Ece Sultan KARACIK

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DESIGN, APPROVAL AND CONSTRUCTION PROCESSES OF EARTHEN BUILDINGS IN PUBLIC AND PRIVATE OWNERSHIP

M.Sc. THESIS

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE

AND THE GRADUATE SCHOOL OF ENGINEERING AND SCIENCE

OF ABDULLAH GUL UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SCIENCE

By

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SCIENTIFIC ETHICS COMPLIANCE

I hereby declare that all information in this document has been obtained in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all materials and results that are not original to this work.

Ece Sultan Karacık

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M.Sc. thesis titled “Design, Approval and Construction Processes of Earthen Buildings in Public And Private Ownership” has been prepared in accordance with the Thesis Writing Guidelines of the Abdullah Gül University, Graduate School of Engineering & Science.

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ABSTRACT

DESIGN, APPROVAL AND CONSTRUCTION PROCESSES OF EARTHEN BUILDINGS IN PUBLIC AND PRIVATE OWNERSHIP

Ece Sultan Karacık
MSc. in Architecture
Advisor: Assoc. Prof. Buket Metin
September 2025

This research focuses on the production of buildings constructed with earth in Türkiye. Although earth has been a widely used natural building material in the past, especially in rural areas, its use has decreased due to the widespread production of industrial concrete, urbanization, and changes in zoning regulations. The study has recently identified the limited number of buildings constructed with earth in Türkiye and the lack of knowledge among architects regarding their production processes as a problem.

This study aims to raise awareness about the use of earth materials in architectural practice and to encourage the use of this material. Earth buildings constructed on both public and privately owned sites in Türkiye have been examined, and in-depth interviews were conducted with the designers, representatives of approval authorities, and construction team members to gather information about the design, approval, and construction processes.

The research has developed an explanatory model for the production processes of earthen buildings by comparing the production process of earthen buildings with conventional building production process, in the light of the data obtained from the stakeholders involved in each stage of these processes. The study aims to increase the use of earthen materials and contribute to the sustainability of cities, and to provide a comprehensive roadmap for architects and practitioners in the design and construction of earthen buildings.

Keywords: earthen building techniques, earthen buildings production process, public and private ownership buildings production, vernacular materials. natural buildings.

ÖZET

KAMU VE ÖZEL MÜLKİYETLİ TOPRAK YAPILARIN TASARIM, ONAY VE YAPIM SÜREÇLERİ

Ece Sultan Karacık
Mimarlık Anabilim Dalı Yüksek Lisans
Tez Danışmanı: Doç. Dr. Buket Metin
Eylül 2025

Bu araştırma, Türkiye'de toprak ile inşa edilen yapıların üretimini ele alan bir çalışmadır. Toprak, geçmişte özellikle kırsal alanlarda yaygın olarak kullanılan doğal bir yapı malzemesi olmasına rağmen, endüstriyel beton üretiminin yaygınlaşması, kentleşme ve değişen imar yönetmelikleri nedeniyle bu kullanım azalmıştır. Bu çalışma kapsamında, son yıllarda Türkiye'de toprak malzeme ile yapılan yapıların sayısının sınırlı kalması ve bu tür yapıların üretim süreçlerinin mimarlar tarafından bilinmemesi problem olarak ele alınmaktadır.

Bu çalışma, toprak malzemelerinin kullanımı konusunda mimarlık pratiğinde bir farkındalık yaratmayı ve bu malzemenin kullanımını teşvik etmeyi amaçlamaktadır. Türkiye'de hem kamu hem de özel mülkiyetli arsalara inşa edilmiş toprak yapılar incelenmiş, bu yapıların tasarımcısı, onay veren kurum temsilcisi ve yapım ekibi temsilcisi ile derinlemesine görüşmeler yapılarak tasarım, onay ve yapım süreçleri hakkında bilgi toplanmıştır.

Araştırma, toprak yapı üretim süreçlerini konvansiyonel yapı üretim süreçleriyle karşılaştırarak, bu süreçlerin her aşamasında görev alan paydaşlardan elde edilen veriler ışığında, toprak yapıların üretim süreçlerine dair açıklayıcı bir model geliştirmiştir. Çalışma, toprak malzemesi kullanımını artırmayı ve kentlerin sürdürülebilirliğine katkı sağlamayı hedefleyerek, özellikle mimar ve uygulayıcılar için toprak yapıların tasarım ve inşası konusunda kapsamlı bir yol haritası sunmayı amaçlamaktadır.

Anahtar kelimeler: toprak yapı teknikleri, toprak yapıların üretim süreci, kamu ve özel mülkiyetli yapıların üretimi, yerel malzemeler, doğal yapılar.

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LIST OF ABBREVIATIONS

TS	Turkish Standards
IDEF	Icam Definition for Function Modeling
CEB	Compressed Earth Block
LSC	Light Straw Clay
TSE	Turkish Standards Institute
UNESCO	United Nations Educational, Scientific and Cultural Organization
TMMOB	Union of Chambers of Turkish Engineers and Architects
DIN	German Institute for Standardization
DIMC	Departments of Investment Monitoring and Coordination

To my nieces and nephews

Chapter 1

Introduction

The global climate crisis and the disasters experienced in recent years require more sensitivity in the use and recycling of natural resources in the world. The whole world is taking various actions and developing policies in this regard. One of these is the European Green Deal published by the European Commission in December 2019 (Directorate for EU Affairs, 2024). The main goal of this agreement is to make Europe a region with net zero carbon emissions by 2050 (Europen Commission, n.d.). This agreement is one of the most important climate and economic action plans of Europe, emphasizing topics such as clean and secure energy supply and circular economy (Leyen, 2019). One of the priority sectors that should be included in these climate-related action plans and can contribute to the solution of these problems in terms of recycling and energy efficiency topics is the building sector (Sameh, 2014). Within this perspective, one of the critical component of the architecture and building sector is building materials. Therefore, it is important to focus on using building materials that requires low energy for the production, are natural and recyclable to contribute the health of the physical environment and human wellbeing during architectural production.

Earth is one of these building materials that people began to prefer more with the transition to settled life. Earth is one of the natural, easily processed, recyclable, local and readily available materials used to build for meeting the need for shelters (Bozyel, 2021; Minke, 2006). It has been used as a building material in traditional and vernacular architecture, in walls, floors, and roofs for a long time (Minke, 2006). It is known that earthen materials have been used in many historical buildings including the Great Wall of China, and these buildings have stood for many years (Niroumand et al., 2013). Although it has been used frequently in the past, including prehistoric times, and has many advantages, the emergence of new materials has caused earth-based building materials to lose their importance specifically due to rapid production cycle developed with the industrial revolution (Solhan and Arpacıoğlu, 2021).

Although many sources describe the conventional building production process, there is not enough information on how this process will be shaped when the building material and construction technique change. Especially when this material is earth there is no systematic information on the earthen building construction process management. Interest in earth, a building material traditionally associated with rural areas and used for centuries across various regions with different construction techniques, has increased in recent years. However, the lack of sufficient knowledge regarding the management of organizations involved in its production process is noteworthy. (Pele-Peltier et al., 2022). Although new steps have been taken for building with earth materials in recent years, the production is still quite limited (Pacheco-Torgal and Jalali, 2012). The fact that the production of earthen buildings is not widespread today makes the building production process with this material undefined.

1.1 Problem Definition and Research Question

As in the whole world, there are many buildings constructed using earth as a building material in Türkiye. Moreover, it is one of the traditional building materials, which has been used specifically in the rural areas. However, the number of earthen buildings has decreased day by day due to lack of local labor force, which is in the core of traditional earthen building production. In addition, the lack of information about designing with this material, the uncertainty of approval processes and the lack of sufficient knowledge about construction techniques with earth are other reasons for not using it in urban areas. Considering these reasons, it becomes evident that a comprehensive approach is needed for earthen building production processes. This study addresses the problem of the uncertainty of the design, approval and construction processes of buildings produced using earth building materials, as well as the lack of a systematic approach in this regard. Therefore, this thesis focuses on the question of how to manage the design, approval and construction processes of earthen buildings. The sub-questions required to answer this question are defined as;

- What are the construction techniques used for earthen buildings in Türkiye?
- What are the design, approval and construction processes in conventional buildings in Türkiye?

- What are the differences between earthen building production process and conventional building production process?
- How do earth building designers, approving institutions and construction teams manage the earth building production process?

1.2 Literature Review

When the existing studies on earthen building production processes are analyzed, it is observed that they mostly focus on design, construction and approval processes separately. However, the studies that take a holistic and systematic perspective to the entire earthen building production process are limited. In this context, prominent studies will be examined in the subsequent sections.

Minke (2006) defines the construction process of natural building materials and techniques. In this study, soil as a building material and providing its sustainability this it with modern construction technologies are discussed examining both historical and current examples.

Fethi (2010) designed and built both residential and cultural buildings using earth, which were particularly in Yeni Gurna village in Egypt. In these buildings, the local people participated in the project and construction process, and buildings were built that would set an example for participatory architecture. The construction process of the implemented projects was explained by providing detailed information such as step-by-step techniques, work plans, labor supply, and cost calculations.

Kafesçioğlu (2018) presented a guide for the production and construction of an earth-based material named “alker” developed by himself, which has a gypsum-added soil content. In this guide, the details of the preparation, mixing and implementation stages were defined “alker”, The study is specifically aimed to be used by people who will practice construction earthen building with “alker.”.

Koç and Akbulut (2017) emphasized the relationship between ecological design and earth material and investigated the approval processes of these materials. They examined the building standards and regulations according to the countries and the type

of earth construction techniques, and comparatively evaluated the limitations, deficiencies and positive aspects in the approval processes.

Solhan and Arpacıoğlu (2021) evaluated the parameters affecting the earthen building design process. They examined the constructed examples of pioneers in the field of earthen buildings and examined the earthen building design process within the scope of local and ecological architecture.

Although these studies provide an insight that will help users, designers, and contractors, a comprehensive study example that explains all stages of earthen building production from design to construction has not been found in the literature. For this reason, this thesis study presents a framework covering the design, approval and construction processes of earthen buildings.

In this context, the unique value of this study lies in its holistic approach to the earthen building production process and its exploration of the differences between the earthen building production process and conventional building production methods.

1.3 Motivation and Objective

This study aims to define the design, approval and construction processes of earthen buildings, systematically. As a result of this study, the production processes of earthen buildings will be defined in detail within the scope of basic phases, inputs and outputs, and a guide that will support the production processes of earthen buildings will be developed.

Thus, the proposed the guide can encourage the use of earth as a building material, which has had an important place in architectural practice. It can also provide knowledge to professionals, and them about earthen construction techniques, and encourage them to include these techniques in their works. By clarifying this process, the study aims to attract the attention of not only architects but also contractors and public institutions. As a result, it is expected to indirectly contribute to the increased production of earthen buildings.

1.4 Scope and Context

In Türkiye, the conventional building production processes differ according to ownership types. Therefore, in this research, the production process of earthen buildings are also discussed within the scope of public and private ownership, similar to conventional building production processes.

In order to understand the production process earthen buildings, it is necessary to consider the design and construction processes together. This study aims to define the process from design to occupancy and to reveal the differences between earth construction and conventional building practices. Therefore, it focuses on the first two stages of the building lifecycle: design and construction.

In addition to these main processes, approval processes, which are generally considered as part of the design process are also considered as one of the main components of earthen building production process. Therefore, the basic stages of the earthen building production process are examined through on design, approval and construction processes within the scope of the thesis study.

Standards and regulations are important inputs used in earthen building approval processes in Türkiye. When the Turkish standards are examined, it is seen that the Turkish Standards Institute published the “TS2514 Adobe Blocks and Construction Rules”, “TS2515 Adobe Construction Rules” standard, and the “TS537 Cemented Adobe Blocks and Walls” standard in 1977 and 1985. (Turkish Standards Institute, 1977; Turkish Standards Institute, 1985). The TS2514 and TS2515 standards were repealed in 2011, and the mandatory enforcement of TS 537 was canceled in 2010.

When the regulations in Türkiye are examined, there is no statement regarding earthen buildings in the current “Planned Areas Zoning Regulation”, but there are some statements in the “Ankara Metropolitan Municipality Zoning Regulation” and “Unplanned Areas Zoning Regulation”. (Unplanned Areas Zoning Regulation, 1985; Planned Areas Zoning Regulation, 2017; Ankara Metropolitan Municipality, 2018). In the “Regulation on Buildings to be Constructed in Earthquake Zones” that came into force in 2007, adobe buildings were evaluated in the category of masonry structures and various provisions were published regarding construction methods. However, in the document

that addresses the “Principles for the Design of Buildings Under Earthquake Effect” in the annex of the new “Turkish Building Earthquake Regulation” published in 2018 and still in force, it is stated that adobe can only be used as an infill material and can never be used as a load-bearing wall material (Regulation on Buildings to be Constructed in Earthquake Zones, 2007; Turkish Building Earthquake Regulation, 2018).

When these studies are taken into consideration, it is understood that there have been restrictions in the regulations and standards regarding earthen buildings in Türkiye since 2010. However, despite the provisions removed from the regulations and the cancelled standards, it has been seen that there are buildings constructed using earthen materials in Türkiye.

1.5 Research Design and Methods

Obtaining and analyzing the necessary data to achieve the objectives of this study require the use of qualitative research methods. The thesis study is structured in five basic stages: defining earthen building materials and techniques, determining conventional building production processes in Türkiye, analyzing earthen building construction processes in Türkiye, developing a design guide defining the earthen building production process, and discussing the proposed design guide and its contributions.

In the first stage, secondary data sources were used to define earth building materials and techniques, and information was gathered on earthen building construction in the historical process, and techniques used to build them. In addition, a detailed examination of earth construction techniques used in Türkiye was conducted.

In the second stage, data was obtained from secondary sources to define conventional building production processes in Türkiye. Since, the building production processes in Türkiye differ according to ownership types, the building production process was examined for publicly owned and privately owned buildings, separately. Within this context, building life cycle stages were taken as a reference to define these processes, and the sub-stages, namely design, approval and construction, were analyzed. Each sub-stage was defined focusing on the main activities, inputs, and outputs. Besides, the share/stake-holders were also designated for each sub-stage.

In the third stage in-depth interviews with stakeholders who are involved in the sub-stages of the earthen building production process, were conducted. In this stage, the conventional building production process was taken as a reference to design the interviews, and a sampling process was conducted to define the earthen buildings constructed in Türkiye.

Since the design, approval and construction processes involve different stakeholders, interviews are designed for each stakeholder, separately s to understand the earthen building production process with a detail perspective. A sample list of earthen buildings was simultaneously developed and these samples were categorized according to criteria such as construction year, design team, information on the approval institution, construction team, construction technique and ownership status. Both secondary and primary data sources were used in collecting this data. First, secondary data sources were used to determine publicly and privately owned earthen buildings whose implementation was completed in Türkiye. This data was taken from the websites and social media accounts of associations, research groups and institutes that are pioneers in the field of earthen buildings in Türkiye. In the database created, all buildings constructed after 2010 were categorized and the samples were listed. Then, designers of these samples were contacted to obtain information about whether the building had gone through the approval processes. The buildings that had gone through the approval process were determined and the sampling a for the interviews were selected using the convenience sampling method.

In the fourth stage, in-depth interviews were conducted with the designer or design team representative the representative from the institution conducted the approval process and the construction team representative of the buildings in the sampling list. The following data regarding the earthen building production process were obtained from these interviews as follows:

Data obtained for the design process are;

- Information and official documents related to the site,
- Employer expectations,
- How the material selection shapes the design,
- Legislation and regulations examined during the design process,
- Design duration.

Data obtained for the approval process are;

- Information on the approving institution,
- Expectations of the institution from the designer,
- Stakeholders that the institution deals with,
- Which legislation and regulations the approving institution bases for the control process
- Official institution approval duration.

Data obtained for the construction process are;

- Material supply process,
- Equipment supply process,
- Procurement of craftsmen and workers,
- Where and for what purpose the soil material is used in the building,
- Construction duration.

Then, the gathered data from the interviews were analyzed using thematic analysis method by associating the results with the conventional building production processes. Then, the defined patterns were used to model earthen building production process using the IDEF0[1] process modeling technique.

In the last stage, flow diagrams were made for the earthen building production process and a guide was created. Earthen building flow diagrams were associated with conventional flow diagrams and the results were compared and evaluated. The thesis was concluded by defining the future perspective of the thesis and its contribution to global sustainability.

[1] This is a is a function modeling methodology for defining production functions.

Chapter 2

Earthen Building Material and Techniques

This chapter presents a study on earth buildings, examples of which have been found across various geographies for centuries. It is well known that earth buildings of different scales and construction techniques exist both in rural areas and urban centers, in Türkiye and around the world. Within the scope of this study, prominent earth buildings and the traditional earth construction techniques used in these structures have been examined, covering both prehistoric times and the present day, across the seven geographical regions of Türkiye as well as in selected global contexts.

2.1 Earthen Materials and Buildings in the World

With the Neolithic Age, the transition from a hunter-gatherer lifestyle to settled life began, and the foundations of production-based and agricultural societies were laid. These societies, which sustained themselves through agriculture, began constructing spaces to meet their needs for shelter and protection, using readily available materials in their surroundings. In this context, earth, one of the oldest building materials used throughout human history, has been used not only for agricultural production but also as a building material (Akman, 2003). Earth is particularly more commonly used in hot and arid regions with limited alternative building materials such as natural stone or wood, where rainfall is low (Keefe, 2012). The unique climate conditions and local soil characteristics of each geographical region have led to the construction of these buildings using different techniques, thus giving rise to distinct building traditions in each region.

Examples of earth material use and earthen buildings in **Asia** are concentrated in *China, the South-Central Asia, and the Middle East.* It is estimated that the first settled settlements in the *Middle East* date back to 9000 BC, close to the Euphrates and Tigris

rivers. One of the most important examples in this region is Çatalhöyük, located within the borders of Türkiye. The dwellings found in this settlement, which is estimated to date back to around 7500 BCE, are irregularly planned and made of adobe (Kafesçioğlu, 2017). Furthermore, the world's tallest adobe building is the minaret of the Al-Muhdhar Mosque in Yemen, which stands at 53 meters in height (Jaquin, 2012). The first settlements in the *South and Central Asia* are the adobe housing settlements of Mehrgarh, located within present-day Pakistan, dating back to 7000 BCE. In this region, through which the Silk Road passed, traces of adobe buildings and rammed earth defense walls have been found in Mongolia, Turkmenistan, and Tajikistan. *In China,* traces of settlements that are a reference to settled life date back to 2300 BC. The earth in these settlements was typically applied in the form of rammed earth walls. Rammed earth walls and adobe were also used in some parts of the Great Wall of China, one of the most important examples in this region (Yıldız et al., 2018).

In **Africa,** remains of reed and wattle-covered earth have been found in settlements near the Nile Delta, dating back to 5000 BCE. Archaeological excavations have revealed that buildings were built with adobe bricks, especially in Egypt. One of the most important examples in this region is the Great Mosque of Djenne in Mali, which is on the UNESCO World Heritage list and is the largest adobe mosque in the world. It is estimated that this mosque was built around 1200 AD; however, as a result of the destruction, it was rebuilt in 1906 (Tulaganov, 2005).

Europe is the region with the greatest diversity of earth building techniques. The oldest evidence of earth use in Europe dates back to 5000 BCE and is found in the Sesklo settlement in Greece, where adobe dwellings were discovered (Jaquin, 2012). In the south of Europe, adobe and rammed earth techniques were mostly used, while in the north, using earth together with wood was common. The wattle and daub technique is also one of the most widespread earthen techniques using wood in Northern Europe. One of the most important examples from this region is the Alhambra Palace in Spain. Certain parts of this building were constructed with the rammed earth technique (Jaquin, 2012).

Since **North America** is a region that has received intense migration, the use and spread of earth occurred much later than in other regions. It is estimated that people, especially from China and Europe, knew these techniques and produced the first earthen structures in this region (Jaquin et al., 2008). Easton (2007) suggested that the Spanish

brought the rammed earth technique to Florida in the 16th and 17th centuries (Easton, 2007). In the 1800s and 1900s, the rammed earth technique was applied and became the dominant earth construction technique in the region.

In South America, archaeological excavations prove the existence of settlements made of earth dating back to 2000 BC. Mostly around Peru, traces of earthen buildings have been found, and in general the adobe brick technique was used. In the 18th and 19th centuries, this focus shifted to São Paulo, Brazil, where the rammed earth technique was predominantly used (Schroeder, 2016).

In Australia, there is no information on the use of earthen structures by indigenous people. Similar to America, Europeans who immigrated to this region used the rammed earth technique and built some buildings. Since the 1800s, many earth construction techniques, mainly rammed earth and adobe, have been tried in many places, especially in New Zealand (Jaquin, 2012).

2.2 Earthen Materials and Buildings in Türkiye

Earth material has been utilized through various construction techniques across different geographical regions of Türkiye, as in many parts of the world. Archaeological excavations from prehistoric periods and traditional lifestyles in Anatolia reveal that the predominant building materials in Türkiye's vernacular architecture are stone, earth, and timber. These materials have been applied using various construction techniques depending on the natural resources available in each region. The local communities have processed readily accessible and locally abundant materials to form the fundamental elements of vernacular architecture. Studies based on archaeological sites, traditional buildings, and contemporary examples demonstrate that these materials have been used both independently and in combination.

When the use of earthen materials in Türkiye is considered in the context of geographical regions, it is seen that in all regions, earth is used as a building material in accordance with local building traditions. Therefore, in this section, the use of earth as a building material in Türkiye will be discussed at a regional level within the framework of examples from archaeological sites, its place in traditional building culture, and its current status. In this way, the changing forms of earthen material usage over time and its regional

variations across different geographical areas are revealed. Through the analysis of selected settlements and buildings from each region, the diversity and continuity in the use of earth as a building material within Türkiye's architectural heritage are emphasized.

2.2.1 Use of Earth Materials in Prehistoric Times

The earliest evidence of the use of earth as a building material in Türkiye has been revealed through archaeological excavations. Traces of settlements found in these sites are of great importance in demonstrating how earth was processed using various techniques and utilized as a structural component. This section examines the use of earthen building materials through prominent archaeological sites located in different geographical regions of Türkiye.

The Central Anatolia Region is one of the most prominent areas in terms of archaeological sites. The most important examples of earthen buildings in the region are found in Çatalhöyük and Aşıklı Höyük. These sites are among the earliest settlements in Türkiye where examples of earthen buildings have been identified. (Kafesçioğlu, 2017; Schroeder, 2016). Çatalhöyük, one of the prominent examples in Asia, is dated to 8000–7500 BC. In this settlement, which is located within the borders of Konya province and included in the UNESCO World Heritage List, mudbrick walls were used together with a timber structural system to construct rectangular houses with adjoining roofs. In Aşıklı Höyük, located in Aksaray and dated to approximately 8500 BCE, buildings constructed using wattle and daub and adobe brick techniques have been identified (Kalkan et al., 2020).

Aktopraklık Höyük, one of the archaeological sites in the **Marmara Region,** is an important settlement where remains of earthen buildings were found. This settlement, located in the Nilüfer district of Bursa, dates back to 6350 BCE. In the settlement where the wattle-and-daub system was used extensively, mudbrick walls were preferred in some buildings; flat roofs were covered with rammed earth over wattle-and-daub walls (Karul et al., 2010).

Çayönü Tepesi, located in Diyarbakır-Ergani within the **Southeastern Anatolia Region,** is a significant Neolithic settlement. In this area of approximately 8000 squaremeter, flat-roofed buildings with mud brick walls were built on stone foundations (Özdoğan, 1999). The earthen building samples from this area provide important

information on both the use of vernacular materials in the region and the resistance of these materials to climatic conditions.

One of the prominent archaeological sites **in the Mediterranean** is Hacılar Höyük, located within the borders of Burdur province. It is estimated that the archeological remains in this region, where there are different opinions about its chronological history, date back to the Neolithic Age. The buildings in this stratified area are generally rectangular in plan and similar to Megaron. Although the building material used is not predominantly earth, it is observed that the remains of the walls of some buildings are mudbrick (Umurtak and Duru, 2012; Türkteki, 2021).

Eastern Anatolia is a region where traditional buildings using earth and stone materials are common. One of the most striking archaeological sites in this region is the Aslantepe Höyük in Malatya. This mound was used as a settlement area between 6000 BC and the 11th century AD (Republic of Türkiye Ministry of Culture and Tourism, n.d.). The presence of a mudbrick palace dating to approximately 3300 BC is one of the most unique remains here. Tests revealed that organic additives that increase stabilization were used in the buildings in this area, where adobe block and earth plaster applications were used intensely (Liberotti and Quaresima, 2010).

One of the most famous archaeological sites in the **Aegean Region** is Ulucak Höyük, located within the provincial borders of Izmir. It is estimated that this region was used intermittently from 7500 BC until the Late Roman-Byzantine Age. In the excavations of this mound with many cultural layers, it is possible to mention stone foundations and rectangular mudbrick walls in the 4th layer dating to the Late Neolithic and Early Chalcolithic Periods. The courtyards of these buildings, which usually have two rooms are surrounded by wattle and daub walls (Çilingiroğlu and Abay, 2005).

Although investigations in the **Black Sea Region** are more limited than in other areas, there are still some examples of the use of earth at archaeological sites in this region. The use of mudbrick in landmark buildings such as the Dündartepe Höyük in Samsun and the Kurul Castle in Ordu draws attention. At Dündartepe Höyük, there are traces of mudbrick houses with stone foundations, which are estimated to belong to the Hittite Period. It is known that the upper levels of the magnificent stone city walls in

Kurul Castle were continued to be built with adobe bricks, but it is seen that these have not survived to the present day (Şenyurt and Akçay, 2016; Yılmaz and Gül, 2018).



Figure 2.1 Geographical distribution of prominent archaeological sites in Türkiye where earthen materials and construction techniques were employed.

2.2.2 The Place of Earth Materials in Traditional Building Culture

Traditional building culture in Türkiye presents a construction practice rooted in locally available natural materials. Within this cultural framework, earth has served as a primary building material, especially in rural areas, for centuries. Regional variations in earthen construction techniques have been shaped by factors such as climate conditions, material availability, and local lifestyles. This section examines the role and application of earth materials in traditional buildings across Türkiye's seven geographical regions.

In the **Central Anatolia Region,** the widespread use of earth as a traditional building material is primarily due to its easy accessibility and favorable physical properties for construction. Studies focusing on traditional Anatolian architecture show that, similar to archaeological sites in the region, mudbrick walls are commonly used. One of the most significant examples can be found in the Divriği district of Sivas. In this settlement, residential buildings typically employ a timber load-bearing system, with mudbrick used as an infill material between the wooden framework (Tuztaşı and Çobancaoğlu, 2006).

Cumalıkızık village in Bursa has come into prominent in terms of traditional residential architecture in the **Marmara Region**. These traditional houses, with a history of approximately 700 years and included in the UNESCO World Heritage List, were

designed as two- or three floor buildings. The ground floors were built with stone, while the upper floors were constructed using adobe bricks and timber structural systems (Aktürk, 2021).

When the traditional texture of **Southeastern Anatolia Region** is analyzed, Şanlıurfa Harran Houses, which have a history of approximately 150-200 years, stand out as unique examples of vernacular architecture. These houses, built in accordance with the climatic conditions of the region, draw attention with their domed conical form applied with the overlapping technique. Built with mud bricks, the interior and exterior walls of these houses were coated with earth plaster (Güney, 2022).

One of the prominent places in the vernacular architecture of the **Mediterranean** is the Elmalı district of Antalya. The traditional Anatolian Turkish houses and neighborhood were generally built with stone masonry on the ground floor and 'bağdadi' or adobe brick walls with timber frames on the upper floors in this area. In some buildings, earth plaster was applied, while others were left unplastered. Additionally, the floors of some open or semi-open courtyards were constructed using rammed earth (Oktaç, 2005).

In the **Eastern Anatolia** region, Malatya and Erzincan have the traditional building culture. Looking at the residential buildings in rural settlements such as Yediözönü, Yeşilyurt and Kozluca in Malatya, it is seen that mudbrick is both built as a load-bearing masonry wall and used as an infill material between timber frames (Tuztaşı and Çobancaoğlu, 2006). Another important example in this region was the buildings constructed in Kemaliye, Erzincan. The houses in this region, which are generally built using stone, wood and adobe, have a mixed construction system. While masonry stone walls were used on the ground and basement floors of the buildings built in Kemaliye, adobe infill wall technique was used between the timber frame or 'hımış' on the upper floors (Korkmaz and Akdemir, 2015).

In the **Aegean Region,** the climatic conditions have also affected the vernacular building culture. Stone is mostly used in the coastal areas, while wood and adobe are more common in the inland parts of the region. While the ground floor of most of the buildings in the hinterland is masonry stone, the upper floors consist of infill walls with timber frame structure. In these infill walls, stone, adobe or bricks are used as in the traditional "Hımış" technique (Bayram, 2012). One of the examples that represent this construction

character and preserve its original features until today is the Historical Kula Houses in Manisa (Tanac Zeren and Yılmaz Karaman, 2015).

Considering the climatic conditions and natural resources of the **Black Sea region,** it is understood that the predominant vernacular building material used is timber in this region. The places that stand out in the traditional architectural culture of this region are Amasya-Safranbolu and Samsun-Havza. It is seen that earthen materials are used together with timber in the buildings in these areas. One of the dominant building techniques used in these areas is the "Hımış" technique, in which adobe bricks are used as infill material between a timber frame structures. These walls were sometimes plastered with earthen plaster, and in some buildings this earthen plaster was even applied on the walls covered with small wooden laths known as "Bağdadi" building technique (Tuztaşı and Çobancaoğlu, 2006).

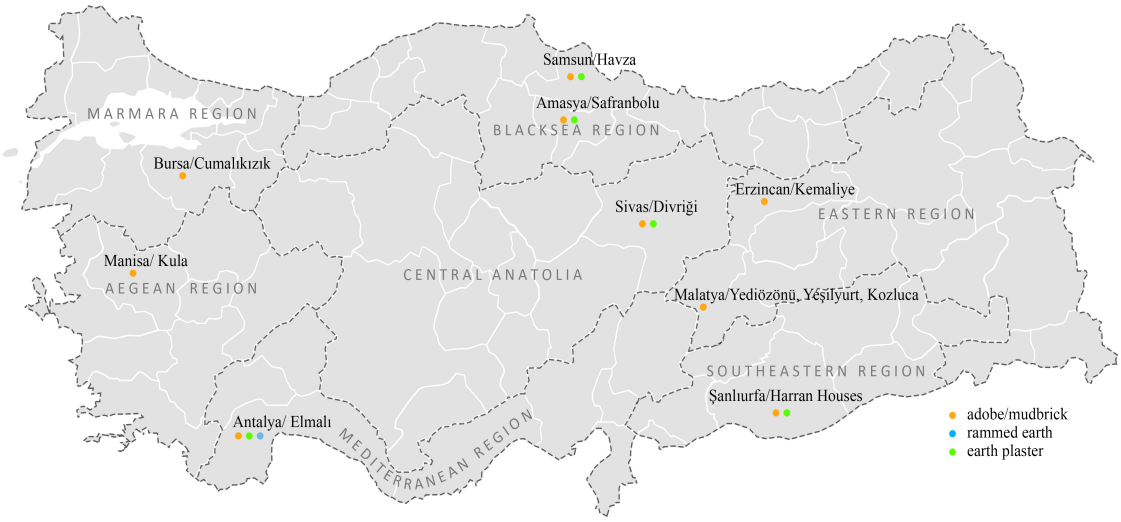


Figure 2.2 Important examples and geographical distribution of earth materials and techniques used in traditional building culture in Türkiye.

2.2.3 Use of Earth Materials in Current/Contemporary Examples

In recent years, interest in earthen building materials has resurged, driven by growing concerns for sustainability, environmental responsibility, and local production. In contemporary architecture and construction practices, both reinterpretations of traditional techniques and innovative integrations with modern technologies can be observed. This section evaluates the current uses of earthen materials and their technical characteristics through selected recent examples from different regions of Türkiye.

When looking at recent examples in **Central Anatolia Region,** the "Sonsuz Şükran Village" in the town of Çavuşlu in Konya seems to feature. Designed as a culture and art village, the buildings are built with timber and adobe. The interior and exterior walls of these buildings, which were constructed using timber for the load-bearing elements and adobe bricks for the walls, are plastered with earth (Yeşilyurt & Köse Doğan, 2022).

One of the recent examples **in Marmara Region** is the "Tezekevleri" project built in Tekirdağ. Located within a farm, this project includes three separately designed and constructed houses, employing diverse earth construction techniques such as light straw clay (slipstraw), adobe (mud bricks), and straw bales. This project also includes wet areas such as WC-bathrooms built with earthbag technique with earth plaster. (Koluba, n.d.).

When we look at the **Southeastern Anatolia Region**, modern building examples using the rammed earth technique are encountered. One of these is the "Şanlıurfa Göbeklitepe Visitor Center." Although the structure is built using reinforced concrete and steel, both its interior and exterior walls were constructed using the rammed earth technique (Volkan & Yıldız, 2018). In this context, another notable example is the "Toprak Oda" a residential building constructed with compressed earth blocks, which is the result of the reinterpretation of traditional adobe brick construction techniques with modern construction methods. The compressed earth blocks used in the construction were produced through the recycling of excavated soil, representing an environmentally conscious approach to material use. Moreover, the vault design built with this material is significant in demonstrating the aesthetic and engineering potential of compressed earth blocks (Arkiv, n.d.).

One of the recent examples of earthen buildings in **Mediterranean** is "Eko-Döşemeci House" in Döşemealtı District of Antalya. In this building, where ecological architecture principles are adopted, the load-bearing system was constructed using wooden frame and the mud brick was used as the infill material in the walls, which can be considered an example of the "Hımış" technique (Natural Building Materials and Methods Association, n.d.).

One of the current examples in the **Eastern Anatolia** region is the earthen structure called the "Anadolu Meleği Women's Education and Production Center" in Elazığ Keban, which has been operating since 2019. This building was built with local craftsmen

using the rammed earth technique. The load-bearing rammed earth walls were covered with a timber terrace roof and completed with a green roof application (Yardımlı, 2021).

One of the most remarkable examples of recent earthen buildings in the **Aegean Region** is the "Kadıovacık Biohouse" in Urla - Izmir, which is used as the Institute of Building Biology and Ecology. Many natural building materials and techniques were used in this building, some parts of which consist of mud brick infill walls between timber frames (Itez, 2020).

As a result of the research conducted on the earthen building examples in recent history, no building constructed with earth was found in **Black Sea Region.**



Figure 2.3 Map showing the regional distribution of contemporary/recent architectural examples in Türkiye that involve the use of earthen materials.

2.3 Earthen Building Techniques in Türkiye

With the increasing importance of ecological design and sustainable architectural approaches today, earth -an environmentally friendly material- plays a vital role in the construction of sustainable cities. Earth, which consists of organic matter, clay, silt, sand, and gravel, is a readily available and fully recyclable material (Kafesçioğlu, 2017; Minke, 2006). One of the most remarkable features of earth as a building material is its ability to be processed manually without the need for industrial procedures. This characteristic significantly reduces energy consumption and waste generation during the production phase, thereby contributing to the minimization of environmental impacts (Acun Özgünler & Gürdal, 2012). Furthermore, owing to its high thermal mass, earth passively

enhances indoor comfort by reducing the demand for artificial heating and ventilation systems (Carrobé et al., 2021). With these attributes, earth presents a strong potential not only for rural structures but also for the construction of recycable urban built environments with identity. Therefore, earth and its associated vernacular or contemporary construction techniques should be regarded as significant alternatives in material selection for both rural and urban contexts.

It is clearly understood from the ancient city remains and vernacular Anatolian building examples that earthen material is widely used in Türkiye. Not only the use of earth as a building material, but also the techniques with which this material is used requires another way of understanding this material. The regional research conducted within the scope of this thesis shows that different earth construction techniques are applied in each geographical region of Türkiye depending on local conditions, cultural and climatic factors. Therefore, in this chapter, the earth building techniques used in Türkiye, which are rammed earth, adobe/mudbrick, compressed earth block, earthbag, light straw clay/slip straw, wattle and daub and earth plastering/rendering, are discussed within the framework of their historical background, mixture properties, construction stages, where they are used in the buildings, their distinct advantages and disadvantages and innovative applications.

2.3.1 Rammed Earth

The history of rammed earth techniques dates back to 5000 BCE, and it is known that this method was used by the Assyrians in foundation construction. Over time, the technique spread to various regions and was adopted as a vernacular construction method in some areas (Minke, 2006).

Rammed earth construction technique is based on the principle of mixing building earth with aggregates, gravel, and sand in specific proportions, moistening the mixture with a small amount of water, and then compacting it in layers within formworks. To improve stabilization, binding materials such as lime or cement are occasionally added to the mix. The formworks are typically made of wood or steel. During construction, the mixture is placed into the formwork layer by layer rather than all at once. Each layer is compacted individually, and this process is repeated until the formwork is fully filled. Once the formwork is removed, the resulting form constitutes the basic geometry of the building (Niroumand et al., 2021), (Figure 2.1).



Figure 2.4 Göbeklitepe Visitor Center in Şanlıurfa. (taken by İ.B. Şen, 2025).

Rammed earth walls can either be used directly after the formwork is removed or optionally treated with protective coatings such as wax to shield them from external factors. While this method is predominantly used for wall construction, rammed earth has also been applied in flooring and roofing. Various prefabrication works are being carried out in order to offer an alternative to traditional on-site construction methods and to integrate this technique with contemporary technologies. This prefabrication method, which is realized by assembling factory-produced rammed earth blocks on site, not only reduces construction time and costs, but also demonstrates that earthen structures can be integrated with innovative approaches (Jörchel, 2019).

2.3.2 Adobe/ Mud Brick

Adobe or mud brick is produced by mixing earth with a suitable clay content with a certain amount of straw and water. Since the properties of earth vary from region to region, the proportions of the materials added to the mixture also differ. The prepared mixture is usually poured into wooden formworks to form bricks, then removed from the formwork and allowed to dry in the sun on all surfaces. Once all surfaces are fully dried, the mud bricks become ready for use. Although these bricks are produced in various sizes according to the needs of different regions, two standardized sizes are widely used in Türkiye. The dimensions of adobe bricks, called “Ana” and “Kuzu” in Anatolia and defined in the “TS 2514 Adobe Blocks and Construction Rules” standard published by the Turkish Standards Institute, are as follows: if the “Ana (mother)” brick measures 12×30×40 cm, the “Kuzu (lamb)” brick measures 12×19×40 cm; if the Ana brick is

12×25×30 cm, the Kuzu brick is 12×18×30 cm (Çavuş et al., 2015). These bricks are primarily used in wall construction, but also appear in roofing such as arches, vaults, and domes.



Figure 2.5 A mudbrick house in Kahramanmaraş (SDMIM, 2015).

Adobe offers several advantages: it is easy to obtain, can be produced manually without machinery, maintains thermal and humidity balance for extended periods, and thanks to its high thermal mass, it helps regulate indoor temperature against external conditions (Austin, 1984). However, it also has some disadvantages. For example, its low compressive strength makes it necessary to use it in accordance with structural criteria, especially in earthquake zones. Another disadvantage is that mud bricks have low resistance to water and moisture. Two basic methods are used to overcome this: The first method involves protecting the exterior surfaces of mud bricks with materials such as plaster or paint and positioning the bricks above ground level. Therefore, in adobe buildings, the foundation and ground floor walls are generally constructed with stone, while the upper sections are built with adobe bricks. The second method aims to stabilize the adobe mixture by adding various binders. These binders include gypsum, cement, lime, and asphalt, and in this way, the weaknesses of adobe bricks are eliminated (Austin, 1984; Değirmenci, 2005).

The most commonly used materials for stabilization in adobe mixtures are gypsum and lime. Ruhi Kafesçioğlu, a pioneer in this field, conducted stabilization studies in the earth structure laboratory he established at Istanbul Technical University and developed a special mixture known as “alker” in the literature (Kafesçioğlu, 2016). Kafesçioğlu

(2016) defines alker as an improved earth mixture produced by adding specific proportions of gypsum, lime, and water to clay-rich earth.

The mud bricks produced are used in two different ways as masonry and infill material according to their intended use in the building. The mud bricks used as part of masonry system is one of the most widely used and oldest construction techniques in Anatolia. In this system, no additional structural elements are employed; walls are built directly with mud bricks and function as load-bearing components. It has been widely applied in single floor, flat roofed traditional dwellings. Timber bond beams (hatıl) placed between adobe walls have been widely used, as they help distribute vertical loads. Both plastered and unplastered examples of these masonry walls exist (Yalçın et al., 2022).

A different application is the timber frame with adobe infill system, where the load-bearing structure is made of timber, and mudbricks are used only as infill material. In this technique, known as “Hımış” in Anatolia, the building is constructed with a timber frame system, and the walls are filled with materials such as adobe and stone. These buildings are usually two or three stories tall and are constructed on masonry foundations. In this system, loads are not transferred to the main walls; the load-bearing function is undertaken by the timber frame. Due to the lighter structure and reduced load, this system is considered more durable than masonry adobe systems. The infill walls can be used either plastered or unplastered (Yalçın et al., 2022).



Figure 2.6 A house built with Hımış technique in Elmalı, Antalya (taken by B.Metin, 2025).

2.3.3 Compressed Earth Block (CEB)

Compressed Earth Block (CEB) is a construction material produced by pouring an earth mixture into formworks of specific dimensions and compressing it under high pressure using manual or mechanical methods. This method, which is considered a modern interpretation of the traditional adobe brick technique, became widespread thanks to the compression device known as “Cinva-Ram” developed by Colombian engineer Raul Ramirez in 1952. The portability and ease of use of this device enabled more practical and widespread production of these blocks (Guillaud, 1995; Rael, 2009).

The basic mixture used in CEB production typically consists of clay-rich earth, aggregate, and sand in specific proportions. However, in many applications, stabilizing agents such as portland cement, lime, or fly ash- up to 15% by volume- are added to enhance the strength of the mixture. After the dry mix is homogenized with the stabilizers, water is gradually added to achieve the desired moisture content. The resulting humid mixture is poured into formworks and compressed under high pressure using manual pressing devices or hydraulic machines. As a result of this process, dense and durable earth blocks are obtained. The blocks are cured in the shade to gain strength, as rapid drying under direct sunlight may adversely affect their mechanical performance (Kamal, 2023; Sitton et al., 2018).

Compressed earth blocks have significant advantages in terms of the diversity of their usage areas. Depending on the climatic conditions of the region where the building is located and the mixture content, the blocks can be used plastered or unplastered. They can be applied directly as a load-bearing element in masonry wall construction or as infill material in walls supported by different structural systems (Rael, 2009). One of the most notable advantages of these blocks is their high thermal performance. Thanks to their mass properties, they help to stabilize the indoor temperature by storing heat. Moreover, since they can be produced in various forms and shapes, they offer considerable design flexibility. They can be used primarily in wall construction, but also in roof systems such as arches, vaults and domes. By changing the arrangement of the blocks, it is also possible to create aesthetic and decorative façade designs (Holliday, 2016).



Figure 2.7 Toprak Oda in Şanlıurfa (Arkiv,n.d.).

2.3.4 Earthbag

Earthbag construction technique was first implemented by Iranian architect Nader Khalili. In this technique, natural materials such as earth, gravel, and clay, mixed in certain proportions, are filled into bags, usually made of jute. The mixture is lightly compressed to remove the air and increase its formability. The filled bags are stacked on top of each other to form walls. After each row of bags is completed, barbed wire is placed between the horizontal layers to create a mechanical bond between the top and bottom rows and reduce the risk of slippage between layers. This process is repeated until the form of the structure is completed. Once construction is finished, the surface is usually coated with lime-based plasters to protect the building from moisture and water (Hunter & Kiffmeyer, 2004).

The “Superadobe” method, a technique derived from the Earthbag system, is based on similar principles but differs in certain construction details. The most obvious difference is that the bags used in the “Superadobe” technique are longer and continuous. These long bags can be placed continuously according to the building form, which reduces the number of joints in the construction process and provides a more holistic building structure. While Superadobe, like Earthbag, is used in the construction of load-bearing walls, it is particularly preferred for the creation of curved forms such as domes and arches (Hart, 2018).



Figure 2.8 Superadobe Children Library in Kahramanmaraş (HİM,n.d.).

One of the most notable advantages of the Earthbag and Superadobe techniques is their low cost. The fact that they can be produced with local resources and do not require advanced technology has enabled these methods to be used especially in underdeveloped countries, such as Africa and South America, to meet the need for shelter. Moreover, the limited need for building materials and the relative simplicity of the construction steps make this technique suitable for post-disaster emergency buildings. In addition, the relative newness of this method and the lack of an internationally recognized construction

standard are important challenges to the widespread adoption of the Earthbag construction technique (Canadell et al., 2016).

2.3.5 Light Straw Clay/ Slipstraw

The Light Straw Clay (LSC) technique is derived from vernacular construction methods originating in Europe and Asia and became widespread particularly in several European countries -espacially Germany and Austria- following World War II. This method is considered a modernized version of the “wattle and daub” system, which dates back to the 12th century, and it also shares methodological similarities with rammed earth techniques (Doleman, 2017).

The primary component of the LSC construction method is straw, and the mixture is produced by combining clay-rich earth, water, and straw in specific proportions. This mixture is homogenized using small-scale mixers or hand tools until a slightly wet, fibrous consistency is achieved. During the construction process, a structural framework -typically made of wood- is first assembled. Temporary molds are then prepared with plywood, OSB (oriented strand board) or similar sheet materials for the wall application. The prepared light straw-clay mixture is packed into these formworks layer by layer and lightly tamped using manual tools similar to tampers. At this stage, care is taken to ensure that there are no gaps and that the compaction is smooth. Once the forms are completely filled, the mixture is left to dry. After sufficient drying, the formwork is removed, revealing the finished wall surface (Baker-Laporte & Laporte, 2015).

This technique is widely used in wall filling application. Clay or lime-based plasters, natural paints, or different coating systems were used to make the completed LSC walls resistant to environmental influences. One of the most distinctive advantages of this technique is its high straw content, which significantly reduces the building load while also enhancing the thermal performance of the material. Its low density contributes positively to energy efficiency. However, the method also has some disadvantages, the most important of which is the long drying process. Although this can directly affect time management during the construction process, it is relatively acceptable compared to other natural infill techniques. (Doleman, 2017).



Figure 2.9 A slipstraw wall construction in Tekirdağ (Koluba, n.d.).

2.3.6 Wattle and Daub

Wattle and Daub technique is classified as a wall infill and plastering method, and can be described, in its simplest form, as an earthen plaster system applied to a woven branch framework. Terminologically, “wattle” refers to the woven framework made from branches or twigs, while “daub” refers to the earth plaster applied over this framework. In this technique, the main structural system of the building typically consists of a timber frame. When necessary, thinner wooden elements are placed vertically or horizontally within this frame. The intermediate elements, such as thin branches, shrubs, or bamboo reeds, are interconnected to form a tight woven structure. The gaps in this woven system are filled and plastered with a clay-rich earth mixture. While in some applications natural infill materials like straw, moss, or leaves are added to these gaps, it is more common to fill them with the earth mixture as it ensures a smoother surface (Graham, 2008).

Archaeological findings reveal that this technique dates back to the Iron Age. It was widely used in European countries such as Germany, France, England and Bulgaria, especially in the 19th century. In Türkiye, this technique is known as the “Bağdadi” wall

system and has been frequently preferred in traditional housing construction and civil architecture examples since the Ottoman period. The “Bağdadi” system involves placing small wooden slats on both sides of the gaps between the primary supports and applying a clay-based earth plaster over these slats. The plaster adheres to the surface by passing between the slats and a continuous coating is obtained along the entire facade (Tuztaşı and Çobancaoğlu, 2006; Graham, 2008).



Figure 2.10 Bağdadi wall in Tekirdağ (Koluba, n.d.).

The buildings constructed using this method have a lightweight structure, which provides an advantage in terms of earthquake resistance. The materials used can be easily sourced locally, and the simplicity of the application steps makes this technique economical and accessible. However, the correct application of the plaster layer is crucial during the construction process. If the plaster is not applied smoothly and homogeneously to the surface, cracks may develop over time, weakening the building’s resistance to moisture. This, in turn, can negatively impact the overall durability of the structure (Volhard, 2016).

2.3.7 Plaster and Rendering

One of the weakest aspects of earthen buildings is that they require constant maintenance and are sensitive to water. To prevent damage from rainfall, using wide eaves on the roof systems and protecting wall surfaces from direct exposure to rain are key strategies for preserving these buildings. In this context, the earth plaster technique is widely used to increase the surface durability of earthen buildings. The main components of the plaster mixture used in this technique are clay, silt, sand, and earth. An effective plaster mixture must contain at least 10–20% clay, with the silt content not exceeding 25% of the clay content. Natural and artificial additives are frequently added to improve the performance of the mixture. Straw, the most common natural additive, gives the plaster a fibrous structure and plays a crucial role in preventing the formation of cracks. Additionally, artificial additives such as cement, lime, and gypsum are used to enhance the plaster's resistance to moisture and strengthen the binding properties of the earth (Weismann & Bryce, 2015).



Figure 2.11 Sonsuz Şükran Köyü in Konya (taken by S.Konyalı).

The proportions of clay and sand in the plaster mixture have a determining impact on its final performance. Clay provides binding properties to the plaster, while sand acts as a balancing element, especially in preventing cracks that may form during the drying

process. The harmony between these two components optimizes both the mechanical strength and elasticity of the plaster. The prepared plaster mixture is applied to the surface of the building using a trowel or by hand, and the process is repeated until a smooth finish is achieved. This application method not only preserves the aesthetic integrity of earth buildings but also improves their water resistance, extending the life of the building (Stazi et al., 2016).

Chapter 3

Building Production in Türkiye

Building production has a holistic structure that encompasses many sub-processes, from the emergence of the construction need to the completion and readiness for use. This structure is defined by the stages of the building life cycle. These stages are defined as the design, construction, use, and demolition processes (Spišáková et al., 2022). The first two of these stages represent the production process. In this study, building production is defined based on the first two stages of the building life cycle: the design and construction processes. However, since the implementation of these stages depends on obtaining various official permits, the approval process is also considered an integral part of the production process. Accordingly, this thesis examines the building production process in Türkiye under three main headings: design, approval, and construction.

The **design process** is defined as the period from the initiation of a project until the building is completed and ready for construction (Broadbent, 1969). Yazıcıoğlu (2007) describes the design process as the project-making phase in which the building is planned according to its functions and prepared in the form of drawings. In the architectural design process, the act of designing aims to spatialize the intended activities within the building and transform them into a project (Kıran & Polatoğlu, 2006). The Chamber of Architects, a member of the Union of Chambers of Turkish Engineers and Architects (TMMOB), defines the stages of the design process as preparation and research; preliminary and final design studies, application project; preparation of system, assembly, and manufacturing details; and the preparation of technical specifications, quantity surveys, estimates, and cost analyses (TMMOB Chamber of Architects, 2011).

The **approval process** is central to both the design and construction stages. For a building to be realized, the designed project must be constructed in accordance with the existing regulations. The compliance of buildings to be constructed with the current Building Law and regulations is certified by a building permit issued by the relevant

authorities (Building Law, 1985). Apart from certain exceptional cases within the scope of the Building Law, a building permit is required for all buildings. A building permit is a document issued by the relevant administration upon approval of projects for a parcel, along with the documents required by the "Zoning Regulation" (Planned Areas Zoning Regulation, 2017). During the approval process, the designer is expected to prepare a design for the existing site that complies with the zoning plan and the applicable regulations and legislation. Design approval by the relevant authority and receipt of a building permit are directly linked to the design's compliance with legal regulations (Planned Areas Zoning Regulation, 2017).

The **construction process** is defined as the process that begins with the transportation of materials to the construction site and continues until the assembly of these materials, and it continues until the building is completed and ready for use (Birgisdottir and Rasmussen, 2016). The building construction process also has its own sub-stages. Riley and Cotgrave (2018) define these stages for residential buildings as site preparation, building infrastructure services, and building superstructure works. Preparing the land for construction includes clearing vegetation, demolishing any existing buildings or structures on the site, and installing the necessary infrastructure (sewage, drainage, etc.) and utilities for the construction site. Building infrastructure services include preparing the ground in accordance with the ground survey report, excavation work, and foundation work. The final sub-stage, building superstructure works, also includes the construction of load-bearing walls above the foundation, partition walls, flooring and roofing applications, stairs, and door and window installation stages (Seeley, 1986). After the completion of these stages, the relevant institution conducts inspections at the construction site and, if it decides that the building has been constructed in accordance with the project, prepares the occupancy permit. With the issuance of this certificate, which indicates that the building is suitable for use, the building's use phase begins, and the building's construction phase ends (Kaya, 2008).

Although these processes follow a general operating principle, their implementation varies significantly depending on the ownership status of the building. In particular, approval processes differ between "privately owned buildings" and "publicly owned buildings". For this reason, this section is divided into two subsections. The steps of each process are visualized with flowcharts (See Appendix B1 and Appendix B2).

3.1 Building Production Process in Buildings with Private Ownership

Private ownership can be defined as the legal entitlement that allows individuals to possess and exercise control over movable and immovable assets (Economics Dictionary, n.d.). In other words, it is the ownership right granted to natural and legal persons, excluding the state and public legal entities. Private ownership buildings refer to structures built on land owned by any natural or legal person, granting them the right to use and benefit from the property (Economics Dictionary, n.d.).

The production process for privately owned buildings usually begins with an application from the employer. In the initial phase, documents such as the title deed, zoning status, and site plan are collected; site visits and reviews of relevant institutional archives are conducted to analyze the current situation. Based on this data, the architect or design team creates a requirements program and conducts preliminary design studies, taking into account the employer's expectations. Once the employer approves the proposal, it is converted into a preliminary architectural project (TMMOB Chamber of Architects, 2011). The preliminary project is submitted to the relevant institution. If the project is approved by the control departments, the process continues with the preparation of construction project (including structural, mechanical, electrical, landscaping, etc. drawings) and technical reports. If approval is not granted, the designer makes the necessary revisions and resubmits the project. This stage is repeated until the preliminary project is approved. Once the preliminary project is approved, the prepared construction drawings are subject to inspection. The inspection process varies depending on the location and size of the building:

- In cities, a building inspection company is appointed for buildings subject to the Planned Areas Zoning Regulations and larger than 200 m²; for smaller buildings, a separate technical responsible person is appointed for each project prepared by different disciplines (architectural, structural, mechanical, electrical, etc.). (Construction Inspection Law, 2001).
- In rural areas, a building inspection company is appointed for buildings that are subjected to the Unplanned Areas Zoning Regulations and larger than 500 m²;

otherwise, technical responsible persons are appointed (Construction Inspection Law, 2001).

After the inspection process is completed by building inspection companies or technical responsible persons, the necessary documents and all prepared construction drawings are submitted to the relevant institution. The relevant institution also checks all projects and documents. If the projects and documents are complete, the projects are approved, and a building permit is issued along with the necessary documents (Planned Areas Zoning Regulation, 2017). If approval is not granted, revisions are made and the process continues until all projects are approved.

Obtaining a building permit means that field work can begin. The construction phase begins with the procurement of materials and labor and the preparation of the construction site. During construction, building inspection companies or technical responsible persons inspect whether the construction is being carried out in accordance with the projects. When construction is completed, the relevant institution checks that the constructed building complies with all projects and applicable regulations. If it is found to be appropriate, a building occupancy permit is issued, completing the building production process (Planned Areas Zoning Regulation, 2017).

The overall functioning of these steps is modeled in a flow chart (See Appendix B1).

3.2 Building Production Process in Buildings with Public Ownership

Public ownership can be defined as the state's control and possession of social and industrial resources for public benefit (Economics Dictionary, n.d.). Publicly owned structures are those built on land owned by the state, granting the public the right to use and benefit from them.

In public owned projects, the production process generally follows the steps taken in privately owned buildings up to the preliminary project review. However, it differs in terms of the stage of obtaining the building permit. In public buildings, the permit is granted before the construction drawings are completed, once the preliminary project is

approved. This directly affects the progress of the process, allowing the construction drawings and the tender process to be carried out after the permit is obtained (Planned Areas Zoning Regulation, 2017).

After the permit is obtained, the construction drawings (structural, installation, ground survey, landscaping, etc.) are prepared and reviewed by the relevant institution. The process proceeds upon approval; if not approved, revisions are made and the project is resubmitted. In this respect, the approval mechanism is similar to that for privately owned buildings (Planned Areas Zoning Regulation, 2017).

Another important difference in public buildings is the stage of determining the technical responsible persons. While building inspection companies or independent technical responsible persons can be appointed in privately owned buildings, in public buildings, the responsibility is mostly assumed by technical responsible persons selected from within the institution. These persons are responsible for the exact implementation of all drawn projects (architectural, structural, electrical, etc.). However, it is also possible to purchase services from outside if necessary. After the approval process, two methods can be followed to undertake the construction work:

- Tender method: A tender file is prepared, and a contractor is selected under the Public Procurement Law No. 4734 (Public Procurement Law, 2002).
- Direct supply method: Within certain limits, the work is undertaken directly by the relevant institution or individuals (Public Procurement Law, 2002).

The construction process begins with material and equipment procurement, labor organization, and infrastructure preparation, as in private property. Then, all construction work is carried out in accordance with the construction drawings. Upon completion of construction, the relevant institution inspects the project for compliance with the regulations. If compliance is ensured, the process is finalized by issuing an occupancy permit.

All steps followed in public property are modeled in a flowchart. (See Appendix B2).

Chapter 4

Examination of Earthen Building Production in Türkiye

This chapter will examine the production process of earthen buildings constructed in Türkiye after 2010 that have completed the approval process under two subtitles. The first subtitle presents the methodological framework of the study and explains in detail the data collection strategies, sampling and research approach. In the second subtitle, the data analysis process and the findings are presented.

4.1 Case Study Design

This section provides an overview of the research methods employed in this study. It summarizes the criteria for selecting the sample groups included in the research, outlines the boundaries of the study, and explains the data collection tools utilized. Additionally, it presents the data analysis methodology, offering insights into how the data will be processed and interpreted.

4.1.1 Tools and Limitations

This study examines buildings constructed in Türkiye after 2010 using any earth building technique and aims to systematically define the design, approval, and construction processes of these buildings. The reason for the focus on buildings constructed after 2010 is that the last earthen building standards in force were repealed at that time and their mandatory enforcement was cancelled (Turkish Standards Institute, 1977; Turkish Standards Institute, 1985). Of these buildings, only those that have completed the legal approval process are included in the thesis.

In Türkiye, the building production process is legally based on these two types of property ownership: Privately owned buildings production process and publicly owned buildings production process. The reason for dividing the study into privately owned and publicly owned buildings is that conventional building production processes differ between these two types of ownership. Therefore, the thesis covers the production processes of earth buildings constructed on public and private sites.

This study requires qualitative data collection, since it focuses on the characteristics of the design, approval and construction processes of earthen buildings. Qualitative data are obtained through primary or secondary data sources. Since access to detailed information on earthwork production processes from secondary sources is limited, the research focuses on primary data sources. Verbal data, one of the primary data sources, is typically collected through survey and interview methods (Aydın, 2022). Surveys are mostly preferred in obtaining generally accepted information and in studies where large sample groups need to be reached This study is based on a limited number of examples of earthen buildings constructed after 2010 that have completed approval processes in Türkiye. Due to the small sample size and the need for in-depth and qualitative information, the survey method was not deemed appropriate. For these reasons, in-depth interview technique, one of the verbal data collection methods, was preferred.

In-depth interview is frequently used to explore individual or institutional experiences. It allows to obtain qualified and detailed information from a small number of participants (Showkat & Parveen, 2017). In-depth interview questions can be applied in three different formats: structured, semi-structured and unstructured, and there are also hybrid applications in the literature where these formats are used together. Semi-structured technique is applied in interviews where participants can respond freely, and the researcher can ask deepening questions based on the responses (Morse, 2012). One of the most important elements in this method is the quality of the interview questions. It is of great importance to prepare the questions in a way that is open, answerable, non-leading and allows for detailed narration. In addition, the questions should be of a quality that cannot be passed over with short answers such as “yes” or “no” (Kvale, 1996). Due to these characteristics, the interview questions in this project were designed to be semi-structured. The questions were designed distinctively for each stakeholder group (designers/design teams, approval authorities and construction teams) involved in each stage of the earthen building production process (See Appendix A). In addition, since the

thesis aims to reveal the differences of the earthen building production process from conventional building production processes and to develop a production process model accordingly, the interview questions were prepared with reference to the stages of the conventional building production processes (See Appendix B).

After the design of the interview questions was finalized, pilot interviews were conducted with the stakeholders; through these interviews, feedback on the clarity of the questions, interview flow and duration was evaluated, and the questions were finalized by making the necessary revisions.

4.1.2 Determination of the Samples

This study required information on earth building that was built in Türkiye after 2010. To obtain these data, research was conducted on various associations, research groups, and institutes in Türkiye that are contributing to this fields voluntarily:

- Institute of Building Biology and Ecology (n.d.)
- Natural Building Materials and Methods Association (n.d.)
- Adobe Academy (n.d.)
- Modern Earthen Buildings Design and Research Center (n.d.)

The information shared by these organizations on their websites and social media accounts was examined; the completed earthen buildings in Türkiye were identified and the sampling population of the project was determined accordingly. Then, these samples, classified as public and private buildings, were categorized according to location, year of construction, construction technique, approval authority, designer and application team.

After this research, a total of 34 earth buildings were identified across six regions of Türkiye (See Figure 4.1). It was found that nine of these buildings were constructed on public land, while the other twenty-five were built on privately owned land. Then, the process of selecting samples from this created population was started and sampling techniques were examined.

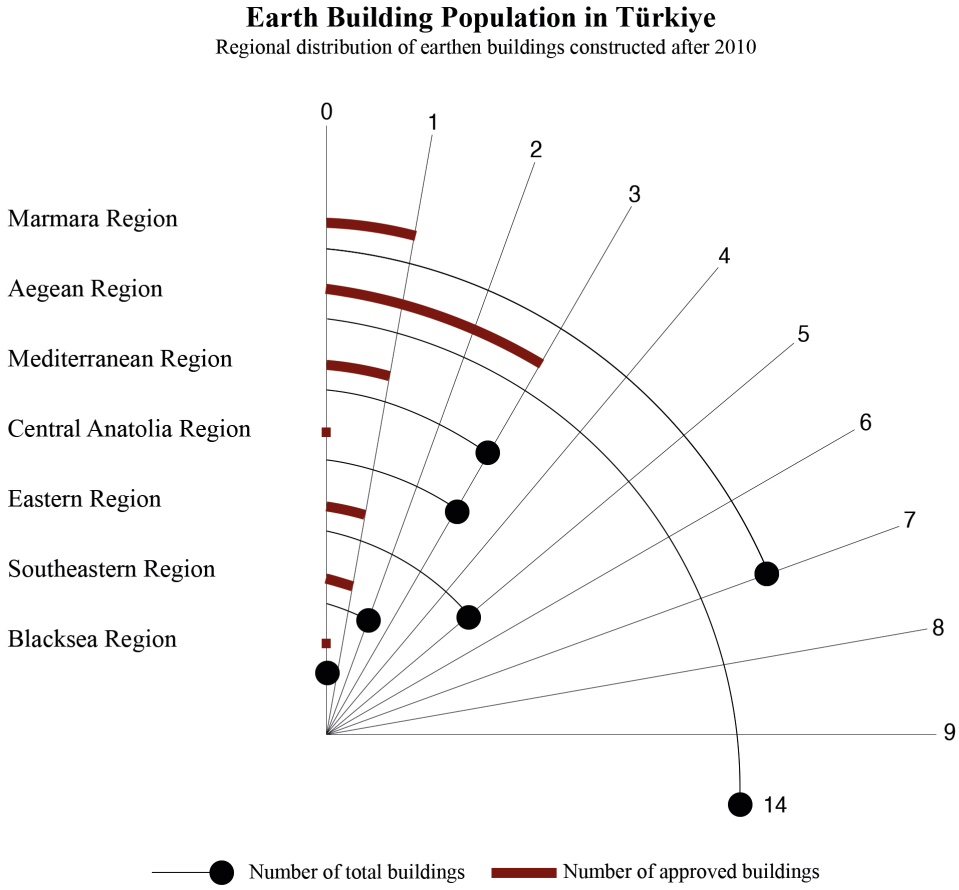


Figure 4.12 Regional distribution of earthen buildings constructed after 2010 in Türkiye.

Sampling techniques in qualitative and quantitative research are divided into two main groups: probability sampling and non-probability sampling (Pace, 2021). In this project, one of the non-probability sampling types was preferred, which is defined as "convenience sampling" or "random sampling" in the literature (Pandey & Pandey, 2015). Convenience sampling is based on the researcher selecting the samples that are the easiest to access from the population (Roy, 2020). This method was preferred because it is the fastest and most practical way to reach the first data on the subject. In the process of conducting the interviews, after obtaining the ethical committee approval for the study, (This approval was received by the Abdullah Gül University Ethics Committee on November 11, 2024, with decision number E-23934413-050.04-107625),the designers of the buildings included in the earth buildings list were contacted and requested to participate in an interview. The participants who responded positively to this request and confirmed that the buildings had completed the approval process formed the sample group for this project based on the convenience sampling process. This sample group consists

of a total of seven buildings, four of which are privately owned and three of which are built on publicly owned property. Detailed information about the sample group is provided in the table below:

Table 4.1 Sampling group information

Building Code	Ownership Status	Year of Construction	Earth Construction Techniques	Building Type	Location
1	Private	2023	• Adobe Wall (Hımış) • Clay Plaster	House	Mediterranean Region
2	Private	2019	• Adobe Wall (Hımış) • Clay Plaster	House	Aegean Region
3	Private	2020	• Adobe Wall (Hımış) • Clay Plaster	House	Aegean Region
4	Public	2022	• Rammed Earth Wall	Entrance Building	Aegean Region
5	Private	2022	• Rammed Earth Wall	Seed Room	Marmara Region
6	Public	2018	• Adobe Wall • Earth Plaster	Mixed Use	Eastern Region
7	Public	2019	• Rammed Earth Wall	Visitor Center	Southeastern Region

4.1.3 Collection and Analysis of Data

In order to answer the research questions of this project, data specific to earthen buildings were identified with reference to the stages of a conventional building

production process, particularly in terms of design, approval, and construction. Within this scope,

The required data related to the design process include:

- Official documents and information regarding the site
- Employer expectations
- How the choice of materials shaped the design
- Legislation and regulations consulted during the design phase
- Duration of the design process

The required data related to the approval process include:

- Information about the approving institution
- The expectations of the institution from the designer
- Stakeholders involved with the institution
- On the basis of which regulations and legislations the approving body carries out the control process
- Duration of the formal approval process

The required data related to the construction process include:

- Procurement of materials
- Procurement of equipment
- Master-worker supply
- Where and for what purpose earth materials is used in the building
- Duration of the construction process

Within the scope of the thesis, verbal data obtained through in-depth interviews from various stakeholders regarding different stages of earthen building production were analyzed by using the thematic analysis method. Although content analysis and thematic analysis are commonly used methods for analyzing verbal data, thematic analysis was preferred since the research was process-oriented and experience-based. Ten themes were identified for the design process, and seven themes each for the approval and construction processes. First, the responses provided by all stakeholders were categorized according to the specified themes. Subsequently, general assessments were made based on similar patterns in these responses, and improvement suggestions were made for the process in

line with the findings from the design, approval, and construction phases. This study has provided a roadmap for those who want to design and build earth buildings.

4.2 Finding and Discussions

This section presents the findings of the in-depth interviews conducted with the stakeholders in the sample group and places these findings in a holistic analysis framework by evaluating them with a thematic approach.

The research aims to reveal experiences related to the design, approval, and construction processes of earthen buildings constructed in Türkiye and to analyze these processes in detail. Interviews were conducted regarding the design, approval, and construction processes of a total of seven approved buildings. The design team representatives for two of the seven buildings on the sampling list (Building-6 and Building-7) and the approving authority representative for one building (Building-5) could not be reached. Therefore, while the design process evaluations covered five buildings, the approval process evaluations were conducted for six buildings. The construction process evaluations, on the other hand, were conducted based on data obtained from all buildings in the sampling list (See Table 4.2).

Table 4.2 Interview condition and interviewee specification according to building code.

Building Code	Design		Approval		Construction	
	Interview Condition	Interviewe	Interview Condition	Interviewe	Interview Condition	Interviewe
1	✓	I-1	✓	I-2	✓	I-1
2	✓	I-3, I-4	✓	I-5	✓	I-3
3	✓	I-3	✓	I-6	✓	I-3
4	✓	I-7	✓	I-8	✓	I-7
5	✓	I-9	✗	-	✓	I-7
6	✗	-	✓	I-10	✓	I-10
7	✗	-	✓	I-11	✓	I-12

Architect: I-1, I-2, I-5, I-6, I-9, I-10.
Designer: I-3, I-7.
Interior Architect: I-9.
Engineer: I-12.
Landscape Designer: I-8.
Archeologist: I-11.
Employer/Owner: I-1, I-4, I-9.

4.2.1 Evaluation of Earthen Buildings Design Process

In this section, responses gathered from design team representatives were evaluated. Participants were asked the interview questions (See Appendix A1), and a theme was identified for each question. Based on these themes, the responses of the designers were compiled, and an evaluation was made.

During the interviews related to the design process, data was collected on a total of five buildings. While interviews were conducted with the design team representative for four of these five buildings, interviews were conducted with both the design team

representative and the employer for one building. Since the designers of Building-2 and Building-3 were the same, some responses to certain themes were shared. Additionally, no information could be obtained about Buildings-6 and Building-7 because the design team representatives could not be reached (See Table 4.2). The themes identified for the questions directed to the design team representative and the interview evaluations are detailed below:

The "employer profile (T1A)" and "employer requirements (T1B)" themes were aimed at determining the level of knowledge of the employers about the earth material. In addition, it was investigated whether the employers are the ones who consciously demand this material or the ones who have the buildings constructed with the guidance of the designers. The responses of the **"Employer Profile (T1A)"** theme are provided below (See Appendix C.1):

- In the interview about Building-1, it was learned that the employer was the designer him/herself and his/her family. This model presents a project model where the user is also the decision maker, in other words, the responsibilities of design, ownership and construction are gathered in one hand.

- The interview regarding Building-2 and Building-3, employers are upper-middle income group individuals with high environmental awareness. Interviewee (I-3) stated that this group had already been informed about the use of natural materials and healthy living spaces, and that they applied to the projects with this motivation. This profile points to a user group that spontaneously creates demand for natural building materials.

- During the interview about Building-4, it was informed that the employer was a public institution. This proves that earthen buildings are not only limited to individual initiatives, but also that public institutions have developed an awareness and desire to work with this material.

- In the interview for Building-5, the interviewee (I-9) stated that the project was carried out as a family initiative. The participant served as both architect and employer. The project emphasized an approach aimed at making ecological processes visible. This reflects an employer profile that encourages sustainable practices

The interviews on earthen building projects reveal a range of employer profiles. These profiles include individuals who serve as both designers and employers, environmentally conscious upper-middle-income groups, and public institutions. This indicates that earthen buildings can be realized not only through individual initiatives but also through decisions made by institutional actors. Additionally, employers actively request the use of this material and seek out specialists to work on such projects. In particular, public institutions that directly demand this material and implement it in public buildings represent an important step in promoting earthen construction. Furthermore, ecologically motivated public projects highlight the cultural and environmental potential of earthen buildings.

The answers to the theme **"Employer Requirements (T1B)"** are as follows (See Appendix C.2):

- The first interviewee (I-1) indicated that, in their first meeting with the employer, the employer requested a design that takes into account energy efficiency, is in harmony with its environment with natural materials, and includes microclimate analysis. In addition, the employer requested that adobe as a building material should present a modern and holistic appearance without being noticed. These requests show that the employer is looking for innovative and environmentally friendly solutions, both technically and aesthetically.

- During the interview about Building-2 and Building-3, it was stated that the employers consciously demanded the use of natural building materials for both buildings, and that this preference was supported by the motivation to both protect the environment and create healthy living spaces.

- The interview regarding Building-4, it was stated that the main expectation was constructing the with natural materials, especially with earth. This shows that even public institutions have a sensitivity towards the use of natural building materials.

- In the interview for Building-5, it was stated that the employer's expectations were directly related to the function of the building. Since the building was intended for seed storage, the use of earth material emerged naturally as both a functional and symbolic choice. The employer supported this approach, considering the insulation properties of earth to be beneficial for seed preservation. This example

shows that employer expectations can be shaped not only by technical and aesthetic concerns but also by symbolic and functional motivations.

In the light of these data, it can be concluded that employer expectations are shaped within the framework of sustainability, health and aesthetic factors, and that employers with different profiles and motivations can prefer having buildings constructed with natural materials. This indicates that the use of earth materials cannot be reduced to a single motivation; rather, they can be preferred for different reasons in different contexts.

The theme for the second question asked to the design team representative is "Documents at the Preliminary Project Phase (T2)". This theme aimed to understand which documents and data are needed by the designer who intends to design a building with earth materials, and which documents are required by the approving institution. The responses related to the **"Documents at the Preliminary Project Phase (T2)"** theme are provided below (See Appendix C.3):

- In the interview conducted for Building-1, it was stated that some documents of the building owner and the contractor, as well as all other projects were submitted during the approval process of the project. The participant stated that apart from these documents, no additional documents were requested by the municipality. It was emphasized that no extra control or supervision content was added to the process due to the use of earth materials.

- In the interview conducted for Building-2 and Building-3, it was similarly stated that the documents requested did not change regardless of the construction method or material type. It was clearly stated that standard documents such as title deed, zooning status and boundary survey are requested for all projects, and that earth building systems do not require any special application or documentation at this stage. The interviewees (I-3, I-4) emphasized that the permitting process follows standard procedures even for natural buildings.

- In the interview conducted for Building-4, the project in question is a public building directly organized by the municipality. The interviewee (I-7) stated that he was involved in this process as a consultant and was not directly involved in the preliminary preparation phase. The documents and the process were carried

out by the municipality's own architects and engineers, and the project design and permitting processes were coordinated with stakeholders in this institution.

- In the interview conducted for Building-5, the participant referred not directly to the required documents at the preliminary stage, but rather to the general construction system of the building. It was stated that earth material was used only in a small section as infill; however, this was not reflected in the official documents submitted to the municipality. At the municipality's request, the relevant section was recorded in the permit documents as "20 cm aerated concrete brick." On the other hand, it was emphasized that no additional documents were requested apart from the standard ones required in conventional procedures.

Despite the use of natural materials in earth building projects, it is understood that the procedures applied to conventional buildings are also valid in the preliminary phase. In these interviews, it is clear that there is no demand for a different document due to the use of earth as a building material, and that the legal processes do not include a separate definition or exception for earth buildings. In some projects, it was stated that earth-based materials were officially recorded as different conventional materials in the documents. This shows that the visibility of natural building systems on the legal ground is still limited, but at the same time they can be integrated into existing procedures.

The third theme asked to the design team representative is "Related Legislation (T3)", which aimed to understand whether the designers were aware of the legislation and regulations related to the earth buildings. The answers for the **"Related Legislation (T3)"** theme are presented as below (See Appendix C.4):

- The first interviewee (I-1) mentioned that there is no comprehensive legal framework for earthen buildings in Türkiye. The project was directly subject to the "Planned Areas Zoning Regulation;" no additional documents, tests or technical bases were required for the earthen material. The participant also indicated that she/he was not very familiar with the regulations and emphasized that the process proceeded entirely within the scope of standard building systems.

- In the interview conducted for Building-2 and Building-3, the interviewee (I-3) made it clear that earthen material was not included in the structural system of the building and therefore the relevant regulations were not needed. She/He said that

static calculations are made based on the three structural systems that are valid in Türkiye - reinforced concrete, steel and timber frame - and that when materials such as adobe or earth are used as infill materials, they are not seen as different from any type of blocks or bricks. Therefore, no direct relationship was established with structural regulations, especially the "Earthquake Regulation." The participant noted that if it was a masonry system, then it would have become mandatory to refer to the regulations.

- During the interview about Building-4, it was clearly stated that earth and adobe structures are not included in the building legislation in Türkiye. According to the interviewee (I-7), a building permit can be obtained when the structural system of the building is designed as reinforced concrete in the projects, and earth is used only in secondary components such as walls. However, it does not seem possible for a building to be licensed by directly defining it as an "earth structure".

- In the interview regarding Building-5, the interviewee (I-9) emphasized that no relevant legislation concerning earth buildings could be found in Türkiye. Instead of focusing on international codes or standards, the design team preferred to examine practical applications from similar geographical contexts. The participant stated that they considered real-world examples to be more guiding than formal regulations, since existing codes were not seen as beneficial in addressing the earthen design challenges of this project.

According to these responses, it is seen that earthen materials are still undefined in the current building legislation in Türkiye. Participants emphasized that they either use earthen material only as an infill material in order to bypass or speed up the legal process. Although this situation makes the construction of earthen buildings technically possible, it limits the spread of this type of building and construction techniques in the long-term. In some cases, instead of consulting specific legislation or standards, designers sought guidance from existing practices and applications in similar contexts. Legislation that does not include earth buildings as a structural system point to a serious gap in terms of the integration of earth buildings into the legal framework.

The fourth theme is "Performance of the Earth (T4)" that aimed to understand the designers' approach to the compressive strength or thermal performance of the earth as a

building material. The responses for the **"Performance of the Earth (T4)"** are as follows (See Appendix C.5):

- In the interview regarding Building-1, it was mentioned that calculations for the thermal performance of earth buildings are not included in standard engineering software. The interviewee (I-1) stated that they obtained the thermal conductivity rates of the building components by researching from foreign sources and scientific articles. The calculations were carried out with the engineer based on hypothetical data and manual data entry was made into the programs. This process shows that performance calculations are based on personal research and the lack of a standardized technical infrastructure.

- In the interview about Building-2 and Building-3, a different approach came to the fore. The interviewee (I-3) stated that she/he uses an application with natural building materials and that she/he performs building performance calculations by defining the facade components on her/his own through this application. Since this application contains data such as thermal conductivity and heat storage capacity of natural building materials, such as adobe, it provides an important support for designers working with these materials. It was also emphasized that the calculations are made by taking into account climatic data. This shows that the designer is involved in the process with more technical equipment in evaluating the performance of natural building materials.

- In the interview about Building-4, it was reported that there is no standard or practice for performance calculations of earthen buildings. The interviewee (I-7) mentioned that traditional test methods are applied for the compressive strength of the earth material during the construction.

- In this building (Building-5), earth was used only in a small section as infill material. The interviewee (I-9) stated that this condition was not included in the official documents, and at the request of the municipality, it was recorded in the permit file as "20 cm aerated concrete brick." Therefore, no performance test, technical report, or additional document was required regarding the use of earth material. This example reveals that performance assessments are often overlooked and that the use of earth can be rendered invisible within official procedures.

The interviews on the performance of earth buildings indicate that there is still no standardized practice in this field in Türkiye. Participants emphasized that calculations such as thermal performance and compressive strength are mostly carried out through personal research and manual methods, and that there is no regulation or technical infrastructure in national legislation on this issue. In some cases, data obtained from foreign sources were used, while in others, designers carried out calculations through software that already includes natural materials. However, in certain projects, the fact that earth material was recorded under a different building material in the permit files shows that performance calculations can be entirely bypassed. This situation clearly reveals both the lack of legal and technical infrastructure regarding the performance of earth buildings and the dependence of the process on individual initiatives.

The fifth theme, "Effect of material on design (T5)", intends to reveal what the designer pays attention to when designing with earthen material. The **"Effect of material on design (T5)"** theme responses are provided below (See Appendix C.6):

- In the first interview, the interviewee (I-1) stated that the earth material does not have a direct impact on the design as it is used as an infill material. She/He explained that a timber frame system was used as the load-bearing system of the building and that this system was the main element that shaped the design. The participant stated that there were various difficulties, especially during the construction phase, but this did not make a radical difference in the design process.

- A similar approach was observed in the interviews of Building-2 and Building-3. The interviewee (I-3) stated that due to the dwelling scale of the project, there was no need for large openings, thus there were no material-based design limitations. It was stated that small openings are sufficient in the system where wooden structural elements are placed at certain distances. On the other hand, it was mentioned that climatic conditions were taken into consideration and, adobe bricks with high heat storage capacity were used especially on the west and south facades. This shows that earth material plays an important role in passive air conditioning strategies and indirectly influences design decisions.

- In the interview about Building-4, there is no clear explanation of the design process. Instead, the decisions taken during the construction process and the

details of the construction were emphasized. Therefore, this interview does not provide direct data on the impact of the material on the design.

- In the interview conducted for Building-5, it was stated that decisions about earth materials during the design process were largely experimental. The interviewee (I-9) stated that there was no clear technical data on issues such as material thickness and composition, and therefore both literature research and examples from abroad were used. It was also noted that although small-scale on-site trials were conducted, the technical input expected from the construction team was limited, and clear scientifically based results could not be obtained. Ultimately, an approximately 40 cm thick rammed earth wall was constructed, but most decisions were based on experimental observations.

Interviews on the effect of earth material on design reveal that this influence is mostly limited due to its use as infill material. Some participants emphasized that the main determinant in the design process was the structural system (mostly timber frame), while earth material created only indirect effects. However, in some cases, it was observed that the thermal performance characteristics of earth were taken into account in facade decisions, particularly with regard to climatic conditions. This indicates that the lack of technical background still plays a decisive role in the design of earth buildings, and that decisions are largely based on individual experiences.

The sixth theme, "Approval Institute Impressions (T6)", aimed to understand how the approval institutes react when they are confronted with an earthen building design. The responses of the **"Approval Institute Impressions (T6)"** are presented below (See Appendix C.7):

- The first interviewee (I-1) indicated that the process was completed without any barriers in the municipality where the project was carried out. However, she/he emphasized that this was an institution-specific convenience and said that the same process may be more challenging in other municipalities. This statement shows that approval processes can vary from municipality to municipality and that the initiative of implementing institutions is a determining factor.

- In the interview about Building-2 and Building-3, it was stated the approach of the approval institutions to material selection was described as more

interventionist. It was stated that reed-based insulation boards, one of the natural materials used in the design, were not approved to be included in the project, and instead, materials such as fiberglass or rock wool, which are included in the regulations, were requested to be included in the construction documents. This intervention reveals that since natural building materials are not defined in the current technical regulations, the approval institutions evaluate the projects only on the basis of the material possibilities limited to the current legislation.

- In the interview conducted for Building-4, the approval process was carried out by the municipality's own technical staff since the building was realized on a site directly owned by a municipality. It was stated that the process was easy as it was managed by in-house teams.

- During the interview for Building-5, it was emphasized that it was not possible to specify earth material directly in the approval process. The participant explained that the earth material used for infill in a small section of the building was listed under a different material name in the permit documents. It was noted that the municipality and the building inspection team can only accept materials defined in existing legislation, so the rammed earth wall was recorded as "20 cm aerated concrete bricks". This demonstrates that earth structures are rendered invisible during the approval process and that the current system operates solely on standard material classes.

In general, it is seen that the approaches of the approval institutions in earth building projects are based on interpretation. While some municipalities adopt a facilitative attitude, some institutions may directly reject natural building materials that are not included in the regulations and request them to be changed. This situation shows that natural building materials have not yet been institutionalized at the legislative level and that the approval processes are largely determined by the level of knowledge and approach of local authorities. Stabilization of the approval process and acceptance of natural building materials is directly related to the definition and standardization of these materials in legislation.

The seventh theme for the design team representatives is “Synchronization with Engineers (T7)”, which aimed to understand the interest and knowledge of engineers,

who are the representatives of the project team other than the designer, when earth is used as a building material. The answers related to the **"Synchronization with Engineers (T7)"** are provided below (See Appendix C.8):

- During the interview for Building-1, it was explained that the most challenging part was to find a suitable engineer for the project. In particular, the search for an experienced engineer who could draw the drawings of a timber structure took a long time, but it was stated that the process progressed quickly and smoothly after working with the appropriate person. The participant emphasized that they constantly communicated with all engineering disciplines in the project and, many revisions were made from the beginning to the end of the process. She/He also stated that there were frequent changes, especially in mechanical projects.

- In the interviews about Building-2 and Building-3, it was stated that all of the engineering projects were prepared for submission to the municipality. The interviewees (I-3, I-4) indicated that the data required for the "energy performance certificate" was submitted and the data was organized according to the construction method used in the mechanical projects. They also stated that as the architectural team, they actively guided the engineering process. This approach shows that engineering studies focusing on natural building materials are limited.

- In the interview regarding Building-4, it was emphasized that the project design process was carried out directly by the municipality's own technical staff. The participant drew attention to the necessity of working with a good civil engineer and highlighted that experience is a determining factor in this process. However, there was no mention of communication with engineering disciplines.

- In the interview conducted for Building-5, it was stated that communication with engineers was limited only to the permit phase. Since the building was electrically and mechanically very simple and conventional, no engineering support was required after the permit process. It was also stated that comprehensive technical analyses were not conducted on issues such as thermal insulation and wall thickness, and decisions were made based on the construction team's previous experience.

The common impression that emerges from these responses is that such buildings require technical details that differ from standard practices, and therefore it is critical to work with experienced, open-minded engineers. It is seen that architectural teams direct the engineering processes due to the technical details specific to the project and, take on problem-solving role when necessary. However, in some projects, engineering contribution may be limited to the permitting phase, and decisions in subsequent stages are based more on the experiences of the architectural team or construction team. This reveals the importance of interdisciplinary harmony, mutual learning and, co-production in earthwork projects.

The eight theme, "Building Inspection Company / Technical Responsible Experiences (T8)," aimed to understand the communication between the designer and the building inspection company or engineer of record. The responses for the **"Building Inspection Company / Technical Responsible Experiences (T8)"** are as follows (See Appendix C.9):

- In the interview about Building-1, it was stated that the interviewee (I-1) was both an architect and a technical responsible in the project. There was constant communication with all engineering disciplines, but it was stated that the main control mechanism was directly the designer himself.

- In the interview regarding Building-2 and Building-3, it was stated that the building control process was almost non-existent. The interviewees (I-3, I-4) expressed that the building inspection company did not come for inspection, only a visit was made to take core samples for the reinforced concrete part. The next building inspection visit was carried out after the building was almost completed; the interior was finished, including the plasters, so the inspection had no technical validity.

- In this building (Building-4) was undertaken by engineers who are civil servants. The interviewee (I-7) stated that she/he carried out the process as a consultant and that the supervision in such public buildings is shaped more by the technical knowledge of the practitioner.

- During the interview for Building 5, it was stated that communication with the building inspection company was quite limited. The interviewee (I-9) stated that

the building inspection team witnessed the construction process of the earth walls but did not show any interest in it. The fact that the focus of the inspection process was only on the load-bearing system led to the use of earth material not being taken into consideration. According to the participant, the building inspection process did not include any evaluation or feedback specific to earth materials.

In earthen building projects, it is observed that building inspection processes operate in a flexible or inadequate. Participants reported that inspection mechanisms are often superficial, and in some cases, building inspection companies don't even visit the site or focus only on the structural system. This situation reveals that earthen buildings remain invisible within inspection processes and that responsibility is largely left to the designers and builders.

The ninth theme asked to the design team representatives is "Advantages and Disadvantages of Earth Materials (T9)," which aimed to understand how the designer expressed his/her experiences on earth building material in general terms. The responses for the **"Advantages and Disadvantages of Earth Materials (T9)"** are presented below (See Appendix C.10):

- In the first interview, no direct evaluation was made regarding the effects of earth building materials on the project process, and a neutral approach was displayed with the statement "there were no advantages or disadvantages".

- In the interview about Building-2 and Building-3, the positive effects of earth and natural building materials on indoor comfort were clearly emphasized. In particular, it was stated that earth plasters increase breathability and have a positive effect on factors such as heat, humidity and sound. Features such as summer-winter temperature balance were emphasized as thermal performance advantages of the material.

- This interviewee (I-7) did not focus directly on advantages or disadvantages but rather emphasized that earthen buildings cannot be evaluated in terms of standardization and performance criteria. The participant stated that there are no standards for natural building materials in Türkiye and therefore, the performance of the material cannot be measured technically.

- In the interview conducted for Building-5, it was stated that the advantages of earthen building materials are primarily cultural and symbolic, and that making the material visible is considered important for raising awareness. From a technical perspective, its contributions to moisture regulation and interior comfort were limited. However, it was reported that cracks appeared in rammed earth walls after a while, requiring additional plastering on the exterior, and increased maintenance requirements. This demonstrates that the potential advantages of the material can turn into disadvantages if not supported by the correct formulation and application techniques. The interviewee (I-9) emphasized that such projects are risky for employers under current conditions, both economically and due to the difficulties of implementation.

In general, the effect of earth materials on indoor comfort was found to be positive. Breathability and climatic balance provided by natural buildings were identified as important advantages. However, the lack of technical standards and legal definitions prevents these advantages. Furthermore, maintenance requirements, application errors, and the scarcity of specialized labor were cited as significant factors limiting the applicability of earthen buildings. This situation reveals that, despite the potential benefits of the material being recognized, it is considered a risky choice for employers unless proper technical knowledge, standards, and economic sustainability are ensure.

The interview responses regarding the design phase of earthen building projects in Türkiye demonstrates that production processes are highly dependent on individual expertise and institutional interpretation rather than standardized procedures. Although employers with diverse profiles -ranging from environmentally conscious individuals to public institutions- show growing interest in earth materials, the lack of legal recognition and technical standards continues to constrain their broader application. Current legislation does not define earthen building systems as a structural system type, forcing designers to adapt them within conventional frameworks, often as infill components. As a result, design decisions largely rely on personal experience and project-specific experimentation.

Moreover, approval authorities interpret regulations differently, and the absence of clear performance criteria or standardized documentation leads to inconsistencies across projects. While these challenges reveal institutional and technical gaps, they also

highlight the adaptability and problem-solving capacity of design teams who seek alternative methods to integrate earthen materials into contemporary architectural practice. Overall, the findings indicate the need for stronger interdisciplinary collaboration, formal recognition of earth construction in legislation, and the development of technical standards to ensure design quality and procedural stability.

4.2.2 Evaluation of Earthen Buildings Approval Process

In this section, responses collected from representatives of approving institutions were evaluated. Participants were asked interview questions prepared for the approving institution (see Appendix A1), and a theme was identified for each question. Based on these themes, the designers' responses were compiled and evaluated.

During the interviews regarding the approval process, data were collected on a total of six buildings. Interviews were held with representatives of the institutions conducting the approval process for three of these six buildings (Building-1, Building-2, Building-3). However, as the individuals conducting the approval process for Buildings-4, Building-6, and Building-7 could not be reached, interviews were held with the technical personnel involved in those projects. Furthermore, as communication could not be established with the institution conducting the approval process for Building-5, no interviews could be held regarding that building (See Table 4.2). The questions directed to the design team representative and the themes determined for the interview evaluations are presented below:

The theme determined for the first question posed to participants as part of the approval process is **"Stakeholder Profession (T1)."** This theme aims to reveal the professional backgrounds and institutional experiences of stakeholders involved in the approval processes. Participants' professional identities and work histories are important for understanding which perspectives come to the fore in the evaluation of earth building projects. The responses received for the **"Stakeholder Profession (T1)"** are listed below (See Appendix C.11):

The representative of Building-1 is an architect with 14 years of professional experience. Having experience in both the private sector and the municipality demonstrates her/his mastery of different institutional perspectives. This diversity offers

the potential to consider both market conditions and public operations in her/his evaluations of the approval processes for earth building.

- The representative of Building-2 is an architect who has been working for the municipality for approximately 8.5 years. Her/His role is to monitor the compliance of projects with regulations and manage the architectural control process. Her/His long experience working within the municipality indicates that they have a regulatory perspective and are knowledgeable in this area.

- The representative of Building-3 has a Master's Degree in Architecture and has been working for the municipality for 14 years. She/He served in the urban planning department for approximately 10 years and is currently responsible for architectural project control. Her/His professional experience is concentrated in pre-permit processes. This position clearly demonstrates his ability to identify the bureaucratic and technical obstacles that may be encountered in the approval mechanism for earth building.

- The interviewee regarding Building-4 is a landscape architect who has been working at the municipality for 10 years. She/He has previous experience in the private sector and extensive experience in plant production. Therefore, her/ his diverse areas of expertise, particularly her/his background in landscape and ecology, enable her/ him to approach projects involving natural materials such as earth building from an environmental perspective.

- The interviewee is an architect who provided insights into the approval processes for Building-6. After starting her/his career in building inspection, she/he worked for the municipality for approximately 10-11 years. Now employed in another public institution, she/he has experience on both the implementation and regulatory sides of the approval process. This dual perspective enables her/him to evaluate bureaucratic procedures, regulatory compliance, and administrative mechanisms in a comprehensive manner.

- The representative of Building-7 is an archaeologist who has been working in public institutions since 2010, particularly in conservation implementation and inspection departments. Her/his field of work is archaeological sites, historical buildings, and restoration projects. In this context, she/he offers a different

perspective that can ensure that earth building is considered in terms of its cultural heritage dimension and as a value that must be preserved.

The professional backgrounds and areas of expertise of the participants vary, who had experiences in the earth building approval process. While architects and master architects are more involved in the control processes of privately owned buildings, different stakeholders such as landscape architects and archaeologists are also involved in publicly owned buildings. The collaboration of experts working at different institutional levels (municipality, central administration, supervision) highlights the diversity encountered in the approval processes for earth building and the perspectives that different areas of expertise bring to the process.

The theme identified in the second question posed to participants as part of the approval process is **"Documents for Building Permit (T2)"**. This theme helps to understand the similarities and differences between the documents required for building permits in both privately owned buildings and public structures, as well as highlighting variations in the process due to special circumstances (such as forest lands or archaeological sites). The responses received for **"Documents for Building Permit (T2)"** are shown below (See Appendix C.12):

- According to the interviewee regarding Building-1, the building permit process consists of preliminary approval, building permit, and building occupancy permit stages. For preliminary approval, documents such as the architectural project, zoning plan, title deed, land application, ground survey report, and road elevation record are required. After the project is submitted, the necessary revisions are communicated to the architect approximately 15-20 day review period. Once the corrections are made, the calculations (construction area, parking, etc.) are checked. Then, the building permit stage begins, and in addition to the architectural project, the mechanical, electrical, and structural projects are also reviewed. Once all projects have been reviewed and approved, and the necessary documents have been completed, the building occupancy permit is issued.

- Since the approval processes for Building-2 and Building-3 are carried out by the same institution, the questions related to these buildings were jointly answered by the two interviewees. A comprehensive file called the "Technical Application

Responsible File" is prepared during the building permit processes for these buildings. The file contains documents such as title deeds, zoning status, application drawings, building site, and code drawings. In addition, structural, electrical, and mechanical engineering projects, as well as thermal insulation reports, are submitted along with the architectural projects. The documents also include the registration certificates of the authors who prepared the project, contractor-author contracts, and other parcel-based commitments. The documents are checked step by step, and if there are no deficiencies in the final stage, the permit is granted.

- Building-4 is located on forest land, so the approval process was conducted differently from other buildings. The interviewee (I-8) stated that an allocation process must be carried out before working in such areas. For the allocation process, the boundaries of the area must first be determined, and an area use plan must be prepared. Once this plan is prepared, it is first approved by the Regional Forest Directorate of the city where the building is located and then by the Ankara Regional Forest Directorate. Subsequently, a development-management plan is prepared, specifying the types, sizes, material details, and intended use of the buildings to be built. The file is completed with landscape projects and reports, and the process proceeds within the framework of the relevant provisions of the Forest Law. After the allocation process is completed by the Regional Forest Directorate, the municipal control department requests architectural, structural, electrical, mechanical, and infrastructure projects. The building permit process is completed once all projects are approved.

- The approval process for Building-6 was carried out by the municipality. Interviewee (I-10) stated that approval process generally began after the bidding process, with control engineers being assigned to the project. Although participants did not clearly recall the details of the documents, they indicated that documents such as road elevation canal records related to infrastructure were requested.

- The approval process for Building-7, located in a third-degree archaeological site, was carried out under certain specific conditions. According to the participant, in third-degree sites, archaeological excavations are first carried out in collaboration

with the General Directorate of Cultural Heritage and Museums. The Cultural and Natural Heritage Conservation Board reviews the excavation results and, if approved, the projects of the building to be constructed in the archeological excavation area are submitted to the relevant district municipality along with the site documents. After the projects are approved by the municipality, they are sent to the Cultural and Natural Heritage Conservation Board. During this process, projects, reports, photo albums, and additional documents are submitted to the Board, and the completeness of the documents facilitates the decision-making process. If the Board approves the submitted project, the construction phase begins.

Findings from the interviews related to the required documents for building permit reveal both commonalities and differences in the process. Regardless of whether the property is a privately owned building or a publicly owned one, documents related to the land (zoning plan, title deed and application) and projects are required. In addition to these documents, the existence of special circumstances (being a forest land, archaeological site, etc.) on some publicly owned land is noteworthy. Different institutions are involved in these special conditions, leading to differences in both the required documents, drawings and the approval process. This situation points to the need for privatization of approval processes, particularly on publicly owned land.

The third question posed to participants inquired whether they had been involved in the approval process for a building constructed with earth materials and what challenges they encountered during this process. Accordingly, the identified theme was **"Experience Level on Earthen Buildings (T3)"**. This theme allows us to understand the level of experience of institutional representatives in earthen building projects, the difficulties they encounter, and how earth materials affect approval processes. The responses received for **"Experience Level on Earthen Buildings (T3)"** are presented below (See Appendix C.13):

- In the interview regarding Building-1, the interviewee (I-2) described this project as her/his first experience and stated that she/he particularly struggled to understand and evaluate the drawings. She/He stated that the projects were presented using the drawing language used for reinforced concrete structural system, and therefore, details specific to materials such as wood and adobe were

not adequately conveyed. She/He explained that they conducted the process for this project through additional meetings within the institution, particularly with mechanical and civil engineers.

- During the interview regarding Building-2, the interviewee (I-5) stated that they had not been involved in the permitting process for a building previously constructed with earthen materials. She/He stated that the projects presented to her/him did not directly specify adobe or rammed earth panels, but that different applications may have been implemented on-site. She/He added that the only indication of earth use in this project was the green roof.

- The interviewee (I-6) stated that the infill walls of Building-3 appear as clay/blend bricks in the drawings, and that adobe bricks are not shown in the project. The only indication of earth use in this project is the green roof application. There is no mention in the thermal insulation report indicating that adobe was used in the walls. The interviewee stated that the responsibility for performing the calculations in this report lies with the project designer and that their institution did not re-examine it.

- The interviewee (I-8) stated that the municipality encountered difficulties in the building permit process for Building-4, as the project was located on a forest land. In the initial stage, there were problems in obtaining a building permit because the building did not have architectural and structural projects, but the process was overcome with allocation procedures. After the area was allocated by the Regional Forest Directorate, it is known that the building's projects were drawn up by outsourcing services. The municipal planning department reviewed and approved the projects, and the permit process was completed.

- The interviewee (I-10) stated that they first encountered adobe buildings in Building-6 project, which began in 2016. She/He mentioned that she/he had only previously worked on restoration and building projects with reinforced concrete structural systems, and that she/he became familiar with adobe during this project.

- During the interview regarding Building-7, the interviewee (I-11) stated that she/he had not previously been involved in the approval process for a new earth building but had worked on the restoration of another earthen building. She/ He

noted that the greatest challenge in this process was the inability to find skilled craftsmen capable of constructing such structures, forcing them to learn earth building techniques by trial and error.

The interviews reveal that, despite their extensive professional experience, interviewees faced earthen building projects for the first time. This situation led to various difficulties, ranging from evaluating drawings in the approval processes to understanding technical details. Participants experienced difficulties in interpreting material properties, determining appropriate standards, and clarifying processes from an administrative perspective, particularly in projects that differed from conventional building types. Overall, the interviews show that the approval processes for earth buildings have been adapted to the existing system and that there is limited institutional experience in evaluating this type of building technique.

The theme defined for the fourth question regarding the approval process is **"Earth Material Impact on Approval Documents (T4)"**. This theme aims to examine whether additional documents or projects are requested beyond standard documents in permit and approval processes for earthen building projects. Thus, the impact of earth material on bureaucratic processes and whether it creates differences in current practices is evaluated. The responses received for **"Earth Material Impact on Approval Documents (T4)"** are presented below (See Appendix C.14):

- The interviewee (I-2) stated that the earth material used in Building-1 project did not lead to any additional document requests during the building permit process. Routine documents (structural, mechanical, and electrical projects, etc.) were requested, as is the case with buildings having reinforced concrete, wood, or steel structural systems, and the process was carried out in accordance with standard procedures.

- During the interview for Building-2 project, the interviewee (I-5) emphasized that this institution did not request any documents other than the standard ones. Only an additional detailed drawing of how the green roof system would be implemented was requested.

- As a result of the interview regarding Building-3, it was revealed that information about earth materials was not reflected in the project, and therefore the interviewee

(I6) stated that there was no request for additional documentation. It was conveyed that the projects were presented in standard forms and that the process was proceeding normally.

- During the meeting for Building-4, the interviewee (I8) stated that initially there was no static project for the building, and therefore. the municipality's engineers did not approve the project. The process was resolved by preparing both the architectural and static projects through outsourcing and subsequently obtaining approval from the municipal planning department.

- The participant stated that no distinction was made in this project (Building-6) and that the standard permit process was applied. It was emphasized that soil material was not considered a special category.

- The interviewee regarding Building-7 stated that, due to her/his profession, she/ he had only been working on the archaeological site survey for this project and was not aware of any additional documentation regarding earth material usage in the permit process.

In general, the responses indicate that the earth material does not create additional requirements beyond the standard documents in the permit process. Only in some specific applications (e.g., green roof systems) have additional detailed drawings been required; otherwise, the procedure has been carried out similarly to conventional buildings. This situation reveals that there is no specific document list for earth building projects and that the approval process is operated according to existing standards.

The theme for the fifth question regarding the approval process was defined as **"Regulatory Compliance (T5)".** This theme aims to reveal which legislation, regulations and standards are referenced in earthen building permit and approval processes. The responses received for **"Regulatory Compliance (T5)"** are presented below (See Appendix C.15):

- The approval process for Building-1 was carried out in accordance with the Planned Areas Zoning Regulation and the Metropolitan Municipality Zoning Regulation. No additional documentation related to earth building was requested

during the process, nor were any other regulations or laws reviewed because of this material.

- Since Buildings-2 and Building-3 are located in unplanned areas, the Unplanned Areas Zoning Regulation has been applied. In addition, the Energy Performance Regulation, Fire Regulation, Türkiye Building Earthquake Regulation (2018), and relevant TSE standards have been considered in the permit process. It was stated that the project designers guaranteed the compliance of the materials with the standards, while the institutions only checked the documents and controlled compliance with the regulations.

- During the interview regarding the approval process for Building-4, the interviewee (I-8) was unable to provide information on which regulations were used because she/he was not working with the building permit department.

- The approval process for Building-6 was based on the Planned Areas Zoning Regulation, the Türkiye Building Earthquake Regulation, the Fire Regulation, and regulations related to car parks and shelters.

- No information could be obtained from the interviewee regarding Building-7.

The responses obtained from the interviews reveal that existing zoning regulations and standards are largely used in the permit process and approval for earth building. The Planned Areas Zoning Regulation served as the primary reference in planned areas, while the Unplanned Areas Zoning Regulation served as the primary reference in unplanned areas. In addition, technical regulations such as the Türkiye Building Earthquake Regulation, Fire Regulation, Energy Performance Regulation, and TSE standards were also taken into account in all projects. It is understood that there is no specific legislation for the use of earth materials and that processes are carried out within the framework of existing standards. This situation indicates that earth buildings are not considered a separate category in legal terms and that permit processes are carried out in adaptation to general regulations.

The theme for the sixth question posed to the participants was **"Project Drawings and Documents Audit (T6)".** This theme aims to understand the stages through which projects and documents are reviewed during the permitting process, the criteria used for

inspections, and the interdisciplinary nature of the process. The responses received for **"Project Drawings and Documents Audit (T6)"** are listed below (See Appendix C.16):

- In the interview regarding Building-1, it was understood that the project, assigned to the project control department, takes approximately 15–20 days to review. During this process, any deficiencies and revisions identified in the projects are communicated to the project designer, and after the necessary corrections are made, the project is re-evaluated. The interviewee (I-2) emphasizes that calculations (total construction area, parking, and other calculations required for planned areas) play a central role in project control. After these calculations are verified, the projects are transferred to the building permit stage, where the architectural, mechanical, electrical, and structural projects are re-examined.

- The project control process for Building-2 and Building-3 has been explained with a focus on the technical criteria specified by the regulations. Interviewees (I-5, I-6) stated that they initially examined elements such as compliance with the zoning plan, dimensions, codes, area calculations, clearances, and roof heights. It was stated that material selection was evaluated in subsequent stages, particularly during static, mechanical, and installation checks. Technical documents such as thermal insulation and acoustic reports were also examined at this stage.

- Interviews regarding Buildings-4, Buildings-6, and Buildings-7 were conducted with technical personnel working at the relevant institutions. However, as these individuals were not directly involved in the project approval process, they were unable to answer this question.

As the interviews regarding privately owned buildings (Building-1, Building-2, and Building-3) were conducted with individuals directly involved in the process, the project control processes could be presented more clearly. In contrast, in publicly owned buildings (Building-4, Building-6, and Building-7), the approval stages were seen to be more complex due to the involvement of different institutions and departments in the process. The processes for privately owned buildings can be defined more clearly as they follow a specific sequence, but the approval process for public buildings is more fragmented and involves multiple stakeholders, making it difficult to track the approval processes for these buildings.

The theme determined for the seventh question of the approval process is **"Project Inspection for Occupancy Permit (T7)".** This theme aims to understand the frequency of inspections carried out during the construction phase, which actors carry them out, and the experiences gained during this process. Thus, it is possible to reveal how application inspections work in both privately owned and publicly owned buildings. The responses received for **"Project Inspection for Occupancy Permit (T7)"** (See Appendix C.17):

- The interviewee for Building-1 stated that she/he did not issue the building's occupancy permit. She/He also explained that the occupancy permit department generally conducts final inspection of the buildings. This suggests that the inspection process is carried out by different stakeholders within the municipality.

- It was stated that the municipality conducted two inspections in Building-2 and Building-3 projects, at the foundation and sub-basement stages. She/ He stated that previous applications included some inspections such as thermal insulation and roof application, but these were later eliminated. This resulted in the transfer of inspection responsibility to technical responsible persons or building inspection firms. After the building is completed, the building occupancy permit is issued following a final on-site inspection.

- The control process for Building-4, which is publicly owned, differs because it is located within forest land boundaries. The Regional Forest Directorate conducted annual site visits to verify whether the project was progressing according to the approved plans and prepared reports accordingly.

- During the approval process for Building 6, it was stated that the technical responsible persons appointed by the municipality were present on site throughout the construction. It was reported that each stakeholder, such as the construction engineer, electrical engineer, and landscape architect, carried out controls according to their own area of expertise. This situation reveals that a multidisciplinary team carried out the control process during the construction phase.

- During the interview about Building-7, no direct information about the control process was obtained. The interviewee (I-11) mentioned that the personnel responsible for approving this building had left the institution for various reasons.

This illustrates that the control process cannot be clearly tracked in public projects due to personnel changes and institutional fragmentation.

When examining project control processes, it is seen that controls in privately owned buildings operate in a more regular and standardized framework, particularly under the responsibility of building control companies and technical supervisors. In contrast, control mechanisms in public projects exhibit a more complex structure, and control processes are fragmented due to the involvement of different institutions and numerous stakeholders. Furthermore, institutional changes over time lead to gaps in information regarding the inspection process. This situation demonstrates that the continuity and comprehensive monitoring of inspections in public projects is weaker compared to private projects.

Overall, the findings indicate that the approval processes for earthen buildings in Türkiye typically follow the same procedures used for conventional buildings, with no specific legal framework defining or regulating earthen materials. The participation of professionals from diverse disciplines, including architects, landscape architects, and archaeologists, demonstrates the multi-dimensional nature of these processes but also results in varying interpretations and practices among institutions. Since most participants encountered earthen building projects for the first time, limited institutional knowledge led to challenges in assessing material performance and determining appropriate standards. Moreover, the absence of a distinct category for earthen buildings in national regulations means that these projects are evaluated through the lens of existing planning, zoning, and technical standards. While privately owned buildings follow a clearer and more standardized control process, public projects -due to their multi-institutional structure- exhibit fragmented and less transparent procedures. These findings highlight the need for defining earthen materials within the legal framework, developing specific approval criteria, and strengthening institutional experience to ensure consistency and reliability in future earthen building practices.

4.2.3 Evaluation of Earthen Buildings Construction Process

This section evaluates the interviews analyze the construction processes of earthen buildings. Interviews were conducted for a total of seven buildings with individuals who were familiar with the construction process of each sample earthen building. Participants were asked questions prepared only for construction team representatives (see Appendix

A3), and separate themes were determined for each question. Based on these themes, the responses of construction team representatives were compiled, and thematic analyses were made.

During interviews regarding the construction process, data was obtained for all buildings. In four of the seven buildings, the representatives of the construction and design teams are the same individuals. In the other three buildings, the construction process was carried out by teams different from the design team. However, the construction team representative for Building-2 and Building-3 is the same as the construction team representative for Building-4 and Building-5 (See: Table 4.2). The questions asked to the construction team representatives and the themes used in the evaluation of these interviews are detailed below.

For the first question directed to construction team representatives, the theme **"Stakeholder Profession (T1)"** was identified. This theme aims to reveal the professional expertise and knowledge of the individuals involved in the construction process of earthen buildings. The answers for the **"Stakeholder Profession (T1)"** theme are presented as below (See Appendix C.18):

- For Building-1, the stakeholder involved in construction process was also responsible for the design of the project. The participant had an architectural education and specialized in sustainable architecture and landscape design. Their interest in natural materials began with workshops and field experiences during university and gradually developed into knowledge and experience in the field of earthen buildings. Thanks to this experience of over ten years, they were able to construct this building, which was the first project where they assumed professional-level responsibility for both design and construction.

- The stakeholder involved in Building-2 had conducted the first earthen building project in Türkiye and previously had twenty years of experience in constructing similar buildings abroad. Therefore, this project represents an important example of transferring international experience to local conditions.

- The stakeholder in Building-3 was the same person as in Building-2. After completing their first application in Türkiye, they participated in this project.

Their twenty years of international experience ensured that the project was carried out with a high level of technical and practical knowledge.

- For Building-4, information was obtained from two different stakeholders. The first participant is a construction team representative and has worked in the construction industry for many years. After completing their university education, they had a brief experience in restoration, followed by long-term management in construction companies. Her/his experience with natural structures, which began in 2014, has changed his direction in the industry. The second participant has experience in local government and is motivated to work on natural buildings. This combination provided support for the project from both technical and administrative perspectives.

- Two stakeholders were interviewed regarding the construction process of Building-5. The first participant was the same as the construction team representative of Building-4 and also assumed construction responsibility in this project. The second participant was the designer of the building. This stakeholder, who studied interior design in Türkiye and architecture in France, has approximately six to seven years of professional experience in the field of earthen buildings.

- The stakeholder involved in the construction process of Building-6 had architectural training and worked in building inspection company and municipality. This project, which she/he took part in in 2016, was her/his first experience in the field of earthen construction. Although she/he had previously worked on restoration and new building construction sites, earth construction has become a new field in her/his professional career.

- The stakeholder for Building-7 had a civil engineering education and has been involved in earthen buildings since 2016–2017. With approximately eight years of experience, she/he contributed to the process from an engineering perspective.

The responses related to the "Stakeholder Profession (T1)" theme show that the professional backgrounds and areas of expertise of the stakeholders are, as expected, closely linked to the construction sector. Participants come from different disciplines, including architecture, civil engineering, interior architecture, and local government

experience. Some have extensive national and international experience, while others are entering the field for the first time through these buildings. International experience plays a crucial role in transferring technical knowledge and practical skills to Türkiye. Furthermore, teams with multiple stakeholders and diverse professional backgrounds can strengthen both the technical and administrative aspects of projects. This diversity allows diverse knowledge and experience to be integrated into the construction of earthen structures, ensuring a multidisciplinary production process and enhancing the quality of the work.

The theme chosen for the second question asked to the construction team representatives was **"Employer Profile (T2)".** This theme explores whether earth materials are requested by employers or recommended by designers. Looking at the answers received for **"Employer Profile (T2)"** (See Appendix C.19):

- The employer of the first building is also the designer and builder of the structure. The proposal to build an earthen building came directly from the designer and was accepted by the family. The process was started by the architect, who took on the role of both design and construction team representative for this building, motivated by the desire to build a home using natural materials for her/his family and herself/himself.

- Although the employers of Buildings-2 and Building-3 were different, they expressed very similar expectations. Both employers were already interested in earthen construction and had conducted research in this direction. The employers stated their intention to use natural building materials from the outset. They chose the construction team for their expertise in this area, and the process progressed more smoothly due to their prior knowledge and motivation.

- The person who initiated the construction process for Building-4 was an employee of the relevant public institution and had an interest in the natural building techniques. The project came about within the framework of a search for local-scale environmental planning and the use of natural materials, and the construction team was met by chance. The individual's personal curiosity and institutional position guided the project and played a decisive role in its implementation by motivating other officials within the institution.

- The employer of Building-5 was also the designer of the building. The connection with the construction team was established through individuals and associations with experience in natural construction. The employer began the project trusting the construction team's knowledge and experience in this field, and the process took shape through a reference relationship.

- Building-6's employer is the governor of the province where the building is located. The project, initiated by the provincial special administration but not completed, was transferred to DIMCs (Departments of Investment Monitoring and Coordination) and the Metropolitan Municipality after the closure of these administrations. The process, which was jointly carried out by the two institutions, began at the individual request of the provincial administrator but was concluded with an institutional takeover and completion approach.

- The employer for Building-7 is one of Türkiye's leading organizations. Since the design team representative for this building could not be reached, information about the project was obtained from secondary data sources such as articles and websites. According to these sources, the building was realized as a result of an invited competition. The construction team representative was included in the project because she/he was one of the few professionals working in the region with experience in earthen buildings and familiar with the concept.

When examining employer profiles within the framework of "Employer Profile (T2)" theme, it is observed that in most projects, employers already had the idea of earth construction and sought professional support in this direction. In privately owned projects, motivation is mostly shaped by environmental awareness, health concerns, or personal interest in the use of natural materials. In public projects, the process sometimes begins with the individual initiatives of local administrators and sometimes progresses with the completion of unfinished projects. Furthermore, in certain projects, employers choose to realize designs selected through invited competitions and, accordingly, select the construction team from a limited number of professionals with local knowledge and experience. This situation shows that demand for earthen buildings can be generated by both individual and institutional actors. However, the small number of projects suggests that demand generally comes from actors with prior knowledge and high motivation.

The theme determined for the third question addressed to the construction team representatives is **"Design and Construction Conflict (T3)".** This question was prepared specifically for buildings where different teams are involved in the design and construction. This theme explores how proficient the design team is in designing with earth and whether they are aware of the limitations of earth as building material. Looking at the answers received for **"Design and Construction Conflict (T3)"** (See Appendix C.20):

- In the first interview, it was reported that several practice-oriented issues complicated the construction process. Major challenges included the building foundation, solutions for wet spaces, and the compatibility between the timber structure and ground surfaces exposed to water. It was mentioned that details such as the balcony section above the kitchen, the risk of fire in the wooden structure, and the application of ceramic coating to the adobe wall surfaces required intensive research. This situation reveals that the project requires a high level of technical solutions in terms of both material properties and design details.

- During the meeting regarding the second building, it was stated that there were no direct problems with the earth material, but that difficulties arose due to the choice of material in the application technique. The participant stated that the use of linen mesh instead of polyester mesh resulted in hairline cracks at the joints of the rammed earth panels, and that this problem was solved by reapplying polyester mesh. This example shows that even small changes in material selection can directly affect the quality of construction.

- In the third interview, it was stated that there were no problems with earth material or detailed solutions. This demonstrates the designer's experience in this field and shows that the coordination between design and application proceeded smoothly.

- In the interviews conducted for Building 4, it was stated that the entire design and construction process was carried out by the same person, that the projects were designed in accordance with legislation, and that no design-construction conflicts occurred during the construction phase. This demonstrates that design-construction compatibility is higher in projects managed by a single stakeholder.

- In the interview conducted for Building-5, it was stated that existing projects were revised through as-built projects and that such cases were encountered frequently. It was reported that some problems arose due to the lack of consultancy during the design process, and these problems were resolved during the construction phase. This highlights the importance of involving technical consultancy at an early stage in the design process.

- In the sixth meeting, it was stated that various material problems were encountered during the construction process due to the building being taken over unfinished. It was decided to continue with adobe plaster to repair the cracks in the walls, but it was expressed that the adobe supplied contained plastic-based additives instead of straw. This condition indicates that there may be problems in the material supply chain.

- During the interview about Building-7, it was noticed that some design elements required modifications due to the material's properties. The design called for the removal of the protruding reinforced concrete frames of the windows, and it was stated that additional structural measures were taken due to the large window openings. This demonstrates the critical importance of opening dimensions and structural system design in projects constructed with natural materials.

Data obtained for the "Design and Construction Conflict (T3)" theme indicates that conflicts between the design and construction processes are most often related to material selection, detail solutions, and the compatibility of the existing design with the material. In some projects, having the same designer and builder enabled potential problems to be anticipated and eliminated during the design phase. However, lack of consulting, difficulties in sourcing suitable materials, or the incompatibility of the existing design with the material required revisions during the construction process. The technical limitations of natural materials, such as adobe and wood, necessitated the development of specialized solutions, particularly regarding wide openings, wet area details, and fire safety solutions. These findings demonstrate that early-stage coordination between the design and construction teams and, the appropriate material selection are critical to project success.

The theme for the fourth question posed to construction team representatives was **"Construction Duration (T4).”** This theme aims to reveal the completion duration of earthen buildings compared to conventional buildings, considering the total area and function of the buildings. Responses to this theme indicated that (See Appendix C.21):

- The construction time for the first earthen building was stated to last approximately one year. This represents an average timeframe for a 200 m² privately owned building.

- The completion duration for the second and third buildings was stated to be between nine and twelve months. It can be said that the construction duration for these two privately owned buildings, measuring 250 m² and 225 m², is similar to that of conventional buildings.

- Construction of the fourth building was carried out in phases, with each phase taking approximately two months to complete. Because this earthen building was part of an urban design project, no specific construction time was provided. However, it was stated that it took 1,5 to 2 years for all phases of the urban design project to be completed and ready for use.

- No clear information was provided regarding the construction timeframe for the fifth building during the interview. This limits the evaluation of this project in the timeframe analysis.

- The construction duration for the sixth building was reported to have taken approximately 1.5 years, including duration extensions. The long completion duration for this complex project, consisting of five buildings, can be considered an average timeframe, considering the breadth of the scope and the impact of administrative processes.

- The earthen walls for the seventh building were reported to have been completed in three months. This information only covers the wall construction timeframe and does not provide data on the entire construction duration for the building.

Construction durations for the examined projects vary depending on the building type, size, and function. While privately owned buildings generally last between 9 and 12

months, more comprehensive and multi-building projects can extend this timeframe to 1.5 to 2 years. At the same time, the problem of finding experienced workers and the variability in the number of workers employed in buildings also makes it difficult to conduct a comprehensive comparison.

The theme for the fifth question posed to construction team representatives was **"Stakeholder Communication on Site (T5)".** This theme aimed to assess the availability of workers and craftsmen capable of working with earthen materials on site and their knowledge and experience with these materials. The contribution of the local workforce to the projects was also evaluated within the scope of this theme. Responses to **"Stakeholder Communication on Site (T5)"** stated that (See Appendix C.22):

- It was stated that no workers or craftsmen capable of working with earth materials could be found for the construction of the first building. For this reason, a previously known plasterer was brought in and additional people were hired to assist him. It was reported that a representative of the construction team was constantly present at the site throughout the construction process and closely monitored the work.

- In the second and third interviews, it was stated that the labor force was organized with the help of different teams of experts in their fields. The foundation was built by a standard construction team, and then the wooden structural system was completed by a local team of carpenters. The earth walls were built by local plasterers and brick layers. It was also stated that some of the craftsmen had lived in mud brick houses since childhood, so they were familiar with this material and even enjoyed working with earth.

- For Buildings-4 and Building-5, the findings revealed that craftsmen were given a few days of training when working with new teams in a new location and, then the work was closely monitored. It was noted that other workers could be directed by an experienced craftsman, and therefore, the practice was continued in this manner.

- It was stated that the construction process for the sixth building began with a strengthening project and was carried out in collaboration with an experienced civil engineer. Positive assessments were made regarding the durability of the

mud brick used in the project, and it was stated that local craftsmen were preferred for the plastering applications. These craftsmen were reported to have previously worked in village houses and were familiar with adobe wall construction methods.

- The result indicated that no specialized experts were brought in for the seventh building; instead, standard teams received the necessary training. It was noted that all the workers were local, and that no foreign workforce was required on site.

In general, local craftsmen and workers play an important role in earth construction practices. In particular, the familiarity of people who had lived in or worked with mud brick buildings in the past contributed to the facilitation of some projects. The availability of a local workforce had made it unnecessary to bring in external experts in most cases; however, due to the limited knowledge and experience of the craftsmen, construction team representatives were constantly present on site and closely supervised the work. Although earth construction techniques have been widely used historically in Türkiye, it has been noted that there are very few craftsmen who know how to work with this material today. The proliferation of industrialized construction methods has led to a gradual loss of knowledge about traditional materials and techniques. This has forced construction team representatives to provide short-term training. Therefore, the need for local knowledge transfer and master craftsman training in the reproduction of earthen buildings is a critical element for the sustainability of current practices.

The theme for the sixth question posed to the construction team representatives was **“Earth Material Procurement (T6).”** This theme aims to identify the sources and methods of procuring materials and equipment used in earthen construction projects, the use of excavated soil or local materials, and the need for specialized application tools. The answers given for the **"Earth Material Procurement (T6)”** are represented below (See Appendix C.23):

- In the first building, mud bricks were ordered from a firm outside the city and delivered to the construction site. The construction team representative specifically noted that producing the bricks on-site would require a significant workforce and space, which is why on-site production was not carried out. It was stated that some of the ordered bricks were damaged due to waiting a long time, so molds were made in the production plant and, the damaged ones were reshaped.

It was also mentioned that other materials, such as horasan mortar, were sourced locally, and no special equipment was needed at the construction site.

- In the second building, mud bricks and earth plaster were purchased as ready-made products from outside the city. Construction team representatives emphasized that this method was specifically chosen to show that mud bricks and earth plaster can be ordered and delivered quickly, just like other industrialized building materials. At the same time, rammed earth panels were used instead of plaster, but since this product is not produced in Türkiye, it was imported. This situation reveals that some earth-based building materials are not yet produced in Türkiye. Industrial products such as ready-made clay plaster was also used in the project, thus benefiting from the convenience provided by modern production and distribution networks in material supply. It was emphasized that the tools used in the process consisted of standard equipment.

- In the third building, as in the second building, adobe bricks and earth plaster were supplied as ready-made products. However, in this project, straw-based rough plaster was used instead of rammed earth panels, so there was no need for importing a finishing material. It was stated that standard construction tools were preferred in terms of equipment use and that there was no need for special tools.

- In the fourth building, it was reported that local earth was used directly for material supply and, that the rammed earth technique was applied. It was reported that a special machine was produced for the mixing process and that this machine was designed by construction team representative and used on the construction site.

- It was noted that specialized equipment was developed for the fifth building due to the high cost of standard machinery. A portable mixing machine and compaction devices were designed and used by the labor, and it was stated that these tools were more efficient than compactors. In addition, the earth to be used on the construction was obtained from the surrounding area because the earth in the construction area was not suitable.

- The interviewee (I-10) regarding Building-6 did not have clear information on this subject, as the mud brick walls were constructed during the first phase of the

project and he was involved in the process during the second phase. However, she/ he suggests that these bricks were sourced from the nearby area. It's been said that standard methods and existing materials were used for plastering, and no extra equipment or special materials were needed.

- It was mentioned that the earth used in Building-7 was sourced from a region close to the construction site, and the molds were brought from Ankara. It was mentioned that the steel molds were supplied from outside the city because they required special production due to their circular shapes. Other equipment was reported to have been sourced locally.

Overall, the findings regarding material and equipment procurement reveal diverse approaches to earthen construction practices. In some projects, materials such as mud bricks and earthen plaster were procured directly from companies as ready-made products, which accelerated and facilitated the process. This shows that, although they are few, these materials can be produced industrially today and do not have to be produced on-site. On the other hand, in some projects, simple machinery was developed to reduce costs or create solutions suitable for construction site conditions, supporting labor processes in this way. It was also observed that local earthen resources were used experimentally, but depending on the material's quality, procurement from other regions was also employed. All these findings reveal a two-way process in the procurement of earthen construction materials in Türkiye, involving both traditional methods and the use of local resources and ready-made products.

The theme for the seventh question posed to construction team representatives was **"Construction Techniques (T7)."** This theme aims to reveal the construction techniques employed in contemporary earth buildings in Türkiye and identify the materials used for the foundation, load-bearing system, walls, floor, and roof components. Thus, both the contemporary reflections of traditional methods and hybrid solutions used in combination with modern construction techniques can be examined. The responses received for **"Construction Techniques (T7)"** theme are provided below (See Appendix C.24):

- In the Building-1, a timber frame structural system was constructed on a reinforced concrete raft foundation. Mud bricks of varying thicknesses were used for the walls. Reed insulation was provided on some external walls, and

waterproofing materials were also applied to walls connected to wet areas. The wall surfaces, clad with laths, were coated with lime-based mortar. In the interior, roughcast and final rendering were applied over the adobe walls. Ceramic tiles were used on the ground floor, while wooden parquet flooring was used on the upper floor. The roof was designed in a gable roof form, with moisture barriers and cellulose-based insulation.

- In the second building, a reinforced concrete foundation and a timber frame structural system were chosen due to regulatory requirements. The walls were constructed using a combination of mud bricks and rammed earth panels. Wooden parquet flooring was preferred, and the roof was designed as a flat roof with metal roofing.

- The third building also has a reinforced concrete foundation and a timber frame structural system. The walls are made of mud bricks and rough earth plaster mixed with straw, and solid wood parquet flooring was chosen for the floors. The roof is a hipped roof covered with clay tiles.

- In the fourth building, rammed earth walls were constructed on a reinforced concrete foundation, and the roof was completed with a wooden stick frame system. Unlike the other examples, this building shows that earth material can be used not only as an infill material or a secondary component, but also as a direct load-bearing element.

- The fifth building has a reinforced concrete foundation, with the ground floor made of reinforced concrete and the upper floor made of steel frame structural systems. The roof is also made of with steel frame system. Rammed earth was used only in certain sections of the walls. Terrazzo flooring was preferred for the floor, although earth flooring was initially considered, it was not implemented due to for seen problems such as implementation problems and difficulties.

- In the sixth building, the foundation was made of natural stone up to the sub-base level. Although the adobe walls were built using a masonry system when the project first began, the current load-bearing system is timber, as the building was reinforced with timber columns after 2016. The walls were made entirely of

adobe, covered with earth plaster and plastic-based paint. Wooden flooring was preferred for the floor, and ceramic tiles were used in wet areas.

- The seventh building has a completely reinforced concrete load-bearing system. Earth material was used only on the exterior and interior walls as an infill material surrounding the reinforced concrete structure. Rammed earth walls were applied, but they did not play a load-bearing role. The floors and roof were designed as reinforced concrete slabs, and waterproofing was added to the roof.

A general overview reveals that hybrid systems are prominent in contemporary earthen construction practices in Türkiye. Only one example (Building-4) stands out, where earthen materials were used directly as a load-bearing element. In other structures, earthen materials generally served as infill or cladding. Reinforced concrete foundations are common in most buildings; this is attributed to both the requirements of current regulations and durability concerns. While natural materials such as wood are often used in structural systems, steel or fully reinforced concrete systems have been preferred in some projects. Mud brick, rammed earth techniques, and earthen plaster applications are prominent for walls, and in most cases, these are supported by reinforced concrete or wooden supports. Conventional materials such as ceramics, wooden parquet, and terrazzo were preferred for flooring, while various roof types, such as gable, hipped, and flat roof, various roof structure materials, like steel and wood, and various roofing solutions, such as clay or metal tiles, were employed.

Overall, the findings reveal that the **construction process** of earthen buildings in Türkiye involves a multidisciplinary structure shaped by diverse professional backgrounds, ranging from architecture and civil engineering to local administration. Employers generally approach these projects with strong motivation and awareness of natural materials, although the limited number of examples suggests that such initiatives are still driven by individual enthusiasm rather than a broad institutional framework. The data highlight frequent conflicts between design and implementation, often arising from the incompatibility of existing designs with earthen materials and the lack of early coordination between teams. Despite historical familiarity with earthen techniques, the scarcity of skilled craftsmen today poses a major challenge, necessitating close site supervision and short-term training by construction teams. Material procurement practices show a dual nature, blending traditional on-site production with the use of

industrially manufactured components, reflecting both experimentation and adaptation to modern conditions. Finally, contemporary earthen buildings in Türkiye predominantly employ hybrid systems -combining earthen materials with reinforced concrete, wood, or steel- revealing an effort to balance regulatory compliance, structural safety, and the environmental aspirations of natural construction.

Chapter 5

Conclusions and Future Prospects

This thesis explores the production process of earth buildings in Türkiye in the context of design, approval, and construction phases, using examples built and approved after 2010. Data collected through semi-structured interviews revealed the experiences of various actors and the institutional, technical, and practical dynamics involved. The findings reveal common problems in all three phases, as well as opportunities and constraints unique to each stage. This section presents conclusions based on the findings and discussions related to the design, approval, and construction phases of earthen buildings, emphasizes the study's societal impact and contribution to global sustainability, and outlines future prospects.

5.1 Conclusions

When the evaluations made within the scope of the interview findings related to the design, approval, and construction phases of the earthen buildings are considered, the following conclusions can be drawn.

Design process related outcomes show that earth buildings can be produced through both individual initiatives and the decisions of institutional actors. It is understood that employer motivations are shaped by environmental concerns, health factors, aesthetic preferences, or cultural values. However, the lack of a defined category for earth building in the current legal framework leads to technical calculations and standards in the design process being left to individual efforts. Performance calculations are mostly carried out through personal research, manual methods, or foreign sources, which results in both technical diversity and a lack of standards. Another important

finding observed in the design process is that earth material is mostly defined as non-load-bearing infill material. This approach leads to the limited use of the material's potential and the lack of technical knowledge becoming decisive in design decisions. Therefore, experienced engineers and interdisciplinary collaboration play a critical role in the success of the process.

Approval process findings show significant differences between privately owned projects and public projects. While more clear and standardized processes are followed in privately owned projects, the involvement of numerous institutions and the introduction of special conditions (forest areas, archaeological sites, etc.) in public projects make the process complex and fragmented. Furthermore, since most of the public employees interviewed were not directly involved in the approval process, the information conveyed about the processes was limited. However, approval processes for both private and public buildings are carried out in accordance with existing legislation (Regulations on Planned/Unplanned Areas, Earthquake Regulations, Fire Regulations, Energy Performance Regulations, TSE standards, etc.), and no special regulations or documentation are required for earth building. This situation shows that earth buildings are not defined as a separate category within the legal framework and that approval processes are carried out in accordance with existing legislation. The fact that participants stated that they were encountering such buildings for the first time points to a lack of institutional experience and uncertainty in the legislation.

Construction process data reveal a multi-actor-based and interdisciplinary structure in the production of earth buildings. The collaboration of different professional groups, such as architects, civil engineers, interior designers, and local government representatives, enables the transfer of technical knowledge and experience. However, inconsistencies between the design and construction processes cause various problems, particularly in material selection and detail solutions. This highlights the importance of early-stage consulting and design-construction coordination. Construction times vary depending on the scale of the project but are generally long, with a lack of experienced craftsmen and labor being one of the most prominent problems in the process. Despite the partial contributions of local craftsmen, knowledge of earth building has seriously declined today, making short-term training courses a necessity. Material supply is progressing in two directions: on the one hand, products such as adobe bricks and earth plaster can be obtained ready-made through industrial production, while on the other

hand, production is carried out directly from local sources. In terms of construction techniques, hybrid systems are prominent, only in one example (Building-4) earth material was directly used as a load-bearing component. In most projects, reinforced concrete foundations were used in conjunction with wood or steel systems, with earth material serving as an infill or cladding material.

Since the main limitation of this thesis is approved buildings, it is also very important to assess how the approval stage affects the design and construction stages. The findings show that the absence of specific standards or legal definitions for earth materials creates a significant challenge in the design process. This challenge is the lack of an official reference or guideline that designers can rely on. As a result, design decisions are often shaped by personal experience and interpretation rather than standardized criteria. Furthermore, the approval process directly influences material selection and structural preferences. For example, following the 2018 earthquake regulations, earth materials can only be legally accepted as infill material, which limits the material's potential. This legal restriction has also affected the general construction process, shaping the technical solutions and application methods adopted on site. Therefore, the approval process, which is the focus and main limitation of this thesis, emerges as a decisive factor that indirectly shapes the entire production of earthen buildings in Türkiye.

In light of all these findings, it is clear that it is essential to develop recommendations for improving the earthen building production processes in Türkiye. The recommendations identified in this regard are outlined below:

- **Integration of Expertise into Design Processes:** It would be beneficial to incorporate consulting services into the design process of earth building, as is often done during the construction process. Designers unfamiliar with the technical requirements of earth materials are prone to certain design errors. In future projects, consultants or experienced practitioners should be involved in the design phase to ensure technical feasibility and minimize costly revisions during construction.
- **Awareness and Dissemination of Information:** One of the most significant barriers to earthen building material is the perception that it must be produced manually on site. In fact, ready-made earth products can be sourced from industrial suppliers. Raising awareness among designers, approval authorities,

and employers about the availability of these materials and the existence of many construction techniques beyond adobe bricks (such as rammed earth) can strengthen the legitimacy and visibility of earth building applications.

- **Development of Standards and Regulations:** Although there were once specific standards for adobe buildings in Türkiye, it is known that these standards are no longer in force today. Rather than removing standards, reintroducing updated standards not only for adobe but also for rammed earth and other earthen building techniques is crucial for institutionalizing earth building. In particular, the growing interest in rammed earth buildings highlights the urgency of developing comprehensive technical guidelines. Standards will provide legal clarity, facilitate approval processes, and increase the confidence of employers and designers.
- **Legislation and Institutional Compliance:** Approval processes for earthen buildings are carried out under general regulations such as the Planned and Unplanned Areas Zoning Regulations, Earthquake, Fire, and Energy Performance Regulations. However, these regulations do not sufficiently address the specific requirements of earth as a building material. Future policy development efforts should focus on incorporating earth building as a separate structural category into legislation, supported by relevant standards.
- **Public Projects and Multi-Stakeholder Complexity:** The approval and control of public projects are more complex due to the involvement of multiple institutions and personnel changes. Future research should examine these processes in greater depth, particularly where special conditions exist, such as forest areas or archaeological sites. Understanding how multiple stakeholders coordinate or fail to coordinate will be crucial to increasing transparency and efficiency.
- **Capacity Building and Training:** The lack of skilled craftsmen familiar with earth building techniques is a serious problem. Creating training programs for local workers and encouraging knowledge transfer from experienced international or national experts can ensure the sustainability of earth building practices. Supporting the revival of the master-apprentice model can also play a vital role.

5.2 Societal Impact and Contribution to Global Sustainability

The outcomes of this research suggest that it holds the potential to support the achievement of three Sustainable Development Goals, mainly. In relation to the scope of the study, its potential contributions to "SDG 11 Sustainable Cities and Communities," "SDG 12 Responsible Consumption and Production," and "SDG 13 Climate Action" are discussed below:

SDG 11 Sustainable Cities and Communities: The earth-based buildings promote sustainable construction practices by relying on local material resources and environmentally conscious structures. By detailing the production processes of earth buildings, this study contributes to increasing awareness of these structures and encouraging their use, which in turn enhances the resilience of communities. To build sustainable cities, minimizing environmental impacts and utilizing local resources efficiently are crucial. The earth buildings discussed in this project help reduce the environmental footprint by producing fewer carbon emissions compared to industrial construction materials. Moreover, the feasibility of these buildings for local communities contributes to the economy while preserving local traditions and cultures.

SDG 12 Responsible Consumption and Production: The production processes of earth buildings examined in this study are based on sustainable material use and waste management practices. Earth is an environmentally efficient construction material that requires minimal energy in its production and is recyclable. The earth buildings discussed in this project may help reduce dependency on industrial construction materials, facilitating the widespread adoption of more environmentally friendly production methods. Additionally, the production processes of these earth buildings promote waste reduction and the more efficient use of natural resources. The use of local and sustainable materials in the production of earthen buildings can be seen as an example of responsible consumption and production from the construction industry perspective.

SDG 13 Climate Action: The use of earthen buildings make a significant contribution to combating climate change. These structures offer more sustainable options

compared to industrial buildings in terms of lower carbon emissions and energy efficiency. Additionally, constructing earthen buildings in harmony with nature paves the way for eco-friendly building techniques in the fight against climate change. This research highlights the importance of promoting sustainable buildings to mitigate the effects of climate change.

5.3 Future Prospects

The findings of this study, along with ongoing practices and research on earthen buildings in Türkiye, highlights the need for updates and improvements in both academic and practical fields. Although the recent increase in interest -reflected in architectural biennials, competitions, and pilot projects- demonstrates a growing awareness of earthen architecture, further steps are required to ensure its sustainable and systematic development. The following points outline the potential directions for future research and development:

- Research can be conducted on strategies for involving professionals experienced in earthen materials during the early stages of design to enhance design accuracy and technical compatibility.
- Studies may explore effective ways to increase public and professional awareness of earthen materials and investigate how this awareness could contribute to the wider use and acceptance of earthen construction practices.
- Future efforts may involve research collaborations between academia and public institutions to establish national standards and technical guidelines for earthen construction techniques, such as adobe and rammed earth, which are among the most widely used and recognized methods in Türkiye.
- Further studies could focus on developing proposals for updating and harmonizing regulations to ensure consistency across institutions and formal recognition of earthen materials within legal frameworks.
- Investigations can be carried out to analyze coordination mechanisms among public institutions involved in earthen projects and propose models to streamline multi-stakeholder processes.

- Research and educational initiatives may aim to integrate theoretical and practical training on earthen materials into university curricula and professional programs to strengthen knowledge transfer and technical capacity.

In conclusion, this study highlights that the institutionalization of earthen architecture in Türkiye requires a multifaceted approach combining academic research, policy development, and professional training. Through collaborative and systematic efforts, earthen construction can transition from isolated experimental practices to an integrated and recognized component of sustainable architecture.

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APPENDIX

Appendix A: Interview Questions for Stakeholders

The following questions were prepared for all stakeholders involved in the selected sample of earthen buildings. Separate sets of questions were developed for each stakeholder. Since all stakeholders of the buildings are based in Türkiye, the questions were prepared in Turkish.

Appendix A.1 Interview questions for design team member.

1. Which institution or individual did you collaborate with on this project? Could you provide us with information about the project details?

- How was the communication with the employer?
- What were the employer's (site owner's) expectations for the project?
- Is this your first project using earth as a material?

If yes, did you propose the use of earth materials, or was it the employer's request?

If no, what motivated you to use earth for construction?

2. What data and documents were required for the preliminary preparation of the project?
3. What regulations and codes did you examine during the design process? Could you briefly explain them? (e.g., Earthquake Regulations)

- Were you aware of the regulations, codes, or standards related to earthen structures in Türkiye and worldwide? How did they impact your project?

4. Did the approving institution require any additional documents or reports concerning the thermal performance, static strength, or other characteristics of the earth used in the project? (Did the material undergo any performance tests? If so, where and how were these tests conducted?)

5. What did you pay attention during the design phase of the earthen building? (How did using earth materials shape your design process compared to reinforced concrete, steel, or masonry construction?)
6. How did the approval process progress at the institution where you submitted the preliminary project? (Were there any difficulties in reviewing or understanding the project? If so, how did you resolve these issues?)
7. What was your experience working with engineers during the implementation phase? (Could you briefly explain your collaboration with mechanical, structural, and electrical engineers, and their involvement in the drawing process?)
8. How was your communication with the building inspection company or engineer of record?
9. Could you explain the advantages and disadvantages of using earth as a construction material during the design and approval phases?
10. Is there anything else you would like to add? If so, could you briefly mention it?

Appendix A.2 Interview questions for the representative of the approval institution.

1. What is your profession and how long have you been working at this institution?
2. What documents are required in order to obtain a permit for private and public buildings at this institution?
3. Have you previously been involved in the approval process of a building constructed with earth materials? If you faced any challenges during this process, could you briefly explain them?
4. Did you request any additional documents during the permit process due to the materials used in the building? If yes, what were these documents?
5. Which regulations and codes did you refer to during the project approval process?
6. Could you explain the project control process?
7. How often did you conduct inspections during the building construction phase? What did you experience during these inspections, and could you share some of your insights?
8. Is there anything else you would like to add? If so, could you briefly mention it?

Appendix A.3 Interview questions for construction team member.

1. What is your profession and how long have you been working with earthen buildings?
2. Could you briefly describe your process for acquiring projects?
3. When reviewing the designed project, were there any aspects of the construction you found problematic or difficult to resolve?
4. How long did it take to complete the construction of the building?
5. How did you communicate with the workers on site? What was your experience in finding workers or craftsmen who are familiar with working with this material?
6. How and where did you source the materials and equipment for the construction?
7. Can you describe the construction process of the building?

- What was the foundation like?
- What is the load-bearing system?
- What materials were used for the walls?
- What material was used for the floor?
- What was the roof system like?

8. Is there anything else you would like to add? If so, could you briefly explain?

Appendix B: Flowcharts

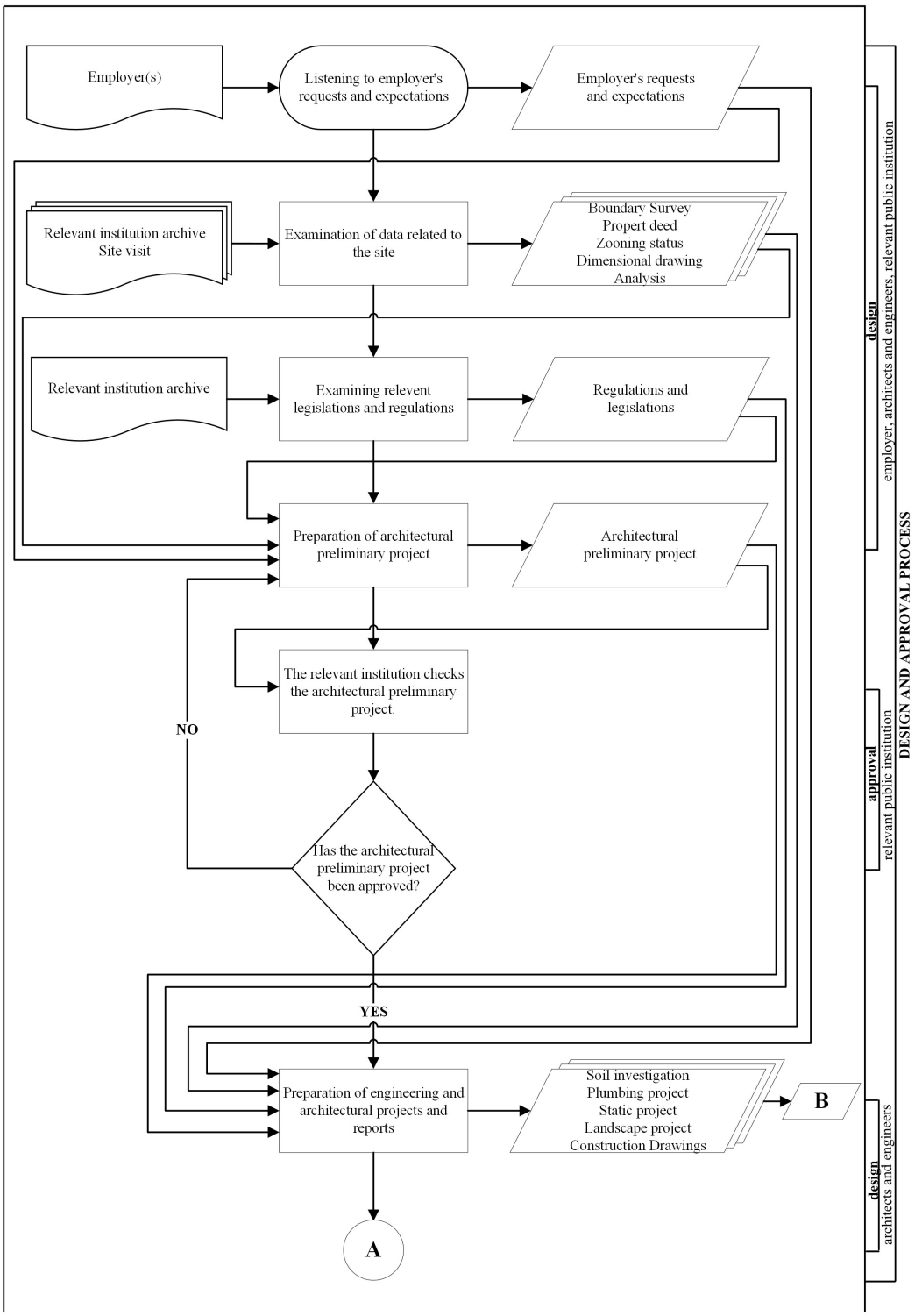


Figure B.13 Conventional design, approval and construction processes of privately-owned buildings.

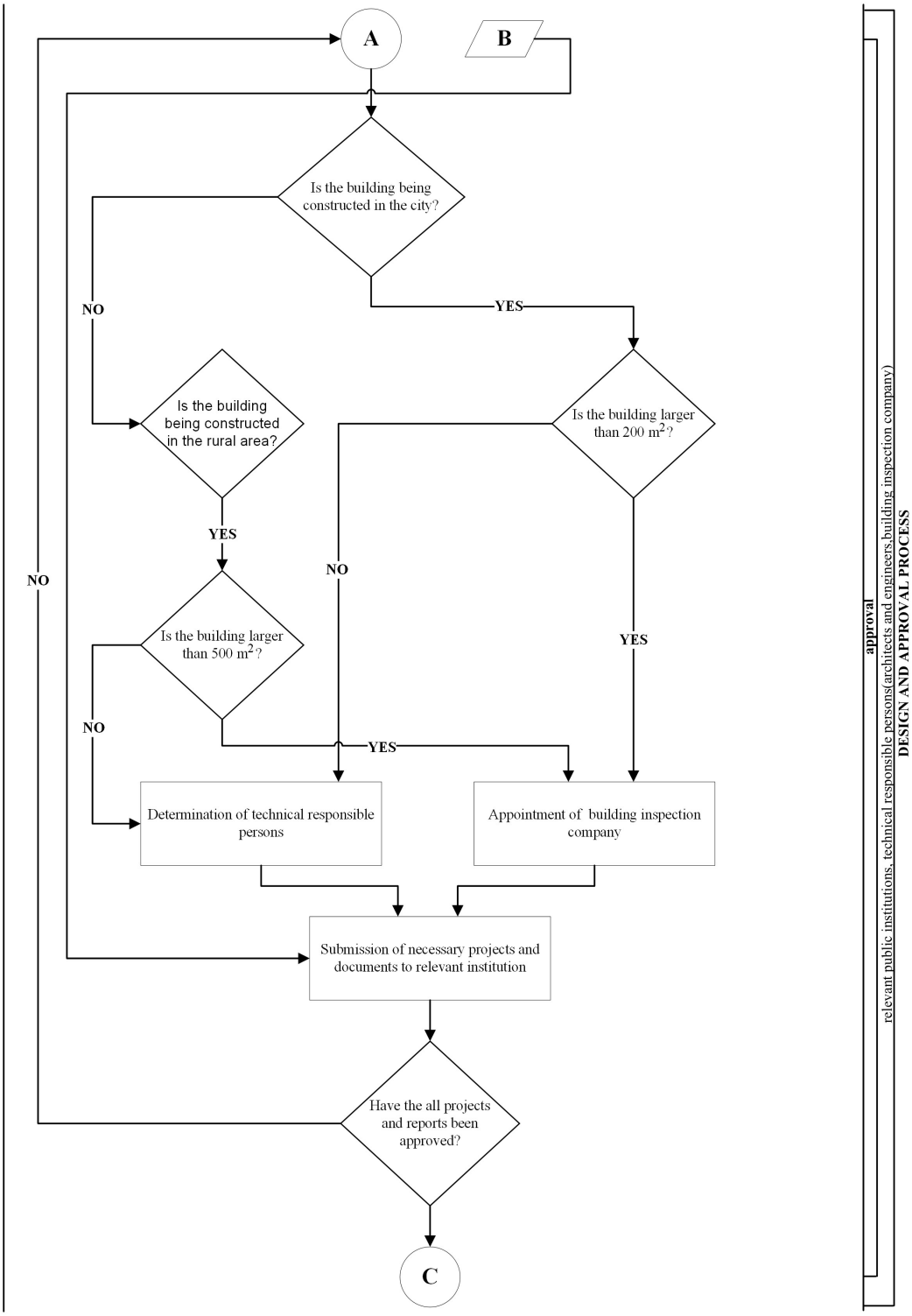


Figure B.14 (Continued) Conventional design, approval and construction processes of privately-owned buildings.

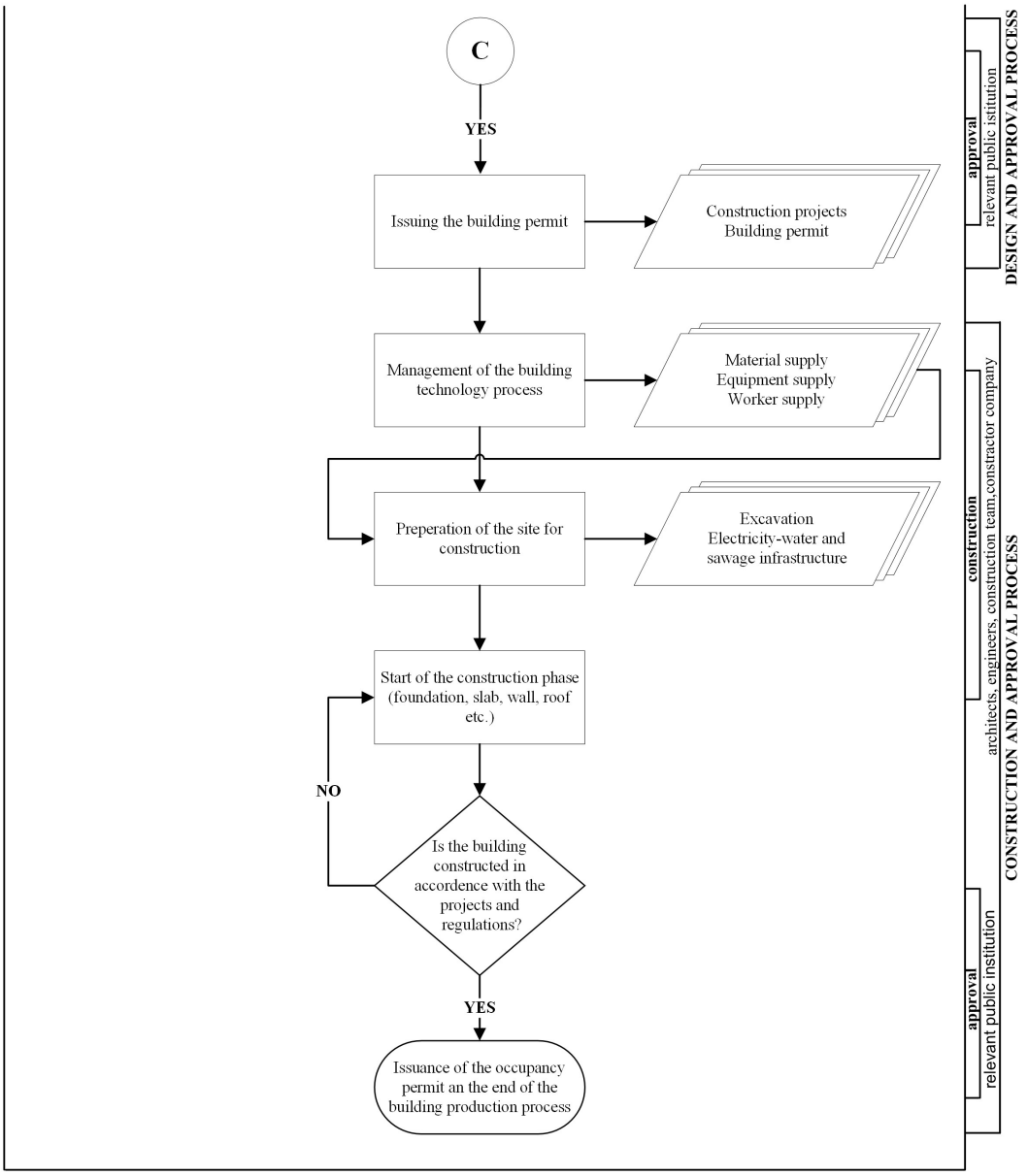


Figure B.15 (Continued) Conventional design, approval and construction processes of privately-owned buildings.

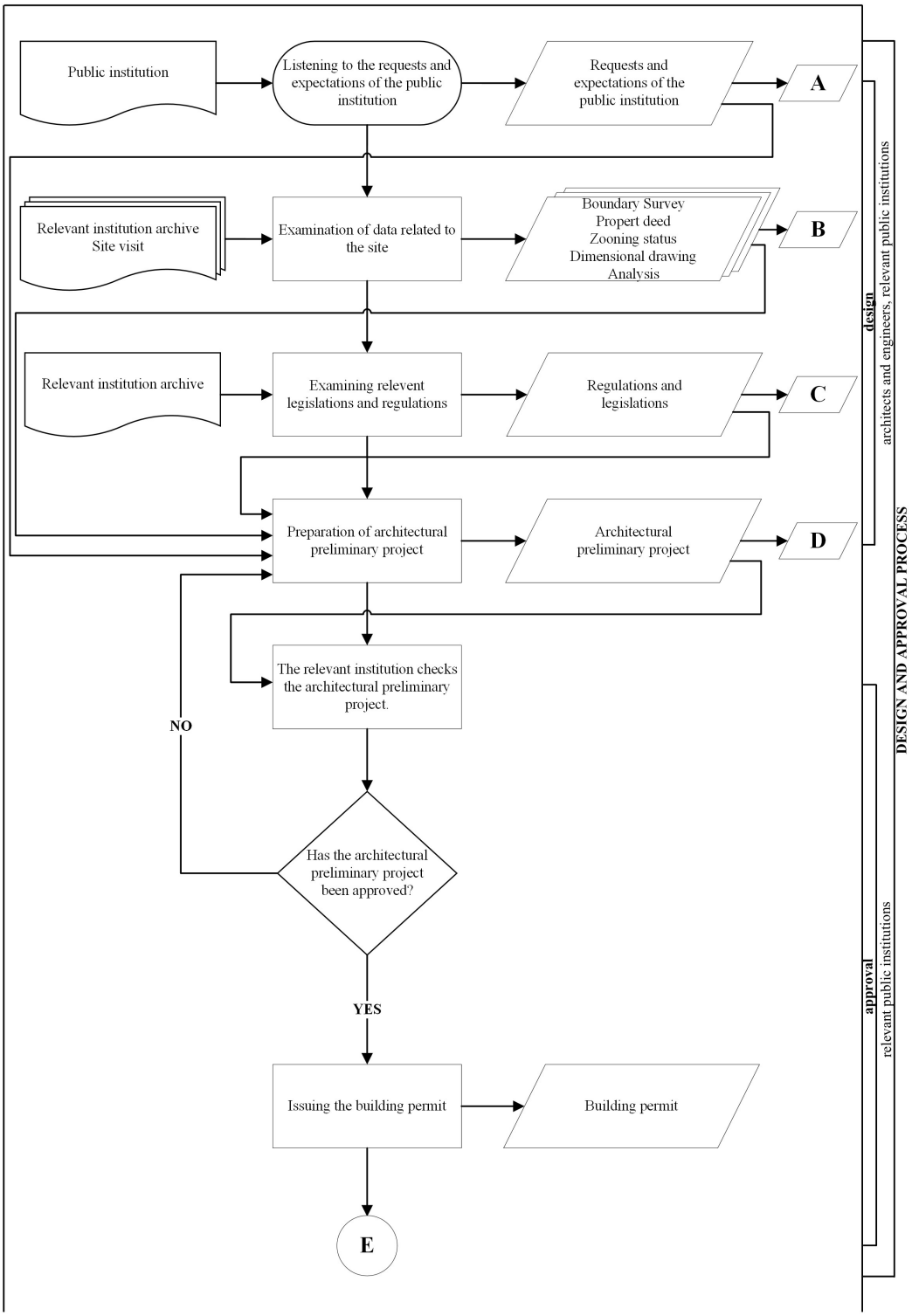


Figure B.16 Conventional design, approval and construction processes of publicly-owned buildings.

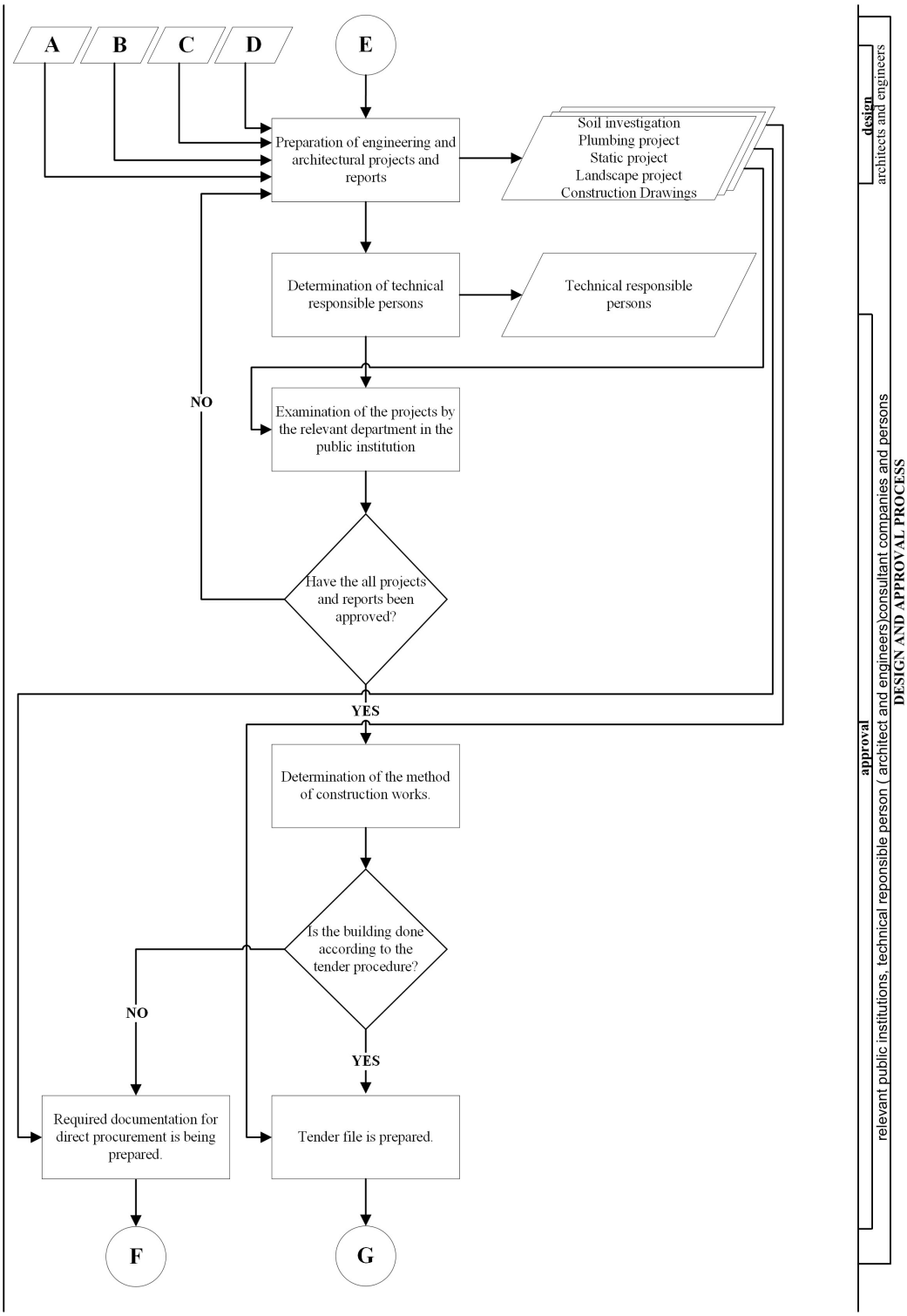


Figure B.17 (Continued) Design, approval and construction processes of publicly-owned buildings.

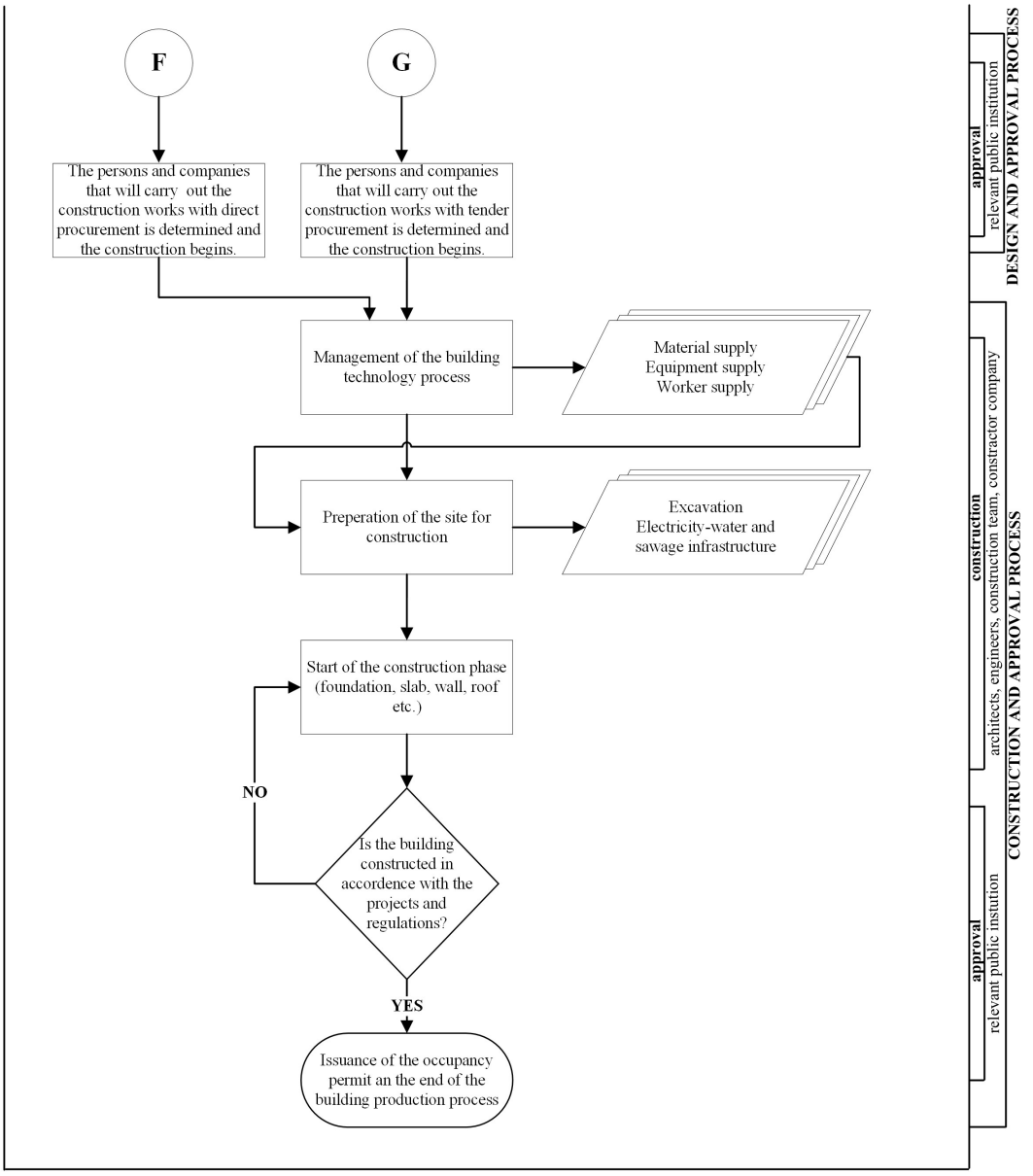


Figure B.18 (Continued) Conventional design, approval and construction processes of publicly-owned buildings.

Appendix C: Answers to Themes

Appendix C.1 Responses to themes identified for the design process (in English)

Table C.3 Answers to the Employer Profile (T1A)

Building-1	We are the employer, my family and me.
Building-2	…upper middle income, high environmental awareness…
Building-3	
Building-4	X municipality.
Building-5	The employer profile here is a bit specific. Because I worked here both as an architect and as an employer. X is our family project.
Building-6	-
Building-7	-

Table C.4 Answers to the Employer Requirements (T1B)

Building-1	I was dreaming of a design that considers energy efficiency, integrates with its garden, where everything is in harmony, from the water cycle to the use of natural materials. Including microclimate analyses. A village house comes to mind when it is called Adobe, but I wanted someone to talk in and not realize that it is adobe, but in fact it is. These were my expectations.
Building-2	The person who demanded to build with natural building materials was the employer. No one came to us without target.
Building-3	… people prefer these buildings. They request these buildings to be constructed both to protect the environment and their own health.
Building-4	It was the basic expectation that the building should be made with natural materials, especially with earth.
Building-5	The purpose of this place is to make these types of processes a little more visible. In other words, it is possible to live differently today. How can we do this? Where do we stumble and fall while trying to do this? What are we learning from this, and how can we move forward by sharing this whole process with people? That is the approach here. Additionally, the building we are constructing is an agricultural production facility, and it has a seed bank on one side. The seed bank is already a hallmark of this place. It is what is advocates, what it tries to convey, and what it strives to continue. Therefore, I believe that the idea of storing seeds in the earth here was already something that needed to be done, both for political reasons and in terms of its meaning.
Building-6	-
Building-7	-

Table C.5 Answers to the Documents at Preliminary Project Phase (T2)

Building-1	Documents required from the building owner, construction site documents required from constructors, project drawings. Apart from these, nothing else was requested.
Building-2	…nothing changes at the building permit phase. Title deed, diameter, application, geological ground survey report. No matter which method you use, the project or construction… the documents do not change.
Building-3	
Building-4	…carried out directly by the municipality… with the municipality's own architects and engineers. I acted as a consultant.
Building-5	Actually, this building is a conventional one. It has a ground floor constructed with a reinforced concrete column-beam system. The upper floor has a steel frame and steel roof. Therefore, we reviewed the classic zoning regulations, earthquake regulations- in other words, the same regulations we would normally review when constructing a building.
Building-6	-
Building-7	-

Table C.6 Answers to the Related Legislation (T3)

Building-1	…there is not much in Türkiye anyway…I am not very familiar with the regulations and legislation to be honest…it was already based on the zooning regulation. There was nothing extra about the earth part that we benefited from. There is no standardization in the legislation anyway. They didn't ask for anything.
Building-2	…In fact, we do not need any legislation on earth buildings. We have three options, steel reinforced concrete timber frame. Therefore, calculations are made on the structural system of these three building materials. Adobe, earth is the infill material here. It makes no difference whether I use gas concrete, brick or adobe. Therefore, we are not interested in such regulations. Especially with earthquake regulations. If there was a masonry structure, then it would be necessary.
Building-3	
Building-4	In Türkiye, earthen buildings, adobe buildings aren't included in the legislation. There was reinforced concrete, only the walls were to be made of earth. These structures can get a building permit but when you go to an official institution as an earthen building, you can't get a building permit.
Building-5	We couldn't find anything in Türkiye. Instead of researching regulations around the World, we researched applications. Because, we didn't think regulations would be of much use to us, but we looked at the applications that had been made. We researched what had been done in similar geographical areas.
Building-6	-
Building-7	-

Table C.7 Answers to the Performance of the Earth (T4)

Building-1	While making the calculations, we found materials that are not in the programmes. For example, we entered the U values of an Adobe wall of this thickness, for example. We proceeded hypothetically. I looked at foreign sources and articles, the friend looked at other sources. Together with the engineer, we said okay, let's use this value. Such a total calculation was made.
Building-2	Now we make those calculations ourselves, that is, we do not leave it to the mechanical engineer, there is a programme we use, all these Adobe and natural building materials are in its library, together with their values, so I can create the facade myself in that programme. And in the result, the total thermal insulation value of this, what is the heat storage capacity and what is not, these are revealed. Of course, we do this ourselves, taking into account the climatic conditions where the building will be built.
Building-3	
Building-4	No. There is no place for it in Turkish legislation.
Building-5	There were some local teams at the building who helped us with the building permit, and we spoke with them. They told us that the municipality
Building-6	-
Building-7	-

Table C.8 Answers to the Effect of Material on Design (T5)

Building-1	To be honest, nothing many changes at the design stage. We have difficulties in the construction phase. Actually, the wooden carrier system comes into play here. It makes the main difference. The earth only forms the infill; there were some limitations imposed by the wood.
Building-2	I think, there is no change, because since these examples are on the scale of a house, there are no very large openings here. We have timbers with a spacing of 60 cm, smaller openings were not a problem. On order to make the right decision on wall details in our projects, we consider the climate conditions of the place where it will be built. There is no heat insulation material on the west and South facades, adobe brick with heat storage capacity is more prevalent. Because, I want to protect those facades against the summer heat.
Building-3	
Building-4	There was no clear statement about the design process. Rather, what was taken into consideration during the construction process was explained.
Building-5	So everything went very experimentally. Because we were expecting this data from the building team. But we couldn't get very good results there. …At the same time, the studies we conducted abroad at this stage also came into play. So we had some suggestions, especially regarding wall thickness, but ultimately the decision made there was a slightly more experimental one. We also thought about and discussed the mixture. To decide on these, we had conducted a small trial on-site a few months earlier. We looked at its results but there was no more scientific approach than that on site. …So, as a result, if I'm not mistaken, we built a 40 cm thick earth wall. We discussed the details of how to build it, but there was no more data available.
Building-6	-
Building-7	-

Table C.9 Answers to the Approval Institute Impressions (T6)

Building-1	To be honest, nothing many changes at the design stage. We have difficulties in the construction phase. Actually, the wooden carrier system comes into play here. It makes the main difference. The earth only forms the infill; there were some limitations imposed by the wood.
Building-2	I think, there is no change, because since these examples are on the scale of a house, there are no very large openings here. We have timbers with a spacing of 60 cm, smaller openings were not a problem. On order to make the right decision on wall details in our projects, we consider the climate conditions of the place where it will be built. There is no heat insulation material on the west and South facades, adobe brick with heat storage capacity is more prevalent. Because, I want to protect those facades against the summer heat.
Building-3	
Building-4	There was no clear statement about the design process. Rather, what was taken into consideration during the construction process was explained.
Building-5	So everything went very experimentally. Because we were expecting this data from the building team. But we couldn't get very good results there. …At the same time, the studies we conducted abroad at this stage also came into play. So we had some suggestions, especially regarding wall thickness, but ultimately the decision made there was a slightly more experimental one. We also thought about and discussed the mixture. To decide on these, we had conducted a small trial on-site a few months earlier. We looked at its results but there was no more scientific approach than that on site. …So, as a result, if I'm not mistaken, we built a 40 cm thick earth wall. We discussed the details of how to build it, but there was no more data available.
Building-6	-
Building-7	-

Table C.10 Answers to the Synchronization with Engineers (T7)

Building-1	I think, the most difficult part was finding the right person. I searched for a long time, I couldn't find someone who could draw the wooden stadium project. Then I found someone with experience and thanks to him, the process was quite fast and easy. We progressed by making revisions to the project by staying in contact with all engineering. It was never like we drew and finished. There were many revisions in mechanics.
Building-2	All engineering projects were prepared and submitted to the municipality. We submitted the values for the energy identity certificate. We organized the data in the mechanical project according to the application we used. In other words, we also directed the engineering works.
Building-3	
Building-4	The municipality's own architect- engineer staff solved it. Of course, experience is needed, it is necessary to work with a good civil engineer.
Building-5	The relationship with engineers was limited to the building permit stage in this building. The building is quite simple, both electrically and mechanically. It is a truly conventional and very simple building. There was no further engineering phase required of us afterwards. Therefore, we cannot speak of any significant interaction here.
Building-6	-
Building-7	-

Table C.11 Answers to the Building Inspection Company/ Technical Responsible Experiences (T8)

Building-1	I was the architect and the chief engineer. We stayed in contact with all engineering departments and made revisions to the project. It was never like we drew it and it was done. There were many revisions in mechanics.
Building-2	The building inspection company never came. Only someone came to take a core sample in reinforced concrete, they asked for photos before the settlement, that is, in that process, there was already exterior plaster. Even the thin plaster was completed, so there was nothing left to see the cross section. They did not have an inspection of the interior.
Building-3	
Building-4	The technical responsible were municipality personnel. Since I was a consultant, I carried out the process more.
Building-5	I wasn't there when they came for the inspection, but we hadn't hidden the fact that we used earth on the walls anyway. Our friends tried to explain it to the building inspector on site, but it wasn't something the building inspector focused on. I guess it didn't catch their attention because the building inspector's focus was specifically on the load-bearing system. I think they just looked and moved on because they weren't curious, and they never contacted us about it afterward.
Building-6	-
Building-7	-

Table C.12 Answers to the Advantages and Disadvantages of Earth Material (T9)

Building-1	There was no advantage and disadvantage.
Building-2	Earth plasters make a big difference in terms of breathability and interior comfort. Interior quality really changes when working with natural materials. It has a serious effect on factors such as heat, humidity and sound. I can transfer experiential knowledge such as storing heat, being cool in summer and warm in winter.
Building-3	
Building-4	We also talk about this in association. DIN norms, performance, standardization. I think this will also take time. As a matter of fact, there are no standards for natural and earthen buildings in Türkiye.
Building-5	So I think it worked well as an element that made this work visible and changed the culture in architectural processes… Technically, I think it might be slightly beneficial in terms of humidity regulation. But right now, we have to use air conditioning inside that seed room. Otherwise, we can't keep the seeds at the right temperature. We also wanted to leave this earth wall exposed on the exterior facade. Because when done correctly, this is possible. But it didn't work out that way. A lot of cracks formed inside. Since it wasn't a load-bearing system, we didn't dwell on it too much, but I can say there are elements that show us there were some mistakes in the application. Therefore, we had to cover the exterior facade with plaster. So I think this is all related to lack of standardization. This becomes a vicious cycle. The less it's done, the less standardization, the less research, the less budget, and so on. Now, looking back today, I think I wouldn't undertake something like this again. Because if I think about it from the perspective of an employer and business owner, it's not really possible to overcome all the difficulties that this type of building brings. In today's World, in today's Türkiye, this is not the right solution.
Building-6	-
Building-7	-

Appendix C.2 Responses to themes identified for the approval process (in English)

Table C.13 Answers to the Stakeholder Profession (T1)

Building-1	I have been an architect for 14 years now. I previously worked in the private sector
Building-2	I am an architect and have been working in the project control unit of this institution for about eight and a half years. So, when a building is to be constructed, an architectural project is prepared first. We audit its compliance with regulations.
Building-3	I am a master architect. I have been working at the municipality for 14 years. I worked in the planning department for about 10 years and continue to do so. I am currently controlling architectural projects. I control architectural projects before they are permitted.
Building-4	I am a landscape architect. I have been working as a civil servant at the municipality for 10 years. Before that, I had my own private company. Prior to that, I gained experience in plant production by working at a nursery for 5 years. That makes a total of 18 years.
Building-5	-
Building-6	I graduated from the architecture department in 2012. I worked in building inspection for about a year. After that, I continued at X Metropolitan Municipality. I worked at X Metropolitan Municipality for about 10-11 years. Now I work in the project review department at the X governor's office. Here, we focus more on the work of the Ministry of Interior, looking at projects and tenders.
Building-7	I am an archaeologist. I first started working in 2010 at the Cultural Heritage Preservation Office of the X Special Provincial Administration. After the provincial administrations closed, I came to the X Metropolitan Municipality's Cultural Heritage Preservation Office. I have been here since 2014. Our actual area of responsibility is archaeological sites, restoration, historical buildings and their maintenance and repair. We also conduct joint excavations with the museum in archaeological areas. That is our general job description.

Table C.14 Answers to the Documents for Building Permit (T2)

Building-1	Since property deeds for privately owned buildings are held by individuals, specific documents are required from them. The same documents are also required from public institutions. Correspondence between institutions continues with cover letters. For individuals, the process continues through their own applications. It is divided into the following stages: preliminary approval stage, building permit stage and building occupancy permit stage. ….The documents required for preliminary approval are as follows: Zoning Plan, Title Deed, Land Application, Ground Study Report, Road Level Record. After applying with a petition in the preliminary approval stage, the architectural project is forwarded to us along with the necessary documents. After all checks have been completed, if approved, it is forwarded to the building permit stage. The architectural, mechanical, electrical and structural projects are also checked at the building permit stage. Once they are approved, the permit is issued and the construction stage begins.
Building-2	So we have a long list. This list includes documents such as the title deed, zoning status, construction drawings, building site sketch and code sketch. After submitting these documents along with the architectural project, we review the project. After passing the preliminary approval stage, the engineering projects must also be submitted in addition to the architectural project. These include the structural project, electrical project, plumbing project, thermal insulation reports and building skeleton system projects. In addition, we also want a file containing the registration documents of all the authors who drew the project, their commitments, contractor-author contracts and other more specific contracts based on the parcel. Everything is checked step by step. If there are no deficiencies in these documents and contracts at the final permit. Stage, the permit can be obtained.
Building-3	
Building-4	…The architectural project and the landscape project were drawn up. All the general sections, views and details were provided. All the details of the material buildings were provided. In addition to that, you prepare a report. … For the permit, of course, we want the architectural project and structural project to be completed. We want the electrical, water and infrastructure projects to be submitted and construction to be completed. That's how we issue permits both for our own buildings and for those of citizens outside.
Building-5	-
Building-6	The building permit for this area was issued by our zoning department, but I was always involved in the project side. Normally, we apply for preliminary approval for other public buildings but that's not how things work at the municipality. Eventually, the building permit was issued. I don't remember exactly but we applied the general rules in that section. We probably submitted those documents too, but the municipality requested them separately, as they do for public buildings …there should be documents related to infrastructure services, such as a road-under canal record…

Table C.15 (Continued) Answers to the Documents for Building Permit (T2)

Building-7	Archeological sites have classification degrees. This site falls under the third degree. If a third-degree building is to be built, the museum conducts an archeological excavation there. They drill holes in various places. If there are no archeological remains, they send their report to the conservation board. The conservation board approves the project in this way, meaning that buildings can be built on third-degree archeological sites, but within certain rules. … But I'm not very sure about the documentation part. They want a photo album, they want the projects and the reports. When you go to committee, the committee doesn't ask for any missing documents or anything. In fact, the more information and documentation there is, the more it helps the committee. It makes their decision easier.

Table C.16 Answers to the Experience Level on Earthen Buildings (T3)

Building-1	It was my first project; it's a never-before-seen example. Evaluating the building was very difficult. Because it's our first project, we generally do research. Steel structures, for example, are the same. Because municipalities generally rely heavily on reinforced concrete, evaluating wood and adobe structures is naturally difficult. Therefore, we also seek opinions from other disciplines, such as mechanical and civil engineers. We also received opinions about insulation. In other words, it is not a job that can be evaluated immediately, even if you give it to any mechanical engineer or civil engineer.
Building-2	The structural system of this building was a wooden frame, and the roof was described as a metal roof system in the details. They also installed a green roof on one section. That is, a system we call a green roof on top of soil fill. I remember when this project came to me. We want an eco-friendly, transformable, sustainable life. They said we would use the materials in that way. In that sense, it was the first project of this kind I had seen. It was a very enjoyable project, but as far as I remember, it was not specified that the walls were made of an earth-related material like adobe. Probably, they constructed adobe walls on site.
Building-3	In the project we received, the wall infills were shown as brick walls in the detailed drawings. A green roof application had been implemented in some areas of the roof. I believe the structural system was a combination of wood and reinforced concrete. My personal opinion is that they probably consulted with mechanical engineers before coming to us, and since those materials are not included in the standards, adobe bricks were not presented to us. Therefore, there were no details regarding earthen wall infill in the projects we received or in the thermal insulation details. That's why we listed brick as the wall infill material in the permit.… I haven't encountered such a project before. As you know, earthen or adobe applications are more common in rural areas. This structure is a special application.
Building-4	There were no problems when we went through the Forestry Department. Because they only look at things like the area and the number of floors. They don't care how the building is constructed. They just test whether it's made of natural materials. But here's what happened. We had some trouble with the municipality. Because a permit cannot be issued for this type of building construction, as there is no structural analysis. We didn't have a structural analysis project either. That's why they created problems in issuing the permit; as you know, the zoning department issues it at the municipality. We had some trouble there, we managed to sort it out somehow.…The zoning department reviewed the architectural project. An architect from outside was hired to draw the architectural project again. That's how the permit was issued. The other projects and details were also drawn up, submitted to the zoning department, and approved.
Building-5	-

Table C.17 (Continued) Answers to the Experience Level on Earthen Buildings (T3)

Building-6	When this job came along in 2016, I had no experience in this field. I mean, I did academic work while I was in school, and I had been on the construction side of the school, building stone walls or building inspection. It was actually through the adobe project that I became familiar with this work.
Building-7	This was the first earthen building project we worked on, and we conducted a study with the Conservation Board. There were already archaeological remains at the construction site, so the building was categorized as a third-degree archaeological site. Since the Conservation Board gave approval, it became an earthen structure. We prepared all the necessary drawings and documents in accordance with the Conservation Board approval process.

Table C.18 Answers to the Earth Material Impact on Approval Documents (T4)

Building-1	No additional documents were requested. The same documents required for other routine projects involving reinforced concrete, wood, and steel structures were requested. Structural, mechanical, and electrical projects were also requested.
Building-2	There are no other documents. I only wanted this green roof detail because they were building an earthen roof at the time. Since it was a different application, I wanted to see how they would implement it.
Building-3	There was nothing extra because these materials weren't specified in the project we received.
Building-4	They didn't ask for anything special for this project. They only wanted a structural design. The buildings here didn't have an architectural design or a structural design at first. On-site applications were carried out first. Later, when the Forestry Directorate requested an architectural design from us, we had both the architectural and structural designs prepared by an external architect and engineer. This was because our engineer and architect colleagues at the municipality said that the design for this building did not comply with reinforced concrete standards or other regulations and that they did not want to sign it. So, we outsourced the work. That's how we solved it. So, there was no structural design initially; we added it later.
Building-5	-
Building-6	We didn't make any distinctions. We did what was required for the permits for our buildings in a normal place. Because, as I said, the municipality didn't consider this a separate category at the time.
Building-7	Since I was only involved in the archaeological site survey of this structure, I do not know the answer to this question.

Table C.19 Answers to the Regulatory Compliance (T5)

Building-1	The zoning regulations for planned areas are our primary regulations. In addition to this, there are the X Metropolitan Zoning Regulations.
Building-2	Since there was no 1/1000 scale plan, we examined it based on unplanned areas. There is also a regulation regarding the energy performance of buildings, which is being reviewed. There is a fire safety regulation. We are reviewing the earthquake regulation. When the project is reviewed along with all engineering projects, it is subject to the relevant regulations. For example, the structural system of the building is reviewed according to the earthquake regulation. I remember that it was updated in 2018. Apart from that, we are also subject to TSE standards. In other words, the relevant author already guarantees us that the building elements comply with TSE standards and that materials compliant with these standards will be used. We already check the existence of these documents and whether they are in the file. Other than that, since there is no plan, we used the zoning regulations for unplanned areas. Because there is no plan for the area. There are 100,000 and 25,000 environmental planning plans, and we examined it according to them.
Building-3	
Building-4	I don't know anything about this.
Building-5	-
Building-6	Planned areas zoning regulations, shelters, parking lots, fire… Türkiye Earthquake Regulation. If there are plan notes for the parcel, you process those too. Along with these, of course, there are other regulations we want, but they are not fixed; they can change depending on the building. For example, if it is a fuel station, we have to check with TSE (Turkish Standards Institute). For example, accessibility rules must be followed in every building. We generally look at these.
Building-7	Since it was not possible to speak with the responsible person involved in the building's approval process, no answer could be found to this question.

Table C.20 Answers to the Project Drawings and Documents Audit (T6)

Building-1	After submitting an application during the preliminary approval stage, the architectural project is forwarded to us along with the necessary documents. Once forwarded, the process takes between 15 and 20 days. During this process, any revisions to the projects are communicated back to the architect. After making the revisions and corrections, the architect brings the project back to us. After the revisions, the finalization stage begins. Subsequently, all calculations required for the construction area and other planned areas are made (parking lot calculations, etc.). After these calculations, the total construction area is determined. Once the construction area of the building is determined, it is forwarded to the building permit stage. At the building permit stage, the architectural, mechanical, electrical, and structural projects are also checked. After that, the construction phase begins.
Building-2	We review the regulatory requirements regarding room dimensions, codes, levels, area calculations, dimensions, roof height, top floor slab height, and other limitations imposed by the regulations. These are the priorities. After we finish, our colleagues check other aspects: they look at the earthquake regulations in the static control, and they look at the materials in the mechanical and plumbing projects. Thermal insulation and acoustic reports are reviewed. Materials come into play a little more there.
Building-3	
Building-4	Since it was not possible to speak with the responsible person involved in the building's approval process, no answer could be found to this question.
Building-5	-
Building-6	Since it was not possible to speak with the responsible person involved in the building's approval process, no answer could be found to this question.
Building-7	Since it was not possible to speak with the responsible person involved in the building's approval process, no answer could be found to this question.

Table C.21 Answers to the Project Inspection for Occupancy Permit (T7)

Building-1	I didn't conduct the inspections. The people who issue the building occupancy permits usually conduct these visits.
Building-2	After the permit is obtained, colleagues from another department of the municipality visit the site twice during the foundation and subfloor stages once construction begins. They check that the documents provided to us and the project are compliant. After that, I believe we don't visit again until the work is completed. Currently, there are no inspections, but in previous periods, inspections were conducted during the construction of walls and the roof. Thermal insulation and roof inspections were carried out.
Building-3	
Building-4	I was in control until the final approval process was completed. After approval was granted and the allocation process was completed, the Forest Management Directorate became the institution responsible for overseeing all activities carried out there. They come once a year, in September or October, and conduct a technical inspection of the site. They check whether the project we submitted is progressing as planned. They check whether anything has been added outside the scope of the project and keep a record of their findings. Every year, they have us sign that report.
Building-5	-
Building-6	All the engineers were involved in the construction during the control process. Even the landscaping was involved later. At first, there was no landscaping project at all. They had also put me in charge of its control. But I remember telling my manager that a landscaper was also needed here. We later assigned a landscaper friend to that task. He was responsible for the planting.
Building-7	Some people were fired during that period. For example, one of the inspectors here was removed from her/ his position.

Appendix C.3 Responses to themes identified for the construction process (in English)

Table C.22 Answers to the Stakeholder Profession (T1)

Building-1	I am an architect. I studied sustainable architecture and landscape design. I have been interested in this field for a very long time. I participated in workshops offered by X. While at university, I attended workshops in a village as part of my coursework. In total, we can say it has been over 10 years.
Building-2	This house is my first job in Türkiye. Before that, I worked on buildings like this abroad for 20 years.
Building-3	This is also one of the first jobs in Türkiye. Before that, I worked on buildings like this abroad for 20 years.
Building-4	Construction is our family business. After graduating from university, I worked briefly in antique restoration but then decided that construction was the industry where we would make our living, so I established a construction company. I worked in Bodrum for many years. About 11 years ago, in 2014, I came to Köyceğiz. I started construction of natural buildings with the X building.
Building-5	
Building-6	I graduated in 2012. I worked in building inspection for about a year. After that, I continued at X Metropolitan Municipality. I worked at X Metropolitan Municipality for about 10-11 years. Now I work in the project review unit at the X Governor's Office. Here, we handle matters related to the Ministry of Interior, specifically project and tender work. When this job came up in 2016, I had no experience in this field. While in school, I worked on restoration projects and on construction sites for new buildings during my time in building supervision, but it was through this job that I became familiar with adobe.
Building-7	I am a civil engineer. I started in 2016-2017. So it's been about 8 years.

Table C.23 Answers to the Employer Profile (T2)

Building-1	We are the employers, my family and I. My father owns the land. I suggested it to my family, and they agreed.
Building-2	They come to us with a vision and intention. When they look at who they can work with on this project, we are the ones who come to them. They come to us saying they found us through social media research. They demand that these buildings be constructed both to protect the environment and to protect their own health. The people demanding that these buildings be constructed using natural building materials were the employers. No one came to us without a goal. That's why we don't try to convince them. Because employers come to us knowing our expertise in this area. If someone came to us without knowing anything about this subject from scratch, we would have had to put in much more effort to convince them.
Building-3	
Building-4	X municipality. I had previously worked as a consultant for this municipality for five years. At that time, there was an approach focused on preserving nature. I liked it, and we subsequently realized such a project.
Building-5	We met X from the Building Biology Association. My friend there recommended me. When the employers learned about my sensitivity and knowledge regarding natural structures, we got in touch and started this project.
Building-6	It was a project initiated by the governor of the time to preserve mud-brick houses for the future. At that time, it was a project that X city referred to as its cultural and attraction center. The Provincial Special Administration launched this project in 2010. However, when it remained unfinished and the provincial special administrations closed down, it was transferred to the municipality in 2016. DIMC's and we completed the job.
Building-7	There aren't many employers. As far as I know, there are very few projects in Türkiye. I live in X city, and if the project is close to here, I get involved. Because I also do stonework and restoration work. So I work on masonry structures, traditional buildings. Soil is another area I work in. I usually work on traditional buildings or masonry structures. So if there's a project like that and it's close to where I live, it will come to me somehow. There aren't many people who know and do this kind of work anyway.

Table C.24 Answers to the Design and Construction Conflict (T3)

Building-1	There were so many difficult things to solve, for example, how would the wet floor work? This is earthen structure and wooden structure; how would it work with a wet floor? Wet floors are very difficult. For example, there was a balcony right above the kitchen. It was very difficult to make that section. Fire, the risk of fire in a wooden structure... I researched those things too. The walls are adobe, but how will the ceramic tiles adhere to that? It was very difficult to solve these issues.
Building-2	We applied the earth plaster using a linen mesh instead of polyester mesh. The linen mesh did not perform its function, and fine hairline cracks appeared on the surface at the joints of the earth panels behind it. We then decided to use polyester mesh and resolved the issue.
Building-3	There was no problem with the earth.
Building-4	The design and implementation are entirely my own. We designed the projects to comply with the regulations.
Building-5	Generally, there are certain errors in incoming projects. In such cases, we modify the project by providing a modification project. For example, a project is drawn up without consulting an expert, resulting in a number of problems, which we then modify.
Building-6	The building had some problems because it was exposed to the outside conditions and had been waiting. So we decided to re-plaster it and wanted it to be made of adobe. However, we couldn't get adobe. They brought us adobe, which normally contains straw, but the adobe that came later contained a plastic-based material. The contractor also said he couldn't source any other adobe. So we made a mixture using the adobe containing plastic and used it as earth plaster.
Building-7	Of course there were. In the first project, there were reinforced concrete frames around the reinforced concrete openings, and I requested that they be removed. I thought it would make our job easier. So a revision was made to the project. I worked out the wall thicknesses and connection details. The openings were very important. The openings here were also large. Special extra measures were taken for those openings. Even if you only use it as an exterior wall cladding, the openings must not exceed a certain size. There were 9-10-meter openings in that structure, which is quite a large opening.

Table C.25 Answers to the Construction Duration (T4)

Building-1	It took approximately 1 year.
Building-2	Both projects lasted between 9 and 12 months.
Building-3	
Building-4	We carried out this project in stages. Each stage took 2 months. In total, the entire process took about 1,5 to 2 years.
Building-5	The interviewee was unable to provide clear information on this issue.
Building-6	We requested an extension for this project. We had originally set the project duration at 365 days, but with their approvals, we will likely complete it in about a year and a half.
Building-7	We completed all the interior and exterior rammed earth walls in three months.

Table C.26 Answers to the Stakeholder Communication on Site (T5)

Building-1	Of course, I couldn't find a worker-master who worked with soil. We knew a plasterer master beforehand, and he found someone to work with him. I was always there at the beginning anyway.
Building-2	The team that specializes in standard reinforced concrete, which we are already familiar with, handles the foundation part, and that's where their work ends, really. We worked with a good team of carpenters in Izmir for the wooden support system. After the carpenters completed the wooden frame, we worked with a plasterer or bricklayer we already knew for the construction of the earthen walls. So, we worked with local craftsmen throughout the project. There was no need to bring in someone special from Istanbul or elsewhere. It's also beneficial to try to choose the right person here. For example, we had two or three plasterers. They are very good, they really enjoy this work, and they actually prefer working with earth plaster. These are things they know from childhood; many of them say things like, "We grew up in adobe houses, I wish we could go back there," expressing their longing. Here, of course, when we first start handling the mortar or the mix, I give them some guidance. The important thing here is that they are curious and enthusiastic about this material. It was very difficult at first, of course, but as they worked, they got used to this material and everything became easier. In fact, I think we can say this: Plasterers and bricklayers with a certain level of skill don't find it too difficult because the material itself isn't overly challenging.
Building-3	
Building-4	When starting a new job in a new location, we provide 3-5 days of training to the experts and then follow up on the work. So, if someone knows how to do it, they can actually guide the others.
Building-5	
Building-6	There was a civil engineer working with me who knew a bit about these things. We also worked together on the reinforcement project. We reinforced the building inside and out using the cage frame method, for example. I remember X saying at the time, "This adobe is really good adobe. It has lasted until now and withstood adverse conditions. If it had been done better and hadn't been left for so long, who knows how it would have turned out." We also found local people who had done this work before for the earth plaster. Our woodworker was good, and the person who did the adobe plaster was also very good. Someone who knew the one main two lamb wall construction method used for village houses locally had come.
Building-7	Standard teams received specific training. In other words, there were no special individuals. All of these people were local.

Table C.27 Answers to the Earth Material Procurement (T6)

Building-1	There was a place outside the city that produced this material. We ordered adobe bricks from there, and a truck arrived. No tools other than standard tools were needed when building the adobe walls. We sourced the Horasan mortar used on the exterior and the reed mats for insulation from here.
Building-2	No, standard tools were used. Things that all craftsmen already have with them. We buy the adobe bricks ready-made. In the past, for example, they would start making the adobe bricks in the garden months before construction. Of course, those days are long gone. Now you make a phone call, and three days later, twenty thousand adobe blocks arrive at the construction site, ready to use. So this is no longer a constraint. The same applies to earth plaster. In the past, earth plaster was mixed on site, applied by hand, and finished by hand, but today we also buy ready-made earth plaster.
Building-3	
Building-4	We prepared a mixture using soil from the nearby area and built the rammed earth walls. I also built a machine myself for mixing. Other than that, we didn't use anything else.
Building-5	We used local earth from another location. We tried excavated earth but found it unsuitable. Another type of earth from the immediate vicinity was used. Since some machines would be costly for individual jobs, I developed some machines myself. I made the mixing machine myself. It is a portable, mobile machine. I made an attachment for a 10-kilogram Hilti drill to compact the soil. I have been using it for a long time. We can use it easily anywhere there is 220-volt electricity. You can compact the soil better than with a compactor. There is no ready-made mixing machine on the market for mixing soil.
Building-6	I don't know where the adobe bricks came from. Because when I started working, all the walls of this building had already been completed. But I guess they were found nearby, so the material might even have been sourced locally.
Building-7	The earth is local, from the nearby area. Only the mold system was required. The steel molds required special production due to their shape. That's why they were brought from Ankara. Other than that, we sourced the equipment we used from here.

Table C.28 Answers to the Construction Process (T7)

Building-1	We had to use reinforced concrete for the foundation, so we built a raft foundation. Our load-bearing system was made of wood. We used adobe bricks for the walls. We built walls of different thicknesses depending on the facades. Reed was used for insulation where needed. An extra waterproofing material was used on the north and northwest facades, where the wind from the mountains is strong, covering the bathroom as well. Adobe was placed between wooden slats as filler. The building was covered with Baghdadi slats on the outside and finished with Horasan mortar plaster. After laying the adobe blocks on the interior walls, we first worked with the remaining adobe material we had on hand, mixing it with some adobe, between the wooden studs. We then ordered the rough and fine plaster.
Building-2	Since there are no regulations for masonry buildings, it was not possible to obtain a permit, so reinforced concrete foundations and a wooden load-bearing structure were used in this project. The floor is wooden planking. The walls are adobe brick + compressed earth panels. The roof is a corrugated metal roof and flat roof.
Building-3	Since there are no regulations for masonry buildings, it was not possible to obtain a permit, so reinforced concrete foundations and a wooden load-bearing structure were used in this project. The floor is solid wood parquet. The walls are adobe brick + straw-reinforced rough earth plaster. The roof is a tiled pitched roof.
Building-4	There was a reinforced concrete foundation and load-bearing rammed earth walls. The roof was a wooden structure.
Building-5	It has a reinforced concrete foundation. The ground floor beams are reinforced concrete, while the upper floor and roof are steel. We used rammed earth walls only in certain sections of the walls, where the seed room is located. We used terrazzo on the floor. We considered rammed earth flooring. But I think it's a good thing we didn't go for it because I think we would have had problems there too.
Building-6	It was a masonry structure. It was covered in natural stone from the foundation to the subfloor. I didn't see them using concrete, but they might have; I'm not sure. But what I saw was stone cladding. The structural system was made of adobe and wood. All the walls were adobe walls. We applied earth plaster and a plastic-based paint on top for a clean look. We also used wood on the floor. Of course, we used ceramic tiles in wet areas.
Building-7	The building is already a completely reinforced concrete structure. Only the earth walls surround the reinforced concrete structure from the outside, meaning they are not load-bearing. So, the load-bearing system and foundation are reinforced concrete. The walls are rammed earth walls. We used ceramic and marble on the floor. The roof also has a reinforced concrete slab. We completed it by applying the necessary insulation.

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