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Examination of Antalya Akseki Traditional Dwelling Examples in Terms of Energy-Efficient Building Design

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Abstract

Anatolia, which has been a settlement area since ancient times, has many traditional structures designed according to environmental factors. Traditional dwellings located in various geographical locations of Turkey exhibit original architecture with the most appropriate design examples for their environment and climatic conditions. These traditional dwellings, which are in different climatic zones and have very low energy expenditures have the qualifications to transfer a lot of information about the design understandings obtained with years of experience to the designers and structures of today and the future. In this context, the study aims to examine the energy-efficient architectural solutions of traditional dwellings. For this purpose, it is aimed to investigate the energy-efficient features of "Button Houses", which are examples of traditional dwellings belonging to the Antalya/Akseki region and has hosted different civilizations for centuries. The energy activities of traditional structures specific to the region were analyzed and evaluated in terms of land placement and orientation, formation, appropriate volume organization, building shell properties, and material properties within the scope of the examinations.

Keywords: Antalya / Akseki, Traditional Dwelling, Düğmeli Evler[1], Energy Efficient Building Design, Sustainable Architecture

Introduction

Energy-effective structures can be defined as structures that are responsible for the environment, which are sensitive to ecosystems, encourage the use of natural and non-waste materials, and consumed as much as the need for climatic data and the conditions of the place. Therefore, designing energy effective structure requires designing to reduce the loyalty to energy sources, be the most utilized of environmental resources, and obtain the most efficiency from extinct energy sources (Tokuç 2004; Kantaroğlu, 2011). In this regard, it is important to design energy-effective structures today.

There are two important objectives that must be included in the design process to reduce energy losses and increase energy gains in energy-effective design (Dörter, 1994). The basis of energy-effective building design is designing the elements that will reduce the heating, cooling, and lighting loads of the structure in climatic conditions of the outdoor environment (Göksal & Ülgen, 2000).

The features that distinguish energy-efficient building designs from other design approaches can be listed as follows (Utkutuğ, 1999):

[1] The name was given to Akseki traditional dwelling

- Manufacturing of all materials and components that comprise the building, usage of the structure as well as its design, maintenance, operation, and selection and management of air-conditioning systems, without lessening the building's standard, while minimizing the amount and cost of energy inputs for individual and social benefit,
- Design, production, and operation with the aim of adapting the building to the environment and benefiting from self-renewing energy sources, as well as taking measures to protect and prevent energy waste.

The concept of energy efficiency in buildings is related to the energy supply required to achieve the desired environmental conditions (Pacheco et al., 2012). The design parameters, which are effective in creating an energy-efficient sustainable environment, can be listed as follows (Tönük, 2001; Soysal 2008; Mert & Saygın 2016; Canan 2008; Küçükdoğu, 2007):

- Settlement and direction on the land (location selection and direction of the structure),
- Forming (form, positioning, and physical properties of the structure),
- Space Organization (Space Programs and Organization of Functions),
- Structural shell properties (dimensional and structural features of building elements such as walls, roofs, flooring, windows, and doors),
- Material selection and construction technique.

When evaluated within the framework of the life cycle starting from the land selection, it is observed that traditional structures are designed with a holistic approach. Like other traditional buildings in our country, it has practices that can be an example in the traditional Akseki Dwellings. In this context, it is aimed to investigate the energy-efficient features of "Düğmeli Evler", which are examples of traditional dwellings belonging to the Antalya/Akseki region, which has hosted different civilizations for centuries.

Materials and Methods

Akseki is a district of Antalya Province of Turkey (Figure 1). It was founded in the southern foothills of the Western Taurus Mountains and is the oldest settlement in the region after Alanya (Yıldız, 1999).



Figure 1. The geographical location of the Antalya-Akseki region

In addition to being home to trade routes throughout history, Akseki and its surroundings are also transition regions in terms of their climatic features. The fact that this environment is the transition area between the temperate and inland continental climates of the Mediterranean has led to the emergence of this original architectural technique (Tümertekin & Özgüç, 1997). The distribution characteristics of "Düğmeli Evler," whose original examples are only found in the western part of the Taurus, can be seen in Antalya province's "Akseki Mountainous Environment" in a local framework.

The traditional dwelling of Akseki is known as "Düğmeli Evler". Although the exact date of the first examples of "Düğmeli Evler" is unknown, it is currently usable, and the construction dates of the oldest surviving specimens are dated to 330 years ago (Manav & Çalışkan, 2017) (Figure 2).



Figure 2. Examples of dwelling with Düğmeli Ev" in the Akseki region

The fact that "Düğmeli Ev" have a limited distribution only in the Akseki-İbradı region in the Taurus Mountains makes this example of traditional housing impressive (Figure 3). The biggest reason why these traditional dwellings, which are observed in the settlements established in the settlements located at the highest above sea level of Antalya province and in

the settlements established in the areas adjacent to the lower border of the forest, have survived to the present day is hidden in the geographical features of the region. The high and rugged terrain conditions of the region have adversely affected the transportation facilities, causing the region to later meet the modern construction materials and new-modern construction techniques. Natural environmental conditions have helped preserve the housing tradition unique to the region for many years (Manav & Çalışkan, 2017).

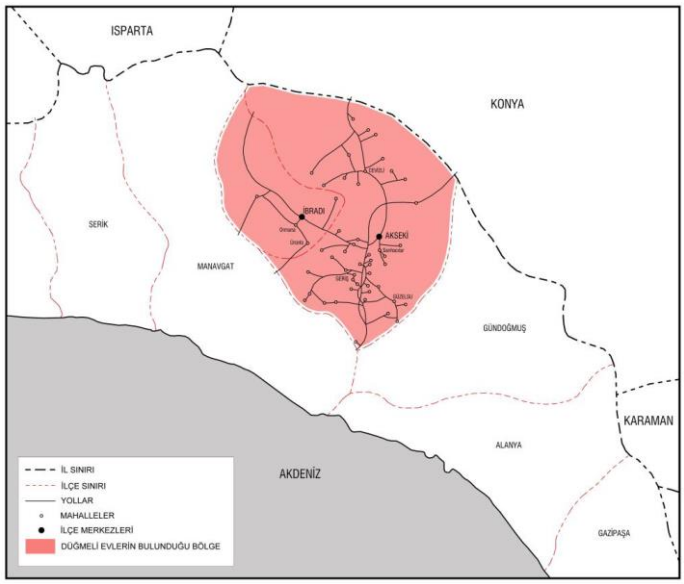


Figure 3. The area where the "Düğmeli Ev" are located (Bakışlı, 2019)

Akseki traditional dwellings are designed on two stories. In general, the entrance is from the ground floor and there are also those designed to receive entrance from each floor according to the topography (Karayazı, 2015). They are usually formed in the middle of the garden or on one or two sides of the garden, facing the street.

In residential dwellings, the ground floor is divided into animal and storage areas. The space that connects the other spaces and is created in the projection of the "sofa[2]" on the upper floor is called "evöğün[3]" or barn in the region at the entrance of the ground floor. In this section, there are haystacks, cellars, woodsheds, rarely coops, pens, and barns. This space also has a staircase entrance or the staircase itself (Figure 4).

[2] The name was given to the common area on the upper floor of the dwellings
[3] The common one to which the ground floor rooms of the dwellings are connected

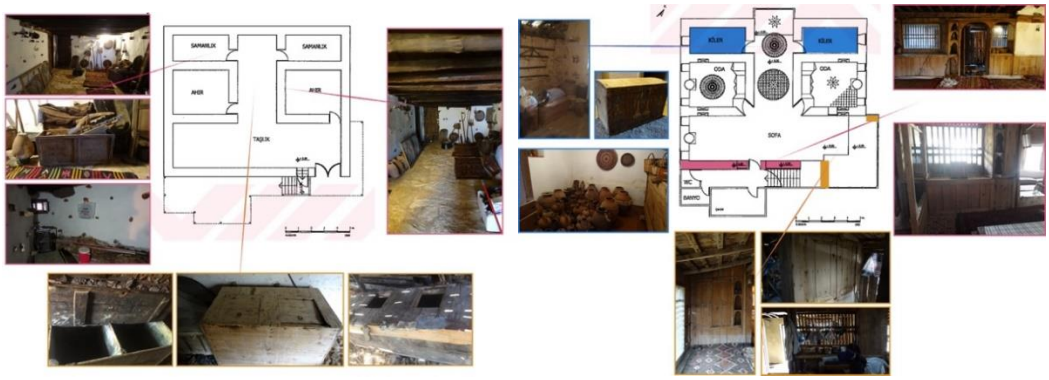


Figure 4. Example of the ground floor and upper floor layout

Its open ups into the living room or to the sofa on the living floor in dwellings with stairs. The rooms on the living floor are designed in two ways: cellar and rooms (Figure 4). On the living floor, there is a café area raised with "seki[4]" on one side of the sofa. Distribution is provided from the sofa area to the rooms. Rooms feature original rural architectural features. Doorways are available when moving into rooms. There is a single window in the cellars and a "sergen[5]" with a shelf system on the walls. Each of the other rooms on the living floor includes the equipment that a nuclear family can sustain, and which is called fireplace, "başmak[6]", "yüklük[7]", "musandıra[8]", "gusülhane[9]", "lambalık[10]" and "sergen" (Figure 5).



Figure 5. Room and sofa layout in the upper floor layout

[4] The wooden element is located on the sofa and sitting on the ground between 15 cm and 20 cm.
[5] In traditional dwelling rooms, the shelf system, which surrounds all the room walls except the 'load' and around the surrounding area, is at a certain height
[6] The name was given to the region's wooden hood on the stove.
[7] Cabinet system for storage purposes in the rooms
[8] A wooden grille in front of it is designed on the '" yüklük' in the region, intended for storage or fruit drying, without covering the 'yüklük' section.
[9] In the local dwellings, the single lid washing section, forms the farthest part of the entrance door of the load cabinet.
[10] We used to put candlesticks, gas lamps, candles, or frequently used small ornaments in the region; A wooden niche with a carved board in front of it, designed in front of the wall alone, in the cupboard, or as a part of the load.

The energy efficiency of traditional Akseki Dwellings was examined in the study technique within the scope of the literature by taking into account the criteria of settlement and orientation, formation, space organization, building envelope characteristics, and material selection-construction (Yavaşcan et al., 2016; Pacheco et al., 2012; Utkutuğ, 1999; Tönük 2001; Soysal 2008; Mert & Saygın 2016; Canan 2008; Küçükdoğu, 2007).

Findings and Discussion

Settlement and Direction to the Land

Akseki is built in a mountainous and rugged area. The texture created by the traditional dwellings shows an organic formation suitable for the topography, considering the prevailing wind direction. The prevailing wind in Akseki blows from the northeast. The prevailing wind effect was considered in the construction orientation. The houses were built respectfully of each other in a way that would not interrupt each other's light, sun, and view with the effect of topography, and they had the opportunity to benefit more from the sun by using the sloping land (Figure 6).



Figure 6. Land Settlement Example

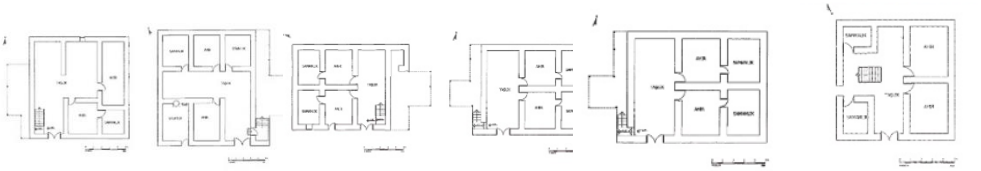
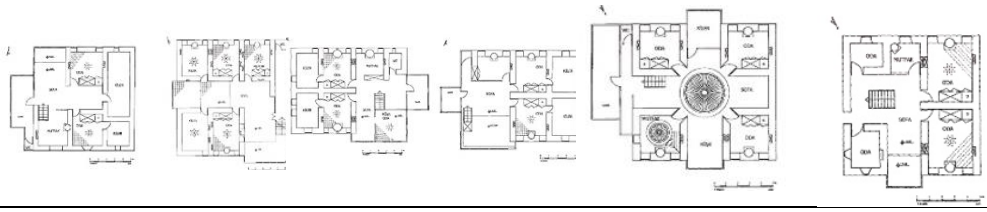
Formation

When considering Eldem's (1954) classification of Turkish house plan types, three types of plan schemes emerge in the dwellings in the Akseki district center: outer sofa, inner sofa, and middle sofa (Başarır, 2001).

The houses in the villages are generally designed with outer sofas. This sofa can be rectangular or "L" shaped. Akkaya (2005) defines the arrangement with an outer sofa created in the shape of an "L" "outer sofa with an eyvan[11]" and evaluates them in two separate groups based on whether or not they have an "eyvan" (Table 1).

[11] In the Sofa settlement of traditional dwellings, one of the facades is a seating area.

Table 1. Plan typology of traditional residences in the Akseki region (Akkaya, 2005)

	"Eyvan" with outer sofa	"Eyvansız" with outer sofa	with central sofa	with inner sofa
				
				

The windows are produced in small sizes on the ground floors of the buildings. The lower floors, which can be called almost completely deaf, are the floors where the barn and haystack places are located. In the dwellings, the façade that dominates the view and opens to the external environment the most is the south façade. Wooden outcomes in buildings are also usually located on this façade. Since the north façade usually faces the slope, window and door openings are very rare (Figure 7).



Figure 7. Example of summer use in sofa layout

The main element that forms the façade in Akseki dwellings is the overhangs. In addition, the dry-stone wall with wooden lines is the determining element that forms the façade texture. The overhangs in the buildings are sheathed with wood. In the buildings where there is no exit, the section where the sofa is reflected on the façade is again closed with wood (Başarır, 2001). Since there are windows along the exits in the buildings, the place where the exit is located is bright.

The ground floor of the traditional Akseki dwelling has almost no windows. On this floor, traditional dry masonry comes to the fore (Figure 8a). The buildings are perceived as single-story from the north façade. Since these facades usually face the slope, window and door openings are very rare (Başarır, 2001). There are no overhangs on the north façade of the buildings (Figure 8b).

a.  b. 

Figure 8a. Example of overhang in Akseki dwelling (Sağıroğlu et al., 2016); 8b. Facade example in Akseki dwelling (Karayazı, 2015)

Spatial Organization

Sofas and rooms, which are among the places in the house where the sun is required, have been solved on the south-facing facades. Service spaces such as toilet, bathroom, kitchen, tandoor house, granary, and outbuildings are located on the north-facing facades with less sun.

In the traditional rural dwellings of the Akseki region, the places used extensively in the summer and winter months are separated from each other due to the climatic characteristics of the region. In the summer, the bench is used, which is generally positioned in the direction of the prevailing wind, whereas in the winter, rooms positioned in the south, west, and east are used (Figure 9).



Figure 9. Summer Usage Example

The stables on the ground floors of the dwellings are located under the rooms used in the winter months and the heat emitted by the animals is utilized. Orienting the parts of the building that are heavily used during the winter months to the south, east, and west, prevents the energy gained during the winter from being destroyed by the wind effect. The building is ventilated and cooled without consuming energy by positioning parts of the building, such as "seki" and "pergola", which are mostly used during the summer months, so that the prevailing wind is inside the building (Figure 10).



Figure 10. "Pergola" and "Seki" example

The cages are mostly concentrated on the upper floors of the dwellings in the direction of the prevailing wind, between "console", "sofa", "ayazlık, and aralık[12]" sections called 'kafesönü[13]' in the" selamlık[14]" sofa, which is mostly used in the summer months (Figure 11).

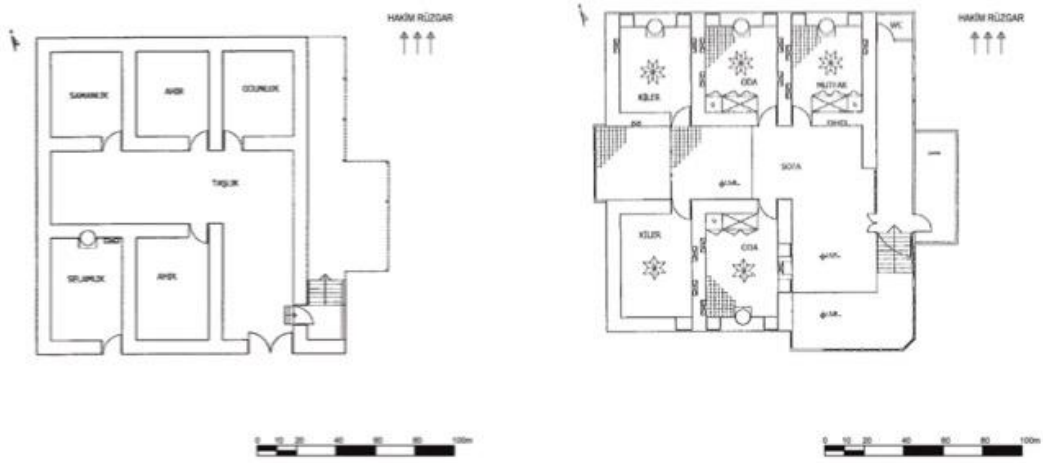


Figure 11. The prevailing wind direction in the traditional residential settlement of Akseki

Structural Shell Features

[12] The section connecting the upper floor entrance of the houses to the sofa venue, intermediate transition area
[13] The wooden section that forms a part of the sofa in the region also includes the eight. It took this name because it was closed around with wooden bite windows.
[14] The seating area in the 'sofa' venue in the residences and hosted guests is the area called 'kafesönü'

The use of local materials in traditional Akseki dwellings reduces the energy of transport and gives the structures an important ecological feature. The first floor of the structures has wooden beam flooring. The floor structure is composed of beams that run from wall to wall as carriers to the short sides of the spaces. Many of the traditional Akseki dwellings feature wooden overhangs. These overhangs were carried by wooden supports that are called 'Eli Böğründe[15]'. The top of the overhang is covered with tiles independent from the roof (Çelebi, 2012).

The gazebos in the houses were supported by cedar wood posts. Wooden elements are arranged at regular intervals on wooden beams that run from post to post. Nail floorboards to these elements to create wooden gazebos. The roofs of Akseki dwellings are either gable or hipped in shape. In the area, there is no flat roof form (Çelebi, 2012). The roof form and material are shaped by the region's geography under the influence of cold and rainy winter months and dry and harsh summer months. In this regard, the efficiency of energy is achieved.

The gardens of the Akseki dwellings are covered with stone. The walls surrounding the garden are built with the wooden carpeted stone wall technique. The wooden elements that are called "semerkandi[16]" are placed on the garden walls (Çelebi, 2012). This system provides privacy while also ensuring a balance of cold and hot air caused by the effect of the prevailing wind (Figure 12).



Figure 12. An example of the garden wall "semarkandi" (Sağıroğlu et al., 2016)

The material used in the doors of Akseki dwellings is wood. It is observed that the main entrance gate and the garden gate of the dwellingsare double-winged (Yeşildal, 2008). W

[15] The name was given to the pads where wooden systems in the housing front order are supported
[16] A wood fence system made on the upper part of the garden walls

When looking at the windows of the dwellings in the area, it is clear that the use of wood is extensive. On the ground floors, where the cellar and barn spaces are located, the windows were made in small sizes (Yıldız, 1999). In this framework, the ground floors are cooler by taking sunlight less. In the use of these spaces, energy efficiency was obtained in the storage and protection of goods such as food and beverage (Figure 13).



Figure 13. View from the Garden and Ground Floor Entrance, which is the main entrance gate (Çelebi, 2012)

On the upper floor, the windows in the "kafesönü" space are seen in large sizes and quite frequently. The windows of the exit are shutting down from the outside. At the same time, these windows have wood or iron bars that started to be used in the 19th century (Başarır, 2001). The upper floor rooms include wooden windows on both sides of the hood. These windows are the original windows with internal shutters from the outside. The cellar rooms also have original wooden windows that open out. With the formation of doors and windows in the upper floor settlement, summer usage areas and cellar rooms are cooler and winter usage areas are warmer (Figure 14a, 14b).

a.  b. 

Figure 14a. Example of an overhang window (Şenocak 2016); **14b.** Cellar room window example (Şenocak 2016)

Material Selection and Construction Technique

The geographical conditions in and around Akseki have been decisive elements in the traditional material and construction technique used in the region. Unlike the Mediterranean coast, the harsh winter climate in Akseki separated this district from Antalya, resulting in the development of a regional architectural understanding.

Stone was used with the effect of geography in Akseki, which was established at the foot of the Taurus Mountains. Pine and cedar forests, which cover large areas of the same geography, are also a source of wood material. One of the most distinguishing features of traditional architecture in Akseki is the harmonious combination of stone and wood (Çelebi, 2012). The stone material is used as a flooring material in some locations such as the ground and also in the body walls, garden walls, and in certain places.

The majority of the materials used in summer buildings were made of wood. Stone material was used on the walls of the winter spaces, and the walls were kept quite thick. Thus, heat losses were prevented (Figure 15).



Figure 15. The use of stone and wood in Akseki dwelling

In Akseki traditional architecture, mortar is not used when building the walls of the structure. These carrier walls, which are built with the drywall technique, are placed inside and outside the wall every 40-60 cm (Başarır, 2001). The beams are connected to each other with wooden elements called "Düğmeli Evler". The buttons used along the wall as needed are left out about 15-20 cm from the wall (Kaya & Güvenç, 2001).

In traditional Akseki dwellings, there are not many examples where the outward-facing surfaces of the walls are plastered. The dry-stone walls of some buildings were plastered with lime-based mortar called "sakar sıva[17]" (Çelebi, 2012). An energy-efficient structure is created with the stone and wood used as sustainable materials in the carrier system. The

[17] The name was given to a traditional plaster process applied on housing walls

workmanship in the masonry technique provides a unique energy efficiency to these structures (Figure 16a, 16b).

a. b.

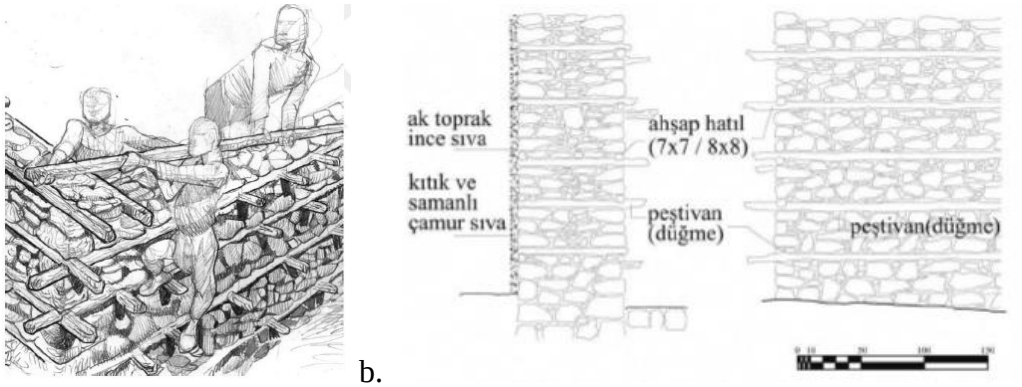


Figure 16a. Drywall building technique (Kavas, 2011); **16b.** Traditional Wall Lining (Tayla, 2007)

Some of the houses have 50-60 cm windows on the ground floors, and some have no windows at all. In houses with windows on the ground floor, the windows are kept both narrow and small in size (Figure 17). Windows are usually more in summer spaces on the upper floors of the structures. Windows were used extensively in the sequences in the summer spaces and even shutters were used. The number of windows is kept small in the places used in winter. The windows in this place have the inside of the cage from the outside. Thanks to these shutters, it has provided the protection of the structure from the heat in the summer and from the cold in winter.



Figure 17. Window with external fence and internal shutter

In the windows, sun breakers are used to protect them from the sun. With this approach, the effect of the sun is reduced during the summer months, and the interior space is kept from overheating. Because the sun is more inclined in the winter, the sunshades become ineffective, and the interior is heated by the penetration of the sun's rays into the building.

Beams, flooring, ceilings, carrier and coating material, windows and doors of the safes and joinery, cabinets, and cedar wood materials are used in traditional Akseki dwellings. Wood is a natural material obtained from renewable sources. Natural materials cause less damage to the environment., the use of these materials in structures has great importance in terms of energy efficiency.

Conclusion and Recommendations

Traditional dwellings are structures that are sensitive to the environment, consume less energy, produce practical solutions, and have ecological sensitivity. Traditional Akseki Dwellings are designed to have an understanding that can create comfortable interiors thanks to the ecological sensitivity in the facade systems, which are responsible for protecting environmental resources.

In addition to building with natural and sustainable materials readily available in the environment, the combination of these materials with rational detail solutions provided a rational space design and a compact building form. The necessary heat, light, and ventilation are provided by passive system solutions and directing, physical, ecological, and economic sustainability. The occupancy-divide rates in traditional Akseki dwellings also make a positive contribution to the natural lighting and ventilation in the interior.

Great importance has been given to the prevention of heat losses in the design of the building element. For this purpose, thermal insulation is provided by using natural materials such as stone, soil, and wood, which have good heat properties. Their placement of interior spaces against heat losses has also saved energy by preventing heat losses. Fewer windows and doors were taken on the north-facing facades of the structures and heat losses were reduced from these openings.

In order to benefit from solar energy in structures, more windows were opened to the southern fronts than other facades. Thus, the amount of energy required by the structure for heating has decreased. Besides, thanks to frequently intermittent windows, natural lighting, and natural ventilation are saved additional energy to be spent on lighting and ventilation.

The maximum benefit from solar energy is provided in buildings. The direction was well calculated, and the structures were placed in accordance with the land slope. The houses are located in the best way to use the slope of the land.

Energy effective design criteria taken into consideration in the examined traditional structures can be an example of today's structures. These design criteria can be adapted to today's technology and user expectations.

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