story6	18.715	3.5	0.001037	0.088
Story5	14.064	3.5	0.000926	0.088
Story4	9.913	3.5	0.000796	0.088
Story3	6.342	3.5	0.000645	0.088
Story2	3.434	3.5	0.00047	0.088
Story1	1.286	4	0.000212	0.100

Table A.14: Drift & Displacement Values of Flat Floor Case 2 for Model (8.3-7.5-7.2).

Story	Displacement (δ_i)	Story height	(Δ_i) Story Drift Ratio (%)	Allowable Story Drift Ratio (Δ_a)
	mm	m		
Story25	145.046	3.5	0.011	0.088
Story24	138.95	3.5	0.011	0.088
Story23	132.718	3.5	0.012	0.088
Story22	126.366	3.5	0.012	0.088
Story21	119.88	3.5	0.012	0.088
Story20	113.256	3.5	0.012	0.088
Story19	106.5	3.5	0.012	0.088
Story18	99.625	3.5	0.012	0.088
Story17	92.65	3.5	0.012	0.088
Story16	85.6	3.5	0.012	0.088
Story15	78.506	3.5	0.012	0.088
Story14	71.402	3.5	0.012	0.088
Story13	64.327	3.5	0.012	0.088
Story12	57.326	3.5	0.012	0.088
Story11	50.447	3.5	0.012	0.088
Story10	43.746	3.5	0.012	0.088
Story9	37.266	3.5	0.011	0.088
Story8	31.07	3.5	0.011	0.088
Story7	25.218	3.5	0.010	0.088
Story6	19.775	3.5	0.010	0.088
Story5	14.812	3.5	0.009	0.088
Story4	10.401	3.5	0.008	0.088
Story3	6.624	3.5	0.007	0.088
Story2	3.565	3.5	0.005	0.088
Story1	1.324	4	0.003	0.100

Table A.15: Drift & Displacement Values of Waffle Floor Case3 for Model (8.3-7.5-7.2).

Story	Displacement (δ_i)	Story height	(Δi) Story Drift Ratio (%)	Allowable Story Drift Ratio (Δa)
	mm	m		
Story25	136.444	3.5	0.007232143	0.088
Story24	130.819	3.5	0.007408286	0.088
Story23	125.057	3.5	0.007561286	0.088
Story22	119.176	3.5	0.007736143	0.088
Story21	113.159	3.5	0.007916143	0.088
Story20	107.002	3.5	0.008087143	0.088
Story19	100.712	3.5	0.008246571	0.088
Story18	94.298	3.5	0.008381571	0.088
Story17	87.779	3.5	0.008485714	0.088
Story16	81.179	3.5	0.008553857	0.088
Story15	74.526	3.5	0.008580857	0.088
Story14	67.852	3.5	0.008559	0.088
Story13	61.195	3.5	0.008483143	0.088
Story12	54.597	3.5	0.008349429	0.088
Story11	48.103	3.5	0.008146286	0.088
Story10	41.767	3.5	0.007890429	0.088
Story9	35.63	3.5	0.007557429	0.088
Story8	29.752	3.5	0.007149857	0.088
Story7	24.191	3.5	0.006661286	0.088
Story6	19.01	3.5	0.006086571	0.088
Story5	14.276	3.5	0.005420571	0.088
Story4	10.06	3.5	0.004655571	0.088
Story3	6.439	3.5	0.00378	0.088
Story2	3.499	3.5	0.002781	0.088
Story1	1.336	4	0.001503	0.100

A.2.3 Checking Rigidity of Structure

Seismic force could cause eccentricity between the locations of the centre of mass and the centre of rigidity.

Table A.16: Centre of Rigidity and Centre of Mass Conventional Floor for Model (6.3-5.5-5.2).

Story	Mass (kg)	Center of mass in X direction (m)	Center of mass in Y direction (m)	Center of rigidity in X direction (m)	Center of rigidity in Y direction (m)	Ratio Eccentricity %
Story25	888562.33	22.2393	13.8007	22.0271	12.3997	5.1
Story24	1031158.23	22.2421	13.7928	22.0058	12.4755	4.7
Story23	1031158.23	22.243	13.7904	21.9895	12.5455	4.5
Story22	1031158.23	22.2434	13.7892	21.9748	12.608	4.3
Story21	1031158.23	22.2436	13.7885	21.9604	12.6655	4.0
Story20	1031158.23	22.2438	13.7881	21.9464	12.7198	3.8
Story19	1031158.23	22.2439	13.7878	21.9327	12.7722	3.7
Story18	1031158.23	22.244	13.7875	21.9195	12.8235	3.5
Story17	1031158.23	22.2441	13.7874	21.9066	12.8744	3.3
Story16	1031158.23	22.2441	13.7872	21.894	12.9254	3.1
Story15	1031158.23	22.2442	13.7871	21.8818	12.9769	2.9
Story14	1031158.23	22.2442	13.787	21.8698	13.0292	2.7
Story13	1031158.23	22.2442	13.7869	21.8579	13.0825	2.5
Story12	1031158.23	22.2443	13.7868	21.846	13.1369	2.3
Story11	1031158.23	22.2443	13.7868	21.8339	13.1923	2.1
Story10	1031158.23	22.2443	13.7867	21.8212	13.2488	1.9
Story9	1031158.23	22.2443	13.7867	21.8075	13.3061	1.7
Story8	1031158.23	22.2443	13.7866	21.7921	13.3639	1.5
Story7	1031158.23	22.2443	13.7866	21.7738	13.4215	1.3
Story6	1031158.23	22.2444	13.7866	21.7506	13.4783	1.1
Story5	1031158.23	22.246	13.8498	21.7192	13.5334	0.9
Story4	1031158.23	22.2461	13.8497	21.6737	13.5851	0.7
Story3	1031158.23	22.2462	13.8496	21.6027	13.6314	0.6
Story2	994107.68	22.2462	13.8496	21.4825	13.6685	0.4
Story1	1037654.47	22.2463	13.8495	21.2735	13.6792	0.4

Table A.17: Centre of Rigidity and Centre of Mass of Flat Floor for Model (6.3-5.5-5.2).

Story	Mass (kg)	Center of mass in X direction (m)	Center of mass in Y direction (m)	Center of rigidity in X direction (m)	Center of rigidity in Y direction (m)	Ratio of Eccentricity %
Story25	881800.99	22.2471	13.861	22.0744	12.2397	5.85
Story24	1024396.9	22.2514	13.8377	22.049	12.3272	5.45
Story23	1024396.9	22.2514	13.8377	22.0294	12.4081	5.16
Story22	1024396.9	22.2514	13.8377	22.0114	12.4809	4.90
Story21	1024396.9	22.2514	13.8377	21.994	12.5482	4.66
Story20	1024396.9	22.2514	13.8377	21.9771	12.6118	4.43
Story19	1024396.9	22.2514	13.8377	21.9607	12.673	4.20
Story18	1024396.9	22.2514	13.8377	21.9448	12.7329	3.99
Story17	1024396.9	22.2514	13.8377	21.9294	12.792	3.78
Story16	1024396.9	22.2514	13.8377	21.9146	12.851	3.56
Story15	1024396.9	22.2514	13.8377	21.9002	12.9102	3.35
Story14	1024396.9	22.2514	13.8377	21.8862	12.9699	3.13
Story13	1024396.9	22.2514	13.8377	21.8724	13.0303	2.91
Story12	1024396.9	22.2514	13.8377	21.8588	13.0914	2.69
Story11	1024396.9	22.2514	13.8377	21.8451	13.1534	2.47
Story10	1024396.9	22.2514	13.8377	21.831	13.2159	2.24
Story9	1024396.9	22.2514	13.8377	21.816	13.2789	2.02
Story8	1024396.9	22.2471	13.861	21.7994	13.3418	1.79
Story7	1024396.9	22.2514	13.8377	21.78	13.4042	1.56
Story6	1024396.9	22.2514	13.8377	21.7557	13.4652	1.34
Story5	1024396.9	22.2514	13.8377	21.7233	13.5239	1.13
Story4	1024396.9	22.2514	13.8377	21.6768	13.5786	0.94
Story3	1024396.9	22.2514	13.8377	21.6049	13.6273	0.76
Story2	1024396.9	22.2514	13.8377	21.4836	13.6662	0.62
Story1	1065138.59	22.2514	13.8377	21.2733	13.6786	0.55

Table A.18: Centre of Rigidity and Centre of Mass of Waffle Floor for Model (6.3-5.5-5.2).

Story	Mass(kg)	Center of mass in X direction (m)	Center of mass in Y direction (m)	Center of rigidity in X direction (m)	Center of rigidity in Y direction (m)	Ratio Eccentricity %
Story25	744226.55	22.2338	13.9058	22.1218	12.1009	6.5
Story24	886822.46	22.2408	13.8718	22.0935	12.1972	6.0
Story23	886822.46	22.2408	13.8718	22.0709	12.2867	5.7
Story22	886822.46	22.2408	13.8718	22.0502	12.3674	5.4
Story21	886822.46	22.2408	13.8718	22.0302	12.442	5.2
Story20	886822.46	22.2408	13.8718	22.0108	12.5126	4.9
Story19	886822.46	22.2408	13.8718	21.992	12.5805	4.7
Story18	886822.46	22.2408	13.8718	21.9738	12.6467	4.4
Story17	886822.46	22.2408	13.8718	21.9562	12.712	4.2
Story16	886822.46	22.2408	13.8718	21.9392	12.7769	4.0
Story15	886822.46	22.2408	13.8718	21.9228	12.8418	3.7
Story14	886822.46	22.2408	13.8718	21.9068	12.9071	3.5
Story13	886822.46	22.2408	13.8718	21.8911	12.973	3.2
Story12	886822.46	22.2408	13.8718	21.8757	13.0395	3.0
Story11	886822.46	22.2408	13.8718	21.8603	13.1066	2.8
Story10	886822.46	22.2408	13.8718	21.8445	13.1743	2.5
Story9	886822.46	22.2408	13.8718	21.8279	13.2421	2.3
Story8	886822.46	22.2408	13.8718	21.8098	13.3098	2.0
Story7	886822.46	22.2408	13.8718	21.789	13.3767	1.8
Story6	886822.46	22.2408	13.8718	21.7635	13.442	1.6
Story5	886822.46	22.2408	13.8718	21.73	13.5045	1.3
Story4	886822.46	22.2408	13.8718	21.6824	13.5628	1.1
Story3	886822.46	22.2408	13.8718	21.6097	13.6145	0.9
Story2	886822.46	22.2408	13.8718	21.4878	13.656	0.8
Story1	927564.14	22.2425	13.864	21.2779	13.6703	0.7

Table A.19: Centre of Rigidity and Center of Mass of Conventional Floor for Model.

Story	Mass (kg)	Center of mass in X direction (m)	Center of mass in Y direction (m)	Center of rigidity in X direction (m)	Center of rigidity in Y direction (m)	Ratio Eccentricity %
Story25	1899323	27.2633	18.7987	26.8796	17.4116	5.0
Story24	2126397.72	27.2752	18.7502	26.86	17.4786	4.6
Story23	2126397.72	27.2752	18.7502	26.8438	17.5468	4.3
Story22	2126397.72	27.2752	18.7502	26.831	17.6101	4.1
Story21	2126397.72	27.2752	18.7502	26.8193	17.6689	3.9
Story20	2126397.72	27.2752	18.7502	26.8081	17.724	3.7
Story19	2126397.72	27.2752	18.7502	26.7972	17.7766	3.5
Story18	2126397.72	27.2752	18.7502	26.7864	17.8273	3.3
Story17	2126397.72	27.2752	18.7502	26.7758	17.8766	3.2
Story16	2126397.72	27.2752	18.7502	26.7653	17.9251	3.0
Story15	2126397.72	27.2752	18.7502	26.7548	17.9729	2.8
Story14	2126397.72	27.2752	18.7502	26.7441	18.0202	2.6
Story13	2126397.72	27.2752	18.7502	26.7331	18.0671	2.5
Story12	2126397.72	27.2752	18.7502	26.7217	18.1132	2.3
Story11	2134444.34	27.2786	18.7396	26.7097	18.1572	2.1
Story10	2143009.95	27.2823	18.7284	26.6965	18.1993	1.9
Story9	2143009.95	27.2823	18.7284	26.6809	18.2414	1.8
Story8	2143009.95	27.2823	18.7284	26.6623	18.2811	1.6
Story7	2143009.95	27.2823	18.7284	26.6394	18.3169	1.5
Story6	2143009.95	27.2823	18.7284	26.61	18.3463	1.4
Story5	2143009.95	27.2823	18.7284	26.5711	18.3653	1.3
Story4	2143009.95	27.2823	18.7284	26.5186	18.3665	1.3
Story3	2143009.95	27.2823	18.7284	26.4484	18.3336	1.4
Story2	2143009.95	27.2633	18.7987	26.8796	17.4116	1.8
Story1	1899323	27.2752	18.7502	26.86	17.4786	2.8

Table A.20: Centre of Rigidity and Center of Mass of Flat Floor for Model (8.3-7.5-7.2).

Story	Mass (kg)	Center of mass in X direction (m)	Center of mass in Y direction (m)	Center of rigidity in X direction (m)	Center of rigidity in Y direction (m)	Ratio of Eccentricity %
Story25	1851710.82	27.2451	18.8657	26.8519	17.547	4.8
Story24	2061033.06	27.2475	18.8468	26.8311	17.6158	4.4
Story23	2061033.06	27.2475	18.8468	26.8152	17.6835	4.2
Story22	2061033.06	27.2475	18.8468	26.8029	17.7463	4.0
Story21	2061033.06	27.2475	18.8468	26.7917	17.8047	3.8
Story20	2061033.06	27.2475	18.8468	26.7808	17.8596	3.6
Story19	2061033.06	27.2475	18.8468	26.7703	17.9118	3.4
Story18	2061033.06	27.2475	18.8468	26.7599	17.9619	3.2
Story17	2061033.06	27.2475	18.8468	26.7496	18.0105	3.0
Story16	2061033.06	27.2475	18.8468	26.7394	18.0577	2.8
Story15	2061033.06	27.2475	18.8468	26.7291	18.1039	2.7
Story14	2061033.06	27.2475	18.8468	26.7187	18.1491	2.5
Story13	2061033.06	27.2475	18.8468	26.708	18.1932	2.4
Story12	2061033.06	27.2475	18.8468	26.6968	18.2362	2.2
Story11	2091012.72	27.261	18.8051	26.6856	18.2757	1.9
Story10	2120992.37	27.2741	18.7646	26.6748	18.3118	1.6
Story9	2120992.37	27.2741	18.7646	26.6595	18.3487	1.5
Story8	2120992.37	27.2741	18.7646	26.6407	18.3832	1.4
Story7	2120992.37	27.2741	18.7646	26.6171	18.4138	1.3
Story6	2120992.37	27.2741	18.7646	26.5866	18.4382	1.2
Story5	2120992.37	27.2741	18.7646	26.5456	18.4532	1.1
Story4	2120992.37	27.2741	18.7646	26.4895	18.4521	1.1
Story3	2120992.37	27.2741	18.7646	26.4126	18.4203	1.2
Story2	2120992.37	27.2741	18.7646	26.3177	18.3176	1.6

Table A.21: Centre of Rigidity and Center of Mass of Waffle Floor Case for Model (8.3-7.5-7.2).

Story	Mass (kg)	Center of mass in X direction (m)	Center of mass in Y direction (m)	Center of rigidity in X direction (m)	Center of rigidity in Y direction (m)	Ratio Eccentricity %
Story25	1819153.5	27.2316	18.9135	26.8712	17.591	4.8
Story24	2028475.7	27.2354	18.8894	26.8487	17.657	4.4
Story23	2028475.7	27.2354	18.8894	26.8312	17.7218	4.2
Story22	2028475.7	27.2354	18.8894	26.8172	17.7818	4.0
Story21	2028475.7	27.2354	18.8894	26.8044	17.8375	3.8
Story20	2028475.7	27.2354	18.8894	26.792	17.8899	3.6
Story19	2028475.7	27.2354	18.8894	26.7798	17.9398	3.4
Story18	2028475.7	27.2354	18.8894	26.7678	17.9878	3.3
Story17	2028475.7	27.2354	18.8894	26.7558	18.0344	3.1
Story16	2028475.7	27.2354	18.8894	26.7438	18.0799	2.9
Story15	2028475.7	27.2354	18.8894	26.7317	18.1245	2.8
Story14	2028475.7	27.2354	18.8894	26.7193	18.1684	2.6
Story13	2028475.7	27.2354	18.8894	26.7065	18.2114	2.4
Story12	2028475.7	27.2354	18.8894	26.6929	18.2535	2.3
Story11	2057566.7	27.2431	18.859	26.6792	18.2926	2.0
Story10	2088476.4	27.2549	18.8114	26.6655	18.3286	1.7
Story9	2087230.5	27.2565	18.8146	26.6467	18.366	1.6
Story8	2087239.8	27.2565	18.8147	26.6239	18.4014	1.5
Story7	2087239.8	27.2565	18.8147	26.5955	18.4335	1.4
Story6	2087537.1	27.2566	18.817	26.5591	18.4607	1.3
Story5	2088169.9	27.2547	18.809	26.5106	18.4801	1.2
Story4	2087732.4	27.2563	18.818	26.4435	18.4866	1.2
Story3	2088169.9	27.2547	18.809	26.3486	18.469	1.2
Story2	2088169.9	27.2547	18.809	26.2161	18.3985	1.5
Story1	2156541.8	27.2588	18.794	26.0488	18.2188	2.1

A.2.4 Checking for Amplification of Accidental Torsional Moment

From ASCE7-16 section (12.8.4.3) amplification of Accidental Torsional Moment calculated and categorize torsion irregularity from table (12.3-1) as shown in equation and tables below

$$Ax = \left(\frac{\delta_{max}}{1.2 \delta_{avg}} \right)^2$$

Table A.22: Amplification of Accidental of Conventional Floor in Y Direction Model (6.3-5.5-5.2).

Story	Max	Average	Ax
	m	m	
Story25	96.631	91.953	0.8
Story24	93.209	88.536	0.8
Story23	89.654	85.01	0.8
Story22	85.973	81.381	0.8
Story21	82.149	77.631	0.8
Story20	78.175	73.751	0.8
Story19	74.051	69.741	0.8
Story18	69.784	65.605	0.8
Story17	65.384	61.353	0.8
Story16	60.867	56.999	0.8
Story15	56.253	52.562	0.8
Story14	51.566	48.064	0.8
Story13	46.834	43.532	0.8
Story12	42.087	38.996	0.8
Story11	37.359	34.488	0.8
Story10	32.689	30.046	0.8
Story9	28.117	25.709	0.8
Story8	23.687	21.521	0.8
Story7	19.449	17.53	0.9
Story6	15.455	13.788	0.9
Story5	11.761	10.35	0.9
Story4	8.431	7.279	0.9
Story3	5.531	4.641	1.0
Story2	3.135	2.51	1.1
Story1	1.338	0.978	1.3

Table A.23: Amplification of Accidental of Flat Floor in Y Direction for Model (6.3-5.5-5.2).

Story	Max	Average	Ax
	m	m	
Story25	120.037	116.017	0.74
Story24	115.511	111.521	0.75
Story23	110.826	106.882	0.75
Story22	106.009	102.128	0.75
Story21	101.037	97.236	0.75
Story20	95.905	92.201	0.75
Story19	90.614	87.022	0.75
Story18	85.173	81.706	0.75
Story17	79.596	76.267	0.76
Story16	73.905	70.723	0.76
Story15	68.123	65.1	0.76
Story14	62.281	59.425	0.76
Story13	56.413	53.731	0.77
Story12	50.556	48.055	0.77
Story11	44.75	42.436	0.77
Story10	39.043	36.92	0.78
Story9	33.481	31.553	0.78
Story8	28.118	26.389	0.79
Story7	23.012	21.483	0.80
Story6	18.222	16.895	0.81
Story5	13.815	12.693	0.82
Story4	9.864	8.946	0.84
Story3	6.447	5.735	0.88
Story2	3.647	3.141	0.94
Story1	1.568	1.275	1.05

Table A.24: Amplification of Accidental of Waffle Floor in Y Direction for Model (6.3-5.5-5.2).

Story	Max	Average	Ax
	m	m	
Story25	106.788	103.381	0.74
Story24	102.522	99.142	0.74
Story23	98.146	94.807	0.74
Story22	93.667	90.383	0.75
Story21	89.07	85.856	0.75
Story20	84.349	81.22	0.75
Story19	79.507	76.476	0.75
Story18	74.553	71.632	0.75
Story17	69.498	66.698	0.75
Story16	64.362	61.692	0.76
Story15	59.165	56.635	0.76
Story14	53.934	51.552	0.76
Story13	48.698	46.471	0.76
Story12	43.491	41.424	0.77
Story11	38.349	36.448	0.77
Story10	33.312	31.582	0.77
Story9	28.423	26.866	0.78
Story8	23.727	22.348	0.78
Story7	19.276	18.077	0.79
Story6	15.121	14.104	0.80
Story5	11.321	10.487	0.81
Story4	7.937	7.286	0.82
Story3	5.035	4.567	0.84
Story2	2.69	2.4	0.91
Story1	0.99	0.865	0.1

Table A.25: Amplification of Accidental of Conventional Floor in Y Direction Model (8.3-7.5-7.2).

Story	Max	Average	Ax
	m	m	
Story25	150.089	140.055	0.80
Story24	144.197	134.413	0.80
Story23	138.135	128.604	0.80
Story22	131.919	122.657	0.80
Story21	125.529	116.562	0.81
Story20	118.959	110.313	0.81
Story19	112.211	103.912	0.81
Story18	105.296	97.371	0.81
Story17	98.233	90.706	0.81
Story16	91.046	83.939	0.82
Story15	83.767	77.1	0.82
Story14	76.433	70.222	0.82
Story13	69.085	63.346	0.83
Story12	61.77	56.514	0.83
Story11	54.541	49.777	0.83
Story10	47.455	43.189	0.84
Story9	40.567	36.802	0.84
Story8	33.943	30.677	0.85
Story7	27.653	24.882	0.86
Story6	21.77	19.487	0.87
Story5	16.374	14.565	0.88
Story4	11.549	10.195	0.89
Story3	7.39	6.463	0.91
Story2	3.997	3.456	0.93
Story1	1.489	1.27	0.95

Table A.26: Amplification of Accidental of Flat Floor in Y Direction for Model (8.3-7.5-7.2).

Story	Max	Average	Ax
	m	m	
Story25	115.269	108.976	0.78
Story24	110.598	104.333	0.78
Story23	105.79	99.583	0.78
Story22	100.866	94.747	0.79
Story21	95.817	89.815	0.79
Story20	90.643	84.785	0.79
Story19	85.35	79.662	0.80
Story18	79.948	74.454	0.80
Story17	74.454	69.177	0.80
Story16	68.888	63.848	0.81
Story15	63.273	58.489	0.81
Story14	57.64	53.128	0.82
Story13	52.018	47.794	0.82
Story12	46.443	42.521	0.83
Story11	40.954	37.344	0.84
Story10	35.599	32.309	0.84
Story9	30.408	27.446	0.85
Story8	25.43	22.805	0.86
Story7	20.714	18.433	0.88
Story6	16.313	14.381	0.89
Story5	12.282	10.701	0.91
Story4	8.68	7.452	0.94
Story3	5.574	4.693	0.98
Story2	3.039	2.491	1.03

Table A.27: Amplification of Accidental of Waffle Floor in X Direction for Model (8.3-7.5-7.2).

Story	Max	Average	Ax
	m	m	
Story25	150.089	140.055	0.80
Story24	144.197	134.413	0.80
Story23	138.135	128.604	0.80
Story22	131.919	122.657	0.80
Story21	125.529	116.562	0.81
Story20	118.959	110.313	0.81
Story19	112.211	103.912	0.81
Story18	105.296	97.371	0.81
Story17	98.233	90.706	0.81
Story16	91.046	83.939	0.82
Story15	83.767	77.1	0.82
Story14	76.433	70.222	0.82
Story13	69.085	63.346	0.83
Story12	61.77	56.514	0.83
Story11	54.541	49.777	0.83
Story10	47.455	43.189	0.84
Story9	40.567	36.802	0.84
Story8	33.943	30.677	0.85
Story7	27.653	24.882	0.86
Story6	21.77	19.487	0.87
Story5	16.374	14.565	0.88
Story4	11.549	10.195	0.89
Story3	7.39	6.463	0.91
Story2	3.997	3.456	0.93
Story1	1.489	1.27	0.95

A.2.5 P-Delta Effects

From ASCE7-16 section (12.8.4.3) amplification of Accidental Torsional Moment calculated and categorize torsion irregularity from table (12.3-1) as shown in equation and tables below

$$\theta = \frac{P_x \Delta_i e}{V_x h_{sx} C_d} \text{ Where}$$

P_x total vertical design load

Δ the design story drift

V_x the seismic shear force

Table A.28: P-Delta Effects for Different Stores of Conventional Floor for Model (6.3-5.5-5.2).

Level	Seismic Shear force V_x (kN)	Axial force P_x (kN)	Displacement U_x (mm)	Story Drift (Δ_i) (mm)	stability coefficient θ
25	-277.2965	10112.2081	126.872	21.92	0.05
24	-574.7942	20224.477	122.049	22.48	0.05
23	-848.9209	30336.7459	117.104	23.09	0.05
22	-1100.6071	40449.0148	112.024	23.80	0.06
21	-1330.7852	50561.2838	106.788	24.56	0.06
20	-1540.3903	60673.5527	101.384	25.32	0.06
19	-1730.3595	70785.8217	95.811	26.05	0.07
18	-1901.6328	80898.0906	90.078	26.71	0.07
17	-2055.153	91010.3595	84.197	27.29	0.1
16	-2191.8654	101122.6284	78.189	27.74	0.1
15	-2312.7187	111234.8974	72.079	28.07	0.1
14	-2418.6647	121347.1663	65.9	28.22	0.1
13	-2510.6588	131459.4352	59.685	28.19	0.1
12	-2589.6601	141571.7042	53.475	27.97	0.1
11	-2656.6318	151683.9731	47.315	27.52	0.1
10	-2712.5415	161796.242	41.254	26.82	0.1
9	-2758.3619	171908.511	35.345	25.87	0.1
8	-2795.0708	182020.7799	29.646	24.63	0.1
7	-2823.6523	192133.0488	24.219	23.09	0.1
6	-2845.0974	202245.3178	19.131	21.22	0.1
5	-2860.405	212357.5867	14.456	18.99	0.1
4	-2870.5836	222469.8556	10.27	16.38	0.08
3	-2876.6532	232582.1246	6.661	13.33	0.07
2	-2879.6488	242694.3935	3.722	9.74	0.05
1	-2880.6654	253605.7414	1.575	7.14	0.03

Table A.29: P-Delta Effects for Different Stores of Flat Floor for Model (6.3-5.5-5.2).

Level	Shear force V_x (kN)	Axial force P_x (kN)	Displacement U_x (mm)	Story Drift (Δ_i) (mm)	stability coefficient θ
25	-275.2073	10045.9021	139.313	24.6735	0.06
24	-570.7766	20091.865	133.83	25.2135	0.06
23	-843.1264	30137.8279	128.227	25.8075	0.06
22	-1093.1812	40183.7908	122.492	26.5185	0.06
21	-1321.8673	50229.7537	116.599	27.2655	0.07
20	-1530.1136	60275.7166	110.54	28.017	0.07
19	-1718.8514	70321.6795	104.314	28.7235	0.07
18	-1889.0146	80367.6424	97.931	29.367	0.08
17	-2041.5396	90413.6053	91.405	29.907	0.08
16	-2177.3658	100459.5682	84.759	30.321	0.10
15	-2297.4357	110505.5311	78.021	30.582	0.10
14	-2402.695	120551.494	71.225	30.672	0.10
13	-2494.0928	130597.4569	64.409	30.564	0.10
12	-2572.582	140643.4198	57.617	30.24	0.10
11	-2639.1195	150689.3827	50.897	29.6775	0.11
10	-2694.6669	160735.3456	44.302	28.863	0.11
9	-2740.1902	170781.3085	37.888	27.7605	0.11
8	-2776.6612	180827.2714	31.719	26.3655	0.11
7	-2805.0574	190873.2343	25.86	24.651	0.11
6	-2826.3635	200919.1972	20.382	22.5855	0.10
5	-2841.5719	210965.1601	15.363	20.1555	0.10
4	-2851.6845	221011.123	10.884	17.3205	0.10
3	-2857.7147	231057.0859	7.035	14.049	0.07
2	-2860.691	241103.0488	3.913	10.206	0.05
1	-2861.7011	251948.0907	1.645	7.4025	0.04

Table A.30: P-Delta Effects for Different Stores of Waffle Floor for Model (6.3-5.5-5.2).

Level	Shear force V _x (kN)	Axial force P _x (kN)	Displacement U _x (mm)	Story Drift (Δ_i) (mm)	stability coefficient θ
25	-237.413	9122.3244	122.036	21.4425	0.05
24	-498.1064	18032.8067	117.108	22.023	0.05
23	-738.3201	26943.289	112.055	22.653	0.05
22	-958.8694	35853.7713	106.885	23.3955	0.06
21	-1160.5716	44764.2536	101.586	24.183	0.06
20	-1344.2457	53674.7359	96.152	24.9795	0.06
19	-1510.7133	62585.2182	90.585	25.74	0.07
18	-1660.7979	71495.7005	84.895	26.442	0.07
17	-1795.3256	80406.1828	79.097	27.054	0.08
16	-1915.1249	89316.6651	73.211	27.5445	0.08
15	-2021.0271	98227.1474	67.263	27.9	0.10
14	-2113.8662	107137.6297	61.281	28.0935	0.10
13	-2194.4898	116048.112	55.299	28.107	0.10
12	-2263.7176	124958.5943	49.356	27.909	0.10
11	-2322.404	133869.0766	43.492	27.495	0.10
10	-2371.404	142779.5589	37.754	26.8425	0.10
9	-2411.5558	151690.0412	32.189	25.9155	0.10
8	-2443.7233	160600.5235	26.851	24.7095	0.10
7	-2468.7729	169511.0058	21.796	23.1975	0.10
6	-2487.565	178421.4881	17.085	21.3525	0.10
5	-2500.9789	187331.9704	12.78	19.1385	0.09
4	-2509.8982	196242.4527	8.953	16.542	0.08
3	-2515.2169	205152.935	5.676	13.5	0.07
2	-2517.8419	214063.4173	3.032	9.9	0.05
1	-2518.7375	223772.9785	1.112	7.308	0.04

Table A.31: P-Delta Effects for Different Stores of Conventional Floor for Model (8.3-7.5-7.2).

Level	Seismic Shear force V_x (kN)	vertical design load P_x (kN)	Displacement U_x (mm)	Story Drift (Δ_i) (mm)	stability coefficient θ
25	20852.8386	-592.744	140.028	25.497	0.06
24	41705.6772	-1206.2442	134.362	26.136	0.06
23	62558.5158	-1771.5487	128.554	26.757	0.06
22	83411.3544	-2290.5761	122.608	27.423	0.06
21	104264.193	-2765.2497	116.514	28.1115	0.07
20	125117.0316	-3197.4974	110.267	28.791	0.07
19	145969.8702	-3589.2522	103.869	29.43	0.08
18	166822.7089	-3942.4523	97.329	29.9835	0.08
17	187675.5475	-4259.0417	90.666	30.4425	0.09
16	208528.3861	-4540.9702	83.901	30.7665	0.09
15	229381.2247	-4790.194	77.064	30.9375	0.09
14	250234.0633	-5008.676	70.189	30.933	0.10
13	271086.9019	-5198.3863	63.315	30.7305	0.10
12	291939.7405	-5361.3028	56.486	30.3165	0.10
11	312955.4895	-5499.9345	49.749	29.6415	0.11
10	333971.2384	-5616.1324	43.162	28.7325	0.11
9	354986.9874	-5711.3613	36.777	27.5445	0.11
8	376002.7364	-5787.6539	30.656	26.064	0.11
7	397018.4854	-5847.0552	24.864	24.264	0.10
6	418034.2343	-5891.6248	19.472	22.1355	0.10
5	439049.9833	-5923.4388	14.553	19.647	0.09
4	460065.7323	-5944.593	10.187	16.785	0.08
3	481081.4813	-5957.2075	6.457	13.5225	0.07
2	502097.2302	-5963.4334	3.452	9.828	0.05
1	524433.4606	-5965.5296	1.268	5.706	0.03

Table A.32: P-Delta Effects for Different Stores of Flat Floor for Model (8.3-7.5-7.2).

Level	Shear force V_x (kN)	Axial force P_x (kN)	Displacement U_x (mm)	Story Drift (Δ_i) (mm)	stability coefficient θ
25	-275.2073	10045.9021	139.313	24.6735	0.06
24	-570.7766	20091.865	133.83	25.2135	0.06
23	-843.1264	30137.8279	128.227	25.8075	0.06
22	-1093.1812	40183.7908	122.492	26.5185	0.06
21	-1321.8673	50229.7537	116.599	27.2655	0.07
20	-1530.1136	60275.7166	110.54	28.017	0.07
19	-1718.8514	70321.6795	104.314	28.7235	0.07
18	-1889.0146	80367.6424	97.931	29.367	0.08
17	-2041.5396	90413.6053	91.405	29.907	0.08
16	-2177.3658	100459.5682	84.759	30.321	0.10
15	-2297.4357	110505.5311	78.021	30.582	0.10
14	-2402.695	120551.494	71.225	30.672	0.10
13	-2494.0928	130597.4569	64.409	30.564	0.10
12	-2572.582	140643.4198	57.617	30.24	0.10
11	-2639.1195	150689.3827	50.897	29.6775	0.11
10	-2694.6669	160735.3456	44.302	28.863	0.11
9	-2740.1902	170781.3085	37.888	27.7605	0.11
8	-2776.6612	180827.2714	31.719	26.3655	0.11
7	-2805.0574	190873.2343	25.86	24.651	0.11
6	-2826.3635	200919.1972	20.382	22.5855	0.10
5	-2841.5719	210965.1601	15.363	20.1555	0.10
4	-2851.6845	221011.123	10.884	17.3205	0.10
3	-2857.7147	231057.0859	7.035	14.049	0.07
2	-2860.691	241103.0488	3.913	10.206	0.05
1	-2861.7011	251948.0907	1.645	7.4025	0.04

Table A.33: P-Delta Effects for Different Stores of Waffle Floor for Model (8.3-7.5-7.2).

Level	Shear force V_x (kN)	Axial force P_x (kN)	Displacement U_x (mm)	Story Drift (Δi) (mm)	stability coefficient θ
25	20026.2748	-575.9167	136.353	24.147	0.05
24	40052.5495	-1169.154	130.987	24.7995	0.05
23	60078.8243	-1715.7874	125.476	25.416	0.06
22	80105.0991	-2217.6723	119.828	26.1045	0.06
21	100131.3739	-2676.6682	114.027	26.829	0.06
20	120157.6486	-3094.6395	108.065	27.5355	0.07
19	140183.9234	-3473.4553	101.946	28.2105	0.07
18	160210.1982	-3814.9898	95.677	28.8045	0.08
17	180236.473	-4121.1227	89.276	29.313	0.08
16	200262.7477	-4393.7396	82.762	29.6865	0.09
15	220289.0225	-4634.732	76.165	29.9115	0.09
14	240315.2973	-4845.9979	69.518	29.979	0.09
13	260341.5721	-5029.4424	62.856	29.844	0.10
12	280367.8468	-5186.978	56.224	29.502	0.10
11	300982.1216	-5322.4862	49.668	28.935	0.10
10	321596.3964	-5437.2487	43.238	28.116	0.11
9	342210.6711	-5531.3013	36.99	27.0225	0.11
8	362824.9459	-5606.6515	30.985	25.6455	0.11
7	383439.2207	-5665.3191	25.286	23.9625	0.10
6	404053.4955	-5709.3381	19.961	21.942	0.10
5	424667.7702	-5740.7591	15.085	19.575	0.09
4	445282.045	-5761.652	10.735	16.821	0.08
3	465896.3198	-5774.1107	6.997	13.6755	0.07
2	486510.5946	-5780.2597	3.958	10.044	0.05
1	508465.8693	-5782.3322	1.726	7.767	0.04

A.3 UNITE PRICE CALCULATION

The price of one cubic meter of concrete Grade 30 calculated assumed that water cement ratio (W/c=0.4) as shown

Table A.34: One Cubic Meter of Concrete Grade 30.

item	Unite	QTY	Rate (\$/Unite)	Amount (\$/m2)
Cement	Bags	7	4.5	31.5
Water	Liter	140	0.1	14
Fine aggregates	Cubic meter	0.4	11.38	4.552
Coarse aggregate	Cubic meter	0.8	15.17	12.136
Skill laborer	Days	1	22	22
Un Skilled Laborer	Days	1	18	18
Transporting, vibrator, operator	Days	1	18	18
Total price for cubic meter				120.188

The price of one square meter of framework calculated as shown in the table.

Table A.35: Price of one Square Meter of Floor Frame Work.

item	Unite	QTY	Rate (\$/Unite)	Amount (\$/m2)
Sheathing (1" thick plywood)	m2	1	2	2
Joist Timber (2"x4")	m.l	2	1.5	3
Stringers Timber (2"x6")	m.l	1	3	3
cost of nail 1"	kg	1	1.5	1.5
Bracing props	m.l	7	0.5	3.5
Carpenter	Day	0.2	25	5
Un Skilled Laborer	Day	0.2	18	3.6
Total price for Square meter				21.6

The price of one ton of steel rebar calculated as shown in the table (5.3)

Table A.36: Price of one Ton of Steel Rebar.

item	Unite	QTY	Rate (\$/Unite)	Amount (\$/m2)
Steel rebar	Ton	1	730	730
Binding wire	kg	1	3	3
smiths	Days	0.5	50	25
unskilled laborers	Days	0.5	50	25
Total				783

A.4 MODEL (6.3-5.5-5.2) MATERIAL CALCULATIONS

A.4.1 Conventional Floor Calculations

From case stud 1 of the section figure (4.2) quantity of concrete & framework of conventional slab is calculated as shown in the table (5.4) and table (5.5) where slab thickness is (165 mm).

Table A.37: Concrete Requirement for Conventional Slab.

Panel	Number of panels	Length (m)	Width(m)	Height(m)	Quantity (m3)
5.2x5.2	5.2	5.2	0.165	8.92	5.2
5.2x5.5	5.2	5.5	0.165	37.75	5.2
5.2x6.3	5.2	6.3	0.165	21.62	5.2
5.5x5.5	5.5	5.5	0.165	19.97	5.5
5.5x6.3	5.5	6.3	0.165	22.87	5.5
B(500x450)	5.5	0.45	0.335	3.32	5.5
B(350x250)	123.8	0.25	0.195	6.04	123.8
Total					120.48

Table A.38: Framework Requirement for Conventional Slab.

Panel	Number of panels	Length (m)	Width(m)	Quantity (m2)
5.2x5.2	2	5.2	5.2	54.08
5.2x5.5	8	5.2	5.5	228.80
5.2x6.3	4	5.2	6.3	131.04
5.5x5.5	4	5.5	5.5	121.00
5.5x6.3	4	5.5	6.3	138.60
B(500x450) sides	8	5.5	0.33	14.52
B(350x250) sides	28	123.8	0.185	22.90
Total				710.94

From case study 1 figure (4.8) and figure (4.9) quantity of Steel reinforcement of Conventional floor is calculated as shown

Table A.39: Steel Rebar Requirement for Conventional Slab.

Bar size	Length (m.l)	Density (kg/m.l)	Weight (kg)
10	774.7	0.616	477.2
12	2952	0.888	2621.4
14	1181.2	1.21	1429.3
16	1078.8	1.579	1703.4
18	939.9	1.998	1877.9
Internal beams			2940.0
Total weight(kg)			11049

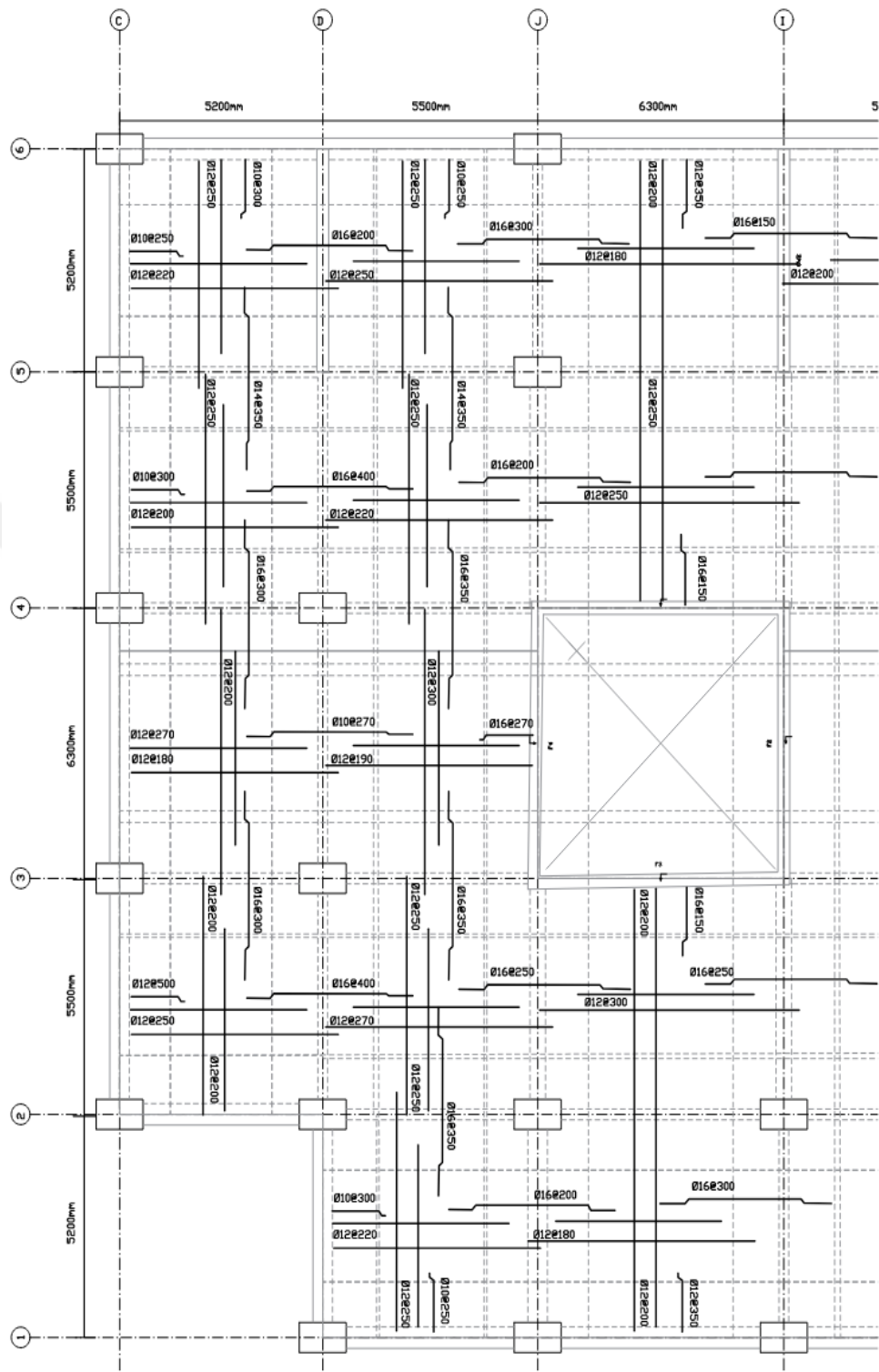
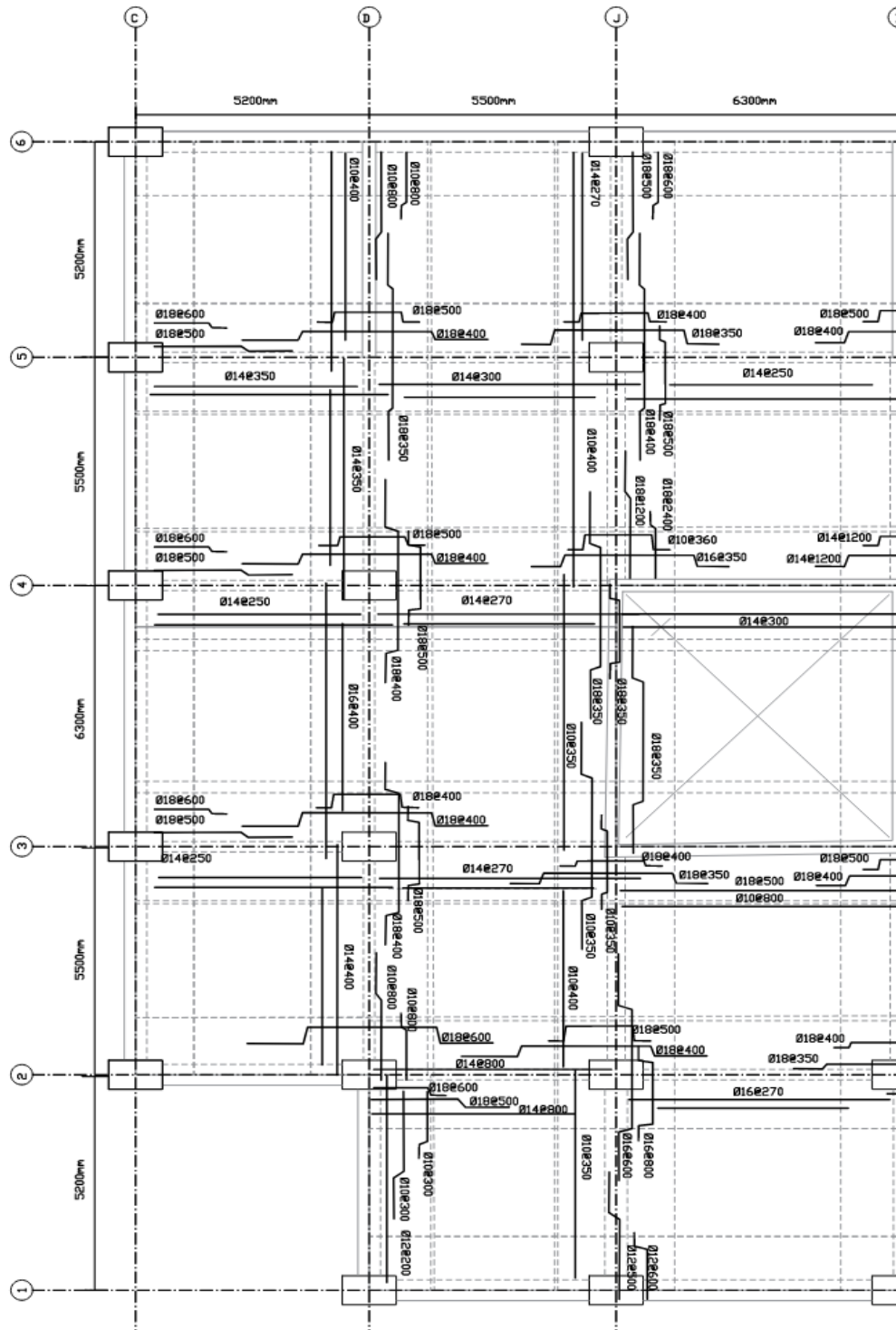


Figure A.1: Middle Strip Steel Reinforcement for Story-10 Conventional Floor.



A.4.2 Flat Floor Calculations

From case study 2 of the pervious chapter figure (4.12) and quantity of concrete & framework of conventional slab is calculated as shown in the table (5.8) and table (5.9) where slab thickness is (195mm).

Table A.40: Concrete Requirement for Flat Slab Without Drop Panel.

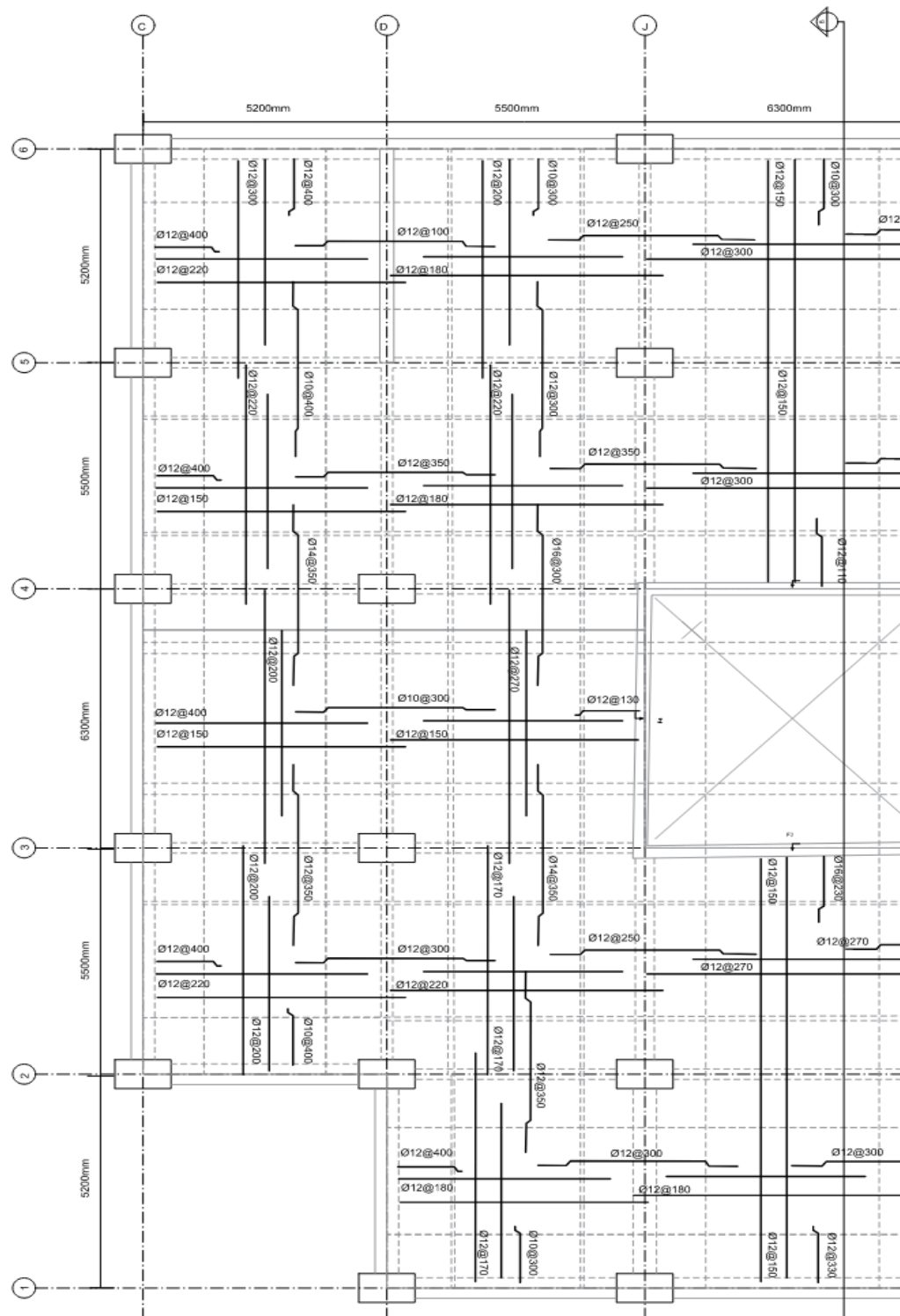
Panel	Number of panels	Length (m)	Width(m)	Height(m)	Quantity (m3)
5.2x5.2	2	5.2	5.2	0.195	10.55
5.2x5.5	8	5.2	5.5	0.195	44.62
5.2x6.3	4	5.2	6.3	0.195	25.55
5.5x5.5	4	5.5	5.5	0.195	23.60
5.5x6.3	4	5.5	6.3	0.195	27.03
Total					131.34

Table A.41: Framework Requirement for Flat Slab Without Drop Panel.

Panel	Number of Panel	Length (m)	Width (m)	Quantity (m2)
5.2x5.2	2	5.2	5.2	54.08
5.2x5.5	8	5.2	5.5	228.80
5.2x6.3	4	5.2	6.3	131.04
5.5x5.5	4	5.5	5.5	121.00
5.5x6.3	4	5.5	6.3	138.60
Total				673.52

Table A.42: Steel Rebar Requirement for Flat Slab Without Drop Panel.

Bar size	Length (m.l)	Density (kg/m.l)	Weight (kg)
10	403	0.616	248.2
12	3830	0.888	3401.0
14	478.9	1.21	579.5
16	2154.2	1.579	3401.5
18	1952	1.998	3900.1
Total weight(kg)			11530



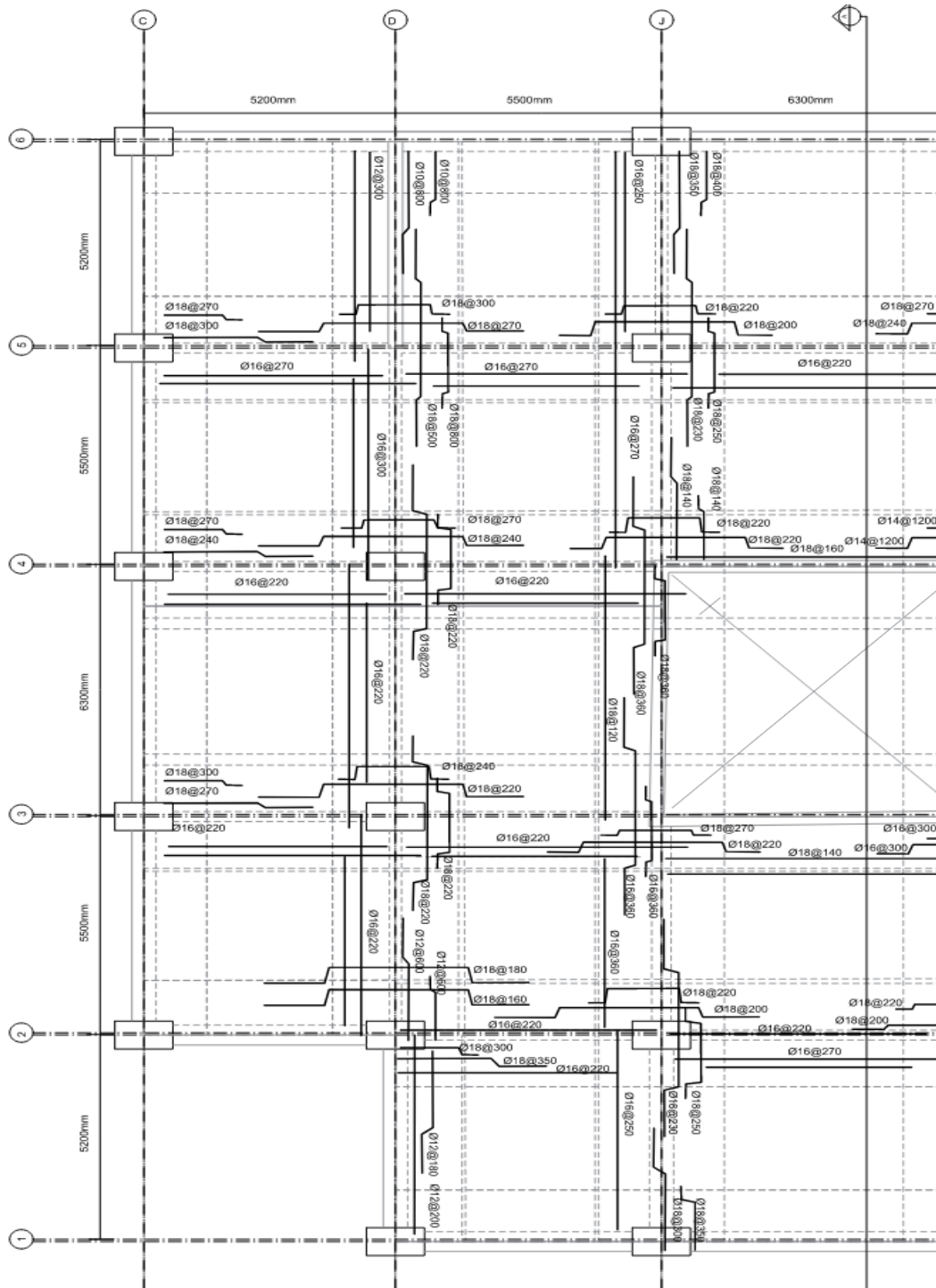


Figure A.4: Middle Strip Steel Reinforcement for Story-10 Flat Floor.

A.4.3 Waffle Floor Calculations

From case stud 3 of the pervious chapter figure (4.27) and quantity of concrete & framework of Waffle floor is calculated as shown in the tables below where over all slab depth is (280mm)

Table A.43: Concrete Requirement for Waffle Floor.

Panel	Number of panels	Length (m)	Width (m)	Height (m)	Quantity (m3)
5.2x5.2	2	5.2	5.2	0.12	6.49
5.2x5.5	8	5.2	5.5	0.12	27.46
5.2x6.3	4	5.2	6.3	0.12	15.72
5.5x5.5	4	5.5	5.5	0.12	14.52
5.5x6.3	4	5.5	6.3	0.12	16.63
Rib (200x200)		1665.6	0.2	0.16	53.30
Drop panel	8	2.6	2.054	0.16	6.84
Total					135.47

Table A.44: Framework Requirement for Waffle Floor.

Panel	Number of Panel	Length (m)	Width(m)	Quantity (m2)
5.2x5.2	2	5.2	5.2	54.08
5.2x5.5	8	5.2	5.5	228.80
5.2x6.3	4	5.2	6.3	131.04
5.5x5.5	4	5.5	5.5	121.00
5.5x6.3.	4	5.5	6.3	138.60
Total				673.52

From case study 3 of the pervious chapter figure (4.30) quantity of Steel reinforcement of waffle floor is calculated as shown in the table (5.18).

Table A.45: Steel Rebar Requirement for Waffle Floor.

Bar size	Length (m.l)	Density (kg/m.l)	Weight (kg)
8	3110.467	0.395	1228.6
10	7837.333	0.616	4827.8
14	5064	1.21	6127.4
16	915.2	1.579	1445.1
Total weight(kg)			13195.3

A.5 MODEL (8.3-7.5-7.2) MATERIAL CALCULATIONS

A.5.1 Conventional Floor Calculations

From case study 1 section (A1.1) quantity of concrete & framework of conventional slab is calculated as shown in the table (A.1.4-1) and table (A.1.4-2) where slab thickness is (260 mm)

Table A.46: Concrete Requirement for Conventional Slab for Model (8.3×7.5×7.2).

Panel	Number of panels	Length (m)	Width(m)	Height(m)	Quantity (m3)
7.2x7.2	2	7.2	7.2	0.26	26.96
7.2x7.5	8	7.2	7.5	0.26	112.32
7.2x8.3	4	7.2	8.3	0.26	62.15
7.5x7.5	4	7.5	7.5	0.26	58.50
7.5x8.3	4	7.5	8.3	0.26	64.74
B(350x250)	28	229.6	0.35	0.24	19.29
7.2x7.2	2	7.2	7.2	0.26	26.96
Total					343.95

Table A.47: Framework Requirement for Conventional Slab for Model (8.3×7.5x7.2).

Panel	Number of panels	Length (m)	Width(m)	Quantity (m2)
7.2x7.2	2	7.2	7.2	103.68
7.2x7.5	8	7.2	7.5	432.00
7.2x8.3	4	7.2	8.3	239.04
7.5x7.5	4	7.5	7.5	225.00
7.5x8.3	4	7.5	8.3	249.00
B(350x250)	8	5.5	0.24	10.56
B(350x250)	28	229.6	0.24	55.10
Total				1314.38

Table A.48: Steel Rebar Requirement for Conventional Slab for Model (8.3×7.5x7.2).

Bar size	Length (m.l)	Density (kg/m.l)	Weight (kg)
10	10	1319	0.616
12	12	12866	0.888
14	14	1205	1.21
16	16	10973	1.579
18	18	7716	1.998
Internal beams			6671
Total weight(kg)			53109

A.5.2 Flat Floor Calculations

From case study 1 section (A1.2) quantity of concrete & framework of conventional slab is calculated as shown in the table (Table A.1.4-5) and table (Table A.1.4-6) where slab thickness is (280 mm)

Table A.49: Concrete Requirement for Flat Slab Without Drop Panel for Model (8.3×7.5×7.2).

Panel	Number of panels	Length (m)	Width(m)	Height(m)	Quantity (m3)
7.2x7.2	2	7.2	7.2	0.28	29.03
7.2x7.5	8	7.2	7.5	0.28	120.96
7.2x8.3	4	7.2	8.3	0.28	66.93
7.5x7.5	4	7.5	7.5	0.28	63.00
7.5x8.3	4	7.5	8.3	0.28	69.72
Total					349.64

Table A.50: Framework Requirement for Flat Slab Without Drop Panel for Model (8.3×7.5×7.2).

Panel	Number of Panel	Length (m)	Width (m)	Quantity (m2)
7.2x7.2	2	7.2	7.2	103.68
7.2x7.5	8	7.2	7.5	432.00
7.2x8.3	4	7.2	8.3	239.04
7.5x7.5	4	7.5	7.5	225.00
7.5x8.3	4	7.5	8.3	249.00
Total				1248.72

Table A.51: Steel Rebar Requirement for Flat Slab Without Drop Panel for Model (8.3×7.5×7.2).

Bar size	Length (m.l)	Density (kg/m.l)	Weight (kg)
10	1495	0.616	920.9
12	16041	0.888	14244.4
14	1498	1.21	1812.6
16	10028	1.579	15834.2
18	11578	1.998	23132.8
Total weight(kg)			55945

A.5.3 Waffle Floor Calculations

From case study 3 section (A1.3) quantity of concrete & framework of conventional slab is calculated as shown in the table (A.1.4-13) and table (A.1.4-14) where slab thickness is (260 mm)

Table A.52: Concrete Requirement for Waffle Floor for Model (8.3×7.5x7.2).

Panel	Number of panels	Length (m)	Width (m)	Height (m)	Quantity (m ³)
7.2x7.2	2	7.2	7.2	0.14	14.52
7.2x7.5	8	7.2	7.5	0.14	60.48
7.2x8.3	4	7.2	8.3	0.14	33.47
7.5x7.5	4	7.5	7.5	0.14	31.50
7.5x8.3	4	7.5	8.3	0.14	34.86
Rib (200x200)		2926.8	0.2	0.2	117.07
Drop panel	8	2.8	2.8	0.2	12.54
Total					306.95

Table A.53: Framework Requirement for Waffle Floor for Model (8.3×7.5x7.2).

Panel	Number of Panel	Length (m)	Width(m)	Quantity (m ²)
7.2x7.2	2	7.2	7.2	103.68
7.2x7.5	8	7.2	7.5	432.00
7.2x8.3	4	7.2	8.3	239.04
7.5x7.5	4	7.5	7.5	225.00
7.5x8.3	4	7.5	8.3	249.00
Total				1248.72

Table A.54: Steel Rebar Requirement for Waffle Floor for Model (8.3×7.5×7.2).

Bar size	Length (m.l)	Density (kg/m.l)	Weight (kg)
8	6352.085	0.395	2509.1
18	8612.8	1.998	17208.4
10	2334.976	0.616	1438.3
14	8612.8	1.21	10421.5
20	1254.4	2.5	3136.0
Total weight(kg)			42396.6

a. Floor parameters and the moment and area of steel**Table A.55:** Moment& Steel Area for Conventional Floor for Model (6.3×5.5×5.2).

	Panel 1	Panel 2	Panel 3	Panel 4
$I_{\text{beam}} (\text{mm}^4)$	1373840583	1373840583	1373840583	1373840583
$I_{\text{slab}} (\text{mm}^4)$	1277792837	1409154718	127792837	140915471
Stiffness ratio(α)	4.075	1.075	0.975	0.975
	Panel 1	Panel 2	Panel 3	
$I_{\text{beam}} (\text{mm}^4)$	5719815455	5719815455	5719815455	5719815455
$I_{\text{slab}} (\text{mm}^4)$	3789544117	4073115446	3789544117.8	40731157446
Stiffness ratio(α)	1.509	1.509	1.404	1.0404

Table A.55: Moment& Steel Area for Conventional Floor for Model (6.3×5.5x5.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-15.3653	330	0	17.5299	377	749	6.178	0
Story10	-13.0214	280	0	17.5966	379	749	6.6411	0
Story10	-8.129	174	0	13.0502	280	749	6.6414	0
Story10	-7.9723	171	0	8.6165	185	749	2.5134	0
Story10	-10.9249	234	749	5.1719	111	0	28.4879	0
Story10	-62.9707	1390	749	0	0	0	54.4405	0
Story10	-8.1069	174	749	7.7582	166	0	76.9416	0
Story10	0	0	0	36.3649	791	749	40.8171	0
Story10	-0.0291	0	0	33.5362	728	749	39.127	0
Story10	-15.9708	343	749	2.6317	56	0	77.3532	0
Story10	-98.0022	2210	749	0	0	0	79.9301	0
Story10	-24.2484	524	749	0.6761	0	0	103.4754	0
Story10	-0.0463	0	0	36.3999	791	749	59.9715	0
Story10	0	0	0	46.8187	1024	749	19.9925	0
Story10	-0.0486	0	0	36.1583	786	749	49.4362	0
Story10	-25.4314	550	749	0.4681	0	0	77.3352	0
Story10	-95.4533	2149	749	0	0	0	77.2364	0
Story10	-73.9449	1643	749	0.76	0	0	74.8657	0
Story10	-6.3467	136	0	8.6016	184	749	34.3604	0
Story10	0	0	0	33.8448	735	749	0.787	0
Story10	-13.924	299	749	5.0579	108	0	63.5171	0
Story10	-73.0642	1623	749	0	0	0	63.5171	0
Story10	-10.8661	233	749	5.9483	127	0	57.5426	0
Story10	-2.7509	59	0	13.5131	290	749	15.5087	0
Story10	-3.8365	82	0	14.1581	304	749	9.1737	0
Story10	-19.5264	421	749	5.4506	117	0	26.163	0
Story10	-0.7053	0	0	33.7992	734	749	35.857	0

Table A.55: Moment& Steel Area for Conventional Floor for Model (6.3×5.5x5.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-50.4838	1106	749	0	0	0	27.1858	0
Story10	-7.7145	166	374	2.3722	51	0	8.8844	0
Story10	-6.5395	140	374	3.6081	77	0	1.4193	0
Story10	-5.2025	112	374	2.8089	60	0	1.9206	0
Story10	-6.9594	149	374	4.0135	86	0	5.6117	0
Story10	-8.4251	181	374	2.1653	46	0	8.5618	0
Story10	-21.5286	464	749	0.0535	0	0	8.7565	0
Story10	-49.2797	1079	749	0.0619	0	0	44.3576	0
Story10	-18.2468	393	749	6.7807	145	0	28.0362	0
Story10	-3.4649	74	0	12.7702	274	749	2.0487	0
Story10	-2.7662	59	0	14.9161	321	749	5.393	0
Story10	-11.237	241	749	5.8773	126	0	24.1043	0
Story10	-37.9662	826	749	0	0	0	32.9021	0
Story10	-9.6288	206	749	5.3239	114	0	22.6662	0
Story10	-6.5412	140	0	8.9491	192	749	5.2623	0
Story10	-8.0605	173	0	13.8148	297	749	3.4358	0
Story10	-18.7356	403	749	17.1255	368	0	7.7575	0
Story10	-27.052	585	749	16.385	352	0	5.4678	0
Story10	-16.745	360	0	20.948	452	749	9.1462	0
Story10	-14.6868	316	0	17.5088	377	749	8.8355	0
Story10	-10.5534	226	0	11.3369	243	749	4.8421	0
Story10	-8.8077	189	749	7.0643	151	0	2.3016	0
Story10	-14.1289	303	749	4.2718	91	0	15.1083	0
Story10	-30.0928	652	749	0.6062	0	0	23.7701	0
Story10	-12.8641	276	749	12.0386	258	0	12.7649	0
Story10	-3.1316	67	0	18.167	391	749	43.6322	0
Story10	-7.0142	150	0	15.2826	328	749	13.0569	0

Table A.55: Moment& Steel Area for Conventional Floor for Model (6.3×5.5x5.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-12.2878	264	749	4.4414	95	0	33.0042	0
Story10	-67.8201	1502	749	0	0	0	124.036	0
Story10	-8.8741	190	749	6.6249	142	0	72.0574	0
Story10	0	0	0	35.7578	777	749	36.206	0
Story10	0	0	0	34.6441	753	749	32.3194	0
Story10	-11.0839	238	749	10.3474	222	0	39.9979	0
Story10	-70.7517	1569	749	9.9894	214	0	39.9979	0
Story10	-73.3389	1629	749	4.4544	95	0	102.2903	0
Story10	-11.6645	250	749	7.1623	153	0	54.0163	0
Story10	-0.0404	0	0	35.8191	779	749	34.9993	0
Story10	0	0	0	34.1819	742	749	22.073	0
Story10	-10.036	215	749	3.5025	75	0	62.8366	0
Story10	-95.4055	2148	749	0	0	0	82.5749	0
Story10	-20.1106	433	749	7.2489	155	0	49.1736	0
Story10	0	0	0	38.7411	843	749	16.7414	0
Story10	0	0	0	39.8018	867	749	17.2023	0
Story10	-18.805	405	749	10.1625	218	0	49.7041	0
Story10	-90.0871	2022	749	0	0	0	77.7493	0
Story10	-95.701	2155	749	0	0	0	128.6026	0
Story10	-10.0946	216	749	4.1012	88	0	76.2137	0
Story10	0	0	0	33.0043	716	749	34.7984	0
Story10	-0.0226	0	0	33.7255	732	749	35.9665	0
Story10	-12.3958	266	749	4.0571	87	0	67.3684	0
Story10	-78.5783	1751	749	0	0	0	135.8786	0
Story10	-7.3648	158	749	4.7489	101	0	70.0202	0
Story10	0	0	0	33.127	719	749	34.3994	0
Story10	0	0	0	33.0208	717	749	30.9982	0

Table A.55: Moment& Steel Area for Conventional Floor for Model (6.3×5.5x5.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-81.7408	1825	749	0	0	0	-81.7408	0
Story10	-10.5362	226	749	4.6304	99	0	-10.5362	0
Story10	-0.0203	0	0	34.9703	760	749	-0.0203	0
Story10	0	0	0	35.3406	768	749	0	0
Story10	-11.0128	236	0	11.4217	245	749	-11.0128	0
Story10	-70.1161	1554	749	10.8634	233	0	-70.1161	0
Story10	-70.1123	1554	749	10.7947	231	0	-70.1123	0
Story10	-11.0596	237	0	11.3502	243	749	-11.0596	0
Story10	0	0	0	35.3878	769	749	0	0
Story10	0	0	0	35.0053	761	749	0	0
Story10	-10.2232	219	749	4.6507	99	0	-10.2232	0
Story10	-81.2309	1813	749	0	0	0	-81.2309	0
Story10	-13.9069	299	749	6.3607	136	0	-13.9069	0
Story10	-0.0612	0	0	34.8713	758	749	-0.0612	0
Story10	0	0	0	33.883	736	749	0	0
Story10	-15.3725	330	749	4.6568	100	0	-15.3725	0
Story10	-74.9419	1666	749	0.045	0	0	-74.9419	0
Story10	-27.9798	606	749	0.3636	0	0	-27.9798	0
Story10	-8.6372	186	374	3.5863	77	0	-8.6372	0
Story10	-6.5091	140	374	6.2795	135	0	-6.5091	0
Story10	-4.5059	97	374	4.3207	93	0	-4.5059	0
Story10	-6.1171	131	0	6.2822	135	374	-6.1171	0
Story10	-8.2073	176	374	4.0971	88	0	-8.2073	0
Story10	-81.409	1817	749	0	0	0	-81.409	0
Story10	-15.7787	339	749	4.1513	89	0	-15.7787	0
Story10	-0.0287	0	0	35.5139	772	749	-0.0287	0
Story10	-0.0238	0	0	37.3769	813	749	-0.0238	0

Table A.56: Moment& Steel Area for Flat Floor for Model (6.3×5.5x5.2).

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-19.8079	333	0	26.1833	441	913	11.725	0
Story10	-15.6575	263	0	19.3033	324	913	10.0468	0
Story10	-13.1022	220	913	10.646	178	0	0.9948	0
Story10	-18.622	313	913	7.4358	124	0	9.9574	0
Story10	-60.4848	1030	913	2.9925	50	0	53.0487	0
Story10	-87.6315	1506	913	45.6819	774	0	208.9375	0
Story10	-2.8617	48	0	80.3622	1377	913	52.1324	0
Story10	0	0	0	81.4331	1396	913	22.2613	0
Story10	-37.5577	634	913	28.9718	488	0	90.3232	0
Story10	-266.4393	4913	913	0.32	0	0	48.2186	0
Story10	-61.2595	1043	913	35.6838	602	0	328.9061	2166.67
Story10	-0.3933	0	0	88.5265	1522	913	91.3627	0
Story10	0	0	0	94.4305	1627	913	30.2684	0
Story10	0	0	0	79.3652	1360	913	29.2539	0
Story10	-48.1006	815	913	19.9258	335	0	90.6007	0
Story10	-265.1153	4885	913	0.4551	0	0	243.1159	0
Story10	-210.7727	3795	913	7.8702	132	0	221.2631	0
Story10	-23.2022	390	0	39.8117	673	913	82.6278	0
Story10	0	0	0	85.7409	1472	913	5.3598	0
Story10	-1.1301	0	0	93.0597	1602	913	65.2576	0
Story10	-39.3948	666	0	58.4591	994	913	187.9038	0
Story10	-159.9195	2822	913	12.1972	204	0	30.545	0
Story10	-154.8083	2727	913	18.5134	311	0	294.0119	2166.67
Story10	-5.8798	98	0	43.1205	730	913	290.5542	2166.67
Story10	0	0	0	85.0158	1460	913	53.2903	0
Story10	-0.0768	0	0	88.3276	1518	913	58.5722	0
Story10	-43.9366	744	0	45.2338	766	913	195.6666	0

Table A.56: Moment& Steel Area for Flat Floor for Model (6.3×5.5x5.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-189.8865	3391	913	29.5744	498	0	161.271	0
Story10	-157.8454	2783	913	12.1489	203	0	322.5429	2166.67
Story10	-31.245	527	0	62.2857	1061	913	193.5743	0
Story10	0	0	0	98.5977	1701	913	73.3422	0
Story10	-0.1539	0	0	93.0937	1603	913	77.9655	0
Story10	-43.8775	743	0	48.4236	821	913	229.0697	0
Story10	-267.7056	4939	913	0.3743	0	0	378.2317	2166.67
Story10	-38.4252	649	913	33.2717	561	0	90.3249	0
Story10	0	0	0	86.0419	1478	913	25.3302	0
Story10	0	0	0	87.5895	1505	913	25.7145	0
Story10	-35.4728	599	0	38.8353	656	913	91.2202	0
Story10	-251.1513	4600	913	3.5536	59	0	243.902	0
Story10	-267.0371	4925	913	0.3633	0	0	243.8339	0
Story10	-41.685	705	0	45.9073	778	913	220.9688	0
Story10	0	0	0	84.9922	1459	913	72.9322	0
Story10	-0.1986	0	0	86.4411	1485	913	70.3912	0
Story10	-43.8555	742	0	51.6466	876	913	219.1913	0
Story10	-232.0841	4216	913	0.7387	0	0	437.0882	3033.27
Story10	-26.6959	449	0	33.4615	564	913	144.1747	0
Story10	0	0	0	83.016	1424	913	15.2938	0
Story10	0	0	0	84.3547	1448	913	56.7812	0
Story10	-7.7902	130	0	40.9284	692	913	150.9947	0
Story10	-172.1327	3052	913	23.0966	388	0	151.3511	0
Story10	-177.0751	3146	913	25.1781	424	0	162.7046	0
Story10	-6.2604	105	0	32.8757	554	913	68.779	0
Story10	0	0	0	85.1359	1462	913	3.9002	0
Story10	-0.5366	0	0	82.4621	1414	913	60.8115	0

Table A.56: Moment& Steel Area for Flat Floor for Model (6.3×5.5x5.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-0.109	0	0	93.9759	1619	913	66.107	0
Story10	-35.2055	594	0	64.1241	1093	913	211.2861	0
Story10	-158.3541	2793	913	11.0935	186	0	16.5239	0
Story10	-191.0073	3412	913	29.9825	505	0	167.2478	0
Story10	-3.8817	65	0	36.3063	613	913	89.401	0
Story10	0	0	0	94.104	1621	913	41.0238	0
Story10	-0.2417	0	0	101.5477	1754	913	83.6883	0
Story10	-41.7841	707	0	54.7023	929	913	239.5671	0
Story10	-253.0425	4638	913	0.6277	0	0	134.803	0
Story10	-34.4425	581	0	39.0354	660	913	87.8097	0
Story10	0	0	0	84.359	1448	913	5.0387	0
Story10	-0.2165	0	0	75.7885	1297	913	59.3441	0
Story10	-32.1269	542	913	20.6031	346	0	128.3555	0
Story10	-110.5037	1915	913	4.3104	72	0	9.5447	0
Story10	-13.6395	230	456	0	0	0	29.8781	0
Story10	-12.086	203	456	0.1635	0	0	2.7017	0
Story10	-11.212	188	456	0.2166	0	0	1.6457	0
Story10	-11.2553	189	456	0.1031	0	0	2.7489	0
Story10	-18.9897	321	456	0	0	0	9.2381	0
Story10	-188.6044	3366	913	0.1189	0	0	118.3752	0
Story10	-39.7141	671	913	31.1737	525	0	179.9319	0
Story10	0	0	0	88.9654	1529	913	27.2705	0
Story10	-0.2043	0	0	95.9442	1654	913	71.7684	0
Story10	-43.0857	729	0	61.4046	1046	913	232.5175	0
Story10	-253.901	4656	913	0.8061	0	0	466.2225	3616.51
Story10	-29.9262	504	0	38.1613	645	913	164.3927	0
Story10	0	0	0	91.426	1573	913	17.3327	0

Table A.56: Moment& Steel Area for Flat Floor for Model (6.3×5.5x5.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-10.5853	178	0	12.4932	210	456	15.5647	0
Story10	-43.2078	742	456	0.1636	0	0	53.9662	0
Story10	-11.4172	192	0	18.1214	306	456	169.0881	1083.33
Story10	-2.0384	34	0	17.7502	300	456	39.4315	0
Story10	-2.2436	37	0	14.0069	236	456	8.5541	0
Story10	-9.6099	161	0	16.892	285	456	48.1	0
Story10	-36.4112	622	456	0.4006	0	0	48.8229	0
Story10	-2.696	45	0	8.9042	149	456	13.4272	0
Story10	-1.7267	29	0	20.6092	349	456	1.8905	0
Story10	-5.1467	86	0	28.9682	493	456	6.6544	0
Story10	-15.3292	258	0	28.2258	480	456	16.9211	0
Story10	-30.8027	525	456	18.2478	308	0	16.928	0
Story10	-15.8061	266	0	27.4421	466	456	23.3542	0
Story10	-5.0551	85	0	22.7314	385	456	13.401	0
Story10	-1.4225	24	0	20.7531	351	456	6.1051	0
Story10	-2.2051	37	0	9.5123	160	456	13.0857	0
Story10	-34.9133	596	456	0.4258	0	0	47.868	0
Story10	-9.7501	164	0	15.9505	269	456	145.1729	1083.33
Story10	-2.1517	36	0	18.0146	304	456	36.0997	0
Story10	-1.9761	33	0	13.7256	231	456	8.2237	0
Story10	-10.4226	175	0	18.3378	310	456	52.1731	0
Story10	-42.7082	733	456	0.1476	0	0	52.866	0
Story10	-10.7837	181	0	11.5221	194	456	15.808	0
Story10	-2.9383	49	0	21.6932	367	456	3.1571	0
Story10	-0.3321	0	0	13.3008	224	456	3.1811	0
Story10	-3.7432	63	0	19.3671	327	456	11.1142	0
Story10	-11.0023	185	0	13.4457	226	456	11.1401	0

Table A.56: Moment& Steel Area for Flat Floor for Model (6.3×5.5x5.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-4.0788	68	0	22.8441	387	456	5.9709	0
Story10	-2.3229	39	0	18.6922	316	456	3.61	0
Story10	-8.4553	142	456	7.7661	130	456	14.3792	0
Story10	-39.662	680	456	0.1599	0	0	46.3933	0
Story10	-11.4566	193	0	15.1147	255	456	45.4908	0
Story10	-3.6939	62	0	16.4162	277	456	9.0489	0
Story10	-4.7807	80	0	23.117	392	456	6.6955	0
Story10	-11.8886	200	0	20.2039	342	456	23.9963	0
Story10	-27.6337	470	456	6.598	111	0	59.5771	0
Story10	-10.2392	172	0	19.4794	329	456	40.9502	0
Story10	-1.7447	29	0	22.0642	373	456	23.6772	0
Story10	-1.5131	25	0	19.882	336	456	7.0844	0
Story10	-11.7667	198	0	25.5487	433	456	17.1864	0
Story10	-27.1208	461	456	18.2446	308	0	23.642	0
Story10	-10.0558	169	0	26.1194	443	456	16.9275	0
Story10	-4.1365	69	0	20.3676	344	456	12.7957	0
Story10	-0.3573	0	0	15.4345	260	456	12.0203	0
Story10	-5.0375	84	0	6.4105	107	456	11.5289	0
Story10	-40.0604	687	456	0.6348	11	0	52.8751	0
Story10	-9.0744	152	0	18.1293	306	456	153.5328	1083.33
Story10	-2.3387	39	0	19.845	335	456	29.0429	0
Story10	-1.0951	18	0	16.4904	278	456	2.2411	0
Story10	-12.0209	202	0	17.239	291	456	53.0663	0
Story10	-42.5786	731	456	0.1653	0	0	54.2594	0
Story10	-9.3767	157	0	12.4831	210	456	15.4552	0
Story10	-2.5876	43	0	22.0242	373	456	2.378	0
Story10	-0.3727	0	0	13.3161	224	456	3.1243	0

Table A.57: Moment& Steel Area for Waffle Floor for Model (6.3×5.5x5.2).

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-2.8151	42	0	12.8188	191	366	4.5344	0
Story10	-7.1377	106	0	12.9093	192	366	6.562	0
Story10	-10.6181	158	366	7.7403	115	0	4.4892	0
Story10	-18.9339	284	366	7.7673	115	0	31.597	0
Story10	-60.7589	936	366	2.6729	40	0	56.5261	0
Story10	-90.0171	1416	366	41.3982	619	0	229.2226	1831.7
Story10	-2.188	32	0	90.7258	1373	366	56.5492	0
Story10	0	0	0	95.7766	1451	366	21.5246	0
Story10	-36.7345	557	366	30.2128	451	0	104.7352	0
Story10	-298.499	5273	366	0	2443	0	56.3327	0
Story10	-45.7414	698	366	22.3383	333	0	401.2943	4892.28
Story10	-0.3257	0	0	97.6262	1479	366	102.974	0
Story10	0	0	0	116.9661	1780	366	31.2277	0
Story10	0	0	0	92.5169	1400	366	31.5986	0
Story10	-43.9918	670	366	18.9372	282	0	107.0496	0
Story10	-304.3652	5380	366	0.0285	2607	0	281.682	2764.78
Story10	-225.8194	3947	366	3.0554	411	0	252.5726	2247.02
Story10	-20.3855	306	0	35.7984	535	366	98.1062	0
Story10	0	0	0	101.7919	1544	366	4.8511	0
Story10	-1.0729	16	0	104.251	1582	366	79.3073	0
Story10	-30.6537	463	0	39.8415	596	366	211.6778	1519.64
Story10	-183.4364	3112	366	18.0803	269	0	33.7338	0
Story10	-172.5534	2899	366	26.5007	395	0	422.4473	5268.53
Story10	-1.445	21	0	38.5193	576	366	419.2048	5210.85
Story10	0	0	0	108.0112	1641	366	72.7	0
Story10	-0.0675	0	0	106.2999	1614	366	65.3278	0
Story10	-32.7292	495	366	30.1201	449	0	238.9569	2004.84

Table A.57: Moment& Steel Area for Waffle Floor for Model (6.3×5.5x5.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-8.7365	130	0	13.8389	206	366	10.3286	0
Story10	-12.8763	192	366	8.1776	121	0	7.4635	0
Story10	-20.5222	308	366	3.2894	49	0	16.4366	0
Story10	-63.114	974	366	0.6769	10	0	56.6589	0
Story10	-69.86	1083	366	54.7901	822	0	561.491	7741.65
Story10	-1.59	24	0	102.9266	1562	366	63.6363	0
Story10	0	0	0	94.3935	1429	366	28.6146	0
Story10	-36.0629	547	366	22.7653	339	0	99.712	0
Story10	-230.6694	4035	366	0.0755	546	0	100.0379	0
Story10	-21.7092	331	183	0	0	0	16.0239	0
Story10	-12.8893	194	183	0.0282	0	0	8.2159	0
Story10	-11.0524	166	183	0.1121	0	0	1.7568	0
Story10	-10.9325	164	183	0.0428	0	0	1.7364	0
Story10	-19.3213	293	183	0	0	0	10.5869	0
Story10	-79.9265	1248	366	0.2536	0	0	52.3284	0
Story10	-27.7726	419	366	26.2401	391	0	191.5472	1161.58
Story10	-0.2097	0	0	91.6847	1387	366	82.655	0
Story10	-0.0708	0	0	101.6468	1542	366	80.4178	0
Story10	-32.8543	497	0	35.6088	532	366	264.1033	2452.12
Story10	-269.139	4737	366	0.2565	1622	0	549.6236	7530.57
Story10	-21.0547	316	0	30.2506	451	366	182.3102	997.29
Story10	0	0	0	107.9038	1639	366	4.2615	0
Story10	0	0	0	107.2821	1629	366	79.568	0
Story10	-3.1521	47	0	32.1276	480	366	174.0954	851.17
Story10	-198.4318	3414	366	35.0387	523	0	173.613	842.59
Story10	-180.7202	3058	366	17.7765	265	0	414.4991	5127.15
Story10	-21.6894	326	0	42.9795	643	366	219.8655	1665.27

Table A.57: Moment& Steel Area for Waffle Floor for Model (6.3×5.5x5.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-20.6343	310	0	27.4897	410	366	161.2401	0
Story10	0	0	0	99.4595	1508	366	4.4557	0
Story10	0	0	0	100.5826	1525	366	74.1945	0
Story10	-1.6523	25	0	31.8631	476	366	163.0969	0
Story10	-183.5717	3115	366	30.5466	456	0	163.51	0
Story10	-193.8569	3321	366	34.0274	508	0	170.5712	842.03
Story10	-3.6293	54	0	27.5029	410	366	87.8989	0
Story10	0	0	0	94.1992	1426	366	12.7612	0
Story10	-0.1571	0	0	94.0554	1424	366	68.1633	0
Story10	-20.3856	306	0	47.651	714	366	188.3321	1104.4
Story10	-212.7244	3708	366	0.4036	45	0	95.577	0
Story10	-20.5384	308	0	21.4058	319	366	141.8174	0
Story10	-0.0432	0	0	87.0574	1316	366	98.9896	0
Story10	0	0	0	86.1556	1302	366	10.347	0
Story10	-35.683	541	366	23.2012	346	0	93.7587	0
Story10	-300.4677	5309	366	0.0178	2498	0	523.3475	7063.2
Story10	-281.2355	4958	366	1.1288	1960	0	439.5922	5573.48
Story10	-31.8346	481	0	38.6626	578	366	104.0924	0
Story10	0	0	0	101.7287	1543	366	24.6734	0
Story10	0	0	0	96.5049	1462	366	31.4431	0
Story10	-26.697	402	366	25.2886	377	0	97.0847	0
Story10	-239.3135	4193	366	0.0693	788	0	211.3953	1514.62
Story10	-15.0006	224	0	30.0347	448	366	215.7329	1591.77
Story10	0	0	0	100.7129	1527	366	78.8012	0
Story10	-0.1071	0	0	106.14	1612	366	80.0629	0
Story10	-26.124	394	0	41.1631	616	366	249.9621	2200.59
Story10	-185.3925	3151	366	18.1019	269	0	45.3076	0

Table A.57: Moment& Steel Area for Waffle Floor for Model (6.3×5.5x5.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-196.1889	3368	366	33.7893	505	0	173.9593	848.75
Story10	-195.6581	3358	366	33.6897	503	0	175.9208	883.64
Story10	-1.8572	28	0	34.2217	511	366	427.2016	5353.09
Story10	0	0	0	110.1213	1674	366	132.3021	0
Story10	0	0	0	111.0202	1688	366	5.5647	0
Story10	-21.7496	327	0	30.7054	458	366	93.1711	0
Story10	-272.1361	4792	366	0.2976	1706	0	281.9471	2769.5
Story10	-32.2743	488	0	35.5765	531	366	489.1284	6454.56
Story10	-0.3744	0	0	98.201	1488	366	145.7017	0
Story10	0	0	0	87.9823	1330	366	11.3109	0
Story10	-26.1279	394	366	21.282	317	0	86.7143	0
Story10	-225.5453	3942	366	0.0395	403	0	195.2571	1227.57
Story10	-44.2761	696	183	0.661	10	0	36.9536	0
Story10	-15.8125	239	183	0.0288	0	0	6.43	0
Story10	-9.9821	150	183	0.0489	0	0	0.2776	0
Story10	-10.3047	155	183	0.088	0	0	1.1371	0
Story10	-10.7444	161	183	0.0424	0	0	6.7607	0
Story10	-19.7479	300	183	0	0	0	26.9513	0
Story10	-193.9789	3323	366	0.1829	0	0	287.4208	2866.85
Story10	-28.4043	428	366	25.0829	374	0	192.4337	1177.35
Story10	-0.0422	0	0	92.1723	1395	366	83.587	0
Story10	-0.0908	0	0	100.8194	1529	366	78.5838	0
Story10	-31.9272	483	0	36.1196	540	366	260.0909	2380.75
Story10	-271.9553	4788	366	0.2502	1701	0	538.0921	7325.46
Story10	-22.4306	337	0	29.9011	446	366	178.644	932.08
Story10	0	0	0	107.5925	1634	366	1.5659	0
Story10	0	0	0	108.467	1648	366	78.6069	0

Table A.58: Moment& Steel Area for Conventional Floor for Model (8.3×7.5x7.2).

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-86.5169	1050	842	40.9939	492	0	56.6397	0
Story10	-47.3724	569	0	67.8179	819	842	45.1308	0
Story10	-16.3785	195	0	64.21	775	842	20.1652	0
Story10	-3.3469	40	0	49.006	589	842	6.9856	0
Story10	-2.0191	24	0	42.3666	509	842	8.6844	0
Story10	-11.3268	135	0	46.8302	563	842	26.8378	0
Story10	-37.2369	447	842	32.9651	395	0	124.5112	0
Story10	-134.4689	1653	842	0.0614	0	0	150.4915	0
Story10	-36.3763	436	842	34.5652	414	842	127.0018	0
Story10	-10.8815	130	0	56.5813	682	842	32.3477	0
Story10	-1.5044	0	0	51.4812	619	842	13.2636	0
Story10	-1.5735	0	0	51.6514	622	842	13.3362	0
Story10	-10.984	131	0	56.7001	683	842	32.3582	0
Story10	-36.8298	442	842	34.7675	417	842	126.8789	0
Story10	-134.7648	1656	842	0.0587	0	0	138.2201	0
Story10	-23.9173	286	0	35.8005	429	842	123.2888	0
Story10	-7.5558	90	0	49.2349	592	842	26.5304	0
Story10	0	0	0	38.5254	462	842	8.1672	0
Story10	-7.6779	91	0	48.7167	586	842	26.191	0
Story10	-24.4897	293	0	36.8709	442	842	116.4923	0
Story10	-124.0942	1521	842	0.0642	0	0	134.7466	0
Story10	-20.3512	243	0	38.4445	461	842	120.8386	0
Story10	-6.8794	82	0	50.988	613	842	27.0996	0
Story10	-0.6085	0	0	45.7507	550	842	8.3854	0
Story10	-10.5316	125	0	64.8891	783	842	20.4506	0
Story10	-40.9083	491	0	70.5936	853	842	43.6041	0
Story10	-83.9441	1018	842	41.5848	499	0	43.6041	0

Table A.58: Moment& Steel Area for Conventional Floor for Model (8.3×7.5x7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-128.1432	1546	1720	13.2462	158	0	158.2714	0
Story10	-24.8524	296	0	100.7312	1211	1720	142.1337	0
Story10	0	0	0	150.451	1820	1720	46.4366	0
Story10	0	0	0	147.3818	1783	1720	55.6337	0
Story10	-30.9881	370	0	94.1962	1132	1720	152.2826	0
Story10	-149.0336	1803	1720	0.4123	0	0	263.7614	0
Story10	-416.1663	5211	1720	0	0	0	287.343	0
Story10	-158.6775	1922	1720	0.5414	0	0	261.5554	0
Story10	-0.2681	0	0	120.1304	1448	1720	179.1968	0
Story10	0	0	0	186.5456	2267	1720	87.6611	0
Story10	0	0	0	186.6694	2269	1720	87.7828	0
Story10	-0.2686	0	0	120.0273	1447	1720	179.2504	0
Story10	-158.9701	1925	1720	0.5744	0	0	259.9719	0
Story10	-413.21	5172	1720	0	0	0	408.9864	0
Story10	-106.0258	1276	1720	0.7979	0	0	260.6259	0
Story10	-0.1699	0	0	124.2939	1499	1720	146.8692	0
Story10	0	0	0	157.1374	1903	1720	50.4453	0
Story10	-0.1734	0	0	126.0623	1521	1720	147.5012	0
Story10	-108.2216	1303	1720	1.2633	0	0	238.6065	0
Story10	-366.8348	4563	1720	0	0	0	304.7967	0
Story10	-99.2098	1193	1720	1.4829	0	0	249.0281	0
Story10	-0.1656	0	0	129.0915	1558	1720	150.1443	0
Story10	0	0	0	168.0705	2038	1720	57.5792	0
Story10	-0.0852	0	0	131.1835	1584	1720	125.2833	0
Story10	-68.411	820	1720	21.8704	261	0	125.2833	0
Story10	-255.974	3138	1720	72.3425	867	0	102.0899	0
Story10	-65.5417	785	1755	19.633	234	0	228.6617	0

Table A.58: Moment& Steel Area for Conventional Floor for Model (8.3×7.5x7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-2.5615	0	0	154.2528	1863	1942	136.2223	0
Story10	-69.5492	833	1942	21.0145	250	0	136.2223	0
Story10	-280.4838	3441	1849	88.5684	1063	0	284.0038	0
Story10	-83.8316	1005	1849	31.9225	381	0	304.7912	0
Story10	-0.1025	0	0	143.6578	1735	1849	134.5624	0
Story10	0	0	0	190.1588	2308	1849	65.7512	0
Story10	-0.1923	0	0	142.4726	1720	1849	169.3651	0
Story10	-115.168	1386	1849	4.3894	52	0	273.6658	0
Story10	-402.0604	5006	1849	0	0	0	273.6658	0
Story10	-159.1764	1925	1849	6.1361	73	0	525.0909	0
Story10	-34.9047	416	0	113.2607	1363	1849	228.7936	0
Story10	0	0	0	165.4744	2003	1849	59.0126	0
Story10	0	0	0	155.8018	1884	1849	58.0962	0
Story10	-33.8599	404	0	89.2143	1071	1849	153.3323	0
Story10	-160.5689	1943	1849	1.1903	0	0	204.1943	0
Story10	-377.6438	4688	1849	0	0	0	204.1943	0
Story10	-37.1454	445	877	0	0	0	65.1062	0
Story10	-29.1767	349	877	3.5562	42	0	5.3352	0
Story10	-26.3882	316	877	4.8368	58	0	3.3863	0
Story10	-22.2376	266	877	3.0096	36	0	2.0892	0
Story10	-27.4183	328	877	2.3711	28	0	7.4384	0
Story10	-35.588	426	877	0	0	0	69.0923	0
Story10	-379.2794	4709	1849	0	0	0	141.8785	0
Story10	-114.8424	1382	1849	17.2026	205	0	207.2521	0
Story10	-0.6189	0	0	120.9035	1456	1849	142.1484	0
Story10	0	0	0	186.8319	2267	1849	53.4807	0
Story10	-0.8694	0	0	137.2847	1656	1849	123.3381	0

Table A.58: Moment& Steel Area for Conventional Floor for Model (8.3×7.5x7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-80.0249	959	1849	32.3612	386	0	134.3428	0
Story10	-275.8656	3382	1849	85.5421	1026	0	126.9735	0
Story10	-61.5738	737	1755	18.8369	224	0	105.1181	0
Story10	-10.3729	123	0	115.5861	1392	1755	163.006	0
Story10	0	0	0	164.6871	1995	1755	99.9412	0
Story10	0	0	0	187.7544	2281	1755	42.6644	0
Story10	0	0	0	144.1087	1742	1755	95.5618	0
Story10	-18.944	226	0	27.7098	330	1755	112.2559	0
Story10	-152.6486	1847	1755	0	0	0	112.2559	0
Story10	-37.7826	451	1755	18.0953	215	0	150.9292	0
Story10	-5.5365	66	0	105.5242	1270	1755	101.6902	0
Story10	0	0	0	151.8517	1837	1755	33.5395	0
Story10	0	0	0	146.9944	1777	1755	41.217	0
Story10	-10.077	120	0	93.141	1119	1755	94.674	0
Story10	-55.8619	668	1755	10.1777	121	0	117.3644	0
Story10	-184.116	2236	1755	0	0	0	117.3644	0
Story10	-82.1046	985	1755	2.2935	0	0	131.7171	0
Story10	-2.4593	0	0	90.7137	1089	1755	95.9496	0
Story10	-1.5067	0	0	130.9843	1581	1755	48.1265	0
Story10	-0.8311	0	0	115.2992	1389	1755	34.2897	0
Story10	-1.5487	0	0	92.4815	1111	1755	73.6036	0
Story10	-43.6574	521	1755	15.6219	186	0	88.7722	0
Story10	-151.7	1835	1755	0	0	0	115.1626	0
Story10	-16.3395	195	0	43.0658	514	1755	106.2675	0
Story10	0	0	0	141.0301	1704	1755	51.0013	0
Story10	0	0	0	173.7179	2107	1755	4.1442	0
Story10	-0.2146	0	0	124.8362	1505	1755	69.2257	0

Table A.58: Moment& sSteel Area for Conventional Floor for Model (8.3×7.5x7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-37.247	445	0	85.2444	1023	1720	155.987	0
Story10	-170.0588	2063	1720	0	0	0	266.4919	0
Story10	-442.0747	5555	1720	0	0	0	266.4919	0
Story10	-179.6051	2181	1720	0.1898	0	0	305.4681	0
Story10	-1.8335	0	0	112.3309	1353	1720	266.561	0
Story10	0	0	0	185.4637	2254	1720	141.1843	0
Story10	0	0	0	190.8344	2321	1720	72.0476	0
Story10	-0.1893	0	0	126.5062	1526	1720	151.5985	0
Story10	-112.0616	1350	1720	5.9831	71	0	229.9719	0
Story10	-358.9017	4460	1720	0	0	0	229.9719	0
Story10	-63.3067	758	1720	5.4744	65	0	149.6827	0
Story10	0	0	0	128.1494	1546	1720	126.7119	0
Story10	0	0	0	173.8096	2109	1720	51.759	0
Story10	-0.102	0	0	130.1906	1571	1720	129.5106	0
Story10	-89.4809	1075	1720	17.9546	214	0	198.6956	0
Story10	-311.4027	3845	1720	37.2283	444	0	144.5009	0
Story10	-19.867	237	0	43.5536	523	877	167.4567	0
Story10	-7.3436	87	0	56.4765	680	877	32.8822	0
Story10	-0.2041	0	0	45.933	552	877	9.2142	0
Story10	-10.8671	129	0	64.9827	784	877	22.6793	0
Story10	-44.6761	536	0	70.0228	846	877	43.4365	0
Story10	-89.4029	1085	877	42.0092	504	0	43.4365	0
Story10	-63.0708	755	1685	18.5644	221	0	209.5777	0
Story10	-7.605	90	0	113.5024	1368	1685	101.8254	0
Story10	0	0	0	157.4758	1908	1685	56.803	0
Story10	0	0	0	177.1527	2152	1685	45.8008	0
Story10	0	0	0	144.6292	1749	1685	118.0817	0

Table A.58: Moment& Steel Area for Conventional Floor for Model (8.3×7.5x7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-19.8079	333	0	26.1833	441	913	11.725	0
Story10	-15.6575	263	0	19.3033	324	913	10.0468	0
Story10	-13.1022	220	913	10.646	178	0	0.9948	0
Story10	-18.622	313	913	7.4358	124	0	9.9574	0
Story10	-60.4848	1030	913	2.9925	50	0	53.0487	0
Story10	-87.6315	1506	913	45.6819	774	0	208.9375	0
Story10	-2.8617	48	0	80.3622	1377	913	52.1324	0
Story10	0	0	0	81.4331	1396	913	22.2613	0
Story10	-37.5577	634	913	28.9718	488	0	90.3232	0
Story10	-266.4393	4913	913	0.32	0	0	48.2186	0
Story10	-61.2595	1043	913	35.6838	602	0	328.9061	2166.67
Story10	-0.3933	0	0	88.5265	1522	913	91.3627	0
Story10	0	0	0	94.4305	1627	913	30.2684	0
Story10	0	0	0	79.3652	1360	913	29.2539	0
Story10	-48.1006	815	913	19.9258	335	0	90.6007	0
Story10	-265.1153	4885	913	0.4551	0	0	243.1159	0
Story10	-210.7727	3795	913	7.8702	132	0	221.2631	0
Story10	-23.2022	390	0	39.8117	673	913	82.6278	0
Story10	0	0	0	85.7409	1472	913	5.3598	0
Story10	-1.1301	0	0	93.0597	1602	913	65.2576	0
Story10	-39.3948	666	0	58.4591	994	913	187.9038	0
Story10	-159.9195	2822	913	12.1972	204	0	30.545	0
Story10	-154.8083	2727	913	18.5134	311	0	294.0119	2166.67
Story10	-5.8798	98	0	43.1205	730	913	290.5542	2166.67
Story10	0	0	0	85.0158	1460	913	53.2903	0
Story10	-0.0768	0	0	88.3276	1518	913	58.5722	0
Story10	-43.9366	744	0	45.2338	766	913	195.6666	0

Table A.59: Moment&Steel Area for Flat Floor for Model (8.3×7.5x7.2).

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-111.5826	1247	907	60.9618	674	0	74.7257	0
Story10	-65.4528	724	0	89.852	999	907	52.7978	0
Story10	-24.0769	264	0	85.7578	953	907	24.4354	0
Story10	-7.4488	81	0	69.993	775	907	9.4738	0
Story10	0	0	0	49.504	546	907	7.6054	0
Story10	-4.043	44	0	42.4106	467	907	28.4898	0
Story10	-57.3187	633	907	56.1442	620	0	162.8205	0
Story10	-157.6376	1779	907	0.4462	0	0	333.0819	1500
Story10	-40.1478	442	907	37.9328	417	0	76.1144	0
Story10	-8.8398	97	0	57.8958	640	907	36.792	0
Story10	0	0	0	54.7899	605	907	13.4887	0
Story10	0	0	0	54.6916	604	907	13.82	0
Story10	-8.7964	96	0	56.7579	627	907	18.1526	0
Story10	-39.034	430	907	34.0523	374	0	66.7213	0
Story10	-161.3668	1823	907	0.4467	0	0	165.7611	0
Story10	-44.8584	494	0	61.7199	682	907	163.6242	0
Story10	-5.0458	55	0	48.5623	535	907	28.8867	0
Story10	0	0	0	40.7014	448	907	7.9672	0
Story10	-5.8145	64	0	49.5088	546	907	28.3231	0
Story10	-40.6653	448	0	57.1754	632	907	152.0318	0
Story10	-145.5066	1638	907	0.6745	0	0	306.4577	1500
Story10	-21.8562	240	0	41.4913	457	907	77.3486	0
Story10	-1.9977	0	0	49.4656	546	907	30.3246	0
Story10	-4.3302	47	0	67.1674	743	907	10.1098	0
Story10	-15.8149	173	0	87.9627	978	907	24.9579	0
Story10	-58.3717	645	0	94.1636	1048	907	51.499	0
Story10	-109.6771	1225	907	62.5782	692	0	51.499	0

Table A.59: Moment& Steel Area for Flat Floor for Model (8.3×7.5x7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-5.6155	61	0	102.3828	1129	1890	94.6365	0
Story10	-1.1816	0	0	149.4451	1656	1890	44.7662	0
Story10	-1.3639	0	0	152.9975	1696	1890	50.466	0
Story10	-4.074	0	0	106.0727	1170	1890	50.4216	0
Story10	-113.6268	1254	1890	26.0987	286	0	76.0107	0
Story10	-128.8289	1424	1890	5.462	60	0	15.3711	0
Story10	-37.8736	415	0	48.449	531	1890	68.8579	0
Story10	-0.0926	0	0	199.2565	2219	1890	103.5961	0
Story10	0	0	0	222.6218	2485	1890	59.8887	0
Story10	-0.5314	0	0	180.4143	2005	1890	117.4335	0
Story10	-79.9798	880	1890	7.2757	79	0	57.4674	0
Story10	-155.8736	1728	1890	0.3562	0	0	91.6705	0
Story10	-77.9713	858	1890	28.3577	310	0	222.783	0
Story10	0	0	0	197.6307	2200	1890	144.4499	0
Story10	0	0	0	289.9866	3260	1890	78.6675	0
Story10	0	0	0	249.8241	2796	1890	90.0982	0
Story10	-9.6276	105	0	157.8743	1751	1890	133.6857	0
Story10	-45.9952	504	1890	19.2742	211	0	134.2774	0
Story10	-558.2903	6442	1991	138.884	1536	0	925.1761	3436.4
Story10	-76.1211	837	0	116.1511	1282	1991	365.3997	0
Story10	0	0	0	298.5165	3353	1991	195.0569	0
Story10	0	0	0	366.2491	4142	1991	102.0293	0
Story10	0	0	0	298.9158	3358	1991	207.8454	0
Story10	-207.3054	2308	1991	39.7947	436	0	288.0654	0
Story10	-887.4548	10633	1991	0.873	0	0	637.4384	0
Story10	-336.2584	3791	1991	85.528	941	0	602.2319	0
Story10	-58.8409	646	0	227.7564	2541	1991	256.4024	0

Table A.59: Moment& Steel Area for Flat Floor for Model (8.3×7.5×7.2)"Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-211.1665	2352	1991	35.8513	393	0	295.7625	0
Story10	-903.5255	10847	1991	0.8857	0	0	652.1863	0
Story10	-339.6802	3831	1991	87.1826	960	0	1481.5291	10725.66
Story10	-59.139	649	0	228.065	2544	1991	290.0397	0
Story10	0	0	0	294.3781	3305	1991	72.1569	0
Story10	0	0	0	268.5484	3008	1991	78.8902	0
Story10	-45.2356	496	0	164.6119	1825	1991	228.5152	0
Story10	-256.7436	2872	1991	39.478	433	0	426.8952	0
Story10	-615.4256	7146	1991	0	0	0	164.6495	0
Story10	-63.1633	698	945	0	0	0	23.1737	0
Story10	-39.7056	437	945	0.783	0	0	4.4456	0
Story10	-36.5602	402	945	2.4378	27	0	3.4436	0
Story10	-35.5714	391	945	2.2197	24	0	6.4952	0
Story10	-40.9314	450	945	1.0485	0	0	20.5981	0
Story10	-71.0994	787	945	0	0	0	97.1655	0
Story10	-663.6229	7747	1991	6.708	73	0	230.2657	0
Story10	-195.256	2171	1991	83.6645	921	0	397.0621	0
Story10	-5.1138	56	0	223.3971	2491	1991	216.6195	0
Story10	0	0	0	318.0972	3580	1991	75.4869	0
Story10	-3.481	0	0	254.6893	2848	1991	89.9203	0
Story10	-208.7986	2325	1991	55.8861	613	0	255.9934	0
Story10	-860.8511	10281	1991	0.5543	0	0	126.7773	0
Story10	-251.9571	2817	1991	84.436	929	0	644.4752	0
Story10	-1.4444	0	0	313.5513	3527	1991	548.6324	0
Story10	0	0	0	365.9888	4139	1991	178.3243	0
Story10	0	0	0	289.8274	3253	1991	132.6791	0
Story10	-75.8872	834	0	115.9044	1279	1991	367.0571	0

Table A.59: Moment& Steel Area for Flat Floor for Model (8.3×7.5×7.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10		263	0	97.5581	1075	1890	113.2388	0
Story10	-0.241	0	0	211.8153	2362	1890	50.7904	0
Story10	0	0	0	241.4748	2701	1890	1.5086	0
Story10	-1.0275	0	0	188.0627	2092	1890	73.781	0
Story10	-63.529	698	0	75.6772	832	1890	149.3333	0
Story10	-125.5116	1387	1890	2.9281	0	0	29.1253	0
Story10	-56.3191	618	1890	38.3585	420	0	57.4905	0
Story10	-0.8912	0	0	182.6586	2031	1890	175.9504	0
Story10	0	0	0	237.3949	2654	1890	101.7196	0
Story10	0	0	0	218.8273	2442	1890	17.1821	0
Story10	-8.2524	90	0	164.2412	1822	1890	134.0914	0
Story10	-74.4807	819	1890	37.4693	411	0	133.7779	0
Story10	-566.2122	6569	1852	129.3522	1431	0	363.2981	0
Story10	-81.2519	894	0	102.3127	1128	1852	363.7394	0
Story10	0	0	0	277.6884	3119	1852	188.7784	0
Story10	0	0	0	316.7182	3573	1852	81.28	0
Story10	-0.105	0	0	255.2732	2861	1852	220.7578	0
Story10	-120.359	1330	1852	58.0272	637	0	323.6246	0
Story10	-597.486	6958	1852	0.847	0	0	429.0671	0
Story10	-206.1474	2298	1852	56.1993	617	0	416.4364	0
Story10	-31.2589	342	0	173.8971	1932	1852	256.249	0
Story10	0	0	0	255.7987	2867	1852	57.5529	0
Story10	0	0	0	259.2255	2906	1852	75.7649	0
Story10	-58.248	640	0	181.8527	2022	1852	245.0858	0
Story10	-336.1845	3800	1852	49.0965	539	0	582.5179	0
Story10	-902.3561	10923	1852	0.2611	0	0	613.7867	0
Story10	-269.7944	3028	1852	7.0924	77	0	277.7914	0

Table A.60: Moment & Steel Area for Waffle Floor for Model (8.3×7.5x7.2).

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-48.598	600	305	4.1798	50	0	45.7967	0
Story10	-15.3747	185	0	40.3659	487	305	52.687	0
Story10	-4.9901	60	0	51.0284	617	305	21.6106	0
Story10	-1.3427	16	0	49.3046	596	305	11.0764	0
Story10	-0.0331	0	0	43.8979	530	305	5.099	0
Story10	-0.5796	0	0	37.6359	453	305	8.6025	0
Story10	-27.581	335	0	29.1753	351	305	114.1391	0
Story10	-205.4491	2906	305	0	89	0	38.8053	0
Story10	-12.6403	152	0	26.1045	314	305	118.2813	0
Story10	-1.0693	13	0	34.7832	419	305	13.465	0
Story10	0	0	0	38.0425	458	305	2.8798	0
Story10	0	0	0	37.2761	449	305	4.4944	0
Story10	-2.8959	35	0	35.7477	430	305	10.9454	0
Story10	-10.4426	126	0	11.614	139	305	36.4781	0
Story10	-212.8236	3009	305	0.0415	218	0	615.4034	14754.31
Story10	-22.6843	275	0	71.353	867	305	121.9897	0
Story10	-0.3501	0	0	33.7414	406	305	12.1272	0
Story10	0	0	0	31.5502	379	305	3.5789	0
Story10	-0.3682	0	0	32.3543	389	305	10.62	0
Story10	-8.2965	100	0	28.5792	344	305	109.6377	0
Story10	-187.0544	2607	305	0	0	0	11.1618	0
Story10	-6.1435	74	0	34.413	414	305	202.8056	1465.83
Story10	0	0	0	43.1131	520	305	20.4996	0
Story10	0	0	0	45.9799	555	305	7.6114	0
Story10	-3.973	48	0	50.014	604	305	8.6455	0
Story10	-12.9198	156	0	42.6061	514	305	25.8368	0
Story10	-46.1399	569	305	5.3197	64	0	43.8997	0

Table A.60: Moment& Steel Srea for Waffle Floor for Model (8.3×7.5x7.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-29.7174	358	610	10.114	121	0	69.1519	0
Story10	0	0	0	87.3227	1053	610	42.4597	0
Story10	0	0	0	121.1334	1468	610	4.2363	0
Story10	-0.0762	0	0	95.7224	1156	610	44.5526	0
Story10	-17.6093	211	610	16.0957	193	0	46.0707	0
Story10	-47.1305	572	610	8.0408	96	0	44.2484	0
Story10	-59.1251	720	610	2.5675	31	0	4.4961	0
Story10	-45.073	546	610	14.5987	175	0	35.6611	0
Story10	-10.7456	129	0	38.4389	461	610	75.568	0
Story10	-0.1531	0	0	134.8876	1637	610	69.5392	0
Story10	0	0	0	195.9636	2397	610	35.8516	0
Story10	0	0	0	193.9808	2372	610	43.7001	0
Story10	-1.728	21	0	130.807	1587	610	126.0113	0
Story10	-35.9685	435	610	4.1084	49	0	129.1776	0
Story10	-50.8774	628	318	5.1452	61	0	47.5986	0
Story10	-14.2034	171	0	38.8439	468	318	24.6949	0
Story10	-4.3893	53	0	48.1152	581	318	13.6811	0
Story10	0	0	0	45.2397	546	318	6.1483	0
Story10	0	0	0	42.5267	513	318	13.6968	0
Story10	-26.6312	323	0	35.0986	422	318	137.8402	568.18
Story10	-454.2424	6421	623	0.0286	1372	0	298.5977	2778.01
Story10	-67.6377	826	623	43.447	521	0	723.1591	7420.31
Story10	-2.7442	33	0	249.0652	3065	623	157.1858	0
Story10	0	0	0	285.5698	3531	623	16.0785	0
Story10	-3.8799	46	0	177.3364	2163	623	174.1951	0
Story10	-182.1669	2320	623	2.7377	0	0	295.7738	1298.36
Story10	-600.5332	5604	1530	0	0	0	804.7659	2979.58

Table A.60: Moment& Steel Area for Waffle Floor for Model (8.3×7.5x7.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-12.3508	148	0	166.8407	2032	623	211.8257	0
Story10	-148.5113	1867	623	1.2564	0	0	481.8736	0
Story10	-518.0033	4790	1530	0	0	0	479.5361	0
Story10	-889.4243	8589	1530	0	0	0	383.7916	0
Story10	-532.6851	4934	1530	0	0	0	458.0888	0
Story10	-142.025	1781	623	2.1837	26	0	660.9994	2083.33
Story10	-7.1882	86	0	197.5902	2416	623	253.7209	0
Story10	0	0	0	286.6198	3545	623	82.7054	0
Story10	0	0	0	242.0236	2976	623	50.7411	0
Story10	-10.3766	124	0	40.9195	491	623	188.9932	0
Story10	-360.6992	4973	623	68.0687	819	0	134.1333	0
Story10	-37.1246	448	636	3.9354	47	0	142.4893	0
Story10	0	0	0	134.2554	1628	636	64.6046	0
Story10	0	0	0	200.1227	2446	636	9.787	0
Story10	0	0	0	200.7907	2455	636	50.7042	0
Story10	-0.0691	0	0	136.5451	1656	636	88.3361	0
Story10	-16.3879	197	0	30.1079	361	636	79.5018	0
Story10	-53.2587	647	636	11.1431	133	0	30.6591	0
Story10	-79.1557	970	636	4.9411	59	0	29.5388	0
Story10	-45.8745	556	636	9.8095	117	0	21.2449	0
Story10	-32.7664	395	636	23.2585	278	0	69.7633	0
Story10	-0.0369	0	0	124.1164	1503	636	71.7301	0
Story10	0	0	0	166.7597	2030	636	11.6901	0
Story10	-0.0535	0	0	141.2691	1715	636	58.986	0
Story10	-18.311	220	0	45.4496	545	636	70.271	0
Story10	-40.9247	495	636	19.7991	237	0	52.8006	0
Story10	-85.2282	1046	636	7.8716	94	0	125.3965	0

Table A.60: Moment& Steel Area for Waffle Floor for Model (8.3×7.5×7.2) "Table Continued".

Story	F Top Moment	FTop Area	FTop AMin	FBot Moment	FBot Area	FBot AMin	V Force	V Area
	kN-m	mm ²	mm ²	kN-m	mm ²	mm ²	kN	mm ² /m
Story10	-1.8027	22	0	198.3218	2421	670	194.4293	0
Story10	-119.6895	1484	670	32.6463	391	0	338.2375	1686.74
Story10	-556.8133	7866	670	0	2049	0	342.7581	3410.57
Story10	-55.5395	688	318	0	0	0	56.1143	0
Story10	-32.4184	395	318	0	0	0	9.8807	0
Story10	-25.3189	307	318	1.2137	14	0	8.9907	0
Story10	-28.8821	351	318	0.6945	8	0	4.1101	0
Story10	-36.9132	451	318	2.1701	26	0	22.9868	0
Story10	-51.5134	636	318	0.5494	0	0	37.5795	0
Story10	-538.3044	7606	670	0.4619	1725	0	231.7264	0
Story10	-122.9836	1527	670	46.3219	556	0	546.7775	4673.91
Story10	-2.9731	36	0	195.5244	2386	670	217.0512	0
Story10	0	0	0	259.71	3193	670	48.1238	0
Story10	0	0	0	177.1759	2157	670	120.9171	0
Story10	-172.8952	2183	670	11.7604	104	0	596.7046	2083.33
Story10	-563.4258	5237	1530	0	0	0	821.4156	3154.94
Story10	-1001.9091	9816	1530	0	0	0	769.2309	2605.29
Story10	-574.5746	5347	1530	0	0	0	1509.8435	10406.07
Story10	-155.4409	1951	670	2.3983	29	0	518.9963	4275.97
Story10	-0.8357	0	0	209.4458	2560	670	278.3089	0
Story10	0	0	0	315.8673	3910	670	40.7133	0
Story10	-0.4343	0	0	269.1518	3313	670	191.6454	0
Story10	-27.9205	336	0	61.9202	744	670	352.8292	1895.76
Story10	-418.9088	5863	670	74.5495	897	0	320.0697	1426.5
Story10	-25.3985	305	704	2.3025	27	0	166.535	0
Story10	-0.4625	0	0	177.7499	2162	704	67.5159	0
Story10	0	0	0	254.0656	3117	704	1.1169	0