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An Analysis of Quantitative and Qualitative Publications in the Architecture Field about 6 February 2023 Kahramanmaraş Earthquake

Mimarlık Alanında 6 Şubat 2023 Kahramanmaraş Depremi'nin Nicel ve Nitel Yayın Analizi

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Öz

6 Şubat 2023 tarihinde Kahramanmaraş-Elbistan merkezli meydana gelen deprem Kahramanmaraş'ta ve çevre illerde büyük can ve mal kaybına sebep olmuştur. Kapsamlı etkisi olan bu deprem sonrasında çalışmada deprem sonrası yapılan yayınlar analiz edilerek çalışma trendleri ve çalışmaların içerik analizi ile mimarlık alanına dair odak noktaları tespit edilmiştir. Bu bağlamda çalışmada Web of Science, Google Scholar, Scopus, Dergipark veritabanlarından "Şubat 2023-Mart 2024'' zaman kısıtlamasıyla ve "Kahramanmaraş earthquake and buildings'', "6 Şubat 2023'', "architecture'', "heritage'', "damage assessment'' anahtar kelimeleri kombinasyonları ile literatürde 50 makaleye ulaşılmıştır. Sonraki aşamada makalelerden elde edilen anahtar kelimeler ile VOSviewer'da nicel kelime analizi yapılarak çalışmaların odak noktaları ortaya konmuştur. Sonrasında MAXQDA programında çalışmalar içerik analizi yapılarak deprem aşaması, bina ölçeği, bina işlevi, bina strüktürü, bina elemanları ve bina malzemelerine göre gruplandırılmıştır. Sonuç olarak nicel analiz sonuçlarına göre, ele alınan çalışmaların çoğunluğu 2023 yılı Şubat-Nisan ayları arasında yayınlanmıştır. Kelime analizine göre ise incelenen çalışmalar "building damage assessment'', "earthquake'', "damage'', ''seismic hazard'', "masonary structure'', "reinforced concrete'' konularına yoğunlaşmıştır. Yapılan nitel analiz sonuçlarına göre ise çalışmaların %94,2'si deprem sonrasına odaklanmıştır. Odaklanılan ölçek ise %37,5 ile strüktür ölçeği olmuştur. Fonksiyon olarak %59,6 ile kullanım amacı ayırt etmeden tüm yapı stokuna odaklanmıştır. Bina strüktürüne göre %49,2 ile betonarme yapılar üzerinde durulmuştur. Bina elemanı kategorisinde %35.4 ile duvar elemanı incelenmiştir. Son olarak bina malzemesine göre %41,2 ile beton çalışmaların odak noktası olmuştur. Makale kapsamında ortaya çıkan sonuçların öncelikli araştırma konusu olarak ileriki süreçlerde yapılacak çalışmalar için mimarlık ve yakın ilişkideki alanlara katkı sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Kahramanmaraş, Deprem, Bibliyometrik Analiz, Binalar, VOSviewer, MAXQDA

ABSTRACT

The earthquake on February 6, 2023, centered in Kahramanmaraş-Elbistan, caused significant loss of life and property in Kahramanmaraş and surrounding provinces. After this earthquake, which had a comprehensive impact, the articles published after the earthquake were analyzed, and focal points in the field of architecture were determined through research trends and content analysis of the articles. In this context, 50 articles in the literature were accessed from Web of Science, Google Scholar, Scopus, and Dergipark databases with the time limitation of "February 2023-March 2024" and the keywords "Kahramanmaraş earthquake and buildings," "6 February 2023", "architecture," "heritage," "damage assessment". In the next stage, the focal points of the articles were revealed by performing quantitative word analysis in VOSviewer with the keywords obtained from the articles. Subsequently, the studies were categorized using text analysis in MAXQDA based

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on earthquake stage, building scale, building function, building structure, building components, and building materials. As a result, according to the quantitative analysis results, the majority of the articles were published between February and April 2023. According to the word analysis, the articles examined focused on "building damage assessment," "earthquake," "damage," "seismic hazard," "masonry structure," and "reinforced concrete." According to the results of the qualitative analysis, 94,2% of the articles focused on the post-disaster. The focussed scale was the structure scale, with 37,5%. Regarding function, 59,6% focussed on all building stock without discriminating against the building function. According to the building structure, reinforced concrete structures were focused at 49,2%. The wall component was analyzed with 35,4% in the building component category. Finally, according to the building material, concrete was the focus of the articles, with 41,2%. It is thought that the results obtained within the scope of the article will contribute to architecture and closely related fields for future research as a priority research topic

Keywords: Kahramanmaras, Earthquake, Bibliometric Analysis, Buildings, VOSviewer, MAXQDA

INTRODUCTION

In this study, the research question is whether the articles published after the February 6, 2023 earthquake centered in Kahramanmaraş-Elbistan reveal the main research topics and focal points in the fields of architecture and construction. It is hypothesized that these articles primarily focus on building damage assessment, seismic risk, wall components, and the study of reinforced concrete structures. The past earthquake records of Turkey, especially the earthquakes of Mw 7.4 on 17 August and Mw 7.1 on 12 November 1999, have caused serious concerns about the earthquake risk in the country (Naji et al., 2021). Following these disasters, two separate earthquakes occurred in Pazarcık and Elbistan districts of Kahramanmaraş province on 06 February 2023 at 04:17 and 13:24 local time. The epicenter of the first earthquake was Pazarcık, and the epicenter of the second earthquake was Elbistan, with magnitudes of Mw=7.7 and Mw=7.6, respectively (Figure 1). After these earthquakes, many aftershocks occurred in the region. As a result of both primary and aftershocks, 11 provinces were significantly affected. Especially in Hatay, Kahramanmaraş, and Adıyaman provinces and districts, the extent of destruction was much more significant (Işık et al., 2023).

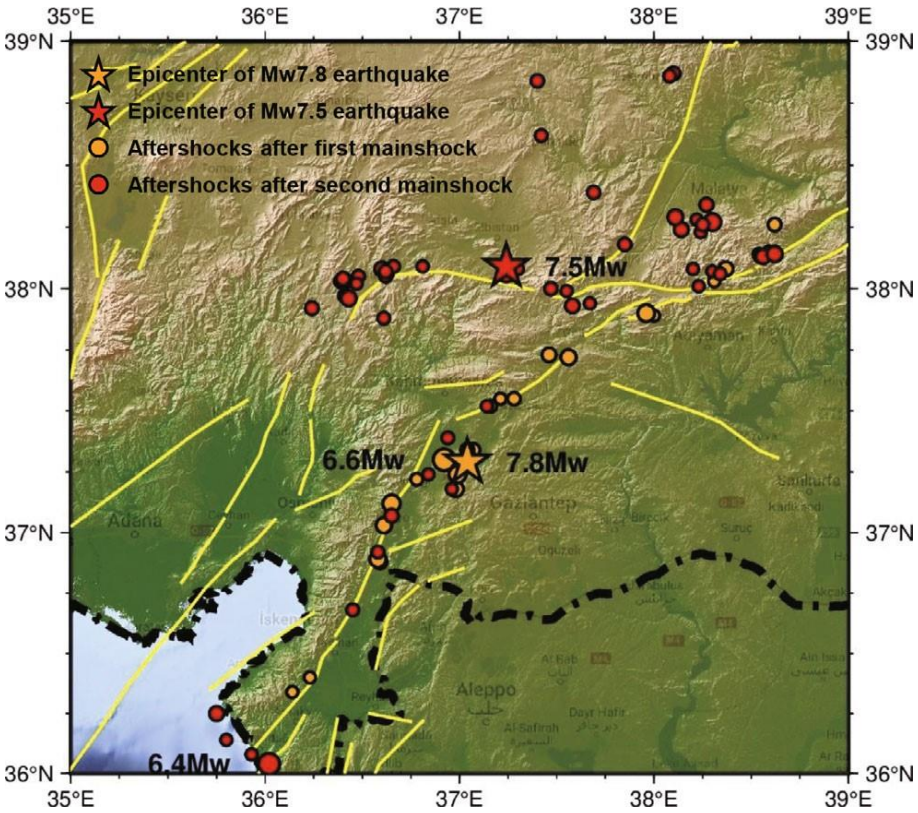

Figure 1. Location of the Main Shock and Aftershocks (Wang et al., 2023)

The Kahramanmaraş earthquake caused massive loss of life and structural damage, and the integrity of more than 500,000 buildings was endangered in Turkey. It was also the deadliest earthquake to occur in Turkey, claiming more than 55,000 lives and leaving behind destroyed cities and towns (Vuran et al., 2023). The widespread damage to buildings and infrastructure resulted in total economic losses expected to exceed $100 billion, equivalent to 9% of Turkey's expected national income in 2023 and nearly six times the losses suffered in the 1999 Marmara Earthquake (Sağbaş et al., 2024). Approximately 87% of the buildings are reinforced concrete in the affected area. Other structural systems, such as masonry and steel, constitute about 13% of the inventory (Binici et al., 2023).

The research aims to make a detailed situation analysis in the field by scanning the literature on what kind of studies have been carried out in the fields of architecture and closely related fields, which subjects are intensive in such an event, which is essential and destructive for our country and whose effects are still intensely experienced. A detailed analysis has been made of what the field focuses on, specializes in, and wants to draw attention to. Both qualitative and quantitative studies were carried out on the articles. Thus, while numerical analysis data and visuals were obtained with the help of software, a holistic result was revealed with detailed content analysis for the critical points in the articles.

1. CAUSES OF DAMAGE TO BUILDING STRUCTURES

The main reason for the collapse of structures in developing countries is that they do not have the safety requirements recommended by seismic codes. Although there are many reasons related to the amount of earthquake damage, such as soil structure, research has shown that poor craft and poor-quality building materials are directly related to the degree of structural damage (Celep et al., 2011). Structures were categorized as reinforced concrete, masonry, or industrial in the articles that were reviewed for this study, and the reasons behind damage were looked into.

1.1. Causes of Damage to Reinforced Concrete Structures

According to the research analyzing the damages to reinforced concrete structures, the leading causes of damages are insufficient concrete quality, use of unribbed (plain) reinforcement, construction on unsuitable ground, design of the structural system as hollow slabs, use of heavy cantilevers and shops/stores with high floor heights on the lower floors of the buildings (Atmaca et al., 2023). Also, another study discusses the vulnerabilities of reinforced concrete (RC) buildings in Turkey after the Kahramanmaraş earthquake and the resulting destruction caused by these structures. It highlights that the widespread collapse of buildings constructed after 2000 was unexpected, despite improvements in seismic codes and hazard maps. The study also notes that while some damage patterns observed in recent earthquakes are similar to those seen in pre-2000 buildings, other types of damage—such as out-of-plane bending, shear failures, brittle fracture, bond-slip failure of reinforcement, and tension failure of beams and slabs—were not typically seen before. The paper presents a carefully selected set of examples comparing the damages and collapses of pre-2000 and post-2000 buildings, also providing a detailed summary and comparison of code developments in Turkey (Vuran et al., 2024).

1.2. Causes of Damage to Masonry Structures

Unlike other building structures, masonry systems exhibit non-linear behavior even at deficient horizontal load levels due to their limited tensile strength (Felice et al., 2017). Masonry structures have low resistance against situations that may occur in natural disasters. For this reason, there are standards and regulations to increase the strength of masonry structures. Our country's regulations on masonry structures are mentioned, especially after 1961. Although various precautions and requirements are specified in the regulations, it is seen that the number and rate of masonry structures

affected by the Kahramanmaraş earthquake are high. It was observed that the number of damaged structures and collapsed structures was high due to the failure to meet the conditions specified in the regulations (Thippa et al., 2023). It is thought that constructing masonry buildings, incredibly dense in rural settlements, has an essential effect on the users' means. Reasons such as non-use or incomplete use of reinforcements, lack of expert control, and even the absence of a project during the construction process of most buildings are essential points that cause damages. Also, another study discusses the assessment, repair, and retrofitting of these structures, highlighting the role of machine learning techniques in evaluating damage, seismic vulnerability, and optimizing materials. It also covers structural health monitoring methods and concludes with case studies and recommendations for future research in enhancing the resilience of masonry buildings (Keshmiry et al., 2024).

As a result of the field investigations, the causes of masonry structures' damage and collapse were poor craft, poor quality materials, inadequate load-bearing walls, and inappropriate connection details (Kâhya et al., 2024). In addition, these damages were caused because they were constructed using local materials and construction technologies without any engineering services, horizontal and vertical beams were not used, and the earthquakes occurred very close to the surface and were very large (Işık, 2023).

1.3. Causes of Damage to Industrial - Precast Structures

Precast elements are more widely used in commercial and industrial buildings due to the shorter construction period than traditional reinforced concrete structures. In constructing precast structures, the vertical elements are fixed to the base, and the beams are supported. The failure of precast structures during the earthquake in Turkey in 2023 is due to the problems related to the beam-column connection (Thippa et al., 2023). In addition, a significant portion of the reported economic losses is due to damages to industrial facilities (Büyük, 2023). Inadequate or no earthquake engineering services in design and construction processes are the most significant cause of damages that may occur in industrial structures. This means that the seismic forces that may cause damage to the structural components in industrial buildings are not considered. On 6 February 2023, successive earthquakes caused significant damage and destruction in prefabricated reinforced concrete industrial buildings with articulated joints, as in other structures (Sezen & Whittaker, 2006; Arslan et al., 2024).

Mild steel bars, inadequate use of steel in structural elements, and soft floors are the main reasons for more damage to the buildings constructed before the 2000 Turkish earthquake code. Structures constructed after the publication of the 2000 earthquake code in Turkey were damaged and collapsed due to inadequate foundation design and underestimation of seismic demand (Thippa et al., 2023).

2. MATERIAL AND METHOD

In the study method, qualitative and quantitative analyses were conducted in line with the collected data. In the quantitative analysis part, analyses were made using the VOSviewer with the data obtained. In the qualitative analysis part, analyses were made with the MAXQDA.

In line with the data obtained from the analyses, the qualitative and quantitative data extracted from the articles and the current situation, contributions, and implications of the articles are presented in the conclusion section. Then, in line with these inferences, deficiencies and critical situations were revealed, and suggestions were made for future research.

SEARCH STRATEGY AND DATA COLLECTİON	DEFINITON OF THE TOPIC	2023 KAHRAMANMARAŞ EARTHQUAKE AND ARCHITECTURE	
	DATABASE SELECTİON	WEB OF SCIENCE, SCOPUS, DERGIPARK, GOOGLE SCHOLAR	
	SEARCH SCOPE	SEARCH FIELD	TITLE - KEYWORDS - ABSTRACT
		TİME SPAN	02.2023-03.2024
		LANGUAGE	ENGLISH - TURKISH
		PUBLICATION STAGE	FINAL
	DETERMINING KEYWORDS AND SEARCH STRING	Kahramanmaraş, Hatay, Malatya, February 6 2023, earthquake, archiecture, building, heritage, damage, determination	
	DOCUMENT TYPE LIMIT	PUBLISHED ARTICLE	
	DATA CLEANING AND PROCESSING	LIMIT THE SUBJECT AREAS AND EXCLUDE IRRELEVANT SUBJECTS	
ANALYSIS	SEARCH ANALYSIS TYPE AND SOFTWARE	QUANTITATIVE	VOSVIEWER
		QUALITATIVE	MAXQDA
	IMPORT TO DATA	VOSVIEWER	
		MAXQDA	
	QUANTITATIVE ANAYSIS VOSVIEWER	YEAR OF PUBLICATION	
		TOP KEY WORDS	
		AUTHORS	
	QUALITATIVE ANALYSIS MAXQDA	DISASTER PHASES	
		BUILDING SCALE	
		BUILDING FUNCTION	
		BUILDING STRUCTURE	
		BUILDING COMPONENT	
		BUILDING MATERIAL	
INFERENCES AND RECOMMENDATIONS	INFERENCES AND CONTRIBUTIONS		
	SUGGESTIONS FOR FUTURE STUDIES		

Figure 2. Flow Chart of the Study

As seen in Figure 2, the period from the February 2023 earthquake until March 2024 is considered the research's date range. The articles produced in this date range constitute the scope of the article. Since the time limit is quite limited, more than one database was used. Web of Science, Scopus, Dergipark, and Google Scholar were searched. The search focused on the articles' titles, keywords, and abstracts.

"Kahramanmaraş," "Hatay," "Malatya," "Earthquake," "Architecture," "Building," "Structure," "February 6, 2023", "Waste," "Damage," "Determination," "Effect" words and word groups were used in different combinations to search the databases.

By scanning the databases with these word groups, 50 articles produced by architecture and earthquake and closely related specialty fields were identified. In order to analyze the articles obtained, data such as titles, article abstracts, and keywords from 50 articles were obtained. These data were exported according to the appropriate format to be transferred to the software for performing the analyses. Quantitative and qualitative analyses were carried out for the articles in the process. VOSviewer was used for quantitative analysis, and MAXQDA was used for qualitative analysis.

2.1. Quantitative Analysis

In the quantitative analysis section, data on the year distribution and keywords distribution of the studies were analyzed using VOSviewer, and visual maps were created (Figure 3 and Figure 4).

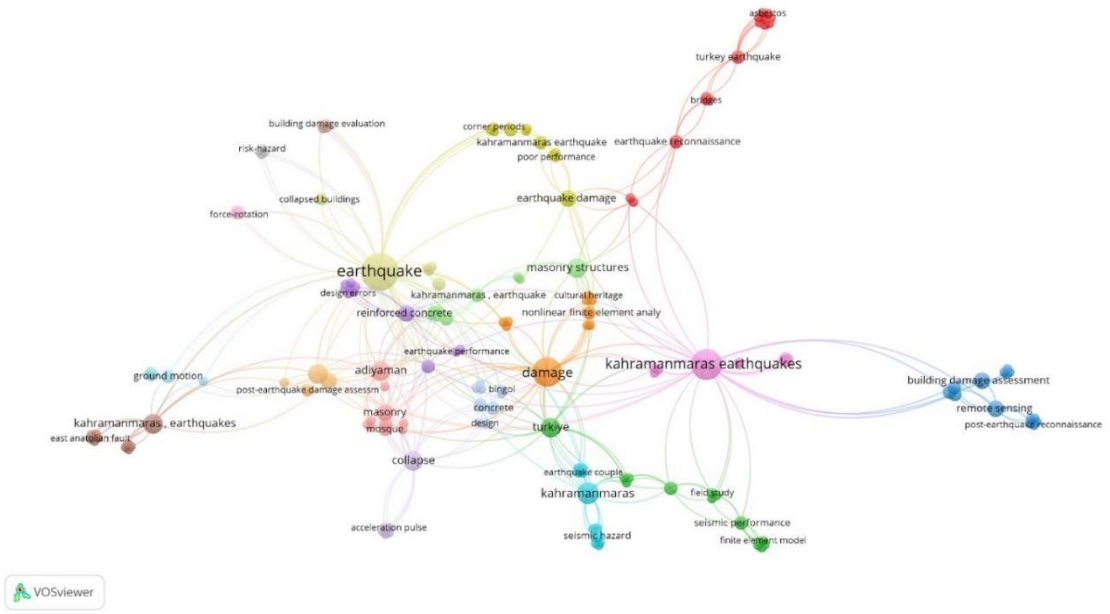

Figure 3. Keyword Analysis with VOSviewer

According to Figure 3, when the "keyword" analysis of the publications examined is analyzed, it is seen that the words that attract attention are "building damage assessment," "earthquake," and "damage." In addition to these, the words "seismic hazard," "masonry structure," "reinforced concrete," and "damage" came to the fore in the second place. As a result, it is seen that damage research occurring after earthquakes is frequently carried out in publications, and articles are published on a wide range of topics, from seismic damage to building components. In terms of structure type, it was determined that reinforced concrete and masonry building types were predominantly analyzed.

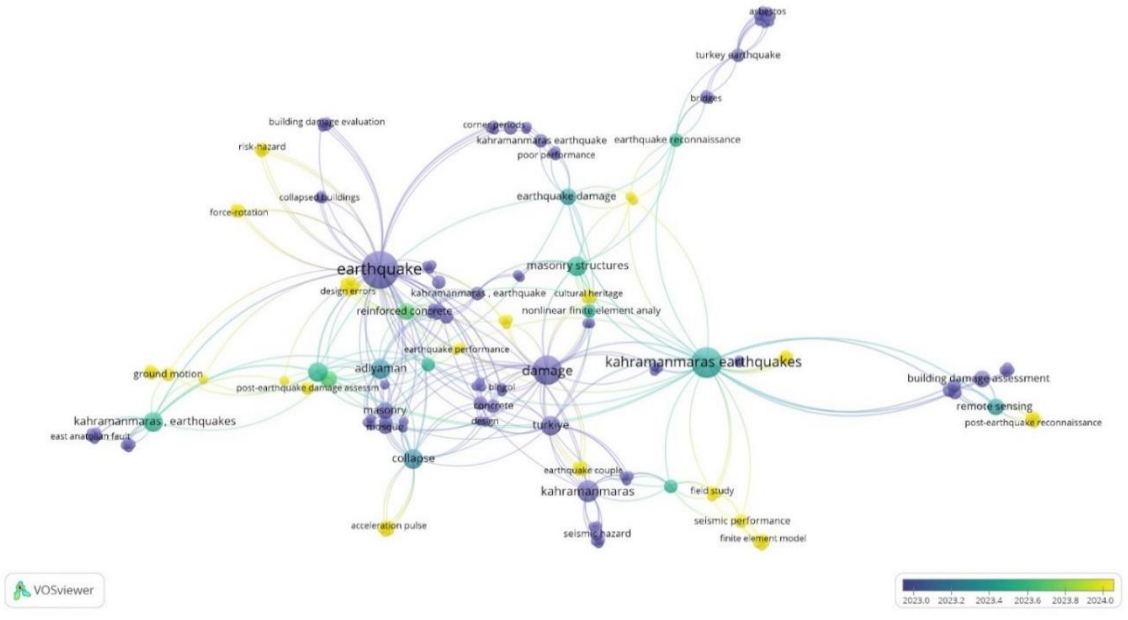

Figure 4. Year Analysis of Publications Made with VOSviewer

As can be seen in Figure 4, when looking at the year of publication analysis of the articles in VOSviewer, it is seen that the most intensive articles were published in February, March, and April of 2023, that is, immediately after the earthquake. In the following months of 2023, it was observed that the number of articles decreased compared to these months. The reason for the intensive publication of the articles immediately after the earthquake is to contribute to the renovation works to be carried out in line with the data collected from the field.

2.2. Qualitative Analysis

The articles were analyzed in the qualitative analysis section regarding the Disaster Phase, Building Scale, Building Function (Intended Use), Building Structure, Building Component, and Building Material (Table 1).

Content analysis was conducted on the articles' titles, keywords, and abstracts. According to the approaches focussed on the situation analyses or recommendations made in the articles, grouping was made under six sub-headings. These headings are: 1. Disaster phase, 2. Building scale, 3. Building Function (Intended Use), 4. Building Structure, 5. Building component, 6. Building material.

In the first grouping, the disaster process that the subject of the articles focused on was determined. Two different processes, namely pre-disaster and post-disaster processes, or focusing situations for both processes were analyzed. In the second grouping, the scale of the approach to the issue addressed was revealed. From the most comprehensive level to the detail level of the focussed situation, the cases of addressing the regional scale, building scale, component scale, or material scale have been analyzed. In the third grouping, the purpose of use of the buildings in the subject was analyzed. Residential buildings, health buildings, religious buildings, industrial buildings, or all building stock were identified without distinguishing the purpose of use. The fourth grouping was made according to the structural characteristics of the focussed structures in the articles. Masonry structures, reinforced concrete structures, and prefabricated structures are divided into three groups. In the fifth grouping, a grouping was made according to the focused building components in the articles. The focused building components are the foundation, wall, column, beam, floor, roof, and plaster. In the sixth and last grouping, a grouping was made according to the building materials. The focused building materials are stone-brick, adobe, concrete, wood, and steel (Table 1).

Table 1. Content Analysis Grouping with MAXQDA

		Disaster Phases		Building Scale				Building Function					Building Structure			Building Component							Building Materials				
		Pre- Disaster	Post-Disaster	Material	Component	Construction	Region	Residental	Health	Religious	Industrial	All stock	Masonary	Reinforced Concrete	Prefabric	Foundation	Wall	Column	Beam	Floor	Roof	Plaster	Stone- Brick	Adobe	Concrete	Wood	Steel
1	Mertol et al., 2023		X	X	X	X						X		X			X	X	X						X		
2	İnce, 2024		X	X	X	X						X		X			X	X	X	X					X		X
3	Ozturk et al., 2023		X		X	X						X		X			X	X	X	X					X		X
4	Coza, 2023		X	X	X							X		X			X	X				X	X		X		
5	Vapur et al., 2023		X	X	X							X		X			X	X	X						X		X
6	Kırıcı & Soyluk, 2024		X				X					X		X		X	X	X	X	X					X		
7	Yıldız & Kına, 2023		X		X							X	X	X			X	X	X				X	X	X		
8	Eroğlu Azak & Ay, 2023		X				X					X	X	X		.	.	.	.	.	.	.	.	.	.	.	.
9	Ersoy, 2024		X		X	X						X	X				X						X				
10	Soyluk & Köse, 2024	X					X					X	X			.	.	.	.	.	.	.	.	.	.	.	.
11	Kutlu & Soyluk, 2024		X			X						X	X				X						X				
12	Arkan et al., 2023		X			X						X	X				X			X			X				
13	Olğun & Karatosun, 2023		X	X	X	X						X	X				X						X	X			
14	Koçak et al., 2024		X	X								X		X		.	.	.	.	.	.	.	.	.	.	.	.
15	Temelli et al., 2023		X	X								X		X		.	.	.	.	.	.	.	.	.	.	.	.
16	Güneş et al., 2023		X	X		X						X	X	X		.	.	.	.	.	.	.			X		X
17	Karataş & Dal, 2023		X		X	X				X			X				X						X				
18	Kocaman, 2023		X			X				X			X				X						X				
19	Işık et al., 2023		X	X						X			X	X			X				X		X		X		
20	Valente, 2023		X		X	X				X			X				X						X				
21	Işık et al., 2023	X		X	X	X				X			X	X			X						X		X		
22	Olğun, 2023		X		X	X				X			X				X						X				
23	Qu et al., 2023		X		X	X			X					X		X	X	X	X						X		
24	Mercimek, 2023		X		X	X		X					X										X	X			
25	Avcı, 2023		X		X	X					X			X	X		X	X	X						X		X
26	Ivanov & Chow, 2023		X	X	X	X						X		X		.	.	.	.	.	.	.			X		
27	Gökçeoğlu, 2023		X				X					X	X	X		.	.	.	.	.	.	.	.	.	.	.	.
28	Papazafeiropoulos & Plevris, 2023		X				X					X		X		.	.	.	.	.	.	.			X		
29	Baser et al., 2023		X		X	X	X					X		X		X									X		
30	Karakale et al., 2023		X			X	X	X						X			X								X		
31	Yılmaz et al., 2023		X			X	X					X	X	X	X	.	.	.	.	.	.	.	.	.	.	.	.
32	Wang et al., 2023		X		X	X	X					X		X				X	X						X		
33	Vuran et al., 2023		X	X	X	X						X		X		X	X	X	X	X					X		
34	Zengin & Aydın, 2023		X	X	X	X	X	X						X		X	X	X	X						X		
35	Binici et al., 2023		X			X	X					X		X			X								X		
36	Altunışık et al., 2023		X	X	X	X	X					X		X				X	X	X					X		
37	Tonyalı et al., 2024		X	X	X	X		X						X		X	X	X	X	X					X	X	
38	Işık et al., 2023		X		X	X	X	X					X							X				X			
39	Arkan et al., 2023		X	X	X	X		X					X				X						X	X			
40	Işık et al., 2023	X	X	X	X	X	X					X	X				X	X	X					X			
41	Coşgun, 2023		X			X		X					X				X			X	X		X				
42	Işık, 2023		X	X	X	X						X	X				X							X			
43	Thippa et al., 2023		X	X	X	X						X	X	X	X	X							X	X	X		X
44	Atmaca et al., 2023		X			X		X		X	X		X	X	X		X	X	X	X	X		X	X	X		X
45	Sağbaş et al., 2024		X		X	X					X				X			X	X		X				X		X
46	Kahya et al., 2024		X			X						X	X				X						X				
47	Nasery, 2023		X		X	X				X			X				X						X	X			
48	Altınsu et al., 2024		X		X	X						X	X	X	X		X	X	X	X				X	X		X
49	Sevim et al., 2024		X		X	X						X		X			X	X	X						X		
50	Peker & Altan, 2024		X		X	X		X						X			X	X	X						X		

The content distribution analyses of the studies according to the groupings, as seen in Table 1, were made and explained under separate headings.

3. FINDINGS

This study aims to comprehensively examine the research conducted in the field of architecture following the major earthquake centered in Kahramanmaraş-Elbistan on February 6, 2023. The study begins by analyzing the impacts of the post-disaster phase, identifying how the focus of research has been shaped. It then details the scales of research used in post-earthquake studies, such as building scale, building components, and material types. Additionally, factors like building function, structural characteristics, and material usage are discussed as key elements influencing the resilience of

buildings. This study highlights the interrelationships between these factors and explores how the findings from post-disaster literature analysis may affect future research and the strengthening processes of buildings.

3.1. Disaster Phase

In the articles on disasters, suggestions and analyses have been made on the measures to be taken pre-disaster and improvements to be made post-disaster. Some articles cover both processes. The number of studies focussing on the pre-disaster process was found to be 3 for the 50 articles analyzed within the time limits determined within the scope of the research (Soyluk & Köse, 2024; Işık et al., 2023; Işık et al., 2023). The rate of these articles is 5,8% (Figure 5). The most significant reason why such a small number and proportion of articles cover the pre-disaster period is the recent earthquake disaster that shook the country and the world. In addition, reducing the effects of the disaster is a priority needed in this process. The damage and traces of the earthquake continue to be seen since the country, and even the whole world, has been mobilized to overcome the effects of the earthquake.

It was observed that the articles focussing on another post-disaster process were made at a higher rate. It is seen that 48 articles focussed on post-disaster, and the ratio is 94,2% (Figure 5). When the factors of this rate are analyzed, it is seen that the process covers a short period immediately after the earthquake. Another factor is that the recovery efforts are intensively continuing since the earthquake was severe and extensive.

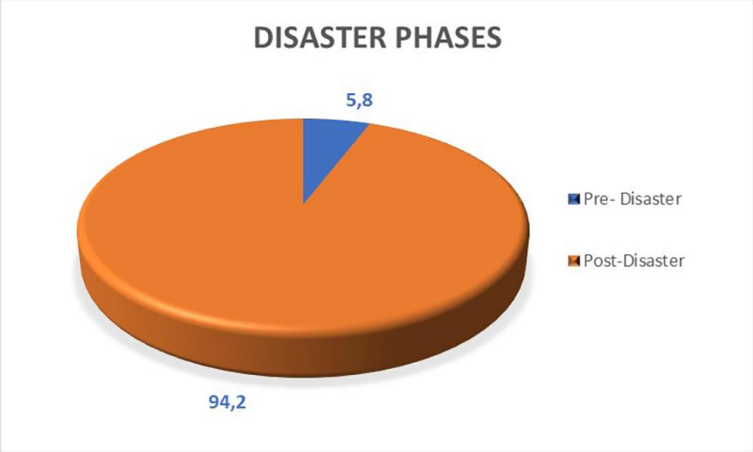

Figure 5. Percentage Distribution of Articles Grouped by Disaster Phase

3.2. Approach Scale

In this grouping, 50 articles were analyzed according to the focus scale. The focussed scales in the articles were grouped from the most comprehensive regional scale to the lowest material scale. It was seen that the focussed grouping was handled in 4 different scales: region, structure, component, and material scale. It has been observed that some studies have focussed on more than one scale. The most commonly analyzed scale was the building scale. The number of articles addressed in the structure scale is 39, and its ratio is 37,5% compared to all articles. The following scale that was most analyzed was the building component scale. The number of articles dealing with building components is 32, and its ratio is 30,8%. The following scale is the scale of building materials. The number of articles dealing with building components is 19, and the ratio is 18,3%. The least number of articles addressed at the scale of region or texture. The number of articles addressed at the region scale is 14, and the rate is 13,5% (Figure 6).

There is research in which all scales, including material, component, structure, and regional scales, are addressed (Zengin & Aydın, 2023; Altunışık et al., 2023; Işık et al., 2023). In some research, all three scales have been the focal point. The number of articles dealing with three scales as component, structure, and region scales is 3 (Işık et al., 2023; Wang et al., 2023; Baser et al., 2023). The number of articles on material, component, and structure scales, another combination of three scales, is 10. In some articles, it is seen that two scales are handled together with different combinations. The number of articles dealing with component and building scales is 13. Three articles deal with structure and region scales (Karakale et al., 2023; Yılmaz et al., 2023; Binici et al., 2023). The least number of two scales are material and component scales, and there are 2 of them (Coza, 2023; Vapur et al., 2023).

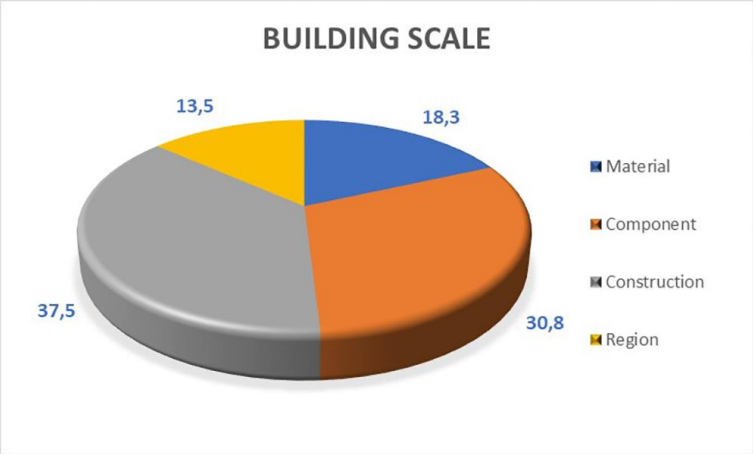

Figure 6. Percentage Distribution of Articles Grouped by Building Scale

3.3. Building Function

Grouping was made according to the intended use of the buildings discussed in the articles. This grouping has five groups for the buildings, including four groups of intended use and a group where the entire building stock is handled without distinguishing the intended use. These are residential, health, religion, industry, and building stock. The least focused buildings in terms of intended use were health buildings. Among the articles analyzed, there was only one article on health buildings (Qu et al., 2023). Its ratio to the whole is 1,9% (Figure 7).

The next least analyzed building group was industrial buildings. In 3 articles, the damages to industrial buildings were investigated (Avcı, 2023; Atmaca et al., 2023; Sağbaş et al., 2024). According to all research, the ratio is 5,8% (Figure 7). The small amount of research is because there are few industrial buildings in the earthquake zone.

8 articles focus on religious buildings and the ratio is 15,4% (Karataş & Dal, 2023; Kocaman, 2023; Işık et al., 2023; Valente, 2023; Işık et al., 2023; Olğun, 2023; Atmaca et al., 2023; Nasery, 2023, Olğun, 2023). The reason for this is the area's dense presence of historical buildings. The research addresses historical buildings due to the need to protect them as a heritage value and to increase their resistance against future earthquakes. In this context, one article focuses on the pre-earthquake condition of the historical building (Işık et al., 2023). In addition, research on the retrofitting of damaged historic buildings is intensive. Of these 8 articles, 7 focused on analyzing historical buildings that collapsed or were damaged after the earthquake.

It is seen that there are 9 articles covering only residential buildings (Mercimek, 2023; Karakale et al., 2023; Zengin & Aydın, 2023; Tonyalı et al., 2024; Işık et al., 2023; Arkan et al., 2023; Coşgun, 2023; Atmaca et al., 2023; Peker & Altan, 2024). The ratio to all studies is 17,3% (Figure 7).

It has been observed that most of the articles are analyzing the whole building stock. In 31 studies (Ersoy, 2024; Ivanov & Chow, 2023; Koçak et al., 2024, Mertol et al., 2023; Olğun & Karatosun, 2023) all buildings were addressed without focusing on the purpose of use. The ratio of articles dealing with the whole building stock to all articles is 59,6% (Figure 7). This ratio is because the earthquake affected vast areas, including many buildings in the earthquake zone. For this reason, an inclusive analysis and solution search was conducted in the articles without discriminating between buildings.

1 article observed that research was conducted in three different building types: residential, religious, and industrial (Atmaca et al., 2023).

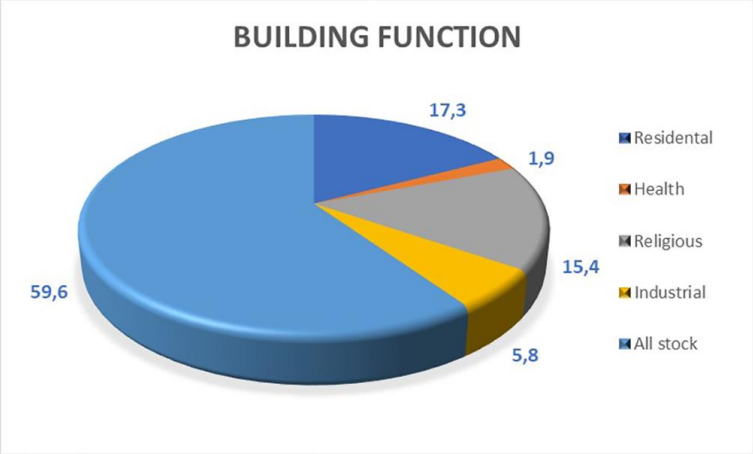

Figure 7. Percentage Distribution of Articles Grouped by Building Function

3.4. Structure Characteristic

The analyzed articles were grouped according to the types of structures. According to the grouping, it is seen that 3 different structural systems are focused on masonry, reinforced concrete, and prefabricated.

It is seen that the least number of focussed structural systems are prefabricated systems. Prefabricated structural system was analyzed in 6 articles (Avcı, 2023; Yılmaz et al., 2023; Thippa et al., 2023; Atmaca et al., 2023; Sağbaş et al., 2024; Altunsu et al., 2024). Its ratio to the whole is 9,3% (Figure 8). The reason is that industrial and industrial buildings made of prefabricated systems are less than other structural systems in the earthquake zone.

The number of articles focusing on masonry systems is 27 (Kutlu & Soyluk, 2024; Olğun & Karatosun, 2023). The ratio is 41,5%. The number of articles dealing with reinforced concrete structures is 32 (Ivanov & Chow, 2023). The ratio to the whole is 49,2% (Figure 8). The reason for this is that the reinforced concrete building system constitutes a large part of the building stock in Turkey.

The number of articles dealing with all system types, including masonry, reinforced concrete, and prefabricated systems, is 4 (Yılmaz et al., 2023; Thippa et al., 2023; Atmaca et al., 2023; Altunsu et al., 2024). The number of articles dealing with masonry and reinforced concrete structures is 6 (Yıldız & Kına, 2023; Azak & Ay, 2023; Güneş et al., 2023; Işık et al., 2023; Işık et al., 2023; Gökçeoğlu, 2023, Koçak et al., 2024). There is only one study on reinforced concrete and prefabricated systems (Avcı, 2023).

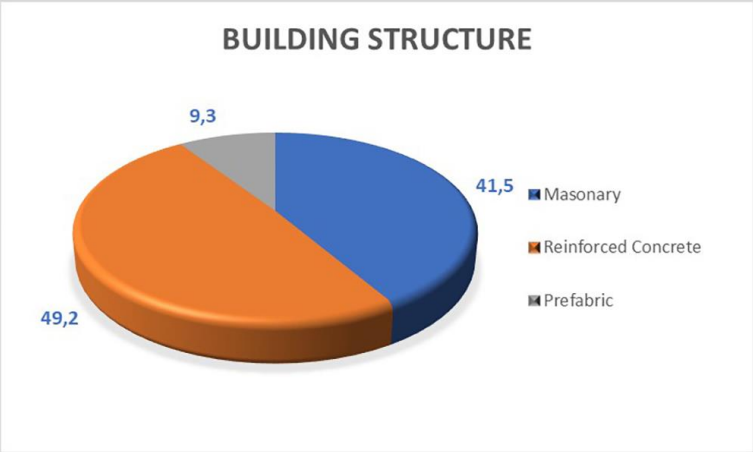

Figure 8. Percentage Distribution of Articles Grouped by Building Structure

3.5. Building Component

The 50 articles were analyzed according to the building components they focused on. The building components were grouped under 7 sub-headings: foundation, wall, column, beam, slab, roof, and plaster. The least number of articles is about plaster (Coza, 2023). Its rate is 1,1%. The next least focused building component is roofs (Işık et al., 2023; Coşgun, 2023; Atmaca et al., 2023; Sağbaş et al., 2024). The rate of articles focusing on roofs is 4,2%. The next focused structural component was found to be foundations. The number of articles focusing on foundations is 7 (Kırıcı & Soyluk, 2024; Işık et al., 2023; Coşgun, 2023; Atmaca et al., 2023; Sağbaş et al., 2024). Its ratio compared to other building components is 7,3%. The other focused structural components are columns and beams. The number of studies focusing on column and beam components is equal, with 20 studies each. The ratio of articles for column and beam is 20,8% (Figure 9).

The most focused building component is the wall. The number of articles on the walls is 34. The ratio is 35,4% (Figure 9). The reason for the highest rate in the wall is that masonry and reinforced concrete structures are more likely to be damaged in earthquakes, and there are many masonry and reinforced concrete structures in the area.

In some articles, it was observed that more than one building component was handled together. There is an article in which 5 components, namely walls, columns, beams, beams, slabs, and roofs, were considered (Atmaca et al., 2023).

Some articles did not focus on the building component at all. These articles were excluded from the grouping since it is a general evaluation that concerns all structures. The number of articles done this way is 9, and the ratio is 9% (Figure 9).

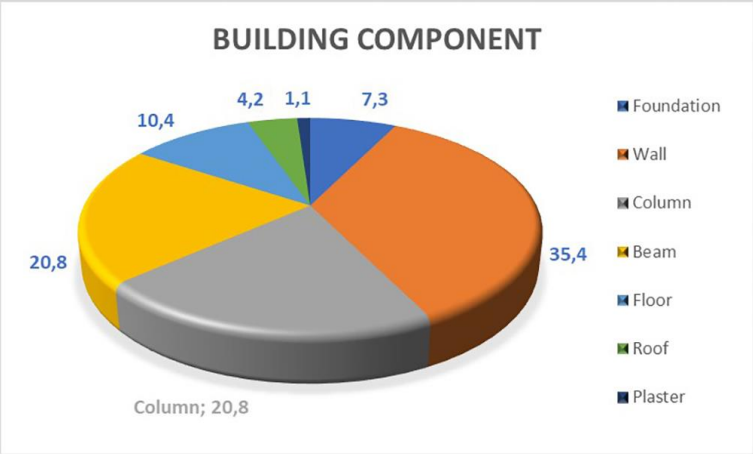

Figure 9. Percentage distribution of articles grouped by building component

3.6. Building Material

The 50 articles were grouped according to the building materials focused on. They were divided into five groups: stone-brick, adobe, concrete, wood and steel. According to the building materials, wood was the least studied. Only 1 article focused on wood (Tonyalı et al., 2024). The rate is 1,5% (Figure 10). The low number of articles on wood is because it is not an intensively used material in the region's architecture.

The next least studied material was steel. The number of researches focusing on steel is 9 (İnce, 2024; Ozturk et al., 2023; Vapur et al., 2023; Güneş et al., 2023; Avcı, 2023; Thippa et al., 2023; Atmaca et al., 2023; Sağbaş et al., 2024; Altunsu et al., 2024). The low rate is due to the low use of steel materials in buildings in the area.

The number of articles focusing on adobe material is 11. Its ratio to all studies is 16,2% (Figure 10). Generally, mudbrick materials were analyzed in the articles dealing with rural dwellings and building stock.

The number of articles dealing with brick and stone materials is 19, and the ratio is 27,9% (Figure 10). It was observed that brick and stone materials were examined, especially in cultural heritage buildings and buildings where the building stock was examined.

Concrete was observed as the most common material covered in the articles. The number of studies focusing on concrete material is 28 (Mertol et al., 2023; Papazafeiropoulos & Plevris, 2023; Sevim et al., 2024). Its ratio to all articles is 28%. Due to the high number of studies focusing on reinforced concrete structures, it was seen that there were more articles focusing on concrete material.

Some articles did not focus on building materials at all. In the studies considered building stock, the scale of the material has not been reduced. The number of such articles is 6.

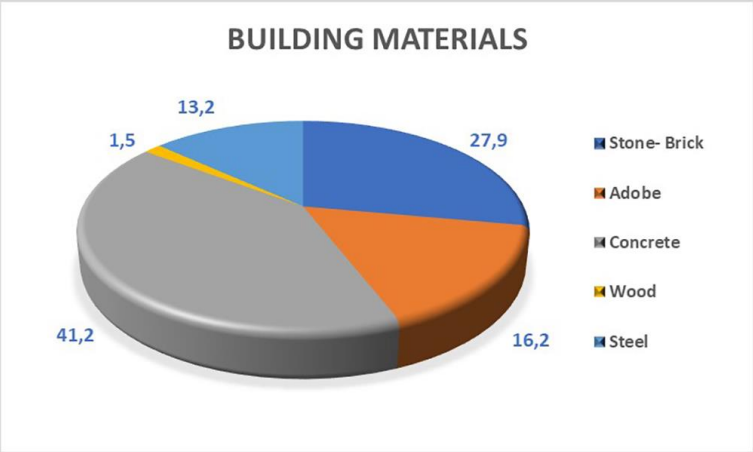

Figure 10. Percentage Distribution of Articles Grouped by Building Material

4. DISCUSSION

The post-disaster literature primarily focuses on damage to reinforced concrete structures, but masonry structures and industrial buildings have also been studied. Most research emphasizes the damage to buildings after earthquakes, with some offering solutions for repair and retrofitting. The highest damage was observed in residential buildings in urban areas and masonry structures in rural regions. Of the 50 studies analyzed, 48 focused on post-disaster damage, indicating the need for rapid recovery solutions. As time progresses, future research will likely focus more on recovery processes and pre-earthquake conditions.

Regarding scale, most studies focused on the entire building rather than components or materials. This suggests that future research may shift to more detailed studies on specific building elements and materials as data collection becomes easier. While residential buildings were the most damaged, 31 studies addressed various building types to propose holistic solutions. Reinforced concrete buildings were the most analyzed due to their widespread use and high vulnerability. Key issues such as inadequate reinforcement was common in post-2000 buildings. Studies on building components revealed that load-bearing walls were the most frequently analyzed, followed by columns and beams. Concrete, being the most common material, was frequently examined due to its role in reinforced concrete buildings' vulnerability.

In conclusion, the recovery from the Kahramanmaraş earthquake will take time, with a focus on building renovation and strengthening. Future research should prioritize:

-Promoting the use of wooden structures in place of reinforced concrete.

-Integrating earthquake-resistant materials in construction processes.

-Ensuring quality control in masonry buildings in rural areas.

-Addressing issues like faulty reinforcement in buildings post-2000.

-Using technology for rapid damage assessments and interventions during future earthquakes.

-These steps will enhance the resilience of buildings and communities in earthquake-prone areas.

The originality of the study lies in the detailed analysis of the findings derived from a literature review focused on architecture following the February 2023 Kahramanmaraş earthquake. The study systematically examines publications through both quantitative and qualitative analysis methods,

identifying research trends and focal points within the field of architecture. Additionally, the use of advanced analysis tools such as VOSviewer and MAXQDA offers a unique approach to comprehensively understanding the literature in this area. The focus on post-earthquake structures, particularly reinforced concrete and wall components, highlights critical gaps and priority research topics within the field.

The contribution to the architectural literature is significant as the study not only reviews the existing literature but also provides insights into how post-disaster studies are shaping research in architecture and civil engineering. By identifying priority topics for future research, such as the design, repair, and retrofitting of earthquake-resistant buildings, the study offers valuable guidance for future work in these critical areas. Furthermore, the analysis broadens the scope of post-earthquake structure evaluations, contributing to a better understanding of the effects of such disasters. In this sense, the study serves as an important resource and a guiding reference for the scientific community in both architecture and civil engineering.

5. CONCLUSION AND RECOMMENDATIONS

When looking at the post-disaster articles in the literature, seeing that while the articles mainly focus on damages to reinforced concrete structures, damages to masonry structures and industrial buildings have also been examined. The process mainly focuses on the damages in post-earthquake structures, and some studies have also presented suggestions for improvement. The most damaged building types were residential buildings in urban areas and masonry buildings in rural areas. In addition to residential buildings, cultural heritage buildings (mosques, minarets, churches), industrial buildings, and health structures were also analyzed in terms of damage (Figure 11).

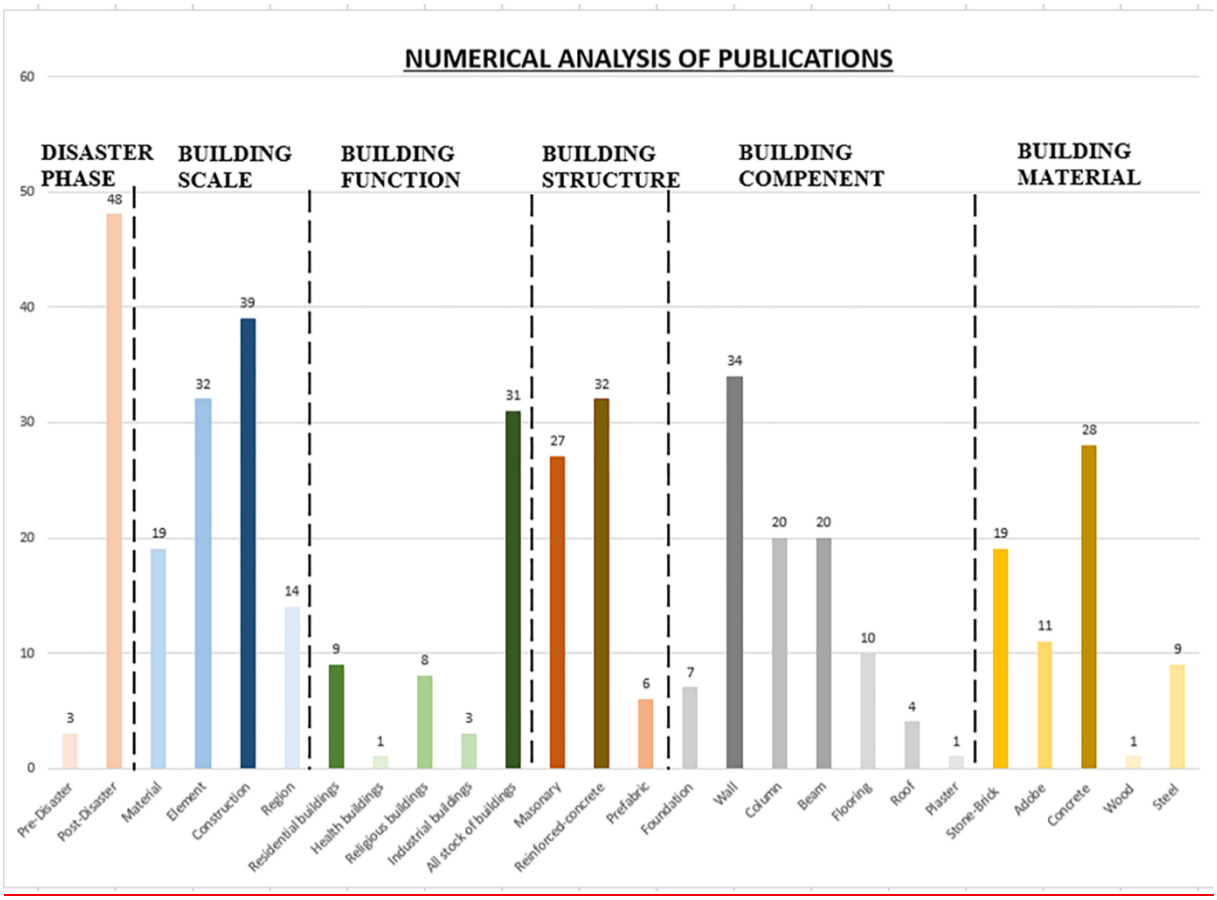

Figure 11. Numerical Analysis of Publications

As a result, when the articles were analyzed, 48 of the 50 publications examined within the scope of the article belonged to post-disaster research. At the same time, 3 of them dealt with the pre-earthquake period. 1 article examined both periods. The reason for this is to reveal the results of the sudden destruction after the earthquake and produce quick solutions to this situation. Within the scope of the study, articles from 2023-2024, the period immediately after the earthquake, were analyzed. In future research, more publications will likely focus on the recovery process for recent dates. For later processes, studies that address the pre-earthquake process and studies on precautions will likely increase.

When the publications within the scope of the study were analyzed in terms of scale, it was determined that the focus was on the whole building rather than the building component, building material, or urban scale, which was 39 in number. According to this result, studies focus more on the integrity of the building, and the reason for conducting research at smaller or larger scales is due to the difficulty of data collection. Therefore, it is predicted that future research studies on scales such as materials and building components will increase as it will be easier to access data. Moreover, conducting research at these scales will contribute to the retrofit/renovation processes the non-collapsed buildings undergo.

When looking at the types of buildings analyzed in the articles, although residential buildings were the most damaged in the earthquake, 31 publications focused on all types. The reason was the attempt to produce solutions to destruction and damage from a holistic perspective.

Regarding structure, the most significant number of reinforced concrete building types were analyzed in 32 articles. The reason for this is that it is the most damaged reinforced concrete building type and has the highest number in Turkey. In addition, since it is the most preferred masonry building type in rural areas, it has been the most studied after reinforced concrete structures. Defects in reinforcement systems are frequently mentioned in the articles about reinforced concrete buildings. While in pre-2000 reinforced concrete buildings, problems arising from the regulations were prominent, it was revealed that faulty reinforcement density and fixings were the factors in reinforced concrete buildings constructed after 2000 and damaged or collapsed. As a result, it was revealed that detailed craft should be considered in new reinforced concrete buildings.

When the publications are analyzed in terms of building components, it is seen that the load-bearing walls of damaged or collapsed buildings were examined in 34 publications, followed by columns and beams.

When the publications on building materials are grouped, it is seen that concrete material is frequently examined in 28 articles. This situation corresponds to the fact that they are the most damaged and damaged reinforced concrete buildings in Turkey in terms of structure (Figure 11).

As a result, it will take a long time to compensate for the losses caused by the Kahramanmaraş earthquake on February 6, 2023. According to the focal points where the studies are concentrated, focusing on renovation works in damaged buildings and their surroundings will be a priority. Apart from this,

- In a country like Turkey, which is rich in forests and greenery, wooden structures can be encouraged instead of using mainly reinforced concrete in building structures.

-The use of earthquake-resistant materials should be integrated into all building construction processes, and scientific studies on this subject should be supported.

-As emphasized by the studies, while replacing the buildings with masonry structures that have been heavily damaged and collapsed in rural areas, especially the quality details should be well supervised within the framework of the regulations.

-Errors such as faulty reinforcement density, especially in the buildings demolished after 2000, should be meticulously inspected and corrected in the new buildings.

-Technology and informatics should be used, and new programs/software should be developed to carry out damage assessment studies quickly and start interventions in case of similar disasters in the future.

-Future research should prioritize recovery and resilience in post-earthquake areas. Specifically, more publications will likely explore retrofitting techniques for non-collapsed buildings and the integration of sustainable materials, such as wood, in construction to reduce earthquake risks. Additionally, research focusing on the pre-earthquake preparedness, including structural reinforcement and regulatory compliance, will be crucial for minimizing future damage.

Compliance with the Ethical Standard

Conflict of Interest: *The author(s) declare that they do not have a conflict of interest with themselves and/or other third parties and institutions, or if so, how this conflict of interest arose and will be resolved, and author contribution declaration forms are added to the article process files with wet signatures.*

Ethics Committee Approval: *There is no need for ethics committee approval in this article, the wet signed consent form stating that the ethics committee decision is not required has been added to the article process files on the system.*

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