THE EFFECTS OF TURKISH DISASTER REGULATIONS ON ARCHITECTURAL DESIGN

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ABSTRACT

THE EFFECTS OF TURKISH DISASTER REGULATIONS ON ARCHITECTURAL DESIGN

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The aim of this study is to examine the role of 'Turkish Disaster Regulations' on architectural design. Although the preliminary aim of Turkish disaster regulations is to provide knowledge for designers and builders to control structural and constructional system of buildings that can resist disasters in the pre-disaster period, these regulations can create some restrictions for architects in their design process. Following an analytical examinations of Turkish disaster regulations that have been developed continuously after different disaster experiences for years from an architectural view, the focus will be given to the 2007 disaster regulation called 'Specification for Buildings to be Built in Earthquake Areas' in order to evaluate critically the limitations of those regulations for architects in their design process. Furthermore, seven types of irregular buildings that are mentioned in 2007 disaster regulation will be examined and discussed in detail.

Keywords: disaster regulations, architectural design, irregular buildings.

ÖZ

TÜRK AFET YÖNETMELİKLERİNİN MİMARİ TASARIMA ETKİLERİ

Özyıldıran, Güler
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Bu çalışmanın amacı Türk afet yönetmeliklerinin mimari tasarıma etkilerini incelemektir. Türk afet yönetmeliklerinin birinci hedefi afet öncesi dönemde tasarımcılara ve uygulayıcılara afetlere dayanıklı bina sistemi ve inşasını kontrol edecek bilgi üretmektir. Ancak bu konuda hazırlanan yönetmelikler mimari tasarım sürecinde bazı kısıtlamalar getirmektedir. Bu çalışmada, geçmişteki farklı afet deneyimlerinden sonra gelişen Türkiye'deki afet yönetmeliklerinin analizleri yapılmakta, daha sonra 2007 yılında 'Deprem Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik' adıyla yayınlanan son afet yönetmeliğine odaklanılmaktadır. Bu yönetmeliklerin tasarım sürecinde mimarlara getirdiği kısıtlamalar sunulup değerlendirildikten sonra da 2007 afet yönetmeliğinde geçen yedi düzensiz bina tipi detaylı olarak incelenmektedir.

Anahtar Kelimeler: afet yönetmelikleri, mimari tasarım, düzensiz binalar.

To My Family

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INTRODUCTION

1.1 Statement of the Problem

The aim of this study is to examine the effects of Turkish disaster regulations on architectural design. The ultimate goal is to analyse the architectural restrictions of the 2007 disaster regulation called "Specification for Buildings to be Built in Earthquake Areas" (*Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik*). This is the current disaster regulation of Turkey. Past disaster regulations and experiences from the past major disasters were the basis of 2007 disaster regulation. In order to understand this disaster regulation accurately, this thesis also covers the relationship between the past disaster regulations and the past major disasters.

Natural events, such as earthquakes and floods, are likely turn into a disaster by the collapse of man-made environment. It was seen many times that these natural events resulted in catastrophes in Turkey. The rates of natural disasters that cause building damages and collapses in Turkey are %61 earthquakes, %15 landslides, %14 floods, %5 rock falls, %4 fires, and %1 other natural disasters.[1] As can be seen in Figure 1.1, earthquakes have dominated Turkey's history of disasters.

[1] T.C. Başbakanlık Doğal Afetler Koordinasyon Baş müşavirliği. "Doğal Afetler Genel Raporu". May 1997, p.5, http://www.bayindirlik.gov.tr/turkce/dosya/Basbak_DAfetRap4.pdf, Last accessed: 16th Oct2006.

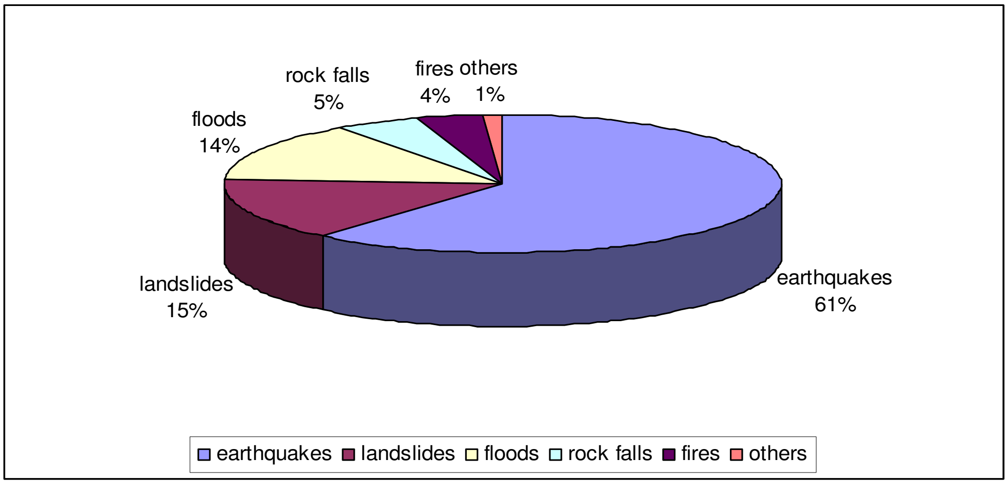

Figure 1. 1 Rates of natural disaters that cause building damages and collapses in Turkey.
Source: Doğal Afetler Genel Raporu, p.6.

The fact that Turkey is on one of the most active earthquake zones in the world, Alp-Himalayan fault line, is the reason for the many earthquakes in Turkey. Turkey has three significant faults; North Anatolian Fault (NAF), South Anatolian Fault (SAF) and Western Anatolian Fault. Stresses on Anatolian lands are discharged by the broken land on faults and by the rise of eastern Anatolia, having a mountainous morphology on the east where NAF and SAF intersect.[2] An official Earthquake Zoning Map of Turkey was prepared by the Ministry of Public Works and Settlement considering the latest knowledge. (see Figure 1.2) It was approved by the government and published in 1996. According to this map, 66 percent of the surface area of Turkey lies on Zones 1 and 2 levels of seismic hazard, and 71 percent of the population are living in these risk prone areas.[3] Hence, earthquake is a significant factor in Turkey that should be considered during building design.

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[2] Erman, Ercüment. Deprem Bilgisi ve Deprem Güvenli Mimari Tasarım. Ankara: ODTÜ Mimarlık Fakültesi Ara-Yayın Serisi, 2002, p.1.

[3] Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, p.25, http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16th Oct2006.

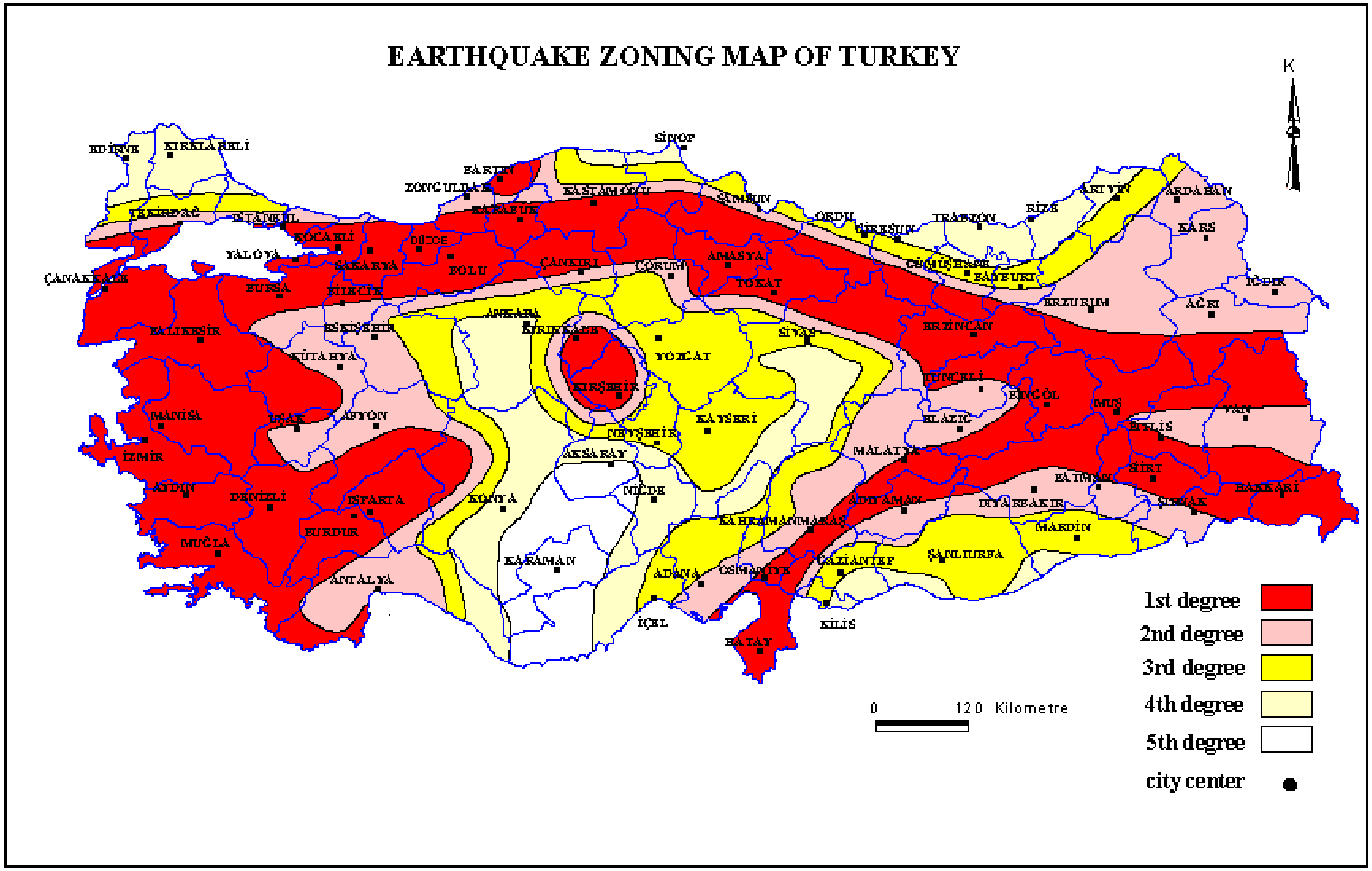

Figure 1. 2 Earthquake Zoning Map of Turkey.
Source: http://www.deprem.gov.tr/linkhart.htm

Earthquake resistance of a built environment is the responsibility of architects, civil engineers, geological engineers, city planners, contractors, land owners, controllers and the other staff participated in construction process. It was seen from the past earthquakes that these responsibilities did not fulfilled satisfactorily. Figure 1.3 shows the importance of considering earthquakes while designing and constructing a building. It is a photo of Gölcük taken after the 1999 Marmara earthquake. This photo shows some buildings have completely collapsed, while other buildings in the same vicinity being intact. These buildings being intact were the indication of the fact that earthquake could be less hazardous. Hence, it can be derived that earthquake was not the only cause of these collapses. Such examples were commonly seen in other earthquake prone areas in Turkey. The question is why some buildings were collapsed while others remained intact in the same area.

Figure 1. 3 General building damage in the vicinity of Gölcük.
Source: http://www.eas.slu.edu/Earthquake_Center/TURKEY/xx3.jpg

In the first anniversary of 1999 Marmara earthquake, Chamber of Architects (section of UIA in Turkey) published a report. In this report, why earthquake turned into a catastrophe was defined in five headings:

1. unplanned settlements
2. supervision without sanction
3. risky structural system
4. deficiency in professional education
5. unconsiousness after earthquake[4]

The first major earthquake of Republic of Turkey was the big Erzincan earthquake in 1939. After the Erzincan earthquake, it was understood that the disaster problem could not be solved only by constructing new building in the place of the collapsed one. Thus, the first Turkish disaster law (*4623 Sayılı Yer Sarsıntılarından Önce ve Sonra Alınacak Tedbirler Hakkında Kanun*) was promulgated in 1944. It was mainly about the precautions before, during and after an earthquake. In accordance with this law, the first disaster regulation of Turkey (*Zelzele Mıntıkaları Muvakkat Yapı Talimatnamesi*) published with the first earthquake zoning map of Turkey in 1945. This regulation was the basis of the current Turkish disaster regulation. After 1958, significant political changes were made about disaster reducing works parallel to the new improvements in the international area. In 1958, current disaster law with the number of 7269 (*Umumi Hayata Müessir Afetler Dolayısıyla Alınacak Tedbirler ve Yapılacak Yardımlara Dair Kanun*) was constituted.[5] In the course of time, some changes in the present laws and regulations were made and new ones were added. In 1998, disaster regulation called "Specification for Structures to be Built in Disaster Areas" (*Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik*) was promulgated and it was revised in 2007 with a new name "Specification for Buildings to be Built in Earthquake Areas" (*Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik*).

[4] Mimarlar Odası Merkez Yönetim Kurulu. "Depremin 1.Yıl Dönümünde Durum Değerlendirmesi". Mimarlık Dergisi, no:295, 2000, pp.19-22.

[5] "Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

Ersoy defines regulations as legal documents edited by authorized public institutions, which determines minimum requirements for safe and functional buildings. The main aim of regulations is to prevent major faults of engineers that endanger the safety of building. The principle of disaster regulations is to define disasters in a standard.[6] In fact, disasters are variable in nature, they may occur over the standards. The determination point for these standards is the experiences from the past earthquakes.

However, decisions made just after the earthquakes are sometimes so hard to apply in practice. After the successive earthquakes of 1970s, it was decided to increase the coefficient of design earthquake in disaster regulation in 1975. Karaesmen stated that this increase was inappropriate to construction tradition in Turkey. Hence, problems occurred during the application of this coefficient.[7] Another example is a newspaper which wrote the decision of Public Works Directorate after 1992 Erzincan earthquake. It was written that 1,5 ton iron used per 100 square meter construction in the western cities, 6,5 ton iron per 100 square meter construction should be used in Erzincan which is in earthquake zone.[8] It is clear that major earthquakes lead changes in perceptiveness of engineering.

After major disasters in Turkey, "disaster" phenomenon was commonly seen as a significant subject of published area of architecture as the case in engineering. It was also presented to public in a panic atmosphere by the slogan "nothing will be the

[6] Uğur Ersoy. "Yönetmelikler ve Konut Yapımı." http://www.parlar.com.tr/ersy/indexs.htm1, Last accessed: 28th December 2006.

[7] "70'li yıllarda Gediz depremi, arkasından Burdur depremi ve Bingöl depremi oldu. Nefes almaya vakit kalmadan arka arkaya depremler geldi. Bu depremlerden sonra, hesaplarda kullanılan deprem katsayılarını arttırma kararı alındı ve 75 yönetmeliğinde deprem kuvveti birden bire çok arttırıldı. Türkiye'de kiriş kolon boyutları da çok büyüyemiyor. Sokak arasındaki 5 katlı sıradan binalarda kiriş kolon boyutları aşağı yukarı yerleşmiştir. Duvar kalınlıkları gibi unsurlara bağlantılı yerleştirildiğinden fazla büyütülemiyor. Kolonları büyütmek için de her köşeden kolon çıkmasını göze almak gerekiyor. Kiriş yüksekliği de artamıyor çünkü kapı yüksekliği değişmediği için kapı üstü açıklığı büyüyemiyor. Bu Türkiye'deki sıradan yapım alışkanlığını çok rahatsız etti. Boyutlar büyütülemediği için, sorun fazla demir kullanılarak halledilmeye çalışıldı. Fazla demir de betonu gevrek yapıyor ve o hacime sığmıyor. Çok fazla itiraz oldu." Erhan Karaesmen, interview by the author, Ankara, 13th February 2007.

[8] Fikret Çuhadaroğlu, Ruhi Kara, Engin Ustaoğlu. Deprem ve Erzincan: 13 Mart 1992 Erzincan Depreminin Öncesi, Deprem Olayı ve Sonrası. Erzincan: Erzincan Valiliği, 1992, p.81.

same again". By the time pass, "disaster" phenomeneon becomes outside of the current issues. In architectural journals published just after 1999 Marmara earthquakes, "disaster" was the dominant subject. However, in the subsequent volumes, it was hard to see "disaster" as a subject, except in the following anniversaries of the earthquakes. This shows that, in Turkey, architects do not consider "disaster" as one of their significant subject, and they leave their resposibilities to civil engineers.

Besides these, subject of "earthquake" is seen as in the fields limited with jeology and civil engineering. On the other hand, experiences of architects and urban planners are not taken into consideration. Committe of 2007 disaster regulation was also composed of eight civil engineers from universities, public institutions and practice. 2007 disaster regulation first published in March 2006 and it has been in force since March 2007. During the one year period between March 2006 and March 2007, disaster regulation was discussed only in the field of civil engineering in conferences, seminars and so on. Thus, it was not discussed much from the architectural point of view.

During an interview with Haluk Sucuoğlu who was the executive member of the committee of 2007 disaster regulation, he claimed that 2007 disaster regulation would not be a limitation for a project that has good architecture and engineering services.[9] This is a key claim to be criticized in this thesis.

1.2 Aim and Boundary of the Thesis

The aim of the thesis is to put emphasis on the effects of Turkish disaster regulations on architectural design. In this thesis, Turkish disaster regulations are not discussed in their all aspects. These regulations are prepared by civil engineers and they are

[9] "İyi mimarlık, iyi mühendislik hizmeti alınıyorsa projede, deprem yönetmeliğinin bir kısıtlama getireceğini zannetmiyorum. İllaki "şu yapı deprem bölgesinde olursa böyle olur, deprem bölgesinde olmazsa böyle olur" demek mümkün değil. Tabi bazı düzensizlikleri etkiliyor. Bazı düzensizliklere müsaade edilmiyor deprem yönetmeliğinde." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

commonly used by civil engineers. There may be civil engineering aspects that I am not able to comprehend in depth as an architect. Hence, in this thesis, Turkish disaster regulations will be discussed only in their direct related parts to architectural design. There are also some studies and thesis about detecting seismic design faults in architecture. This thesis does not aim to detect these faults. It aims to make people aware and be more conscious about Turkish disaster regulations from the architectural point of view.

1.3 Methodology and Structure of the Thesis

In this study, first, reports written by Research Commission of Grand National Assembly of Turkey (TBMM), Turkish Prime Ministry, and country strategy paper written by Japan International Cooperation Agency (JICA) were examined in order to understand disaster profile and disaster history of Turkey. Turkish Disaster regulations from 1944 to 2007 were also examined in order to understand the development of disaster regulations. Beside these, a literature survey from other related papers in architectural and engineering magazines, books and web also helped the development of this study. Information was collected mainly from library of Middle East Technical University (METU), web archieves of METU Disaster Management Research & Implementation Center (DMC), web archieves and library of General Directorate of Disaster Affairs, web archives of The Ministry of Public Works and Settlement and web archives of Arkitera Architecture Center.

Interviews had significant contribution to this study. Interviews were carried out with people who prepared disaster regulations; Prof. Dr. Haluk Sucuoğlu from METU, Inst. Dr. Erhan Karaesmen from METU and Fikret Kuran from General Directorate of Disaster Affairs Earthquake Research Department. By these interviews, it was attempted to understand the factors that were considered during the preparation of the regulations and their reflections on architectural design. In order to understand disaster regulations from architects' side, interviews were carried out with Murat Artu and Ragıp Buluç who are architects in practice. In the interview with Zafer

Kınacı, who is a civil engineer in practice, incompatibilities of architectural designs with disaster regulation in practice are discussed.

Introduction of the thesis includes the definition of the problem where disaster profile of Turkey is briefly introduced. It is emphasized in this chapter that disaster regulations seem as a way of disaster mitigation. It is stated that disaster regulations have not been criticized enough from architects' point of view.

Chapter two gives brief information about disaster regulations about selected three countries. These three countries are USA, Japan and Italy which are in high disaster prone areas as Turkey.

In the third chapter, Turkey's history of disaster regulations is discussed. An attempt was made to understand in what conditions disaster regulations promulgated and how they were developed to the current disaster regulation.

Chapter four is the brief presentation of interviews made for this thesis. Under three subtitle, experiences and opinions of civil engineers and architects are summarized.

The fifth chapter includes the final disaster regulation "Specification for Buildings to be Built in Earthquake Areas" which was promulgated in 2007. In this chapter, items related with architectural designs are identified.

The sixth chapter considers 2007 disaster regulation in the narrower field, "irregular buildings", which is the most significant part for architects. In this chapter, all the six types of irregularities are analysed.

Chapter seven is the conclusion which comprises a summary of the previous assessments. It also makes some recommendations for the further studies.

CHAPTER 2

DISASTER REGULATIONS AROUND THE WORLD

Turkey is one of the most hazardous areas in the world. This fact is clearly seen in the Global Seismic Hazard Map in Figure2.1. Warm colors show high risks and cold colors show low risks, and Turkey has the warmest color. In this map, countries like Japan, Italy and west side of the USA have also similar color with Turkey, which means they have similar vulnerability with Turkey. In order to understand disaster regulations of Turkey properly, these three countries are briefly introduced in this chapter.

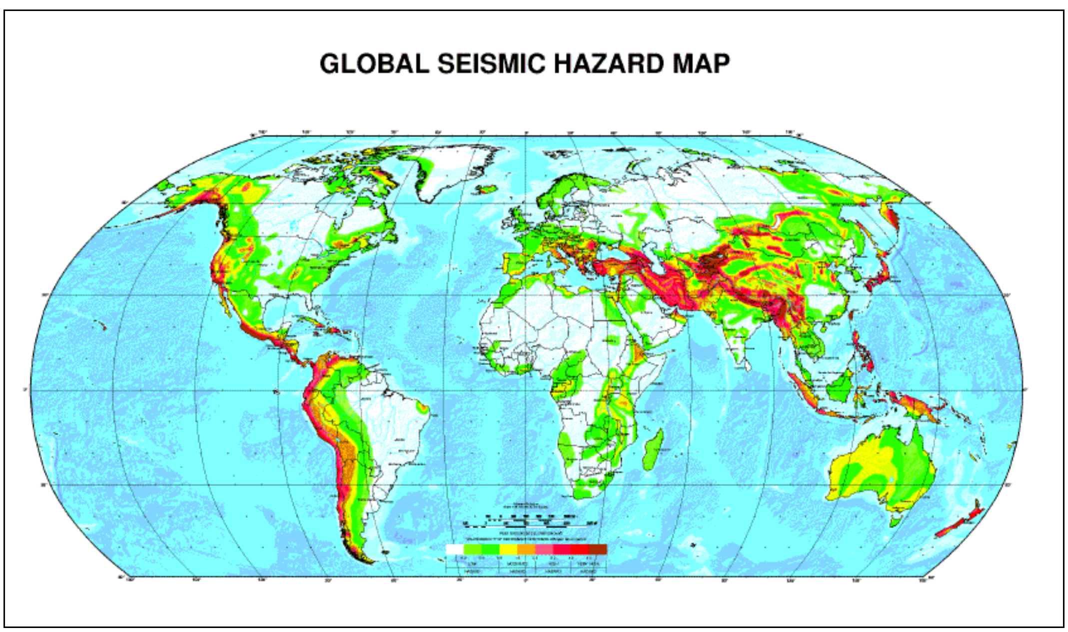

Figure 2. 1 Global Seismic Hazard Map.
Source: http://www.seismo.ethz.ch/GSHAP/index.html

2.1. United States of America

United States of America (USA) has several disaster regulations currently in use in its different regions. Uniform Building Code (UBC) is the most extensively used building regulation, particularly in the western part of the country. Four major building regulation of USA are:

1. UBC published by the International Conference of Building Officials (1991)
2. The BOCA (Building Afficials and Code Administrators International) (1990)
3. The National Building Code published by the American Insurance Association (1976)
4. The Standard Building Code, of the Southern Building Code International.[10]

In addition to these regulations, there is the ASCE Standard Minimum Design Loads for Buildings and Other Structures (1988). Several organizations concerned with earthquake-resistant design published recommendations that form the basis for requirements in the official regulations. The organizations contain:

1. The Structural Engineers Association of California (SEAOC 1990),
2. The Applied Technology Council (1978),
3. The Building Seismic Safety Council (BSSC 1988), and
4. The Federal Emergency Management Agency (FEMA) which leads the National Earthquake Hazard Reduction Program (NEHRP) with publications issued by Building Seismic Safety Council (BSSC 1988).[11]

These organizations periodically published recommendations and requirements for earthquake-resistant design of structures. Their studies based on combinations of theories, experiments, and practical observations.[12]

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[10] Mario Paz. "United States of America". International Handbook of Earthqauke Engineering: Codes, Programs, and Examples, edited by Mario Paz. New York; Chapman & Hall publications, 1994, pp.485-486.

[11] Ibid.

[12] Ibid.

The earthquake-resistant design regulations of the UBC-91 are based mainly on the recommendations of the Structural Engineers Association of California entitled, Recommended Lateral Force Requirements and Tentative Commentary (SEAOC 1990).[13]

2.2. Japan

Japan is located in the center of several earthquake zones. These are high and medium seismic regions on the Pacific Ocean side, a medium seismic region on the Sea of Japan side, and a low seismic region in the inland areas of the country. [14]

Japan has experienced a number of severe earthquakes that have caused considerable damage to buildings and civil structure since the major Kanto earthquake of 1923. After the Kanto earthquake, seismic forces were first considered in the design of building structures. Earthquake regulations were examined and amended several times after severe damages of consecutive earthquakes.[15]

The main provisions for seismic resistant design of buildings are the Building Standard Law Enforcement Order (BSLEO), published by the Ministry of Construction (1981), and the Standards for Seismic Civil Engineering Construction in Japan (1980).[16]

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[13] Mario Paz. "United States of America". International Handbook of Earthqauke Engineering: Codes, Programs, and Examples, edited by Mario Paz. New York; Chapman & Hall publications, 1994, p.486.

[14] Yoshikazu Kitagawa & Fumio Takino. "Japan". International Handbook of Earthqauke Engineering: Codes, Programs, and Examples, edited by Mario Paz. New York; Chapman & Hall publications, 1994, p.331.

[15] Ibid.

[16] Ibid.

2.3. Italy

Italy has a long history of earthquake mitigation works. As a result of major earthquake in Calabria in 1783, regulations for seismic-resistant design were promulgated. After an earthquake in Messina and Reggio (Sicily) in 1908, around 80.000 people were killed. Hence, Royal Decree was formulated in 1909. In 1915 another major earthquake hit Avezzano and caused the loss about 30.000 lives. These provisions were further refined in 1916 and updated in 1924 [17]

The current Italian earthquake regulation was updated in 1986. This regulation encompasses a complete set of provisions for repairing and strengthening existing buildings, which represent a major portion of urban construction in Italy. A special feature of the regulation is the freedom given to the designer to choose the design approach and technical solutions that may be more appropriate for a specific case. This aspect of the regulation is particularly seen in the rules provided for strengthening masonry buildings.[18]

It is expected that the Italian earthquake regulation will be modified further in order to agree more closely with other European codes.[19] The Eurocodes are common set of building codes in Europe. After a period of co-existence, they will replace national codes. At the moment, they are still in a trial phase. There are ten Eurocodes developed and published. European earthquake regulation is "Eurocode 8" called "Design of Structures for Earthquake Resistance".

[17] Gianmario Benzoni & Carmelo Gentile. "Italy". International Handbook of Earthqauke Engineering: Codes, Programs, and Examples, edited by Mario Paz. New York; Chapman & Hall publications, 1994, p.317

[18] Ibid, p.318.

[19] Ibid.

CHAPTER 3

HISTORY OF TURKISH DISASTER REGULATIONS

Anatolian lands have been exposed to big disasters since the beginning of written history. Some civilizations were erased from history or some civilizations were transported because of disasters. Hierapolis (*Pamukkale*), Troy (*Truva*) and Ephesus (*Efes*) are examples of these ancient cities.[20] Figure 3.1 illustrates ruins of ancient city of Hierapolis.

Figure 3. 1 Ancient City of Hierapolis.
Source: http://www.istanbulguide.net/insolite/grandes_photos/hierapolis.htm

[20]Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.4., http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

Disaster response and recovery activities can be traced back in history. The first recorded example of this phenomenon was in the 1509 Great 'İstanbul' earthquake. After this earthquake, 109 mosques and 1047 buildings were collapsed, and it was rumored that 13.000 people were killed. Figure 3.2 illustrates the woodcut description of the 1509 İstanbul earthquake by Peter Coecke in 1529.

Bayezid II, the Ottoman *padishah*, declared a *ferman* (imperial edict) after this major earthquake. By this *ferman*, Bayezid II donated 20 gold coins per family provided that they rebuild their houses. In order to reconstruct the ruined capital, 50.000 construction workers were recruited, and all males between the ages of 14 and 60 were commanded to work in the construction.[21] This *ferman* prohibited constructing masonry houses, allowing only timber framed construction. It also prohibited constructing the houses on filled ground. Following this *ferman*, in 6 months, 2000 new buildings were built and some mosques were repaired.[22] This *ferman* was significant from two points:

1. It was the beginning of the habit of house construction for victims of disaster.
2. It was the first known application of disaster 'mitigation' which is the significant stage of disaster management cycle. [23]

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[21] T.C. Başbakanlık Doğal Afetler Koordinasyon Baş müşavirliği. "Doğal Afetler Genel Raporu". May 1997, p.20., http://www.bayindirlik.gov.tr/turkce/dosya/Basbak_DAfetRap4.pdf, Last accessed: 16th Oct2006.

[22] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997. p.6, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16th Oct2006.

[23] T.C. Başbakanlık Doğal Afetler Koordinasyon Baş müşavirliği. "Doğal Afetler Genel Raporu". May 1997, p.20, http://www.bayindirlik.gov.tr/turkce/dosya/Basbak_DAfetRap4.pdf, Last accessed: 16th Oct2006.

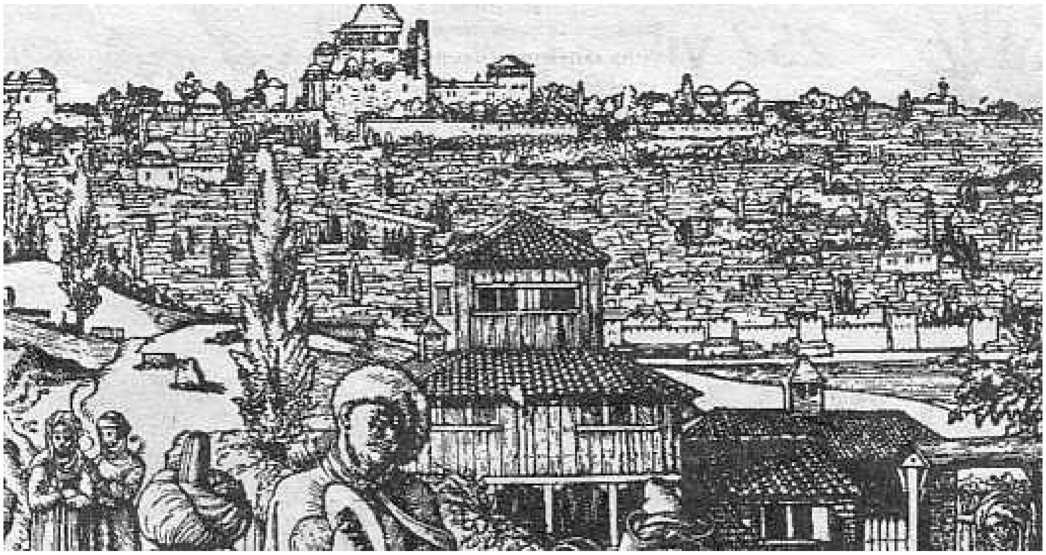

Figure 3. 2 A woodcut of "1509 İstanbul Earthquake" by Peter Coecke in 1529.
Source: http://tr.wikipedia.org/wiki/Resim:1509petercoecke.jpg

In terms of determining the type of construction and material, this *ferman* was considered as one of the first disaster regulations concerning mitigation at pre-disaster phase.[24] During the Ottoman period, there were other examples of disaster response wherein the public was provided with emergency aid and house contribution by the *padishah fermans*. None of these actions were the disaster mitigation works at pre-disaster phase, but they were continued as relief and reconstruction actions at the post-disaster phase.[25]

History of Turkish disaster regulations can be examined in four periods in terms of Turkey's disaster profile and important political changes at disaster management:

[24] Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, p.36., http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16t^{h}Oct2006.

[25] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.6, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

1. The pre-1944 period
2. The 1944-1958 period
3. The 1958-1999 period
4. The post-1999 period

3.1 The Pre-1944 Period

In the Ottoman period, there were three significant earthquakes which were well recorded in written history. First one is the 1509 Great 'İstanbul' earthquake which was also the starting point of disaster mitigation works in the history of Anatolia. Second major earthquake was the 1766 İstanbul earthquake. This earthquake also caused in heavy damage and great loss of life. However, this earthquake did not provoke significant changes in building techniques or urban planning principles. Only repairs were made to cure the most visible damages and to bring buildings to their previous state.[26]

Rules for urbanization and building construction were needed for Istanbul after the big fires and migration tendency towards the city.[27] In 1848, the first settlement rules were enacted with "Regulation for Buildings" (*Ebniye Nizamiyesi*) for Istanbul. It became widespread around all the municipalities in the empire by a new regulation in 1877. These regulations turned into a law called "Law for Buildings" (*Ebniye Kanunu*) in 1882. In that period, although these regulations were not directly about mitigation, it helped indirectly to mitigation by introducing new rules about new settlements and new buildings.[28]

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[26] Mazlum, Deniz. Osmanlı Arşiv Belgeleri Işığında 22 Mayıs 1766 Depremi ve Ardından Gerçekleştirilen Yapı Onarımları. PhD Thesis. İstanbul: İstanbul Technical University, 2001, p.xvi.

[27] Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, p.36, http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16th Oct2006.

[28] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.6, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16th Oct2006.

The third and last significant earthquake of Ottoman period was 1894 İstanbul earthquake (*büyük hareket-i arz*) which was also known as '1310 earthquake' due to Julian calendar. This earthquake was also subject of Europian media, and France magazine, L'Illustration, published photographes of this earthquake.[29] Figure 3.3 illustrates Bayezid Square in İstanbul after 1894 earthquake. After this earthquake, Abdülhamid II, the Ottoman *padishah*, ordered a seismometer to be brought İstanbul, so Turkish seismological studies started.[30]

After the foundation of Turkish Republic, the first big earthquake, Erzincan Earthquake (M=7.9), occurred on 26th December 1939. Figure 3.4 illustrates the city of Ercincan before 1939 earthquake. 32.962 people were killed and 116.720 buildings collapsed or were damaged. Thus, the government of that time felt the need for a legal enactment. On 17th January 1940, Law No.3773 "Law Related to Aids for Erzincan Earthquake Area" (*Erzincan Depremi Dolayısıyla Yapılacak Yardımlar Hakkında Kanun*) was decreed. This law was the first disaster law of the republic but it was basically about post-event response. It only contained economic support for the earthquake victims. For example, free land was donated to people whose houses collapsed or became unfit for use, and construction material was also provided for those people.[31]

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[29] Tuncay Taymaz. "İstanbul Depremleri: Bugünkü Durum ve Geçmişteki İki Büyük Deprem". Cumhuriyet Gazetesi Bilim ve Teknik Dergisi, 11thSep1999, http://triton.elk.itu.edu.tr/~batman/welcome/deprem.html, Last accessed: 31stDec2007.

[30] Shuhei Kimura. "Seismology, Practices, and Networks: An Antropological Study of Seismographic Observation in Turkey". Japanese Journal of Cultural Antropology, vol.71, No.4, 2007, http://ci.nii.ac.jp/naid/110006273524/en/, Last accessed: 31stDec2007.

[31] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.8, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

Figure 3. 3 Bayezid Square in İstanbul after the earthquake of 1894.
Source: http://www.kanyak.com/seismic.html

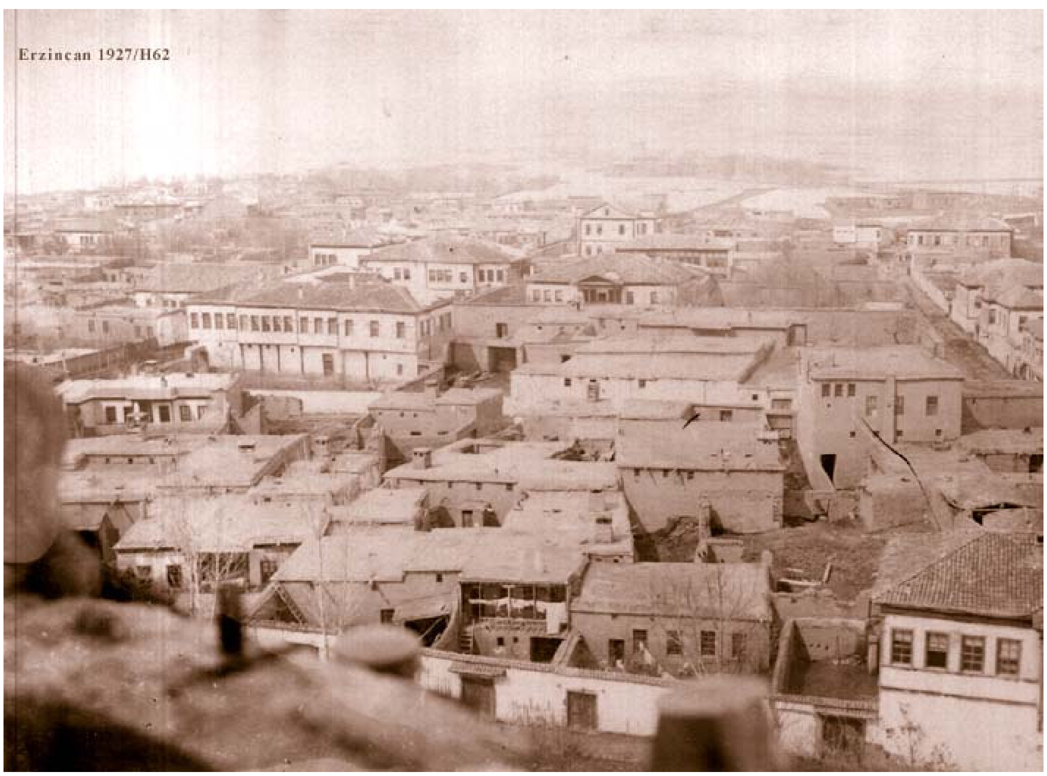

Figure 3. 4 General view of Erzincan before the big Erzincan Earthquake of 1939.
Source: http://www.erzincan.bel.tr/fotograflarlaerzincan.asp?sayfa=1

The first law concerning disaster mitigation activities in Turkey was enacted after a great number of flash floods between the years of 1935 - 1943. These floods affected Turkey causing extensive losses of lives and property damage.[32] On 14th January 1943, Law No.4373 called "Precautions and Preventions of Floods and Underground Waters" (*Taşkın Sulara ve Su Baskınlarına Karşı Korunma Kanunu*) was enacted. This was the first law that determined the precautions before disasters and it established new principles for works to be done during disasters.

After the Erzincan Earthquake (M= 7.9) in 1939, between the years of 1939-1944, other major earthquakes occurred in Turkey. The most significant ones were:

'Tokat'-'Erbaa' earthquake (M=7.0) in 1942,

'Adapazarı'-'Hendek' earthquake (M=6.6) in 1943,

'Samsun'-'Ladik' earthquake (M=7.2) in 1943 and

'Bolu'-'Gerede' earthquake (M=7.2) in 1944.[33]

Because of these earthquakes between the years of 1939-1944, 43 319 people were killed, 75.000 people were injured and around 200.000 buildings collapsed or became unfit for use.[34]

3.2 The 1944-1959 Period

After the Erzincan Earthquake and the following major earthquakes mentioned under the previous subtopic, the government understood that they could not solve this problem by building new houses in the place of the collapsed ones and they were

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32 Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, p.37, http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16thOct2006.

33 Bogazici University, Kandilli Observatory and Earthquake Research Institute. "Türkiye'de 1900-2004 Yılları Arasında Can Kaybı ve Hasara Neden Olmuş Önemli Depremler (M_s>5.0)", http://www.koeri.boun.edu.tr/sismo/Depremler/tLarge0.htm, Last accessed: 20thDec2006.

34 Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.8, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

determined to do some works about earthquake mitigation. Thus, on 18th July 1944, Law No.4623 called "Measures to Be Put into Effect Prior and Subsequent to Ground Tremors" (*Yer Sarsıntılarından Evvel ve Sonra Alınacak Tedbirler Hakkında Kanun*) was enacted, which started earthquake mitigation works. This law made obligatory to take preventive measures before an earthquake disaster.

In the "Country Strategy Paper for Natural Disasters in Turkey" of JICA, it was stated that Law No.4623 achieved the following:

- Development of an Earthquake Hazard Map,
- Development of earthquake resistant design regulations,
- Required geological studies prior to land use decisions,
- Establishment and better definition of mandates for provincial and district rescue and relief committees,
- Provision of basic principles for research and education in mitigation activities,
- Definition of principles and resources for post-earthquake rescue and relief efforts and housing,
- Definition of principles for post-earthquake damage assessment, determination of new settlement areas and expropriation of property.[35]

This law of 1944 was among the first disaster law to be enacted around the world; Japan had enacted a disaster law in 1924, and the USA and Italy in 1940.[36]

Although this law made obligatory to take preventive measures before an earthquake disaster, the issue of "permanent building" was not addressed in this law yet. In accordance with this law, Turkey's first map showing Turkey's disaster areas (*Türkiye Deprem Bölgeleri Haritası*) was prepared with the first mandatory earthquake resistant design regulation (*Zelzele Mıntıkaları Muvakkat Yapı*

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[35] Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, pp.37-38, http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16th Oct2006.

[36] Meclis Araştırma Komistonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.8, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16th Oct2006.

Talimatnamesi) in 1945. This regulation contained rules for designing "permanent building". It was the basis of today's current disaster regulation called "Specification for Buildings to be Built in Earthquake Areas" (*Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik*).

After the Law No. 4623, the specific earthquake laws also continued to be enacted for the regions affected from natural disasters. For example, Law No.5343 "Law for Housing to Be Built in Erzincan" (*Erzincan'da Yapılacak Meskenler Hakkında Kanun*) in 1948, Law No.5663 "Law for Housing to Be Built for the People Affected from Flood in Eskişehir" (*Eskişehir Sel Baskınından Zarar Görenler için Yapılacak Meskenler Hakkında Kanun*) in 1950, Law No.6746 "Law for Structures to Be Built for People Affected from Disasters during 1955-1956 in Aydın, Balıkesir, Bilecik, Edirne, Eskişehir, Konya and Denizli" (*Aydın, Balıkesir, Bilecik, Edirne, Eskişehir, Konya ve Denizli Vilayetlerinde 1955–1956 Yıllarında Tabii Afetlerden Zarar Görenlere Yapılacak Yapılar Hakkında Kanun*) in 1956.[37]

3.3 The 1959-1999 Period

Although Law No.4623 was an effective law of its time, as new needs arose, new separate laws for each major disaster continued to be enacted. In order to bring all disaster laws together, Law No.7269 "Measures and Assistance to Be Put into Effect Regarding Natural Disasters Affecting the Life of the General Public" (*Umumi Hayata Müessir Afetler Dolayısıyla Alınacak Tedbirler ve Yapılacak Yardımlara Dair Kanun*) was enacted in 1959. This law superseded the Law No.4269 and it is still effective today. The new law did not only cover earthquake disasters but covered also other disasters, such as; landslides, floods, avalanches, rock falls, fires and so on. "Disaster Fund" was one of the innovations of this law in order to prevent separate aid laws. Upon new needs and new experiences from the earthquakes,

[37] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.10, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

floods and landslides between the years of 1960-1967, Law No.7269 was amended by Law No.1051 in 1968. [38]

Major earthquakes continued consecutively between the years of 1968-1971:

'Bartın'-'Amasra' earthquake (M=6.5) in 1968,

'Manisa'-'Demirci' earthquake (M=5.9) in 1969,

'Manisa'-'Alaşehir' earthquake (M=6.5) in 1970,

'Kütahya'-'Gediz' earthquake (M=7.2) in 1970,

'Burdur' earthquake (M=5.9) in 1971 and

'Bingöl' earthquake (M=6.8) in 1971.[39]

Figure 3.5 and 3.6 show some of the post-earthquake houses built in Bingöl and Erzurum for earthquake victims by government support. After these earthquakes, 'Disaster Fund' of Law No.7269 was not sufficient enough to provide enough economic support. This Law was amended again by Law No.1571 in 1972. With the same reason, Law No.7269 was further amended by Law No.2479 in 1981, Law No.3177 in 1985 and Law No.4133 in 1995.[40]

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[38] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, p.12, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

[39] Bogazici University, Kandilli Observatory and Earthquake Research Institute. "Türkiye'de 1900-2004 Yılları Arasında Can Kaybı ve Hasara Neden Olmuş Önemli Depremler (M_s>5.0)", http://www.koeri.boun.edu.tr/sismo/Depremler/tLarge0.htm, Last accessed: 20thDec2006.

[40] T.C. Başbakanlık Doğal Afetler Koordinasyon Baş müşavirliği. "Doğal Afetler Genel Raporu". May 1997, p.27., http://www.bayindirlik.gov.tr/turkce/dosya/Basbak_DAfetRap4.pdf, Last accessed: 16thOct2006.

Figure 3. 5 Post-earthquake apartment buildings in Genç in Bingöl after 1971 earthquake.
Source: http://www.bayindirlik.gov.tr/turkce/fotoarsiv.php

Figure 3. 6 . Post-earthquake houses in Muratbağı Village in Horasan in Erzurum after 1983 Erzurum-Kars earthquake.
Source: http://www.bayindirlik.gov.tr/turkce/fotoarsiv.php

Figure 3. 7 Old disaster regulations in the library of General Directorate of Disaster Affairs.
Source: Photographed by the author, 2007.

In terms of these earthquakes' hazards, earthquake hazards maps and earthquake resistant design regulations of 1945s were needed to be amended. Earthquake hazard map of 1945 contained two disaster zones. 'Zone 1' included the areas with the highest risk and areas outside these two zones were considered safe. This map revised in 1943 by increasing the zone number to 3, and in 1972 by increasing the zone number to 4. [41] Earthquake resistant design regulation of 1945 (*Zelzele Mıntıkaları Muvakkat Yapı Talimatnamesi*) was amended parallel to these evolutions in 1949 (*Türkiye Yer Sarsıntısı Bölgeleri Yapı Yönetmeliği*), in 1953 (*Yer Sarsıntısı Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik*), and in 1962 (*Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik*). In 1975, the regulation

[41]Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, p.105, http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16[th]Oct2006.

"Specification for Structures to Be Built in Disaster Areas" (*Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik*) was introduced both to amend the previous regulations and to add new requirements in the design and details of reinforced concrete buildings.[42] Figure 3.7 shows the cover pages of these regulations.

In 1992, Erzincan was again hit by an earthquake (M=6.8). Hazards of this earthquake were much more than physical hazards, it caused social and economic ones, such as; migration, unemployment, so on. Thus, Law No.3838 (*Erzincan, Gümüşhane ve Tunceli İllerinde Vuku Bidati Deprem Afeti ile Şırnak ve Çukurca'da Meydana Gelen Hasar ve Tahribata İlişkin Hizmetlerin Yürütülmesi Hakkında Kanun*) was enacted in 1992 for Erzincan, Gümüşhane, Tunceli and Şırnak, which let to the reconstruction of Erzincan.[43] Since such a law was required for other regions as well, Law No.4123 (*Tabii Afet Nedeniyle Meydana Gelen Hasar ve Tahribata İlişkin Hizmetlerin Yürütülmesine Dair Kanun*) enacted in July 1995. Three monts after the enactment of the Law No.4123, a new damaging earthquake occurred in Dinar in Afyon (M=6.1) in October 1995. A month after this earthquake, Law No.4123 was removed and Law No.7269 (*Umumi Hayata Müessir Afetler Dolayısıyla Alınacak Tedbirler ve Yapılacak Yardımlara Dair Kanun*) was amended again by the Law No.4133 (*Tabii Afet Nedeniyle Meydana Gelen Hasar ve Tahribata İlişkin Hizmetlerin Yürütülmesine Dair Kanun*) in 1995. Figure 3.8 illustrates post-earthquake houses built in Erzincan after 1992 earthquake and Figure 3.9 illustrates post-earthquake houses in Afyon after 1995 earthquake by government support. As it is seen from these figures, they were built almost built with the same architectural design; despite they were in different regions.

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[42] Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, pg.105, http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16thOct2006.

[43] Meclis Araştırma Komisyonu. "Doğal Afetlerde Meydana Gelen Can ve Mal Kaybını en Aza İndirmek İçin Alınması Gereken Tedbirlere Ait Meclis Araştırma Komisyonu Raporu". June 1997, pp.13-14, http://www.bayindirlik.gov.tr/turkce/dosya/DAfetMeclisRap8.pdf, Last accessed: 16thOct2006.

Figure 3. 8 A post-earthquake apartment building in Erzincan after the 1992 Erzincan Eartquake.
Source: http://www.bayindirlik.gov.tr/turkce/fotoarsiv.php

Figure 3. 9 Post-earthquake apartment buildings in Afyon after 1995 Dinar Earthquake.
Source: Photographed by the author, 2002.

Floods and landslides also caused major damages and loss of lives in Turkey in 1995. The most significant ones were landslide in Senirkent in Isparta in July 1995 and flood in İzmir[44] in November 1995.

In 1998, 1975 disaster regulation called "Specifications for Structures to be Built in Disaster Areas" (*Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik*) was revised in the same name. Since 22 year is a long time span for the revision of a regulation, there were major differences between 1975 and 1998 disaster regulations.[45]

In 1998, 'Adana-Ceyhan' earthquake (M=6.2) occurred. The difference of this earthquake was that it was the first earthquake occured in an industrial area. In industrial area, there was not any loss of life but there was significant economic hazard. Pause of industrial production in Adana caused significant losses in economy of Turkey.[46]

3.4 The Post- 1999 Period:

The most hazardous earthquakes of the 20th century in Turkey occurred in 1999. First one was 'Kocaeli - Gölcük' earthquake (M= 7.8) in 17th Agust 1999 and the second

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[44] TBMM Genel Kurul Tutanağı, 19.Dönem 5.Yasama Yılı 38.Birleşim. 22th Oct.2007. http://www.tbmm.gov.tr/develop/owa/tutanak_b_sd.birlesim_baslangic?P4=557&P5=T&page1=2&page2=2, Last accessed in 15th July 2007.

[45] "75'ten sonra 98 yönetmeliğinde ciddi değişiklikler oldu yapı tasarımında. Betonarme yapılarda özellikle "kapasite tasarımı" denen bir ilke gelişmişti, o yansıdı. Deprem mühendisliği konsepti çok değişti 75'ten 97'ye. Aslında depreme maruz gelişmiş ülkelerde, Amerika, Japonya gibi, böyle 20 yılda bir değişmez yönetmelik. 3 yılda bir "update" edilir. Her tarafı da değişmez, belirli maddelerinde revizyon yapılır. Biz de bundan sonra o yola gitmek istiyoruz. Ama 75-97 arası yönetmelik kapsamında çok büyük değişiklikler oldu. 97, 98'te kesinleştikten sonra 99 depremi olunca da aslında yönetmeliğin herhangi bir yetersizliği ortaya çıkmadı ama eksikliği ortaya çıktı. Mevcut yapıların değerlendirilmesi ve güçlendirilmesi kısmı ihtiyaç oldu. 2006-2007 yönetmeliğinin esas amacı oydu, yeni bir bölüm eklendi. O da mimariyi etkilemedi bence." Haluk Sucuoğlu, interview by the author, Ankara, 14th February 2007.

[46] Ersoy, Uğur. "Binaların Mimarisinin ve Taşıyıcı Sisteminin Deprem Dayanımına Etkisi". Deprem Güvenli Konut Sempozyumu, edited by Teoman Aktüre. Ankara: MESA yayınları, 1999, p66.

one was 'Düzce' earthquake (M=7.5) in 12th November 1999. [47] Although the centers of these earthquakes were Kocaeli-Gölcük and Düzce, earthquake area was so large that Adapazarı, Yalova, İstanbul (Avcılar, Küçükçekmece and Tuzla), Bolu, Bursa and Mudanya were also affected. These areas had high population density and also the significant industrial center of Turkey was there. Hence, the affects of these two earthquakes were not limited in a region; these two earthquakes affected the whole Turkey. [48]

After the losses of these earhquakes, the government promulgated several decrees known as "Decree with Force of Law" to solve problems and meet the needs quickly. The most important decrees were Decree No.587 "Compulsory Earthquake Insurance" (*Zorunlu Deprem Sigortası Hakkında Kanun Hükmünde Karaname*) on 27th December 1999 and Decree No.595 "Building Construction Supervision" (*Yapı Denetimi Hakkında Kanun Hükmünde Kararname*) on 10th April 2000.[49]

A great number of existing buildings were not strong enough to resist a new earthquake and some of them were also damaged. Hence, there was a need for rehabilitation of existing buildings. In order to prevent exploitation of this subject, a regulation about seismic assessment and rehabilitation of existing building was needed.[50] For this reason, 1998 disaster regulation was revised in 2007 and a new chapter called "Seismic Assessment and Rehabilitation of Existing Buildings" added.

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[47] Bogazici University, Kandilli Observatory and Earthquake Research Institute. "Türkiye'de 1900-2004 Yılları Arasında Can Kaybı ve Hasara Neden Olmuş Önemli Depremler (M_s>5.0)", http://www.koeri.boun.edu.tr/sismo/Depremler/tLarge0.htm, Last accessed: 20thDec2006.

[48] Nilüfer Akıncıtürk. "17 Ağustos Depreminin Yapılardaki Etkisi". Yapı Dünyası Dergisi, March-April 2006, pp.11-21.

[49] Japan International Cooperation Agency. Country Strategy Paper for Natural Disasters in Turkey. Ankara: July 2004, pg.44-48. http://dmc.metu.edu.tr/DMC/index_dl.php?lang=&dirpath=./AnaSayfa/Dosyalar/Raporlar&order=0, Last accessed: 16thOct2006.

[50] "Marmara depreminden sonra, devlet bir takım krediler aldı. Belirlediği öncelikle kamu binalarını onarım ve güçlendirme çalışmalarına başladı. Özel kesimde de buna meraklı bazı insanlar oldu. 99 depreminden sonra "güçlendirme" diye bir furya oldu insanlar arasında. Bu furya'da vatandaşın korkusu istismar edildi. Dolayısıyla yanlış işler yapıldı. Yavaş bir süreç içinde de olsa devlet bir şeyler yaptırıyor, vatandaş da yaptırabilir diye buna bir tarif getirme ihtiyacı doğdu. O tarif onarım ve güçlendirme ile ilgili yeni bir bölüm eklenerek getirildi." Erhan Karaesmen, interview by the author, Ankara, 13thFebruary 2007.

This new regulation was called “Specifications for Buildings to be Built in Earthquake Areas” (*Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik*), and it came into effect on 6th March 2007.

CHAPTER 4

INTERVIEWS IN RELATION TO 2007 DISASTER REGULATION

4.1 How Civil Engineers, from Preparation Committee of Disaster Regulation, Approach Architectural Design

Haluk Sucuoğlu, a professor in civil engineering department in METU, is the executive member of 2007 disaster regulation committee. He shared some of his experiences and opinions about disaster regulation during the interview on 14thFebruary 2007. This interview was held one month before the 2007 disaster regulation to be effective. Sucuoğlu stated that disaster regulation should not be an obstacle for architectural design. Disaster regulation should not change architectural decisions taken during design process. However, he added that disaster regulation may affect the choice of structural system according to earthquake zone.[51]

Erhan Karaesmen, an academician in civil engineering department at METU, is one of the experts of disaster regulations. He talked about the general principles of disaster regulations and compared 1945, 1975 and 1998 regulations in the interview.

Karaesmen considered 1975 disaster regulation as an important development according to 1945 disaster regulation because "specific period of building" concept was added. This concept was also new in the world in 1970s. Earthquake prone countries, such as Japan, China, New Zealand also made such changes in the years of

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[51] "Deprem yönetmeliğinin mimari tasarımı engellememesi gerekir. Bir mimarın tasarımda göz önüne aldığı mimari unsurları değiştirmemesi gerekir. Ama deprem bölgesiyle ilişkili olarak, belki projedeki sistem seçimini etkileyebilir." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

1970s. Karaesmen explained the "specific period of building": Every building has its own reaction to earthquake movement. In fact, as the ground is shaken, buildings also move and return with this shake. Elapsed time of this movement and return is called "period". Tall buildings have long periods. When period of a building is increased, earthquake impact to the building is decreased. In the past, it was only known that when the height of a building was increased, earthquake impact was also increased due to the mass increase. With the discovery of "specific period of building" concept, it is understood that there is not a direct proportion between building height and earthquake impact.[52]

Karaesmen said that there could not be amendments on disaster regulations between 1975 and 1997. In this period chamber of civil engineers and universities delivered new opinions. There were some offices considering these opinions in practice but it was not obligatory. Karaesmen compared regulations with opinions: "Regulations are official and binding rules. They are not opinions, they are authoritative. When one does not obey regulations, it is a crime."[53]

Sucuoğlu explained the innovation of disaster regulation between 1975 and 1998. After 1975, significant changes were made about structural design in 1998 disaster regulation. A new principle called "capacity design" was developed in reinforced concrete buildings, and it was added to 1998 disaster regulation. There was a major change in the concept of "earthquake engineering" between 1975 and 1998. In fact,

[52] "Her yapının deprem hareketine bir karşı koyuş biçimi vardır. Aslında sarsılan yerdir, bu hareketi yapı da sürdürür. O hareket içinde yapı kedisi de gider gelir. Bu zaman dilimini 'periyot' olarak adlandırıyoruz. Yüksek yapıların periyodu da yüksektir. Yapının özgün periyodu büyüdüğünde, o yapının davet ettiği deprem etkisi azalıyor. Bir yapıyı yüksek yaptığında, kütle ağırlaşmasının sonucu, yapıya giderek daha büyük deprem kuvvetleri gelmesi bekleniyor. Ama öyle olmuyor, düz orantılı olmaktan çıkıyor. Çünkü yüksek yapının periyodu da arttığı için deprem etkisi azalıyor. Bu nedenle yüksek bina yapılırken deprem kuvvetinin sonsuz şekilde artmasından korkulmuyor. Deprem kuvveti artıyor ama beklenenden çok az artıyor. 1975'te bu 'yapı özgün periyodu' kavramı yönetmeliğe girdi. 1945 yönetmeliğine nazaran bir hayli sıçramalı bir anlayıştı. Çünkü bu kavram dünyada da yeniydi." Erhan Karaesmen, interview by the author, Ankara, 13thFebruary 2007.

[53] "1975'ten 1997'ye kadar yönetmelikte güncelleme yapılamadı. Gayri resmi güncellemeler yapıldı. Yani inşaat mühendisleri odaları, bir takım üniversitelerin de katkısıyla görüşler getirdiler. O görüşleri nazarı itibara alan dizayn büroları oldu. Ama dikkate almak zorunda değildiler, kendi içlerinden geldiği için dikkate aldılar o görüşleri. Halbuki yönetelik resmi ve bağlayıcı. Orada belirtilenler artık görüş değil, amir bir şey. O dikkate alınmadığı taktirde mesleki suç işlenmiş oluyor." Erhan Karaesmen, interview by the author, Ankara, 13thFebruary 2007.

in earthquake prone countries, such as Japan and USA, regulations do not change in a twenty year period. They are updated almost in every three years. Not all the regulation is changed, only specific parts are revised. Sucuoğlu stated that they also wanted to work in such way in Turkey. However, in 1998, major changes brought in the scope of regulation due to the long period of time between 1975 and 1998. One year after publication of 1998 disaster regulation, Marmara earthquakes occurred. After these earthquakes, any inadequacy of 1998 disaster regulation did not reveal. However, a new need about "seismic assessment and rehabilitation of existing buildings" arose. Sucuoğlu said that the main aim of the amendment and publication of 2007 disaster regulation was to add a new part about this.[54]

Sucuoğlu also explained why some parts of 1998 disaster regulation removed from 2007 disaster regulation. "Adobe buildings" and "timber buildings" were removed from 2007 disaster regulation. Sucuoglu said that they did not consider "adobe buildings" as a subject of engineers, so it was removed from the regulation. "Timber structure" is an unused type of structure in Turkey. It has not been used since the last 50 years. Moreover, the part for timber structures in the 1998 disaster regulation was inadequate. It also needed to be supported by a Turkish standard of timber structures because disaster regulations only take supplementary standards. For instance, there is a Turkish standard for reinforced concrete buildings called TS500, and earthquake principles are added to that. The Turkish standard of timber structures was insufficient, so was the earthquake standard. There is a comprehensive regulation of Eurocode for timber structures, and it is being translated to Turkish. Sucuoğlu added that there was not any practice or knowledge of timber construction in Turkey. By

[54] "75'ten sonra 98 yönetmeliğinde ciddi değişiklikler oldu yapı tasarımında. Betonarme yapılarda özellikle 'kapasite tasarımı' denilen bir ilke gelişmişti, o yansıdı. Deprem mühendisliği konsepti çok gelişti 75'ten 97'ye. Aslında depreme maruz gelişmiş ülkelerde, Amerika, Japonya gibi, böyle 20 yılda bir değişmez yönetmelik. 3 yılda bir 'update' edilir. Her tarafı da değişmez, belirli maddelerinde revizyon yapılır. Biz de bundan sonra o yola gitmek istiyoruz. Ama 75-98 arası yönetmelik kapsamında çok büyük değişiklikler oldu. 99 depremi olduktan sonra da 98 yönetmeliğinin herhangi bir yetersizliği ortaya çıkmadı. Ama yeni bir ihtiyaç ortaya çıktı, 'mevcut yapıların değerlendirilmesi ve güçlendirilmesi'. 2006-2007 yönetmeliğinin hazırlanmasının esas amacı oydu, yeni bir bölüm eklendi. O da mimariyi etkilemedi bence." Haluk Sucuoğlu, interview by the author, Ankara, 14th February 2007.

mentioning that recently constructed timber structures were generally imported, Sucuoğlu stated that Turkey was not a country of timber.[55]

Sucuoğlu briefly explained past approaches to architectural design after disasters. In the past, it was thought that if buildings were designed in simple forms, without any projections in plan and so on, they would not be damaged by earthquake that much. This means that if professions did the same poor quality engineering and architectural works but used simple forms, damage of buildings would be less in earthquake. Sucuoğlu stated that this was true but the approach to the problem was false. He said that engineer should do his work properly. Instead of this, it was biased that engineers could not do qualified engineering services, and qualified construction. [56]

Sucuoğlu believed that if there is a good architectural and engineering service, disaster regulation would not impose any restrictions to architectural design. However, he also accepted that disaster regulation affect some irregularities in design. Some irregularities are forbidden. [57]

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[55] "Kerpici bir mühendislik mimarlık yapısı olarak kabul etmiyoruz. Ahşap da Türkiye'de aslında kullanılmayan bir yapı türü ve son 50 yıldır yapılmıyor. Yönetmeliğin ahşap kısmı çok yetersizdi. Tabi bir de ahşabın Türk standartları olması lazım. Deprem yönetmeliği tek başına bir binayı yaptıramaz, ilave hususlar getirir. Mesela betonarme yapılar için bir standart vardır, TS500. Onun üzerine depremde yapılacaklar ilave edilir. Ahşap için olan Türk standartları çok yetersizdi. Onun için biz ahşabı deprem yönetmeliğinden kaldırdık. Şimdi Avrupa yönetmeliklerinin Türkçe'ye tercümesi yapılıyor. Türkiye'de zorunlu yönetmelik olacağını sanmıyorum ama Avrupa'da 2014 yılında olacak sözde. Ama "Eurocode"un ahşapla ilgili çok kapsamlı bir yönetmeliği var, o tercüme ediliyor. En azından o ortaya çıkınca onun kullanımı mümkündür. Türkiye'de ahşap yapı alışkanlığı yok. Ahşap konstrüksiyon yapımını bilen de yok zaten. Son zaman da yapılanlar da genelde ithal olarak yapılıyor. Bütün detayları vs. dışarıda çözülmüş, malzemeleri taşıyıcı sistemi buraya ithal ediyorsunuz ki o bile çok sınırlıdır. Yani çok ahşap ülkesi değiliz." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

[56] "Geçmişte meseleye şöyle yaklaşıldı: 'Biz binalari daha basit, çıkmasız, şusuz busuz yapsaydık, depremde bu kadar zarar görmezlerdi'. 'Yani gene kötü mühendislik ve mimarlık yapsaydık ama böyle yapmasaydık binalar da az zarar görürdü'. Tamam doğru ama mantık doğru değil. Mimarı bu şekilde kısıtlamak doğru değil. Mühendis doğru dürüst yapsaydı işini. 'Zaten doğru dürüst mühendislik yapamayacağız, burada doğru dürüst üretim yapamıyoruz. O yüzden çıkmaları da kaldıralım, onu da kaldıralım, bunu da kaldıralım' gibi mimarı kısıtlayıcı öneriler geliyor." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

[57] "İyi bir mimarlık mühendislik hizmeti alınıyorsa projede, deprem yönetmeliğinin bir kısıtlama getireceğini zannetmiyorum. İllaki 'şu yapı deprem bölgesinde olursa şöyle olur, deprem bölgesinde olmazsa böyle olur' demek mümkün değil. Tabi yönetmelik bazı düzensizlikleri etkiliyor. Bazı düzensizliklere müsaade edilmiyor deprem yönetmeliğinde." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

Sucuoğlu, explained some irregular type of designs. He considered projection in plan as a nuisance in Turkey because it discomposes frame system of building. Buildings with projections in plan are weaker due to poor qualified engineering. In Turkey, this is the reason of damage in buildings with projections in plan.[58] Sucuoğlu also mentioned nonparallel axes of structures. In Turkey, there is a habit of designing plan according to land borders. Thus, it is common to design plans in skewed forms on skewed lands. Sucuoğlu stated that it was not a good approach because the simplest design is the easiest one to control. It is both easy to do engineering calculations and reliable.[59]

Sucuoğlu mentioned the importance of shear walls. According to him, reinforced concrete buildings over six storeys are not safe to be built in frame system in Turkey. Thus, shears walls are needed for those buildings. Sucuoğlu stated that architects should prepare the design principles of the shear wall system, so that civil engineers can design properly.[60]

One may intervene the façade of a building while it is strengthened. Sucuoğlu said that rehabilitation of an existing building was an opportunity to change an ugly building while strengthening its structure. However, city development plan do not allow all of the changes because these changes may enlarge gross floor area. Only

[58]"Çıkma Türkiye'de başa beladır. Çünkü çıkma yapıldığı zaman binanın çerçeve sistemi bozuluyor. O nedenle çıkma olan binalarda zayıflık vardır, daha yumuşak olur bina. Bu da kötü bir mühendislik çözümü nedeniyle. Yani bizde hasar gören çıkmalı binalar böyle olduğu için hasar görüyor." Haluk Sucuoğlu, inreview by the author, Ankara, 14th Febrauary 2007.

[59] "Arsa yamuk olunca genellikle yamuk akslar yapılıyor bizde. Arsaya göre plan oturtma alışkanlığı olduğu için öyle yapılıyor. Aslında bu iyi bir şey değil. Yapısal sistemin en basit olanı, kontrolü en kolay olanıdır. Hem hesabı kolaydır, hem de hesaba güven en fazla onlarda sağlanır. Yamukluklar olduğu zaman yaptığımız hesabın gerçeğe yansımasında hep zorluklar olur." Haluk Sucuoğlu, interview by the author, Ankara, 14th February 2007.

[60]"Türkiye'de 6 kattan yüksek bina yapacaksınız, o zaman çerçeve sistemiyle yapmak zordur. Muhakkak perde gerekir, öyle çözülebilir. Bu da mimara büyük bir kısıtlama değil bence. Tabi orada mimarın perdeli sistemin alt yapısını hazırlaması lazım ki mühendis ona göre tasarım yapabilsin." Haluk Sucuoğlu, interview by the author, 14th February 2007.

projections can be intervened. Sucuoğlu stated that it should be allowed because it prevents the collapse of the building.[61]

4.2 How Architects Approach Disaster Regulation

Murat Artu is an architect in practice, who has designed quite a number of buildings in Ankara. His commentary on disaster regulation was that disaster regulation affected civil engineering services, and it indirectly affected their study from civil engineering services. However, the thing that makes a building stable and resistant is, beside civil engineers, architects' accumulation of knowledge and serious consciousness about earthquakes.[62] When architects design a building, they should think about structure as well. However, it is probably not the general case in Turkey. Additionally, Artu mentioned that there might be major differences between architectural project and built form.[63]

Artu's main observation on disaster regulations after 1998 was that dimensions of columns and beams were increased, slabs became thicker, and the definition of shear wall was changed.

Artu complained about these dimensions and said that there was a viewpoint that there may be "stealing"[64] of 30 per cent of iron. Hence, a regulation is prepared to

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[61] "Bir binayı güçlendirdiğiniz zaman dış cephesinden de ona müdahale edebilirsiniz. Çok çirkin bir binayı yapısal olarak da güçlendirdiğiniz zaman dış cephe görünümünü de değiştirme imkanınız var. Ama imar kuralları hepsine izin vermiyor, binanın oturduğu alanı genişletmiş oluyorsunuz. Halbuki binayı yıkılmaktan kurtarıyorsunuz, niye olmasın? Çıkmalarına müdahale edebiliyorsunuz." Haluk Sucuoğlu, interview by the author, Ankara, 14th February 2007.

[62] "Deprem yönetmeliği inşaat mühendisliği hizmetlerine yansıyor. İnşaat mühendisliği hizmetlerinden dolaylı olarak bize yansıyor. Ama depremde yapının sağlamlığını ya da depreme olan mukavemetini sağlayacak şey, inşaat mühendisliğinden ziyade, mimarın projede bu sorunu düşünerek ele almasıdır." Murat Artu, interview by the author, Ankara, 21st March 2007.

[63] "Biz bir proje yaptığımız zaman statiği falan da doğru düzgün oluyor. Ama Türkiye genelinde bu böyle değil galiba. Yapılan projeyle uygulanan şey arasında çok büyük farklar olabiliyor." Murat Artu, interview by the author, Ankara, 21st March 2007.

[64] With Murat Artu's own words.

use 30 per cent more iron. Artu argues that, instead of this, stealing should be controlled. [65]

Artu complained about standard forms of disaster regulations. He stated that regulation might detect how to calculate earthquake, and henceforward should be left to civil engineers. However, disaster regulation restricts dimensions. Artu said that it was considered as everybody was designing in the same way and it did not give opportunity to new designs. As an example, he mentioned that these dimensions were for perpendicular columns. Artu asked what would happen whether an architect designs columns in diagonal or crosswise forms.[66]

Artu's other example was about building form. According to disaster regulation, beams of a building in a pyramidal form have the same conditions as a building in the upside-down pyramidal form. In fact, earthquake resistance of pyramid and upside-down pyramid are different due to their architecture. However, they are all put in the same category and dependent to the same dimensional rules. Regulations are generally concerned with rectangular buildings which is a limitation for other types of building forms.[67]

Artu stated that it was not possible to design car parking in the basement of a hotel project. Due to the restrictions of disaster regulation, it is not possible to design

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[65] "Herhalde şöyle bir bakış açısı var: "Bu adam bunu içinden %30 demirini çalar". Dolayısıyla %30 fazla demir koymaya dair bir yönetmelik yapılıyor. Halbuki demirin çalınmasını denetlemesi lazım." Murat Artu, interview by the author, Ankara, 21st March 2007.

[66] "Deprem hesabının nasıl olacağıyla ilgili bir şey verebilirsiniz. Ondan sonra onunla ilgili bir hesaplama yapılır. İşte mühendislik de orada. Yani sadece "kiriş 25'lik olacak" demekle siz bir şey sağlamıyorsunuz ki. Kolonu herkes dik alıyor. Eğri olsa ne olacak kolon? Ya da kolonlar çapraz bağlanırsa ne olacak? Herkes aynı şeyi yapıyormuş gibi yönetmelik çıkarılıyor. Yeni bir şey yapmaya imkan bırakmıyor, ona hiçbir şans yok." Murat Artu, interview by the author, Ankara, 21st March 2007.

[67] "Diyelim ki ben bir tane piramit formlu bina yaptım, Mısır'daki gibi. Onun kirişi de ters bir piramitle aynı şartlarda oluyor. Halbuki piramit bir bina ile, ters piramit bir binanın depreme dayanıklılığı sadece mimarisi yüzünden bambaşka bir şeydir. Ama o da aynı yönetmeliğe 'kolonu şu kadar olacak, kirişi şu kadar olacak…' diye geçiyor. Yani düşünülen hep dikdörtgen bir bina." Murat Artu, interview by the author, Ankara, 21st March 2007.

comfortable wide span area, such as a restaurant. Especially in tall buildings, building structure restricts architects design.

Artu designed the annex of Ankara Sheraton Hotel and he used 30 meters span where all the columns were resting on slab. Because it is post-tensioned concrete system, it is outside the scope of disaster regulation. So it was possible for this project to be approved. Architects come accross with the same situation for "tunnel form" system. This regulation did not affect tunnel form systems and post-tensioned buildings.

Artu said that the structural project of post-tensioned building of Sheraton Hotel in Ankara could not be approved by Çankaya Municipality because there was not a staff qualified for controlling a post-tensioned building project. Thus, an advisor from METU stepped in, and then the project could be approved. He gave another example from rural areas. When an architect submits an architectural project to Bodrum Municipality, there is not an architect to understand and approve the project. A topographic technician is approving architectural projects there. Artu stated that if projects were approved by municipalities, there should be an arrangement in order to employ qualified staff, instead of preparing regulations to ease unqualified staff's work.

Buluç is an architect in practice who is known with his buildings such as Atakule in Ankara and Abdi İpekçi Sport Hall in İstanbul (together with Ziya Tanalı and Ercan Yener). In 1999 Marmara earthquakes, Abdi İpekçi Sport Hall stood intact while buildings in the same vicinity collapsed. He explained this as: "It is seen in earthquakes that there is a destructed building and a steady building next to it. In fact, either all of them should collapse or all of them should stay safe. This shows that when a good architect and a good engineer work together, buildings are not collapsed."[68]

[68] "Depremde görüyorsunuz, yıkılan binalar var, yanında sapasağlam bina var. Ya hepsinin yıkılması lazım, ya hiçbirinin yıkılmaması lazım değil mi? Bunun nedeni doğru mimarla doğru mühendis çalıştığı zaman binalar yıkılmıyor." Ragıp Buluç, interview by the author, Ankara, 26th March 2007.

Buluç stated that even if a wonderful regulation is prepared, the problem will not be solved until a public ethic is formed. [69]

Buluç said that when they need to submit a project for approvel to a public institution, it was checked meticulously. However, there is not such a control in construction process. Buluç stated that contractors also know this fact, so they might change the project as they want.

Buluç said that the more rules are established, the more people occur around to break these rules. For an ordinary two storey building, approximately 17 types of license (*ruhsat*) is necessary. Should architect deal with design issues of the project or deal with these licenses? Hence, specific offices were created in order deal with licenses.[70]

Buluç said: "Especially universities and researches who deal with regulations, should know that number of rules should be kept at minimum. For example, there may be a rule defining maximum construction height and diameter of a land as a cone, and allow architects to design whatever they want in the boundary of the cone."[71]

Buluç added that barriers were put in the middle of street in order to prevent pedestrians to cross the street but pedestrians passed under the barrier or jumped over them. He said that he wish rules should be obeyed but the more rules are established, the more ways to break them are revealed.

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[69] "İstediğiniz kadar yönetmeliği değiştir, mükemmel yapın, toplum ahlakı bozuk olduğu sürece, çalışmalar sürdüğü müddetçe bu iş devam edecektir." Ragıp Buluç, interview by the author, Ankara, 26th March 2007.

[70] "Bizde ne kadar çok kural getirirsen, o kuralı bozmaya yarayan binlerce adam ortaya çıkıyor ve rüşvetin fiyatını arttırmış oluyorsun. Basit bir iki katlı bina yapmak için galiba 17 tane ruhsat alman gerekiyor. Yani proje mi çizeceksin, bunlarla mı uğraşacaksın? Bunlarla uğraşan özel bürolar kuruldu." Ragıp Buluç, interview by the author, Ankara, 26th March 2007.

[71] "Özellikle üniversitelerin, bunu araştıran insanların bunları çok iyi bilmesi, kural sayısını minimize etmesi lazım. Mesela şöyle bir kural olabilir: "Bunu şu arsada, şu çapta, şu yükseklikte, verilen gabarili koni içinde istediğinin yapabilirsin." Ragıp Buluç, interview by the author, Ankara, 26th March 2007.

Buluç stated that there was nothing false than hedging architects in with rules and regulations because of the fact that architects need freedom in order to do their job. A civil engineer should do engineering calculations of any project architect designed. A qualified civil engineer is able to do this. Today, nothing is impossible due to technological facilities.[72] Buluç's suggestion was to adopt disaster regulation from Japan.

4.3 Dimensional Restrictions of 2007 Disaster Regulation

Kınacı, a civil engineer in practice in Ankara, briefly spoke about the effects of disaster regulation on architectural design according to his experiences in practice. 2007 disaster regulation affected architectural design due to dimensional limitations of structures. For example, minimum dimension of columns and beams is 25cm. So the smallest column dimension is 25cm. x 30cm. Engineers can only design 20cm. thicknesses in shear walls. However, in order to categorize a bearing as a shear wall, it should have minimum 1/7 proportion in plan. For example, if the minimum thickness, 20cm., is used, dimensions of this shear wall should be 20cm.x 140cm. This is a major dimension that may restrict architectural design. This dimension is also depending on the storey height. Minimum thickness of shear wall should not be under 1/20 of the storey height. For instance, if the storey height is 6 m., minimum thickness of the shear wall is 30cm.

There occurs a horizontal displacement of building under earthquake forces. For this reason, there is also a compulsion of using shear walls in sufficient number. It is also a significant factor affecting architectural design. Kınacı stated that it was nearly impossible to design a building without shear walls. Only two or three-storey-buildings in fourth earthquake zone may be designed only with columns, without

[72] "Mimarlık gibi özgürlüğe ihtiyacı olan, işini yapmak için serbest olmaya mecbur kişi için elini kolunu bağlamak kadar yanlış bir şey olamaz. Benim tasarladığım herhangi bir yapıyı bir mühendis hesap etsin; ne kadar içine demir koyacak, ne yapılacak. İyi bir mühendis zaten onu söyler. Bugün teknoloji olarak da yapılamayacak diye bir şey yok." Ragıp Buluç, interview by the author, Ankara, 26th March 2007.

using shear walls. When a building is designed without shear wall, columns are expected to be stronger in two directions, even if this is a low-rise building. For this reason, column turns into a square form such as 60cm. x 60cm., instead of a rectangle of 30cm. x 100cm.

Kınacı said that there were more restrictions for masonry buildings and structural steel buildings. However, these are not preferred structures in Turkey. In fact, structural steel building was not common in the past, and they are also uncommon today. It is mostly used in industrial buildings. Trend of masonry construction habit on the other hand is nearly abandoned today.

Kınacı also mentioned irregularities in the regulation. According to the previous disaster regulations, shear walls could rest on columns but it is forbidden in 2007 disaster regulation. He also added that some architects were designing buildings as if they were not in earthquake zone. For instance, they may not arrange shear walls in architectural design of a ten-storey-building. Sometimes shear walls in upper floors may be inadaptable to lower floors. Although calculating earthquake forces is civil engineer's work, at first, architects should consider these. He emphasized that designing earthquake resistance of a building should start with architectural design.

CHAPTER 5

SPECIFICATION FOR BUILDINGS TO BE BUILT IN EARTHQUAKE AREAS

Last disaster regulation of Turkey is “Specification for Buildings to be Built in Earthquake Areas” (*Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik*) which was published on 6th March 2006. After a one year period, it came into effect on 6th March 2007 and superseded previous 1998 disaster regulation called “Specification for Structures to be Built in Disaster Areas” (*Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik*). Both of them were prepared in support of Law No.7269 “Measures and Assistance to Be Put into Effect Regarding Natural Disasters Affecting the Life of the General Public” (*Umumi Hayata Müessir Afetler Dolayısıyla Alınacak Tedbirler ve Yapılacak Yardımlara Dair Kanun*).

In the name of new regulation, “disaster” turned into “earthquake”, and “structure” turned into “building”. 2007 disaster regulation is containing only earthquake and buildings. Rules of 1998 disaster regulation for other disasters, such as, flood and avalanches were removed and fire prevention of buildings was enacted as a specific regulation (*Binaların Yangından Korunması Hakkında Yönetmelik*) by Ministry of the Interior (*İç İşleri Bakanlığı*) in 2002. Other kinds of structures, such as, bridge, dam, road and port, are not covered by 2007 disaster regulation.

Sucuoğlu said that there were no important differences between 1998 and 2007 disaster regulations. The name has changed to “earthquake regulation for buildings".[73] After the 1999 Marmara earthquake, which was the most hazardous earthquake of Turkey in the last century, shortcomings of the 1998 disaster regulation was tried to be overcome by the introduction of a new chapter called "seismic assessment and rehabilitation of existing buildings". Hence, the main aim of updating 1998 disaster regulation was to solve the rehabilitation problems of existing buildings.[74]

2007 disaster regulation has two parts: First part is composed of 6 articles in one page which contains aim, scope of the regulation and articles being in force. Second part is the supplement of the regulation and it is placed in the name of "Basis for Buildings in Disaster Areas" (*Deprem Bölgelerinde Yapılacak Binalar Hakkında Esaslar*). All the provisions about earthquake resistant design are placed in this part which has seven chapters.

Chapter numbers were different from 1998 regulation because 2007 regulation was narrowed by removing chapters about disasters except earthquake. Because the existing rules for timber buildings were insufficient for today's conditions, chapter called "earthquake resistant requirements for timber buildings" was also removed from this regulation until a new chapter for modern industrial timber construction be prepared. There is not any specific chapter for adobe buildings in this regulation; it is placed in the chapter for masonry buildings. An additional chapter called "seismic assessment and rehabilitation of existing buildings" was added.[75] (see Table 5.1)

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[73] "2006 yönetmeliği yeni binalar için büyük değişiklikler getirmiyor. 98 yönetmeliğiyle arasında çok büyük değişiklikler yok. Şimdiki adı binalar için deprem yönetmeliği." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

[74] "99 depremi olduktan sonra da 98 yönetmeliğinin herhangi bir yetersizliği ortaya çıkmadı. Ama yeni bir şhtiyaç ortaya çıktı, 'mevcut yapıların değerlendirilmesi ve güçlendirilmesi'. 2006-2007 yönetmeliğinin esas amacı oydu, yeni bir bölüm eklendi." Haluk Sucuoğlu, interview by the author, Ankara, 14thFebruary 2007.

[75] Fikret Kuran & Cahit Kocaman. "Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik'deki (2006) Değişiklikler". Yapı Dünyası Dergisi, October-November 2006, pg.42.

TABLE 5. 1: Contents of 1998 and 2007 Disaster Regulations

1998 SPECIFICATION FOR STRUCTURES TO BE BUILT IN DISASTER AREAS	2007 SPECIFICATION FOR BUILDINGS TO BE BUILT IN EARTHQUAKE AREAS
Part I General Rules Chapter 1 – Scope of the Specification Chapter 2 – Land Unsuitable for Building Construction **Part II Flood and Fire Disaster Prevention** Chapter 3 – Flood Disaster Prevention Chapter 4 – Fire Disaster Prevention **Part III Earthquake Disaster Prevention** Chapter 5 – Objective, General Principles and Scope Chapter 6 – Analysis Requirements for Earthquake Resistant Buildings Chapter 7 – Earthquake Resistant Design Requirements for Reinforced Concrete Buildings Chapter 8 – Earthquake Resistant Design Requirements For Structural Steel Buildings Chapter 9 – Earthquake Resistant Requirements for Timber Buildings Chapter 10 – Earthquake Resistant Requirements for Masonry Buildings Chapter 11 – Earthquake Resistant Requirements for Adobe Buildings Chapter 12 – Foundation and Earthquake Resistant Design Requirements for Foundations Chapter 13 – Final Clauses	Chapter 1 – General Clauses Chapter 2 – Analysis Requirements for Earthquake Resistant Buildings Chapter 3 – Earthquake Resistant Design Requirements for Reinforced Concrete Buildings Chapter 4 – Earthquake Resistant Design Requirements for Structural Steel Buildings Chapter 5 – Earthquake Resistant Requirements for Masonry Buildings Chapter 6 – Foundation and Earthquake Resistant Design Requirements for Foundations Chapter 7 - Seismic Assessment and Rehabilitation of Existing Buildings.

General principle of the earthquake resistant design in 2007 disaster regulation is stated in article 1.2.1:

> The general principle of earthquake resistant design to this Specification is to prevent structural and non-structural elements of buildings from any damage in low-intensity earthquakes; to limit the damage in structural and non-structural elements to reliable levels in medium intensity earthquakes, and to limit permanent structural failures in high-intensity earthquakes in order to avoid the loss of life.[76]

2007 disaster regulation has six chapters. Some of these chapters are only about requirement analysis for engineers and some of these chapters may affect architectural design. These chapters are defined briefly in the following subtitles:

5.1. General Clauses

In the first chapter of the 2007 disaster regulation, there are sections related to scope and general principles of the regulation. In this chapter, it is emphasized that this regulation is effective for reinforced concrete buildings, steel buildings and masonry buildings.

5.2. Analysis Requirements for Earthquake Resistant Buildings

This chapter contains seismic loads and analysis requirements to be applied to the earthquake resistant design of reinforced concrete buildings and structural steel buildings. In addition to this chapter, there are specific chapters for both reinforced concrete buildings and structural steel buildings. Masonry buildings are not mentioned in this chapter, they are only mentioned in a specific chapter.

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[76] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.2. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

General principle of building constructional system is mentioned in article 2.2.1.1. of this regulation:

> The building structural system resisting seismic loads as a whole as well as each structural element of the system shall be provided with sufficient stiffness, stability and strength to ensure an uninterrupted and safe transfer of seismic loads down to the foundation soil.[77]

There is a subtitle called "Irregular Buildings" which is the most significant part of the disaster regulation for architects. Irregular buildings are defined in this part as "buildings whose design and construction should be avoided because of their unfavorable seismic behavior". The concept of "irregular buildings" was not addressed in 1975 disaster regulation. This concept was first mentioned in 1998 disaster regulation. After experiences from past earthquakes, it was understood that irregular design of buildings is one of the reasons for building damage which can be seen in both reinforced concrete buildings and masonry buildings.[78] Types of irregular buildings and their effects are examined in detail in the following chapter of this thesis.

In the chapter of analysis requirements for earthquake resistant buildings, buildings are also categorized into four groups according to their importance factor. Since earthquake safety is one of the significant factors that increases the cost of buildings, it is not expected for all buildings to resist earthquakes in the same standard. As mentioned in article 1.2.1, in high-intensity earthquakes, it is only expected to limit permanent structural failures in order to avoid the loss of life. By categorizing buildings, some types of buildings are considered more significant, so they are built stronger. As it is seen in Table 5.2, the first group includes buildings to be utilized after the earthquake and buildings explaining hazardous materials. This type of

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[77] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.5. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

[78] "Düzensizlik kavramı 75 yönetmeliğinde yoktu. 97 yönetmeliğinde getirildi. Yapısal hasarlar yol açan şeyler arasında "düzensizlik faktörü" var. Bu düzensizlik faktörü yığma binalarda da oluyor, beton binalarda da." Erhan Karaesmen, interview by the author, Ankara, 13th February 2007.

buildings should be the most durable during and after an earthquake. These buildings are hospitals, fire fighting buildings, telecominication buildings, transportation buildings, power generation and distribution facilities, government administration buildings and so on. Second group is intensively and long-term occupied buildings and buildings preserving valuable goods, such as, schools, dormitories, military barracks, museums and so on. Third group is intensively but short-term occupied buildings, such as, sport facilities, cinema, theatre, concert halls and so on. The last and the least important group is buildings other than defined buildings, like residential and office buildings, hotels, industrial structures and so on.

TABLE 5. 2: Importance Factor for Different Kinds of Buildings in 2007 Disaster Regulation

Purpose of Occupancy or Type of Building	*Importance Factor* (I)
1. Buildings to be utilised after the earthquake and buildings containing hazardous materials **a)** Buildings required to be utilised 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.)	**1.0**

5.3. Earthquake Resistant Design for Reinforced Concrete Buildings

The scope of this chapter is stated in article 3.1.1:

> Dimensioning and reinforcing of all structural elements of reinforced concrete buildings to be built in seismic zones shall be performed, along with current enforced relevant standards and codes, primarily in accordance with the requirements of this chapter.[79]

This chapter is composed of general rules, columns of high ductility level, beams of high ductility level, beam-column joints of frame system of high ductility level, structural walls of high ductility level, columns of nominal ductility level, beams of nominal ductility level, beam-column joints of frame systems of nominal ductility level, structural walls of nominal ductility level, slabs, special requirements for prefabricated buildings, requirements for reinforced concrete application design drawings.

Beside these, there is also a term "short column" which architects should know. It was written in the regulation that short columns might be developed due to structural arrangements or due to openings provided in infill walls between columns. In case where short columns cannot be avoided, regulation advices an analysis method for shear force of transverse reinforcement. (see Figure 5.1)

Short columns occur when the infill walls between the columns are not constructed all along the full height in any storey. They are also created by window openings or designing a storey shorter than the others in order to create a technical instrumentation storey for air conditioning etc. [80]

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[79] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.30.
http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

[80] Semih Tezcan & Cenk Alhan. Behavior of Irregular Structures Under Earthquake Loading.
İstanbul: Turkish Earthquake Foundation, Teknik Rapor TDV/TR 027-44, September 1999, pp.15-16.

Short columns are susceptible to be damaged heavily in earthquakes because their shear forces are larger than normal height columns. In order to avoid this, an adequate space should be left between the infill walls and the columns. If the short column effect cannot be avoided, such columns should be designed agaist large shear forces as mentioned in the regulation. Therefore, building cost increases due to short columns.[81]

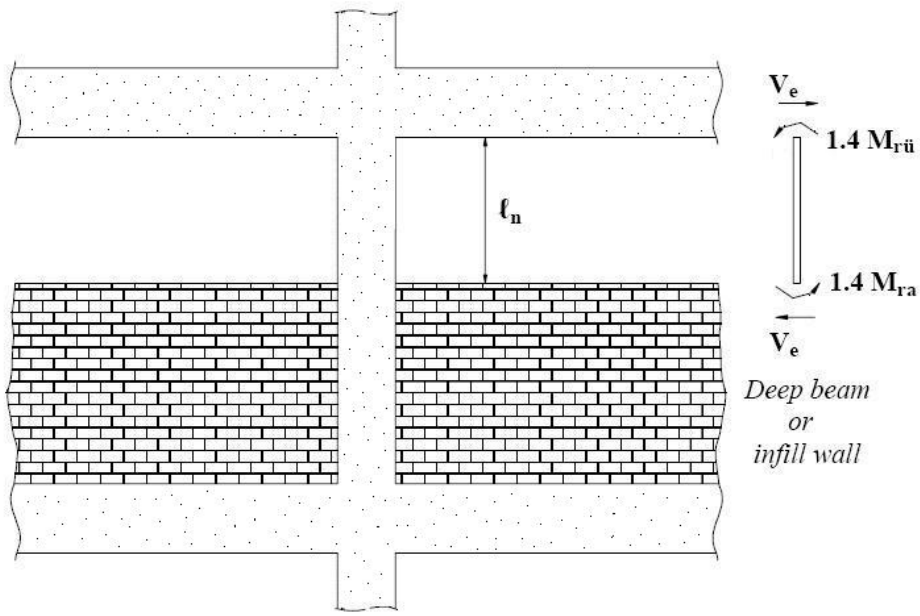

Figure 5. 1 Short column.
Drawing from Specification for Buildings to be Built in Earthquake Areas. 2006.

Zafer Kınacı, a practicing civil engineer, summarized the general restrictions for reinforced concrete building design. He said that the committee preparing the disaster regulation wanted buildings having a plan pattern with shear walls placed

[81] Semih Tezcan & Cenk Alhan. Behavior of Irregular Structures Under Earthquake Loading. İstanbul: Turkish Earthquake Foundation, Teknik Rapor TDV/TR 027-44, September 1999, pp.15-16.

symmetrically. According to 2007 disaster regulation, irregular buildings can be built, but if these kinds of irregular designs are proposed, an extra fictious earthquake load should be taken into account. In such cases, more shear walls are needed in structures. By the increase in the earthquake load, it becomes impossible to design without shear walls. Especially, in tall buildings, amount of shear walls increased due to the torsion of the columns. The more storeys you design, the more shear wall you need.[82]

5.4. Earthquake Resistant Design for Structural Steel Buildings

The scope of this chapter is stated in article 4.1.1:

> Dimensioning and design of connections of all structural elements of structural steel buildings to be built in seismic zones shall be performed along with currently enforced relevant standards and codes, primarily in accordance with the requirements of this chapter.[83]

There are not major differences in this part between 1998 and 2007 disaster regulations. Only an instructional appendix was added to 2007 regulation.

[82] "Deprem yönetmeliğini hazırlayanların istediği sabun kalıbı gibi, bütün perdeleri gayet simetrik yerleştirilmiş binalar. Bunlar *(düzensizlikteki maddeler)* yapılamıyor değil. Bunlar yapılıyor da, bunları yaptığınız zaman deprem yükü arttırılıyor. O zaman da daha fazla perde koymanız gerekiyor. Yani getirilen sınırlamalar şimdilik ilk başta bunlar. Tabi deprem yüklerinin fazla olması dediğim gibi perdesiz çözümleri imkansızlaştırıyor. Çok katlı binalarda bilhassa kolonlarda burkulma sorunu çıktığı için perde miktarını daha da arttırmamız gerekiyor. Bina katı arttıkça perde miktarını arttırmanız gerekiyor." Zafer Kınacı, interview by the author, Ankara, 21st March 2007.

[83] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.30. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

5.5. Earthquake Resistant Design for Masonry Buildings

Rules for masonry buildings in this regulation are the most restrictive rules for architectural design. This chapter includes statements that restrict architectural design with regard to the number of storeys of buildings, wall thicknesses.

Kınacı, a civil engineer in practice, said that civil engineers did not recommend architects to design masonry buildings due to the restrictions brought by the regulation. Only small buildings with regular shape, with small windows can be designed as masonry building according to this regulation. Regulation also restricts the sizes and places of the blank spaces in the building. Thus, architects are not able to design a villa or an attractive building as masonry building. Only a storehouse can be designed with these rules. It is not allowed to design a composite building having a combination of load bearing walls and columns together.[84]

The allowed maximum number of storeys of masonry buildings according to are shown in Table 5.3. according to earthquake zones:

TABLE 5. 3: Maximum Number of Storeys for Masonry Buildings

Earthquake zone	Maximum number of storeys
1	2
2, 3	3
4	4

Minimum wall thicknesses are also determined according to earthquake zones as shown in Table 5.4.

[84] "Bir de yığma binalarla ilgili bir takım sınırlamalar var ama artık ben yığma bina tavsiye etmiyorum mimarlara. Çünkü ancak nedir? Hani bir depo gibi bir şey, çok ufak bir bina, pencereleri küçük, çok düzgün olduğu zaman yığma yapabiliyorsunuz. Çünkü duvarların içerisindeki delikleri sınırlıyor. Deliklerin yerini sınırlıyor. O kadar sınırlama getiriyor ki, hani böyle güzel bir villa, güzel bir yapı yığma olarak yapılamıyor. Pencerelerin boyutları sınırlı. Pencerelerin işte köşeden olan mesafeleri sınırlı. Böyle eskisi gibi 'yükleri bulduğumuz duvarlara taşıtalım sonra olmazsa bir kolon koyalım' o tip yapılara müsaade edilmiyor." Zafer Kınacı, interview by the author, Ankara, 21stMarch2007.

TABLE 5.4: Minimum Wall Thicknesses of Masonry Buildings According to Earthquake Zones in 2007 Disaster Regulations

Earthquake Zones	Numbers of Allowed Floors	Natural Stone (mm)	Concrete (mm)	Brick and Gas concrete	Others (mm)
1, 2, 3 and 4	Basement	500	250	1	200
	Ground floor	500	-	1	200
1, 2, 3 and 4	Basement	500	250	1,5	300
	Ground floor	500	-	1	200
	First floor	-	-	1	200
2, 3 and 4	Basement	500	250	1,5	300
	Ground floor	500	-	1,5	300
	First floor	-	-	1	200
	Second floor	-	-	1	200
4	Basement	500	250	1,5	300
	Ground floor	500	-	1,5	300
	First floor	-	-	1,5	300
	Second floor	-	-	1	200
	Third floor	-	-	1	200

Figure 5.2 shows maximum door and window openings in structural wall. Figure 5.3 shows limited total length of the structural wall according to gross floor area. The building importance factor (*I*), which is mentioned in the second chapter of the regulation, is also considered in this restriction.

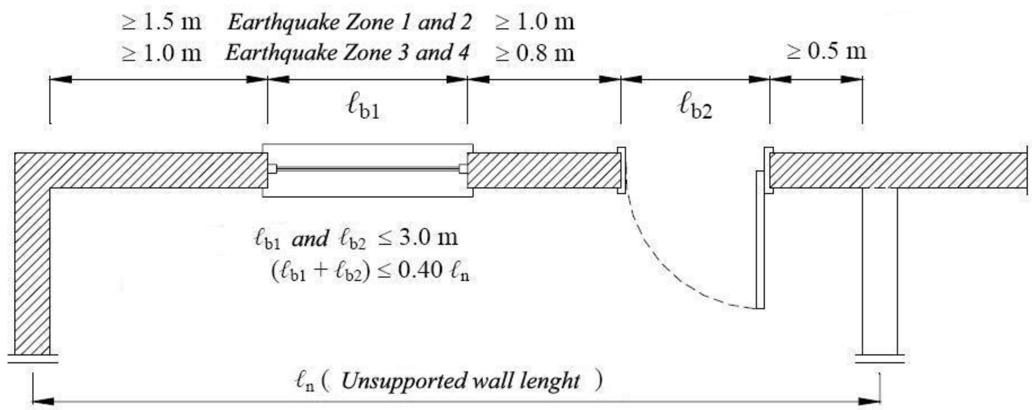

Figure 5. 2 Door and window openings in structural walls.
Drawing from Specification for Buildings to be Built in Earthquake Areas. 2007.

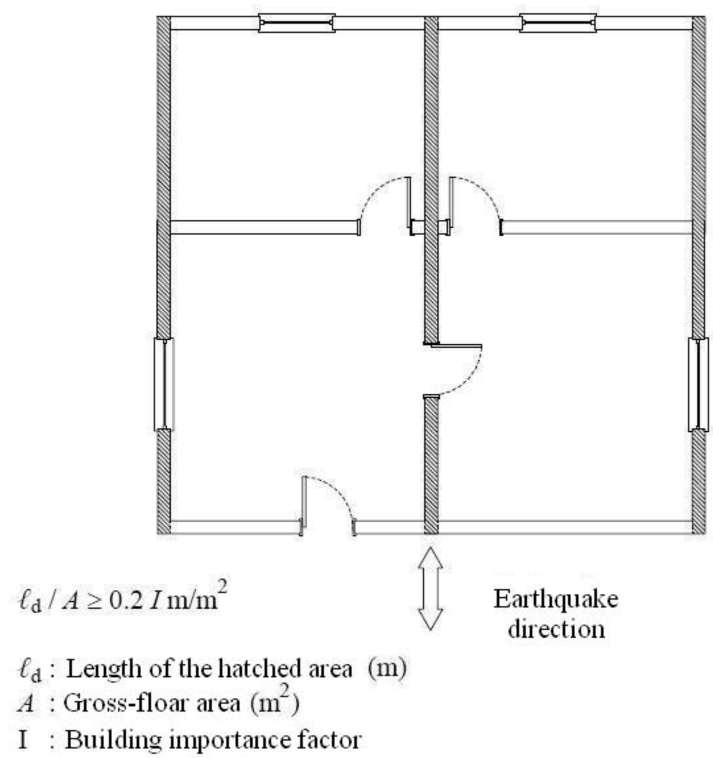

Figure 5. 3 Lenght limitation of structural walls in masonry buildings.
Drawing from Specification for Buildings to be Built in Earthquake Areas. 2007.

One example of masonry houses built according to 1998 disaster regulation is shown in Figure 5.4. It is a single-storey masonry house which was built 2001 in Bozcaada.

As mentioned, it is a small building with small doors and windows.

Figure 5. 4 A masonry house in Bozcaada.
(Selçuk Erdoğmuş, Seda Bildik Erdoğmuş, 2001)
Source: http://arkiv.arkitera.com/p4582-bozacaadada-bag-evi.html

5.6. Foundation and Earthquake Resistant Design Requirements for Foundations:

Reinforced concrete buildings, structural steel buildings, masonry buildings, and buildings to be strengthened should obey the rules stated in this chapter for their foundations. At the beginning of the chapter, lands are categorized according to its origin, tightness, pressure resistance, thickness of its upper layer and so on. The rest of the chapter explains the minimum requirements for foundation design.

5.7. Seismic Assessment and Rehabilitation of Existing Buildings:

"Seismic Assessment and Rehabilitation of Existing Building" was the main reason for the revision of the 1998 disaster regulation. After the Marmara Earthquake in 1999, seismic assessment and rehabilitation of existing buildings were needed. Karaesmen stated that this need was abused in private sector after 1999 earthquakes. Hence, in order prevent this abuse; rules of seismic assessment and rehabilitation of existing buildings are prescribed in a specific chapter in 2007 disaster regulation.[85]

[85] "Marmara depreminden sonra, devlet bir takım krediler aldı. Belirlediği öncelikle kamu binalarını onarım ve güçlendirme çalışmalarına başladı. Özel kesimde de buna meraklı bazı insanlar oldu. 99 depreminden sonra "güçlendirme" diye bir furya oldu insanlar arasında. Bu furya'da vatandaşın korkusu istismar edildi. Dolayısıyla yanlış işler yapıldı. Yavaş bir süreç içinde de olsa devlet bir şeyler yaptırıyor, vatandaş da yaptırabilir diye buna bir tarif getirme ihtiyacı doğdu. O tarif onarım ve güçlendirme ile ilgili yeni bir bölüm eklenerek getirildi." Erhan Karaesmen, interview by the author, Ankara, 13th February 2007.

CHAPTER 6

IRREGULAR BUILDINGS

6.1. Impact of Irregularity

According to experiences from past earthquakes of Turkey, the collapses or damages of buildings were directly or indirectly related to the irregularities developed during the architectural design. As the irregularity of a building is one of the main causes of heavy damages, there has been a title called "Irregular Buildings" in Turkish disaster regulations since 1998. Under this title, some types of buildings are defined irregular, and architects and engineers are advised to avoid these kinds of irregular configuration designs. In 2007 disaster regulation, this is clearly stated in article 2.3.1:

> Because of the negative effects in their response to earthquake, design and construction of buildings that have any of these irregularities should be avoided.[86]

Article 2.2.1.4 of 2007 disaster regulation states that:

> Design and construction of irregular buildings should be avoided. Structural system should be designed to be symmetrical or close to symmetrical in plan and torsion should be avoided as much as possible. Related to this fact, rigid

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[86] Revised from Semih Tezcan & Cenk Alhan. Behavior of Irregular Structures Under Earthquake Loading. İstanbul: Turkish Earthquake Foundation, Teknik Rapor TDV/ TR 027-44, September 1999, p.2.

> structural members, such as shear walls, should be placed so that torsion would not be created. Soft storey and weak storey irregularities should be avoided.[87]

Hazardous effect of irregular configuration is also mentioned in other countries. For instance, in USA, in the Commentary to the 1997 NEHRP Recommended Provisions for Seismic Regulations for New Buildings, it is noted that:

> The Provisions were basically derived for buildings having regular configurations. Past eartqaukes have repeatedly shown that buildings having irregular configurations suffer greater damage than buildings having regular configurations. This situation prevails even with good design and construction.[88]

As mentined above, even with good design and construction, irregular buildings are more vulnerable to earthquake hazards. Figure 6.1 shows the irregularities defined in 1997 NEHRP Provisions. It is a graphic interpretation of Table 5.2.3.1 and Table 5.2.3.2 in original regulation. The impact of configuration irregularity was first introduced into the Uniform Building Code (UBC) of the USA in 1973. Starting from 1988, the UBC quantified some configuration parameters to establish the condition of regularity or irregularity, and laid down some specific analytic requirements for irregular structures.[89] In other countries, there are also some examples of restrictions against irregularities in configuration. For instance, in the earthquake regulation prepared by the SEAOC and especially in the UBC, there are some prohibiting rules against the usage of irregularities in hospitals and school buildings. If any project of a school or hospital building has an irregularity, it is hard to be approved by the Municipal authorities in the State of California in the USA.[90]

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[87] Revised from Semih Tezcan & Cenk Alhan. Behavior of Irregular Structures Under Earthquake Loading. İstanbul: Turkish Earthquake Foundation, Teknik Rapor TDV/ TR 027-44, September 1999, p.2.

[88] Arnold, Christopher. "Architectural Considerations". The Seismic Design Handbook, edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, p.283.

[89] Ibid.

[90] Semih Tezcan & Cenk Alhan. Behavior of Irregular Structures Under Earthquake Loading. İstanbul:Turkish Earthquake Foundation, Teknik Rapor TDV/ TR 027-44, September 1999, p.1.

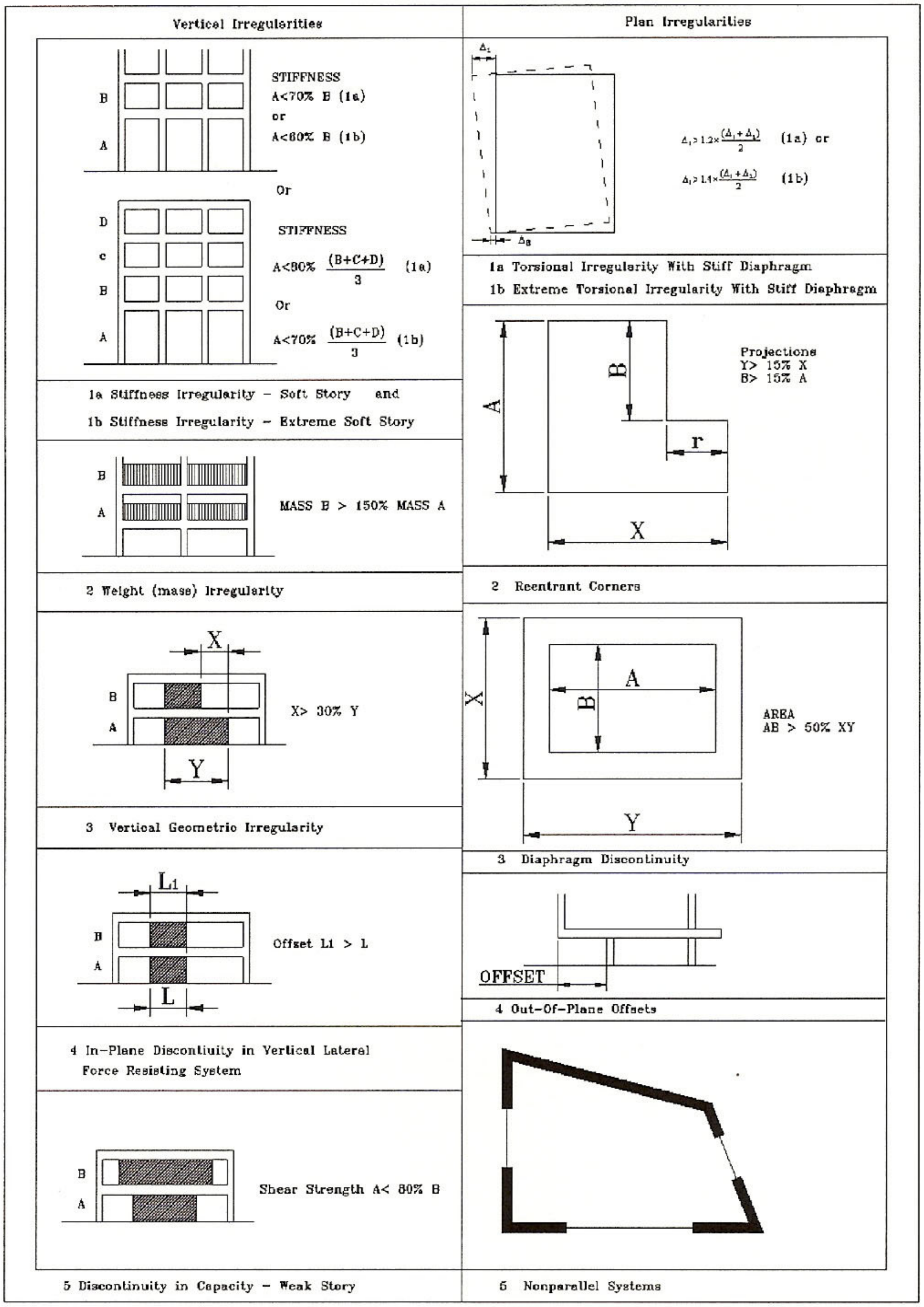


Figure 6. 1 Irregularities Defined in the 1997 NEHRP Provisions
Source: C. Arnold, "Architectural Considerations", Structural Design Handbook, edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, p.286.

Definitions of irregularities in configuration vary in different regulations. For instance, in the Commentary to the 1980 SEAOC Recommended Lateral Force Requirements and Commentary, there were over 20 types of "irregular structures or framing systems" stated as examples of designs that should involve extra analysis and dynamic consideration. These types are illustrated in Figure 6.2.[91]

> The list of irregularities defined the conditions, but provided no quantitative basis for establishing the relative significance of a given irregularity. These irregularities vary in the importance of their effects, and their influence also varies in accord with the particular geometry or dimensional basis of the condition. The determination of the point at which a given irregularity becomes serious is a matter of judgment. The SEAOC Commentary explained the difficulty of going beyond this basic listing as follows:
> Due to the infinite variation of irregularities (in configuration) that can exist, the impracticality of establishing definite parameters and rational rules for the application of this Section are readily apparent.[92]

[91] Arnold, Christopher. "Architectural Considerations". The Seismic Design Handbook, edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, p.283.

[92] Ibid., p.285.

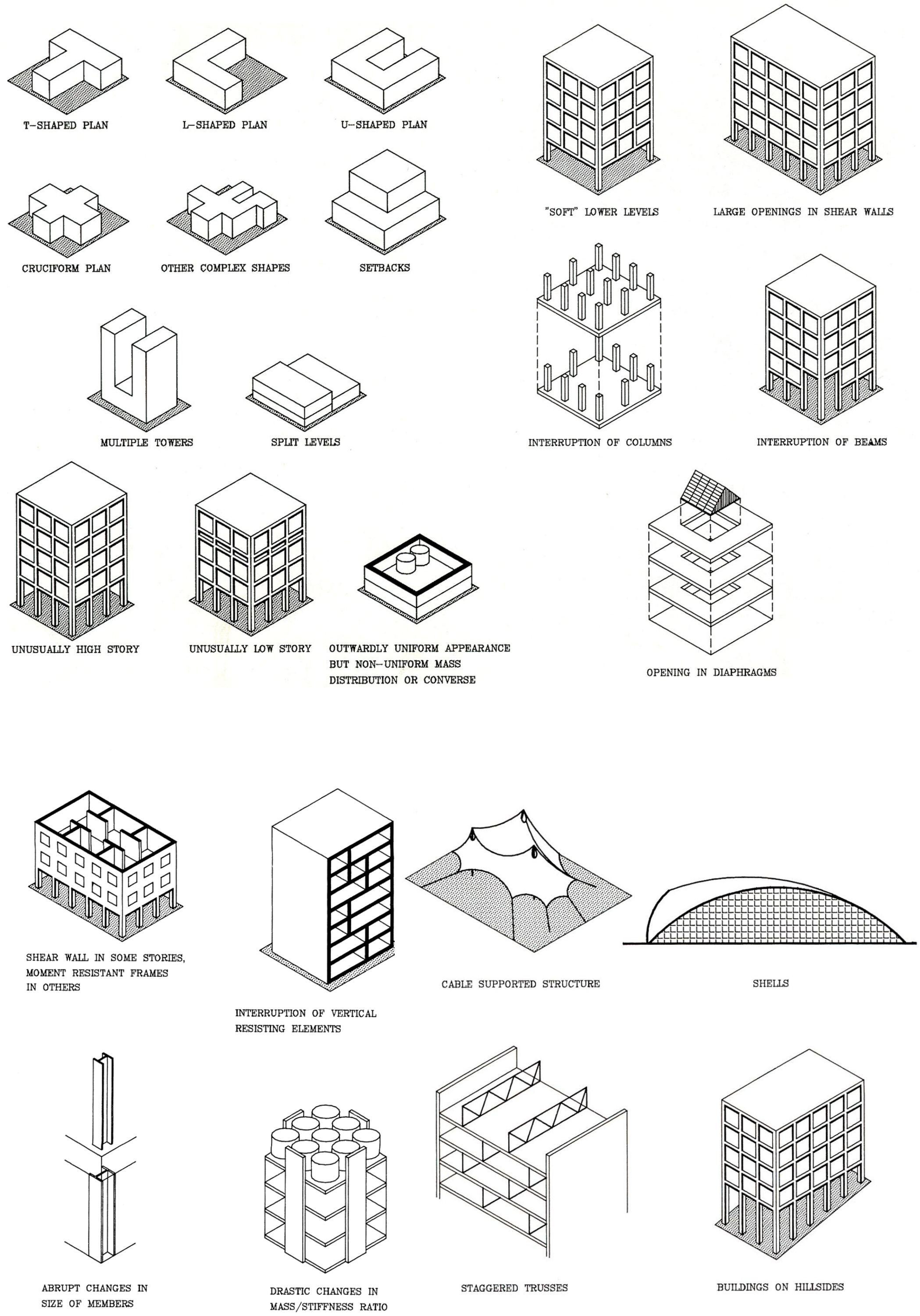


Figure 6. 2 Graphic interpretation of "Irregular Structures or Framing Systems" from the commentary to the "SEAOC Recommended Lateral Force Requirements and Commentary" (a) Buildings with Irregular Configuration (b) Buildings with abrupt changes in lateral stiffness (c) Buildings with abrupt changes in lateral stiffness (d) Unusual or novel structural features.
Source: C. Arnold, "Architectural Considerations", Structural Design Handbook. edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, p.284.

6.2. Irregularities in Turkish Disaster Regulation

In 2007 disaster regulation, six types of irregular structures were defined. As seen from Figure 6.3, these irregularities, first divided into two groups. The first grup is about irregularities seen in plan called “A-type of irregularities” and second one is concerned with irregularities in elevation called “B-type of irregularities”. Irregularities in plan are further subdivided into three groups. These are torsional irregularity, floor discontinuities and projections in plan. In 1998 disaster regulation, there was also a fourth group called nonparallel axes of structural elements. Irregularities in elevation are also further subdivided into three groups. These are weak storey irregularity, soft storey irregularity and discontinuity of vertical structural elements. These irregularity types and their related item numbers are listed in a table in 2007 disaster regulation (see Table 4.2).

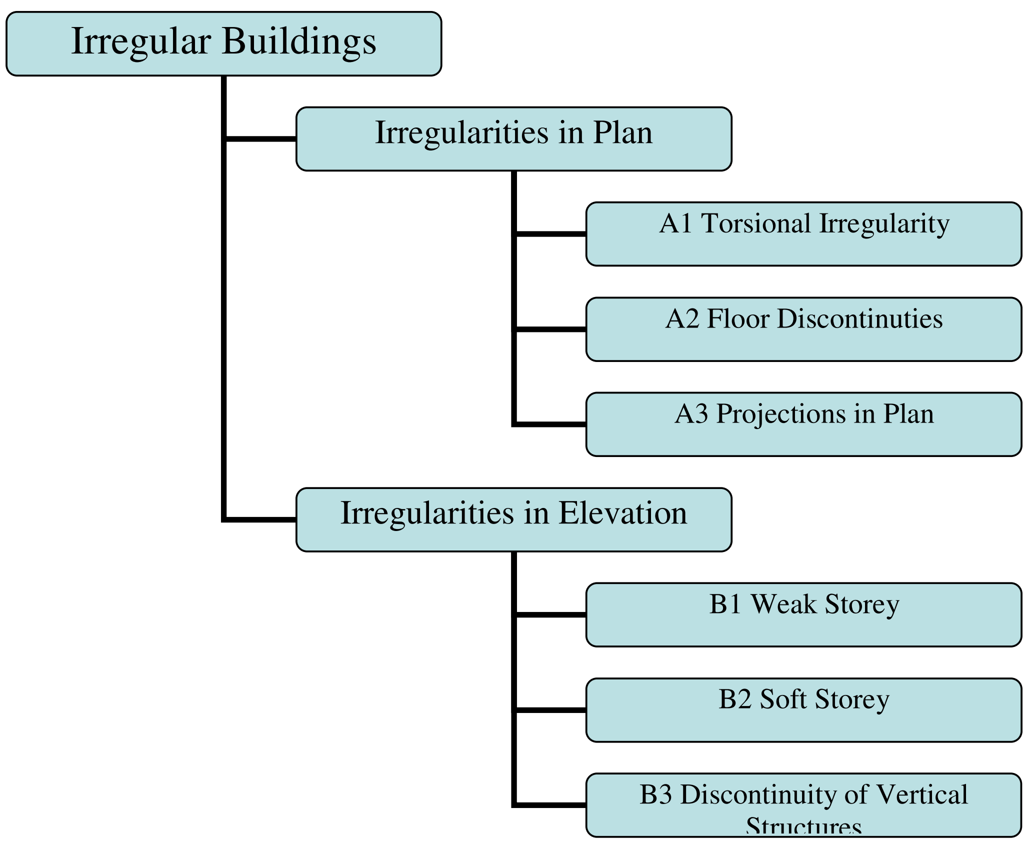


Figure 6. 3 Irregular Building Types of 2007 Turkish disaster regulation.
Source: Drawn by the author.

TABLE 6. 1: Irregular Buildings in 2007 Disaster Regulation

A – *IRREGULARITIES IN PLAN*	*Related Items*
A1 – Torsional Irregularity : The case where *Torsional Irregularity Factor* η_{bi}, which is defined for any of the two orthogonal earthquake directions as the ratio of the maximum storey drift at any storey to the average storey drift at the same storey in the same direction, is greater than **1.2**. $[\eta_{bi} = (\Delta_i)_{max} / (\Delta_i)_{ort} > 1.2]$ *Storey drifts shall be calculated in accordance with* **2.7**, *by Considering the effects of* ± *%5 additional eccentricities.*	**2.3.2.1**
A2 – Floor Discontinuities : In any floor ; **I** - The case where the total area of the openings including those of stairs and elevator shafts exceeds 1/3 of the gross floor area, **II** – The cases where local floor openings make it difficult the safe transfer of seismic loads to vertical structural elements, **III** – The cases of abrupt reductions in the in-plane stiffness and strength of floors.	**2.3.2.2**
A3 – Projections in Plan : The cases where projections beyond the re-entrant corners in both of the two principal directions in plan exceed the total plan dimensions of the building in the respective directions by more than **20%**.	**2.3.2.2**
B – *IRREGULARITIES IN ELEVATION*	*Related Items*
B1 – Interstorey Strength Irregularity (*Weak Storey*) : In reinforced concrete buildings, the case where in each of the Orthogonal earthquake directions, *Strength Irregularity Factor* η_{ci} which is defined as the ratio of the *effective shear area* of any storey to the *effective shear area* of the storey immediately above, is less than **0.80**. $[\eta_{ci} = (\sum A_e)_i / (\sum A_e)_{i+1} < 0.80]$ *Definition of effective shear area in any storey* : $\sum A_e = \sum A_w + \sum A_g + 0.15 \sum A_k$	**2.3.2.3**
B2 – Interstorey Stiffness Irregularity (*Soft Storey*) : The case where in each of the two orthogonal earthquake directions, *Stiffness Irregularity Factor* η_{ki} , which is defined as the ratio of the average storey drift at any storey to the average storey drift at the storey immediately above, is greater than **1.5**. $[\eta_{ki} = (\Delta_i)_{ort} / (\Delta_{i+1})_{ort} > 1.5]$ *Storey drifts shall be calculated in accordance with* **2.7**, *by considering the effects of* ± *%5 additional eccentricities.*	**2.3.2.1**
B3 - Discontinuity of Vertical Structural Elements : The cases where vertical structural elements (columns or structural walls) are removed at some stories and supported by beams or gusseted columns underneath, or the structural walls of upper stories are supported by columns or beams underneath	**2.3.2.4**

Figure 6. 4 Architectural 3D Model of SSK Adapazarı Hospital.
(Cem Altınöz, Önder Kaya, Enis Öncüoğlu, 2002)
Source: http://arkiv.arkitera.com/p6045-ssk-250-yatakli-adapazari-hastanesi.html

Figure 6. 5 SSK Adapazarı Hospital as built.
(Cem Altınöz, Önder Kaya, Enis Öncüoğlu, 2004)
Source: http://arkiv.arkitera.com/p6045-ssk-250-yatakli-adapazari-hastanesi.html

One example of building designed after 1998 regulation is SSK Adapazarı Hospital. First building collapsed after 1999 Marmara earthquake. In 2002, a new building was designed. Figure 6.4 shows 3D model of the hospital in 2002 and Figure 6.5 shows the hospital as built in 2004 from web archive of Architera Architecture Center. As seen in these photographs, 3D architectural model and the hospital as built are different. There may be various reasons of these differences between the first and the second photographs, such as economic reasons. Whatever the reasons are, it can be derived from these photographs that first one has lots of irregularities defined in 1998 and 2007 disaster regulations, such as weak story, soft story, projections in plan, and also short columns. On contrary to this, second photograph is more regular in design with its more simple forms.

6.2.1 Torsional Irregularity (A1)

The first type of irregularity in both 1998 and 2007 disaster regulation is "torsional irregularity". It is also called "A1 type of irregularity". Table 2.1 in 2007 disaster regulation states that:

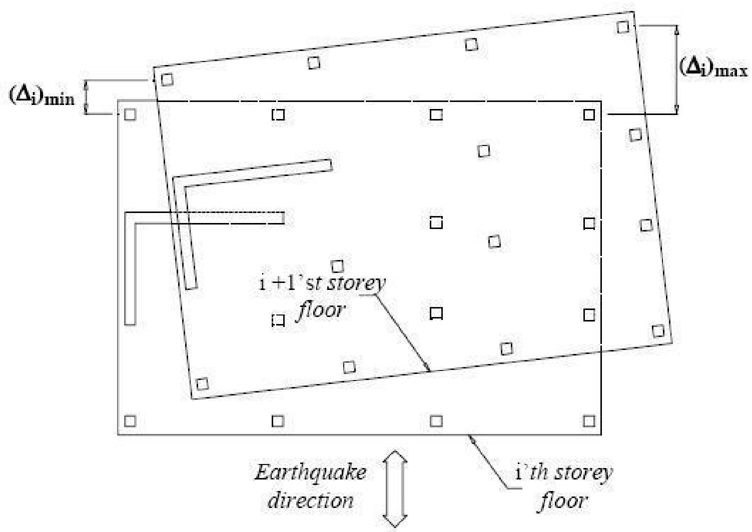
> The case where Torsional Irregularity Factor η_{bi}, which is defined for any of the two orthogonal earthquake directions as the ratio of the maximum storey drift at any storey to the average storey drift at the same storey in the same direction, is greater than 1.2.[93]

There is a coefficient of torsional irregularity "η_b" defined in the regulation. It is the ratio of the maximum relative storey displacement of storey to the average relative storey displacement of that storey for any one of the earthquake directions, which are orthogonal to each other. In case η_b is greater than 1.2, there exists a torsional

[93] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.7. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

irregularity.[94] This article is supported with a drawing and formulae summarizing this definition. (see Figure 6.6)

In addition to this description, it is mentioned in article 2.3.2.1 in 2007 disaster regulation that A1 type of irregularity governs the selection of the method of seismic analysis as specified in article 2.6.[95]



In the case where floors behave as rigid diaphragms in their own planes:

$$(\Delta_i)_{ave} = 1/2\ [(\Delta_i)_{max} + (\Delta_i)_{min}]$$

Torsional irregularity factor :

$$\eta_{bi} = (\Delta_i)_{max} / (\Delta_i)_{ort}$$

Torsional irregularity : $\eta_{bi} > 1.2$

Figure 6. 6 Torsional irregularity (A1).
Drawing from Specification for Buildings to be Built in Earthquake Areas. 2007.

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94 Semih Tezcan & Cenk Alban. Behavior of Irregular Structures Under Earthquake Loading. İstanbul: Turkish Earthquake Foundation, Teknik Rapor TDV/ TR 027-44, September 1999, pg.3.

95 Revised from "Specification for Structures to be Built in Disaster Areas". (English translation prepared under the direction of M.Nuray Aydınoğlu). p.6. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

Torsion in a building is caused by unsymmetrical distribution of rigidity. If distribution of columns and shear walls are unsymmetric, the rigidities are all accumulated in one side of the building during the vibration. Because of large displacements, columns in weak side are damaged excessively which may result in the collapse of the weak part of the building.[96]

Karaesmen stated that this type of irregularity commonly existed in the buildings which are looking to street in frontview and adjacent in backview.[97] Store front design, particularly on corner lots and in free-standing commercial and industrial buildings with varied openings around the perimeter are common examples of this condition.[98]

Torsional irregularity can be avoided by designing key resisting elements. By this way, they yield at approximately the same time and maintain symmetry of resistance.[99] (see Figure 6.7) Reducing the possibility of torsion, and the balance the resistance around the lightweight materials, to reduce the stiffness discrepancy between these walls and the rest of the structure is the objective of any solution to this problem.[100]

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[96] Semih Tezcan & Cenk Alban. Behavior of Irregular Structures Under Earthquake Loading. İstanbul: Turkish Earthquake Foundation, Teknik Rapor TDV/ TR 027-44, September 1999, p.7.

[97] "Binanın ağırlığının ve kütlesinin getirdiği bir ağırlık merkezi var. Bir de binaya her iki doğrultudan gelen deprem kuvvetini karşılamak üzere "rjitlik merkezi" var. Bazı mimari projelerde, mimar bazı yerlere perde olmasını istemez, kolonlarla çözülmesini ister. Perdelerin yoğun olduğu taraf daha rijitdir, hareketi zordur; kolonların yoğun olduğu taraftaysa hareket daha kolaydır. Rijitlik merkezi bu az hareket eden nesneye doğru kayar. Ağırlık merkeziyle rijitlik merkezi arasında büyük fark bulunması halinde, bina rijitlik merkezi etrafında döner. Çünkü deprem kuvveti oraya çarpar. Düzlemsel burulma dediğimiz o. Özellikle bir tarafı duvar hakim binalarda rastlanabilen bir olaydır. Ön tarafı caddeye bakıyordur, ağır cephe yoktur. Arkası rüzgara bakıyordur, duvarlar kalındır. Mimar bunun kötü bir iş olduğunu, binanın başına bir iş geleceğini açıkçası düşünmez. O öncelikle şunları düşünür; ışık, rüzgar, rüzgara karşı binayı koruma…" Erhan Karaesmen, interview by the author, Ankara, 13th February 2007.

[98] Christopher Arnold. "Architectural Considerations". The Seismic Design Handbook. Edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, pp.298.

[99] Ellis L. Krinitzsky, James P. Gould, Peter H. Edinger. Fundamentals of Earthquake-resistant Construction. New York: John Wiley & Sons, Inc., 1993, pp.204-205.

[100] Christopher Arnold. "Architectural Considerations". The Seismic Design Handbook. Edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, pp.299-300.

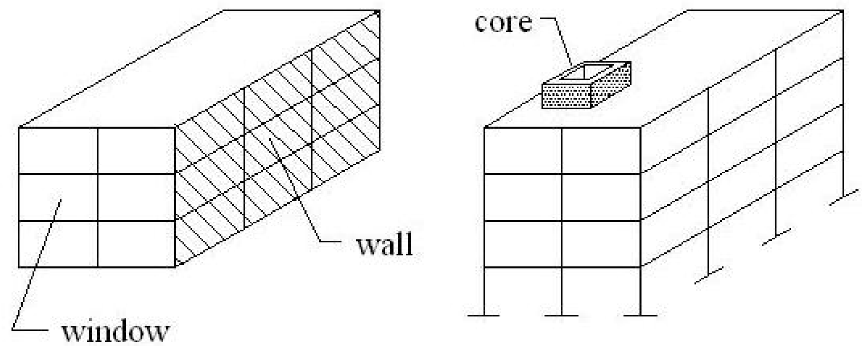

Figure 6. 7 Examples of torsional irregularity.
Source: M. Atçı & R. Palulu, "Depreme Dayanıklı Betonarme Yapılarda Mimari Tasarımın Önemi". TÜBİTAK Deprem Sempozyumu. Erzincan ve Dinar Deneyimleri Işığında Türkiye'nin Deprem Sorunlarına Çözüm Arayışları: Bildiriler Kitabı, edited by Tuğrul Tankut. Ankara, 1996.

6.2.2 Floor Discontinuities (A2)

The second type of irregularity is “floor discontinuities” which is also called “A2 type of irregularity”. Table 2.1 in 2007 disaster regulation states that:

> In any floor;
> I – The case where the total area of the openings including those of stairs and elevator shafts exceeds 1/3 of the gross floor area,
> II – The cases where local floor openings make it difficult the safe transfer of seismic loads to vertical structural elements,
> III – The cases of abrupt reductions in the in-plane stiffness and strength of floors.[101]

There are also drawings in Figure 6.8 supporting this definition in the 2007 disaster regulation:

[101] Revised from “Specification for Structures to be Built in Disaster Areas”, 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.7. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

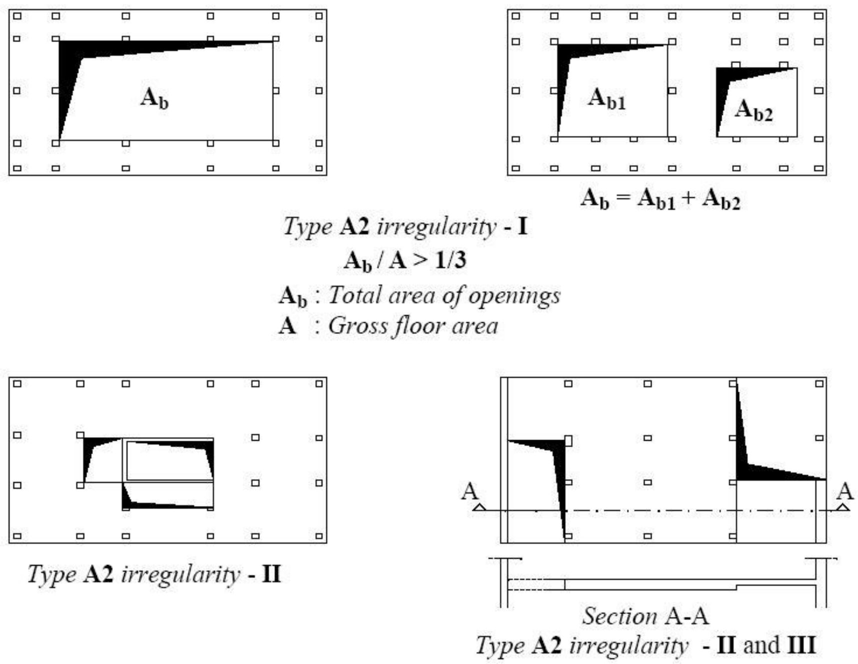

Figure 6. 8 Floor discontinuities (A2)
Drawing from Specification for Buildings to be Built in Earthquake Areas. 2007.

Floor discontinuity exists if the total area of holes including stairs and elevators exceeds the 1/3 of the gross floor area. These holes cause difficulty in transferring the lateral load to the vertical structural members.[102]

Architectural requirements, such as staircases, elevators and duct shafts, skylights, and atria, results in varity of slab penetrations.[103] This irregularity is widespread in

[102] "Deprem kuvvetinin dağılımında ve aktarılışında en sürekli yer alan unsur döşemedir. Çünkü kolonlar ve kirişlerin hepsi seyrektir. Kolon sadece kirişle bağlandığı zaman bu yeterli olmuyor. Döşeme, kolon başları arasındaki ilişkiyi sağlıyor, kolon başlarının hepsinin eşit miktarda hareket etmesini sağlıyor. Boşluk, döşemenin bu özelliğini ortadan kaldırıyor." Erhan Karaesmen, interview by the author, Ankara, 13thFebruary 2007.

[103] Christopher Arnold. "Architectural Considerations". The Seismic Design Handbook. Edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, pp.303.

buildings, such as, shopping centers, hotels which have large foyer, lounge and so on.[104]

Article 2.3.2.2 in 2007 disaster regulation states that:

> In buildings with irregular types A2 and A3, it shall be verified by calculation in the first and second seismic zones that the floor systems are capable of safe transfer of seismic loads between vertical structural elements. [105]

This irregularity is not strictly forbidden in 2007 disaster regulation but it is obligatory to show with calculations that the transformation of lateral loads to the vertical elements is safely achieved. The slab should be subdivided into adequate number of finite elements and 5 per cent additional eccentricity should be separetly applied for each element. Hence, lateral loads are safely transferred to the vertical elements by way of analytical calculations.[106]

6.2.3 Projections in Plan (A3)

Projection in plan is the third irregularity of both 1998 and 2007 disaster regulations. It is also called “A3 type of irregularity”. Table 2.1 in 2007 disaster regulation states that:

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[104] “Büyük alışveriş merkezlerinde, zengin olsun diye iki kat boş bırakılıyor. Döşeme yine var ama iki kat büyük bir boşluk var. Birden bire çok yüksek bir kolon çıkıyor. O kolonların davranışı ile ona komşu gelen, yani döşemenin altında kalan kısa kolonların davranışı birden bire çok farklı oluyor ve binanın genel davranışı bozulmaya başlıyor. O yüzden yönetmelikteki madde çok haklı.” Erhan Karaesmen, interview by the author, Ankara, 13th February 2007.

[105] Revised from “Specification for Structures to be Built in Disaster Areas”, 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.6. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

[106] “Yönetmelikte şöyle söylüyor: “Eğer şu düzensizlikler varsa, bu döşemelerin depremde kırılmayacağını ya da bu gelen yükü aktaracağını göstermeniz gerekir.” Bu aslında çok zor bir şey. Ama tüm yapıdaki döşemeleri sonlu elemanlara bölerek, parçalara bölerek, inceleyebiliyorsunuz. Normal programlarla yapılamıyor, mesela SAP2000 gibi programlarla bu döşemelerin zorlanmasını bulabiliyorsunuz. Öyle bir hesap yaptığınızda, “Tamam döşeme zorlanmıyor. Düzensizlik var ama döşeme kurtarıyor.” diyorsanız o zaman proje geri dönmüyor.” Zafer Kınacı, interview by the author, Ankara, 21st March 2007.

> The cases where projections beyond the re-entrant corners in both of the two principal directions in plan exceed the total plan dimensions of the building in the respective directions by more than 20%. [107]

A3 type of irregularity exists if the dimension of any projection transcends 20 per cent of overall dimension of the building. In Figure 6.9, there are also three drawings in 2007 disaster regulation explaining this irregularity:

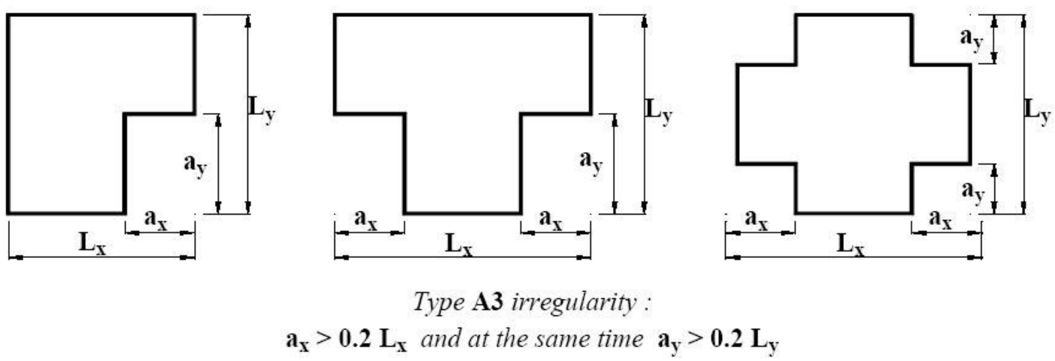

Figure 6. 9 Projections in plan (A3).
Drawings from Specification for Buildings to be Built in Earthquake Areas. 2007.

Projections in plan destroy order of the frame system.[108] In irrregular shaped lands, projections in plan are commonly exist. Projections in plan may be prefered to nonparallel axes of structral elements.[109]

[107] Revised from “Specification for Structures to be Built in Disaster Areas”, 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.6. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16th Oct2006.

[108] “Çıkma Türkiye’de başa beladır. Çünkü çıkma yapıldığı zaman binada çerçeve sistemi bozuluyor. O nedenle çıkma olan binalarda daha bir zayıflık vardır, daha bir yumuşak olur binalar. Bu da kötü bir mühendislik çözümü nedeniyle. Yani bizde hasar gören çıkmalı binalar, böyle olduğu için hasar görüyorlar.” Haluk Sucuoğlu, interview by the author, Ankara, 14th February 2007.

Like in A2 type of irregularity, these projections can be acceptable if it is verified by calculations that the floor systems are capable of safe transfer of seismic loads between vertical structural elements. This is mentioned in article 2.3.2.2 in 2007 disaster regulation. For A3 type of irregularity, the most effective prevention method is to divide the building to rectangular buildings.[110]

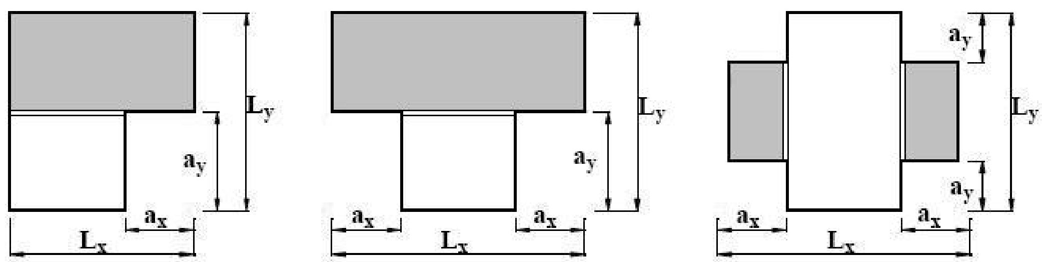

Figure 6. 10 Prevention method of A3 type of irregularity.
Source: S.Tezcan. Depreme Dayanıklı Tasarım için Bir Mimarın Seyir Defteri. İstanbul: Turkish Earthquake Foundation, 1998, p12.

An example of this kind of solution is Hospital building called Anadolu Sağlık Merkezi in Kocaeli Gebze built in 2004. (see Figure 6.11) Beside this, there was different example of projection in plan in Çakan House in Bodrum which was written as built in 2004 by web archive of Arkitera Architecture Center.

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109 "Mesela diyelim ki, size yamuk bir arsa verildi ve apartman yapılacak. Şimdi bu arsaya binayı yamuk da yerleştirebilirsiniz, bazı mimarlar yamuk yerleştirip de odaların yamuk olmasını istemiyorlar. Mimar diyor ki: 'Bu inşaat alanımın birazını kullanmam ama binam düzgün çıkar.' Yamuk planlı bir bina hiç güzel durmaz, bütün bu içerideki hacimler de yamuk olur. Hem içeriden çirkin görünür, hem zaten kullanışsız olur. Binayı şu şekildeki gibi yerleştirebilirsiniz. 1m. – 2 m. çıkıntı olur, ona da müsaade ediliyor." Zafer Kınacı, interview by the author, Ankara, 21st March 2007.

110 Semih Tezcan. Depreme Dayanıklı Tasarım için Bir Mimarın Seyir Defteri. İstanbul: Turkish Earthquake Foundation, 1998, p.19.

Figure 6. 11 Anadolu Sağlık Merkezi.
(Kocaeli- Gebze, Doğan Hasol, Ayşe Hayzuran Hasol, Ayşe Haol Erktin, 2002)
Source: http://arkiv.arkitera.com/p285-anadolu-saglik-merkezi.html

Figure 6. 12 Çakan Evi.
(Bodrum -Muğla, Durmuş Dilakçi, Emir Uras, 2004)
Source: http://arkiv.arkitera.com/p4610-cakan-evi.html

6.2.4 Nonparallel Axes of Structural Elements (A4)

In 1998 disaster regulation, there was "A4 type of irregularity" called nonparallel axes of structural elements. Although nonparallel axes of structures are also mentioned in 2007 disaster regulation, it isn't placed in the category of the irregular buildings. Table 6.1 in 1998 disaster regulation stated that:

> The cases where the principal axes of vertical strucural elements in plan are not parallel to the orthogonal earthquake directions considered.[111]

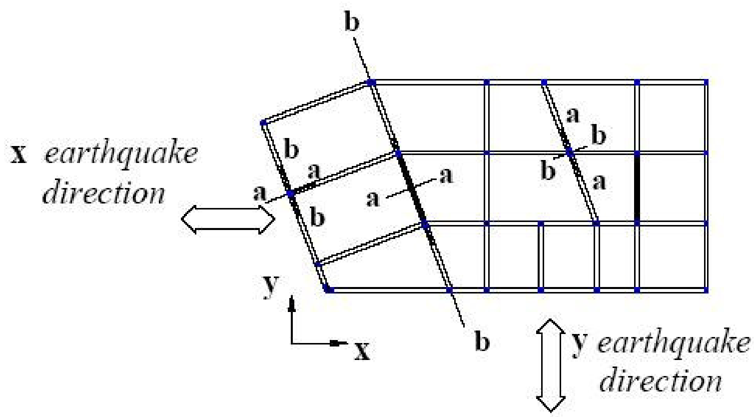

Figure 6. 13 Non-parallel axes of structural elements.
Drawing from Specification for Buildings to be Built in Earthquake Areas. 2007.

Article 6.3.2.3 in 1998 disaster regulation states that:

> In buildings with irregular type A4, internal forces along the principal axes of structural elements shall be determined in accordance with 6.7.5 and 6.8.6.[112]

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[111] "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.7.
http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

[112] "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.6.
http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

These articles 6.7.5 and 6.8.6 are called "the response quantities of structural elements with principle axes nonparallel to earthquake directions". Same titles exist with the same contents in the articles 2.7.5 and 2.8.6 in 2007 disaster regulation, although nonparallel axes of structures under the "irregular buildings" title was removed.

Nonparallel systems have been identified as a problem configuration in other countries. Although it was not identified as irregular in the 1980 SEAOC Commentary, it is identified as irregular in the 1998 UBC, the 1990 SEAOC Commentary, and subsequent codes and previsions.

Buildings with nonparallel axes of structures commonly exist in irregularly shaped building lots in Turkey. Sucuoğlu stated that a simple and symmetric building is safer and easier than a building with nonparallel axes of structures in analysis and design. It is also easy and safe in construction stage and its control is more reliable.[113]

A4 type was not a forbidden irregularity. This type was only showing a specific calculation method for nonparallel axes of structures. Although A4 type of irregulartity is not mentioned in 2007 disaster regulation, specific calculation method of nonparallel axes of structures exists in this regulation.[114]

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[113] "Arsa yamuk olunca genellikle yamuk akslar yapılıyor bizde. Arsaya göre plan oturtma alışkanlığı olduğu için öyle yapılıyor. Aslında iyi birşey değil, yapısal sistemin en basit olanı, kontrolü en kolay olanıdır. Hem hesabı da kolaydır, hesaba güven de en fazla onlarda sağlanır. Yamukluklar olduğu zaman yaptığımız hesabın gerçeğe yansımasında hep zorluklar olur." Haluk Sucuoğlu, interview by the author, Ankara, 14th February 2007.

[114] "Eğer böyle binalarda eğrilikler varsa, bunların nasıl hesap edileceğini anlatıyor. Yoksa bu yasaklanan bir şey değil. Yapılabilir, onda bir mahsur yok. Mühendislere hesabın nasıl yapılacağı tarif ediliyor. "İşte buraya gelen deprem yükünün bir kısmını da böyle alın" gibi şeyler söylüyor. Yani burada sadece hesap yöntemini anlatıyor. Mimari de bir kısıtlama yok." Zafer Kınacı, interview by the author, Ankara, 21st March 2007.

6.2.5 Interstorey Strength Irregularity (Weak Storey) (B1)

The first type of irregularity in elevation is the interstorey strength irregularity. This B1 type of irregularity is also called "weak storey". Table 2.1 in 2007 disaster regulation states that:

> In reinforced concrete buildings, the case where in each of the Orthogonal earthquake directions, Strength Irregularity Factor η_{ci} which is defined as the ratio of the effective shear area of any storey to the effective shear area of the storey immediately above, is less than 0.80. [115]

B1 type of irregularity commonly exists in the ground floors of the commercial buildings. Columns may be eliminated in order to create large area for shops, restaurants and so on.[116, 117] It is also seen in some apartment buildings, such as, the buildings between Kadıköy and Bostancı in İstanbul, walls are eliminated in ground floors in order to gain a garden view.[118]

For this B1 type of irregularity, there is not any drawing in the regulation. It is supported with article 2.3.2.3 in 2007 disaster regulation, which states that:

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115 Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.7. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last Accessed: 16thOct2006.

116 "Deprem kuvveti en altta en kuvvetlidir. Üstten aşağıya doğru şiddetle artarak gider. En alta gelindiğinde birden bire bina cılız bir bina oluyor. Bazen kolon bile konmuyor. Araya duvarlar konmuyor. Çünkü orası mağaza, lokanta falan… Yani konut amaçlı veyahut işyeri amaçlı binaların giriş katında Türkiye'de bol miktarda küçük ticari kullanım yapılır oldu. Zayıf kat dediğimiz bu. En büyük kuvvet buraya geliyor ama bina burada zayıf." Erhan Karaesmen, interview by the author, Ankara, 13thFebruary 2007.

117 "Bir otel yaptığınız zaman, binanın altına otopark falan yapamaz hale geliyorsun. Deprem yönetmeliği yüzünden, şöyle rahat, geniş açıklıklı restoran falan yapılamıyor. Özellikle yüksek yapılarda, binanın strüktürü yüzünden bir şey yapılamaz hale geliyor." Murat Artu, interview by the author, Ankara, 21stMarch 2007.

118 Semih Tezcan. Depreme Dayanıklı Tasarım için Bir Mimarın Seyir Defteri. İstanbul: Turkish Earthquake Foundation, 1998, p.14.

> In buildings with irregularity type B1, if total infill wall area at i'th storey is greater than that of the storey immediately above, then infill walls shall not be taken into account in the determination of η_{ci}. In the range $0.60 \leq (\eta_{ci})_{min} < 0.80$, Structural Behavior Factor, R, given in Table 2.5 shall be multiplied by 1.25 $(\eta_{ci})_{min}$ which shall be applicated to the entire building in both earthquake directions. In no case, however, $\eta_{ci} < 0.60$ shall be permitted. Otherwise strength and stiffness of the weak storey shall be increased and the seismic analysis shall be repeated.[119]

As mentioned above, if the strength irregularity factor, η_{ci}, is smaller than 0.6, then the building is designed again.

6.2.6 Interstorey Stiffness Irregularity (Soft Storey) (B2)

B2 type of irregularity in elevation is "interstorey stiffness irregularity" which is also called "soft storey". Table 2.1 in 2007 disaster regulation states that:

> The case where in each of the orthogonal earthquake directions, Stiffness Irregularity Factor η_{ki}, which is defined as the ratio of the average storey drift at any storey to the average storey drift at the storey immediately above, is greater than 1.5. [120]

As article 2.3.2.1 in 2007 disaster regulation states, B2 type of irregularity governs the selection of the method of sysmic analysis as specified in 2.6.[121]

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[119] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.6. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

[120] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.7. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

[121] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.6. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

If there is a soft storey in a building, total displacement of building that should be in upper floor, occurs only in one floor where soft storey is. This unexpected displacement in soft storey causes the collapse of the whole building.[122]

Different heights of storeys also causes soft storey. For instance, if a building which has storeys with 3m. height has an extra ordinary storey with 5 meter height, there also exists a soft storey. [123] (see Figure 6.14 and 6.15)

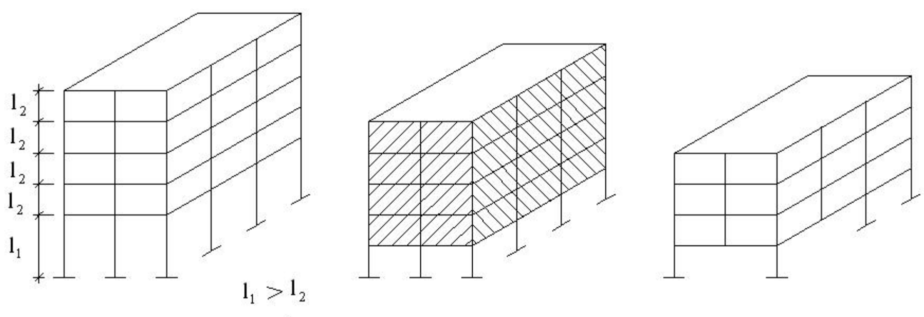

Figure 6. 14 Examples of soft storey irregularity.
Source: U. Ersoy. "Binaların Mimarisi ve Taşıyıcı Sisteminin Deprem Dayanımına Etkisi". Deprem Güvenli Konut Sempozyumu, edited by Teoman Aktüre. Ankara: MESA yayınları, 1999, p.73.

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[122] Semih Tezcan. Depreme Dayanıklı Tasarım için Bir Mimarın Seyir Defteri. Turkish Earthquake Foundation, pg.28. 1998

[123] "Bazı binalarda alt katında dükkan yapıldığı zaman, kat yüksekliği 5 m olabiliyor. Sonra normal katlar 3 m. devam ediyor. Ya da bazı mimari projelerde, katlar 3'er metre giderken, bir katında toplantı salonu vb. olduğu için 5 m. olabiliyor. O zaman orada yüksek bir kat yapılıyor. Bu katta yeteri kadar perde yoksa, kolonlar narin oluyor. Orada kolonlarda deprem sırasında burkulmalar meydana geliyor. Yönetmelikte zaten bunu, binanın göreli kat ötelemesiyle sınırlandırmış. Göreli kat ötelemesi de şu demektir; herhangi bir kattaki alt döşemeyle üst döşeme arasındaki farka göreli kat ötelemesi denir. Mesela, 10.kat döşemesi ile 11. kat döşemesi arasındaki farkı buluyor, kat yüksekliğine bölüyor. Bunu sınırlandırıyor yönetmelik. Bu tabi yumuşak kat olan yerlerde oldukça fazla oluyor. Onun fazla olması depremde o katta istenmeyen önemli etkiler meydana getiriyor. Mesela Gölcük'te, altında dükkan olan binalarda yıkılma daha fazla görülmüş, yumuşak kattan dolayı." Zafer Kınacı, interview by author, written notes, Ankara, 21st March 2007.

Figure 6. 15 An apartmant building in Dikmen Ankara.
(Tamer Başbuğ, Baran İdil, Hasan Özbay, 2001)
Source: http://arkiv.arkitera.com/p2960-dikmende-apartman.html

Soft storey is common in buildings which have restaurant, shop, installment, vatilation hole, VIP hall and so on in the middle storeys. In these storeys, removed walls decrease the rigidity of the storey. Thus these storeys are the weakest parts of the building that may cause the collapse. [124]

If a soft storey has to exist in a design, its danger can be removed by special analysis and specials dimensions of structural elements. Hence, beside its risks, soft storey is

[124] "Yüksek binalarda normal fonksiyonlu katlar yükseldikçe araya tesisat katı giriyor. Havalandırma, ısıtma vb. büyük bir merkezden yapılamıyor, buradan aktarılıyor. Burada mimar değil, makine mühendisi kolonları değiştirtebiliyor. Yüksek betonarme binalarda bol perde oluyor. Tam tesisat katına gelindiğinde, perdesi delik deşik oluyor, sonra yukarıda normal devam ediyor. Bazen de otellerde VIP salonunda ara duvarlar kaldırılıyor. Kolonları küçültülmüş, sağa sola itilmiş, perdeleri delinmiş ve ara duvarları kaldırılmış katlar geliyor. Buna 'yumuşak kat' diyoruz." Erhan Karaesmen, interview by the author, Ankara, 13thFebruary 2007.

one of the factors that increase cost of building. [125] Ambrose and Vergun stated that if relatively open ground floor is necessary there are some possible solutions to reduce soft story effect:

> 1. Bracing some of the open bays. If designed adequately for the forces, the braced frame (truss) should have a class of stiffness closer to a rigid shear wall, which is the usual upper structure in these situations. However, the soft story effct can also occur in rigid frames, where the "soft" story is simply significantly less stiff.
> 2. Keeping the building plan periphery open, while providing a rigidly braced interior.
> 3. Increasing the number and/or stiffness of the ground-floor columns for an all-rigid frame structure.
> 4. Using tapered or arched forms for the ground-floor columns to increase their stiffness.
> 5. Developing a rigid first story as as upward extension of a heavy foundation structure.[126]

If large spaces, such as meeting rooms or banking hall, must be provided at ground level, a taller first story often has strong programmatic justification. Likewise, such an open ground floor often meets urban design needs by providing both real and symbolic access to a plaza or street, or by providing space at the base of a building. Arnold stated that the changes in proportion provided by high story were very real aesthetic tools for the architect, although engineers might find such concepts hard to rationalize in their terms.

> Engineers must accept that some form of variation in the first story will remain a desirable architectural characteristic for the foreseeable future: whether it is "soft" or "weak" in seismic terms is a matter for the architect and engineer to resolve.[127]

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[125] Semih Tezcan. Depreme Dayanıklı Tasarım İçin Bir Mimarın Seyir Defteri. Turkish Earthquake Foundation, pg.80. 1998

[126] James Ambrose & Dimitry Vergun. Seismic Design of Buildngs. New York: Wiley-Interscience Publication, 1985, pp.45-46.

[127] Christopher Arnold. "Architectural Considerations". The Seismic Design Handbook. Edited by Farzad Naeim. Boston: Kluwer Academic Publishers, 2001, pp.304-305.

6.2.7 Discontinuity of Vertical Structural Elements (B3)

The last type of irregularity is B3 type of irregularity called "discontinuity of vertical structures". Table 2.1 in 2007 disaster regulation states that:

> The cases where vertical structural elements (columns or structural walls) are removed at some stories and supported by beams or gusseted columns underneath, or the structural walls of upper stories are supported by columns or beams underneath.[128]

A3 type of irregularity also existed in 1998 disaster regulation. In both 1998 and 2007 disaster regulation, A3 type of irregularity has four items. Although some items of this irregularity were not forbidden in 1998 disaster regulation, they are forbidden in 2007 disaster regulation. Article 2.3.2.4 in 2007 disaster regulation defines these items:

> In all seismic zones, conditions related to buildings with regular irregularities of type B3 are given below:
>
> a) Columns at any storey of the building shall in no case be permitted to rest on the cantilever beams or on top of or at the tip of gussets provided in the columns underneath.
>
> b) In the case where a column rests on a beam which is supported at both ends, all internall force components induced by the combined vertical loads and seismic loads in the earthquake direction considered shall be increased by 50% at all sections of the beam and at all sections of the other beams columns adjoining to the beam.
>
> c) Both ends of a structural wall in no case be permitted to rest on columns underneath.
>
> d) Structural walls shall in no case be permitted in their own plane to rest on the beam span at any storey of the building.[129]

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[128] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.7. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

[129] Revised from "Specification for Structures to be Built in Disaster Areas", 1997, (English translation prepared under the direction of M.Nuray Aydınoğlu). p.8. http://www.deprem.gov.tr/depyon/Turkishseismiccode.pdf, Last accessed: 16thOct2006.

Types “a” and “d” were strictly forbidden in 1998. They are still forbidden in 2007 disaster regulation. In addition to these, type “c” is also forbidden in 2007 disaster regulation. Type “b” is not forbidden but vertical loads are increased by 50 per cent for the beams and columns connected to these beams. (see Figure 6.16)

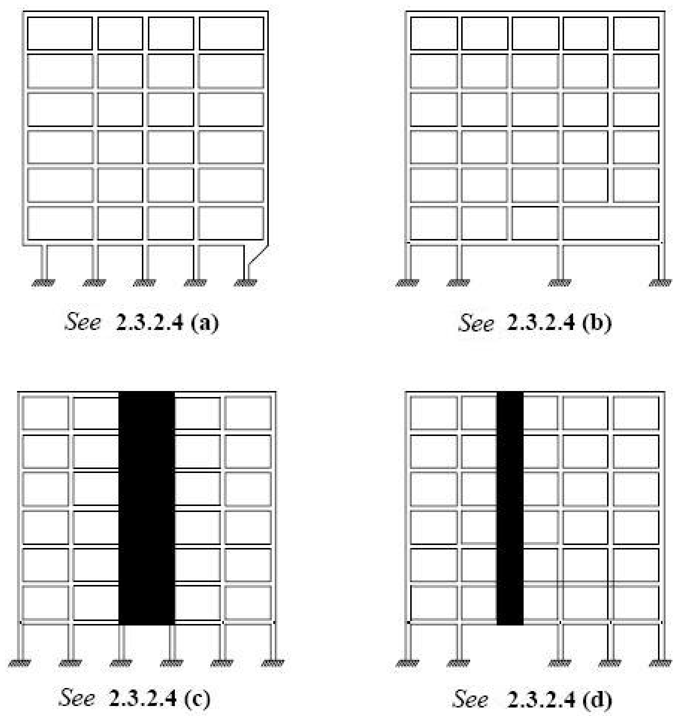

Figure 6. 16 Discontinuity of vertical structures (B3).
Drawings from Specification for Buildings to be Built in Earthquake Areas. 2007.

Type “a” is the first item of discontinuity of vertical structures. Placement of columns on cantilever beams is forbidden since 1998. Kınacı stated that architects and engineers are also avoiding this kind of irregularity before the prohibition. “B” type of irregularity which is removal of some columns and placement of those columns on beams is not a forbidden irregularity.[130] There are common examples of

[130] “Sheraton Oteli’nin aneksini yaptık, orada 30 m. açıklık geçiyoruz. Üstte bütün kolonlar döşemeye basıyor. Ama öngerilmeli yapıldığı için sistem bu yönetmeliğe girmiyor. Tünel kalıp da bu

this in Ankara. For example, in apartment buildings which have symmetric plan, main entrences intersect to a column in the groundfloor. So the column may be eliminated and columns over this are placed on beams. [131]

In type “c” of the discontinuity of vertical structural elements, placement of any shear wall at both ends on the columns is forbidden. Civil engineers face with this problem if there is a need of a hole in a shear wall, such as doorways. The remaining parts from the doorway should be shearwalls again. In 2007 disaster regulation, definition of shear wall was also changed from the past regulations. If the ratio of dimensions is maximum 1/7, it is a shear wall. If this ratio is smaller, it is a column. In the Figure 6.17, there is an example of how a civil engineer copes with this problem. [132]

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yönetmeliğe girmiyor. Yönetmelik tünel kalıpla yapı yapanları ve post-tension yapanları hiç etkilemedi.” Murat Artu, interview by the author, Ankara, 21st March 2007.

[131] “Apartmanlarda tam simetrik çift daire yapıldığı zaman, kapının tam ortasına iki daireyi bölen kolon geliyor. Şimdi Ankara’yı dolaşırsanız, genelde birçok apartmanın tam giriş kapısının ortasında bir kolon görürsünüz. Yani kapı ikiye bölünmüştür. Halbuki orada iki tane kolon koyup, onun üzerine iyi bir kiriş atıp, kolonun oraya bastırıyoruz. Buna, eski deprem yönetmeliğinde de müsaade edilirdi, şimdi de müsaade ediliyor. Bazıları bunun müsaade edilmediğini zannediyorlar ama müsaade ediliyor. Bir tek orada gerekiyor. Yoksa kolonların havada kesilmesi bir yerde gerekmiyor. Ona mimarlar da dikkat ediyorlar, aşağıdan yukarı kolonu devam ettiriyorlar. Konsol yüzüne kolon basma yapılmıyor, eskiden beri yok.” Zafer Kınacı, interview by the author, Ankara, 21st March 2007.

[132] “Mesela aşağıya kadar inen perdede bir kapı deliği isteniyor. O zaman yanlarda kalan parçaların perde olması gerekir. Mesela bir binada 5 m.lik bir perde var ve bu perdenin kalınlığı da 25 cm. olsun. Buradan mimar arkadaş, bizden 1 m.lik bir kapı boşluğu istedi. Burada 2’şer m.lik parçalar kaldı. 25 x 200’lük iki tane parça. Bu şimdi perde mi? Perde, çünkü 25 cm. kalınlığında, boyu eninin 7 katından fazla. “Perde gelip kolona oturamaz” diyor yönetmelik. O zaman ne olur? Perdede boşluk açarsın ama kalan parçaların da perde olması lazım. Burada yönetmelikte yazmıyor ama biz onu anlıyoruz. Yani burada benim anladığım, bu yönetmeliğe uymak için, şöyle bir boşluk açamazsınız: Mesela mimar perdede 3 m.lik bir boşluk istedi. Burada da birer metrelik parça kaldı. Bu nedir? 25 x 100. Kolon mu, perde mi? Kolon, o zaman bu olmaz. O zaman perdeyi getirip iki tane kolona oturtmuş oluyorsunuz. Ama ben şunu yaparım; perde gelip 2 tane perdeye oturabilir.” Zafer Kınacı, interview by author, written notes, Ankara, 21st March 2007.

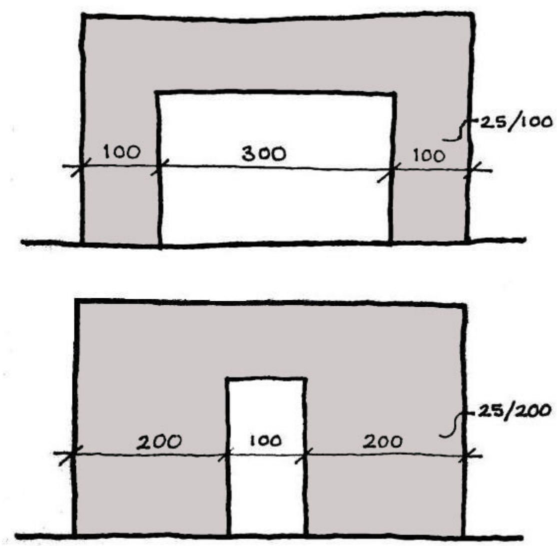

Figure 6. 17 Doorways in shear walls.
Freehand drawing from the author's interview with Zafer Kınacı.

In the first drawing, after opening a 3 m. doorway from a 5 m. shear wall, there remains two 25/100 cm. parts which are considered as columns. Hence, this design is forbidden in "c" type of irregularity. However, in the second drawing, the remaining parts are 25/200 cm. which are considered as shear walls again, so it is a possible solution. (see Figure 6.16)

"D" type of irregularity is placement of a shear wall on the beams in the lower storeys. It is also a strictly forbidden irregularity. Architects should be sensitive not to design shear walls resting on beams at any storey. [133]

> Forces applied to buildings must flow with some direct continuity through the elements of the structure, be transferred effectively from element to element, and eventually be resolved into the ground. Where there are interruptions in the

[133] "Bazı mimarlar hiç deprem bölgesinde bina yapmıyormuş gibi çizim yapıyorlar. Mesela 10 katlı binayı çizerken perde miktarını ayarlayamıyor veya üste perde koyuyor altta denk gelmiyor. Şimdi tabi burada deprem hesabını mühendisler yapıyor ama mimarın başta gerçekten bunlara dikkat etmesi lazım. Yani depreme uygun ilk tasarım mimariden başlıyor." Zafer Kınacı, interview by the author, Ankara, 21st March 2007.

normal flow of the forces, problems will occur. For example, in a multistory building the resolution of gravity forces requires a smooth, vertical path; this columns and bearing walls must be stacked on top of each other. If a column is removed in a lower story, a major problem is created, requiring the use of a heavy transfer girder or other device to deal with the discontinuity.[134]

[134] James Ambrosse & Dimitry Vergun. Seismic Design of Buildings. New York: Wiley-Interscience Publication, 1985, p.17.

CHAPTER 7

CONCLUSION

Turkey has always been vulnerable to various kinds of disasters, and earthquakes are the most hazardous kind of these disasters. Each major disaster has been an experience for Turkey's disaster management. Hence, after these major disasters, new laws and new regulations enacted or old ones were revised. Turkey's current disaster regulation,"Specification for Buildings to be Built in Earthquake Areas", was enacted in 2007 after the experiences 1999 Marmara earthquakes.

In this research with the help of interviews, Turkish disaster regulations are examined from three different points of views; civil engineers who prepared the regulations, architects in practice and civil engineer in practice. First issue of these interviews is to explore the attitude in preparation process of disaster regulations and the attitude to architectural design in this process. By the way, reflections of disaster regulations on architectural design are evaluated. As the second issue of the interviews, interests, awareness, attitudes and expectations of some architects towards disasters and disaster regulations are searched. And the final issue of the interviews was to search the technical reflections of 2007 disaster regulation on architectural design and its difficulties in practice.

2007 disaster regulation contains reinforced concrete buildings, structural steel buildings and masonry buildings. Architects' designs are mostly restricted in reinforced concrete buildings and masonry buildings by this regulation. Masonry building design is so restricted that it is difficult to design a functional, contemporary masonry building for architects but restrictions in reinforced concrete building designs do not affect architects directly. 2007 disaster regulation restricts architects in designing reinforced concrete building in three factor:

1. minimum dimensions of columns, beams and slabs
2. shear wall necessity
3. avoidance from irregular design

The most significant part of 2007 disaster regulation for architects is “irregular buildings”. In this part, designing regular and symmetric buildings are advised to architects and engineers. Six types of irregular buildings which should be avoided are defined in this part:

1. A1 type: torsional irregularity
2. A2 type: floor discontinuities
3. A3 type: projections in plan
4. B1 type: interstorey strength irregularity (weak storey)
5. B2 type: interstorey stiffness irregularity (soft storey)
6. B3 type: discontinuity of vertical structural elements

There are no clear-cut restrictions of these irregularities, only type B3 has strict rules. Others types on the other hand have some warnings and discouraging rules against these irregularities.

By these irregularities, it was understood that there was a strong relationship between architectural design and building resistance to disasters. Earthquake safety of a building is not only the responsibility of engineers. Arhitects have also responsibility for earthquake safety. However, architects leave all the resposibilities for earthquake safety to engineers but it is the responsibility of both architects and engineers.

Architects should know the advantages of regular and symmetrical buildings. Regular and symmetrical buildings are stronger against earthquake forces. Irregular buildings have weak parts that may not resist earthquakes. Thus, these weak parts may cause damages even collapse of buildings. In order to make an irregular building resistant to earthquakes, a perfectly designed engineering project is necessary.

There is not any architectural design that a qualified engineer cannot deal with and solve its problems. Except some strictly forbidden rules of 2007 disaster regulation, the regulation gives chance to design irregular buildings provided that the engineering project is well designed. Generally, design and construction of regular buildings are more reliable than irregular ones. In order to constitute standart quality in building design and construction, disaster regulation leads architects and engineers to regular buildings.

Laws and regulations are systems of rules developed by government or society to control social or business relationships. Before laws and regulations, there should be ethical values. Then, mission of laws and regulations can be accomblished.

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