UCTEA
Turkish Chamber of Civil Engineers

PRE-ASSESSMENT REPORT ON FEBRUARY 6, 2023 KAHRAMANMARAŞ PAZARCIK AND ELBISTAN EARTHQUAKES

14 February 2023

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1. Introduction

Two major eathquakes occured on Monday, February 6, 2023, in Turkey. The first one, with a magnitude of 7.7, struck at 04.17 h, at Pazarcık district of Kahramanmaraş; the second earthquake with a magnitude of 7.6 struck Elbistan district of Kahramanmaraş at 13.24 h. The earthquakes caused widespread collapsed and severely damaged residential and commercial buildings, public facilities, and infrastructure in Kahramanmaraş, Gaziantep, Şanlıurfa, Diyarbakır, Adana, Adıyaman, Osmaniye, Hatay, Kilis, Malatya and Elazığ provinces with substantial casualties. As of February 13, 2023, 10.55 am, according to official records, the death toll was 31 thousand 643 and 80 thousand 278 people were injured, 6 thousand 444 buildings collapsed, and 11 thousand 302 buildings were reported as demolished.

The resulting damage shows that the strong ground motion characteristics were felt in a very large area. Major earthquakes seldom occur on the same day. These earthquakes, in that sense, are of a nature that will go down in history in terms of their characteristics and results. Eathquakes are natural phenomena; the reason why they turns into disasters is basically related with improperly designed and/or misconstructed structures. If the construction processes were carried out properly, according to the Seismic Design Code, buildings would still be damaged, perhaps even heavily damaged, but they would act to make people come out of them, and the earthquakes would not have been turn into a disaster. Although the structural damages would be great, the loss of life would not be too much.

After the August 17, 1999 Kocaeli and November 12, 1999 Düzce earthquakes, the awareness on the production of earthquake resistant structures increased, the 1998 Seismic Code came into force, the use of ready-mixed concrete and ribbed reinforcement bars became widespread. Consequently, it was thought that the earthquake resistance of the structures built after 1999 would be higher. The building inventory in the earthquake area is currently unknown. However, it is understood that some of the collapsed or severely damaged buildings were built after 2000. In fact, there have been demolitions in buildings that were known to have been built very recently, just a few years ago, and those were, most probably, should have been designed according to the latest (2018) Turkish Seismic Code.

2. PRE-ASSESSMENT OF STRUCTURAL DAMAGES

Weak Geotechnical Conditions:

The regions where earthquake damage is common are mostly the cities planned on agricultural lands. Consequently, 10 to 15-storey buildings with rather flexible structural systems that were constructed on weak soils where the bedrock is very deep or even on soils with high liquefaction potential were severely damaged or collapsed. Besides, even if not collapsed, ground liquefaction is thought to occur in some areas, as buildings have been observed to sink one floor down or tilt to the side.

It is possible to to construct stuctures under all kinds of ground conditions, of course. However, it may be too costly. The soil should be improved to safely bear the structural loads. The proper foundation and structural systems should be selected in accordance with the soil conditions. Besides, the design process should be rigorously carried out in accordance with good engineering approach and should be supervised by expert engineers. A qualified inspection should also be carried out during all construction stages, as should be done in all construction processes. However, the above-mentioned system still have several deficiencies, in practice. The earthquake resistance of the structures, particularly those built by small-scale contractors who may avoid meeting the high construction costs, built on weak soils should be questioned. Actually, the problem is not totally associated with the cost. It is more of a social problem related with the level of consciousness, experience, ethical and moral understanding. Therefore, city planning activities should be reviewed, considering the issues mentioned above.

Material Quality Problems:

There are material weaknesses observed in reinforced concrete structures. Until about early 1990s, concrete for reinforced concrete structures was mostly hand-mixed. Although ready-mixed concrete was being used to some extent, it started to get widespread after the 1999 Kocaeli earthquake. Therefore, it is known that the concrete quality of the buildings built in the 80s and 90s, and even at the beginning of the 2000s, is below the required design concrete strengths, and this is unfortunately a common situation. Similarly, use of plain bars as reinforcement was common within those years. Therefore, it is possible to say that material weaknesses are one of the important factors in the collapse of or the heavy damage occured in the reinforced concrete buildings constructed in these years.

However, it has been determined that some of the buildings that were built later and even a few years ago, were collapsed or heavily damaged, unfortunately. The collapse of such buildings, which were supposedly designed according to the new earthquake regulations, used ready-mixed concrete and ribbed reinforcement bars, and received building control services, had shocked and traumatized the people.

It is not possible to state the reasons for the collapses or heavy damages without detailed technical examinations. However, it is easier to estimate the causes of damage to structures built before 2000 since the reasons of collapse or major damage observed in buildings built at the same time in the previous earthquakes can also be traced in this earthquake. Low material quality is one of these reasons. However, it is not easy to predict why recently built structures collapsed or suffered heavy damage. If material weakness is detected as one of the reasons for collapse in these structures, it means that the building inspection system has not worked properly since according to the building control law and implementation regulation, obligatory operations such as inspection, materials sampling and testing must have been carried out properly and legal and compulsory actions such as demolishing the part of the structure that has strength lower than the design strength were not taken.

Construction Problems:

From the debris of the collapsed buildings; It was observed that the necessary reinforcement details were not applied in the column-beam intersections and the stirrup spacing was sparse. In addition, it can be observed that the stirrup hooks are at ninety degrees and the length of the column rebars forming the upper layer shoots is shorter than required.

The minimum dimensions and reinforcement details of reinforced construction elements such as columns, beams, and shear walls are defined and the principles for shear calculation of column-beam intersections were given in the section on reinforced concrete buildings of the 1975 Seismic Code, which is the basis for the design of buildings before 1999. However, in the construction practices of that period, the requirements on the transverse reinforcement details in the joint area and the stirrup hook detail could not been implemented. Situations such as not using transverse reinforcement in column-beam junction areas, lack of sufficient bond length of beam longitudinal reinforcements, large transverse reinforcement spacings and having 90 degree hooks of transverse reinforcements are present in our construction practice before the 2000s, and unfortunately caused complete or partial collapses and severe damage in major earthquakes.

Damages Caused by Building Irregularities:

- The common collapses observed indicate that first the ground floors collapsed and then the other floors fell on top of each other resulting in sandwich-type failure. One of the main reasons for the damages is considered to be the absence of infill walls in the commercial spaces on the ground floors. Although infill walls are considered only as a load in the design of the structural systems, it has been shown by experimental studies that they contribute to the behavior of the structural system in terms of strength and stiffness to a certain extent. For this reason, control of weak storey as a structural irregularity is also taken into into consideration in the modern earthquake regulations. The infill walls inside the frames on the upper floors maintain their integrity when faced with an earthquake load that does not exceed their strength, thus ensuring that the building exhibits a more positive earthquake behavior in general. However, when there is no such integrity on the ground floor, if there is not enough ductility in the columns of the ground floor and there is not enough rigidity in the structural system, the displacement of the ground floor compared to the upper floors becomes too large and sudden collapses are facilitated when this floor is crushed.
- As a result of the short column damage, which is the damage caused by the ribbon windows between the columns short column damages, which are defined as the loss of strength and failure of the column primarily by shear fracture, are seen in heavily damaged structures.
- Collapsed buildings also indicated that large torsional effects caused by the uneven distribution of stiffness in the structural system resulted in failures. The presence of more rigid vertical structural elements such as curtain walls all in the same direction and the presence of frame discontinuities are the factors that create torsional irregularity.

- One of the mostly questioned issues by the people is why one of the two adjacent or nearby buildings with the same geometry have collapsed and the other remained standing. The most probable answer to that would be that some of the above-mentioned irregularities are present in one but not in the other. In addition to these, it should be taken into account that there may be differences in soil conditions (alluvium thicknesses on the bedrock may be different), materials used and workmanship quality, also.

DAMAGE PHOTOS:

Photograph 1 - Hatay

Photograph 2 - Hatay

Photograph 3 - Kahramanmaraş

3. PRELIMINARY ASSESSMENT OF DISASTER MANAGEMENT

Disaster Management can be simply defined as expecting for the unexpected and managing the worst.

Modern Integrated Disaster Management consists of the following phases:

1. Risk/Damage Reduction

2. Preparation

3. Intervention

4. Improvement

The Risk Management part of the Disaster Management includes the first 2 of the above stages, and the Crisis Management part includes the work in the 3rd and 4th stages. In other words, Disaster Management is not a search-rescue process after a disaster. The initial post-disaster actions are emergency response and pre-remediation works. It is a big mistake to consider emergency response works in case of any disaster as "Disaster Management". Disaster Management is a serious sustainable development problem for Türkiye and it should never be taken as only search and rescue efforts.

It is NEVER possible to be successful in “Disaster Crisis Management” without adequate Disaster Risk Reduction measures.

The first reason for the failure after this natural disaster caused by the two major earthquakes with magnitudes of 7.7 and 7.6, centered in Kahramanmaraş Pazarcık and then Elbistan, respectively, is the fact that the risks in these regions, have not been reduced to a manageable level before the earthquakes occured. Therefore, the first and most important stage of Disaster Management is Risk and Damage Reduction.

Photograph 4 - AFAD Tents Established in the Earthquake Area

The work to be done at this stage is as follows:

I. Risk and Damage Reduction:

a) Hazard Analysis

b) Risk Analysis

c) Risk Reduction

Prevention

Cautiousness

Risk and Harm Reduction

Risk Transfer

d) Risk Communication

e) International Risk Reduction Policies

In order to cope with disasters and search and rescue, “risk must be manageable”. Therefore, first of all, existing risks should be identified and “reducing the risk” is needed. The biggest problem in the last earthquake was the violation of this basic principle of disaster management.

After the size of the possible disaster is brought to a manageable level, preparations are made for the residual risk, which cannot be avoided. In other words, it is not possible to prepare for a disaster that cannot be managed, it cannot be done easily, and it cannot be successful.

Disaster risk must first be reduced to “manageable” and “tolerable” levels. Then, what is needed to be done for the second phase is "Preparation" phase of disaster management;

ii. Preparation:

a) Incident Command System

b) Planning

c) Forecasting and Early Warning

d) Exercises

e) Education

In the last earthquakes, it was understood that there was a lack of coordination. It clearly shows that the command system, planning, training and exercises were not sufficient in the region and those in the surrounding provinces that will help the region.

Following are the activities to be done after the disaster.

iii. Intervention:

a) Impact and Needs Analysis

b) Incident Scene Management

c) Pre-Remediation

The first operations that should be done in the first moments to respond to disaster victims are disaster impact and needs analysis. The fact that the first of the last earthquakes was at late night and the weather was cloudy and rainy in the region prevented optical images from being taken from the satellites. Due to the collapse of the communication system in the region, it was very difficult, if not impossible, to communicate with the police stations, headmen, etc. and get information.

In addition, the fact that the number of destroyed buildings was over 10 thousand made it very difficult to reach all of them and to take them under control.

This made the destruction caused by the Kahramanmaraş, Pazarcık and Elbistan earthquakes, which occurred one after the other, "unmanageable". It was an incredible mistake that this unmanageable risk of destruction was allowed to occur in the region.

4. TRANSPORTATION

Information on transportation to the region is as follows:

Highways:

According to the data of the General Directorate of Highways, the following roads have been closed.

- Hatay Airport road 0 – 5 Km, 6.02.2023 as of at 6.00 am
- Saimbeyli-Feke Highway in Adana, 70 - 75. Km, 6.02.2023 as of at 15.00 pm.
- Hatay-Reyhanlı Highway 20-22. Km, 6.02.2023 as of at 00.02 am
- TAG Highway (Ayran Viaduct -Kızlaç Viaduct) 0 - 5. Km, 7.02.2023 as of at 14:00 pm
- TAG Highway (Bahçe İntersection) 0 - 5. Km, 7.02.2023 as of at 14:00 pm
- Nurhak-Kapıdere İst.-Gölbaşı Highway 0 -7. Km, 2.02.2023 as of at 10.00 am
- Elbistan-Nurhak Highway 0 - 54. Km, 7.02.2023 as of at 10.00 am
- Çelikhan-Sürgü Highway, 0 - 6. Km, 6.02.2023 as of at 04.17 am
- Adıyaman-Çelikhan Highway, 0- 74. Km, 6.02.2023 as of at 4.17 am
- Malatya-Çelikhan Highway 0 - 25 Km, 6.02.2023 as of at 5.00 am
- Çelikhan-Sürgü Highway 0 - 12. Km, 6.02.2023 as of at 5.00 am
- Malatya-Gölbaşı Highway 74 - 84. Km, 6.02.2023 as of at 4.17 am
- Malatya-Gölbaşı Highway 0 - 74. Km, 6.02.2023 as of at 4.17 am
- Osmaniye-Kaypak 2 - 7. Km, 12.02.2023 as of at 14:00 pm

Photograph 5 - Highway of Gaziantep - Osmaniye

Photograph 6 - Highway of Malatya - Adıyaman

Osmaniye-Gaziantep direction was completely closed to traffic.

Hatay-Reyhanlı Highway was completely closed to transportation .

Hatay Kırıkhan-Topboğaz Highway was closed to traffic.

Adiyaman-Çelikhan-Sürgü Highway, Balık Burnu Bridge had collapsed.

The area between Adıyaman Gölbaşı and Malatya Sürgü was closed to traffic due to landslides.

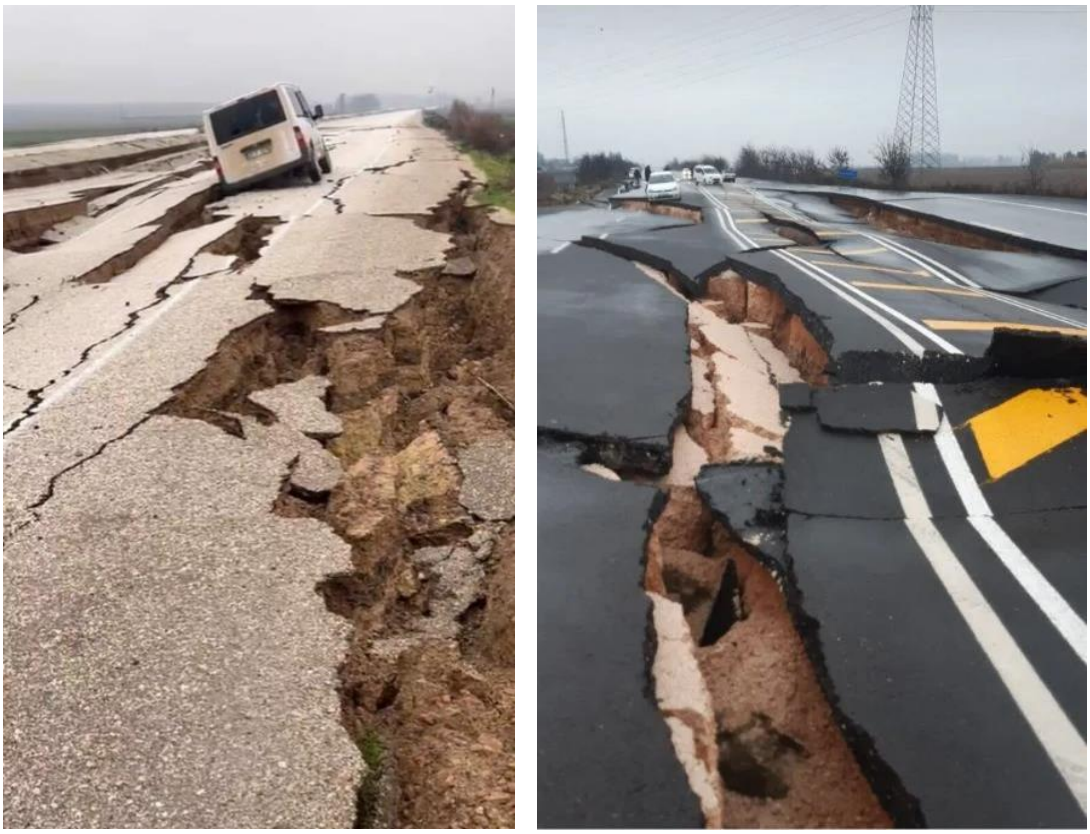
The Highway between Hatay Kırıkhan and Belen was closed to transportation due to a collapse.

Adıyaman Gölbaşı-Malatya highway was closed to transportation due to landslide and spalling of concrete in the tunnel

There were difficulties in transportation lines due to seasonal conditions, and some roads were closed due to snow.

As of the data released by the General Directorate of Highways on February 13, 2023, all highways have been opened to traffic except Osmaniye-Kaypak (Dam Road).

Photograph 7 - Highway of Kahramanmaraş - Pazarcık



Photograph 8 - Highway of Hatay - Kırıkhan and Highway of Kırıkhan - Reyhanlı

Railways:

According to the information given by the General Directorate of State Railways of Türkiye, while 1275 kilometers of railway lines were affected and there are 446 bridges, 6161 culverts and 175 tunnels on these lines by the earthquakes in Kahramanmaraş.

It has been determined that the railway infrastructure is deformed in the Toprakkale - Narlı, Narlı - Malatya and Narlı - Gaziantep line sections. Energy could not be supplied from 10 substations that provide electrical energy for the lines in the region.

Since the maintenance teams were also affected by the earthquake, it became difficult to control the lines. The control of the lines was tried to be ensured by forming teams from other regions.

Visual inspections were carried out by teams affiliated to the General Directorate on the currently closed line sections of Bahçe - Fevzipaşa, Fevzipaşa - Narlı, Narlı - Malatya and Narlı - Gaziantep. As a result of the controls; It was observed that deformations occurred in the railway infrastructure at a level that would prevent train traffic.

The current status of the railway lines is given in the table below.

Between of Ulukışla - Adana	Free
Between of Adana – Mersin	Free
Between of Adana - Toprakkale	Free.
Between of Toprakkale - İskenderun	Free.
Between of Toprakkale - Osmaniye	Free.
Between of Osmaniye - Fevzipaşa	Free for emergency
Between of Fevzipaşa - Narlı	Closed.
Between of Narlı - Gaziantep	Closed.
Between of Narlı - Malatya	Closed.
Between of Malatya - Çetinkaya	Free for emergency
Between of Malatya - Yolçatı	Free
Between of Yolçatı - Diyarbakır	Free.
Between of Yolçatı - Elazığ	Free.
Between of Elazığ – Tatvan	Free.

In addition, according to the statement made by the General Directorate of State Railways,

- Operation of the Fırat Express between Elazig-Adana-Elazig and the Southern Kurtalan Express operating between Ankara-Kurtalan-Ankara dated 06 February 2023 were suspended.
- The 4 September Blue Train, which runs between Ankara-Malatya-Ankara, will run between Ankara-Sivas-Ankara. Business between Sivas-Malatya-Sivas was suspended.
- The Van Lake Express, which would operate between Ankara-Tatvan-Ankara on February 7, 2023, had been suspended for passenger transportation.
- For regional trains, the trains operating between Islahiye-Mersin and Gaziantep-Nizip were not operated temporarily.

On February 11, 2023, The General Manager of the State Railways announced that the 1,275-kilometer line was damaged in the earthquake. In addition, he stated that maintenance was carried out in a thousand-kilometer area, while work continues in other regions.

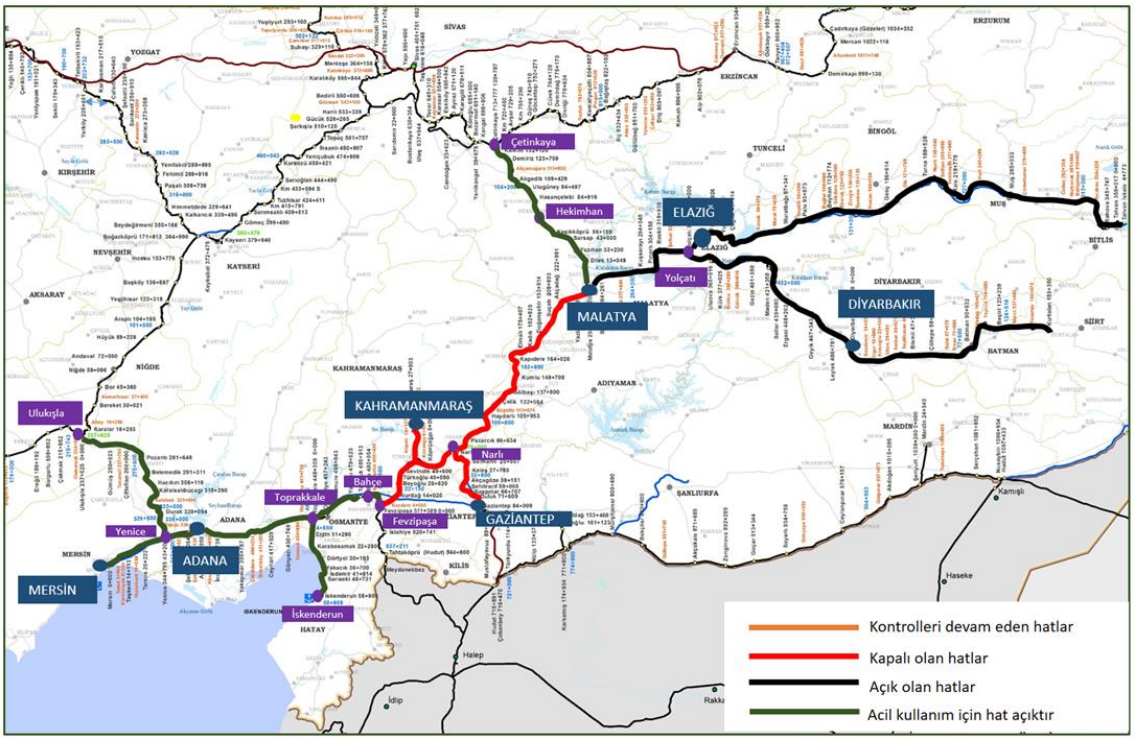


Image 9 – Turkish Railways Open & Closed Status

Airways:

Kahramanmaraş and Hatay Airports were closed to flights due to damage.

Gaziantep and Şanlıurfa Airports were open to aid flights.

As of February 13, 2023, Airports have been opened to flights.

Photograph 10 - Hatay Airport Runway– 1

Photograph 11 - Hatay Airport Runway– 2

Photograph 12 - Hatay Airport Runway Road – 3

5. WATER STRUCTURES

The provinces affected by the February 6 earthquake include the important part of the western Fırat-Dicle basin, the Ceyhan and Seyhan Basin and the Asi Basin.

These basins constitute a large part of the total water potential of Türkiye (DSI, General Directorate of State Water Works, 2020): The western part of the Fırat-Dicle basin, (30.4%), the Ceyhan Basin (4.2%), the eastern part of the Seyhan basin (3.3%), and the Asi Basin (1.0%) which are all within the the region struck by the earthquakes have important water resources and very important hydraulic structures like many large dams. At the same time, this region hosts the most important facilities of the country in terms of irrigation and hydroelectricity. Some of these facilities are under construction whereas some are being operated for decades for the fertile agricultural lands within earthquake region and this increases the significance of the region even more.

According to the information received from the open sources, the water storage structures in the region were examined after the earthquakes on February 6, 2023 and it was declared that the Sultansuyu Dam in Malatya would be emptied as a precautionary measure due to the cracks in the dam body.

Sultansuyu Dam, designed for irrigation purposes, was built on the Sultansuyu River in Malatya. A total of 1,350,000 m³ of excavation and 3,200,000 m³ of fill production were carried out during the construction of the dam, which was built as an earth fill type. The body height of the dam is 60 m (from the foundation) and its length is 721 m. The diversion tunnel is 397 m long and 4.5 m in diameter.

Photograph 13 – Sultansuyu Dam

6. WATER MOVEMENTS AND TSUNAMI OBSERVED IN THE EASTERN MEDITERRANEAN AFTER THE EARTHQUAKE

After the earthquake, a tsunami occurred in the Eastern Mediterranean, recorded at Iskenderun, Erdemli and Famagusta water level measurement stations. Approximately 33 minutes after this earthquake, the highest tsunami width measured in Iskenderun was 14 cm. This value was ~13 cm in Erdemli, 54 minutes after the earthquake, and a tsunami amplitude of 17 cm in Famagusta was recorded approximately 65 minutes after the earthquake. The epicenter of the earthquake is about 90 km inland from the sea and the fault rupture shows strike-slip characteristics. Therefore, it is considered that the tsunami formation may have occurred due to a piston effect or due to mass movements due to shaking on the sea floor,

depending on whether the fault rupture reaches the sea or not. Field research was carried out on 11-13 February 2023 on the coasts from İskenderun Karataş to Samandağ. With the analysis of tide gauge measurements and numerical modeling studies, it is thought that two different mass movements off the coast of Karataş and off Samandağ may be the cause of the recorded tsunamis. The rise in water level and flooding on the shores east of the fisherman's shelter and the harbor in Iskenderun on 7 February is another matter. During the field survey, damage to coastal structures and settling/collapse behavior in the back field were observed. It is evaluated that this was in the form of the ground approaching to the water level due to the collapse/settlement behavior that occurred in the area built on the fill, and the sea to rise on land due to tidal wave and barometric effects. The waters could not go back for a long time due to the accumulation of overflowing waters on the collapsed ground and the quay/coast edge acting as a threshold preventing backflow into the sea. It is possible that the water discharge channels were also clogged due to collapse, damaged or could not go back because they were below the water level.

7. CONCLUSION

The February 6, 2023 earthquakes turned into a major disaster due to the damage they caused. It will affect everybody not only in the earthquake region but also throughout the whole country and will create serious traumas. The life losses we had are above all.

The financial and moral damages caused by the earthquakes we experienced within the last 30 years are similar. When the collapsed and heavily damaged structures in the 1992 Erzincan earthquake, 1995 Dinar, 1998 Ceyhan, 1999 Gölcük, 1999 Düzce, 2002 Afyon, 2003 Bingöl, 2010 Elazığ, 2011 Van, 2020 Elazığ and 2020 İzmir earthquakes are examined, the similarities can easily be seen. Although Pazarcık and Elbistan earthquakes are no exceptions, they differ from the others in that there are collapses or severe damage in structures that have been built very recently.

Most of the region has weak soil conditions. For this reason, receiving expert engineering services should have been inevitable.

As a result of this earthquake, all the issues that were forgotten, ignored, neglected and not accepted, despite what science dictates, should be remembered by all the parts of the problem. Legal deficiencies must be corrected. Laws and regulations that will regulate all stages of the construction production process should be prepared. Deficiencies must be identified. All parties must cooperate fort he solutions. Merit and proficiency should be made an integral part of the building production process, as soon as possible. The Law 3458 for Professional Engineering should be changed as soon as possible. Professional Engineering is essential.

Organization of search and rescue efforts was late and insufficient. Search and rescue efforts were carried out in very limited areas, with insufficient staff and equipment. Many earthquake survivors waited under the rubbles for days without any search and rescue team reaching the area. Help from experienced civilian search and rescue teams like those of mine workers was delayed.

A serious lack of coordination in disaster management was observed in all earthquake region. Search and rescue teams could not be directed properly. Aid could not be delivered to the

areas in need. There were problems in terms of shelter and food aid. The solidarity of the people throughout the country for directing help to the region relieved the problems to a certain extent. However, there was a chaos in the distribution of the aid in earthquake region, also.

It is very important that military units and democratic mass organizations take part in meeting the basic needs in earthquake areas with their organized and experienced structures. However, such supports were prevented or delayed. Therefore, great problems were experienced in the maintaining the daily life in the disaster area, after the earthquake,

TCCE Work after the Earthquake:

Immediately after the earthquake, a crisis department was established at the General Center of the Chamber. Information flow was provided from the branches and representative offices located in the earthquake area. UCTEA and Chamber Board Members and Branch Managers arrived in the region and started their investigations on the same day .

Simultaneously, in coordination with UCTEA and its affiliated chambers, it was organized to supply the materials needed in the region. Aid was quickly delivered to the earthquake region. These operations are still continuing.

After the earthquake, thousands of our colleagues supported the work of our Chamber. Colleagues volunteered to work in the earthquake region through participating in Damage Assessment Trainings. This is a source of pride for our Chamber. As a result of the meetings of our Chamber with the Ministry of Environment, Urbanization and Climate Change, more than two thousand of our members have participated in damage assessment work. Our colleagues started to work by reaching the earthquake zones by their own means, with great effort and devotion.

Besides, all the needs of the earthquake survivors who were transferred to various cities, including accommodation, were tried to be met by many colleagues through UCTEA solidarity organizations. This had been among the unforgettable memories of this earthquake in terms of the importance and effectiveness of social solidarity in healing our wounds.