FEBRUARY 2019 M.Sc. Thesis in Civil Engineering SATURNIN FLORIS KACKA SANGOLA

REPUBLIC OF TURKEY
GAZİANTEP UNIVERSITY
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NATURAL & APPLIED SCIENCES

DETERMINATION OF CONFORMITY OF URBAN TRANSFORMATION PROJECT IN GAZIANTEP CITY WITH THE NEW EARTHQUAKE CODE BY USING SAP2000

M.Sc. THESIS
IN
CIVIL ENGINEERING

BY

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Supervisor

Assoc. Prof. Dr. Nihat ATMACA

by

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This is to certify that we have read this thesis and that in our consensus opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Saturnin Floris KACKA SANGOLA

ABSTRACT

DETERMINATION OF CONFORMITY OF URBAN TRANSFORMATION PROJECT IN GAZIANTEP CITY WITH THE NEW EARTHQUAKE CODE BY USING SAP2000

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86 pages

The structural characteristics of a seismic building in Gaziantep, Turkey with 2007 and 2018 Turkish Earthquake code by using SAP2000 v20.2 have been analyzed in this thesis. The city is located on the East Anatolian fault with several seismic activities. The geotechnical properties of the related area have been carried out by using 2007 and 2018 Turkish earthquake codes to obtain elastic spectrum acceleration values. DD-2 is selected as the main earthquake design data via using the new earthquake code 2018 in the analysis. The target spectrum having 10% probability of exceedence in 50 years for the bedrock level has been estimated using the attenuation relationships between the terms after a number of analyses. The response spectra has compared to the design spectra given in the Turkish Seismic Code (TSC-2007) and 2018 Turkish Earthquake code for the related seismic zone. The local earthquake site spectrum, TSC-2007 and 2018 Seismic Code spectra have been analyzed by using seven different real earthquake records. The time-history analyses of the Reinforced Concrete buildings according to the 2018 Earthquake codes have indicated that the earthquake records scaled by the local spectrum induced higher base shear force, overturning moment and top lateral displacement values in the 2007 Earthquake codes.

Keywords: Urban Transformation, TSC 2007, TSC 2018 and SAP2000, Time History Analysis

ÖZET

SAP2000 KULLANARAK GAZIANTEP'TEKI KENTSEL DÖNÜŞÜM PROJESININ YENI DEPREM YÖNETMELIĞINE UYGUNLUĞUNUN BELIRLENMESI

KACKA SANGOLA, Saturnin Floris
Yüksek Lisans Tezi, İnşaat Mühendisliği Bölümü
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86 sayfa

Bu çalışmada, Gaziantep ili Akkent bölgesinde bulunan sismik bir binanın yapısal özelliklerini 2007 ve 2018 Türk Deprem Yönetmeliği ile SAP2000 v20.2 kullanarak analizi yapılmıştır. Gaziantep Doğu Anadolu fayı üzerinde ve farklı sismik faaliyetlerle dolu bir konumda yer almaktadır. Zemin sınıfı özelliklerine gore 2007 ve 2018 deprem kodları kullanılarak elastic spectrum ivme değerleri elde edilmiştir. Analizlerde, yeni deprem yönetmeliği 2018'e göre DD-2 esas tasarım deprem verisi alınarak kullanılmıştır. Hedef spectrum, ana kaya seviyesi için 50 yıl içinde% 10 aşılma olasılığına sahip olan terimler arasındaki azaltma ilişkileri kullanılarak bir dizi analiz sonrasında tahmin edilmiştir. Tepki spektrumları, Türk Sismik Kodunda (TSC-2007) verilen tasarım spektrumları ve ilgili sismik bölge değerleri için 2018 Türk Deprem koduyla karşılaştırılmıştır. Yerel deprem spektrumu, TSC-2007 ve 2018 Deprem Kodu spektrumları, yedi farklı gerçek deprem very kayıtları kullanılarak analiz edilmiştir. 2018 Deprem kodlarına göre Betonarme binaların zaman tanım alanı analizleri, yerel spektrum tarafından ölçeklendirilen deprem kayıtlarının, 2007 Deprem kodlarında daha yüksek taban kesme kuvveti, dönme momenti ve üst yanal deplasman değerlerine neden olduğunu göstermiştir.

Anahtar Kelimeler: Kentsel Dönüşüm, TSC 2007, TSC 2018 ve SAP2000, Zaman Tanım Alanlı Analiz.

To My Late Parents

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First of all, I would like to thank God Almighty who created the Universe and give me knowledge to complete this work.I praise His Glorious Name above all thing He has done in my life.

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I must express my profound gratitude to my parents for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. Also to my brothers and sisters without their passionate participation and input, the validation survey could not have been successfully conducted.

Special thanks to my fiancee Sandra Lea MONTOUT for her great support, to my uncles Jean Felix OUANFIO and Germain WAMOSTOYO that support me in all this time of studying. Great thank to my friend Abdulhadi PALA to give his time to help me during my work. May God bless all of you abundantly in Jesus Name.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

SYMBOLS / ABREVIATIONS

A(T)	Spectral Acceleration Coefficient
A_0	Effective Ground Acceleraion Coefficient
D_i	Amplification factor to be applied in Equivalent Seismic
DL	Dead load
D	Roof displacement
FEMA	Federal Emergency Management Agency
L.L	Live load
S.L	Seismic load
LLRS	Lateral force withstanding system
M3	Flexural moment hinges
RC	Reinforced concrete
T_A ,T_B	Spectrum Charactereristic Periods (s)
T	Building Natural Vibration Period (s)
T_1	First Natural vibration period of the building (s)
V	Maximum base shear
V	Base shear
Δ_m	Roof displacement
M_e	Magnitude
RCF	Reinforced concrete frames
3D	Three dimension
RS	Response spectrum
M	Mass

u(t)	Time-dependent vector for the absolute nodedisplacement
u''(t)	Time-dependent vector for the accelerations
u'(t)	Time-dependent vector for the velocities
t	Time peroid
g	Gravity
A	Acceleration
H	Height of building
SAP2000	Structural Analysis Program
F	Force
$R_a(T)$	Seismic Load Reduction Factor
R	Structural Behavior Factor
I	Building Importance Factor
H_N	Total height of building measured from the top foundation level (In buildings with rigid peripheral basement walls, total height of building measured from the top of the ground floor level)
g	Acceleration of gravity (9.81 m / s2)
$S_{ae}(T)$	Elasticity spectrum ordinate [m /s2]
S(T)	Spectrum Coefficient
$R_a(T)$	Seismic Load Reduction Factor
ΔI	Storey drift of i'th storey of building
$\Phi_{\theta in}$	In buildings with floors modeled as rigid diaphragms, rotational component of n'th mode shape around the vertical axis at i'th storey of building

θ_I	Second Order Effect Indicator defined at i'th storey of building
ΔF_N	Additional equivalent seismic load acting on the N'th storey (top) of building
W	Total weight of building calculated by considering Live Load Participation Factor
n	Live Load Participation Factor
TSC	Turkish Standard Code

CHAPTER 1

LITERATURE REVIEW

1.1 Introduction

Renovations are happening in all places. They affect every aspect of international economic, political and social organizations. The major revolution of the last two decades is globalization. Globalization is not an unexpected incidence but it is an observable fact of interdependence between financial, social, political, cultural and conservation practices that continuously mold and influence the world. The progression of globalization has revolutionized urban places more than rural areas. The main aim of urban transformation is to improve the social, economic and environmental features of the cities. The Urban Transformation means the resolution of problems in different areas of a city, carrying out implementations to reorganize and make them healthier places. In other words, the urban transformation is the eradication of the troubles that spoil the foundation of the city. Through urban planning discussions and policies, governments intend to prevent the illegal constructions and reduce the damages of possible natural catastrophes by restructuring the unstable buildings more resistant to earthquakes. Urban transformation is constructing reliable, secure and contemporary buildings instead of weak structures not resistant against natural disasters such as earthquakes; in line with new earthquake code taking into account the urban issues and requirements. Therefore, as demonstrated in this thesis, we will look at how urban construction not only considers the past but also reveals factors determining the development of a city such as Gaziantep in the future.

1.2 Definition of Urban Transformation

What is an Urban transformation?

Through this question, many different answers were given :

Zielenbach and Levin (2000) defined urban transformation as the physical advancement of shattered areas, a development of local infrastructure, the destruction of undesirable individuals or private organizations and the creation of additional jobs. According to Lingbeek et al. (2006) urban transformation is applied to rebuild and redevelop an urban slums, i.e. deprived, underused, and vacant land and buildings in an urban area.

Robert (2000): Urban transformation as an inclusive and coherent vision and action, is trying to ensure the continuous improvement of area's economic, physical social and environmental conditions. Urban transformation can be broadly summarized as the action of providing a permanent solution to the economical, physical, and social and environmental problems in a comprehensive manner for altered urban area. Thus, the understanding and reconciliation of the urban decay process, the improvement of low living conditions for public health, the elimination of the lack of physical and social infrastructure and the conditions infrastructure and the coordination and resolution of problems in a continuous manner can be highlighted.

Urban transformations are a way of intervening in urban space by urban planners, designers and policy-makers. URPs guide the ways of how to develop the built environment. They are an important activity for the real estate and other related industries. Also, they are an important tool for the state to deal with the social and physical problems related to the built environment, such as urban decline, uneven and unbalanced urban growth, diseases, and social unrests. Finally, they are important to arrange spatial regulations, to create secure livable environments (Anderson 2004, Knox 2001).

Urban transformations needs varies across temporal and geographical contexts based on the changing, socio-economic, political, demographic, and urban factors. Also, related to such factors, the reasons and the ways of implementing URPs might vary across countries and sometimes even across cities of an individual country. Yet based on the long history of urban projects across countries, urban planning literature has already recognized many similar reasons and also common techniques and strategies for implementing Urban transformations.

In these countries of the west at the beginning of the nineteenth century, urban transformations tends to sustaining social health, hygiene, and social order. In the following periods, the aims of Urban Transformations in these countries included the Urban transformation emerges as a possibility that can be implemented though the determination and evaluation of all city institution, the production of alternative solution and the making and of decisions as well all by taking responsibility for monitoring the process as a whole (Karakut, 2013). There are different definitions of the concept of urban transformation put forth by various scientists.

1.3 Implementation Zones of Urban Transformation

The implementation zones of urban transformation are classified in the following headlines:
-Shanty zones,
-Zones gained upon dislocation of the industrial fields from the centrums,
-Centrums,
-Zones probe to disasters and urban risks.

1.4 Historical Development of Urban Transformation in the World

Urban development corresponds to the industrial revolution period. With the mass migration from rural areas, the population concentration in cities has brought along infrastructure, transportation and ecological problems. These problems have created unhealthy lifestyles for the poor factory workers who came from the village to the town. The population in the cities suffered from diseases such as typhoid and cholera. The death toll of these diseases rose significantly because initially, factory owners and workers built their houses around the factories. (Tekeli, 2010: 30; Ersoy, 2007a: 24-26; Ersoy, 2007b: 119-121). By the end of the 19th century, urban transformation projects originated in industrialized metropolises in order to deal with the insalubrious living conditions and housing difficulties that had arisen. Those developments connected to public health matters were performed in poor neighborhoods ruined by the smell and dirt of the sewage.

However, the industrial revolution was not the main cause for those problems. Poverty had become prevalent in the course of industrialization. The concentration level had amplified (Schubert, 1996: 67, 60).

The process of industrialization led to the emergence of urban issues in planned habitat conversion. Consequently, in the industrial society, both the production factories and urban planning procedures have transformed the urban space. The concept of urban transformation in the world materialized into efforts to revitalize the area of social and economic crisis in that city. However, these practices that bring about major changes in urban areas are projects of "renovation", "restructuring", actual content, "improvement", "protection" and "activation" (Uyar, 2009: 27).

Moreover, in industrialized countries, to resolve housing and health problems, efforts are being made to create new cities, in addition to transforming the existing ones by the end of the century. In this context, Camillo Sitte's "City Planning According to Artistic Principles" , Ebenezer Howard's "Garden City", "Plan Amsterdam-Zuid" by H.P. Berlage, "Cité Industriel" of Tony Garnier became planned and implemented utopian cities. (Tekeli, 2010: 34-42; Ersoy, 2007: 30-31; Harvey, 2008: 196-213). Le Corbusier's Athens Charter (La Charte d'Athenes) is commonly thought of as a defining era in Modernist urban development, a period when architects concurred on what the outlook of our cities should correspond to. Le Corbusier's vision was an accessible utopian dream, formed by a fundamentalist understanding that cities must be destroyed and rebuilt (Gürel Üçer et al., 2004: 140).

In regard to the 1930s, world trade had increased in the wake of the global economic crisis in the industrialized countries. Those countries had to face the problem of housing to get rid of the economic crisis towards residential investment. On the other hand, fast-growing vehicles and road development were also crucial in urban transformation (Tekeli, 2010: 43-45).

After the Second World War, the planned "urbanization policies" were reintroduced, which led to the adoption of the approach and priority was given to social housing programs. In the 1950s, the capitalist industry saw the emergence of redevelopment programs and the preservation of historic regions and cities. In the 1970s, the tourism sector occupied vacant urban areas "(St, 2009: 11). This is the context of the chosen approach in European countries after the second global configuration of" restructuring "as an instrument for planned urbanization. In the following years, urban tools, such as" revitalization "," improvement "," health and protection" were elected (Uyar, 2009: 27).

In the 80's, the United States entered the "revitalization" and "improvement of housing" phase.

High taxes were applied to real estate, and poor houses were subject to improvements.

All investments made during this period were used for housing projects and it is considered that the private sector assumed a more important role. Local governments destroyed vacant and unexploited buildings, causing those to become prohibited shelters. In short, destruction in this period is the method used for urban renewal "(Üstün, 2009: 27).

By the 1990s, the perspective of urban renewal in the United States took on urban protection methods in agreement with the 'American Community Renewal Law'. It was expected that the unoccupied and ill-equipped structures in the possession of the Development Section (HUD) to be transferred to local governments licensed in this area, within six months, to be sold to the community development units for profit. . Those units, on the other hand, allowed low-income families to buy, restore and sell (Özden, 2009: 260-261).

From the 1980s until today, the collapse of the welfare state at the urban level has been reflected in the neoliberal policies around the world. The core modification was that the state took away the provision of urban services, education, health, transportation and similar services.

1.5 Urban Transformation in Turkey

1.5.1 Historical and overviews

Due to worldwide industrialization and economic changes since the 1960s, Turkey has experienced a significant growth of its population moving from rural areas to big cities; accordingly the demand for accommodation in these metropolitan areas has considerably increased. In addition, with the recent immigration wave from Syrian refugees, new urbanization problems have started to arise. As a result, Turkey is currently undergoing an important cultural and architectural transformation of its infrastructure. In order to meet the critical need for housing, temporary emergency shelters sprouted. The unplanned and uncontrolled areas of urban land used to build these shelters have created poor living and housing conditions leading to many infrastructure and social issues that have not been solved yet.

From the 1960s to the 1990s Turkish governments have unsuccessfully tried to tackle the urbanization problems faced by many cities in Turkey. For the last two decades, the urban planning agenda have implemented various forms of Urban Regeneration Projects (URP) to eradicate this urbanization crisis (Mutlu, 2009). However, the impact of urban regeneration on the structural, social and economic prospect of Turkish cities and their inhabitants implies that at the planning stage of urban regeneration projects, it is essential for architects and engineers to collaborate with sociologists and economists to harmonize the strategies utilized towards successful results.

Since then the late twentieth-century Turkey the application of the system UTs to achieve such settlements is illegal to modern commodities good planning, through the Department of housing development in Turkey (TOKI) and private companies. Since the random housing and neighborhoods historic Old cities not only lead to changes in the physical infrastructure of cities, they also affect the environmental, economic and dynamics of social issues in the built environment. Used the municipalities where there are residential areas, illegal or legal within the boundaries of their projects transformational and renewal of urban to improve their living conditions and the built environment based on the standards of the contemporary lifestyle with the conversion of these areas to appropriate the prestige of success government also using a great economic potential for the president on space (Oulu, 2007). Through and after URPs many advantages are offered to squatters and squatters. However, due to insufficient drop, the handmaidens faced uncomfortable situations. Many of them could not afford new apartment payments or could not keep up with the new lifestyle.

1.5.2 Cities under the Desasters Risk in Turkey

Turkey is located on the one disaster region of the world. Disasters of a different kind cause loss of property and life caused by disasters and earthquakes caused by , rock falls such as floods, droughts, avalanches, storms, and erosion, landslides and climate change. The economic loss caused by disasters in Turkey is due to landslide by 10%, earthquakes by 76%, rock decline by 4%, flood by 9% and flood by 9%. The remaining 1% of other types of disasters remain. Turkey is located in the region with the most active fault lines on the face of the earth and always faces the risk of earthquake and its danger.

Turkey is located in the area with the most active fault lines on Earth and always faces the danger and gravity of the earthquake. According to Turkey's earthquake-related map, 96% of Turkey is located in areas with different levels of earthquake risk, and 98% of the population lives in these areas. 66% of these areas are located in areas of active failure.

Between 1900 and 2009, nearly 300 earthquakes occurred in Turkey, causing significant loss of life and property. 100,000 people died in these seismic activities, 600,000 buildings and offices were demolished, and 180,000 wounded or rendered unfit for habitation. The earthquakes of eastern Marmara and Dozki in 1999 are the largest earthquakes in Turkish history.

Although the official and legitimate structure in dealing with disasters until 1999 has been organized in the form of disaster response and mitigation, a number of legal and institutional changes have been made, especially since earthquakes in 1999; the disaster mitigation strategy has been changed, for pre-disaster risk assessment studies. The Building Inspection Act was prepared and the regulations on building materials were implemented. It was confirmed that the new buildings would increase the technological and technical levels by changing the construction guidelines, especially for the construction of strong earthquake-resistant buildings. It has also been ensured that the construction market has changed from companies that provide small-scale capital contracting services to large-cap real estate companies. New institutional structures have been created.

The percentage of buildings entering the compulsory seismic system, which has been in force since 2000, has increased from 28% to 36% by the end of 2013 with respect to measures introduced through the Disaster Insurance Act published in 2012.

During the Earthquake Council conference held in 2004, the earthquake phenomenon was discussed in all aspects. The views and recommendations were expressed in detail and decisions were made on the earthquake policy in Turkey.

The most advanced one of the examples in the world is the earthquake regulation that was updated in 2006. Moreover, rating evaluation, supervision and market inspection activities have recently been institutionalized in relation to the compatibility of building materials. In 2009, a new institutionalization process was undertaken, and all issues and coordination were allocated to the pre-disaster and post-disaster response to disaster management and emergency management

The organization has been mandated to take the necessary measures to effectively implement disaster, the defense services and emergency civil throughout the country and to coordinate between institutions and organizations that prepare and plan for pre-disaster, disaster and post-disaster response. Recovery actions, and the development and implementation of policies on these issues. The Turkish Disaster Data-Bank was created to collect all information and sources related to disasters, analyze past data and develop existing studies on natural and technological disasters, in order to prepare for disasters and mitigate potential damage,

The National Earthquake Strategy and Action Plan (2023) was organized in 2011 to prevent or mitigate the potential physical, environmental damage to earthquakes, social and, economic, and to build new resistant earthquake urban areas. Ready and sustainable. By the end of 2013, the short-term actions were completed in the work plan. By early 2014, work on most actions had begun within the scope of the Action Plan.

The Urban Transformation Act, which also contains financial incentives to strengthen cities and buildings in the face of disasters as part of disaster preparedness, began in 2012. This law recognized the areas facing disaster risk along with vulnerable buildings that define the framework of urban transformation.

Work on hazardous areas, precarious buildings, reserve area, financial support (secondment, rent, source transfer, etc.) is carried out with information and advice through urban transformation practices. In September 2014, 150 hazard areas were declared in 38 counties. In addition, 150 other risk zone proposals are being evaluated. In September 2014, 44,500 precarious buildings have been identified across the country, and these buildings are being demolished.
In 2000, the Natural Disaster Insurance Foundation was established starting with compulsory earthquake insurance, and the coverage of other non-earthquake disasters was included in coverage in 2012.

The Roadmap for Technological Disasters (2014-2023) was prepared for the prevention of technological disasters as well as natural disasters and the mitigation of risks and associated damage. Attempts have been made to prevent incidents occurring in urban areas of production through this road map.

Istanbul, which hosts 18.4 per cent of Turkey's 76.6 million population, hosts a densely populated urban area of 2275 inhabitants per square kilometer. Several studies are being carried out to determine the risk of earthquakes and risk mitigation in this city, which has a large earthquake risk due to its presence in the Marmara region. The most important of these are the preparation of small zoning reports and maps, seismic studies, earthquake-oriented urban transformation projects, the identification and enhancement of hazardous buildings, the preparation of a disaster and emergency plan and the implementation of the basic disaster mitigation plan jointly with Japanese experts.

1.5.3 The Challenge of Urban Transformation in Turkey

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1.5.3.1 The Actor of Urban Transformation Turkey

Achieving urbanization is a win-win situation that should be won by all actors in the process. However, the consequences of urbanization affect every distinguished representative such as ؛

- **The Municipality**

  Some of the municipality around the world is obliged to give a better life to the people via various investments and offering activities. Also, the municipality make benefits from the side effects like lower crime levels, lower maintenance costs and higher real estate values which will increase the prices of lands of the municipality also.

- **The Contractor**

  The goal and the enthusiasm of the private sector is the benefit. URPs afford boundless sum of profit depending on project's dimension. Shortly, URPs are good opportunities for the building firms. . According to the forecasts of the Turkish Contractors Association, the construction sector, which contributes about 6 per cent of the economy, is facing a downturn and fierce competition abroad in 2012: The local URPs program, which is estimated to generate 250 billion pounds of profits, 55 billion pounds sterling in Istanbul alone, is seen as a suitable alternative.

- **Squatters**

  The main goal of the URPs is squatters. These people endure due to lack of basic services such as no tap water; no gas and some don't even have electricity. Therefore, URPs purposes are to help the occupiers get a better quality of life. However, some URPs are based on locating hand-makers into a residential complex outside the city, which is good for quality of life but bad for their business. However, some URLs are based on locating hand-makers in a residential complex outside the city, which is good for quality of life but bad for their commercial

- **Landowners**

Handlers usually occupy privately owned land or state-owned land. Landowners in the occupied territories benefit from the UTs, due to the renovation of their lands into valuable land, making owners the most fortunate players in the process.

- **Environment**

Nature is the major beneficiary of the urban transformation process. However, this profit is the main axis in UTs and therefore, the renovation areas look like a concrete forest. On the other hand, the installation of sewage networks, buried electrical cables 20, environmental planning devices, and the network of natural gas pipelines, of course, help the project spaces to be naturally strong.

1.5.3.2 TOKI

TOKİ is a non-profit government organization established in 1981 under the Housing Development Fund Act (No: 2487) to solve the housing problem and increase housing production at the national level. The main objective is to provide affordable social housing to low- and middle-income people who can not own a housing unit under current market conditions in Turkey and apply illegal settlement improvement projects throughout Turkey.

The TOKI urban transformation is generally implemented to develop unplanned areas, problems, occupied public lands, areas facing disaster risks, and cultural and historical areas surrounded by illegal settlements. The project areas are generally located around city centers where the land is of special value. This enables TOKI and local authorities to complete development projects in these areas without facing financial difficulties because the built-up homes after being allocated to the right owners are sold at a good price. There are two alternative ways to implement the form:

1- The destruction of illegal settlements, the construction of new homes in the same zone, and their allocation to rights holders.
2- Building new homes in a different space to transfer privileges holders living in the development area (Bayraktar, 2008).

TOKI has built 480,000 properties up till now, moreover, 20,000 drugs at auction today. In addition, nearly 100 hospitals, 700 primary and secondary schools, 500 sports centers, 340 mosques and 400 shopping centers were built. With demand frequently higher than provide, especially in Anatolian metropolises and towns, TOKI generally sells its apartments through lots. Moreover, since 1981, the authority and objective of TOKİ has been expanded with additional laws such as the Housing Development Act No. 2898 and No. 2985. According to the laws of housing development, TOKİ fees are numbered as follows:

- Issuance of internal and external bonds and any kind of shares with or without the guarantee of the State..

- Decide on receipt of appropriations from foreign resources for use in expenditures related to the scope of their activity upon approval by the Treasury Secretariat.

- Take action to ensure banks' participation in housing finance; provide banks with credit for this purpose; and develop procedures to enforce this provision.

- Backing industry related to housing structure or those involved in this area.

- Establishing companies related with housing sector or participating in those that have already been established.

- Subcontracting any research, projects and commitments, where deemed necessary,

- Delegate with any investigation, projects and assurances, where it is indispensable

- Individual and collective housing loans. Granting credits for projects aimed at improving rural architecture, transforming slums, preserving historic and regional architecture; and subsidizing subsidies for all such credits, where is necessary,

- Development projects in both Turkey and abroad directly or through the Agency's participation. Implement or designate others to implement housing, infrastructure and social facilities,

- Implement or designate others to implement profit-oriented projects to guarantee the sources for management,

- Building, strengthening and supporting the construction of housing units as well as collective facilities and infrastructure in locations where catastrophes occur, if deemed necessary.

As mentioned above, the main objective of TOKİ is to make housing projects for low- and middle-income families. To make these projects use TOKI's vast amount of land available for construction, 160 million square meters of land has been converted from treasury and other public organizations and the rest has been bought through special ways or confiscation. While the needs of low and middle-income TOKİ have been met, innovative financial mechanisms such as long-term and low-yield mortgages have been used to make homes more affordable for them. Through this process, contractors first fix the prices of residential units taking into account the cost of land, off-site infrastructure, infrastructure, social facilities, and technical services.

After the price is determined by the contractors, the sale of housing units begins before the construction period. Depending on the type of project and target population, 10% -40% is collected as a down payment, and the remaining costs are distributed over a period of maturity of 75-240 months, where monthly payments are indexed to increase public sector wages. Sector every six months. Housing projects in TOKI take about 14 months and cost about $ 180-200 per square meter, including infrastructure costs, excluding land costs.

1.5.3.3 Example of Urban Transformation in Turkey

1.5.3.3.1 Case of Sulukule

Sulkuluke, is a district that takes is located in the lowest point of the ramparts between Topkapı and Edirnekapı in the Historical Istanbul Peninsula (Figure 1.1).

Figure 1.1 Sulukule Location

1.5.3.3.2 The Urban Transformation of Sulukule

As a "Urban and Historical Site" by having a high importance for the natural, historical, cultural and a legacy of archeological with the historical peninsula announced by the Resolution No. 6848 of July 12 1995 of the "Cultural and Natural Assets Preservation Board No. 1" of Istanbul, "Neslişah and Hatice Sultan District (Sulukule) has been announced as a Restoration Area as per the Council of Ministers Decree No. 26147 of April 22, 2006, effectuated upon publication in the Turkish Official Gazette No. 26318 of October 13, 2006 under the Law No. 5366. The area was revised as to cover the Neslişah and Hatice Sultan Districts for the projects impemented by the Metropolitan Municipality of Istanbul, Municipality of Fatih and the Public Mass Housing Administration (TOKİ) in 2005. The restoration site, taking place adjacent to the Land Ramparts between Edirnekapı and Vatan Street and within the boundaries of the Rampart Preservation Line, occupies an area of 91.731,46 m2. In the project site takes place 12 islands, 378 lots, 10 districts and 3 streets. For renewal, an adequate number of housing units were included in the project for production on the land of 13 thousand square meters owned by the Municipality of Fatih (Municipality of Fatih).

Following the destructions in Sulukule, TOKİ called a public bidding for construction on the basis of the preliminary designs, and the Contractor "Sulukule İnşaat" started the construction activities. Within the framework of this project, total 577 housing units of 75, 100 and 120 square meters have been built up in 165 blocks.

In the course of the implementation of the Sulukule District Restoration Project, the district people had to leave the social and cultural environment occupied by them for many years, and some part of them removed to Gaziosmanpaşa, Balat and Edirne, and 337 families to The TOKİ housings in Taşoluk and Kayabaşı. Some 5 thousand Roman citizens were determined in the region, and 3 thousand 500 Romans (703 landlords and 303 tenants) were removed from the district before the destruction activities. As a result of the wrong policies, they removed to Karagümrük, their old quarter, just before the end of one ear. Many Roman families lived together and side by side in the housings attached to each other in the form of small rooms, and reflected this form of solidarity even in their spatial organization.

Figure 1.2 *Sulukule slum areas*

While the old Sulukule was a poor but vivacious part of the city, it has now turned into a dead mass housing site (Figure 1.2). Though the quarters around the zone keep vivacious, Sulukule is now sterile and independent of its surroundings.

The villa-like buildings have been arranged in the apartment format, and each building has three flats, each of some eighty square meters. The buildings have been designed to have oriels to fit the old building concept. Two big buildings, a shopping mall and a school, were constructed in addition to 665 housing units, so that the shops and stores of the streets of the od district have all been collected in one shopping mall. While the Sulukule district was not only a housing field, but had the nature of an economic and vivant touristic and cultural district of music, dance and entertainment houses, only one music and cultural center was built in the new district.

Figure 1.3: *Sulukule after urban Transformation by TOKI*

CHAPTER 2

URBAN TRANSFORMATION IN GAZIANTEP

2.1 Introduction

This chapter contains many different concepts of the urban transformation and it will discussing. The description and the urbanization process.

2.2 Localization of Gaziantep city

According to State Institute of Statistics (TUIK, 2013)**,** Gaziantep city covers 6845 km² land of Turkey, and the province occupied around 1% of the total area of Turkey. This province is located in the Southeast Anatolia Region, adjacent to the Mediterranean Region of Turkey. To the west Osmaniye, to the east lies Şanlıurfa, to the northeast Adıyaman, to the northwest Kahramanmaraş, and to the south Kilis, to the southwest Hatay and the border with Syria (Gaziantep Magazine, 2014).

Figure:2.1 *Location of Gaziantep city in Turkey map*

Because of his connection with Syria and Iraq markets, Gaziantep became a traditional market center in Turkey. It is considered also as a transit center in order to reach the Middle East Countries (Yilmaz, 2014). Nowadays, in terms of population, Gaziantep is considered like the largest city in the Southeastern. It became an attractive place for migrants over the last decades, because of these factors. The city created high job opportunities and could accommodate a large number of migrants came from the other around areas until nowadays. Figure 4 can give an idea about the total number of migrants according to (TUIK, 2013).

With his 6887 kilometer square of territorial, Gaziantep city has an altitude of 850 m above the sea level with a range of 250m to 1250 m. The city is located on a plateau, filled with fertile ravines and undulating hills like Duztepe, Mardintepe and Gourban Baba near of the city center.

There are also another hill highest of them all called Türktepe. The southwestern direction of Gaziantep there was a hill filled with hug pieces of granite and basalt, Karataş, which was seat of an ancient volcanic eruption. The city is surrounding territory abounded with stone queries (Ganteping, 2011).

Gaziantep province is divided into 9 districts: Islahiye, Nizip, Nurdağı Oğuzeli, Şehitkamil, Yavuzeli, Araban, Karkamiş, Şahınbey (Figure 4.3). The largest county in terms of land area is Şehitkamil while the smallest is Karkamış as is refered in Table 4.1 (Teker, 2013).

Figure 2.2 *Gaziantep city map with towns within (Yilmaz, 2014)*

2.3 Historical Urban Transformation in Gaziantep city

In 1938, the first master plan of Gaziantep that included two important purposes was made by Herman Jansen. The first one is expanding highway in south of the old city along east-west direction toward Aleppo City. The second important propose was the railway connection to the northern of Gaziantep.

According to the Janssen Plan, the city was separated into three zones. The boundaries of the areas are determined by the Aleppo Highway, the Sports District, the Railroad and the Aliben Table, which passes through the northern part of the Old City (Yilmaz, 2014). The industrial development zone and the worker in the northern part were separate from the city center by the Alleben train and railway. The plan proposes the use of the western and southern parts of the Old City to develop new housing. The residential units are designed as a three-storey garden, while the administrative center is located between the highway in Aleppo and Alleben (Yilmaz, 2014).

***Figure 2.3** The old Card of Gaziantep*

Alleben stream, as the natural asset of city, was located as a recreational corridor for both separating and integrating old city and new city. Topographic elements were handled as a design tool especially for arrangement of new housing areas in the southern part. While Herman Jansen did not offer high-rise blocks, he suggested a height limit of three floors for the larger towns. Moreover, while he specified one house block for every six families of workers neighborhood, he allocated a separated residences for every single-family with a private garden. Jansen attended this rule of developing separate residential area for workers in all his plans of Turkish cities (Yılmaz, 2014). The plan in this period emphasized Castle as greenery area surrounded by residential areas. One of the essential goals of Jansen plan were to respond the increasing population within the border of his urban development plan. Jansen clarified that the city should not overpass beyond the walking distances limits and urban amplification is considered serious regarding security conditions. Jansen designed Gaziantep as a compact city but his assessment of population and macro form growth did not succeed.

In 1950, after Jansen's arrangement for Gaziantep, a new plan for the city had been generated by Kemal Ahmet Aru and Kemali Söylemezoğlu. They emphasized traditional urban values of the road system within the city (SRDA, 2015). Work zone region were placed in the northeast of Nizip road and at southeast development of

Gaziantep borders. On the other side of the city, Aleppo Road and the Alleben River were surrounded by recreation and green areas and the city center started to gain a modern quality. Gaziler Street beside of many roads in the old city were prepared for automobiles traffic. The city developed towards the west and the southeast of the city in parallel with city growing toward the İnönü Street, Akkoyunlu Street and Atatürk Boulevard (Ay, 2001).

In 1950s, according to State Institute of Statistics the city of Gaziantep had speculated population of 120.015. Between 1950 and 1960 and because of unexpected increasing in numbers of population and the accelerated urbanization attendant with migration movements toward the city of Gaziantep that caused a relatively increasing in slums and high raised block in the first time in city history. This increment in population caused also increasing in work places and housing demand. In the second development plan of Gaziantep, though new residential areas are 106 separated from old city, low-rise multi-floor buildings within the old city texture collapsed and city was refreshed with new structures (Yılmaz, 2014).

In Gaziantep 40 new neighborhoods were developed between 1960 and 1975. Plenty of them were out of planned region (Ay, 2001). These new neighborhoods cause a raise in inadequate construction of business and residential region. This style of growth includes qualitative leap, sprawling, low-density and scattered development that experienced especially around rural settlements. Additional urban areas in Gaziantep have been increased because of the new policies and the additional development plans, which have opened extensive, amount areas to development (Ay, 2001).

Third development plan of Gaziantep was prepared by Zühtü Can in order to meet new city requirements until 1990s. Until the 1990s, the city's development tried to observe plan of Zühtü. The new plan consisted of extension for the residential area in order to accommodate 1 million person with total area of 8010 hectares (Ay, 2001). However, the population projection failed because the population of the city sustained beyond the assessment by 1995. The urban population continued to increase dramatically and unplanned areas of the city continued to appear. These unplanned parts of the city were joined to the city thorough additional plans. Subsequently, the expansion of the unplanned and unhealthy city regions speed up. Gaziantep, which had have 8100 hectares of planned areas, between 1974 and 1989, had 31.394 hectares of adjacent area (Ay, 2001).

Due to problems of squatter housing, illegal constructions spreading, increasing in neighboring areas, and considering city's needs a fourth city master plan was prepared by Oğuz Aldan in 1990. The new plan's target was 2005 and the population of the city was assumed to reach 1.800.000. This plan increased city's planned areas from 8.000ha to 21.000ha (Ay, 2001). The next Figure 4.5 refer to the different city borders in the different periods.

Because of the increment in urban population, Gaziantep got many additional master plans. One of the plans was designed in 1980 called Göllüce Mass Housing to accommodate Afghan immigrants who run away of war in their country. However, instead of Afghan immigrants native people lived in this area. Another additional master plan in 1990 is Bağlarbaşı Mass Housing Area which was planned for the immigrants who came because of the terrorism in the southeastern and the eastern Anatolia. In addition, in 1993 Serice Mass Housing Area as an additional master plan in the southwest and south part of the city was prepared by the municipality. After that, 1998 additional master plan was prepared to gentrify the existing squatter housing areas. This plan includes Safa city Mass Housing that is located near of the industry and Taşlica Mass Housing. An Additional Master Plan in 2002, for the west side of the city that is connected by a wide and regular road patterns to the city center and the industry areas. This area was planned for high-income people who want to run away from the unfavorable effects of the city. In 2003 ring road, additional and revised master plan offers 10.000 square meters of area nationalized due to the difference between two road route decisions.

After the Law of Metropolitan Municipality, administrative structure of the municipality changed. The city borders increased from 65.000 ha to 158.400 ha. In 2004, new areas were included close to the highway and terminal with the additional master plan. Areas close to the city center and the industrial areas were planned with 2005 additional master plan. This plan aimed to contribute to the city prestige.

Gaziantep was designed to be compact city, but because of increasing in the city density, people were forced to move to the edge of the city. Those people formed something called sub-centers. While the most of population live near the city center, only a small portion of population live in peripheral areas. The expansion of the city towards peripheral areas caused a rapid growth of population instead of increase in densities of existing parts.

The final master plan of Gaziantep City shows that the inner core of the city has higher density by localization of different functions, while density is decreasing towards the outskirts of the city. At the same time according to urban development levels of the city slums were widely distributed through the urban textures and become a fact should deal with it. As the Mayor of Gaziantep stated, “Still 70% of the city area considers as a slum area” However, New intervention plans for slums were prepared by the municipalities beside of opening new areas for development at the outskirts of the city to decrease the demographic pressure of city center (Haberler News, 2014).

2.4 Challenge of the Urban Transformation in Gaziantep City

The demographic changes cause a high demand on shelters and dwellings. The city like others in the worldwide were not ready to receive all of these new settlements caused by events that have been mentioned. So people found temporary solution, which become by the years a real matter and chronic problem called slums or “gecekondu” as it is called in the local Turkish language. It is worth mentioning that Gaziantep has nine towns: Şahinbey, Şehitkamil, Oğuzeli central towns and Nizip, Islahıye, Araban, Yavuzeli Nuğrdağı and Karkamış. However, this chapter focuses about Şahinbey urban transformation efforts because it includes the most dynamic part of the city.

Like the Mayor of Gaziantep stated, 70% of the city area considers as a slum area, according to (Haberler News, 2014). According to the plans made by the local municipalities that were guided by the a recent legal actions issued by central government, the municipalities of Gaziantep started to build satellite residential area near city borders, and at the same time rebuilding and transforming the inner city slums. Between 2001 and 2009 the total number of new residences reached 53418 apartment that built by Mass Housing Administration of Turkey (Satilmiş, 2011). These urban development patterns reflect the need of government policy to keep up with the fast growth of sub-districts and dispersing population from overly crowded city cores to new developed areas with the lines of transportation .

2.4.1 Case of the Municipality of Şahinbey

The Urban Transformation is a big challenge in Şahinbey municipality, in this municipality height projects are still going on that are Amaçla Nuripazarbaşı, Sakarya, Çamilca, Kahvelipınar, Kıbrıs-Kılınçoğlu-Delbes-Daracık Yazıcık-Türkepe-Bostancı-Bekirbey, Perilikaya-Serinevler, Güzelvadi Mahlleri ve Eski garajlar Bolgesini. During this Urban transformation, a record of the destruction of 6041 houses was recorded and it coasted 430.685.628.60 TL according to (Şahinbey Municpality)

Figure 2.4. *Demolition in Şahinbey Municipality*

In this case, the Municipality of Şahinbey started to apply new urban Transformation process as it allocates in vital part of the city and includes historical city center of Gaziantep around of many commercial centers are located inside its border. The Planning Projects Manager in the Municipality of Şahinbey has mentioned that 80% of Şahinbey Town is a slum area. The Municipality determined an action plan for current urban transformation projects, while it determined others as a high-risk zone should take the next steps of urban transformation as shown in Figure 6. These expected areas includes neighborhoods named “Seyrantepe, Umut, Serinevler, Etiler, Türktepe, Özdemir bey”. However, in some of these areas, urban transformation has been started and the other still waiting until end of the legal issues relating to the retrieval or the liberation of space by the old occupants.

Çamlıca , Nuri Pazarbaşı and Sakarya neighborhoods are considered as one of the earliest inner city slums, which went through urban transformation proses with about 10.35 hectare of land. Figure 7 can give an idea about the urban texture of the neighborhoods, which include high-density buildings, variation in heights and unpaved roads. Beside a lot of building raised up with unsafe constructions standard, which make it in danger of earthquake. All of the last factors and other accumulated problems of these neighborhoods make the retrofitting of the authorized stock is legally and socially not viable.

2.4.2 The Urban Transformation in Şahınbey: Case of Camilca projet

Figure 2.5 *Çamlıca after transformation (şahinbey municipality)*

The selected neighborhoods are located near of the city center of Gaziantep and just about 1.5 k.m south of the historical castle. The over crowded and aged houses are clearly defied in these slums. Figure 8 shows functions distribution at neighborhoods before transforming. Most area of land are covered with residential blocks with ratio of 61%, while just 0.3% of land includes green area, 0.9% for work places and 37.8% for streets and pathways. The Residential area included 1554 flats distributed in 717 house blocks with variable heights. The other factor, which contributed choosing this slum, is the high demand to expand and widen Özdemir Bey Street, as it receives a huge numbers of vehicles according to its location straight forward from the junction of Hürriyet and Atatürk Streets. Özdemir Bey Street also links the nearby working centers to

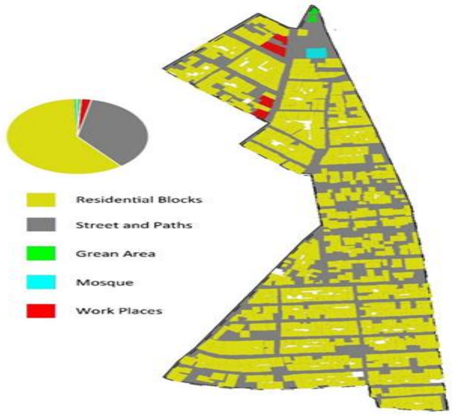

Figure 2.6 *Plan of project area shows functions distribution before transformation (Source: Şahinbey Municipality, 2014)*

In these neighborhoods, Çamlıca project replaces and changes the old and insufficient squats with 1071 new and modern residences in a livable conditions. The project as shown in Figure 10 is divided into current project zone and expansion part for next urban renewal project. Total expropriation of illegal residences reached 2111 for both parts, while it is 1554 for the correct "Çamlıca1071" project. Çamlıca1071 project includes 5 stages planed to run out by the mid of 2015 year according to statements of officials in Şahinbey Municipality. The new design includes two different types of flats with 112 m² and 135 m² area All of there new flats will be selled again to the local and new incoming residents.

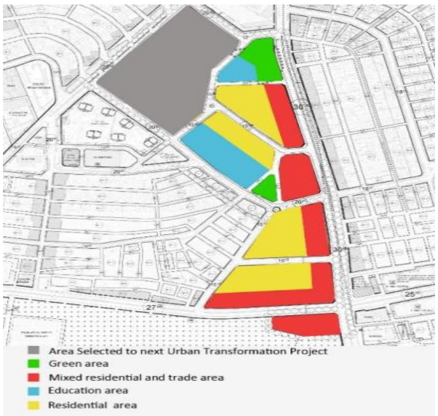

Figure 2.7 *Distribution of functions of Çamlıca Project*

(Source: Şahinbey Municipality, 2014)

To ensure the success of the project, the concept address explicitly the need to create jobs opportunities. In spite of these neighborhoods were used to be a residential area before transforming, the new master plan, designed by the Municipality, uses an integrated design approach due to the fact that people had come to live in these slums for economic and job reasons. It allocates the commercial activities along Özdemir Bey street to make it an artery element of these neighborhoods and surrounding area.

Figure 2.8 *Çamlıca apartments (Şahinbey Municipality)*

The design also give priority to enlarge streets and walk paths specially the main eastern street, beside of creating a sufficient green area within residence block areas. Although all of these new events and others will help improving life standards, introducing variety in economic sectors and employment, and induce social integration, but this project faces also a replacing of local residents by not giving priorities and facilities for them to reallocate them in these new blocks. On the other hand, the number of new residences are much less than the expropriated ones as clarified in Figure 11. That will lead to transfer and accumulate a part of the original social problems of these neighborhoods to other near ones.

Finally, the renewal of Özdemir Bey Street is announced to be as a major target in this case of transformation. Beside of solving the transformation problem within the area by including six new car pathways (Figure 12), it also accelerate the enhancement of the street environment within the plan area to courage established businesses along street.

CHAPTER 3

OVER VIEW ON TURKISH EARTHQUAKE CODE 2007

3.1 Introduction

In the pass years after many disasters that face Turkish Country because of the durability of his ground. The Turkish government adopted a new earthquake code that was TSC 2007 to reduce the damages in the construction field. Some values and coefficient were affected to the regions that were separated by the degree of the vulnerabilities. In this part of our work, we will see the important different part of this earthquake regulation

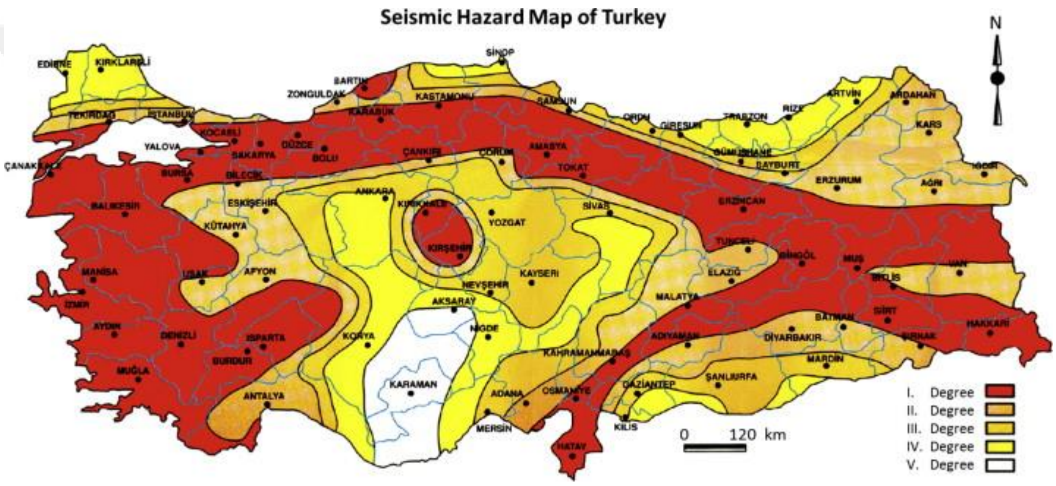

Figure 3.1 *Seism Hazards Map of TSC 2017*

3.2 The Elastic Seism Loads

The Spectral Acceleration Coefficient, *A* (*T*), which shall be considered as the basis for
the determination of seismic loads is given by equation :

$$A\ (T) = A_o\ I\ S\ (T) \quad (3.1)$$

Elastic Spectral Acceleration, *S*ae (*T*) which is the ordinate of *Elastic* Acceleration Spectrum defined for 5 % damped rate is derived by multiplying Spectral Acceleration Coefficient with gravity g.

$$S_{ae}\ (T) = A\ (T)\ g \quad (3.2)$$

3.3 The Effective Ground Coefficients

Table:3.1 effective Ground Coefficient

Seism Zone	*Ao*
1	0.40
2	0.30
3	0.20
4	0.10

3.4 Building Importance Factor

Table 3.2 Building Important Factor

Purpose of Occupancy or Type of Building	Importance Factor (I)
1. Buildings required to be utilized after the earthquake and buildings containing hazardous materials a) Buildings required to be utilized immediately after the earthquake (Hospitals, dispensaries, health wards, fire fighting buildings and facilities, PTT and other telecommunication facilities, transportation stations and terminals, power generation and distribution facilities; governorate, county and municipality administration buildings, first aid and emergency planning stations) b) Buildings containing or storing toxic, explosive and flammable materials, etc.	1.5
2. Intensively and long-term occupied buildings and buildings preserving valuable goods a) Schools, other educational buildings and facilities, dormitories and hostels, military barracks, prisons, etc. b) Museums	1.4
3. Intensively but short-term occupied buildings Sport facilities, cinema, theatre and concert halls, etc.	1.2
4. Other buildings Buildings other than above defined buildings. (Residential and Office buildings, hotels, building-like industrial structures, etc.)	1.1

3.5 Spectrum Coefficient

$$S\,(T) = 1 + 1.5 + \frac{T}{TA} \qquad (0 \leq T \leq TA)$$

$$S(T) = 2.5 \qquad (TA < T \leq TB) \qquad (3.3)$$

$$S(T) = 2.5 + \left(\frac{TB}{T}\right)^{0.8} \qquad (TB \leq T)$$

Table:3.3 Spectrum Characteristic Periods

Local Site Class acc. to Table 12.2	TA (second)	TB (second)
Z1	0.10	0.30
Z2	0.15	0.40
Z3	0.15	0.60
Z4	0.20	0.90

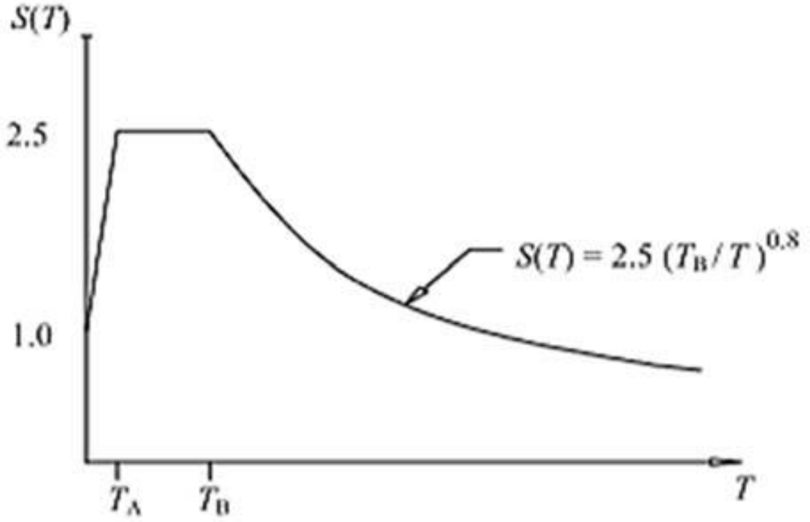

Figure 3.6 *The Factor of the Reduction of the Seismic load*

$$S(T) = 1 + 1.5 + \frac{T}{TA} \qquad (0 \leq T \leq TA) \qquad (3.4)$$

$$R_a(T) = R \qquad (TA < T)$$

CHAPTER 4

NEW TURKISH EARTQUAKE REGULATION 2018

4.1 Introduction

For a better understanding of material behavior of concrete and reinforcement which form the reinforced concrete, as a result of the experiments and earthquakes on reinforced concrete elements and carrier systems, observations have provided new information about the behavior of structural carrier systems under vertical and earthquake loads. In addition to this, speed and mathematical accuracy have been gained at the point of analysis of structural carrier systems with the developments in computer technology. All these factors make it necessary to update earthquake regulations.

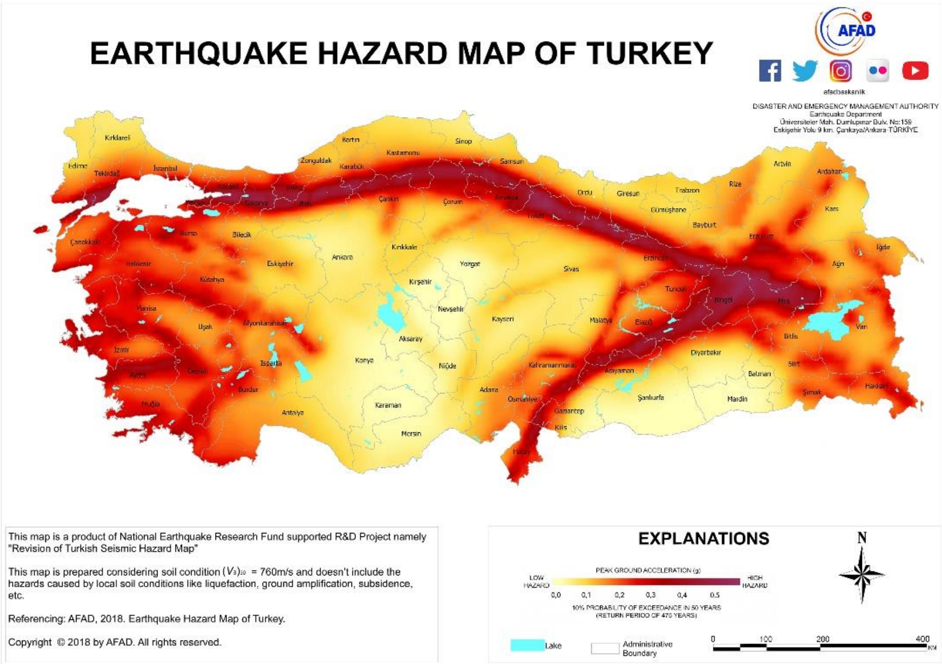

Figure 4.1 *Earthquake of Hazard Map of Turkey for the New Earthquake code 2018*

The Earthquake Building Regulations in Turkey published in 2018, was prepared by a commission created by AFAD. Moreover, developments in earthquake engineering in the preparation process and the developing needs of the country have been taken into consideration. In 2007 Turkey Earthquake Building Regulation, the addition of the section related to the evaluation and strengthening of the existing buildings and the limited modification of the steel buildings section is renewed for the first time after 1997 regulation.

The 2018 Earthquake Building Regulations in 2018 on the assessment of the current draft of the amendment to the next building and seismic strengthening sections have been made many changes at the base. In the earthquake calculation, these basic concepts and changes introduced in the regulation also affect the evaluation and strengthening of existing buildings. Identification of the earthquake level, innovations in elastic earthquake spectrum, building use class, seismic design class, building height class, cross sections basic changes and new entrants concepts to earthquake regulations like rigidities, are described under the heading of "2018 Turkey Earthquake Building Regulation Draft with Earthquake Account fetched General Amendments". Innovations related to the evaluation of existing buildings are explained in other headings. In the section of the evaluation of existing buildings, issues not changed according to DBYBHY 2007 are not mentioned in this section.

In Turkey Earthquake Building Regulations Draft published in 2018, from the knowledge levels defined in DBYBHY 2007, regulations were removed from the middle level of knowledge. The level of limited knowledge and the level of comprehensive knowledge in reinforced concrete buildings have also been changed. In the general approach of Turkey Building Earthquake Regulation 201, compared with 2007 DBYBHY, in the curtains, the columns and the beams with less carotene the same level of knowledge is reached. In DBYBHY 2007, while existing transverse reinforcement ratios used in the calculation of the damage limits of the reinforced concrete sections are obtained, the contribution of the hoops 135 degrees non-twisted are taken as zero, in 2018 Turkey Earthquake Building Regulations, contribution of 30% of the hoops with 90-degree bent hooks will be taken into consideration.

4.2 Turkish Building Earthquake Regulation with Earthquake Account fetched General Amendment

4.2.1 Earthquake ground movements' levels

In 2018 Turkey Earthquake Building Regulation, four different seismic ground motion levels are defined.

Earthquake ground motion level 1: The probability of exceeding the spectral magnitudes for 50 years is 2% and the repetition period of 2475 years is very rare earthquake earth motion. It is also called the largest earthquake ground motion under consideration.

Earthquake ground motion level 2: The probability of exceeding the spectral magnitudes in 50 years is 10% and the recurrence period is 475 years. It is also called Standard design earthquake ground motion.

Earthquake ground motion level 3: The probability of exceeding the spectral magnitudes in 50 years is 50% and the repetition period is 72 years.

Earthquake ground motion level 4: The probability of exceeding the spectral magnitudes in 50 years is 68% and the repetition period is 43 years. It is also called Service earthquake ground motion.

4.2.2 Earthquake ground motion spectra

One of the biggest changes brought by the revised regulation is that the design spectrum is more closely linked to the reality by connecting to more variables. In the new regulation, the design spectra are defined depending on the map spectral acceleration coefficients, the fault proximity coefficient and the local ground effect coefficients defined in the earthquake hazard map for a short period and a second period. Also in 2018 Earthquake Building Regulations in Turkey, the vertical elastic design spectrum where vertical earthquake acceleration can be determined, which are ignored in DBYBHY 2007, are described.

4.2.2.1 Map spectral acceleration coefficients and design spectral acceleration coefficients

The map spectral acceleration coefficients that correspond to the geometric mean of the earthquake effects in two horizontal directions are defined as non-dimensional coefficients by dividing the spectral accelerations of the map given in the earthquake hazard maps for the 5% damping rate based on the reference ground condition for a given earthquake ground motion level. Map spectral acceleration coefficients for each of the four different seismic ground motion levels are defined separately in the earthquake hazard map for SS and S1, short period region and 1 second period. Map spectral ac celeration coefficients, as in Equations (4.1) and (4.2), are converted to design spectral acceleration coefficients, S_{DS} and S_{D1}.

$$S_{DS} = S_S F_S \tag{4.1}$$

$$S_{D1} = S_1 \gamma_F F_1 \tag{4.2}$$

In these equations, γ_F is the coefficient of proximity to the fault, while the FS and F1 are local ground coefficients. There will be horizontal and vertical elastic design spectra by means of the design acceleration spectral coefficients obtained

4.2.2.2 The coefficient of proximity to the fault

For locations within 25 km and less with design spectral acceleration coefficient calculated for 1-second period and only at DD-1 and DD-2 earthquake ground motion levels to be applied to SD1, the fault proximity coefficient γ_F is defined in Equations (4.3) and (4.4):

$$\gamma_F = 1.2 \qquad L_F \leq 15km \tag{4.3}$$

$$\gamma_F = 1.2 - 0.2\,(L_F - 15) \qquad 15 < L_F \leq 25km \tag{4.4}$$

For DD-3 and DD-4 earthquake ground motion levels, the coefficient of proximity to the fault must be equal to γ_F.

4.2.2.3 Local ground impact coefficient

Local ground effect coefficients are given in Table 3.1 and 3.2 of the local ground class Fs and F1. Site-specific ground behavior analyzes will be performed for the ZF class.

Table 4.1: Local soil impact coefficients for short period regions

Local Floor Class	**Local ground impact coefficient Fs for short period zone**					
	Ss ≤0.25	Ss = 0.5	Ss = 0.75	Ss = 1.0	Ss = 1.25	Ss ≥1.5
ZA	0.8	0.8	0.8	0.8	0.8	0.8
ZB	0.9	0.9	0.9	0.9	0.9	0.9
ZC	1.3	1.3	1.2	1.2	1.2	1.2
ZD	1.6	1.4	1.1	1.0	1.0	1.0
ZE	2.4	1.7	1.1	0.9	0.9	0.8
ZF	Site-specific ground behavior analysis will be conducted					

4.2.2.4 Horizontal elastic design spectrum

Horizontal elastic design spectral acceleration values, which are the ordinates of the horizontal elastic design spectrum for any earthquake ground motion level, are given in the following equations 2.5, 2.6, 2.7, 2.8.

$$S_{ae}(T) = \left(0.4 + 0.6\frac{T}{T_A}\right) S_{DS} \qquad (0 \leq T \leq T_A) \tag{4.5}$$

$$S_{ae}(T) = S_{DS} \qquad (T_A \leq T \leq T_B) \tag{4.6}$$

$$S_{ae}(T) = \frac{S_{D1}}{T} \qquad (T_B \leq T \leq T_L) \qquad (4.7)$$

Table 4.2 Local soil impact coefficients for 1.0 second period

Local Floor Class	Local ground impact coefficient Fs for short period zone					
	S1 ≤0.10	S1 = 0.20	S1 = 0.30	S1 = 0.40	S1 = 0.50	S1 ≥0.60
ZA	0.8	0.8	0.8	0.8	0.8	0.8
ZB	0.8	0.8	0.8	0.8	0.8	0.8
ZC	1.5	1.5	1.5	1.5	1.5	1.4
ZD	2.4	2.2	2.0	1.9	1.8	1.7
ZE	4.2	3.3	2.8	2.4	2.2	2.0
ZF	Site-specific ground behavior analysis will be conducted					

In these equations, SDS and SD1 design correspond to the spectral acceleration coefficients, and T corresponds to the natural vibration period of the structure. TA and TB, the corner of the horizontal design spectrum periods; Depending on the SDS and SD1, they are defined as shown in Equation 2.9 below. The transition period to the fixed displacement zone should be taken as 6 seconds. The graph of the horizontal elastic design spectrum is shown in Figure 4.2.

$$T_A = 0.2\frac{S_{D1}}{S_{DS}} \quad ; \qquad T_B = \frac{S_{D1}}{S_{DS}} \qquad (4.8)$$

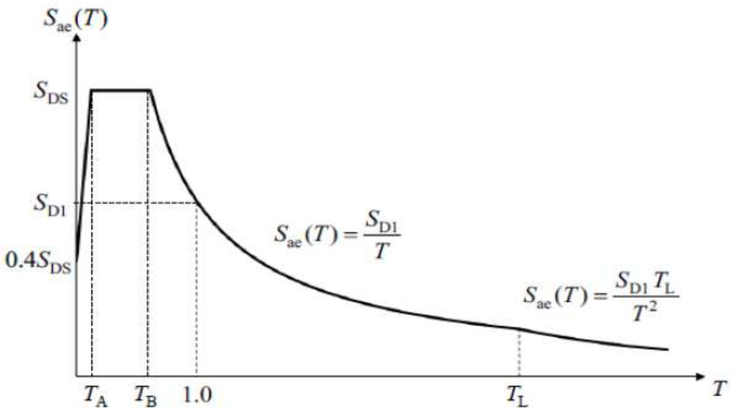

Figure 4.3 *Horizontally elastic design spectrum*

4.2.2.5 Vertical elastic design spectrum

Given that for any earthquake ground level, Vertical elastic design spectral accelerations which are ordinates of the acceleration spectrum of the vertical elastic design SaeD (T), the short period design defined for horizontal earthquake ground motion is defined in terms of the acceleration depending on the spectral acceleration coefficient and the natural vibration period.

$$S_{ae}D(T) = \left(0.32 + 0.48\frac{T}{T_{AD}}\right)S_{DS} \qquad (0 \leq T \leq T_{AD}) \tag{4.9}$$

$$S_{ae}D(T) = 0.8\,S_{DS} \qquad (T_{AD} \leq T \leq T_{BD}) \tag{4.10}$$

$$S_{ae}D(T) = 0.8\,S_{DS}\frac{T_{BD}}{T} \qquad (T_{BD} \leq T \leq T_{LD}) \tag{4.11}$$

The corner periods of the TAD and TBD vertical spectrum and the TLD period in these expressions can be calculated using Equation 2.13. The vertical elastic design spectrum is shown in Figure 4.3.

$$T_{AD} = \frac{T_A}{3}\ ; \quad T_{BD} = \frac{T_B}{3}\ ; \quad T_{LD} = \frac{T_L}{2} \tag{4.13}$$

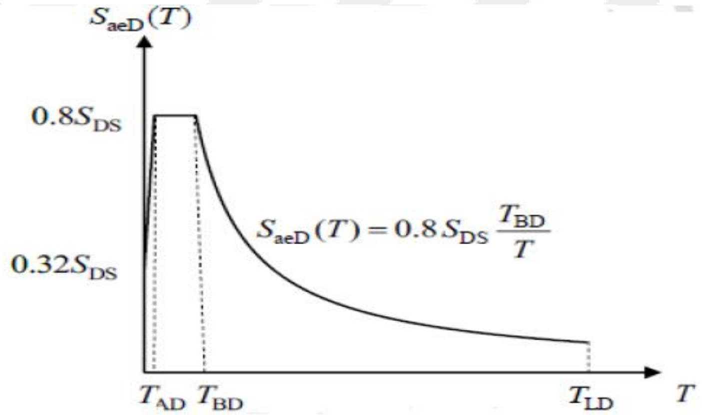

Figure 4.2: *Vertical elastic design spectrum*

4.2.3 Building usage classes and building importance coefficients

The building usage classes used in determining the earthquake design classes are shown in Table 5.3 according to the purpose of the building. In addition, building importance coefficients selected according to building usage class are defined in Table 4.3

Table 4.3 Building usage classes and building importance coefficients

Building Usage Class	**Purpose of Building usage**	**Building Importance coefficient**
BKS=1	buildings Buildings that need to be used after earthquake, buildings which people use intensively and for a long period, buildings where valuable goods are stored and buildings containing dangerous goods. Buildings to be used immediately after the earthquake (Hospitals, dispensaries, health centers, fire stations, communication facilities, transportation stations). Schools, educational buildings, dorms, dormitories, barracks, prisons. Museums. Place where there are substances with explosive properties or stored substances.	1.5
BKS=2	Buildings used for short term and in an intensive way by people. Shopping centers, sports facilities, cinema, theater, halls etc.Other buildings	1.2
BKS=3	Houses, businesses, hotels, industrial	1.0

4.2.4 Earthquake design classes

Earthquake Design Classes (DTS) to be used in design under earthquake effect Short-term design for Use Classes and DD-2 earthquake ground motion level depending on the spectral acceleration coefficient is determined in Table 4.4.

Table 4.4 Earthquake design classes

(DD-2) Short Period Design Spectral Acceleration Coefficient (SDS) at Earthquake Ground Motion Level	Building Use Class	
	BKS=1	BKS=2,3
SDS < 0.333	DTS=4a	DTS=4
0.333 ≤ SDS < 0.667	DTS=3a	DTS=3
0.667 ≤ SDS < 1.00	DTS=2a	DTS=2
1.00 ≤ SDS	DTS=1a	DTS=1

4.2.4 Height and height classes of building

The rigid basement curtains in the building in the prevailing vibration mode in the direction of the perpendicular building axes and the enclosure surrounding the building at least on three sides, the natural vibration period calculated for the entire building including basement floors, the building floor is defined in buildings with basement, which provide both of the conditions for the ratio of the natural vibration period to be calculated to be equal to the natural vibration period calculated in the same direction as the deletion of all basement masses, including the ground floor slab are defined at the level of floor slab in the upper elevation of the basement floor curtain.
Under the effect of earthquake, buildings are divided into eight and building height classes. These eight classes are shown in Table 4.5, depending on building height ranges and earthquake design classes.

Table 4.5 DTS and building height classes defined by building heights

Building Height Class	Building Height Classes and Earthquake Design Classes Defined Building Height Ranges [m]		
	DTS=1, 1a, 2, 2a	DTS=3, 3a	DTS=4, 4a
BYS=1	HN >70	HN >91	HN >105
BYS=2	56 < HN ≤ 70	70 < HN ≤ 91	91 < HN ≤ 105
BYS=3	42 < HN ≤ 56	56 < HN ≤ 70	56 < HN ≤ 91
BYS=4	28 < HN ≤ 42	42 < HN ≤ 56	
BYS=5	17.5< HN ≤ 28	28 < HN ≤ 42	
BYS=6	10.5 < HN ≤ 17.5	17.5 < HN ≤ 28	
BYS=7	7 < HN ≤ 10.5	10.5 < HN ≤ 17.5	
BYS=8	HN ≤ 7	HN ≤ 10.5	

4.2.5 Building performance objectives and design approaches to be applied

The building performance target indicates the level of performance that is targeted for a particular earthquake ground motion level. For the four seismic earth motion levels defined in the Regulation, the normal performance targets defined for earthquake design class 1, 2, 3, 3a, 4, 4a and the advanced performance targets defined for earthquake design class 1a, 2a are specified in Table 4.6, 4.7, 4.8. In addition, the design approach and the scope of application of the evaluation and design approach according to deformation are also stated in these tables

Table 4.6 Performance targets and evaluation approaches for new buildings

Earthquake Location Objective Level	DTS =1, 1a, 2, 2a, 3, 3a, 4, 4a		DTS =1a, 2a	
	Normal Performance Objective	Evaluation/Design Approach	Advance Performance Objective	Evaluation/Design Approach
DD-3	-	-	HK	ŞGDT
DD-2	CG	DGT	CG	DGT
DD-1	-	-	CG	ŞGDT

Table 4.7 Performance objectives and evaluation approaches for new high buildings

Earthquake Location Objective Level	**DTS =1, 2, 3, 3a, 4, 4a**		**DTS =1a, 2a**	
	Normal Performance Objective	Evaluation/Design Approach	Advance Performance Objective	Evaluation/Design Approach
DD-4	KK	DGT-ŞGDT	-	-
DD-3	-	-	HK	ŞGDT
DD-2	CG	DGT	CG	DGT
DD-1	GÖ	ŞGDT	CG	ŞGDT

Table 4.8 Performance objectives and evaluation approaches for existing building

Earthquake Location Objective Level	**DTS =1, 2, 3, 3a, 4, 4a**		**DTS =1a, 2a**	
	Normal Performance Objective	Evaluation/Design Approach	Advance Performance Objective	Evaluation/Design Approach
DD-3	-	-	HK	ŞGDT
DD-2	CG	ŞGDT	-	-
DD-1	-	-	CG	ŞGDT

4.2.6 Effective cross-section stiffness of reinforced concrete structural system elements

The effective section rigidity multipliers given in Table 4.9 shall be used in the modeling of the cross-sectional properties of the reinforced concrete structural system elements.

Table 4.9 The multipliers of effective cross-section stiffness of reinforced concrete structural system elements

Reinforced Concrete Carrier System Element	**Effective Section Stiffness Multiplier**	
Curtain-Pavement (Interior Plane)	*Axial*	*Slip*
Curtain	0.50	0.50
basement curtain	0.80	0.50
Pavement	0.25	0.25
Curtain-Pavement (Exterior Plane)	*Bending*	*Cutting*
Curtain	0.25	1.00
basement curtain	0.50	1.00
Pavement	0.25	1.00
Rod element	*Bending*	*Cutting*
Vineyard beam	0.15	1.00
Frame beam	0.35	1.00
Frame column	0.70	1.00
Curtain (equivalent rod)	0.50	1.00

The curtain, modeled with finite elements and the effective section stiffness factors corresponding to the axial and shear behavior of the slabs in their planes are given in Table 2.9 for application to the modulus of elasticity and the slip module.

Effective cross-section stiffness of frame beams and columns corresponding to the bending and shearing behavior of curtains modeled as equivalent rods and bonding beams in the girder beams, for applying the moment of inertia to the section and the cutting area, are given in Table 2.9.

4.3 Gathering Information from Reinforced Concrete Buildings

4.3.1 Knowledge levels

The knowledge levels, in 2018 Earthquake Building Regulations of Turkey, are classified as limited and comprehensive. The level of medium knowledge defined in DBYBHY 2007 is not defined in this regulation.

Limited Knowledge Level: The characteristics of the structural system are determined by the measurements to be made in the building. Limited level of knowledge can be

used only in buildings with building class 3.
Comprehensive Knowledge Level: compare to limited knowledge, more measurements are made.

4.3.2 Limited level of knowledge in reinforced concrete buildings

According to DBYBHY 2007, 10% of the curtains and columns, at least one of each floor, 5% of the beams should be peeled off and the reinforcement control should be performed. As for the new regulation, 5% of the curtains and columns, at least one in each floor, are enough to make the reinforcement control by peeling the rust shares of a beam. In the new regulation, the reinforcement coefficient of the reinforcement is calculated; for beams only the reinforcement required for vertical loads is used. In DBYBHY 2007, the reinforcement coefficient is calculated for both beams and columns. According to DBYBHY 2007 when determining the strength of concrete, the strength of the lowest sample is taken from the samples. In the new regulation, if the total sample is less than three, the minimum concrete strength is taken as strength. If the sample number is more than three, the average minus standard deviation value obtained from the samples and the greater than the average value of 0.85 times are taken as concrete strength.

4.3.3 Extensive level of knowledge in reinforced concrete buildings

While in the DBYBHY 2007 projects are mandatory to be able to classify the building, in the event that the new regulation does not have building projects, the building can still be classified at the level of comprehensive knowledge. If the reinforced concrete detail project is available according to the new regulation, rust share stripping is done for the limited level of knowledge to check whether the reinforcement is suitable for the project. If the project is not available, 10% of the columns and curtains will be stripped off at least two pieces on each floor, 30% of the remaining elements and 15% of the beams are equipped with reinforcement fixing device. When determining the strength of concrete, according to DBYBHY 2007, each of the columns or curtains in each floor shall be not less than 3 pieces; in the building not less than 9 in total from each 200m2 one core is taken. Average minus standard deviation value obtained from the samples is taken as the existing concrete strength. In the new regulation, one core of every 400 m2 is taken from the columns or curtains on the ground floor, not less than 2 pieces in 3 floors and in the building not less than 9. The average minus standard deviation value obtained from the samples and the greater than the average value of 0.85 times are taken as concrete strength.

4.3.4 Knowledge level coefficients

The knowledge level coefficients to be applied to the member capacity according to the level of knowledge obtained from the buildings examined are determined according to Table 4.10.

Table 4.10 Knowledge level coefficients

Knowledge Level	Knowledge Level Coefficient
Limited	0.75
Comprehensive	1.00

4.4 Earthquake Calculation with Linear Elastic Calculation Methods

4.4.1 Calculation methods

In the determination of earthquake performance of buildings, linear calculation methods to be used are equivalent earthquake load method and modal join method.
The buildings where equivalent earthquake load can be applied are given in Table 4.11. Additional eccentricity shall not be applied in the earthquake calculation of buildings. The total equivalent earthquake load shall be obtained according to Equation 4.14. In this equation, the elastic design spectral acceleration can be used directly instead of the reduced design spectral acceleration because the earthquake load reduction coefficient is equal to one.

Table 4.11: Equivalent earthquake load method can be used in buildings

Building Type	**Permitted Building Height Class**	
	DTS= 1, 1a, 2, 2a	DTS= 3, 3a, 4, 4a
Buildings where the torsional irregularity coefficient of each layer provides the condition ηbi≤ 2.0 and also the type B2 of irregularity.	BYS (BHC) ≥4	BYS (BHC) ≥5
All other buildings	BYS (BHC) ≥5	BYS (BHC) ≥6

$$V_{tE} = m_t S_{ae}(T) \geq 0.04 m_t I S_{DS}\, g \tag{4.14}$$

In this equation, S_{ae} *(T)* refers to the horizontal elastic design spectral acceleration values, SDS, design spectral acceleration for the short period region, and $\boldsymbol{m_t}$ is the total mass of the building.

In the mode combining method, the ground load reduction coefficient is taken in the calculation of the base shear force.

4.4.2 Determination of impact-capacity ratios and types of damage in structural elements of reinforced concrete buildings

Ductile beam, curtain and effect/capacity ratio (ECR) of column sections are obtained by dividing the total section moment calculated by taking the earthquake load reduction coefficient under the effect of earthquake and vertical loads. The direction of the earthquake force applied in the ECR calculation will be taken into consideration. The axial forces corresponding to the bending moment capacities of the column and curtain sections shall be calculated by considering 4 as reduction coefficient of vertical loads and earthquake load under the common influence of calculated earthquake loads.

4.4.3 The limits of the application of linear calculation methods

Linear elastic calculation methods cannot be used where any of the following conditions are encountered. If any of the stated conditions occur, one of the linear non-elastic calculation methods should be considered.

- The building height class should be smaller than 5.
- In the building, B3 disorder defined as discontinuity in vertical elements of the carrier system should be found.
- In reinforced concrete buildings, the average ECR value of vertical ductile elements for each earthquake direction is greater than the average ECR value of the beams in the earthquake direction for any floor except for the top floor.
- The average ECR value of the vertical ductile elements for each earthquake direction on any floor except the top floor of the building is greater than 2 with the shear force scaled.
- At any floor of the building, except the upper floor, the average ECR value of ductile beams in each earthquake direction is greater than 5.5.

4.4.4 Determination of unit deformation requests

The unit deformation requests of the element sections will be determined by using equivalent earthquake load or modal merge method with the help of the total displaced axis rotation θk obtained at the end of any element.

Total curvature request of element end section $\emptyset_t$ can be calculated using Equation 4.15

$$\emptyset_t = \frac{(\theta_k - \theta_y)}{L_p} + \emptyset_y \qquad (4.15)$$

The θy is the displaced axis flow rotation in the element end section while $\emptyset_y$ is the yield curvature in the element end section. Lp is the plastic hinge length and will be taken equal to half of the section size in the effective direction.

The unit pressure deformation request of the concrete and the unit deformation request of the reinforcement steel shall be calculated by moment-curvature analysis according to the total curvature request.

4.4.4 1 The concepts of displaced axis rotation and displaced axis flow rotation

The deformation characteristics of a typical bending element under double curvature bending are shown in Figure 4.3. Here *l* represents the total length of the element, l_c shows the clearness, Δ indicates the inter-floor to be shifted, θ_i and θ_i where i and j respectively show the rotations of the nodes, θ_{ki} and θ_{kj} where i and j respectively show displaced axis rotation at the ends and θ_{yi} shows the rotation at the end of the flow.

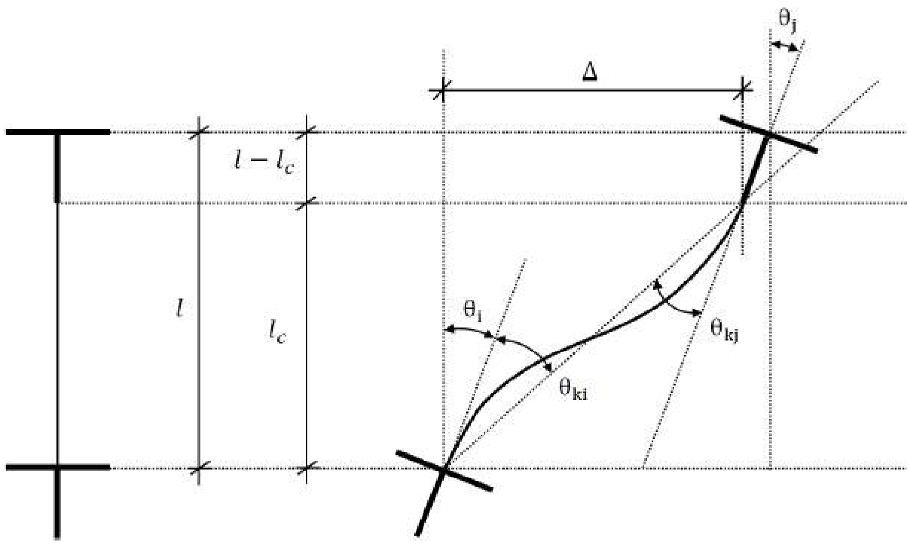

Figure 4.3 *Deformation properties of the bending element*

While the bending element is in the case of linear elastic deformation, dislocated axis at i-end and the relation between the node rotation and the inter-floor displacement is described in Equation 2.16 below.

$$\theta_{ki} = \frac{\Delta}{l_c} - \theta_i \tag{4.16}$$

In the beam elements, the inter-floor displacement value is generally assumed to be zero. Total displacement of the axis at the i end, when flow has occurred at the end of element i, is equal to the sum of the flow rotation and the plastic rotation. Equation 2.17 shows this situation.

$$\theta_{ki} = \theta_{yi} + \theta_{pi} \tag{4.17}$$

The relations between the end flow rotations and the end moments at the ends i and j of a bending member at both ends are given in Equations 2.18 and 2.19. At identifying the spindle turns for the elements with both ends flowing, the unit of substitution requests corresponds to the most unfavorable situation in the calculation

$$\theta_{yi} = \frac{M_{yi} l_c}{3EI}\left(1 - \frac{1}{2}\frac{M_{yj}}{M_{yi}}\right) \tag{4.18}$$

$$\theta_{yj} = \frac{M_{yj} l_c}{3EI}\left(1 - \frac{1}{2}\frac{M_{yi}}{M_{yj}}\right) \tag{4.19}$$

Myi and Myj are the effective yield moments at the i and j ends, respectively. The directions of yield moments are counterclockwise positive and clockwise negative.

The relationship between flow rotation at the ends of a bending element defined as a curtain and yield moment is given in Equation 5.20.

$$\theta_y = \frac{M_y l_c}{3EI} \tag{4.20}$$

4.5 Linear Non Elastic Calculation Methods and Earthquake Calculation

In the evaluation of existing or reinforced buildings the nonlinear calculation methods to be used are push methods and nonlinear method in the time definition field.

4.5.1 Push methods

The pushing methods are the nonlinear incremental counterpart of the single mode implementation of the linear mode assembly method. As in all nonlinear methods, in the initial step of the calculation, nonlinear incremental static analysis is performed under non-earthquake loads. The internal forces and nonlinear deformations obtained as a result of this analysis constitute the initial values of the earthquake calculation**.** Given that building height class is 5 and greater than that, torsional irregularity coefficient is less than 1.4 and the base shear force effective mass of the first vibration mode is calculated according to the linear elastic behavior, push methods can be used in buildings where the ratio of the basement floors surrounded by rigid curtains to building mass other than masses is at least 0.7. If one of these three conditions is not fulfilled, push methods cannot be used.

4.5.1.1 Fixed mode push method

In the fixed mode push method, the earthquake load increments acting on the floors in each push step in the earthquake direction considered are defined as being proportional to the constant mode shape, which is determined in the first step after out-of-earthquake loads and which is not changed at all during the pushing calculation. As a result of the push calculation, the displacement curve is obtained with the coordinates of the peak displacement-base cutting force. Then, with this coordinate transformation applied to this curve, a modal capacity diagram with modal displacement - modal acceleration is obtained. In the last stage of the account, this diagram is based on the calculation of the modal displacement demand under the defined earthquake effect and the internal force and plastic deformation demands of the carrier system.

In buildings where vertical loads can be important in second-order effects caused by deformed load-bearing systems, variable-mode propulsion method should be used.

4.5.1.2 Variable mode push method

In a variable mode thrust method, earthquake load increments and floor displacement increments are defined as proportional to the free vibration mode shape which is recalculated by taking into consideration the plastic hinges formed earlier in each push step after the initial state of out-of-earthquake loads.

In this method, the modal capacity diagram is obtained directly without drawing the push curve as in the fixed mode push method. The remainder of the calculation is the same as in the fixed mode push method.

4.5.1.3 Obtaining the modal displacement request of the earthquake

Obtaining the modal displacement demand of the earthquake corresponds to the calculation of the largest displacement of the modal single degree of freedom system expressed by the modal capacity diagram under the given earthquake effect.

The modal displacement demand of the earthquake can be obtained from non-linear spectral displacement in the modal single degree of freedom system or from the calculation of the modal single degree of freedom system in the time domain under the effect of earthquake.

4.5.2 Non-linear calculation method in the time domain and earthquake calculation

The nonlinear calculation in the time domain corresponds to the step-by-step direct integration with the time increments of the differential equation set, which express the equations of motion of the carrier system under the effect of earthquake ground motion. In this process, the continuous change of the system stiffness matrix due to non-linear behavior is taken into account in the calculations.

4.5.2.1 Selection and scaling of earthquake records

At least 11 earthquake ground motion sets should be used in non-linear accounts in the time domain. The acceleration records in two directions perpendicular to each other shall be affected simultaneously with the principal axes of. Then the process will be repeated by rotating the acceleration records ninety degrees.

The choice of earthquake records to be used for earthquake calculation in the time domain of building carrier systems should be done by considering earthquake magnitudes in accordance with earthquakes ground motion level, fault distances, welding mechanisms and local soil conditions. In the area of the building, if there are past earthquake records that are compatible with the design earthquake level motion, these records will be used. Earthquake hazard decomposition process can be used to determine the magnitude and fault line distance of the earthquakes that contribute the most to the site specific earthquake hazard.

In cases where a sufficient number or quality of earthquake recording cannot be selected, simulated ground motion records can be used in the time domain. If such records are used, the seismic source, wave propagation and local soil characteristics of the site where the building is located will be considered. The model parameters to be used for the simulation will be confirmed by the actual earthquake records recorded in the past earthquakes and in the region in question.

The number of earthquake records to be selected for one or two dimensional calculation and the number of sets of earthquake records to be selected for the three-dimensional calculation shall be at least eleven.

According to the rule that the amplitudes of the average spectra of all the recordings selected for one or two-dimensional calculus between the periods of 0.2Tp and 1.5Tp, the prevailing natural vibration period of the building is according to Tp, are not smaller than the amplitudes of the design spectrum in the same period range, the amplitudes of earthquake ground motions should be scaled.

For the three-dimensional calculation, the resultant horizontal spectrum will be obtained by taking the square root of the sum of the squares of the spectra of the two horizontal components of each earthquake record set. The average of the resultant spectra of all selected records according to the prevailing natural vibration period Tp of the building (amplitudes between the periods 0.2Tp and 1.5Tp), the amplitudes of the earthquake ground motion components should be scaled according to the rule that the ratio of the design spectrum to the amplitudes of the same period is not less than 1.3. This period range may vary for insulated buildings. Scaling of both horizontal components should be done with the same scale coefficients.

In scaling of earthquake records or record sets to be used in free-floor analysis, the upper limit of the prevailing natural vibration period shall be taken as 2Tp.

In case of the required earthquake data and the requirements of the building characteristics and the site specific earthquake ground motion spectrum, using the conditioned average spectra associated with a certain number of vibration periods of the building, results of earthquake records analysis can be scaled by selecting a less scattering way.

4.5.2.2 Deformations based on evaluation and internal force demands

Requests to change the form based on evaluation of the elements with ductile behavior and internal force demands based on evaluation of the elements with non-ductile behavior shall be calculated as the average of the biggest absolute values of the results obtained from each of the analyzes.

4.6 Cross-Section Limits of Reinforced Concrete Elements

In this section, according to DBYBHY 2008, with the purpose of comparing the calculated concrete and reinforcement steel with the unit deformation demands, there has been no change given unit deformation capacities at limit values.

However, in the volumetric calculation of transverse reinforcement arranged as special seismic hoops and kits in the section used in the calculation of the unit deformation limits, while hooks with 90 degrees of hoops are not considered in DBYBHY 2007, 30% of these hoops can be included in the calculation in the 2018 Turkey Building Earthquake Regulation.

If the $\frac{V_e}{b_w d f_{ctm}} < 0.65$ condition for the design shear force ratio of the reinforced concrete section having the deformation calculation is valid, the upper limit of deformation which is the same as the values in the DBYBHY 2007 applies. If the cutting force ratio is greater than 1.30, the upper limit of deformation will be reduced by multiplying by 0.5. As for intermediate values, interpolation shall be applied.

4.7 Determination of Earthquake Performance of Existing Buildings

Earthquake levels to be determined in determining earthquake performance of existing or strengthened buildings and minimum performance targets for buildings at these earthquake levels are given in Table4.6.

In order to determine the earthquake performance of the existing buildings, five different damage cases were taken as the basis. From these 5 different cases of damage, use performance level, life safety performance level, level of immigration prevention performance and migration status damage levels are the levels of damage defined by DBYBHY in 2007 and no change has been made in terms of the rules to be applied for these damage levels. However, apart from these four performances, the level of continuous use performance is also defined.

4.7.1 Uninterrupted performance level of existing buildings

All of the carrier elements are in the minimum damage zone. Provided that strengthened elements are strengthened if they are present, it is assumed that the buildings in this situation are at the level of continuous use performance.

CHAPTER 5

CASE STUDIES

5.1 Introduction

In this section, we analyzed an existing concrete building which has been previously evaluated linearly according to the 2007 Earthquake Regulation and which is described below is going to be solved separately according to the 2007 and 2018 earthquake regulations with the method of linear non-elastic calculation in the time domain. The results of the nonlinear dynamic analysis obtained for both regulations are compared according to the 2007 earthquake regulation by using the renewed earthquake regulation by comparing with the linearly solved analysis results on the different displacement levels. The current building is specified in the 2007 and 2018 earthquake regulations. It does not meet the requirements to use push analysis. The torsion effect in the existing building and the low rate of mass participation of the first mode cause it not to meet the necessary conditions. Therefore, the building is only solved by the nonlinear method in the time domain. For his analysis we used Sap2000 v20.2 that is the common program used in the analysis of the structure. The general view of the building is seen in Figure 3.1

5.2 General information about the building

This present building is located in Gaziantep and it is a reinforced concrete structure that is using as an residence building.

The building is a nine-story building consisting of a basement floor and eight normal floors. Structure of the structure of the system, cast concrete curtain frame system is formed. Floor heights in the building are 4.5 meters on the basement; ground, first and second normal floors 3.5 meters; between the third and eighth normal floors 3 meter. The flooring of the building was used as a floor slab in the basement and in the other floors, gear and slab systems were used together. The thickness of all slabs is 20 centimeters. The thickness of all curtains throughout of the structure is 20 centimeters.

5.2.1 Building Information

Table 5:1

Residence and office		
Storey number	Total Height: HN	Total area
9	27.5 m	712.96 m2

5.2.2 Material Information

Existing Strength of Concrete (C25): fcm = 25 MPa

Existing Strength of Reinforcement Steel (S420): fcm = 420 MPa

Modulus of Elasticity for concrete: Ec = 26150 MPa

Modulus of Elasticity for concrete: Es= 200000 MPa

Concrete density: 25 kN/m3

5.2.3 Project Information

Seisme zone	A_0	Soil class	T_a	T_b	n	R_a	I
3	0.20	Z2	0.15	0.40	0.30	1	1

A_0: Effective Ground Acceleration Coefficient

I: Building Importance Factor

T_a and T_b: Spectrum Characteristic Periods

n: Live Load Participation Factor

R_a: Seismic Load Reduction Factor

5.2.4 Modeling the structure in 3D

The creation of this 3D, is to determine the internal force and the displacement of the structure under the charge of the gravity and seism. We used Sap2000 that is a program to analysis with this existing building. The existing strengths of the have been taken in the consideration In this work, we assign in the structure the membrane such slab, beams, columns. On the beams, we applied the Wall load, on the slab we applied the live and the dead loads. By considering slabs as rigid diaphragms, the rigid diaphragms are defined and assigned for any other floor level of existing building. As load participation live factor is n = 0.30

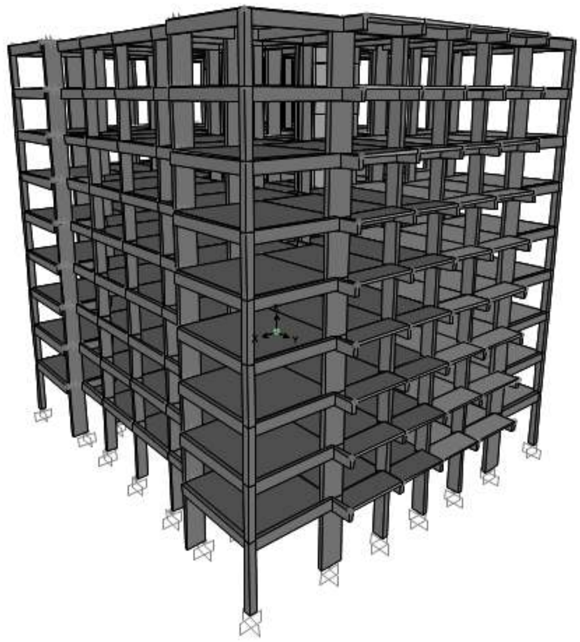

Figure 5.1 *Presentation of the building in 3D with SAP200*

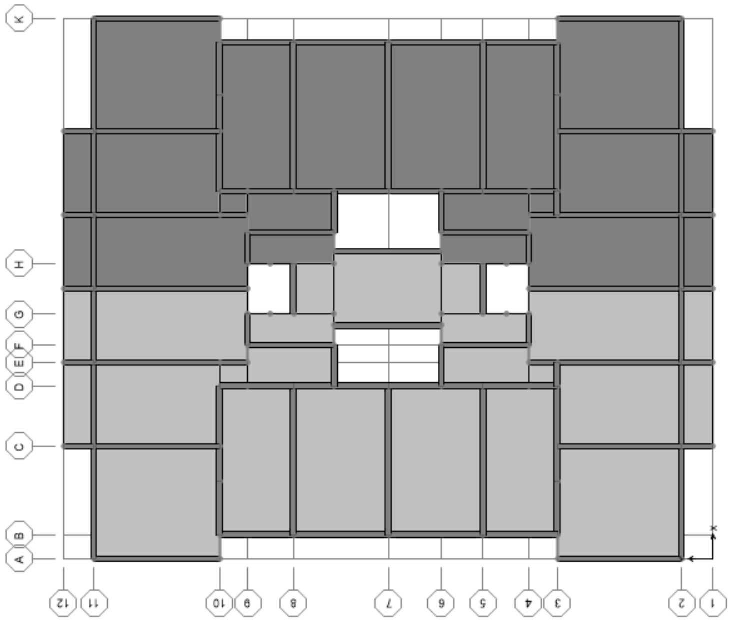

Figure 5.2 *Presentation of the building in 2D with SAP2000*

5.2.5 Evaluation of the Non-Linear Method for the Current Reinforced Concrete Building According to the 2007 Earthquake Regulation

5.2.5.1 Earthquake parameters, design spectrum and knowledge level

According to DBYBHY 2007, the building is located in the 3rd degree of earthquake zone. The floor class is Z2. The effective ground acceleration coefficient for the 3rd degree of earthquake region is 0.2 g and the design spectrum for the Z3 ground class is shown in Figure 5.3

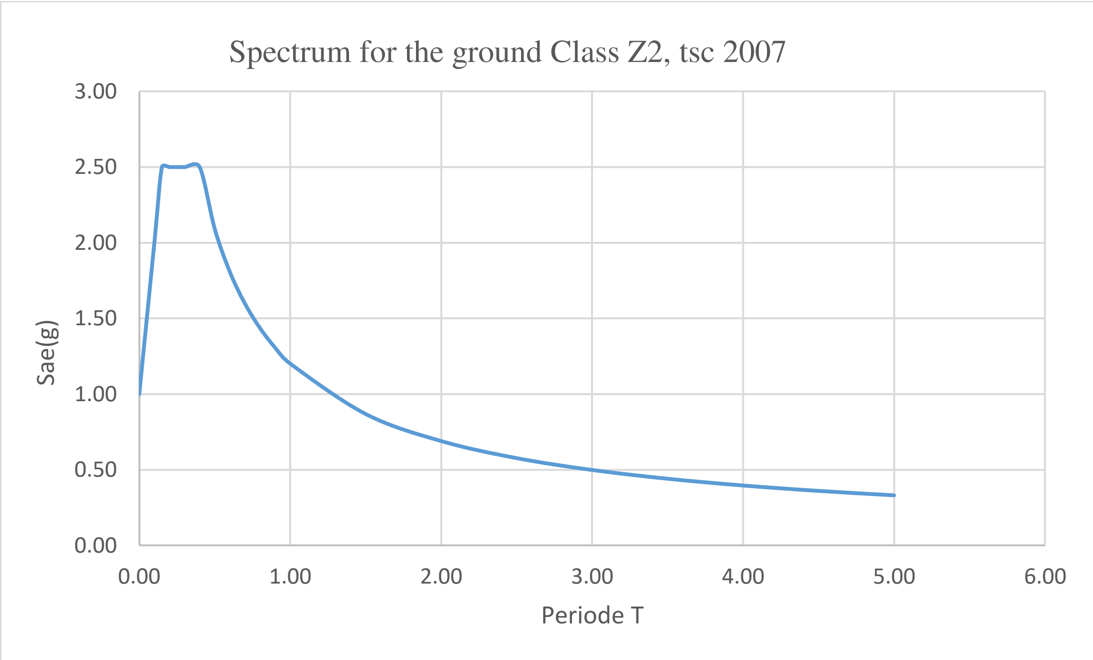

Figure 5.3: *the Spectrum design for Ao= 0.2 g and floor ground Z2.*

5.2.6 Earthquake Records Used And their Scales According To The TSC 2007

According to the 2007 Earthquake Regulation. A total of 7 simulated earthquake records were used in the nonlinear calculation in the time domain. The selection of earthquakes must be made in relation to the position of the location of the present building. In our case, we must seek to take the great earthquakes that have passed around. By the way, the city of Gaziantep is located in the East Anatolian fault area, unfortunately there are not great earthquakes that are noticed in this area. So we took seven earthquakes that are recorded as the largest earthquakes in the past to make the scale. Earthquakes used are shown in Table 5.5. And these rules are :

I. The earthquake records used must comply with the requirements of DBYBHY 2007 2.9.1. These requirements are:

II. The duration of strong motion part of the acceleration shall neither be less than 5 times of the first natural vibration period of the building nor less than 15 seconds.

III. Average of spectral acceleration values of simulated seismic ground motion corresponding to period zero shall not be less than Aog.

IV. Average of spectral acceleration values to be recalculated for each simulated acceleration record with 5 % damping ratio shall not be less than 90 % of elastic spectral accelerations Sae(T) defined in 2.4 for the periods between 0.2T1 and 2T1 according to first period T1 in the direction of earthquakes considered. In the case where nonlinear elastic analysis is performed in the time domain, spectral acceleration values to be based on in order to obtain reduced seismic ground motion shall be calculated by Equation (5.13).

The earthquakes to be used should be scaled according to these previous conditions. The scales can be made in the time domain or in the frequency definition field. When the scaling is in the time definition field, the acceleration of the earthquake is multiplied by a certain coefficient and the acceleration amplitudes are changed so that it is optimized according to the design spectrum.

The earthquake records were scaled by changing the frequency content of the earthquake acceleration records using the Seismomatch program [6]. This process simulates the earthquake spectrum similar to the original acceleration records with spectrarecords were obtained. The spectra of these earthquake-scaling earthquake records were drawn for 5% damping and checked whether they meet the requirements in the regulation.

Table5.1 The earthquake recorded

Recorded	Dates	Local	Mw	Deph	PGA	Time/s
CHI-CHI	20.09.1999	Taiwan	7,7	33 km	0.36	39
FRIULI	06.05.1976	Italy	6,5	10 km	0.32	30
HOLLISTER	09.04.1961	California	5,9	12 km	0.19	39.40
KOBE	17.01.1995	Kakogawa	6.9	17.6 km	0.34	40.09
KOCAELI	17.08.1999	Turkey	7,6	17 km	0.35	37
NORTRIDGE	17.011994	South California	6.7	18.20km	0.57	40
TRINIDAD	24.08.1983	Venezuela	5.8	25 km	0.30	32

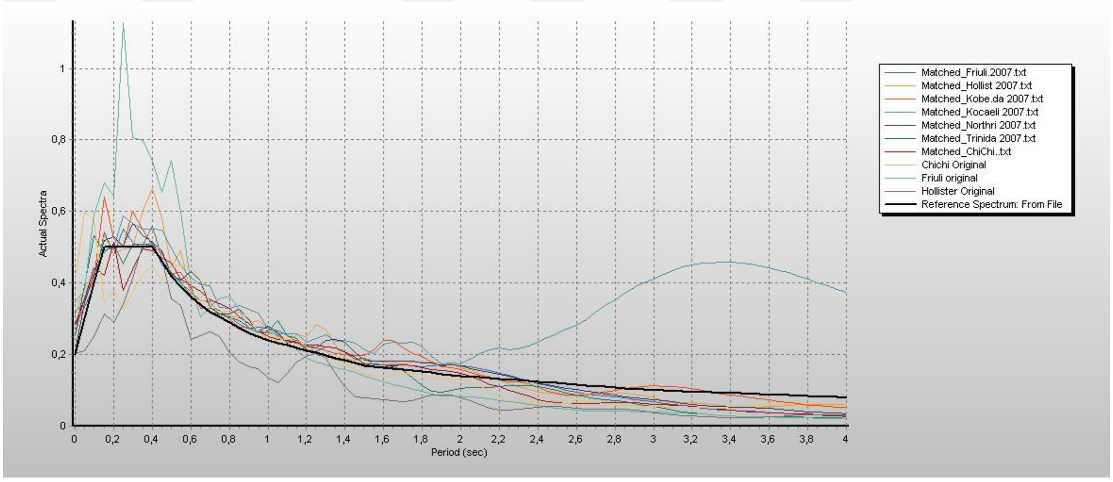

Figure 5.4 *Scales of original records with 2007 earthquake regulation*

5.3 Evaluation of the Non-Linear Method for the Current Reinforced Concrete

5.3.1 Earthquake parameters

In the new earthquake regulation, the spectrum definition and earthquake parameters have undergone radical changes. The definition of the structure specific to the structure has come. The spectrum definition is calculated based on the map spectral coefficients, the number of local ground effect coefficients, and the number of proximity to the fault. The coefficient of the spectral acceleration of the map is obtained as two values, for the 1 second period and for the short period region. The current building is located in Gaziantep city, precisely in Akkent one of the Şahınbey district. The net location of the building in latitude and longitude is 37.00263 ° North parallel to the East longitude of 37.3831 ° the current structure is on DD-2 earthquake ground motion, the coefficient of the spectral magnitude is estimated to be 10% in 50 years and the corresponding repetition period is 475 years. With the new earthquake regulation, the local soil classes have been also changed. The local floor class of the building is ZB floor grade used for very tight sand, gravel and hard clay layers or decomposed much fractured weak rocks according to the 2018 earthquake regulation. It was obtained. The distance of the building from the fault line is 32.175 km. The coefficients of the acceleration spectral, local ground impact coefficients, fault coefficient are obtained from the site http://testtdth.afad.gov.tr. The designation of the concepts based on the building location is shown in Figure 5.3

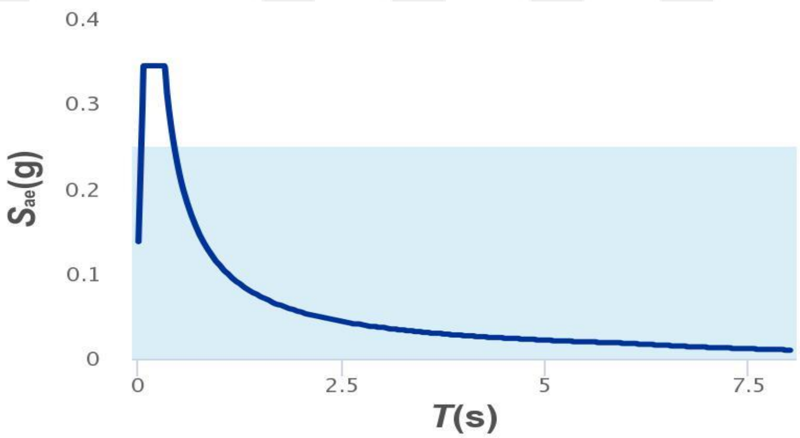

Figure 5.5 *Horizontal Elastic Design Spectrum for the Akkent District*

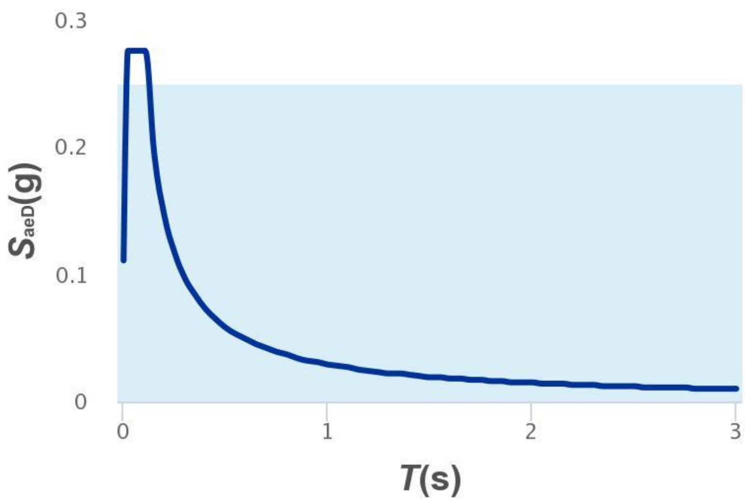

Figure 5.6 *Vertical Elastic Design Spectrum for the Akkent District*

The definition of building elevation in buildings with basement for the 2018 earthquake regulation has been defined. In this definition, the height of the building in the basement buildings that meet the following conditions is the height measured from the upper level of basement curtains.

I. The rigid basement curtains surround the building on all sides or on at least three sides. In the existing building, basement curtains surround the building on only two sides.

II. The ratio of the natural vibration calculated for the entire building including basement floors to the natural vibration period calculated in the same direction with the deletion of all basement masses, including basement floors, in the prevailing vibration mode in the direction of each of the perpendicular building axes, is less than 1.1no. In the current building, the calculated period for the whole building in X direction is 0.721 seconds. In the X direction calculated by removing the basement.

III. Since the existing building cannot provide both conditions, the building height HN, the base upper it was measured from the elevation and the HN value was 32.5 meters. The building is used as a municipal additional service building, in this sense as the building usage Class 3 has been identified. The earthquake design class and the building height class are shown in Table 2.4.in Table 2, dts1 and BYS4 were determined by using Table 2.5 respectively.

The existing building is considered to be intermediate level when evaluated according to DBYBY 2007. In 2018 earthquake regulation, the medium level of information was removed from the regulation. The requirements of the comprehensive level of knowledge were reached in accordance with the 2007 regulation. On this basis, the existing building is considered to be at a comprehensive level of knowledge when evaluated according to the 2017 earthquake regulation. Current material strengths were multiplied by 1.0, which is the number of layers of comprehensive knowledge.

5.4 Earthquake records used according to the 2018 earthquake regulation scaling

The earthquake records used for 2007 earthquake regulation were also used for 2018 earthquake regulation. These earthquake records were scaled based on the acceleration spectrum vertical design of 2018 earthquake regulation with the same method. With the 2018 earthquake regulation, the scaling rule of earthquake records has been also changed. According to the 2018 earthquake regulation, the following rules were followed when the earthquake records were scaled. Belonging to two horizontal components of each earthquake record set selected for the three-dimensional calculation the square root of the sum of the squares It will be the average of the resultant spectra of all selected recordings between 0.2Tp and 1.5Tp periods (Tp = the prevailing natural vibration period of the building) are within the same period of the defined design spectrum.

The amplitudes of the earthquake ground motion components shall be scaled according to the rule that their ratio to amplitude that is not less than 1.3

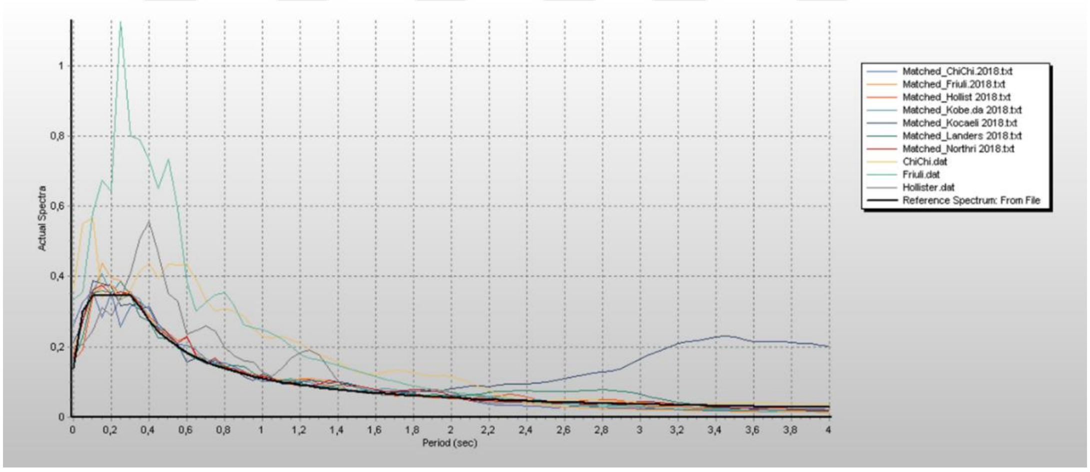

Figure 5.8 *Scales of original records with 2018 earthquake regulation*

5.5 Comparison of the earthquake regulation 2007 and 2018 through the Building According to the 2018 Earthquake Regulation calculations made

The earthquake records used in the calculations were scaled according to the design spectrum. As the earthquake regulations of 2007 and 2017 have two different design spectrum, earthquake acceleration records are scaled according to different spectra. In addition, the rules used to scale up acceleration records, as described in previous sections, have also changed. The following figure shows the comparison of the original, accelerated earthquake accelerations according to the 2007 and 2017 regulations. The original of the earthquake records used is scaled according to the DBYBHY 2007 and scaled according to the 2018 earthquake regulation as it shows in the figures below.:

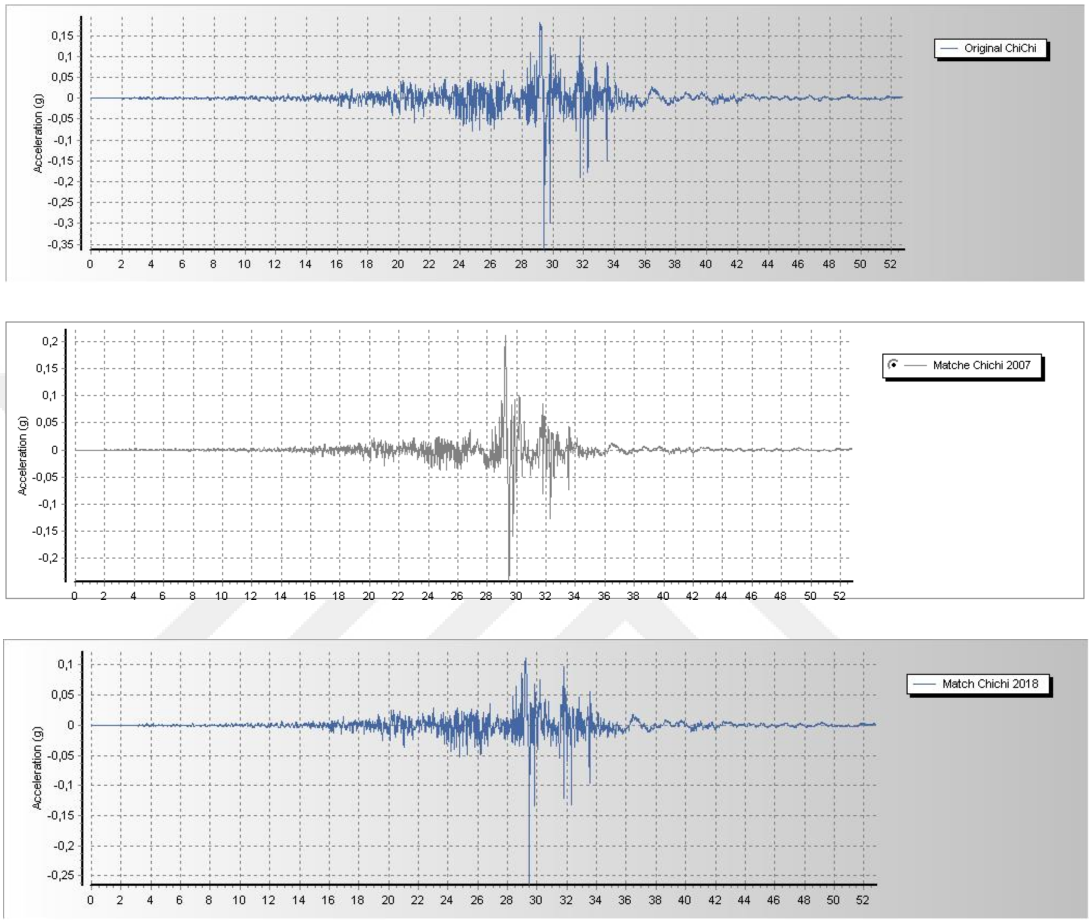

Figure:5.6 *Chichi record*

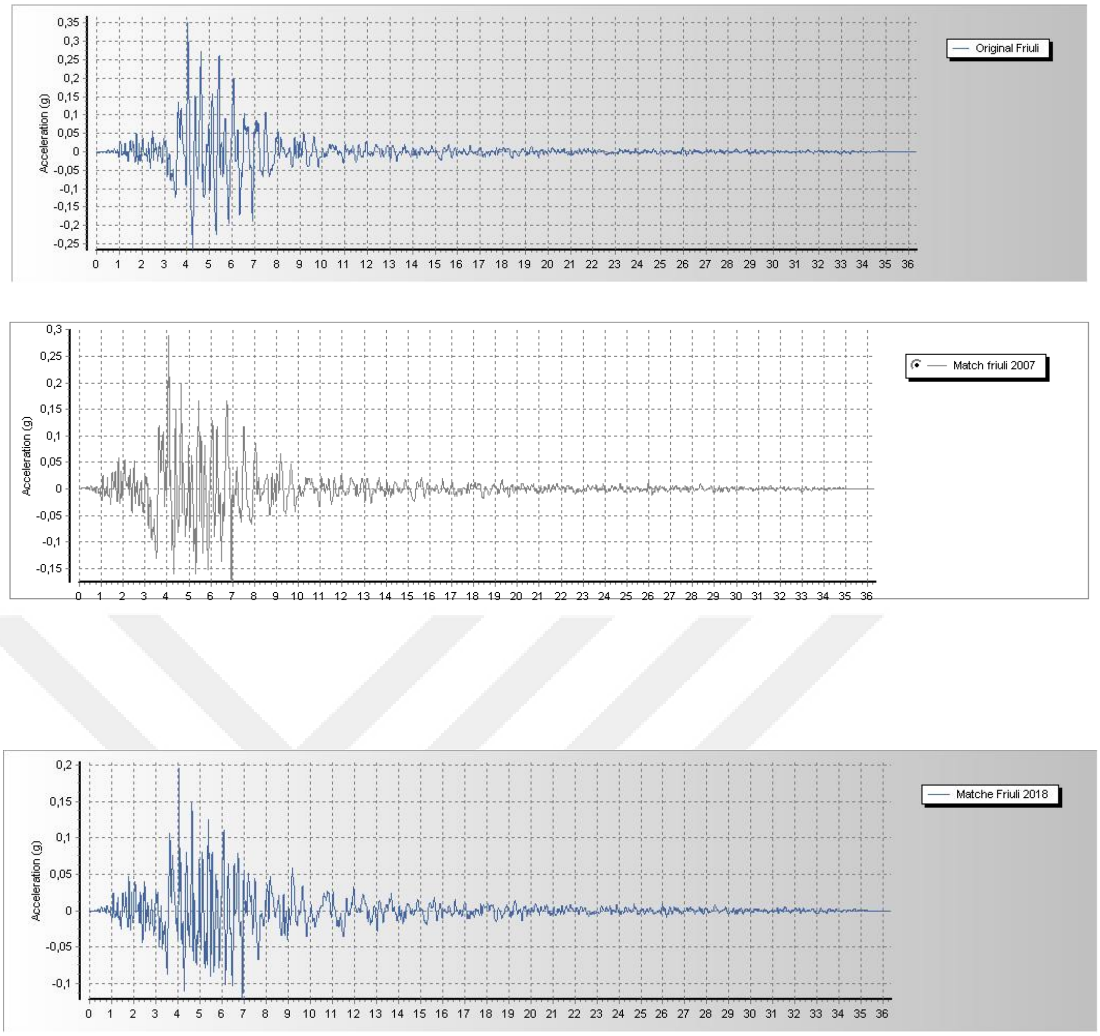

Figure:5.7 *Friuli record*

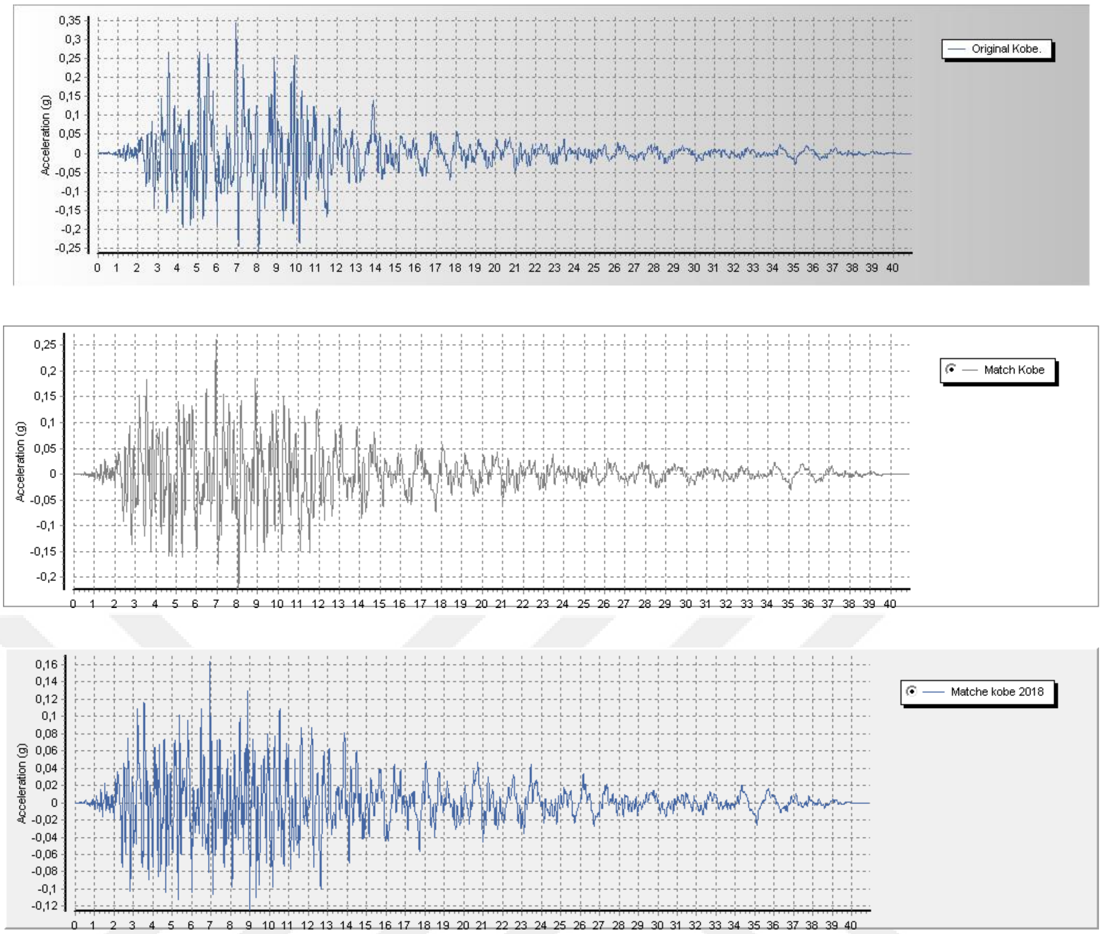

Figure:5.8 *Kobe record*

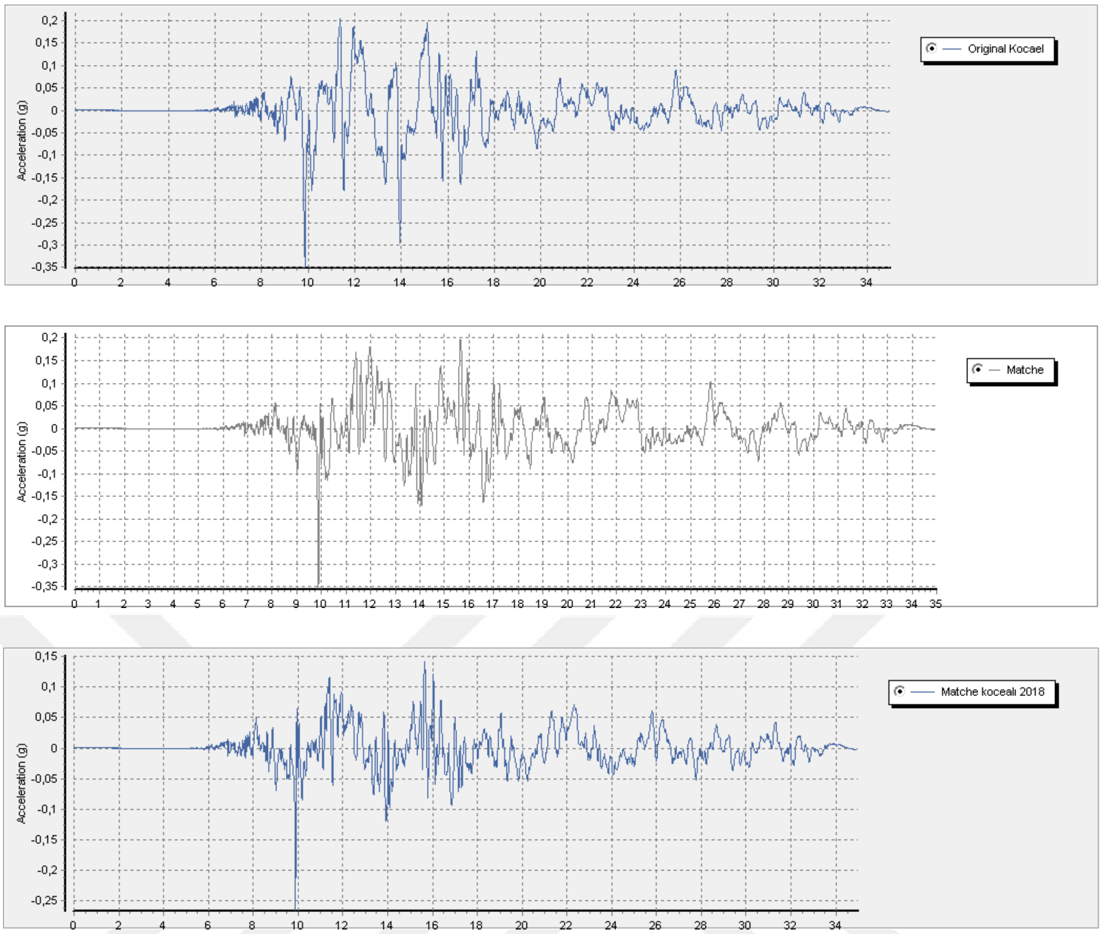

Figure:5.9 *Kocaeli record*

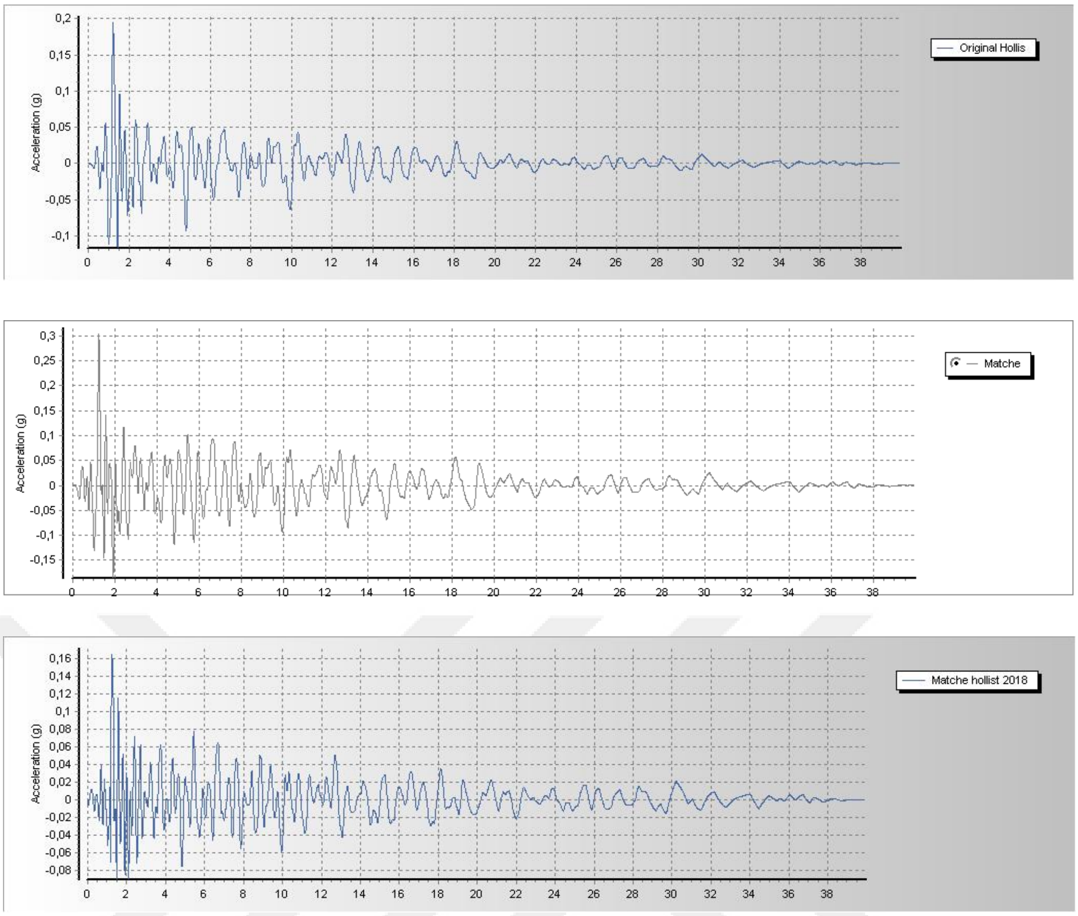

Figure:5.10 *Hollist record*

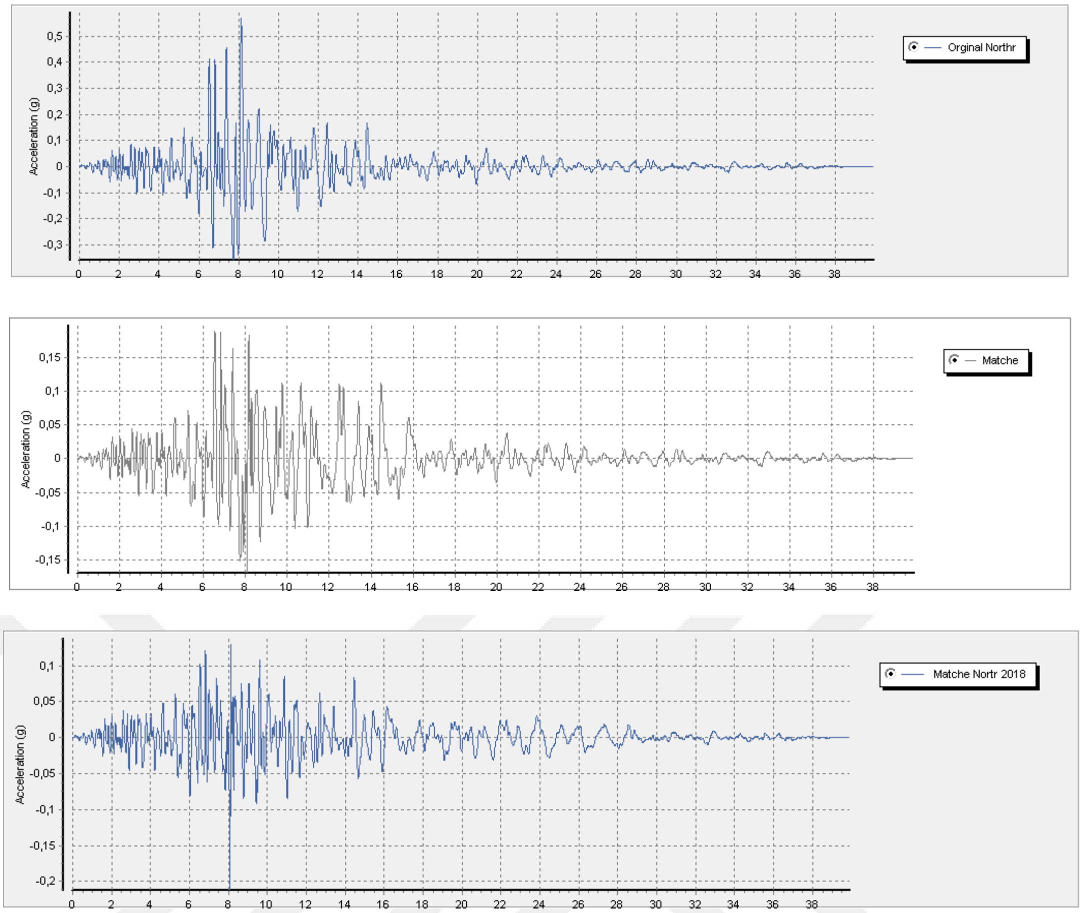

Figure:5.11 *Northridge record*

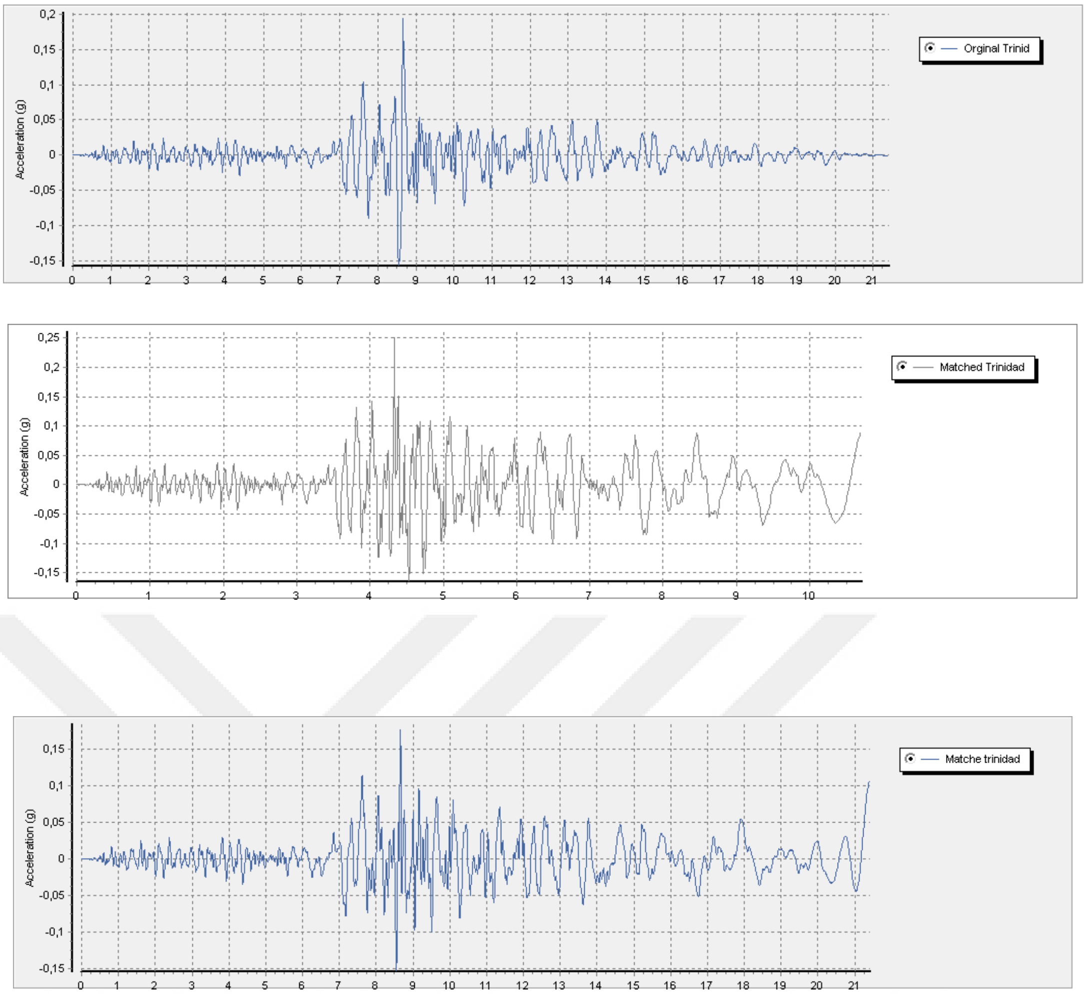

Figure:5.12 *Trinidad earthquake*

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Introduction

The result of the analysis of nine story concrete building structure is given in this chapter. The performance of the structures was evaluated by utilizing the linear dynamic time history analysis. The analysis was carried out by using SAP2000 software. the structures were considered as regular in shape to run the analysis on two dimensional models which easy to explanation of the results of the analysis. For this, a total of fourteen different accelerations were studied with 2007 and 2018 Turkish Earthquake Regulation. The results were obtained in terms of the capacity curve for the maximum base shear force in the X and Y direction.

6.2 Comparison of the displacement of the floor according to the 2007 and 2018 earthquake regulation.

For seven different earthquakes, the displacement made by the floors in the X and Y directions. These displacements were shown separately on charts for the calculations made for the regulation of 2007 and 2018. The results of the analysis for 2007 regulation are shown in figure 3.41, while the results of the analysis for 2017 regulation are shown in Figure 3.42.

Figure 6.1 *Displacement of the floor in (X+) direction, (cm)*

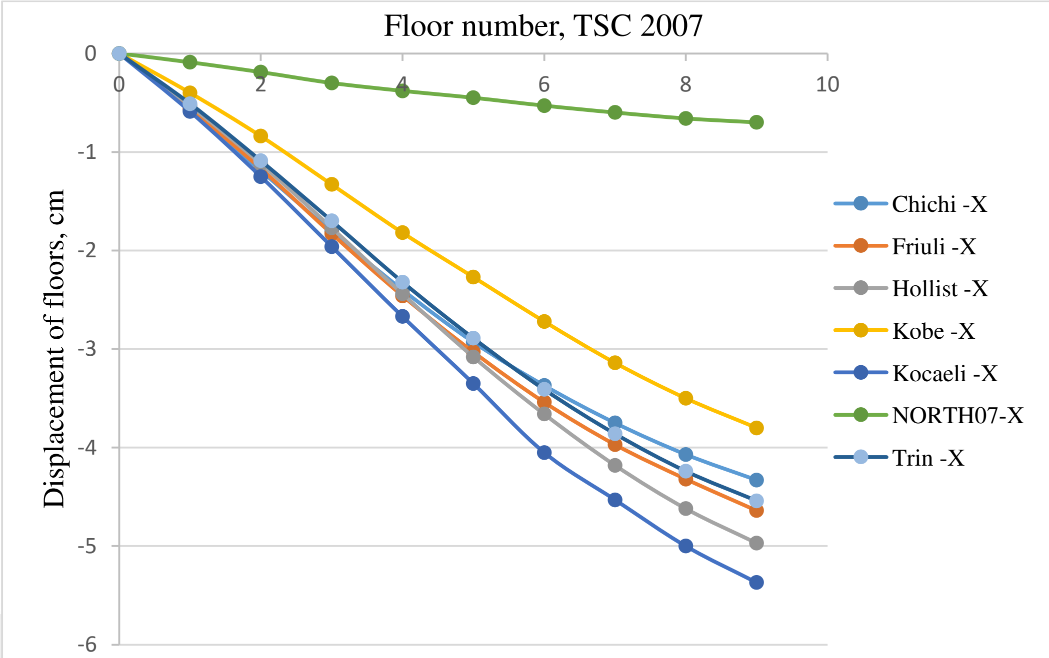

Figure 6.2 *Displacement of floors in the (X-) direction*

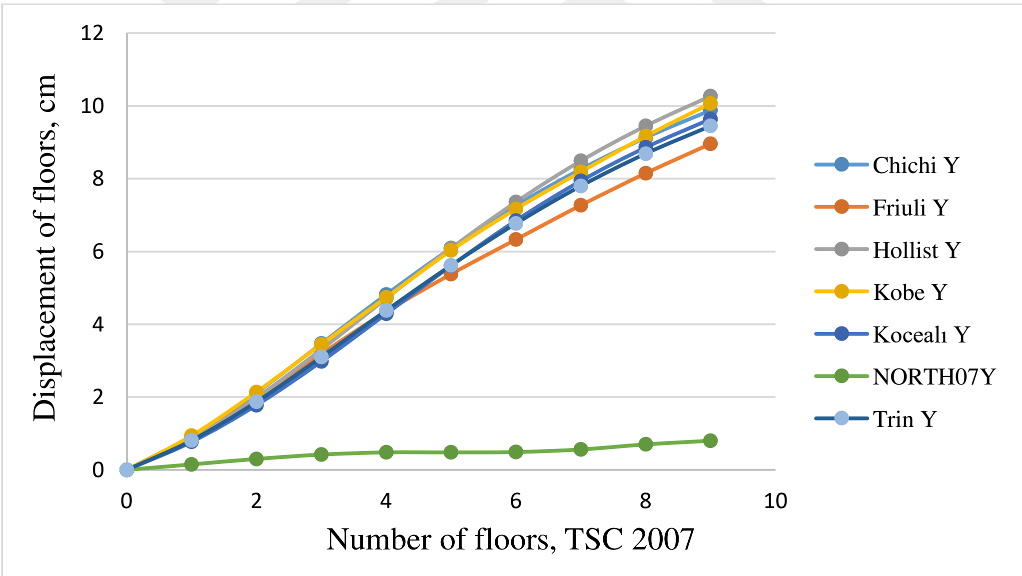

Figure 6.3 *Displacement of the floors in the Y direction*

Figure 6.4. *Displacement of the floor in (Y-) direction*

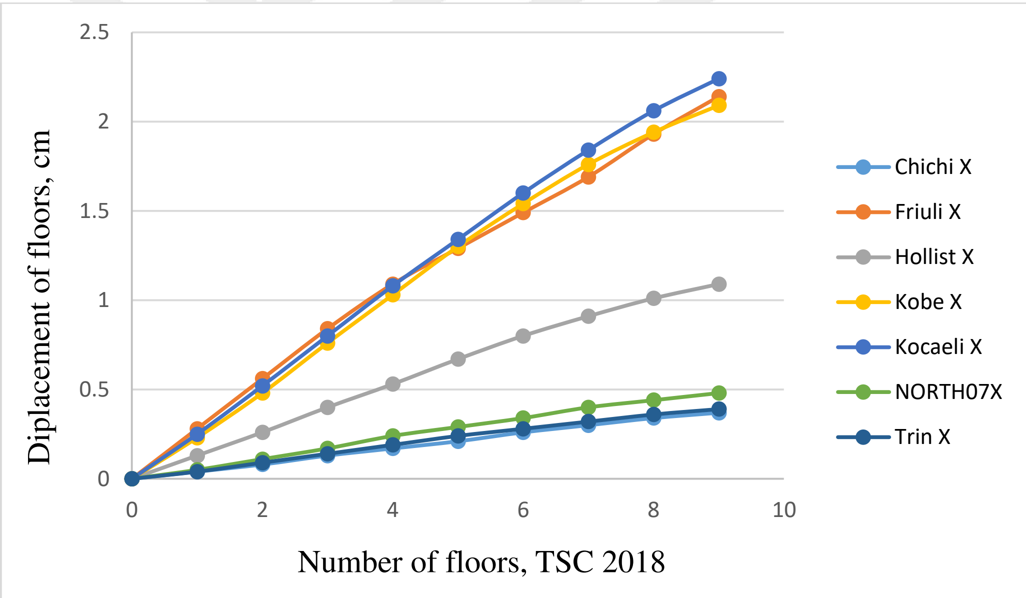

Figure 6.5 *Displacement of the floor in (X+) direction, (cm)*

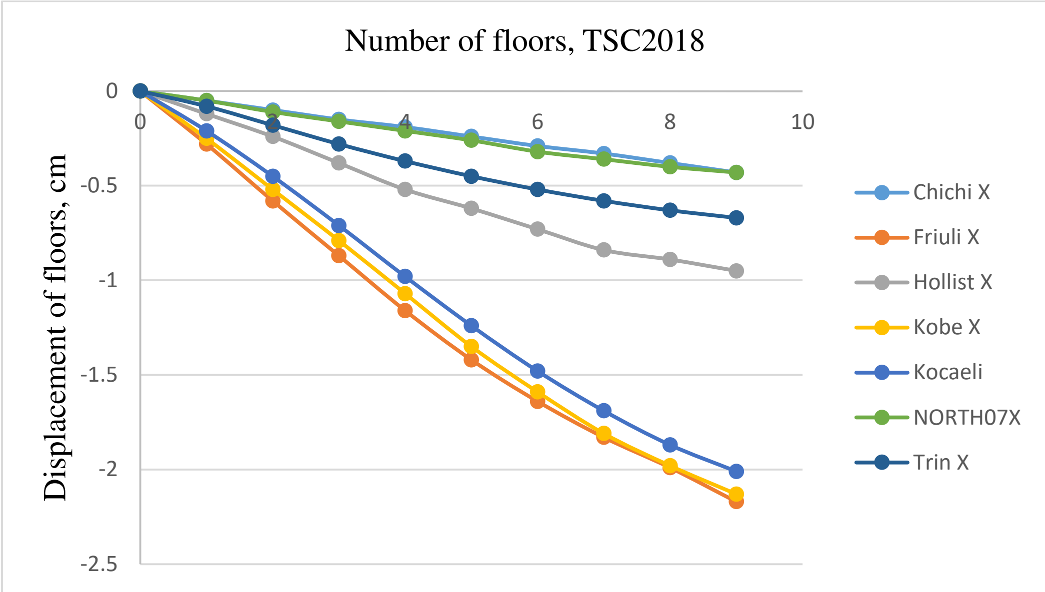

Figure 6.6 *Displacement of floors in the (X-) direction*

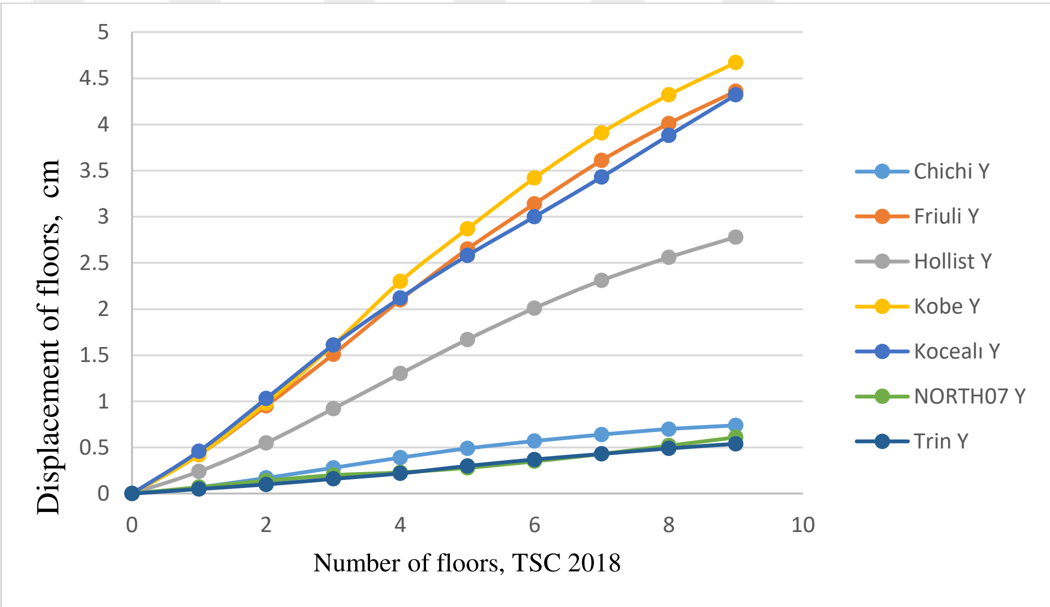

Figure 6.7 *Displacement of the floors in the (Y+) direction*

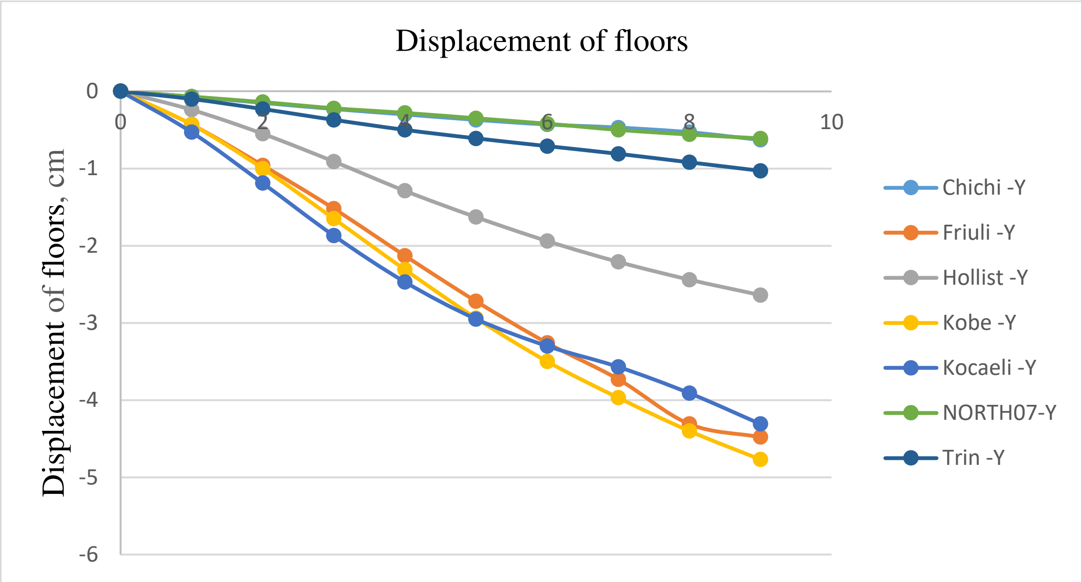

Figure 6.4. *Displacement of the floor in (Y-) direction*

In our case, Kocaeli is the earthquake that in the both of regulations had the largest floor displacements. The analysis according to 2007 regulation and according the results, the maximum value for the building Hill displacement is 5.35 cm in X direction and 10.27 cm in Y direction. The same values are 2.24 cm and 4.36 cm respectively in the calculation made according with the 2018 regulation. Looking at the average of the results obtained for seven earthquake recording, the analysis conducted in accordance with the 2007 regulation shows that there is a demand for positive direction 3.22 cm and negative direction 3.1 cm for the hill displacement. In the analysis conducted in accordance with the 2018 regulation, the average peak displacement is 1.30 cm in positive direction and 1.18 m in negative direction. The distribution of the relative distortions obtained as a result of calculations made in both regulations are shown in figure 5.15 and figure 5.16.

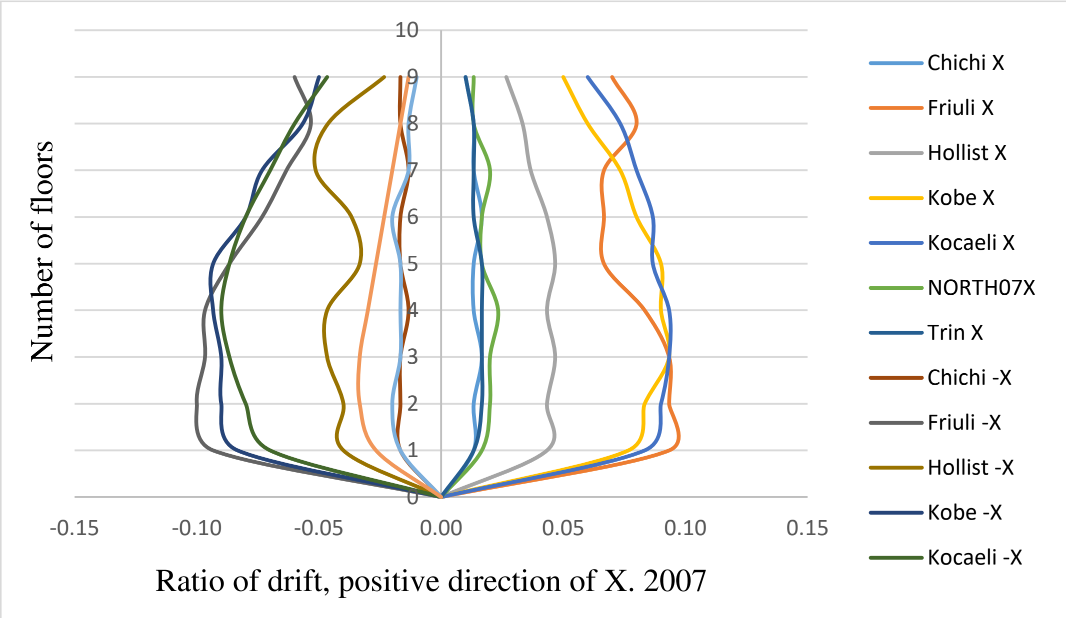

Figure 6.5. The effective relative storey drift according to 2007 regulation

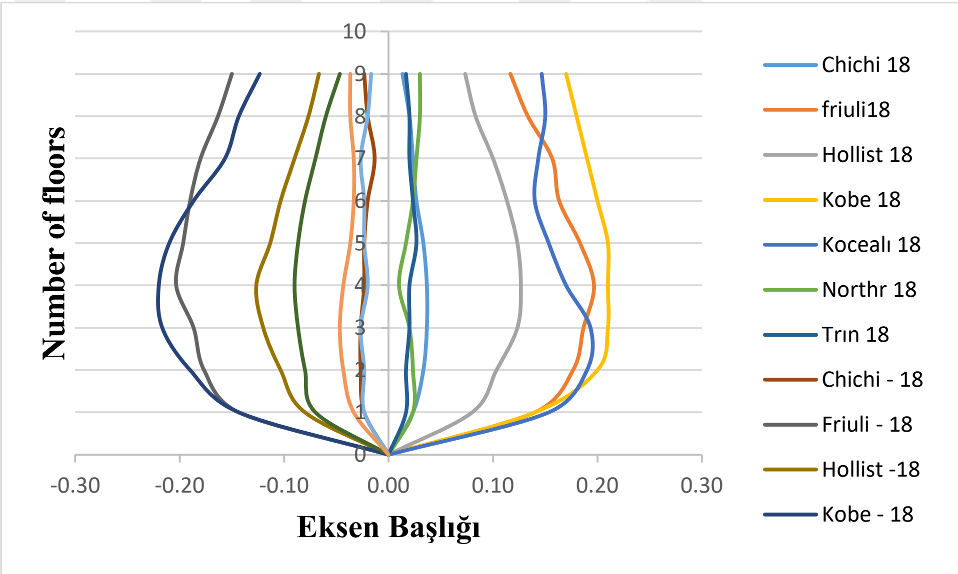

***Figure 6.6** The effective relative storey drift according to 2018 regulation*

6.3 Comparison of the Shear force between 2007 and 2018 regulations

Base shear is an estimation of the greatest possible lateral force that will occure as a result to seismic motion at the bottom of a structure. Seismic forces are always growing downward in a building. Seismic forces are always higher at the base of the building compared with other levels. therefore, we can say the seismic force at the base of the building is named the base shear . In a multi-storey building, all shake forms of the building contribute to the base shear.

After the analysis made according to the 2007 and 2018 earthquake regulations for the seven different earthquakes, the building floor shear forces were obtained in X and Y directions. These results are shown in the following figures for the four different directions as a comparison of the calculation made according to the 2007 and 2018 regulations for each earthquake. Figure 6.7, 6.8, 6.9, 6.10, the comparison of the cutting forces are given.

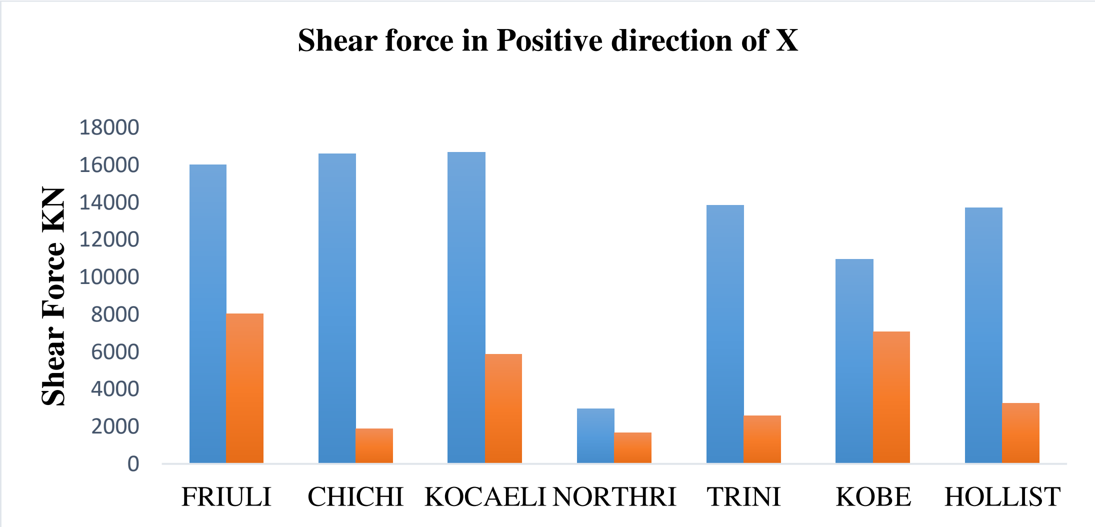

Figure 6.7 *Shear Force in the positive direction of X*

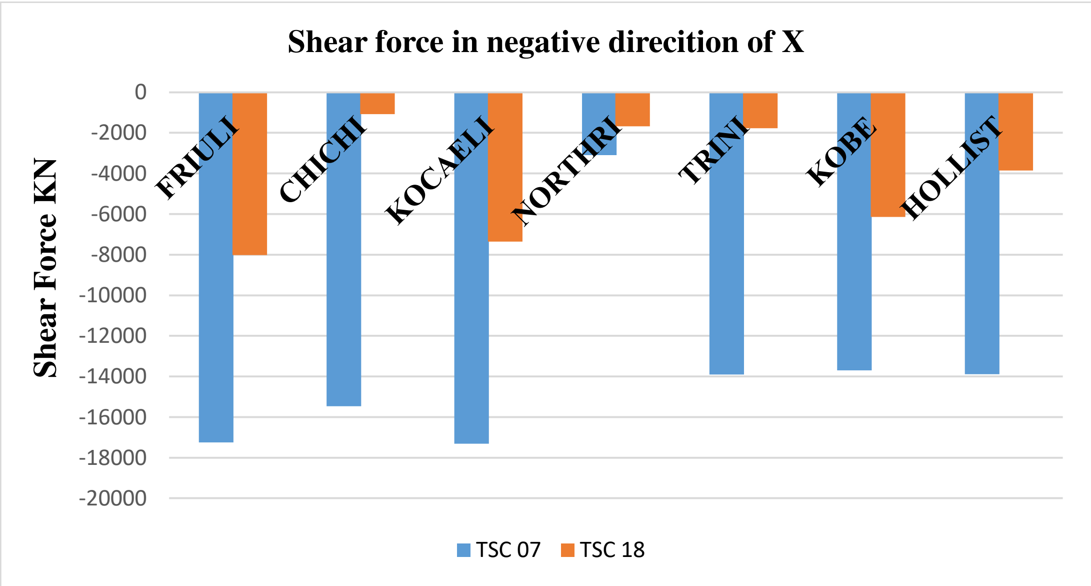

Figure 6.8 *Shear Force in the negative direction of X*

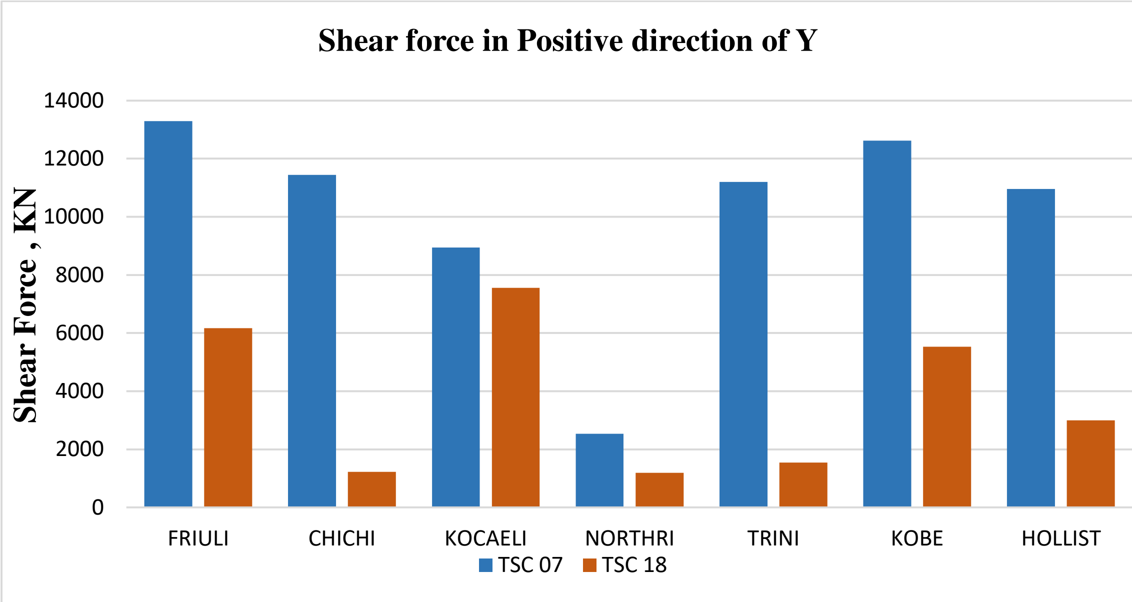

Figure 6.9 *Shear Force in the positive direction of Y*

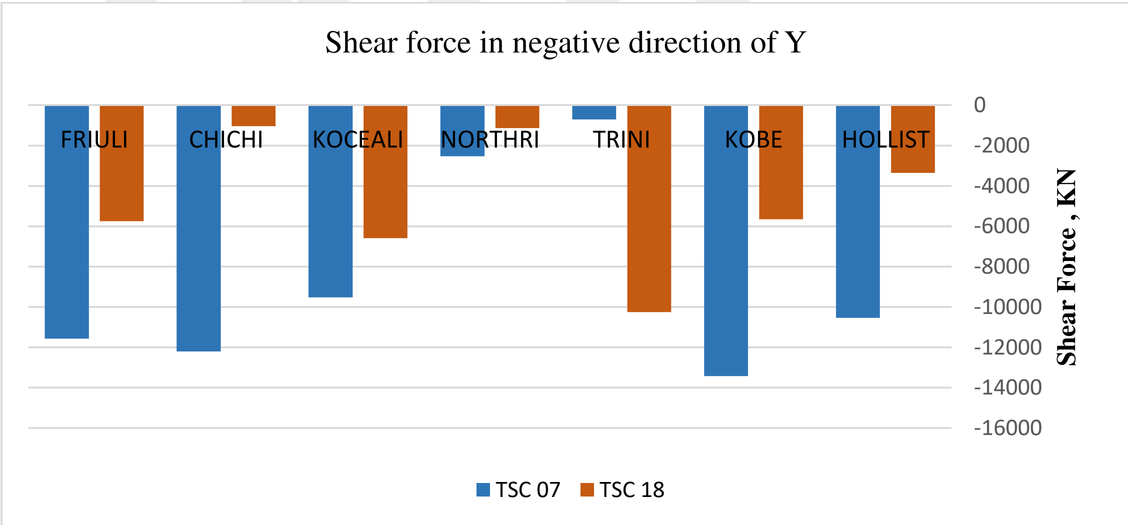

Figure 6.10 *Shear Force in the negative direction of Y*

The design spectrum of 2007 regulation has larger spectral acceleration values, the results of the analysis made according to this 2007 regulation shows that the result of the analysis is seen to be large. According to the results of the building shear force 2018, the analysis gave a maximum of the shear force less than the 2017 regulation. The maximum shear force value obtained in the analysis is 1676,63 kN, whereas this value is 7083,63 kN in the 2007regulation.

6.4 Overturning Moment

After the analysis made according to the 2007 and 2018 earthquake regulations for the seven different earthquakes, the building overturning moment were obtained in X and Y directions. These results are shown in the following figures for the four different directions as a comparison of the calculation made according to the 2007 and 2018 regulations for each earthquake. Figure 6.11, 6.12, 6.13, 6.14, the comparison of the cutting forces are given.

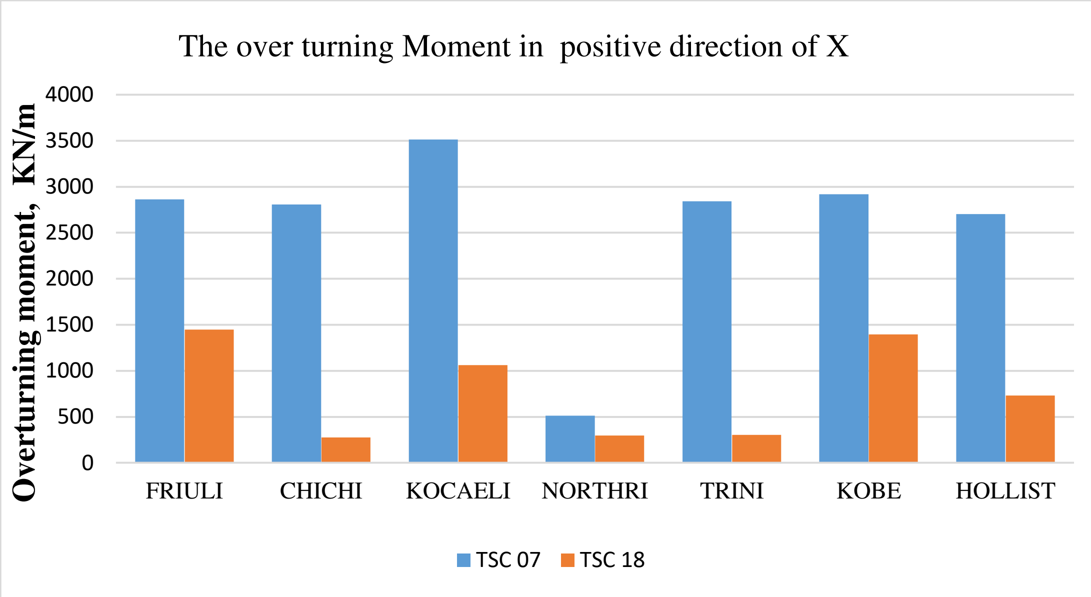

Figure 6.11 *The over turning Moment in positive direction of X*

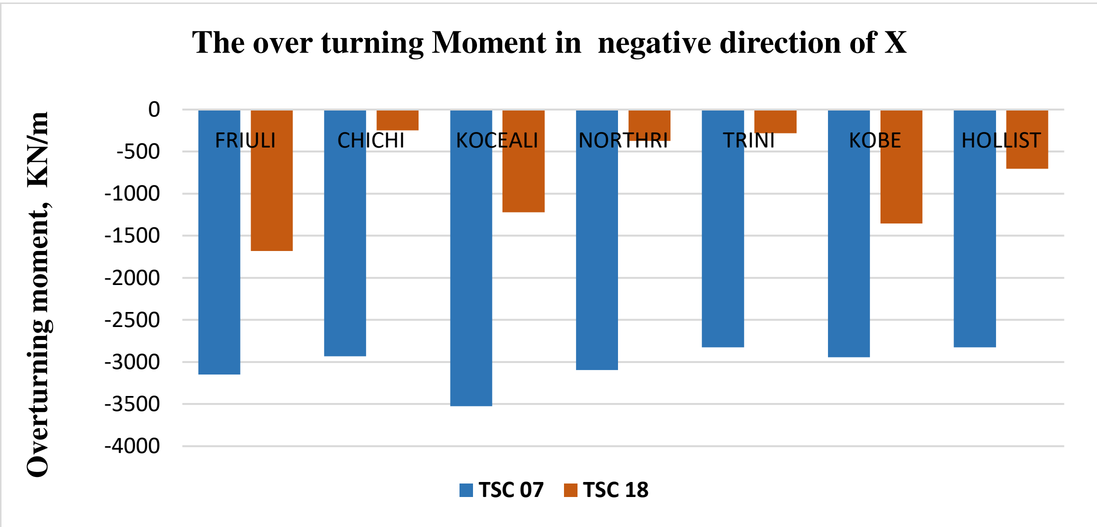

Figure 6.12 *The over turning moment in negative direction of X*

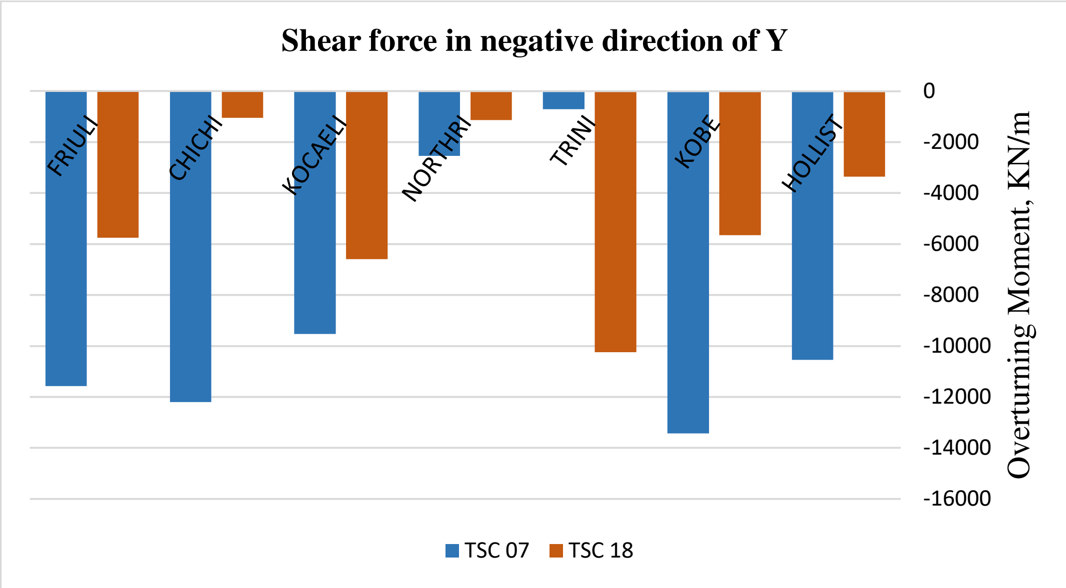

Figure 6.13 *The over turning moment in the positive direction of Y*

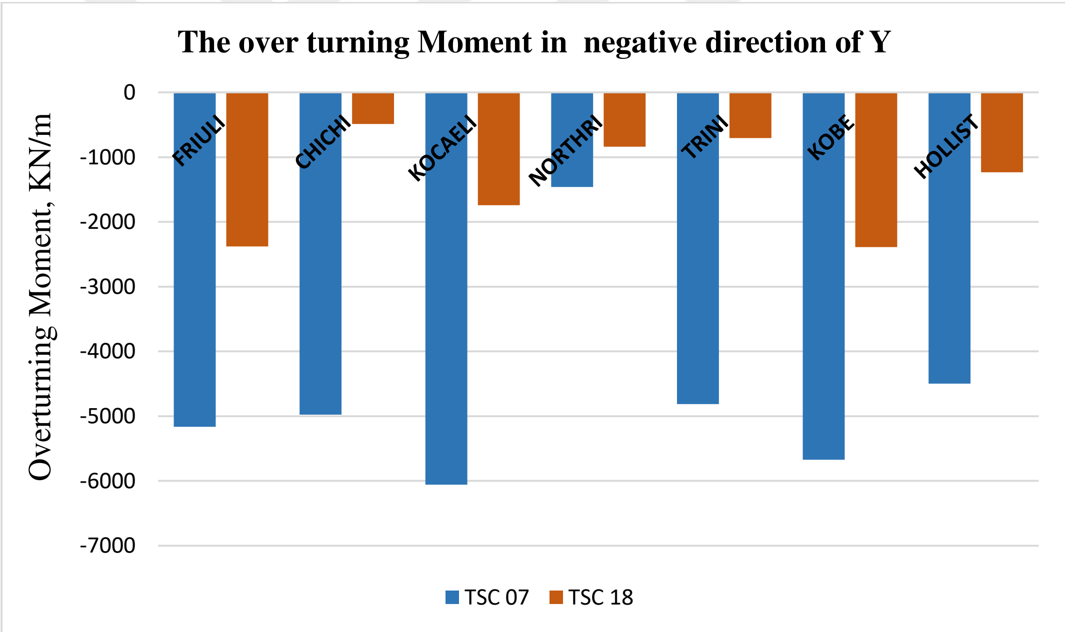

Figure 6.14 *The overturning moment in negative direction of Y*

CHAPTER 7

CONCLUSIONS

This study achieved the modelling, analysis and design of time history analysis in a concrete building. In time history analysis, seven earthquakes accelerations have been used and applied on the nine story frame by using the Turkish Standart Regulation of the building 2007, 2018 via SAP 2000 v20.2 program. In order to compare the seismic performance of the buildings, all results obtained from the program have been exported to Microsoft Excel 2016 to draw all the graphics required for the study.

The structural performances of all these buildings have been studied with reference to displacement, base shear, overtuning moment and the ratio of the drift of the building. From the results gained from this study, it can be recognised that the application of the brace system can increase the base shear due to the increase in side stiffness.

- It was pointed out that time history analysis had a useful tool of performance based seismic design of a structure, it could be used to assess the performance of different types of structures by controlling their displacements (at local and global levels) and it gives a useful data about the behavior of structure under seismic action until the structural collapse.

- Our results show that the analysis conducted using the TSC 2007 with the different earthquake ground motion taken from peer Nga, displays greater values than the analysis using the TSC 2018.

- The reason for this contrast can be explained because the geographical selection in the TSC 2018 is more specific and restricted than the one in the TSC 2007. Since the spectrum acceleration according to both of the earthquake code 2007 and 2018 diverges, it leads to inconclusive results.

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