

T.C.
BAHCESEHIR UNIVERSITY
GRADUATE SCHOOL
FACULTY OF ARCHITECTURE AND DESIGN

**SUSTAINABILITY AND SAFETY OF VERTICAL ARCHITECTURE/HIGH
RISE BUILDINGS: CASE STUDIES IN ATAŞEHİR**

DİLARA EBRA SADIKOĞLU

ISTANBUL 2024

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MASTER'S THESIS

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ABSTRACT

SUSTAINABILITY AND SAFETY OF VERTICAL ARCHITECTURE/HIGH RISE BUILDINGS: CASE STUDIES IN ATAŞEHİR

Dilara Ebra SADIKOĞLU

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With the rapid increase of urban density and land being a major constraint, there seems to be need for solutions that allow the city to expand. Vertical expansion looks like the common practice around the world. Istanbul is the primary practice ground in Turkey. According to Sarı (2017), the vertical structuring density phenomenon, that spreads from the city center to the peripheries of the city, reflects a form of construction that can be seen in different functions such as residence or commerce. After 2000, it spreads to new areas creates a global residence image. But, since Istanbul is a very dense city, it is not possible to escape vertical architecture. According to Eren (2007), the most discussed issues in the development of high rise buildings in Turkey are; controlling these projects, also determine and evaluate their negatif and positive impacts. In these headings, in addition to measurable objective criteria such as building and system performance, other criterias come to the fore such as, continuity, urban identity, human-environment interaction and urban life.

After the concepts of Istanbul and vertical architecture; safety and earthquake issues were investigated for this thesis. Develepment of vertical architecture and the fact that it is located on the earthquake fault line, make Ataşehir risky in terms of the climate, ecology and environment. Particularly, it is planned to focus on sustainable architectural design and earthquake resistant parameters. In this study, the effects and relations of these factors on vertical architecture, will be discussed with sustainability and safety as well.

Keywords: Vertical Architecture, High Rise Buildings, Sustainability, Safety, Earthquake Resistancy, Ataşehir



ÖZ

DİKEY MİMARİ/YÜKSEK BİNALARIN SÜRDÜRÜLEBİLİRLİĞİ VE GÜVENLİĞİ: ATAŞEHİR İLÇESİ ALAN ÇALIŞMALARI

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Kentsel yoğunluğun hızla artması ve arazilerin kısıtlanmasıyla, şehrin genişlemesine olanak tanıyan çözümlere ihtiyaç duyulduğu görülmektedir. Dikey mimari gelişimi, dünyada yaygın bir uygulamaya benzetilebilir. İstanbul ili ise, Türkiye'deki başlıca uygulama alanıdır. Sarı (2017) makalesine göre, kent merkezinden kentin çevrelerine yayılan dikey yapılaşma yoğunluğu olgusu, konut ya da ticaret gibi farklı işlevlerde görülebilen bir yapı biçimini yansıtmaktadır. Aynı zamanda, dikey yapı tipolojisi mimari söylemin de merkezindedir. Genellikle, dünya çapında ekonomik ve kültürel entegrasyon ile tanımlanır. Dikey mimari, özellikle 2000 yılından sonra yeni alanlara yayılarak küresel bir konut imajı yaratmıştır. Ancak İstanbul çok yoğun bir şehir olduğu için dikey yapılaşmadan kaçınmak mümkün değildir. Eren (2007) makalesine göre, günümüzün en önemli ve vazgeçilmez bina tipleri olan yüksek binaların, Türkiye'de gelişmesinde en çok tartışılan, projelerin çeşitli etkenlere göre nasıl denetleneceği, yarar ve sakıncalarının nasıl belirleneceği ve değerlendirileceği konularıdır. Bu başlıklarda, bina ve sistem performansı gibi ölçülebilir nesnel kriterlerin yanı sıra, kentsel yaşamla ilgili kriterlerin ağırlık kazandığı süreklilik, kentsel kimlik, insan-çevre etkileşimi gibi kriterler de öne çıkmaktadır.

Bu tez çalışmasında, dikey mimari ve sürdürülebilirlik kavramlarından sonra güvenlik ve deprem konusu ele alınmaktadır. Dikey mimarinin hızlı deprem fay hattı

üzerinde yer alması, Ataşehir'i iklim, ekoloji ve çevre açısından riskli hale getirmektedir. Bu ilçede bulunan belirli konut ve/veya ticari yüksek binalar seçilecek ve araştırılacaktır. Özellikle bu yapılarda kullanılan sürdürülebilir tasarım parametrelerine ve deprem dayanıklılık özelliklerine odaklanılmıştır. Bu çalışmada, sürdürülebilir tasarım ve güvenlik/deprem faktörlerin dikey mimari üzerindeki etkileri ve ilişkileri, İstanbul'un Ataşehir ilçesinde bir alan çalışması ile tartışılacaktır.

Anahtar Kelimeler: Dikey Mimari, Yüksek Katlı Yapılar, Sürdürülebilirlik, Güvenlik, Depreme Dayanıklı Yüksek Katlı Bina Tasarımı, Ataşehir



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LIST OF ABBREVIATIONS

BKS	Bina Kullanım Sınıfı (Building Usage Level)
BRB	Buckling Restrained Braces
CTBUH	Council on Tall Buildings and Urban Habitat
EPS	Expand Polistren
KH	Kontrollü Hasar
PV	Photovoltaic Panel
TDG	Teknik Destek Grubu (Technical Support Team)
VOC	Volatile Organic Harmful Compound
XPS	Extrude Polistren

Chapter 1

Introduction

“Architects have to become designers of eco - systems. Not just designers of beautiful facades or beautiful sculptures, but systems of economy and ecology, where we channel the flow not only of people, but also the flow of resources through our cities and buildings.”

Bjarke Ingels

In the process of rapid economic development after the end of World War II, developed cities received great migration to improve their business and urbanization potentials. As a result of urbanization, due to reasons like scarcity of land, increasing demand for business space and residential space, economic growth, technical developments, creative innovations in structural systems and the excessive increase in land prices have triggered the design of vertical architecture and high rise buildings. In the contemporary era, this situation continues to increase dramatically.

With the modernization and technological developments, a remarkable wide range concept is vertical architecture. At the same time, it started to develop and built in many cities. Due to its physical nature, vertical architecture stands out in visibly in metropolitan areas. Also it affects and changes the climate, ecology and environment. All of these effects have a great impact on the human life. What is more, they are very important for the well-being of future generations. This situation can continue with the elimination and controlling of waste and environmental pollution. At this point, sustainable development plays a significant role for the whole world. As for buildings and other structures, the issue of sustainable architecture comes to the fore. On the other hand, vertical architecture is among the building type, that need to abide by sustainability issues in effective ways. The sustainability of high rise buildings has gained importance because the amount of energy and resources consumed by them in the construction, usage and demolition processes are very high compared to other building types and structures.

Another inevitable problem in the world is earthquake. Also this problem is relation with human safety. It is known that most of high rise buildings, which have a large place in the Turkey, are located in the province of Istanbul and Istanbul is located in a seismically active region. For this reason, after a possible earthquake, it has become a necessity to examine the hazards that may arise from high rise buildings in detail. Because, vertical architecture, that concentrating in the earthquake zone, increases its impact and damage on the climate, ecology and environment. There are some design principles and certifications in order to be both environmental friendly and earthquake resistancy. These principles and certifications can be effective in reducing environmental damage, if they are used appropriately. In addition, the effects of earthquake on high rise buildings are very strong in risky areas, so earthquake resistant high rise building design is necessary for human safety and climate, ecology and environment. In this context, interrogation and investigation of sustainability and earthquake resistance issues are very significant. Whether it is a stacking of functions and services on top of each other, its friendliness with climate, ecology and environment needs to be interrogated.

1.1 Purpose of the Study

Within the scope of the study, the effect of vertical architecture's sustainability and safety criterias, will be investigated. In order to examine these criterias in more detail and to compare them each other, this thesis intends to follow two main headings. These are:

1. High Rise Buildings in Sustainable Architecture
2. High Rise Buildings and Earthquake Resistancy

Features and effects of having these headings in a high rise building will be investigated. Whether a single heading is sufficient or not sufficient in terms of the climate, ecology and environment, will be examined and discussed. To give an example, the effects of having all headings in a high rise building will be inspected. Therefore, the hypothesis to start with is: "Is it possible with a sustainable and earthquake resistancy design to minimize the damage caused by high rise buildings to the climate, ecology and environment?". Following this question, this thesis also aims to guide high rise buildings architects and designers about sustainability and earthquake resistancy design parameters in the process of projects. Also, it is planned

to emphasize that sustainability and earthquake resistancy issues are in relation to each other about to the climate, ecology and environment. In addition, this thesis aims to encourage the monitoring and controlling of high rise buildings in terms of these important issues.

1.2 Methodology & Content

This thesis utilizes to use qualitative research methods. First of all, in the literature analysis, historical researches and basic concepts were examined. During the collection and analysis of visual and written data, literature review was carried out and theses, articles, journals, books, internet and personal archives were utilized. In addition, sustainable and earthquake resistant high rise building projects that, were designed, completed and under construction or in the project phase worldwide, were examined. Then, according to the literature review used, in a chronological order, the history of Ataşehir district, the development of vertical architecture and high rise sustainable and earthquake resistant buildings in Ataşehir were examined respectively.

After these steps, vertical architecture and metropolitan areas relationship will be explained. In this chapter, vertical architecture, high rise buildings, metropolitan areas and city concepts are examined from general to specific. For instance, İstanbul is a worldwide important metropol and Ataşehir is one of the districts where vertical architecture has been developing rapidly.

The next chapter will examine and discuss with sustainable architectural design and earthquake resistancy in high rise buildings. Various methods, factors, strategies and energy efficient design parameters were explained as guidelenes for architects and designers.

As for the case study, Ataşehir district was analyzed. Convenience Sampling Method following Fridah (2002), has be used and the limits of the study and the selection criteria were be indicated. According to this method, the characteristics and content of case study buildings were be explained easily. These buildings were visited and people who, have mastered case study building's projects, were interviewed.

The last chapter include results, conclusion and discussion sections. In this way, case study buildings and all data were evaluated in detail.

Intense vertical architecture and being in the red earthquake zone context were the primary factors in choosing Ataşehir district as a case study for this thesis. After selection of Ataşehir district, some high rise buildings were determined for this study according to many criterias. Therefore, Convenience Sampling method is used when selecting case study buildings. According to Simkus (2022), convenience sampling (also called accidental sampling or grab sampling) is a method of non-probability sampling where researchers will choose their sample based solely on the convenience.

In this thesis, Ataşehir contains intensive collection of buildings and some of these buildings will be selected as a case study according to certain characteristics. To indicate the context of the thesis, limitations and selection criteria was determined, including location, time, typology, floor limit and format of the study. According to Convenience Sampling method, (Fridah, 2002), Ataşehir high rise buildings were inspected and buildings for the case study (commercial and residential) were selected. Table of the thesis method is below in Table 1.

Table 1

Convenience Sampling Method, Fridah, M., 2002, Sampling in Research

LOCATION	TIME	TPOLOGY	FLOOR LIMIT	FORMAT
İstanbul, Ataşehir	After 2000's	Residential and Commercial Buildings (Have Sustainable Certifications)	14 storey, above 50 meters	Seeking solutions for high rise buildings in relation with the climate, ecology and environment

When deciding to floor limit of these buildings, high rise buildings definitions was researched in worldwide. According to Council on Tall Buildings and Urban Habitat (CTBUH), number of floors 14 and above or 50 m in height and above, can report as

high rise building. In this way, this reference was used to determine floor limit of case study buildings.



Chapter 2

Literature Review

Istanbul is the most important city where vertical architecture has first appeared in Turkey. According to Stokes (2013), since 1983 İstanbul has become a practising area of a neo liberal and populist politic following a global trend. Especially the post republic period is very important in terms of the emerging of vertical architecture. According to Kurtuluş (2005), since 1950s the rapid growth of the city is based on Republican Period's general politic - economic conditions and concept of nation - development. The post 1980 period has been dominated by globalization and neo - liberal economic policies. The spatial transformation process has started since the second half of 1980s. In 2000s, the new macroform, which became more evident with the urban segregation, is connected to urban dynamics that emerged at different scales.

After 2000, vertical architecture is still developing and consists of various building types. According to Sarı and Dülgeroğlu (2019), in recent years, high - rise buildings, which are mostly business centers and hotels, were become dominant in residence typologies, to creating different urban foci in İstanbul. The different urban foci include Şişli - Maslak, Başakşehir - Beylikdüzü, Kozyatağı - *Ataşehir*, Maltepe - Kartal and Historical Peninsula Walls. After 2000s high rise buildings, mostly emerging as hotels and office buildings. Also, they have differences in the number of floors and building typologies. Sarı and Dülgeroğlu (2019) also says that, the focus of criticism to this new architectural trend, which has developed in Istanbul and also in parallel with the changing world, is public space discussions. Also, this impact is relation with architectural aesthetics, street scale, city scale and urban silhouette. One of the issue, that has gained importance worldwide, is the relationship between the vertical architecture and the city. This issue has produced popular concepts such as durability, sustainability, ecological and green architecture.

According to Günay (2006), from the Urban and Regional Planing Discipline, with the property law, return of land is more important than public - oriented planning in Turkey. Especially after 2000s, Şişli - Maslak, *Kozyatağı* - *Ataşehir*, Maltepe - Kartal, Başakşehir - Beylikdüzü and Suriçi - Ceplerler has become business and residential areas where vertical architecture is concentrated in İstanbul.

In this thesis, Ataşehir district has been chosen as a case study, because vertical architecture is intense in there and it is located on earthquake fault line.

Ataşehir district has been affected by economic and political changes and this situation has also influenced the development process. According to Topçu (2013), today, urban transformation aims to address issues that are associated with change in the economy, employment, community issues, vacant and deteriorated location in cities, new land and property requirements, environmental quality and sustainable development. Topçu (2013) adds that, Ataşehir was built to be an isolated new town, but its isolation did not last long, and its interaction with its environment continued. Construction in its environment has constantly been increasing, and squat in its immediate environment are being transformed. Ataşehir started to be settled in 1994. It was planned with its retail and social facilities and office buildings, to form a new sub - centre for the city. Ataşehir become a symbol of a modern life style and it become attraction point and stimulated the transformation of its surrounding neighbourhoods through construction. In addition, on the Asian side in İstanbul, Ataşehir has the most high rise buildings, The map, indicating the usage of high rise buildigs is below in Fig. 1.

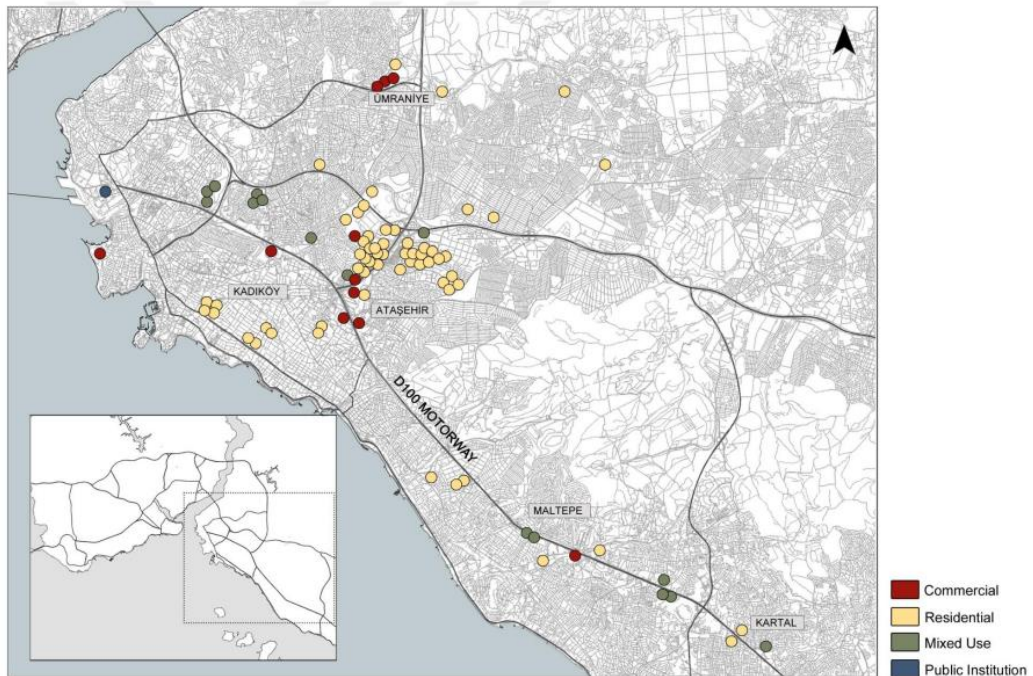


Figure 1. Map indicating the usages of the high rises on the Asian side. (Şevkin, 2016).

Today's societies are in an ever increasing state of consumption due to current economic models. In order to survive, it is necessary to adopt a culture that consumes much less natural resources and is committed to the principles of sustainability, equality and cooperation. (Kellog and Pettigrew, 2007). The increase of vertical architecture in Istanbul leads to an increase in consumption and a decrease in natural resources. At the same time, It causes the problem of climatical, ecological and environmental pollution. In order to prevent these problems, it is argued that the design of high rise buildings should be sustainable and earthquake resistant as well.

High rise buildings are more noticeable and visible than other buildings, because of their multiple storeys. The definition of high rise building varies according to periods, context and environment. Toprakal (2008), in her master thesis, compiled together many definitions of high rise buildings in chronological order. Some of these definitions are below;

-“Generally, high rise building can be defined as; a structural form of many floors, formed by arranging vertically.” (Lang, 1977.)

-“The base area is small, the height is higher than the base dimensions, usually it is in the form of a tower and fragile buildings.” (Büyük Larousse Sözlük ve Ansiklopedisi, 1986.)

-“High rise buildings are referred to as "Multi - Storey Building" in the shortest way.” (Anabritannica, 1988.)

Sustainability has entered the English language as 'sustain' (to protect, to support, to endure) from the Latin word 'sustinere' (to hold, to up) as 'sustain' (to protect, to support, to endure) (Onions, 1964.)

Sustainable architectural design is about realizing the most with the least resources. Instead of dependence on mechanical systems that produce excess waste, it is about the use of passive architecture, which reduces the use of non-renewable energy sources that contribute to global warming and enviromental pollution. In addition, sustainable architecture is environmentally concious, energy saving and utilizes responsive and renewable materials and systems. (Newman, 2001). Sustainability is the quality of the architecture, but it has more to do with the quality of ideas and ways of thinking than with the quality of the materials used. (Foster, 2001.) In order to

realize the concept of sustainable architecture, building design and city fiction should be evaluated by considering the criteria of sustainable area selection and land use, sustainable community life, health and welfare, building components, energy and water concepts. (Aydoğan, 2015). It is very important to consider sustainability with whole concepts and to implement it as a purpose in high rise buildings.

According to Ali and Armstrong (2008), environmental awareness extends to both the urban environment and the context in which a high rise building is placed as well as its interior environment. High rise buildings, are massive consumers of energy. They are the dominant element in urban architecture due to their scale and purpose, and should be the focus of sustainable design. A high performance of high rise building is one that achieves the peak efficiency of building functions while meeting the requirements of optimum performance employing green technologies. These technologies and innovations offer radical changes to the built environment in terms of energy usage, structural performance, and environmental effects. In other words, a high performance of high rise building warrants an approach to design for maximum sustainability. Therefore, architectural, structural and mechanical issues are in relation with them. High rise building system integration is below in Fig. 2. (Ali and Armstrong.)

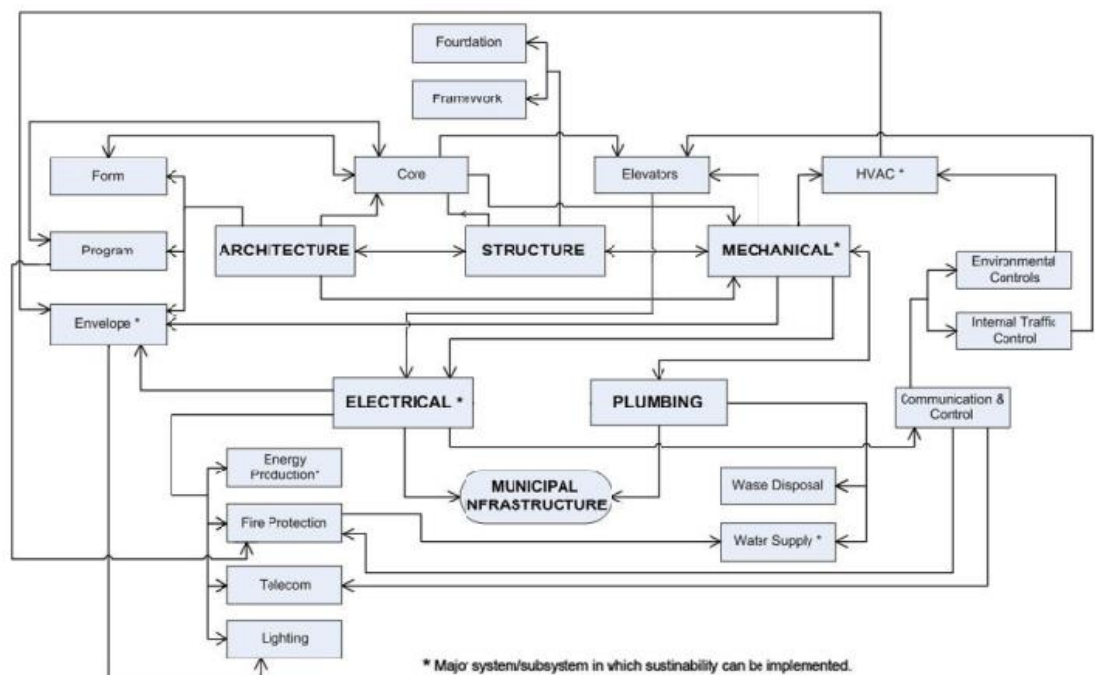


Figure 2. High Rise Building System Integration, (Ali and Armstrong (2008))

According to this diagram, in terms of sustainability, it is important to determine the systems that are prioritized to be used in high rise buildings in a certain order. In this way, architects also need to have knowledge about architectural, structural and mechanical fields. Because, especially for the sustainability of high rise buildings, the of all of these parameters should be control and follow by architects.

Especially in developed cities such as Istanbul, high rise buildings must be build earthquake resistant in terms of their sustainability. The process from the construction of the building to its demolition, the building's durability as well as its sustainability are part of this process. Therefore, this thesis proposes earthquake resistant design as part of sustainability as well.

The increasing trend of population and crowded cities have resulted in an increased demand for high rise buildings. In addition, due to the development of technology the software and tools employed for structural analysis have improved significantly, thereby, making it possible to obtain more accurate and realistic results. (Özaydın, 2019.) According to Topçu (2019), thenceforth the high rise buildings has been rising higher, spring to mind that, regulations are adequate or not. At time same time, high rise buildings are not separated from other structures and equate together. They has been evaluate separately from the other kind of structures. Turkish Building Earthquake Regulation divides high rise buildings into three different level class, regarding their design matters. These are BKS:1,2,3. It has been decided to inspect them according to that content. Therefore, this makes it important to investigate and determine level classes of high rise buildings.

As the consequences of the earthquake, it is a fact accepted the obligation of construction of the buildings under the principles of "earthquake resistant building design" starting from the planning stage. It must be noticed the importance and effect of the architectural design during earthquake resistant building construction. (Gümrükçü, 2022.) Therefore, It is very significant for this thesis that, researching design principles and methods on high rise buildings of earthquake resistant building design and effects of many systems used to protect the building from the earthquakes' effects.

In summary, in the light of all this informations, according to earthquake risk map from AFAD, Istanbul is an earthquake risk city. On the other hand, Ataşehir

district increases this risk due to both the abundance of high rise buildings and the proximity of these buildings to the main roads and transportation issues. High rise buildings damage the climate, ecology and environment in buildings daily routine or event of an earthquake. In addition, due to the damage to main roads in a possible earthquake, a major transportation problems occur. In order to reduce and investigate all these effects, this thesis emphasizes the issues of sustainable architecture and earthquake resistance design in high rise buildings. Whatever the future holds for the environment, high rise buildings must become sustainable and earthquake resistant considering the environment, long term economic growth, and human needs. (Ali and Armstrong, 2008.)



Chapter 3

The Relationship of Vertical Architecture with the City and People

Vertical architecture, which can be referred to as a new monumentality, is developing rapidly in metropolitan areas. To be more specific, metropolitan area can be defined as a developed city and surrounding affiliated regions due to economic, social and political factors. In recent years, vertical architecture stands out in metropolitan areas and developed cities, where the population has increased rapidly and land production is not sufficient. The biggest reason for preference of vertical architecture is that, it allows the formation of a large number of house holds even in a narrow space. On the other hand, another biggest reasons for this development, are new architectural trends, technological innovations and population growth. The increasing of vertical architecture is directly relation with the development of metropolitan areas. Besides metropolitan areas, vertical architecture is also in constant interaction with the city and people as well.

The concept of vertical architecture is in interaction with the concept of high rise building. Significantly, vertical architecture comprise high rise buildings. However, vertical architecture and high rise buildings utulize verticality and they develop vertically. In this thesis, vertical architecture will refer to a community of high buildings while the term of high rise building will refer to a specific building and/or more.

Vertical architecture is preferred in developed cities for the following reasons;

- Population density,
- Urban growth,
- Infrastructure,
- Economical advantages,
- Land prices.

Especially as the population density continues to increase, so development of vertical architecture become inevitable in these areas. This increase constantly act upon the climate, ecology and environment.

First of all, vertical architecture affect the strength of the wind and the direction of the natural breeze. As the wind speed rises above the ground, high rise buildings are exposed to strong wind loads compared to low rise buildings. So, circulation in the air corridors, which can be defined as air flow in cities, is disturbed. On the other hand, when the wind hits the body of the building rapidly, this situation creates powerful noise and turbulence that will disturb the environment and also human life.

Secondly, blocking the sun due to vertical architecture, is not in favor of low rise buildings. The construction of high rise buildings, without insulation calculation and inappropriate orientation, affects other buildings in sorroundings and natural environment, that need natural lighting. For this reason, low rise buildings, that blocked by high rise buildings, cannot benefit from solar energy.

After blocking wind and sun, the next issue is waste management that is generated during the construction stage. According to Zezhou Wu and others, in their research, since 2008, there has been a noticeable increase in the amount of construction waste in the world. These wastes return to the environment as pollution. Some sustainable high rise buildings use recyclable materials to reduce this pollution. Increasing of waste, pollution, fossil fuel and greenhouse gas emissions, due to the vertical architecture, create unhealthy climatic, ecological and environmental conditions.

Lastly, in addition to environmental effects, it can be said that, vertical architecture, without suitable design principles and program, has psychological effects on people. It blocks people's field of vision, day light and also slow down to transportation. In addition, vertical architecture affect the silhouette of the city. It has both physical and mental effects on people. Because everything, related to the climate, ecology and environment, has to be related to people as well.

3.1 Examining the Development of Vertical Architecture in Istanbul with the Historical Process

İstanbul is the most populous city in Turkey with the most advanced job opportunities. Due to this density and various opportunies, vertical architecture has been envolving in the city. According to Şevkin (2016), since the 1950s, Istanbul has been in the process of a transformation to a modern metropolis, which means constant

change in its urban morphology and visual image. High rise buildings developments are one of the main components of this transformation. According to Sarı (2017), vertical architecture in Turkey and Istanbul, can be studied in a historical sequence as: 1950 -1980 is the beginning period, 1980 – 2000 is the development period and from 2000 to present day is the period of wealth. Also according to Sarı and Dülgeroğlu (2019), reflections of globalization phase of the business world, have become evident in 1980, in Istanbul metropolitan area. After 2000, it has spread to new areas and created a new global residential image. Starting from here, after 2000's, vertical architecture has began to increase in İstanbul mostly appearing as hotels and office buildings. Istanbul has become the key player of Turkey in the global financial network. Due to increasing capital flows the built environment of the city restructured (Keyder, 2010).

In the development period, first high rise buildings built in Istanbul, did not exceed 25 floors. In this period, along with İstanbul, vertical architecture has began to be seen in Ankara. In 1980 - 2000, developments in tourism, technology and architecture can be regarded as factors that accelerated of vertical architecture. Also in these years, especially in İstanbul, high rise buildings consisting of residential and commercial units are seen in many metropolitan areas, such as Ankara, İzmir and Antalya. (Sarı and Dülgeroğlu, 2019.) The period of wealth, acknowledged that since 2000, it is observed that vertical architecture and storey number of buildings have increased. According to the following informations received from building's websites. It is easy to observe, storey number of these buildings are higher than other periods. At the same time, this increasing is common all over Turkey.

After 2000, vertical architecture still continues to develop in İstanbul. Among the districts of Istanbul, those having the most high rise buildings, are; as for the European side, Şişli, Gayrettepe, Maslak, Beşiktaş, Sarıyer, Levent and Kağıthane; as for the Asian side, **Ataşehir**, Kozyatağı, Kadıköy, Acıbadem and Üsküdar.

Ataşehir and Şişli are among the districts where vertical architecture is the most common in İstanbul. The reasons for this density originated by lots of job opportunities, gated communities, residential sites, commercial buildings, shopping malls, accessibility, transportation and multiplicity social areas. The preference of Ataşehir and Şişli, causes increasing of population and density, and also the development of vertical architecture. Especially after 2000, the increasing of high rise

buildings is clearly visible in İstanbul. When most of these buildings are examined, they are close to the main roads especially in Ataşehir district. This situation creates both environmental effects and transportation problems in a case of possible earthquake.

3.2 Earthquake Risk Factor in İstanbul

In Turkey, natural disasters happen frequently and the price paid due to those disasters is quite high. Moreover, the lack of legal, administrative and technical support and illiteracy increase the deficits of natural disasters. (Keleş, 2010.) For İstanbul, which has witnessed many earthquakes in the historical process, it is crucially importance to carry out studies to eliminate these deficiencies.

İstanbul, which is the largest city in Turkey in terms of population and at the same time under the threat of earthquake due to its proximity to the western flank of the North Anatolian Fault line, should be evaluated in terms of earthquake risk within the scope of the environment variables and existing potentials. In the historical process, according to Kundak and Türkoğlu (2007), İstanbul faced several earthquakes. They were experienced in 1509, 1799 and 1894. These earthquakes were very destructive and also they were caused by the Northern Anatolian fault line. This fault line, which is more than 1000 km long, has brought about devastating earthquakes through at the history.

According to recent scientific researches, another major earthquake will likely to occur and cause vast damage in İstanbul. After 1999 earthquake, laws and regulations in the construction sector were arranged for new buildings to being more durable and strong. According to Barka (2000), there is %62 probability that a major earthquake will occur in this region, in the next 30 year. However, according to the news of Anadolu Agency, in case of a possible earthquake of 7.5 intensity and above, it is expected that 13.492 buildings will be damaged very heavily, 39.325 buildings will be severely damaged, 136.746 buildings will be moderately damaged, and 300.963 buildings will be slightly damaged. The failure of structure and foundation systems of buildings, insufficient ground survey, durability and many different factors create a high risk for İstanbul in general. 6 February 2023 Kahramanmaraş earthquake clearly demonstrated the need to inspect and strengthen the systems of buildings, especially those located on the earthquake fault lines.

According to earthquake risk map of AFAD, the earthquake fault line coming from the Black Sea reaches south of İstanbul. Southern districts of İstanbul are; Avcılar, Bahçelievler, Bakırköy, Fatih, Zeytinburnu, Eminönü, Üsküdar, Kadıköy, **Ataşehir**, Maltepe, Kartal, Pendik, Tuzla. The earthquake risk map from AFAD is below in Fig. 3.



Figure 3. Ataşehir District in Earthquake Risk Map (AFAD)

Although, there is less earthquake risk in the north of İstanbul, the main construction and buildings are in the south of the city. In case of an earthquake, it is estimated that it will affect a wide geography, especially southern parts of İstanbul. However, northern earthquake fault line and south of İstanbul districts are very significant in terms of the earthquake risk factor. Because the fault line passes through the Marmara Sea. Therefore, the districts of İstanbul facing the Marmara sea are in a risky situation more than the others.

According to Kundak and Türkoğlu (2007), In İstanbul, as a result of the migration after the 1950s, the area owned by the old settlements does not have the balance of use and infrastructure due to the unplanned development of new settlements. In addition, due to the fact that old settlements are close to central business areas, can benefit from different transportation systems, have all kinds of equipment and have high land values. As a result, their risk levels due to earthquakes are lower than new settlements. Ataşehir district is a new settlement and It is preferred by people in terms of transportation, business, health, shopping facilities and especially high rise building

density. In addition to the magnitude of the earthquake risk, the lack of planning in the development of Istanbul plays the biggest role in the increase of earthquake risk. 75% of the casualties and injuries in earthquakes are due to the collapse of buildings (Coburn and Spence, 1992.) Therefore, especially high rise buildings increase this risk even more. Determining the structural and sensitive characteristics of residential areas covering 60-70% of settlements is especially important in making loss estimates. (Comerio, 1998.) According to all this information, in the event of a possible earthquake in Istanbul, identifying and assessing the environmental impacts of high rise buildings will play an important role in reducing the damage caused by the impacts of the earthquake to the climate, ecology and environment.



Chapter 4

Sustainable and Earthquake Resistancy in Architectural Design Criteria

There are various design parameters used to minimize the damage of buildings to the climate, ecology and environment. Especially in vertical architecture, it is very important to utilize these parameters. Sustainable architecture and earthquake resistance design parameters are the most important criterias for high rise buildings. Importantly, for a building to be real sustainable, it must also be earthquake resistant.

4.1 Sustainable Architecture

The concept of sustainability and sustainable development policies, which have been on the agenda in the second half of the 20th century, have made great contributions to the solution of economic, environmental and social issues. Sustainability is defined as "ensuring the long term survival of relations between society and nature." (Tosun, 1996.) To be more specific, the concept of sustainability; are complementary components of economic, social and environmental sustainability. In this thesis, the environmental field of sustainability will be examined

Although the relationship between architecture and the environment has been interpreted and named in various ways, today it is referred to as "sustainable architecture" in its most comprehensive form. Sustainable architecture is the design of buildings in relation to their climate, ecology, environment and also people, with minimum energy consumption and environmental damage. According to Sev (2009), sustainable architecture can be defined as, "Buildings that, in all conditions and in every period of its existence, taking into account the future generations, gives priority to use of renewable energy sources, environmental friendly, using the energy, water, material and space with effective way, as well as providing for people's health, safety, psychological and physical comfort and productivity." On the other hand, sustainable architecture is preferred due to the increasing population, buildings and harmful gases released into the climate ecology and environment. In order to be successful and suitable of sustainable building examples, sustainable architecture strategies and building design parameters need to be assimilated. In puts and out puts of these buildings are very important in terms of as a sustainable building. To be more specific, resource management needs to be well planned. Therefore, energy, water, materials, building areas and other resources must be used effectively.

Sustainable architectural design takes into account resource conservation and energy efficiency, healthy buildings, structures and materials, ecologically and socially sensitive land usage, conservation and enhancement of biodiversity, and combines all this with an inspiring and aesthetic sensibility. One of the important goals of sustainable architecture is the optimal use of resources in the long term. These resources are expressed as energy and water. (Kohler and Chini, 2005.) The process of creating new areas and buildings for the growing population regularly depletes a large part of natural resources. As architecture, technology and population evolves, the need for all type of buildings, such as residential and commercial, building construction materials and energy requirements are increasing. The production and consumption, resulting from these requirements, have climatic, ecological and environmental effects. Therefore, sustainable architectural design significantly reduces people's negative effects on the natural environment, while improving the quality of life and economic well-being.

4.1.1 Sustainable high rise building design. Historically until 1998, the highest building in the world was The Sears Tower in Chicago. With the construction of Petronas Towers / Malaysia in 1998, Sears Tower lost its title as the highest building in the world. This incident has led to various controversies all over the world. After that, the increase in high rise buildings began to increase rapidly in these years.

With the architectural and technological developments, the number of floors in high rise buildings have become higher than in the past. Therefore, it is very important that especially energy production systems, air conditioning systems, ventilation systems, heating - cooling and other systems are to be designed in a sustainable way. Taking into account the safety, health and comfort of people and not pollute the climate, ecology and environment are very important.

In the construction industry, energy and resources consumed by high rise buildings are much more than other buildings in every stages of the building process. According to Sev (2009), nowadays, in the building construction sector, number of high rise buildings are increasing rapidly and architects should take more care of energy needs and design them with a sustainable and safety architectural approach. To provide sustainability of high rise buildings, it is necessary to give importance to many criterias such as;

- Climatic conditions,
- Sustainable land using,
- Landscape usage,
- Orientation,
- Mass form,
- Elevation
- Facade systems
- Use of floor areas,
- Space organization,
- Vertical circulation systems,
- Service systems,
- Structural elements,
- Foundation systems.

Although sustainable building evaluation systems examine the construction and building system performances. For this reason, the guidance in sustainable high rise building design can be insufficient. If the interpretation strategies of performance systems and sustainable architecture parameters evaluate are together, it increases the sustainability of high rise buildings. Another way to increase the sustainability of high rise buildings is earthquake resistant design. Because, structural elements and foundation systems are also related with earthquake resistance criterias. From this point of view, safety can be evaluated as an accomplishing factor of sustainable design.

Sustainable high rise buildings with different climatic, physical and geographical conditions, should have different land using types, building forms, layout and infrastructural systems. Climatic and physical factors are very significant because high rise buildings may pollute the climate, ecology and environment more than other buildings, during the **design, construction, occupation and demolition phases**. Therefore, from starting to building, site selection, as one of the key principles of building planning, plays an important role and has a huge impact on the design of a

proposed building. (Cheng et al., 2007). According to Kumar and Bansal (2016), architects and engineers play a major role and contribute significantly to site selection. On the other hand, energy efficiency is an integral part, if not the key, in green and sustainable buildings. (Shi and others, 2016) According to Chen and others (2015), energy efficiency in existing and new buildings is a fast-track solution for limiting the environmental, economic, social, and other impacts in sustainable architecture. In addition to energy production and savings; water usage and recycling of natural resources are also mentioned in this thesis. In the context of sustainable high rise building design, this section include;

- Site selection,
- Energy production,
- Energy savings,
- Water savings,
- Waste management,
- Material selection.

These items were deemed necessary and important for the design of high rise buildings and were selected and summarized for this thesis.

4.1.1.1 Site selection. The issue of site selection and analysis in sustainable architecture constitutes the first step of the design. The choices to be made at this stage affect the sustainability success of the subsequent cycle stages of the building. Climate, is one of the most important factor for sustainable building design. When deciding on sustainable design principles, the climate region ,where the building is located, and meteorological data should be evaluated appropriately. In sustainable architectural design, it is crucial to analyze the site's long and short term impacts on the climate, ecology and environment. The protection of the natural contours of the site and the applications that require high costs such as excavation and filling, and also destroy the environment should be avoided. When designing on sloping topography, it is necessary to design sections that fit into the natural topography. The vegetation cover and ecosystem characteristics of the site are also factors that need to be investigated before the construction step.

Selection of suitable site is one of the most important criteria for high rise buildings. Economically, maximum benefit from land has always been at the forefront for investors and construction companies. For the effective usage of the land, besides its economic effect, it also has an climatic, ecological and environmental effects. For this reason, the land should be well studied before the construction stage. Ground character of the land, soil type and ground water level factors affect the structural elements and foundation system of the building. For a solid and strong foundation, some additional measures may need to be taken as a result of the ground quality being worse than expected. It should be investigated whether the land has sufficient infrastructure, and it should be aimed not to impose too much burden on infrastructure of the land. According to Yeang (2001), who is an architect, the land is not only a plane, which the building will settle on. But also, it is a living and functioning eco - system. In this way, it should be aimed to have the least impact on the land and the existing eco - system. It is not possible to build a building that will not affect the eco - system in any way, but it is possible to minimize the negatif effects. Site selection and open spaces planning support or reduce the overall sustainability performance of the building. With the selection of the appropriate site, a number of factors that may pose an environmental threat can be eliminated. In this regard, the existing conditions at the stage of choosing the site should be evaluated in multiple directions. As the requirements of a sustainable urban life, suitability for public transportation, pedestrian paths and bicycle paths are important in site selection criteria. The main purpose of site selection is to determine the areas that will have a minimum negative impact on natural habitat and green areas by preferring central areas that have infrastructure completed from external pollution sources, without any transportation problems. According to Kayıhan and Tönük (2008), at this stage the criteria that are considered mandatory to be listed as follows;

- Assessment of the site in terms of industrial and agricultural or spontaneously occurring factors to health, such as asbestos and heavy metals,
- Identification of neighbouring buildings emitting harmful air emissions, control of hazardous materials, objects or waste, and should established "Air Quality Management Unit."
- Not preferring site that close to high voltage lines, railway lines, transport lines that are harmful to health, active fault lines and old fault cracks.

During the construction process, all materials and waste must be separated and recycled. Following and controlling of these issues should be ensured. The main purpose of the land selection is to protect people from external pollution sources. The perimeter of the construction area must be properly sealed. In this way, the disturbance and pollution to the environment and people, is minimized. Transportation of the site is also important for this parameter. It is necessary to give preference to central areas, which do not have any transportation problems. Appropriate entry - exit areas should be determined for users and visitors. On the other hand, parking areas should be provided for vehicles.

Selection area of the building is a design parameter that, is effective in controlling climate and preventing environmental pollution. Aiming at the optimization of climatic effects for settlement areas, choosing the right location is beneficially in terms of the climate, ecology and environment

Surroundings buildings are also very important in terms of site selection. Depending on ranges between them, their height and relative position, can act as solar radiation and wind obstacles for each other. Therefore, the utilization or avoidance of the heating effect of solar radiation in passive heating and air conditioning, is a function of the measure in open spaces. In this way, building ranges, should be determined in a way as not to hinder solar radiation gain and wind effects of buildings. Especially in high rise buildings, this situation is more important because of sun blocking. However, as the number of floors increases, the wind pressure that, hitting the building, also increases. When resizing building ranges, intermediate hours and sunrise - sunset hours should be taken into account in terms of land slope, direction and settlement density. The angular position of the sun relative to the facades during the day, varies depending on the building directions. So, it is clear that the appropriate building ranges will also vary according to the orientation of the building sequences.

External climate elements, such as solar radiation and wind are changing according to their directions. According to the orientation, the heating effect of solar radiation and the cooling effect of wind changes. Therefore, through this parameter, they can be optimized depending on climatic comfort needs. According to Yilmaz (2005), building orientation is one of the most important design parameters that affect facades injury rate from the solar radiation and total solar radiation gain. To give an example, The Menara Mesiniaga building in Kuala Lumpur / Malaysia, is oriented

according to the solar orbit to benefit from natural lighting. At the same time, the cylindrical form of the building contributes to the utilization of sun radiation. However, it provides passive heating - cooling systems and saves energy. In addition to this, vertical landscape concept was used in the building design. Therefore, according to the climate zone, sustainable buildings should benefit from natural lighting with appropriate orientation in their sites. According to Ali and Armstrong (2008), around the base of the tower lies a semicircular, steeply sloping garden, which continues into the building itself in the form of spiral terraces. This visibly brings the natural environment into the architecture. The example project picture is below in Fig. 4.



*Figure 4. Menara Mesiniaga Building, Kuala Lumpur / Malaysia
(www.archdaily.com)*

It is very important that using the site in a sustainable way both in the construction and demolition stages and in the usage stages. Land and soil and the way it is used are also directly related to climate change. According to Bruyninckx (2019), soil contains significant amounts of carbon and nitrogen, which can be released into the atmosphere depending on the way of land using.

4.1.1.2 Energy production. Energy production in sustainable buildings is realized with the use of renewable energy. Renewable energy; can also be defined as, obtained from natural resources and having sustainable design parameters. Renewable energy is obtained from natural sources such as sun, wind, water, biomass, geothermal and wave energy. Especially, solar energy can be used to generate heating - cooling and electricity in sustainable buildings. It is also possible to produce electricity directly from the sun light with photovoltaic (PV) panels. Photovoltaic panels are that produce electricity directly from the solar energy. Nowadays, photovoltaic panels have become a building material used by architects in their designs. To give an example, it can be on the facade for a shading element or among the components of the roof. According to Lloret (1996), in facade design example, PV modules are placed between two thermally reinforced glass sheets. A distance is necessary in between these modules and the double glazed facade. Thus, PV cells created a gap and at the same time, this gap serve to cool the interior in the summer and heat it in the winter days. The air, heated in the space, is supplied to the conventional heating system with fans in the winter while this hot air is given to the outside in the summer. This design of the facade saves about %30 of energy.

The most important advantage of using solar energy is that, does not produce any environmental pollution and waste. Photovoltaic panels, can also be used as a solar control element on the facade. According to Yilmaz (2005), the use of photovoltaic panels as a solar control element and facade cladding examples, are indicated below in Fig. 5.



*Figure 5. PV Panels Using as a Solar Control Element and Facade Cladding
(Yilmaz, 2005)*

In addition, solar control elements on facades, provide sufficient day light interior spaces. Also, they prevent overheating from outdoor to indoor. In this case, it

saves energy and electricity. To give an example about this issue, The Pixel Building is Australia's first carbon neutral office building project to produce its own energy and water on its site. Carbon neutral buildings reduce and balance their green house gas emissions, or their carbon foot print. The building's energy saving features include colorful panels in the facade design that provide shading and maximizing day light when needed. On the other hand, it supports to help process waste water, collects rain water with its roof, and produces energy with series of vertical wind turbines. The Picture of the Pixel Building is shown below in Fig. 6.



Figure 6. Pixel Building in Melbourne / Australia (www.austrotherm.com.tr)

To give an another example, PV panels are used in the sustainable facade design of the Solar - Fabrik Building in Freiburg / Germany. PV panels, which are used as shading elements on the building facade, get rid of solar radiation and prevent overheating of the interior space of this building. In addition, some of the energy needs of the building are provided by this radiation. The facade of the building is below in Fig. 7.



Figure 7. Solar – Fabrik Building in Freiburg / Germany (www.solar-fabrik.com)

In high rise buildings, wind also can be used to provide energy requirements like solar energy. A significant amount of energy can be produced by using wind turbines, which convert the kinetic energy into mechanical energy and then into electrical energy in buildings. Bahrain World Trade Center is a significant example of a high rise building project in Manama. This complex consists of two towers, was designed by British architect Tom Wright. In history, it is the world's first high rise building that has its own wind turbines. There are three wind turbines in between two towers and also connect with them. According to Guthrie (2008), these turbines are expected to supply 10 - 15% of the building's electricity needs. The image of the building is below in Fig. 8.



Figure 8. Bahrain Trade Center, Bahrain / Manama. (www.arkitera.com)

To give an another example, Strata Tower is a sustainable high rise building project that have wind turbines. This building is the highest residential building in central London / England. It is the first skyscraper in the world where wind turbines are integrated into the building. According to Çerçi (2011), Strata Tower is aimed to provide approximately % 8 of the total electricity need of the building with three wind turbines, each have a radius of 9 meters. The image of the building is below in Fig. 9.



Figure 9. Strata Tower, London / England. (www.urbannews.fr)

4.1.1.3 Energy savings. In sustainable architecture, energy savings can be considered in relation to envelope and electrical & mechanical systems of the building. Energy savings can be defined as, consuming less energy for the building without reducing the quantity and quality of the goods or services produced. According to Çakmanus (2021), buildings use more than 40% of the world's fossil based energy. This data show that buildings have an important role in the world, both in the consumption of energy and in the emission of green house gases. In this context, it is becoming increasingly important to carry out studies to take necessary measures in order to ensure the sustainability of life and natural resources.

Buildings need energy consumption as a function of the climate zone in which they are located. Energy consumption in buildings varies depending on parameters such as building envelope characteristics, type of energy systems and operation of the building. At the same time, function, aesthetics and economic status also affect energy consumption and efficiency.

In sustainable buildings, there are some methods that are used to reduce energy consumption. At the same time, during the construction phase of the building

project, the most important requirement is energy. At this point, the energy performance of the building is very important. Energy performance can be defined as, the amount of energy required to provide the energy demand of the building for heating, cooling, ventilation, hot water and lighting, and other technical building systems. Reducing heat transfer between outdoor and indoor, decreases cooling and heating loads in the building. Also, insulating the building is cheaper than mechanical heating or cooling systems. In this way, with suitable insulating design, in addition to energy savings, economical savings are ensured. The solutions that can be made to ensure the sustainability of life and resources can be listed as sustainable energy use, reducing energy needs and increasing efficiency in energy use. According to Hamidabad & Begeç (2015), in order to provide thermal comfort in buildings in all climatic conditions, heating and cooling (HVAC) systems need to be well controlled.

The main purpose of the energy efficient design approach, is effective on to reduce the amount of energy use and fossil fuel consumed in the building. In addition, during the construction process and also during the occupation period, the building needs an uninterrupted flow of energy. Therefore, energy saving provides great benefits in every process of sustainable high rise buildings. To give an example about energy savings, Copen Hill building is one of the most advanced sustainable building project in the world. It is located in Copenhagen / Denmark. This building provide power plant, high efficiency and minimal emissions from waste. According to Dağtekin (2020), Copen Hill Building will provide electricity and heating for 150,000 homes in a year and has the capacity 440,000 tonnes of waste convert to clean energy by burning. The image of the building is below in Fig. 10.



Figure 10. Copen Hill Building, Copenhagen / Denmark. (Dağtekin, 2020.)

On the other hand, the building has a sloping green roof that resembles a mountain. This green roof also absorbs heat, removes harmful particles from the air and minimizes the risk of flooding. At the same time, furnaces, steam and all turbines are hidden under this green roof. The image of the green roof of the building is below in Fig. 11.



Figure 11. Copen Hill Building, Green Roof. (Dağtekin, 2020.)

The form of the building is an important parameter that, affects the energy performance of the building. In sustainable building design, building form can not be considered independent of the urban texture. The building must reflect the character and qualities of the environment. Optimum form and planning in the construction of buildings, aims heat loss in winter and minimizes the heat gain in summer. As the shell surface area increases, also the energy losses increase. So, the optimum surface area should be created for having beneficial and suitable form. However, the wind, which is one of the most important external climate element, has an increasing effect on heat losses. At the same time, it is necessary to create a appropriate form according to the climate zone.

Building form and plan should be in a way to maximum benefit from sun light. In order to maximum benefit from use of natural lighting, the priority areas should be listed. For example, office areas, work areas and core areas need natural lighting. Meeting rooms, storages, parking and toilets are non priority areas for natural lighting. According to Özdemir (2005), in hot humid climates, open surface to the wind, elongated rectangular form; in hot dry climatic regions, with courtyards, square base, open surface to indoors; in temperate dry climatic regions, closed to the wind, close to square form; in temperate humid climate regions, wide surface to the wind, rectangular form or free plan; in cold climatic regions, interacting the wind with less surface, minimizing the outer surface, compact, square based forms should be preferred. In sustainable architectural design, in order to ensure the least energy use of non renewable energy sources, the size of the total surface area is directly related to heat losses as it affects the building form. An example about building form that, is the Swiss Re Building in London / England. The image of the building is below in Fig. 12.



Figure 12. Swiss Re Building, London / England. (www.tricon.co.uk)

The building has a circular form and plan scheme. Floors of the building overlap by turning and spiral atriums are formed by the height of the building. In summer, these atriums expel the hot air in the building with the effect of chimney. But in winter, it creates a green house effect and reduces the heating load of the building. In addition, these atriums also provide natural ventilation and lighting. According to Foster (2005), the aerodynamic form of the tower encourages wind to flow around its face, minimizing wind loads on the structure and cladding, and enables the use of a more efficient structure. Natural air movement around the building generate substantial pressure differences across its face, which can be used to facilitate natural ventilation within the building.

In high rise buildings, circulation is usually and naturally in a vertical way. At the same time, the effect of the core on the structural system is excessive. Therefore, core planning is very important for the building circulation and structural system. In terms of aesthetically, the incompatibility between the load bearing systems and partition walls in the core area, can be eliminated. For the effective operation of the building, according to Çakır and Selçuk (2016), core areas can be designed inside as well as outside of the building or at the periphery. In hot climates, placing the core

areas on the east and west facades, cooling systems provides great savings. In cold climatic regions, placing the core areas in north - east or north - west directions, protects the building from cold winter winds. Also, it provides great savings in heating costs.

When the number of floors and floor areas increases, also the number of elevators increases and the core area involves. If the building structure narrows from the ground to the upper floors, the elevator need on the lower floors is not the same with upper floors. In such a case, the elevators are divided into horizontal and vertical zones. Then, a part of the area allocated for the elevator shaft on the upper floors, can included in the usage area. To give an example, the usage area of the upper floors was increased by using this method in Conde Nast Tower in New York. The image of the building and plan is below in Fig. 13 and Fig. 14.



Figure 13. Conde Nast Tower, New York. (www.flickr.com)

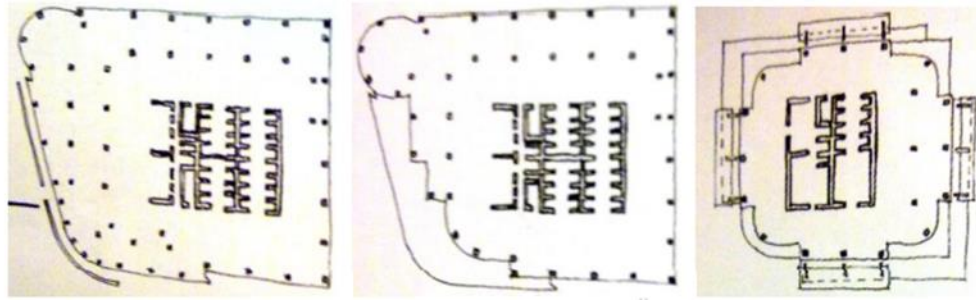


*Figure 14. Ground Floor - Middle Floor - Upper Floor Plans of Conde Nast Tower
(Sev, 2009)*

At the same time, in the design of floor plans, more corner offices were obtained with geometric form and the view perspective of the employee was increased.

Natural ventilation is another sustainable design principle for high rise buildings. It is replacement of used air with fresh air or outside air. The natural ventilation conditions that occur in volumes are related to the characteristics of the natural ventilation system and external climatic conditions. At the same time, this system is the cheapest ventilation type to establish and maintain in all building types. It works silently and electric power is not used. In this way, it reduces the need for mechanical ventilation and other air conditioning systems. Also it provides a significant saving on fossil based energy use. Natural ventilation conditions should be designed before the construction phase of buildings. In the design of high rise building, natural ventilation is provided by using ventilation chimneys, floor gardens, atriums, winter gardens, windows that can be controllably opened and closed, air inlet - outlet ducts and fans. Especially after corona pandemic, the control and monitoring of using and rate of clean air is very important for people's health and comfort. With suitable layout, plan and building form design can take advantage of the summer wind convert to natural ventilation. The air corridors, inner courtyards, canopy gaps, which are provided as a direct result of the building form, can create natural air circulation, provide comfort in the immediate surroundings of the building and refreshment in the interior space. In addition, the direction of the wind and the position of windows on the facade are very important. Because, windows are essential elements of natural ventilation. By controlling the wind pressure; heat, light and sound transmission between the indoor - outdoor environments can be prevented. In addition, negative features of the outdoor environment need to be controlled.

The use of natural ventilation with windows is mostly used in single and multi - storey building, low rise buildings, offices, schools, and health facilities. However, energy saving, indoor air quality, sustainable energy and energy efficient building concepts, which have come to the fore in recent years, enable the development of new systems and sustainable solutions. An example building of using natural ventilation on the facade design is the National Commercial Bank in Jeddah / Saudi Arabia. In the building project, the courtyard was adapted on the triangular plan scheme and the void areas were used as sky courtyards. The exterior facade of the building was covered with stone, while the areas of the sky courtyard are covered with glass material. The vertical layout of the sky courtyard provides air movement by creating a chimney effect. So, it saves cooling costs by reducing the heat on the inner facade of the building. While providing natural ventilation, it is necessary to pay attention to design of the facade system. Because the wind ,that hits the building strongly, can damage facade of the building. For this reason, the facade should be designed with attention to the wind corridors in surroundings. The image of the building is below in Fig. 15.



*Figure 15. National Commercial Bank, Jeddah / Saudi Arabia
(www.skyscrapercenter.cn)*

Commerzbank Building, which was the tallest building in Europe at the time it was built, was based on the natural ventilation system. The mechanical ventilation system would only be activated in extreme conditions. As seen in the figure below, the double skinned facade, atrium and winter gardens contribute natural ventilation. The air between the double skinned walls, which works as a passive solar energy system, is used to heat the ventilation air while contributing to the heating of interior spaces in winter. The image and the plan of the building is below in Fig. 16. and Fig 17.



Figure 16. Commerzbank Building, Frankfurt / Germany (www.archipicture.eu)

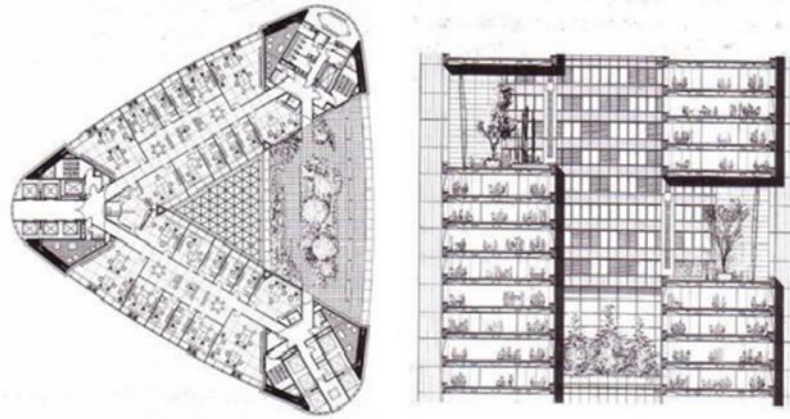


Figure 17. Atrium, Winter Gardens and Double – Skinned Facade of the Commerzbank Building (Yilmaz, 2005)

The facade system and building's materials are also important in terms of energy savings. According to Yilmaz (2005), the most important component of sustainable buildings is building facade, which is the most important design parameter that affects the energy performance of the building as a passive system. She also mentioned that, in recent years, problems in obtaining fossil energy resources, the environmental problems caused by the use of these resources. For this reason, the total energy of % 40 - 50 is used by buildings in Turkey. Therefore, with the increasing importance of energy efficiency in high rise buildings design, sustainable facade design is very important, in parallel with the developments in architectural developments and material technology.

Sustainable facade design has many functions in terms of solar energy usage. Transparent or translucent solar control elements, various natural shading elements, such as curtains, shutters and blinds, glass selection with appropriate U value, and PV panels on facade design are parameters that used for solar energy. Sustainable facades contain high sound insulation combined with self -regulating heat, ventilation and sun protection measures that adapt to changing light and climatic conditions. Some of them already use solar energy to provide comfortable heating and air conditioning. The optical and thermophysical properties of the building envelope are the determinants of the amount of heat gained and heat lost through the effects of outside air temperature and solar radiation. Also, all heating and cooling systems, used in the indoor of the building, affected by the total amount of heat lost and heat gain from the building facade.

According to the climate zone, all building elements (exterior and /or interior walls, roof, floor, window, door, etc.) should be considered separately in the determination of the building facade. (Özdemir, 2005) To give an example from Madrid / Spain, is Carabanchel Housing Project. The most striking element of the project is the use of reed material on the facade design. At the same time, the facade of the building is made of shutters, which are mounted on a collapsible frame. These shutters, are protecting the building from the sun light and also they increase safety because of the person living in each unit is under their own control. The aim of this parameter is to create a comfortable interior environment based on minimal heating - cooling and air conditioning energy consumption. In this way, it must be ensured that the building envelope and facade performs their functions as an optimal passive system element. The facade of the building's images are below in Fig. 18. and Fig. 19.



Figure 18. Carabanchel Housing, Madrid / Spain (www.archdaily.com)



Figure 19. Sustainable Facade Design of Carabanchel Housing, Madrid / Spain.

(www.ekoyapidergisi.org)

Another facade system preferred in sustainable high rise building design is the double skin facade system. According to Jiru, Tao and Haghighat (2011), double skin facade system is defined as the building envelope design, with back to back placement of two windows, consisting of a ventilated air space in between, and solar control elements placed inside the cavity. According to Yılmaz (2005), nowadays, double skinned facades, which are frequently used in energy efficient smart buildings, offer designers wide possibilities in this regard. In addition, double skin facades provide natural ventilation, solar control and heat gain control systems. On the other hand, it is also effective in preventing high wind pressure in high rise buildings. Particularly in high rise design, double skin facade system are favored for their transparency, thermal and auditory comfort, reduced air conditioning costs, and elimination of the need for window and specific technologies. (Souza, 2019.)

Natural lighting is one of the most important way to saving energy. It minimizes the amount of artificial light, reduces electricity and HVAC (heating, ventilation and air conditioning) costs. Electric lighting generates a lot of heat, while natural lighting produces almost any heat. In order to find a gratifying natural lighting solution, it is necessary to use an integrated approach in design of the building project. The most important decision is position of building and windows, according to the sun direction. According to Özdemir (2005), depending on the direction of the building in direct sun light, the fact that it affects the facade and enters the building through the windows. It can be determined as a result of detailed analyzes based on latitude, days

and hours. These analyzes must be carried out in order to design the natural lighting system in a way that can supply the visual comfort conditions. The design of the roof and facade, the selection of glazing systems, the choice of day light control mechanisms, such as roller shutters and blinds, are also important in terms of natural lighting. For example, Beirut has become one of the city where vertical architecture and modern projects are carried out in recent years. Land constraints have begun to consist in the city, which has grown horizontally before this problem. Therefore, Beirut's city planners are focused on growing the city vertically and saving space from the lands. The Martyrs Square project is one of the first high rise building project in the result of this target. The square project, located in one of the most central points of the city, resembles an observation tower with its glass facade design. In this project, glass balconies were included, especially based on the aim of maximum use of natural lighting and open spaces. Images and the facade design of the building are below in Fig. 20 and Fig 21.



Figure 20. Martyrs Square Project in Beirut / Lebanon (<https://www.solidere.com>)



Figure 21. Martyrs Square Project in Beirut / Lebanon (<https://www.solidere.com>)

4.1.1.4 Water savings. Water, is one of the most important natural resources for nature, humanity and future generations. There are many regions of the world where water sources are scarce. Factors such as population growth, urbanization, the irrepressible increase in industrial activities, developments in technology, increasing buildings and climate changes are among the main factors that cause an increase in the demand for clean water. With the addition of the damaged eco system to this increase in demand, the water crisis has emerged. Water has become one of the main elements considered as a strategic product all over the world. Therefore, water savings has a great contribution to the climate, ecology and environment.

First of all, the amount and measurement of water used in the building should be carried out especially in high rise buildings. According to Gökten (2017), water accounting and reporting should be consider within the conceptual framework. Water accounting records the amount of water and waste water used directly and indirectly by organizations and buildings. In addition, it is a field that evaluates the risks arising in relation to water and examines the impact of all these on stakeholders. In other words, it covers the measurement and reporting of the water used directly or indirectly, the effects of this use and the contributions of the organization to water. In this context, the measurement and impact of water using is one of the most important

concept of sustainability certificates. Water measurement for the entire building enables buildings to identify opportunities for water conservation, monitor and control of water using.

For water savings in high rise buildings, it is necessary to consider indoor use, outdoor use, special uses and measurement holistically. Sustainable design principles encourage the reuse of all water such as waste water, gray water, condensed water, process water, rainwater, etc. recovered to irrigation, toilet cleaning and other suitable uses in the building. Water conservation and treatment is essential for a sustainable high rise building design. Secondly, gray water system ensure the reuse of used water by utility water tanks. These system purify used water and convert it into usable clean water for garden irrigation or toilet flushing etc.. At the same time, preventing leaks in water pipes, is very important for the protection of water resources. Installation systems need to be checked regularly, leaks need to be detected and repaired.

The rainwater collection system on the building's roof or facade, is one of the parameter that water saving. For this system, storage areas in the building are required. Rainwater can be collected from the roofs of buildings with large roof areas or large surface on the facade that high rise buildings, hospitals, factories, airports, university buildings and collected in water storages. According to Mengü and Akkuzu (2008), in order to collect rainwater, horizontal and vertical grooves on the collection surface, pumps for the transmission of water, filters for purification, rainwater tank that can be located above or below the ground where the collected water accumulates and dispensing systems for transmission to the area are required. The rainwater collected in the tanks can be used in many areas of need such as garden irrigation, ornamental pool filling, fire extinguishing, toilet and wash basins.

4.1.1.5 Waste management and recycling. With the increasing population all over the world, environmental pollution problems come to the fore. More than half of the waste is organic. According to Kök (2021), as long as it is managed correctly, all organic waste can be recycled. In this way, recycling, which provides positive effects on the environment as well as its economic benefit; saves energy by reducing pollution. In the construction phase and occupation phase of the building, maintaining the waste management is very significant for recycling. The transportation, storage, disposal and management of wastes, generated by the consumption of products in various forms,

are related with this issue. Sorting the used garbage, separated them according to their types (glass, paper, metal, plastic ex.) and delivering to the municipality are some of the method of waste management. At the same time, the presence of recycling bins, can facilitate this method.

In order to ensure sustainable waste management, it is necessary to examine the environmental and economic loads of each element of the system and to operate it continuously. According to Yaman (2012), the waste management that can get the most economical and highest efficiency system where the least waste is produced. In order to reduce the level of waste, it is necessary to apply techniques that will produce minimum waste and to ensure the recovery of waste as energy. In order to create a more efficient waste management system and to benefit from the power of the natural cycle, recyclable waste needs to be separated at its' source. There is a waste management hierarchy developed by the U.S. Environmental Protection Agency (EPA). According to this hierarchy, reduction, reuse and recycling /composting should be included as a priority in an effective waste management system.

In addition to all of this; public participation and willingness play an important role in the success of the waste separation process at source. In this way, awareness campaigns to be carried out by local governments including educational institutions, the internet and the media can contribute to waste management. In addition to awareness activities, it is also necessary to increase the accessibility of waste separation equipment and to encourage the process for manufacturers. In the planning and operation stages of an effective waste management system, enterprises and street collectors in the recycling sector must be included in the process, controlled and in relationship with buildings.

4.1.1.6 Material selection. Sustainable building, can be defined as a system that has the characteristics of a process that will exist continuously without any deterioration in the property of the existing material and without any decrease in the material that support it. (Nicholson, 2004). The life cycle of the building covers the period from the extraction of the raw materials to be used for construction to their destruction. Sustainable materials can support to high rise buildings due to their environmental positive properties in ecologically and economically ways. In addition, materials that consume less energy result in less carbon dioxide emissions and also lead to a reduction in environmental pollution from the building materials. Especially

when choosing the material of high rise buildings, features such as building life cycle, aesthetics and performance should be taken into account. For these reasons, during the selection of the appropriate material at the beginning of the design process, it is environmentally important to take into account energy efficiency characteristics along with many other criterias. Careful selection of environmental friendly building materials is the easiest way for architects to incorporate sustainable design principles in high rise buildings. Natural materials, compared to human made materials, are more laborious, lower in toxicity, require less processing, and cause less damage to the climate, ecology and environment. According to Godfaurd (2005), when low energy natural materials are incorporated in to the building products, the products also become sustainable. Sustainable materials are not harmful to climate, ecology, environment and also human health because they do not contain toxic components. At the same time, they can be recycled or reused.

Recycling of the material and having low carbon dioxide emission are among the saving measures that can be taken. As with most components, the number of windows is much more in high rise buildings. In this case, windows also affect the heating and cooling systems of the building. Correct U value selection of the glass is required to energy saving on this issue. Hearst Tower, the first LEED Gold certified building in New York, is one of the significant example project. The building's facade, which provides illumination of office and square areas with natural lighting, has a sloping form. In addition, this facade consists of steel triangular glass elements. The facade design allows natural light into the building becaouse of its' material. At the same time, the glass material type is low - e glass. It was used to reduce solar radiation that causes heating effect. The facade design and material of the building is below in Fig. 22.



Figure 22. The Facade Design of Hearst Tower in New York. (www.juzaphoto.com)

4.2 Earthquake Resistant High Rise Building Design

One of the most risky types of natural disasters occurring in the world is earthquake. Earthquakes are complex ground motions and involve significant uncertainties as their frequency content changes depending on its time and environments. On the other hand, It is known that Turkey is one of the most affected country in terms of loss of life, socio - economic and social effects in various earthquakes. (Akıncıtürk, 2003). The formative design of architecture used to be closely related to structure, but with the development of structural engineering it has gained considerably more freedom, although of course it still needs to be rational. We sometimes find incompatibility between everyday function and disaster prevention performance. Methods for designing modern high rise buildings have developed to achieve a good balance between these two competing factors. (Nakata, Ikeda, Murao, 2012.)

Nowadays, especially in high rise buildings, earthquake become a much more important issue. Design of the high rise building in a sustainable way and being resistant to earthquake is also very important in terms of the building's impact on the

climate, ecology and environment. The design of earthquake resistant building is often thought to be a topic that covers the field of study of civil engineers. (Morales-Beltran, Charleson ve Aydın, 2020). However, according to Arbabian (2000), considering that the structural system of the building is designed depending on the form of the structure, the architectural design stages are a direct determining factor on the performance of the building in an earthquake. Therefore, as in all architectural and construction works, it is an important issue for earthquake resistant design that the architect and the engineer have a common design perspective.

According to Yüksel (2017), seismic loads are among the most important loads in high rise building design. As the floor height of the building increases, the horizontal effects (earthquake and wind) also increase. Thus, the response of the structural system elements to these loads, affecting the building durability. According to Çelep and Özuygur (2017), in a case of an unexpected collapse, the risk of material damage and loss of human life caused by high rise buildings is much more than other buildings. Earthquake regulations make it possible to create earthquake resistant buildings that provide the desired level of performance for the predicted design with a certain probability and to take into account these uncertainties. Therefore it is not possible to precisely determine the dynamic load effects that will occur in the structure in advance. Most regulations are valid for general buildings. But high rise buildings have to comply regulations for them. In this way, the design of high rise buildings requires special research and design methods distinct from general regulations.

In this section, this thesis determine and summarize basic issues of earthquake resistant design for high rise buildings.

4.2.1 Structural systems and building form. First of all, It is expected that the structural system, which is designed in accordance with the form of the building, will maintain the rigidity and ductility of the structure by showing sufficient strength during the earthquake. It will be able to safely transmit the earthquake load acting on it to the ground. Therefore, the form of the building and the structural system should work as a whole in harmony against the earthquake effect. (Hünük, 2006). After that, It is necessary to understand how earthquakes affect buildings. According to Karakoç (2023), when an earthquake occurs, it sends seismic waves through the ground, at short and fast intervals that propagate in all directions. While buildings are often designed to withstand the vertical forces caused by their weight and gravity, they

cannot handle the horizontal force emitted by earthquakes. As the number of floors of the building increases, this risky situation also increases. Horizontal seismic motion vibrates walls, floors, columns, beams, and binders that hold them together. The difference in movement between the top and bottom of the buildings exerts excessive stress, causing damage to the structure and eventually the collapse of the entire building.

One of the way to counteract the force of an earthquake is to "lift" the foundation of the building from the ground through a method called foundation insulation. When the building base moves during an earthquake, seismic insulators vibrate while the structure remains stationary. This helps to reduce the impact of seismic loads and effectively prevent them from moving through the building.

In order for high rise buildings to be resistant to destruction, they must redistribute the force that passes through them during a earthquake event. The choice of structural system have a significant impact on the exterior and interior of the building. It is also very important to regularly monitor, repair and strengthen the building structural system. Shear walls, cross joints, diaphragms and momentum strength structures are of great importance in strengthening a building. Shear walls are a useful building technology that can help transfer earthquake forces. These walls, which consist of multiple panels, help a building maintain its shape when the building is moving. They are usually supported by diagonal cross joints made of steel. These beams can support compression and stress, helping to resist compressive and thrust forces. (Karakoç, 2023). These structural elements, which are used to building safety, are generally used in most building types and are also valid for high rise buildings. Another method used to increase the durability of the high rise building is the structural facade systems. These façade systems are the carrier of the element used in the facade of the structure. Therefore, the structural system can be used as a facade element on the exterior, and it can also play a role in determining interior spaces.

During the earthquake, one of the biggest factors affecting the behavior of high rise buildings is the building form. Building form plays an important role in forming the structural and load bearing systems. According to Nakata, Ikeda, Murao (2012), together with the increasing emphasis on environmental conservation and saving energy and resources of recent years, forms have become more and more dependent on environment-oriented facility planning. In addition to designing the

building form aesthetically, it should also be constructed as earthquake resistant. Because seismic forces are horizontal loads, so they have a great effect on the building form. Among the horizontal loads, the earthquake is the most important one and it followed by the wind. The design of the narrowing, expanding, recessed or protruding areas of the facade should be designed by considering these horizontal loads. To give an example, Tokyo Imperial Hotel form is a solution of earthquake resistance. Designed by Frank Lloyd Wright in the early 1920s, the building is neatly divided into pieces. In designing this method, it is understood that he was concerned about the possibility of different oscillations that would be generated by the surface wave over the building area. The reason, why the building was not damaged in the 1923 Kanto Earthquake, can explained as the use of this idea in the design of the building. (Reitherman, 1980.)

To give an another example from Los Angeles, the most highest building is New Wilshire Grand Center. Engineer Leonard Joseph says that, "This was the most complicated and the highest seismic-demand project I have been involved in." Because, Southern California is an earthquake risk region. According to Monks (2016), the design team settled on a plan for a concrete core with a steel perimeter frame, connected by braces known as outriggers at three levels of the tower. Leonard Joseph compares the latter elements to the arms and poles of a skier, providing balance on the slopes. The image of the buildings is Fig. 23.



Figure 23. New Wilshire Grand Center (tnc.network)

Another basic element used to strengthen the structure of the building is diaphragms. They can also be named horizontal frames. Diaphragms, which consist of the floors of the building, the roof and the decks placed on them, help to remove the tension on the floor and push the force towards the vertical structural elements of the building. Another element is momentum strength frames and It provides extra flexibility in the design of a building. This structure is placed between the joints of a building and allow the columns and beams to bend while the joints remain rigid. Thus, the building can withstand the force of a larger earthquake. Therefore, architects design and arrange the building elements freely.

4.2.2 Dampers and structural health monitoring system. Dampers, are used as an element of the building's horizontal load bearing system and external support system to control horizontal displacements and accelerations caused by earthquake loads. According to Aldemir and Aydin (2005), earthquake damping systems place flexible energy-damping elements between the ground and the base of the structure, helping to reduce the earthquake forces transferred from the ground to the structure and absorb seismic energy and movements. They reduce the magnitude

of earthquake waves and help reduce pressure on the building. At the same time, dampers involve placing between columns and beams on each level of a building. While the damper reduces the vibration and cross section effects, it supports the building structure from the outside. During the earthquake, dampers reduce horizontal displacements and bending effects, while increasing the overall translational stiffness of the building. The optimum amount of damping to be added to the building and the optimum distribution of this damping throughout the height of the building are the subject of a different examination issue. For this reason, it is very important to use dampers properly in sustainable high rise buildings.

According to earthquake regulation for high rise buildings, another method used in high rise buildings, is Structural Health Monitoring System to control the effects of earthquake. Also in the new earthquake regulation, this system is obligatory for high rise buildings. In addition, it is necessary to continuously monitor the dynamic movements of high rise buildings with Structural Health Monitoring Systems, and to create periodic and incident based reports. According to earthquake regulations for high rise buildings, this system's detail is below in Fig. 24;

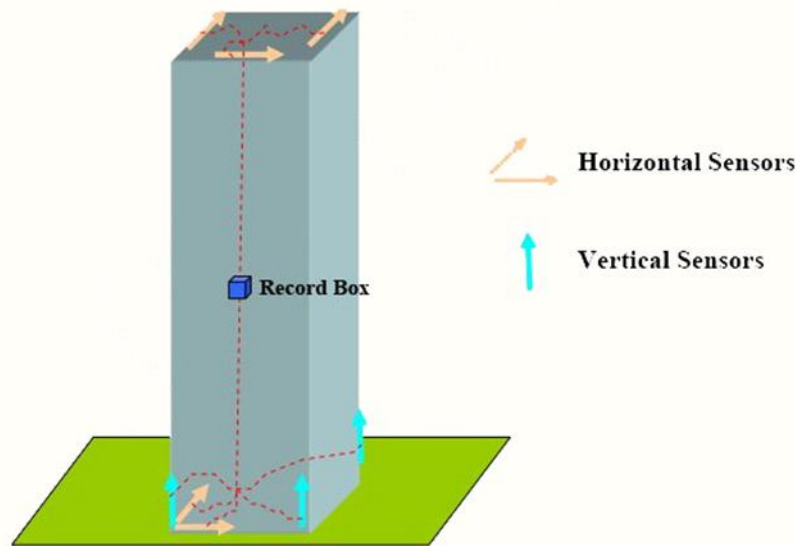


Figure 24. Structural Health Monitoring System in Regulation for High – Rise Buildings (translated to English by the author)

In this system, the horizontal and vertical movements of the building can be measured with accelerometers. It is intended for continuous usage, not only in the event of an earthquake. Accelerometers provide immediate usage, maintenance and estimation of

damage after the earthquake. They are also sensitive enough to measure building's horizontal and vertical movements, even in remote areas earthquakes. In addition, in a case of earthquake, damage assessment and before and after comparison results can be prepared quickly. When it necessary, these results are supported by advanced analyzes and solutions are made ready with the situation of the building after earthquake. Also, solutions about the precautions are presented in detail.

High rise buildings are the most monitored building group by accelerometers or sensors in the world. The use of dampers and structural health monitoring system, which is not very common in Turkey, should be investigated and interrogated for high rise building design.

4.2.3 Earthquake regulations in Turkey. Earthquake regulations differ according to country, building types and floor numbers. In our country, there is an earthquake regulation for high rise buildings. Buildings, that have height classes (BYS = 1) can be defined as high rise buildings depending on Building Height Class and Earthquake Design Class. Importantly, this regulation includes “Building Usage Class (BKS)” and “Performance Levels”. In the earthquake regulation, BKS (Bina Kullanım Sınıfı) is defined as depending on the purpose of use of the building. As BKS = 1, buildings that need to be used after the earthquake. Also buildings, where people are present for a long time and densely and valuables and dangerous substances are located. As BKS = 2, buildings where people are concentrated for a short time. Lastly, less important buildings, are classified as BKS = 3. The value of BKS = 3 is necessary for high rise buildings in the regulation. But, the value of BKS = 1 should target for less negative impact on the climate, ecology and environment. The table of building usage class, building usage aim and building value in earthquake regulation, is below in Table 2.

Table 2.

Building Usage Class (BKS), Building Usage Aim and Building Value in Earthquake Regulation (translated to English by the author)

Building Usage Class (BKS)	Building Usage Aim	Building Value
BKS=1	Buildings, that need to be used after earthquake, buildings where people are concentrated for a long time, buildings where valuable objects are stored and which contain dangerous substances. <i>a) Hospitals, dispensaries, health centers, fire brigade buildings and facilities, PTT and other communication facilities, transportation stations and terminals, power generation and distribution facilities, provinces, governorships and municipal buildings, first aid and disaster planning stations.</i> <i>b) Schools, educational buildings, dormitories, military barracks and prisons.</i> <i>c) Museums</i> <i>d) Buildings where toxic, explosive and flammable materials are stored.</i>	1.5
BKS=2	Buildings where people are concentrated for a short time. <i>-Shopping malls, sport centers, cinema, theatre, concer halls, temples, mosques, etc.</i>	1.2
BKS=3	Other Buildings <i>-Buildings that don't contain in the definitions of BKS=1 and BKS=2 (Residential buildings, business centres, hotels, industrial buildings)</i>	1.0

After BKS value, the performance level is the expected damage limit state from a building, under the influence of a earthquake. According to Çelep & Özüygür

(2017), in earthquake resistant building design, there are varying levels of performance levels depending on the social importance, height of the building, continuing the use of the building and limiting the damage. Performance levels are;

- Uninterrupted Usage Performance Level
- Limited Damage Performance Level
- Controlled Damage Performance Level
- Prevention of Migration Performance Level

Performance levels' details in earthquake regulation are below in Table 3.

Table 3

Building Performance Levels from Earthquake Regulation (translated to English, by the author)

3.4 BUILDING PERFORMANCE LEVELS

Building performance levels are defined in 3.4.1, 3.4.2, 3.4.3, 3.4.4 for buildings structural systems in a possible earthquake, as a basis for the definition of the performance aims.

3.4.1 Uninterrupted Usage Performance Level

This performance level means that structural damage has not occurred on structural elements of the building or the damage is negligible.

3.4.2 Limited Damage Performance Level

This performance level means that , it can occur limited damage on structural elements of the building. In other words, it is the level of damage that, non linear movement is limited.

3.4.3 Controlled Damage Performance Level

This performance is the level of damage that is not too heavy and it is mostly possible to repair in the building structural system elements, to ensure life safety.

3.4.4 Prevention of Migration Performance Level

At this performance level, heavy damage occurs on structural elements of the building. Partial or complete migration of the building is prevented.

High rise buildings must be designed to be earthquake resistant before the construction stage. According to Çelep & Özuygur (2017), nowadays, special issues

related to earthquake design of high rise buildings, are solved by performance based design method, with non linear analysis and seismic code design rules.

Performance based system should be considered as a design aim of high rise buildings. Because this system allows immediate using after the earthquake, and protect the building structural system. Especially in design of high rise buildings, uninterrupted usage performance level should be targeted. At this level of performance, there is no structural damage in elements of the building structural and foundation system or the damage can be negligible. Therefore, this thesis suggest BKS:1 level and uninterrupted usage performance level for high rise building.



Chapter 5

Case Studies: Ataşehir District

Ataşehir district is the most intense district of the Asian side, in terms of high rise building. This district continues to develop in line with needs such as high rise buildings, residential housing, business, health and shopping opportunities. In this way, Ataşehir district has been chosen as a case study due to the increase in preference by people, high building density and earthquake risk in İstanbul.

5.1 History of Ataşehir

Before the proclamation of the republic, Ataşehir district was known as Karaman Farm in Ottoman period. Until 1912, on the land of Karaman Farm, it was the center of various farming and trading works. . (Ataşehir District Governorship.) According to the historical research of the General Directorate of State Archives, the land of Karaman Farm was transferred to the treasury after the proclamation of the republic. During the Ottoman period and also today, Kayışdağı, which is located in Ataşehir, is very important in terms of the history of İstanbul According to Ataşehir District Governorship, Kayışdağı neighborhood constitutes the most important historical and geographical texture in Ataşehir. According to website from municipality of Ataşehir, it takes the name from the 438 meters high of Kayışdağı Hill, which is the third highest point of İstanbul.

Ataşehir district, has an area of 25.84 square kilometers and it have partially bumpy land. According to municipality of Ataşehir, the district population is 422,513 and the total number of neighborhoods is 17. (Ataşehir District Governorship.) These neighborhoods are; Yenisahra, İçerenköy, İnönü, Kayışdağı, Barbaros, Küçükbakkalköy, Fetih, Esat Paşa, Örnek, Yeniçamlıca, Mimar Sinan, Mevlana, Yenişehir, Aşık Veysel, Yenişehir, Yeni Çamlıca and Mustafa Kemal. On the other hand, it is bordered by Kadıköy in the south - west, Maltepe in the south and south - east, Üsküdar in the west, Ümraniye in the north and Sancaktepe in the east.

In 1978, Kemal Ilıcak, who is owner of Tercüman newspaper, and businessman Alim Kantarcı bought the land, which was put up for sale by the treasury. In 1980, it was decided to transfer this land to Anadolu Bank on the condition of building collective housing projects. . (Ataşehir District Governorship.) With the participation

of Yapı Kredi and a few other companies, which have %6,4 portion, this land has become a portioned property. (Yalçın, 1995). Ataşehir district, which is between the D - 100 highway, the E - 80 and 02 high way and the ring road, has great advantages especially in terms of intercity transportation. In 1988, Fatih Sultan Mehmet Bridge was opened. Therefore, Ataşehir district has become both prestigious residential area and business center on the Asian side, with the connection roads passing through Ataşehir - Kozyatağı axis. This axis is still very important for the Asian side. Since 1990s, residential and business centers, especially gated community projects have been built under the leadership of TOKİ. (Ataşehir District Governorship.) From 1990 to today, gated communities, that have security services and various social requirements can be easily provide, are increasing in Ataşehir district. Ataşehir, which is still developing, is among the most preferred districts of the Anatolian side, especially in terms of vertical architecture.

5.2 The Development of Vertical Architecture in Ataşehir

According to Kılıç (2006), in the period from the beginning of 1989 to the middle of 1992, various problems were encountered in the Ataşehir project. Although great resources have been invested in the project, there has been no progress in the construction process. The project, which created significant pressures on bank's resources, began to develop from the middle of 1992, for determined attitude of the Board of Directors. In Ataşehir construction project, which continues in many stages, the residence and life started in 1993. Following the rapid construction of other stages and infrastructure works, by the end of 1998, most of construction works in the eastern part of Ataşehir were completed, Meanwhile, it became a residential area with a rapid increasing population and popularity.

After this rapid developments, the number of commercial and residential buildings have started to increase. At the same time, Ataşehir district started to receive immigration from Kadıköy district. With the population of increase, the number of building floors has also increased. Commercial and residential buildings, such as business centers, hospitals, hotels, schools, shopping malls and gated communities, have been constructed.

Especially after 2000, high rise buildings with higher floor numbers than in previous periods, have begun to be constructed. In this way, Ataşehir has become one

of the district where vertical architecture is intense and also continues to develop rapidly.

5.3 Case Studies High Rise Buildings in Ataşehir (Commercial, Residential)

In this section, many sustainable high rise buildings in Ataşehir region were selected. These buildings were visited and interviewed with people who mastered in building projects and details. At the same time, these buildings were examined and discussed in terms of their sustainability parameters and earthquake resistance status. The location of case study buildings are shown below on Fig. 25.





Nidakule North



Andromeda Gold



Metropol



Mynewwork Ağaoğlu



Palladium Tower



Allianz Tower



Büyükhanlı Plaza

Figure 25. Case Study Buildings in Ataşehir Map

5.3.1 Allianz Tower. Allianz Tower, is the first commercial high rise building project that have Leed Platinum certification with 80+ score value. The building height is 186 m with 44 storey. The building is located on E5 main road in Ataşehir. In an interview with Dr. Ceyhun Eren, who is Group Minister of Technical Underwriting and Risk Control Department and also civil engineer at Allianz Tower, building earthquake situations and sustainable features were discussed.

Firstly, according to the information received from him, performance based design was targeted in the building, in terms of earthquake. Before the construction of building, the design was considered in accordance with the earthquake parameters. Performance based design is the ability, by analitical ways, attainment a building design that will reliably operate as predicted under one or more seismic hazard conditions. In addition, the building was designed according to building using situation after earthquake. The “Uninterrupted Usage Performance” level is targeted in this building, which aims the building will not be affected operationally after the earthquake. Along with building damage, life safety is an important parameter in terms of uninterrupted usage performance. While % 10 - % 30 damage is considered normal in Turkey, this rate is planned to be much lower in Allianz Tower. He also shared the concept of performance based design. The presentation of design method is below in Fig. 26.

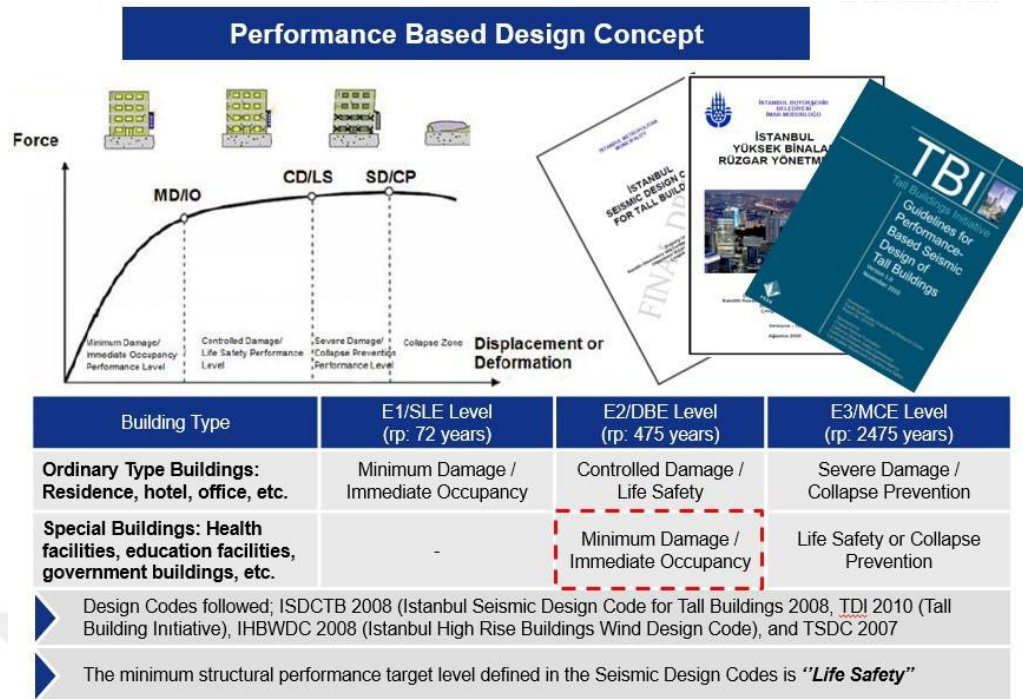


Figure 26. Performance Based Design Concept Presetation from Allianz Tower (Dr. Ceyhun Eren)

In the second part of the interview is about the building's structural system and static condition. The building is made of reinforced concrete and using buckling -restrained braces (BRB) system. This is a structural system that designed resistance to earthquake - induced load and cyclic lateral loads. The image of structural system is below in Fig. 27.



Figure 27. Structural System of Allianz Tower (Dr. Ceyhun Eren)

Earthquake movement situation of each building is different. Especially high rise buildings have different movement modes during an earthquake. While a flat oscillation is expected from normal buildings, whip movement can occur in high rise buildings. Due to the form of the building, there are inclined columns around it. A strong core structure carries the load of these columns. In 17 – 19 floors, there are four steel cross beams for using earthquake dampers. They are connecting the outer columns with the core system. During a major earthquake, these cross beams ensures that outer columns remain in minimal movement. Placing flexible energy absorbing elements between the ground and the base of the structure is reducing the earthquake forces transferred from the ground to the structure and to absorb seismic energy and movements. However, Structural Health Monitoring System has been established to monitoring the changes periodically in the material and geometric properties of the building. In high rise buildings, this system has been made compulsory in the new building regulations. During an earthquake, accelerometers are used to monitoring the building's movement and oscillation. These accelerometers have successfully measured and monitored 2019 Silivri and 2020 İzmir earthquake. In addition, accelerometers can quickly analyze the damage of the building. So, it is prevented the fire that can occur after the earthquake. The presentation of structural health monitoring system is below in Fig. 28.

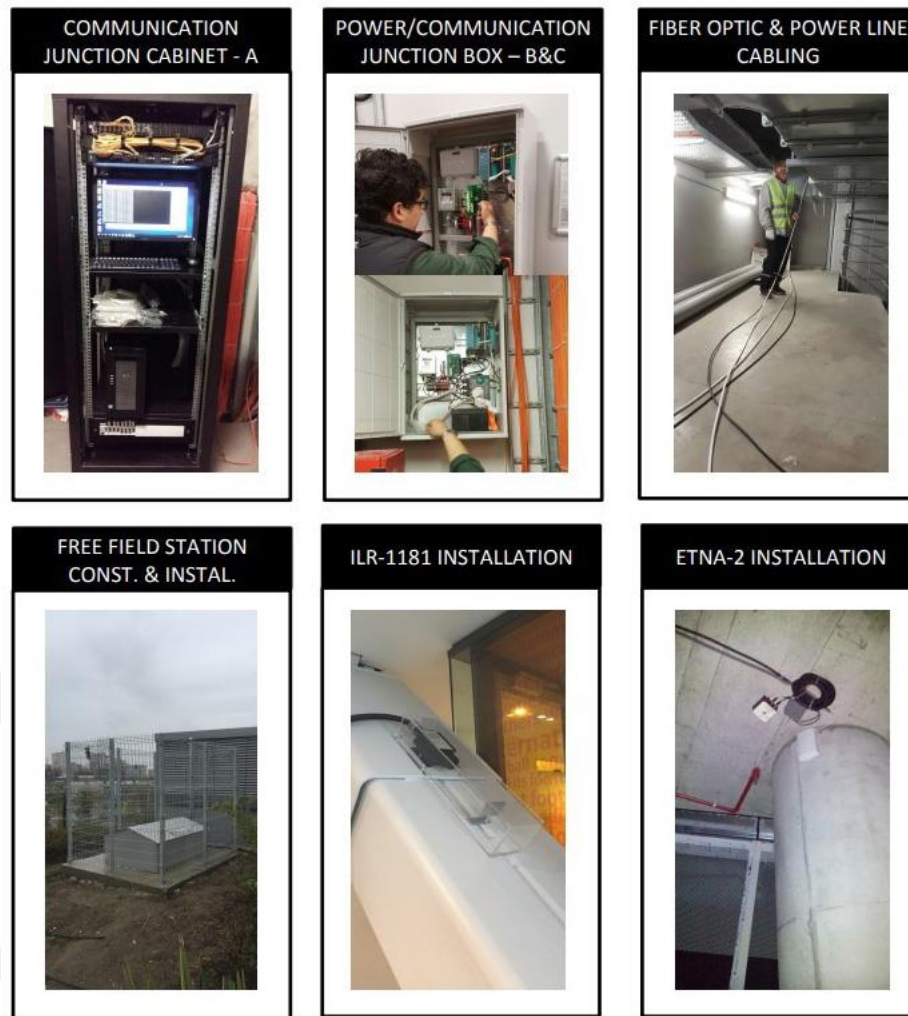


Figure 28. Structural Health Monitoring System in Allianz Tower (Dr. Ceyhun Eren)

During an earthquake, an earthquake suspension system was used to prevent the pipes and mechanical elements from breaking. The other name of the system is flexible transition. In summary, the earthquake issue was used as a design target in this building and it is successfully completed.

After earthquake issues, informations about sustainable design parameters was discussed with him. The most significant sustainable parameter is energy of the building. There is a wind turbine in the building to obtain the electrical energy. Also, the building has a Clean Energy Certification as well as with LEED Platinum certification. In addition to wind energy, there are sun breakers on the facade of the building, but these breakers do not produce energy. In high rise buildings, the ventilation system is very important because windows do not open due to high pressure. The building is ventilated entirely from fresh air and the air quality is

continuously measured. The name of the ventilation system ,used in the building, is displacement ventilation systems. In this system, air is supplied to the environment from the floor level and sucked in from the ceiling level. The aim is to provide the necessary comfort conditions in the occupied zone, which is defined as the height of the human head, and to maximize the air quality. After corona pandemic, air suction rate and air cleanliness have been increased. In addition to the ventilation of the building, every two floors have floor gardens. These floor gardens have many plants and also can used as resting area. Another sustainable parameter of the building is having waste management. There are not any trash tins in the building. Instead, garbages are collected in special areas that can be separated according to their features. (Paper, plastic, metal, glass, etc.) Building workers have to comply with this issue. At the same time, document management was provided in the building and the rate of paper usage was limited. In the building, people use only glass bottles of water, instead of plastic. Water, one of the most important resources of the building, is very significant in terms of sustainability. An automatic on-off system is used in the building to saving water, and the amount of water is regularly measured and recorded. In addition to this system, it is also used in the purification water system. In this way, the water is used in a cleaner way. But the rain water collecting system is not used in this building. When the building sustainability is examined in terms of transportation, the building has parking spaces for bicycles, electrical scooters and electrical cars. Also, the building has its own electrical vehicles. The building image is below in Fig. 29.



Figure 29. Allianz Tower from Büyükhanlı Plaza (Author)

5.3.2 Palladium Tower and Nidakule Ataşehir North. Palladium Tower and Nidakule North buildings are constructed by the same company, which is Tahincioğlu, and have similar sustainability and earthquake resistant parameters. First of all, Palladium Tower and Nidakule North buildings are office projects and both have Leed Gold certifications. Palladium Tower's floor number is 42 and Nidakule's is 30. The architecture firm of these buildings is Swanke Hayden Connel. In interview with Didem Baycan, one of the architects of Tahincioğlu Company in Palladium Tower, building's sustainability and earthquake parameters were discussed.

First part of the interview is about earthquake parameters. "Uninterrupted Usage Performance Level" is aimed in both buildings. According to this system, the building is ready for use after an earthquake without electricity, natural gas and mechanic interruption. Also BKS values are taken as 1 for both buildings. Images of the building are below in Fig. 30A-30B and Fig. 31.



Figure 30 A. Palladium T.



Figure 30 B. Palladium Tower (D. Baycan)



Figure 31. Palladium Tower from Büyükhanlı Plaza (by the Author)

As a structural decision, in both building projects, it was designed as a block at the bottom and a tower above the block. While Palladium Tower consists of a single block, Nidakule consists of four blocks with different heights. Palladium Tower has hollow tile floor slab, Nidakule has flat floor type. In this type, supporter components are inside the flooring, so the thickness of the flooring increases. This situation increases durability of the building.

The second part of the interview is about sustainability parameters of these buildings. She shared score cards of buildings and discussed about them. First of all, under the heading of energy production, no contribution has been made to the buildings as sustainability. But, it is aimed to take advantage of maximum use of solar energy from windows. For instance, U value of glass parameter provides % 20 energy

efficiency. U value, is the glass parameter that characterizes the heat transfer through the middle part of the glass and expresses the steady density of the heat transfer rate according to the temperature difference between the ambient temperatures on both sides. This also stabilizes the temperature of the building and absorbs sun light in indoor appropriately. When examining water efficiency, both buildings have different and same parameters. There are utility water tanks in basements of both buildings. In these tanks, dirty water can be treated and reused up to a certain level in the building. In addition, various precautions have been taken to ensure water efficiency in toilets. For instance, she indicated that adjusting the sink battery to consume less water and reducing the water volume of the WC reservoirs are contributes to water efficiency. But, only these parameters are predicted to be insufficient for water, which is the most important natural resource in the world. Only in Nidakule, there is also a rain-water tank. So, in addition to utility water tanks, rain water can also be converted. The landscape irrigation system is provided by drip method, not squirt. The next part is about sustainable sites. In this issue, it is easy to see from score cards that both buildings received 22 / 28 points. According to Makous (2017), The Sustainable Sites (SS) credit category of LEED was created to ensure that a project's natural environment would be valued and respected throughout every step of the building process, from planning to construction to management. SS credits reward projects that acknowledge that buildings do not exist separately from the landscapes on which they are built, and that the environmental integrity of those landscapes should be preserved. There are garbage gathering and separation areas in both buildings. In these areas, wastes are separated according to their materials and deliver to the municipality for recycling. The last issue is ventilation system. Before and after corona pandemic, % 100 clean air is used for human health and comfort, in both buildings. Windows do not open due to high pressure, so to promote natural ventilation, buildings have floor gardens for resting. It is easy to see floor gardens of buildings, are below in Fig. 32A-32B. Also Nidakule North Building images are below in Fig. 33A-33B. LEED certifications are present below in Fig. 34 and Fig 35.



Figure 32 A. Floor Gardens (Author)



Figure 32 B. Floor Gardens (Author)



Figure 33 A. Nidakule North



Figure 33 B. Nidakule North (D. Baycan)

	SUSTAINABLE SITES	AWARDED: 22 / 28
	SSp1 Construction activity pollution prevention	REQUIRED
	SSc1 Site selection	1 / 1
	SSc2 Development density and community connectivity	5 / 5
	SSc3 Brownfield redevelopment	0 / 1
	SSc4.1 Alternative transportation - public transportation access	6 / 6
	SSc4.2 Alternative transportation - bicycle storage and changing rooms	2 / 2
	SSc4.3 Alternative transportation - low-emitting and fuel-efficient vehicles	3 / 3
	SSc4.4 Alternative transportation - parking capacity	0 / 2
	SSc5.1 Site development - protect or restore habitat	0 / 1
	SSc5.2 Site development - maximize open space	1 / 1
	SSc6.1 Stormwater design - quantity control	1 / 1
	SSc6.2 Stormwater design - quality control	0 / 1
	SSc7.1 Heat island effect - nonroof	1 / 1
	SSc7.2 Heat island effect - roof	1 / 1
	SSc8 Light pollution reduction	0 / 1
	SSc9 Tenant design and construction guidelines	1 / 1
	WATER EFFICIENCY	AWARDED: 8 / 10
	WEp1 Water use reduction	REQUIRED
	WEc1 Water efficient landscaping	2 / 4
	WEc2 Innovative wastewater technologies	2 / 2
	WEc3 Water use reduction	4 / 4
	ENERGY & ATMOSPHERE	AWARDED: 15 / 37
	EAp1 Fundamental commissioning of building energy systems	REQUIRED
	EAp2 Minimum energy performance	REQUIRED
	EAp3 Fundamental refrigerant Mgmt	REQUIRED
	EAc1 Optimize energy performance	5 / 21
	EAc2 On-site renewable energy	0 / 4
	EAc3 Enhanced commissioning	2 / 2
	EAc4 Enhanced refrigerant Mgmt	2 / 2
	EAc5.1 Measurement and verification - base building	3 / 3
	EAc5.2 Measurement and verification - tenant submetering	3 / 3
	EAc6 Green power	0 / 2
	MATERIAL & RESOURCES	AWARDED: 6 / 13
	MRp1 Storage and collection of recyclables	REQUIRED
	MRc1 Building reuse - maintain existing walls, floors and roof	0 / 5
	MRc2 Construction waste Mgmt	2 / 2
	MATERIAL & RESOURCES	CONTINUED
	MRc3 Materials reuse	0 / 1
	MRc4 Recycled content	2 / 2
	MRc5 Regional materials	2 / 2
	MRc6 Certified wood	0 / 1
	INDOOR ENVIRONMENTAL QUALITY	AWARDED: 5 / 12
	EQp1 Minimum IAQ performance	REQUIRED
	EQp2 Environmental Tobacco Smoke (ETS) control	REQUIRED
	EQc1 Outdoor air delivery monitoring	0 / 1
	EQc2 Increased ventilation	1 / 1
	EQc3 Construction IAQ Mgmt plan - during construction	1 / 1
	EQc4.1 Low-emitting materials - adhesives and sealants	1 / 1
	EQc4.2 Low-emitting materials - paints and coatings	1 / 1
	EQc4.3 Low-emitting materials - flooring systems	0 / 1
	EQc4.4 Low-emitting materials - composite wood and aggrifiber products	0 / 1
	EQc5 Indoor chemical and pollutant source control	0 / 1
	EQc6 Control of systems - thermal comfort	0 / 1
	EQc7 Thermal comfort - design	1 / 1
	EQc8.1 Daylight and views - daylight	0 / 1
	EQc8.2 Daylight and views - views	0 / 1
	INNOVATION	AWARDED: 6 / 6
	IDc1 Innovation in design	0 / 1
	IDc2 LEED Accredited Professional	0 / 1
	REGIONAL PRIORITY CREDITS	AWARDED: 4 / 4
	EAc1 Optimize energy performance	1 / 1
	EAc3 Enhanced commissioning	1 / 1
	EAc5.2 Measurement and verification - tenant submetering	1 / 1
	WEc1 Water efficient landscaping	1 / 1
	WEc2 Innovative wastewater technologies	0 / 1
	WEc3 Water use reduction	0 / 1
TOTAL		66 / 110
40-49 Points CERTIFIED		50-59 Points SILVER
		60-79 Points GOLD
		80+ Points PLATINUM

Figure 34. LEED Certification of Palladium Tower (Altensis)

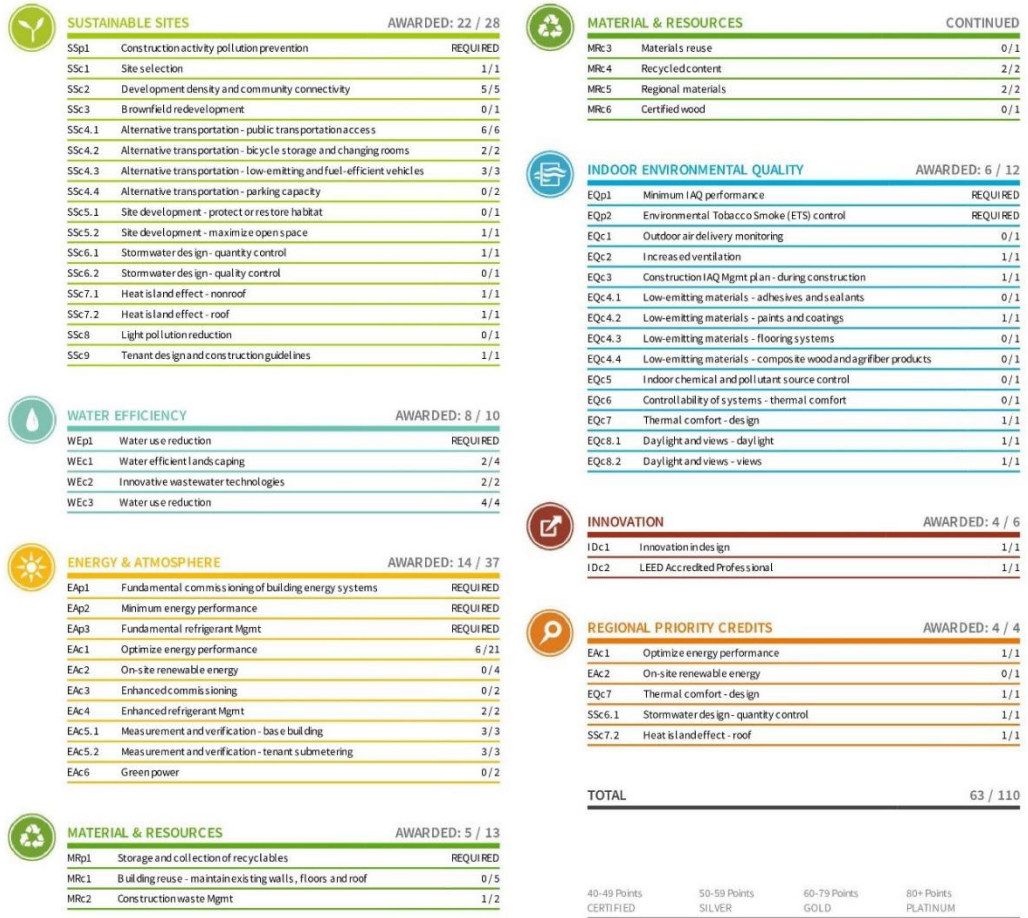


Figure 35. LEED Certification of Nidakule North (Altensis)

5.3.3 Büyükhanlı Plaza. Büyükhanlı Plaza is a commercial building project and have Breeam Two Star certification. Building's floor number is 15. In order to get information about the building's sustainability and earthquake situation, a meeting was arranged with Hasan Eratıcı, who is architect in Büyükhanlı.

First of all, the building started to get Breeam certification in construction phase and continued in management. The building is constructed of reinforced concrete and designed to be earthquake resistant. Performance based design not used in this building. Instead of, Controlled Damage Performance Level was selected. As for the BKS value, which is the building usage class, was chosen as 3. As in the Allianz Tower, Palladium Tower and Nidakule, uninterrupted Usage Performance is not targeted and no extra precautions were taken in terms of earthquake in this building. It

is foreseen that in a case of earthquake, the building can suffer minor damage ,such as breaking off a component on the facade, but it will not collapse.

The lighting and mechanical systems used in the building are designed with energy efficiency in the foreground. It is aimed that, the building will be energy efficient (approximately % 25) compared to standard buildings. Because, the efficient systems, high performance glass systems and heat insulation, selected in the building, supported energy saving. The energy consumption of all kinds of systems in the building is monitored by energy analyzers and the building automation system. In this way, the extent of which energy efficiency targets have been achieved, can be analyzed immediately. While designing the facade of the building, it was aimed that the employees could easily see the outdoor spaces when they were working or sitting. At the same time, the lighting components on the facade, were chosen from economical types to the energy. During the construction phase, the VOC (volatile organic harmful compound) ratios in the construction chemicals (paint, primer, putty, etc.) used in indoors are minimized. Ventilation system is provided from %100 fresh air. Using of windows is possible in this building, so the use of natural ventilation is encouraged. At the same time, there are floor gardens on each floor for resting. Air conditioning is provided by fan coil heating-cooling system. It is also used in heating boilers, for heating. About waste management, there are garbage sorting boxes on each floor. There is also a garbage room in open area, where household waste and hazardous waste are separated. A comprehensive waste management plan has been prepared and implemented regarding the recycling of wastes to be generated during construction. During and after the construction, adequate areas were allocated for the collection of recyclable wastes. Waste management and recycle bins are below in Fig. 36A-36B. Interior offices of the building is below in Fig. 37. Lastly, the Breeam certification of the building is below in Fig. 38.



Figure 36 A. Waste Management (Aut.)



Figure 36 B. Recycling Bins (Author)

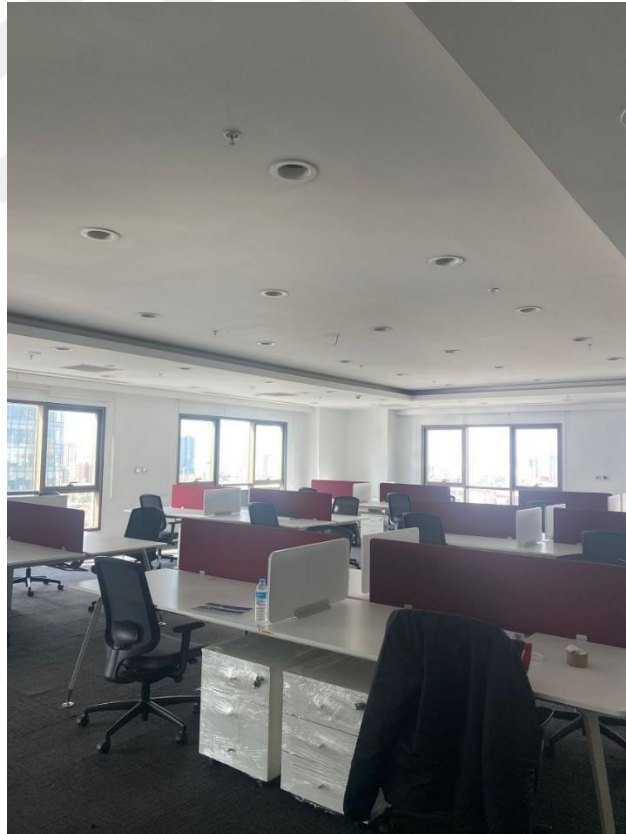


Figure 37. Seventh Floor Office / Büyükhaneli Plaza (by the Author)

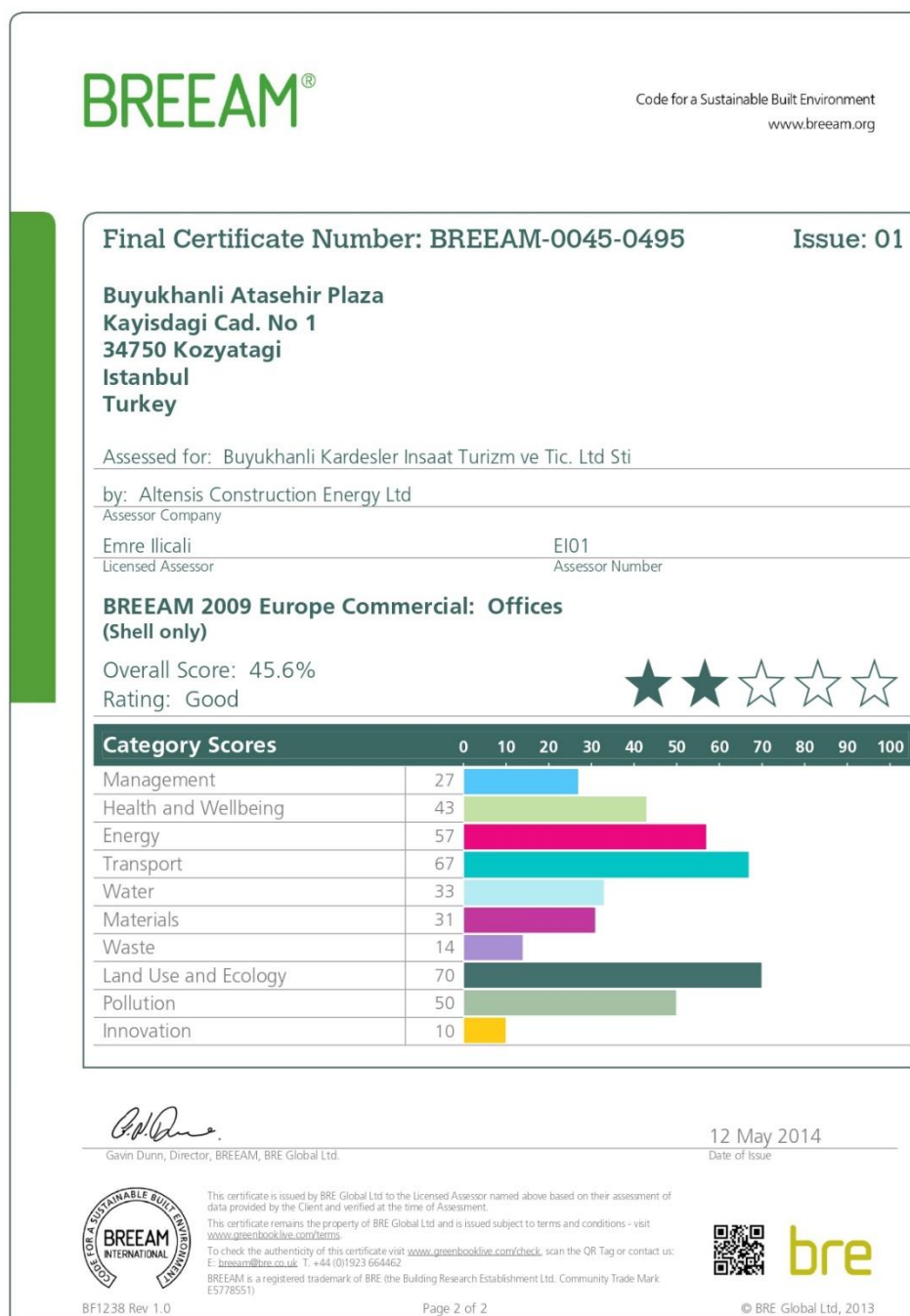


Figure 38. BREEAM Certification of Büyükhanlı Plaza (Altensis)

5.3.4 Andromeda Gold Ataşehir. Andromeda Gold is mixed use project with 51 storeys and has LEED Gold certification. The building's architect is Tuncay Çavdar from Atelier T. Upper floors of the building are designed as residences. On the other hand, on the ground floor, there are shops, cafes and restaurants as areas for public usage. Andromeda Gold, is a building that has developed many measures and strategies in terms of earthquake resistant and sustainable architecture. In an interview

with the project development manager of the building and architect Gülnur Meraklı, earthquake and sustainability informations was obtained.

First of all, about earthquake parameters, tunnel form-work system was used in the building construction. The tunnel form - work is a system in which the curtain and floor concrete are poured together. This system can be easily applied in high rise buildings, residential, hotel, shopping malls and dormitory projects. According to Apay (1983), tunnel form - work system reduces the need for connection beams on the foundation and functions as a single beam. Thus, the resistance of the structure is increased. Therefore, it can be said that the tunnel form - work system is suitable for earthquake zones in vertical architecture. In addition, the construction speed of tunnel form - work system is very fast compared to other systems and also it has economical advantages. The building performance level is controlled damage and BKS value is 3. Controlled damage performance is the level of damage that is not too heavy and it is mostly possible to repair in the building structural system elements. Also, this performance level care about human life safety.

As for sustainable design parameters, the construction company states that they aims to design all buildings with sustainable design parameters. For instance, one of the most important parameter in vertical architecture, is the wind issue. Therefore, this building was tested for wind, before the construction phase. This wind test is done in two stages. In the first stage, the building is physically modeled and tested with various vectorial forces. Then, in the second stage, the building is tested with 3D modeling programs. With this test, the behavior of the building can be observed with wind loads. At the same time, the facade details of the building can also be analyzed by this test. The electrical and mechanical systems used in the building are designed to save energy. But the building does not have solar panels and wind turbines to produce energy and electric. On the other hand, heat and sound insulation is provided on floors and walls from four sides. Therefore, indoor heat is preserved and energy saving is observed. Glass, is the most important issue in the facade design. U values of the glass used on the facade have been preferred in accordance with energy saving. Appropriate UV value, aims to provide energy savings in building heating-cooling systems in summer and winter. In addition, the openable transom windows on the facade, also contribute to natural ventilation. Also, there are floor gardens on each floor for both natural ventilation and resting. The indoor air quality in the building is

also high and it consists of % 100 clean air. As for the facade, during the building design stage, a double facade system was considered, but it was canceled because of the cost is doubled. However, the materials used on the facade, provide heat permeability and insulation. As for water saving, rainwater collecting system is used in this building. Therefore, rainwater can be used in building's garden for irrigation. As for waste management in the building, only the garbage is separated according to its material (glass, plastic, metal or paper).

5.3.5 My Newwork İstanbul. My Newwork building is an office project with 21 storey. The building has Leed certification. To get more information about the building project and technical issues, Gülnur Meraklı from Ağaoğlu Group Architect and Cemil Yaman from Erke Tasarım, were interviewed.

In interview, earthquake parameters were discussed with Gülnur Meraklı. BKS value of the building was taken as 3 and building performance level is controlled damage same with their other project Andromeda Gold. As a design aim, conveying power method was used in the design of reinforced concrete structure and its elements. To be more specific, the conveying power is a method in which the situation in the state of maximum bearing capacity at complete breakage, taking into account the real behavior of concrete or steel elements.

In interview with Cemil Yaman, sustainable parameters of the building were discussed. First of all, the building's sustainable land using is suitable with leed criterias. Point of this criteria is 22 / 28. On the other hand, land location is close to public transport. In this way, he indicated that the use of special vehicles is aimed to be reduced. About energy savings, there is no any energy production system in the building. Solar panels or wind tribunes are not available in there. But, generally, building energy saving targeted at % 32, in a design process. At the same time, the building is contributing reducing the urban heat island effect . In the design process, it is aimed to reduce this effect on the roof, facade and other elements of the building. Thus, the release of heat to the outside environment of the building has been controlled. After that, water saving is one the important issue for the climate, ecology and environment. % 35 of water saving was ensured in the building systems and %50 water saving provided in landscape. But, rain water collection system is not available in there.

5.3.6 Metropol C2 Block. Metropol is a mixed - use project with 57 storey. As the content, there are offices, residences and shopping mall in the project. The project has LEED Gold certificate. In an interview with Cemil Yaman, who is co - founder of Erke Tasarım and green building expert, sustainability parameters of Metropol C2 block project was discussed.

First of all, the building is built in accordance with sustainable land using. All decisions about the land are planned before the construction process of the building. The density of the land and its proximity to basic services are suitable. Moreover, the proximity of the building to public transport is reduce the use of private vehicles. About energy, there is no energy producing system in the building. For instance, solar panels or wind tribunes, that can produce energy from natural sources, are not available. On the other hand, energy saving in heating and cooling systems is targeted. Therefore, this building aims to save % 24 energy in total. To reducing the urban heat island effect, light colours are preferred on the facade, roof and other surfaces of the building. At the same time, the use of open and green spaces reduce this affect. He indicated that the building saves % 30 water in general. This saving is provided by small bowl sinks, lavatory and water-saving armatures. More important than these are rain-water collection system and gray water system, and they are not available in this building.

As for the earthquake and static parameters of this building, these issues discussed with Dr. Ali Ruzi Özuygur from Yapı Proje Uygulama. He worked in the project and knows the building's static structural issues. The building was built in accordance with the earthquake, but no extra precautions were taken. To be more specific, controlled damage performance level was preferred instead of uninterrupted usage performance level. BKS value of the building is determined 3 and there is not structural health monitoring system in this project.

5.4 Sustainable Certifications of Buildings and Analysis of Their Score Contents

Sustainable and earthquake resistance buildings projects should meticulously plan and implement site location, project design and site processes. It should not based on only using process of the building, It is necessary to plan properly during the construction and demolition phases. In other words, green building certifications should cover all processes in buildings and interiors, from the selection of the project

site to the completion of construction. As mentioned before, all case buildings have sustainable certification. However, the types and score values of these certifications are different.

First of all, LEED green building certification systems include many issues such as maximizing the health and efficiency of building users, using less natural resources, reducing the amount of waste and negative environmental impacts, and reducing life cycle costs. The certification process covers the design, construction and operation of buildings. LEED Certification consists of Certified, Silver, Gold, Platinum levels, which vary according to the scores collected. These scores based on sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality and innovation in design. Platinum is the most highest level in LEED certification.

BREEAM certification system measures sustainability value in a range of categories, from energy to ecology. Each of these categories aims at low-impact design and reduction of carbon emissions. Numerous issues such as design resilience, adaptation to climate change and conservation of ecological value and biodiversity are assessed during this certification process. According to Breeam Services, Breeam Certification is graded according to five criterias. These are; pass, good, very good, excellent and outstanding. These levels based on management, health and well-being, energy, transportation, water, materials, waste, land use and ecology, pollution and innovation. Büyükhanlı Plaza have good level certification of Breeam. The certification types and score values of case buildings are below in Table 4.

Table 4.

The Certification Types and Score Values of Case Buildings

BUILDINGS	CERTIFICATION YEAR & TYPE	SCORE VALUE
 ALLIANZ TOWER <i>Fxfowle Architects</i>	2014 LEED PLATINIUM	80+ / 110
 PALLADIUM TOWER <i>Swanke Hayden Connell Architects</i>	2014 LEED GOLD	66 / 110
 NIDAKULE NORTH <i>Swanke Hayden Connell Architects</i>	2016 LEED GOLD	63 / 110
 BUYUKHANLI PLAZA <i>Büyükhanlı Kardeşler</i>	2012 BREEAM (TWO STAR)	45.6 / 100
 ANDROMEDA GOLD <i>Atelier T. & Ağaoğlu</i>	2013 LEED GOLD	61 / 110
 MYNEWWORK AGAOGU <i>Ağaoğlu</i>	2017 LEED GOLD	66 / 110
 METROPOL C2 BLOCK <i>Gap & Varyap</i>	2017 LEED GOLD	64 / 110

5.5 Synthesized Results and Tabulation of Scores

In the long term, the fact that high rise buildings are sustainable and earthquake resistant is very important for energy conservation. Because the fact that the building is earthquake resistant is also a factor that supports its sustainability. The durability of the building is directly related to energy conservation. Because the energy released in the destruction of the building is very high. According to Sözen (2022), the longevity and durability of the building both delays the demolition process and minimizes the energy consumption. Energy usage in high rise buildings should not be considered only as energy expenditures during the building using phase. In fact, starting from the production of materials used in the construction phase, also energy consumption during this phase, energy consumption in the process of using and demolition are also issues to be considered in energy usage. How the materials are produced, how they are brought to the construction site, how they are applied, and the energy consumed in the maintenance and repair of the buildings should also be considered within this cycle. According to Green (2021), mentioned for energy savings in buildings, “These buildings are much healthier for people and the planet, and also significantly reduce energy consumption in the long term. It can also build a new relationship with power grids, increasing the decentralization of energy systems, which in turn can make communities resilient to climate shocks such as more severe storms and hurricanes and more dangerous floods, heat waves and wildfires.” Therefore, the importance of energy in terms of climate, ecology and environment is emphasized. The parameters that are important for this thesis and certifications scores are summarized as **sustainability and safety** in the table. Safety concept include earthquake, fire, flood and hurricane. However, since the risk and problem of earthquake is higher in Istanbul, this thesis focused on earthquake issue as safety.

First of all, all case buildings had been evaluated according to the LEED certification. Büyükhanlı Plaza have Breeam certifications and it had been recalculated in accordance with the LEED criteria. This calculation is indicated as a result of the ratio - proportion of the same parameters with each other. The BKS value was calculated out of 3 and the performance level value was calculated out of 4. In the earthquake regulation, the strongest BKS value is taken 1, but in this study, the strongest value is taken as 3. Synthesized results are below in Table 5;

Table 5.

Sustainability and Safety Features of Case Study Buildings

Case Buildings	Site Selection	Energy Production	Energy Saving	Water Saving	Material and Resources	BKS	Energy Performance Level
Allianz Tower	1/1	Wind Turbines	12/21	8/10	6/13	3/3	4/4
Palladium Tower	1/1	Not Avaliable	5/21	8/10	6/13	3/3	4/4
Nidakule North	1/1	Not Avaliable	6/21	8/10	5/13	3/3	4/4
Andromeda Gold	1/1	Not Avaliable	5/21	7/10	4/13	1/3	2/4
Mynewwork Building	1/1	Not Avaliable	11/21	4/10	6/13	1/3	2/4
Metropol İstanbul	1/1	Not Avaliable	7/21	6/10	6/13	1/3	2/4
Büyükhanlı Residence	0.7/1	Not Avaliable	11.97/21	3.3/10	5.85/13	1/3	2/4

SUSTAINABILITY

SAFETY

Chapter 6

Results and Suggestions

High rise buildings are always have much more ratio than other buildings in terms of production, consumption and expenditure. In this way, it is important to control, follow and especially reduce in all these issues. According to case studies, sustainable design parameters of buildings selected in Ataşehir and their earthquake resistance status in the regulation, were obtained. First of all starting with sustainability, when case study buildings were examined from these tables, it is observed that some features are sufficient but some are not. For instance, all buildings are seems comply with sustainable site selection and using. One of the reasons that, it is not on track to achieve the aim of halting bio-diversity loss, is the way it uses the construction sites. Concrete and asphalt surfaces make the soil unproductive. They also preventing the soil from performing its functions such as storing water, producing food and biomass, regulating the climate, cleaning harmful chemicals and providing open spaces. Rainfall on unproductive surfaces has no benefit to the soil. However, when all case buildings sites are examined in generally, it is determined that more than half of them covered with concrete surface. Sustainable site selection and using is important during construction process, but the life cycle process of the building is much longer. For this reason, sustainable certifications also need to audit the concrete and soil/greenery distribution on the site, especially in high rise buildings. Because this distribution is more important than bicycle storages or changing rooms.

Another important parameter is energy production and savings in sustainable high rise buildings. At this point, it is expected to the building produce its own energy and also save this energy. But it is determine that only Allianz Tower produces own energy with wind tirbunes as a sustainable building. In this way, especially in high rise buildings, at least one parameter of sustainable certifications should be mandatory to pruding own energy system. Because only energy savings are not enough for a sustainable high rise buildings. If these buildings produce their own energy with photovoaltic panels, wind turbines or energy from other natural resources, it will be very positive effects in terms of the climate, ecology and environment.

As with all resources, the water usage in high rise buildings is above the ambient. About water savings, all buildings comply with it in different percentages.

Simply reducing the volume of toilet reservoirs or water saving faucets/sinks cannot be a sufficient criteria in terms of water conservation. The most important parameters of water savings are rainwater collection and gray water systems. But, only Palladium Tower use gray water system and Nidakule North building have rainwater collection depot on basement. In these systems, water used in the building, can be treated and reused. Therefore, sustainable certifications should mandate rain water collection and gray water systems. Because these systems provide “real water savings.”

About earthquake resistance, the negative effects of the earthquake on the climate, ecology and environment are undeniable especially for high rise buildings. First of all, the issue of earthquake should not be considered separately from sustainability. To give an example, earthquake breaks can create large cracks in the ground. It change the axis of rivers and streams, and cause other changes in the natural environment. Damage to rivers, streams, forests and other habitats can lead to the loss of plant and animal species, disruption of food sources and other ecological processes. To give an another example, earthquake can trigger landslides, which can block roads and rivers, damage infrastructure, and create hazards for people living in affected areas. Landslides can also damage natural habitats and ecosystems, leading to the loss of plant and animal species. It is possible to list many more negative climatical, ecological and environmental effects. In addition, local certification methods should become active in our country. Because each region has different climate, ecology, topography, geography and earthquake risk.

Considering all of these, earthquake resistance should be a mandatory parameter in sustainable certifications for high rise buildings. At the same time, high rise buildings should be revised according to the renewed regulations. In technically, structural health monitoring system is mandotory for high rise buildings in the new earthquake regulation. But only Allianz Tower have this system. Therefore, controlling and following high rise buildings and revise them according to the new regulations and techniques are very significant. On the other hand, performance levels and BKS values of these buildings should be mandatory to keep higher than other buildings. However, it is much more beneficial to choose BKS value as 1. As building performance level, choosing uninterrupted usage is much better.

Chapter 7

Conclusion and Discussion

High rise buildings are getting more important in the last decades due to reasons like, scarcity of land, increasing demand for business space and residential space, economic growth, technical developments, creative innovations in structural systems, growing demand for aesthetics in urban settings, proliferations of and human cultural significance and prestige and human aspiration. Pollution, climatic, ecological and environmental damage caused by vertical architecture is increasing, especially in metropolitan areas and developed cities. On the other hand, earthquake is an inevitable phenomenon all over the world. Vertical architecture, high rise buildings and earthquake concepts are becoming significant in terms of the climate, ecology and environment. They are closely connected with each other and will affect future generations and the world.

This thesis intends to reveal that vertical architecture and high rise buildings in spite of the above mentioned reasons has more negative impact on the climate, ecology and environment, compared to other building types and structures. In order to benefit from high rise buildings to the most efficient way and to minimize the damage to the natural environment, it is very important that these buildings are built with sustainable and earthquake resistant construction techniques. The environmental damage, insufficient energy and water savings, inadequate use of green space of high rise buildings, is an indication that sustainable certifications and earthquake resistant design parameters are used only as a **implement**. As a matter of fact, all sustainable certifications and earthquake resistant parameters should be used as a **purpose** for the whole world and humanity. The result of certifications score values were examined and in interviews with the building managers, it was concluded that almost no work was done, especially under the heading of energy production. At this point, It is very important that sustainable certifications are used as an “purpose” or “implement”. Therefore, the contribution of sustainable certifications to "true sustainability" is negligible for high rise buildings. In addition, there should be parameters that specifically mandated in these certifications.

An architect required to have awareness, judgment, and energy as the person responsible for the whole of the project architecture in such a way that they should see

the issues in a variety of fields as they relate to the whole picture, and not just to each individual field. (Nakata, Ikeda and Murao, 2012.) He stated for earthquake resistance for architects. He also stated that, an architect is required to comprehensively create a space for these functions and environment as well as safety. At the same time, architects must consider earthquake resistance from such a comprehensive perspective. (Nakata, Ikeda and Murao, 2012.) All information indicates that architects should have sufficient knowledge and equipment on the subject of earthquake resistance especially in high rise buildings. Earthquake is an unpredictable natural disaster, so it is very important that architects and buildings are prepared for this. Kahramanmaraş earthquake that occurred on 6 February 2023, shows that buildings are unprepared for this situation very well in many cities and districts in Turkey. Before an earthquake and destructions occurs, it is very important for the climate, ecology and environment to keep all precautions at the highest level. At this point, architects and engineers must agree and collaborate. In districts like Atışehir, encouraging the control and inspection of high rise buildings, in terms of sustainability and earthquake resistant, are among the objectives of this thesis. For this control and inspection, the support of municipalities are required. At the same time, high rise buildings need to be inspected by a certain team of experts in terms of these two important concepts.

Sustainable high rise buildings need to adapt to innovations and changes of architecture and technology. According to Gro Harlem Brundtland, sustainable development is "not a static concept, it is a development process that can change direction with the use of resources, the direction of investments, technological and scientific developments, provided that it is compatible with the needs of the future as well as today." (Sev, 2009.) Therefore, sustainable design parameters and earthquake resistant status of high rise buildings should also improve for the world that is developing and changing every day. Therefore, in order to provide a guide to high rise buildings, the environmental friendly design parameters and earthquake resistant status of these buildings were investigated and encouraged. These parameters and principles are not mandatory to be followed. But when followed, they can guide for high rise building architects and/or designers with positive impact on the climate, ecology and environment.

According to Eren (2007), today's high rise buildings are formed in convenience with the targets of the investors and gain private characters. Existing regulations

remain deficient to find solutions for integration with the city and sometimes the rigid rules in the regulations prevent positive development. To revise the issues of control in a totalitarian way for each new high rise building is ideal method in a city having very different dynamics.

When evaluating the positive and negative features of high rise buildings, there are objective and subjective ones. High rise buildings today are realized by the objectives of the investors and display a private character. Existing regulations have deficiencies for a better integration of the high rise with the city.

In conclusion, the aim of this thesis is not to suggest a design system to be used in sustainable and earthquake resistant high rise building design. On the other hand, this thesis summarize the collected data for guiding purposes. To be able to give ideas to architects and designers in sustainable and earthquake resistant high rise building design by compiling the obtained design principles and draw attention to them with the help of architectural and technological developments, to obtain a better world through buildings.

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