

RESEARCH ARTICLE

Open Access



An approach for the reconstruction of a traditional masonry-wooden building located in an archeological area. Part I: Methodology

Cemil Akçay¹, Nail Mahir Korkmaz² and Baris Sayin^{3*} 

Abstract

This study, presented in a pair of articles, defines a comprehensive methodological approach to the reconstruction of a traditional masonry-timber mansion building constructed in the 1880s of the Turkish house typology on Istanbul's historical peninsula area that was intentionally demolished in 1948. A historical process research was carried out in the first stage of the study, after which ground penetration radar measurements and an archeological excavation were carried out to determine any possible remains or ruins of the structure, and the original architectural features of the demolished building were ascertained from the obtained data. The proposed stages in the current paper can be considered a comprehensive approach to the determination of the authentic properties of demolished or destroyed buildings in historical areas, given that the methodology allows for the integration of construction features obtained separately and independently through different activities, such as excavations, georadar measurements and historical surveys. The result is a versatile approach to the complete and realistic reconstruction of historical buildings.

Keywords: Cultural asset, Demolished building, Reconstruction methodology, Ground penetration method, Archeological excavation

Introduction

The current study presents a comprehensive methodology for the reconstruction of historical buildings. The entire process is illustrated through a case study of a historical building that was intentionally demolished in 1948 (Fig. 1). The building, known as *İbrahim Efendi Konağı*, was built in the 1880s on Istanbul's historical peninsula, and as a prime example of the traditional Turkish houses built in the *Süleymaniye* region at the time, it has considerable historical significance. The building served as a secondary school until 1945 and was demolished in 1948, and while aerial photos from 1950 and 1966 show

two buildings, no buildings have been constructed on the site since 1982. The original architectural features of the building were ascertained in three stages: (i) a historical process research, (ii) ground penetration radar measurements, and (iii) archeological excavation. The original form of the building in terms of its façade and plan was determined in the present paper. The reconstruction applications will be described in Part II of the study.

Cultural assets are destroyed by both natural events, such as earthquakes, or by fire, or may be completely demolished as a result of anthropogenic factors, urbanism movements, wars, and vandalism over time. Historical buildings that are symbolic of a political view, on the other hand, may be demolished by people with different views. The term "restoration" refers to the return of a place to an earlier known state through the removal of accretions or the reassembly of existing elements without

*Correspondence: barsayin@iuc.edu.tr

³ Department of Civil Engineering, Istanbul University-Cerrahpasa, 34320 Istanbul, Turkey

Full list of author information is available at the end of the article



Fig. 1 The project area (white-marked by dashed lines) (left); 3D illustration of the proposed building (right)

the introduction of new material. Reconstruction, on the other hand, is a building process in which the first known state of the building is recreated [1]. Ancient materials must be preserved through the addition of further elements to achieve an adequate degree of safety and functionality. The reconstruction of a building that is defined as cultural heritage, however, should only be carried out in exceptional circumstances, while the reconstruction of partially or completely demolished buildings may be acceptable if sufficient documentation is available [2]. In this respect, one of the most important stages in a reconstruction is the restitution stage, in which the original building features are determined. At this stage, many sources are accessed, such as old photographs, documents, technical specifications, drawings, similar building typologies and communications related to the period. The parameters can then be associated with each other to ascertain the features of the original building.

Süleymaniye Neighborhood, where *İbrahim Efendi Mansion* is located, is on the coast of the Historical Istanbul Peninsula facing the Golden Horn. This region is one of the important urban areas of the Byzantine, Ottoman and Republican periods (Fig. 2). The importance of this neighborhood increased even more in the Ottoman Period when a palace (Old Palace) built in 1455 after Fatih Sultan Mehmet conquered Istanbul. *Süleymaniye Mosque (Kulliye)*: a social complex including mosque, school, etc.) (1551–1579), the most important work of the Ottoman Classical period, was also built in this region during the reign of Suleiman the Magnificent, and after the *Kulliye* was built, it became

a district where high-level public officials and wealthy merchants lived until the beginning of the twentieth century [3]. The *Süleymaniye* district, namely the *Süleymaniye Mosque (Kulliye)* and the streets around it, have a historical texture consisting of traditional Turkish houses.

The importance of the neighborhood decreased after the establishment of the Republic in 1923, the transfer of the capital from Istanbul to Ankara, and the transfer of institutions related to the central government from the region. The status of the neighborhood also considerably declined due to the establishment of numerous workshops, increased urbanization, fires, and many other sociological, economic, and urbanization-related reasons in the 1950s [4, 5]. At that time, many civil architectural structures were destroyed and still being destroyed due to excessive construction, functional changes, conversion to car parking spaces, insufficient protection. Today, mostly low-income individuals live and student dormitories are located in this region due to its proximity to the university. The night population of the district is very low; there is a big difference between night and daytime populations.

In order to restore the historical texture lost due to various reasons and to protect civil architectural works, cultural property registrations have been made by the High Council of Monuments since 1980 and cultural heritage structures have been taken under protection. The *Süleymaniye* district was declared as a protected site in 1977, UNESCO World Heritage Site in 1985, and a restoration area in 2006. In 2012, a conservation master plan was



Fig. 2 Süleymaniye Mosque (Kulliye) and District [4, 5]

prepared for the entire *Fatih* district, and a Management Plan was created for the Historic Peninsula in 2018.

In 2012, a decision was taken to reconstruct a large number of previously destroyed civil architectural works with the reconstruction method, in accordance with the conservation master plan covering the entire *Fatih* district, which was approved by the Istanbul Metropolitan Municipality, the Fatih Municipality Prime Ministry and the Ministry of Culture—Regional Board for the Protection of Cultural Heritage. The project area marked in Fig. 3 is included in this zoning plan. As the owner of the examined building, the University has prepared projects in accordance with the principles of the conservation master plan and “Intervention Methods/Reconstruction” article of the decision numbered 660 entitled “Grouping, Maintenance and Repairs of Immovable Cultural Heritage” determined by the cultural and natural heritage preservation high board under the Ministry of Culture. Accordingly, the university received approval from the relevant local municipalities and the Cultural Heritage Preservation Board.

Reconstruction approach

Reconstruction is a method that is implemented when a cultural heritage building or a group of buildings are partially or completely destroyed due to natural disasters

such as earthquakes and fires, or man-made causes. Rehabilitation of the society, meeting the housing needs, restoring the symbolic value of the buildings for the city and society, as well as preventing the loss of social identity and memory are among the reasons for the implementation of the reconstruction method. This also shows the integral role of reconstruction in terms of urban, social, and economic aspects. Moreover, a reconstruction that serves scientific purposes is considered a positive practice, provided it does not damage the original values. International statutes and declarations stated that a reconstruction carried out in very special cases using meticulous and scientific studies based on precise and indisputable information and documents, clearly and not misleadingly indicating that the building is reconstructed will be appropriate [7]. Due to a lack of information about the structural features of design and construction, and insufficient knowledge about the historical process, demolished or destroyed structures are difficult to reconstruct. Therefore, different scenarios should be developed during the planning phase of such practices. Although the unpredictability of many parameters that will be needed in reconstruction is an important problem, the function, duration, and cost of such practices are also among important issues that should be considered [8]. Technical methods and historical knowledge

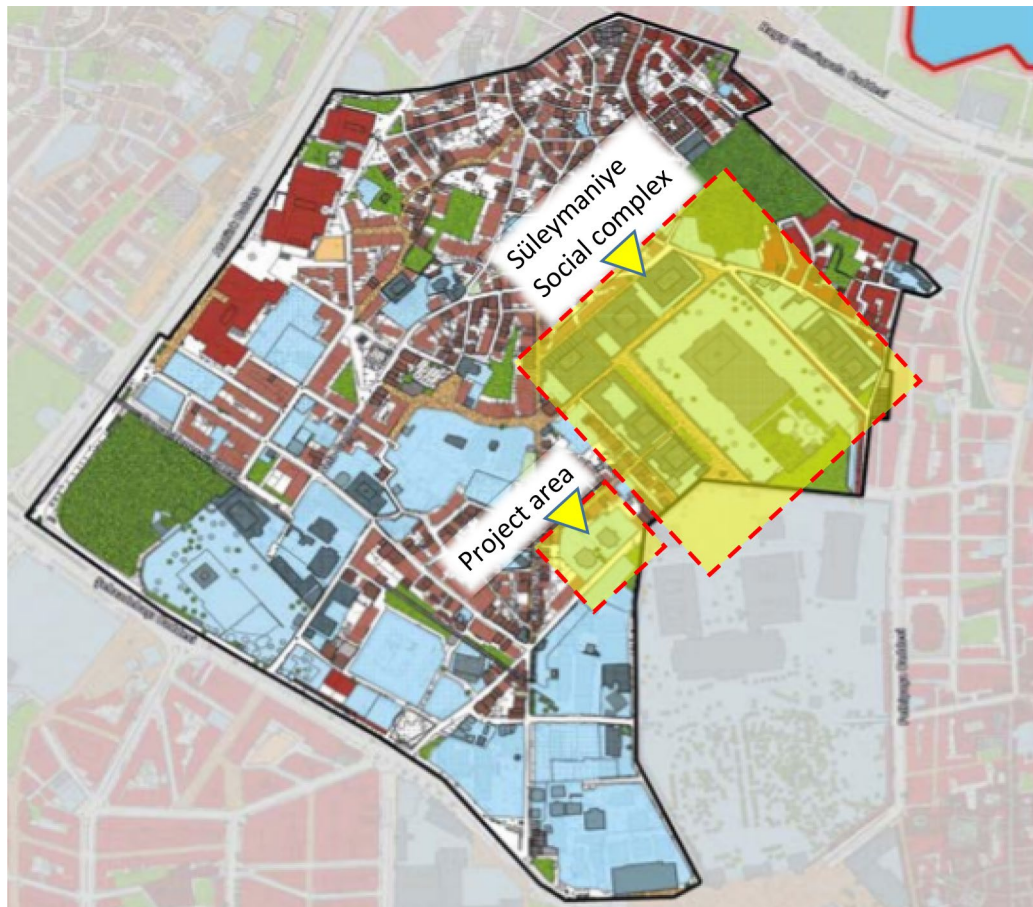


Fig. 3 Conservation master plan for historical peninsula—conservation area of *Süleymaniye Mosque* and its surroundings [6]

are required to preserve the historical characteristics of cultural heritage structures that are aimed to be reconstructed. The aesthetic and cultural values of the building can be achieved by evaluating some specific information and scientific methods together. In the reconstruction process of a building, an approach that focuses not only on the structural elements, but especially on the whole structure should be applied. The reconstruction process requires the use of historical evidence and the characteristics of the original structure, a thorough understanding of the structural elements and material properties, and therefore an interdisciplinary approach [9].

However, more reconstruction practices were carried out than conservation implementations in the twentieth and twenty-first centuries in connection with the destruction caused by the two world wars as well as recent wars in different parts of the world.

One of the interventions to which historical buildings are subjected is the reconstruction approach. Article 10 of the Venice Charter states, “Where traditional techniques prove inadequate, the consolidation of a monument can

be achieved by the use of any modern technique for conservation and construction, the efficacy of which has been shown by scientific data and proved by experience” [10]. Several principals and limitations related to reconstruction processes are defined in the Burra Charter [11], in which Article 18 states “reconstruction should reveal culturally significant aspects of the place”, while Article 19 says “reconstruction is appropriate only if there is sufficient evidence of an earlier state of the fabric”. The following article states: “reconstruction is appropriate only where a place is incomplete through damage or alteration, and only where there is sufficient evidence to reproduce an earlier state of the fabric. In some cases, reconstruction may also be appropriate as part of a use or practice that retains the cultural significance of the place. Reconstruction should be identifiable on close inspection or through additional interpretation”. Accordingly, four approaches to the reconstruction of historical buildings are: (i) The engagement of existing and new elements, (ii) Minimal interventions aimed at improving structural performance, (iii) The reconstruction of new parts that

respect the plan, and (iv) The engagement of new elements and some demolitions [12]. According to the Burra Charter [13], reconstruction is returning to a known previous state by recombining existing elements or canceling additions without using new materials. Also, Article 22 of the Burra Charter published in 2004 states “New work should be readily identifiable as such but must respect and have minimal impact on the cultural significance of the place”. According to Declaration on Dresden [14], a culturally important historical building should only be preserved by reconstruction in exceptional cases. On the other hand, in the presence of appropriate documentation, the reconstruction of a building, a building complex, a district, or a city that has been largely or completely destroyed due to some reasons is an acceptable method. Elimination the risk of social trauma and restoring the sense of belonging are essential elements for using this method [15]. Consolidation of the building is an important intervention option in restorations for cultural heritage buildings. According to Article 10 of the Venice Charter, if traditional methods are found to be not sufficient, a structure can be strengthened with contemporary conservation and construction methods which were determined to be successful based on scientific results and past experience [16]. Natural or human-related factors including wars, natural disasters, economic causes, architectural trends, and the end of material lifetime demolish cultural heritages. But when recognized as historically important buildings, such structures can be reconstructed based on their original characteristics. From this point of view, cultural heritages are architectural artworks that represent past traditions, craftsmanship, methods, and materials.

Reconstruction is the preferred approach in the event of the complete demolition of a historical building or group of buildings that have been defined as a cultural asset. In such situations, the reconstruction has didactic purposes, since new functions focus on the reconstruction of only the external envelope, rather than on construction techniques and materials, such as carpentry, joints, masonry organization, etc. In the case of a partial demolition, repair should generally be the preferred option. Reconstructions are made in line with an expected outcome, such as for the rehabilitation of society; for the addition of symbolic value to buildings in the city and society; and for preventing losses of cultural identity and memory. In addition, the reconstruction process must be implemented carefully to ensure the preservation of the original values, and the process is to be carried out considering the scientific purposes, and should include an evaluation to check whether all tasks in the entire process have been fulfilled. In international codes, it is noted that reconstructions should be made appropriate by relying

on exact information and documents, and by performing scientific studies. The reconstruction of demolished or destroyed buildings can sometimes be challenging due to limitations in the knowledge of the architectural properties and construction approaches, as well as the historical processes. Thus, the planning of a reconstruction should include an assessment of various alternatives. The reconstruction of a historical building should follow a technical approach and should be based on historical knowledge to ensure the conservation of the cultural identity of the building in question. Furthermore, the current international conservation charters and standards should be considered in all of the above-mentioned processes. A reconstruction operation should be preceded by an interdisciplinary study to identify the construction technique, and the structural elements and material features of a building, in accordance with historical documents.

A decision can be made to reconstruct a building that does not exist today in accordance with its original form for different purposes. The first of these purposes is to regain the historical belonging in the region where the building is located. Thus, such a building goes beyond being an architectural work and can continue to be a witness of ancient traditions, construction techniques, and materials. The second purpose of reconstruction is to use the building as a representation, in order to revive a political or to re-establish loyalty to a past state, in other words, to use it as an origin. The third is an educational purpose by using the reconstruction process as an important part of a scientific research project. In this regard, experiencing the process makes it easier for experts to understand the past, whereas providing non-experts with new information about the whole work. For example, in Japan, the Temple of Ise is renewed every twenty years as a religious cult; the reconstruction of the temple serves both instructive purposes and the preservation of a tradition and intangible values [17]. On the other hand, reconstruction is a method also used for tourism purposes or to increase public/private sector revenues. The Hwangnyongsa temple in the Republic of South Korea is an example of this [18].

Various opinions can be sought when deciding whether or not a reconstruction is appropriate. The opinions against reconstruction claim that reconstructed buildings are little more than imitation, and do not reflect the true value of the demolished building. New construction systems and techniques have emerged since the construction of the building examined in the present study, and from this point of view, questions may be raised regarding the preservation of the original building system and/or construction technique of a demolished building in a reconstruction application. One such issue is the interaction of a studied building with its neighboring

buildings in the design stage, while another is the seismic performance and the results of the needs analysis in the selection of an appropriate construction type and construction materials. Although the use of the original building's construction methods and material properties is the main preference in reconstruction applications, if these methods and materials are not suitable for particular reasons or limitations, methods and materials whose suitability has been scientifically determined may also be preferred.

The background

Historical buildings are defined as cultural assets that are considered a part of a national and/or international identity [19]. Such buildings may disappear over the years for various reasons. In the reconstruction of such buildings, many issues should be considered. It is crucial to seek balance between several parameters, such as refunctionality and need, to ensure that the cultural and architectural values are not damaged when the functions of historical buildings are changed to meet current and future needs. The reconstruction of the structures to their original state in the period in which they were built is an important factor in the protection of the cultural and historical value of a building [20–22]. In addition, the relationship of the building with the environment is also to be taken into consideration in reconstruction efforts [23, 24], for which there are various approaches, including model-based methods and BIM, in reconstruction [25, 26]. An approach to the planning of construction projects, including those involving the reconstruction of historical buildings are presented. To overcome the problems associated with the reconstruction planning of structures, especially those of historical significance, a digital tool has been described that was utilized in the modeling and analysis phases of a project to reconstruct a historical retaining wall. In another approach, reconstruction projects were prepared based on a statistical analysis and multiple criteria decision-making methods, making use of BIM technologies [27], and a methodology proposed for the identification of problems with the potential to influence the design, construction and maintenance of reconstruction projects. The advantages brought by BIM to the avoidance of preidentified problems in reconstruction operations were subsequently discussed. When dealing with the reconstruction of structures, structural safety and the results of a needs analysis are also considered in the selection of the optimum structural system and materials. In a related study, Pohle and Jager [28] reported on the reconstruction needs of a masonry building, based on their investigation of the characteristics of the building and functional requirements from the reconstruction, as well as the materials to be used in the reconstruction.

Financing and duration are other criteria that need to be taken into account related to a reconstruction project. In a study addressing this issue, a financial model was proposed for the reconstruction of residential structures following an earthquake [29], with critical issues such as the timing and funding of the reconstruction also being analyzed. The reconstruction efforts following earthquakes [30–32] may include the renewal of all buildings in a region through reconstruction or strengthening [33]. Post-earthquake reconstruction is a complex field, with economic, social and technological aspects, including those related to reconstruction [34], and decision-making methodologies have been suggested to guide reconstruction operations following seismic events. The attitudes of central and local governments towards post-disaster reconstruction in terms of disaster assessment, reconstruction management and the current policies should be investigated [35], and to this end, a comprehensive reconstruction scenario has been put forward for earthquake-affected regions [36]. In the next stage a series of tasks should be performed for the reconstruction of buildings after a disaster, ensuring their careful implementation [37]. In this stage, 3D visualization approaches are applied to steer the reconstruction based on old maps, plans, and drawings after they have been sufficiently digitized and quantified [38].

The scope

A remarkable number of researches exist putting forward various approaches to the reconstruction of destroyed buildings, and many such studies have reported the reconstruction process of buildings that have been partially or completely destroyed by earthquake or fire. This study, which is presented in two parts, describes the reconstruction process of a specifically selected three-story traditional masonry-timber building with a semi-basement and some unique features that was built in the 1880s and demolished in 1948 due to anthropogenic reasons. Since that time, a number of buildings have been built on the site but later demolished. In 1/1000 conservation master plan, only the original building was given permission to be built on the site, preventing any modern construction, and so to satisfy a need of Istanbul University for new buildings, as the owner of the site, a decision was made to reconstruct the building for use as an administration facility. In the first part of this two-part study, a comprehensive methodology is presented for the reconstruction of historical buildings.

The first three stages of this methodology are presented in the current paper, while the reconstruction phase and the other three stages are described in Part II [39]. The methodology proposed in this paper can be considered an effective approach to the reconstruction

of demolished buildings, and is presented here in four sections: (i) A presentation of the original architectural and structural features of the building based on historical documentation, (ii) GPR measurements for the determination of archeological findings and any remains of the original building on the site, (iii) An archeological excavation of the construction site based on the GPR measurement results, and (iv) a presentation of façade views as well as floor and roof plans as the architectural features of the original building.

Methodology

Insufficient information about the historical background, architectural, and construction techniques of a cultural heritage building make the preparation of design projects for the reconstruction of such a structure difficult. This is why preparation and planning stages of reconstruction practices should include alternative practices. In specific reconstruction practices, many factors are uncertain, on the other hand, whether such factors are mandatory, their duration, and cost also cause issues [40].

To preserve the cultural identity and historical characteristics of cultural heritage structures, such buildings should be reconstructed using scientific data and information about their cultural history. Only implementing such specific knowledge and the scientific approach may preserve the aesthetic and historical values of a heritage building. Instead of focusing on structural members, a reconstruction practice must target the entire structure. An interdisciplinary approach, as well as documents regarding historical purpose of the heritage building, are required to achieve a complete understanding about the construction method of the structure and material properties of its components.

In the reconstruction of a building or building complex, the entire region and city must also be considered in addition to the structure itself. A sensitive and careful method should be implemented for the existing structure. High costs can be a major barrier to the reconstruction of such cultural heritage structures. Accordingly, some historical buildings are transferred to commercial organizations. These organizations undertake the preservation, reconstruction, and adaptation of structures for new social purposes [41]. Therefore, reconstruction can be considered the most complex way for the transformation of a building. Changing the technical and economic condition or function of a building, as well as improving working conditions, service quality, and increasing the scope of service are associated with changing the volume and appearance of the building [42, 43].

The proposed methodology can be considered a comprehensive and appropriate approach to the reconstruction of demolished or destroyed buildings, and is

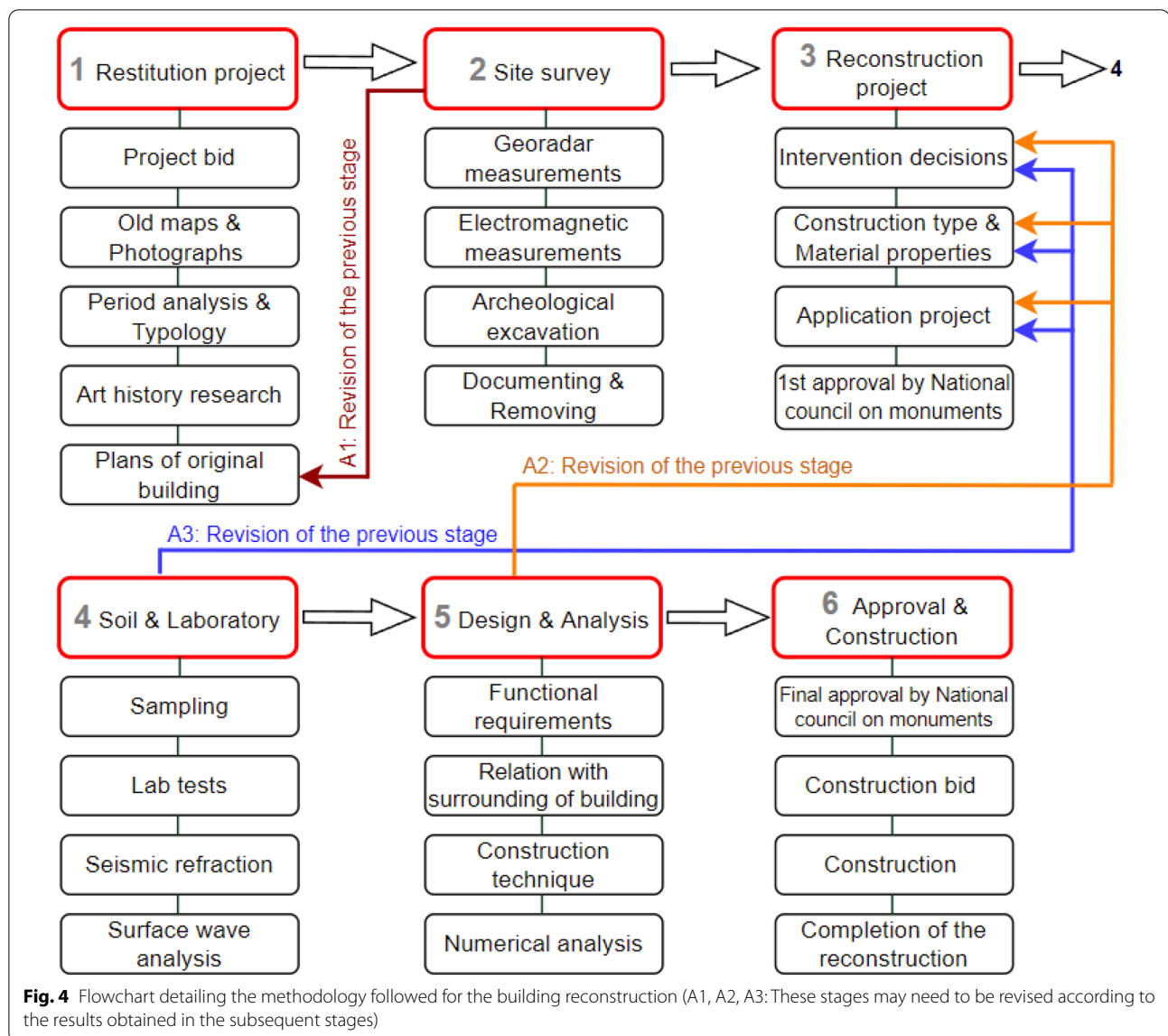
conducted in six stages, with each stage providing data for the subsequent stages. Figure 4 presents the methodological approach to perform the reconstruction process.

The proposed project is not realized linearly step by step. For example, the first stage includes preparation of the restitution project with information gathered from old maps and photographs. However, depending on the data obtained in the second stage, the project prepared in the first stage is subject to change. To put it another way, the outputs of the first stage can be revised. Similarly, intervention decisions, construction, and material properties are determined in the first three stages and then are submitted to the board for approval. Decisions made in the 3rd stage can be revised and resubmitted for approval, depending on the evaluation of the data obtained during the soil and laboratory studies in the 4th stage. Plus, as a result of the practices performed in the 5th stage, the restoration project prepared in the 3rd stage can be revised again. As described here, back and forth shifting between the stages may be required. Persons with different expertise are employed at these stages. For example, while an architect and an art historian work at the 1st stage, an archaeologist, geology and geophysics engineer at the 2nd stage, an architect and restoration specialist at the 3rd stage, a civil engineer and geological engineer at the 4th stage, a civil engineer and an architect at the 5th stage, and at the last stage, a progress payment personnel, architect, electrical, mechanical, and civil engineers are required.

The first stage involves historical research, for which historical documents such as specifications, photographs, official decisions and maps related to the building were obtained. Then, the common building typologies, structural elements and material properties from the time the building was first constructed were investigated. The obtained information served as reference data for the examined building.

In the second stage, georadar measurements were carried out in the area in which the building was located to identify any remains or possible archeological findings that may have belonged to the original building. Any anomalies that could indicate the presence of foundation ruins detected in the georadar study were investigated with archeological excavations, and any findings uncovered by the excavation work were documented and removed from the site for exhibition at an appropriate location.

In the third stage, the plan and façade features of the building were ascertained from the data obtained in the first two stages. Accordingly, the size of the building spaces and their relationships with each other were calculated, and the features of the interior doors and windows, the window forms on the façade and the cascading



were determined. At this stage, the construction type and techniques were investigated and the material properties of all structural and non-structural elements were determined. In cases where the planning scheme of a demolished building cannot be obtained, the plan types of buildings from the same period are considered, from which floor plans and façade features can be prepared. The *Süleymaniye* district, where the examined building is located, has experienced many fires and earthquakes, and so new materials with appropriate seismic and fire-resistant properties should be used in buildings to be constructed in the area. The use of original materials (especially timber) can be financially difficult for the user due to the constant maintenance costs and unsustainable use. Currently, the reconstruction of such buildings

is quite laborious and expensive, and furthermore, user satisfaction is linked to specific features of the building related to low heat loss, sound-acoustic performance and new technological infrastructures. For example, the original guillotine windows on the exterior façade lead to significant heat loss as the original details of these windows cannot prevent heat transitions, thus increasing the heating costs of the building. Moreover, insulation and plaster coatings to the inner surfaces of external walls both prevent water penetration and provide thermal insulation at the maximum level. Also, an elevator system had to be included in the design to make the building disabled-friendly, which was not a requirement in the original building. In this case, it may be apparent to users that the reconstruction works were carried out considering the

different construction periods. The results of these initial project stages were submitted to the relevant municipalities and cultural asset protection boards for approval, as a mandatory step prior to the launch of the next phase.

In the fourth stage, boreholes were drilled, and seismic refraction and surface wave analyses were carried out to determine the soil characteristics. The data obtained in this stage were used in a structural numerical analysis.

In the fifth stage, the original building system, the applied construction techniques and the construction materials may be revised considering seismic effects, functional requirements, and the building-environment relationship. In other words, sometimes original building plans may not be considered. In this case, a new spatial organization to suit the new function of the building was arranged for the reconstruction project, ensuring the original façade layout was maintained along with its material properties. On the other hand, the use of modern building materials may be preferred instead of the original materials to suit the new function, although in this case the construction area and plan features of the building were preserved. A structural model was prepared based on the selected steel-frame construction system, and considering seismic effects, a numerical analysis of the model was carried out, and thus the dimensions of the structural members were determined. Final design and construction projects were then prepared based on images of the original façade and the plan features of the building utilizing all the obtained data.

In the sixth and final stage, the prepared reconstruction project proposal was submitted to the relevant municipalities and cultural assets protection boards for approval, and after approval was granted, the construction bid phase were completed. During the application process, the structural members were produced and transported to the construction site, and the construction began.

The original building served as a residence and a school building, however the University had no need for a building with such functions and so the floor plan of the building was redesigned to include technical office spaces, in accordance with the needs of the University. The sustainability of a building depends on its usefulness and its satisfaction of requirements. Since the original interior details (layout, materials and configuration) were unknown, instead of a fictive interior design, a building was designed that met the current needs of the University, but with its original appearance, thus contributing to the preservation of the historical memory, and the project was sent to the Ministry of Culture Protection Board for approval. The original load-bearing system could not be adopted due to the current seismic regulations related to public buildings. Furthermore, while the maintenance

and sustainability of timber buildings is possible for relatively small structures, in the present case, it was not applicable due to the size of the building.

A reconstruction project was prepared for the site, which is detailed on the 1/1000 conservation master plan, and was granted approval by the relevant conservation board. The application was made in accordance with the approved project. We believe the contribution of the project to the cultural environment to be very high. Since the project site is within the *Süleymaniye* quarter, it attracts the attention of many local and foreign visitors, and a sign has been placed at the entrance informing visitors that the building has been reconstructed. The intention in the project was not to create a new history, but to offer a common value and make to contribute to the cultural environment and the University.

Literature contains many studies charting the reconstruction of buildings that have been damaged or collapsed as a result of an earthquake, and in these approaches, the existing/available materials associated with the buildings that were affected by seismic effects have been used in the reconstruction process. The methodology presented here is proposed for buildings that have been intentionally demolished or destroyed many years ago of which there are no surviving materials or ruins other than the foundations. Hence, the proposed approach differs from other methodologies in certain aspects, and so can be considered appropriate for demolished or destroyed masonry or timber buildings. But this approach is not suitable for structures destroyed or collapsed by exposure to destructive effects including earthquakes and fires.

The historical context of the building

The masonry-timber building detailed in the present study, known as *İbrahim Efendi Konağı*, was constructed in Istanbul in the 1880s (Fig. 5), and comprised a partial basement, a ground floor, and two further floors (Fig. 6). The mansion original stood on a site that now belongs to Istanbul University in the *Süleymaniye* neighborhood of the Fatih district on the historical peninsula of Istanbul, which has been included on the UNESCO World Heritage list [44]. The examined building is located in a renovation area [45, 46]. The area and the subsurface remains were decided to be registered as a cultural asset by the Istanbul Renovation Areas Protection Regional Board of Cultural and Natural Assets, based on the qualifications specified in Law 2863 on the Protection of Cultural and Natural Assets [47], and in accordance with Article 18 of the Law, the building falls under Protection Group II. The reconstruction application was accepted upon a decision of the Superior Council of Cultural and Natural Heritage [48, 49]. Based on photographs in the archives

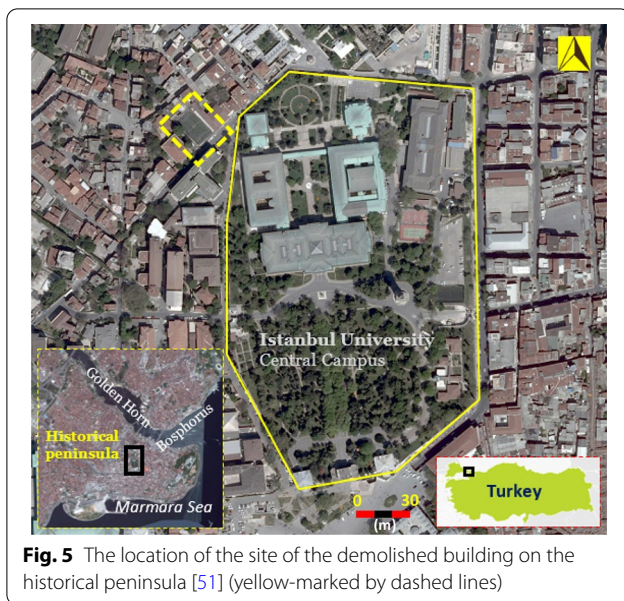


Fig. 5 The location of the site of the demolished building on the historical peninsula [51] (yellow-marked by dashed lines)

of the German Archeology Institute and the Abdulhamid II Collection, we concluded that the examined building was constructed in the 1880s. The building is described as a secondary school on the German Blue Maps from 1913, the Pervititch maps of 1935 and the Istanbul aspect map of 1945. The building is absent from a photograph dated 1948 (Figs. 7 and 8), leading us to conclude that the building was demolished some time between 1945 and 1948. In photographs dated 1950 and 1966, in the decades following the demolition of *İbrahim Efendi Konağı*, two buildings can be seen on the site (Fig. 9a, b), while a 1982 photograph shows the site to be empty (Fig. 9c), and no construction has taken place since.

Field study

Ground-penetrating radar (GPR) is a significant underground scanning technique that is mostly preferred in the initial stages of field researches, and so was considered for the development of the project. Georadar measurements were conducted to identify any evidence of the foundation ruins of the original building, or the presence of possible archeological findings [50].

Georadar method

A field study was made of the site of the building (Fig. 10). The area is currently serving as an outdoor sports facility within Istanbul University. For the GPR measurements, a Zond 12e-brand georadar control unit, transceiver antennas and battery were used, and a total of 1480 m measurements were taken on the site along 41 lines with 300 and 500 MHz antennas. Accordingly, two- and three-dimensional radargrams were obtained from the

continuous form measurements along with parallel profiles, and any anomalies detected on the radargrams were transferred to radargram diagrams. Using 2D radargram sections and 3D radargram block diagrams, the anomaly distributions were specified, and the anomaly images were thought to indicate the foundations of the original *İbrahim Efendi Konağı* (Figs. 11, 12). In the 3D radargram sections, the distribution of anomalies below ground was determined in 3D sections prepared by selecting the equivalent amplitude distributions (Fig. 13).

Following the field research, it was ascertained that the GPR data could make a clear identification of foundation ruins, since the examined area was littered with the remains of former buildings, and the fact that the site had undergone considerable compaction and infilling to allow the ground to serve as the sports field for which it was being utilized at the time of measurement. Furthermore, the contribution of 2D and 3D imaging anomalies from the GPR scans was only limited.

Archeological excavation

Based on the findings of the georadar surveys, archeological excavations were carried out to identify any existing foundation ruins and to any ancient findings in the construction area. The excavation locations are given in Fig. 14a. A total of four boreholes were drilled for excavation analysis: Borehole no. 1, measuring 3.1 m × 2.3 m, was made in the eastern corner of the plot, while borehole no. 2, measuring 3.3 m × 3.6 m, was in the southeast of the area. During the excavations carried out in these locations, various marble items were found at different depths, the geometric and material properties of which are presented in Table 1. The finds were relocated to a place within the Central Campus of Istanbul University, where other fragments were also collected (Fig. 14b).

Borehole no. 4 in the center of the site produced a remnant of which the formal features and architectural characteristics were unclear (Fig. 15). An examination of the general appearance and the construction technique applied to the item suggested that it came from a cistern (reservoir, water tank) that was probably built in the Late Ottoman era (the 18th or nineteenth centuries). The mass of the item was around 400 kN, and in situ observations and examinations showed that material deterioration had occurred in some structural materials, such as brick, stone, joints, fillings and plaster mortars. Furthermore, another small reservoir with relatively weak joints and grouts was identified in the northern part of the first construction area. In parallel to this, it was understood that the mortar on the architectural find had significantly lost its binding properties. The Cultural Assets Preservation Board decided that the finding had no architectural or historical value, and could thus be removed from the

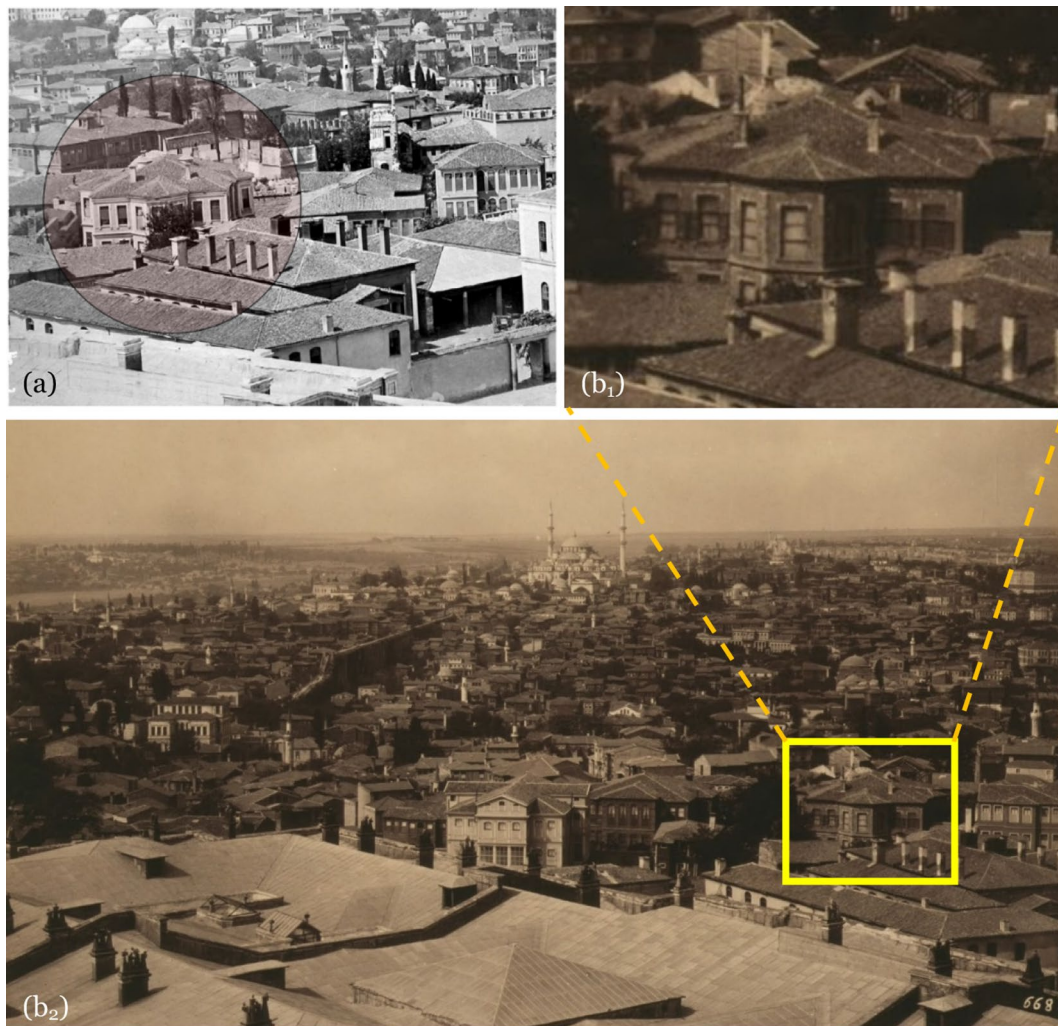


Fig. 6 The view of the mansion building in the 1880s from (a) DAI [52] and the (b1, b2) Abdulhamid II Collection [53]

area. After the completion of the documentation procedures, the remains were removed, and excavations restarted for the construction of the retaining system. The justification for the selection of a well foundation as the retaining system is presented in detail in Part II, "Georadar method" section of the study [39].

An excavation was also carried out for the well foundation-shear wall on all sides of the construction area (Fig. 16). Soil embankments were identified during excavations on the north, west and eastern edges of the site, while the remains of a stone wall at a depth of 2 m were determined during the excavations to the southwest part. The wall, which was built using a mud and sand mortar, measured 0.6 m high and 0.26 m wide, and ran in a northwest-southeast direction, and three cut stones were found behind it, side-by-side, at a depth of -1.85 m, that were determined to be unconnected. In another

excavation carried out in the southwest of the site, foundations from the Turkish republic era were identified that were assumed to belong to buildings constructed following the demolition of *İbrahim Efendi Konağı* in 1948 (Figs. 17, 18).

During the excavations for the construction of the well foundation, marble finds of various types and dimensions were identified at different depths (Fig. 19), the geometric and material properties of which are given in Table 2. It was decided to carry out an excavation work of the entire area under the supervision of the Directorate of Istanbul Archeology Museums, since it was believed that more unearthed remains could exist across the construction area [59], although no such cultural assets, whether movable or immovable, were found during these excavations. All remains were documented with survey reports and photographs and were removed from the site [60]. Thus,

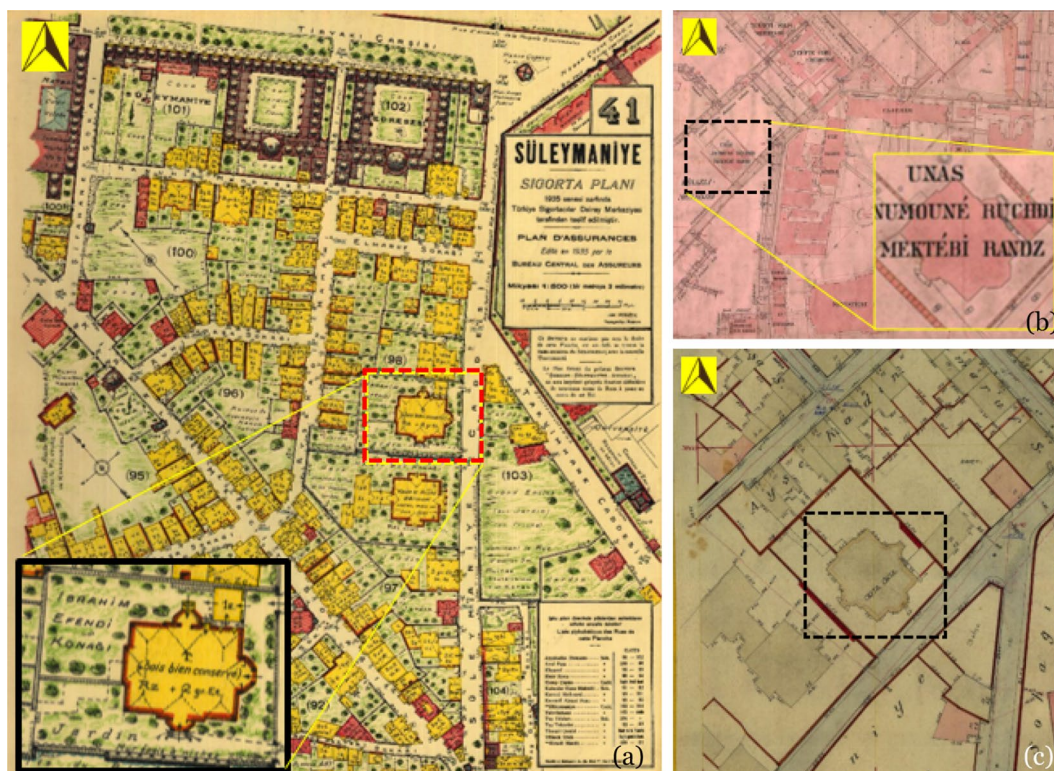


Fig. 7 View of the building on old maps. **a** 1935 [54], **b**, 1913 [55], **c** 1945 [56]

no ruins of the foundations of the mansion building were identified during either the archeological or well foundation excavations.

The archaeological excavation was initiated in the light of the GPR data. During the excavation, the possibility of finding a cultural layer was considered, and so the process was carried out for the entire area. The cistern base identified on the construction site is thought to have been linked to the original building, although all of the remains revealed during the excavation were the archaeological fill or residuals from the other buildings constructed after the demolition of the original building. With the excavation, the potential destruction of a cultural layer was eliminated. Great care was taken in efforts to identify the original foundations of the building, but none of these led to any such discoveries. If foundation remains had been found, they would have contributed considerably to the understanding of the building's plan and spatial arrangement.

Architectural features of the building

In the Ottoman period, in addition to their use in daily life, Istanbul's mansions also had official and social functions. All houses with more than 20 rooms were defined as mansions at the time, and they served mostly as the

residences of chancellors such as the grand vizier, sheikh al-Islam and cadilesker, but were also used as government offices. In addition to their use for official business, they were also used to host meetings on science and for the presentation of inventions [61]. *İbrahim Efendi Konağı* was a three-story building with a semi-basement, featuring two timber stories built on top of a masonry ground floor. The building, a masonry/timber mansion, could be considered a large building for its time.

The architectural and structural features of the building were estimated based on: (i) the Istanbul Archeology Institute Archive, (ii) Abdullah Brothers' Albums (The brothers were photographers of international fame during the late Ottoman Era), (iii) historical Süleymaniye photos in the Abdulhamid II Collection, (iv) old Turkish house typologies, and (v) timber mansions in Süleymaniye region. The traditional Turkish house type—primarily two- or three-story timber buildings—was common up until the end of the nineteenth century in the Ottoman Empire, and especially in the regions inhabited by Turkish people, such as in the *Rumeli* and *Anatolian* regions within the borders of the Ottoman state. It was the preferred accommodation type for local people for 500 years, and is well known for its unique characteristics. The relationship of the building in the present study

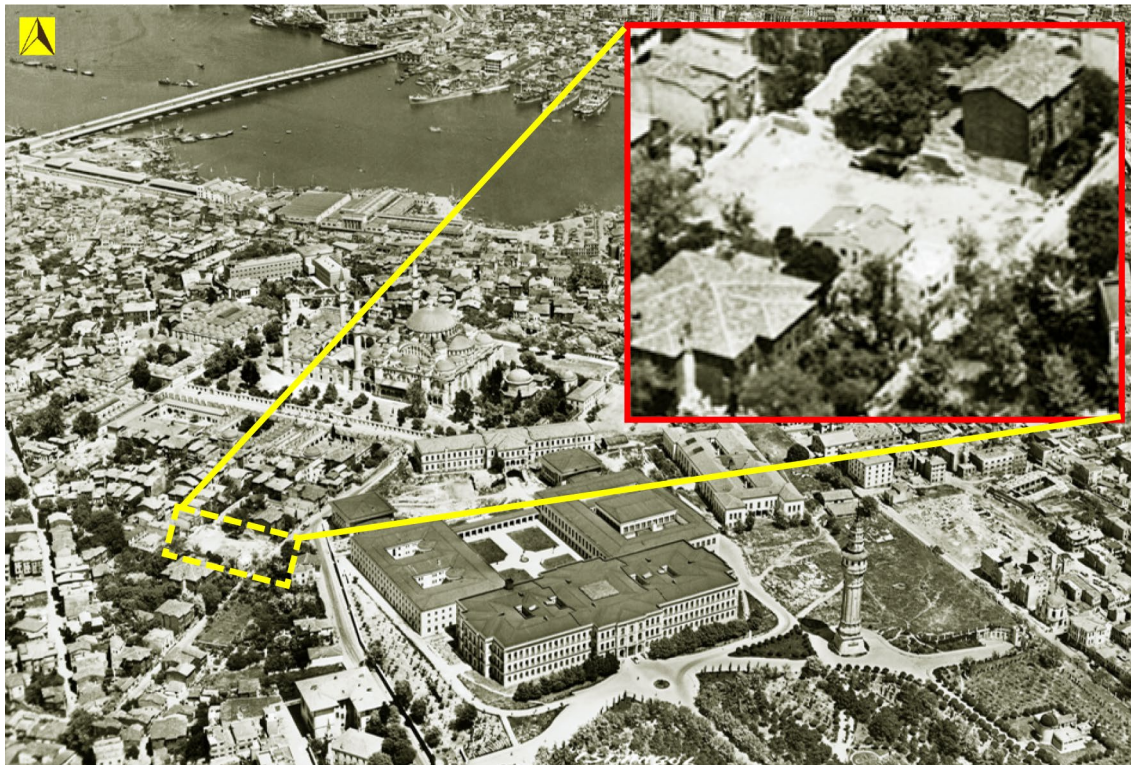


Fig. 8 Aerial view of the area in 1948 [57]

with its surroundings was determined based on information obtained from the German blue maps of 1913, aerial photographs dated 1918 and the Pervititch insurance maps of 1935. The outer façades of the building were determined from the measurements on the map of Istanbul from 1945, while the Pervititch map was used for the entrances to the *harem* (the women's quarters) and the *selamlık* (men's quarters) at the front of each flank, as well as the servant and basement entrances [62–66].

The plans of buildings built in the same period that served the same functions can be used to obtain such missing information as plan type, stair shape, location, the *harem-selamlık* separation and the spaces such as the anteroom in these structures. In this case, spatial planning was made based on the predictions of a typological study. Most of the information about the building was obtained from the Pervititch maps, from which the entrance directions, construction area, material types and simple façade layout were obtained, and as can be understood from the obtained data, the exterior of the building was clad in timber. The *sofa* (anteroom) is the most important space in a traditional Turkish house, and all rooms are accessible through it, and such buildings characteristically have a symmetrical plan with a central anteroom.

In the Islamic culture, houses are traditionally divided into separate sections for men and women, and especially palaces and mansions. The most common plan type in Ottoman-era Istanbul, especially in medium-sized mansions, are therefore buildings with *harem* and *selamlık* sections, with two stories and lobbies. *İbrahim Efendi Konağı* was a medium-sized mansion with a *harem* and *selamlık*, and so carries traces of the traditional Turkish house. The plan types of the timber mansion buildings in the Süleymaniye region, where the building is located, played an important role in the reconstruction of *İbrahim Efendi Konağı*. In such traditional Turkish houses, all rooms are located around an anteroom – known traditionally as a *sofa*. In this plan type, possible changes to the shape, size or qualities of rooms are limited, although the *sofa* can take various forms. Iwans, known traditionally as *eyvan*, are recessed spaces within the central anteroom that are added to bring air, light and decoration to the anteroom. The main factors behind the preference for anterooms in such mansions are the shelter and effective heating the design provides. Turkish house-plan types can be classified as: (i) without anteroom, (ii) with an outside anteroom, (iii) with an inner anteroom, and (iv) with a central anteroom. Locating the *sofa* in the center gives the house plan a squarer or nearly square rectangular

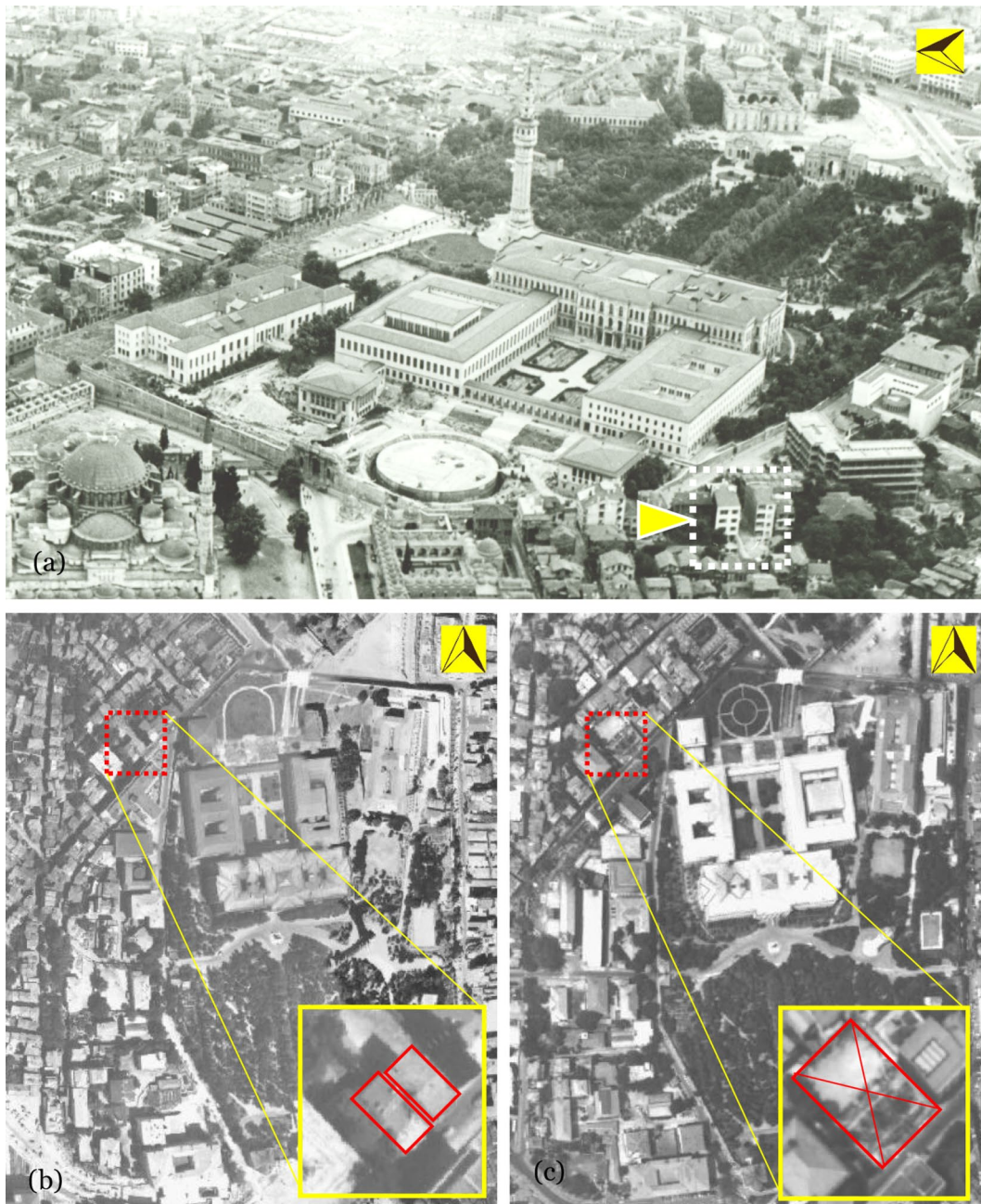


Fig. 9 Views of the area: **a** 1950 [58], **b** 1966 [51], **c** 1982 [51], (marked by dashed lines)

form. In this house-plan type there are generally four large rooms and four corners, between which, service spaces such as stairs, iwans, storerooms and kitchens are located. The plan type with a central sofa allows alternative plan layouts, and so this type was generally preferred over other types in the larger mansions and palaces in Istanbul. *İbrahim Efendi Konağı* features a central anteroom, giving it a symmetrical plan. In other words, the

plan of the mansion matches with the buildings in this typology (Fig. 20).

The examined building is located in the *Süleymaniye* region, where houses with an ancient typology were planned to protect privacy. The houses sit within a garden and are separated from the street by walls. The rooms around the sofa are usually located on the upper floors with views of the street and the garden, meaning

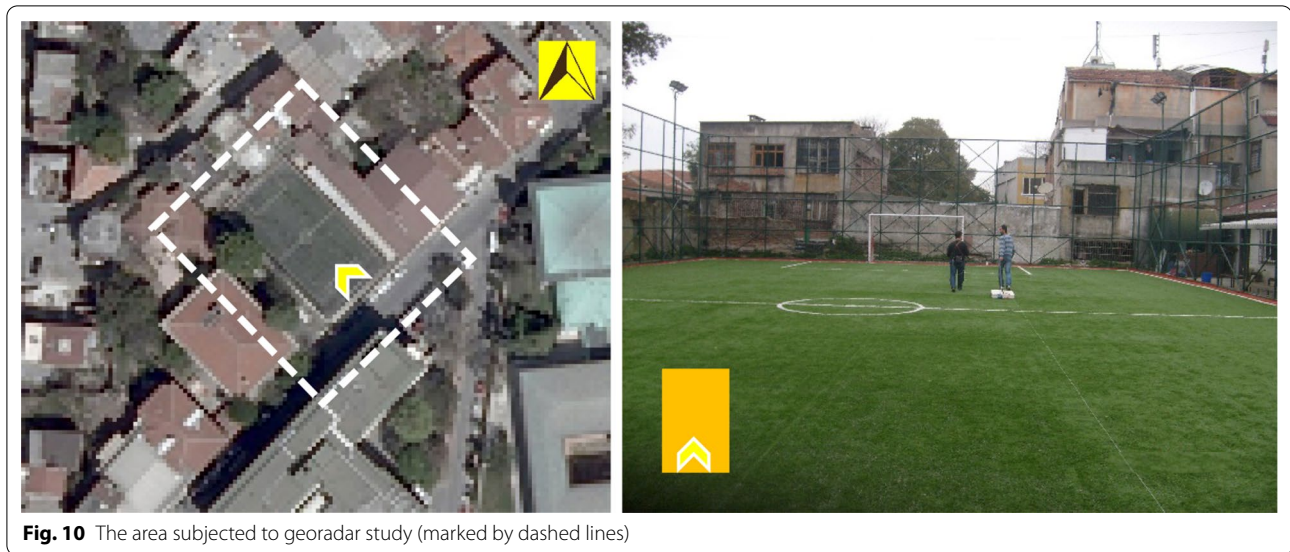


Fig. 10 The area subjected to georadar study (marked by dashed lines)

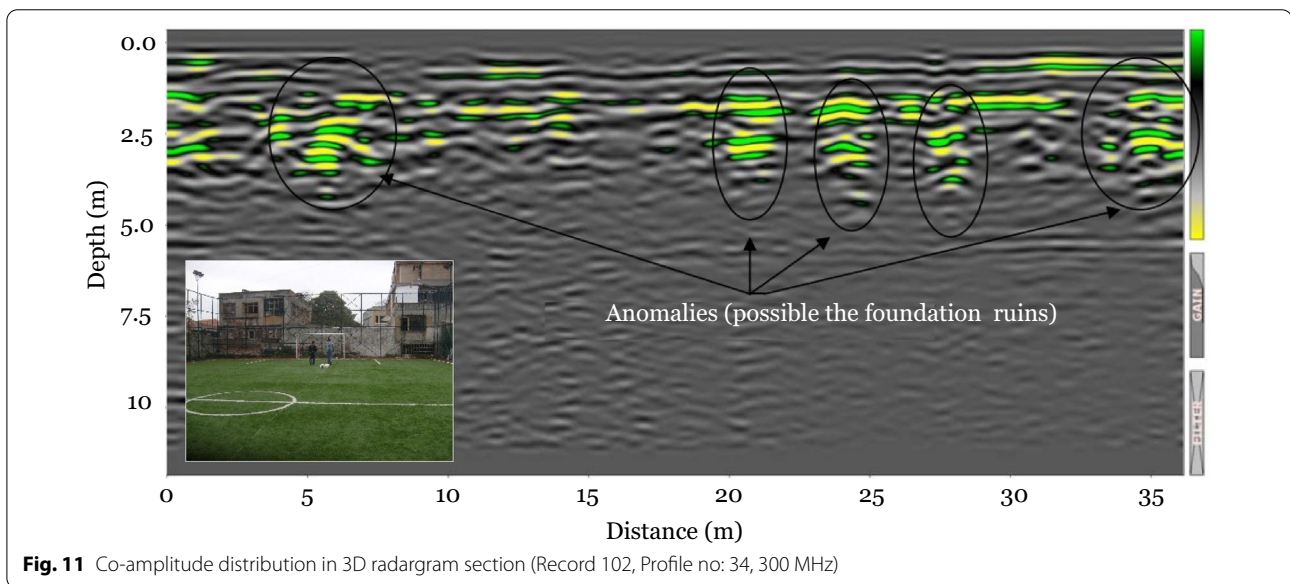
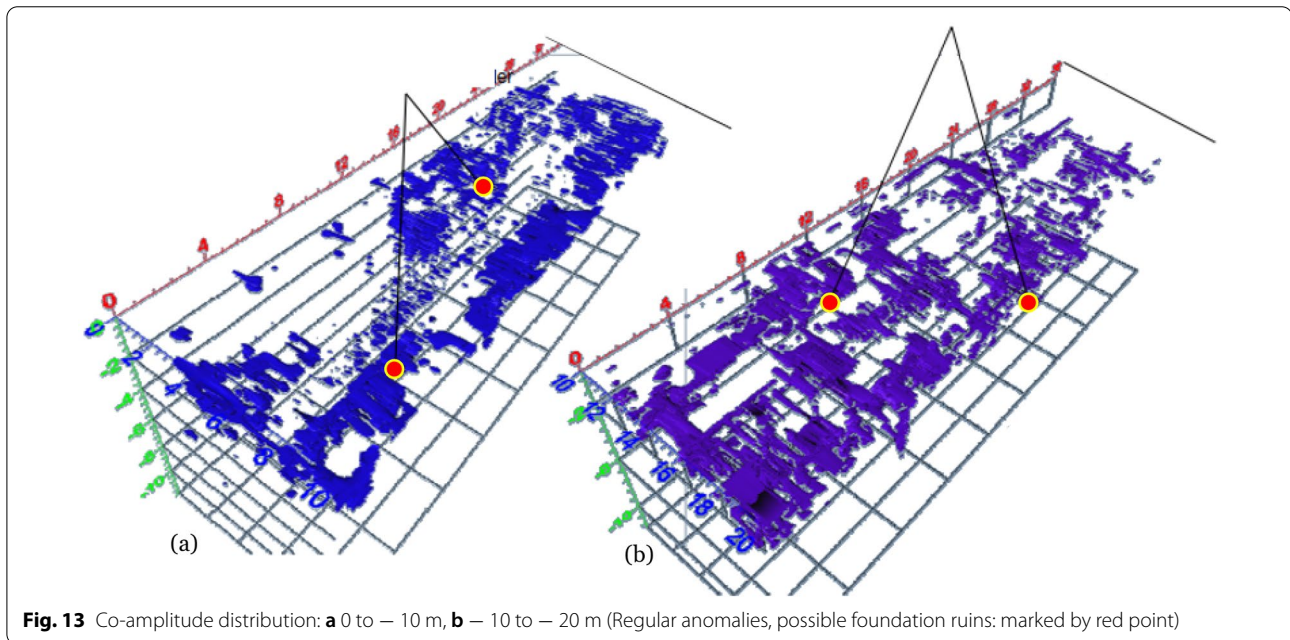
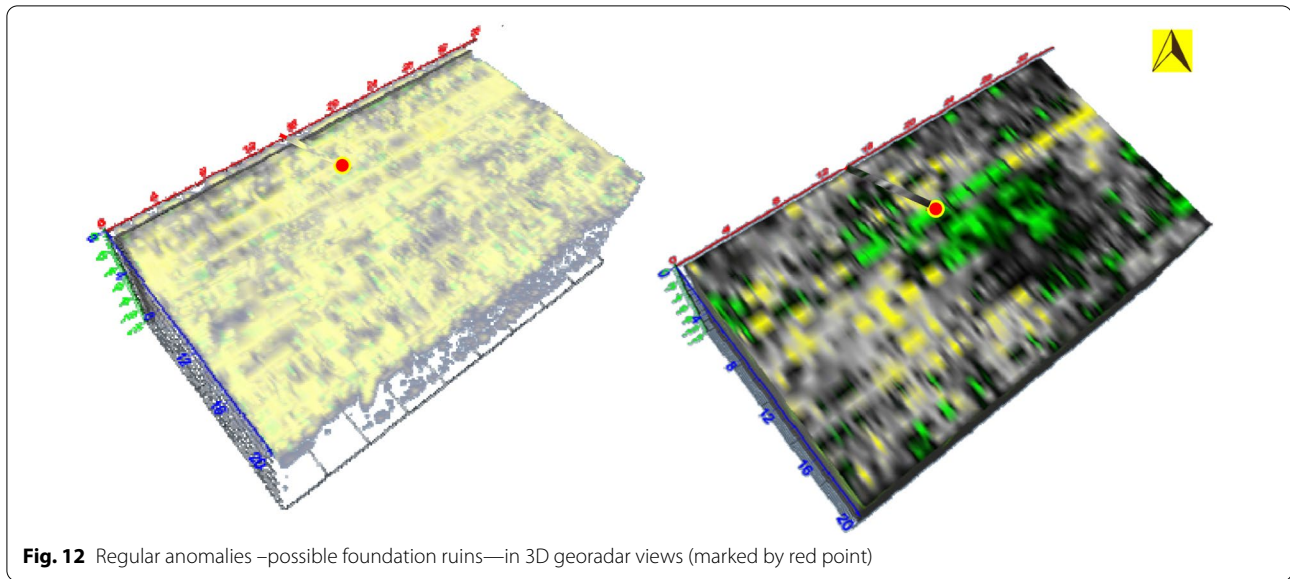


Fig. 11 Co-amplitude distribution in 3D radargram section (Record 102, Profile no: 34, 300 MHz)

that a connection with street life was maintained through the upstairs rooms and exits. An examination of the general features of the timber mansions in *Süleymaniye* revealed that the residences were mostly built with a central anteroom. The sofa is the central area of the house, extending also into the upper floors, while the other rooms are accessed via the stairs at the end of the sofa. Windows on either side of the entrance door provide illumination to the anteroom, and the other rooms are located around the anteroom in an almost square geometry. These houses have a two- or three-step rise in the anteroom at the main entrance. Typology studies in this region revealing all the above information were taken

as reference, as the examined building's façade and plan features corresponded to those of the other timber mansions [67]. The mansion building attracts particular attention with its façades, as can be seen in old photographs of the *Süleymaniye* region. In these photographs, the walls of the building, which appear as polygons, can be clearly perceived, resembling half an octagon, and these polygonal walls descend to the ground on three sides of the building, and are seen as exhedras on one façade. In the middle of the rear façade, a solid rectangular console continues up to the first and second floors.

The façades of the building were symmetrical in layout. The façade layout of the building was arranged in a



traditional timber architectural style in the *Süleymaniye* region. While arched windows adorned the ground and basement floors, guillotine windows were preferred for the upper floors. The guillotine windows, which had timber casings and sills, gave the *façade* a linear rhythm, and timber moldings at each floor level broke the monotony of the design by providing dynamism to the *façade*. Consistent with the traditional elements of timber architecture seen in the *Süleymaniye* region, timber veneer boards decorated the *façade* of the building. Aerial photographs show also a symmetrical layout

to the roof. Although the bright lanterns on the roof of the building are uncommon elements in this typology, there are other rare examples in the *Süleymaniye* region. The fact that the building had two different entrances indicates that it was designed with a *harem* and *selamlık*. Similar to the typological ceiling features of the period, traditional geometric decoration forms were created using timber slats on the building, and it is believed that similar ornamentations could be seen in other houses, although with minor differences [49]. As stated earlier, the dimensions and proportions of the

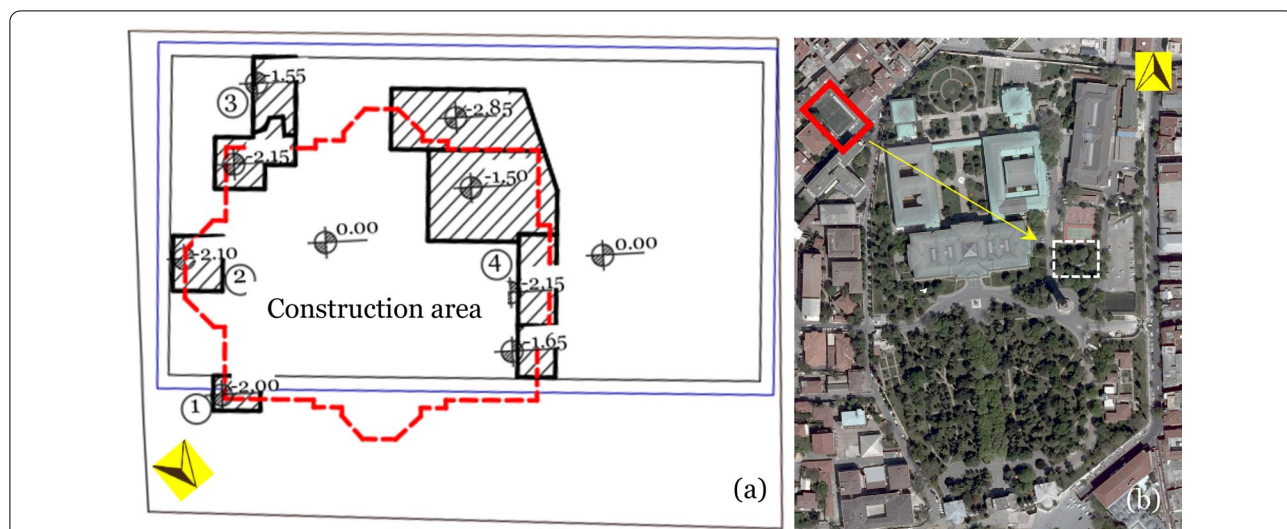


Fig. 14 a Archeological excavation points (1 to 4) in the construction area, b The site of the relocated architectural fragments (marked by dashed lines)

Table 1 Physical and geometrical features of the remains

Remain ID*	Definition	Material	Dimension (cm)**	Elevation (m)
r ₁	Cladding stone	Marble	<i>h</i> :48, <i>l</i> :60, <i>t</i> :6	- 4.9
r ₂			<i>h</i> :114, <i>l</i> :60, <i>t</i> :9	- 4.7
r ₃	Shaft part of column	Gray veined marble	<i>h</i> :93, <i>d</i> :34	- 4.4
r ₄	Railing post	Marble	<i>h</i> :61, 14 × 10	- 5.5
r ₅	Shaft part of column	Gray veined marble	<i>h</i> :87, <i>d</i> :34	- 3.5
r ₆			<i>h</i> :58, <i>d</i> :34	- 3.6
r ₇			<i>h</i> :67, <i>d</i> :40	- 3.6
r ₈	Column base	Andesite	<i>h</i> :35	- 4.9
r ₉	Column heading	Marble	75 × 48	- 3.0
r ₁₀	Shaft part of column	Marble	<i>h</i> :103, <i>d</i> :56	- 6.2

* r₁, r₂: The late Byzantine Era, r₃ to r₁₀: The Byzantine Era, ** *h*: height, *l*: length, *d*: diameter, *t*: thickness



Fig. 15 Views of the cistern on the project site

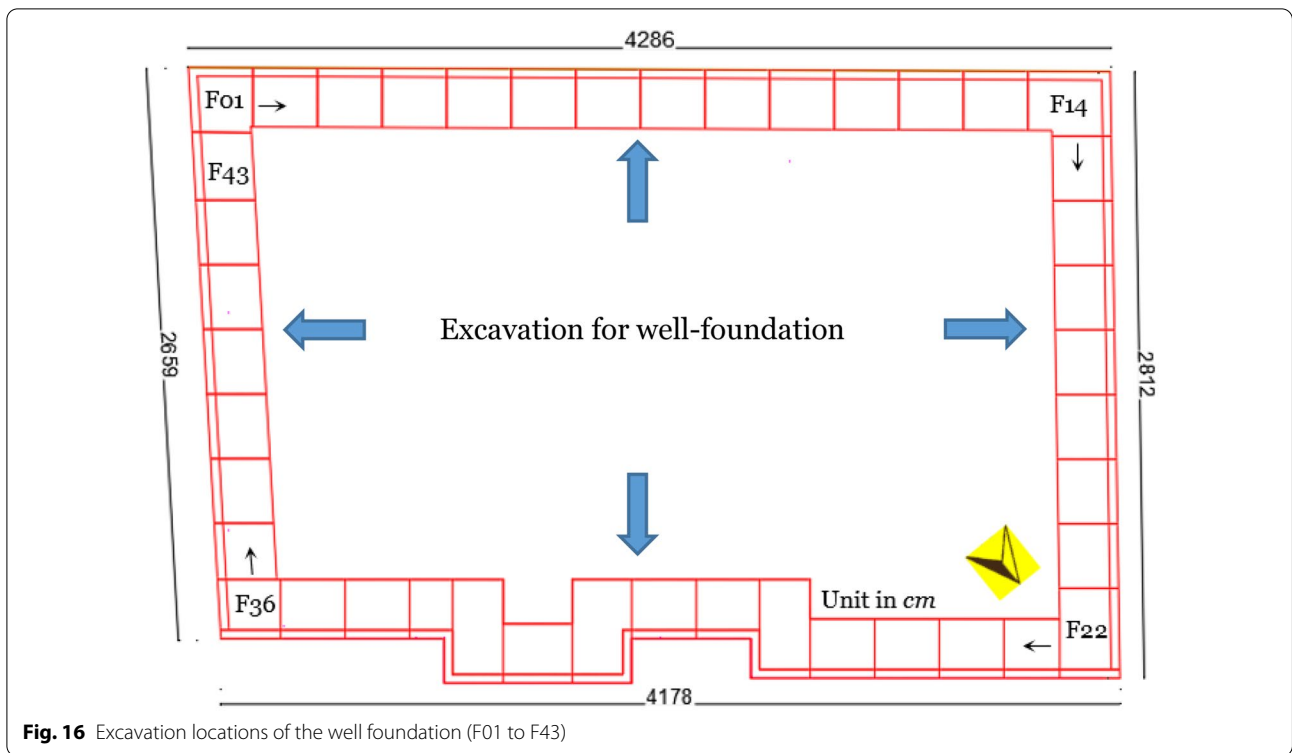


Fig. 16 Excavation locations of the well foundation (F01 to F43)

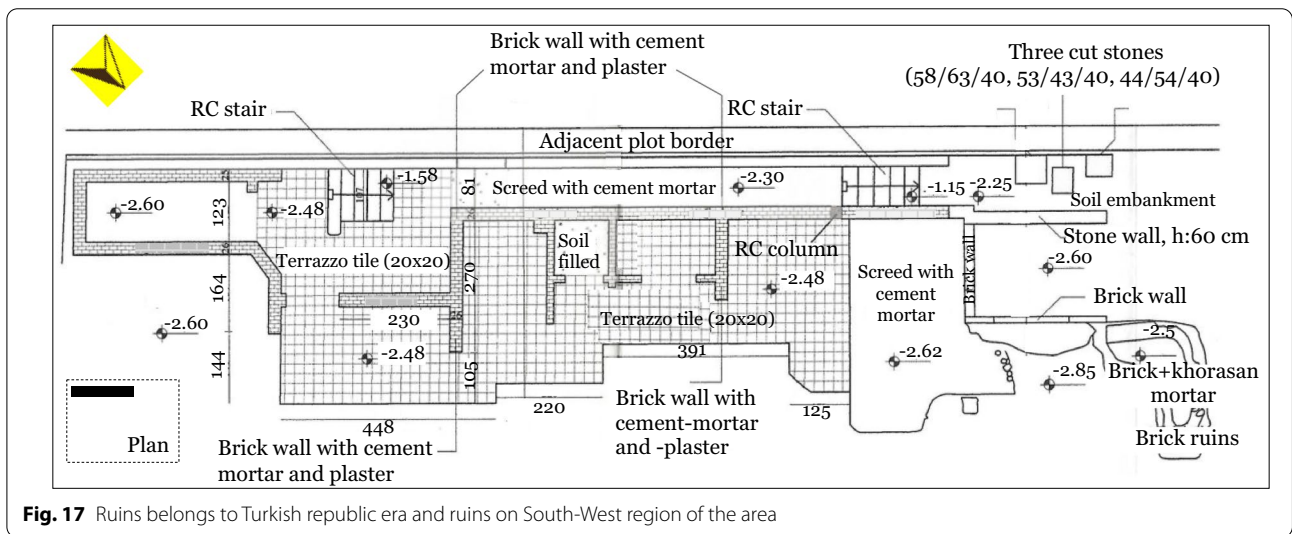


Fig. 17 Ruins belongs to Turkish republic era and ruins on South-West region of the area

façade of *İbrahim Efendi Konağı* were garnered from historical maps, photographs and old documents. The internal organization of the spaces was based on the typology of the building and from references obtained from the façades. In the light of all this information, in addition to the floor and roof plans prepared for the building, the estimated sectional elevations and façade views are presented in Figs. 21, 22, 23, 24.

Due to the two mentioned entrances, situated on the northeast-southwest axis of the building, of which the one on the north-eastern façade faces the main street, there is only space for the staircase to the *selamlık* on the southwest side. A set of stairs on the southwest façade leads to both the entrance and the *harem*, with a sofa in the center of this spatial layout. No exact match with similar buildings from the same period can be expected.



Fig. 18 Remains uncovered in the well foundation excavation on the southwest side of the area

The room plan was changed according to needs in the reconstruction study, and a new office arrangement was implemented.

Conclusions

The current study presents details of a project for the reconstruction of a traditional masonry-timber mansion building that was built originally in the 1880s, and that was intentionally demolished in 1948. A comprehensive methodology is proposed for the effective reconstruction of historical buildings. Although no residuals of the building were identified from excavations or georadar surveys, the proposed approach provided details of the building as a functional and comprehensive method based on the use of various datasets obtained using different tools and



Fig. 19 Archeological finds during excavations for the well foundation

Table 2 Physical and geometrical features of the remains

Remain ID*	Definition	Material	Dimension (cm)**	Elevation (m)
S ₁	Cladding stone	Marble	<i>h</i> :60, <i>l</i> :47, <i>w</i> :6	− 10.2
S ₂	Attic-ion column heading	Gray veined marble	<i>h</i> :30, <i>d</i> :88	− 9.5
S ₃	Column heading	Marble	<i>h</i> :74, <i>d</i> :57	− 3.8
S ₄	Shaft part of column	Gray veined marble	<i>h</i> :112, <i>d</i> :37	− 9.5
S ₅			<i>h</i> :89, <i>d</i> :40	− 11.1
S ₆			<i>h</i> :115, <i>d</i> :28	− 9.5
S ₇	Paving stone	Marble	<i>h</i> :45, <i>l</i> :73, <i>w</i> :4.5	− 3.0

* S₁, S₇: Late Byzantine Era, S₂-S₆: Byzantine Era, ** *h*: height, *l*: length, *d*: diameter, *w*: width

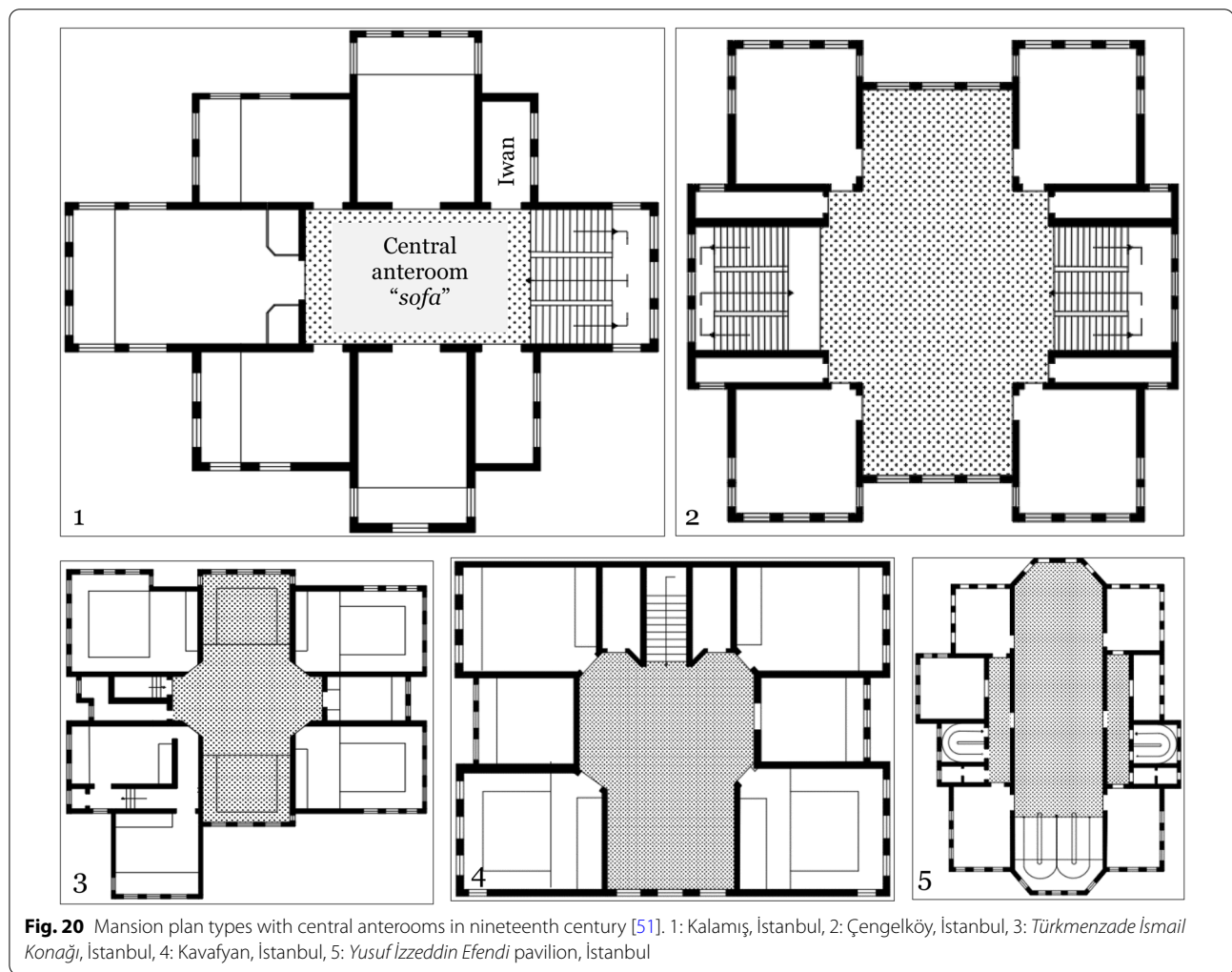


Fig. 20 Mansion plan types with central anterooms in nineteenth century [51]. 1: Kalamış, İstanbul, 2: Çengelköy, İstanbul, 3: Türkmenzade İsmail Konağı, İstanbul, 4: Kavafyan, İstanbul, 5: Yusuf İzzeddin Efendi pavilion, İstanbul

measurements. Similar buildings in the near vicinity did not contribute to the study, since almost all of the buildings from the period have been demolished or destroyed in time through vandalism. The presented methodology can be applied by other researchers as an

effective approach to the reconstruction of demolished buildings in historical areas.

As a cultural heritage, *İbrahim Efendi Mansion (Konağı)* was a subject in a novel but unfortunately completely ruined by a society that lacks the consciousness

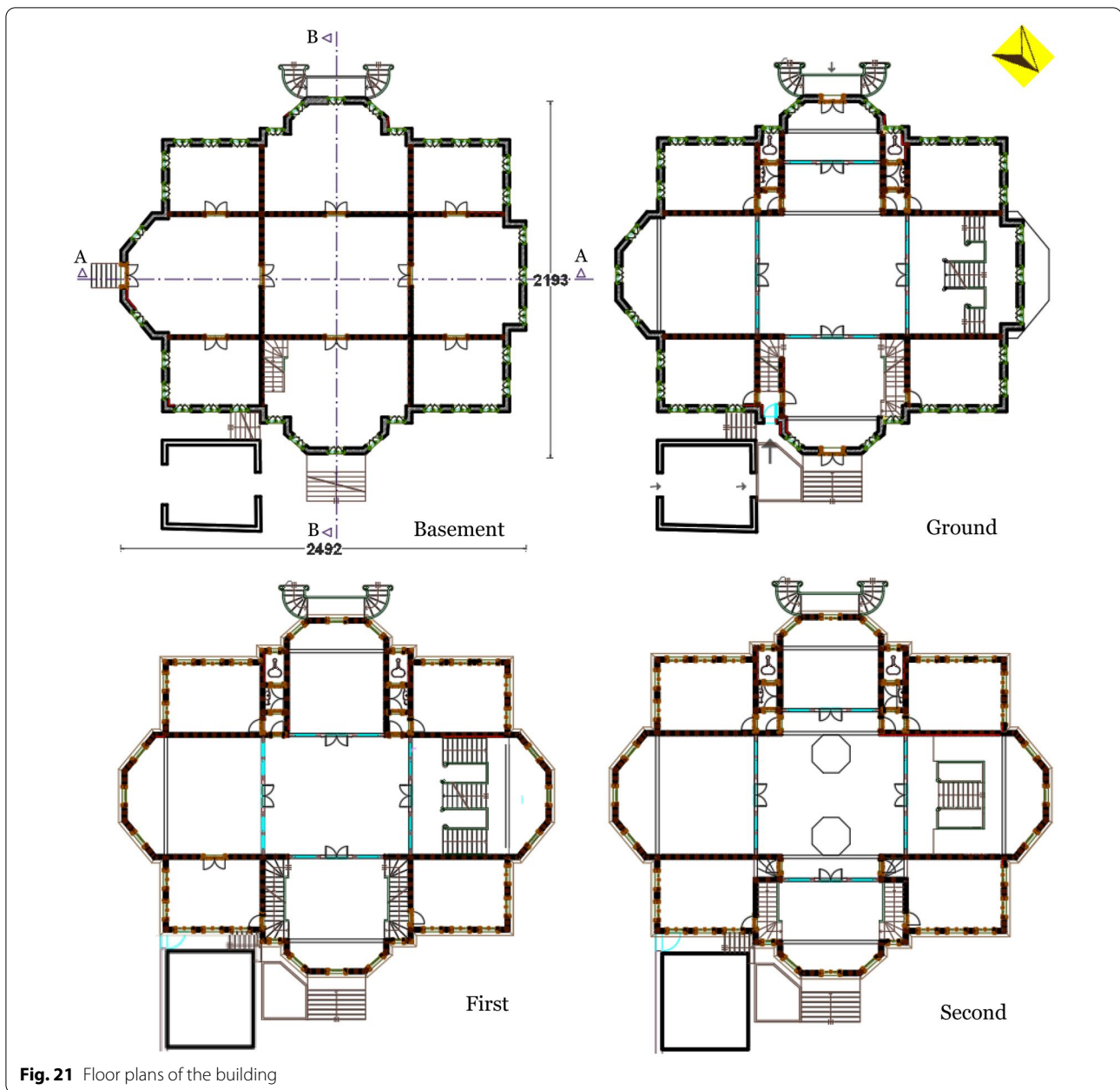
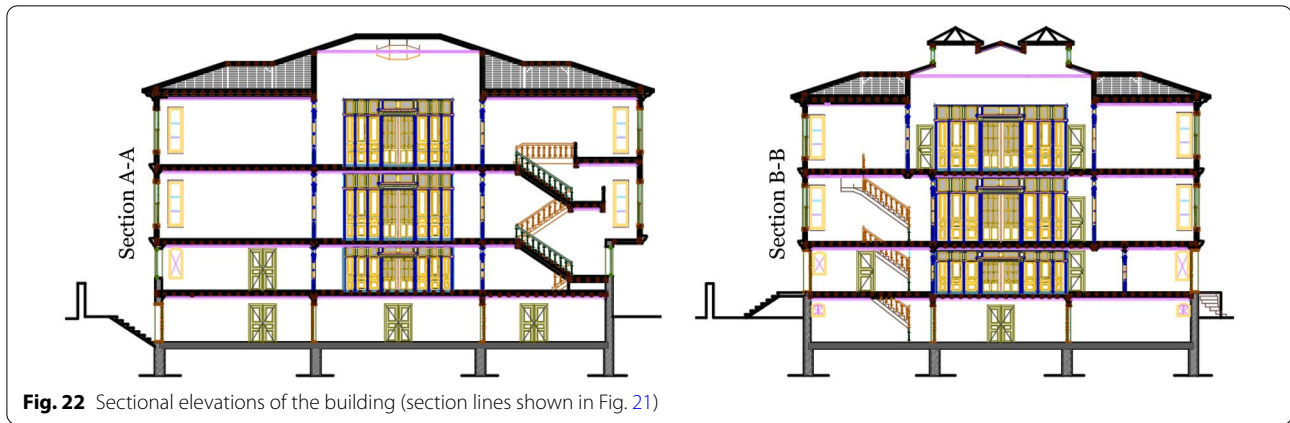


Fig. 21 Floor plans of the building

of protecting historically important works. Therefore, the original building has completely lost including all its memories. For this reason, reconstruction of this structure can only be performed in specific circumstances explained below. There are currently no structural components remaining from the building. Therefore, for the design of the façades of the building in accordance with the original structure, documents, data, and visual materials obtained from archival studies were taken as source information. On the other hand, sufficient data and visual materials about the interior design and features of the

building could not be found. At this point, there were two design possibilities to choose from. For example, an original interior plan design might be prepared using the interior plan of the buildings that still standing and built at that time. The negative aspect of this option is that the interior plan will not be like the original of the building in question. Another alternative is the design of a partially new interior plan in accordance with the building's façade and current modern office space needs. In the current study, the second alternative was used since the interior plan of the original building does not exist.



Accordingly, the university's present demands were taken into consideration and a new office building was planned based on the available information about the exterior and façade plan of the building.

If there are no remnants of the original building, a reconstruction practice might be described as a new structure. Therefore, such a structure might not be expected as totally authentic. Although the structure

was reconstructed according to the original architectural plan with similar structural elements, its spatial memory is not available and therefore could not be restored. However, building the façades according to the original structure helps revive spatial memory, albeit partially. On the other hand, the current form of the interior design is quite compatible with the needs of the institution, namely the university. The

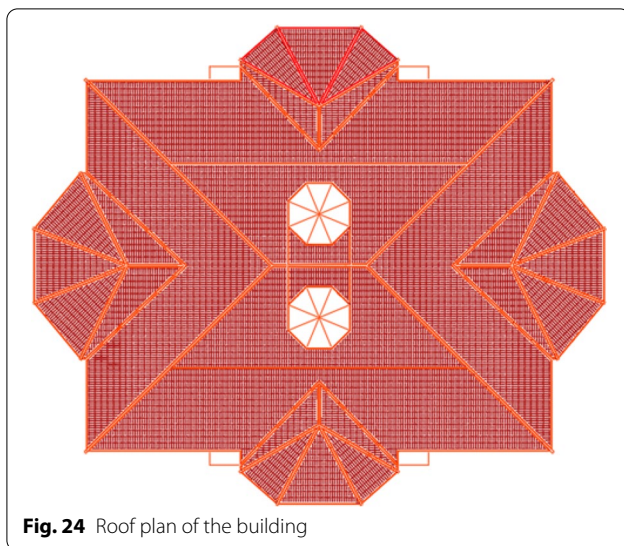


Fig. 24 Roof plan of the building

reconstructed structure contributes to the region both socially and architecturally.

Such projects that may emerge during multi-dimensional and multi-disciplinary works to access information about demolished buildings can involve a long implementation process after obtaining the approval of the relevant institutions, resulting in demolished buildings being brought back to cultural life. *İbrahim Efendi Mansion* is an example of such buildings. As a result of long and laborious efforts, a reconstruction decision was made and implemented, and the building today has an important role in the historical positioning and the sustainability of the Süleymaniye region, while serving also as a guide to further renovations and reconstructions of the surrounding buildings, and a source of fascination for both local and foreign visitors. The building is the outcome of a reconstruction process that involved both its interior design and its harmonious contribution to the historical texture through its exterior façades. Accordingly, it can be considered a successful reconstruction project, given the great effort that went into reproducing its original form and preserving its originality.

Finally, destroyed *İbrahim Efendi Mansion* was rebuilt using all accessible information and documents. Thus, a destroyed cultural heritage of the city was brought back to the society and a building that meets the needs of the university, produces cultural values, and promotes tourism of the city was obtained.

Acknowledgements

The authors would like to thank the Department of Construction and Technical Affairs of the Istanbul University Rectorate. The author also gives special thanks to TEB Mimarlık Co. for their valuable technical contributions.

Authors' contributions

CA introduced the background and reviewed all the published papers. NMK was the main responsible for the georadar research and archeological excavation. BS developed the methodology and presented the major contributor in writing and organization the manuscript. All authors read and approved the final manuscript.

Funding

Not applicable.

Availability of data and materials

Not applicable.

Declarations

Competing interests

No potential conflict of interest was reported by the authors.

Author details

¹Department of Architecture, Istanbul University, 34116 Istanbul, Turkey.

²Department of Construction and Technical Affairs, Istanbul University, 34116 Istanbul, Turkey. ³Department of Civil Engineering, Istanbul University-Cerrahpasa, 34320 Istanbul, Turkey.

Received: 17 December 2021 Accepted: 26 February 2022

Published online: 18 March 2022

References

1. The Burra Charter. The Australia ICOMOS Charter for the conservation of places of cultural significance, 2013.
2. The Cracow Charter. Principles for conservation and restoration of built heritage, ICOMOS, 2000.
3. Şimşek D. Investigation of the current usage and current status of the examples of Ottoman civil architecture in the Süleymaniye region of Istanbul. 1999. MSc thesis, Marmara University, Institute of Social Science, Istanbul, Turkey.
4. Varol Ç. Evaluation of the Reconstruction Applications of World Heritage Area Süleymaniye Camii and Surroundings. 2015. MSc thesis, Kadir Has University, Science Institute, Istanbul, Turkey.
5. Durgut O., Durgut F. (2022) Photograph album, islamansiklopedisi.org.tr/suleymaniye-camii-ve-kulliyesi.
6. Istanbul Historic Peninsula Management Plan. 2018. alanbaskanligi.gov.tr/evrak/engtyp.pdf.
7. Deniz M. Conservation theory's perspective on architectural reconstruction (Koruma Kuramının Mimari Rekonstrüksiyona Bakışı). *J Archit (Mimarlık dergisi)*. 2014;380:72–7 (in Turkish).
8. Radziszewska-Zielina E, Śladowski G, Sibielski M. Planning the reconstruction of a historical building by using a fuzzy stochastic network. *Automat Constr*. 2017;84:242–57.
9. Yıldızlar B, Sayin B, Akçay C. A case study on the restoration of a historical masonry building based on field studies and laboratory analyses. *Int J Archit Herit*. 2019;13(4):1–19.
10. The Venice Charter. The Charter for the restoration of historic monuments. Venice, Italy, 1964.
11. The Burra Charter. The Australia ICOMOS Charter for Places of Cultural Significance 1999, australia.icomos.org/publications/charters, 1999.
12. Caponette R, Sebastiano d'urso S, Rosso R, Poggioreale SM. Urban monument to negligence restoration strategies, Proceedings of the 4th Biennial of Architectural and Urban Restoration, BRAU 4 host of the itinerant congress hidden cultural heritage: Under water, underground and within buildings, 2018.
13. The Burra Charter, The Australia ICOMOS charter for the conservation of places of cultural significance, 2004.
14. Declaration of Dresden, Reconstruction of Monuments Destroyed by War, ICOMOS, 1982.
15. The Venice Charter, International charter for the conservation and restoration of monuments and sites in: Adopted at the Second International

- Congress of Architects and Technicians of Historic Monuments, Venice, Italy. 1965.
16. Ugurlu E. The importance of historical mortar and plaster analysis in conservation studies. *J Mater Archit (Mimarlıkta Malzeme)*. 2009;4(11):83–7 **(in Turkish)**.
 17. Bilgili B. Istanbul's cultural assets revived by reconstructions (Istanbul'un Yeniden Yapımlarla "İhya (!)" Edilen Kültür Varlıkları). *Journal "Serbest Mimar"*. Turkish Professional Architects Association, 2018; 29 **(in Turkish)**.
 18. Stanley-Price N. The reconstruction of ruins: principles and practice. In: Richmond A, Bracker A, editors. *Conservation: principles, dilemmas and uncomfortable truths*. Elsevier: Oxford; 2009. p. 32–46.
 19. Wallace I, Knight BD. In: Hampson FO, Reppy J, editors. *Societies in space and place, earthly goods: environmental change and social justice*. Ithaca: Cornell University Press; 1996. p. 75–95.
 20. Schildgen BD. *Heritage or heresy: preservation and destruction of religious art and architecture in Europe*. New York: Palgrave Macmillan; 2008. p. 266.
 21. Dushkina N. Historic reconstruction: prospects for heritage preservation or metamorphoses of theory? In: Stanley-Price N, King J, editors. *conserving the authentic: essays in honor of jukka jokilehto*, vol. 10. ICCROM Conservation Studies: Roma; 2009. p. 83–94.
 22. Bilgili B. An assessment of lost cultural heritage and reconstructions: Examples from Istanbul Historical Peninsula (Kaybolan kültür varlıkları ve yeniden yapımlarının değerlendirilmesi: İstanbul Yarımada'dan örnekler). The 5th Symposium on strengthening and preserving historical buildings and cultural heritage, Union of Chambers of Turkish Engineers and Architects, Chamber of Civil Engineers. 2015; 2: 415–430 **(in Turkish)**.
 23. Kong X, Liu D, Tian Y, Liu Y. Multi-objective spatial reconstruction of rural settlements considering inter-village social connections. *J Rural Stud*. 2020. <https://doi.org/10.1016/j.jrurstud.2019.02.028>.
 24. Shabiev SG. Architectural concept for reconstructing social facilities, based on the environmental requirements. In: *Proceedings of XXIII Russian School on Scientific and Technological Problems*, Moscow: Russian Academy of Sciences; 2003. pp 638–648.
 25. Di Miceli E, Bianco V, Monti G, Filetici MG. A reconstruction hypothesis of collapsed archaeological masonry barrel vaults employing frictional bearings, with application to the case study of the Galleria Delle Volte Crollate. 2017. Rome, COMPDYN 2017: 6th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, 2587–2606. Greece, 15–17 June 2017
 26. Shindler K, Bauer J. A model-based method for building reconstruction. 2003. First IEEE International Workshop on Higher-Level Knowledge in 3D Modeling and Motion Analysis, 2003. First IEEE International Workshop on Higher-Level Knowledge in 3D Modeling and Motion Analysis.
 27. Pavlovskis M, Migilinskas D, Antuchevičienė J, Urbab I, Zigmund V. Problems in reconstruction projects, BIM uses and decision-making: Lithuanian case studies. *Procedia Eng*. 2017;208:125–8.
 28. Pohle F, Jäger W. Material properties of historical masonry of the Frauenkirche and the masonry guideline for reconstruction. *Constr Build Mater*. 2003;17:651–67.
 29. Di Ludovico M, Protà A, Moroni C, Manfredi G, Dolce M. Reconstruction process of damaged residential buildings outside historical centres after the LAquila earthquake: part II—“heavy damage reconstruction. *Bull Earthq Eng*. 2017;15:693–729.
 30. Astaneh-Aghda SM, Mir Ghaderi SR, Heidarinejad G. Reconstruction of housing destroyed in the 2003 Bam-Iran Earthquake. 2006. 100th Anniversary Earthquake Conference. San Francisco.
 31. Tringali S, De Benedictis R, La Rosa R, Russo C, Bramante A, Gavarini C, Valente G, et al. The reconstruction of the Cathedral of Noto. *Constr Build Mater*. 2003;17:573–8. [https://doi.org/10.1016/S0950-0618\(03\)00052-7](https://doi.org/10.1016/S0950-0618(03)00052-7).
 32. Curti E, Podestà S, Resemini S. The post-earthquake reconstruction process of monumental masonry buildings: suggestions from the Molise Event (Italy). *Int J Archit Herit*. 2008;2:120–54. <https://doi.org/10.1080/15583050701646703>.
 33. Murao O. Recovery curves for housing reconstruction from the 2011 Great East Japan Earth-quake and comparison with other post-disaster recovery processes. *Int J Disaster Risk Reduct*. 2020;45: 101467. <https://doi.org/10.1016/j.ijdrr.2019.101467>.
 34. Yaoxian Y. Decision-making for recovery and reconstruction following a strong earthquake. *Post Earth Rehab Reconstr*. 1996. <https://doi.org/10.1016/B978-008042825-3/50009-0>.
 35. Li Q, Umaier K, Koide O. Research on post-Wenchuan earthquake recovery and reconstruction implementation: a case study of housing reconstruction of Dujiangyan City. *Prog Disaster Sci*. 2019;4:1–10.
 36. Khadka B. Mud masonry houses in Nepal: a detailed study based on entire reconstruction scenario in 31 earth-quake-affected districts. *Structures*. 2020;25:816–38.
 37. Liu C, Fang D, Zhao L. Reflection on earthquake damage of buildings in 2015 Nepal earthquake and seismic measures for post-earthquake reconstruction. *Structures*. 2019;30:647–58.
 38. Tobiáš P, Cajthaml J, Krejčí J. Rapid reconstruction of historical urban landscape: the surroundings of Czech chateaux and castles. *J Cult Herit*. 2018;30:1–9.
 39. Akçay A, Korkmaz NM, Sayin B. An approach for the reconstruction of a traditional masonry-wooden building located in an archeological area. Part II: Building reconstruction. *J Asian Archit Build* 2021;1–17. <https://doi.org/10.1080/13467581.2020.1869024>
 40. Radziszewska-Zielina E, Sładowski G, Sibieliak M. Planning the reconstruction of a historical building by using a fuzzy stochastic network. *Autom ConStruct*. 2017;84:242–57.
 41. Pavel V. Analysis of methodologies of the reconstruction of buildings on the example of masonry structures, Hame University of Applied Sciences. 2018.
 42. Gorse C, Johnston D, Pritchard M. A dictionary of construction, surveying and civil engineering. 2005. 1st edition, Oxford Quick Reference.
 43. Zolotozubov DG, Bezgodov MA, Zolotozubov D. G., Bezgodov M. A. Reconstruction of buildings and structures (Rekonstruktsiya zdaniy i sooruzheniy). Perm National Research Polytechnic Universty, s.181 2014 **(in Russian)**.
 44. Ahunbay Z. Conservation and restoration of historical environment (Tarihî çevre koruma ve restorasyon) YEM publishing, 2004;134. ISBN: 975-7438-38-3 **(in Turkish)**.
 45. Republic of Turkey, Ministry of Culture and Tourism, Regional protection board for Istanbul renovation areas, Decision no. 6848 dated 12.07.1995.
 46. Republic of Turkey, Ministry Board. Decision no. 10501 dated 24.05.2006 based on Law 5366 dated 16.06.2005.
 47. Republic of Turkey, Ministry of Culture and Tourism, Regional Protection Board for Istanbul renovation areas. Decision no. 1301 dated 18.12.2010.
 48. Republic of Turkey, Ministry of Culture and Tourism, Protection Board for Cultural and Natural Assets, Principle decision no. 660 dated 05.11.1999.
 49. Republic of Turkey, Ministry of Culture and Tourism, Protection Board-4 for Cultural and Natural Assets, Decision no. 2478 dated 28.11.2008.
 50. Yüksel AF. Examination of archaeological remains using GPR method for Istanbul University, İbrahim Efendi Konağı building, Project no. 2010/7160, 2010.
 51. Istanbul satellite map. Istanbul Metropolitan Municipality. 2012. sehirharitasi.ibb.gov.tr. Accessed Dec 2020.
 52. DAI. Deutsches Archäologisches Institut, Istanbul Photo archive, 1880.
 53. Library of Congress Prints and Photographs Division Washington, D.C. 20540.0000. USA: Abdulhamid II collection, 1880.
 54. Pervititch J. Istanbul in the insurance maps of Jacques Pervititch. *Axa Oyak: Tarih Foundation publishing*; 1935.
 55. German blue maps. Deutsch syndikat für staebaliche arbeiten, 1911–1913.
 56. Dağdelen İ. The map of Istanbul and Rumeli aspects, Istanbul Metropolitan Municipality, Directorate of Library and Museums, 2005 **(in Turkish)**.
 57. Panoramic aerial view of Istanbul. harita.gov.tr/urun-256-haritasi.html&katid=14. Accessed Aug 2019.
 58. Restoration report. Surveying, restitution and restoration project for Istanbul University, Rectorate Building, Istanbul Special (Local) Provincial Administration, 2011 **(in Turkish)**.
 59. Republic of Turkey, Ministry of Culture and Tourism, Regional Protection Board for Istanbul-I renovation areas, Decision no. 150 dated 18.07.2012.
 60. Republic of Turkey, Ministry of Culture and Tourism, Regional Protection Board for Istanbul renovation areas, Decision no. 624 dated 06.03.2013.
 61. Kuban D. Turkish house (Türk "Hayat"lı Evi). Istanbul: Eren Publisher; 1995. **(in Turkish)**.
 62. Bektaş Ç. Turkish house (Türk Evi). Istanbul: Yapı Kredi Publisher; 1996. **(in Turkish)**.
 63. Eldem SH. Turkish houses in Ottoman period I-II-III (Türk Evi Osmanlı Dönemi I-II-III). Istanbul: TAÇ foundation publisher; 1984. **(in Turkish)**.

64. Eldem SH. Plan types in Turkish houses (Türk evi plan tipleri). İstanbul: İTÜ, Architecture Faculty publisher; 1954. **(in Turkish)**.
65. Eldem SH. Works of Turkish Architecture (Türk mimari eserleri), Yapı Kredi publications, 1975, İstanbul **(in Turkish)**.
66. Küçükerman Ö. Rooms in terms of space organization in traditional Turkish house of Anatolia (Anadolu'daki Geleneksel Türk Evinde Mekan Organizasyonu Açısından Odalar). İstanbul: Apa Publisher; 1973. **(in Turkish)**.
67. Uysal Ö.N. Research about the interior planning of traditional Turkish house and analysing the examples from Süleymaniye zone, Mimar Sinan Fine Arts University, Science Institute, MSc thesis, 2007 İstanbul **(in Turkish)**.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen[®] journal and benefit from:

- ▶ Convenient online submission
- ▶ Rigorous peer review
- ▶ Open access: articles freely available online
- ▶ High visibility within the field
- ▶ Retaining the copyright to your article

Submit your next manuscript at ▶ [springeropen.com](https://www.springeropen.com)
