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Investigation of Interior Architecture Projects within the Frame of National and International Regulations Against the Risks that May Occur During Earthquake

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Abstract

One of the countries where active plate movement is frequently experienced is Turkey. In addition to the disasters caused by the earthquake, it is necessary to take into account the physical and moral effects. When seven regulations (1947, 1953, 1961, 1968, 1975, 1998, and 2007) on earthquakes in our country are examined, the issues that should be applied to structural elements are mentioned in detail. However, there is no detailed and systematic study on the risks of non-structural elements (doors, windows, interior walls, suspended ceilings, coatings, interior stairs, furniture, accessories, lighting elements, elevators, equipment) other than the load-bearing elements of the building. The deterioration of non-structural elements due to the shaking of the buildings causes material damage, bodily harm, hindering the use of buildings, and temporary cessation of activities. In this context, deaths, and injuries are largely due to non-structural elements. And the financial losses experienced by those who continue their lives after the earthquake are mainly due to non-structural elements. However, despite this available data, there are deficiencies in inspection and regulations for interior design projects. When the 2018 Turkish Building Earthquake Code is examined, it is seen that it is not possible to inspect interior design projects in a certain systematic way. At the same time, there is no definite sanction for the risks posed by non-structural elements. Within the scope of this study, the sources of earthquake regulations and standards in Turkey and in the world were researched, and national and international legislations on the inspection of non-structural elements in interior design projects against earthquake risk were examined. As a result of the study, an evaluation has been made to ensure the safety of life and property by reducing future earthquake risks for non-structural elements.

Keywords: Non-structural elements, ınterior architecture, ınterior space, earthquake regulation, ınterior architecture project audit.

Introduction

An earthquake is an occurrence that results from the rupture of the earth's crust and has significant global and environmental effects. It is difficult to prevent the predictable and destructive effects of an earthquake (Işıltan, 2010). Turkey is one of the most seismically active nations in the world due to the movement of the earth's crust. Many disastrous earthquakes have also been caused by the faults that cross this area (Atalay, 1987). In the last 58 years, 58,202 people have lost their lives in earthquakes in our country; 122,096 people have been injured; and 411,465 structures have been severely damaged or destroyed (Karamanoğlu & Ulay, 2017). Given the closeness and frequency of the earthquake, it is imperative that immediate action be

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taken. If steps aren't taken, it's likely that things that have happened in the past will happen again.

An earthquake may cause three different kinds of damage; on people's life safety, on the economy, and on buildings. We can divide the elements belonging to a structure into structural and non-structural elements. According to the 2012 FEMA-74 handbook, structural components include the columns, beams, slabs, load-bearing walls, and foundations that make up the building's load-bearing system. Non-structural elements are described in the following three sections:

• **Architectural Components:** Walls, ceilings, showcases, glass, cladding, roof, chimney, fences, and architectural embellishments...

• **Mechanical, Electrical, and Plumbing (MEP) Components:** Pumps, chillers, fans, air handling units, motor control centers, distribution boards, transformers, and distribution systems consisting of pipelines, ducts, and tubing.

• **Furniture, Fixtures, and Equipment:** Shelves and bookcases, industrial storage racks, retail products, books, medical records, computers and desktop equipment, wall and ceiling mounted TVs and monitors, filing cabinets, kitchens, machine shops, or other special content including equipment, industrial chemicals or hazardous materials, museum artifacts and collectibles…(FEMA-74, 2012).

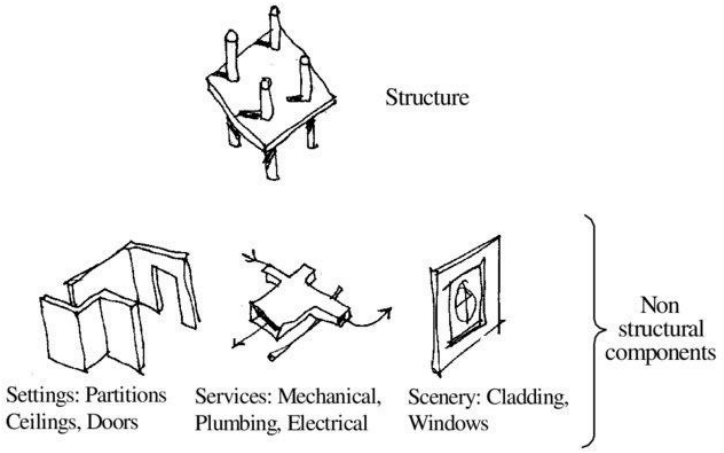


Figure 6. Structural and non-structural elements (Colin F. Duffield)

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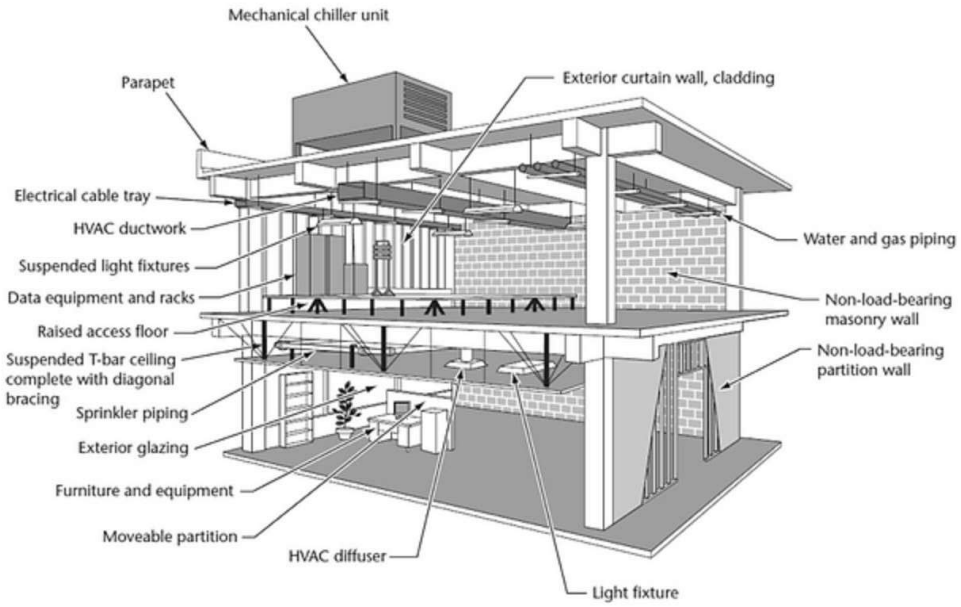


Figure 7. Non-Structural Components (CSA-S832) (https://www.sensequake.com/blog-non-structural-components)

There are many cases of non-structural elements damage all over the world, including Turkey. One of them was the 1995 Great Hanshin-Awaji Earthquake, which affected Kobe City and the surrounding areas, in which 104,906 buildings collapsed, 6,148 buildings were seriously damaged, and 6,433 people died. It is estimated that 80% of the deaths that take place here are caused by falling buildings or furniture (Tomohiro, 2013).



(a) (b)

Figure 3. (a) Failure of office partitions, ceilings, and lighting fixtures in the 1994 Northridge Earthquake (FEMA 74, 1994). (b) Damage to overloaded shelves during the magnitude 6.7 Northridge Earthquake of 1994 (FEMA 460, 2005).

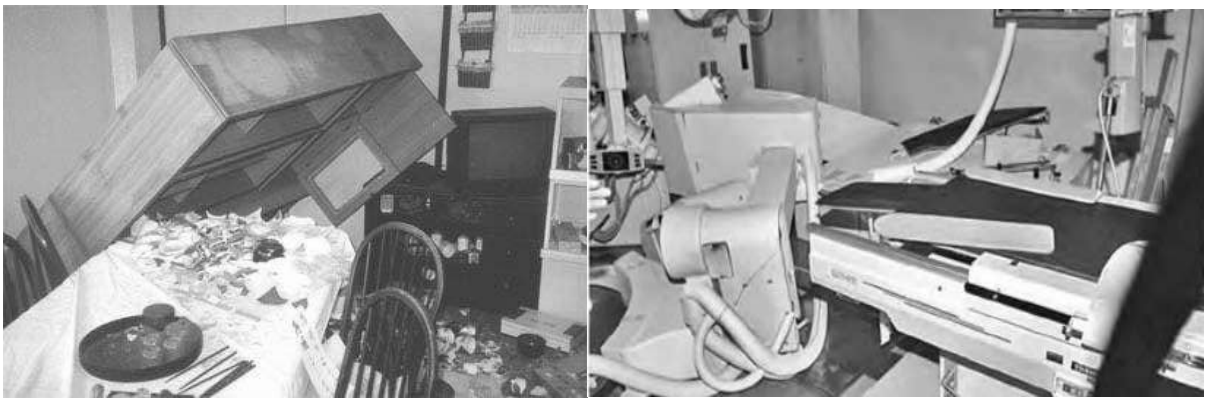
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The 1989 Loma Prieta Earthquake in San Francisco caused a lot of damage to the library. It cost a lot to rebuild, fix broken books and shelves, organize, and reshelve everything (Wong, 1993; Dobb, 1993).



(a) (b)

Figure 4. (a) Damage to library interiors (Dr. Vasudha A. Gökhale). (b) Blocked exit routes (Dr. Vasudha A. Gökhale).



(a) (b)

Figure 5. (a) Overturning of furniture (Dr. Vasudha A. Gökhale). (b) Overturned Hospital Imaging Equipment (NEHRP, 2015)

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(a) (b)

Figure 6. (a) Falling ceiling tiles and furniture, a library office at the U. of Canterbury in Christchurch, New Zealand. (Source: 2 Universities in New Zealand Cope With Earthquake Damage (chronicle.com) (b) Damage to interior walls during the earthquake in Nepal (indiatimes.com)



Figure 7. In-plane and out-of-plane infill wall damages (TMMOB, 2020).

In terms of non-structural components, according to Birinci (2004), 30% of the financial damage incurred by those affected by the Izmit earthquake of 1999 was attributable to the loss of furniture, white goods, electronic equipment, and valuables. In the context of today's earthquake standards, even a building design that conforms to the regulations to the extent will not give clear and comprehensive security because there are still inadequacies in the non-structural element regulation (Aytöre, 2005).

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(a) (b)

Figure 8. (a) Earthquake damage situations of non-structural components (b) Cost ratio to recover earthquake damage (Sang-Moon Lee & Woo-Young Jung)

Damages caused by non-structural elements during earthquakes and their consequences and cost rates indicate the need for greater awareness of the seismic design of interior spaces. In some instances, the shaking, overturning, breaking, or collapse of non-structural materials during an earthquake can result in human injury, death, property damage, suspension of function, and even structural element failure. Therefore, it is of the utmost importance to identify and reduce the seismic risk associated with non-structural components. Thus, it is crucial to look into the national and international regulations that disregard the earthquake safety of non-structural materials. When examining earthquake rules in this context, it has been found that the earthquake safety of non-structural elements in the World and the 2018 Turkey Building Earthquake Code, the assessment of interior design projects for seismic risk are unsatisfactory. In this study, it was determined how much Turkish and international law refers to the seismic design of non-structural elements. In this context, it is crucial to collect data about the general status of the earthquake-resistant design of non-structural materials in regulations and to determine the necessary measures for seismic design of interior design projects. The goal of this study is to find out how and by what criteria national and international seismic regulations handle interior design projects. As a result of this study, the goal is to learn about the rules in the earthquake regulations and the seismic risks that could happen in the interior, as well as to take the proper steps to reduce the loss of life and property. Furthermore, by identifying the issues that ought to be incorporated in the legislation, it will be proposed that more studies be conducted on non-structural aspects and that these elements incorporate more provisions for earthquake risk.

Overview of Earthquake Regulations for Non-Structural Elements

3 to 4 percent of our annual gross domestic product is lost due to natural disasters (Gökçe, Özden & Demir, 2008). In 1947, 1953, 1961, 1968, 1975, 1998, and 2007, seven revisions were made to our country's earthquake legislation. (Table 1) The minimal standards for the design

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and construction of earthquake-resistant structures, the earthquake zone, and the features of the ground were considered in the formulation of these regulations. Justifications for amending and updating the regulations According to AFAD (Disaster And Emergency Management Presidency) (2018), developing technology, developing world, material diversity, increasing building models and the need for them, inadequate earthquake resistance of a large portion of the existing building stock, risk reduction and urban transformation studies for buildings to reevaluate and strengthen the need to make various updates. In this context, when these requirements are considered, the ever-changing needs in tandem with the ever-changing world compelled significant adjustments to the legislation. However, it is unknown whether these altering events are accompanied by a similar alteration in the Earth. In this research, the present situation of earthquake legislation in Turkey and the rest of the world will be explored.

Table 1. Earthquake regulations in Turkey up to the present day

1940- Zelzele Mıntıkalarında Yapılacak İnşaata Ait İtalyan Yapı Talimatnamesi
1944- Zelzele Mıntıkaları Muvakkat Yapı Talimatnamesi
1949- Türkiye Yersarsıntısı Bölgeleri Yapı Yönetmeliği
1953- Yersarsıntısı Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik
1962- Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik
1968- Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik
1975- Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik
1999- Afet Bölgelerinde Yapılacak Yapılar Hakkında Yönetmelik
2007- Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik
2018- Türkiye Bina Deprem Yönetmeliği

Table 2. Change of UBC in terms of non-structural elements by year and event

Olay (Deprem)	Meydana Gelen Durum	Kanun	Bulunduğu Bölüm
San Francisco Earthquake (1906) / Santa Barbara Earthquake (1925) / Long Beach Earthquake (1933)	Brick railings and exterior wallr damage (Source: Historical UBC Cd-Rom)	First Non-Structural Element Provisions - Uniform Building Code (UBC, 1927)	Addition
-	-	(Ubc, 1935) (1997'e Kadar Değişmeden Kaldı.) (Kaynak:: Historical Ubc Cd-Rom : The Early Years (1927-1964))	Addition
-	-	(UBC, 1961)	Main Body (First) (Source: Mondal & Jain, 2005)
Alaska (1964) Earthquake San Fernando (1971) Earthquake	It made the importance of non-structural elements the focus of attention. (Source: Mondal & Jain, 2005)	(UBC, 1967)	-
San Fernando (1971) Earthquake	The failure of suspended ceiling systems, metal book shelves in libraries and	(UBC, 1973)	-

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	mechanical equipment (Source: Mondal & Jain, 2005)		
	For the first time, the "Importance Factor" has been mentioned. (Source: Mondal & Jain, 2005)	(UBC, 1976)	-

In the last 40 years, a substantial amount of research effort has been committed to the development of reasonable seismic analysis methodologies for non-structural materials. Nevertheless, earlier attempts have concentrated on the safety of more crucial and critical equipment (Mondal & Jain, 2005). However, even if it is minor, each building component has the potential to directly or indirectly compromise earthquake safety. As a result of each event's negative outcomes, precautions were taken and regulations were modified in this manner. Important examples of this are the San Francisco (1906), Santa Barbara (1925), and Long Beach (1933) earthquakes, which raised awareness of the fragility of brick railings and exterior walls. In 1927, the provisions on non-structural elements were first introduced in the Uniform Building Code (UBC) as follows:

"(b) bonding and tying. All buildings shall be firmly bonded and tied together as to their parts and each one as a whole in such manner that the structure will act as a unit. All veneer finish, cornices and ornamental details shall be bonded in the structure so as to form an integral part of it. This applies to the interior as well as the exterior of the building (Historical UBC CD-ROM: The Early Years (1927-1964)''

However, these clauses were not mandatory because they were included in the annex section of the law (Mondal & Jain, 2005). As a result of the earthquakes and the lessons acquired, the non-structural elements' place in the rules gradually grew, but could not as focused as structural elements.

Materials and Methods

This study, which is based on a literature review, was carried out in four steps. First of all, the seismic design provisions of the non-structural elements in the sources were examined. Then, it has been examined whether the most frequently used elements in the designs are mentioned among the non-structural elements in these provisions. With the data obtained as a result of the research, an examination of the characteristics of the sources and their status according to the years was conducted. On the other hand, information regarding the status of the non-structural elements in these sources was collected, examined, and conclusions were drawn from it.

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In the study, the existing standards, regulations, guides, and guidelines were examined and analyzed by considering and evaluating the literature findings and legal regulations. With the criteria that can be an indicator of the inspection of interior design projects against the risks that may occur during an earthquake and the literature findings related to them, both the world's situation on this issue and the situation of Turkey in the world have been evaluated. In this context, the regulations, standarts, guides, countries, states, and non-structural elements researched in the sources are given in Table 3.

Table 3. Source, country, state, and non-structural elements investigated

Researched resources:
International construction provisions
Provisions published by international associations and councils
International Standards
International Regulations
Recommendations published by International Professional Chambers
International Guides and Handbooks
International norms
Turkey Building Earthquake Code
Researched Countries and States
America
California
India
Japan
New Zeland
Chile
Canada
Turkey
Investigated Non-Structural Elements
Windows
Doors
Interior Walls
Interior Coatings
Suspended Ceilings
Lighting Elements
Interior Stairs
Furniture and Accessories
Equipment (Electrical and Mechanical)
Elevators

International building provisions for earthquake safety, provisions published by international associations and councils, international standards, international regulations, recommendations published by international professional chambers, international guides and handbooks, international norms, and the 2018 Turkey Building Earthquake Regulation are among the sources investigated for this study. These resources address the design of the building and its components in terms of earthquake resistance. With the findings gleaned from these materials, it is intended to acquire current and trustworthy knowledge. The analyzed sources were especially chosen among those published between 1991 and 2022, which are generally current and still in use. At the same time, objects frequently used in interior design, such as windows, doors, interior walls, internal coatings, suspended ceilings, lighting components, interior stairs, furniture and accessories, electrical and mechanical equipment, and elevators, were chosen for

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resource research. Because they are significant use in the interior, these are the elements that may contribute to earthquake-related damage. During an earthquake, these elements can sustain damage such as breaking, cracking, falling, disintegration, dislocation, collapse, falling, overturning, and shaking, resulting in loss of life, economic loss, and suspension of activity.

Findings and Discussion

In this study, one of the important research criteria is which country and year the legislation, standards, or guidelines belong to. The level of reliability in this study will be determined by how risky the region of the country where the research is being conducted is or how current the source examined is. The regions with the most intense earthquake belts in the world are the Pacific Seismic Belt, the Alpine-Himalayan Seismic Belt, and the Atlantic Region. The Pacific seismic belt is responsible for approximately 81 percent of all earthquakes. Starting from Chile, this belt includes the coast of South America, the west coast of the United States, Central America, Mexico, the Aleutian Islands south of Alaska, Japan, the Philippines, New Guinea, the South Pacific islands, and New Zealand. The Alpine-Himalayan Seismic Belt is responsible for approximately 17% of all earthquakes. Starting from Indonesia, it encompasses the Atlantic Ocean through the Himalayas and the Mediterranean. The Atlantic zone belt is also along the Atlantic ridge (URL 1, 2007). In this context, the countries considered for the research are those where earthquakes are frequently experienced, and high-level precautions should be taken in this regard. As can be seen in Table 4, the majority of the sources examined are from the United States. There are 25 resources, including 12 standards, 3 recommendations, 4 laws, 4 guidelines, 1 accreditation council report, and 1 provision. 1 official report and 1 regulation, belonging to Japan; 1 report (bulletin) and 1 standard from Canada; 1 standard from New Zealand; 2 laws from Chile; 1 standard from India; and 1 regulation from Turkey were examined as sources. Among these sources, the ones that cover the seismic design of non-structural elements the most are those in the USA.

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Table 4. Sources examined, their types, and the countries to which the resources belong

Document number /Source	Description	Type	Year	Country
BCJ	Building Control in Japan	Regulation	2015	Japan
CISCA	Ceilings and Interior Systems Construction Association	Recommendation	1991	USA
NCh 433.Of96	Norma Chilena Oficial	Code	1996	Chilean
UBC 1997	1997 Uniform Building Code	Code	1997	USA
DIN-V-ENV-1998-1-1	Design Provisions for Earthquake Resistance of Structures	Provision	1998	
ATC-38	ATC-38 Postearthquake Building Performance Assessment Form Applied Technology Council	Standard	2001	USA
ASHRAE /SMACNA	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. and the Sheet Metal and Air Conditioning Contractors' National Association.	Standard	2002	USA
IS:1893 (Part 1)	Criteria For Earthquake Resistant Design Of Structures published by Bureau of Indian Standards	Guide	2002	India
NCh 2369.Of2003	Norma Chilena Oficial	Code	2003	Chilean
NZS-1170.5 SUPP1	New Zealand Standard	Standard	2004	New Zealand
Bulletin 2004-014-BU		Bulletin	2004	Canada
Oregon Emergency Management	Earthquake Preparedness and Mitigation Guidance for Oregon State Agency Offices and Warehouses	Guide	2004	USA
DSA-IR 25-3	Division of the State Architect	Standard	2005	USA
CSA S832-06		Standard	2006	
ASCE/SOU 41-06	American Society of Civil Engineers	Standard	2007	USA
NFPA 13	The National Fire Protection Association	Standard	2007	USA
VISCMA 102-07	Vibration Isolation and Seismic Control Manufacturers Association.	Guide	2007	USA
ATC-69	Applied Technology Council - Practical Guide	Guide	2008	USA
ASCE/SEI 7-10	American Society of Civil Engineers	Standard	2010	USA
ASCE/SEI 41-06	American Society of Civil Engineers	Standard	2010	USA
CBC	California Building Code	Code	2010	USA
TMS402-11	2011 Building Code Requirements and Specification for Masonry Structures published by The Masonry Society	Standard	2011	USA
IBC-2012	2012 International Building Code developed by International Code Council	Code	2012	USA
ASCE/SEI 7-05	American Society of Civil Engineers	Standard	2015	USA
ASCE / SEI 7-16	American Society of Civil Engineers	Standard	2017	USA
2018 Turkiye Building Earthquake Regulation	Afet ve Acil Durum Yönetimi Başkanlığı tarafından 18 Mart 2018 Pazar 30364 sayılı resmi gazete	Guide	2018	Türkiye
FEMA E-74	Federal Emergency Management Agency	Guide	2019	USA
White Paper-MLIT-2019	White Paper On Land, Infrastructure, Transport And Tourism published by MLIT (Ministry of Land, Infrastructure, Transport and Tourism)	White Paper - Policies	2019	Japan
NEHRP - 2020 provision	National Earthquake Hazards Reduction Program	Provision	2020	USA
Council for Interior Design Accreditation (CIDA)	Council for Interior Design Accreditation		2020	USA
ASTM E580	American Society for Testing and Materials	Standard	2022	USA
Council for Interior Design Accreditation (CIDA)	Council for Interior Design Accreditation	Recommendation	2022	USA
California Seismic Elevator Code		Code		USA
ASTM STANDARDS	American Society for Testing and Materials	Standard		USA
American Society of Interior Designers (ASID)	American Society of Interior Designers	Recommendation		USA

The presence of 10 distinct non-structural features in standards, rules, and guides was assessed based on the sources studied. The status of 10 non-structural items included in the provisions was shown in Table 5 after a search of 34 distinct documents from 8 nations. During the research, it was determined whether these elements were mentioned and, if so, for what situations and about what. On this basis, the usefulness of the seismic design standards in terms of auditing interior designs will be established. Using the determined data, it will be decided if it is adequate for the control of an interior design project. The number of non-structural elements (windows, doors, interior walls, suspended ceilings, interior coatings, interior stairs, furniture and accessories, lighting elements, equipment, elevators (10) considered in terms of earthquake safety in the sources; the United States ranks first (10 items), followed by Turkey (6 items), Japan (5 items), the European Standardization Committee (4 items), India (3 items), Canada (2 items), and Chile (1 unit). Because these statistics represent the number of non-structural elements discussed, they do not indicate which subject is contained in the sources or

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whether or not it is elaborate. To determine definitively whether these materials cover everything, need to do a thorough subject search and look at what is covered by which subject.

Table 5. Determination of non-structural elements in the researched legislation, standards, regulations, and guidelines

Document number /Source	WINDOW	DOOR	INTERIOR WALL	CEILING	INTERIOR CLADDING	INTERNAL STAIRS	FURNITURE AND ACCESSORIES	LIGHTING ELEMENT	EQUIPMENT	ELEVATORS
BCJ	✓	✓	✓	X	✓	X	✓	X	X	X
CISCA	X	X	X	✓	X	X	X	X	X	X
NCh 433.Of96	X	X	✓	X	X	X	X	X	X	X
UBC 1997	✓	✓	✓	✓	✓	✓	X	X	✓	X
DIN-V-ENV-1998-1-1	✓	✓	✓	X	X	X	X	X	✓	X
ATC-38	✓	X	✓	✓	✓	X	X	✓	✓	✓
ASHRAE /SMACNA	X	X	X	X	X	X	X	X	✓	X
IS:1893 (Part 1)	X	X	✓	X	✓	X	X	X	✓	X
NCh 2369.Of2003	X	X	X	X	X	X	X	X	✓	X
NZS-1170.5 SUPP1	X	X	X	X	✓	X	X	X	X	X
Bulletin 2004-014-BU	X	X	✓	✓	X	X	X	X	X	X
Oregon Emergency Management	X	X	X	X	X	X	✓	X	✓	X
DSA-IR 25-3	X	X	X	✓	X	X	X	X	X	X
CSA S832-06	X	X	✓	✓	✓	X	X	✓	✓	X
ASCE/SOU 41-06	X	X	X	✓	X	X	X	X	X	X
NFPA 13	X	X	X	X	X	X	X	X	✓	X
VISCMA 102-07	X	X	X	X	X	X	X	X	✓	X
ATC-69	X	X	X	X	X	X	X	X	X	X
ASCE/SEI 7-10	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
ASCE/SEI 41-06	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
CBC	✓	✓	✓	✓	✓	✓	✓	X	✓	✓
TMS402-11	X	X	X	X	✓	X	X	X	X	X
IBC-2012	X	X	✓	✓	✓	X	X	X	✓	X
ASCE/SEI 7-05	X	X	X	X	X	X	X	X	✓	X
ASCE / SEI 7-16	✓	✓	✓	✓	X	✓	X	✓	✓	✓
2018 Turkiye Building Earthquake Regulation	✓	✓	X	X	✓	✓	X	X	✓	✓
FEMA E-74	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
White Paper-MLIT-2019	X	✓	X	X	X	X	X	X	X	X
NEHRP - 2020 provision	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Council for Interior Design Accreditation (CIDA)	X	X	X	X	X	X	X	X	X	X
ASTM E580	X	X	X	✓	X	X	X	X	X	X
Council for Interior Design Accreditation (CIDA)	X	X	X	X	X	X	X	X	X	X
California Seismic Elevator Code	X	X	X	X	X	X	X	X	X	✓
ASTM STANDARDS	✓	X	X	✓	✓	X	X	X	X	X
American Society of Interior Designers (ASID)	X	X	X	X	X	X	X	X	X	X

When the sources acquired in the research were analyzed, seven different types of sources were determined. Of these, 43% were created by standards, 17% by law, 17% by guidelines, guides or handbooks, 11% by recommendations, 6% by predictions, 3% by regulations, and 3% by the accreditation council report (Figure 9).

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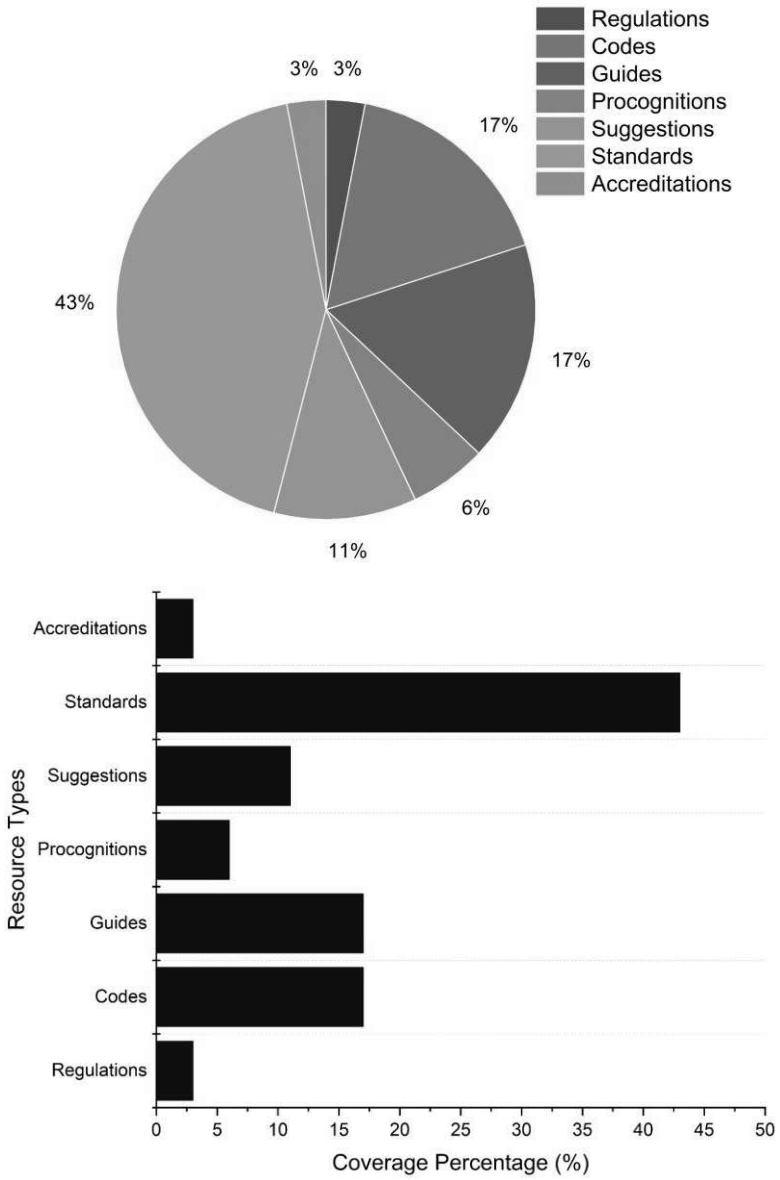


Figure 9. Graph of the resource type being investigated

When conducting the study, it is necessary to take into consideration the years that the sources have been used to ascertain whether or not the investigation is based on current sources. Figure 10 provides the years that the sources that were researched were involved, as well as their distribution by years. It can be observed that the majority of these sources are for the years 2004, 2007 and 2010 (three for each), while the sources for the years 2002, 2019 and 2020 (two for each) come in second. This graphic shows that most of the research for the study was done by looking at publications that came out between 2002 and 2022. And shows that the research is based on current sources.

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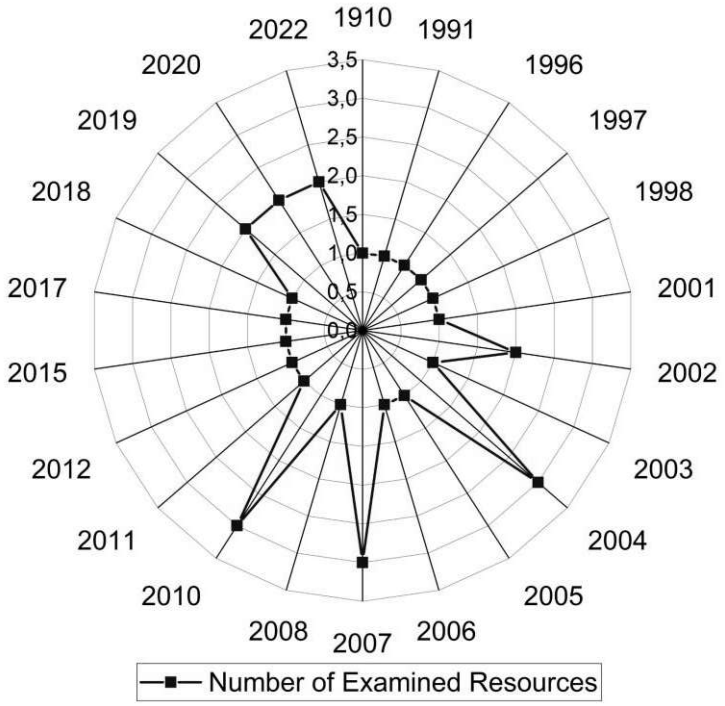


Figure 10. Number of sources under consideration-source publication year chart

Considering the sources that were examined, the situations of 10 different non-structural elements in the provisions were examined. It is important that the requirementsof the design criteria are included in the resources of the countries examined in order to audit interior design projects. However, there is more data on "bracing and system details," which is considered more critical than other criteria observed during the review. The sources that contain only the data for the bracing and support components are not sufficient for examining and supervising a project.

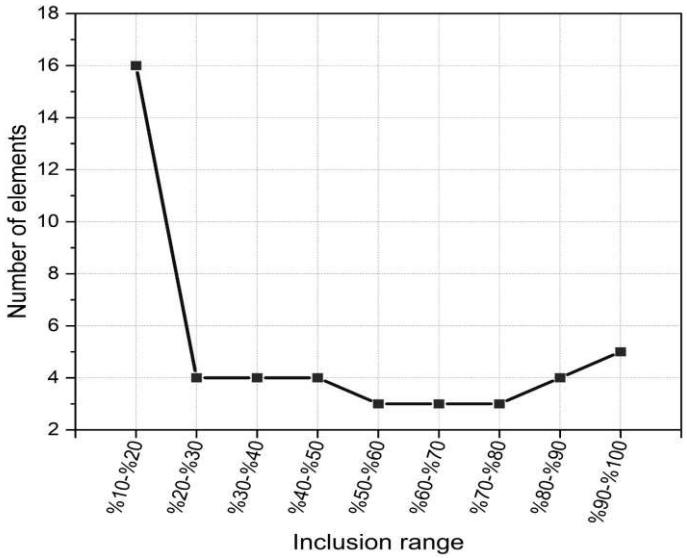


Figure 11. Inclusion range of non-structural elements of the investigated sources

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In the table in which the source research was conducted, how much and to what extent the examined documents contain the issues related to non-structural elements is examined in figure 11. According to this graph, while most of the sources contain non-structural elements in the range of 10-20%, resources with 90%-100% coverage of non-structural elements are at a low rate. If we make an inference from this graph, we can say that the information contained in the sources for the seismic design of nonstructural elements is limited.



Figure 12. Rate of inclusion of non-structural elements in welds

In this graphic, it is seen to what extent non-structural elements are mentioned relative to each other in national and international sources. Figure 12 shows the findings of the non-structural elements in the table where the sources are examined. The most mentioned element is Equipment with 16.2%, Suspended ceilings with 13.7%, interior cladding and interior walls with 12.8%, windows with 10.3%, Doors and elevators were mentioned with a ratio of %7, interior stairs with a ratio of 6.8%, Furniture - accessories and lighting elements with a ratio of 6%. According to this graphic, equipment is mainly mentioned among the non-structural elements in the sources, followed by suspended ceilings, interior claddings and interior walls. Components such as furniture and accessories, lighting elements are included very little. As a conclusion, it is possible to say that the most critical issues in the design for the earthquake risk in the interior space have been concerned and other elements have been neglected a little more.

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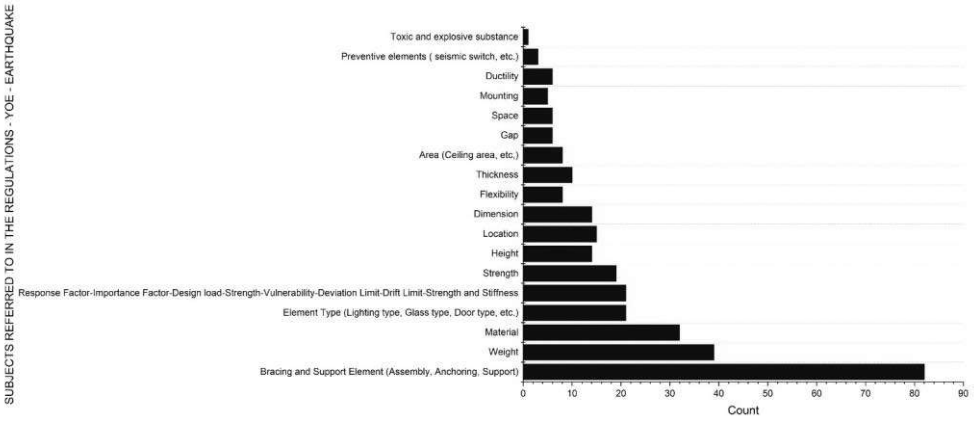


Figure 13. Distribution of the issues mentioned in the legislation regarding non-structural elements

In the sources scrutinized, internal space elements were mentioned, but in order to determine which subject was mentioned and to what extent, the distribution of the subjects mentioned in the legislation involving non-structural elements is given in Figure 13. This chart is usually; shows that criteria such as bracing detail, support element, anchorage and mounting are considered too much. Then, weight, material, element type, response factor-importance factor-design load- durability- fragility- deviation limit- drift limit- strength and stiffness, height, location, size, flexibility, thickness, Area/m² (Ceiling) areas), openings, ductility, preventive elements (seismic controller) and toxic-explosive materials are discussed. When designing an interior design project according to this graphic, these sources are consulted in terms of seismic safety; There is no holistic seismic design guide that also include issues such as the placement, shape, form, ratio, and texture of interior space elements, and it is seen that mostly focuses on the technical detailing, durability and safety of the non-structural element in question.

Conclusion

As a result of the research, the features of the sources were examined by scanning the legislation. Guidelines and standards that have been published so far have revealed which features of non-structural elements are mainly discussed and which elements are more important or which elements are ignored.

In terms of resources in the world, in the FEMA E-74 and NEHRP resources published in the USA, the earthquake safety of non-structural elements is mentioned and discussed in a comprehensive way. Again, in the standards in the USA, ASCE/SEI 7-10 and ASCE/SEI 41-06, the seismic safety issue of other categories other than "doors" is discussed. In the 2010 CBC (California Building Code), provisions related to elements other than lighting elements are

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included. In the United States, information on the seismic design of the element is found in the standards specially organized for the issues that are not covered in the laws. For example, the 2004 Oregon Emergency Management furniture and accessories, the 2007 VISCMA 102-07, the 2007 NFPA 13, the 2015 ASCE/SEI 7-05 standard, the 2002 ASHRAE/SMACNA standard on equipment, the 1991 CISCA (Ceilings and Interior Systems Construction Association), the 2007 ASCE/SOU 41-06 standard, and the 2005 DSA-IR 25-3 standard contain special provisions for suspended ceilings, the 2011 TMS402-11 standard for interior cladding, and the California Seismic Elevator Code for elevators. It is necessary to look to special standards for earthquake-safe designs for these elements. Therefore, in the USA, which has the most comprehensive resources, the details of the earthquake-safe design of interior design projects cannot be reached from holistic and systematic source completely. According to the sources accessed in Japan, which is one of the riskiest countries for earthquakes, in a technical report in 2019 (White Paper On Land, Infrastructure, Transport, And Tourism published by MLIT (Ministry of Land, Infrastructure, Transport, and Tourism), there were provisions related to doors and some equipment, but no information was found about other elements. In the source of Building Control in Japan (Ver.1910) prepared by Hasegawa Tomohiro, one of the Japanese building standards, the subjects of doors, windows, interior walls, interior claddings, furniture, and accessories were not found. While the subject of interior walls and suspended ceilings were discussed in Bulletin 2004-014-BU, from the sources examined in Canada, the subject of interior walls, suspended ceilings, lighting elements, equipment, and interior claddings was discussed in the 2006 CSA S832-06 standard. In Chile, the 1996 NCh 433.Of96 law addressed the interior walls, while the 2003 NCh 2369.Of2003 law dealt with the equipment issue. In the New Zealand NZS-1170.5 SUPP1 2004 standard, only provisions for interior linings were found.

Fixing the non-structural elements to the structure in the 2018 Turkish Building Earthquake Code, the strength of the fixing element, their inclusion in the building load-bearing system in case the ratio of the non-structural element weight to the total floor weight exceeds 10%, the equivalent earthquake load calculation on the element, the total acceleration calculation on the element, mechanical and electrical response coefficients for equipments, architectural elements, steel window and door frames, dowels, connection plates, installation elements, door and window openings and the lintels to be found on it, the reinforcement features, the determination of whether the coatings have bearing properties, the rules regarding panel design, the floor

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coverings, the facade coverings, the interior walls, the parapets, the elevator, the escalator and the interior stairs. It has been found that it has been mentioned to a limited extent. According to these analyses, although it does not seem possible to examine interior design projects in a certain systematic way, it is also seen that there is no definite sanction for the risks posed by the mentioned elements. Therefore, an inspection system should be established by taking international standards as an example for the supervision of interior design projects, the risks of non-structural elements should be determined, and then the measures to be taken against these risks should be put forward.

In general, more detailed information is available on the seismic restraint of non-structural components, such as seismic restraint guidelines and guidelines for mechanical systems. In regulations related to non-structural elements, mostly bracing and support elements, weight, material, element type, etc. are specified. While the criteria are mainly mentioned, it is not sufficient to provide a systematic arrangement for interior architectural seismic design and project control. At the same time, when the sources are examined, there is a limited number of comprehensive studies involving interior design elements. There is a need for studies at national and international level on this subject. And the number of studies needs to go up by addressing and explaining more criteria. Architects do not have access to information on how to accomplish the provisions on the seismic design of the non-structural component of the project in the current regulations in the world and in Turkey. Clarification is required on how to design a non-structural component against earthquake risk. As a result of this study, designers need a systematized guide for designing non-structural elements and a regulation with clear rules about how inspections should be done.

Information Notes

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