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Seismic Activity of Adana City and Assessment of the Building Stock Regarding Earthquake Risk

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Abstract:

This study conducts a comprehensive analysis of the seismicity in the city of Adana, alongside an assessment of the status of structures that either sustained damage or collapsed due to the Kahramanmaraş earthquakes. The research indicates that Adana City and its surrounding areas are situated near active fault lines. The seismic events associated with these faults, both regarding the recent Kahramanmaraş earthquakes and previous occurrences, have resulted in significant loss of life and property in Adana and its vicinity. Therefore, it is essential to thoroughly evaluate the current condition of structures within Adana City and its neighboring regions and implement urgent measures to address those structures that show deficiencies in earthquake resistance.

Keywords: Adana, earthquake, fault, reinforced concrete, seismic belt

1. Introduction

Earthquakes are sudden tremors caused by seismic waves propagating through geological layers. These seismic waves are caused by the sudden release of energy stored in the crust of the Earth. Earthquakes can occur anywhere and at any time. Approximately 4 million earthquakes are recorded worldwide yearly, with approximately 1000 causing devastating effects [1-6].

The most significant fault lines of the world are located on the tectonic plates that constitute the planet's crust. The predominant forces that induce earthquakes are associated with the movements of these plates. Generally, earthquakes are known to transpire at the boundaries of the plates that create the Earth's crust. Similar seismic activities are frequently documented across the globe, as most regions lie along these plate boundaries. Earthquakes predominantly occur along two principal seismic zones on the Earth's surface. The Pacific Seismic Belt, recognized as the largest earthquake belt globally, commences in Chile and extends northward along the coastlines of South America, Central America, Mexico, the west coast of the United States, and southward through Alaska to the Aleutian Islands, Japan, the Philippines, New Guinea, the South Pacific Islands, and New Zealand. Notably, 81% of the world's major earthquakes occur within this belt. The Alpine-Himalayan Seismic Belt accounts for 17% of the world's major earthquakes. This region extends from Indonesia (Java-Sumatra) through the Himalayas and the Mediterranean, reaching the Atlantic Ocean. Turkey is situated on the Alpine-Himalayan belt, recognized as one of the most seismically active areas globally. The country's geographical positioning is between the European-

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Asian (Eurasian) plate to the north and the African and Arabian plates to the south. Its geological framework has been significantly influenced by the continuous movements of these two plates, alongside the closure of the Tethys Ocean, located between them along the Bitlis-Zagros column [1-8].

The frequency of significant earthquakes in and around Turkey can be directly attributed to the active tectonics of the Eastern Mediterranean region. This region is defined by the plate tectonic events that led to the ongoing closure of the Neotethys Ocean. The convergence of the African, Arabian, and Eurasian plates resulted in the closure of the Southern Branch of the Neotethys Ocean, culminating in a continental collision in Eastern Anatolia. Consequently, these geological processes facilitated the formation of primary active tectonic structures and neotectonic regions in Turkey. The main structures shaped by neotectonic processes in and around Turkey include (a) the Aegean-Cyprus Arc System, (b) the Dead Sea Fault Zone, (c) the North Anatolian Fault Zone, and (d) the East Anatolian Fault Zone [1-7].

Two hundred sixty-nine earthquakes have transpired in Türkiye from 1900 to 2023, resulting in loss of life and damage. The most devastating earthquakes regarding loss of life and significant destruction include the 2023 Kahramanmaraş earthquake, the 1939 Erzincan earthquake, and the 1999 Gölcük-centered Marmara earthquake. According to data from the Disaster and Emergency Management Presidency (AFAD), Earthquake Department (DDB), an earthquake with a magnitude (M_w) of 7.7 occurred in Pazarcık, Kahramanmaraş, at 04:17 local time on February 6, 2023. While aftershocks from this earthquake persisted, a subsequent magnitude (M_w) of 7.6 occurred in Elbistan at 13:24 on the same day. Furthermore, another earthquake with a magnitude (M_w) of 6.4 was recorded in the Defne region of Hatay on February 20, 2023. According to AFAD-DDB records, 20231 aftershocks were documented following the main earthquakes between February 6 and March 25, 2023. Based on the epicenter locations of the aftershocks and the moment tensor solutions provided by seismology centers, the Pazarcık and Elbistan earthquakes on February 6, 2023, were characterized by a left-lateral strike-slip faulting mechanism, while the Defne earthquake on February 20, 2023, exhibited a left-lateral strike-slip faulting mechanism with a standard component. Field studies conducted on the Pazarcık earthquake revealed that the Yarpuzlu Compressional Double Bend, Erkenek, Pazarcık, and newly defined Serinyol Segments ruptured from northeast to southwest along the Eastern Anatolian Fault Zone (EAFZ). The Narlı Segment was hypothesized to rupture along the EAFZ, although the Sakçagöz Segment failed to form a surface rupture. The total rupture length of this earthquake exceeded 300 km, with significant surface displacements measuring between 3 and 7 meters. During the Elbistan earthquake, no surface rupture occurred in the Sürgü Segment on the northern branch of the EAFZ; however, it is estimated that the Doğanşehir, Nurhak, and Çardak segments, as well as the Göksu dam, ruptured. The total rupture length of this earthquake was 160 km, with surface displacements ranging from 2 to 8 meters. On February 20, 2023, the Defne earthquake transpired in the 22 km-long northern segment of the Antakya Fault Zone. However, no surface rupture was observed as the earthquake's magnitude did not reach a level sufficient to induce a surface rupture, and the focal depth was relatively deep at 21.7 km. The rupture duration of the Pazarcık earthquake, with a magnitude of 7.7, was estimated to be approximately 100 seconds, while the rupture duration of the Elbistan earthquake, with a magnitude of 7.6, was approximately 60 seconds.

The earthquakes were intensely felt in Kahramanmaraş as well as in Gaziantep, Malatya, Batman, Bingöl, Elâzığ, Kilis, Diyarbakır, Mardin, Siirt, Şırnak, Van, Muş, Bitlis, Hakkâri, Adana, Osmaniye, Hatay, and Syria. It was determined that there are 5.649.317 residences in the 11 cities affected by the earthquakes, of which 1.929.313 were damaged. Among the cities that experienced the most significant damage, it was reported that 68.1% of the residences in Adıyaman, 57.8% in Kahramanmaraş, 55.6% in Malatya, and 50.8% in Hatay were affected. According to the statement issued by AFAD on March 23, 2023, 50.096 individuals lost their lives, and 107.204 individuals sustained injuries due to the earthquakes. During the assessments conducted by the Ministry of Environment, Urbanization, and Climate Change in the 11 cities, a total of 1.895.348 buildings were inspected; it was established that 37.066 of these buildings were demolished, 18.763 were deemed in urgent need of demolition, 200.399 were identified as severely damaged, 47.227 were classified as moderately damaged, 484.147 were categorized as slightly damaged, and 982.154 remained undamaged [6-8].

This study thoroughly examined the number of damaged buildings, the types of damage, and the structural deficiencies in both damaged and collapsed buildings in Adana City following the February 6, 2023, earthquakes. The research is detailed in the sections that follow.

2. Earthquake History and Fault Configuration of Adana City

Historical records show that Adana City has experienced many medium-to-large earthquakes since 69 BC. Notable events include magnitude IX earthquakes in 1114 and 1268 and damaging earthquakes along the Tarsus, Antakya, and Aleppo axis from 1500 to 1800. Significant seismic activity was recorded in Aleppo and Antakya from the early 1600s to the mid-1800s. The 1513 earthquake, likely from the EAFZ, devastated Tarsus, Adana, and Malatya, affecting the Eastern Mediterranean. The largest earthquakes occurred in Antakya in 1822 and Lake Amik in 1872, causing widespread damage in the Çukurova region. However, little notable earthquake activity was reported in the 19th century, especially after 1855 and 1872 (Fig. 1) [1-6].

The Ceyhan-Karataş, Yumurtalık, İmamoğlu, Kozan, Toprakkale, and Savrun Faults are active extensions of the East Anatolian Fault System. Throughout the 20th century, many medium and small-scale earthquakes struck the region, including six notable earthquakes of magnitudes (M_w) 5.2 to 6.3 since 1945 (Fig. 1) [1-6].

The Çukurova region and its surrounding areas in the Eastern Mediterranean are situated near significant fault lines that possess the potential to generate earthquakes. This region falls within the designated high-risk earthquake zones. It is strategically positioned between vital active tectonic structures, including the EAFZ, the Dead Sea Fault Zone (DSFZ), the Ecemiş Fault Zone (EFZ), and the Helen-Cyprus Arc (HCA), thus creating a highly dynamic area in terms of seismic activity. Consequently, the seismic events in this region have laid the groundwork for the occurrence of the significant earthquakes experienced in recent times. Moreover, Adana City and its environs feature active fault lines capable of inciting historical and future seismic events. Among the most prominent of these faults are the Ceyhan-Karataş Fault, the Yumurtalık Fault located to the east-southeast of Adana's city center, and the İmamoğlu (Misis-Yakapınar) Fault, which extends from the Misis-Yakapınar area to the center of İmamoğlu. Additionally, the Kozan Fault, traversing the Kozan region, rises from the Adana Basin and extends eastward from the northern section of the Çatalan Dam, merits attention. Moreover, there are additional, more distant faults, such as the Toprakkale Fault near Osmaniye and the Savrun and Çokak faults located to the north (Fig. 1) [1-6].

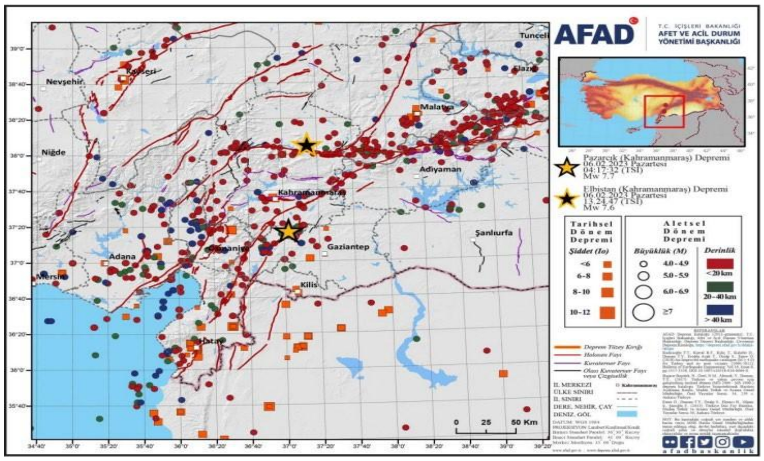

Figure 1. Historical earthquake Map of the Adana region (AFAD) [7]

The Ecemiş Fault Zone, characterized as a left-lateral strike-slip fault adjacent to the western border of the Adana basin, represents one of the significant faults within this region. The aforementioned fault lines hold substantial importance in terms of the seismicity and tectonic characteristics of the area [1-6]. The Toprakkale Fault, originating from the northeast of Andırın and extending to Ceyhan, then to the Yumurtalık district, along with the Ceyhan- Karataş Fault and the Yumurtalık Fault in its southern extension, constitutes critical geological faults traversing the Çukurova region in a northeast-southwest orientation (Fig. 2). These geological structures have formed under the influence of the East Anatolian Fault system and represent significant factors influencing the region's seismic activity. The İmamoğlu (Misis) Fault, which propagates southward over Savrun-Kozan, is an additional active fault within the region, generating a 6.0 magnitude (M_w) earthquake in 1945. Subsequently, the 6.3 magnitude (M_w) Adana-Ceyhan earthquake on this fault in 1998 resulted in substantial damage within the Çukurova region. Notable seismic events in the region include a 5.7 magnitude (M_w) earthquake that transpired in Hatay in 1997; a 5.4 magnitude (M_w) earthquake in Dörtyol (Hatay) in 2001; a 6.1 magnitude (M_w) earthquake in Osmaniye within the same year; and a 5.2 magnitude (M_w) earthquake that occurred off the coast of Adana-Karataş-Tuzla on July 30, 2015. These seismic occurrences were located a mere 20 kilometers from the segment connecting the Ceyhan-Karataş fault line to the Northern Cyprus tectonic extension. On February 2, 2019, a 4.5 magnitude (M_w) earthquake transpired in the vicinity of Ayşehoca-Kozan village, approximately 10 kilometers from the İmamoğlu Fault Zone, positioned 35 kilometers northeast of Adana City. In 2020, earthquakes of 4.0 magnitude (M_w) were recorded around Osmaniye-Sumbas, Kadirli, Andırın, and Ceyhan-Körkuyu, while in 2021, tremors registering between 3.9 and 4.0 magnitude (M_w) were reported around Adana-Karaisalı Nergizlik; 3.8 magnitude (M_w) around Adana Karaisalı-Çevlik; and tremors of 4.3 magnitude (M_w) were observed in the vicinity of Osmaniye-Kadirli-Kösepınarı and Osmaniye-Düziçi-Ellek. In 2022, earthquakes of 3.9 magnitude (M_w) were documented around Adana-Ceyhan-Ceyhanbekirli; 3.9 magnitude (M_w) around Adana Karaisalı-Gildirli; 3.8 magnitude (M_w) around Adana Ceyhan-Tatarlı; and a 5.1 magnitude (M_w) earthquake was recorded in the Osmaniye Düziçi-Çerçioğlu region. Most recently, the 4.8 magnitude (M_w) earthquake that occurred in the Hatay-Kırıkhan-Kangallar area on December 18, 2022, signifies another critical seismic event in the region (Fig. 2) [1-6].

The İmamoğlu (Misis-Yakapınar) Fault is recognized as an active fault line, originating approximately 20 kilometers east of the Adana city center and extending northward towards the İmamoğlu district center. This fault predominantly traverses the flat agricultural landscapes of Çukurova and does not exhibit significant morphological characteristics, such as a pronounced fault scarp. The data about the Misis Fault have predominantly been derived from the examination and analysis of seismic reflection profiles acquired from the region. It has been established that the İmamoğlu (Misis-Yakapınar) Fault demonstrates a left-lateral strike-slip structure with an accompanying reverse component [1-6]. On February 2, 2019, a magnitude (Mw) of 4.5 seismic event occurred approximately 10 kilometers east of the İmamoğlu (Misis) fault line, with its epicenter near the Ayşehoca village. Since this earthquake was approximately 35 kilometers from the Adana city center, it was perceptible to the local population. The 6.3 magnitude (M_w) “Adana earthquake” that transpired in Adana on June 27, 1998, which resulted in numerous fatalities and widespread destruction, also originated along this fault line (Fig. 2) [1-6].

According to the updated Active Fault Map of Turkey, the Ceyhan-Karataş Fault extends northward of the İskenderun Gulf in a direction of N40°E. This fault, which continues for approximately 64 kilometers between Osmaniye to the east and Karataş district to the west, exhibits a left-lateral strike-slip characteristic accompanied by a reverse-slip component. The northern block of the fault is located morphologically at a higher elevation. While the eastern 16 km segment of the Karataş Fault is situated within the Early-Middle Miocene Karataş Formation, the central 38 km section is positioned at the interface between the Karataş Formation and Quaternary deposits. The western 10 km segment of the fault, which coincides with the shoreline, is located within the Quaternary deposits. This fault reaches the Mediterranean Sea in the Karataş region and continues southwestward from the seabed to Cyprus. Significant seismic events indicating the ongoing activity of the Karataş Fault include an earthquake with a magnitude (M_w) of 5.0 that occurred in Kurtkulağı on January 3, 1994, and an earthquake with an epicenter near Tuzla Opening-Adana (Mediterranean Sea) on July 30, 2015, at 01:00 local time, with an instrumental magnitude reported as 5.2 (M_w) by the Kandilli Observatory. Structural field observations have identified morphological features such as stream offsets and elongated ridges that characterize the current activity and the strike-slip fault zone along the fault. Two significant earthquakes associated with faulting and deformations observed in the Late Holocene sediments have been identified. The Ceyhan-Karataş Fault extends nearly parallel to the Mediterranean coastline and the Yumurtalık Fault to the south, forming a fault scarp with a vertical slope of only 2 to 3 meters.

The faults, consisting of numerous parallel segments spanning 62 km between Yumurtalık and Karagedik, are classified as the Yumurtalık Fault [1-6]. This fault, characterized by its distinct 24.5 km section lying between Yumurtalık and İmraniye, extends parallel to the coastline, exhibiting remarkable morphological features. The fault, oriented at N50°E, bisects Middle-Upper Miocene age sedimentary units within this region. Morphologically, the fault delineates the plains situated between Yumurtalık and Kocatepe. Additionally, there exists a fault governing the coastline between Kocatepe and İncirli Çiftlik; this fault intersects the Quaternary basalts and Miocene sediments located between İncirli Çiftlik and İmraniye. Observed morphological shifts to the left and subsidence within the eastern block are apparent between İncirli and İmraniye. The fault intersects a volcanic cone over a 4 km stretch between İmraniye and Delihalil Mahallesi. Furthermore, this fault extends for approximately 2.5 km along the Üçtepe volcanic cone, exhibiting an orientation of roughly N30°W (Fig. 2) [1-6].

The Toprakkale Fault, a segment of the Sürgü-Misis System that extends in a south-southwestward direction, is identified as the northern branch of the East Anatolian Fault. It is classified as a Holocene fault in the updated Active Fault Map of Turkey. The Toprakkale Fault exhibits a left-lateral strike-slip structure characterized by a standard component and extends approximately in the azimuth of N33°E, with an overall length of roughly 52 km. The fault comprises two segments, north and south, separated by a tab structure. The northern segment measures approximately 20 km in length, predominantly intersecting Late Miocene clastic sediments, and in certain regions, it reveals the contact of these sediments with Early Maastrichtian-Late Campanian ophiolites. Active faulting data are observed more distinctly in the southern segment of the fault, which spans approximately 30 km and intersects the floodplain deposits of the Ceyhan River, its tributaries, and the geological formations associated with Quaternary Delihalil volcanism (Fig. 2) [1-6].

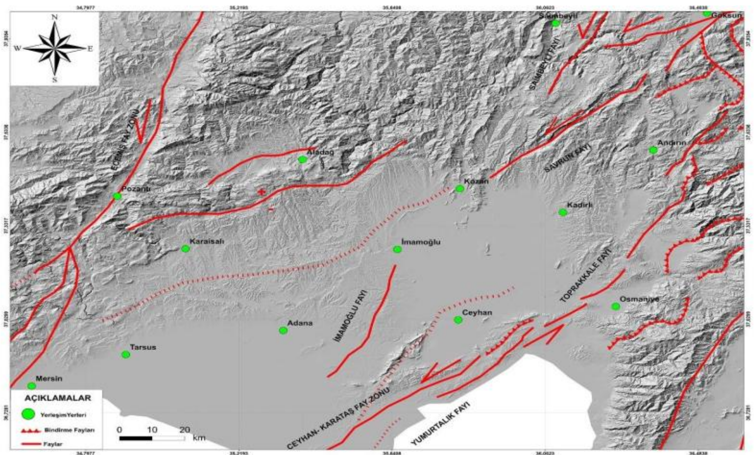

Figure 2. Active faults around Adana City [6]

The Left Lateral Strike-Slip Ecemiş Fault Zone, which delineates the boundary between the Central Taurus and Eastern Taurus Mountains, establishes the northwestern and western perimeters of the Adana basin (Fig. 2) [1-6]. This fault zone continues along the provincial borders of Adana and Mersin. It extends in a southwestward direction from the northern regions of Mersin, with branches near the Mediterranean and the Tekir Plateau in the southern part. The Ecemiş Fault, which has not exhibited seismic activity in recent times, is recognized as one of the neotectonic features of Central Anatolia. The fault comprises both long and short segments originating from Pozantı and advancing through Kamışlı, Burç, and Çamardı towards the Sultansazlığı region and further northward.

The Savrun and Kozan Faults are characterized as normal faults that extend in a northeast-southwest orientation, with a cumulative length of 200 km. It is noted that the Kozan Fault represents the southwestern extension of the Savrun Fault Zone. Furthermore, the Savrun region is recognized as an ancient line of weakness formed along a suture zone situated on the northern edge of the Arabian Plate, which has been reactivated during the neotectonic period. The Kozan Fault extends from the Kozan region into the central parts of the Adana Basin, featuring a standard component and exhibiting left-lateral strike-slip characteristics [1-6]. Following the earthquakes that occurred on February 6, discussions regarding the seismic status of the Adana region persist; however, some researchers have indicated that they have been unable to acquire any data suggesting that the Savrun Fault is currently active. Nevertheless, this fault remains classified as active in the most recent active fault mapping by the MTA (Fig. 2) [1-6].

3. Evaluation of Structural Damage in Adana Following the Kahramanmaraş Earthquake

Adana, one of the eleven cities, suffered profound effects from the earthquakes, with significant damage and loss of life primarily occurring in the northern part of the city. As a result, eleven multi-story buildings collapsed in Adana, leading to a total of 418 fatalities. The locations of these collapsed structures are shown on the map provided in Fig. 3. Notably, the clustering of these collapses in an area distant from the earthquake's epicenter is striking. The northern region of Adana is generally recognized for its high-quality ground. However, local residents who previously lived in this area have reported that stream beds once flowed through this region. Currently, these stream beds have completely disappeared due to extensive construction activities.

The repercussions of the 7.7 magnitude (M_w) earthquake that affected the Pazarcık of Kahramanmaraş city reveal that the horizontal acceleration demands recorded in Adana City exceed the elastic design acceleration values stipulated for the 475-year recurrence interval in TSDC-2018 for structures with periods exceeding 1.5 seconds. This finding indicates that residential buildings taller than 10 stories encountered acceleration demands exceeding the elastic design acceleration values. Upon assessing the vertical acceleration demands, it is evident that the elastic design acceleration values for the 475-year recurrence interval established in TSDC-2018 were surpassed after 0.5 seconds, while those for the 2475-year recurrence interval were exceeded after 1 second. Conversely, the elastic design acceleration values for the 475 and 2475-year recurrence intervals referenced in TSDC-2007 were not surpassed. This observation underscores that the acceleration demands below elastic design accelerations notably impact structures constructed before 2018 that adhered to the regulations.

In the aftermath of the earthquake that recorded a magnitude (M_w) of 7.6 in Elbistan, situated within Kahramanmaraş City, an analysis was conducted regarding the horizontal acceleration demands in Adana City, along with the distributions of elastic design acceleration formulated by various established specifications. It was noted that the elastic design acceleration values, determined for a recurrence interval of 475 years under the TSDC-2018 guidelines for systems characterized by periods exceeding 1.5 seconds, were surpassed by the horizontal acceleration demands. Additionally, it was emphasized that the elastic design acceleration values related to recurrence intervals of both 475 and 2475 years, as pertaining to the vertical direction and as delineated in TSDC-2018, were also exceeded once the 1.5-second threshold was surpassed.

Examining the city of Adana reveals that the demands for horizontal and vertical acceleration generally exceed the elastic design acceleration values calculated by TSDC-2018, particularly at elevated period values. Since a significant portion of the city's building stock was constructed before 2018, the minimal damage observed aligns with the conclusions drawn from these findings.

Figure 3. Location details of buildings destroyed in the earthquake in Adana [9]

The distribution of buildings exhibiting severe or moderate damage in Adana City, categorized by their number of stories, is illustrated in Figure 4. It is observed that the prevalence of buildings with severe and moderate damage is significantly high throughout the city. An earthquake that may occur in Adana, which is encircled by active fault lines, would considerably affect the region and result in substantial destruction. Consequently, it is imperative to evaluate the condition of both structures under construction thoroughly and those that are completed and currently in operation.
The damages causing loss of life and property in previous earthquakes were similar to those observed in reinforced concrete and masonry structures in Adana following the February 2023 Kahramanmaraş earthquakes. The destruction that occurred in Adana relates to the following damage situations: Rigidity differences between the stories of structures cause soft stories and weak stories. Generally, removing infill walls on the ground story or increasing the ground story height for commercial purposes leads to soft story irregularities. During the earthquake, this soft story with less rigidity causes more displacement, causing damage to the structure and even collapse. Such damage situations were also encountered in the collapsed structures in Adana (Fig. 5). The difference between the column designed length and the real length in situ during earthquakes causes a short column effect. The fact that the walls are not raised along the stories and the presence of strip windows also increase this effect. This damaged situation emerges as a notable problem in buildings collapsed due to earthquakes in Adana City (Fig. 5). In Adana and ten other cities affected by the earthquakes, challenges related to concrete quality were observed in nearly all collapsed and severely damaged structures. Nonetheless, concrete is recognized as one of the key materials essential for a structure's performance during seismic activity (Fig. 5). The condition in which the upper story area of a building exceeds that of the lower story is referred to as a “heavy overhang. " Heavy overhangs extend the distance between the centers of gravity and rigidity of the structures, adversely influencing their performance during seismic events. Such structural irregularities are

commonly observed in the buildings of Adana. A significant proportion of the buildings that succumbed during the earthquake exhibited characteristics of heavy overhangs (Fig. 5). The confinement of reinforced concrete members is executed utilizing stirrups; particular emphasis is placed on the tightening of stirrups, especially in the regions of column-beam joints. Insufficient confinement reinforcement is a common issue observed in structures that experienced collapse during earthquakes in Adana (Fig. 5).

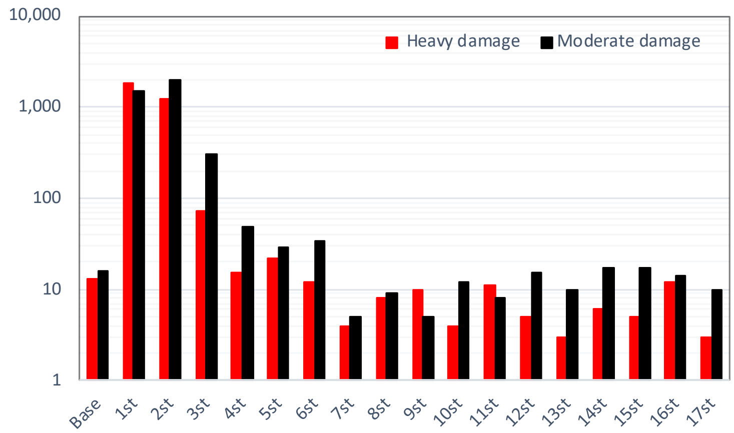

Figure 4. Number of buildings with severe or moderate damage based on story height in Adana City

Figure 5. Collapsed buildings and material conditions in Adana City [8]

When reinforced concrete structures are exposed to weather conditions and come into contact with water, especially those located underground, it is crucial to install concrete spacers as specified in the structural project. Failing to adhere to these guidelines can result in the corrosion of reinforcement bars, which may diminish their cross-sectional area long before they complete their intended service life. This type of deterioration can adversely affect the load-bearing capacity of the reinforced concrete members. This issue is particularly alarming for structures situated in earthquake-prone areas, jeopardizing both human lives and property. Fortunately, thorough examinations of the remains of collapsed buildings in Adana often reveal evidence of corrosion on the reinforcements, allowing us to learn and improve.

In Adana, a common issue with the building stock is the presence of attached structures. When non-rigid buildings are adjacent to more rigid ones, seismic activity causes oscillation movements. These movements result in irregularities in story levels, leading to structural damage due to the pounding effect. Although such events are rare in Adana, there have been recorded cases of this damage in specific collapsed buildings within the earthquake-affected region.

It has been determined that in certain collapsed or severely damaged structures in Adana, the columns were designed and constructed with lower strength than the beams. The energy produced by the earthquake loading effect cannot adequately dissipate due to insufficient rigidity in the column-beam connections and inadequate reinforcement and cross-sectional dimensions. As a result, fractures and failures occur in these regions. This discrepancy, marked by weaker columns relative to stronger beams, causes the stories to collapse on one another during an earthquake, leading to substantial damage. Inadequate reinforcement, overlapping lengths in structural components, or non-compliance with the specified overlap lengths and locations outlined in the TS500-2000 and TSDC-2018 specifications can result in reinforcement pullout, particularly in tension areas. The types of damage described after catastrophic seismic events are often observed in collapsed and severely damaged structures. Seismic codes and fundamental principles of structural earthquake engineering must be strictly adhered to prevent such errors during the design and construction phases of structures.

Conclusions

This study briefly examines the seismicity of Adana city and the structural problems that may arise during both past and future earthquakes. The following issues have been confirmed as a result of the study.

- While not new or the first, it has been determined that Adana City and its surroundings are located within active earthquake faults and are significantly affected by the earthquakes that have occurred.
- A large part of the structures in Adana city and its surroundings consist of reinforced concrete structures. Along with these structures, other types of structures have been significantly affected by the earthquakes that have occurred.
- It has been determined that the structural deficiencies observed in all the structures affected by the Kahramanmaraş earthquakes are similar to the defects detected in previous earthquakes.

Since the region is surrounded by active faults and has experienced destructive earthquakes in the past, society and public institutions need to be comprehensively informed about earthquakes to ensure that structures are resistant to potential future earthquakes.

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