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Research Article

Thermal Performance of Traditional Houses Built with Different Techniques**

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Abstract

This study aims to fill an important gap in the literature by comparing the thermal performance of two residential buildings (timber frame with adobe infill and brick masonry) located within the traditional fabric of Afyonkarahisar, focusing solely on the differences in construction techniques. Unlike previous studies comparing buildings with different morphological characteristics, this research selected two buildings located on the same street and with the same orientation; thus, the analysis was reduced to only the material and construction technique. The study first created a detailed dataset containing building form, facade characteristics, material layers, and climate data; then, the thermal transmittance values of the building elements were calculated according to TS 825 standards and transferred to DesignBuilder software. Through heating design analysis and annual energy simulations, wall-floor heat losses, surface temperatures, heating loads, and annual energy consumption were evaluated. The results showed that timber frame walls with adobe infill provided lower heat loss and higher internal surface temperatures compared to brick walls, despite being thinner in thickness. According to the annual energy results, timber-framed houses use about 35% less heating energy than brick masonry houses. While reinforced concrete floors help increase thermal resistance inside, wooden floors actually perform better when the surface is in contact with the outside air. The results obtained demonstrate that traditional materials can be reevaluated in contemporary buildings through appropriate combinations, providing a scientific basis for conservation efforts and new designs.

Keywords: Traditional house, Thermal performance, DesignBuilder, Afyonkarahisar

Farklı Yapım Teknikleri ile İnşa Edilmiş Geleneksel Konutların Isıl Performansı

Öz

Bu çalışma, Afyonkarahisar'ın geleneksel dokusunda yer alan iki konutun (ahşap karkas-kerpiç dolgu ve tuğla yığma) ısıl performansını yapım tekniği farklılığı üzerinden karşılaştırarak literatürdeki önemli bir boşluğu doldurmayı amaçlamaktadır. Mevcut literatür çalışmaların aksine bu araştırmada analiz edilen iki yapı aynı sokak üzerinde ve aynı yönlenmeye sahip olacak şekilde seçilmiştir. Böylece yapılan analiz, malzeme ve

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yapım tekniği farklılıklarına indirgenmiştir. Çalışmada ilk olarak yapı geometrisi, cepheyi oluşturan yapı elemanları, malzeme katmanları ve iklim verilerini içeren detaylı bir veri seti oluşturulmuştur. Daha sonra TS 825 standartlarına göre yapı elemanlarının ısıl geçirgenlik değerleri hesaplanarak DesignBuilder yazılımına aktarılmıştır. Isıtma tasarım hesabı ve yıllık enerji simülasyonları aracılığıyla, duvar-döşeme ısı kayıpları, yüzey sıcaklıkları, ısıtma yükleri ve yıllık enerji tüketimleri değerlendirilmiştir. Sonuçlar, kerpiç dolgulu ahşap karkas duvarların, daha ince olmalarına rağmen tuğla duvarlara kıyasla daha düşük ısı kaybı ve daha yüksek iç yüzey sıcaklığı sağladığını göstermiştir. Yıllık enerji tüketimi bulguları, ahşap karkas yapının tuğla yığma yapıya göre yaklaşık %35 daha düşük ısıtma enerjisi tükettiğini ortaya koymuştur. Buna karşılık, betonarme döşemelerin iç mekân ısıl direncini artırdığı, ancak dış mekâna bakan yüzeylerde ahşap döşemenin daha avantajlı olduğu belirlenmiştir. Elde edilen sonuçlar, geleneksel malzemelerin uygun kombinasyonlarla güncel yapılarda yeniden değerlendirilebileceğini göstermekte; koruma çalışmaları ve yeni tasarımlar için bilimsel bir temel sunmaktadır.

Anahtar Kelimeler: Geleneksel konut, Isıl performans, DesignBuilder, Afyonkarahisar

1. Introduction

Traditional fabrics are important cultural heritage areas that reflect the lifestyles, cultures, and spatial structures of past periods (Arabacıoğlu & Aydemir, 2007, p. 205). In terms of preserving urban identity and ensuring cultural sustainability, many parameters in these fabrics, such as street structure, parcel organization, building locations, and materials used, must be evaluated holistically (Özkan Özbek, 2018, p. 99). Architecture today involves much more than shaping a building's physical form. Issues such as user comfort, safety, energy use, and indoor thermal conditions have become an integral part of the design process (Sarıyıldız, 2012, p. 316). For this reason, it is important to reconsider how traditional houses perform under present-day requirements and, when necessary, to explore ways of improving them.

Traditional structures, shaped by their geographical and climatic conditions, often provide a certain level of thermal comfort without the need for additional heating or cooling systems. However, the thermal performance of buildings constructed using different construction techniques varies depending on factors such as density, thermal conductivity, and wall thickness. Recent research focuses on understanding and optimizing these characteristics in order to preserve heritage and contribute to sustainability.

Traditional buildings utilize passive strategies such as thick walls, high thermal mass, natural ventilation, orientation, and the use of local materials like earth and brick. These features enhance thermal comfort without the need for mechanical systems (Martinez Molina et al., 2016, p. 74; Moscoso-García et al., 2023, p. 1).

Research shows that traditional buildings perform better than modern buildings in terms of thermal comfort, especially in Mediterranean climates. For example, 88% of people living in traditional homes in Ethiopia report comfort, while this rate is only 22% in modern homes (Hailu et al., 2021, p. 1). In India, traditional dwellings with passive features have provided more stable indoor temperatures and higher satisfaction rates (Martinez Molina et al., 2016, p. 75).

However, studies directly comparing the performance differences of different construction techniques under the same climatic and morphological conditions are quite limited. Mazur et al. (2024, p. 18) compared the heat transfer coefficients (U-values) of timber-framed and masonry wall systems in order to evaluate their thermal performance and energy efficiency. However, no study has been found that compares two different traditional construction techniques located on the same street. Therefore, this study aims to fill this gap in the literature.

Thermal performance analyses contribute to the sustainability of buildings with cultural heritage value by enabling the assessment of energy efficiency, carbon emissions, and operating costs during their reuse or restoration. Various thermal analysis methods exist. These include on-site measurements, infrared imaging, and user surveys. However, simulation-based methods are widely used because they allow for the testing of multiple scenarios.

Researchers often use different types of simulation software to get an idea of how a building might perform later on. These tools help them look at energy use, indoor comfort and where heat may be lost or gained. In many studies, programs such as EnergyPlus, DesignBuilder and TRNSYS are used for this kind of work (Mendes et al., 2024; Bustán-Gaona et al., 2024). Each program offers its own set of options, but all of them allow the user to run dynamic thermal studies and examine the behaviour of the building envelope.

Earlier studies point out that DesignBuilder, in particular, produces results close to measured data and is relatively easy to learn. Its calculation routines have been checked through the BESTest procedure, which is used by the International Energy Agency and several other organisations for validation (Al-Hafith et al., 2017, p. 1998).

This study aims to compare the thermal performance of two residential buildings located within the traditional fabric of Afyonkarahisar, focusing solely on the difference in construction techniques. The primary research question of this study is how different construction techniques affect indoor thermal behavior under the same climatic conditions. Therefore, the thermal performance of two residential buildings located next to each other on the same street, one with a timber frame and the other with a brick masonry structure, was investigated. The study hypothesizes that the timber frame-adobe infill system will exhibit lower heat loss compared to the brick masonry structure due to its thermal conductivity and density properties.

To compare the thermal behavior of the buildings, a Winter Design Day analysis was first performed, followed by annual energy simulations. All analyses were performed using DesignBuilder energy simulation software, and the results were evaluated in terms of sustainable design and conservation decisions within the traditional fabric. This approach involves isolating and comparing two traditional dwellings constructed with different materials under the same street fabric, orientation, and climatic conditions. Thus, the effect of the thermal performance difference solely due to the construction technique was quantitatively demonstrated.

1.1. Traditional Houses of Afyonkarahisar

Afyonkarahisar is a settlement in Inner Western Anatolia with a continental climate. Harsh winters and hot, dry summers have paved the way for traditional dwellings to be built using passive thermal strategies that are compatible with the climate. The traditional fabric of the city is characterized by a settlement pattern with narrow streets and adjacent buildings developed around Karahisar Castle (Figure 1).

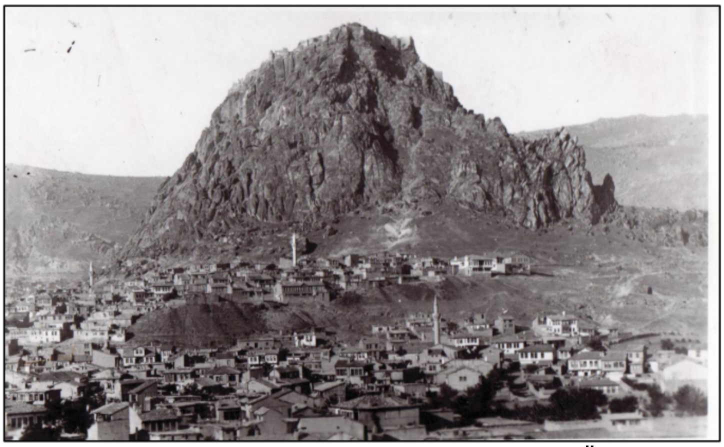

Figure 1. Karahisar castle and traditional settlement (Özpunar, 2014).

The traditional fabric of Afyonkarahisar, its streets, the facades of the houses that shape these streets, the projections that establish the relationship between the houses and the streets, the natural conditions of its geography, and the influences of local culture, reflects all of these elements holistically (Öztank, 2013, p. 48). An example of the traditional street silhouette of Afyonkarahisar is shown in Figure 2.

Figure 2. Traditional street silhouette of Afyonkarahisar (Erdurmuş, 2025, p.103)

The materials used in Afyonkarahisar houses are readily available and require minimal intervention. Materials such as stone, wood, and adobe are recyclable and effective in terms of heat insulation (Özek Karadeniz, 2010, p.105). On the streets, among the traditional houses, there are single and two-story brick buildings constructed in more recent times. Brick structures are used for residential and commercial activities. It is observed that the load-bearing wall elements are usually made of brick, and the walls are covered with plaster.

In traditional timber-framed houses on the street, the load bearing system is a wooden skeleton, and adobe is used as the infill material. In contrast, more recent brick masonry buildings on the same street feature load bearing walls made of brick, with their surfaces covered in plaster.

Yukarıpazar Street, located within the Afyonkarahisar urban conservation area (Karakan, 2006, p. 46), provides a suitable research context for thermal performance evaluations due to the coexistence of different construction techniques on the same street, its restoration processes within the scope of street revitalization projects, and the largely preserved traditional fabric character. The location of Yukarı Pazar Street and the placement of the two residential buildings selected for analysis on the street are shown in Figure 3. The buildings are located on plot number 197 in the zoning plan.

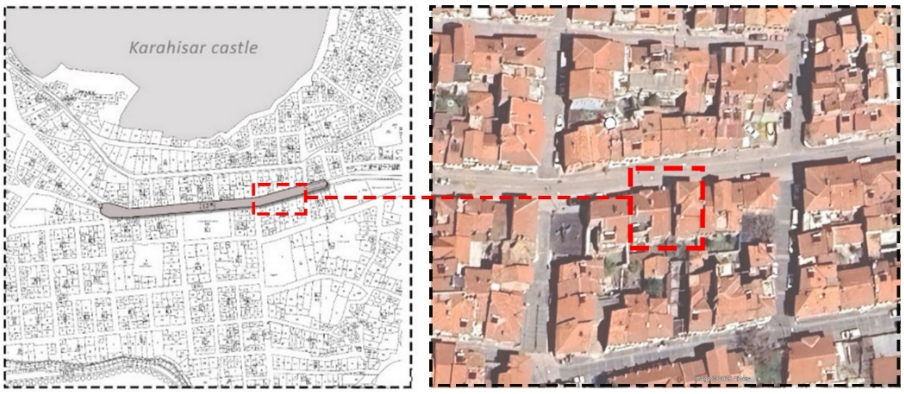

Figure 3. General location of Yukarı Pazar Street in Afyonkarahisar (left) and the location of two selected residences on the same street (right).

2. Methodology

The methodology consists of four stages: data collection, modeling assumptions, simulation process, and evaluation. In the first stage, necessary data such as building form, story height, material properties, and climate data were collected.

In the second stage, modeling assumptions were determined; the same climate file, orientation, HVAC system, heating set point and usage profile were used for both structures. This ensured that the comparison revealed only thermal differences related to construction technique. The methodology diagram is shown in Figure 4.

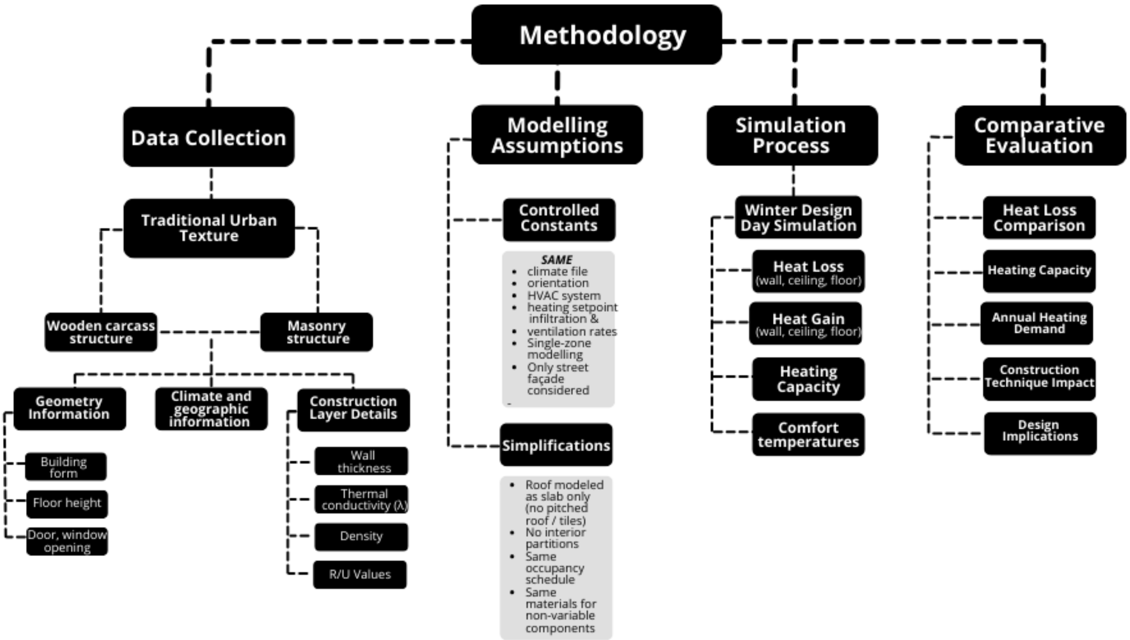

Figure 4. Methodology

In the third stage, Winter Design Day (heating design) and short-term comfort simulations were performed in the DesignBuilder environment, yielding heat loss-gain values through walls, ceilings, and floors, as well as the required heating capacity. In the final stage, the comparative assessment analyzed the thermal performance differences between the two construction techniques and the annual energy requirements, ultimately informing decisions on traditional structures and new construction.

2.1. Data Collection

At this stage, all architectural, material, and climate data related to the two structures and the study area to be analyzed were collected. First, the traditional urban fabric of the study area, located on Yukarı Pazar Street in Afyonkarahisar, was examined. The street form, parcel layout, building locations, and adjacent system relationships were evaluated.

The structures have undergone restoration as part of a street rehabilitation project. For this reason, window and door openings have been designed in accordance with the original. Therefore, facade restoration studies created as part of the street rehabilitation project obtained from the Afyonkarahisar Municipality were used in the modeling. The current condition visuals of the buildings in the contiguous system, the restoration drawings within the project scope, and the DesignBuilder models entered into the system according to these drawings are provided in Figure 5.

Basic material information regarding wall, floor, and roof layers was obtained from restoration projects, literature, and local construction techniques. The EPW file for Afyonkarahisar was used as climate data; outdoor air temperature, radiation, and relative humidity values were defined as standard inputs for the simulations.

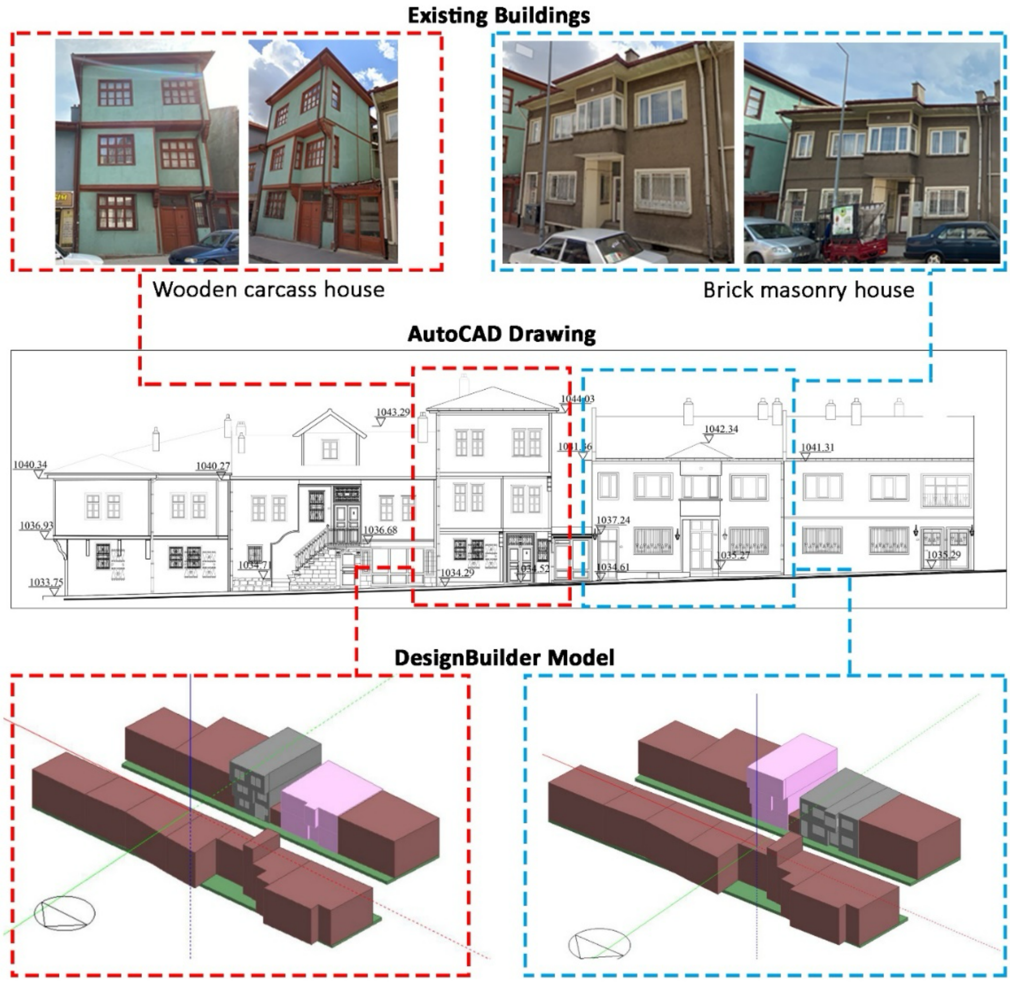

Figure 5. Street view of buildings and DesignBuilder model (produced by the authors)

2.1.1. Timber-framed house data

The timber-framed house has three floors: ground, first, and second floors (Figure 8). The first and second floors of the building have a projection facing the street. The wooden beams on the facade and the S- and C-shaped curved wooden struts add architectural richness to the facade.

Since the infill material used between the timber frames in traditional houses in Afyonkarahisar is usually adobe (Özek Karadeniz, 2010, p. 82), adobe was assumed to be the infill material when creating the wall details. The structure of other houses along the street axis also supports this (Figure 6).

Figure 6. Adobe filling between timber frame (URL-1)

Since no interior building survey was conducted, the wall thicknesses forming the building facade were obtained from literature research. According to the earthquake code, the cross-section of the corner posts of a two-story timber frame structure must be at least 12x12 cm. Furthermore, it is observed that these cross-section dimensions should be increased to 18x20 cm, depending on the number of floors and strength. It is stated that the cross-section of wooden beams used in the floors of traditional wooden buildings in Turkey should be at least 5x15 cm (Aşanlı, 2021, p. 135). In traditional Afyonkarahisar houses, the ground floor is typically made of stone flooring with earth underneath. In contrast, the upper floor flooring is constructed by nailing 2 cm thick wooden planks onto 8-10 cm high wooden battens (Özek Karadeniz, 2010, p. 118). The walls were constructed using a wooden skeleton method, filled with adobe, and had an average wall thickness of 12 cm (Özek Karadeniz, 2010, p. 116; Aliağaoğlu, 2003, p. 71).

Adobe is a material with high heat storage capacity; its thermal conductivity varies depending on the ratio of straw and soil it contains, and its value ranges from approximately 0.17 to 0.73 [W/m·K] (Bassoud et al., 2021, p. 5). The average thermal conductivity value of straw-reinforced adobe material has been calculated to be 0.40 [W/m·K], and its density has been determined to be 1200-1300 kg/m³ (Koçu, 2012, p. 52).

The building materials used in traditional houses in Afyonkarahisar are similar to those used in traditional Turkish houses, and the walls of the houses are plastered with lime plaster on the inside and outside (Özek Karadeniz, 2010, p. 112). The literature indicates that the moisture buffering capacity of lime plaster used in traditional buildings is three times better than that of cement plaster, making it a more suitable material for energy savings (Damle, 2022, p. 2).

After the geometric modeling of structures is completed, it is necessary to calculate the physical properties of structural elements derived from building materials, such as adobe and plaster. Since the DesignBuilder program is primarily used for contemporary structures, the type details within the program are not suitable for historical structures. For this reason, the thermal resistance [R (m².K/W)] of the type details found in the analyzed structures must be calculated based on the thermal conductivity value table of the materials provided in TS 825. After these values are calculated, they can be entered into the DesignBuilder system as an average value. To calculate these values, it is first necessary to create details that specify the material types and thicknesses of the building elements.

The detail created for adobe-filled timber frame walls (D1.1) and the detail created for timber-clad flooring on timber beams (D2.1) are shown in Figure 7.

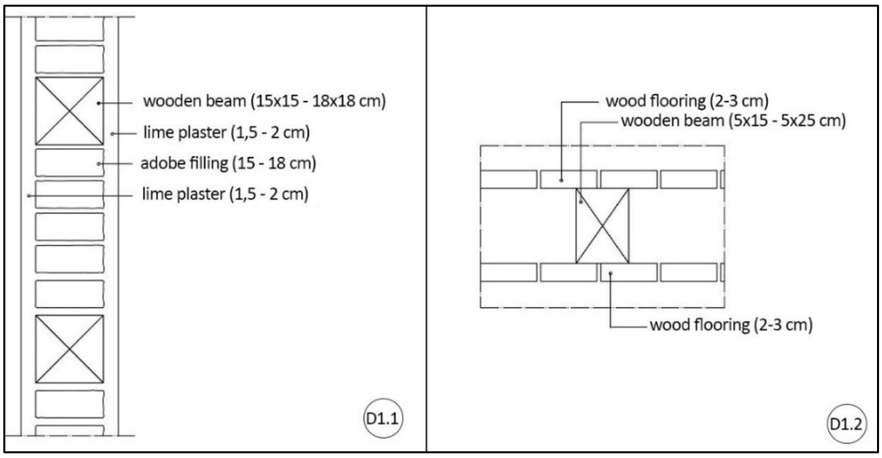

Figure 7. Wall and flooring details of the timber-framed house (produced by the authors)

To determine the physical values of the wall details created, the thermal conductivity values table for materials provided in TS 825 was used (Table 1).

Table 1. Thermal conductivity value of materials (TSE, 2013)

Construction materials	Density kg/m3	Thermal conductivity value (λ), W/mk
straw added adobe	1200-1300	0,40
cement added adobe	1700	0,70
masonry brick wall	2000	0,94
brick (filled)	1800	0,79
brick (perforated)	1200	0,52
natural stone	2400	1,16
reinforced concrete	2400	2,10
plaster (cemented)	2100	1,40
lime + cement mortar	1800	0,87
straw	150	0,058

The thermal resistance (R) and total thermal transmittance coefficient (U) of each layer were calculated using the average material thicknesses provided in the literature and the material properties specified in TS 825. The thermal resistance calculation method given in TS 825:

$$R = \frac{d}{\lambda}$$

Here, R is the thermal resistance (m²·K/W), d is the thickness of the layer (m), and λ is the thermal conductivity coefficient (W/m·K).

The physical value table for wall details is shown in Table 2, while the table for wooden flooring is shown in Table 3. Since the ground floor flooring of traditional houses consists of stone flooring and earth beneath, a third physical value table has been created, and the stone flooring details are provided in Table 4.

Table 2. Physical properties of adobe-filled walls

Material	Thickness (cm)	λ (W/mK)	Density (kg/m³)	R (m²K/W)
Exterior Plaster	2	0,87	1800	0.02
Adobe Infill	12	0.40	1200–1300	0.30
Interior Plaster	2	0,87	1800	0.02
Ri	—	—	—	0.13
Re	—	—	—	0.04
R_total	—	—	—	**0.51**
U-value	—	—	—	**1,96 W/m²K**

Table 3. Physical value of wood flooring and ceiling detail

Material	Thickness (cm)	λ (W/mK)	Density (kg/m³)	R (m²K/W)
Wooden Cladding (floor side)	2	0.13	600	0.15
Wooden Beam (20×20 cm)	20	0.13	600	1.54
Wooden Cladding (ceiling side)	2	0.13	600	0.15
Ri	—	—	—	0.13
Re	—	—	—	0.13
R_total	—	—	—	**2.10**
U-value (W/m²K)	—	—	—	**0.48**

Table 4. Physical value of stone flooring detail

Material	Thickness (cm)	λ (W/mK)	Density (kg/m³)	R (m²K/W)
Stone Flooring	18	1.16	2400	0.155
Mortar Layer	20	0.87	1800	0.23
Soil Layer (ground)	100	1.50	1700–2200	0.67
Ri	–	–	–	0.17
Re	–	–	–	0.04
R_total	–	–	–	**1.265**
U-value (W/m²K)				**0.79 W/m²K**

2.1.2. Brick masonry house data

The brick masonry house has two floors: the ground floor and the first floor. The façade of the house is covered with cement plaster, and the balcony on the second floor has been closed off over time with a window. The building's load-bearing walls are made of plastered brick on both the interior and exterior facades. The floor separating the levels is reinforced concrete (Figure 8).

Figure 8. Brick masonry house, reinforced concrete floor (URL-1)

In the 1960s, due to the ease of construction techniques and local resources, buildings in Turkey were constructed using mortar-bonded brick masonry. (Koç, 2016, p. 37). The minimum thickness of brick walls is determined according to the TS-2510 'Brick Wall Calculation and Construction Rules' and TDY 2007 standards. In the standard, the thickness value of the mixed brick used in the sample house for two-story buildings is 29 cm, which is equivalent to 1.5 bricks. This value is accepted for wall thicknesses, except for single-story walled structures (Bayülke, 2018, p. 35). The detail created for the walls and floors of the brick-walled house (D.2) is shown in Figure 9.

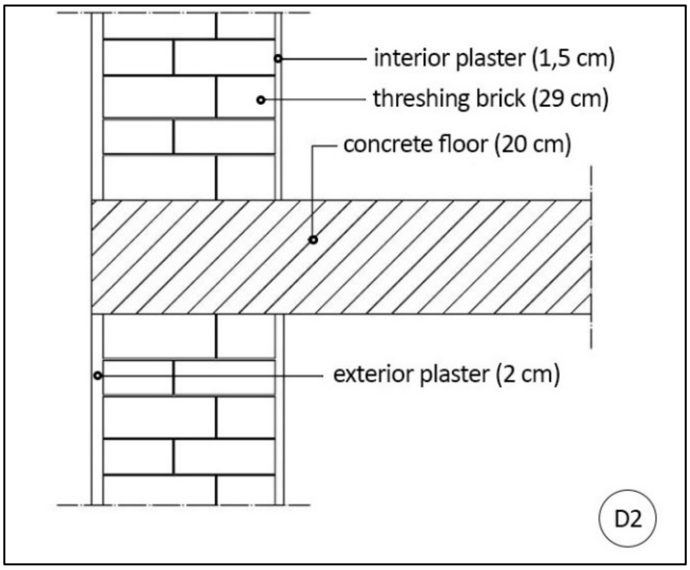

Figure 9. Brick masonry wall and flooring detail (produced by the authors)

The thermal conductivity value specified in TS 825 for walls constructed with bricks compliant with TS EN 771-1 is 0.81 (W/mK) (TSE, 2013). When reviewing standards and regulations related to wall structures, it is seen that the horizontal beams used in brick wall construction must be at least 20 cm (Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik, 2007). When entering data into the DesignBuilder software, it was assumed that the brick wall thickness was 29 cm, the concrete floor thickness was 20 cm, the interior plaster of the brick wall was 2 cm thick, and the exterior plaster was 2 cm of cement plaster. The physical values of the brick wall created with the obtained material data are given in Table 5, and the physical values of the reinforced concrete floor are given in Table 6.

Table 5. Physical properties of brick wall details

Material	Thickness (cm)	λ (W/mK)	Density (kg/m³)	R (m²K/W)
Exterior Plaster	2	1.40	2100	0.01
Brick Wall (TS EN 771-1)	29	0.81	2000	0.36
Interior Plaster	2	1.40	2100	0.01
Ri	—	—	—	0.13
Re	—	—	—	0.04
R_total	—	—	—	**0.55**
U-value	—	—	—	**1.82 W/m²K**

Table 6. Physical properties of reinforced concrete slab details

Material	Thickness (cm)	λ (W/mK)	Density (kg/m³)	R (m²K/W)
Fine Plaster (ceiling)	2	1.40	2100	0.01
Reinforced Concrete (RC slab)	20	2.10	2400	0.10
Cement Screed (floor finish)	2	1.40	2000	0.02
Ri	—	—	—	0.13
Re	—	—	—	0.04
R_total	—	—	—	**0.30**
U-value	—	—	—	**3.33 W/m²K**

3. Simulation Process

Before starting the simulation, all data collected for the buildings must be defined in the DesignBuilder system. The inputs required by DesignBuilder are organized as the module's location, geometry, activity, structure, openings, and HVAC systems (Ascione et al., 2020, p. 3).

First, the geographic and climatic data for the residences were entered into the system. This data was taken from the Afyonkarahisar location template in the DesignBuilder system (Figure 10). This template contains numerous data points for Afyonkarahisar, including its climate zone, latitude, longitude, elevation, wind speed, wind direction, and monthly outdoor temperature values.

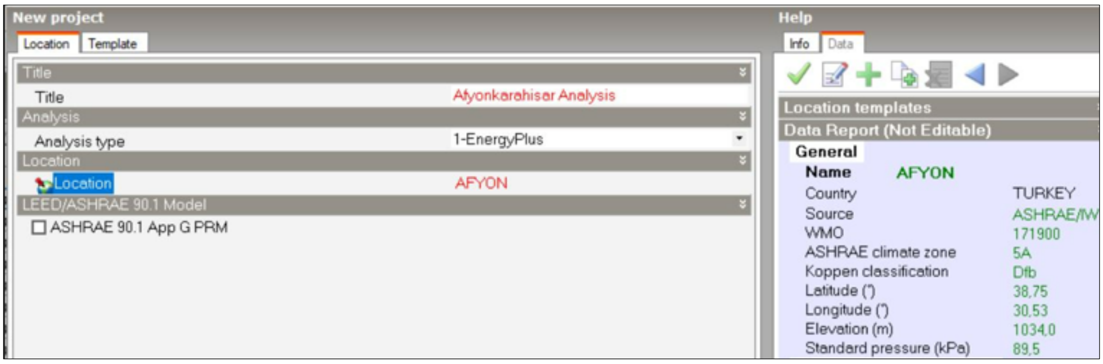

Figure 10. Afyonkarahisar location template

In the second stage, these two houses and other houses adjacent to the residences were modeled in the DesignBuilder program. Additionally, since the thermal performance of the houses could be affected by factors such as shade and wind, the buildings opposite the houses were also included in the model as mass. During the modeling stage, certain assumptions were made that would directly affect the simulation results. These include:

- To eliminate the effect of the buildings' layout and spatial organization on thermal behavior, the two buildings were modeled as a single volume.
- Roofs were not included in the assessment to prevent the thermal effect of the roofs from creating variability. Modeling was completed with the upper floor detail in both buildings.
- Due to the adjacent layout, the effect of the other facades is minimal, so only the main façade facing the street was evaluated in terms of thermal performance.
- The same HVAC system was used for both buildings. (The same heating type and the same fuel type (coal) were used.)
- The occupancy rate of the houses was entered into DesignBuilder with the same value.
- The window and door materials used in the houses were defined as the same for both houses.
- The lighting data of the houses (lighting duration, lighting element, and power) were defined as the same.

After all inputs were completed, two separate DesignBuilder files were created for the two structures, and simulation studies were initiated. In the simulation studies, heating design values and design capacity were evaluated for both structures. Heating Design represents the conditions where the outdoor air temperature reaches its lowest values during the year, thus revealing the actual heat loss potential of the building envelope with the highest accuracy (URL-2). It is also important for comparison studies as it shows the heat loss and gains occurring in building elements.

Secondly, comparing the heat load (Design Capacity) on the winter design day is critical for revealing the actual thermal performance difference between the two construction techniques. In annual simulations, since the HVAC system operates automatically to maintain the internal temperature at the target value, the internal temperatures of different structures show similar results, and heat losses caused by materials are masked. In contrast, Design Capacity directly measures the heating power required for the building to remain operational under conditions where the outdoor air temperature is at its lowest point of the year (URL-2). Therefore, it is the indicator that most clearly reflects heat loss occurring through building components such as walls, floors, and roofs.

The DesignBuilder simulation study was conducted based on a typical winter week between January 27 and February 2. At the end of the simulation study, the heating design calculation results for timber-framed and brick masonry houses are shown in Figure 11.

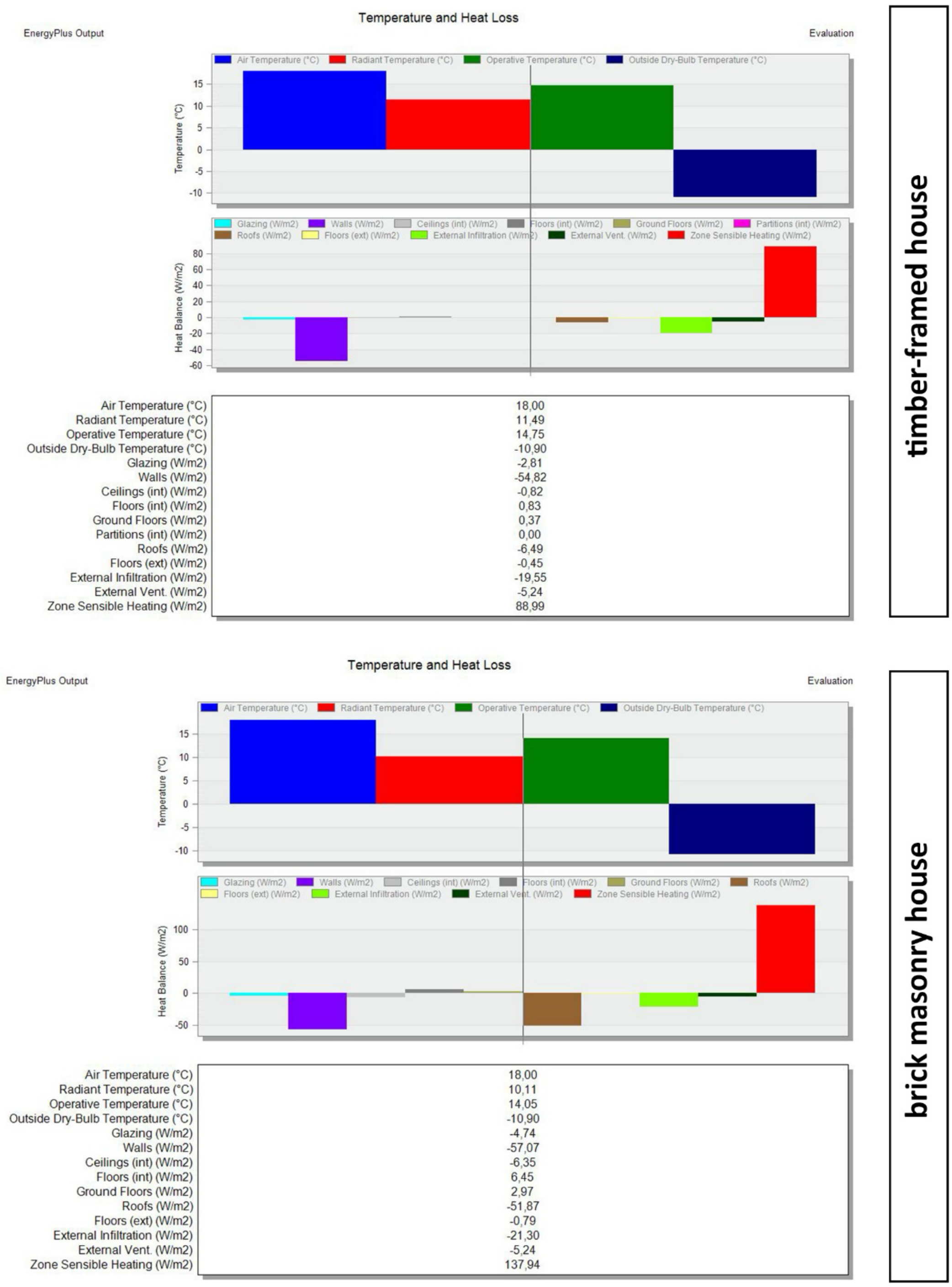

Figure 11. Heat losses and gains caused by building elements

When comparing the heating design calculations for both structures, the key findings are as follows:

- The brick masonry structure provided an operative temperature 0.7°C lower than the timber frame structure. This indicates that the brick wall loses more heat.

However, the reason for the minimal difference is that the HVAC is forced to 18°C (Figure 12). Since the HVAC target is fixed, the actual difference is reflected in the internal surface temperatures.

- The inward-facing surface of the brick masonry house walls is 1.38°C colder than the wooden structure.
- The heat loss through the brick wall is 2.25 W/m² higher. This difference is consistent with the thermal conductivity (λ) values of the materials: Brick λ = 0.87, Adobe infill + timber frame λ ≈ 0.45–0.65. In other words, brick is more conductive.
- Heat loss through the floors on the upper floors was eight times higher in the reinforced concrete floor compared to the wooden structure. This is related to the reinforced concrete floor having a higher thermal conductivity (λ) and lower total thermal resistance (R) values.
- The total heating load was 88.99 (W/m²) in the timber frame structure and 137.94 (W/m²) in the brick masonry structure. This shows that the brick house has a 55% higher heating requirement.

Heating Setpoint Temperatures	
Heating (°C)	18,0
Heating set back (°C)	12,0

Figure 12. Heating Setpoint Temperatures

In addition to heat load analyses, the annual heating energy consumption of the two structures was normalized per square meter and compared. The annual heating energy consumption of the timber frame structure was calculated as 111.24 kWh/m², while that of the brick masonry structure was 171.71 kWh/m² (Figure 13).

timber-framed house

Zone Multipl...	Comfort Temperatur...	Steady-State Heat ...	Design Capacity (kW)	Design Capacity (W...	Glazing Gai...	Wall Gains (...	Floor Gains ...	Roof and C...
1	15,45	4,26	5,33	78,62	-0,268	-2,477	0,078	-0,020
1	13,44	8,87	11,09	149,55	-0,156	-5,481	0,083	-1,355
1	14,78	3,08	3,85	131,35	-0,080	-2,259	0,029	-0,051
1	16,02	2,37	2,97	78,79	-0,083	-1,233	-0,034	-0,101
-	**14,68**	**18,59**	**23,23**	**111,24**	**-0,587**	**-11,450**	**0,156**	**-1,527**

brick masonry house

Zone Multipl...	Comfort Temperatur...	Steady-State Heat ...	Design Capacity (kW)	Design Capacity (W...	Glazing Gai...	Wall Gains (...	Floor Gains ...	Roof and C...
1	14,90	3,70	4,63	133,53	0,222	-2,221	0,225	-0,497
1	15,92	1,81	2,27	94,89	0,152	-0,831	0,086	-0,311
1	14,80	4,08	5,10	131,64	0,117	-2,717	0,256	-0,399
1	13,77	3,85	4,81	217,00	0,149	-0,817	0,025	-2,343
1	12,68	7,89	9,87	209,30	0,163	-2,477	0,715	-4,775
1	12,89	5,09	6,36	246,85	0,110	-1,920	0,316	-2,723
-	**14,11**	**26,43**	**33,03**	**171,71**	**0,913**	**-10,984**	**1,624**	**-11,047**

Figure 13. Design Capacity results

These values show that the timber frame structure consumes approximately 35% less energy than the brick masonry structure to maintain the same internal temperature conditions, thus proving to be more thermally efficient. In other words, the timber frame construction technique has demonstrated approximately 35% better thermal performance than the brick masonry structure.

4. Conclusion

This study evaluated the thermal performance of two buildings constructed using different construction techniques, located on the same street and under the same climatic conditions. While there are studies analyzing the passive thermal advantages of traditional buildings or the performance of different materials (Martinez Molina et al., 2016; Hailu et al., 2021; Al-Radhi et al., 2023; Mazur et al., 2024), no comparative study exists where construction technique is the sole variable. In this regard, the study offers a methodological innovation to the existing literature on the envelope performance of traditional dwellings.

The method used in the study was carried out in four stages. First, a dataset containing street fabric, building geometry, and material properties was created. Then, thermal resistance and thermal transmittance values were calculated according to TS 825 and transferred to the DesignBuilder model. The Heating Design analysis enabled a comprehensive assessment of wall and floor components in terms of heat loss, surface temperatures, and energy requirements. The findings of the study are as follows:

- Timber frame walls filled with adobe provide lower heat loss and higher internal surface temperatures compared to brick walls. This demonstrates that the decisive factor in wall performance is not thickness but the thermal conductivity value of the material.
- The annual heating energy requirement of a timber frame structure is approximately 35% lower than that of a brick masonry structure. This difference demonstrates that the traditional adobe construction technique has significant potential for energy efficiency.
- The performance of flooring components depends on the direction of exposure: Reinforced concrete performed better in flooring facing the interior. Wooden flooring provided lower heat loss on surfaces exposed to the exterior.
- The results show that traditional materials can be used in modern buildings with appropriate combinations; in particular, local materials with low λ values, such as adobe and lime plaster, have high potential for sustainable building design.

In general, the study provides a scientific reference framework that can be applied both in the field of conservation and in new designs compatible with traditional fabrics. The findings demonstrate that local materials can be reevaluated in contemporary buildings, showing that materials such as adobe and lime plaster are compatible with current energy efficiency targets. Furthermore, the use of these materials, developed using modern techniques, has strong potential in terms of sustainability. At the same time, the study proposes a methodological approach for isolating traditional construction techniques in performance analyses. It lays the groundwork for similar analyses to be conducted in the future.

Author Contribution

The conceptual framework of the article was developed under the supervision of Arzu Özen Yavuz. The literature review and analysis process were conducted by Saliha Erdurmuş.

Conflict of Interest Statement

The authors of the study declare that there is no financial or other substantive conflict of interest that could influence the results or interpretations of this work.

Research and Publication Ethics Statement

This study was conducted in accordance with research and publication ethics, and did not require ethics committee approval.

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Internet Resources

URL-1: Google Maps, Street View image of Yukarı Pazar Street, Afyonkarahisar, https://www.google.com/maps/place/Yukar%C4%B1+Pazar+Cd., Accessed: 08/01/2023

URL-2:DesignBuilder Heating Design, https://designbuilder.co.uk/helpv7.0/Content/_Heating_design_simulation.htm, Accessed: 0