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RESEARCH ARTICLE

Comparison of Structural Damages Observed in Kahramanmaraş Earthquakes with the Damage Types in The Regulations

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ABSTRACT

It is reported that a significant number of buildings were damaged in two major earthquakes with a magnitude of Mw=7,7 in Pazarcık, Kahramanmaraş, Turkey on 06.02.2023 and with a magnitude of Mw=7,6 in Elbistan, Kahramanmaraş, Turkey on the same day. It has been stated that the effects of the earthquakes were felt in 10 provinces (Kahramanmaraş, Hatay, Gaziantep, Diyarbakır, Şanlıurfa, Elazığ, Malatya, Adana, Osmaniye and Kilis), and there were many casualties in these 10 provinces where more than 20,000 buildings collapsed. It is reported that in the earthquakes that took place on 06.02.2023, structures built according to the 2018 Earthquake Regulation rules in force for Turkey also suffered significant damage and even collapsed. Although the current investigations are focused on buildings, bridges, prefabricated structures, water structures that provide transportation in this earthquake should also be examined and reported. Based on the rough observations made, many structures were knocked down without any damage due to soil liquefaction due to the ground conditions of many buildings not being considered. Another issue is the detection of demolitions because the structures before the current earthquake regulation, which has been talked about for years but could not be realized, were not strengthened based on the current earthquake regulation. The causes of damage were determined in the investigations. It has been determined that the newly built structures do not comply with the current earthquake regulations. Over 2000 buildings were examined in 10 cities to compare them with the regulations on partially or completely demolished buildings. As a result of these investigations, the reasons for the collapse of the buildings were determined.

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1. INTRODUCTION

After two devastating earthquakes of 7,7 and 7,6 magnitude that occurred in Kahramanmaraş [1], collapses occurred in many structures in Hatay, Gaziantep, Adıyaman, Diyarbakır, Malatya, Şanlıurfa, Osmaniye, Kilis and Adana [2]. Based on the rough observations made, the following conclusions were reached. Although Kahramanmaraş-Pazarcık is far from the earthquake center compared to Kahramanmaraş province, Hatay province has suffered more structural damage due to ground conditions. When the structures built on the silt-sand mixture transported and stored from the mountains for millions of years in the coastal area were exposed to an earthquake, the ground liquefaction caused a large part of the structures to topple or the structures to sink [3].

The Antakya-Kahramanmaraş graben is one of the areas where many tectonic structures coexist and where tectonic activity is intense. Except for the Arabian plate, which continues its activity, this area is under the influence of the Dead Sea and East Anatolian Faults and the African plate Cyprus Arc. The city of Hatay-Antakya is stretched under the influence of the Dead Sea Fault, which shaped and continues to shape the south of the Graben area. Therefore, the city has a very high earthquake risk. Seismic activities and fault traces that occurred in the past prove that this graben is under constant risk [4].

In energy-related disasters such as earthquakes, the structure is expected to absorb energy in a controlled manner. The first damage that occurs in structures is expected to occur in the weakest link of the chain (wall) in the hollow curtains. Cracks that occur in structures where stiffness is damped in the form of force-displacement describe displacement. However, these displacements in the structural element and the geometric shape of the displacement determine the damage status and resistance of the structure. The displacement effect occurring in structures is like a force vector. The size and direction of shear, bending and torsion cracks and the connection status of the elements are important [5].

The shape of the damages detected in the inspections made on the in-situ reinforced concrete structures in the field after the consecutive earthquakes in the province of Kahramanmaraş were examined. In general, the use of low-strength concrete, missing or faulty column-beam connections, deficiencies in the wrapping reinforcement that the craftsmen had difficulty in making and avoided making, soft floors and short columns-beams during the design period, errors in the arrangement of shear walls to increase the function of the workplace, the formations at the points where the beams are connected to the walls-columns. Faults in bending and shearing have been observed as causes of damage.

Sections in source [6] are given in the region. The first of these sections include the units of the Amanos Mountains from the Precambrian to the Mesozoic, and the second includes the alluvial and Quaternary sediments located close to the coasts. The transition zone from the mountains to the coast was covered with serpentines. The structures under investigation were located on Quaternary sediments and undifferentiated clastic rocks. [6]. Studies by Türkmen et al. [7] revealed that the coast in the Dörtyol coastal plain consists of components of the basement rocks. The cross-section of the plain shows that tertiary conglomerates lie beneath the Quaternary alluvium. Alluvial fans on the mountain slopes, where streams emerge from narrow valleys and enter the wide plain, are characterized by coarse materials. Quaternary alluviums in the coastal region were formed by physical processes within river channels and consist of gravel, sand, and clay. Deliçay, Kocaçay, and Payas Streams carry Quaternary alluviums to the coast. While rocks and coarse deposits are mapped on higher slopes, lower and gentler slopes consist mostly of finer-grained deposits, more specifically sand and clay [8].

Geomorphological, lithological, hydrogeological, and tectonic features of an area constitute the local geotechnical (ground) features of that area. It was stated that the same type of structures in areas with different soil properties were damaged at different levels of earthquake intensity at the same magnitude of seismic activity. This situation is seen when the acceleration and earthquake intensities of historical and instrumental earthquakes are examined. This situation, on the other hand, changes in the form of damping or amplification according to the characteristics of the soils as the earthquake waves pass through the soils. Considering the causes of damage to the structures; as the effects of soil properties; liquefaction, soil enlargement, collapse and settlement on the ground, deterioration of stability on the slopes and the ground rising and overturning the structures [9].

Due to the accumulation of alluviums formed by rivers or seas for millions of years to form warehouses, the high groundwater levels along the Asi River, and the fact that the groundwater is filled with seawater in the areas close to the sea, these soil features increase the earthquake waves and create soil amplification in a possible earthquake. In this case, the intensity of the earthquake increases by 2-3 degrees. Liquefaction of silt sand and sometimes gravel in the ground may occur. In short, when the silt-sand-gravel-water and seismic activity required for ground liquefaction come together, if the ground is not rehabilitated with a foundation type that has enough leather foundations for the structure, one of the wrestlers picks up the other and knocks it down like he hits the ground on his back. Looking at the boreholes drilled to determine the foundation and ground parameters of the buildings, it was determined that the groundwater level varied between 3 and 7.5 m. At the same time, it was determined from the drilling logs opened at these levels that these soils were composed of silty and clayey sands. It has been determined that the risk of liquefaction in these areas in a possible earthquake is quite high [10].

The basis for the confirmation of this claim is that there is less structural damage in mountainous areas. Another reason is that most of the building stock was built according to the 1975 earthquake code before 2000, and the buildings between 2000-2007 were built according to the 1998 earthquake code, and the buildings after 2007 were built according to the 2007 earthquake regulations, naturally, they were not built according to the 2018 earthquake regulations. The design earthquakes of buildings built according to the 2007 earthquake regulations do not meet the 2018 earthquake regulations. Another problem is that the earthquake code rules are rarely applied in newly constructed buildings. The regulations updated in 2018 are not implemented in the buildings constructed after the 2018 earthquake regulations. However, although earthquake regulations have changed, only a few existing buildings have been retrofitted. For example, a collapsed building in Adana was damaged in an earthquake 25 years ago, but it continued to be used without any reinforcement [11]. The symbols used in damage detection are given in Table 1 below.

Table 1. Damage symbols and types

Damage symbol	Damage Type	Crack Width (w)	Pressure Damage Type
O	Undamaged	w≤0.5mm	
A	Slightly damaged	0.5mm≤ w ≤3mm	Shell crush
B	Medium		Crust
C	Heavy		
D	Too heavy		Reinforcement buckling kernel crush

Damage detection was examined in two ways: from outside and inside the building. In structures where significant collapses have occurred (complete or partial), detailed examination is required on the soils that are at the stage of collapse due to complete collapse or rotation. During the examination of this structure, the safety of the examiner must be ensured. The personnel who will carry out this situation, which requires expertise, must ensure the safety of the technical staff [4]. For this reason, the building was examined from the outside and if there was no risk of collapse in a possible or imminent earthquake, this structure was subjected to a preliminary examination from the inside. General crack analyses of the main carrier and non-carrier elements were carried out.

Since we have limited resources in world conditions, optimum designs are made based on minimum material and minimum strength. Due to reasons such as lack of qualified personnel, the safety coefficient for steel is increased by 15%, while the calculations are made by increasing it by 50% for concrete. However, due to the incorrect knowledge of this known information in practice, most of the time, the workmanship of the structure is very relaxed [12].

In general, the leading cause of the collapse of buildings is the failure to meet the capacities demanded by the buildings. It is the inadequacy of cutting and bending capacity. The relations of the building elements with each other are like a group pulling a hatay, if there are weak individuals in the group, it pulls all the stresses on it. If there are strong individuals in the group, it tries to crush all other elements.

Damage degrees are defined as follows. Undamaged: The building has not suffered any damage due to a natural disaster, Slightly Damaged: Fine plaster cracks, plaster flaking, 1-4 mm wide fine cracks on the walls, cracks up to 10 mm in filling and gable walls and partial falls, Medium Damage: 5-5 mm on load-bearing walls. Significant cracks 10 mm wide, partial collapse and separation in partition gable and infill walls, Severely Damaged: Widespread shear fractures wider than 10 mm in load-bearing walls, separation and crushing at building corners, conical spills, separation of the building from the vertical, Collapse: In the building carrier system Partial or complete collapse, partial or complete collapse of the roof. Moreover; Very Heavily Damaged (Buildings to be Demolished Immediately): These are buildings in which the load-bearing elements of the building have been partially or destroyed by permanent displacement to a large extent due to the earthquake. These buildings, which cannot be used in any way, cannot be entered and belongings cannot be evacuated. At the end of general aftershocks, this building is removed as debris [11].

Very Heavily Damaged (Buildings to be Demolished Immediately): These are buildings in which the load-bearing elements of the building have been partially or destroyed by permanent displacement largely due to the earthquake. These buildings, which cannot be used in any way, cannot be entered and belongings cannot be evacuated. At the end of general aftershocks, this building is removed as debris.

Within the scope of this study, we examined 11 cities and districts. The purpose of this study determines whether the fracture and damage of the structures specified in the regulations and literature occurred in the Kahramanmaraş earthquake. whether old structures accommodate these fracture patterns. I tried to find out whether the buildings built after the 2018 earthquake regulations meet these damage types and record them in the literature. By combining our field and experience, we revealed the devastating causes of the earthquake.

2. SEISMIC RESPONSE OF REINFORCED CONCRETE AND OTHER STRUCTURES

2.1. Structure Soil Interation

The examined building is in the city center of Adıyaman-Gölbaşı district. The region is located on the lake-formed alluvial deposits of a pull-apart basin connected to the Gölbaşı-Türkoğlu segment of the Eastern Anatolian Fault Zone (EAFZ). The buildings in this region were designed considering earthquake regulations. However, although it was stated in the ground reports, that not enough precautions were taken for the foundations, which had devastating consequences for this area within the Gölbaşı settlement area. Beyond the construction quality, the collapse of buildings due to deep ground behavior such as ground liquefaction, loss of bearing capacity due to loss of strength in the ground, ground deformations - sand jets and lateral spreading, as well as significant damage such as tilting of buildings without any structural damage or level movement and deformations on train tracks.

We did not look at the number of floors of the buildings. We mostly looked at how buildings collapsed and their durability. As seen in Figure 1, there was no need for structural examination of the buildings that were tilted due to liquefied soil. because there was no structural break or collapse other than the collapse and overthrow of the structure (Figure 2).

Figure 1. A building that collapsed due to soil liquefaction but remained intact based on its elements.

Figure 2. A building that moves vertically due to soil liquefaction - sand boiling but remains intact with its elements.

2.2. Soft Story Effects in Ribbed Slab Constructions

The ground floors are designed higher than the upper floors, the wall areas on the upper floors are high, and heavy overhangs are created in the building.

Figure 3. The building built in 2022 in Malatya's Bostanbaşı Neighborhood.

Figure 3 The structure, which was built in 2022 in Malatya's Bostanbaşı Neighborhood, but collapsed due to the soft floor in two major earthquakes of 7.7 and 7.6 magnitudes that occurred in Kahramanmaraş on February 6, 2023. It is seen that the lower part of the collapsed structure in Malatya, which is widely seen on social media, has collapsed. However, the top of the building remains obliquely standing on a pile of dust and rubble. This structure was built last year, and advertisements seen on social media say that the building was "built under the latest earthquake regulations". All materials and workmanship were claimed to be of "first-class quality". The fact that the building is newly constructed requires that it be constructed under the 2018 earthquake regulations. In this regulation, it is stated that high-quality concrete reinforced with steel reinforcements should be used in buildings in areas with earthquake risk.

Figure 4. A soft floor incident that occurred in the city center of Iskenderun

In Figure 4. soft floor incident that occurred in the city center of Iskenderun. It is envisaged that the columns and beams will be effectively distributed and arranged with shear concrete in both directions to meet the horizontal loads to meet the impact of the earthquake. However, we do not have information about the materials and workmanship that determine the construction standards used in this building.

2.3. Short Columns Effects

Illustrated figure 4, since the ground floors are raised more than necessary to sell them at a better price, band windows should be opened in the curtains of the basements surrounded by curtains to provide adequate illumination of the basement. As a result of examining the building photographs above, it was seen that the basement floor was surrounded by curtains and windows were opened from these curtains. It was understood that due to the opening of these windows, a short column effect occurred, and the building collapsed. Figure 5. Despite the warnings made two years ago in Malatya, the building where the columns were cut for the market collapsed in the earthquake.

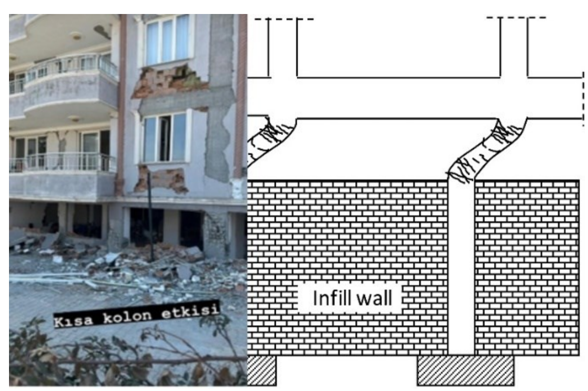

Figure 5. Despite the warnings made two years ago in Malatya, the building where the columns were cut for the market collapsed in the earthquake.

2.4. Strong Beam and Weak Column Behavior

If the beams are stronger than the columns, the beams are solid, like a layered sandwich, but there is no sign of the columns. Figure 6. A collapsed building in the Malatya Özalper Neighborhood collapsed due to a weak column-strong beam.

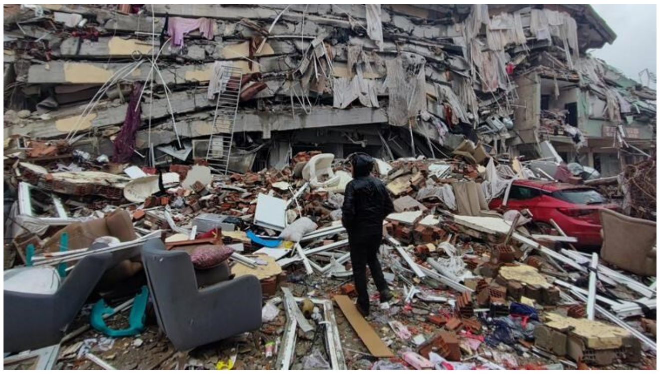

Figure 6. A collapsed building in the Malatya Özalper Neighborhood collapsed due to a weak column-strong beam.

2.5. Historical Building

Historical buildings are the memory of societies and nations, they are visual historical documents that talk about the culture, civilization and historical memory of civilizations. These structures are important in connecting the past of society to the future and showing the progress and lifestyle in the field of art and culture (Figure 7). The Historical Arasa Mosque in the Kahramanmaraş earthquakes.

The masonry construction technique has been used in the construction of buildings all over the world for years. In general, wood, adobe, brick and stone are among the oldest building materials. These materials are still used today due to some of their cost effectiveness, durability, local availability, sound insulation properties and restoration purposes. Earthquake regulations for the protection, design and construction of such structures have generally been updated many times each time [16].

Figure 7. The Historical Arasa Mosque in the Kahramanmaraş earthquakes

From field observations and hand-held studies made after the Kahramanmaraş earthquake, it was seen that the building stock built with the masonry construction method was significantly destroyed. The design technique of the historical buildings in the area consists of arched, domed and vaulted structures. As for the material technique, it is made of terracotta bricks, rubble stones or cut hearth stones. Most of the buildings consist of rubble stone walls, where two smooth surfaces are placed side by side, and unreinforced masonry structures. In some buildings, they are made of wood, steel and brick materials using diagonal horizontal support between floors. Kahramanmaraş earthquakes caused great destruction in historical buildings as well as reinforced concrete, prefabricated and other masonry structures in the earthquake area. This earthquake caused great damage and destruction, especially in Hatay, Adıyaman, Kahramanmaraş and Gaziantep city centers and districts. 65 percent of the historical masonry structures in the earthquake zone were destroyed or severely damaged. Macro seismic scale earthquake damages of magnitude IX-XI occurred in Antakya and Kahramanmaraş [15].

Figure 8. The Historical Church of Saints Peter and Paul, Hatay-Antakya

The main bearing elements of the supporting structures are stone or reinforced concrete. However, stone-type retaining walls are available in rural areas because they are both aesthetic and economical. These structures, designed as masonry structures, collapsed, and blocked the access road, as seen in Figure 10. These walls, built for both load-bearing purposes and to separate spaces, can be thick due to their low strength. These types of structures, which are widely used in rural areas, are sensitive to earthquake effects and can receive damage at many different levels. It suffered serious damage due to the Kahramanmaraş earthquake that occurred on February 6, 2023. There was no excessive damage to transportation bridges and tunnels. However, due to the transportation disruptions caused by the collapse of these masonry-type walls built on the side of the land T-road, it was suggested that other types of retaining walls be built.

The main load-bearing elements of masonry structures are walls obtained using different materials. These walls, which are used both to carry loads and to separate spaces, can be thick because they generally have low-strength properties. Masonry structures commonly found in rural areas are sensitive to earthquake effects and can receive damage at different levels. These masonry structures, which were generally built without any engineering services, suffered serious damage due to the impact of the Kahramanmaraş earthquake couple that occurred on February 6, 2023.

Figure 9. Examples of damage to the structural stone walls

2.6. Earthquake Behavior of Precast Concrete Structures

Precast reinforced concrete structures are made pre-stressed in the factory area and assembled at the construction site. All elements of such structures are made in a controlled manner in a factory environment. However, the assembly is done in the field. The structure's resistance to high bending and shear forces ensures fast and controlled assembly in the field, saving time and costs. The strength of structures built with this method is significantly lower than that of structures built with cast-in-place concrete.

Figure 10. Damage occurring at the connection points of the prefabricated structure

During this earthquake, field observations were made on precast structures in industrial zones, grain warehouses, farms and textile workshops, and the damage to these structures was examined. The most common type of damage is the horizontal beams sitting on the column falling apart from their connection points. In buildings where solar energy panels are widely used on roofs, disintegration has occurred in the elements of the buildings due to damage to the structure during the installation of the panels and the use of non-standard aggregate (flat aggregate). Due to the additional loads of these panels, they overloaded the roof trusses and caused them to topple sideways. Floor damage occurred due to the prefabricated concrete structure with weak columns and heavy roof beams. Another common situation is that purlins that are not sufficiently connected to the beams as third members are stripped.

The structures designed as a displacement-based design method could not meet the horizontal displacement and rotation demands because sufficient displacement and rotation distances were not given at the element joints. The necessary pin connections were not made at the joints. Due to the lack of cement mortar at the connection points of the floors and purlins to the beams, the floors did not work as a diaphragm structure. Some buildings with mezzanine floors appear as design errors. Mezzanines and other floors of the building are exposed to different piping effects.

Most of the wall damage is due to low-stability infilled walls. In addition, the horizontal reinforced concrete beams that provide stability in wide-span building walls did not meet the short height requirement, causing damage. The wall movements here occurred out of the plane. Damping did not occur because the part called c, which should be between the walls and the building elements, was not used. This event caused brittle fractures in the structures.

As seen in Figure 9, not providing the necessary precision in joining the joints during the assembly stages, filling the joints with low-strength cement mortar or leaving them empty, using insufficient or not using nuts, washers and anchor materials completely caused serious damage to the precast structure. In addition, damage such as shear cracks at column-foundation nodes, bending cracks at the lower ends of columns, separation of shell concrete in columns, buckling of reinforcement or rupture of reinforcement occurred.

2.7. Insufficient Shear Reinforcement Detail

To prevent brittle fractures, the reinforcement must be wrapped in detail and its connections must be made well. Therefore, pre-stressed structures have been recommended recently. Therefore, the structures strengthened using coiled material survived the earthquake normally. However, even though this event can't occur during construction, this situation can be overcome by using sufficient equipment and proper workmanship. Figure 11. Insufficient Shear Reinforcement Detail.

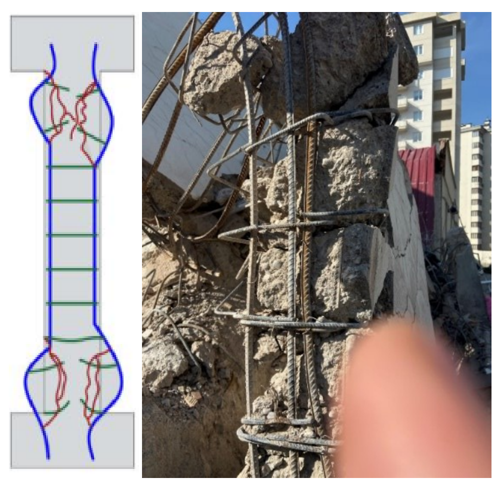

Figure 11. Insufficient Shear reinforcement detail.

2.8. Insufficient Shear Reinforcement at Column-Beam Junctions

A typical column beam combination is given in Figure 4. in other words, throat stirrups are shown. The application of this column beam area requires expertise in terms of mastery and workmanship. If this part is not processed carefully and by an expert, the iron hooks will not be tied well. For this reason, these parts are the first places of destruction to occur in structures with defective connections [12].

Figure 12. Column beam connection detail.

2.9. Poor Concrete Quality and Wrong Placement of Concrete

The common view in field investigations after the earthquake is that the damage occurring in the column-beam junction areas is due to low-quality concrete, unskilled workmanship, incomplete engineering service, segregation in concrete, and accordingly the column-beam junction. In Figure 14. Shows manual crushing of concrete to indicate poor concrete quality.

Figure 13. Shows manual crushing of concrete to indicate poor concrete quality.

In addition to concrete made manually or as blended concrete, even in buildings where ready-mixed concrete is used, incomplete, faulty molds and concrete placed without compaction have brought the partial or entire performance level of the structure both locally and globally. One of the most common faults observed in concrete is the inappropriate aggregate type and aggregate size, causing serious damage to both the column bottoms and the column-beam junction areas [13].

As seen in Figure 5 and Figure 6, low strength and segregation occurred, respectively. This mistake, along with other mistakes in the building, had a great impact on the collapse of the building.

Figure 14. Shows manual crushing of concrete to indicate poor concrete quality.

2.10. Poor Reinforcing Steel Quality, Corrosion, and Improper Placement of Reinforcement

As in the Van earthquake, many of the collapsed and heavily damaged buildings were 4-6-story buildings. Considering the destruction rate of the year of construction, there is a significant increase. For this reason, it seems that the use of flat reinforcement, which constitutes another element of the building material, has not changed even after the 1999 Izmit earthquake. In addition, most of the collapsed or heavily damaged buildings comply with earthquake regulations.

Contrarily, plain reinforcement was used instead of ribbed reinforcement with high interlocking with concrete (Figure 5). In non-collapsed buildings, total collapse did not occur because the infill walls increased structural rigidity and in non-collapsed buildings, the infill walls increased the building performance. However, since such structures are brittle, there is a high probability of collapse [14].

Figure 15. Column beam connection detail for lowes iron and concrete.

2.11. Concrete Settlement Problems

Among the most common defects seen in the field is segregation, which significantly determines the strength of concrete. Figure 17- 18. It is seen that the concrete was placed with segregation and without a vibrator. The investigations have shown that, especially in narrow and deep molded structures, concrete begins to collapse due to excessive segregation and corrosion occurs due to voids. Crusting and corrosion have occurred due to excessive water intake in the unwashed parts of the concrete poured without considering the water permeability of the concrete or without using a compaction machine. It was observed that in a few columns, pressure buckling occurred due to insufficient pressure zone formed due to aggregation and insufficient wrapping.

Figure 16. Aggregate that is not suitable in size and shape.

Even though there may be a decrease in segregation in buildings built according to the latest construction technique and in buildings after 2018 due to the use of stable aggregate, it is possible to encounter segregation in a large part of the building elements that were eventually demolished. figure 6, year of construction new segregation formation that occurs in structures with shows.

Figure 17. It is seen that the concrete was placed with segregation and without a vibrator.

Placing the concrete properly and without a vibrator. The above-mentioned problems cause damage to structures.

Figure 18. We conclude that the structure, completed in 2019, should be built to the latest standards.

The possible collapse of this structure is seen as ground conditions. The number of buildings destroyed in these ten provinces should not be surprising. Current construction regulations ensure that structures can withstand earthquakes of this magnitude. However, the collapse of even the buildings built according to the new earthquake regulations brought up the problems related to building safety standards in the country.

Figure 19. A nine-storey building in Antakya

Another example shows that a building built under the 2018 earthquake regulations in Iskenderun was also largely demolished. The side and back of the 16-storey building completely collapsed and a small part of it remained standing. We found photos of the building in a Google search.

Figure 20. Kahraman Maraş onikişubat haydar bey mah. The building collapsed due to column cutting.

Another structure, a nine-story building in Antakya, seems to have collapsed. We know that the construction was finished in November 2019. Of the 10 blocks built together, only two are demolished. After so many buildings collapsed in the earthquake-affected area, scientists and researchers began to question building regulations. Although earthquakes are severe, experts, scientists and researchers need properly constructed buildings to survive. Illustrated Figure 20. Kahraman Maraş onikişubat haydar bey mah. The building collapsed due to column cutting.

Although the maximum intensity of the earthquake was as severe as we have seen from other earthquakes in the world, it is clear that no earthquake is big enough to destroy well-built buildings according to earthquake regulations. In many places, the intensity of the earthquake was below the expected maximum earthquake magnitude, so we conclude that almost all of the thousands of buildings destroyed are not in compliance with the current earthquake construction code.

Countries like Japan, where millions live in densely populated, high-rise buildings despite the country's history of heavy earthquakes, demonstrate how building codes can protect people from disasters. The rules of construction regulations change according to the purpose of use of the building and its proximity to areas with high earthquake risk. These regulations contain all the rules from simple reinforcements to equipping with strong seismic isolations.

It is mentioned in the report of the Ministry of Environment and Urbanization that 50 percent of the buildings in Turkey, that is, almost 13 million buildings, were not built under the construction regulations in 2018.

3. CONCLUSION

In this study, a comprehensive structural and geotechnical observation evaluation was made during the field investigation after the Kahramanmaraş earthquake that occurred in 2023. During the field investigation, which was carried out by researchers from many universities and a team consisting of geotechnical, earthquake, earth science, material and transportation experts, mutual discussions were held and the causes of damage to the structures were discussed, and on-site conclusions were drawn.

A high level of destruction and structural damage occurred in districts and buildings in districts such as Hatay's Antakya, Adıyaman's Gölbaşı, Kahramanmaraş's Türkoğlu. The main reason for this damage is attributed to their proximity to the fault and the fact that they are built on alluvial deposits. These structures, built on lake beds and riverbanks, show significant increases in earthquake activity, mostly due to unstable local ground conditions. The general problem is that the foundation designs of structures built on problematic soils are designed only according to vertical loads, as required. However, earthquake-resistant foundation designs are not implemented as specified in the ground survey reports.

For this reason, the buildings were not used due to their complete or partial collapse or lying on their side without any damage. It caused the collapse of many buildings and loss of life and property. Although some settlements were far away from the earthquake epicenter, more damage occurred than in places at the same distance with other ground conditions due to vibrations coming through the fault lines. Another issue is that although it was close to the earthquake, the damage remained limited because ground enlargement had not yet occurred due to ground and foundation conditions.

Prefabricated buildings, known as industrial buildings, are mostly formed by separating the floor and beam elements from their connections. The real problem is not paying enough attention to the pin connections. Since the concrete poured inside the slab shortened the confinement area in the parts where the column was connected to the foundation, hinges occurred at a point above the expected area in the column.

General masonry damage types were determined in the historical and factory walls in the studied area. Historical structures built on rock-type soils are less stable than structures built on alluvial soils. The general types of damage that occurred in masonry buildings in the study area occurred in the weak parts of the corner elements and wide-span middle walls. Lack of binders, tensile strength of materials, brittle fractures and wide gaps between structural stone columns have caused out-of-plane movements and overturns.

In this study, the structures were examined observationally and instrumentally, and the defects that occurred due to structural irregularities were examined in comparison with the criteria and incompatibilities given in the literature. On the other hand, structural damages that were not subject to structural irregularities but occurred due to materials and workmanship were examined.

- The biggest problem is that the collapsed structures are on or near the fault line.
- Most of the collapsed structures turned into debris due to the loss of bearing capacity of the material.
- As a result of designing the lowest floors as workplaces, increasing the mezzanine height, and carrying out the construction works that will cause soft floors.
- To sell the ground floor flat at other flat prices, the short column event occurred due to the basements being higher than they should be and the basement windows being opened.
- Removing some columns, missing curtains, or using curtains in different directions to make the workplace more useful.
- Construction of the superstructure on soils with liquefaction potential without adequate soil investigation or project planning. Insufficient foundation improvement with bored piles or jet grouting.
- It has a destructive effect on the structure by increasing the earthquake accelerations of the alluvial ground compared to the rocky ground.
- Seismic isolators are not used in foundations. For this reason, accelerations from the ground directly affect the building.

Considering the general logic of this study; We conducted a study to say that we saw this as a result of the field survey we conducted with a group. This article certainly does not present a new case other than the short column and building-ground relationship data. The photographs and figures we added can be used to witness history. In addition, this article was written to present the academic world the difference between scientific study and field work on earthquakes, in other words, the theoretical studies carried out in practice as a result of the earthquake.

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