JUNE 2022 M.Sc. Civil in Engineering AHMED SALIH

**HASAN KALYONCU UNIVERSITY**

**GRADUATE SCHOOL OF**

**NATURAL AND APPLIED SCIENCES**

# ANALYSIS ASSESSMENT OF ROTATABLE MULTI-STORY BUILDING SUBJECTED TO WIND LOADING

**M.Sc. THESIS**

**IN**

**CIVIL ENGINEERING**

**By**

**Ahmed S. SALIH**

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# Analysis Assessment of Rotatable Multi-Story Building Subjected to Wind Loading

**M.Sc. Thesis**

**In**

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**Supervisor**

**Assoc. Prof. Dr. Amjad KHABAZ**

**By**

**Ahmed SALIH**

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**DECLARATION**

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**Ahmed Sabar SALIH**

# ABSTRACT

## ANALYSIS ASSESSMENT OF ROTATABLE MULTISTORY BUILDING SUBJECTED TO WIND LOADING



SALIH, AHMED

M.Sc. in Civil Engineering
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The wind load of buildings with a height of more than 10 floors has a great effect on the building, so the orientation of the building is important in reducing the wind load. Furthermore, structures must be designed and built for stresses obtained in directions for critical wind forces.

A place was chosen for the construction of a 12-storey building, 10 of which are duplicate and rectangular in shape. The eleventh floor is a circular form of reinforced concrete walls located in the center of the building and extending from the ground floor where the center of the building contains stairs and two elevators. The twelfth floor is an iron structure that can be rotated. The orientation of the building towards the UX direction was chosen to directly counter the wind. The imposing wind speed was 75 km/h.

On this basis, this thesis focused on studying the behavior of the effect of wind on this building. Where the computer analysis was used on ETAPS 2016 which is a program to know the effect of the wind on the floor from the role and effect of the wind on it directly and on the floors below it. Where 8 iron blades were placed and installed around the iron rotor. 3 tests of the building were carried out, the fins were set at zero degrees in the first test and the fins were set at 15.30 degrees in the second and third test. To determine the best degree of wind resistance. We obtained the results of displacement and torque for three tests, and the best results were at the 30 degree.



**Keywords:** wind effect. rotating buildings. steel structures. dynamical Analysis. Finite Element Modeling FEM.

# ÖZET

## RÜZGAR YÜKÜ UYGULANMIŞ DÖNDÜRÜLEBİLİR ÇOK KATLI BİNANIN ANALİZ DEĞERLENDİRMESİ

SALIH, AHMED

Yüksek Lisans Tezi, İnşaat Mühendisliği

Tez Danışmanı: Doç. Dr. Amjad KHABAZ
Haziran 2022, 111 sayfa

Rüzgar yükü, 10 katın yüksekliğinden daha fazla olan binalar üzerinde büyük bir etkiye sahiptir. Bundan dolayı, binanın doğrultusu rüzgar yükünün azalmasında önemlidir. Ayrıca, yapılar rüzgarın doğrultularına göre basınçlar için elde edilmiş kritik kuvvetlere göre tasarlanmalıdır ve inşa edilmelidir.

Çalışma için, 10 katı birbirini tekrar eden ve dikdörtgen formada olan, 12 katlı bir bina tercih edilmiştir. Onbirinci kat yapının merkezinde bulunan zemin kattan itibaren uzanan daire şeklinde betonarme duvardan oluşmaktadır ve yapının merkezi merdivenler ve iki adet asansör içermektedir. Onikinci kat ise döndürülebilir demir bir yapıdan oluşmaktadır. Binanın doğrultusu direkt olarak X doğrultusunda rüzgara direnç gösterecek şekilde tercih edilmiştir. Dikkate alınan rüzgar hızı 75 km/s’dir.

Bu bağlamda, bu tez rüzgarın davranışının bu bina üzerindeki etkisini çalışmaya odaklanmıştır. Rüzgarın, son kattaki döşemenin rolü üzerindeki etkisini ve direkt olarak döşeme üzerindeki etkisini ve aşağı katlardaki etkisini araştırmak için ETAPS 2016 yazılımı kullanılmıştır. Dönen bölümün çevresine 8 adet demir kanat yerleştirilmiştir. Bina için en iyi rüzgar direncinin hangi açıda olduğunu belirlemek için, kanatlar birincide sıfır derece, ikincide ve üçüncüde 15 ve 30 derece olacak şekilde yerleştirilerek, 3 deneme yapılmıştır.

Ölçek. En iyi rüzgar direnci derecesini belirlemek için. Üç test için yer değiştirme ve tork sonuçlarını aldık ve en iyi sonuçlar 30 derecedeydi.

**Anahtar Kelimeler:** Rüzgar etkisi. Dönen binalar. Çelik Yapılar. Dinamik analysis. Sonlu Eleman Modellemesi (SEM).

## THE DEDICATION

Praise be to Allah, who has been blessed with good deeds. Praise be to Allah who has blessed us with writing this letter. I hope it will be useful for every knowledgeable student. I dedicate this message to my mother, father, brothers, sisters, companions and teachers.

## ACKNOWLEDGEMENTS

I would like to give my great thanks to my Assoc. Prof. Dr. Amjad khabaz for his endless guidance and support while working on this thesis. From Heart to my supervisor Assoc. Prof. Dr. Amjad khabaz was always very understanding and supportive whenever I had questions about my thesis.

I would like to thank everyone who contributed from far or near to the completion of this study, especially my friends Dr. Akram Shaker at Anbar University and Zaidoun Mohsen Ali at Anbar University. and Ahmed Hakim. Last but not least, I want to thank Assoc. Prof. Dr.Adem Yurt sever for his advice and encouragement during my post.

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## LIST OF SYMBOLS AND ABBREVIATIONS

| | |
|---|---|
| FRC | dynamic analysis |
| CFD | Numerical simulation |
| Vc r | speed of the wind |
| q | dynamic pressure |
| v | speed air (liquid) |
| S | a constant called the Stromal number |
| D | width of facade exposed to air (liquid) |
| Ux | displacement towards x |
| Uy | displacement towards y |
| Uz | displacement towards z |
| T | Torque |
| M | moment |
| F | axial force |
| V | shear |

# CHAPTER 1

# INTRODUCTION

Due to the existence of many flows that may arise from the wind interaction with the structures, the wind is a very complex phenomenon. The wind consists of a large number of votes of various sizes and characteristics that are carried in a wide course of air that moves in relation to the surface of the earth. The wind has turbulent storm character due to these Eddies. Interaction with surface features causes strong winds to be gusty Less levels of the air. The average wind speed rises with a rise over a period of adolescence or more, while the gustiness decreases.

Features of approaching wind defender to the structure is the function of the structure under study, as well as the geometry and proximity of structures upwind. The pressures are not constant, but rather fluctuate a lot, partly due to the wind's gustiness, but also due to the local vortex that descends into the structures' edges. Volatile stresses cause structural stress. With dynamic excitation if the structure is dynamically sensitive to wind. The stresses are not evenly distributed across the surface of the structure, but vary according to position.

Not using analytical methods to estimate certain types of wind loads and the resulting structural response in a number of situations, which is not possible at all.

For example, The aerodynamic shape of a building when it is unusual or the structure is too flexible, causing a change in the aerodynamic forces acting on it with its movement.

Aero model flexible testing within limits. A laminar wind tunnel will provide the most accurate estimate of the wind's effects on buildings in such cases. High-rise buildings are always subject to wind tunnel testing as part of the design. It is necessary to encourage owners of buildings with somewhat higher elevations to allow wind tunnel testing, and the costs of such testing can be offset by cost savings in the building due to reduced design wind loading. The desire for buildings that adapt to life and are a part of nature spawned the concept of dynamic architecture.

**1.1 There four ways for analyzing wind speeds and directions**

1. The first step is to take measurements on site. Although these give precise information through field measurements are time consuming and costly. They are only useful for analyzing current circumstances, thus their use to forecasting the impact of changes to the built environment is restricted.

2. The second step is to test scale models in wind tunnels. The modeling method is quite simple and sensors may be employed to acquire extract wind speed data, however there are two drawbacks. For starts measurements can only be acquired where sensors location is important to the results. Second, a wind tunnel is a sophisticated piece of equipment and not everyone has financial or technical access to one, which prevents urban planners from adopting it.

3. The third technique is made up of simpler computational methods. Rather of simulating of real physical processes that contribute to wind behavior, they employ simplified, empirical mathematical models to estimate wind speed based on the surrounding urban architecture.

4. The fourth approach for analyzing wind is computational fluid dynamics (CFD). This consists of utilizing a computer. Based model to replicate the real physical processes that govern wind behavior.

The spinning of the structure will be very slow, allowing for a quasi-static approach in the analysis. A completely different method would be the rotation was quicker, in addition wind load for multistory building may effect on it, and there for some objectives will be studied to achieve these concerns:

1. To adopt a nonlinear performance based wind engineering for multistory rotating buildings.

2. To test different wind simulation SAP 2000 software package, focusing on their usability and accuracy an urban planning context.

## 1.2 Assessing the wind analysis of static and dynamics architecture of a various rotating buildings

Comprehensive analysis of rotating multistory building having a significant critical wind loads scenarios.

In this thesis, will use the 2016 ETABS program for a 12-storey building consisting of the ten lower floors in the form of a concrete structure. The 11th floor continues from the center of the building in the form of a circular reinforced concrete wall on which the 12th floor is fixed. The 12th floor is a rotating steel structure that is installed on the 11th floor, on which 8 fins are installed to help the steel floor to rotate. The building is analyzed on the ETAPS program and a wind force of 75 km/h is projected to extract the best case for the wind effect. There were three tests to analyze the building.

1. When installing the fins at zero degrees.
2. When installing the fins at 15 degrees.
3. When installing the fins at 30 degrees.

The results after the analysis of three cases were the best effect in the third case, which is placing the fins at a degree of 30. In terms of the effect of displacement and torque.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction to Rotatable Building

The generation of flow around the building poses difficulties due to the distortion of the medium flow, separation of flow effect, eddy formation, and vigil development when the wind is close to the building. Due to the above properties, it causes high fluctuations in wind pressure force on the structure surface.

Result of this, the structural system is subjected to high aerodynamic loads, and the facades are subjected to intense localized fluctuating forces.

However, the rotating structures should be analyzed for many scenarios that it may done by the wind pressure or direction on facades.

### 2.1.2 Dynamic Architecture

Park et al., (2008) indicated that the Dynamics is a field of mechanics that studies the influence of forces of the motion of objects. Nowadays, architecture is viewed as something static because buildings remain in the same location and its composition does not alter. Dynamics architecture refers to the notion of movements in a building. Building with dynamic architecture continuously change shape; living in a dynamic universe, it stands to reason that the future of building design will remain employed. The fourth dimension in dynamic architecture is time. (Camarri et al., 2005).

This sort of design will be based on change and adaptation to a changing environment. Getting closer. It seems reasonable that structures that take a dynamics approach would change cities. The engineer's thinking level must be raised to develop his scientific level that qualifies him for design. So the main purpose of this book was to present and equip the engineer to obtain knowledge of public works engineering in public and private circumstances, to know the specifications of building materials according to the provisions of the code, and to study quantity surveying for civil engineering projects Increasing the adhesion efficiency Between concrete and fiber, in fiber-reinforced concrete members.

Steel fibers have a reliable correlation with the efficiency of the hardening compound for reinforced concrete due to the similar and identical behavior of the steel fiber components as well as the hardening compound in action (Khabaz, 2016a, b, In fact, because each floor rotates independently, our buildings constantly change shape and never appear the same (Murakami and Mochida, 1989).When designing buildings and other structures, the the modern level architecture design and construction technologies can use of both static and dynamic architecture principles, Also, the dynamic architecture methods that have been improved nowadays. A vertical central core supports suspended floor units surrounding the core in a rotatable building structure. Access to and from the central core is provided via an annular platform that extends from the core at corresponding floor units. A drive mechanism for rotational displacement can be found in the floor units. The rotating structure at the height of the skyscraper necessitates significant concerns in structural construction. The presence of this rotating component on top the structure affects structural efficiency; the huge weight causes the structure to function like an inverted pendulum, reducing the systems effective rigidity (Murakami,1997; Silva and Costa. 2008).

The flow pattern generated around a building is complicated by the distortion of the mean flow, Flow season, whirlpool formation, and heightened vigilance when wind force approaches the building. it causes the aforementioned characteristics,

As a result, the structural system is subjected to significant aerodynamic loads, and the facades are subjected to intense localized fluctuating forces.

However, the rotating structures should be analyzed for many scenarios that it may done by the wind pressure or direction on facades (Richards et al., 2007; Pasto et al., 2008).

Figure 2.1  showed square cross section of wind effects on long building.

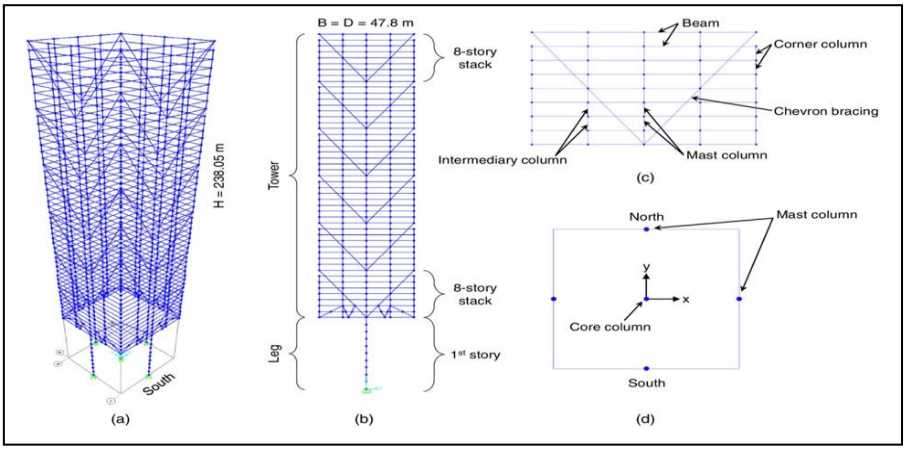


**Figure 2.1** Wind effects on long building with square cross section

Turbulence has the effect that the size of the eddies determines the dynamic loading over structure. As they encircle the structure, large eddies with dimensions comparable to the structure produce fully. stress related. Small eddies, otherwise, cause pressures On a number of sections of the structure to turn into almost unrelated to separation distance (Poggi and Katul, 2007). To depicts the eddies that form around a common structure. It is necessary to know and treat the coefficient of friction in the faces facing the wind. It is possible to add glass and concrete fibers to the concrete mixture and know the coefficient of friction between them to obtain mixing by the wet method.

This book contains new scientific facts such as the coefficient of friction between glass

and concrete, as well as the dynamic analysis of FRC under the influence of vibration. Convenient mixing and pouring of nonmetallic fiber. Reinforced concrete mixes can be obtained by using appropriate vibrating and wet mixing techniques. (Khabaz, 2014). fibers Figure 2.2.

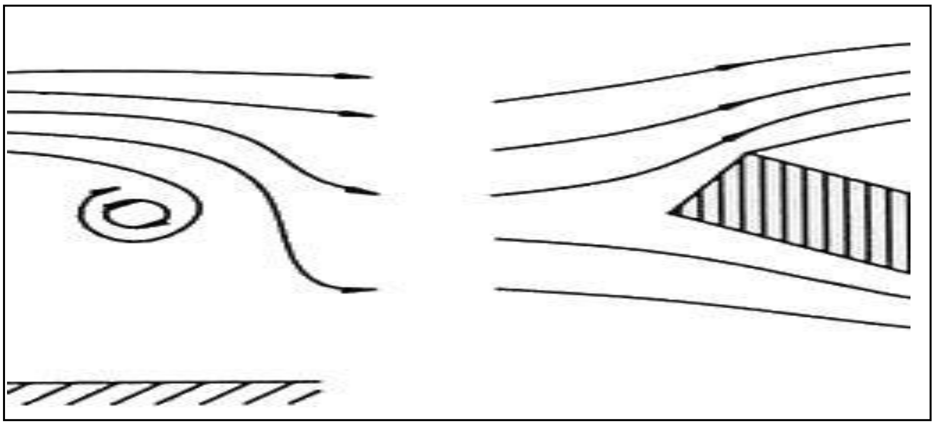

**Figure 2.2** Generation of eddies

### 2.1.3 Speed of the Wind

The direction of air movements runs through pressure gradients in the atmosphere. This is one of the thermodynamic of consequences of the different the solar heating on Earth, at a great height from the surface  Earth, where the effects of friction are very few. The gradient wind velocity is the upper level wind speed (Nozawa and Tamura, 2002; Nozu et al., 2008).

Simple static wind loading treatment, which is widely used in the design  low to midrise structures, Likely to be unacceptably long body designs. However, such a simple remedy It is easy to lead to incorrect results and to be underestimated. very important, This simplified curing of lateral load calculation neglects essential design considerations such as dynamic response (Resonance effects, acceleration, damping, structural rigidity), interference from More structures, wind direction and crosswind response are all important to in the Wind design for buildings with floors more than 11 floors. In the context of universal wind law, It is necessary to define advanced levels of wind design and demonstrates the significant advantages they offer over simpler methods. The wind tunnel test has also been emphasized, as it has the potential to improve Preparing the design of wind loading with its effects on all high-rise buildings (Mendis et al., 2007; Sengupta and Sarkar, 2008).

Wind load symbols can give behavior Wind pressure is constant over time. However, wind pressure varies over a specific period of time phases in the nature of the case, with large changes in amplitude over high frequency intervals. Several factors are associated with wind turbulence and the local special topic EJSE 44: Factors loading on structures influence the magnitude and frequency of fluctuations (2007). The structure and the surrounding environment have caused gusting effects. (Nozu et al., 2008).

Figure  2.3  showed the wind response directions.

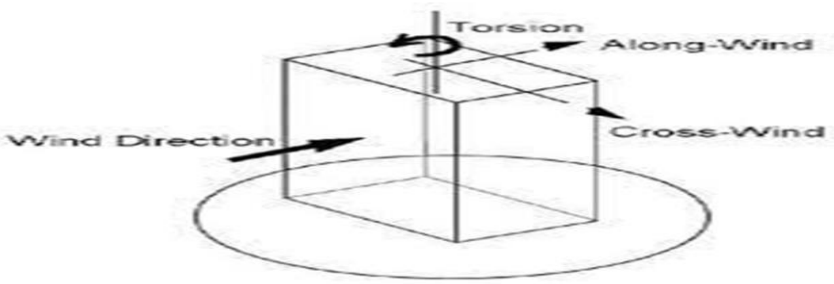


**Figure 2.3** Wind Response Directions

## 4 Along and cross. Wind loading

The flow generated around the building is highly sustained by the contrast of the flow, flow separation, eddy formation, and emission evolution, as well as winds close to the building. And also on the roof of the building, where high fluctuations in wind pressure can occur as a result of these effects. As a result, this structural system is subjected to large aerodynamic loads, and intense local oscillatory forces act on the interfaces of these structures. (Selvam, 1997; Stathopoulos, 2004)

(Figure 2.4 showed the effects of exterior porous facades on reducing wind load on buildings).

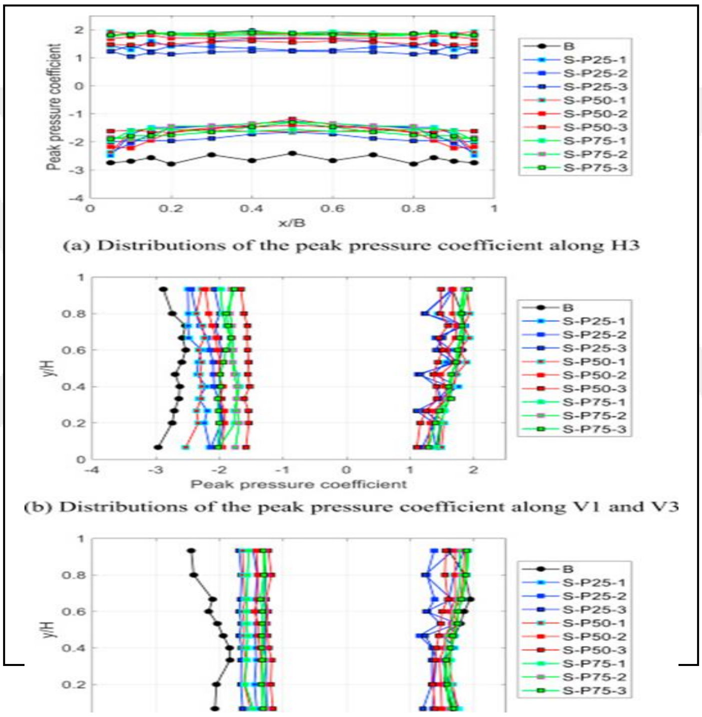


**Figure 2.4** Exterior porous facades have a wind load reduction effect on the building

The building is subjected to vibration at straight positions and torsion under the multilateral action of these fluctuating forces. The amplitude of the oscillations is quantified by the type of aerodynamic forces acting as well as the dynamic properties of the building (AS/NZ1170.2, 002) (Tamura, 2006 & 2008).

Tall buildings are tested to measure wind tunnels as part of their design process. The basics of fibers can be studied. Compounds of reinforced concrete and the effects of fibers upon friction / the effect of concrete on the cohesion ability of fiber strips. with getting results. Concrete, and the coarse Poisson ratio for concrete (Khabaz), 2022a).Until recently, the standards for wind loading of the outer wall were not taken into account with great interest in the form of documents According to building codes. On studies of any wind tunnel model for Structural and external building contents, have been conducted for nearly 30 years, but they were primarily used for special building structures until the last decade (Soong and Constantine, 1994).

As illustrated at Figure 2.5  The impact of wind on multistory buildings.

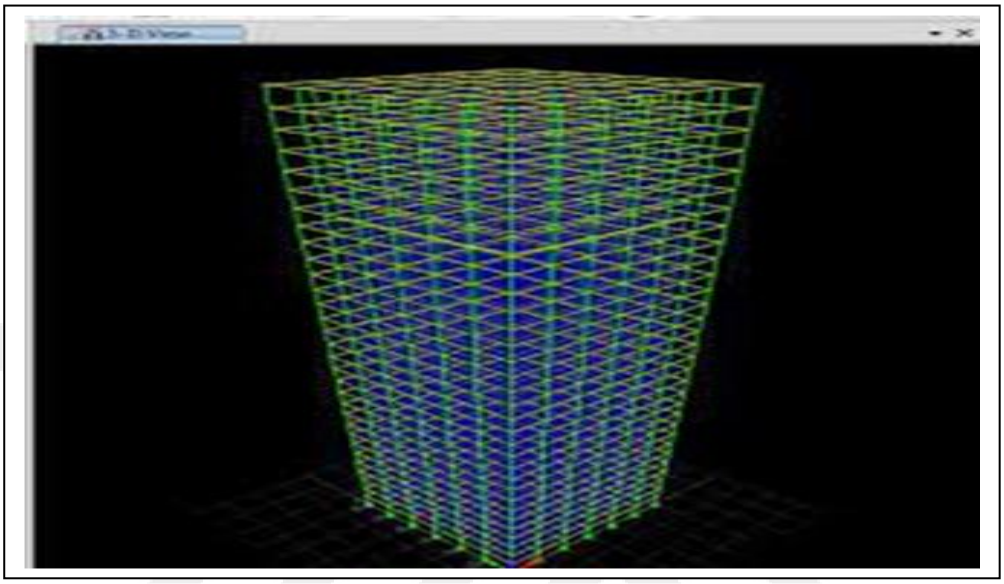

**Figure 2.5**  Effect of wind load on multistory building

Wind/structural activity 'whirl separation' behavior, which results in a large 'intersection'. Wind' deformation of the structure, may lead to higher transitional and torsional deformations of the structural framework, especially in taller and more slender buildings. It is taken into account that the wind loads are fixed loads during the design, The actual wind on the rooftops is continuously dynamic, and the actual response behavior is always taken into account (Hira and Mendes). 1995).

### 2.1.4. Along Wind Loading

When stipulating that there is an average component Because of the action of wind speed (eg, wind speed in hour) The second element that oscillates due to a change in wind speed from the average creates the wind load on the path or response of the building due to the wind blow. Blowing winds always consist of A mixture of storms or eddies. Less vortices are formed (i.e., at a lower frequency) than smaller vortices.  Most structures have a natural frequency of vibration that It is more than a component of the fluctuating load effect arising from large vortices. i.e., This is because the average succession of large storms is much lower than any natural vibration frequencies of a building, they do not force the structure to respond dynamically. As a result, the load caused by those big storms (also known as "background turbulence") It can be solved similarly to that caused by medium winds. Also, Vortex of small size causes the structure to vibrate close to one (or more) of the natural vibration because they occur frequently. As a result, the structure experiences The early effect of dynamic pregnancy, may be significant. The so-called "responsiveness factor" approach, which is mentioned in many design codes, Wind load separation depends on medium and volatile components. So that the pressure and load coefficients are used, after which the load component of the wind speed is calculated. according to (Davenport, 1967), After calculating fluctuating loads separately, the effects so that reduce the volume, dynamic amplification. The storm factor is produced by the dynamic response of buildings, The wind flow should not be highly affected in the presence of tall or surrounding buildings (Hira et al., 2007).

Figure 2.6 showed along and across wind parameters acting in tall structures.

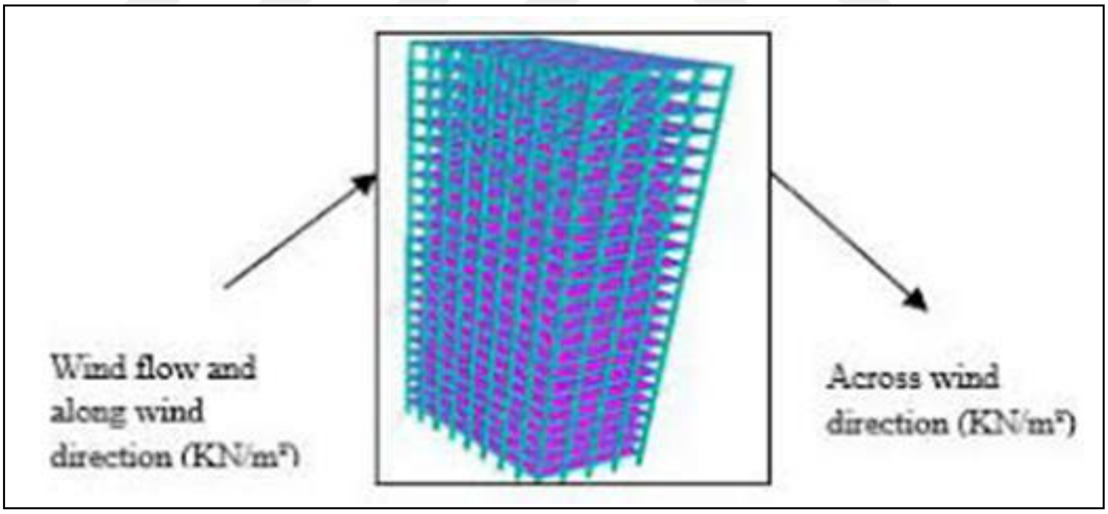


**Figure 2.6** Along and across wind parameters acting in tall structures

### 2.1.5 Wind Tunnel

It is necessary to carefully test building structures that exhibit significant dynamic acceleration properties In knowing and calculating the wind tunnel in relation to the response of the external interface system and to the underlying structure. In order to achieve an acceptable performance range for external interface systems (McNamara et al., 2002).

A. The sliding phase of the fibers Through the concrete matrix using a delayed shear model.

B. The small diameter of the fibers improves the strength of the bond between the working materials, and this was shown through the use of FEM . analysis (Khabaz, 2021).

Figure 2.7 and Figure 2.8 showed Low speed aerodynamic wind tunnel and Advanced design wind tunnel. In this series of tests individual fibers will be drawn onto embedded steel and glass fibers across a cement matrix.

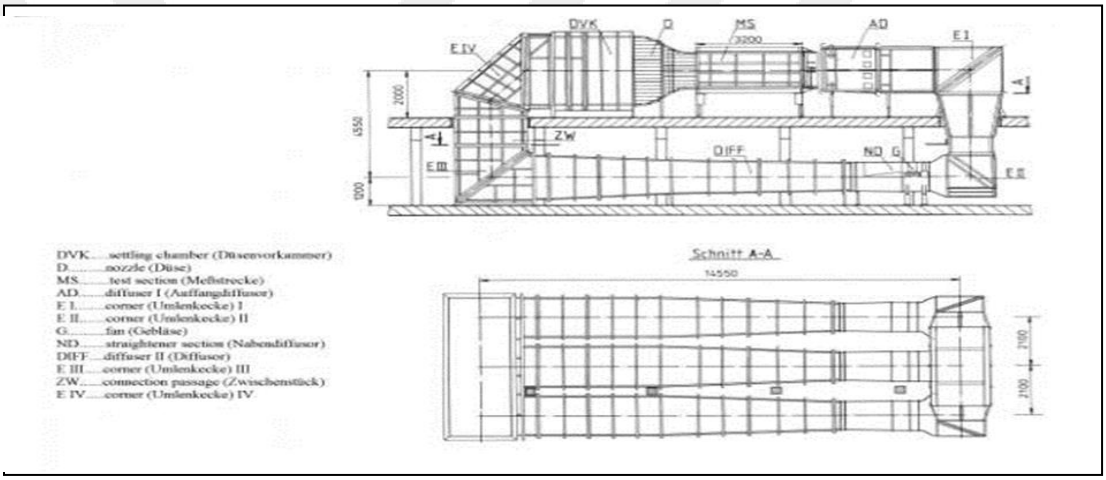


**Figure 2.7** Low speed aerodynamic wind tunnel

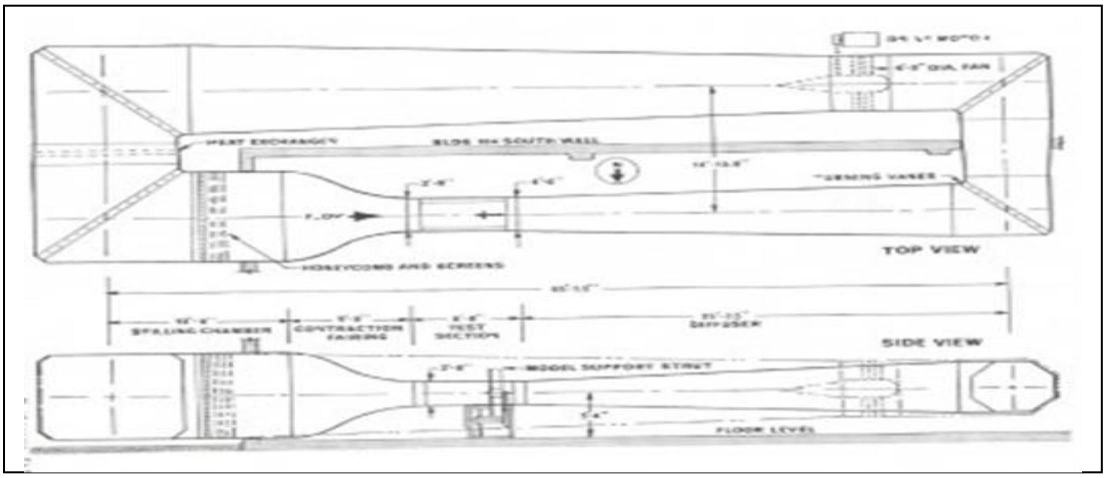


**Figure 2.8** Advanced design wind tunnel

## 2.2 Techniques for computational fluid dynamics

Numerical simulation using CFD ("Computational Fluid Dynamics") It has turned into a powerful and knowledge of the predictive behavior of structures in engineering situations in the world in a variety of fields

Promising and knowledge of the predictive behavior of structures in engineering situations in the world in a variety of fields.

promising. Where applications of fluid structure interaction. CFD techniques can be used to learn about wind effects in situations where criteria are not always clear or easy to apply, such as when designing tall buildings and unconventional structures. As showed in Figure 2.9 STAAD Pro was used to analyses and design a G+11 storied building (Wright and Easom. ,2003; Zhang et al., 2006).

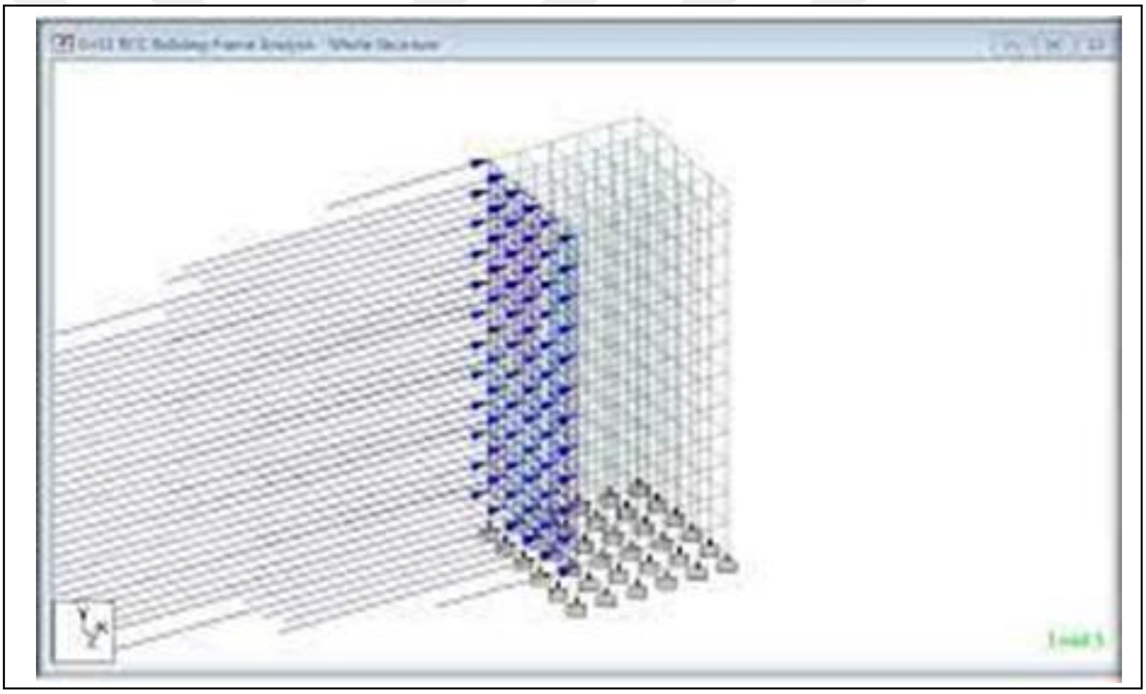

**Figure 2.9** STAAD Pro was used to calculate, design and analyze an 11-storey building

Estrada and Chiu (2004) developed a program for analyzing wind loads on buildings and signs. This program is based on the ASCE 71 standard's wind load calculations. Object-oriented programming was used to write the program in Microsoft Visual Basic 6.0. ASCE 7 was chosen because it is widely referenced by many building codes 6 and is widely accepted across the country.

The Analysis of Wind Loads on Buildings and Signs Program is meant to supplement, not replace, the ASCE 7 standard.

As a result, before using this program, It is imperative for users to be familiar with the ASCE 7 wind load specification. The software is a Microsoft Windows. Based application with Microsoft Windows software functionality. The user enters data or loads data from a file previously saved for use in wind load calculations on buildings. The data from the input and output is then printed or saved to common computer storage media. Analysis of wind loads on buildings and signage is very useful. Although the software gives accurate results for the problems presented in this paper, it is recommended to test it before using it for any realistic engineering calculations; Figure 2.10 Show the effect of wind load on reinforced concrete buildings using the wind factor approach.

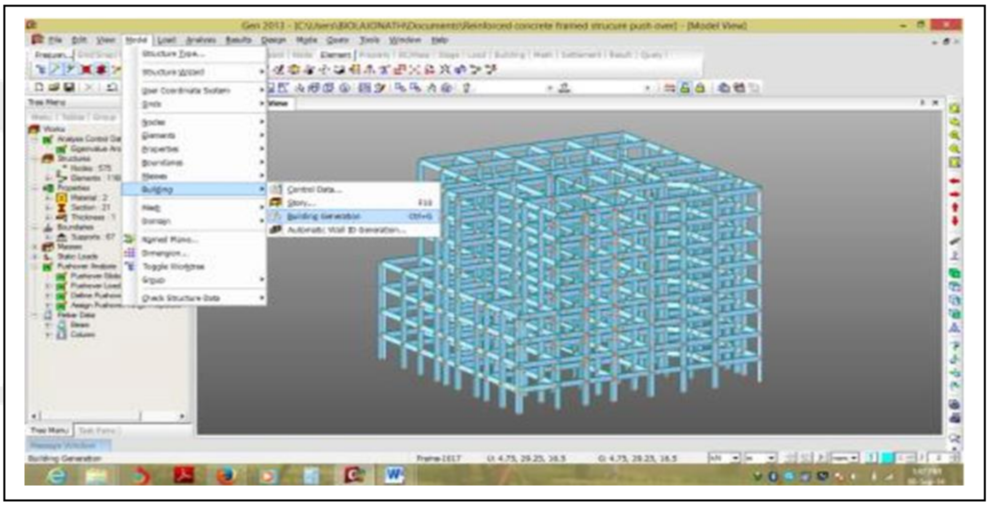

**Figure 2.10** The effect of wind load on multistory buildings is being investigated

Estrada and Chiu (2004) developed a program for analyzing wind loads on buildings and Estrada and Chiu (2004). developed a program for analyzing wind loads on buildings and signs. This program is based on the ASCE 71 standard's wind load calculations. Object-oriented programming was used to write the program in Microsoft Visual Basic 6.0. ASCE 7 was chosen because it is widely referenced by many building codes 6 and is widely accepted across the country.

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Figure 2.11 Show the effect of wind load on reinforced concrete buildings using the wind factor approach.

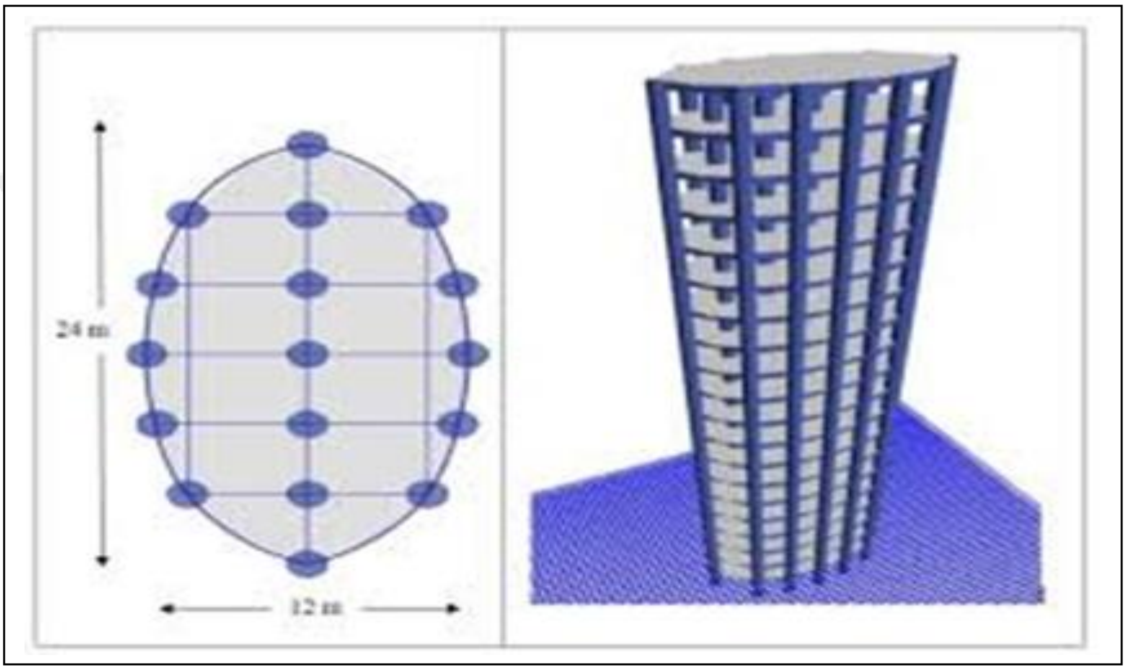


**Figure 2.11** Using the gust factor approach, determine the effect of wind load on RC buildings

When buildings reach a height of more than 150 m The wind dictates the design. The lateral forces caused by the wind are considered to have a significant effect on buildings with a height of more than 11 floors. Buildings become more resilient with increasing height, and they move away from high frequency earthquake waves.

Fig. 2.12, Fig. 2.13 and Fig. 2.14 (Trivedi and Pahwa, 2018) Wind and seismic analysis of buildings with floors above 11 floors in different regions of the Indian subcontinent is described. A twelve storey reinforced concrete structure was selected for the analysis.

## 2.3 Examples of buildings with rotating floors

**Figure 2.12** Rotating Tower in Dubai

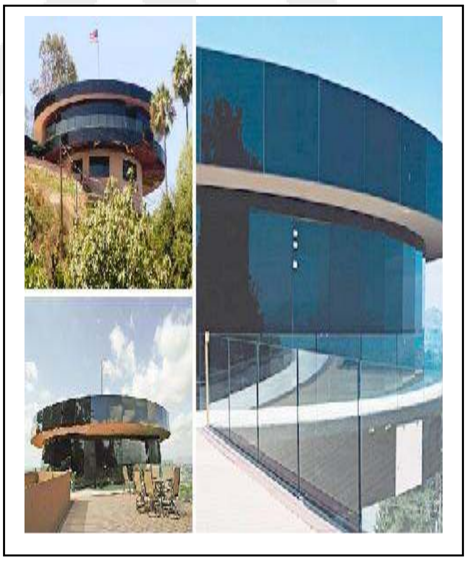

**Figure 2.13** rotating home

**Figure 2.14** kinematic architecture

# CHAPTER 3

# ROTATION UNDER THE INFLUENCE OF WIND IN THE CONSTRUCTION OF ROTATING FLOORS

## 3.1 Introduction

The act of rotating a Figure around a point is known as rotation. It shifts the Figure's orientation and position. Rotations are used in architecture to add interest and ingenuity to a structure. Dilation is the process of increasing or decreasing the size of Figure based on a scale factor around a point (Hand and Cashman, 2020).

Average wind speed rises as taller buildings rise from the storm, and vortices (circular wind speeds) decrease with that height. The height of buildings or towers. are subject to (turbulence (strong and frequent gusts of wind.

It can cause doors and windows to explode, roofs can be removed, and gabled end walls can be destroyed all due to high wind pressures. Roof pilings and other features that trap air underneath and cause high lifting forces are particularly susceptible to damage.

The resultant force acting on heights when the wind is blowing against the building is "wind load". In order to avoid structural collapse, it is essential The structural design of the building safely and efficiently dampens the wind forces and transfers them to the foundations.

When the wind blows toward the building, it creates a positive pressure that rushes against it. The vortex causes negative pressure that pulls on the structure. The main structure and individual cladding units of the building are affected by wind (Borg et al., 2014).

The term 'Wind Load' refers to any pressures or forces exerted by the wind on a structure or building. There are three different types of wind forces that can be applied to a building.

Many variables interact to determine how wind affects a structure. Wind speed, wind height, ground surface characteristics, and air properties are all examples of natural variables interact to determine how wind affects a structure. Wind speed, wind height, ground surface characteristics, and air properties are all examples of natural variables. The shape, location, and physical properties of structures are all factors to consider when designing a building.

It uses sheathing products such as wood structural panels, structural fiberboards, particleboards, and sheet sheathing to make diaphragms and shear walls where loads are transferred to the foundation when designing a wood. Frame building to withstand high winds and other side loads (Carbó et al., 2019).

There is a load applied to the outside of a structure due to wind in pounds per square foot called wind load. It will determine the angle at which the wind strikes the structure. Structure size, height and width.

If multiple loading types work on a structure, it becomes a loading assembly. In addition to the load factors (weights) for each load type, for structural integrity under a variety of expected maximum loading scenarios.
In order to calculate the wind load on a building, use the formula:

Strength = building area * pressure * cadmium. Let's take an example of a simple flat part of the structure, the area. Or the length of the building x the width of the building. Taken over one square foot, we The result on a wind load of 1 * 25.6 * 2 = 51.2 square feet for a wind of 100 mph.

In the northern hemisphere and to the left in the southern hemisphere air flows to the right as the earth rotates on its axis as shown in Fig. 3.1 This deviation is called the Coriolis effect (Xie et al., 2017).

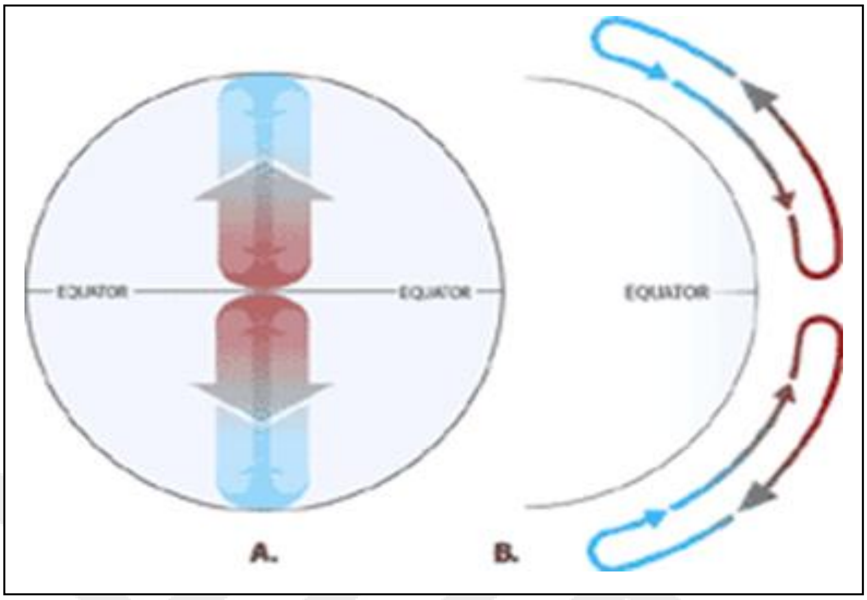


**Figure 3.1** Effect of earth rotation on wind direction

Factors Affecting Wind Motion.

1. Force of Pressure Gradient.

2 . Force of Carioles.

3 . Centripetal Acceleration.

4 . Frictional Force.

5. Primary or Prevailing Winds.

6 . Secondary or Periodic Winds.

7 . Tertiary or Local Winds.

### 3.2 The five factors that can affect wind loads

1. Wind speed and direction are also affected by seasonal temperature changes and the
2. Temperature, Due to changes in the Earth's atmosphere's heating, air temperature varies from day to night and season to season.
3. Pressure in the Air.
4. Centripetal Acceleration is a term that refers to the speed with which something moves.
5. The Rotation of the Earth.

Compared to the same turbines, the turbines produce VAWTs with more power. As a result, it makes sense to investigate their potential to improve wind farm production..

When focusing on this target, the isolated awakening of VAWT is compared to the awakening of alternating VAWTs on trial. The direction of the isolated VAWT heel change towards the area behind its moving blade is upwind due to unstable aerodynamics. (Borg et al., 2014).

As a result, the direction of rotation has a direct impact on the wake deflection.

This wake deflection can be used to your advantage in paired configurations. The upwind moving blades of a pair of counter-rotating VAWTs In the center of the husband, which leads to a particularly active tightness.

VAWTs, being opposite-alternating convergent, have good properties to improve the energy density of a wind farm, with the potential to benefit from increased energy and narrower wake-up. (De Tavernier et al., 2018).

The direction of rotation is sensitive following closely spaced VAWTs. A pair wake deflects with an inward wind moving outward, and a pair wake deflected with an inward wind moving upwind. The two formations produce similar magnitudes of velocity in the direction of the current-wise (Vergaerde et al., 2020).

However, the ups and downs differ slightly for the VAWT pair. Awakened VAWTs expand in a perpendicular direction in the inland wind formation, causing hypo velocity flow up and down the dimensions of the VAWT.

The lateral deflection of the wakes towards each other causes this vertical expansion, leaving the flow with no other option but to expand vertically (Borg et al., 2014).

Vertical flow is similar for a couple, the vertical flow from above or below the waking mainly occurs behind the moving wind blades. The area behind the moving blades upwind is the vertical exit point of a hypo velocity flow from its wake.

Even though the rotation frequency and blade passing frequency can be determined, the mid span wake is unsteady. Disruptions are mostly propagated behind the rotation's upwind moving part. Interaction between the two VAWT sis is responsible for higher unsteadiness around the middle of the pair.

The disruptions (including tip-vortices) are concentrated behind the upwind moving part of the rotation at higher elevations. The inner-downwind and inner-upwind moving blades have large differences as a result of this mechanism. Between the VAWTs, there is a high-velocity channel (Dabiri, 2011).

VAWT activity migrates behind the blades that rotate upwind. For the wind configuration, these are present on the outer surface of the pair. So the big alert is deflected outwards. It leads to a narrower activation because the blades moving upwind in the middle of the pair. Therefore, the internal configuration of the headwind is to improve wind energy production in terms of wake-up (Borg et al., 2014).

The diameter, D, has been used to express all stream distances. Deq indicates that the wake is relatively shorter for the paired configuration an equivalent diameter than for isolated rotors. Furthermore, a previous study found that paired VAWT configurations produce up to 16 percent more energy than two isolated VAWT configurations.

In wind farms, paired VAWTs allow for higher power densities than isolated VAWTs. Figure 3.2 shows the inner-downwind configuration on the left and the inner-upwind configuration on the right (Zanforlin and Nishino, 2016).

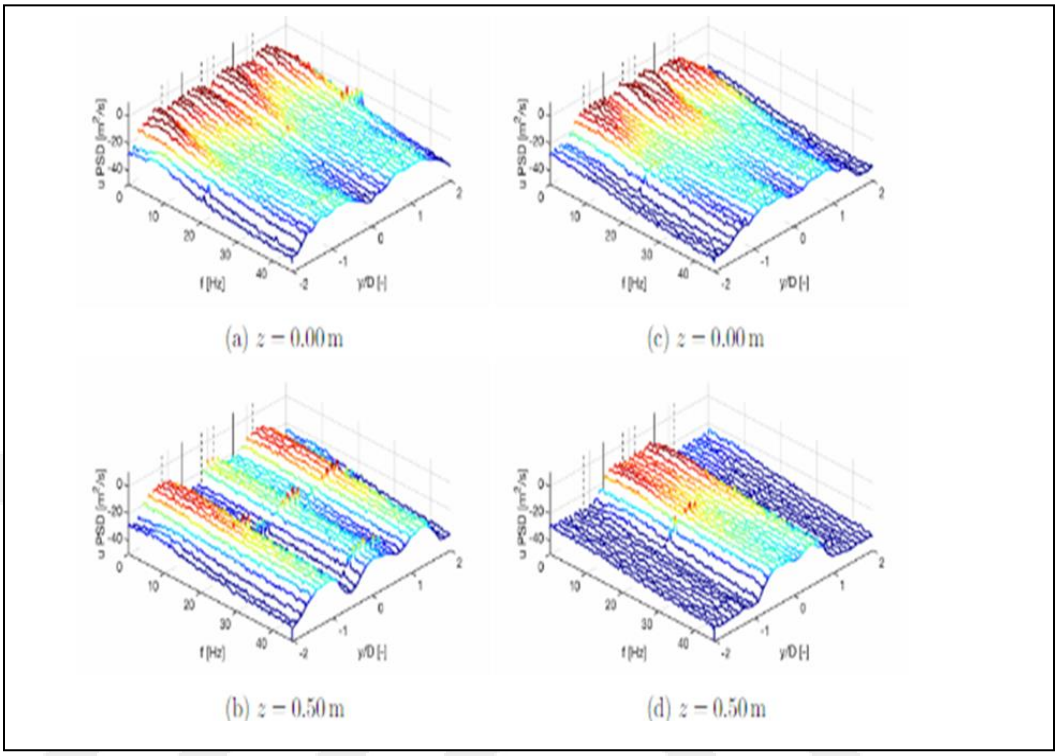


**Figure 3.2** Spectral content measurements at x/D = 4 at different heights. The internal content of the wind direction is downwind on the left, and the internal

## 3.3 The use of hydraulics to rotate the floor concerned with rotation in construction of buildings with rotating floors

A hydraulic compound is used in a hydraulic circuit to protect pressure, store and restore energy, reduce pressure, and dampen shocks and vibrations.

Hydraulic systems are used to generate force or motion. It is a source of energy generates electricity. Accumulators are a type of hydraulic device that is used in multi-story buildings. Accumulators are a common part of hydraulic machinery. Their purpose is to store energy in the form of pressurized gas. A tube with a floating piston is one type. Two functions of an accumulator are to absorb shocks and surges of fluid in the line and to absorb thermal expansion. In aircraft hydraulic systems, there are two types of accumulators: spherical and cylindrical accumulators, generally Nitrogen gas is used in case of gas charged accumulator (Vergaerde et al., 2020).

The accumulator is a pressure vessel that uses the compressible and DE compressible properties of nitrogen gas in which hydraulic pressure is stored. As a result, this compound can be compared to a rechargeable electric battery. Electrical energy is stored in a battery in electricity.

A hydraulic accumulator is a pressure storage tank containing an incompressible hydraulic fluid at a pressure similar to that of a mechanical source. The most common types of accumulators are pressurized gas accumulators, also known as hydro pneumatic accumulators (De Tavernier et al., 2018).

hydraulic system a hydraulic accumulator is described as a pressure vessel that performs a variety of functions. It is used for pressure stabilization, energy storage, pressure reduction, suspension power structure, and shock removal.

An accumulator machine as shown at Figure 3.3 a CPU with accumulator-based architecture, also known as a operand machine, is a type of CPU that, despite having several registers, stores the results of calculations primarily in one special register, typically referred to as "the accumulator" (Lam and Peng, 2016).

**Figure 3.3** Accumulator machine

### 3.3.1 The different types of hydraulic systems

The following are five of the most common hydraulic system examples are:

1. Hydraulic Pumps are the first type of hydraulic pump. A variety of power sources are used to power hydraulic system components.
2. Hydraulic Motors and Cylinders.
3. Aviation Hydraulic System.
4. Open Center Hydraulic System.
5. Closed-Loop Hydraulic system.

### 3.3.2 Hydraulic System Advantages

- Easy-to-operate hydraulic systems.
- Hydraulic systems contain fewer moving parts, they are simpler and easier to maintain.
- Hydraulic systems are the only ones that can deliver constant torque or force regardless of speed.
- Leaks in a hydraulic system are easy to spot (Parneix et al., 2016).

### 3.3.3 Parts of a Hydraulic System

Hydraulic systems are used for a variety of purposes, but the principles of how they work and the components they use are the same in all cases. The fluid or liquid is the most important part of a hydraulic system. The pressure on the fluid will remain constant as it travels through a hydraulic system, according to the laws of physics. Each component of a hydraulic system is described below.

Hydraulic Circuits are used to regulate the flow and pressure of liquid in a system. Figure 3.4 depicts the various components of a hydraulic circuit (Abkar and Dabiri, 2017).

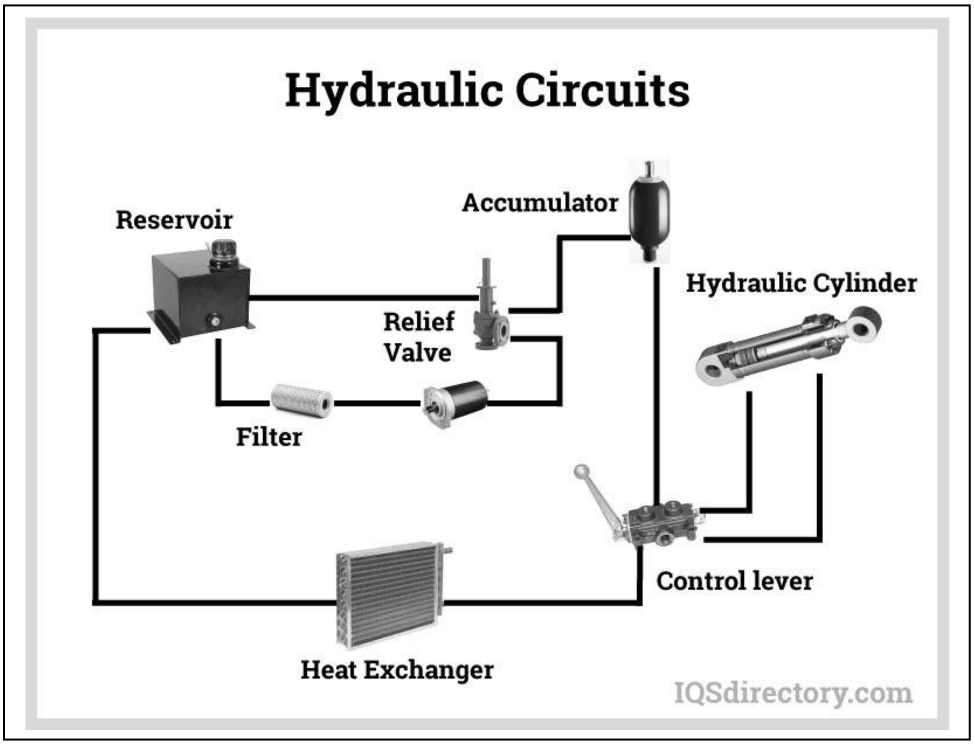


**Figure 3.4** The different parts of a hydraulic

It is difficult to determine the failure of the hydraulic system. Hydraulic systems consist of a sump, motor, pump, valves, actuators, and hydraulic fluid, but any of these components could fail. Not to mention the additional risk of failure due to human error and poor maintenance procedures. If your system fails, you must understand why it fails, how to locate the problem, and how to keep it running smoothly in the future, all while ensuring the safety of your personnel.

It is clear from the above that the effect of wind on hydraulics can be combined in rotation so that the rotation is under the influence of wind on the one hand and on the other hand, the use of hydraulics to rotate the rotating floors.

Figure 3.5 showed the wind-exposed cross section of a multi-story building.

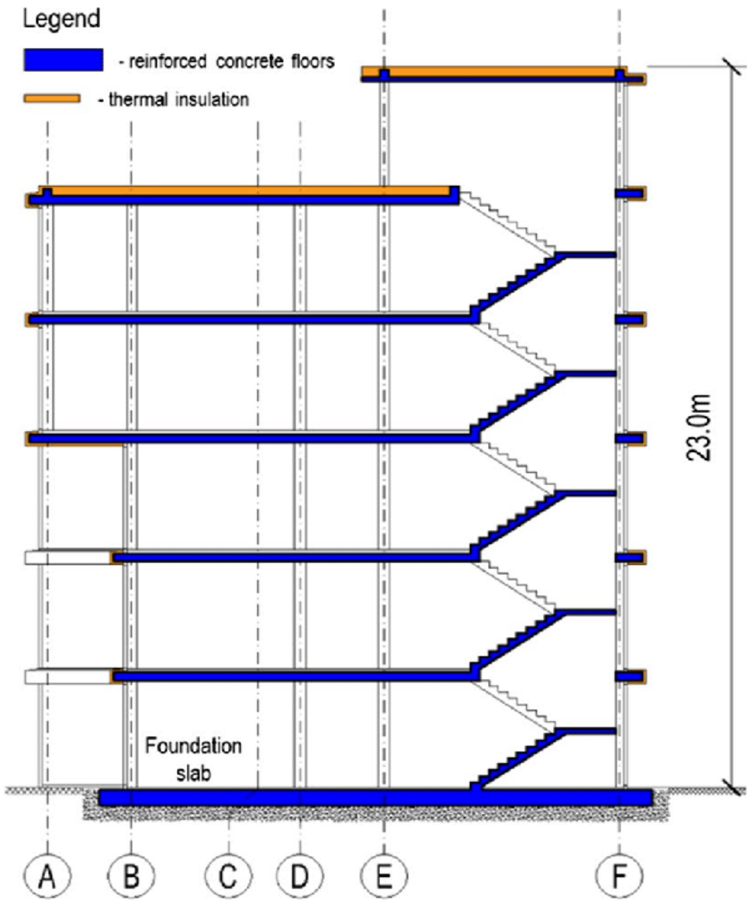


**Figure 3.5** Wind-exposed cross section of a multi-story building

# CHAPTER 4

# THE EFFECT OF WIND DYNAMICS ON THE DESIGN OF ROTATABLE MULTISTORY BUILDINGS

## 4.1 Aim and target

explain the modeling process for the proposed building. With its structural analysis on ETABS and a study of the effect of wind on the building in relation to the floor involving rotation at 0°, 15°, 30° and a wind speed of 75 km/h.

1. Modeling.
2. The value of displacement and the values of moments.
3. The standard deviation of each test.
4. Compare the results to get the best test.

The aim of the research is to create a design environment for a building capable of rotating the last upper floor made of the iron structure to give an architectural benefit in terms of the external view on the one hand. On the other hand, the function of this floor was used as a restaurant, thus achieving another goal, which is the enjoyment of customers while sitting in the restaurant, which rotates at an angle of 360 degrees, as this rotation allows seeing the areas surrounding the building from the top to see the scenic views.

In this chapter, present the results of the designs for the proposed building, which consists of the ground floor and 12 floors, including the floor concerned with the circulation, and at the outset it is necessary to clarify the basic principles of the effect of wind on the building as a whole and the mechanisms for activating its work in terms of design and implementation. Green building technologies can be used and benefit from sustainability. Green buildings improve the positive role of buildings, reduce the negative impact on the natural environment, and support the national economy. The research showed the inefficiency of traditional roofs, especially residential buildings, against heat transfer in different regions within the Kingdom of Saudi Arabia. This thermal analysis, by creating different mathematical models, resulted in improvements of up to 89% on the performance of the roof's thermal insulation. and improving concrete by converting those roofs into green roofs. Several details were presented, and calculations were made for different types of green roofs and compared to traditional roofs in two ways, namely, the absence of air and the presence of air. According to these experiments, the effect of vegetation on the roof of the building was determined using thermal models in two substrates of vegetation, A when using circulation and B when using shrubs. The results showed that the use of lathing as a vegetation cover is insufficient in all thermal climatic zones in the Kingdom, and the use of air spaces increased the efficiency of solid roofs by 87% compared to the old steel roof. The use of shrubs and vacuum technology has resulted in a high increase in efficiency and this level is acceptable in most thermos climatic zones. It was also recommended to use a manufactured heat. Insulating layer, in addition to shrubs and air spaces, in the first thermal climatic zone in the Kingdom of Saudi Arabia. (Khabaz, 2018).

### 4.2 The nature of the dynamic effects of the wind

Wind action in general has dynamic effects, but experiments and studies have proven that these dynamic effects are small when the structures are not thin, that is, when the ratio of the height of the building to the width of its facade is less than 4: $h/d \leq 4$, that is, in the case of slim installations, the dynamic effects resulting from the wind are large and must be take that into consideration (Bala Krishna and Sahithi, 2021).

There are two types of dynamic actions in action:

**A. Dynamic actions parallel to the direction of the wind**

At low wind speeds, the wind flow is constant, so the effect of the wind on the structure in the direction parallel to the direction of the wind is constant (non-dynamic), and therefore, the effect of the wind on the structure in the direction of the wind at low speeds is not considered. (SreeNidhiCodal , 2015).

The relationship between wind speed and the resulting dynamic pressure.

Bernoulli's law defines the relationship between wind speed (V) and the resulting dynamic pressure (q):

$$q = v^2 / 16 \tag{3.1}$$

when: V as m/s , q as Kgl/$m^2$

$$q = v^2 / 16.3 \tag{3.2}$$

when: V as m/s , q as daN/$m^2$

French rules specify two wind speeds (both located in the phase of turbulent flow) to be used in the design of the structure relative to the wind, The first is called normal speed, and the structure is designed under its influence. The other is called the maximum speed, and the designer must use it to conduct additional studies on the slim origin under its influence (MeghaKalra et al., 2016).

The maximum speed is defined as the speed at which pressure is given a value of (1.75 X The pressure value given by normal speed, so: 1.75 = qe/qn , $\sqrt{1.75} = \frac{Ve}{Vn}$

**B . Dynamic pressures in the vertical direction of the wind**

Occurs in the stage of regular flow of the wind, which puts the facility in a state of forced vibration in the direction perpendicular to the direction of the wind and is caused by the alternating swirls (Bernard Karmann swirls), which affect buildings with a cylindrical shape or whose base is in the form of a regular polygon. These alternating swirls become dangerous when their role becomes close to the primary role of the structure vibration.

Given the role of Bernard Karman swirls from the following equation: $Tk = \frac{d}{S.V}$

Whereas: d → width of facade exposed to air (liquid).

V → speed air (liquid).

S → a constant called the Stromal number that relates to surface roughness, shape of origin, and viscosity of the liquid.

1.The value of the Scrotal number in buildings with a cylindrical shape is:

$0.18 < S < 0.27$.

The value of the Scrotal number in buildings with a square base, the value of the Scrotal number is $0.25 < S < 0.3$.

The critical speed of the wind ($V_{cr}$) is the speed at which the effect of the swirls becomes resonant with the lateral vibration of the structure. Therefore, the law that gives the value of critical speed is:

$V_{cr} = \frac{d}{S.T}$ (Building Using STAAD. Pro , 2018).

### 4.3 Study of the stress arising from wind load on installations

To study the effect of wind for structures, we study the wind speed on the area in which the building affects, where the wind affects its speed on the facade of the building, so that speed causes stress on the origin, and from it we calculate the sum of the effective forces and study their impact on the equilibrium of the structure in addition to calculating the values of the moments affecting the structure columns about those forces.

When designing any building, the effect of wind is calculated on the following elements:

1 . Structural structure as a complete unit, including the bases and foundations.

2 . Structural members such as ceilings and walls.

3 . Windows and facades.

To calculate the force acting as a result of wind on different surfaces, we use the following equation: Force = Stress x Area (KN) Force: the sum of the effective loads as a result of the wind pressure stress affecting a specific area (KN) Stress: Stress of the external wind pressure statically affecting the unit area of the roof of the building ($KN/m^2$) Area: Surface area with wind direction being studied.

The effective stress as a result of the effect of a wind at a certain speed is calculated from the following equation in ($KN/m^2$).

Stress (q) = $0.5 \times 10^{-3} \times p \times V^2 \times C_t \times C_s$ ($KN/m^2$) (3.3)

V = Basic wind speed (m/s) corresponding to a wind gust of 3 seconds at a height of 10 meters above the surface of the earth, with the possibility of exceeding the design forces not exceeding 2% in 50 years.
P = the density of air is taken 1.25 kg/m$^3$.
$C_t$ = the topographic coefficient of the land and its value depends on the topography of the surface of the earth surrounding the building and its ripples.
$C_s$ = The coefficient of origin, which is the factor that takes into account the effect of wind. loads at the nonconsecutive occurrence of the peak wind pressure on the building with the effect of building vibration during turbulence, (Turbulence) $71_{zr}$.

The coefficient of origin is taken equal to 1.00 in the following cases:

1. Buildings and facilities less than 60 meters high.
2. Truss (reticular) towers.
3. Buildings and facilities whose height is less than four times less than their horizontal plan.

In other than these cases, the origin coefficient $C_s$ for general shapes and structures is calculated according to the following equation:

$$C_s = \frac{1+g\ Izr\sqrt{B^2+R^2}}{1+71zr} \geq 1 \tag{3.4}$$

Whereas: g = Peak factor specifies the ratio of the maximum value of the variable portion of the time history to its scale of deviation.
$I_{zr}$ = Turbulence intensity $z_r$ (Turbulence intensity).
$B^2$ = Background Factor, which takes into account the lack of complete correlation of pressure on the roof of the building.
$R^2$ = Resonance response factor, which takes into account the effect of the disturbance on the mode of vibration when the phenomenon of resonance occurs (Bala Krishna and Sahithi , 2021).
Due to the increase in wind speed as the height above the ground surface increases, and therefore to increase the value of the static stress calculated from the previous equation, we calculate the value of the effective stress affecting the unit area of the building (Pe)) and then we calculate the result of the effective wind work from the following equation: $F_i = P_e \times A_i$

Whereas: $F_i$ = the sum of the effective loads as a result of the statically affecting external wind pressure on the affected area.

$P_e$ = external wind pressure statically affecting the unit area of the external surfaces of the building ($KN/m^2$).

$A_i$ = the surface area opposite . perpendicular . to the direction of the wind to be studied (taken in the installations = height of the floor h x width of the building b) in the case of analyzing the wind loads for each floor separately.

To calculate the effective stress as a result of wind pressure on the facades of the structure and its increase as we rise above the surface of the earth, we use the following equation:

$$P_e = C_e \times K \times q \ (KN/m^2) \qquad (3.5)$$

Whereas: $P_e$ = external wind pressure statically affecting the unit area of the external surfaces of the building ($KN/m^2$).

$C_e$ = the coefficient of external wind pressure on the roof of the building and depends on the geometric shape of the building.

The external wind pressure coefficient is the coefficient that determines the distribution of wind pressure on the exterior surfaces of the building, and it is a coefficient that enters into the calculation of the wind pressure per unit area, the values of the wind pressure coefficient depend on the geometric shape of the building and its dimensions. The coefficient K is calculated on the basis of which is the height of the place where the external wind pressure is to be calculated from the surface of the earth.

K = the exposure factor varies with altitude; the exposure coefficient is the coefficient that determines the change in wind pressure with altitude and gradually increases with the increase in altitude from the surface of the earth. The areas for which the exposure coefficient is calculated are divided into 3 regions according to the length and ruggedness of the land:

1. Exposure area (A), which includes open and exposed areas with few obstacles.
2. Exposure area (B) includes areas with medium obstacles such as villages and the outskirts of small towns.
3. Exposure area (C) includes areas with huge, high and close obstacles such as large city centers.

$q$ = The basic wind pressure ($KN/m^2$) depends on the geographic location of the building (Vikrant ,2018).

### 4.3.1 The distribution of wind forces affecting each floor (Load Distribution)

(Code of Practice for design loads for building and structures, PART.3, 2015) Part 3 The effect of wind loads on the structure is studied in both the horizontal and vertical directions on the horizontal plane, so that the shape of the distribution of the loads for each role on the structure is calculated according to the following equation, where the point of influence of the forces is the center of the interface for each change in height:

$F_i = P_e$ x Area $= C_e$ x $K_i$ x $q$ x $h_i$ x $b$

$F_1 = C_e$ x $K_1$ x $q$ x $(h_1$ x $b) \rightarrow K = 1$

$F_2 = C_e$ x $K_2$ x $q$ x $(h_2$ x $b) \rightarrow K = 1.15$

$F_3 = C_e$ x $K_3$ x $q$ x $(h_3$ x $b) \rightarrow K = 1.4$

$F_4 = C_e$ x $K_4$ x $q$ x $(h_4$ x $b) \rightarrow K = 1.6$

If: $h_1 = 10$ m, $h_2 = 10$ m, $h_3 = 10$ m, $h_4 = 10$ m.

The place of effect of the force resulting from the wind pressure is the middle of the interface perpendicular to the direction of the wind at the level of each floor.
In the event that the torques resulting from the lateral loads are greater than the moments resulting from the equilibrium of the structure as a result of its own weight, the entire structure will be overturned in the direction of the moments resulting from the lateral loads of the wind.
Moment at base (overturning moment) = $\sum F_i$ x $H_i$.

Overturning moment = $F_1$ x $H_1$ + $F_2$ x $H_2$ + $F_3$ x $H_3$ + ….

Resisting moment.

Moment = $W_{Total}$ x $\frac{B}{2}$

$W_{Total} = W_{floor}$ x Numbers of Floors

Factor of Safety

FoS = $\frac{\text{Resisting moment}}{\text{Overturning moment}} < 1.5$

It should be noted that wind loads are working loads, and therefore they are taken as they are when working Check Sliding, Check Overturning.

**Check Sliding:**

Wind Sliding Force ($F_{total}$) = $F_1 + F_2 + F_3 + \ldots$.

**Resisting Force:**

Resisting Force = $W_{Total}$ x μ.

μ = Coefficient of friction (assume: 0.3).

$W_{Total}$ = Total weight of the building ($W_{S / Floor}$ * Number of Floor).

**Factor of Safety.**

FoS = $\frac{\text{Resisting moment}}{\text{Overturning moment}} < 1.5$

n some buildings and facilities that do not require calculating the distribution of wind pressure on their roofs, especially those whose heights are high relative to the rest of their dimensions, it is preferable to calculate the total force of the wind on the structure as a whole instead of distributing it over the unit area for this type of facility, and the total force of the wind is calculated from the following equation:

$F_i = C_f \times K \times q \times A$

Whereas: $F_i$ is the total wind force on the building ($KN/m^2$).

$C_f$ is total wind force factor.

K is the exposure factor varies with altitude.

q is the basic wind pressure depends on the geographic location of the building.

A is the area of the building facade facing the direction of the wind ($m^2$) (Code of Practice for design loads for building and structures, PART 3, 2015).

### 4.3.2 Steps to deal with wind loads with a manual solution

The manual solution is used to analyze seismic loads to ensure the safety of structures against overturning moments or slipping forces, in addition to analyzing the forces and their distribution on the floors.

1 . Calculating the value of the basic wind pressure affecting the unit area from the facade of the origin.

$q = 0.5 \times 10^{-3} \times V^2 \times p \times C_t \times C_s\,(KN/m^2) = 100(Kg/m^2)$ (3.6)

2. Calculating the value of $C_e$

3. Calculate the pressure forces acting on each change in height.

$P_e = C_e \times K \times q$

4. Calculate the load concentration for each change in pressure value.

$F_i = P_i \times A_i = P_i \times (h \times b)$

To calculate the value of the loads affecting the tower, we multiply the value of the pressure affecting the unit area x the area of the facade exposed to it (the width of the building in the direction to be studied x the height of the area to be studied).

5. Ensure that the building does not tip over:

A. Calculating torques as a result of the acting forces.

Total moment of base (Over – turning moment) = $\sum F_i \times H_i$

B . Calculating the equilibrium moments as a result of the weight of the building

Resisting moment = $W_{total} \times \frac{B}{2}$

6 . Ensure that the building does not slide:

A . Calculate the value of the total forces acting on the building.

B . Calculate the equilibrium forces.

Resisting force = $W_{Total} \times \mu$.

$$FoS = \frac{\text{Resisting force}}{\text{Sliding force}}$$

### 4.3.3 Steps to deal with wind loads with CSI ETABS program

1. Manually calculating the forces affecting each floor in the building:

A. Calculating the value of the basic wind pressure affecting the unit area from the facade of origin.

$$q = 0.5 \times 10^{-3} \times V^2 \times p \times C_t \times C_s \,(KN/m^2) = 100(Kg/m^2) \quad (3.7)$$

B . Calculated of $C_e$ value.

C . Calculation of the exposure factor value (K).

The value of K) is calculated for each floor of the building according to the level of the floor above the ground, so that the value of K increases for every 10 meters.

D . Calculation of effective wind pressure at each floor:

Given the calculated values of (C . K . q), the value of the pressure acting on the plane is set through the following equation: $P_e = C_e \times K \times q$.

E . Calculate the value of the load affecting the slab of each floor in both directions, $F_i = P_e \times A_i$.

Since it is not possible to place the calculated wind loads in the middle of the facade of each floor in the CSI ETABS program, the loads are placed in the middle of the slab of each floor, and therefore instead of calculating the force acting on the area of each façade. separately, the forces acting between the middles of each two floors are calculated to determine the result affecting the slab:

$Fs_i = \frac{1}{2} (P_e \times h_i \times B) + \frac{1}{2} = (P_e \times h_{i+1} \times B)$

(Code of Practice for design loads for building and structures, PART − 3, 2015).

## 4.4 Designs for the proposed building under study

At the end of this chapter, we present the designs of the proposed building in this study, and these designs represent horizontal sections of the twelve floors included in the building in addition to ground floor, general section of building, architectural, structural dimensions and surface. Figure 3.20 to Figure 3.37

**Floors:**

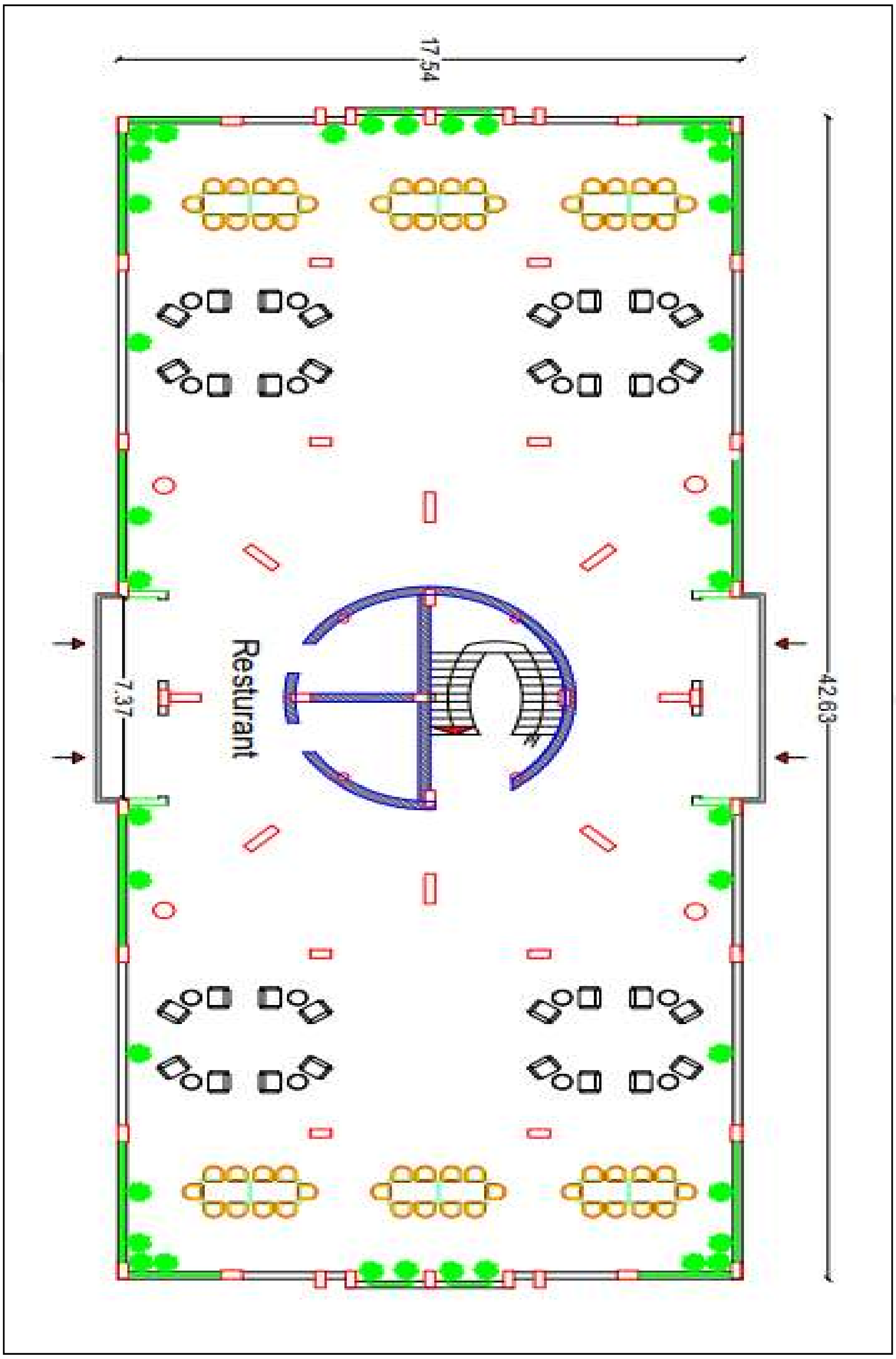


**Figure 4.1** Ground Floor

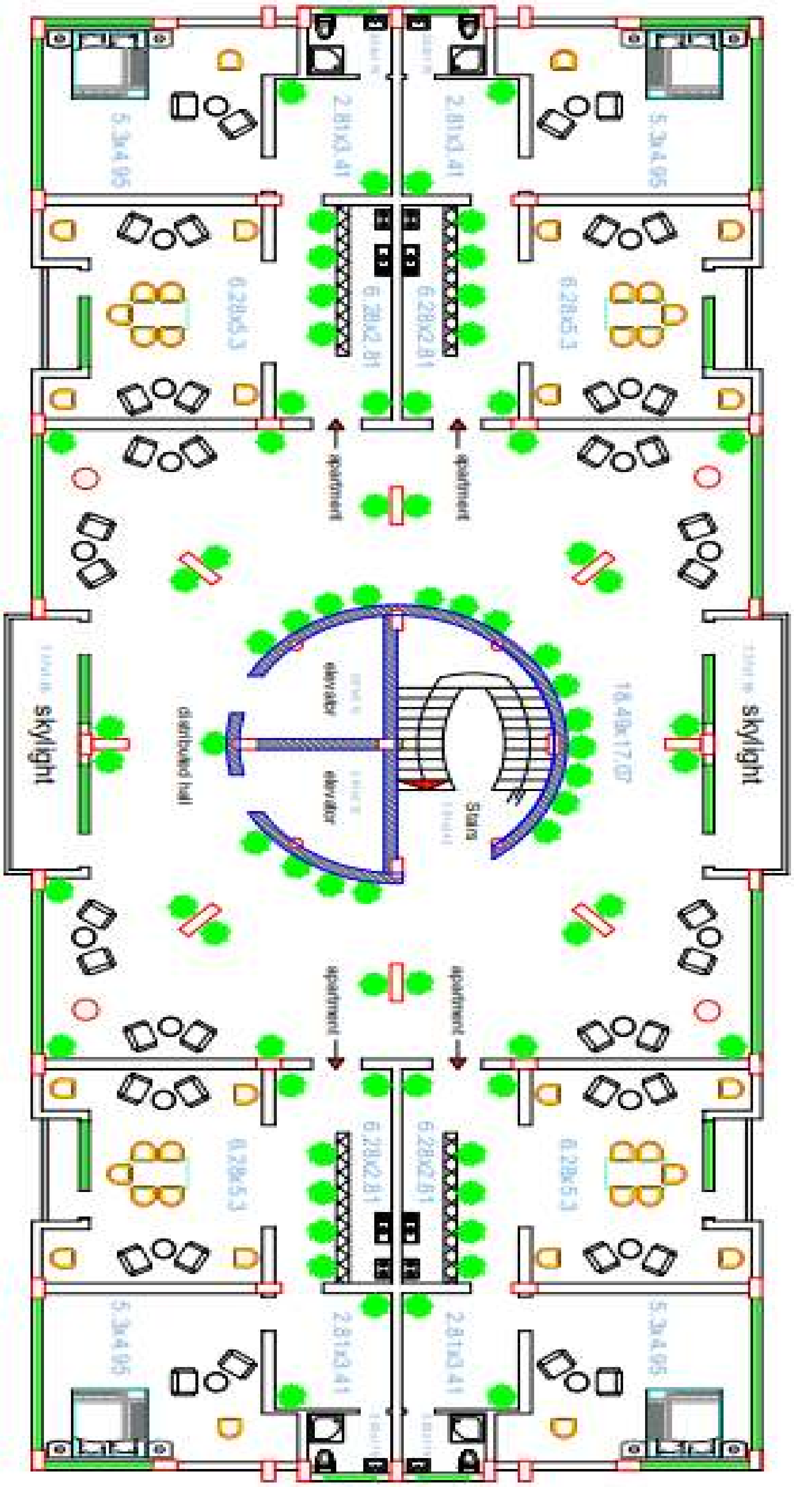

**Figure 4.3** First floor

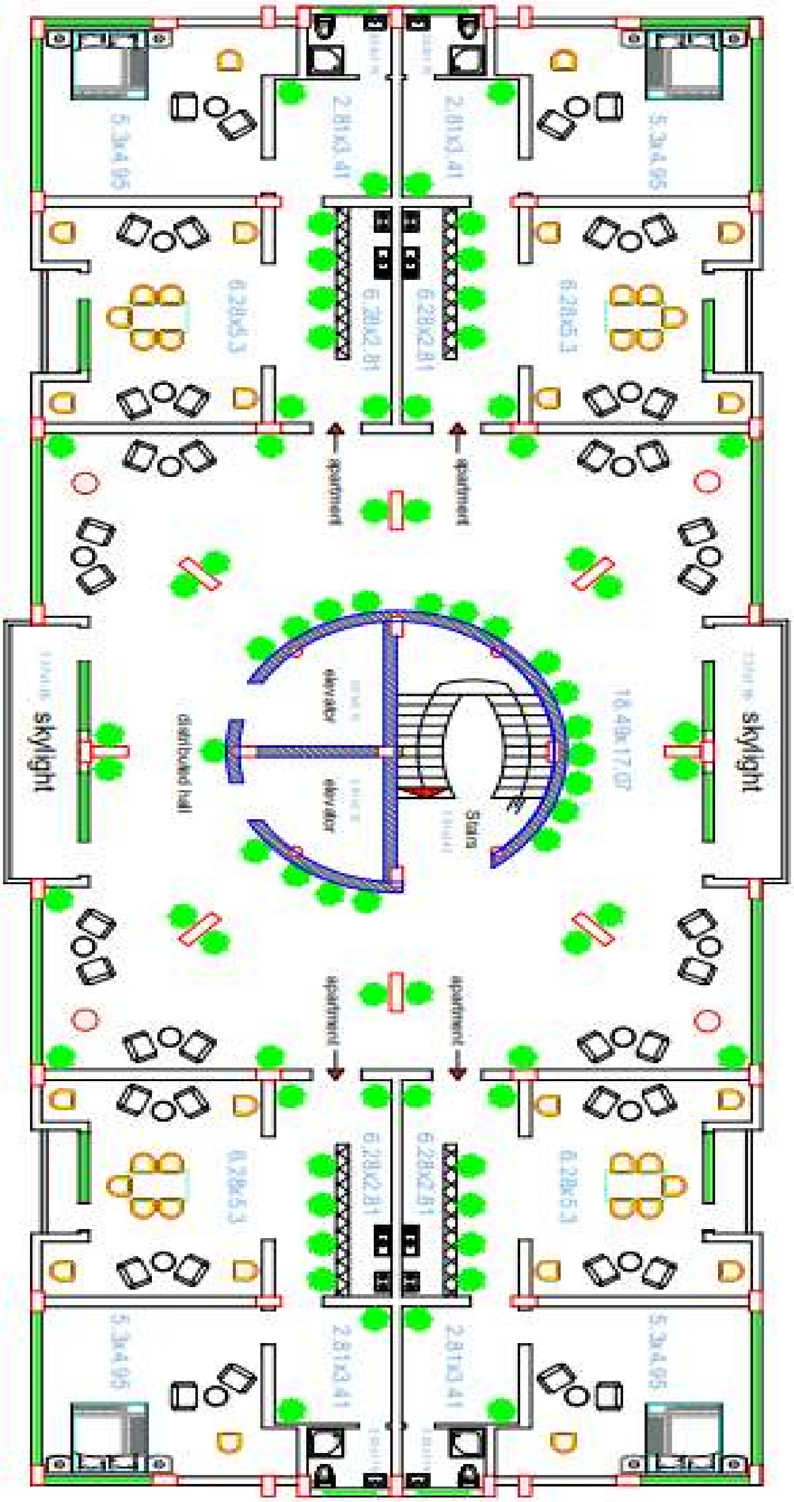

**Figure 4.4** Second floor

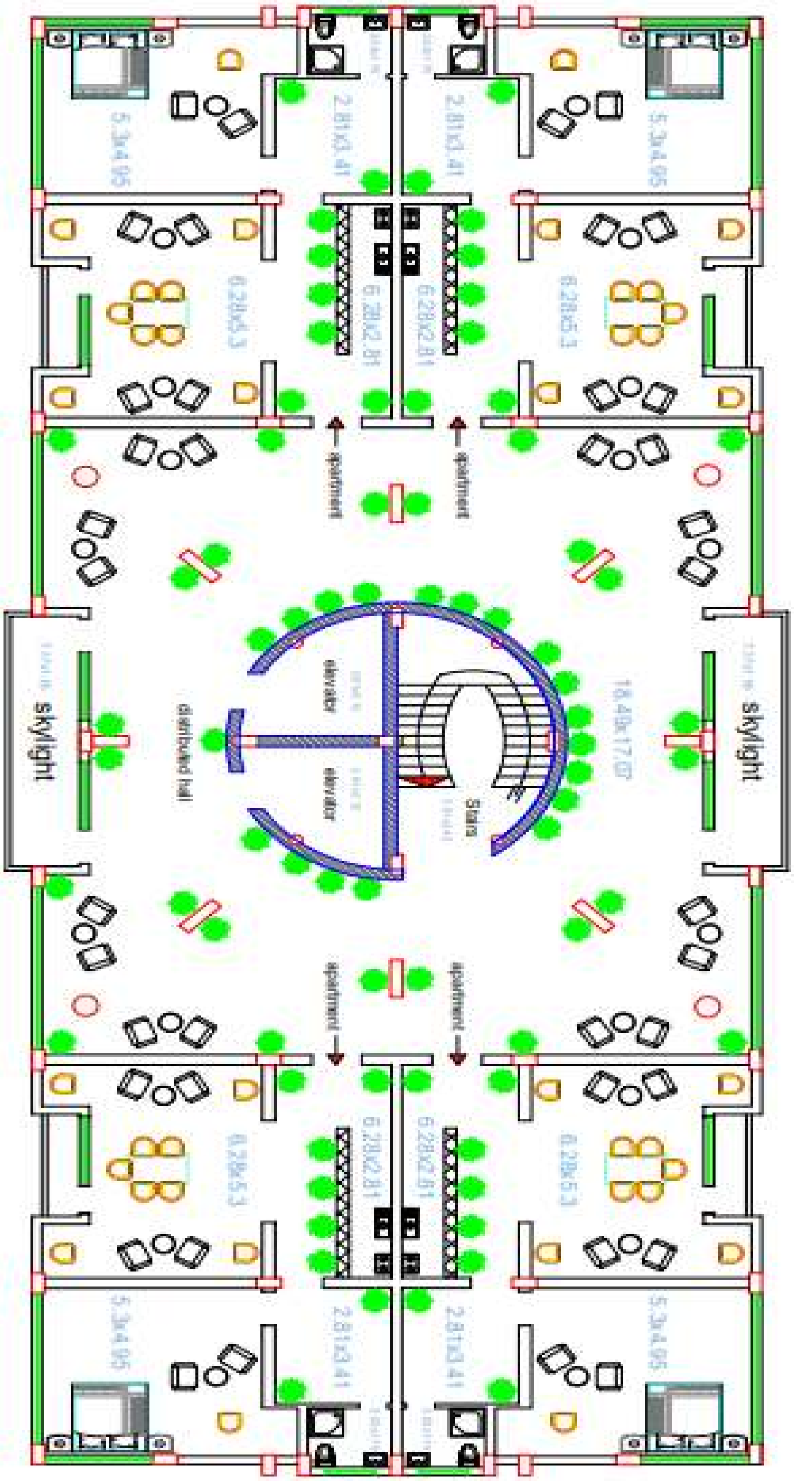


**Figure 4.5** Third floor

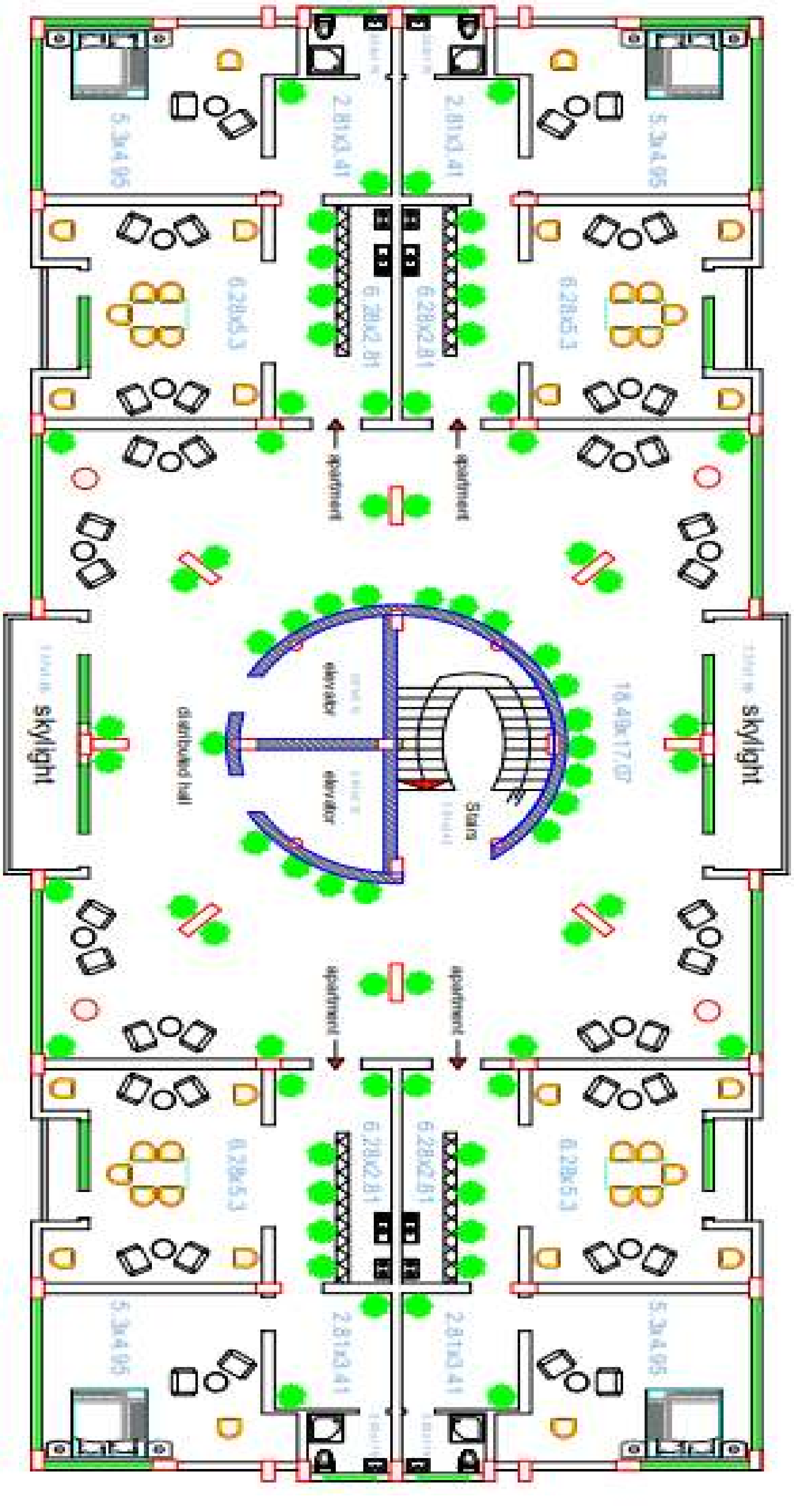


**Figure 4.6** Forther floor

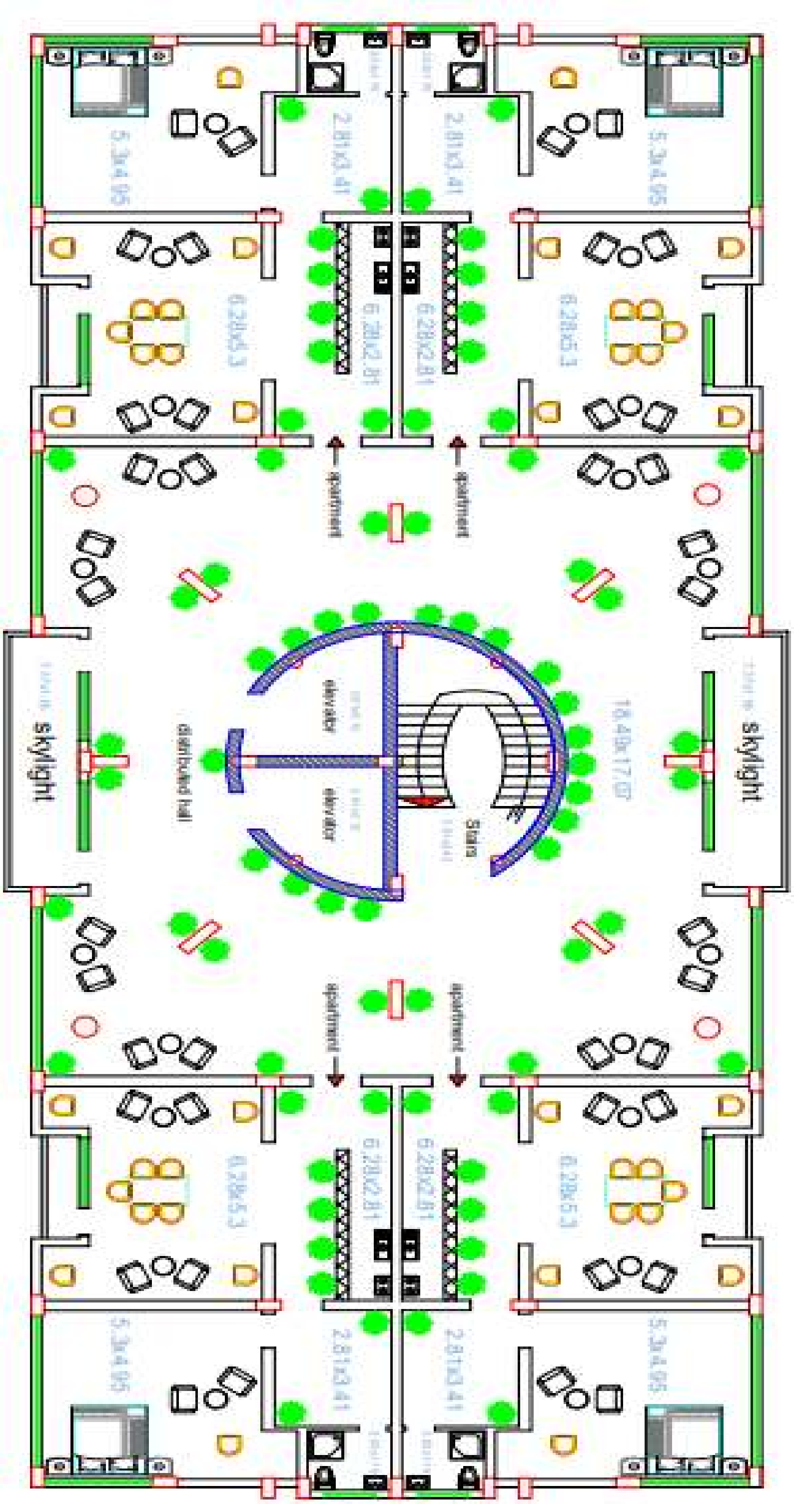

**Figure 4.7** Fifth floor

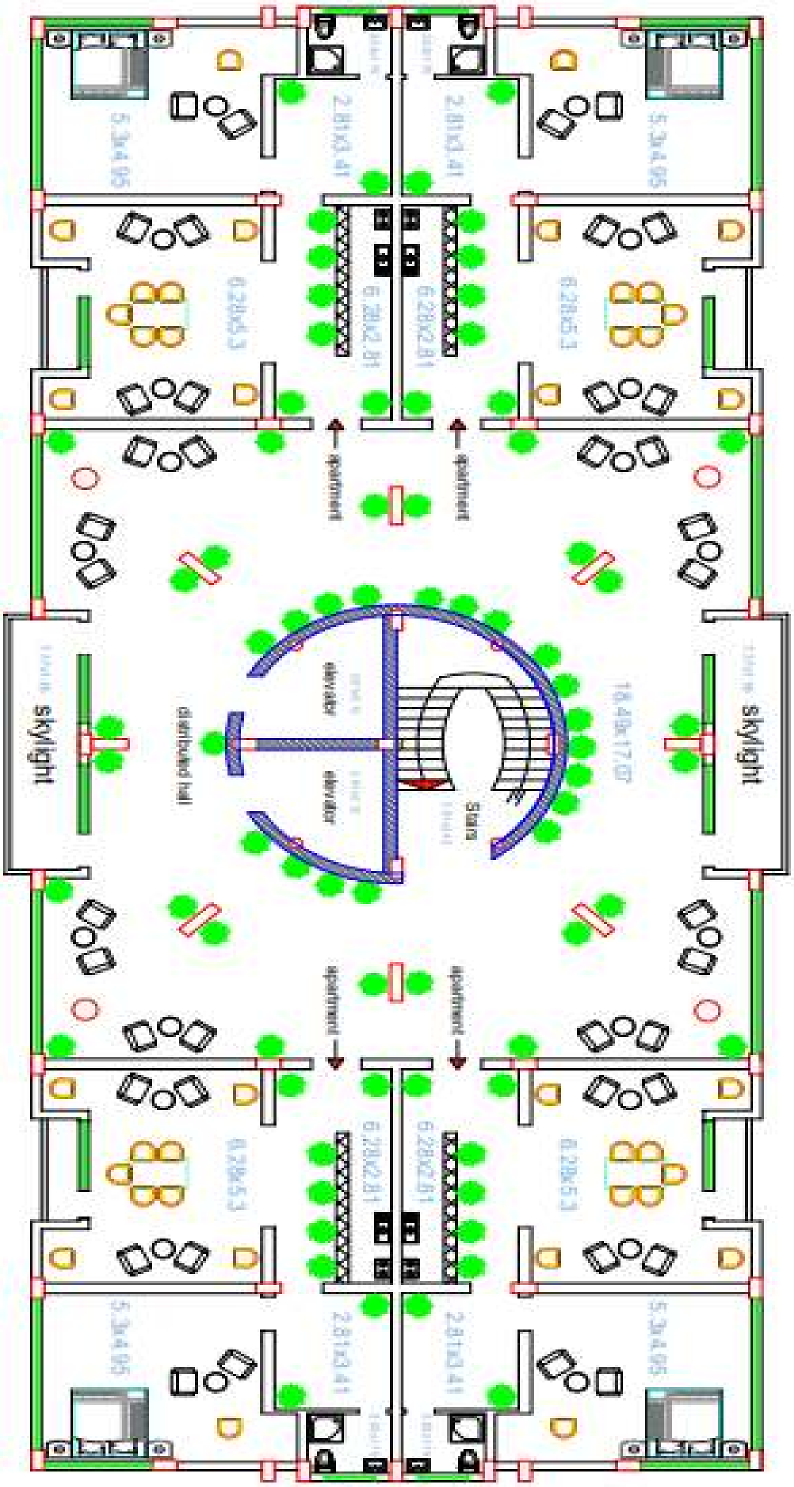


**Figure 4.8** Sixth floor

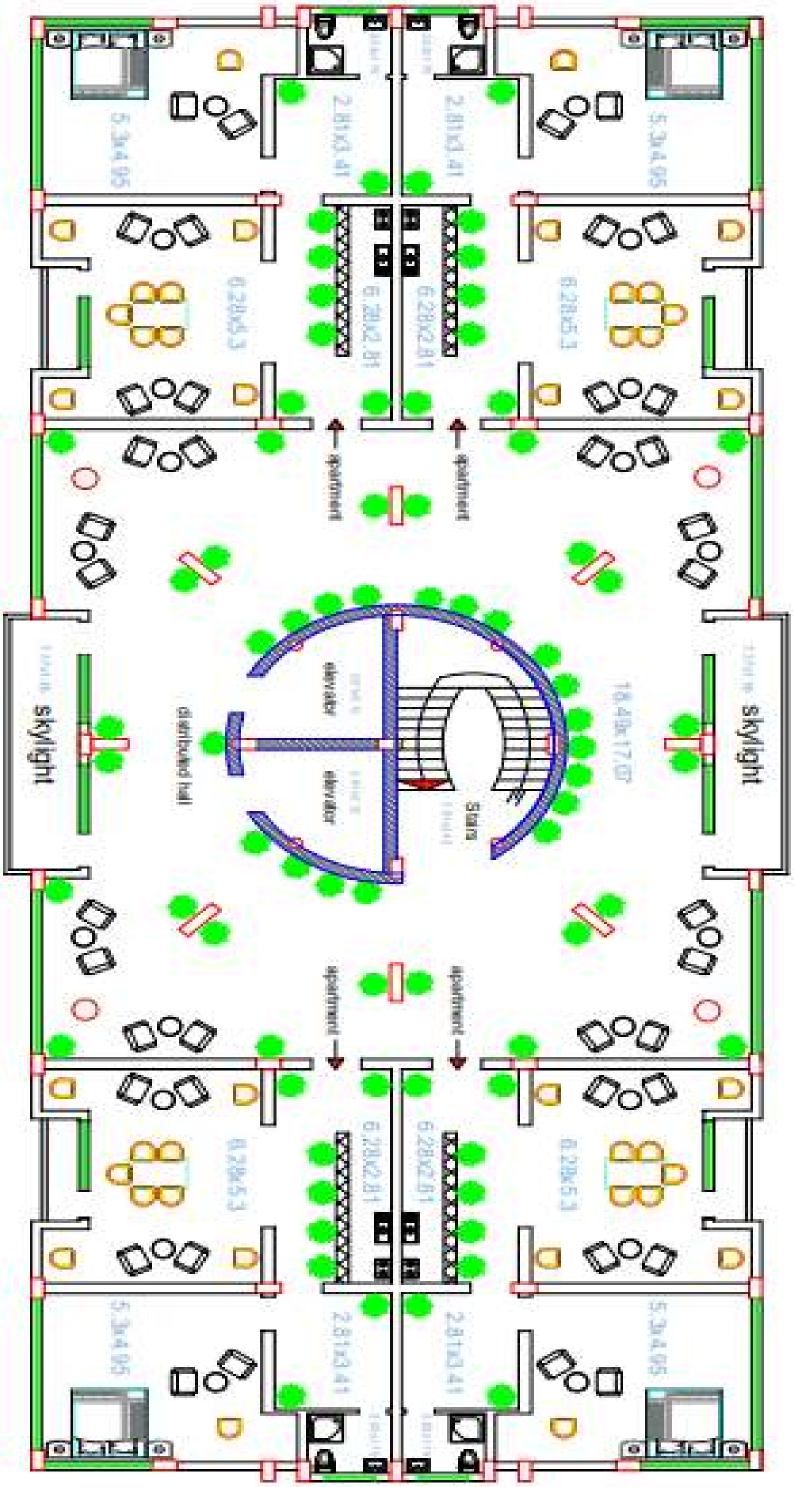

**Figure 4.9** Seventh floor

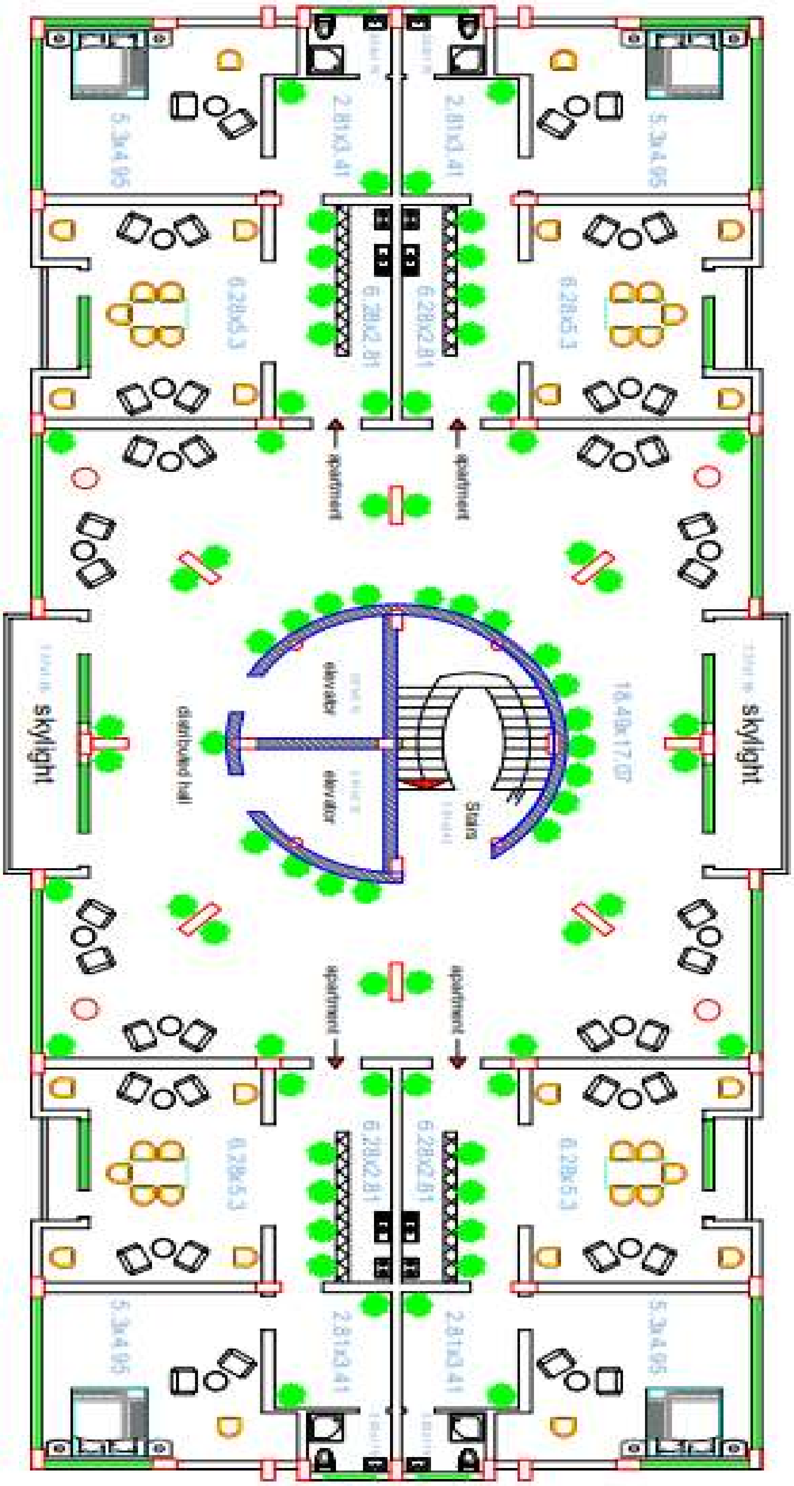


**Figure 4.10** Eighth floor

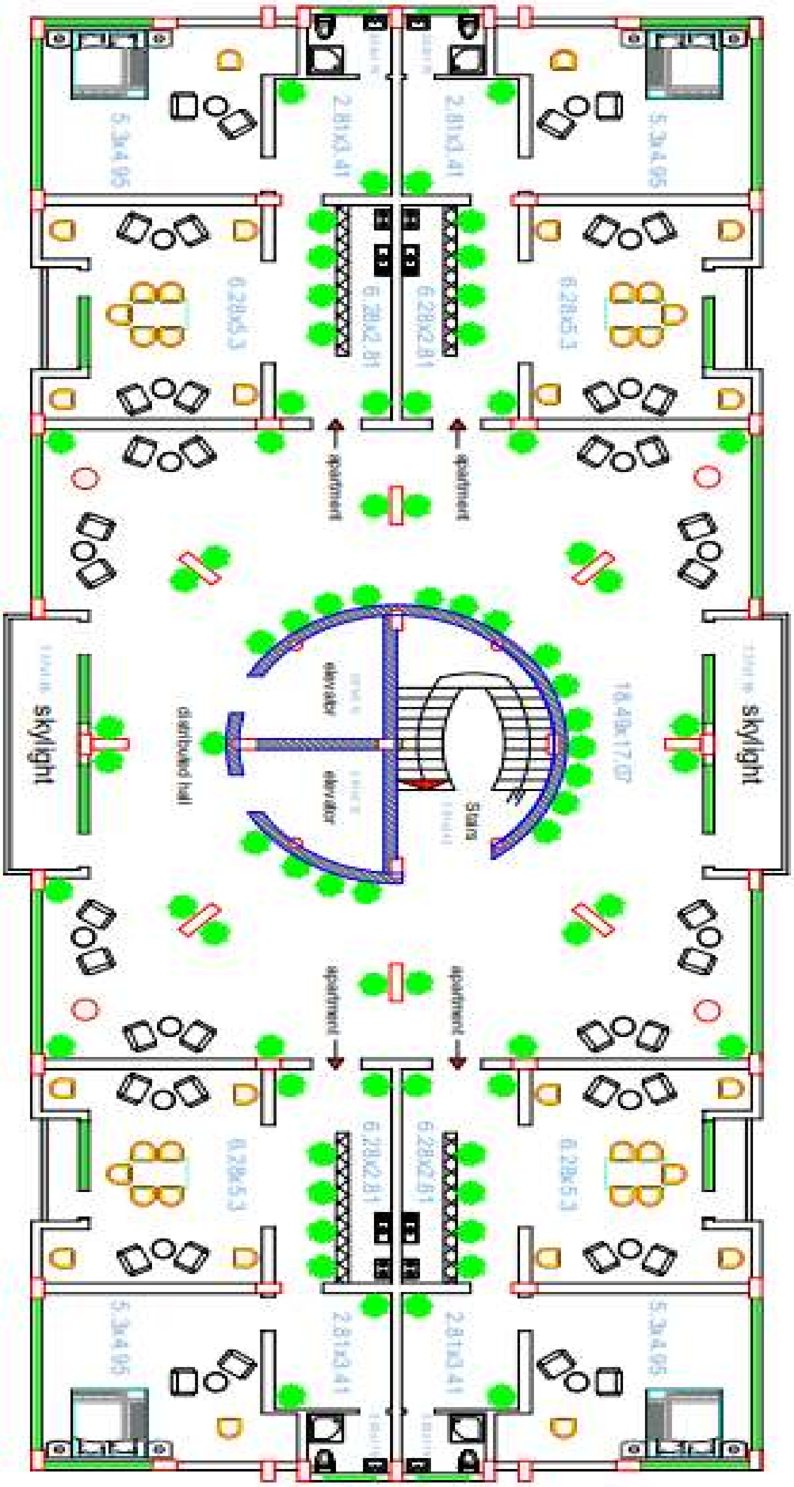


**Figure 4.11** 9th floor

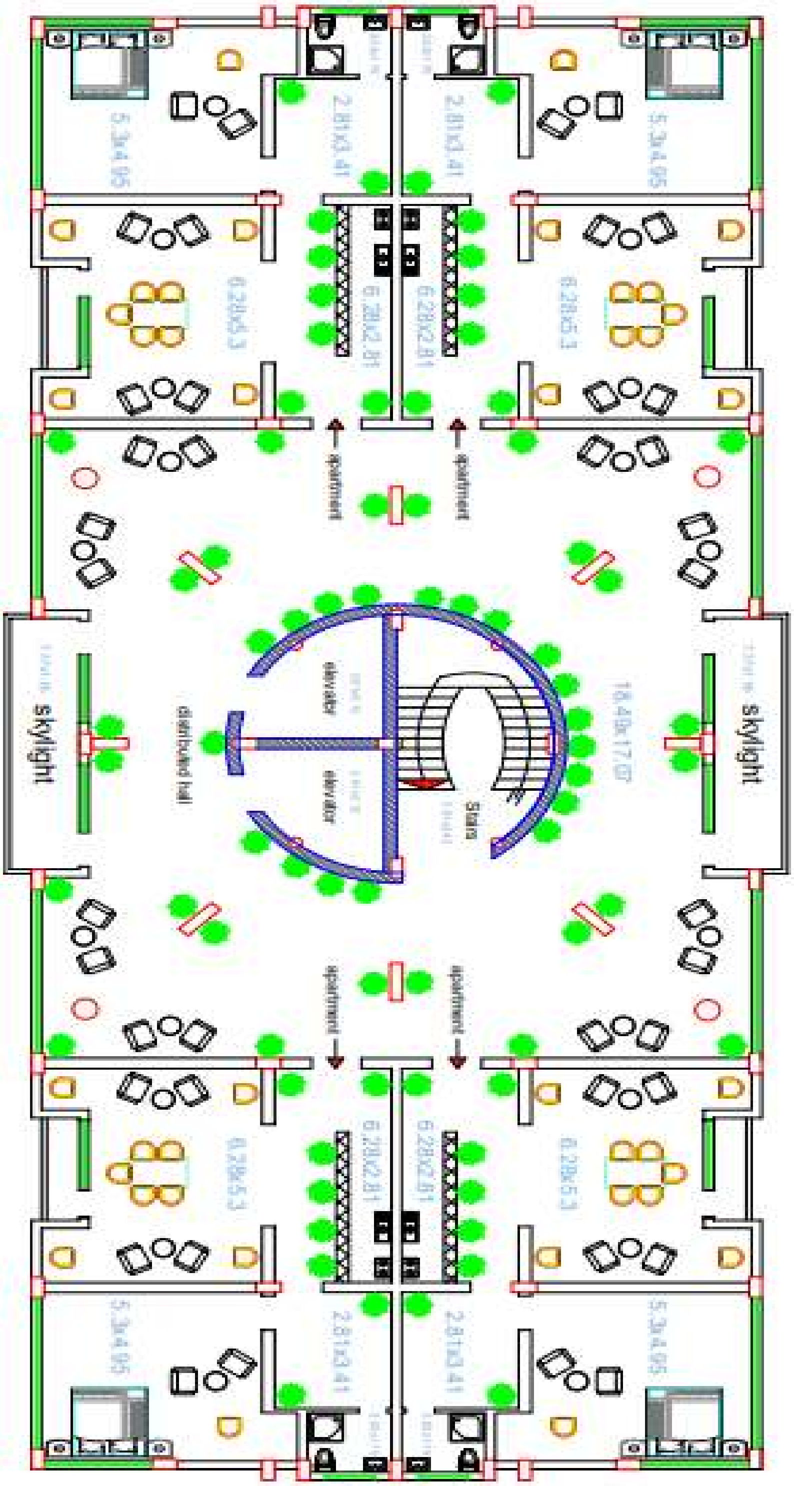

**Figure 4.11** 10th floor

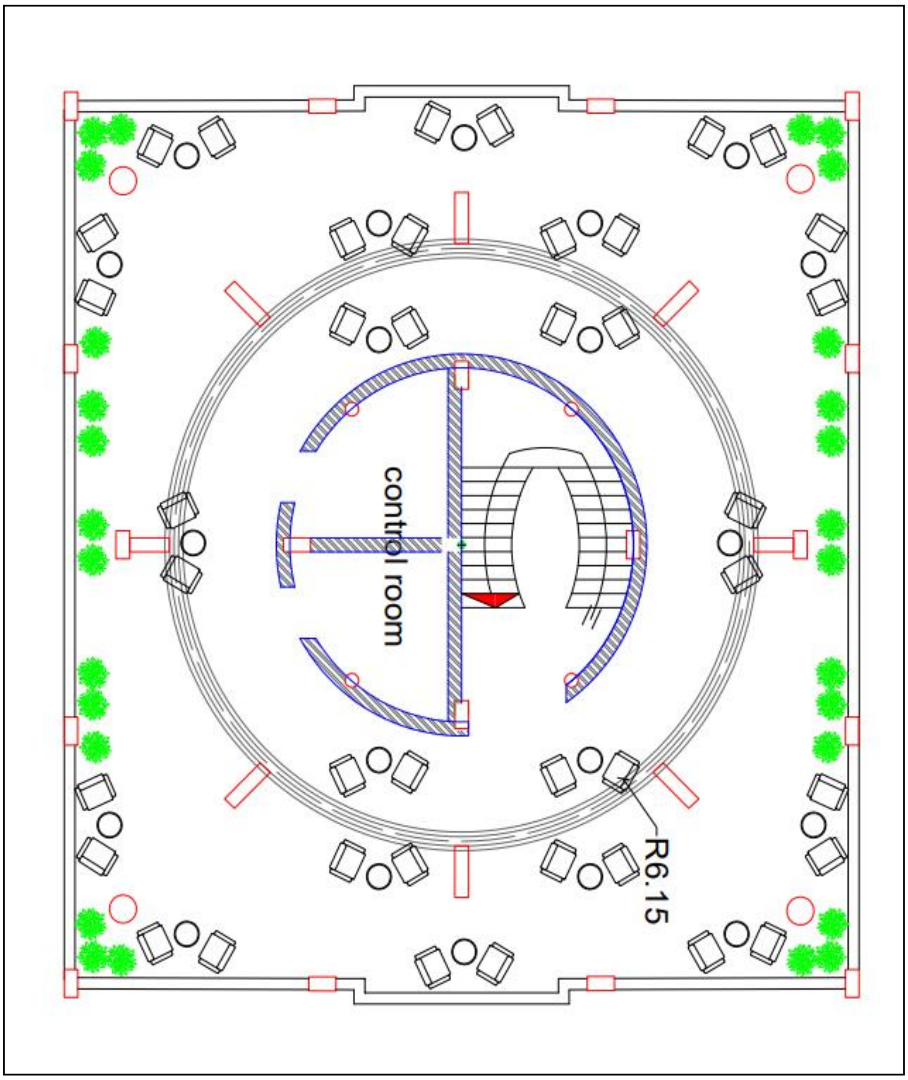


**Figure 4.12** Eleventh floor

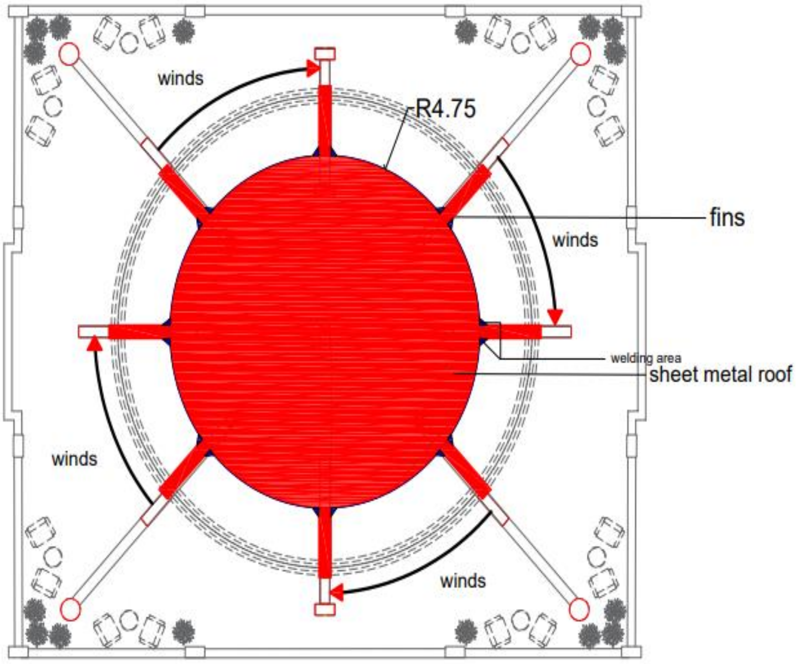


**Figure 4.13** 12th floor

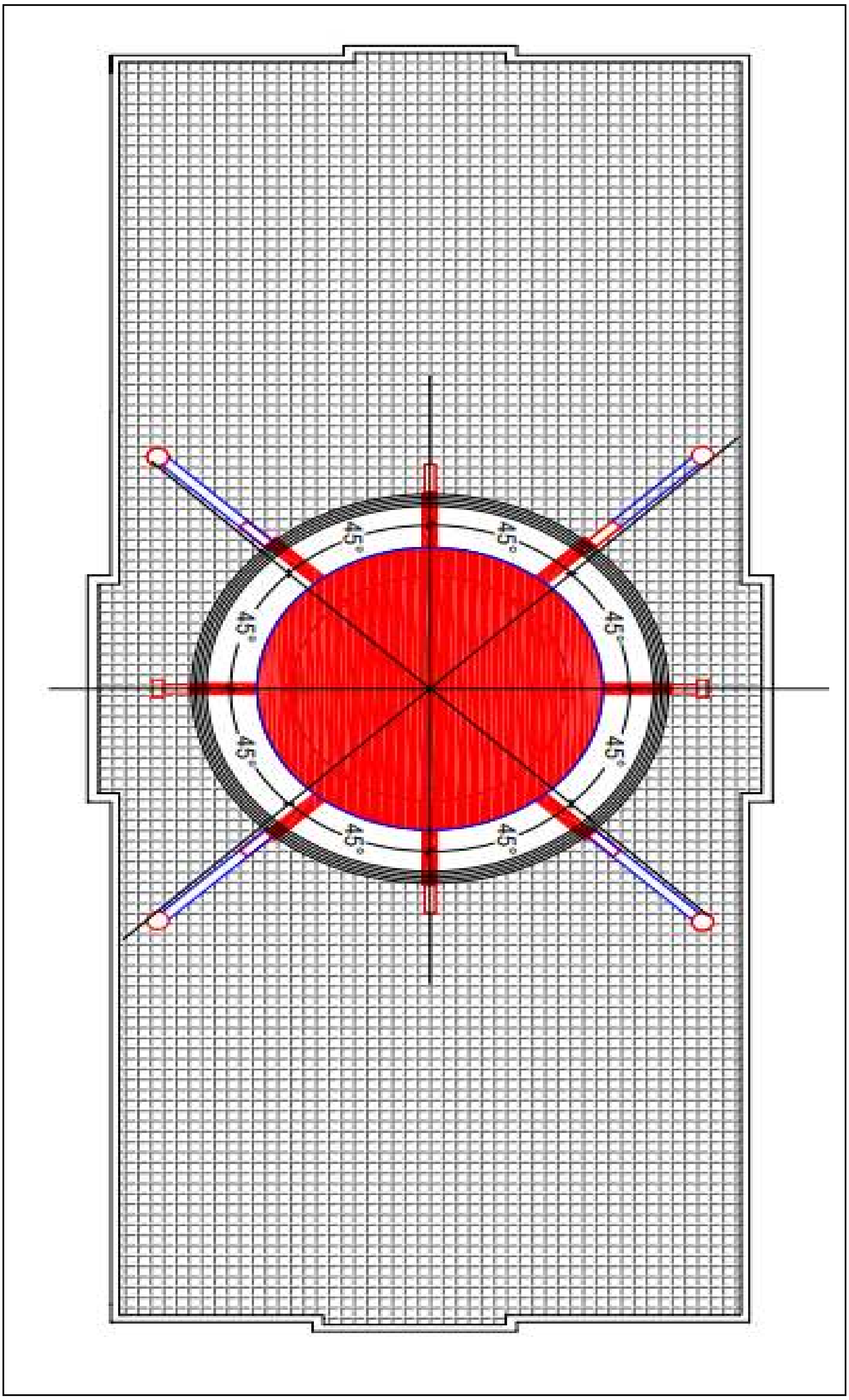


**Figure 4.14** Rotation under the influence of the wind at zero

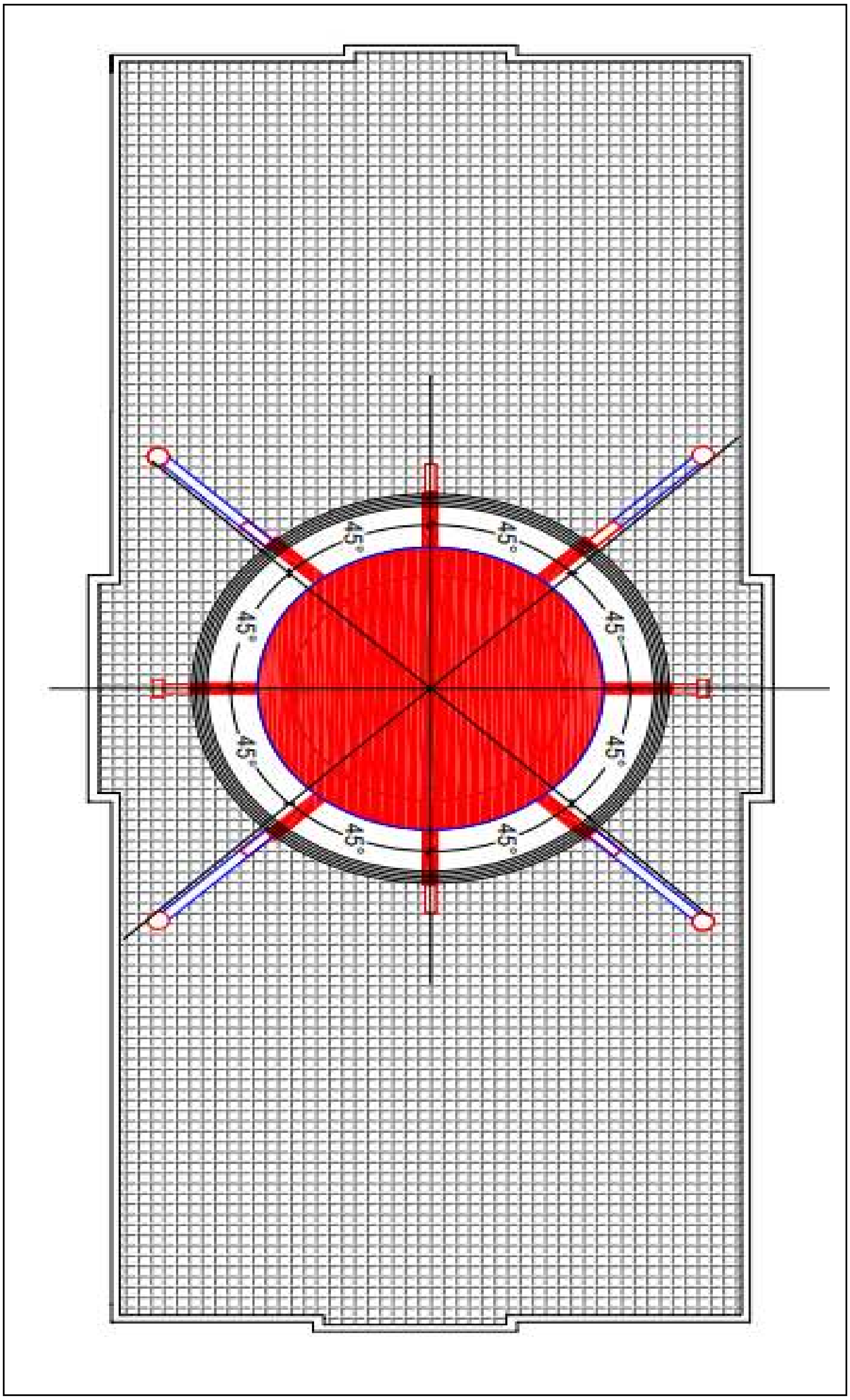


**Figure 4.15** Wind rotation at 15$^{o}$

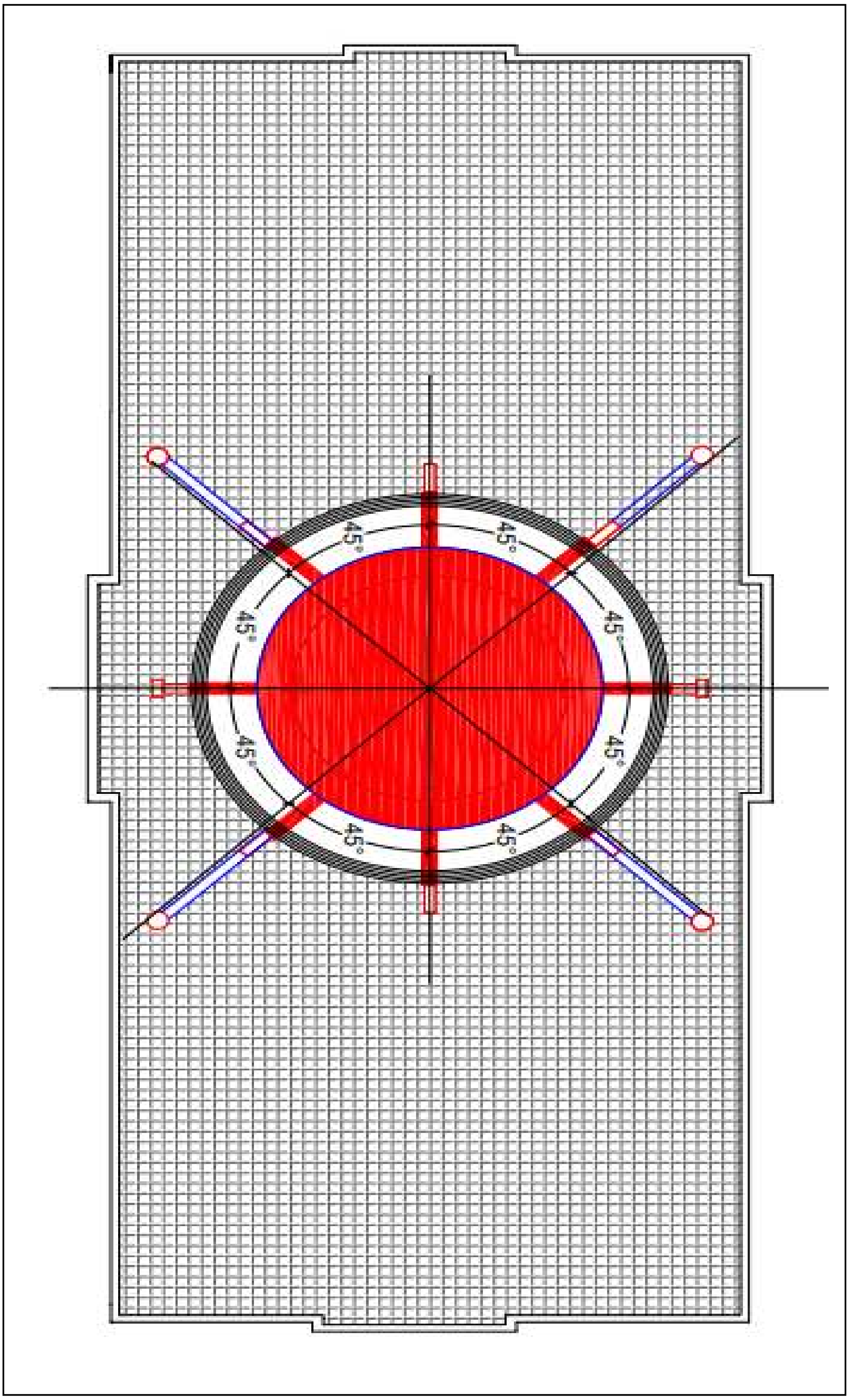


**Figure 4.16** Wind rotation at $30^0$

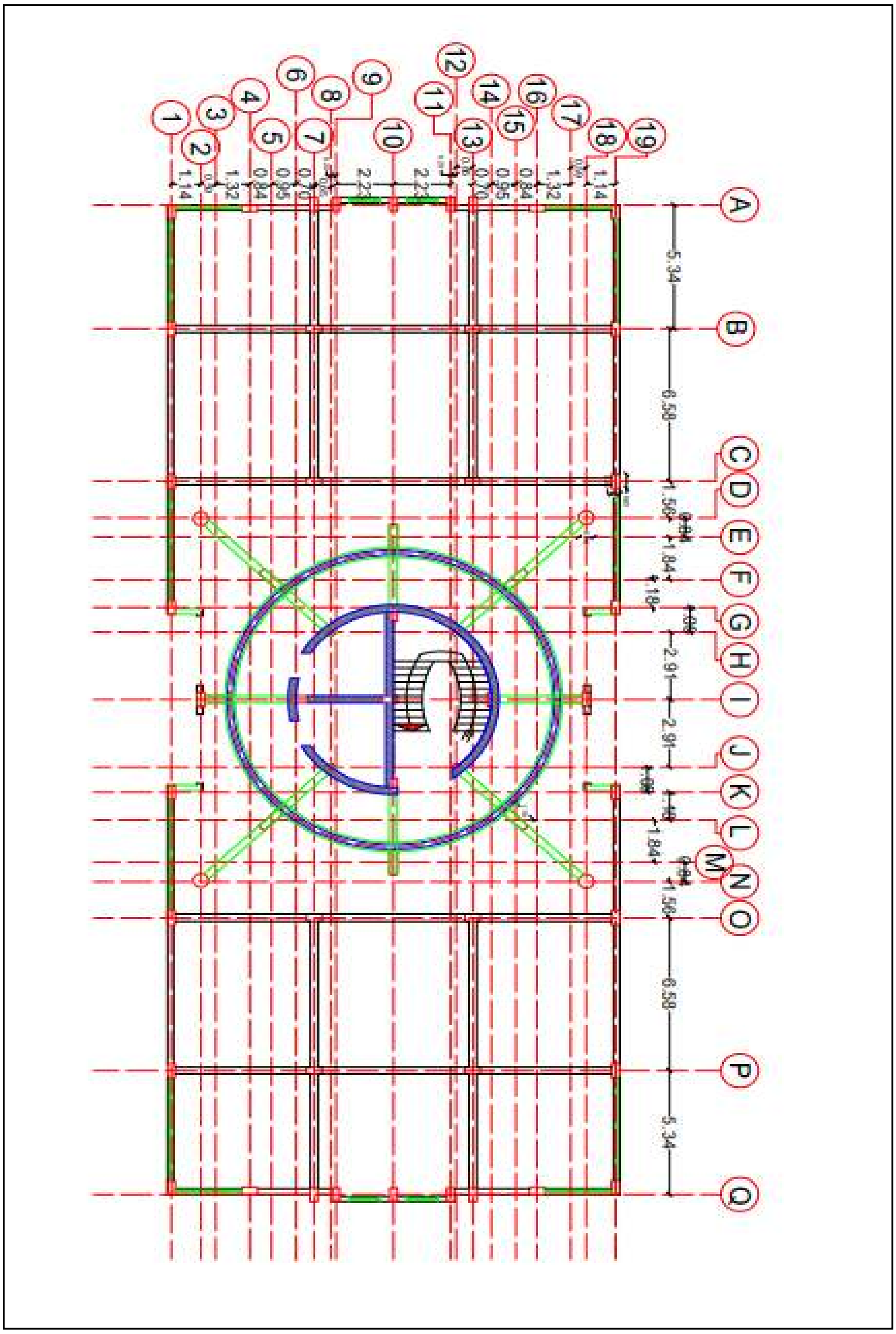


**Figure 4.17** Structural dimensions of repeating floors

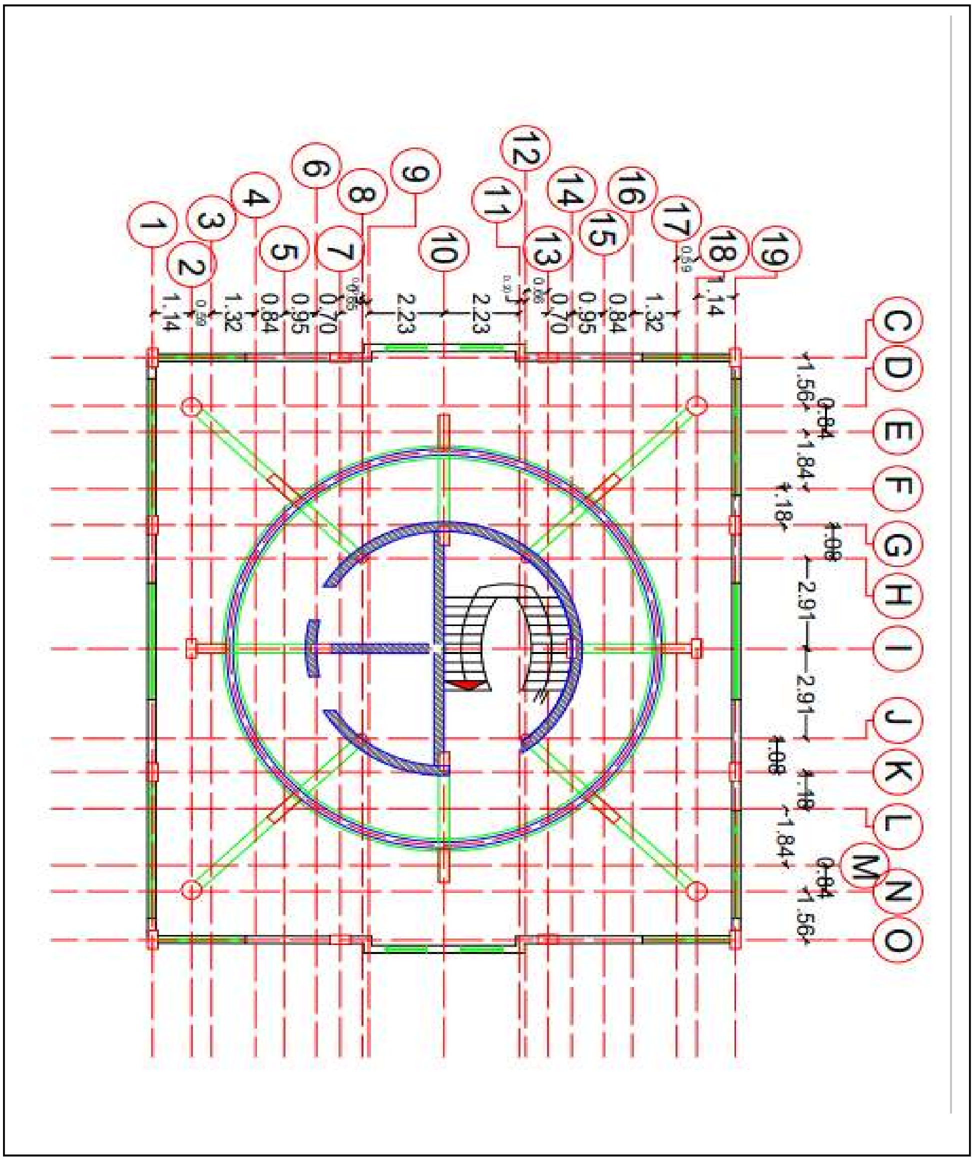


**Figure 4.18** 11th story structural

## 4.5 Wind Speed Law

To get the wind pressure according to the equation P = 0.00256 x $V_2$, where V is the wind speed in meters per second. The unit of measurement for wind pressure.

From the table of conversion of wind level, speed and pressure.

When an object moves, it produces energy, and if it moves faster, the force is greater, for example: a car moving slowly towards a wall, it may not hit the wall, but if the speed is more, you can hit the bottom of the wall. Thus, though the air is too light, if the velocity is too great, great energy can also be formed, and this destroys the house and pulls the tree down. Based on the calculated result, it is approximately:

At a wind speed of 20 m / pressure causes 50 kg / $m^2$

At a wind speed of 30 meters per second, it causes a pressure of 110 kilograms per square meter. The wind pressure using the equation P = 0.00256 x $V_2$, where V It is the wind speed in meters per second. Wind pressure measurement unit.

Wind level and wind speed conversion table with wind pressure.

The tensile strength P increases gradually and the number, spacing and width of the cracks are recorded. Bond stresses vary along the lengths of the fibers between their slits. The maximum stress in the steel fibers is in the cracked part and is lower towards the midsection between the cracks. In the event that the combined length of the straight steel fibers is greater than the development length, it results in the steel fibers, leaving some of the length of the fibers in the concrete. The linear elastic behavior of the fiber matrix system is then interrupted by surface deburring as it occurs due to the weak bonding between the concrete matrix and the steel fiber surface. This is a new developed model of delayed shearing. The maximum tensile strength on the steel fibers is counteracted by using another internal force related to the final bond stress, the diameter of the steel fibers and the yield strength (Khabaz, 2017a,b).

Represents a wind speed of 20 m / s occurs there is a pressure of 50 kg / $m^2$

Represents a wind speed of 30 meters per second, there occurs a pressure of 110 kg per square.

It represents a wind speed of 40 meters per second, there is a pressure of 190 kg / m$^2$

Represents a wind speed of 50 meters per second there is a pressure of 300 kg / m$^2$

A hurricane's wind speed is about 40 meters per second, or about 190 kilograms per square meter. This will blow up a relatively simple house. The conversion list for wind level, speed and pressure is shown in the table.

**Table 4.1** Conversion table of wind level, wind speed and wind pressure.

**Wind level, wind speed and wind pressure conversion table**

| (Wind pressure (kg/m2 | (Wind speed (meters per second | wind level |
|---|---|---|
| 0 | 0. - 0.2 | 0 |
| 1 less than | 0.3 - 1.5 | 1 |
| 1 | 1.6 - 3.3 | 2 |
| 3 - 1 | 3.4 - 5.4 | 3 |
| 7 - 3 | 5.5 - 7.9 | 4 |
| 14 - 7 | 8.0 -10.7 | 5 |
| 23 - 14 | 10.8 - 13.8 | 6 |
| 35 - 23 | 13.9 - 17.1 | 7 |
| 52 - 35 | 17.2 - 20.7 | 8 |
| 72 - 52 | 20.8 - 24.4 | 9 |
| 97 - 72 | 24.5 - 28.4 | 10 |
| 128 - 97 | 28.5 - 32.6 | 11 |
| 164 - 128 | 32.7 - 36.9 | 12 |
| 206 - 164 | 37.0 - 41.4 | 13 |
| 256 - 206 | 41.5 - 46.1 | 14 |

Note: The wind speeds listed in this table are equivalent to the average wind speed in 10 minutes. (Source reference: ROC Central Weather Bureau)

## 4.6 Project modeling on ETABS 2016

The project is a 12. story tower. The height of each floor is 3 m . The ground floor works as a commercial mall and has the main entrance to the building and contains 2 elevators and stairs to go up to other floors .The floors from the first to the tenth are apartments. The number of apartments is 4 for each floor. Floor No. 11 is to use the roof of the tower as a restaurant along the roof of the tower. And this floor is taken advantage of from its height above the tenth floor to get a view of the neighboring areas of the tower and to add an aesthetic character to the tower. Floor No. 12, we will build it in the form of steel, and it will be rotating, and it is affiliated with the restaurant to the 11th floor. To give an additional aesthetic to visitors, as well as help to see the area surrounding the tower from all directions and the customers are seated. We will analyze the building in all its details on the ETABS program to obtain acceptable results. We will be adding side fins to the 12th floor steel 8 around the body to help rotate the floor with the wind at this height. If we take the expected wind speed in the city of Baghdad, we suggest constructing the building there. The speed according to the code is estimated at 75 km / h. The height of the twelfth floor is 36 m. The base on which the rotating iron part will be installed is an iron structure on which U shaped iron beams are installed and iron balls are installed to facilitate sliding and rotation. This structure is installed on the columns and concrete walls of elevators and stairs, which extends from the ground floor to the 11th floor. We will enter the project data and measurements into the ETABS program. After modeling, we insert the loads into the ceilings, beams and columns (live loads and dead loads), as well as entering safety equations according to the American code. After that, we entered the values of earthquake and wind loads for the Iraqi code. The fact that the proposed project is being built on the city of Baghdad.

Since the ETABS program analyzes the movement in two directions only (positive and negative X and positive and negative Y), we will install the rotating part in the program and make the joints installed in it in the form of a PIN and study the effects that will affect the rotating part and the floors below it. And 3 tests.

First: We distribute the fins geometrically on the circumference of the rotor. Since the angle of the rotor is equal to 360, we divide it by 45 degrees, and we get 8 fins. They are installed evenly starting from the angle of zero to 360 degrees.

We analyzed the project on ETABS to get results. It was in the forms shown below.

This Figure shows the installation of the fins on the steel structure of the 12th floor at zero degrees. Then we analyzed it on ETABS and got the results mentioned below.

Program Codes:

UX : direction.

UY : direction.

UZ : direction.

Calculate values : (axial force, Max torque, Max Moment).

**4.6.1 Wind Loads**

Wind Loads Methods for calculating wind loads for the largest wind gust must be taken into consideration in the structural design of buildings or other structures or their parts, and these methods do not apply to buildings and structures with non-prismatic geometric shapes or those implemented in special sites where loads calculation is needed Winds affecting it to laboratory methods. As for buildings and structures with structural features that make them vulnerable to dynamic effects, in this case, the wind loads on them must be appropriately estimated based on documented scientific sources as proven in international blogs, especially for buildings and facilities that are exposed to Shedding Vortex (or those that are exposed to Aerodynamic loads are unstable, which requires dynamic analyzes. The wind load affecting each of: 1 . Buildings and structures in their final form must be calculated. 2 . Elements of the structure individually, such as roofs (roofs) and walls (walls). 3 . Units The external architectural and construction used in the facades. The wind load calculation is according to the following steps: A. The speed wind basic (V) for the area in which the structure will be built is determined based on the speed of the wind gust (which blows during an estimated period of time). By three seconds, and it may be exceeded once during a period of time of (50) years. B. Then the design wind speed (Vs) is calculated (Speed Wind Design) from the following relationship:

Vs = V S1 S2 S3 , (m/sec)

that:

V: base wind speed

S1: Earth's topographic coefficient

S2: A coefficient that takes into account the combined effect of the rough terrain and the change in wind speed with altitude above The surface of the earth and the size of the structure or its parts on the design wind speed Vs.

3:A statistical coefficient that takes into account the required degree of safety and the time period to which the building will be exposed.

wind during the lifetime of the building.

C.Then the design wind speed is converted into dynamic wind pressure (q) as follows:

$q = k\ VS\ 2$ , (N/m2 ).

whereas:

k : a parameter related to the density of air.

Vs: design wind speed.

D. The wind pressure applied to any area of the building roof is calculated from the relationship:

$P = Cp\ q$ , (N/m2 )

The sign of the coefficient Cp is positive if the wind pressure direction is in the direction of the origin, which generates pressure on the structure.

The Cp sign is negative when the wind pressure generates suction.

e. Convert the wind pressure applied to an area of the surface by multiplying the pressure value by that area.

Since the sum of the wind loads applied to the structure element taken into account It is taken on the pressure difference.

between them opposing surfaces (inside with outside), the net wind loads (F) on that element act in the direction of.

perpendicular to the surface as follows:

$F= [Cpe – Cpi]\ q\ A$ , (N)

whereas:

Cpe: coefficient of pressure applied to an external surface.

The coefficient of pressure applied to the interior surfaces, Cpi.

A : the surface area subjected to wind pressure, ( m2).

When the value of the net force (F) is negative, it means that the direction of the net force is outward.

The total force of the wind applied to the building or structure can be calculated by directional summation.

Summation Victoria (For forces on all surfaces).

And . a shorter method can be used to calculate the total wind loads (Loads Wind Total) on the building from.

the following relationship:

F= Cf q Ae

whereas:

Ae: The area of the effective interface of the structure facing the wind. Design Wind Speed. Calculate the design wind speed from the relationship .

V: base wind speed.

S1, S2, S3: Design wind speed coefficients.

Basic Wind Speed.

The basic wind speed is defined as the speed of a wind gust for a period of time estimated at three seconds and is likely to be exceeded.

Only once in a 50 year time period. The basic wind speed is determined by the directions.

Competent official, Figure 4.19 shows these speeds for the different governorates of Iraq after adjusting them to.

**According to the real wind gusts recorded in Iraq**

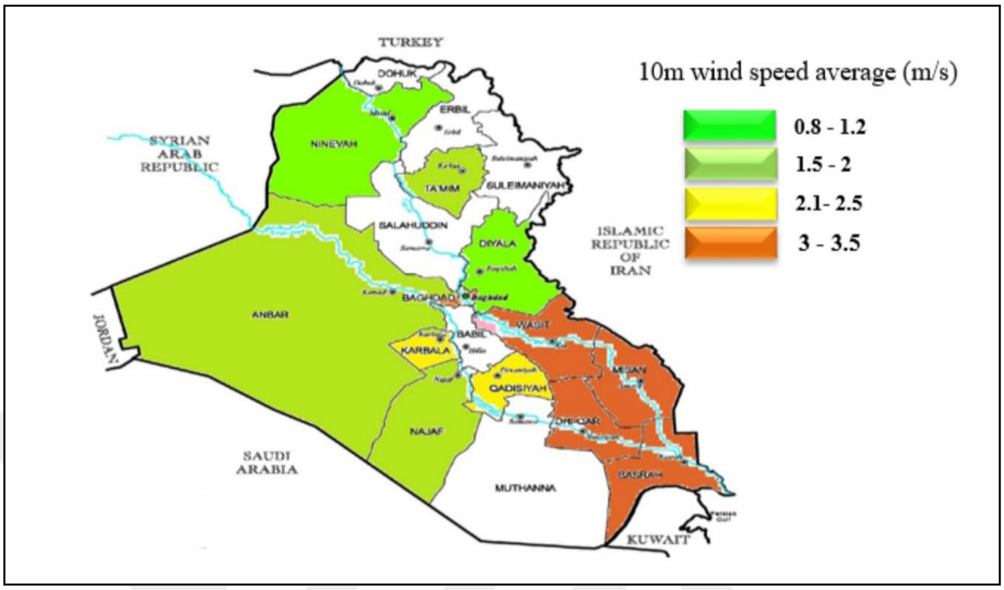


**Figure 4.19** The contour map of the basic wind speeds for the governorates of Iraq, sec/m

Topography Factor, $S_1$.

The value of this coefficient depends on the topography of the earth's surface and its ripples, when the slope of the earth's surface does not exceed

A value of 0.5 (%) within a radius of one kilometer from the site of origin, then the surface can be considered flat.

Depending on this, the topographic coefficient ($S_1$) for this case is equal to one.

And when the lands surrounding the building are uneven, the parameter ($S_1$) will depend on the extent of the land slope.

Facing the winds and on the site of origin relative to the top (the highest point) and the value of the parameter (S1) for this case is within.

($1.36 \geq S_1 \geq 1.0$) limits.

It should be noted that the value of the parameter (S1) changes with the height of the structure above the surface of the earth and that its maximum amount.

It is at ground level and will decrease to (0.1) at the top of the summit.

The roughness of the ground surface, the size of the building and its height above the ground.

This coefficient represents the combined effect of the roughness ground and the size of the building.

Ground above Height, based on wind speed.

Lands are classified according to their roughness into four categories.

Class A is open land without obstacles. Examples include airports and flat coastal areas.

And swamps and farms not surrounded by windbreaks or fences.

Class (B) open lands with dispersed windbreaks.

Class C is open land with many windbreaks such as small towns and suburbs of large cities.

Class (D) lands with large and multiple obstacles such as city centers.

The value of the coefficient (S2) Relies on type and volume of the covering of the facades of structures. The buildings are divided into this.

domain into the following three types.

Class A: It includes cladding, glazing, roofing and their fasteners, and the individual elements of buildings constructed without wrapping.

Class B: It includes buildings and facilities whose dimensions do not exceed the greatest horizontal or the greatest vertical height. Amount (50 m).

Class C: It includes buildings and facilities whose distance exceeds the greatest horizontal and the highest vertical height (50 m).

Where the height of the building is taken to its highest point, or the total height of the structure is divided into parts determined for each.

A part of it is a value of the parameter S2 (according to the highest point of that part from on the surface of the earth. The wind load sheds

At the middle of the total height of the building or the middle of its parts, as the case may be, including pitched ceilings.

Statistical Factor, $S_3$.

The parameter S3 is related to the degree of safety required, the period of time during which The building is always exposed to winds of higher speed and duration than those assumed when designing.

In cases of natural wind loads on constructed buildings and facilities (not under construction), the parameter ($S_3$) is taken equal to (0.1) (assuming an exposure period of 50 years and a probability level of 63.0).

For this coefficient when exposed to time periods and a level of probability that differ from what was mentioned above.

### 4.6.2 Dynamic Pressure of the Wind

The dynamic wind pressure is calculated from the following relationship.

q = k Vs 2

Dynamic wind pressure values (q) in terms of design wind speed (Vs).

(Pressure and Force Coefficients)

whereas:

k = 613.0 when the units of pressure and velocity used are N/ m2

and (s/m) respectively.

Dynamic wind pressure values (q) in terms of design wind speed (Vs .)

(Pressure and Force Coefficients)

whereas:

k = 613.0 when the units of pressure and velocity used are N/ m2

and (s/m) respectively.

Dynamic wind pressure values (q) in terms of design wind speed (Vs .)

(Pressure and Force Coefficients).

To calculate the wind load on a building, structure, or parts of it, multiply the dynamic pressure of the wind by a parameter.

It depends on the shape of the building or the facility and then it is multiplied by the area of the building or the facility or parts of them.

There are two types of transactions:

1 . pressure coefficients ($C_p$).

2 . Force coefficients ($C_f$ ).

## CHAPTER 5

## STRUCTURAL ANALYSIS AND PROJECT MODELING

### 5.1 Introduction

In this chapter, we explain the modeling process for the proposed building in this study, with its structural analysis on the ETABS 2016 Program and study of the effect of wind in the building relative to its floor with rotation at zero degrees, 15 degrees, 30 degrees and the wind speed was 75 km / h, and the building The proposal was in the city of Baghdad, and in its design, taking into account the criteria for the effect of wind and earthquakes in general, and in Baghdad in particular, as previously explained in chapter three.

### 5.2 Project modeling on ETABS 2016

The project is a 12 story tower. The height of each floor is 3 m . The ground floor works as a commercial mall and has the main entrance to the building and contains 2 elevators and stairs to go up to other floors .The floors from the first to the tenth are apartments. The number of apartments is 4 for each floor. Floor No. 11 is to use the roof of the tower as a restaurant along the roof of the tower. And this floor is taken advantage of from its height above the tenth floor to get a view of the neighboring areas of the tower and to add an aesthetic character to the tower. Floor No. 12, we will build it in the form of steel, and it will be rotating, and it is affiliated with the restaurant to the 11th floor. To give an additional aesthetic to visitors, as well as help to see the area surrounding the tower from all directions and the customers are seated. We will analyze the building in all its details on the ETABS program to obtain acceptable results. We will be adding side fins to the 12th floor steel 8 around the body to help rotate the floor with the wind at this height. If we take the expected wind speed in the city of Baghdad, we suggest constructing the building there. The speed according to the code is estimated at 75 km / h. The height of the twelfth floor is 36.

m. The base on which the rotating iron part will be installed is an iron structure on which Unshaped iron beams are installed and iron balls are installed to facilitate sliding and rotation. This structure is installed on the columns and concrete walls of elevators and stairs, which extends It starts from the ground floor to the eleventh floor. We will enter project data and measurements into ETABS. After modeling, we insert the loads into the ceilings, beams and columns (live loads and dead loads), as well as entering safety equations according to the American code. After that, we entered the values of earthquake and wind loads for the Iraqi code. The fact that the proposed project is being built on the city of Baghdad.

Since the ETABS program analyzes the movement in two directions only (positive and negative X and positive and negative Y), we will install the rotating part in the program and make the joints installed in it in the form of a PIN and study the effects that will affect the rotating part and the floors below it. And 3 tests.

First: We distribute the fins geometrically on the circumference of the rotor. Since the angle of the rotor is equal to 360, we divide it by 45 degrees, and we get 8 fins. They are installed evenly starting from the angle of zero to 360 degrees.

We analyzed the project on ETABS to get results. It was in the forms Figure 5.1 shown below.

## The results of the analysis and their impact on the building.

### First : When we install the fins at $0^0$

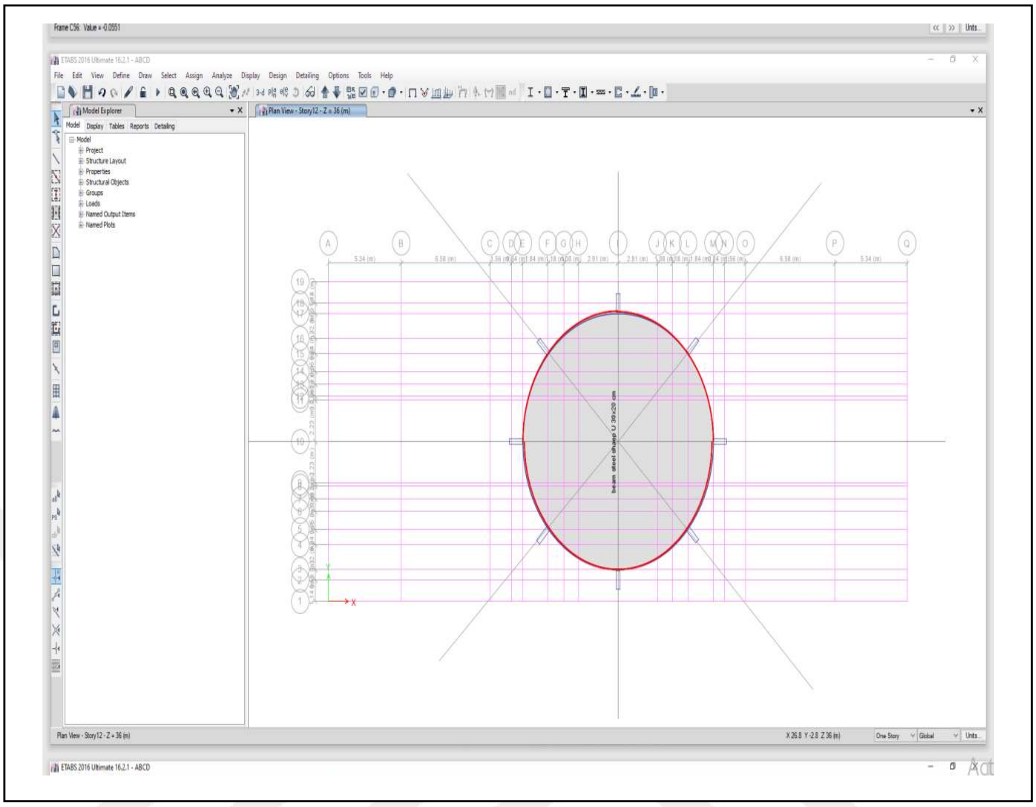

**Figure 5.1** When we install the fins at $0^0$

Scheme showing the installation of the fins at a point of $0^0$ To study the effect of wind force on the building by placing the fins at a point of $0^0$ by fixing the bin.

The shows the installation of the fins on the steel structure of the 12th story at zero degrees. Then we analyzed it on ETABS and got the results mentioned below.
Program Codes:
UX: direction UY: direction UZ: direction.
Calculate values*:* (axial force, Max torque, Max Moment).

### 5. 2.1 Analysis results and influence on the $12^{th}$, $11^{th}$ floor and $10^{th}$ floors under effect of torsion torque, shear and wind forces

Figures illustrate the results of structural analysis and wind influence on the twelfth floor, eleventh floor and tenth floor at the following cases of wind degrees Figure 5.2

**A . When we install the fins at zero degrees**

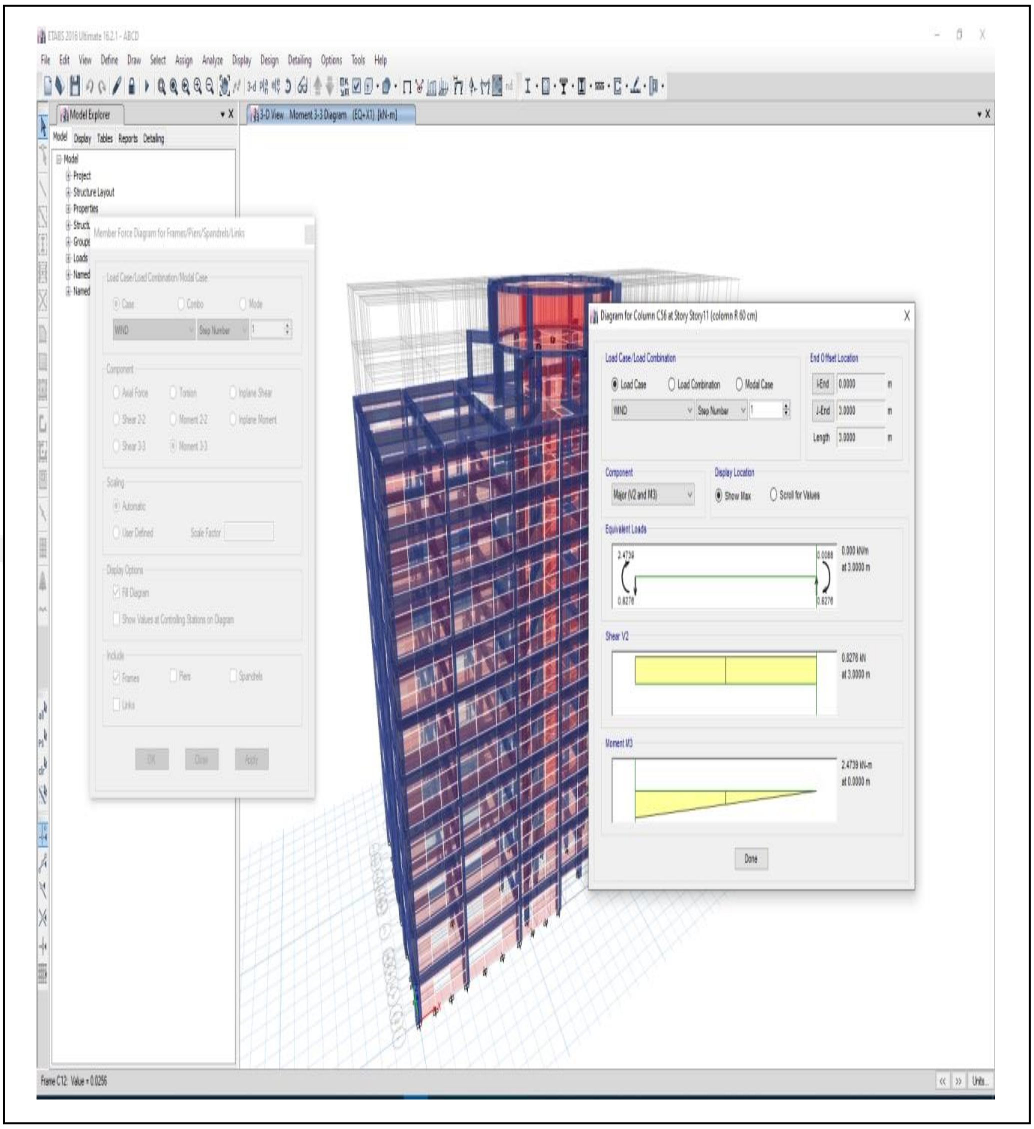

**Figure 5.2** A view showing the effect of moment 3-3 on concrete columns at story 11

In the above Figure at story 11, we get results when analyzing that shows the effect of moment on the concrete columns, and the effect product for the maximum moment 3.3 is equal to M = 0.0551 KN/m Figure 5.3

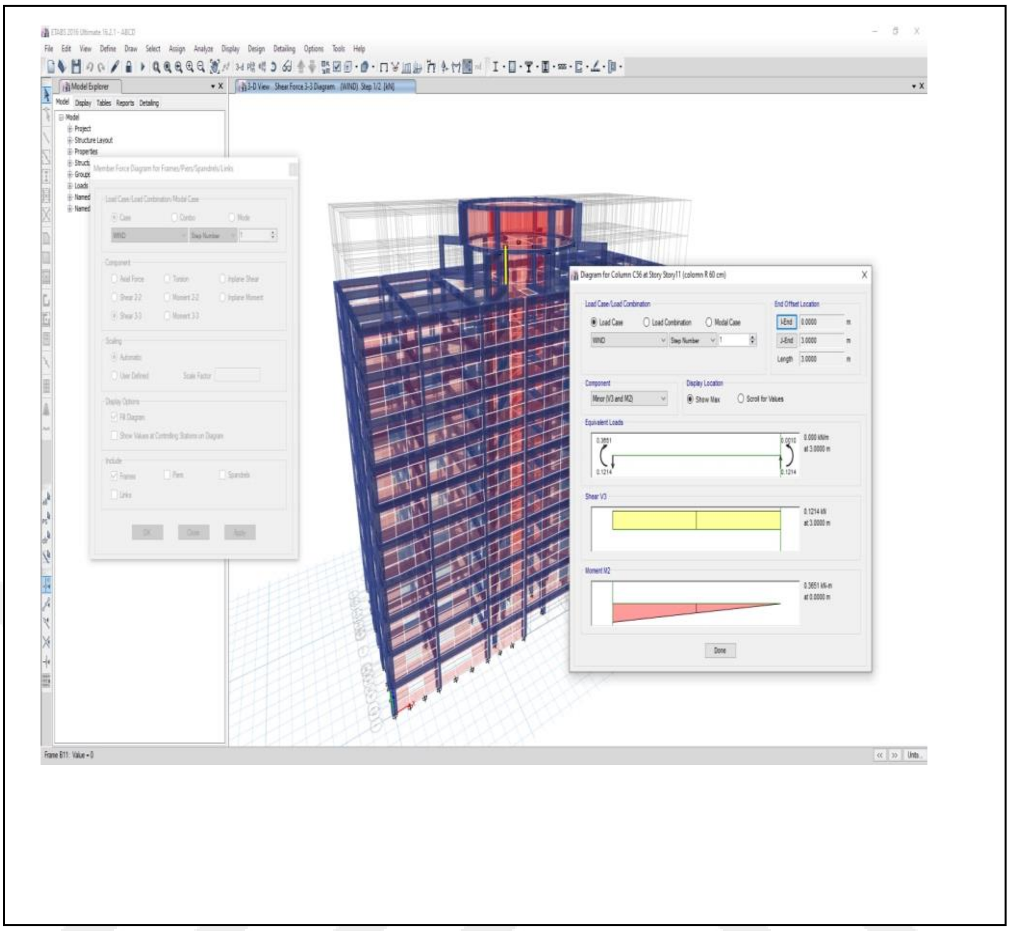

**Figure 5.3** A view showing the effect of member force Diagram for frames Shows shear 3-3 on concrete columns.

In the above Figure, we get results when analyzing that shows the effect of shear on the concrete columns, and the effect product for the maximum shear is equal to V= 0.121 KN.

The figure shows 5.4

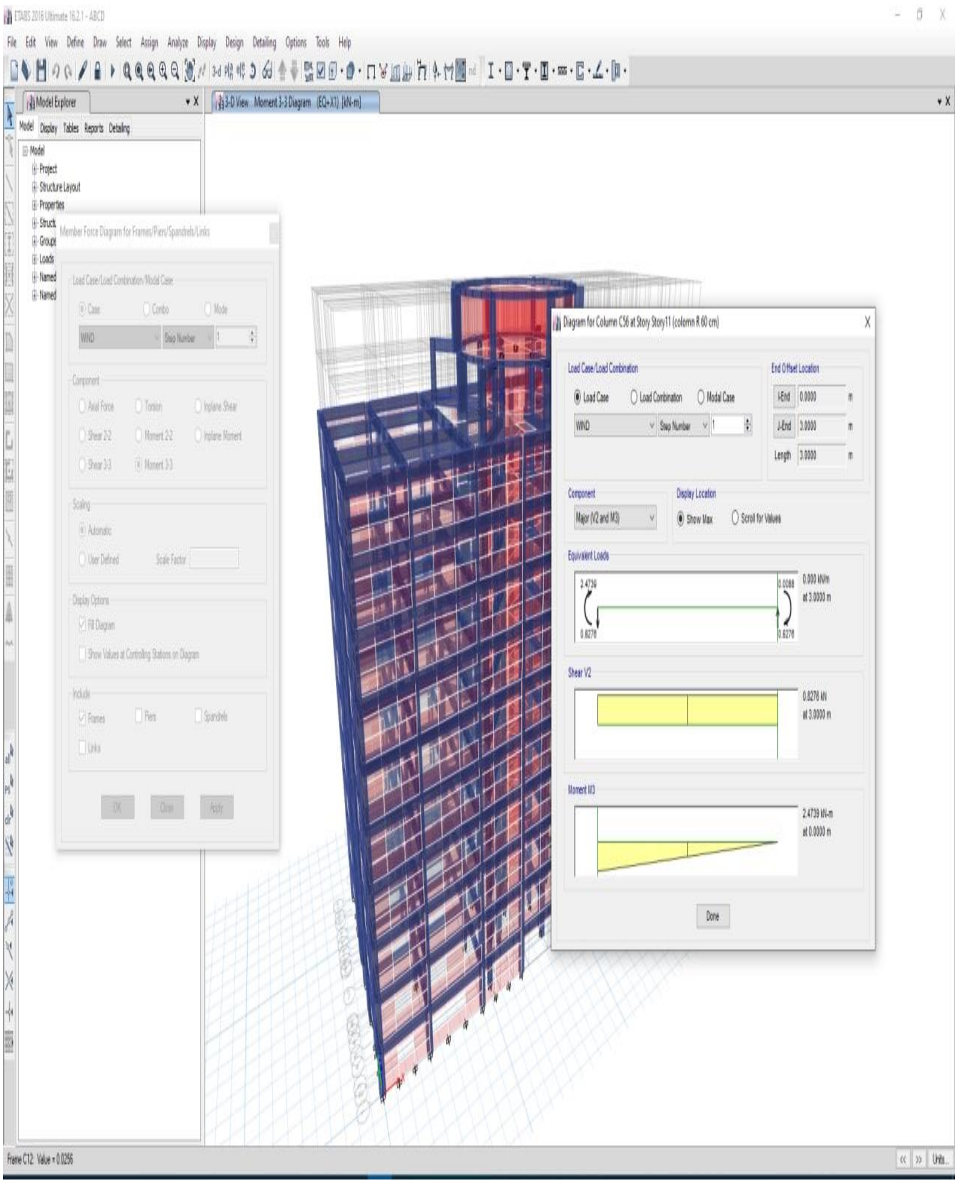

**Figure 5.4** A view Shows Axial force Diagram Wind story 12

In the above Figure, we get results when analyzing that shows the effect of moment 3.3 on the concrete columns at story 11, and the effect product for the maximum moment is equal to M= 2.47 KN/m.

The figure shows 5.5

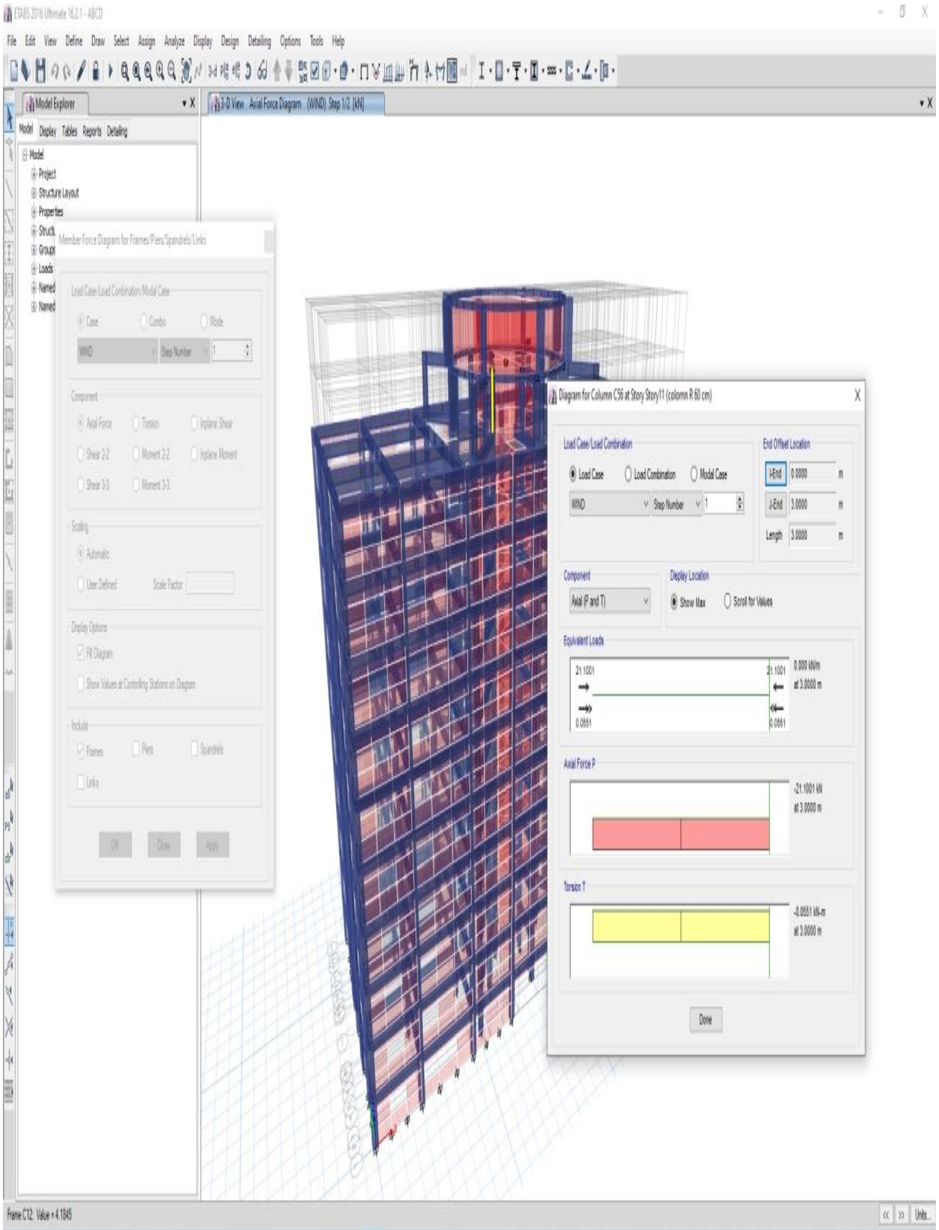

**Figure 5.5** A view Shows Axial force Diagram Wind story 12

In the above Figure, we get results when analyzing that shows the effect Axial force Diagram Wind story 12, and the effect product for the maximum Axial force is equal to F = 21.1 K.

The figure shows 5.6

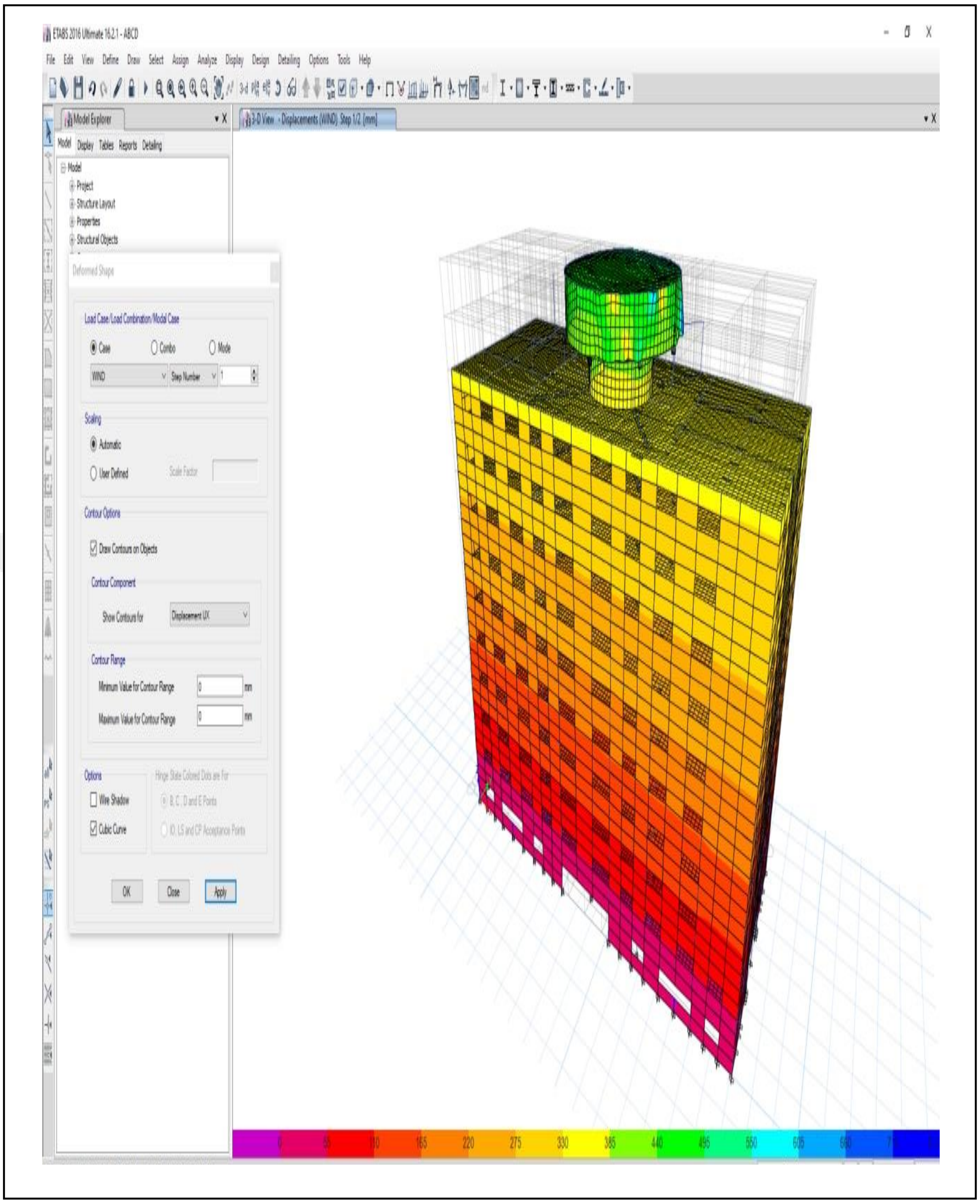

**Figure 5.6** A Presentation showing the effect of wind force on the project in general

The above figure Shows the effect of wind force on the building after modeling and analysis using the ETABS 2016 program and shows the extent of the effect on the displacement according to the colors from blue to red in ascending order.

**Table 5.1** Demonstrate the effect of wind on the building for all floors In the x direction then y then z When placing the fins in the zero area

| The effect of wind on the building for all floors in the direction of x, y, z | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | TABLE: Story Drifts | |
| Z | Y | X | Label | Drift | Direction | Load Case/Combo | Story |
| m | m | m | | | | | |
| 36 | 15.6691 | 21.3303 | 223 | 0.000248 | X | Dead | **Story12** |
| 36 | 8.63 | 14.32 | 6 | 0.000125 | Y | Dead | **Story12** |
| 36 | 15.6691 | 21.3303 | 223 | 4.735E-08 | X | Live | **Story12** |
| 36 | 8.63 | 28.34 | 5 | 8.629E-08 | Y | Live | **Story12** |
| 36 | 15.6691 | 21.3303 | 223 | 0.000163 | X | WIND 1 | **Story12** |
| 36 | 8.63 | 14.32 | 6 | 0.000133 | Y | WIND 1 | **Story12** |
| 33 | 1.14 | 29.18 | 9 | 0.000488 | X | Dead | **Story11** |
| 33 | 3.89 | 26.5 | 3 | 0.000247 | Y | Dead | **Story11** |
| 33 | 1.14 | 29.18 | 9 | 0.000123 | X | Live | **Story11** |
| 33 | 3.89 | 16.16 | 4 | 0.000032 | Y | Live | **Story11** |
| 33 | 15.53 | 21.33 | 7 | 0.000109 | X | WIND 1 | **Story11** |
| 30 | 17.26 | 17.34 | 92 | 0.000123 | X | Dead | **Story10** |
| 30 | 17.26 | 17.34 | 92 | 0.000055 | X | Live | **Story10** |
| 30 | 17.26 | 17.34 | 92 | 0.000084 | X | WIND 1 | **Story10** |
| 27 | 17.26 | 17.34 | 92 | 0.000131 | X | Dead | **Story9** |
| 27 | 17.26 | 17.34 | 92 | 0.00006 | X | Live | **Story9** |
| 27 | 17.26 | 17.34 | 92 | 0.000086 | X | WIND 1 | **Story9** |
| 24 | 17.26 | 17.34 | 92 | 0.000153 | X | Dead | **Story8** |
| 24 | 17.26 | 17.34 | 92 | 0.000071 | X | Live | **Story8** |
| 24 | 17.26 | 17.34 | 92 | 0.000093 | X | WIND 1 | **Story8** |
| 21 | 17.26 | 17.34 | 92 | 0.000166 | X | Dead | **Story7** |
| 21 | 17.26 | 17.34 | 92 | 0.000077 | X | Live | **Story7** |
| 21 | 17.26 | 17.34 | 92 | 0.000097 | X | WIND 1 | **Story7** |
| 18 | 17.26 | 17.34 | 92 | 0.000165 | X | Dead | **Story6** |
| 18 | 17.26 | 17.34 | 92 | 0.000076 | X | Live | **Story6** |
| 18 | 17.26 | 17.34 | 92 | 0.000094 | X | WIND 1 | **Story6** |
| 15 | 17.26 | 17.34 | 92 | 0.000181 | X | Dead | **Story5** |
| 15 | 17.26 | 17.34 | 92 | 0.000083 | X | Live | **Story5** |
| 15 | 17.26 | 17.34 | 92 | 0.000096 | X | WIND 1 | **Story5** |
| 12 | 17.26 | 17.34 | 92 | 0.000184 | X | Dead | **Story4** |
| 12 | 17.26 | 17.34 | 92 | 0.000085 | X | Live | **Story4** |
| 12 | 17.26 | 17.34 | 92 | 0.000093 | X | WIND 1 | **Story4** |
| 9 | 17.26 | 17.34 | 92 | 0.000163 | X | Dead | **Story3** |
| 9 | 17.26 | 17.34 | 92 | 0.000075 | X | Live | **Story3** |
| 9 | 17.26 | 17.34 | 92 | 0.00008 | X | WIND 1 | **Story3** |
| 6 | 17.26 | 17.34 | 92 | 0.000158 | X | Dead | **Story2** |
| 6 | 17.26 | 17.34 | 92 | 0.000073 | X | Live | **Story2** |
| 6 | 17.26 | 17.34 | 92 | 0.000072 | X | WIND 1 | **Story2** |
| 3 | 17.26 | 17.34 | 92 | 0.000103 | X | Dead | **Story1** |
| 3 | 17.26 | 17.34 | 92 | 0.000048 | X | Live | **Story1** |
| 3 | 17.26 | 17.34 | 92 | 0.000046 | X | WIND 1 | **Story1** |

Through ETABS 2016 the results were obtained when placing the fins at zero degree

## The results of the analysis and their impact on the building.

### Second : When we install the fins at $15^{0}$ Figure 5.7

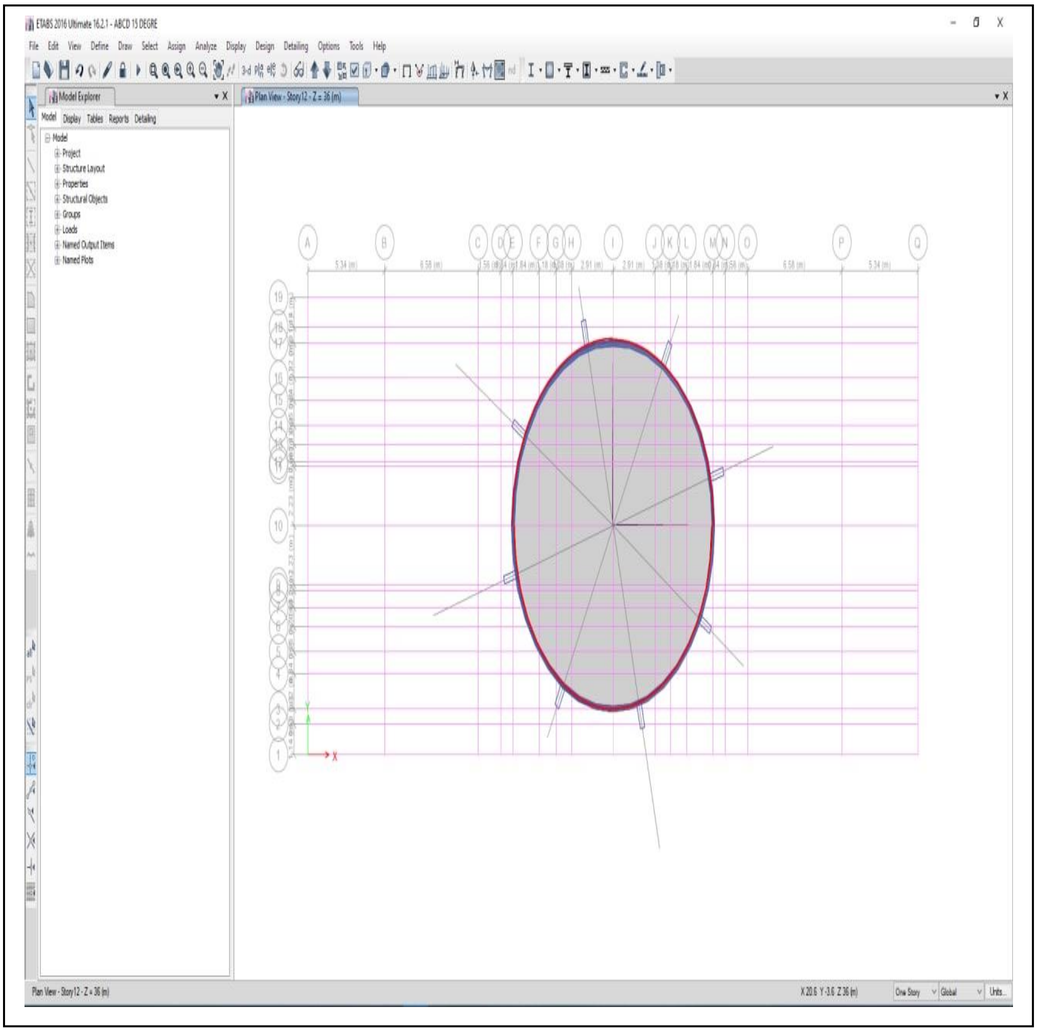

**Figure 5.7** A view Shows The 12th floor projection when fins are positioned. at an angle of 15°

Scheme showing the installation of the fins at a point of $15^{0}$ To study the effect of wind force on the building by placing the fins at a point of $15^{0}$ fixing the bin.

**B . When we install the fins at $15^0$. Figure 4.46. to Figure 5.8**

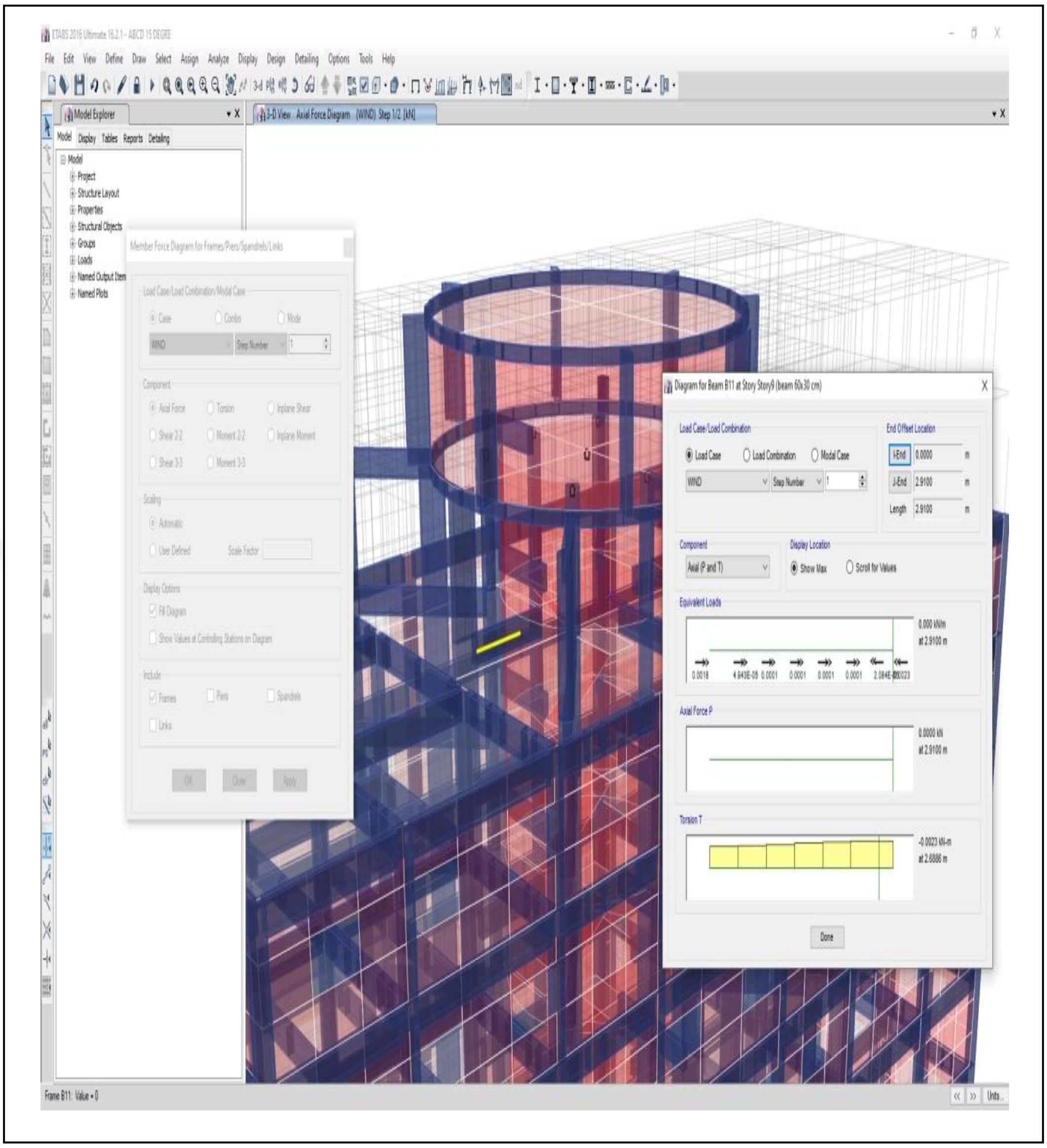

**Figure 5.8** A view Shows The The effect Force of the wind on the Beams

A view of the projection showing the effect of the Force on the beams of the project equals F = 0 kN/m. of placing the fins at a point of $15^0$

The figure shows 5.9

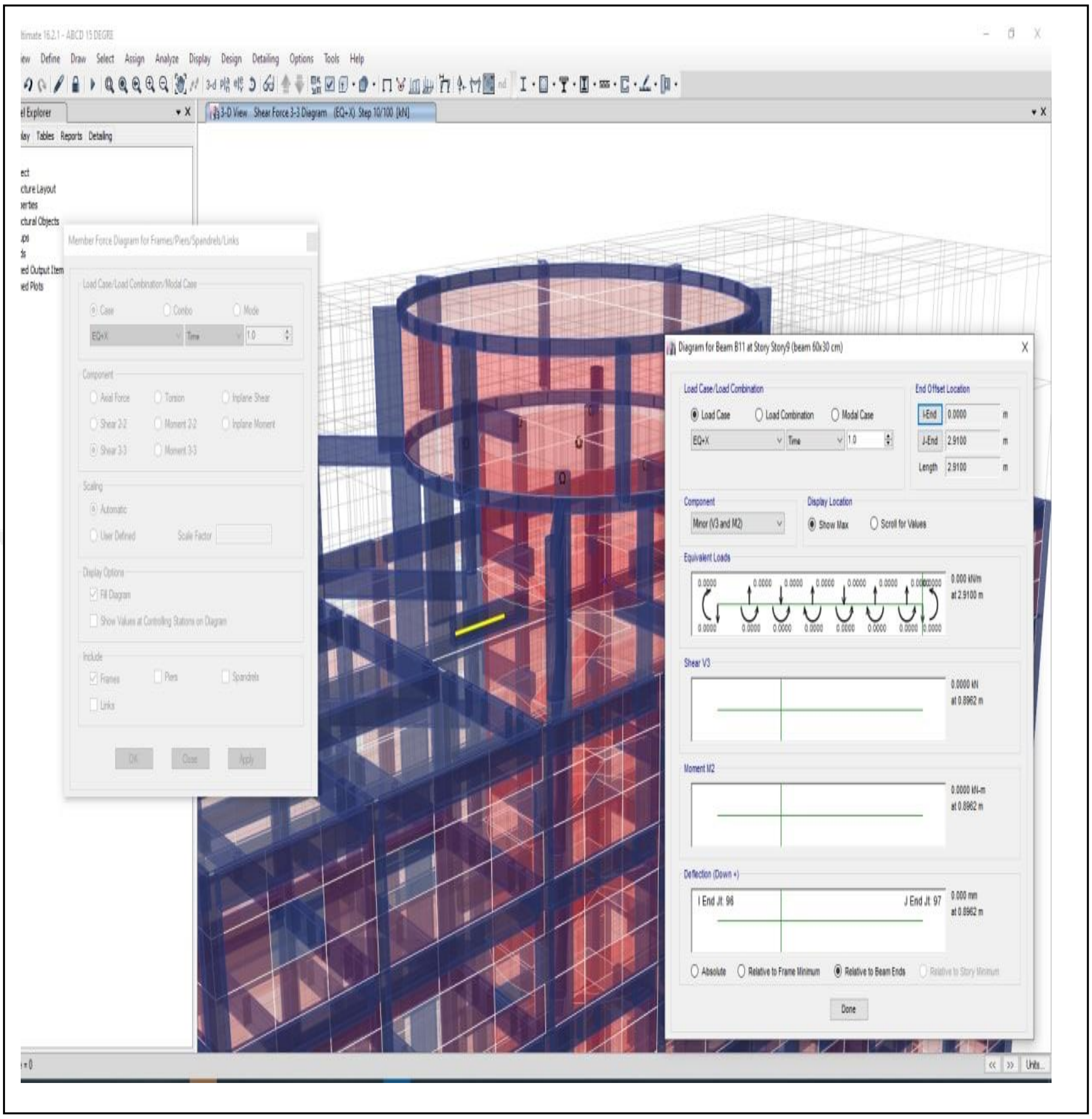

**Figure 5.9** A view Shows The The effect Shear of the wind on the Beams at story 9

A view of the projection showing the effect of the Shear on the beams of the project at story 9 equals V = 0 kN/m. of placing the fins at a point of $15^0$

**Table. 5.2** Demonstrate the effect of wind on the building for all floors in the x, y, z direction When placing the fins at an angle of $15^0$

| The effect of wind on the building for all floors in the direction of x, y, z | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Z** | **Y** | **X** | **Label** | **Drift** | **Direction** | **Load Case/Combo** | **Story** |
| **m** | **m** | **m** | | | | | |
| 36 | 8.63 | 14.32 | 6 | 0.000267 | Y | Dead | **Story12** |
| 36 | 8.63 | 14.32 | 6 | 1.70E-05 | Y | Live | **Story12** |
| 36 | 15.53 | 21.33 | 7 | 2.00E-05 | X | WIND 1 | **Story12** |
| 36 | 3.935 | 16.145 | 42 | 2.60E-05 | Y | WIND 1 | **Story12** |
| 33 | 17.26 | 29.18 | 165 | 9.40E-05 | X | Dead | **Story11** |
| 33 | 1.14 | 13.48 | 11 | 2.90E-05 | X | Live | **Story11** |
| 33 | 17.26 | 29.18 | 165 | 3.30E-05 | Y | Live | **Story11** |
| 33 | 17.26 | 29.18 | 165 | 481.71411 | X | WIND 1 | **Story11** |
| 30 | 11.72 | 42.66 | 15 | 4.20E-05 | X | Dead | **Story10** |
| 30 | 11.72 | 42.66 | 15 | 1.50E-05 | X | Live | **Story10** |
| 30 | 17.26 | 37.32 | 60 | 6.00E-06 | Y | Live | **Story10** |
| 30 | 17.26 | 17.34 | 92 | 7.00E-06 | X | WIND 1 | **Story10** |
| 27 | 6.4 | 0 | 49 | 2.00E-05 | X | Dead | **Story9** |
| 27 | 0 | 37.32 | 61 | 1.60E-05 | Y | Dead | **Story9** |
| 27 | 6.4 | 0 | 49 | 6.00E-06 | X | Live | **Story9** |
| 27 | 0 | 37.32 | 61 | 5.00E-06 | Y | Live | **Story9** |
| 27 | 17.26 | 25.32 | 58 | 7.00E-06 | X | WIND 1 | **Story9** |
| 24 | 0 | 42.66 | 44 | 1.60E-05 | X | Dead | **Story8** |
| 24 | 14.21 | 42.66 | 14 | 1.70E-05 | Y | Dead | **Story8** |
| 24 | 5.54 | 42.66 | 40 | 4.00E-06 | X | Live | **Story8** |
| 24 | 17.26 | 42.66 | 13 | 5.00E-06 | Y | Live | **Story8** |
| 24 | 17.26 | 25.32 | 58 | 7.00E-06 | X | WIND 1 | **Story8** |
| 21 | 0 | 42.66 | 44 | 1.70E-05 | X | Dead | **Story7** |
| 21 | 0 | 42.66 | 44 | 1.70E-05 | Y | Dead | **Story7** |
| 21 | 0 | 42.66 | 44 | 4.00E-06 | X | Live | **Story7** |
| 21 | 0 | 42.66 | 44 | 5.00E-06 | Y | Live | **Story7** |
| 21 | 17.26 | 37.32 | 60 | 7.00E-06 | X | WIND 1 | **Story7** |
| 18 | 17.26 | 42.66 | 13 | 1.80E-05 | X | Dead | **Story6** |
| 18 | 11.62 | 24.715 | 190 | 1.80E-05 | Y | Dead | **Story6** |
| 18 | 11.72 | 42.66 | 15 | 4.00E-06 | X | Live | **Story6** |
| 18 | 11.62 | 24.715 | 190 | 5.00E-06 | Y | Live | **Story6** |
| 18 | 17.26 | 42.66 | 13 | 7.00E-06 | X | WIND 1 | **Story6** |
| 15 | 17.26 | 42.66 | 13 | 1.90E-05 | X | Dead | **Story5** |
| 15 | 11.62 | 24.715 | 190 | 1.90E-05 | Y | Dead | **Story5** |
| 15 | 17.26 | 42.66 | 13 | 4.00E-06 | X | Live | **Story5** |
| 15 | 11.62 | 24.715 | 190 | 5.00E-06 | Y | Live | **Story5** |
| 15 | 17.26 | 11.92 | 57 | 6.00E-06 | X | WIND 1 | **Story5** |
| 12 | 11.62 | 24.715 | 190 | 2.20E-05 | X | Dead | **Story4** |
| 12 | 8.625 | 25.375 | 34 | 5.00E-06 | Y | Live | **Story4** |
| 12 | 17.26 | 42.66 | 13 | 6.00E-06 | X | WIND 1 | **Story4** |
| 9 | 8.625 | 25.375 | 34 | 2.30E-05 | Y | Dead | **Story3** |
| 9 | 8.63 | 0 | 50 | 6.00E-06 | X | Live | **Story3** |
| 9 | 17.26 | 5.34 | 55 | 5.00E-06 | X | WIND 1 | **Story3** |
| 6 | 0 | 42.66 | 44 | 3.20E-05 | X | Dead | **Story2** |
| 6 | 17.26 | 37.32 | 60 | 6.00E-06 | Y | Live | **Story2** |
| 6 | 17.26 | 25.32 | 58 | 5.00E-06 | X | WIND 1 | **Story2** |
| 3 | 11.72 | 11.92 | 74 | 0.000606 | X | Dead | **Story1** |
| 3 | 11.72 | 11.92 | 74 | 0.00026 | X | Live | **Story1** |
| 3 | 8.625 | 17.275 | 17 | 5.00E-06 | Y | WIND 1 | **Story1** |

Through ETABS 2016 the results were obtained when placing the fins at $15^0$

## Third : When we install the fins at $30^0$ Figure 5.10

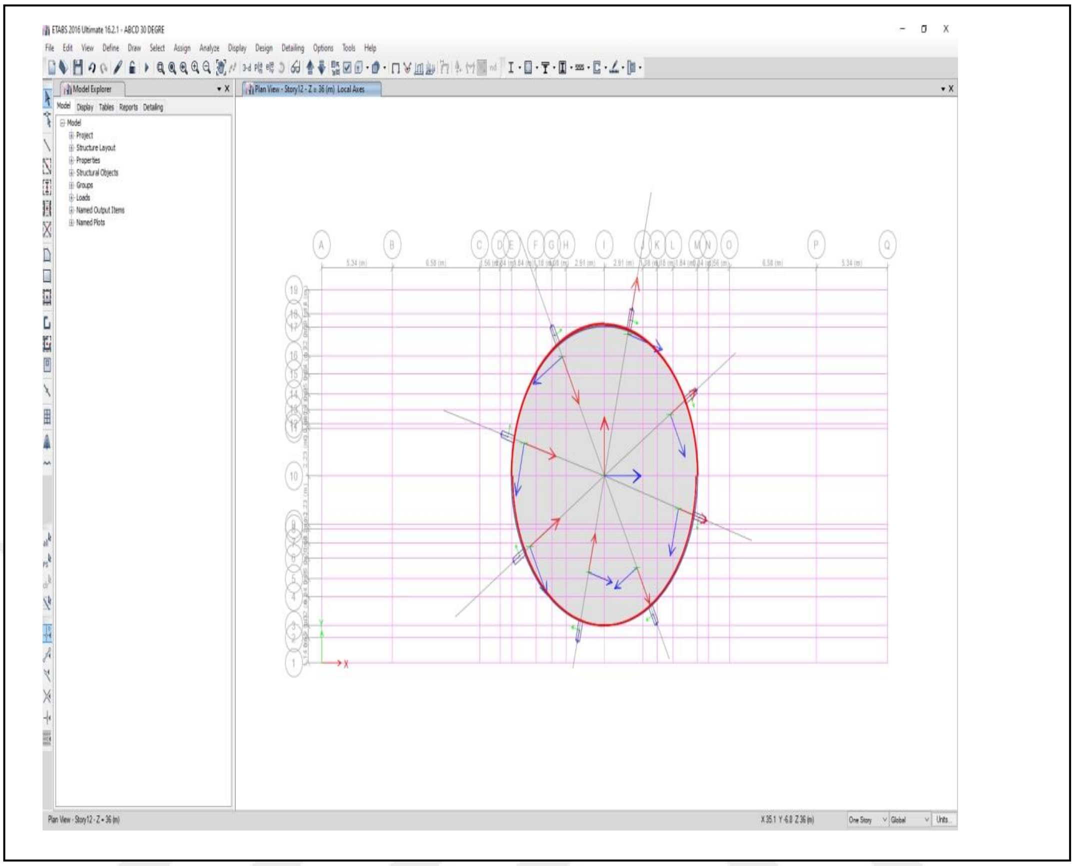


**Figure 5.10** 12th story projection when fins are positioned at an angle of 30°

Scheme showing the installation of the fins at a point of $30^0$ To study the effect of wind force on the building by placing the fins at a point of $30^0$ by fixing the bin.

### C . When we install the fins at $30^0$

Figure shows Figure 5.11

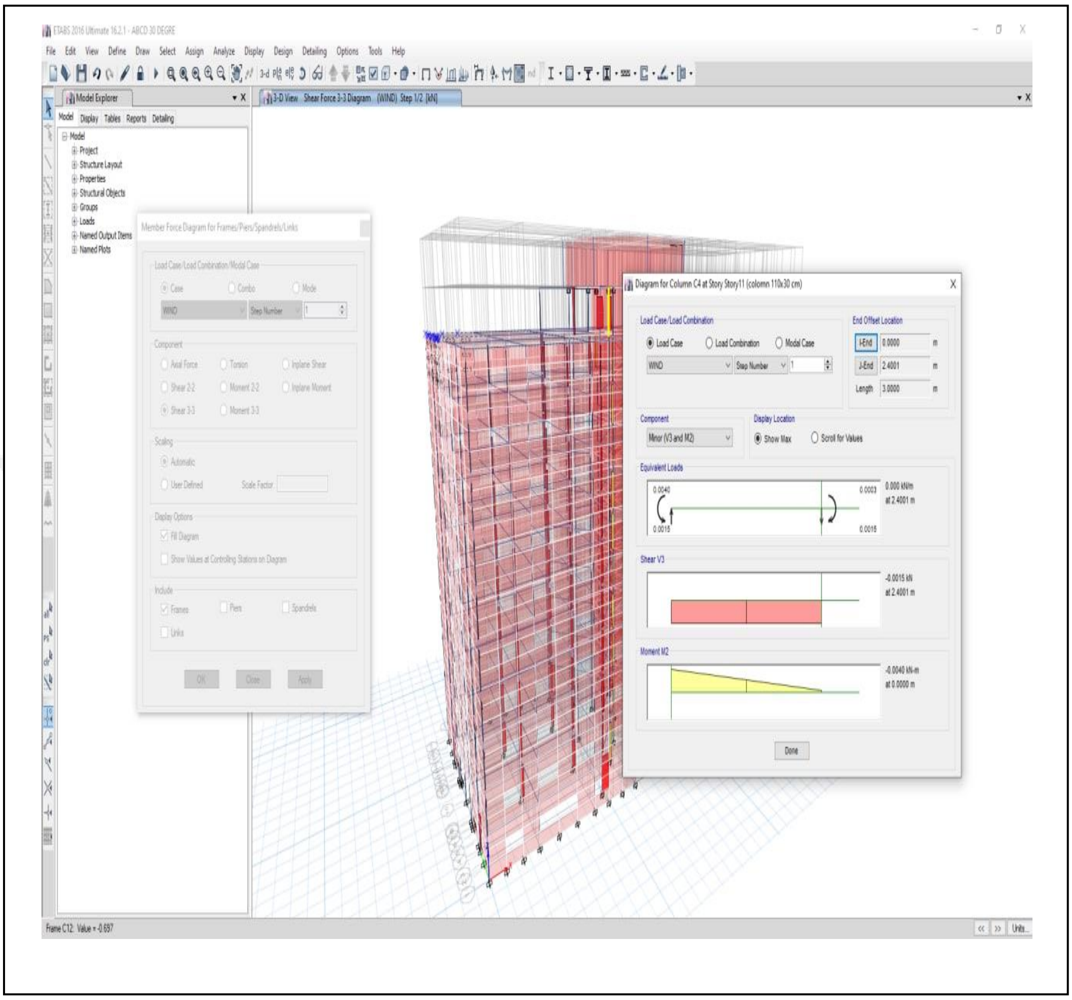

**Figure 5.11** A view Shows The The effect Shear of the wind on the columns at story $11^{th}$

A view of the projection showing the effect of the Shear on the columns of the project at story 11th equals V = 0.0015 KN/m. of placing the fins at a point of $30^0$

Figure shows Figure 5.12

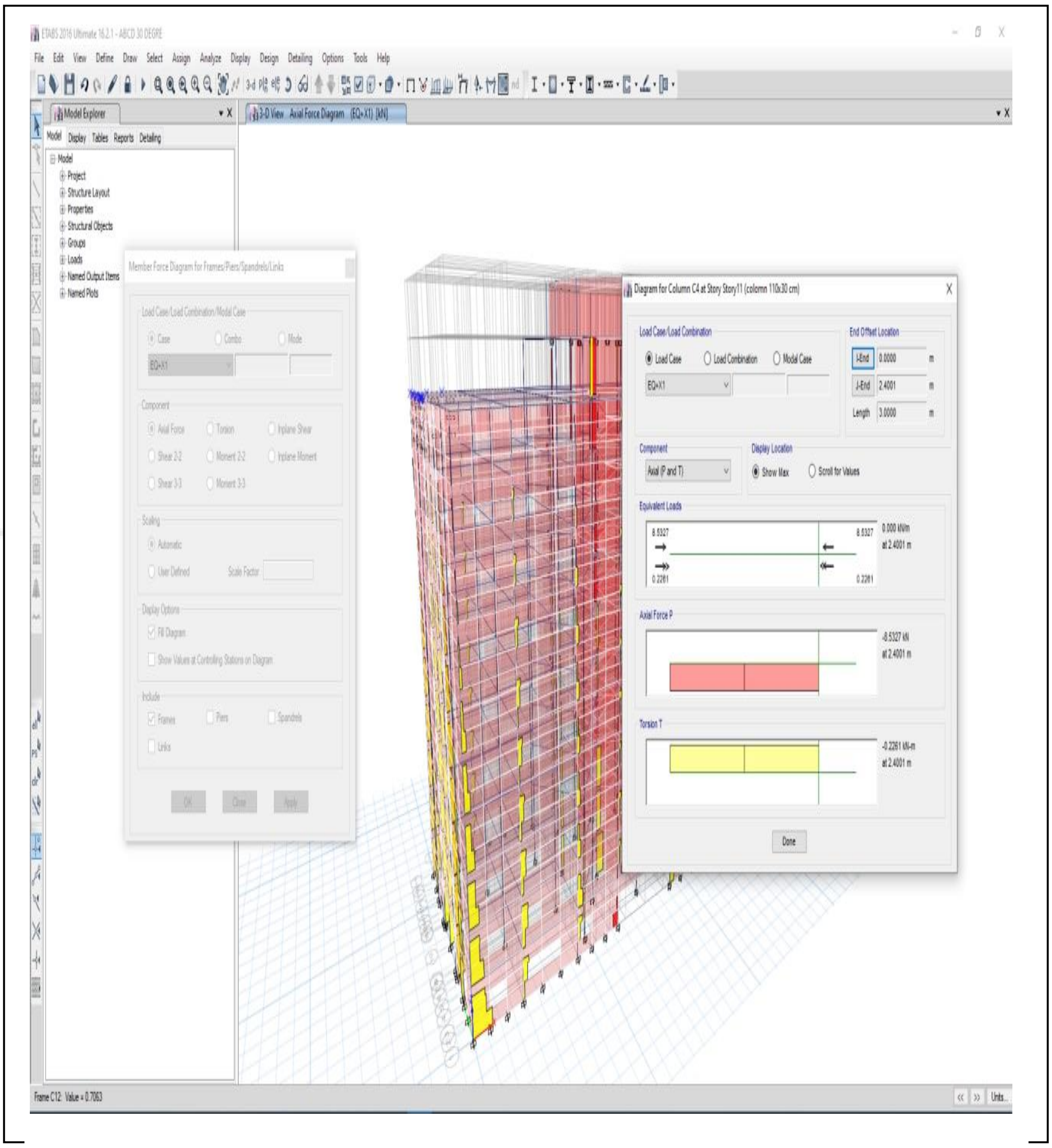

**Figure 5.12** A view Shows The The effect force of the wind on the columns at

A view of the projection showing the effect of the force on the columns of the project at story 11th equals F = .5.612 KN/m. of placing the fins at a point of $30^0$

**Table 5.3** Demonstrate the effect of wind on the building for all stories in the x, direction When placing the fins at an angle of $30^0$

| The effect of wind on the building for all floors in the direction of x, y, z | | | | | | | |
|---|---|---|---|---|---|---|---|
| Z | Y | X | Label | Drift | Direction | Load Case/Combo | Story |
| m | m | m | | | | | |
| 36 | 8.63 | 14.32 | 6 | 0.000165 | Y | Dead | **Story12** |
| 36 | 8.63 | 14.32 | 6 | 3.62E-07 | X | Live | **Story12** |
| 36 | 8.63 | 14.32 | 6 | 0 | Y | WIND 1 | **Story12** |
| 33 | 17.26 | 29.18 | 165 | 4.90E-05 | X | Dead | **Story11** |
| 33 | 1.14 | 13.48 | 11 | 2.00E-05 | X | Live | **Story11** |
| 33 | 0 | 29.18 | 164 | 6.00E-06 | X | WIND 1 | **Story11** |
| 30 | 17.26 | 37.32 | 60 | 6.00E-06 | Y | Dead | **Story10** |
| 30 | 5.54 | 42.66 | 40 | 1.20E-05 | X | Live | **Story10** |
| 30 | 17.26 | 37.32 | 60 | 3.00E-06 | Y | Live | **Story10** |
| 30 | 17.26 | 0 | 54 | 7.18E-09 | Y | WIND 1 | **Story10** |
| 27 | 0 | 5.34 | 56 | 2.00E-06 | Y | Dead | **Story9** |
| 27 | 0 | 37.32 | 61 | 1.00E-06 | Y | Live | **Story9** |
| 27 | 0 | 17.34 | 64 | 3.58E-08 | X | WIND 1 | **Story9** |
| 27 | 3.05 | 0 | 46 | 1.06E-08 | Y | WIND 1 | **Story9** |
| 24 | 12.6275 | 21.19 | 206 | 2.00E-06 | Y | Dead | **Story8** |
| 24 | 17.26 | 30.74 | 59 | 1.00E-06 | Y | Live | **Story8** |
| 24 | 0 | 17.34 | 64 | 4.96E-08 | X | WIND 1 | **Story8** |
| 24 | 0 | 0 | 45 | 1.46E-08 | Y | WIND 1 | **Story8** |
| 21 | 12.6275 | 21.19 | 206 | 3.00E-06 | Y | Dead | **Story7** |
| 21 | 12.6275 | 21.19 | 206 | 1.00E-06 | Y | Live | **Story7** |
| 21 | 0 | 25.32 | 63 | 6.43E-08 | X | WIND 1 | **Story7** |
| 21 | 0 | 0 | 45 | 1.86E-08 | Y | WIND 1 | **Story7** |
| 18 | 17.26 | 42.66 | 13 | 5.00E-06 | X | Dead | **Story6** |
| 18 | 12.6275 | 21.19 | 206 | 4.00E-06 | Y | Dead | **Story6** |
| 18 | 17.26 | 42.66 | 13 | 1.00E-06 | X | Live | **Story6** |
| 18 | 11.62 | 24.715 | 190 | 1.00E-06 | Y | Live | **Story6** |
| 18 | 0 | 11.92 | 72 | 8.07E-08 | X | WIND 1 | **Story6** |
| 18 | 0 | 0 | 45 | 2.22E-08 | Y | WIND 1 | **Story6** |
| 15 | 17.26 | 42.66 | 13 | 6.00E-06 | X | Dead | **Story5** |
| 15 | 11.62 | 24.715 | 190 | 4.00E-06 | Y | Dead | **Story5** |
| 15 | 17.26 | 42.66 | 13 | 1.00E-06 | X | Live | **Story5** |
| 15 | 11.62 | 24.715 | 190 | 1.00E-06 | Y | Live | **Story5** |
| 15 | 17.26 | 0 | 54 | 1.01E-07 | X | WIND 1 | **Story5** |
| 15 | 5.795 | 24.715 | 191 | 2.86E-08 | Y | WIND 1 | **Story5** |
| 12 | 17.26 | 42.66 | 13 | 8.00E-06 | X | Dead | **Story4** |
| 12 | 6.4 | 0 | 49 | 5.00E-06 | Y | Dead | **Story4** |
| 12 | 17.26 | 0 | 54 | 2.00E-06 | Y | Live | **Story4** |
| 12 | 5.875 | 18 | 192 | 1.26E-07 | X | WIND 1 | **Story4** |
| 12 | 0 | 42.66 | 44 | 4.36E-08 | Y | WIND 1 | **Story4** |
| 9 | 17.26 | 30.74 | 59 | 9.00E-06 | X | Dead | **Story3** |
| 9 | 14.21 | 0 | 53 | 2.00E-06 | Y | Live | **Story3** |
| 9 | 12.6275 | 21.19 | 206 | 1.55E-07 | X | WIND 1 | **Story3** |
| 9 | 11.72 | 42.66 | 15 | 6.15E-08 | Y | WIND 1 | **Story3** |
| 6 | 8.625 | 17.275 | 17 | 8.00E-06 | Y | Dead | **Story2** |
| 6 | 17.26 | 5.34 | 55 | 2.00E-06 | Y | Live | **Story2** |
| 6 | 0 | 0 | 45 | 2.86E-07 | Y | WIND 1 | **Story2** |
| 3 | 0 | 42.66 | 44 | 8.00E-06 | X | Dead | **Story1** |
| 3 | 0 | 5.34 | 56 | 1.00E-06 | Y | Live | **Story1** |
| 3 | 17.26 | 0 | 54 | 3.00E-06 | Y | WIND 1 | **Story1** |

Through ETABS 2016 the results were obtained when placing the fins at $30^0$

### 5.2.2 The results of the calculations on ETABS

Through the modeling of the building and its analysis on the ETABS program, the results were extracted below according to the three cases, and the fins were placed at (0, 15, $30^0$). Figure 4.51.

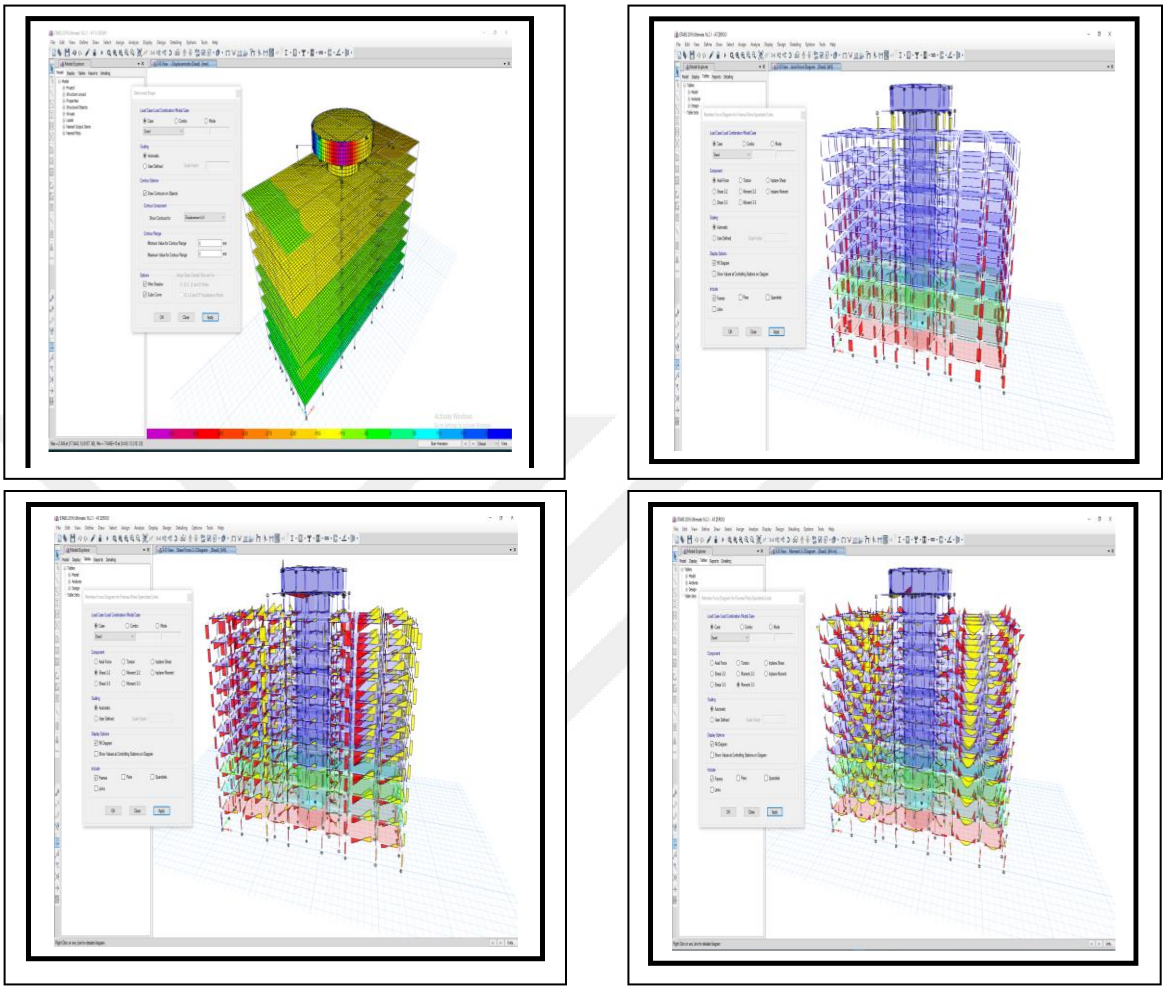

**Figure 5.13** Forms of the effect of wind on the building and finding the moments and displacement in general when placing the fins at zero

Area Figures (5.13) Moments that affect the building if the fins are installed at $0^0$

First: the results of the analysis when placing the fins at 0. The wind speed in all cases is 75 km / h

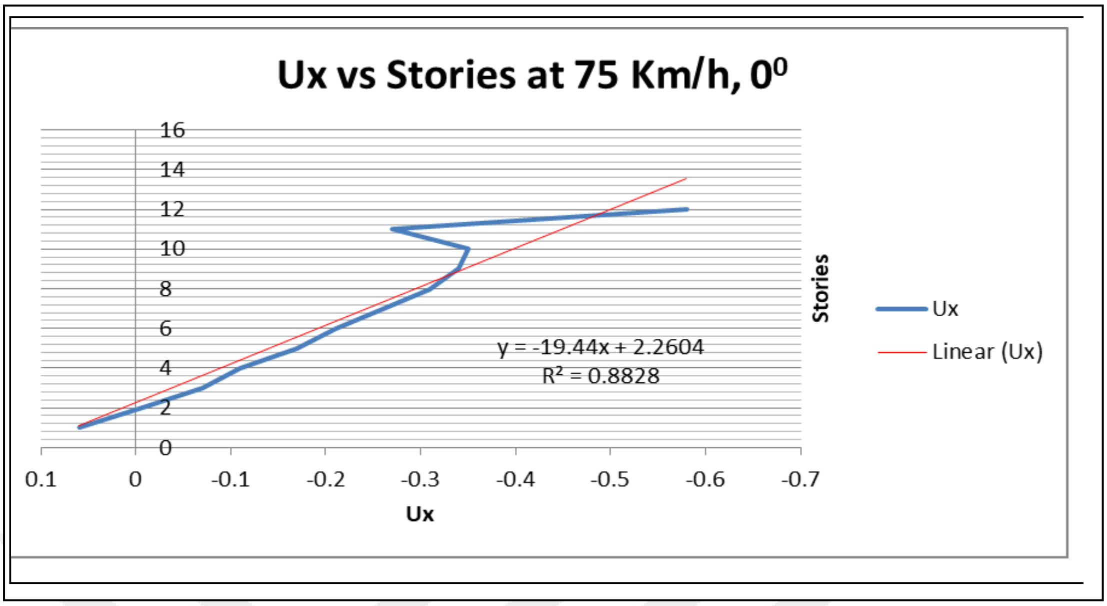


**Figure 5.14** A The graph shows the effective standard deviation of the displacement ux direction at zero

The above graph shows the relationship between displacements in the ux direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.8828$ When fixing the fins at zero degrees

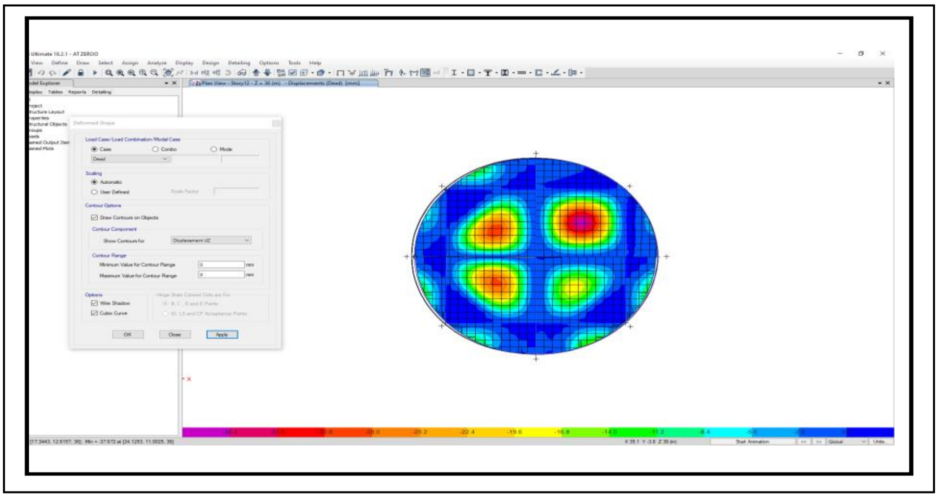

**Figure 5.15** The parsing form of Etabs ux at zero at $12_{th}$

The figure above shows the effect of the displacement in the direction of the ux on the 12th floor when the fins are fixed at zero degrees.

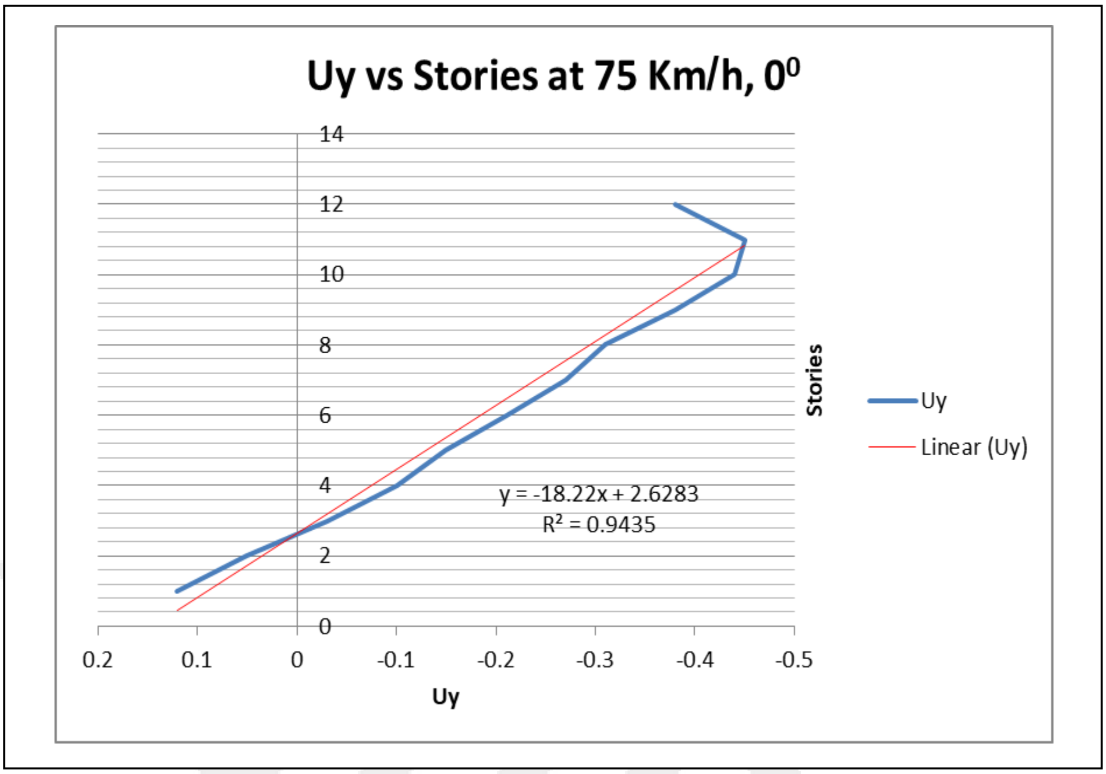


**Figure 5.16** A The graph shows the effective standard deviation of the displacement

The above graph shows the relationship between displacements in the uy direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.9435$ When fixing the fins at zero degrees.

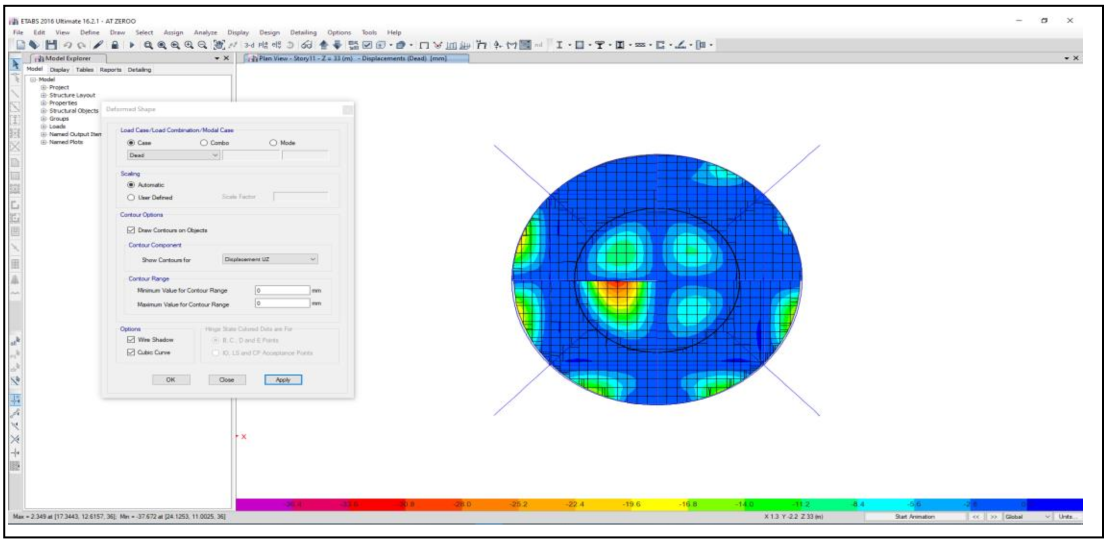

**Figure 5.17** The parsing form of ETABS ux at zero at $11_{th}$ story.

The figure above shows the effect of the displacement in the direction of the ux on the 11th floor when the fins are fixed at zero degrees

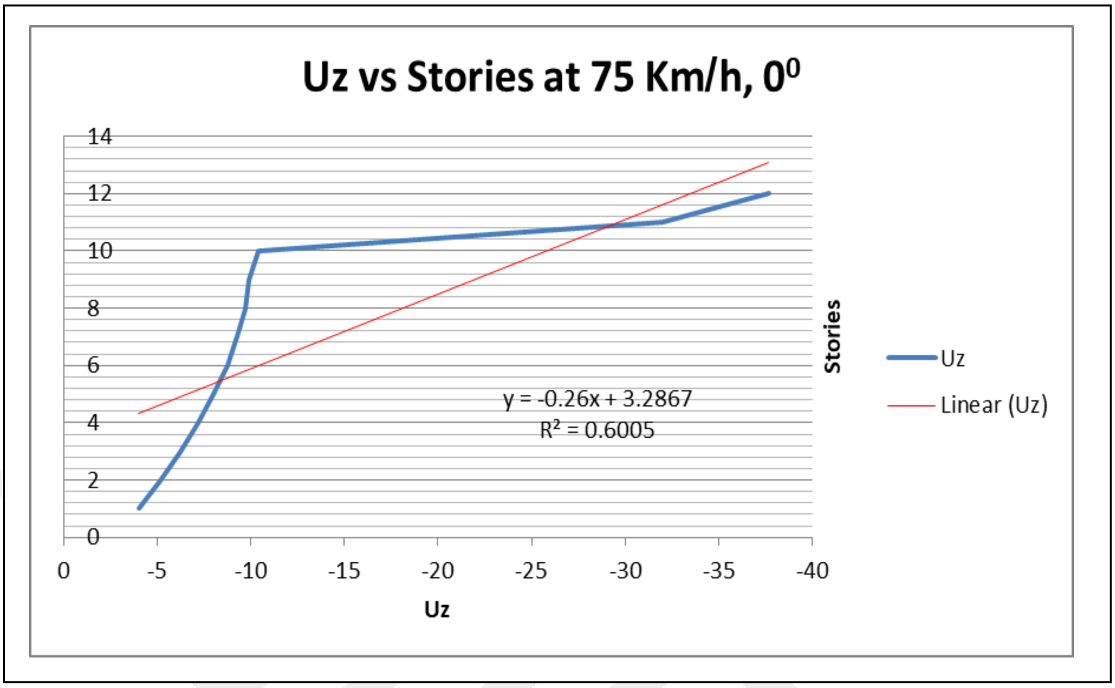


**Figure 5.18** A The graph shows the effective standard deviation of the displacement uz direction at zero

The above graph shows the relationship between displacements in the uz direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.6005$ When fixing the fins at zero degrees.

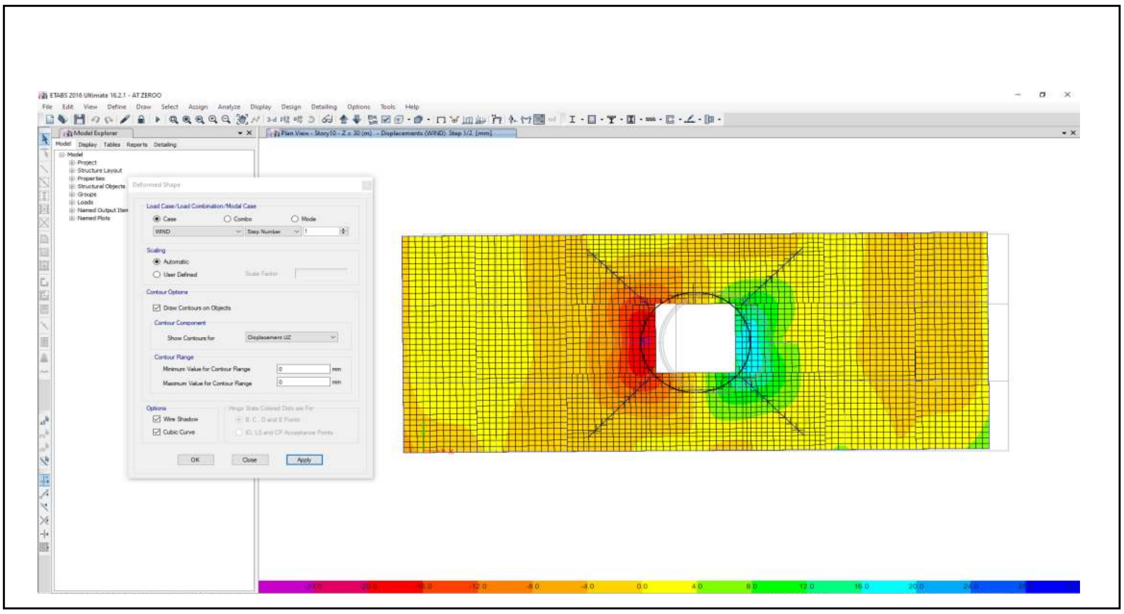

**Figure 5.19** The parsing form of ETABS ux at zero multi story

The figure above shows the effect of the displacement in the direction of the ux on the 11th floor when the fins are fixed at zero degrees.

Secondly: the results of the analysis when placing the fins at $15^0$. The wind speed in all cases is fixed at 75 km per hour

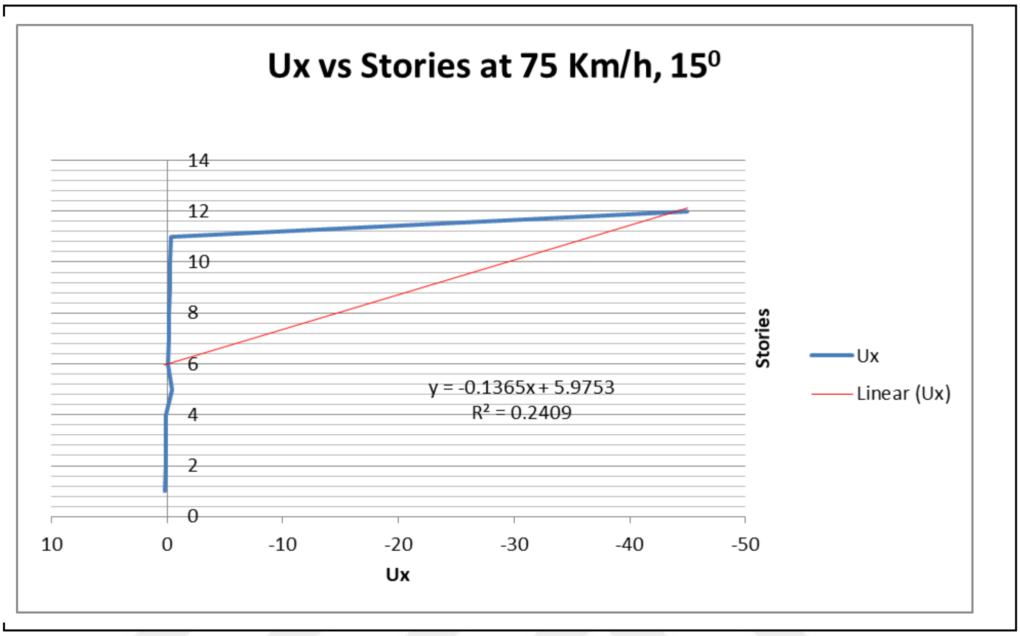


**Figure 5.20** Graph showing the effective standard deviation of the $15^0$-way

The above graph shows the relationship between displacements in the ux direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.2409$ When fixing the fins at $15^0$

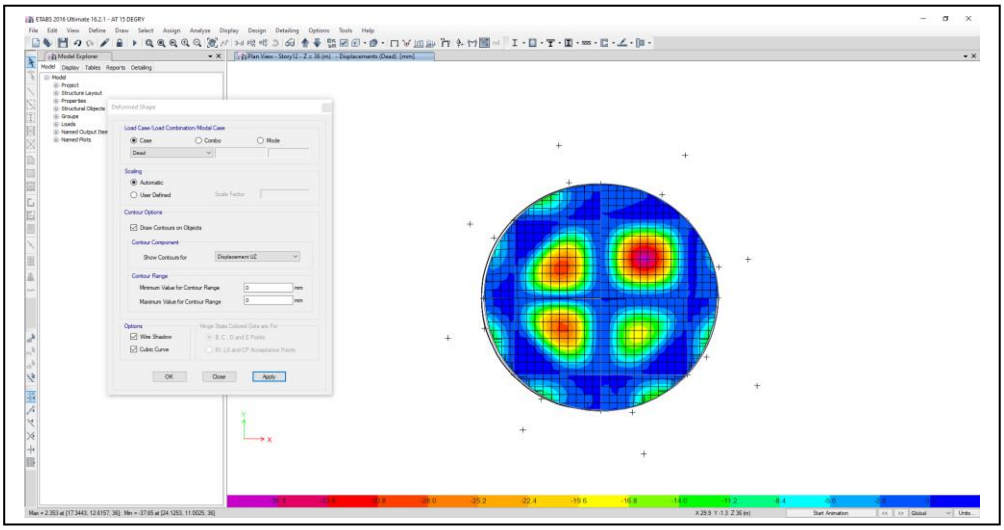

**Figure 5.21** The parsing form of ETABS ux at $15^0$ at $12_{th}$ story

The figure above shows the effect of the displacement in the direction of the ux on the 12th floor when the fins are fixed at $15^0$

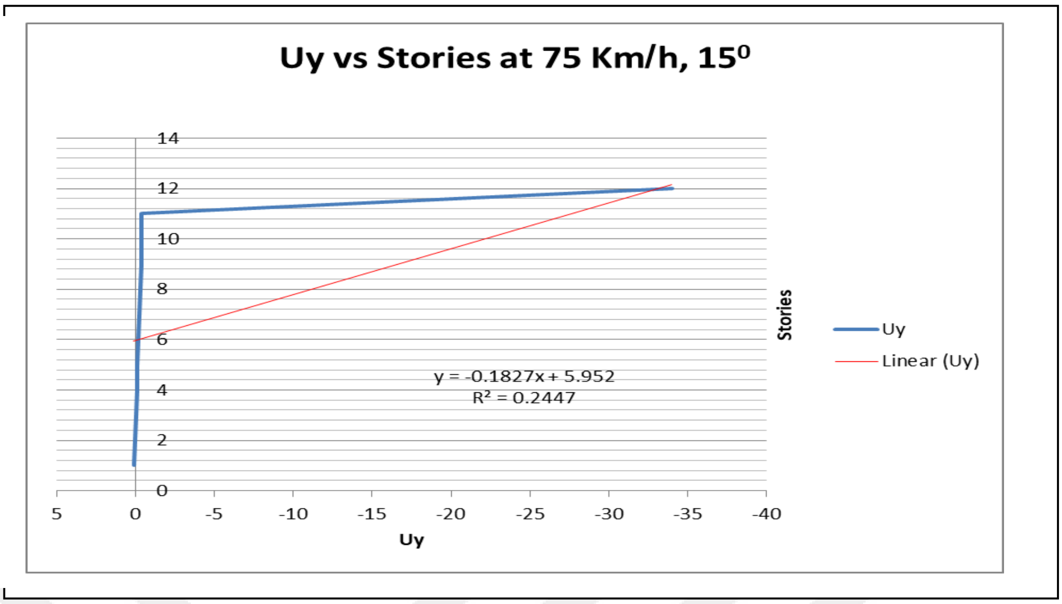


**Figure 5.22** A graph showing the effective standard deviation of the displacement in uy at $15^0$

The above graph shows the relationship between displacements in the uy direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.2447$ When fixing the fins at $15^0$

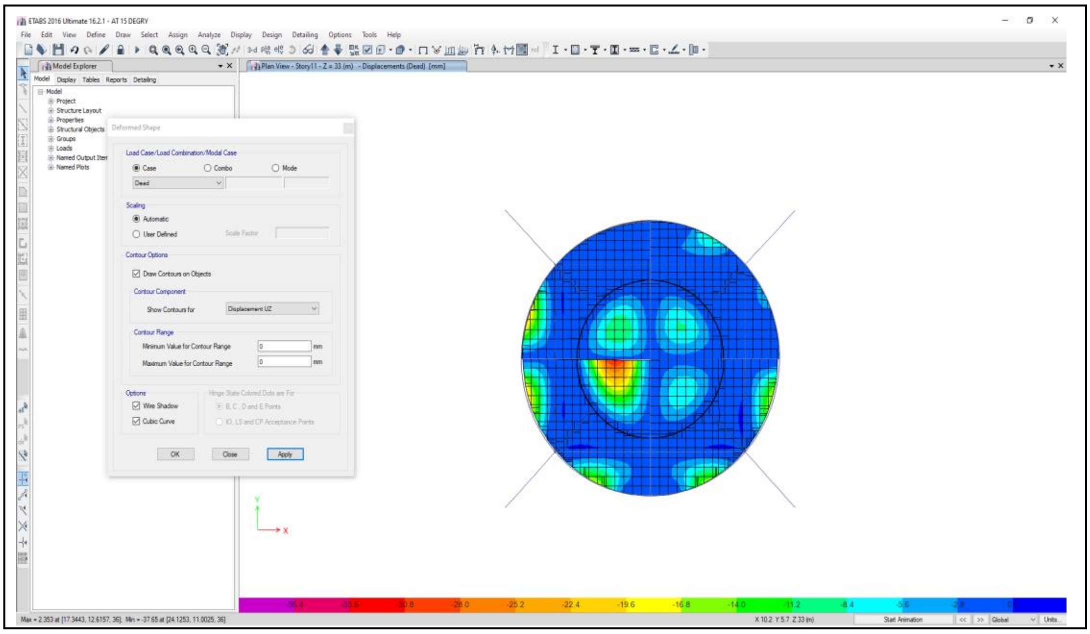

**Figure 5.23** The parsing form of ETABS ux at $15^0$ at $11_{th}$ story

The figure above shows the effect of the displacement in the direction of the ux on the 11th floor when the fins are fixed at $15^0$

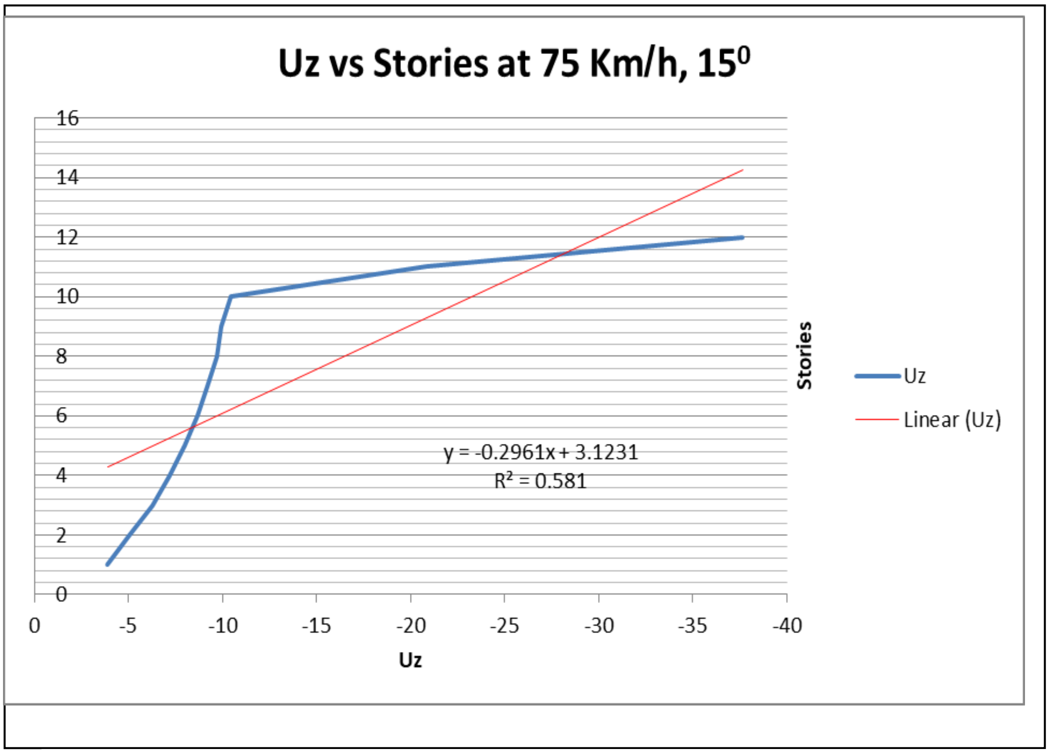


**Figure 5.24** A graph showing the effective standard deviation of the displacement in uy at $15^0$

The above graph shows the relationship between displacements in the uz direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.581$ When fixing the fins at $15^0$

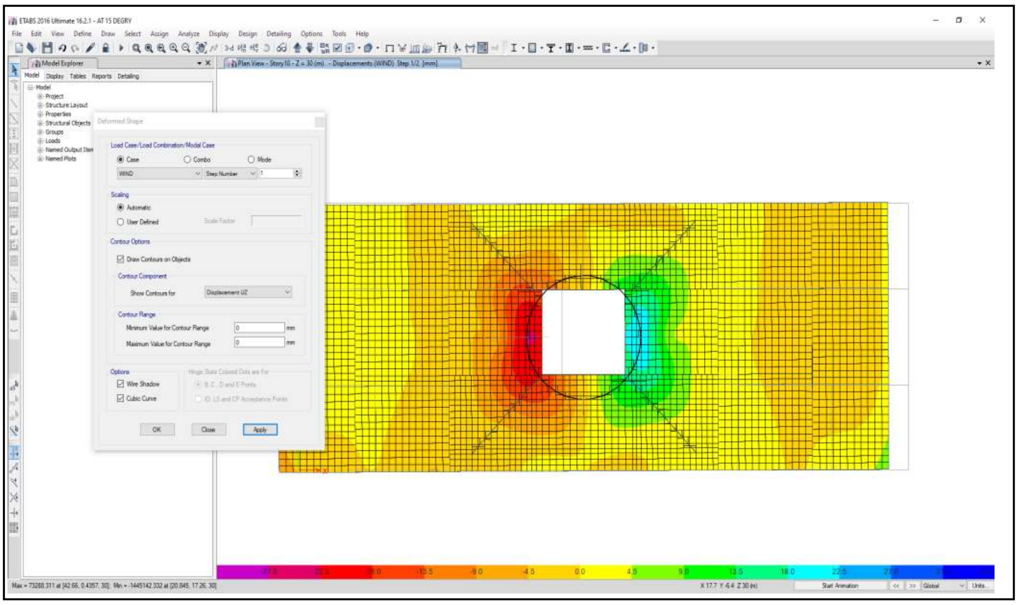

**Figure 5.25** The parsing form of Etabs ux at $15^0$ multi-story

The figure above shows the effect of the displacement in the direction of the ux on the 11th floor when the fins are fixed at zero degrees

Third: the results of the analysis when placing the fins at $30^0$. The wind speed in all cases is fixed at 75 km per hour.

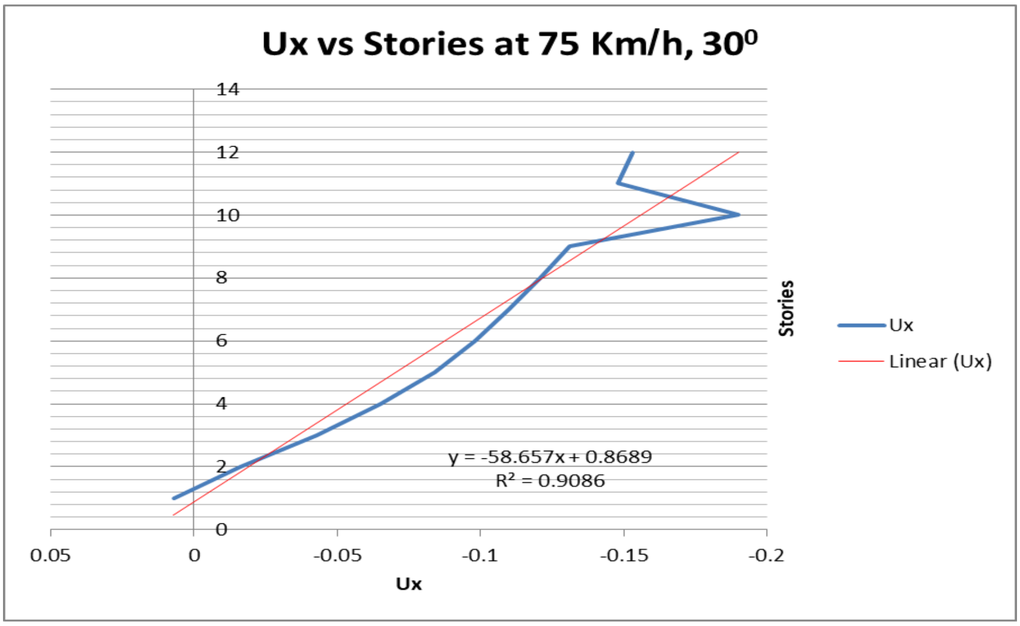


**Figure 5.26** A graph showing the effective standard deviation of the displacement in uy at $30^0$

The above graph shows the relationship between displacements in the ux direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.9086$ When fixing the fins at $30^0$

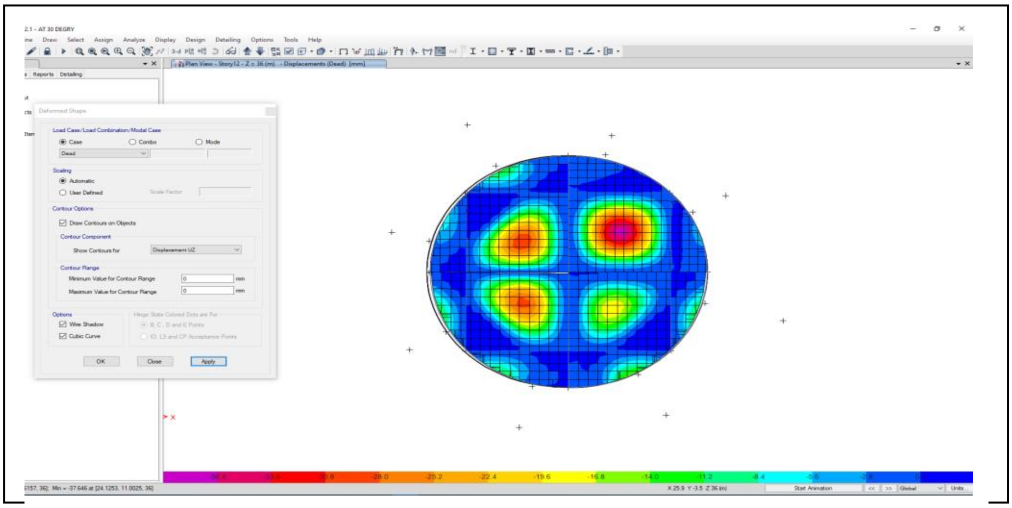

**Figure 5.27** The parsing form of Etabs ux at $30^0$ at $12_{th}$ story

The figure above shows the effect of the displacement in the direction of the ux on the 12th floor when the fins are fixed at $30^0$

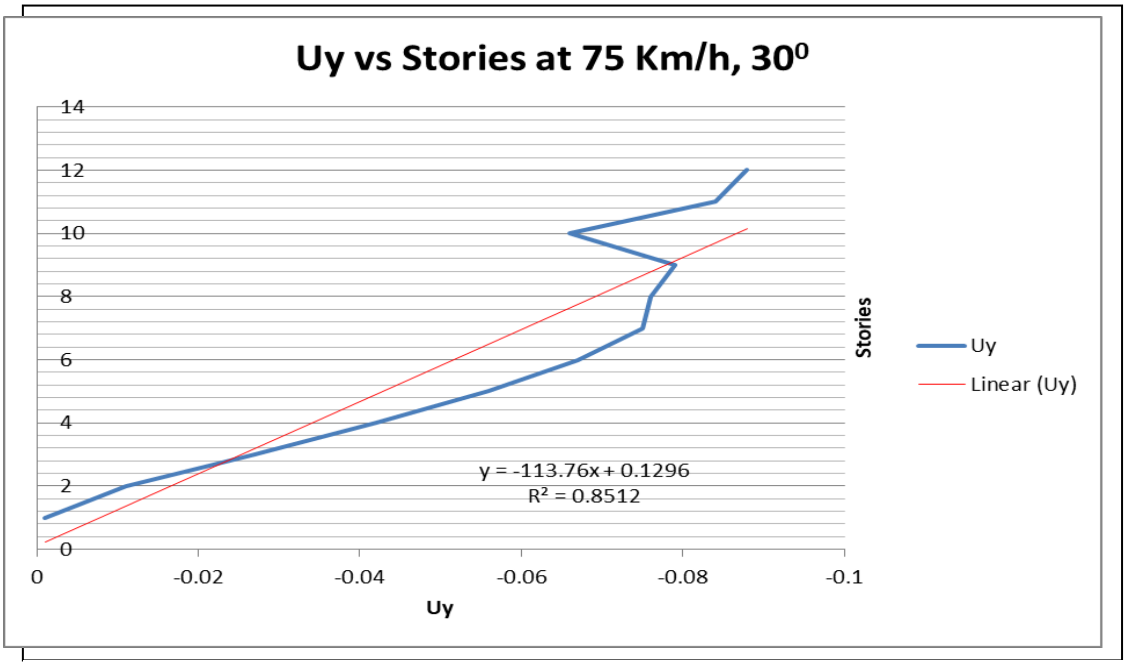


**Figure 5.28** A graph showing the effective standard deviation of the displacement in uy at $30^0$

The above graph shows the relationship between displacements in the uy direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2 = 0.8512$ When fixing the fins at $30^0$

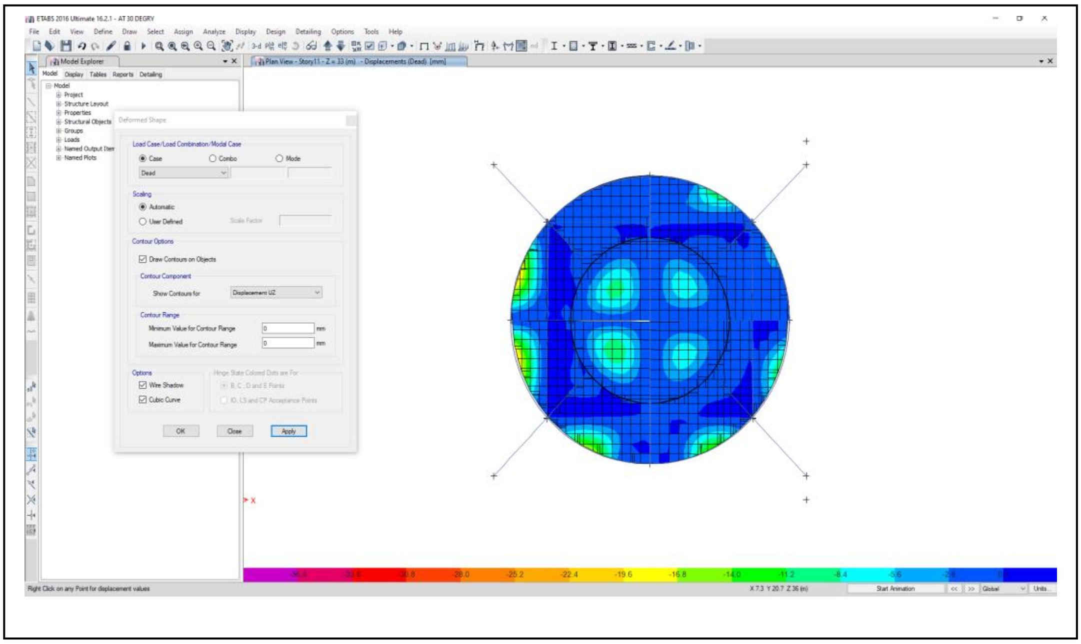

**Figure 5.29** The parsing form of Etabs ux at $30^0$ at $11_{th}$ story

The figure above shows the effect of the displacement in the direction of the ux on the 11th floor when the fins are fixed at $30^0$

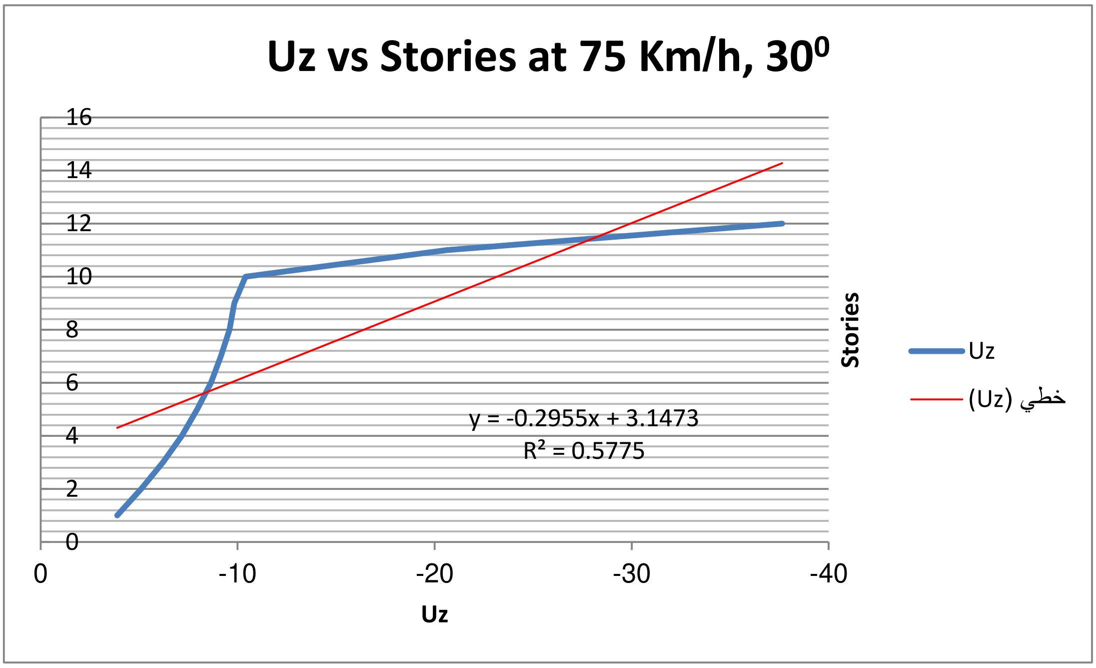


**Figure 5.30** A graph showing the effective standard deviation of the displacement in uy at $30^0$

The above graph shows the relationship between displacements in the uz direction when the wind speed is 75 km / h and when applying the standard deviation law, we get these results: $R^2$ = 0.5775When fixing the fins at $30^0$

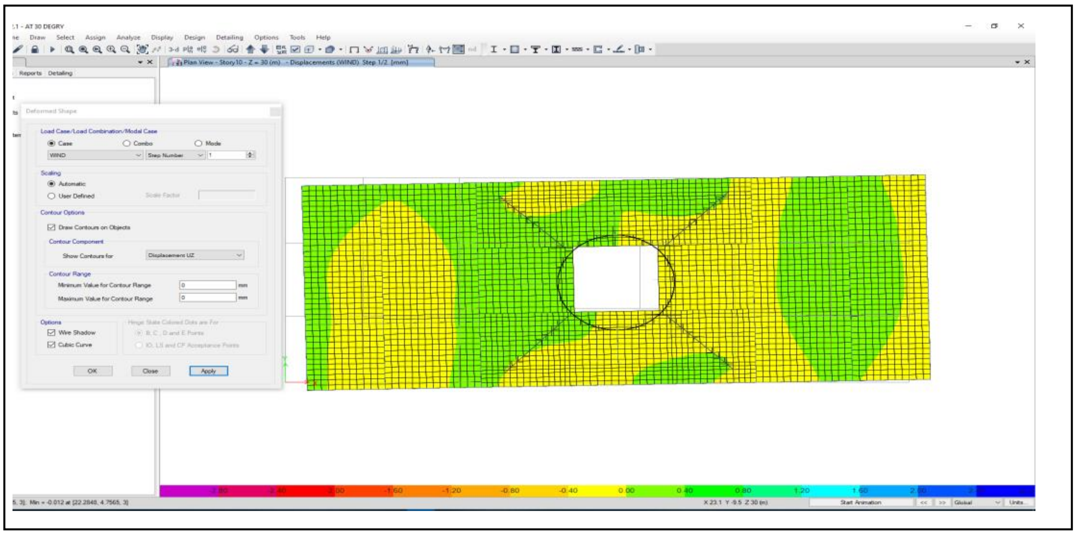

**Figure 5.31** The parsing form of Etabs ux at $30^0$ multi-story

The figure above shows the effect of the displacement in the direction of the ux on the 11th floor when the fins are fixed at zero degrees.

### 5.2.3 Comparison

Comparison between the maximum results of displacements of the axes and the effect of forces and moments on floors under the influence of wind at different angles.

Table 5.4 A table showing the difference in results between the three tests and finding the largest moment and displacement for each experiment.

| **Angles** | **$R^2_x$** | **$R^2_y$** | **$R^2_z$** | **Deflection (mm)** | **$V_{(KN)}$** | **$M_{(KN.m)}$** | **$T_{(KN.m)}$** |
|---|---|---|---|---|---|---|---|
| **0** | 0.8828 | 0.9435 | 0.6005 | 0.002 | 1.9070 | 0.8489 | 0.7115 |
| **$15^0$** | 0.2409 | 0.2447 | 0.581 | 0.004 | 0.3033 | 0.6573 | 0.9013 |
| **$30^0$** | 0.9086 | 0.8512 | 0.5775 | 1.352 | 0.4864 | 1.3336 | 0.0054 |

The table above It shows the results of the building analysis for 3 times, the first when placing the fins at zero, the second when placing the fins at 15 degrees, and the third at 30 degrees. Note that the number of fins used is 8 fins distributed on the circular structure of the 12th floor and installed on the 11th concrete floor in an artistic way. The fins were evenly distributed on the perimeter of the hull. Where the angle between each fin and the other was 45 degrees. This means that in each quarter of the circle there are 2 fins. So we took 3 models for analysis, which are at zero, at 15 degrees, and at 30 degrees. The fact that these tests are sufficient for the symmetry of the circuit in its four parts. SAP 2016 program was used for analysis and modeling of the building and the distribution of live and dead loads on the ceiling, as well as the loads of columns and beams. The hill of the 12th floor was designed from iron using I and U.shaped sections and was installed using PIN brackets. To study the effect of wind on the rotating part and the rest of the building. Through the analysis of the three cases, results were extracted regarding the effect of displacement, as well as the effect of moments for each of the floors.

The results of displacements for UX, UY, UZ were taken for each case and their displacement was extracted. We have obtained different results in each case, where the result of the displacement of UX at zero R2x equals 0.8828 mm and in the UY R2y equals 0.9435 mm and in the UZ R2z equals 0.6005 mm. Also, in the case of 15 degrees, the results were R2x equal to 0.2409 mm and R2y equal to 0.2447 mm and R2z equal to 0.5775 mm and at 30 degrees R2x equal to 0.9086 mm and R2y equal to 0.8512 mm and R2z equal to 0.5775 mm as in Table No. 5.

It was noted that there is a difference in the results in displacements as the differences in UX 0.8828 0.9086 0.2409 The largest displacement at 30 degrees, followed by zero degrees and finally 15 degrees.

It was noted that the differences in UY 0.8512, 0.9435, 0.2447 the largest displacement at zero degrees, followed by the 30 degrees and finally 15 degrees.

The differences in UZ 0.8512,0.9435, 0.2447 are observed to have the largest displacement at zero degrees, followed by 15 degrees and finally 30 degrees.

Also, the results of the largest displacement, torque, torsion and shear results were extracted, and there were differences in the results. Deflection mm (.0.002 at 00, 0.004 at 150, .1.352 at 300 ). And V(KN) shear (1.9070 at 00, 0.3033
At 150, 0.4864 at 300). And M(KN.m) moment (0.8489 at 00, 0.6573 at 150, 1.3336 at 300). And T(KN.m) torsion (0.7115 at 00, 0.9013 at 150, 0.0054 t 300).

Since our study is the The effect of the force of the wind on the rotor floors and its effect on the building, we conclude that the effect is more in the direction of X because it affects the building directly, The effect of the force of the wind on the building increases the higher we go up.

We get the largest and acceptable standard deviation at the 30 degree. The position of the fins at a degree of 30 degrees is the most appropriate for this building. Note that the wind speed of the city of Baghdad was taken 75 km per hour as a maximum speed, and the building was placed in the direction of the X to study the effect of the wind. Thus, the result of placing the most appropriate fins is at a degree of 30.

### 5.2.4 The results obtained from the structural analysis of the proposed building

The following Figures (→) illustrate the results of structural analysis of the proposal building using ETABS 2016 program Figure 4.70 to Figure 4.74

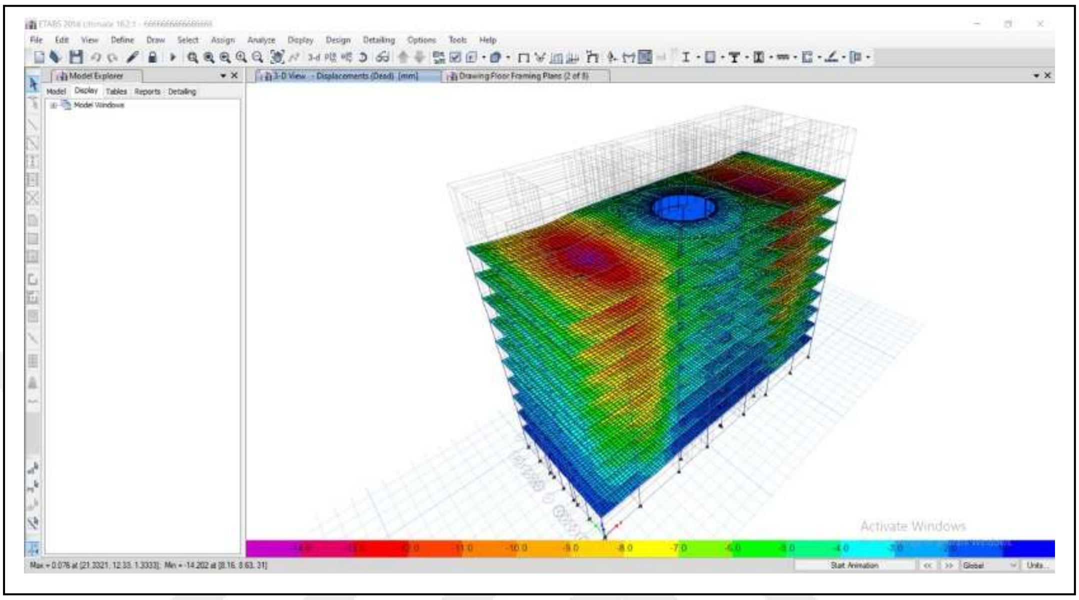

**Figure 5.32** The shape of the building after analysis shows the effect of wind and displacement on the building

The above figure shows the displacement of all floors and the extent of the displacement difference according to each floor and shows the largest displacements in red color descending to blue.

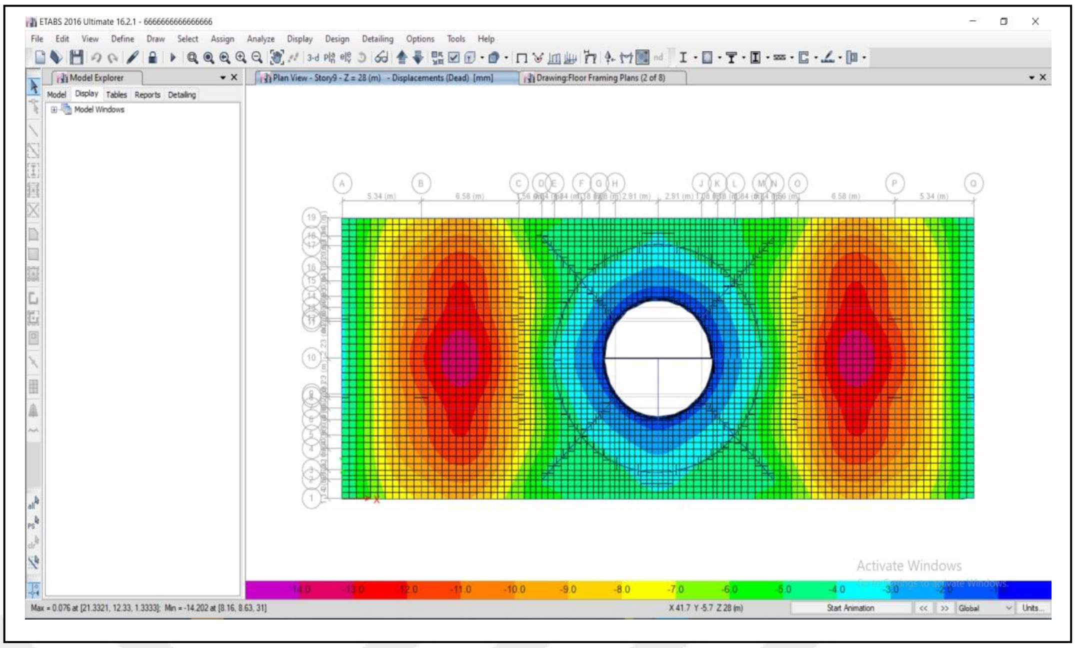

**Figure 5.33** The shape of the building after analysis shows the effect of wind and displacement on the ceilings of the upper floors

The effect of displacement on the upper repeated floors when the building is exposed to ux winds at a speed of 75 km /h.

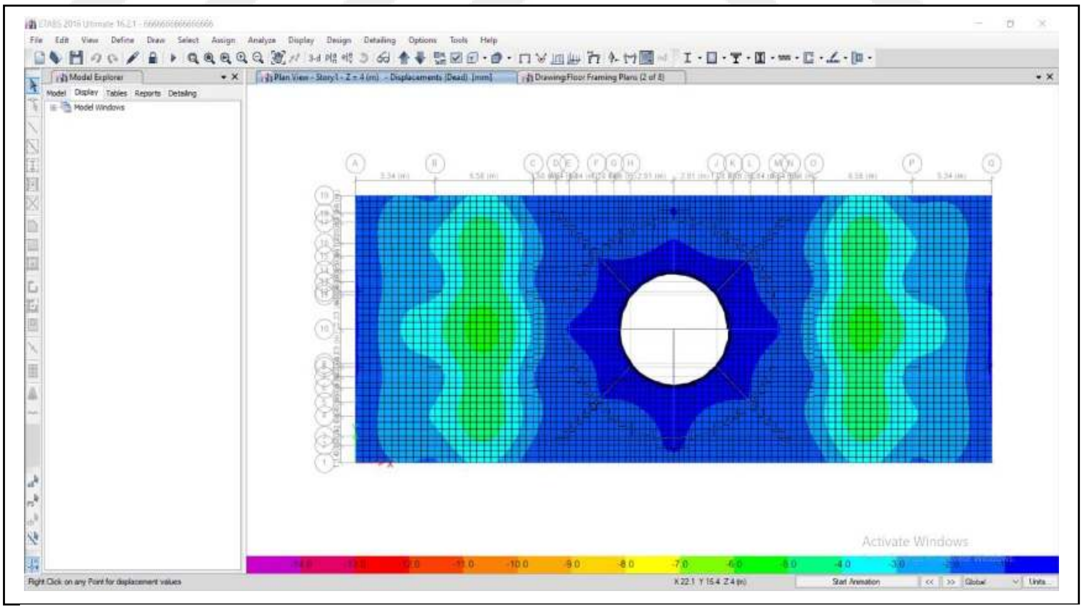

**Figure 5.34** The shape of the building after analysis shows the effect of wind and displacement on the ceilings of the lower floors

The effect of displacement on the lower repeated floors when the building is exposed to UX winds at a speed of 75 km /h

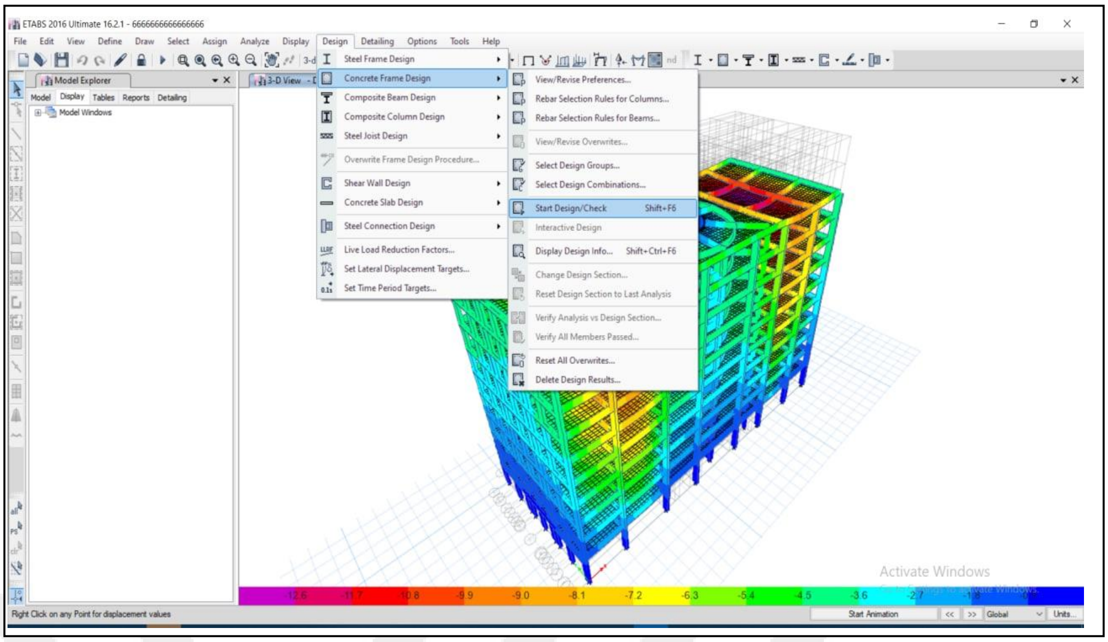

**Figure 5.35** The shape of the building after analysis shows the effect of wind and displacement on the columns and beams

The above figure shows the effect of displacement on the beams on all floors.

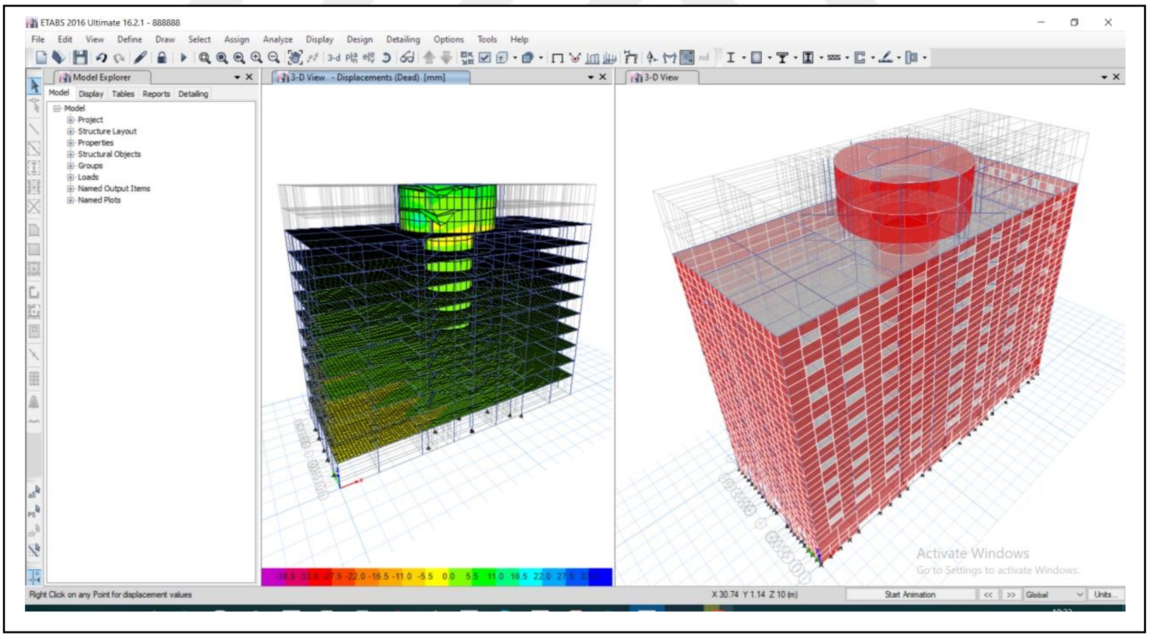

**Figure 5.36** The figure shows the final modeling of the building after analysis under the influence of wind

The above figure shows the building in a grid and 3D form inside the ETABS 2016.

#### 5.2.2.1 Advantages of using ETABS 2016 program in structural analysis.

The ETABS program is one of CSI's products. The program is used to design concrete buildings in a three-dimensional manner, so that it helps to analyze, understand and design buildings structurally using international codes under the influence of side loads such as wind and earthquakes, and gravitational loads (Dead and Live Loads) such as concrete loads, tile loads, and mobile loads such as humans. The ETABS is one of the programs in which we can dynamically analyze hundreds of buildings, especially the structural participants. Nonlinear geometric analysis of area tires under static or dynamic loads can be expected

considering all the geometric nonlinear behavior and inelasticity of materials, and their features can be summarized as follows:

1 . The new version contains important developments in the subject of seismic design and performing the dynamic analysis of the fault by knowing the actual behavior of the structure by calculating and evaluating the dissipated energy within the structure during its exposure to the earthquake, which the company called (Performance Based Design: PBD).
2 . (Hysteresis loops and Hysteresis stiffness), and Stiffness Degradation.
3 . Create Demand/Capacity Diagrams (D/C) with their respective tables in order to judge the structural integrity of the element faster.
4 . Possibility to model the steel structure or frame with a barred brace: grin emoji (BRB: Buckling Restrained Brace)
5 . The possibility of generating a man-made earthquake on the origin by linking the earthquake time history with the response spectrum: (Time History matched to Response Spectrum).
6 . The possibility of modeling the joints formed in the shear walls.
7 . Nonlinear Modeling of Bending Banned Bonding (BRB).
8 . Concentrated mass displacement potential in rigid and semi-rigid films.
9 . Design and verification of steel connections and Base Plate connections.
10 . Nonlinear modeling techniques such as (Construction Sequencing) and the effects of time on the studied element (shrinkage and creep) (Subramani and Murali, 2018).

### 5.2.2 .2 Important of study the wind force at structural analysis using ETABS Program

This study provided an assessment of the effect of wind on the multistory composite structure. The results of the structural analysis Study the extent of the effect of wind on the proposed building show the following:

1 . Composite structures should be preferred because of the speed with which they can be built due to the ease with which the structural elements can be installed.

2 . Composite frames are lightweight, reducing the structure's dead load and thus the building's full load. This reduces the structural member's dimensions, which is beneficial from an economic standpoint.

3 . Because of its large rigidity and low displacement against the wind, the rectangular structure along the wind or across the wind direction is preferred, according to the general analysis. In addition, in windy areas, a Unshaped structure is not recommended. With the many design criteria considered before design, the shape of buildings with heights of more than 11 floors plays a major role in reducing the impact of wind load. Due to the smooth surface which creates less friction at the roof due to wind excitation and drift, the maximum percentage will be reduced after reducing wind pressure compressive on the building, the circular shape of the building is more effective and less affected by wind load. The effect of wind load on building forms can be reduced by using an efficient structural system, lateral strengthening, and increasing the dimension of beams and columns to achieve sufficient stiffness, as well as using a shear wall to reduce wind load.

4 . Wind pressure in tall buildings is primarily determined by the exposed area of the building in relation to the intensity of the wind, so the exposed area of the building must be changed or deviated to a specific angle to reduce wind pressure. The building's orientation is crucial in reducing the lateral load, which in this case is the wind load. Furthermore, structures should be designed and built to withstand forces from various directions, such as critical earthquake or wind loads.

5 . As the height of the building rises, the lateral load from the wind rises with it, causing an increase in wind pressure. This will put the building's occupants

under even more strain. Furthermore, because the story displacement has increased, the structure's stability and stiffness have decreased. With regards to the construction of the structure, the most important elements which make a structure safe in earthquakes are the joints. The more tough and ductile a joint is, the better it will resist earthquake loads.

### 5.2.5 The effect of the wind angle on the building

There are several factors that influence the wind angle that affects the building.

1 . When the wind direction angle of buildings is installed from 0 ° to 45 °, the energy consumption of the buildings is stable, and the building direction is very suitable. Among all the angles, when the wind angle direction is fixed at 15 degrees, the total energy consumption of the building is the lowest. So, in terms of energy saving.

2 . Through the laws of wind angles that affect natural ventilation after analyzing the effects of natural ventilation at different angles of wind strength. Useful recommendations are provided on the design of the orientation of residential buildings, the effect of wind speed on human height and the distribution of air age on the human body are taken into account when analyzing the effects of indoor ventilation.

3 . During the process of natural ventilation of the building, the wind direction in the external environment will change. Then the best use of natural ventilation is made when designing buildings.

4 . The value of indoor air is generally high. As the wind direction angle decreases, the effect of indoor air in the same area will decrease significantly and then the degree of fresh air will increase.

In this part, we explain the effect of the wind direction angle for natural indoor residential ventilation according to the study of indoor air velocity and the distribution of air age on different wind direction angles, when the wind direction angle ranges from 0° to 30°. different wind direction through the eques program (**Zou et al., 2014**) and in this study 3 angles were chosen to estimate the effect of wind direction on the natural internal ventilation of the building when the wind direction angle for buildings is zero degrees, 15 degrees, 30 degrees.

The scale in determining these angles is consistent with studies that confirmed that If the wind direction angle is greater than 45 degrees, the internal wind .speed drops very quickly

Then the angle for ventilation is gradually increased; This is not useful in eliminating indoor air pollution through natural ventilation. Therefore, when the wind direction angle is from 0° to 45°, the effect of indoor natural ventilation is better, so the range (zero - 30°) is the most suitable to reach much better indoor natural ventilation as the direction changes from the building mainly affect residential heating and energy consumption of air conditioning. The results confirmed the following:

5 . As the wind direction angle increases gradually, the annual energy consumption of the building increases continuously. This indicates that the correct orientation of the building should be south or 15 degrees southwest of the building. As the changing base of solar elevation angle is affected, south facing or near south building can make full use of solar energy, thus thermal energy can be reduced, south facing or near south building can avoid the prevailing wind direction in winter and reduce the amount of cold air. As a result, heat loss in residential rooms is reduced. In summer, the architectural sunshine area is small when the building faces south or near south. So, the heat of solar radiation is relatively low. As a result, the building's total annual energy consumption is lower when the building is south-facing or close to south.

6 . When the wind angle varies from 0° to 30°, indoor cross ventilation can be formed, and the wind speed is high in the rooms and there are no ventilation places. When the wind angle is greater than 45 degrees, the internal wind speed drops rapidly. The range of points rises for continuous indoor ventilation. It is not desirable to dispose of polluted indoor air using ventilation and the effect of indoor ventilation is weaker.

The following Figures (107 →196) described the effect of each type of the three wind angles studied.

**A . Rotation under the influence of the wind at $0^0$**

**B . Rotation under the influence of the wind at $15^0$**

**C . Rotation under the influence of the wind at $30^0$**

# CHAPTER 6

# CONCLUSIONS & RECOMMENDATIONS

## 6.1 Conclusions

In this chapter, we shed light on the most important results that could be obtained from the present study; those results were concentrated in two main directions:

### 6.1.1 The importance of modeling high. Rise revolving buildings

The upper floors can be rotated to obtain the architectural view of the building's shape from several sides. And to get a view of the four directions by rotating the upper floor to allow views of the places surrounding the building. All this gives a tourist and material gain to these buildings. Therefore, this study emphasized the importance of developing high buildings and taking advantage of the high height of the building and the wind speed that is stronger the higher the building height. And taking advantage of the wind thrust force by placing fins that help rotate the upper floor made of the iron structure and control the rotation and control it by placing brakes under the rotating floor to control Rotate regularly and not randomly. And we can get a full 360 degree rotation per hour by controlling a control system that is installed on the base of the revolving floor and works in the form of electric control.

### 6.1.2 The importance of choosing the direction of the wind towards the buildings

**Architectural documentation planning**

1. The importance of studying the behavior of high structures when exposed to wind loads.
2. Studying the effect of the shape of the building in the plan on the behavior of the structure.
3. To determine the effect of wind load on various parameters such as floor shift, lateral shift in the building.

## 6.2 Considered payloads

1. Dead loads: The loads of beams and columns are taken into account by the program ETABS.

2. Live load: Take live loads as 3.00 $KN/m^2$ on all floors.

3. Super Dead Step: The super dead state was calculated and applied to tiles and beams i.e. SDL = 9 $KN/m^2$

The proposal building in Baghdad city as a study object composite of ground floor and twelve story s, the $12^{th}$ story is the rotating floor.

In this study, a modeling of the proposed building and its structural analysis was prepared using the ETABS 2016 program to ensure that the building complies with the standards for safety against stress factors represented in wind and earthquake loads. The prevailing wind direction in the region on the rotation process and the effect of wind on the dynamic ventilation process and energy savings has been studied with good internal ventilation at 3 different wind angles at zero degrees, 15 degrees, 30 degrees, and the conclusions drawn from this study can be summarized as follows:

1. The shape of buildings with a height of more than 11 floors is a major source in reducing the impact of wind load in terms of the various design specifications that must be studied during the design. The circular-shaped building is more efficient and less affected by wind load due to the texture of the roof, which creates less friction between the wind load and the roof itself due to the effect of wind force. The general analysis indicates that rectangular hull designs along the wind or across the wind direction are preferred because of the greater rigidity and less displacement against the wind.
2. When changing any shape from a triangular shape to a circular shape, the displacement will be greatly reduced due to the reduction of wind force pressure on the building. The effect of building forms that were severely

affected by the force of the wind can be removed by taking the structural system, the lateral strengthening of the building while increasing the dimensions of the girder and columns to obtain rigidity, the shear wall has been used in several places usually to reduce the wind load.

3. In terms of building a structure, the most important elements that make a structure safe in earthquakes are the joints. The stiffer and stronger the joint, the better it is to withstand earthquake loads. Thus, whether it is reinforced concrete (RCC), steel structure or wood, engineers make sure that the joints in the structure are sufficiently ductile.
4. In terms of building a structure, the most important elements that make a structure safe in earthquakes are the joints. The stiffer and stronger the joint, the better it is to withstand earthquake loads. Thus, whether it is reinforced concrete (RCC), steel structure or wood, engineers make sure that the joints in the structure are sufficiently ductile.
5. As the height of the building increases, the lateral load comes from the wind load as it will also increase causing the wind pressure to increase. This load creates additional stress on the building members. With an increase in the displacement of the story so that the structure is less stable and rigid.
6. Changes in the building's orientation will generally affect energy consumption in heating and air conditioning and will not affect energy consumption. When the wind direction angle of the buildings is from 0 ° to 45 °, the total energy consumption of the buildings is almost stable, which is a relatively favorable building direction. Among all the angles, when the angle of the wind direction is 15 degrees, the total energy consumption of the building is the lowest.
7. The laws of wind angles affecting natural ventilation are derived by analyzing the effect of natural ventilation under different wind angles. There are guidelines and directions on design direction for residential buildings.

### 6.3 Recommendations

The recommendations that can be applied relate to design innovations in construction to make the building designed or installed from dynamic structures more productive, energy and financially feasible to a better degree than using fixed structures. In this regard, successful experiments were conducted using rotating panels over fixed panels in fixed buildings, as well Apply 3D computer modeling to analyze building stresses and make use of innovative building techniques including the "jumping model" system . a unique building template that takes advantage of the building's repeating shape to make the process more efficient. A cylindrical concrete column in the center of the building strengthens the structure. Rotation occurs on each floor around this central block. Precast metal panels are built on precast concrete perimeter columns.

This study correlates with previous scholarly studies by comparing results obtained for this report with journals and the results of a literature review chapter. In the end, I hope that my findings in this project will be to increase knowledge in this field as well as activities for all of us in the future and to do it in the desired way.

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