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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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Amir Abdulmalik MAHOOD

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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.

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# 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].

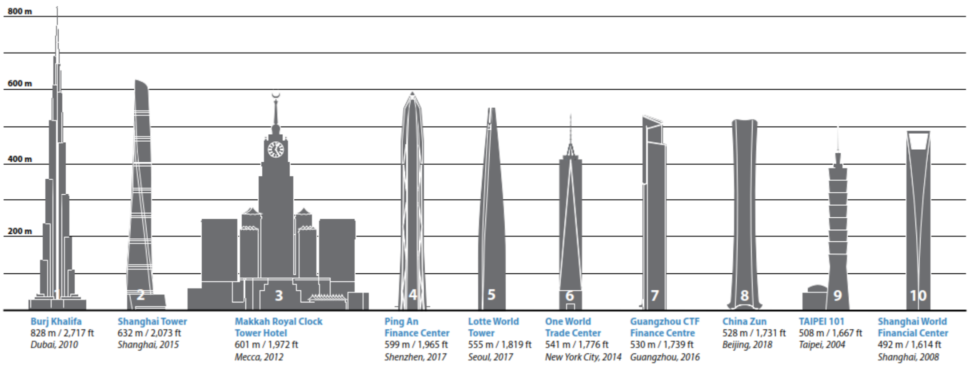



**Figure 2.1:** Diagram of Buildings World's Highest Building.

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].

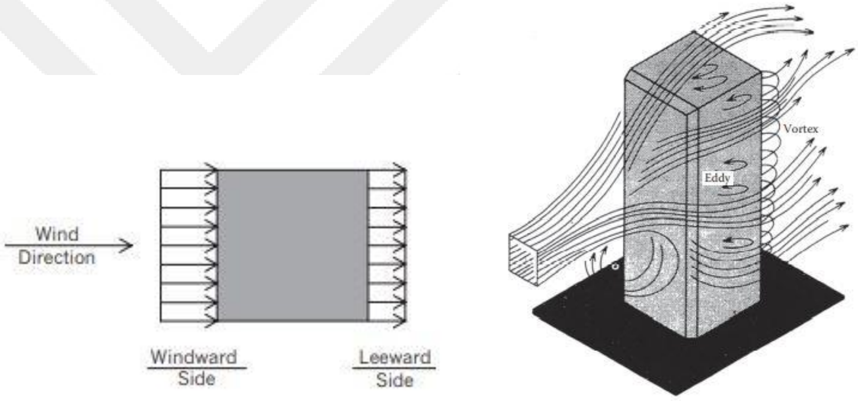



**Figure 2.2:** Wind Effect on Different Sides of Structure.

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 force = mass x 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].

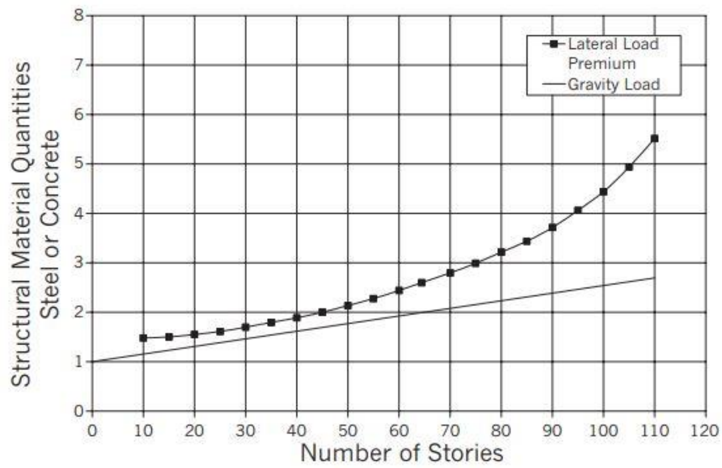



**Figure 2.3:** Diagram Shown Relation between Number of Stories and Materials Quantities.

### 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].

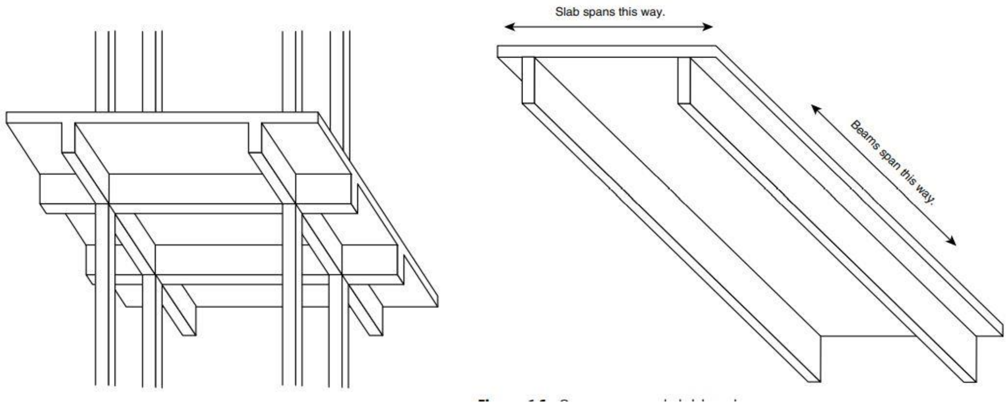



**Figure 2.4:** Diagram Showing One-Way and Tow-Way of Conventional Slab.

### 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].

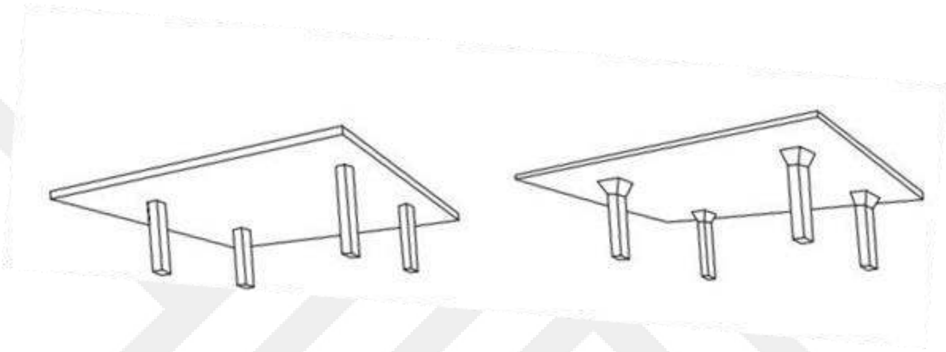
Unlike beam structures, flat slabs are directly supported by concrete columns. There are two types of flat slabs: single-sided slabs with the total load concentrated on a support column, and rectangle slabs known as "drop panels” [23].

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



(a) (b)

**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].

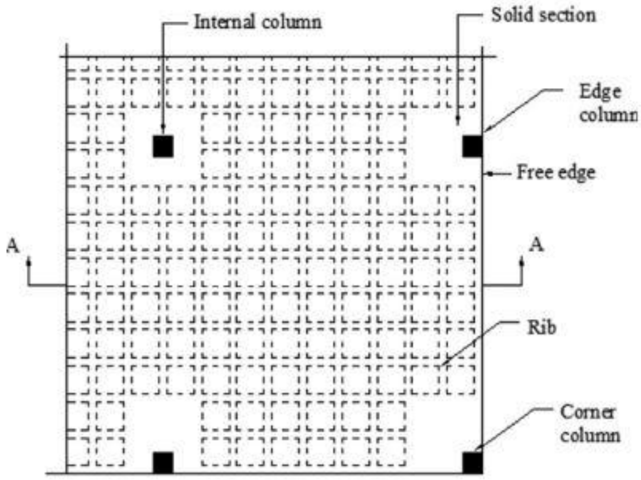



**Figure 2.6:** Diagram Showing Typical Waffle Slab.

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%4 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

$$E_V = 0\ \ .2S_{DS}\,D \tag{3.1}$$

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

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

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

Equivalent Lateral Force Procedure

Find Ss& S1 for Baghdad city from Iraqi Seismic code 2017 for Zones (III) & (II) as shown below:

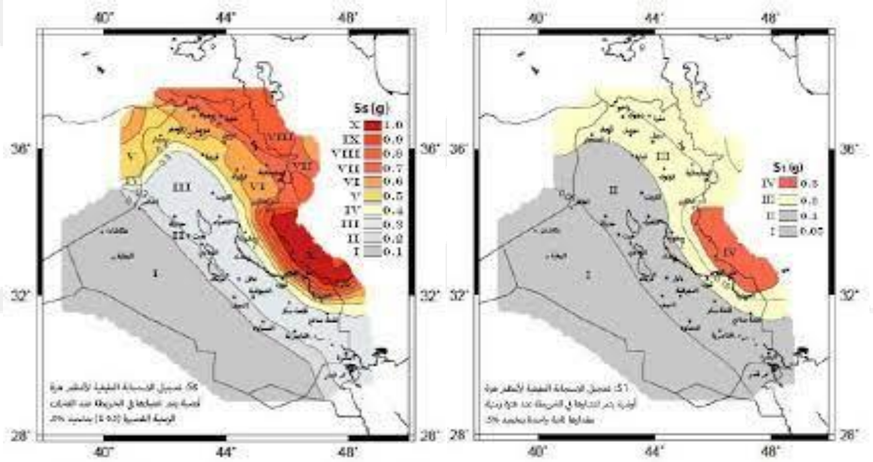



**Figure 3.1:** Shown Iraq Regions for S1&SS.

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

Calculate $S_{Ds}$&$S_{D1}$From Equation as shown below

$$S_{DS} = \frac{2}{3}\, F_a S_S \tag{3.4}$$

$$SD_1 = \frac{2}{3}\, F_v \tag{3.5}$$

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 Ct & x from Table 12.8-1[33]

Calculate value of Ta from Equation:

$$T_a = C_1 H^X \qquad (3.6)$$

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

Calculate value of $T_{max}$ from Equation:

$$T_{max} = C_U T_a \qquad (3.7)$$

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

Find $C_S$ Factor from the Equation

$$Cs = \frac{SD_S}{(\frac{R}{Ie})} \qquad (3.8)$$

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

Calculate Seismic Base Shear

$$V = C_S W \qquad (3.9)$$

Calculate Values of Cvx & $F_X$

$$F_X = C_{VX} V \qquad (3.10)$$

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

**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 |
| Ie | 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=31m/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

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

Then find $V_T = 39.07 m/s$

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:

$$p = q_z GC_p - q_i (GC_{pi}) \quad (3.13)$$

**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 $T_0$, Sa Values find from

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

For T greater than Ts 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

$$S_a = \frac{S_{D1} T_L}{T^2} \tag{3.20}$$

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

$$T_S = \frac{S_{D1}}{S_{DS}} \tag{3.22}$$

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 | |

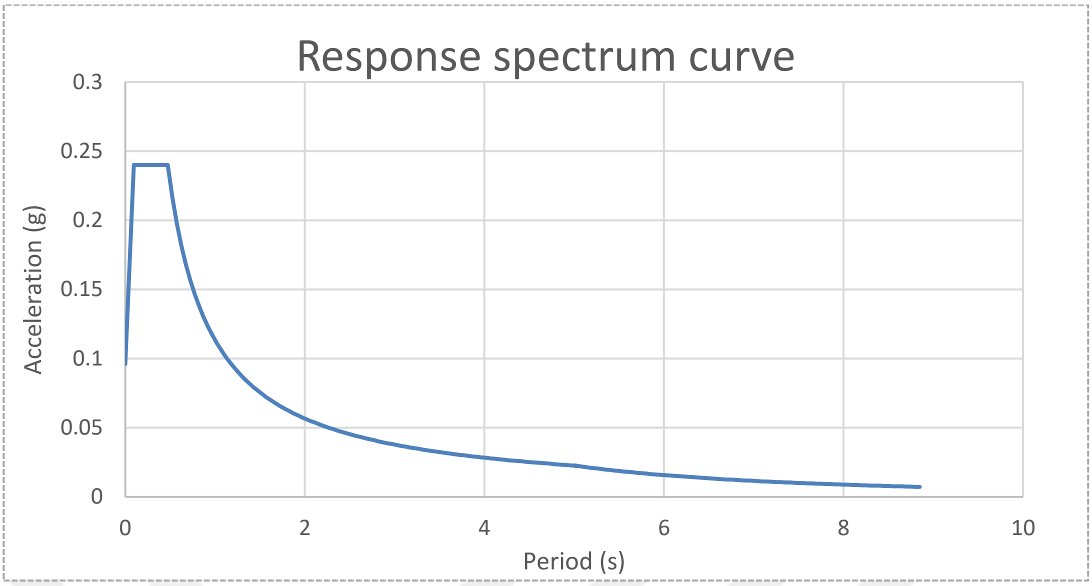



**Figure 3.2:** Design Response Spectrum Curve.

# 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).

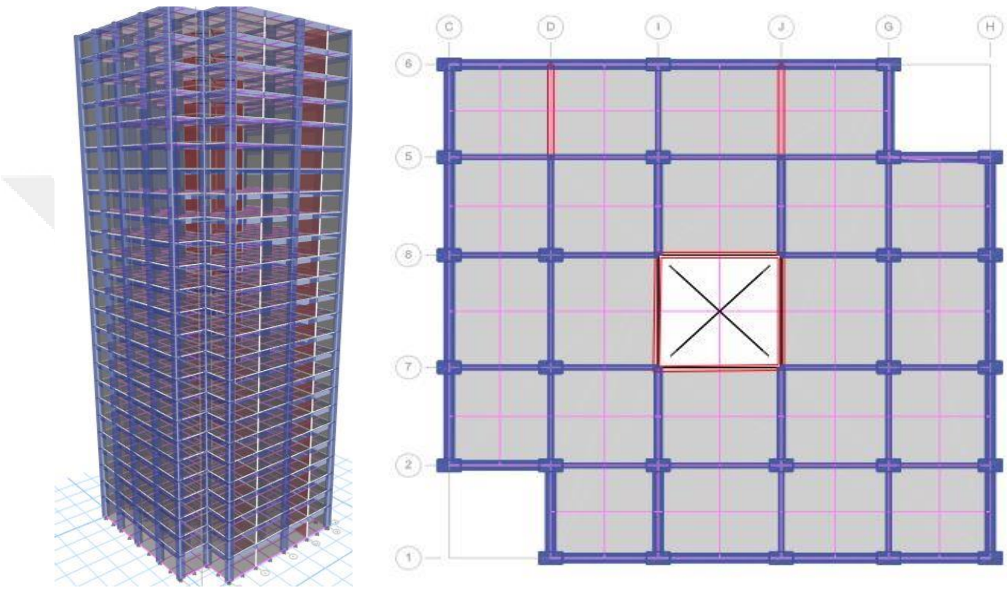



**Figure 4.1:** Conventional Floor Model Isometric & Plan View Model (6.3-5.5-5.2).

**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 Cs max <Cs used

#### 4.1.1.2 Wind loads

By applying the procedure shown in the section (3.6.2) steps (1-13) and find Kz 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

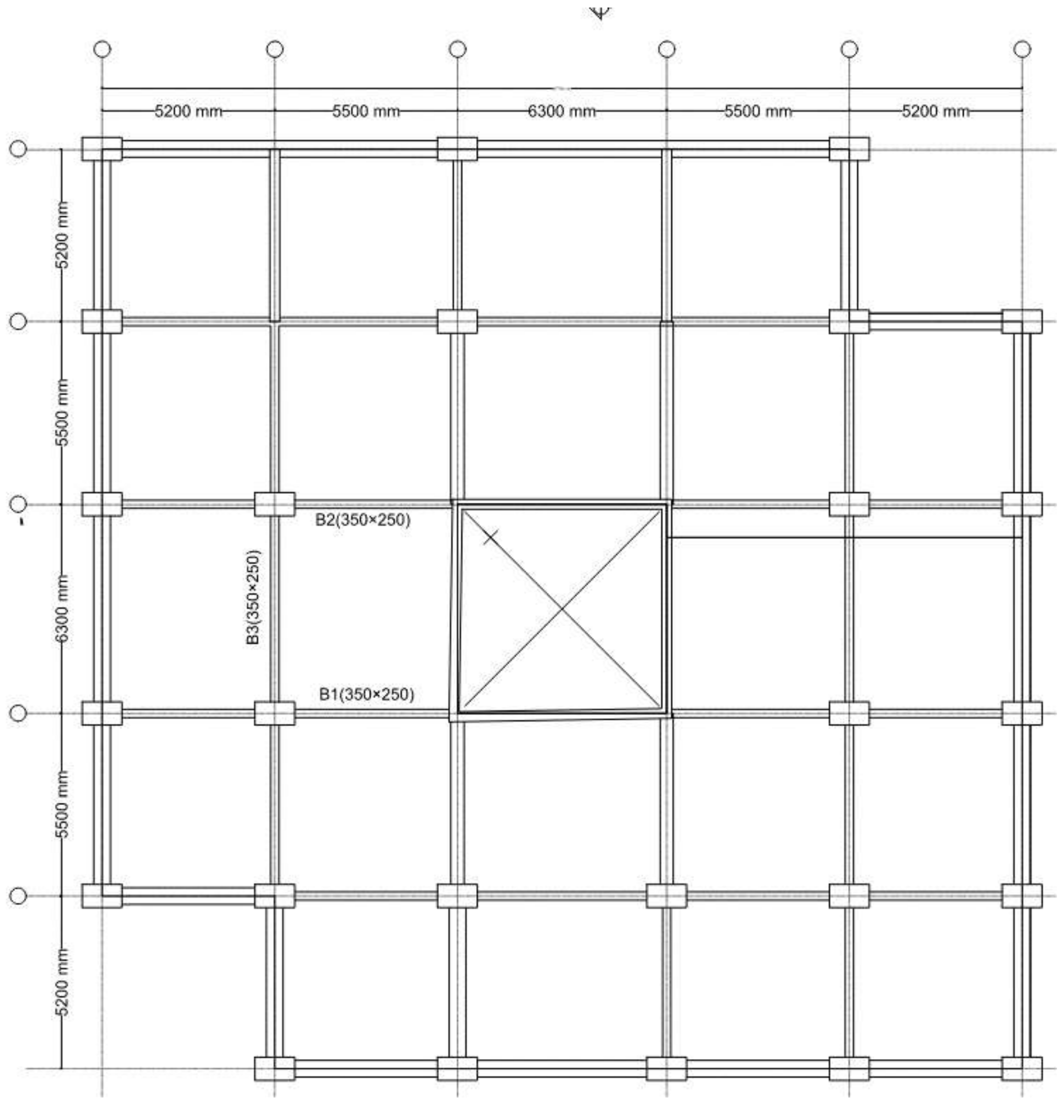



**Figure 4.2:** Showing Internal Beams of Conventional Floor (B1, B2, B3) Model (6.3-5.5-5.2).

### 4.1.3.1 Design for internal beams

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

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

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

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

Take $b_1$ = 250mm & b2= 400 mm for beam span 6.3 m

Beams dimensions B1&B2 &B3 (350x250)

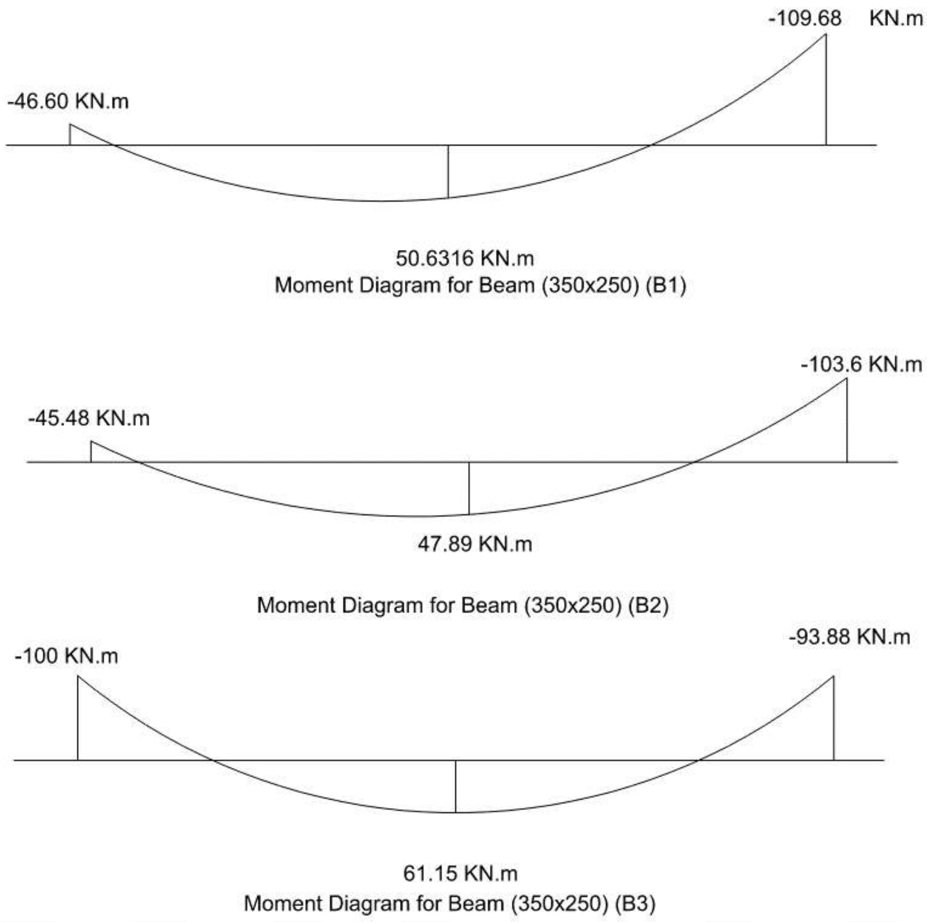



**Figure 4.3:** Showing Moment Diagram for Internal Beams (B1, B2, B3) model (6.3-5.5-5.2).

From ACI 318-14 (Table 20.6.1.3.1).

Find d= h-(c.c+strup+Db/2)  Take $\emptyset = 0.9 \, , jd = 0.889 \times d$

$$\mathrm{As} = \frac{\mathrm{Mu}}{\emptyset \times \mathrm{fy} \times \mathrm{jd}} \tag{4.2}$$

$$a = \frac{As \times fy}{fc \times b} \tag{4.3}$$

$$\beta = 0.85 - \frac{0.05(fc-28)}{7} \tag{4.4}$$

$$c = \frac{a}{\beta}, \varepsilon_t = (\frac{d-c}{c})\ 0.003 \tag{4.5}$$

$$M_d = As\emptyset \times fy \times (d - \frac{a}{2}) \tag{4.6}$$

Moment values of Beams for Story-10

Therefore Check $M_d = \emptyset Mu$

$$As_{min} = \frac{0.25\times\sqrt{fc}}{fy} \times b \times d \quad (4.7)$$

$$As_{min} = \frac{1.4}{fy} \times b \times d \quad (4.8)$$

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

| B1(350x250) | Location | MU | Md | a | $\beta$ | 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 | $\beta$ | 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 | $\beta$ | 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 |

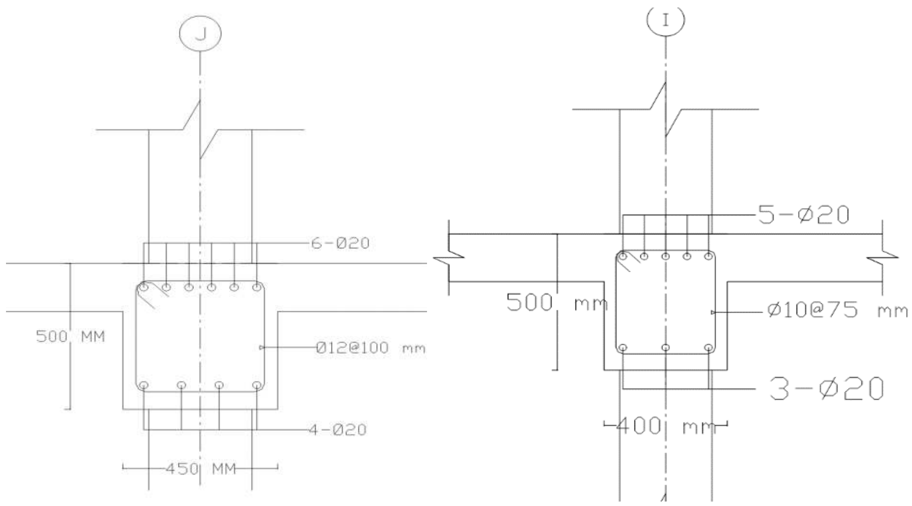



**Figure 4.4:** Show Steel Reinforcement Details for Span 6.3 m Beams Model (6.3-5.5-5.2).

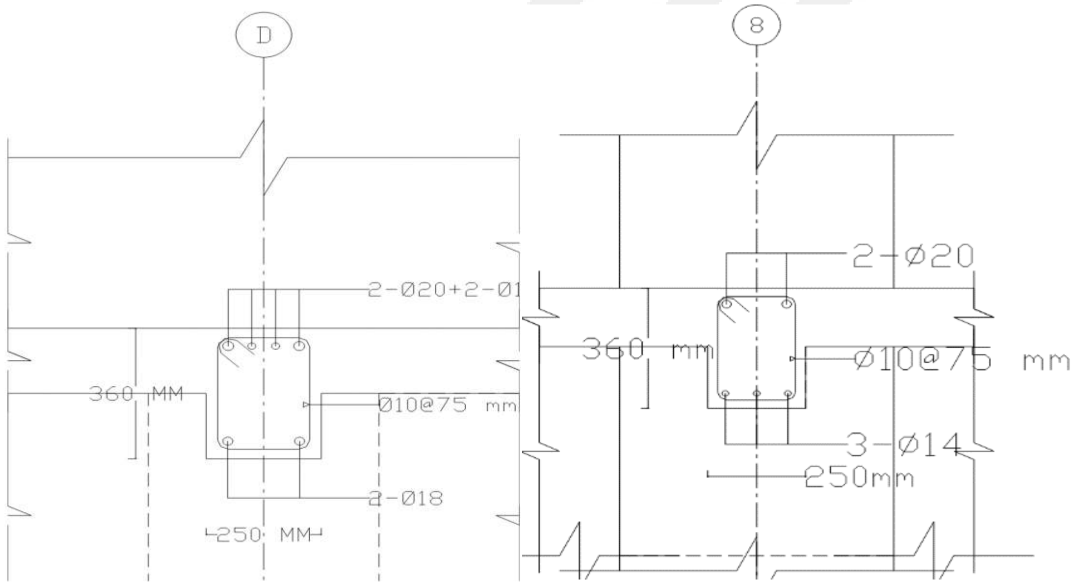



**Figure 4.5:** Show Steel Reinforcement Detail for Beam (B1&B2&B3) Model (6.3-5.5-5.2).

#### 4.1.3.2 Design slab

Check slab thickness for panel (6.3×5.2)

Find

$$\alpha_f = \frac{E_{cb} I_b}{E_{cs} I_s} \tag{4.9}$$

$$\alpha_{fm} = \frac{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}{4} \tag{4.10}$$

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

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

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

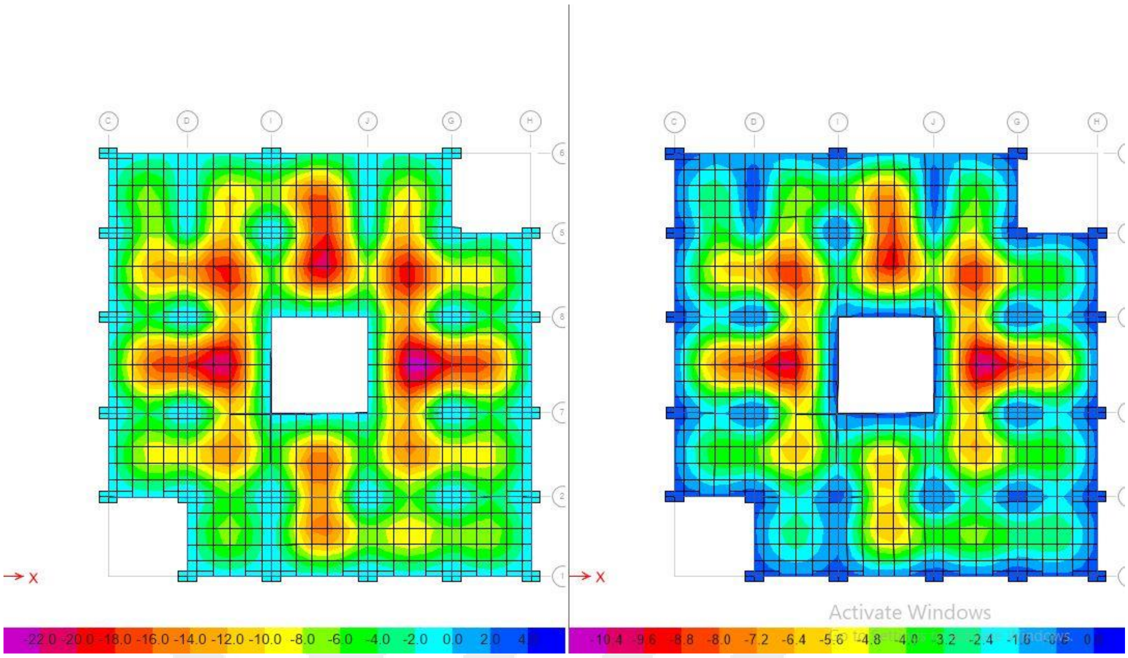
Width of strips

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

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

Width of field strip -Short direction = $Ll - \frac{Ls}{2} = 6.3 - \frac{5.3}{2} = 3.55m$

#### 4.1.3.3 Check deflection



(a) (b)

**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

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

$\frac{L}{240}$ 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 |

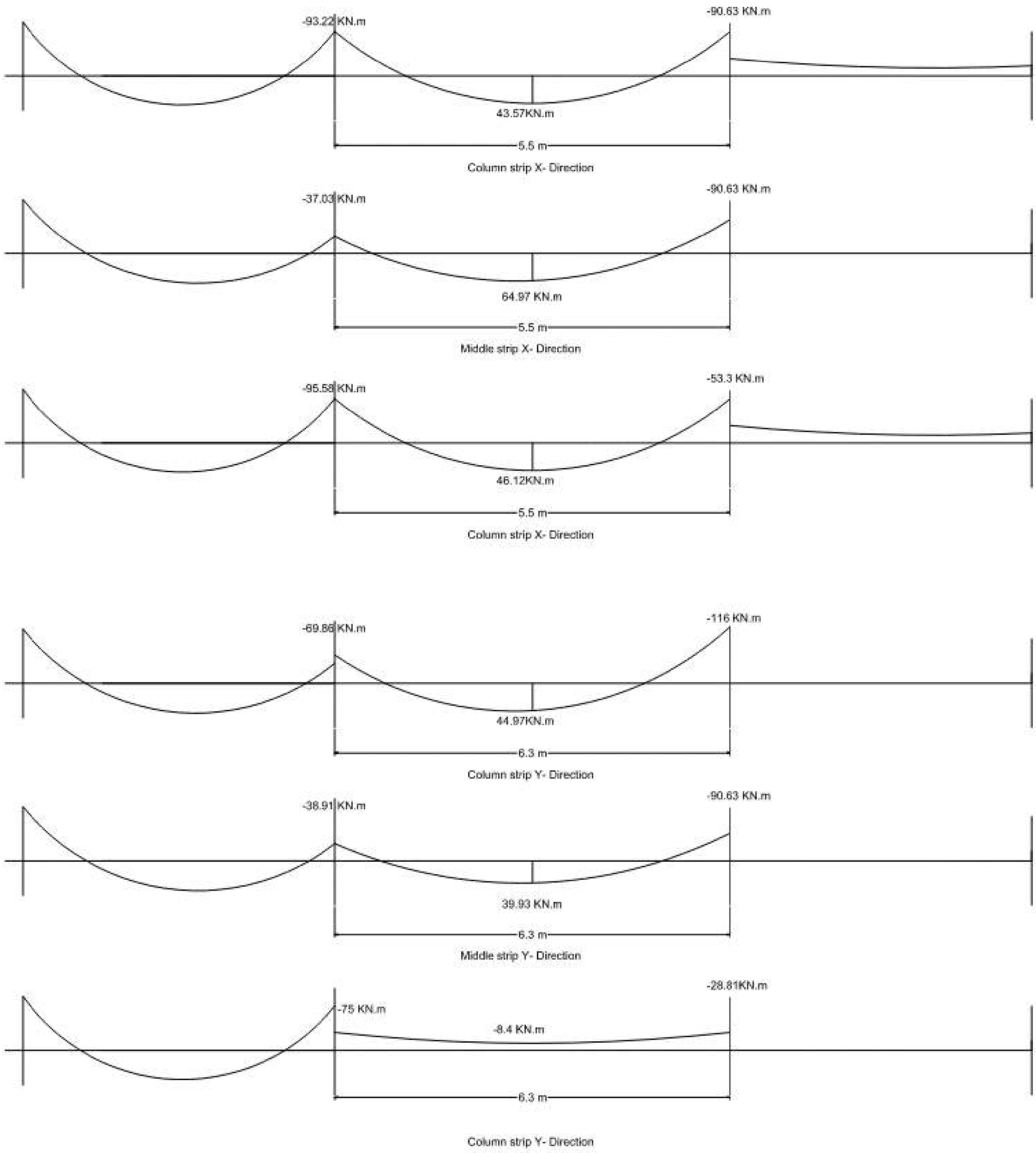



**Figure 4.7:** Bending Moment Diagram for The Convention Floor Model (6.3-5.5-5.2).

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

$$As_{min} = 0.002x1000x\ d = 280\ mm^2 \quad (4.13)$$

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

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

$$R_u = \frac{Mu}{\emptyset bd^2} \tag{4.16}$$

$$\rho = \frac{1}{m}[1 - \sqrt{1 - \frac{2R_u m}{fy}} \tag{4.17}$$

$$m = \frac{fy}{0.85 \times fc} \tag{4.18}$$

$$As = \rho \times bd \tag{4.19}$$

**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 | As | Reinforcement | Additional |
|---|---|---|---|---|---|---|---|---|
| span5.5 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 |
| span6.3 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 |

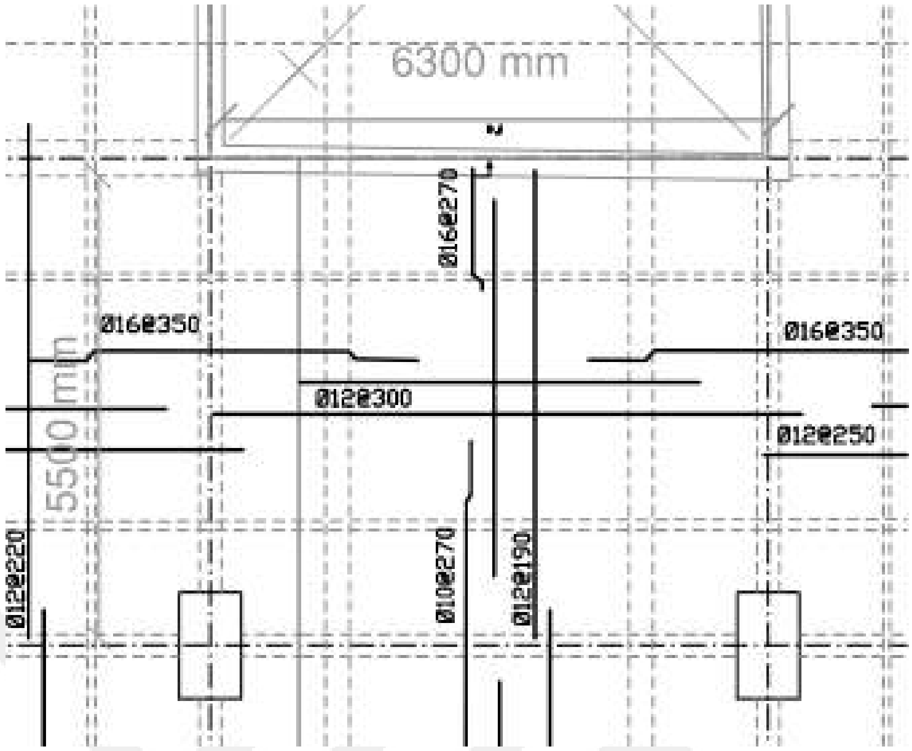



**Figure 4.8:** Middle Strip Steel Reinforcement Details for Panel (6.3x5.5) model (6.3-5.5-5.2).

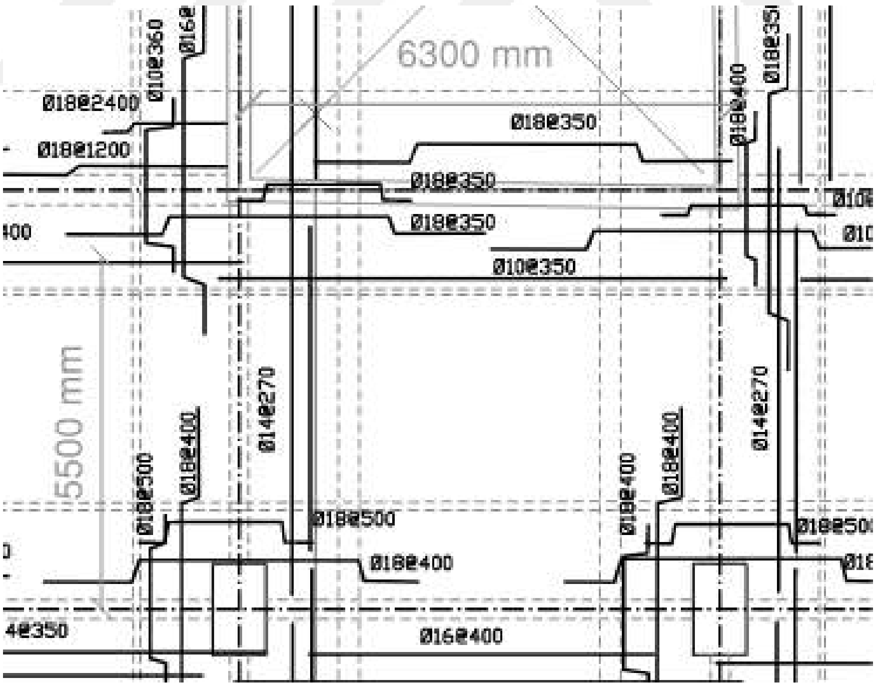



**Figure 4.9:** Column strip Steel Reinforcement Details for Panel (6.3x5.5) Model (6.3-5.5-5.2).

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

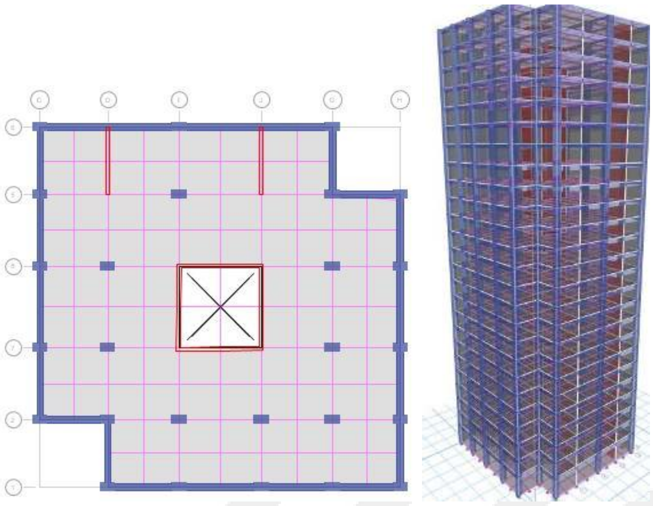


**Figure 4.10:** Flat Floor Model Isometric & Plan View Model (6.3-5.5-5.2).

**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 | Ta ×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 Cs max <Cs 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]

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

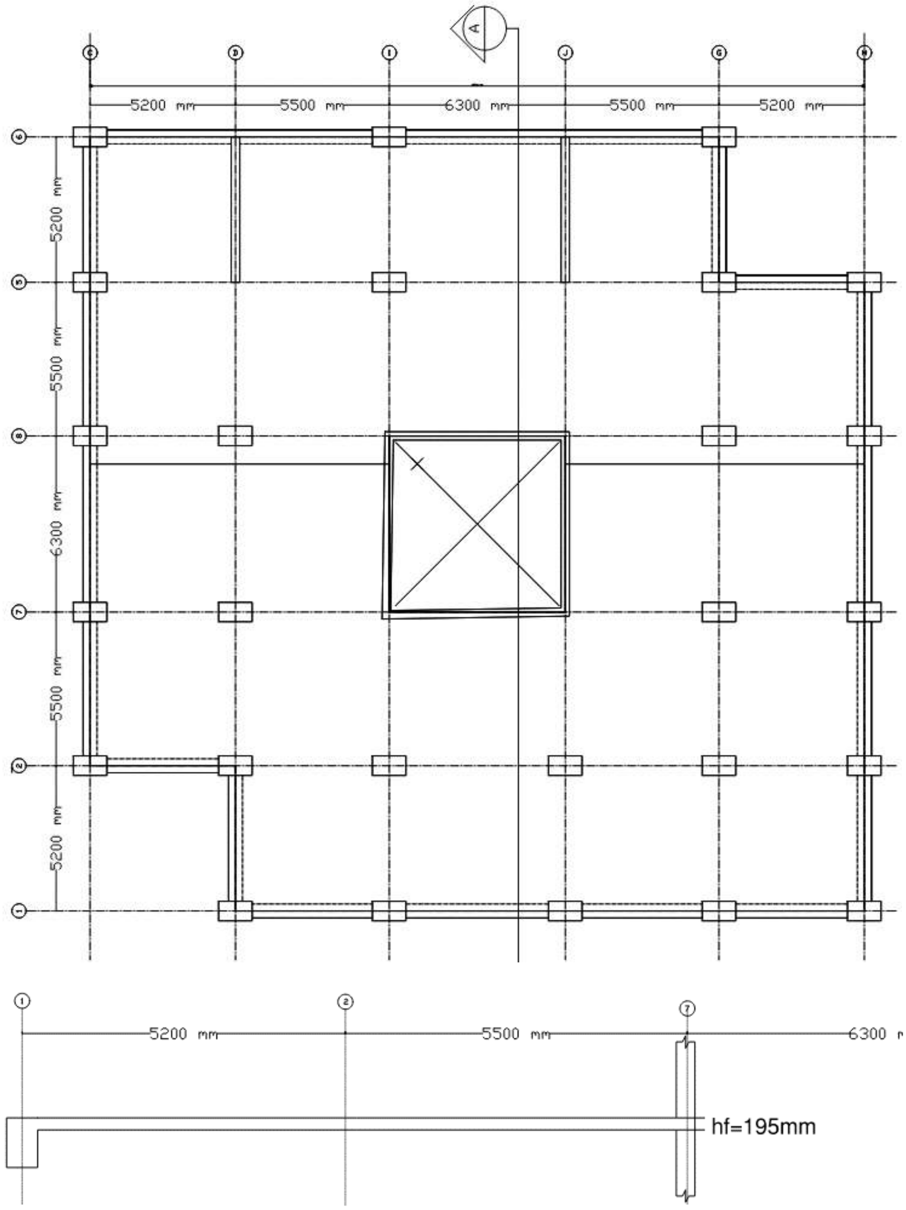



**Figure 4.11:** Framework Plan for Flat Floor Model (6.3-5.5-5.2).

### 4.2.3.1 Slab shear strength – check for punching

The applied shear stress is calculated as

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

$M_u$=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))

$$V_c = 0.33\sqrt{f}cb_0d \tag{4.21}$$

$$Vc = 0.17\,(1 + \frac{2}{\beta})\sqrt{f}cb_0d \tag{4.22}$$

$$Vc = 0.083\,(2 + \frac{d\,\alpha_s}{b_0})\lambda\sqrt{f}cb_0d \tag{4.23}$$

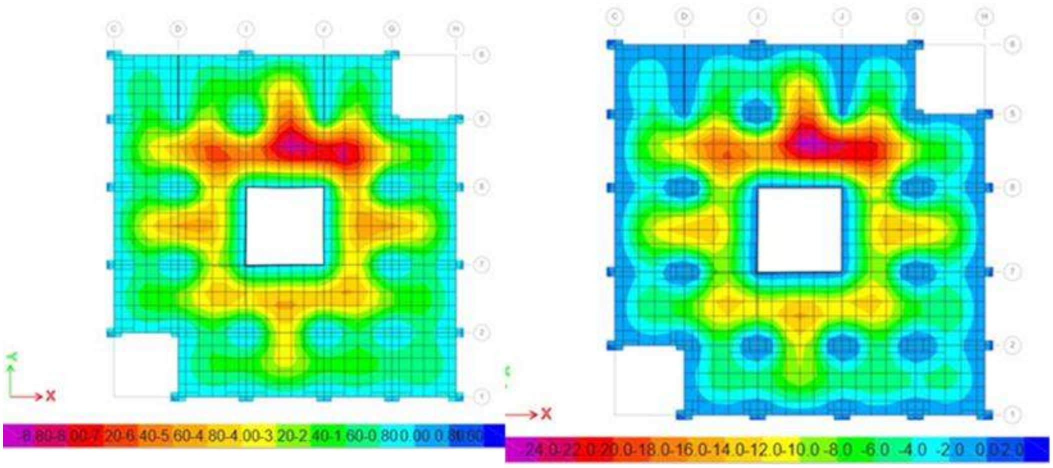
$\beta$ = Ratio of long side to short side of columns

$\alpha_s$= 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 | $\gamma 1$ | $\gamma 2$ | 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



(a) (b)

**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 |

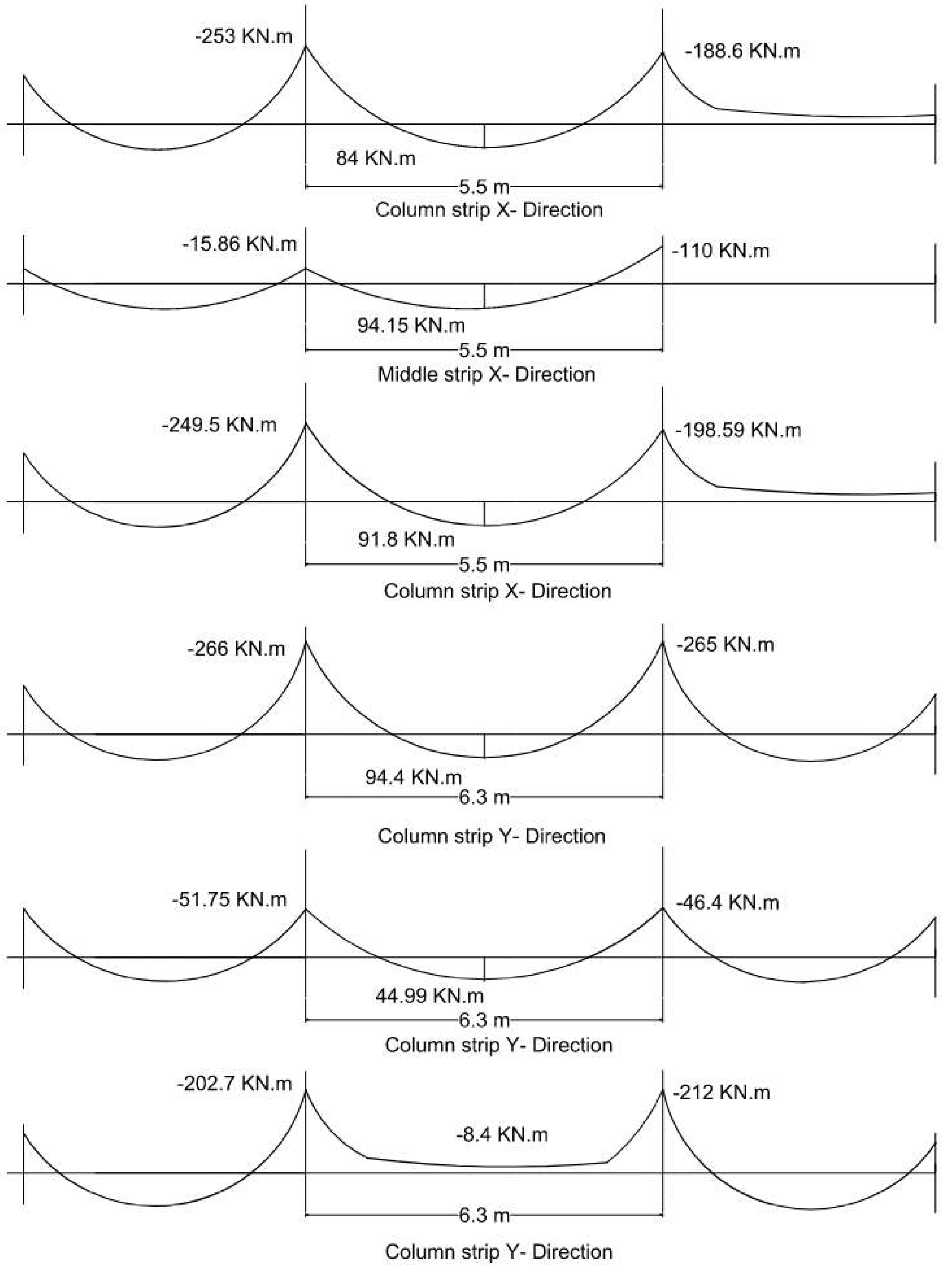



**Figure 4.13:** Showing Bending Moment Diagram for Panel (6.3×5.5) for Flat Floor (6.3-5.5-5.2).

### 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 |

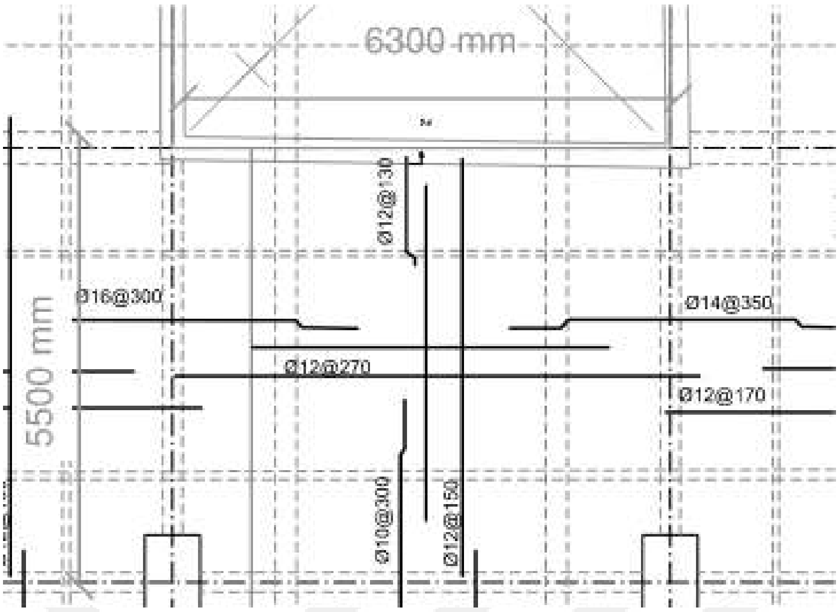



**Figure 4.14:** Middle Strip Steel Reinforcement for Panel (6.3x5.5) of Flat Floor (6.3-5.5-5.2).

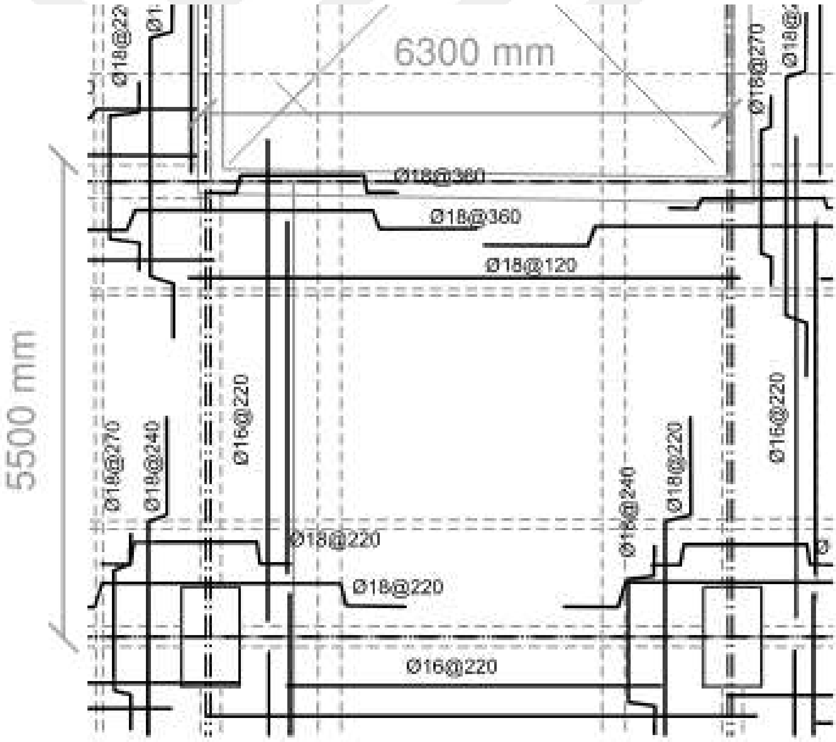



**Figure 4.15:** Column Strip Steel Reinforcement for Panel (6.3x5.5) of Flat Floor (6.3-5.5-5.2).

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

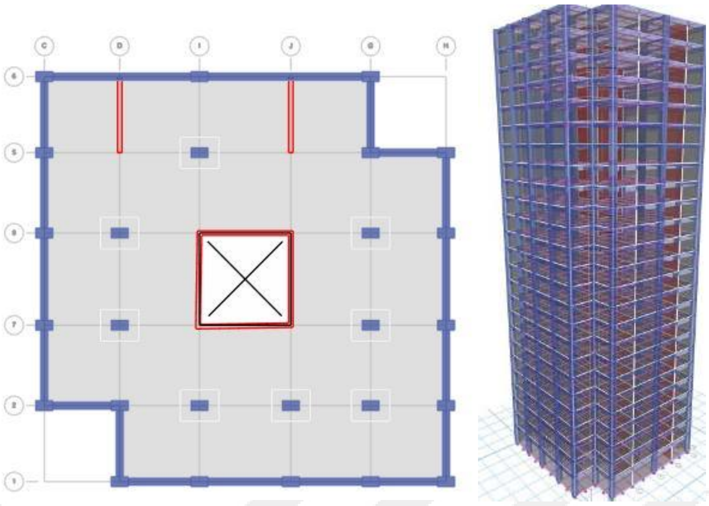


**Figure 4.16:** Waffle Floor Model Isometric & Plan View Model (6.3-5.5-5.2).

**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 | Ta ×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) | 4.41 | |
| 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 Cs max <Cs 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 ≥100mm

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

Increase Rip depth to resist flexural & shear failure

Take Slab thickness $h_w$ =120mm ≥50mm

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

Space between two ribs ($S_{Ribs}$) =550mm ≤750 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

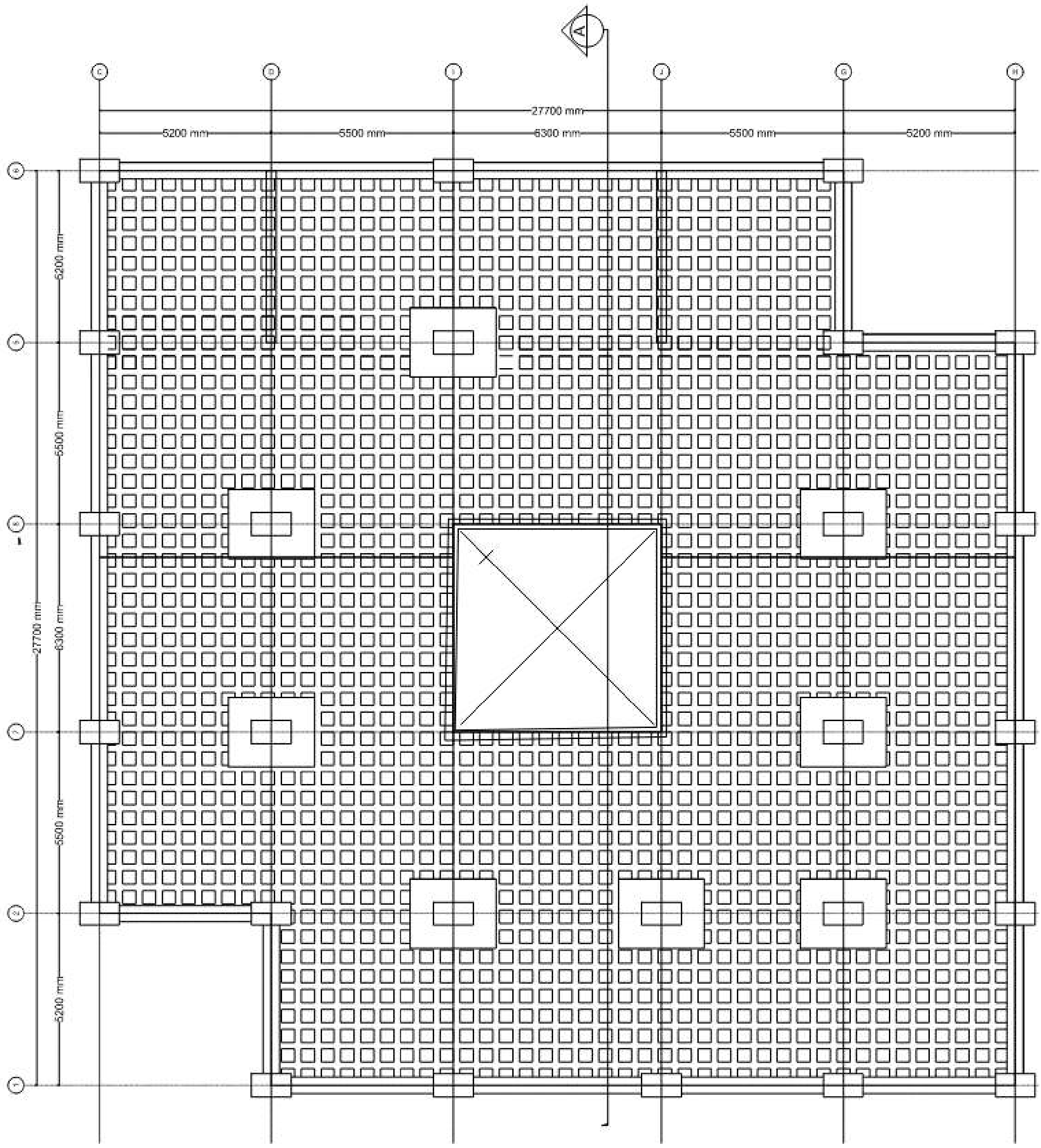


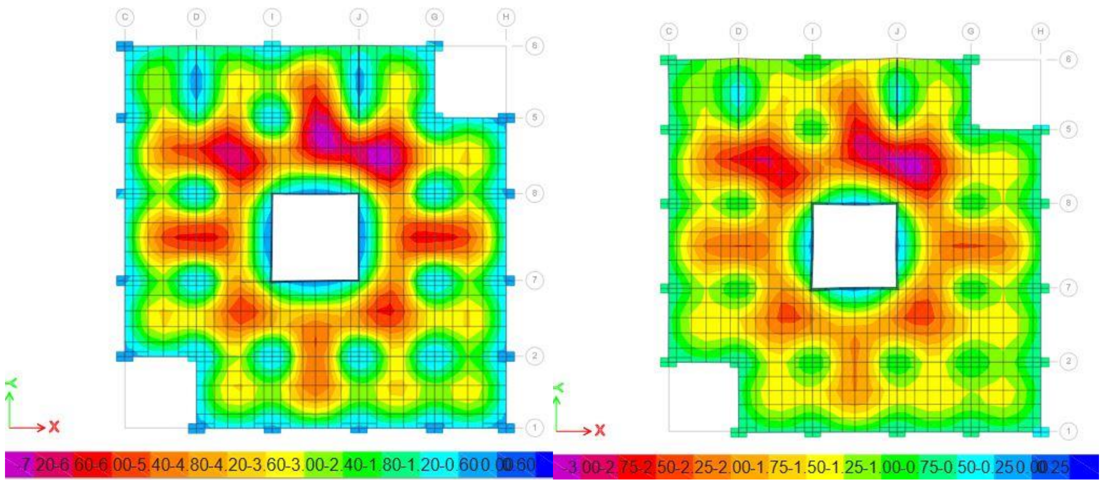

**Figure 4.17:** Show Framework Plan for Waffle Floor Model (6.3-5.5-5.2).

### 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 | $\gamma 1$ | $\gamma 2$ | 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



(a) (b)

**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 |

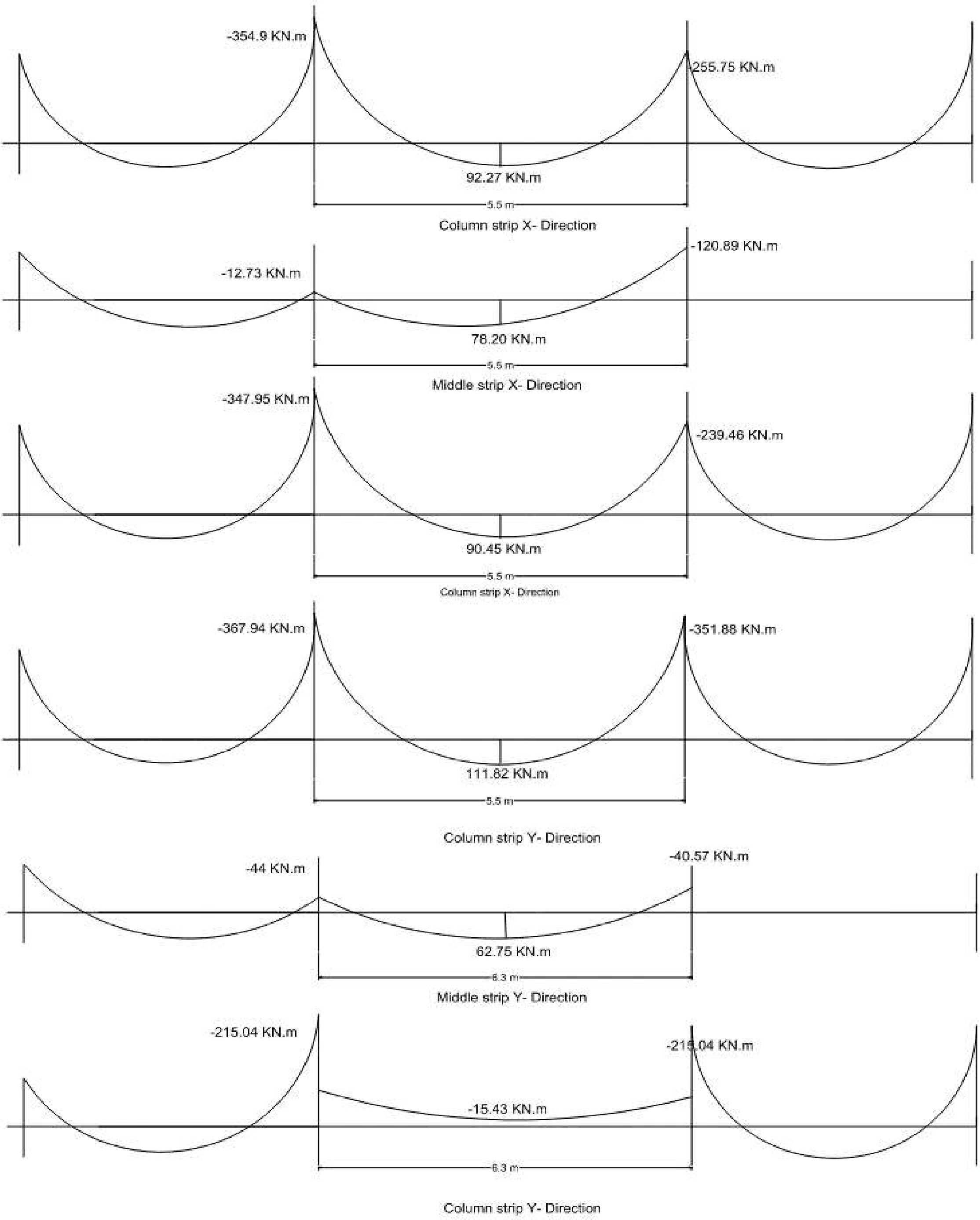



**Figure 4.19:** Showing Bending Moment Diagram for Panel (6.3×5.5) of Waffle Floor Case.

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

For concrete strength fc'=30Mpa, steel rebar strength fy=400 Mpa, d=95mm.

$\emptyset 8$ at top Spacing $\emptyset 8@300mm$

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 |

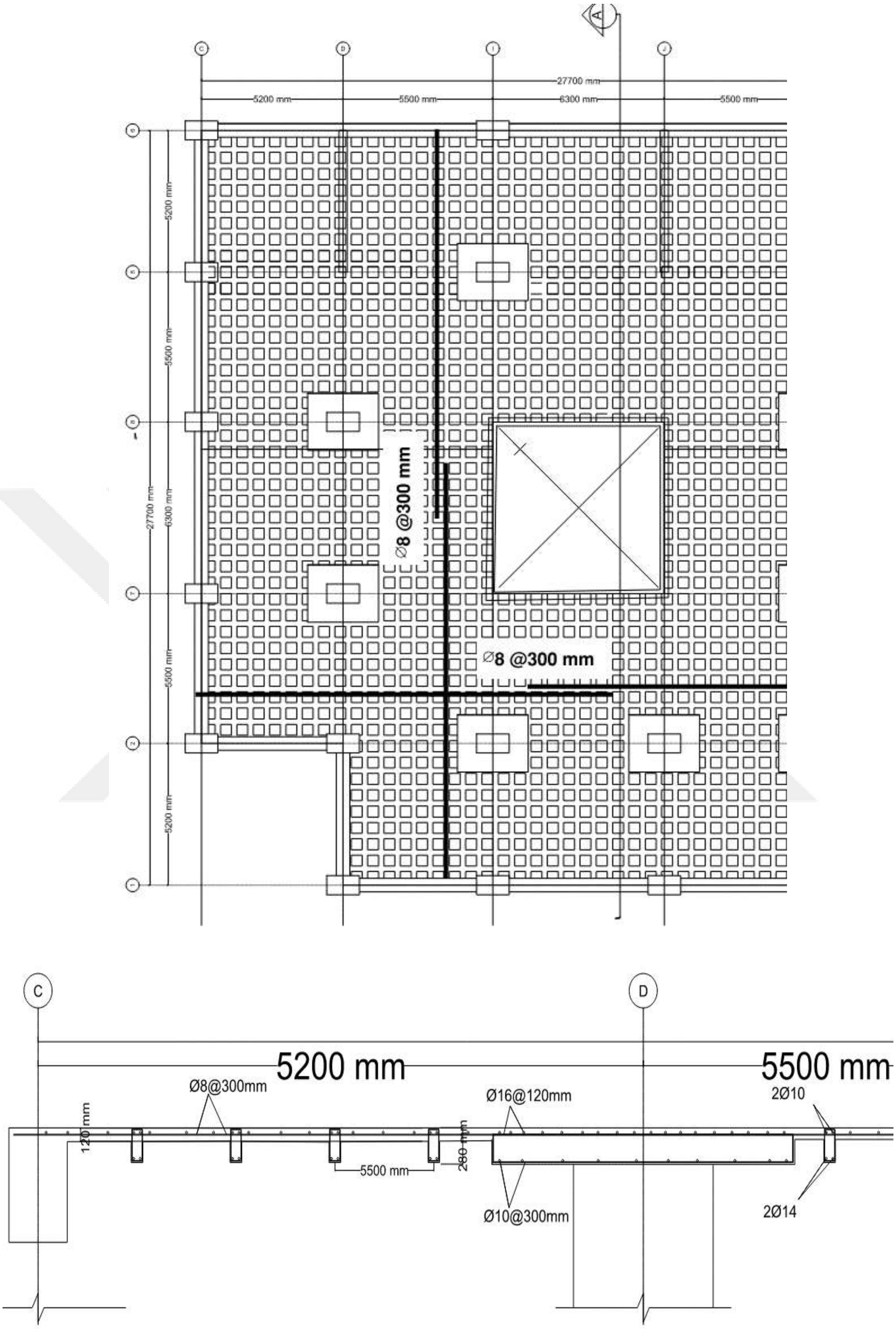



**Figure 4.20:** Steel Reinforcement details for Waffle Floor System Case Model (6.3-5.5-5.2).

## 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).

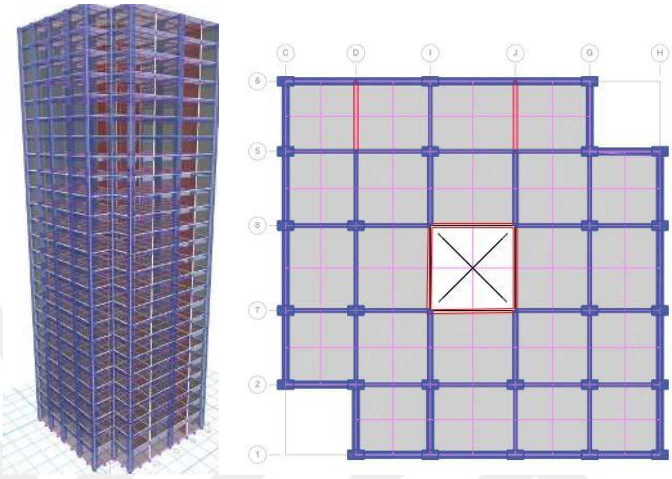


**Figure 4.21:** Conventional Floor Model Isometric & Plan View (6.3-5.5-5.2).

**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 AX 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 mm

Take b = 350mm

From section (4.1.3.1) procedure find beam dimensions and reinforcement

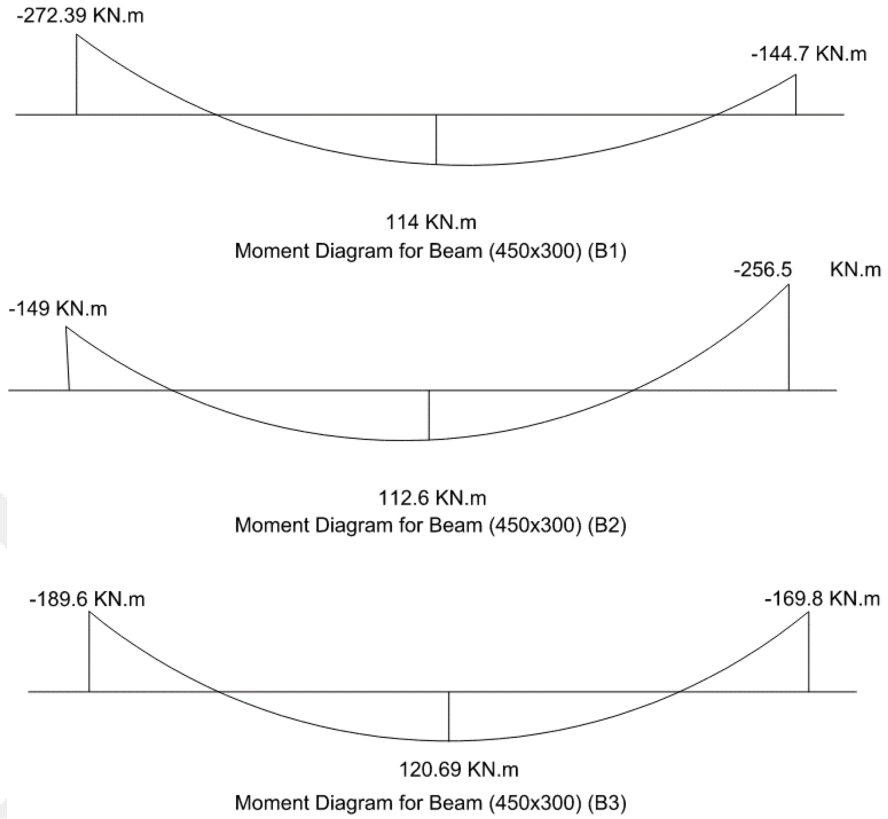
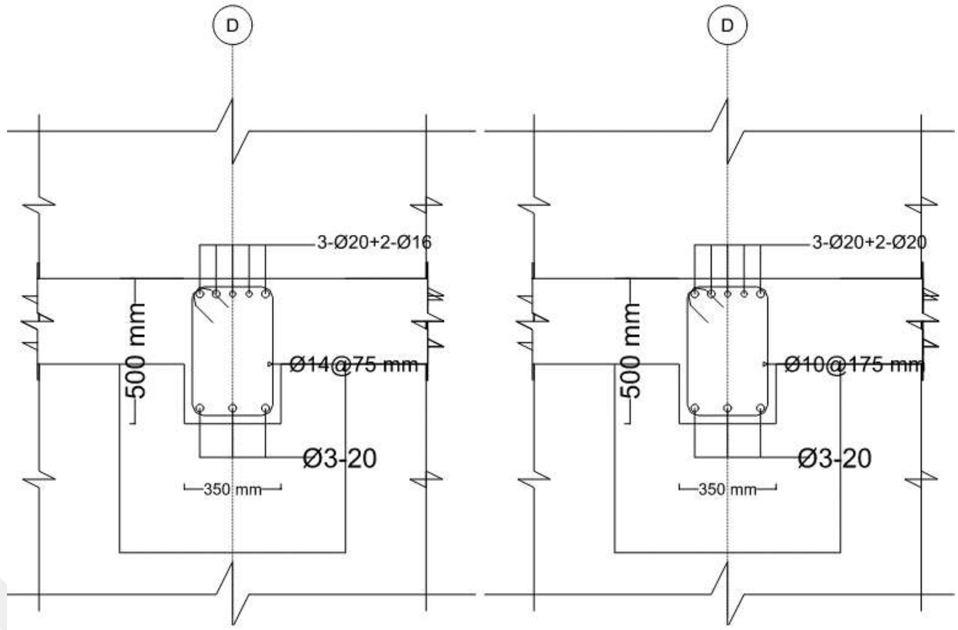
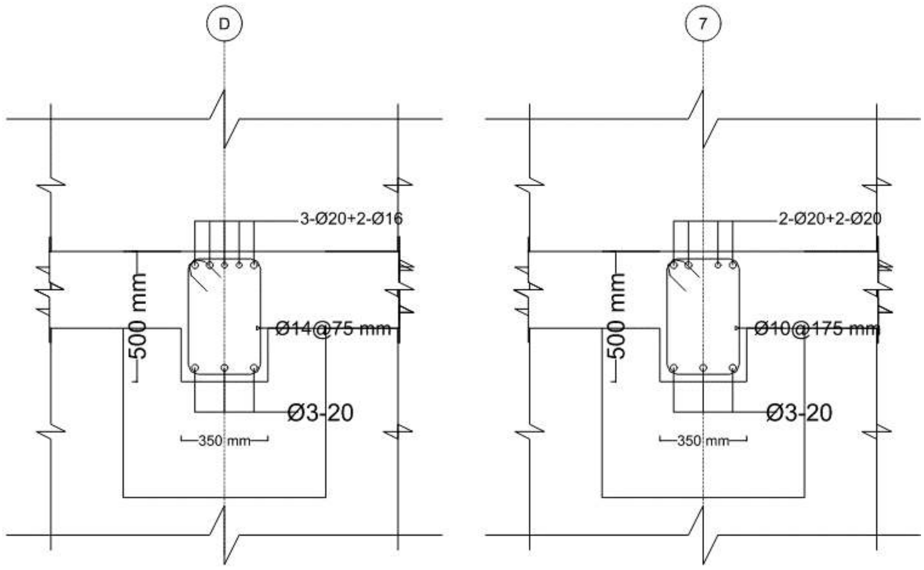



**Figure 4.22:** Showing Moment Diagram for Internal Beams Model (8.3-7.5-7.2).




(a)




(b)

**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 mm

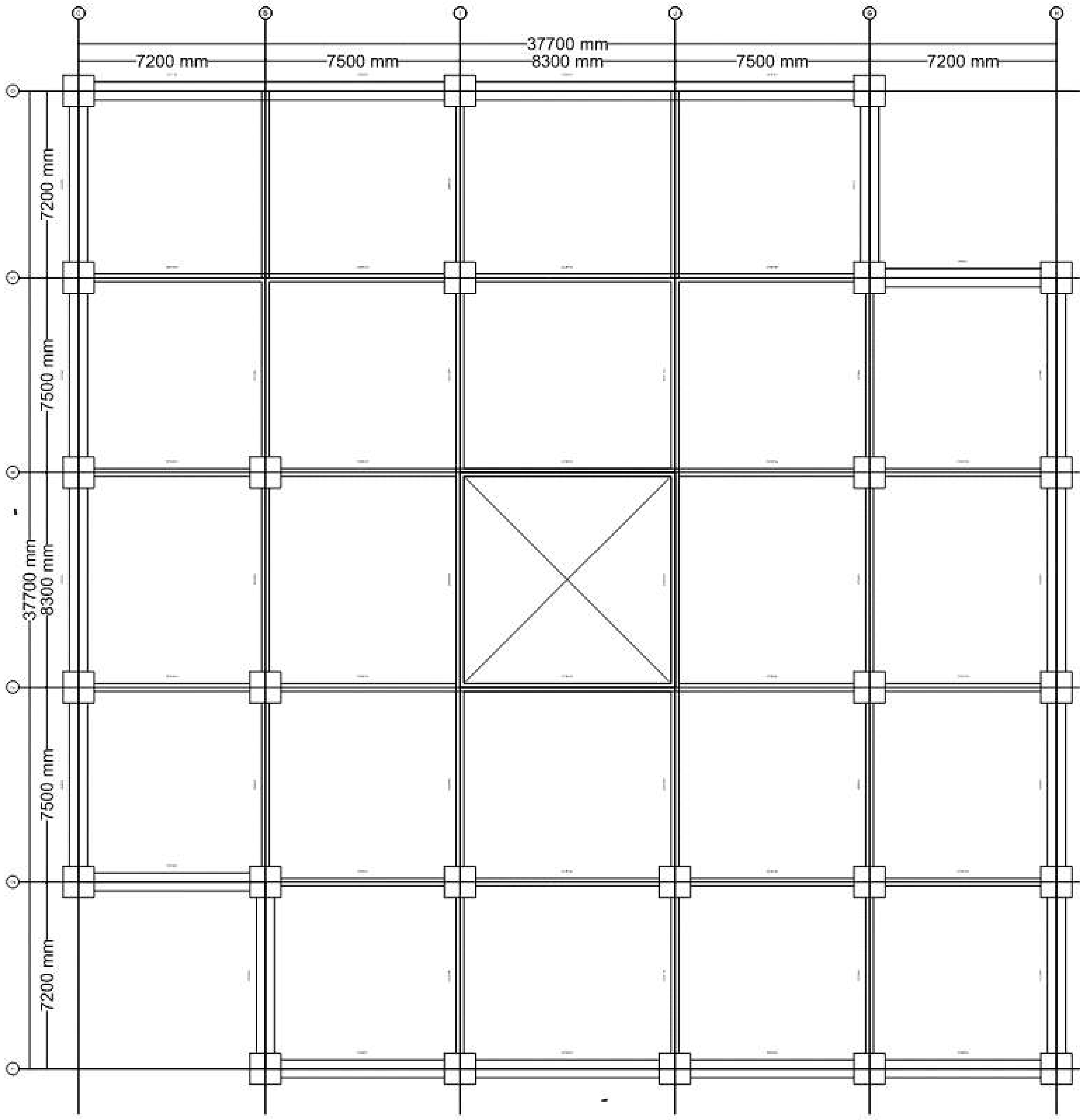
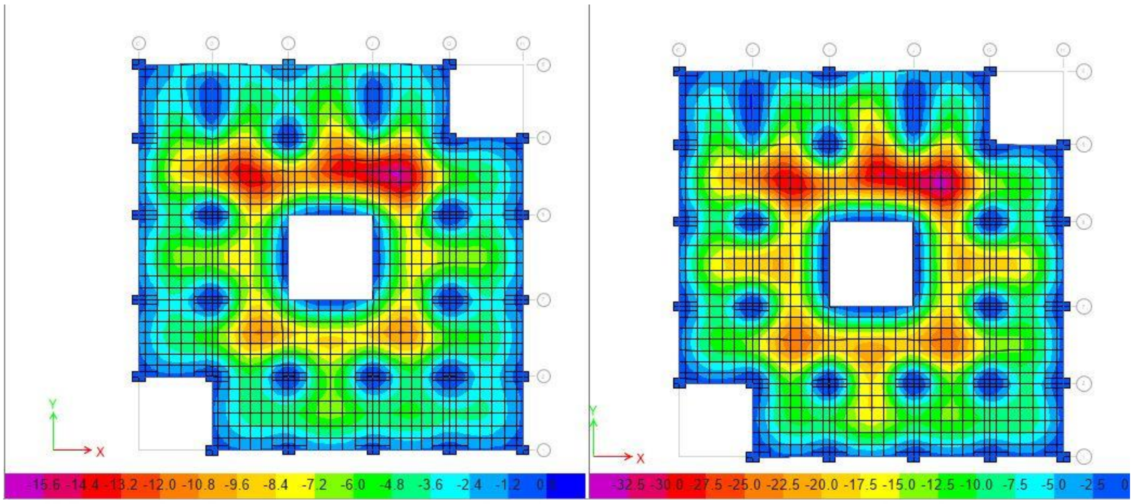



**Figure 4.24:** Conventional Floor Model Isometric & Plan View for Model (8.3-7.5-7.2).

### 4.4.3.3 Check deflection




(a) (b)

**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 |

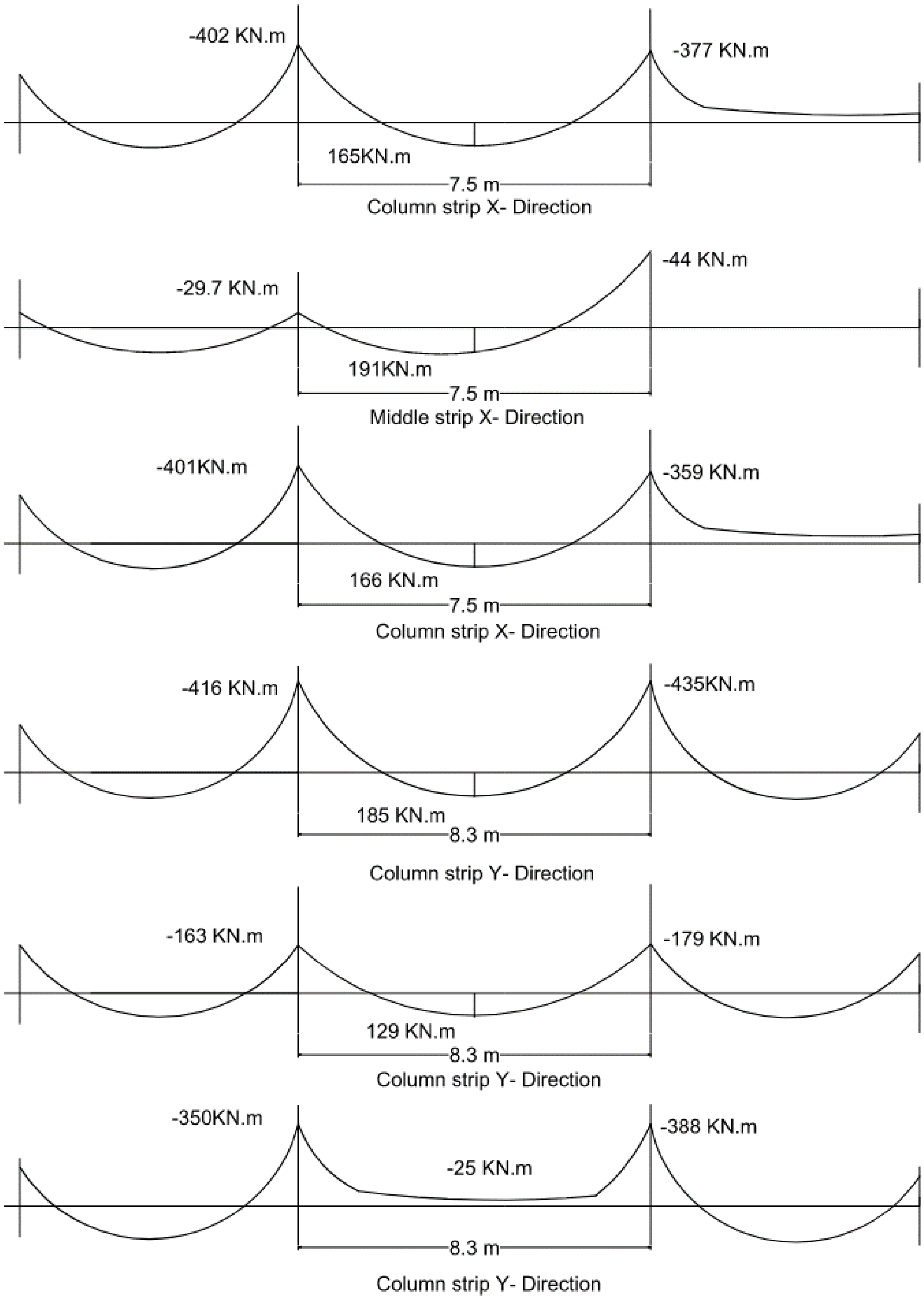



**Figure 4.26:** Bending Moment Diagram for The Convention Floor for Model (8.3-7.5-7.2).

### 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 | $A_S$ | Reinforcement | Additional |
|---|---|---|---|---|---|---|---|---|
| Span7.5 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 |

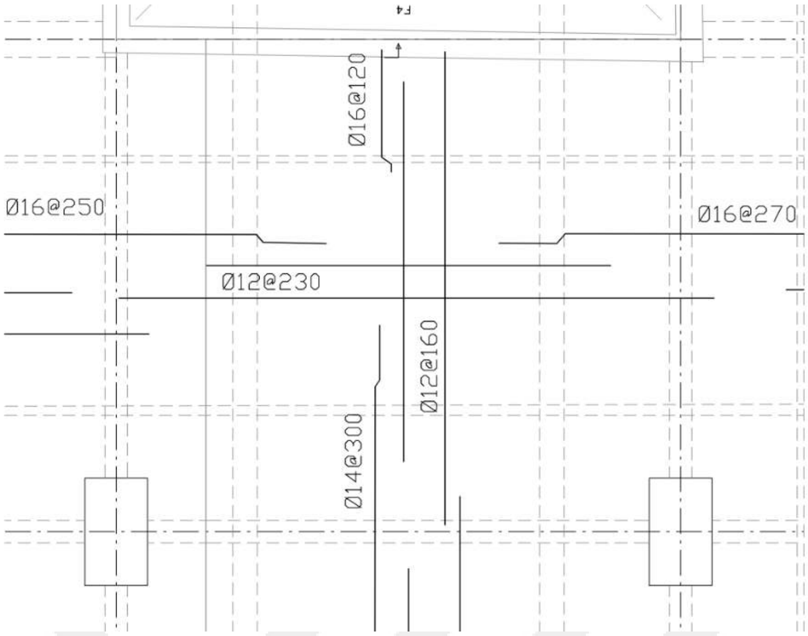



**Figure 4.27:** Middle Strip Steel Reinforcement for Panel (8.3x7.5) for Model (8.3-7.5-7.2).

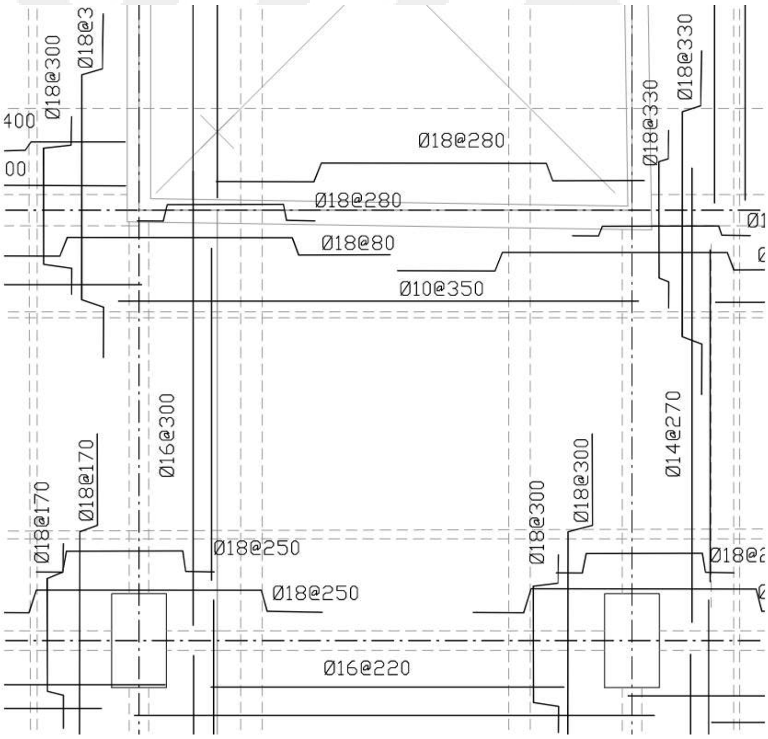



**Figure 4.28:** Column Strip Steel Reinforcement for Panel (8.3x7.5) for Model (8.3-7.5-7.2).

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

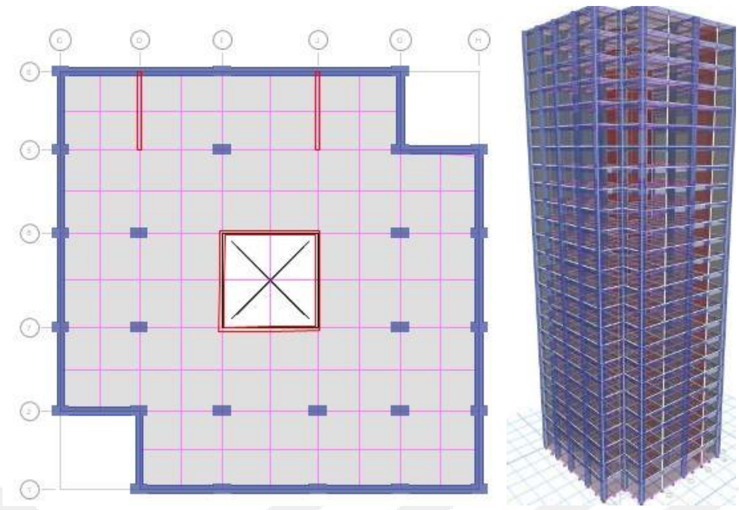


**Figure 4.29:** Flat Floor Model Isometric & Plan View.

**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 | Ta ×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) | 4.502 | |
| 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 Cs max <Cs 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)

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

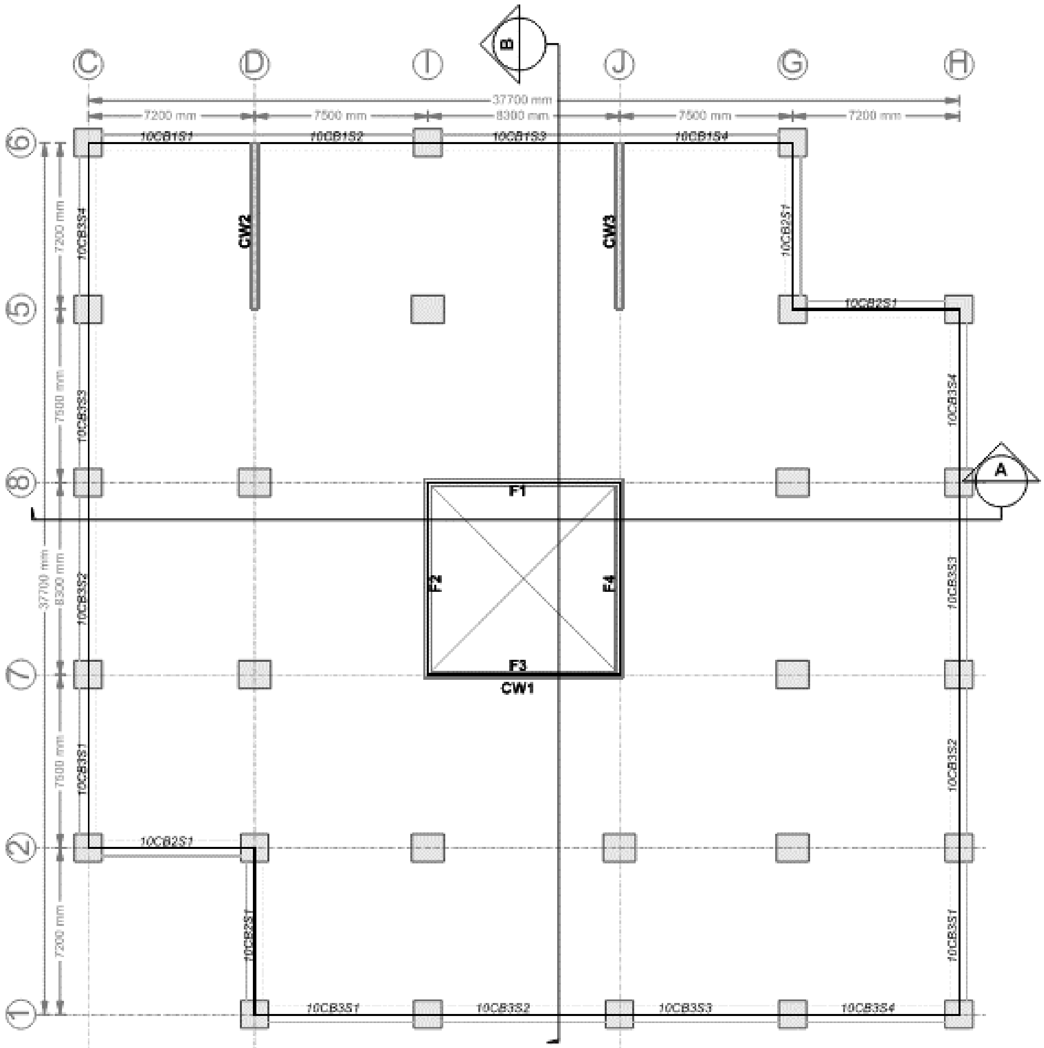



**Figure 4.30:** Flat Plate Model Isometric & Plan View for Model (8.3×7.5x7.2).

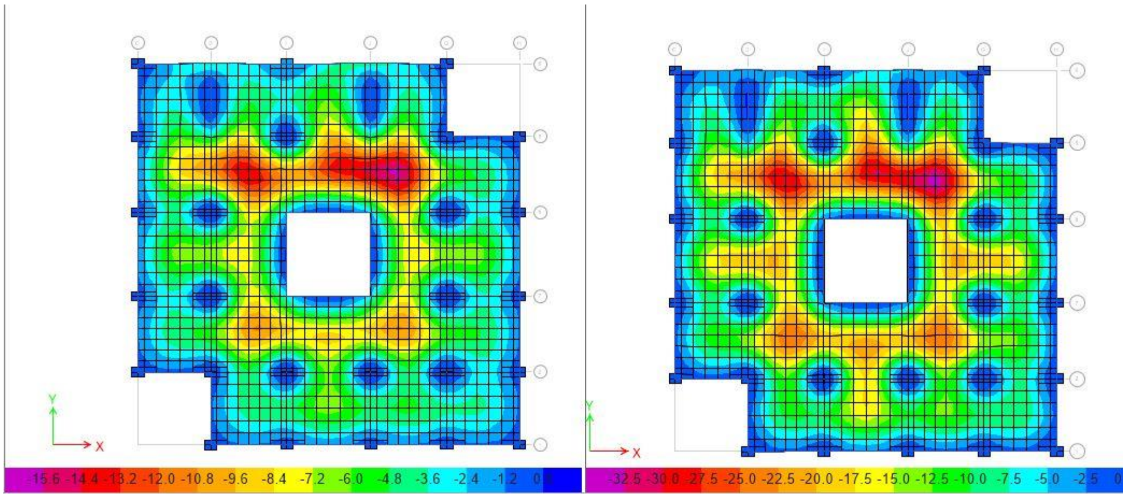
### 4.5.3.1 Slab Shear strength – check for punching

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 | $\gamma 1$ | $\gamma 2$ | 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




(a) (b)

**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 |

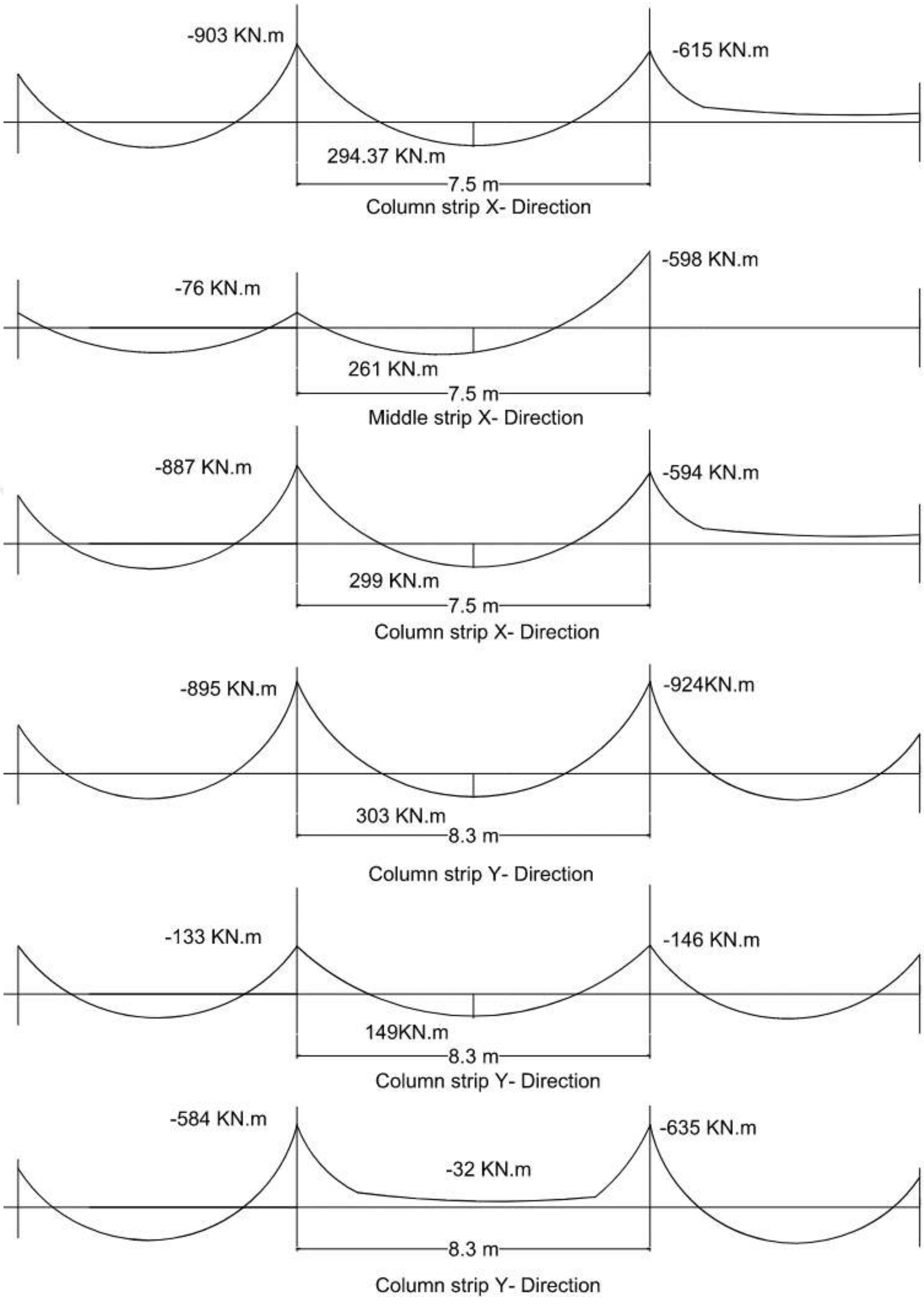



**Figure 4.32:** Showing Bending Moment Diagram for Panel (8.3x7.5) for Flat Floor (8.3-7.5-7.2).

### 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 |
|---|---|---|---|---|---|---|---|---|
| Span7.5 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 |
| Span8.3 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 |

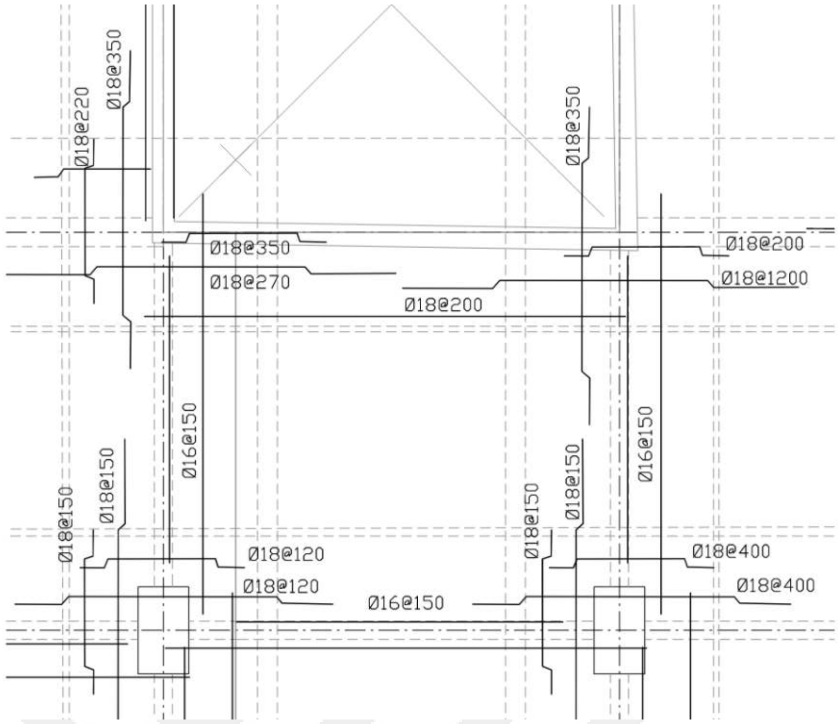



**Figure 4.33:** Column Strip Steel Reinforcement for Panel (8.3x7.5) of Flat Floor (8.3-7.5-7.2).

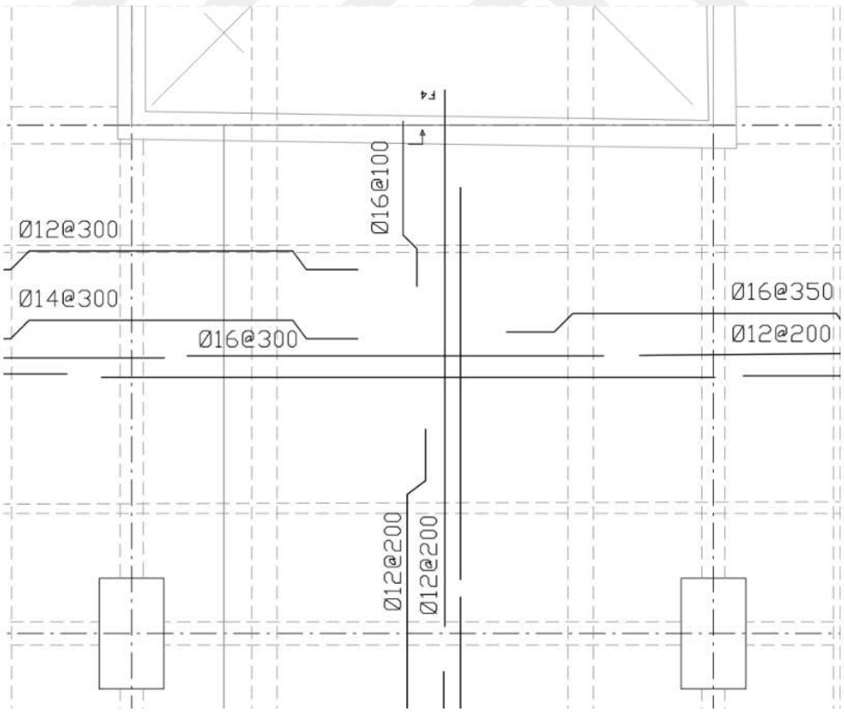



**Figure 4.34:** Middle Strip Steel Reinforcement for Panel (8.3x7.5) of Flat Floor (8.3-7.5-7.2).

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

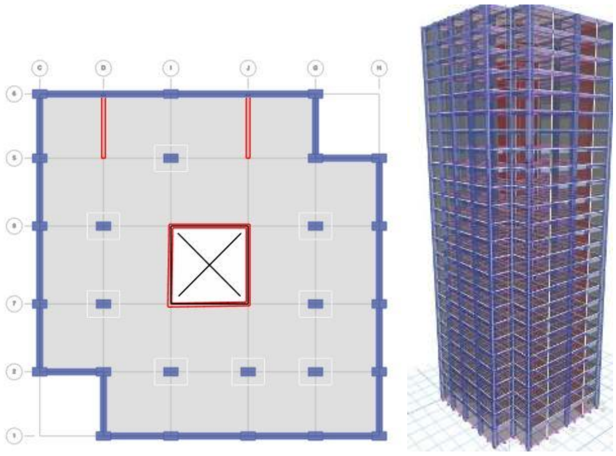


**Figure 4.35:** Waffle Floor Model Isometric & Plan View.

**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 | Ta ×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) | 4.372 | |
| 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 Cs max <Cs 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 ≥100mm

Rip depth=175mm≈200mm≤3.5×$b_{Rip}$ Increase Rip depth to resist flexural &shear failure

Take Slab thickness $t_w$=140 mm ≥50mm

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

Space between two ribs ($S_{Ribs}$) =550mm ≤750 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 | $\gamma1$ | $\gamma2$ | I1 cm4 | I2 cm4 | 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 |

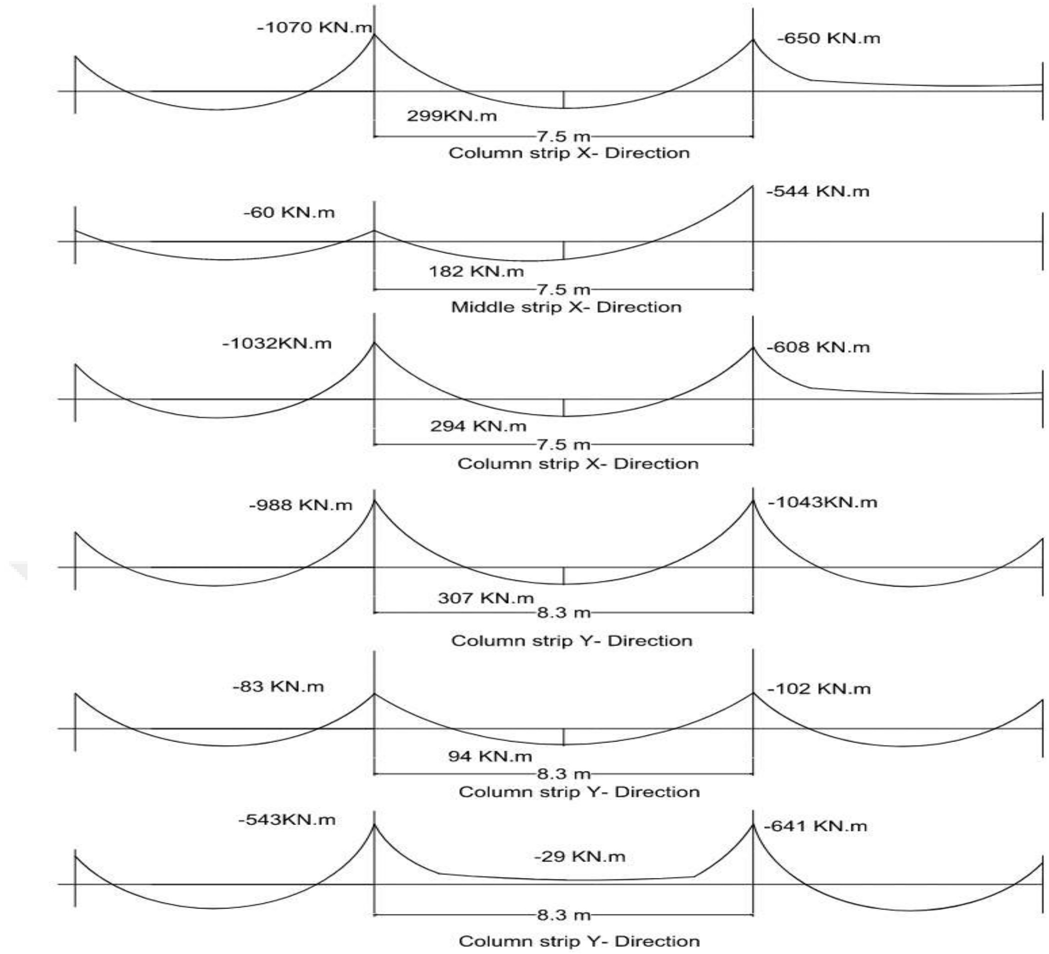



**Figure 4.36:** Showing Bending Moment Diagram for Panel (8.3x7.5) of Waffle Floor (8.3-7.5-7.2).

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

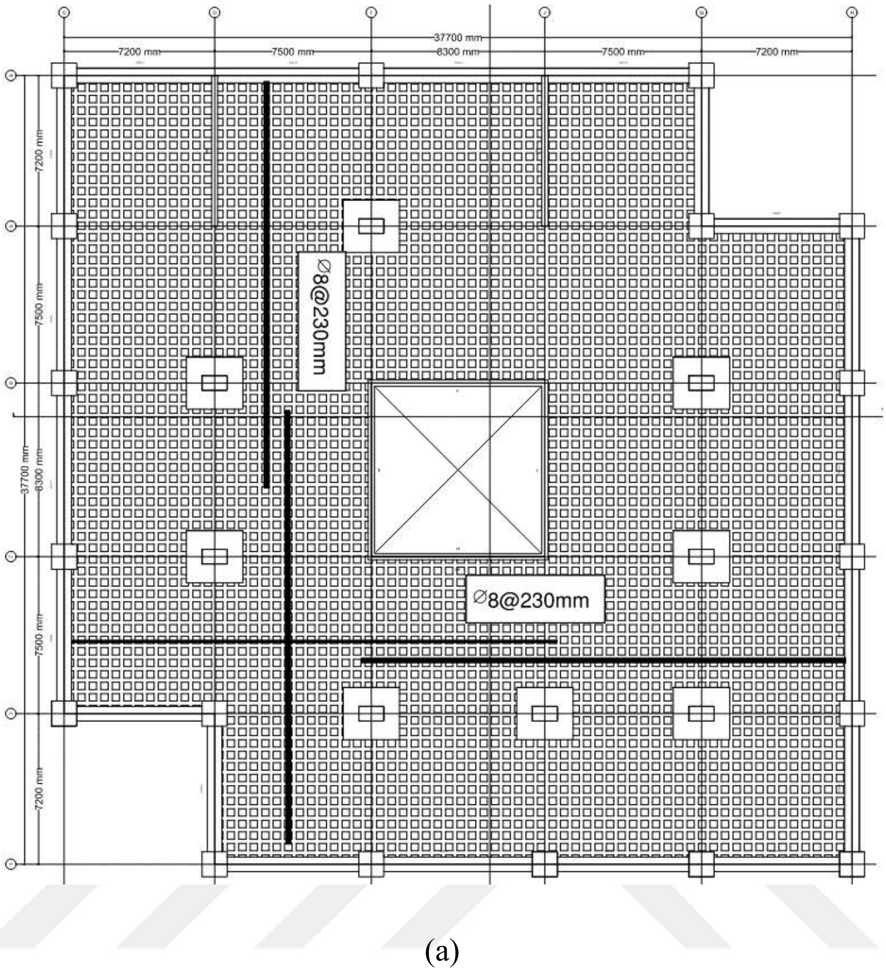
For Concrete Strength fc'=30Mpa, Steel Rebar Strength fy=400 Mpa, d=120mm

For $\emptyset 8$ at top Spacing AS/$As_{8\emptyset}$ , $\emptyset 8@300mm$

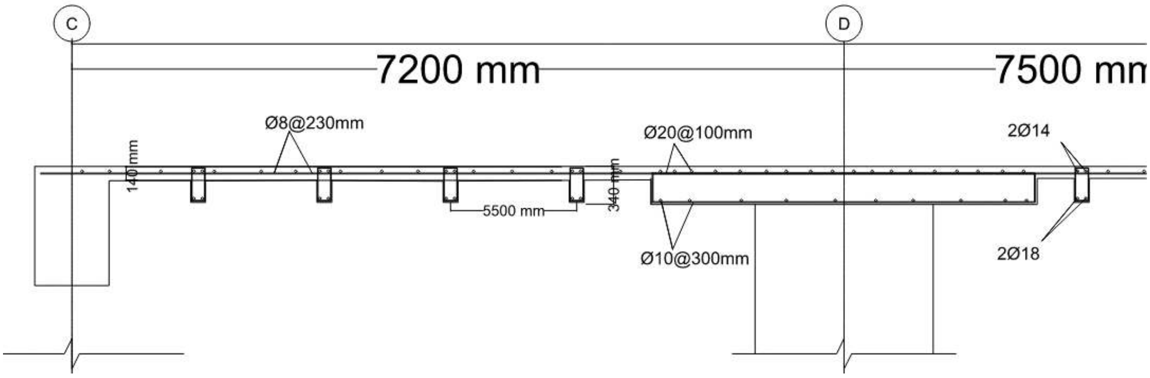
Same procedure as section (4.2.3.1.2)

**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 |
|---|---|---|---|---|---|---|
| Span7.5 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 |




(a)




(b)

**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)

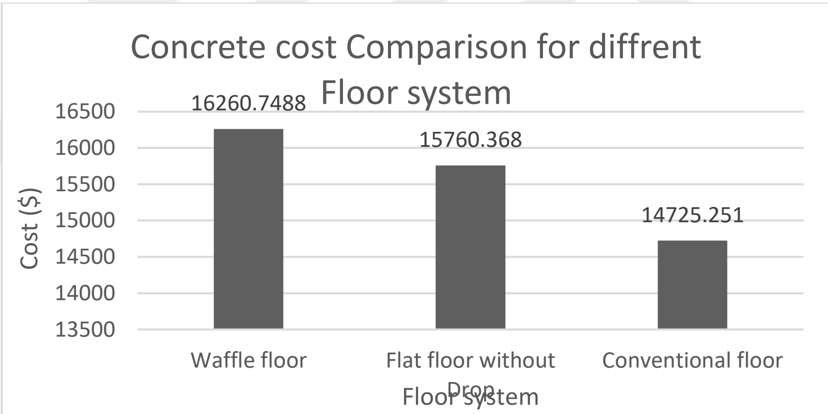



**Figure 5.1:** Concrete Cost Comparison for Model (6.3-5.5-5.2).

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%.

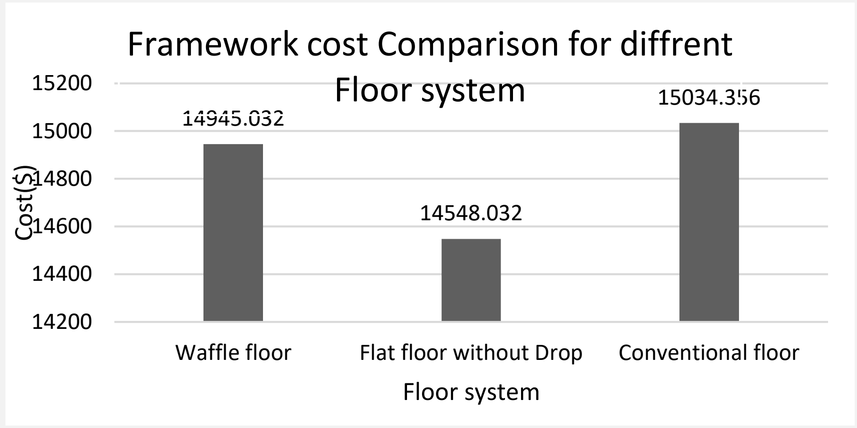



**Figure 5.2:** Framework Cost Comparison for Model (6.3-5.5-5.2).

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.

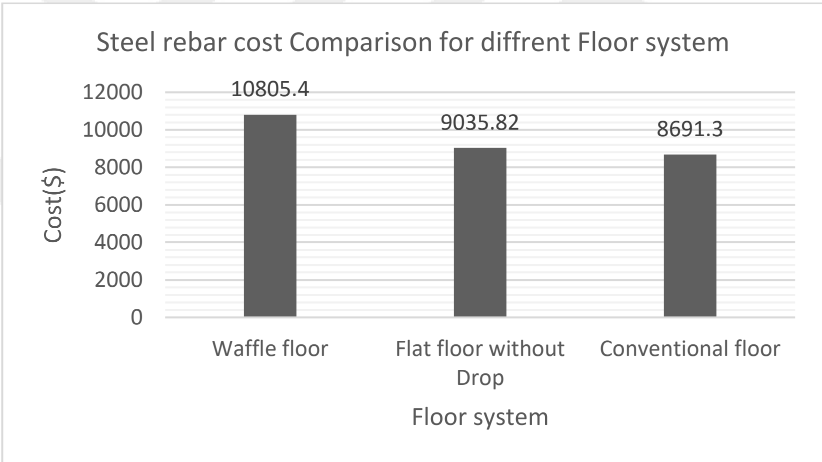



**Figure 5.3:** Steel Rebar Cost Comparison for Model (6.3-5.5-5.2).

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.

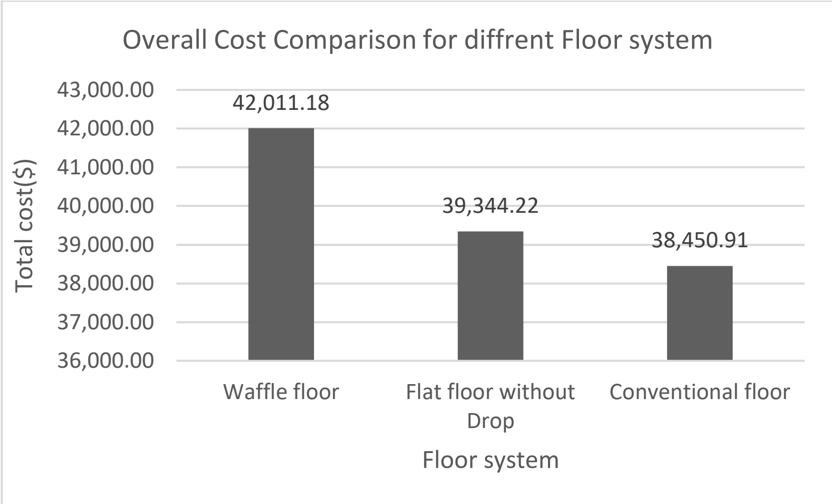



**Figure 5.4:** Overall Cost Comparison for Model (6.3-5.5-5.2).

The results in the figure above show that overall costs for conventional floor s 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)

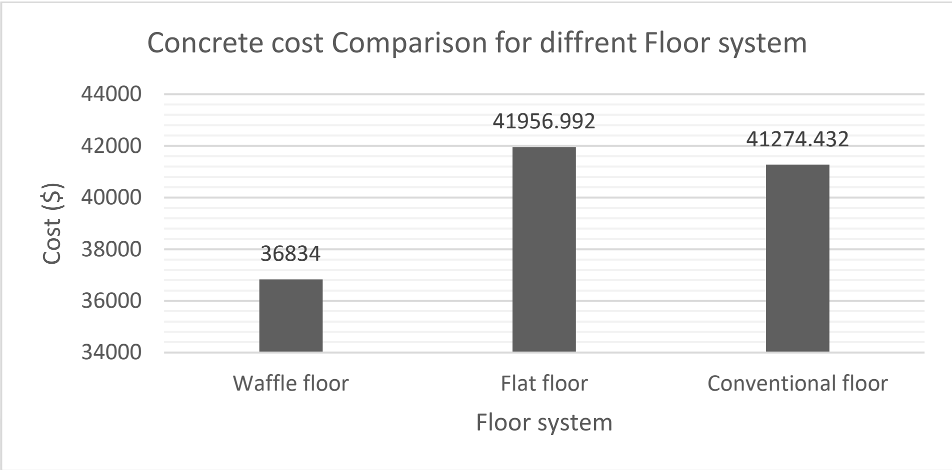



**Figure 5.5:** Concrete Cost Comparison for Model (8.3-7.5-7.2).

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%.

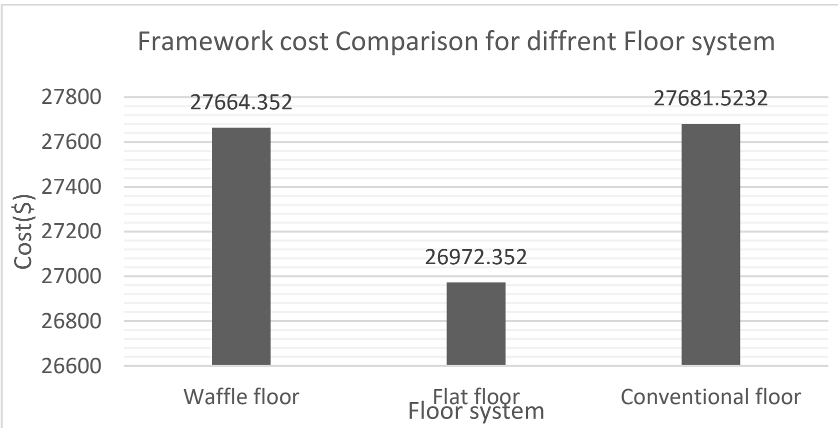



**Figure 5.6:** Framework Cost Comparison for Model (8.3-7.5-7.2).

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%.

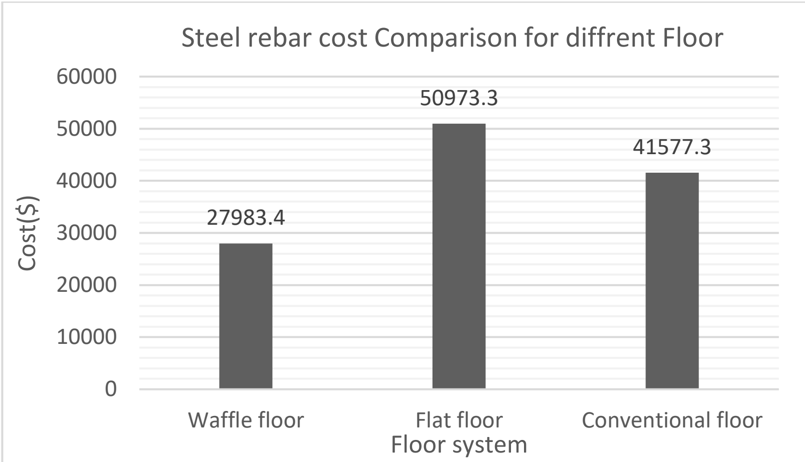



**Figure 5.7:** Steel Rebar Cost Comparison for Model (8.3-7.5-7.2).

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.

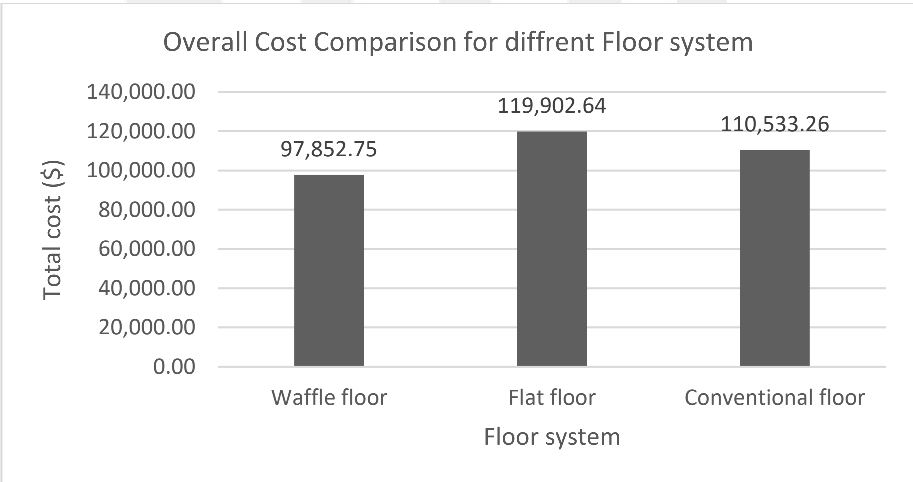



**Figure 5.8:** Overall Cost Comparison for Model (8.3-7.5-7.2).

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 less than 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)

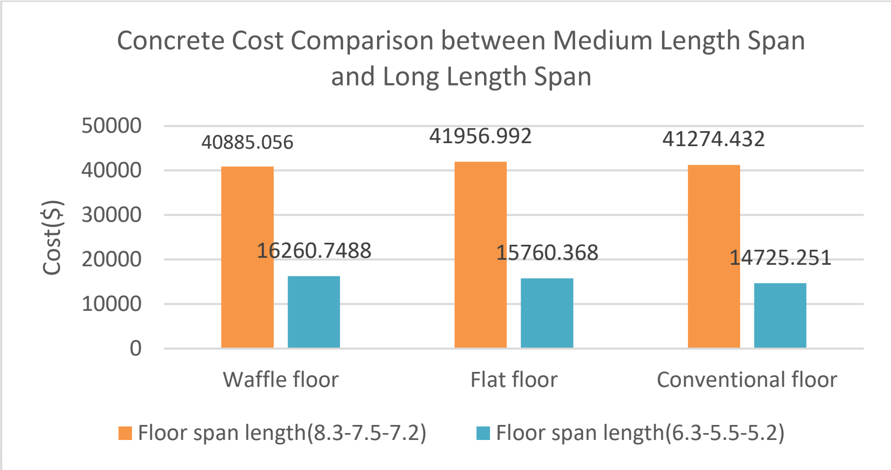



**Figure 5.9:** Concrete Cost Comparison between Medium Length Span and Long Length Span.

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.

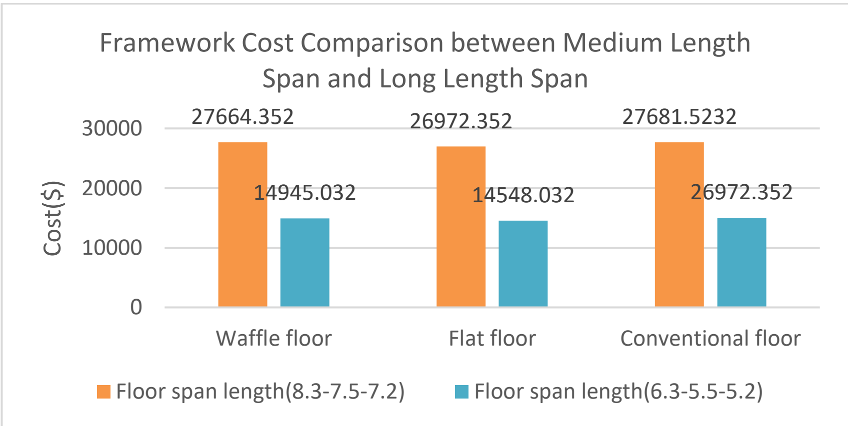



**Figure 5.10:** Framework Cost Comparison for Medium Length Span and Long Length Span.

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.

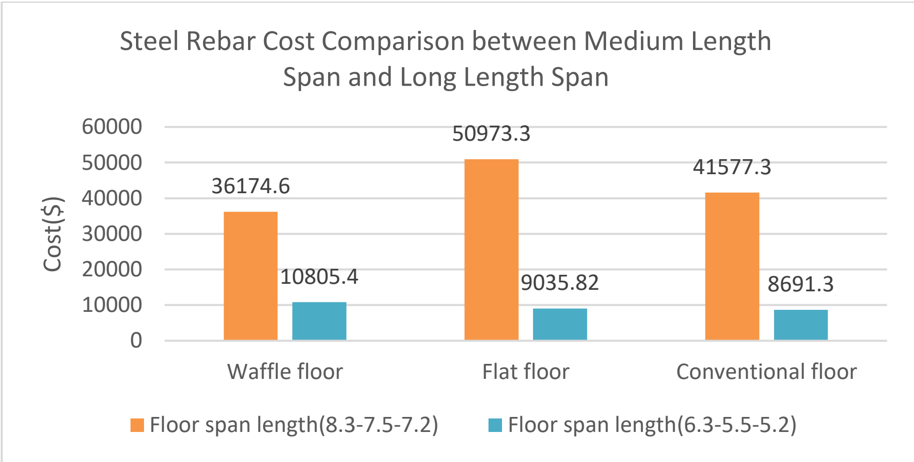



**Figure 5.11:** Steel Rebar Cost Comparison for Medium Length Span and Long Length Span.

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.

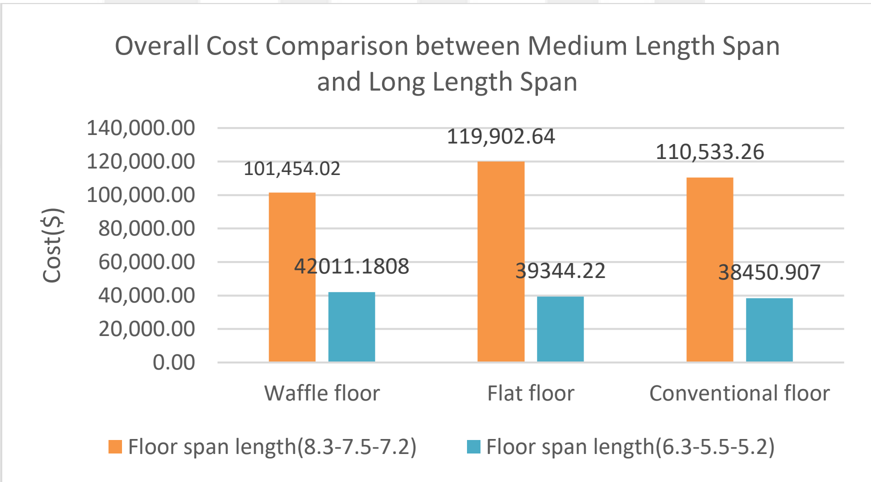



**Figure 5.12:** Overall Cost Comparison for Medium Length Span and Long Length Span.

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

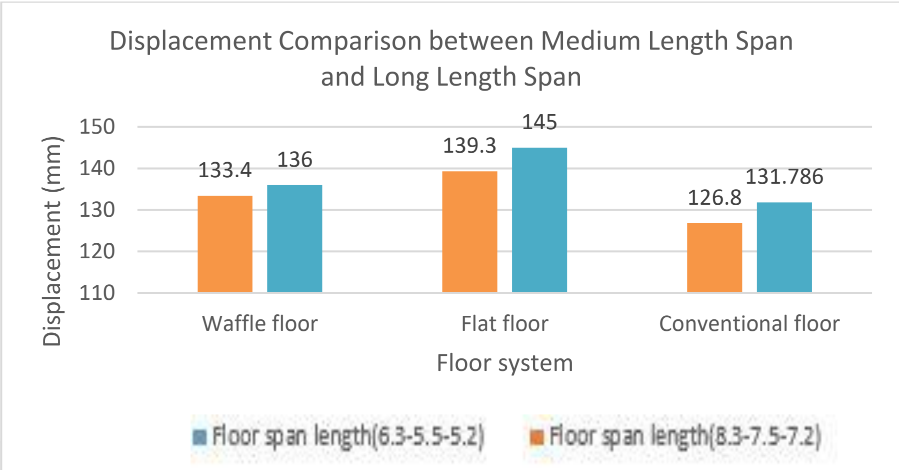



**Figure 5.13:** Shown Floor Displacement for Medium Length Span and Long Length Span.

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),

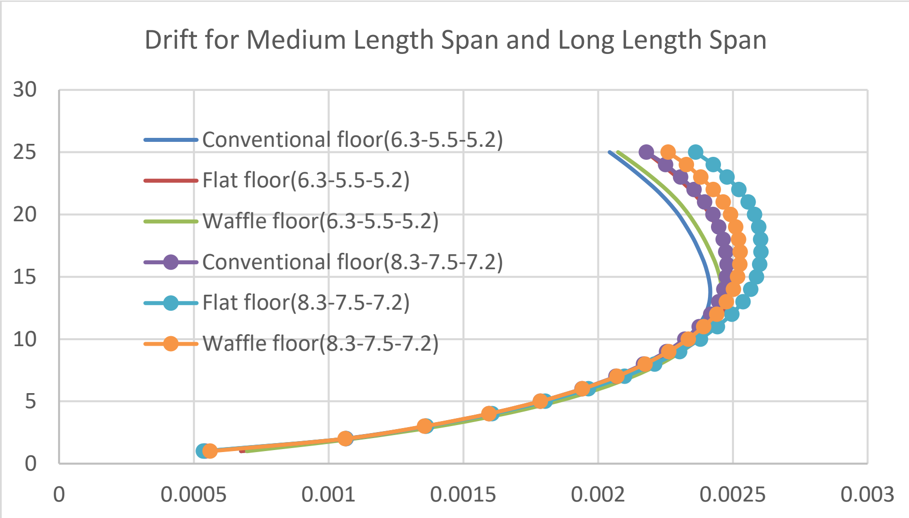



**Figure 5.14:** Shown Floor Drift VS Stories.

### 5.2.3 Time Period

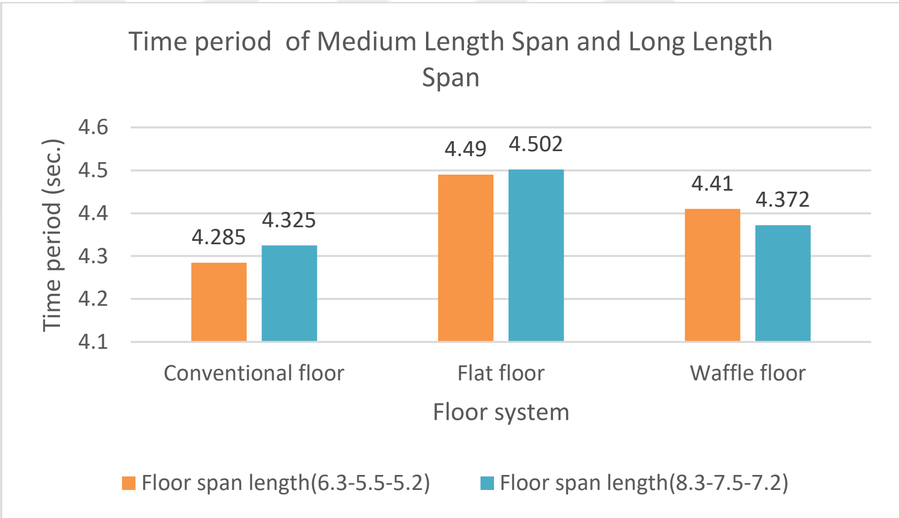



**Figure 5.15:** Shown Time period for Medium Length Span and Long Length Span.

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

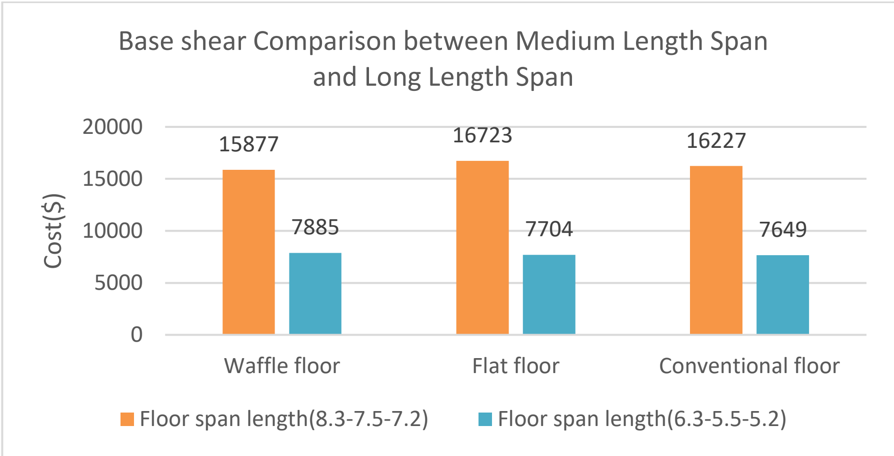



**Figure 5.16:** Shown Base Shear for Medium Length Span and Long Length Span.

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 plats 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.

# REFERENCES


[1] R. R. Nassar and I. A. Al-Qasem, "Comparative cost study for a residential building using different types of floor system," *Int. J. Eng. Res. Technol.*, vol. 13, no. 8, pp. 1983–1991, 2020, doi: 10.37624/ijert/13.8.2020.1983-1991.

[2] C. R. Bettini, O. C. Longo, L. F. Alcoforado, and A. C. G. Maia, "Method for Estimating of Construction Cost of a Building Based on Previous Experiences," *Open J. Civ. Eng.*, vol. 06, no. 05, pp. 749–763, 2016, doi: 10.4236/ojce.2016.65060.

[3] M. H. Kanekar, M. Umare, and A. Deshmukh, "Analysis and Design of Building and Cost Optimization with Different Floor System,", PENSEE, vol. 51, no. 4, pp. 1929–1936, 2021.

[4] K. K. Humphreys and L. M. Engush, "*Project and Cost Engineers' Handbook*",4$^{th}$ ed ,aace INT, NEW YORK. 1993. doi: 10.1080/03043799308928353..

[5] "Cost Engineering Terminology," AACE International, "10S-90: no.10, New York, pp. 1–107,2010.

[6] "*Cost Estimating Manual for Projects"*, Wsdot, vol. M 3034,, New York. pp. 1–8, 2009.

[7] F. R. Dagostino and S. J. Peterson, *Estimating in Building Construction*.8$^{th}$ ed, Pearson, 2015, pp. 1–8.doi: 978-0-13-343110-0

[8] Hasan Jasim Mohammed, "Structural and Cost Analysis for Several Building Models with Different Materials," *Int. Rev. Civ. Eng.*, vol. 3, no. 2, pp. 176–186, 2012.

[9] "Unified Facilities Criteria (UfC) Handbook Construction Cost Estimating," *U. S. A. C. O. ENGINEERS,* New York, *June,* pp. 1–99, 2011.

[10] Richard E. Westney, P.E. Larly Aaron; *"The Engineer's Cost Handbook*. MARCEL DEKKER, INC, New York, ,doi: 0824797965, pp. 1–141, 1997

[11] Bungale S. Taranath "*Reinforced Concrete Design of Tall Buildings"*, vol. 4, no. 1, CRC Press, New York, Pp 88-100, 2010

[12] Bryan Stafford smith, Alex Coull"Tall Building Structures, Analysis & Design", Willey INC, NC, 1991.

[13] Özgür Kurç Guney Ozcebe, "the Analysis and Design of the Tallest Buildings Ankara," Structural Engineers World Congress, Turkey, Ankara, 2007, doi: 10.13140/2.1.5119.6168.

[14] P. Mendis, T. Ngo, N. Haritos, A. Hira, and J. Cheung, *Wind Loading on Tall Buildings*, OPUS,,EJSE INT, pp. 41 - 542007: https://opus.lib.uts.edu.au/handle/10453/5822

[15] E. Guanabara, K. Ltda, E. Guanabara, and K. Ltda, "DESIGN AND ANALYSIS OF TALL AND COMPLEX STRUCTURES" Elsevier BH,UK,Oxford, pp.1–109,2018,doi. 1ll.1016/13978-0-08-101018-1.00001-0

[16] Bungale S. Taranath, Ph.D., P.E., S.E. TALL, *Tall TALL BUILDING DESIGN Steel, Concrete, and Composite Systems* "CRC Press,,NewYork, 2013,Pp 49-70. doi: 10.4324/9780203106464.

[17] M. Sarkisian, "*Designing tall buildings: Structure as architecture"*, Routledge ,NewYork ,2012,. Pp 63-80, doi: 10.4324/9780203806593.

[18] A. Manvi, S. Gouripur, and P. Sambrekar, "Cost Comparison Between Conventional and Flat Slab Structures," *Int. Res. J. Eng. Technol.*, vol. 02, no. 03, pp. 1218–1223, 2015.

[19] S. Bhatt and K. Narayan, "Parametric Study of Conventional Slab and Flat Slab in a Multi Storey RC Building," *Int. J. Eng. Res. Mech. Civ. Eng.*, vol. 3, no. 5, pp. 2456–1290, 2018.

[20] M. Shahbaz and M. Ahmad, "Comparison between the seismic variation of conventional RC slab and flat slab with a drop for G+15 storey building in different zones using etabs software," *Int. J. Adv. Res.*, vol. 4, no. 3, 2018,: www.IJARIIT.com

[21] S. M. Anghan Jaimis, Mitan Kathrotiya, Neel Vagadia, "Comparative Study of Analysis of Flat Slab and Conventional Slab Using ETAB Software," *Glob. Res. Dev. J. Eng.*, vol. 2, no. 2, pp. 674–677, 2016.

[22] A. B. T. C. V. . Hemalatha K.R, "IRJET- Finite Element Analysis of Flat Slab with Drop Panel for Apartment Building using ETABS," *Irjet*, vol. 8, no. 9, pp. 1228–1240, 2021.

[23] R. S. M and V. Selvan, "Seismic Analysis of Flat Slabs in a High-Rise Building," ,IJIRSET,vol. 10, no. 5, pp. 5271– 5278,2021, doi: 10.15680/IJIRSET.2021.1005194.

[24] A. C. Ghaleb and M. A. Jennam, "Optimum Design of Reinforced Concrete Flat Slabs," *Eng. &Tech.Journal*, vol. 33, no. 9, p. 2049- 2065, 2015.

[25] A. F. Al-Bayati, T. L. Lau, and L. A. Clark, "Concentric punching shear of waffle slab," *ACI Struct. J.*, vol. 112, no. 5, pp. 533–542, 2015, doi: 10.14359/51687906.

[26] D. J. Gunaratnam and N. S. Sivakumaran, "Optimum Design of Reinforced Concrete Slabs.," *Struct Eng Part B*, vol. 56 B, no. 3, pp. 61–67, 1978, doi: 10.4203/ccp.55.16.13.

[27] Zekirija Idrizi and Isak Idrizi, "Comparative Study between Waffle and Solid Slab Systems in Terms of Economy and Seismic Performance of a Typical 14-Story RC Building," *J. Civ. Eng. Archit.*, vol. 11, no. 12, pp. 1068–1076, 2017, doi: 10.17265/1934-7359/2017.12.002.

[28] Mohd Rizwan Bhina, Arnab Banerjee, D.K.Paul Abstract,N. "Assessment of Different Aspects of R . C. Flat-Slab Building Over," International Conference on Structural Engineering and Construction Management, Sri Lanka, pp. 8–16., 2013,doi:10.13140/2.1.1578.3689.

[29] Khwaja Moinuddin Khan1, M. Jeelani21B.Tech ,I. Journal, "-Analysis and Design of Flat Slabs in Commercial Building by using ETABS So ware" IRJET,vol. 5 no. 5,pp.998-1002,2018.

[30] C. Arunkumar, K. Saketh, S. Srinivasa senthil, and T. M. Jeyashree, "Behaviour of punching shear in normal RC slab and waffle slab," *Asian J. Civ. Eng.*, vol. 19, no. 1, pp. 27–33, 2018, doi: 10.1007/s42107-018-0003-x.

. [31] A. Mishra and A. Bajpai, "Comparative Analysis of Conventional Slab & Waffle Slab of Different Span Length," JCEET,vol. 7, no. 2, pp. 125–127, 2020.

[32] Sarita R. Khot, Himanshu V. Mahajan, Purval D. Shiram, Vishwajit V. Jadhav, Siddharth V. Tupe, and Kumar T. Bharekar, "Comparative Study of Waffle Slabs with Flat Slabs and Conventional RCC Slabs," *Int. J. Eng. Res.*, vol. V5, no. 04, pp. 715–728, 2016, doi: 10.17577/ijertv5is041092.

[33] L. Balhar and J. N. Vyas, "Review Paper on Comparative Analysis of Flat Slabs & Conventional Rc Slabs With and Without Shear Wall," *Int. Res. J. Eng. Technol.*, vol. 77, pp. 77–81, 2008,: www.irjet.net

[34] M. D. Loads and O. Structures, *Minimum design loads and associated criteria for buildings and other structures*,ASCE, Reston, Virginia,pp. 1–31 2017. doi: 10.1061/9780784414248.

[35] *Building Code Requirements for Structural Concrete (ACI 318M-14) and Commentary (ACI 318RM-1), aci, pp. 83–102, 2014*. doi: 10.14359/51716937

[36] M. Lonare, "Review Paper on Studying the Behavior and Comparison of Flat Slab and Waffle Slab System in Same Building under Seismic Condition," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 10, no. 1, pp. 1173–1178, 2022, doi: 10.22214/ijraset.2022.40009.

[37] S. Vijaya Bhaskar Reddy, "Study of Lateral Structural Systems in Tall Buildings," *Int. J. Appl. Eng. Res.*, vol. 13, no. 15, pp. 11738–11754, 2018,: http://www.ripublication.com

[38] P. Dewangan and B. Singh, "Review of Structural Systems for Tall Buildings," *Indian Concr. J.*, vol. 96, no. 11, pp. 7–17, 2022.

[39] M. W. Abdulmajeed and I. K. Ahmed, "Design of High Rise Reinforced Concrete Buildings,",IISTE, vol. 9, no. 12, pp. 41–54, 2017,: www.iiste.org

[40] G. TUNÇ, A. B. AZİZİ, and T. TANFENER, "Effects of Slab Types on the Seismic Behavior and Construction Cost of RC Buildings," *J. Polytech.*, vol. 0900, pp. 0–2, 2021, doi: 10.2339/politeknik.971343.

[41] N. R. Mule, P. D. H. Tupe, and G. R. Gandhe, "Analysis and Design of High Rise Building Subjected to Combined Effect of Earthquake and Strong Wind using E-Tab Software,", IRJET, vol. 11, no. 09, pp. 1114–1119, 2020.

# APPENDIX A

## A.1 WIND CALCULATIONS AND RESULTS

**Table A.1:** Wind Calculation Parameters.

| Parameter | Value | Definitions |
|---|---|---|
| z(bar) | 174.21 | Equivalent height |
| Iz(bar) | 0.227 | Intensity of turbulence |
| Lz(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 |
| Ct | 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(bar,zbar) | 85.04 | Eq.26-16 |
| N1 | 1.999 | Eq. 26-14 |
| Rn | 0.089 | 26.9-13 |
| μh | 4.792 | |
| Rh | 0.187 | Eq26.9-15a |
| μb | 1.44 | |
| RB | 0.467 | Eq26.9-15a,b |
| hd | 4.822 | |
| RL | 0.186 | Eq26.9-15a,b |
| R | 0.371 | Eq26.9-12 |
| Gf | 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) | $h.^k$ | Cvx | Fx (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) | $h^k$ | Cvx | 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:

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

$\delta_{xe}$ 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 Valves of Case in Conventional Floor for Model (6.3-5.5-5.2).

| Story | Displacement (δi) | 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 Valves of Flat Floor Case for Model (6.3×5.5x5.2).

| Story | Displacement (δi) | 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 Valves of Waffle Floor Case for Model (6.3-5.5-5.2).

| Story | Displacement (δi) | 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 (δi) | 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 (δi) | Story height | (Δi) Story Drift Ratio (%) | Allowable Story Drift Ratio (Δa) |
|---|---|---|---|---|
| | 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 Valves of Waffle Floor Case3 for Model (8.3-7.5-7.2).

| Story | Displacement (δi) | 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

$\theta = \frac{P_x \Delta I_e}{V_x h_{sx} C_d}$ Where

Px total vertical design load

Δ the design story drift

Vx 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 Vx (kN) | Axial force Px (kN) | Displacement Ux(mm) | Story Drift (Δi) (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 Vx (kN) | Axial force Px (kN) | Displacement Ux(mm) | Story Drift (Δi) (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 Vx (kN) | Axial force Px (kN) | Displacement Ux(mm) | Story Drift (Δi) (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 Vx (kN) | vertical design load Px (kN) | Displacement Ux(mm) | Story Drift (Δi) (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 Vx (kN) | Axial force Px (kN) | Displacement Ux(mm) | Story Drift (Δi) (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 Vx (kN) | Axial force Px (kN) | Displacement Ux(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 |

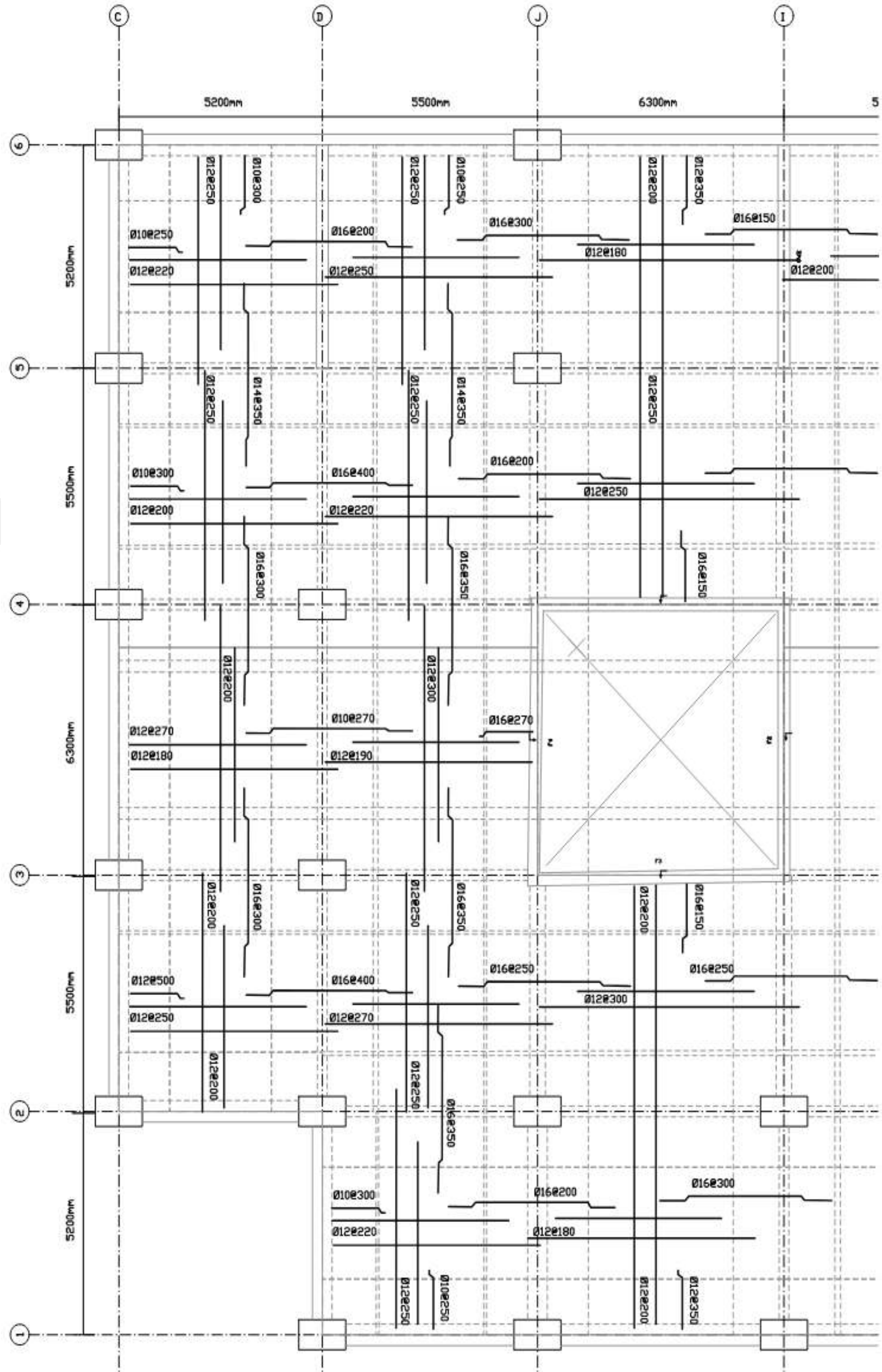


**Figure A.1**: Middle Strip Steel Reinforcement for Story-10 Conventional Floor.

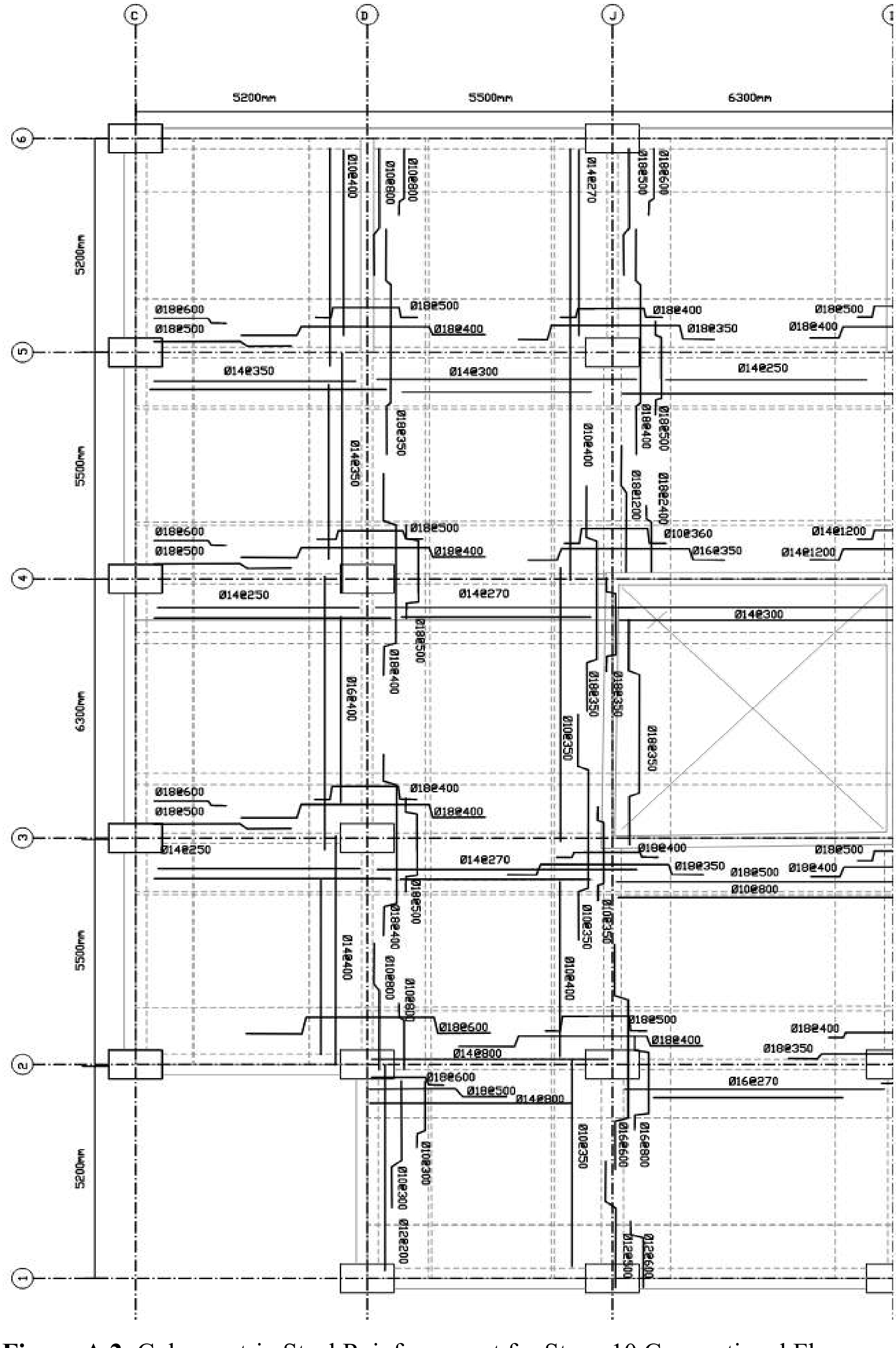


**Figure A.2**: Column strip Steel Reinforcement for Story-10 Conventional Floor.

### 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 |

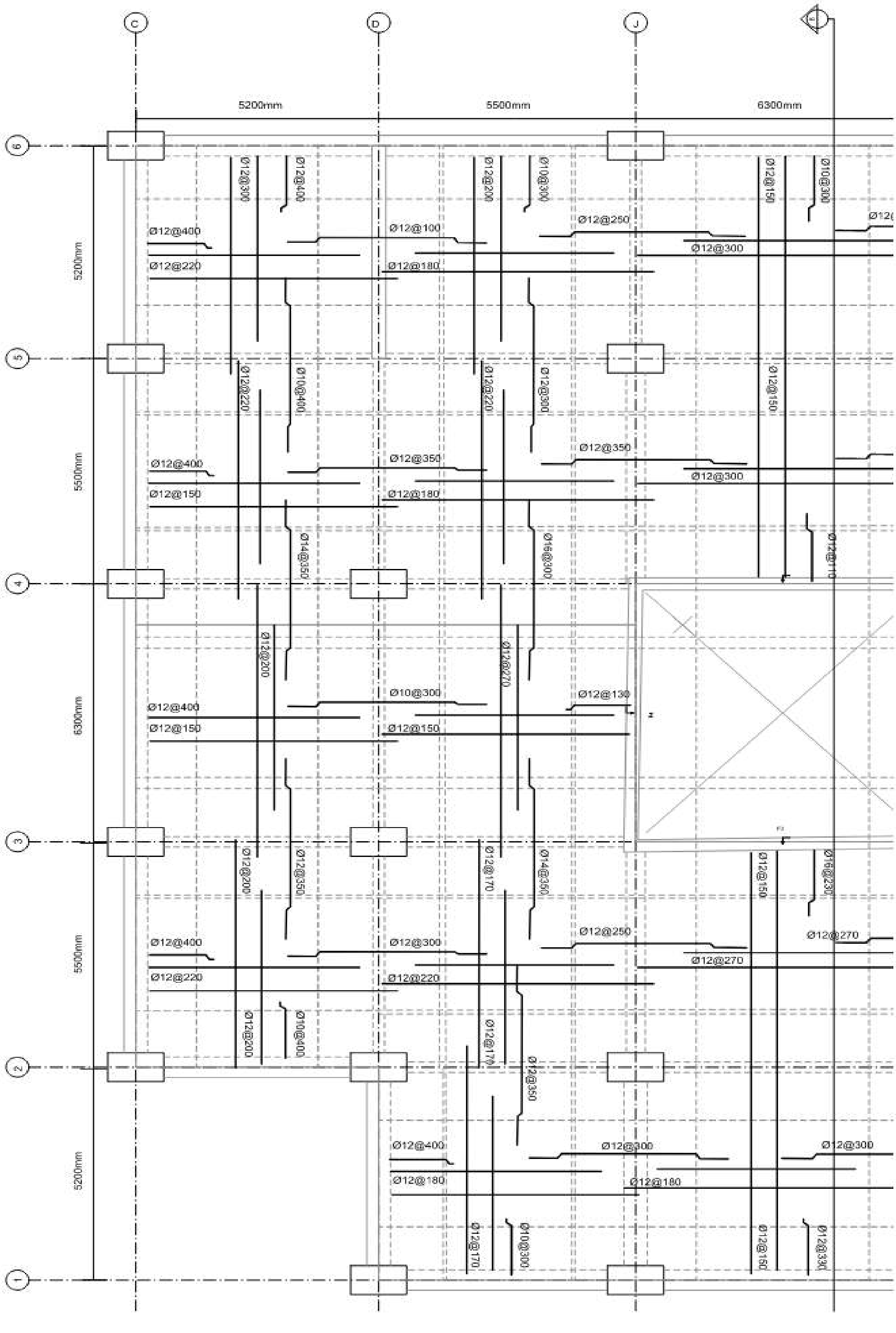



**Figure A.3**: Middle Strip Steel Reinforcement for Story-10 Flat Floor.

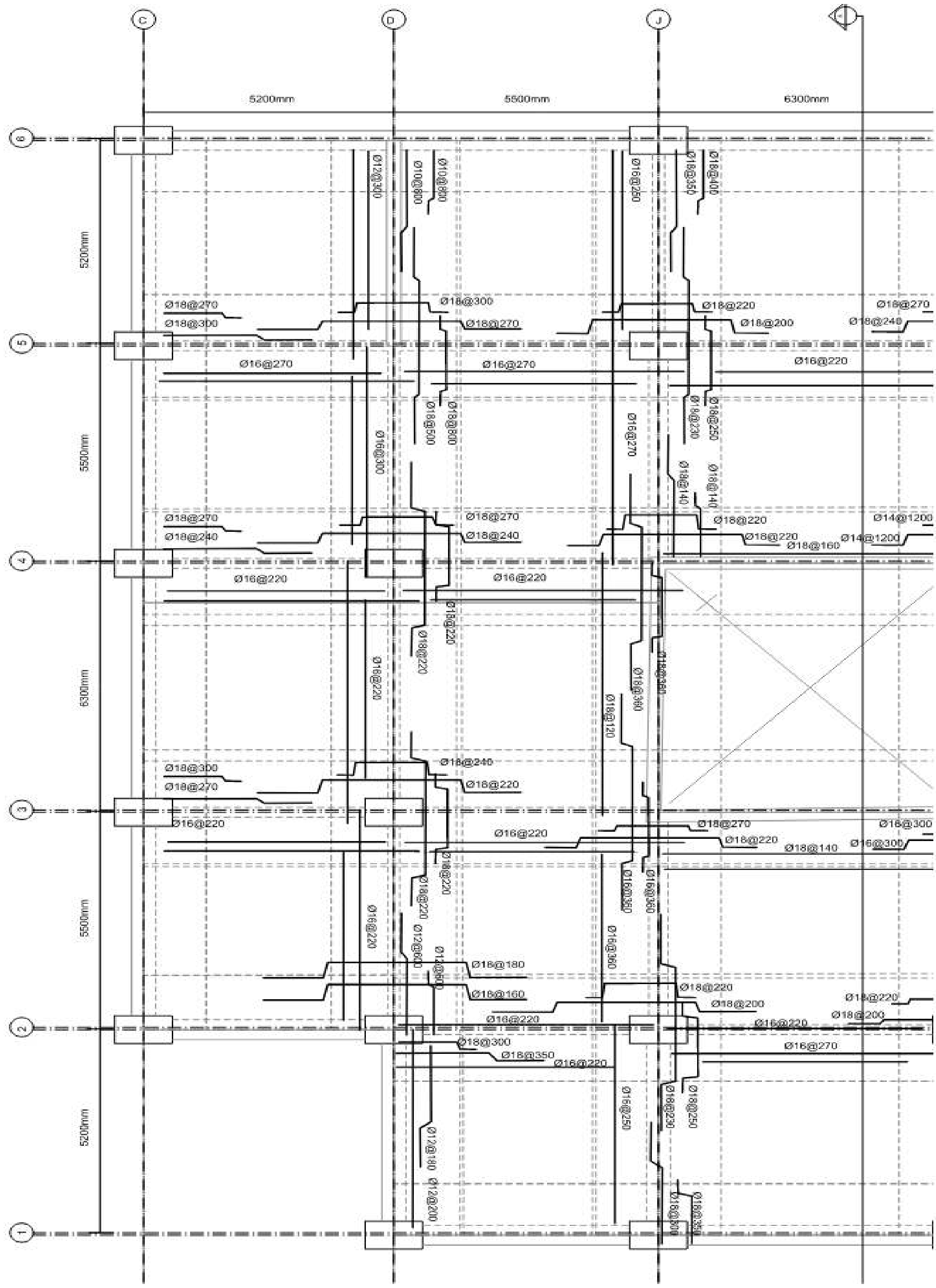


**Figure A.4**: Middle Strip Steel Reinforcement for Story-10 Flat Floor.

### 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 (8.3×7.5x7.2).

| 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 (8.3×7.5x7.2).

| 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 (8.3×7.5x7.2).

| 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 (8.3×7.5x7.2).

| 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 (m3) |
|---|---|---|---|---|---|
| 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 (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.54**: Steel Rebar Requirement for Waffle Floor for Model (8.3×7.5x7.2).

| 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 (6.3×5.5x5.2).

| | Panel 1 | Panel 2 | Panel 3 | Panel 4 |
|---|---|---|---|---|
| $I_{beam}$ ($mm^4$) | 1373840583 | 1373840583 | 1373840583 | 1373840583 |
| $I_{slab}$($mm^4$) | 1277792837 | 1409154718 | 127792837 | 140915471 |
| Stiffness ratio($\alpha$) | 4.075 | 1.075 | 0.975 | 0.975 |
| | Panel 1 | Panel 2 | Panel 3 | |
| $I_{beam}$ ($mm^4$) | 5719815455 | 5719815455 | 5719815455 | 5719815455 |
| $I_{slab}$($mm^4$) | 3789544117 | 4073115446 | 3789544117.8 | 40731157446 |
| Stiffness ratio($\alpha$) | 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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 |

[illegible] Steel Area for Flat Floor for Model (6.3×5.5x5.2) "Table Continued".

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | -189.8865 | 3391 | 913 | 29.5744 | 498 | 0 | 161.271 | 0 |
| [illegible] | -157.8454 | 2783 | 913 | 12.1489 | 203 | 0 | 322.5429 | 2166.67 |
| [illegible] | -31.245 | 527 | 0 | 62.2857 | 1061 | 913 | 193.5743 | 0 |
| [illegible] | 0 | 0 | 0 | 98.5977 | 1701 | 913 | 73.3422 | 0 |
| [illegible] | -0.1539 | 0 | 0 | 93.0937 | 1603 | 913 | 77.9655 | 0 |
| [illegible] | -43.8775 | 743 | 0 | 48.4236 | 821 | 913 | 229.0697 | 0 |
| [illegible] | -267.7056 | 4939 | 913 | 0.3743 | 0 | 0 | 378.2317 | 2166.67 |
| [illegible] | -38.4252 | 649 | 913 | 33.2717 | 561 | 0 | 90.3249 | 0 |
| [illegible] | 0 | 0 | 0 | 86.0419 | 1478 | 913 | 25.3302 | 0 |
| [illegible] | 0 | 0 | 0 | 87.5895 | 1505 | 913 | 25.7145 | 0 |
| [illegible] | -35.4728 | 599 | 0 | 38.8353 | 656 | 913 | 91.2202 | 0 |
| [illegible] | -251.1513 | 4600 | 913 | 3.5536 | 59 | 0 | 243.902 | 0 |
| [illegible] | -267.0371 | 4925 | 913 | 0.3633 | 0 | 0 | 243.8339 | 0 |
| [illegible] | -41.685 | 705 | 0 | 45.9073 | 778 | 913 | 220.9688 | 0 |
| [illegible] | 0 | 0 | 0 | 84.9922 | 1459 | 913 | 72.9322 | 0 |
| [illegible] | -0.1986 | 0 | 0 | 86.4411 | 1485 | 913 | 70.3912 | 0 |
| [illegible] | -43.8555 | 742 | 0 | 51.6466 | 876 | 913 | 219.1913 | 0 |
| [illegible] | -232.0841 | 4216 | 913 | 0.7387 | 0 | 0 | 437.0882 | 3033.27 |
| [illegible] | -26.6959 | 449 | 0 | 33.4615 | 564 | 913 | 144.1747 | 0 |
| [illegible] | 0 | 0 | 0 | 83.016 | 1424 | 913 | 15.2938 | 0 |
| [illegible] | 0 | 0 | 0 | 84.3547 | 1448 | 913 | 56.7812 | 0 |
| [illegible] | -7.7902 | 130 | 0 | 40.9284 | 692 | 913 | 150.9947 | 0 |
| [illegible] | -172.1327 | 3052 | 913 | 23.0966 | 388 | 0 | 151.3511 | 0 |
| [illegible] | -177.0751 | 3146 | 913 | 25.1781 | 424 | 0 | 162.7046 | 0 |
| [illegible] | -6.2604 | 105 | 0 | 32.8757 | 554 | 913 | 68.779 | 0 |
| [illegible] | 0 | 0 | 0 | 85.1359 | 1462 | 913 | 3.9002 | 0 |
| [illegible] | -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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 (8.3×7.5x7.2)"Table Continued".

| Story | F Top Moment | FTop Area | FTop AMin | FBot Moment | FBot Area | FBot AMin | V Force | V Area |
|---|---|---|---|---|---|---|---|---|
| | kN-m | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 (8.3×7.5x7.2) "Table Continued".

| Story | F Top Moment | FTop Area | FTop AMin | FBot Moment | FBot Area | FBot AMin | V Force | V Area |
|---|---|---|---|---|---|---|---|---|
| | kN-m | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 (8.3×7.5x7.2) "Table Continued".

| Story | F Top Moment | FTop Area | FTop AMin | FBot Moment | FBot Area | FBot AMin | V Force | V Area |
|---|---|---|---|---|---|---|---|---|
| | kN-m | mm² | mm² | kN-m | mm² | mm² | kN | mm²/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 |