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Determining the Efficiency of Rapid Damage Assessment Studies after the 6 February Kahramanmaraş Earthquakes

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Abstract

Referred to as "the disaster of the century", Kahramanmaraş earthquakes have exposed the significant seismic vulnerability of many buildings in Türkiye. The February 6, Kahramanmaraş earthquakes, which are the focus of this study, had a very wide impact area, and high intensity, and the limited number of expert teams, resulted in insufficient damage assessment studies. This study aims to examine the suitability of the RYTEİE method for application in Türkiye and to assess the parameters of the method used during the February 6, Kahramanmaraş earthquakes. Data obtained from damage assessment studies revealed critical issues, such as improper establishment of the relationship between buildings and the ground, non-compliance with relevant regulations, and a lack of adequate inspection. Accordingly, the necessity of interdisciplinary cooperation for all structures was emphasized in the study. Considering the earthquakes that cause loss of life and property, this study aims to contribute to the literature.

Keywords: *Kahramanmaraş earthquakes, damage assessment, RYTEIE method, assessment form.*

6 Şubat Kahramanmaraş Depremlerinden Sonra Hızlı Hasar Tespit Çalışmalarının Etkinliklerinin Belirlenmesi

Öz

"Yüzyılın felaketi" olarak adlandırılan Kahramanmaraş depremleri, Türkiye'deki birçok yapının önemli sismik zayıflığını ortaya koymuştur. Çalışmanın merkezinde olan 6 Şubat Kahramanmaraş depremlerinin etki alanının çok geniş olması, şiddetinin büyük olması ve uzman ekip sayısının az olması hasar tespit çalışmalarının yetersiz kalmasına sebep olmuştur. Çalşıma kapsamında RYTEİE yönteminin Türkiye için kullanılmasının uygunluğunun incelenmesi ve 6 Şubat Kahramanmaraş depremlerinde kullanılmış olan yöntemin parametrelerinin değerlendirilmesi amaçlanmıştır. Hasar değerlendirme çalışmalarından elde edilen veriler, binalar ile zemin arasındaki ilişkinin uygunsuz bir şekilde kurulması, ilgili yönetmeliklere uyulmaması ve yeterli denetimin yapılmaması gibi kritik sorunları ortaya koymaktadır. Buna bağlı olarak, çalışmada tüm yapılar için disiplinler arası işbirliğinin yapılması gerekliliği vurgulanmıştır. Can ve mal kayıplarına yol açan depremler düşünüldüğünde bu çalışmayla literatüre katkı sağlanması hedeflenmiştir.

***Anahtar Kelimeler**: Kahramanmaraş depremleri, hasar tespiti, RYTEIE yöntemi, değerlendirme formu.*

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1. Introduction

Historically, Türkiye has been one of the countries most affected by earthquakes that carry a high risk of loss of life and property. As can be seen in the earthquake map prepared by the Turkish Earthquake Research Department under the Disaster and Emergency Management Presidency of the Ministry of Internal Affairs, the majority of the country's population lives under earthquake risk (Figure 1). It is seen that the country's land is located on active fault lines, as well as the lack of implementation of earthquake-resistant building design, plays an important role in the high loss of life and property due to earthquakes in the country. A total of 116,720 buildings were severely damaged due to the earthquake on 27 of December 1939, which hit Erzincan with a magnitude of 7.9, while the number of deaths reached 32,968. Another earthquake hit Kocaeli / Gölcük on 17th August 1999 with a magnitude of 7.8 and caused severe damage to 73,342 buildings and 17,480 people died (Taş, 2003).

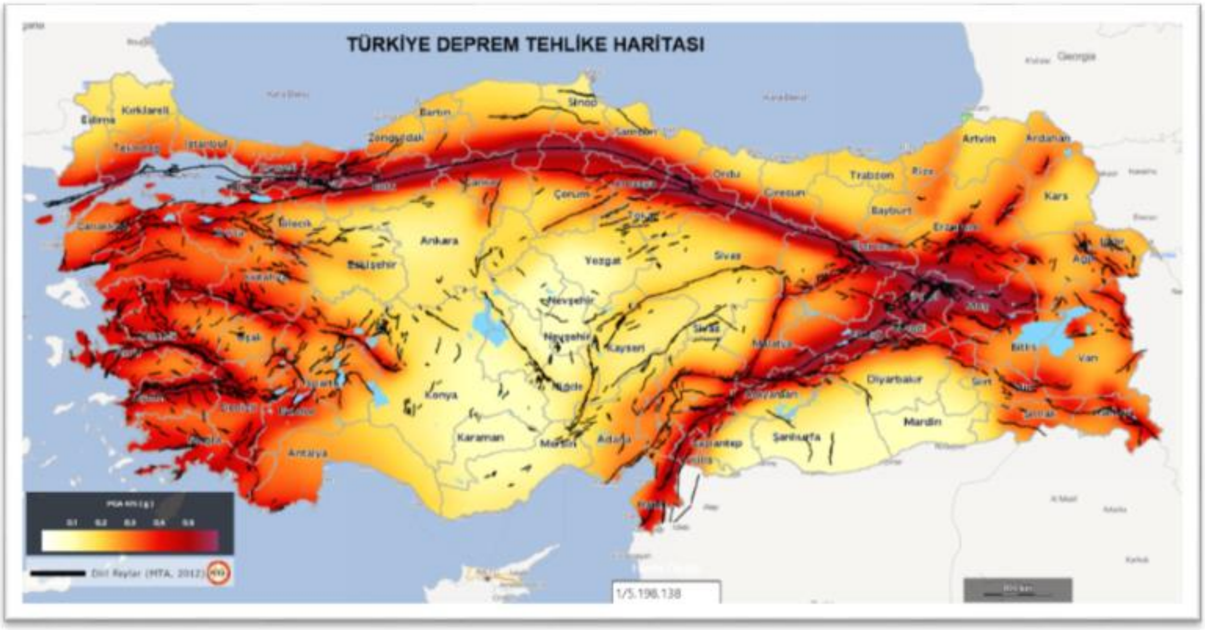

Figure 1. Türkiye earthquake zones map (AFAD, 2024)

The first of the two earthquakes detected by the Disaster and Emergency Management Presidency (AFAD) systems of the Ministry of Internal Affairs of the Republic of Türkiye and the Richter scale on 06.02.2023 occurred in Pazarcık district of Kahramanmaraş province at 04:17 Türkiye time with a magnitude of 7.7 Mw, while the second one was measured at 13:24 in Elbistan district of Kahramanmaraş province with a magnitude of 7.6 Mw (AFAD, 2023). The seismic tremor of this earthquake was sensed in the provinces of Kilis, Gaziantep, Adıyaman, Hatay, Malatya, Osmaniye, Şanlıurfa, Adana, Elazığ and Diyarbakır, and more than 50,000 people lost their lives in this earthquake (TRT, 2023). All this taken together, the Kahramanmaraş/Pazarcık and Elbistan earthquakes highlighted the importance of the rapid detection of existing buildings after earthquakes in Türkiye for the prevention of the safety of life and property.

Türkiye suffered a lot of damage due to the lack of practice in the construction phase, the severity of the earthquake, deficit of knowledge and education, use of improper and poor quality materials, and inappropriate construction techniques. Many of the country's people have been affected by earthquakes in one way or another (Özkul & Gülgeç, 2022).

Structural damage occurs in buildings due to the earthquake effect, therefore, in order to ensure people's life safety, the area must be evacuated as soon as possible, damage assessment studies must be carried out quickly in the buildings by experts, and usable buildings must be identified. This detection process, called "Post-Earthquake Emergency Damage Detection" in buildings, aims to examine buildings with structural damage and to ensure the life safety of people affected by the earthquake while the tremors continue (Yüksel, 2008).

There are many rapid damage detection methods used today to detect damages caused by earthquakes, while studies are still ongoing to make damage detection faster. The main rapid screening methods used in the world and in Türkiye include the Canadian Seismic Screening Method, the Japanese Seismic Index Method, the FEMA-154 Rapid Visual Screening (Gülgeç, 2019) Method, the Indian Rapid Visual Screening Method, the New Zealand Standard and the P25 method developed with the "Zero Loss of Life Project". Türkiye, on the other hand, uses a method called "Simplified Methods That Can Be Used to Determine the Regional Earthquake Risk Distribution of Buildings" which is explained in detail in ANNEX-A of the “Principles for Identification of Risky Structures (RYTEİE)”. All methods described above are generally similar in that, while the base score of the building is calculated based on the load-bearing system type of the building and the earthquake risk of the region in which it is located, the defects on the structure determine the negativity scores, which have been subtracted from the base score to calculate the final the performance score of the building. The performance score obtained as a result of the evaluation determines the risk ranking of the buildings, and with this ranking, the risk level of the building is decided according to the current limit values (Demirbaş, Şahin & Durucan, 2021).

The parameters of the rapid scanning methods used in the World are generally the number of floors and load-bearing system type of the building, soft floor / short column effect, planning irregularities, adjacent order situation, heavy overhangs, etc. In the light of observational on-site examinations, these parameters are classified by giving a score to each defect, and the obtained data are evaluated by writing them on forms (Demirbaş et al., 2021).

Since the rapid detection method to be used after an earthquake will significantly reduce the loss of life and property, it is of great importance to apply the correct method. The aim of the study is to determine the suitability of the method "Principles on Identification of Risky Structures (RYTEİE)" described in ANNEX-A that is applied within the scope of Law No. 6306 in Türkiye, as a rapid damage detection method in the Kahramanmaraş earthquakes of 6 February 2023 and to identify the parameters that cause severe damage.

2. Material and Method

In the qualitative research, buildings in Malatya and Adıyaman provinces with severe damage due to the earthquakes on 6th February 2023 were evaluated with the rapid damage detection method. The samples were selected among 30 cases that have been assessed about court decisions for the second time by the experts who were appointed by the court as arbitrators. The researcher examined the analysis and performed an additional analysis with the rapid damage detection using the RYTEİE method, while the structural and non-structural defect types were examined in detail.

The variables used in the rapid damage detection assessment performed with the RYTEİE method are classified as; the type of carrier system in the buildings, the number of floors of the building, the age of the construction, soft floor and short column effect, irregularities in the plan, vertical irregularity, type of the ground, the slope of the ground, heavy overhangs, seismicity, dilatation, usage of the building. The types of damage were analyzed according to these variables, and the damage caused in each building was evaluated according to the RYTEİE method with field inspections.

2.1. Damage detection method according to the principles regarding the detection of risky structures (RYTEİE) regulation

RYTEIE Method is a damage detection method in which the Principles for Identification of Risky Buildings are prepared in order to prevent possible loss of life and property in earthquakes in Türkiye. This method, which was issued in accordance with the Regulation on the Implementation of the Law No. 6306 on the Transformation of Areas Under Disaster Risk, which came into force in 2012, makes risk assessment according to the region where existing buildings are located (6306 Sayılı Afet Riski Altındaki Alanların Dönüştürülmesi Hakkında Kanun, 2012).

The "final damage assessment report" is given in form in the annex of the Damage Assessment Circular issued in accordance with the Law on the Organization and Duties of Disaster and Emergency

Management Presidency (Afet ve Acil Durum Yönetimi Başkanlığı/AFAD) (AFAD, 2014). Information to help fill out the damage assessment form is included in the attachment of the form.

The context of the attachment to the damage assessment form prepared by AFAD includes information such as the order status of the building (adjacent or separate), Numbering of the building, roof geometry, type of the buildings' structural system, information about the damaged floor of the building, useage purpose of the building (AFAD, 2014).

As the first step, observation has been focused on the elements such as change in structure shape, slips on the ground or deteriorations in the carrier system in order to determine whether the building is severely damaged or not, while dtermination process is terminated if the building is severly damaged to prevent any accident due to any aftershock, etc. If observational detection cannot be made from outside, the damage conditions at the detected points are classified as A, B, C, D types and recorded in the damage assessment forms, after checking the factors starting from the bottom floor of the building to the damaged floors. They are marked as undamaged, slightly damaged, moderately damaged or heavily damaged (AFAD, 2014).

2.1.1. Damage detection stages of the RYTEİE method

According to the RYTEİE damage detection method, the limits of external and internal inspection steps in reinforced concrete structures have been determined. Damage detection in buildings is evaluated according to the parameters in the examination steps given in Figure 2 and Figure 3. When the structures examined from the outside are considered to be heavily damaged, the inspection is terminated and the internal inspection is not carried out. In buildings that are not considered to be heavily damaged, the internal inspection step is started and the evaluation is made by starting from the lower floors of the building and examining it up to the damaged floors (İlki, Demir, Cömert & Halıcı, 2019).

External inspection steps;

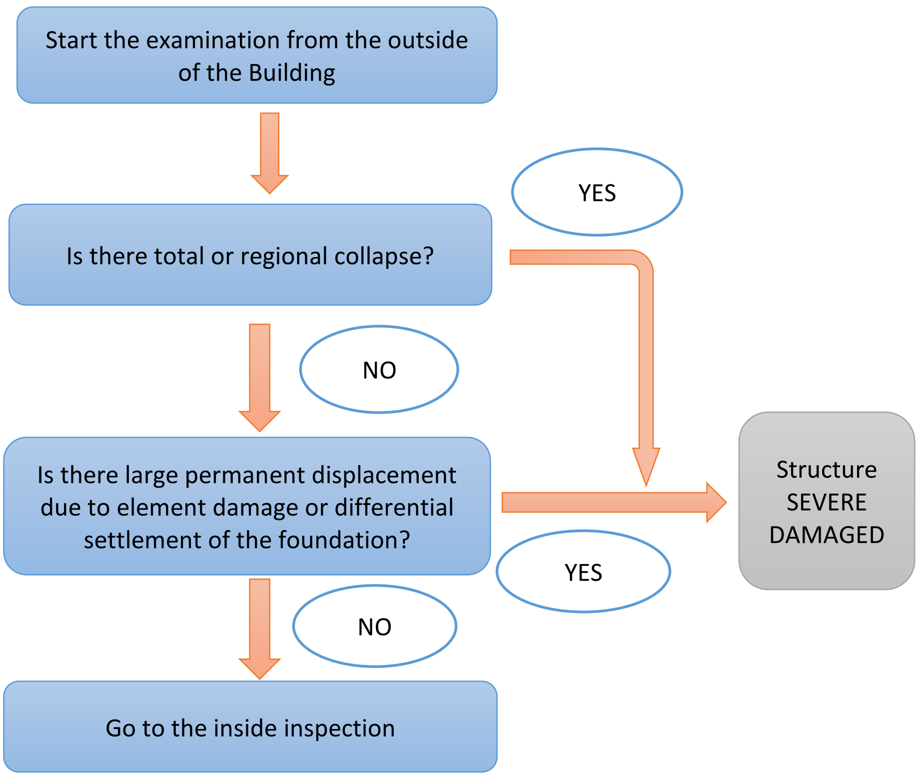

Figure 2. Schematic sequencing of external review steps (İlki et al., 2019)

Internal inspection steps;

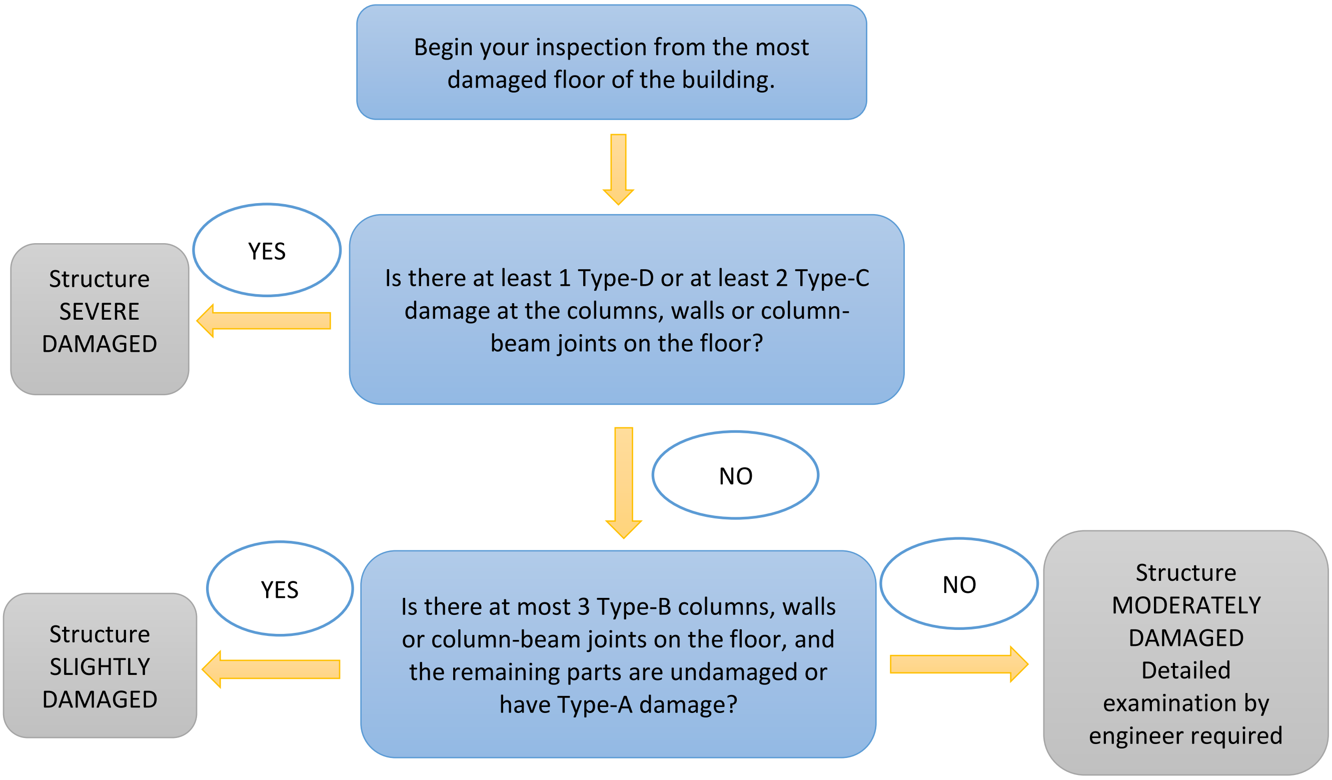

Figure 3. Schematic sequencing of internal review steps (İlki et al., 2019)

In post-earthquake damage assessment studies, by following the instructions of the method in question and determining the damage types according to the observations made on the buildings from outside and inside, the teams in charge finalize their determinations about the buildings by giving codes to the buildings as undamaged, slightly damaged, moderately damaged, heavily damaged and urgently demolished.

2.1.2. External inspection of reinforced concrete structures

1. Investigation step: Regional or complete collapse

If a complete or regional collapse has been observed in the building, the structure is determined as severely damaged the process is terminated and no other stages are examined.

2. Inspection step: Checking permanent horizontal displacement between floors

The following step includes examination for permanent displacements in the floors and the relative drift ratio must be determined. If this ratio is greater than 0.01, the building is classified as severely damaged and the process is terminated.

3. Inspection step: Checking the rotation of the building from ground collapse

At this stage, movements in the ground and foundations and their effects on the structure are evaluated. If there is a proper fit without rotation, the examination continues, however, if a bending of more than 3rd degree is detected, the examination is terminated (Figure 4). If the rotation amount is less than 1 degree, it is determined as minor damage, whereas a bending between 1 and 3 degrees is classified as moderate damage where the examination has been continued (Kaplan, 2018). Settlement and collapse damages on the ground that occur in buildings due to the effect of ground movement and liquefaction are shown in Figure-4.

2.1.3. Internal inspection of reinforced concrete structures

If the structure is not classified as severly damaged after the external observation, experts are allowed to enter the building to examine the horizontal and vertical load-bearing elements of the damaged building, starting from the lowest floors to the most damaged floors. If there are different levels of damage to the load-bearing elements of the building on different floors, the most severely damaged floor is chosen to classify the damage rates on the floors. In reinforced concrete structures, damage to the infill walls is not taken into account, even if the damage is very advanced or severe. On the other hand, the damage to the load-bearing elements of the structure; bending, shear cracks, the width of these cracks, and crushing in the concrete are important and should be taken into account (Kaplan, 2018).

• If there are no cracks or pressure damage in the load-bearing elements of the structure, the element is classified as "**NO DAMAGE**",

• If there are bending or shear cracks not wider than 0.5 mm without any pressure damage, the element is classified as "**SLIGHTLY DAMAGED**",

• If there are bending cracks wider than 0.5 mm, shear cracks between 0.5 mm and 2 mm, or crushing in the concrete shell (cover, concrete cover), the element is classified as "**MODERATELY DAMAGED**",

• If the width of the shear crack is between 2 and 10 mm or if there is peeling (the width of the bending crack is not important), the element is classified as "**SEVERELY DAMAGED**"

• If the width of the shear crack is more than 10 mm or if there is buckling of longitudinal reinforcement or crushing of the core concrete (the width of the flexural crack is not important), the element is considered as "**VERY SEVERE DAMAGED**". If there is damage at the column-beam joints that is more serious than the damage seen in the columns, these are considered as column damage. Damage types, classification and dimensions of load-bearing elements are given in Table 1 (Kaplan, 2018).

2.1.4. Damage types, classes and criteria of load-bearing elements

Table 1. Classification of damage types (Karataş, 2023)

DAMAGE TYPE	DAMAGE CLASS	Flexural Crack Width	Shear Crack Width	Pressure Damage
O Type Damage	*No Damage*	-	-	-
A Type Damage	*Slight Damage*	w ≤ 0.5 mm	w ≤ 0.5 mm	-
B Type Damage	*Moderate Damage*	w > 0.5 mm	0.5 mm < w ≤ 2 mm	Crushed Shell
C Type Damage	*Severe Damage*	-	2 mm < w < 10 mm	Crusting; Spalled Shell
D Type Damage	*Very Severe Damage*	-	w ≥ 10 mm	Reinforcement Buckling, Core Crushing

Damages that may occur on load-bearing structural elements in reinforced concrete structures;

a. Bending cracks in load-bearing structural elements in areas subject to tensile stress,

b. Shear cracks occurring in load-bearing structural elements under the influence of shear force,

c. Along with pressure damage on load-bearing structural elements, damages such as shell crushing, shedding, reinforcement buckling and core crushing may occur. In reinforced concrete systems, the widths of the cracks that will occur in the load-bearing structural elements are measured, while bending and shear cracks are evaluated where the crack is widest. Moreover, the plaster surface should be excavated and it should be checked whether the concrete crack continues in the carrier elements.

• **Shell Crushing**: The concrete layer outside the stirrup is called the Shell, while Shell crushing is defined as crushes occurring in the concrete outside the stirrup (Figure 5).

• **Shell Casting**: It is the pouring of concrete outside the stirrup (Figure 5).

• **Reinforcement Buckling**: These are bucklings in longitudinal reinforcements, stirrups or horizontal reinforcements within the load-bearing structural element (Figure 5).

• **Core Crushing**: The concrete and/or concrete layer inside the stirrup is called the core. Core crushing is defined as the crushing of the concrete inside the stirrup (Figure 5) (Kaplan, 2018).

According to the internal damage inspection, the damage of the building has been classified as “SEVER DAMAGED” when at least 1 of the column, beam, curtain or column-beam connection areas on the floor is in D Type or at least 2 of them are in C Type damage classes. The damage of the building is classified as “SLIGHTLY DAMAGED” if at most 3 of the column, beam, curtain or column-beam connection areas on the floor are in B Type damage classes whereas all the remaining parts are undamaged or in type A damage class. If any of these two conditions are not met, the building is classified as “MODERATELY DAMAGED” and a detailed investigation by engineers is required (Kaplan, 2018).

3. Results and Discussion

Within the scope of this study, the RYTEİE method was suitable and appropriate to be used as a rapid damage assessment in buildings with severe damage after the 6th February earthquakes in Malatya and Adıyaman provinces. We were able to detect and identify the structural and non-structural fault types such as damages caused by the ground (Figure 4.), carrier system errors in buildings (Figure 5.), workmanship and application errors (Figure 6.), manufacturing errors (Figure 7.), short column effect (Figure 8.), weak column strong beam effect (Figure 9.), the soft layer effect (Figure 10.), in the severely damaged buildings, showing that the loss of life and property in earthquakes was mainly due to buildings that are not earthquake-resistant rather than the severity of the earthquake.

3.1. Causes of Structural Damage

The observed parameters used in practice were associated with the damage status of the buildings, whose damage level was determined through rapid damage assessment studies after the Kahramanmaraş earthquakes, while the damage assessment method used in Türkiye will play an active role in creating the risky building stock.

The types of structural damage that occurred on buildings due to the intensity of the Kahramanmaraş earthquakes were explained using field examples under the heading of structural damage causes, and it was evaluated that the collapse or damage of the structure depends on many factors. With the combination of more than one factor, the buildings were damaged in different ways, and the damage conditions and causes in the buildings were evaluated by field investigations using the RYTEIE method. As a result of observation-based field research, these damages were evaluated as defects arising from the construction phase and design.

Defects during construction; Damages caused by the ground, carrier system errors, workmanship errors, use of poor quality materials and lack of inspection, while design errors were determined as lack of technical knowledge and experience. On the other hand, building damage causes were identified as structural damage during the construction phase, damages caused by the ground, carrier system errors during the construction phase, workmanship errors, manufacturing errors and design errors caused by the construction phase; short column, weak column-strong beam and soft storey effect.

3.1.1. Structural Damages Under Construction

In the research performed in Malatya and Adıyaman provinces after the earthquakes, it was observed that damages occurred for different reasons as a result of errors during the construction phase. The types and causes of damage resulting from the construction phase can be explained as described below.

3.1.1.1 Damages caused by the ground

During the evaluation based on the rapid damage assessment method used in Türkiye, the damages caused by ground liquefaction were observed in the Gölbaşı district of Adıyaman province. During an earthquake, a situation called "soil liquefaction" occurs in the ground of the structure when the sand content is high and is additionally influenced by the groundwater. While this situation causes loss of bearing capacity on the buildings, it is observed as ground settling, tilting or collapse, which are considered structural damages in the buildings. The foundation soil of the buildings loses its bearing capacity due to the effect of liquefaction. Thus, structures in such areas where ground liquefaction occurs tend to sink, tilt or topple over (Alpaslan, 2013). After the 6 February 2023 Kahramanmaraş earthquakes collapses and bearing capacity losses in the structures and roads in the Gölbaşı district of Adıyaman were observed due to the ground movements and liquefaction on the ground (Figure 4). The structures, having settlements and bendings as a result of liquefaction on the ground, were evaluated as severely damaged due to type D damages according to the RYTEIE method.

(a) (b) (c)

Figure 4. Ground-related damages (a) (b) Settlement on the ground (loss of bearing capacity), (c) Collapses on the ground – Adıyaman / Gölbaşı; (Karataş, 2023)

3.1.1.2. Damages caused by carrier system errors during construction

The main purpose of determining the damage to buildings after an earthquake is to ensure the safety of life and property. For this reason, buildings that are not suitable for immediate use in damage assessment studies are marked and the use of these buildings is completely or partially restricted. If the building is damaged, they are classified according to the method used as undamaged, slightly damaged, moderately damaged, severely damaged and urgently demolished, based on the observational results of the technical teams during field studies.

In reinforced concrete structures, earthquakes apply very large forces to the column-beam joints, which are the elements of the load-bearing system, and structural damage occurs as a result of the strain on these joints. During field studies in the selected region, it was observed that severe damage occurred at the column-beam joints in many buildings (Figure 5).

Deficiencies in transverse reinforcement

In order to prevent buckling of longitudinal reinforcement in reinforced concrete structures, installing transverse reinforcement in accordance with the regulations increases the durability of the core concrete under pressure. In the field studies, the reinforced concrete buildings in the earthquake zone were severely damaged as a result of the crushing and crusting of the core concrete, which has been categorized as C and D type damages according to the evaluation criteria explained in the RYTEIE method (Figure 5).

(a) (b) (c)

Figure 5. Structural damage types (a), (b) core crushing, shell crushing, shell crushing, reinforcement buckling, (c) insufficient transverse reinforcement - Malatya; (Karataş, 2023)

3.1.1.3. Workmanship and application errors

Design errors originating from the construction phase is another type of error observed in reinforced concrete structures in the earthquake zone. Field studies carried out after the Kahramanmaraş earthquakes showed that both the damage to the carrier system and workmanship and application errors might result in severe damage to the structure during an earthquake. An example of a severely damaged building can be seen in Figure 6/c, where column-beam axes do not meet each other and give rise to severe damage. On the other hand, some buildings were identified as reinforced concrete mixed structures with separations in the load-bearing elements in these structures (Figure 6/b). Since partition walls in reinforced concrete structures do not have a load-bearing function, damage to the walls caused by earthquakes is not taken into account in detection studies and is stated as non-structural damage (Figure 6/a).

(a) (b) (c)

Figure 6. Structural/non-structural damages and construction errors (a) wall crack (non-structural damage in reinforced concrete structures), (b) separation of load-bearing elements (structural damage), (c) design error (structural damage) – Adıyaman; (Karataş, 2023)

3.1.1.4. Manufacture defects

Even if the load-bearing system of the building is designed in accordance with the regulations, concrete spills in columns and beams due to mistakes made during on-site application cause damage to the load-bearing system. Damages resulting from manufacturing errors in the load-bearing structural system of the observed building, in addition to the effect of the earthquake load, caused the rusting iron concrete to crack and the structure to be severely damaged due to not leaving enough cover on the columns (Figure 7).

Figure 7. Damages resulting from manufacturing errors - Malatya (Karataş, 2023)

3.1.2. Structural Damages Due to Design

Severe damage resulting from design errors has been identified in several buildings that has been affected by the 6 February 2023 Kahramanmaraş earthquakes, and some examples are explained in the following section below.

3.1.2.1. Short colon effect

During the design phase, horizontal windows planned on the exterior walls for illumination and ventilation purposes in the basement and ground floors play an important role in the formation of the short column effect. Other reasons for the formation of short columns include gradual foundations made to suit the land structure, mezzanine floor solutions, and different floor alignments in adjacent buildings due to the slope of the land. It has been observed that column damage on the lower floors of such buildings is higher than on the ground floors, as a result of the earthquake effect not distributing the load from the ground to the beams. Examples of the short colon effect giving rise to different types of severe damage in buildings can be seen Figure 8.

Figure 8. Short colon effect damages – Malatya (Karataş, 2023)

3.1.2.2. Weak column strong beam effect

Columns and beams in the load-bearing system of the building should be strictly dimensioned according to the regulations. In the load-bearing system of reinforced concrete structures, the column-beam dimensions should have a harmonious relationship in order to transfer the load to the ground appropriately. In order to create wide space in rooms, columns were constructed thinner and/or weaker than beams, which cause serious damage in the columns due to loss of bearing capacity during earthquakes. It has been observed that weak column gives rise to damages in the load-bearing system of the building resulting in severe damaged structure as seen in Figure 9.

Figure 9. Weak column and strong beam damage - Malatya (Karataş, 2023)

3.1.2.3. Soft floor effect

Especially reinforced concrete structures are expected to be resistant to earthquake loads, however, the ground floors are sometimes planned as workspaces for commercial with a greater height than the other floors, resulting in a soft floor. “Soft floor” is defined as the situation when shear walls on the upper floors do not continue on the ground floor, the height is more compared to the upper floors and the stiffness is less than the upper floors. This situation caused structural irregularities in the building and damage to the structure against the earthquake load (Figure 10.).

Figure 10. Soft Floor Effect Damage - Malatya (Karataş, 2023)

Although challenges have been experienced in building teams to work in damage assessment due to the size of the coverage area of the Kahramanmaraş earthquakes, which were called the disaster of the century, approximately 8,000 technical personnel took place in these rapid assessment teams. Damage assessment not only determines the damages to the structures caused by the earthquake but also can contribute to taking precautions in the reconstruction of the region and carrying out new projects more safely. The Kahramanmaraş earthquakes have once again demonstrated the importance of carrying out damage assessment studies quickly and accurately to create an earthquake-resistant building stock at the beginning of the post-disaster recovery process (Aydoğdu Gürbüz & Aslan, 2023).

Literature shows that analyzes made with rapid damage detection methods used in different earthquakes have detected the same types of damage in buildings. Elyiğit & Ekinci (2023) discussed damage detection in reinforced concrete buildings after the earthquake as structural and non-structural damages, while they explained the cause and effect relationships of the damage caused by the earthquake on buildings, the types of damage and what needs to be done for earthquake-resistant building designs. Authors suggested that safe buildings should be built to ensure the safety of life and property and emphasized that bioharmological buildings should be designed to build safe and durable buildings (Elyiğit & Ekinci, 2023). On the other hand, Yüksel (2008) examined the most common causes of structural damage while classifying damages in buildings and explained the principles of emergency damage detection and usability. As a result of his research, it was emphasized that the team should be experienced and trained and the organization should be well-organized to inspect damaged buildings quickly after the earthquake (Yüksel, 2008).

In his study, Taş (2003) examined the population density brought about by industrialization in big cities and the awareness of earthquake risk in settlements, revealed the damages that may occur and explained the planning that should be done before and after the earthquake. He stated that the negative consequences on the buildings resulting from the destructive effect of the earthquake were not only due to the lack of construction of the building but also to the inadequacy of urban planning and implementation. He stated that it is important for many institutions to share work in order to be prepared for possible earthquake disasters, and emphasized that institutions, organizations and non-governmental organizations should be informed, and organized and the framework of work-sharing should be drawn before a natural disaster (Taş, 2003).

In his study, Solak (2022) conducted research on earthquake-resistant building design in education and evaluated whether civil engineering and architecture students used their knowledge in the design phase and examined their success status and projects. According to the findings of his study, he determined that the students who were successful in these courses designed their projects by taking the earthquake risk into consideration. Therefore, it has been emphasized that these courses should be compulsorily included in the education curriculum in order to raise earthquake awareness among students of both departments for Türkiye, which is in the earthquake zone (Solak, 2022).

In a study examining the rapid assessment method in reinforced concrete buildings, Demirbaş et al. (2021) determined the risk distribution in 130 buildings determined to be heavily damaged after the Elazığ-Sivrice earthquake (2020) by using two different methods, the simplified method presented in the Principles for Identification of Risky Buildings and the Canadian Seismic Scanning Method. The results of these two methods were compared, and findings showed that both methods give outcomes that are not compatible and it was concluded that improvements are needed to eliminate the deficiencies of the existing methods (Demirbaş et al., 2021).

Çatal (2019) compared different damage assessment forms designed to reveal the damage status of buildings affected by the earthquake. While comparing the forms used in different countries and Türkiye, he realized that the damaged parts of the building in the USA are evaluated based on the criteria in ATC-38 and ATC-20 forms including information about the age of the building, its area, whether it is built on sloping land, plan irregularities and torsional irregularities. The UN-Balkan form used in the Balkan countries includes the identity information of the structure, load-bearing system information, degree of damage and ground information, and the form indicates whether the structure requires urgent intervention. He examined the damage assessment forms prepared by AFAD in Türkiye and determined that the common features of these forms are the information of the person making the determination and the identity information of the damaged structure, as well as whether it can be used immediately. As a result of his study, he states that using the damage assessment forms ensure consistent detection since the forms are used by trained technical personnel who focus on the spesific points questioned in the forms and identify the level of damage in similar structures (Çatal, 2019).

Özkul & Gülgeç (2022) conducted a study on a reinforced concrete frame type school building with predetermined earthquake performance and measured the earthquake performance using four different methods and a revised rapid evaluation method, and compared the results of each method and examined its shortcomings and advantages. Rapid damage detection methods were evaluated according to the application time, reliability, ease of application and number of parameters used, and at the end of the study, it was emphasized that the appropriate approach should be the selection of the appropriate method for the building group to be examined (Özkul & Gülgeç, 2022).

According to Özkul & Gülgeç (2022), FEMA 154 Seismic Scanning Method is a simple method that can be applied easily such that it determines the structural risk score of the building via the structural system of the building, the building material and the seismic activity of the region in which it is located. Area scanning can be done easily due to the short application time, however, the limited evaluation parameters decrease the reliability of the method. Moreover, the Canadian Seismic Scanning Method is a simple method that can be performed in a short time, but the method needs to be adapted when used in different countries because it is based on the regulations in different years prepared in Canada, thus it is not reliable and suitable to apply in Türkiye due to the low-risk level in the parameters. On the other hand, The Japanese Seismic Index Method is a 3-stage evaluation method with high reliability due to the evaluation parameters that are more comprehensive than other methods and also fast and easy to use (Özkul & Gülgeç, 2022).

As a result of the study, the RYTEİE Method, currently implemented in Türkiye, has been evaluated as a more applicable method compared to the damage assessment methods used in other countries. In Türkiye, the use of the RYTEİE method in observational assessments of buildings, which are mostly constructed with reinforced concrete and masonry systems, is based on existing defects. Therefore, it is considered an appropriate method for obtaining reliable results. However, it is crucial that the team conducting the damage assessment consists of expert technical personnel and that the team determines a damage level similar to the same damage level on the buildings, ensuring consistency in the assessment. Following the Kahramanmaraş earthquakes, it was observed that the damage statuses of buildings, determined through rapid damage assessment studies, were consistent with the parameters used in practice. Based on the data obtained from the study, it is believed that the RYTEİE method will play an effective role in determining the existing stock of risky buildings in Türkiye.

Türkiye is among the countries with high earthquake risk due to its territory being on active fault lines. As a result of the rupture of the Eastern Anatolian Fault line on February 6, 2023, earthquakes of 7.7 Mw and 7.6 Mw magnitude occurred in Pazarcık and Elbistan districts of Kahramanmaraş province and went down in the country's history as the disaster of the century. While these earthquakes caused many people to lose their lives, it was once again revealed that the earthquake is too important an issue to be ignored, as it caused great destruction in a wide area covering 11 provinces.

4. Conclusion

With this study, the causes of damage to buildings in the February 6, 2023, Kahramanmaraş earthquakes in Malatya and Adıyaman provinces were evaluated using the parameters of the RYTEİE rapid detection method. The use of the RYTEIE method, which can be applied easily and is reliable, in observational determinations on structures built according to reinforced concrete and masonry systems in Türkiye, facilitates the work of those who make the evaluation which is based on existing defects. Since the team that will assess the damage of buildings consists of technical staff who are experts in this field, RYTEİE can be applied with high reliability and consistency in damage assessment.

Within the scope of the study, the most common defects determined during the damage assessment reports prepared with the RYTEİE method after the Kahramanmaraş earthquakes were stated as irregular planning, soft floors, low material quality and poor evaluation of the ground quality in site selection. The experienced earthquakes have shown that although there are reasons such as not establishing the relationship of the buildings with the ground correctly, not complying with the relevant regulations and lack of inspection, the harmony of the load-bearing system and architectural design in all buildings in the country located in the earthquake zone reveals the need for interdisciplinary cooperation.

It is thought that eliminating the control deficiencies in legislation and practices, learning to live with earthquakes as a society by becoming aware of the need to live with earthquakes and constructing suitable buildings will significantly reduce the occurrence of earthquake damages.

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All authors contributed equally to the article. There is no conflict of interest.

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