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Investigation of the earthquake behavior of historical erzincan çadırcı bath and the reasons for its persistence until today

Tarihi erzincan çadırcı hamamı'nın deprem davranışının incelenmesi ve günümüze kadar ulaşmasının sebepleri

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Investigation of the Earthquake Behavior of Historical Erzincan Çadırcı Bath and The Reasons for Its Persistence Until Today

Highlights

- *Historical Bath*
- *Finite Element Modelling*
- *Response Spectrum Analysis*
- *Building Configuration*
- *Shell Modelling/Solid Modelling*

Graphical Abstract

The historical bath was modelled in two different types according to shell and solid modelling techniques. Response spectrum analysis was performed, and structural elements were evaluated.

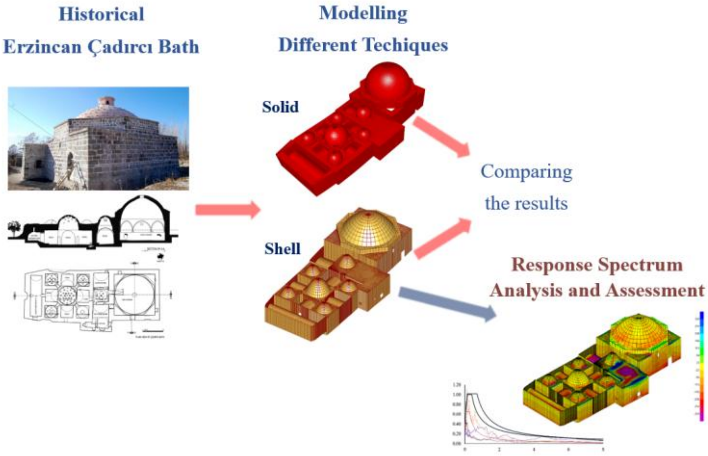

Figure. Graphical abstract

Aim

The aim of this study is to investigate the earthquake behaviour of the Historical Çadırcı Bath.

Design & Methodology

In this study, finite element method was used for the modelling and analyzing of the Historical Çadırcı Bath.

Originality

The originality of this research is modelling the Historical Çadırcı Bath separately solid and shell techniques and comparing the analysis results.

Findings

The shell modelling technique is safe in such studies, considering the analysis time and modelling difficulty.

Conclusion

The configuration characteristics of historical masonry structures are important in earthquake resistance like other building systems.

Declaration of Ethical Standards

The authors of this article declare that the materials and methods used in this study do not require ethical committee permission and/or legal-special permission.

Investigation of the Earthquake Behavior of Historical Erzincan Çadırcı Bath and the Reasons for Its Persistence Until Today

Araştırma Makalesi / Research Article

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ABSTRACT

In this study, the earthquake behaviour of the historical Çadırcı Bath in Erzincan, which is located on the North Anatolian Fault, the most active fault line of Turkey, was investigated. This historical masonry structure has preserved its structural integrity despite being exposed to two earthquakes of magnitude 7.8 in 1939 and 6.7 in 1992. In accordance with the architectural survey studies, the historical building was modelled. According to the results of response spectrum analysis, stress and displacement distributions and modal characteristic parameters of the structure were evaluated. When the analysis results of the models created with the solid model technique and the shell model technique are compared, it is concluded that the shell modelling technique is safe in such studies, considering the analysis time and modelling difficulty. According to the results of the analyses, considering the stress distribution in the historical building elements, it is seen that the configuration characteristics of historical masonry structures are important in earthquake resistance like other building systems.

Anahtar Kelimeler: Historical bath, masonry building, dynamic behavior, finite element analysis, building configuration.

Tarihi Erzincan Çadırcı Hamamı'nın Deprem Davranışının İncelenmesi ve Günümüze Kadar Ulaşmasının Sebepleri

ÖZ

Bu çalışmada Türkiye'nin en aktif fay hattı olan Kuzey Anadolu Fayı üzerinde yer alan Erzincan'daki Tarihi Çadırcı Hamamı'nın deprem davranışı incelenmiştir. Bu tarihi yığma yapı, 1939'da 7,8 (Mw) ve 1992'de 6,7 (Mw) büyüklüğünde iki depreme maruz kalmasına rağmen yapısal bütünlüğünü korumuştur. Çalışmaya konu olan tarihi yapı, mimari rölöve çalışmalarına uygun olarak modellenmiştir. Tepki spektrumu analizi sonuçlarına göre yapıya ait gerilme ve yer değiştirme dağılımları ve modal karakteristik parametreler değerlendirilmiştir. Katı model tekniği ve kabuk model tekniği ile oluşturulan modellere ait analiz sonuçları karşılaştırıldığında, analiz süresi ve modelleme zorluğu da dikkate alındığında bu tür çalışmalarda kabuk modelleme tekniğinin güvenli olduğu sonucuna varılmıştır. Analiz sonuçlarına göre tarihi yapı elemanlarındaki gerilme dağılımı incelendiğinde, tarihi yığma yapıların konfigürasyon özelliklerinin diğer yapı sistemleri gibi depreme dayanıklılıkta önemli olduğu görülmüştür.

Keywords: Tarihi hamam, yığma yapı, dinamik davranış, sonlu elemanlar analizi, bina konfigürasyonu.

1. INTRODUCTION

Historical Turkish Baths (hammams), important washing, purification, relaxation, and meeting places in people's daily life, are monumental buildings connecting past to present with cultural values. Hammams, giving clues to traditional architecture and being a common heritage of human history, have become symbols of cities. Passing them to future generations is crucial in preventing them from collapse and significant damage. In this context, the structural analysis of historic masonry baths has gained significance in the world. In this context, many studies have previously investigated materials and construction techniques [1-5] and the structural behavior of ancient baths under seismic activity [6-10]. However, these studies do not consider the change of dynamic behavior of a historical bath depending on the structural configuration for a very intensive seismic motion.

Many of the baths in Anatolia were constructed using the natural stone masonry technique under the Ottoman Empire. It is known that, therefore, that historically

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masonry structures lack seismic strength [11, 12]. Turkey, which has a lot of historical structures, including baths, mosques, etc. is located in one of the most active earthquake fault zones and high magnitude earthquakes commonly occur in this region frequently.

In this study, the effect of the architectural configuration of the Historical Çadırcı Bath, built 1548 in Erzincan, located on the active North Anatolian fault line in Turkey, on the seismic behavior was investigated. This masonry bath is a rare historic building that survived the strong ground motions like the 1939 and 1992 earthquakes, which caused the collapse of many buildings, including historic buildings in Erzincan [13-15]. Although there are many studies in the literature investigating the seismic performances of historical masonry structures such as mosques, churches and walls [16-18], studies analyzing historical baths are limited [19-20]. The main purpose of this study is to investigate how Çadırcı Bath resists these intensive earthquakes and also to evaluate the importance of the structural configuration on the seismic resistance. Within the scope of the study, first of all, the structural analysis model, which represents the current state of the bath before the restoration, was created using the SAP2000 software [21]. Afterwards, dynamic analysis were made on the model and the behavior of the historical building against intensive ground motions was analyzed. The results of this article give a perspective of thoughts on the construction of Anatolian baths, and we can learn some ideas about resistance to seismic activities.

2. EARTHQUAKES IN TURKEY (THE SEISMICITY OF ERZINCAN PROVINCE)

The North Anatolian Fault (NAF) is one of the world's most active and largest strike-slip faults. The NAF, which is 1500 km long, slides on average 20-25 mm/year, causing devastating earthquakes. Turkey, located in the NAF, has therefore experienced many devastating earthquakes throughout its recent history. In Turkey, more than 25 earthquakes have occurred in this century that ruptured 900 km in length along the fault [22]. This sequence of earthquakes is shown in Figure 1 with the dates of the events and the fracture extensions they formed.

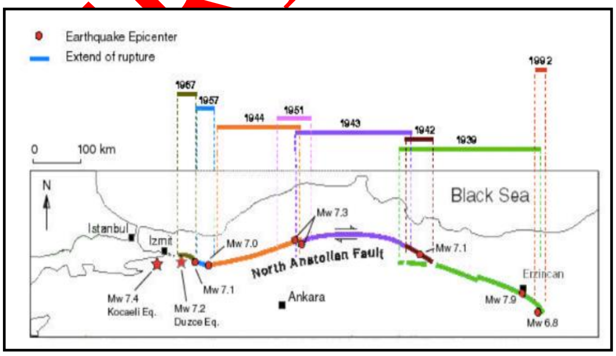

Figure 1. Successive earthquake sequence on the North Anatolian Fault since 1939 [22]

The most severe of this earthquake series is the 1939 earthquake. This earthquake, which occurred in Erzincan on 27 December 1939 shattered approximately 49 km of the surface [23]. 1939 Erzincan earthquake as shown in Figure 2, with a moment magnitude of 7.8 Mw and maximum Mercalli intensity of XII, is the second strongest earthquake recorded in Turkey after the 1668 North Anatolian earthquake [24]. In addition, it is one of the largest in a sequence of violent shocks to affect Turkey between 1939 and 1999 along the North Anatolian fault [25]. While approximately 33,000 died in the earthquake, 100,000 people were injured [26]. Due to the collapse of most of the buildings due to the earthquake, the Erzincan urban settlement was abandoned and rebuilt in a different area.

Figure 2. 1939 Erzincan earthquake surface rupture and Mercalli earthquake intensity map [27]

The Erzincan earthquake on March 13, 1992, with a moment magnitude of 6.7 and a maximum Mercalli intensity of VIII, is another important earthquake affecting eastern Turkey. As a result of this earthquake that shook the country, starting from the North Anatolian Fault, 653 people died, and approximately 2000 people were injured in Erzincan. In studies conducted in the region after the 1992 Erzincan earthquake, it was determined that the main shock occurred due to a complex fault formation in the southeast of the basin [28].

3. RESEARCH AREA AND STRUCTURAL ANALYSIS MODEL

3.1. Historical Çadırcı Bath

The Historical Çadırcı bath, the research object, is located in the old city settlement, which was relocated after the 1939 earthquake in the south of the Erzincan modern urban settlement. According to the construction and repair inscriptions on the building, the Çadırcı bath was built in 1548 by the son of Mahmut, Şeyh Ahmet, and it was repaired between 1677-78 [29]. It is one of the three bath structures that have survived the old city, which was destroyed by the 1939 earthquake. There was no structural damage in the Çadırcı bath in the 1992 earthquake either. The building, which continued to function as a bath until the 1950s, remained unused for many years [30]. It was declared a monument by the Turkish Ministry of Culture in 1980 and restored between 2016 and 2020 (Figure 3).

Figure 3. Çadırcı Bath before and after restoration (2016-2020) (from the the Author's archives)

Before the restoration, the geometry and plan dimensions of the building were determined by the survey studies carried out on site. Laser measurement systems were used in the survey works. The dimensions of the plan drawings prepared by the Erzincan Governorship Culture Directorate were checked and rearranged by the authors (Figure 4-5). Çadırcı bath, built according to the masonry technique using 3 different material types of namely brick, rubble stone, and cut stone, has a rectangular plan with dimensions of approximately 12.54 x 33.71 m from the outside. Its largest dimension is on the north-south axis. The bath consists of a cold room, a warm room, a shaving room, a hot room, a water tank, and a stove from north to south (Figure 4).

The first room of the bath is a square planned cold room with 10.10x10.10 m interior dimensions (Figure 4). This area is covered with a dome resting on an octagonal drum. The dome, which is 19 m in diameter and 3.7 m high, is supported by eight pointed arches resting on eight buttresses inside. At the top of the dome, there is a lantern for illumination. There are two windows on this area's western and northern outer walls. The next area is the warm room measuring 3.76 x 7.60 meters (Figure 4). The warm room is divided into two by an arch and is covered with a vault and a dome (Figure 5, Section A-A). There are 12 light holes (oculus) made of terracotta pipes on the dome for lighting. In addition, from the eastern wall of the warm room, it is passed to the section called the shaving cell. The L-shaped shaving area is the only room that protrudes from the plan view on the east side of the building. This place is also covered with arches and vaults, with windows on the north and east walls. The main bathing area of the bath is the hot room. This place has a square plan with internal dimensions of approximately 10.90 x 10.90 m. The space consists of four iwans (even) placed axially around the center and private cells (halvet) at the corners. A large dome covers the central area. While private cells are covered with a smaller and flat dome compared to the central dome, the iwans are covered with barrel vaults. The middle dome has forty-two light holes (oculus) and ten eyes in the other three smaller domes. The last room is the water reservoir, with a fireplace underneath. This area has internal dimensions of 2.80 x 10.00 m and is covered with a barrel vault. There is also a chimney in the middle of the room. This section, whose walls were destroyed, is the most devastating part of the bath. Although there are plaster traces on the bath walls, it was thought that these are not original [31].

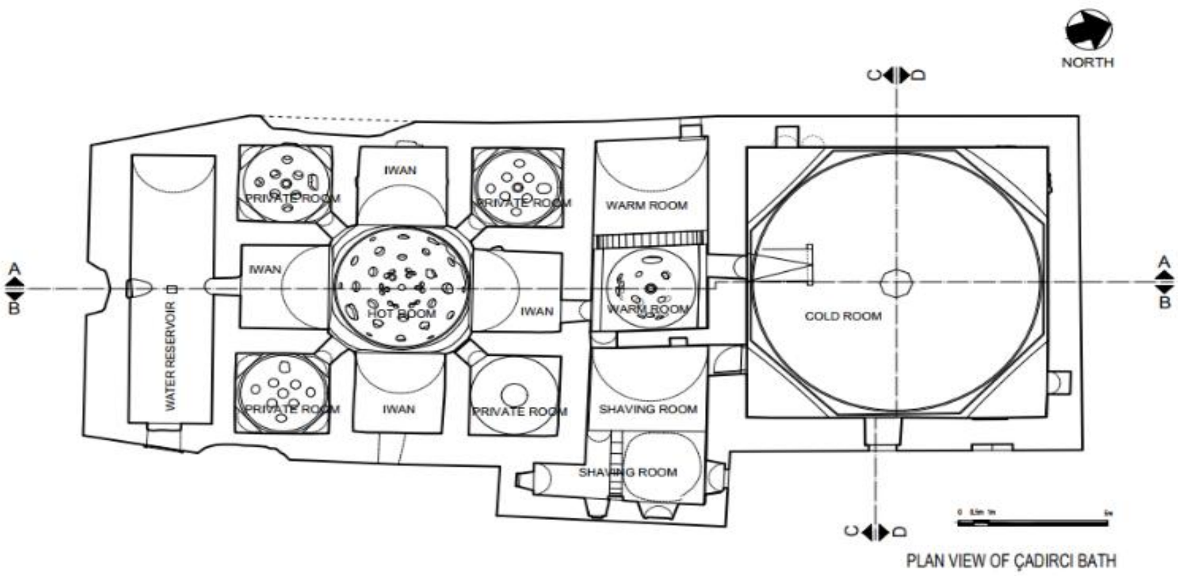

Figure 4. Plan view of Çadırcı Bath

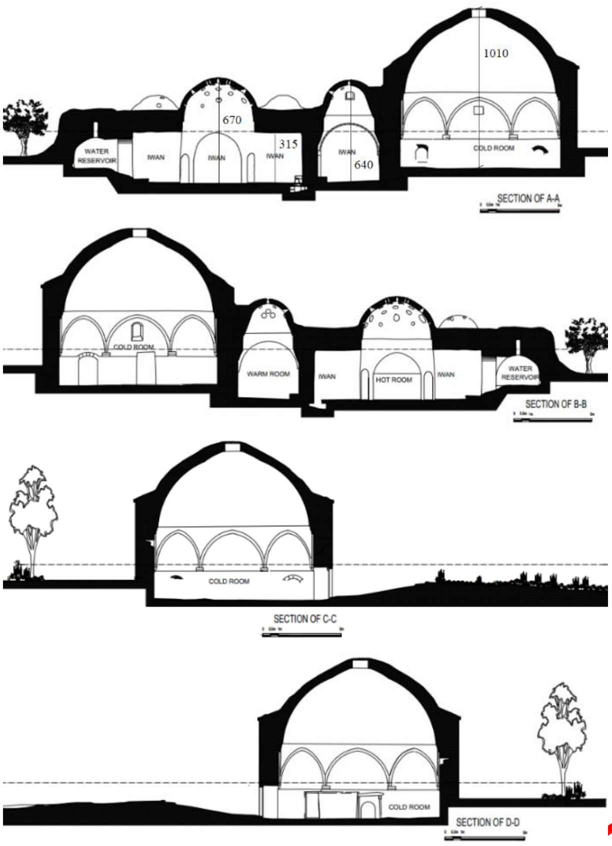

Figure 5. Section views of Çadırcı Bath (The units of heights are cm.)

3.2. Structural Analysis Model

To assessment the structural behavior of the historical Çadırcı bath under earthquake loads, both the solid model and the shell model of the structure were created in SAP2000 V24 software [21]. Two different modeling types, solid and shell, were used in this study to compare modeling processes, analysis times, and analysis results, and to verify the finite element models created with the macro modeling technique. In the macro modeling technique, the masonry units forming the wall and the mortar connecting the masonry units are reduced to a single homogeneous material and modeled. In the solid model, all the walls, vaults, and domes in the historical building are modeled as solid elements, while the arches carrying the main dome are modeled as frame elements. There are 109.497 solid elements and 78 rigid frame elements in the solid model. Eight-node objects were used to meshing in solid model. Each object has six quadrilateral faces with a joint at each corner.

All elements are modeled with 16 different types of shell elements defined to be suitable for their thickness in the shell model. Four-node Quadrilateral Elements were used for meshing in shell model. The Shell elements activates all six de degrees of freedom at each of its connected joints. Eight arches carrying the main dome in the building are modeled as curved frame elements in a 30x30 cm section. In addition, rigid frame elements are used to provide load transfer from the vaults to the walls. The shell model has a total of 30.319 shell elements and 203 frame elements. In both models, the soil-structure interaction is not considered and fixed supports were used. The total weight of the structure was calculated as 2084 tons in the solid model and 2187 tons in the shell model. The solid model was analyzed in 11 minutes and the Shell model in 4 minutes on a 32 Gb Ram 16 core processor computer. The finite element models created are shown in Figure 6.

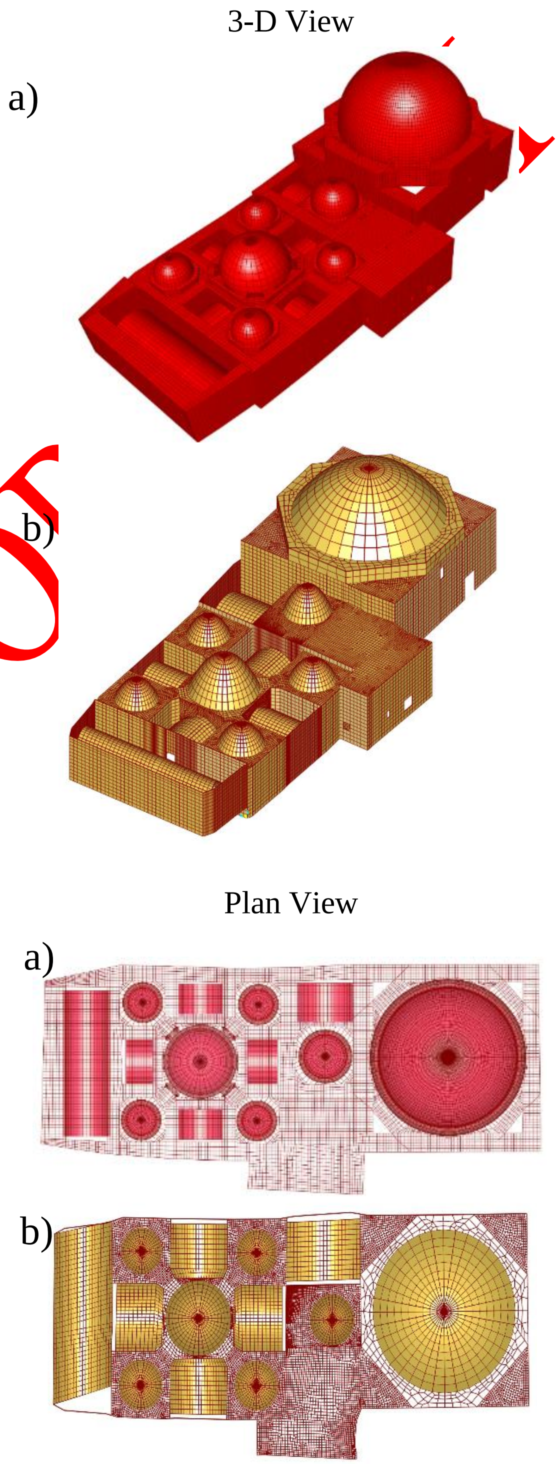

Figure 6. a) Solid model b) Shell model

In the finite element models created, 3 different materials were used in accordance with the exist structure: Rubble Stone Masonry Wall, Brick Wall, and Cut Stone Masonry Wall. Rubble stone material was used in all the masonry walls of the historical bath, and brick material was used in all the vaults, domes, and arches. Cut stones were only used on the octagonal walls under the big dome. Since samples were not taken from the historical building, mechanical tests were not carried out on the materials. For this reason, the mechanical properties of the materials were determined in accordance with the building type from the Earthquake Risks Guide of Historical Buildings of the General Directorate of Foundations of the Republic of Turkey. The mechanical properties of the materials used in the finite element models are given in Table 1 [32]. Mechanical properties of materials are assumed as anisometric, which means all mechanical behaviors are the same for all directions and shearing behavior is uncoupled from extensional behavior.

Table 1. Mechanical properties of materials [32]

Material	*fm* (MPa)	*E* (MPa)	*G* (MPa)	*W* (kN/m^3)
Rubble Masonry Wall	0.90	1050	175	19
Brick Masonry Wall	6.00	4400	880	12
Cut Stone Masonry Wall	2.00	1980	330	21

To assessment the earthquake behavior of the Historical Çadırcı Bath, Response Spectrum analysis was performed according to the Turkish Seismic Code [33]. In the analysis, the earthquake level was determined as a designed earthquake with a probability of exceeding 10% in 50 years (recurrence period of 475 years). As seen in Table 2, local acceleration values of the location of the historical building were taken from AFAD's interactive earthquake risk map [34].

Table 2. Earthquake risk map values

Latitude	39.723186°
Longitude	39.4907°
Soil Class	ZC
PGA (g)	0.578
PGV (cm/sn)	37.934
S_s	1.391
S_1	0.402
S_{DS}	1.669
S_{D1}	0.603

In Table 2, PGA (g): Peak ground acceleration, PGV (cm/s): Peak ground velocity, Ss: Short period map spectral acceleration coefficient, S1: Map spectral acceleration coefficient for 1.0 second period, SDS: The short period design spectral acceleration coefficient and SD1: the design spectral acceleration coefficient for the 1.0 second period. The earthquake load reduction coefficient (Ra) was taken as 1 since the existing historical structure was evaluated. The response spectrum graph is defined as shown in Fig. 7 by using the values taken from the earthquake risk map according to the location of the historical building.

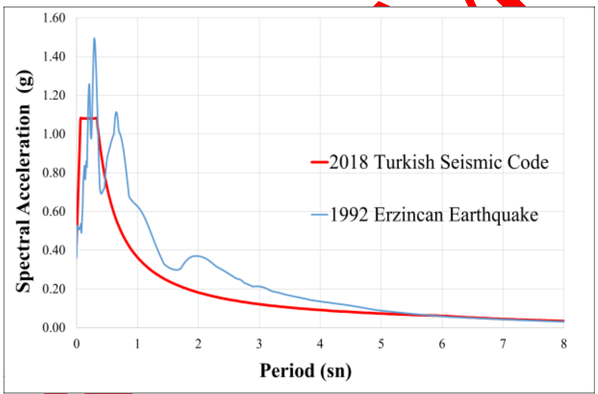

Figure 7. Response spectrum

4. STRUCTURAL ASSESSMENT AND DYNAMIC BEHAVIOR OF ÇADIRCI BATH

In this study, the results of the analysis for the historical Çadırcı bath were examined based on 3 main building elements. These structural elements are domes, vaults, and walls. First of all, modal analysis was carried out, and the dominant mode shapes and periods of the historical Çadırcı bath were obtained separately for the solid and shell models, as seen in Figure 8 and Table 3. In both models, the Y direction translation and torsion mode are obtained in the same mode. The periods calculated in the Solid and Shell models are within the expected limits.

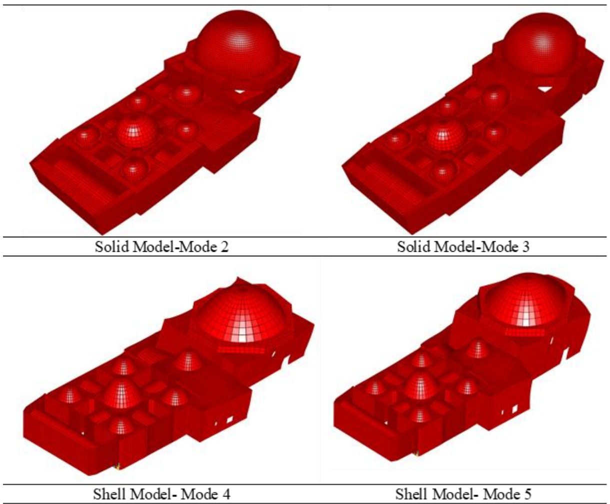

Figure 8. Dominant mode shapes

Table 3. Mode types and modal participating ratios

Dominant Mode Type	Mode No	Period (sn)	UX	UY	UZ	RX	RY	RZ
Solid Model								
Y Direction and Torsion	2	0.103	0.000	0.324	0.000	0.118	0.000	0.273
X Direction	3	0.099	0.359	0.000	0.000	0.000	0.035	0.001
Shell Model								
Y Direction and Torsion	4	0.099	0.015	0.377	0.008	0.083	0.001	0.248
X Direction	5	0.091	0.367	0.013	0.000	0.002	0.027	0.010

Considering the filling material on the vaults and floors in the historical building, a filling load (G) of 3 tons/m2 on the vaults and 1.5 tons/m2 on the floors has been defined. In addition, a live load (Q) of 150 kgf/m2 is defined in the model. As seen in Figure 9, in the static analysis of the structure under its weight, it was observed that none of the elements exceeded the compressive strengths given in Table 1.

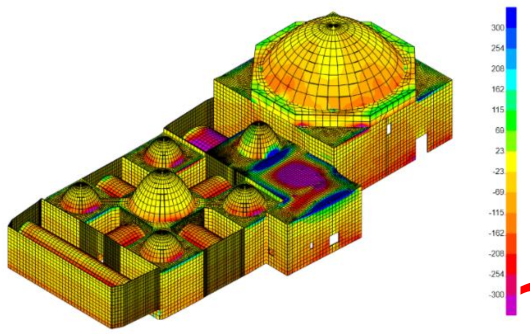

Figure 9. Vertical stresses under G+Q combination

According to the Turkish Seismic Code (TSC), response spectrum analysis was performed in X and Y directions for the historical Çadırcı bath. The complete quadratic coupling (CQC) method was used as the mode coupling method. The damping rate in the analysis is 5%. To evaluate the results more accurately, each building element was named separately as seen in Figure 10.

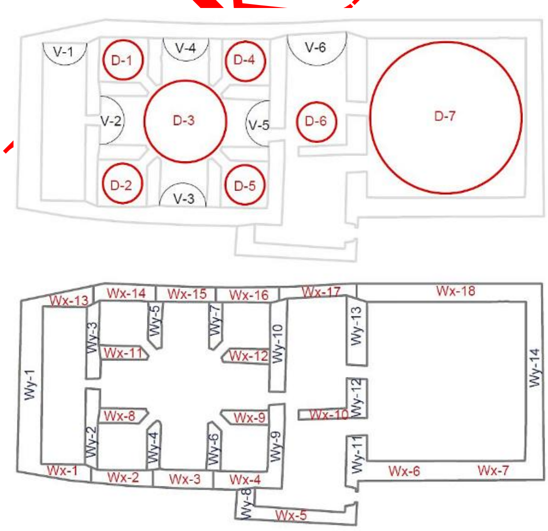

Figure 10. Labels of structural elements

An envelope combination (ENV) containing all the load combinations given in Table 4 were defined and the results were evaluated with this combination.

Table 4. Load combinations

1-	G+Q+SPECX+0.3SPECY
2-	G+Q+SPECX-0.3SPECY
3-	G+Q-SPECX+0.3SPECY
4-	G+Q-SPECX-0.3SPECY
5-	G+Q+SPECY+0.3SPECX
6-	G+Q+SPECY-0.3SPECX
7-	G+Q-SPECY+0.3SPECX
8-	G+Q-SPECY-0.3SPECX

As seen in Table 5, shear strength was calculated for each structural element. To calculate the shear strength according to the Turkish Seismic Code, 2018 Equation 1 was used.

$$f_{vk} = f_{vko} + 0.4\sigma_d \leq 0.10 \quad (1)$$

In this equation fvk = sliding safety stress of structural element, fvko= cracking safety stress of structural elements, σd is vertical wall stress. The average shear stress (τ) obtained according to the analysis results for each structural element is shown in Table 5.

The results of the analyses were evaluated separately for three different structural elements (dome, vault, and wall). Shear stress distributions due to the earthquake were analysed in two different components, 1-3 and 2-3. For each structural element, the stresses in two different directions were analysed and the maximum values determined on the whole element were noted. The elements where the shear strengths calculated by Equation No. 1 were exceeded were marked in red on Table 5. In the stress distributions given in Figure 11, the 1-3 component represents in-plane stresses for the elements extending in the 1 direction, while it represents out-of-plane behaviour for the elements extending in the 2-direction. The 2-3 component represents out-of-plane stresses for the elements extending in 1-direction and in-plane behaviour for the elements extending in 2-

directions. When Figure 11 and Table 5 are analysed, it is seen that the most damage due to the earthquake occurred in the vaults, then in the internal walls and least in the domes and external walls.

Table 5. Calculation of sliding stresses

Type	Structural Element	Material	A (m^2)	F (kN)	σ_D (kN/m^2)	f_{vk0} (kN/m^2)	f_{vk} (kN/m^2)	τ (kN/m^2)
Dome	D-1	Brick	2.28	32.70	14.34	200.00	205.73	22.67
	D-2	Brick	2.28	32.70	14.34	200.00	205.73	22.83
	D-3	Brick	3.29	102.34	31.10	200.00	212.44	48.48
	D-4	Brick	2.28	32.70	14.34	200.00	205.73	23.43
	D-5	Brick	2.28	32.70	14.34	200.00	205.73	23.01
	D-6	Brick	2.16	68.72	31.82	200.00	212.73	32.53
	D-7	Brick	17.19	1026.46	59.70	200.00	223.88	140.95
Vault	V-1	Brick	3.88	1055.21	271.96	200.00	308.78	471.19
	V-2	Brick	1.15	177.64	154.47	200.00	261.79	320.17
	V-3	Brick	1.17	201.01	171.80	200.00	268.72	334.53
	V-4	Brick	1.14	99.69	87.45	200.00	234.98	326.45
	V-5	Brick	1.15	194.60	169.22	200.00	267.69	347.29
	V-6	Brick	1.45	285.68	197.02	200.00	278.81	284.55
Wall	W_x-1	Rubble	3.78	235.29	62.25	100.00	124.90	112.13
	W_x-2	Rubble	3.77	405.04	107.44	100.00	142.97	110.02
	W_x-3	Rubble	4.53	450.86	99.53	100.00	139.81	120.22
	W_x-4	Rubble	4.42	512.19	115.88	100.00	146.35	95.44
	W_x-5	Rubble	5.45	652.02	119.64	100.00	147.85	117.97
	W_x-6	Rubble	11.20	1557.18	139.03	100.00	155.61	240.85
	W_x-7	Rubble	3.11	293.28	94.30	100.00	137.72	173.64
	W_x-8	Rubble	2.51	394.20	157.05	100.00	162.82	259.69
	W_x-9	Rubble	2.68	419.23	156.43	100.00	162.57	183.92
	W_x-10	Rubble	2.54	306.30	120.59	100.00	148.24	163.43
	W_x-11	Rubble	2.44	393.87	161.42	100.00	164.57	265.50
	W_x-12	Rubble	2.68	434.81	162.24	100.00	164.90	204.98
	W_x-13	Rubble	3.76	315.29	83.85	100.00	133.54	134.08
	W_x-14	Rubble	3.68	392.03	106.53	100.00	142.61	97.35
	W_x-15	Rubble	3.84	385.14	100.30	100.00	140.12	95.67
	W_x-16	Rubble	3.57	471.36	132.03	100.00	152.81	133.79
	W_x-17	Rubble	5.29	510.16	96.44	100.00	138.58	121.84
	W_x-18	Rubble	12.61	1840.02	145.92	100.00	158.37	245.16
	W_y-1	Rubble	15.81	1678.94	106.19	100.00	142.48	107.68
	W_y-2	Rubble	4.17	690.22	165.52	100.00	166.21	205.12
	W_y-3	Rubble	4.81	647.46	134.61	100.00	153.84	168.24
	W_y-4	Rubble	2.41	391.03	162.25	100.00	164.90	294.34
	W_y-5	Rubble	2.59	389.63	150.44	100.00	160.17	292.17
	W_y-6	Rubble	2.57	390.54	151.96	100.00	160.78	271.03
	W_y-7	Rubble	2.35	383.40	163.15	100.00	165.26	313.59
	W_y-8	Rubble	1.76	181.95	103.38	100.00	141.35	187.23
	W_y-9	Rubble	4.41	589.76	133.73	100.00	153.49	213.37
	W_y-10	Rubble	6.05	919.04	151.91	100.00	160.76	266.01
	W_y-11	Rubble	6.67	914.06	137.04	100.00	154.82	236.65
	W_y-12	Rubble	3.76	682.91	181.63	100.00	172.65	278.63
	W_y-13	Rubble	5.51	866.93	157.34	100.00	162.94	269.11
	W_y-14	Rubble	12.68	1862.09	146.85	100.00	158.74	279.56

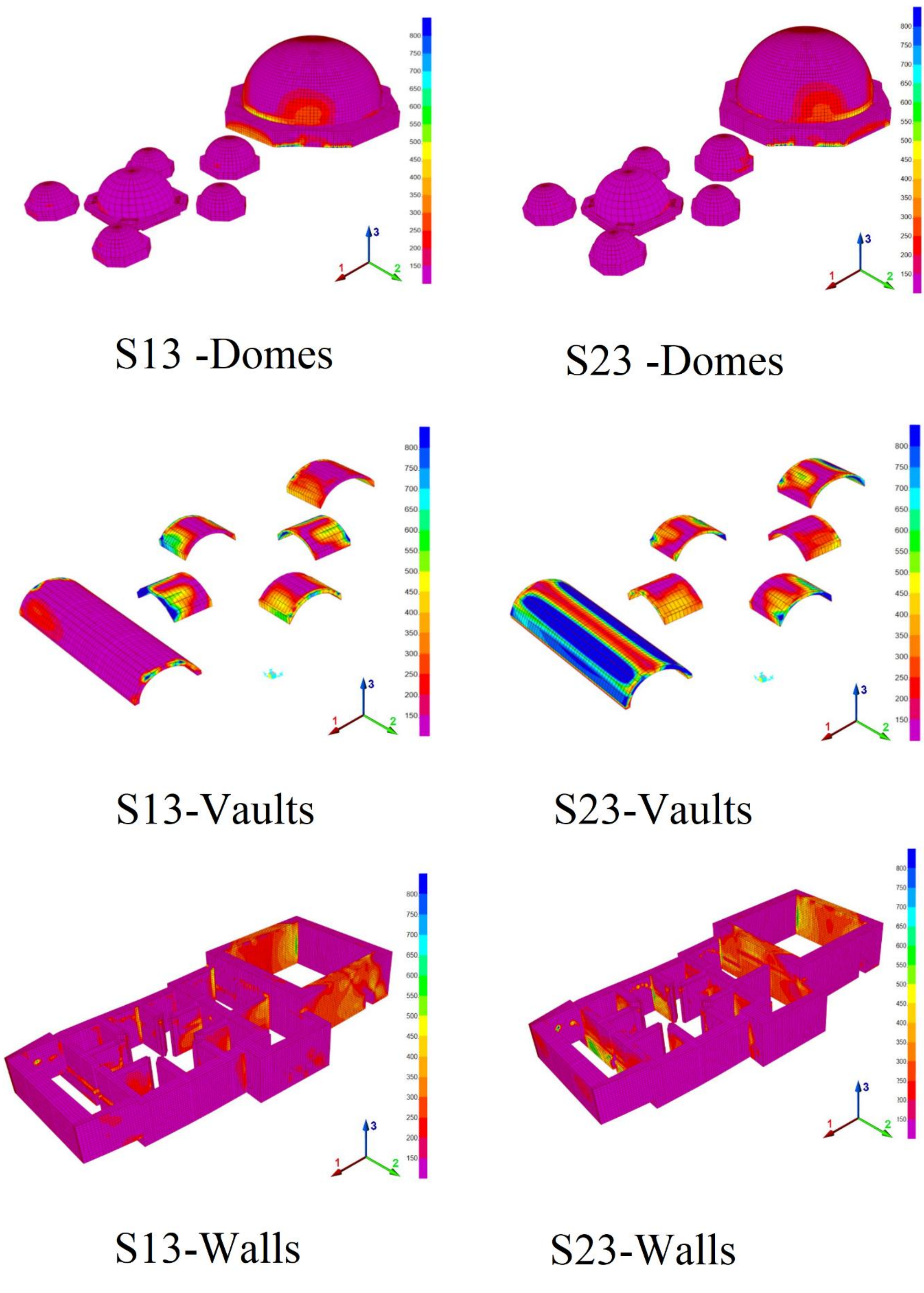

Figure 11. Shear stress distributions

5. CONCLUSIONS

In the 1992 and 1939 Erzincan earthquakes, it was recorded that both masonry and reinforced concrete building stock in Erzincan, Turkey were severely damaged and most of them collapsed. However, the historical Çadırcı bath has not been destroyed until today after major earthquakes. In this study, a finite element model of the historical Çadırcı bath was created and its structural behavior under earthquake loads was examined. As a result of the analyzes made;

- It has been observed that the building can safely bear the compressive stresses under its weight.
- When the shear stresses under the effect of the earthquake were examined, it was observed that the masonry walls under the D-7 dome were severely damaged under the effect of the earthquake. It was observed that the walls under the D-3 dome were partially damaged and the other outer walls were not damaged. When the vaults were examined, it was observed that the slip safety of the V-1 vault, which is known to be used as a water tank, was exceeded and partial damages were observed in the other vaults. No damage was observed under the earthquake load in any of the domes in the building.
- When the drift ratios of the structure under the earthquake effect are examined, it is seen that it does not exceed the ratio of 0.3%, which corresponds to the limited damage performance level.
- The fact that the outer walls of the historical Çadırcı bath are quite thick and that there are very few doors and window spaces in the walls are considered the main reasons for the minor damage to the outer walls under earthquake loads.
- Two different finite element models, which were created as shell and solid, were analyzed separately, and the building masses, periods, and stress distributions overlapped. For this reason, considering the analysis time and modeling difficulty, it has been concluded that the shell modeling technique is safe in such studies.
- Because the outer walls and domes in the historical building did not suffer any significant damage, the external form of the building was preserved and has survived to the present day after undergoing various repairs after the earthquakes.

DECLARATION OF ETHICAL STANDARDS

The authors of this article declare that the materials and methods used in this study do not require ethical committee permission and/or legal-special permission.

AUTHOR'S CONTRIBUTIONS

Arzu GÜNCÜ: Performed architectural surveys

Asena SOYLUK: Performed structural analysis and architectural surveys

Alper ÇELİK: Performed structural analysis and wrote the manuscript.

Erkan Okay MUTLU: Performed structural analysis

CONFLICT OF INTEREST

There is no conflict of interest in this study.

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