Evaluation of the Energy Efficiency of Gaziantep Traditional Houses

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ABSTRACT: It is a generally accepted idea that today's architectural activities should be environmentalist and sustainable. The most significant design input is 'climate' for using sustainable energy in buildings. How energy requirements are used to obtain the comfort conditions of the buildings can be estimated with technological developments and researches today. It is obvious that there is much knowledge which we should learn from traditional architecture as in the context of urban, in single structure and in structural details for energy effective design. In this context, in Turkey, a great amount of energy consumed is used in buildings for air-conditioning and for heating them. To minimize this energy consumption, energy effective passive systems must be used in the design of agglomerations. When Gaziantep traditional houses are observed, it is seen that they have various forms in urban and building scale due to the hot-dry climate. These forms and locations change according to their orientations, wind direction and their topography. To accommodate of traditional dwelling issue on high regions where they can utilize the refreshing effect of the wind, to constitute shady spaces with site plan compositions of the buildings, to obtain weather circulation in hot summer days; frontages of the buildings, size and ratio of the components used in facade are functional solutions for natural climate systems in the urban scale. In this study, energy performances of four traditional houses in Gaziantep traditional urban fabric has been compared with three new buildings which represent the widespread applications in new constructions. In the results of the study, it is seen that four traditional Gaziantep houses need 47% less energy in winter when they are compared with three modern houses. In parallel to this, it is seen that they have 18% less energy loss during the year. As the result of the study, it can be said that the new habitation regions designed by today's development plans are designed without the consideration of natural ventilation systems. In these new examples it is observed that the design of frontages of the buildings and their structural details for conserving energy and natural ventilation are very far from the traditional architecture. And also, in these examples, span of the windows, walls and floor elements and examples in the traditional architecture are not repeated in today's applications as natural passive energy systems.

Keywords: Traditional architecture, low energy

1. INTRODUCTION

It is seen that logical solutions directed towards energy effectiveness take place in traditional architecture. Owing to these solutions a thermal performance which is appropriate for seasons and insulating is met in many historical buildings. It can be said that less energy is used up in the central heating and ventilation systems of these buildings. We can say that these historical buildings could be solutions based on their circumstances with the help of their long lasting try and see methods. It is very essential for modern designers to realize and learn about these past applications from the point of lessons which might be taken. However, rapid construction has gone on so far in parallel with rapid population growth in Turkey and energy performance has inconsiderately been ignored in new applications. It is observed that mass production, concern of architectural form and cost as a forthcoming value are given importance in today's practices. It is also known that Turkey as a country uses most of its energy for the ventilation and heating of the buildings. It is possible to minimize energy consumption by designing the buildings and settlements as passive energy systems [1]. The lessons taken from the historical buildings are in the dimension of formal imitation today. Because of the fact that the aspect of energy preservation and their respect to the nature of historical buildings are not recognized, energy needs show an increase in the usage process of the current applications. This is also an important problem in Gaziantep, a city which is situated in the South east of Turkey, as in every other part Turkey.

The aim of the present study is to get results by analyzing the energy preservation approaches and locations of Gaziantep Houses that have traditional architecture customs at every stage of construction and in space organization and in detail scale. Current practices in the same city will also be evaluated with the same methods and the comparisons of historical houses and current practices will be made from the point of energy performance, yearly heat loss and needs. Computer tool which is to be used during the evaluation process has been drawn up by The Chamber of Turkish Machine Engineers [2]. This computer tool does calculations in accordance with the regulation of Turkish Standards 825 (TS 825) "Regulations of building insulation" which took effect in 2000 [3]. In this regulation, Turkey is separated into four climate regions and Gaziantep takes place in the second region. For this reason, calculations have been carried out according to the coefficient in the working area. The methods of calculation of standard TS 825 took the standards ISO 9164 and EN 832 as bases to ensure conformity with the international standards.

Figure 1: Location of Gaziantep in Turkey

2. GENERAL CHARACTERISTICS OF GAZİANTEP HOUSES

Gaziantep has a kind of transition climate between Mediterranean and terrestrial. It is hot and dry in summers and in winter it is cold and rainy. Yearly average temperature is 14.5 Cº, and the coldest month is (January) 2.3 Cº, the hottest month is (July) 27.1 Cº. The highest temperature so far has been 44 Cº, the lowest temperature has been -17.5 Cº. Dominant wind direction of Gaziantep is the southeast wind [4].

Historical Gaziantep is geographically located in between Mesopotamia and the Mediterranean where ancient civilizations were founded. Thus it has a rooted past. This area has been a settlement place for societies for ages.

Historical Gaziantep Houses have an indicative effect on the urban fabric. Besides, many mosques and churches are structures which are effective on the city's silhouette. Gaziantep traditional settlement has been set up on three hills and it is composed of closely built houses in a valley among these three hills. The most spectacular characteristics of this formation are organic geometric narrow streets. Some of these streets form dead end streets by acquiring a character of their own. While the houses around these dead ends compose units of neighbourhood, we find them as social places where communication among neighbours is provided and where people sit and children play games.

The first space of the house to be reached from the street is usually a courtyard with its high walls. The courtyard can be said to be the main element or the centre of a house in space organization of Gaziantep houses. The main usage areas of the house especially are yards in summer months. The closed parts of the houses are around the courtyards and they have usually a passage directly to the yard. With these, the yards function as a hall or a delivery centre rather than an outdoor space. So its characteristic to be the main element in the space organization becomes stronger. At nights the living area usually moves to these yards and the yards become the basic living space. The houses usually are composed of a basement, a ground floor and a first floor. While lower floors are generally used in winters, upper floors are generally used in summers.

Gaziantep houses that are made of stones have also plain geometric facades. Wardrobes are often fixed in the walls by making use of their thickness. Like Typical Turkish House architecture, Typical House architecture in Gaziantep has flexible usage especially in the rooms.

3. ENERGY PRESERVATION IN TRADITIONAL GAZİANTEP HOUSES

Architectural solutions that are developed to provide energy preservation in typical Gaziantep houses can be grouped under the following titles.

3.1. Massive Solid Walls

The material which is used in the traditional architecture of Gaziantep is made of lime stones which are known as "*havara", "keymık*". Heavy wall stones and small sized windows help the heat storage in winter months. In summers, by protecting the inside from the heat, these stones and windows provide the appropriate comfort. The thicknesses of the walls in the ground floor are usually 70 cm. But rarely this thickness can be up to 80 cm. In the upper floors console walls have a minimum thickness of 22 cm, walls without consoles have a minimum thickness of 50cm (Figure 2,3).

The thick walls used in Gaziantep increase the thermal performance of the building. Thick and heavy walls have the advantage of high inertial heat. Because of this heat inertia the duration of air ventilation from outside to inside becomes longer depending on the thickness of the wall [5].

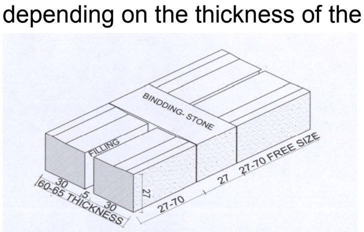

Figure 2: Massive masonry wall.

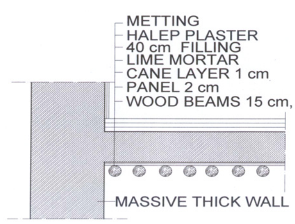

Figure 3: Floor section of Gaziantep traditional houses.

3.2. The shutters and lattices of the Windows

Almost every window in Gaziantep uses these shutters. They are functionally located in harmony with inside wall coverings, wood works and other indoor works. The shutters are differentiated from other samples in other countries by being inside instead of outside. Besides providing controlled light in, heat storage and insulation, they are used as curtains.

In providing appropriate thermal comfort in our buildings, the total ratio of the window to the total ratio of wall thickness is an important value in insulation. In traditional Gaziantep houses the percentage of the window part to the percentage of the wall part is almost the same ratio in current applications. But, some of the historical building's windows percentages are less in contras to current applications. Beside this, simple solutions on the doors and windows where most ventilation takes place may be really effective for conservation of warm and under controlled lighting. For these reason sun protection elements, shutters and lattice works which are not used in modern buildings of Gaziantep show the sensibility of classic architecture on the subject.

Figure 4: Examples of lattices in Gaziantep traditional houses.

Figure 5: Examples of shutters in Gaziantep traditional houses.

The shutters have multifunctional features in Turkish architecture. They are usually used to prevent the person who looks out from being seen by one outside. By this they provide intimacy. These elements at the same time provide controlled sun light in. The screening lattice works that are made of various geometric shapes and materials are also used as controlled natural ventilation items beside its providing controlled sun light in (Figure 4,5).

3.3. Top Windows (Kuştağları)

The building elements that are called "Kuştağası" or top windows are commonly used in the southeast and Mediterranean regions of Turkey. They are unavoidable details that are used in every historical house especially in the south-eastern Anatolia region. They are carefully designed to decorate the facade of the buildings as an indication of wealth and art (Figure 6,7). Moreover, as they are items that provide the ventilation directly they are the most clear and passive simple solutions in historical buildings. Top windows are built in small dimensions on top of the large windows and door's middle perpendicular axle. The top windows especially circulate the warm air coming from the doors and side windows and keep the fresh air in. This simple and easy detail is unfortunately is not used in modern Gaziantep houses. However, Modern houses and flats use electrical systems to provide air conditioning in winter and summer months of the year. Natural ventilation is used to lessen the energy used by cooling systems in buildings and for effective passive cooling (Figure 8). The natural ventilation is mostly carried out by opening windows and doors in Turkey [6]. No design is made for especially for natural ventilation in the houses or flats. At this point, a top window (kuştağları) in every house in Gaziantep provides this natural ventilation. This detail is also a functional building item which is not used in Today's modern houses of Gaziantep.

Figure 6: Examples of top windows with wood lattices in Gaziantep traditional houses.

Figure 7: Examples of top windows with stone lattices.

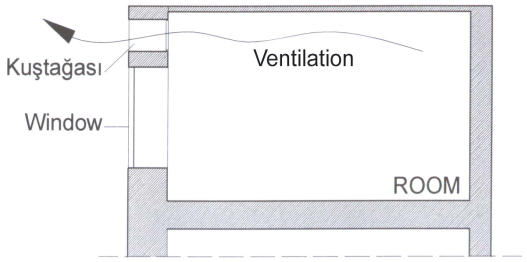

Figure 8: Section of a Gaziantep traditional room and air circulation with top window.

3.4. Cellars (*İzbeler*)

Cellars are cooling depots in dry and hot climate regions. They are used as a fridge especially in summers. These places are connected to the kitchen and the yard in Gaziantep and built by digging the ground of the basement and digging the slope in slipping grounds (Figure 9). In these cellars which are not affected by the humidity and the heat outside, food can stay without being spoiled. These are the cooling depots where the fruit picked in falls can stay with no perish. Nowadays the people still keep their storage using habits alive but they use freezers instead of underground depots which cause extra energy consumption.

Figure 9: Re-functioned cellar as a cafe.

4. EXAMPLE OF HEAT PRESERVATION OF HISTORICAL GAZIANTEP HOUSES

Energy performances of four historical houses of Gaziantep have been compared with the three modern houses that represent the common practices. The architectural characteristics of the houses and the related energy performances have been evaluated as follows:

1. The house of Önder Lahmacun: It is located in the South of a rectangular shaped yard. The house has openings mostly to the North and east directions (Figure 10,11). The South part of the house has been built as a blank wall because of the city's location. In addition, two windows have been built to the west direction in the upper floor. Depending on the general formation of the structure the ratio of the surface to volume has been calculated as (S/V) 0.78. The energy need for winter has been calculated as 110.95 kwh/m², and yearly heat loss has been calculated as 208.31 kwh/m² (Figure 18). Because of the fact that there are windows in the North facade of the house, while there are no windows to the South, energy need and energy loss becomes more.

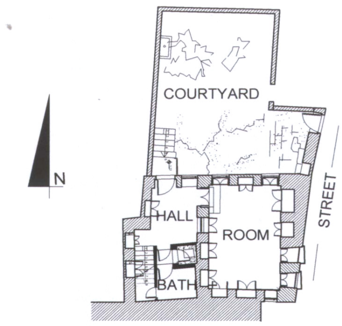

Figure 10: Ground plan of Önder Lahmacun.

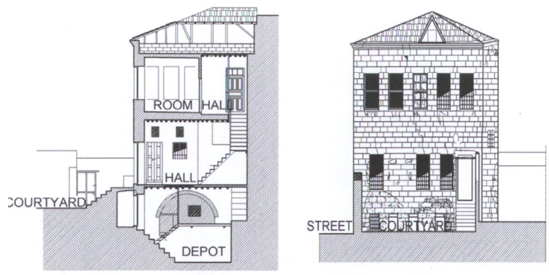

Figure 11: Section and elevation of Önder Lahmacun

2. The house of Nazire Ertütüncü: The living parts are lined in the northern and western part of a rectangular shaped yard. Because of the city location the North facade of the house is blank wall. The living parts of the house and windows are directed to the South and east (Figure 12,13). In the west direction there is only one window. The thicknesses of the walls in the ground floor have been calculated as 60 cm, and the thickness of the floor is similar to the other houses. Depending on the general formation of the structure the ratio of the surface area to volume (S/V) has been calculated as 0.67. The heat energy needed in winter has been calculated as 89.64 kwh/m², and yearly heat loss has been calculated as176.34 kwh/m² (Figure 18).

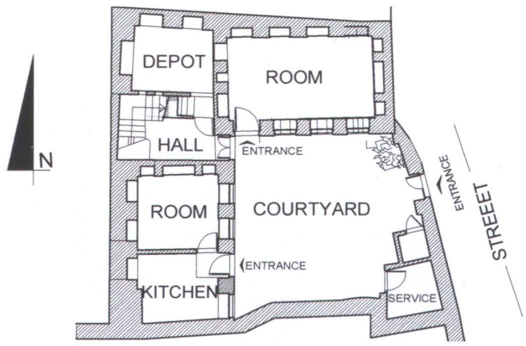

Figure 12: Plan of Nazire Ertütüncü House

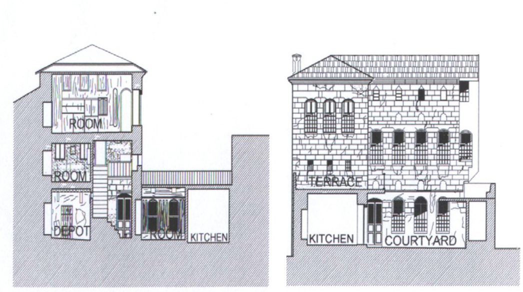

Figure 13: Section and elevation of Nazire Ertütüncü house

3. The house of Bakkaloğlu: It is located in the North and east of a pentagon shaped yard. The parts used at home are at the direction of South and west. Because of the city location the North and east directions are built in a connected structure. There are no windows to these directions (Figure14,15). The thicknesses of walls in the ground floor are 70 cm and they are made of lime stones. The thickness of the floor is similar to the traditional Gaziantep houses. The ratio of the surface area to volume (S/V) is calculated as 0.67. The amount of the energy needed in winter has been calculated as 87.41 Kwh/m² and the yearly loss has been calculated 176.51 Kwh/m²(Figure 18).

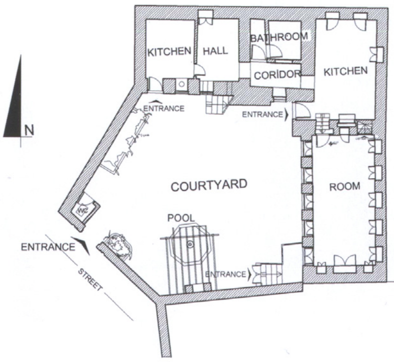

Figure 14: Plan of Bakkaloğlu house

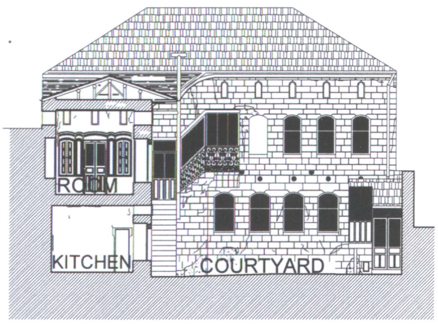

Figure 15: Elevation of Bakkaloğlu house

4. The house of Ahmet Dai: One enters to the yard from a narrow street directly. The yard has been planned in a rectangular shape. The house is composed of a ground floor, a middle floor and a top floor. Rooms mostly have south and west facades but top rooms have windows to the east. And there are only small ventilation windows to the north (Figure 16,17). The thicknesses of walls are about 60 and 70 cm and they are made of lime stones. The thicknesses of the interior floors are similar to the typical Gaziantep houses but in one floor it was found that the thickness was 70cm. Based on the general form of structure, the ratio of the surface area to the volume (S/V) has been obtained as 0.64. It is the lowest value among the other samples. That the thickness of the wall in the outer part is less than the inner part is appropriate to the natural conditions of the region. For this reason in winter the heat loss becomes less and in summers the part that is exposed to sun heat also becomes less. For this reason, while a cool atmosphere is provided in summer months, in winter months a warm atmosphere is provided. Is summer months, typically the ventilation is provided through the top Windows. Depending on architectural form, energy needs and energy loss have been found out as follows: The amount of the energy needed for winter has been calculated as 89.79 Kwh/m². The yearly heat loss has been calculated as 182.95 Kwh/m² (Figure 18).

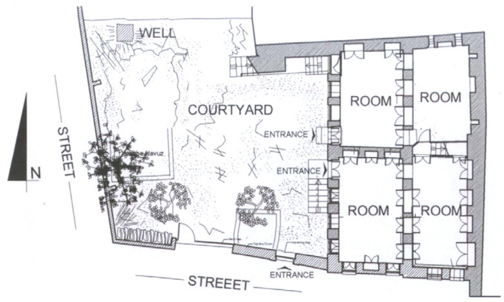

Figure 16: Plan of Ahmet Dai house

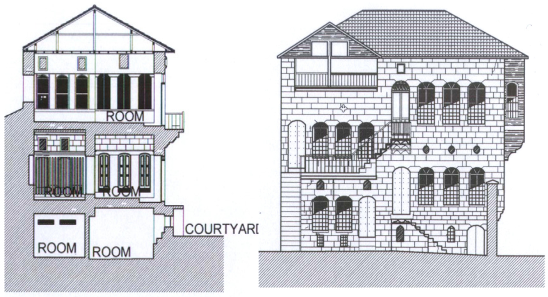

Figure 17: Section and elevation of Ahmet Dai house

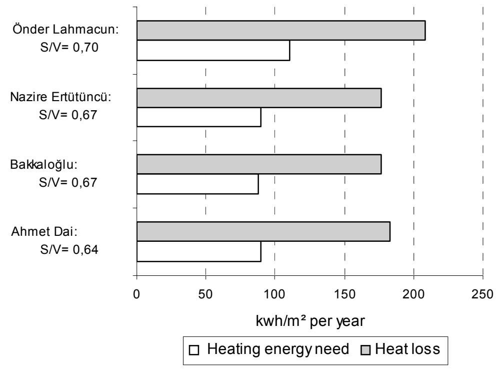

Figure 18: S/V ratio, annual energy needs and heat loss of selected historical houses.

4.1. Modern Houses of Gaziantep:

The present development plans of Gaziantep, being different from traditional urban settlements have generally been appropriately designed to the construction of the detached buildings. There are different types of buildings. While the new development plan which is valid throughout most of the country lets apartments be built, one or two floor detached houses are let to be built in some parts of the city. There exists a construction which is not harmonious with the rest of the city in the borders of parcels. As the area has become a centre of attraction together with increasing industrialisation, especially in the last fifteen years many houses have been built rapidly. This situation affects the general quality of the houses in a negative way. The priorities of land owners and architects are to build as many houses as possible in the most economical and fastest way. Rich people mostly prefer exaggerated, showy and formal houses. After our interviews with the authorities, it has been found out that the issue of energy activity is not an initial criterion in the design of the buildings. In new buildings, central heating systems are used in winters to heat the houses. In summers the internal parts of the houses are cooled by using air conditioning. The thickness of the house walls are usually between 20 cm and 30 cm and insulation is not generally applied. Namely, in modern buildings there are no sensible architectural precautions and solutions (Figure 19).

Figure 19: Modern examples from Gaziantep

Among the chosen houses there is an apartment with many floors (G+5), a detached house with a garden (G+1) and an apartment with a few floors (G+3). These different types of structures are commonly used typologies. The energy performances of these structures have been calculated separately. The results are as follows (Figure 20):

1. Cemil Okkıran house (G+1): The heat energy needed for winter is 165.38 kWh/ m², yearly heat loss 281.03 kWh/ m². The S/V ratio of the building is 0.70.

2. Mustafa Özüzümcü Apartment (G+5): The heat energy needed for winter is 99.44 kwh/m², yearly heat loss is 177.66 kWh/ m². The S/V ratio of the building is 0.35.

3. Ahmet Özsahan apartment (G+3): The heat energy need of the apartment for winter is 129.94 kWh/ m², yearly heat loss is 227.37 kWh/ m². The S/V ratio of the building is 0.57.

5. COMPARISON

While the average heating energy need of the modern building is 131, 60 kwh/m², the heating loss is 228, 68 kwh/m², the average heating need of the traditional houses is 94,45 kwh/m², and the heating loss is 186,03 kwh/m². According to these results, the heating performance of the traditional houses is better when they are compared with the modern houses. The fact that the walls of the traditional houses are thick is effective in obtaining these results, because the total areas of the windows of both modern and traditional houses are almost similar. The traditional house having the highest S/V (0, 78) needs 110, 95 kwh/m² energy for heating (This is the lowest negative result among traditional houses). This house spends (S/V=0, 35, necessary heating energy=99,49 kwh/m²) only 11,49 kwh/m² more energy for heating than the modern one which has the best result , it means that there is only 11,54 % difference between them from the point of energy needed for heating, whereas S/V ratio difference between them is very high 55%. Despite this fact, it is seen that the highest heating energy of this traditional house for winter months is high.

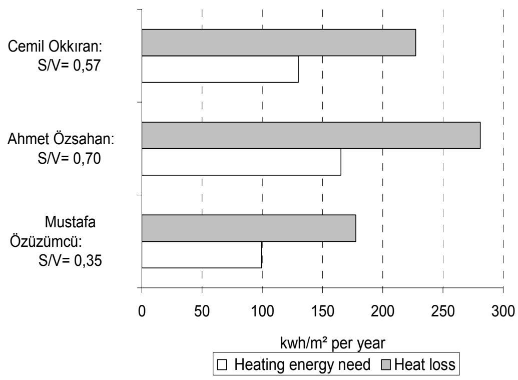

Figure 20: S/V ratio, annual energy needs and heat loss of selected modern houses.

Another comparison has been made between them related to the limit values indicated in TS 825. These limit values are used to indicate the maximum heating energy that can be used in buildings. For the second region the value to be calculated depending on S/V ratio can be obtained with the formula Q' = [68,59 (S/V) + 32,30] kwh/m².

The comparison of heating energy needed for each house with the limit values shown in TS 825 is given in figure 21and 22.

The limited values of heating energy of both traditional and modern houses are given below:

Traditional Houses:
Ahmed : Q' = 76.20 kwh/m²
Bakkaloğlu: Q'= 78.26 kwh/m²

Nazire Ertütüncü: Q'= 78.26 kwh/m²
Önder Lahmacun: Q'= 85.80 kwh/m²

Modern Houses:
Ahmet Özsahan: Q' = 80.31 kwh/m²
Cemil Okkıran: Q' = 71.40 kwh/m²
Mustafa ÖzÜzümcü: Q' = 56.31 kwh/m²

While the average energy need for the traditional houses was calculated 94,45 kwh/m², according to current regulations the average limit value of these houses was calculated as 79.63 kwh/m² . Like this, while the energy need for modern houses was calculated 131,60 kwh/m², according to the current regulation the average limit value of these houses was calculated as 69,34 kwh/m² . As a result of these calculations, the average limit value of traditional houses has been overcome in 18.61%, and the average limit value of modern houses has been overcome in 89,79% ratios. Modern houses are consuming more energy, because of overcoming values indicated in the regulations (Figure 21-22).

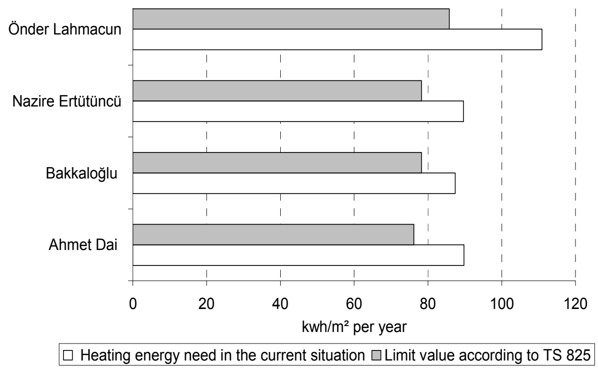

Figure 21: Comparison between the heating energy need and limit values according to TS 825 in the historical buildings.

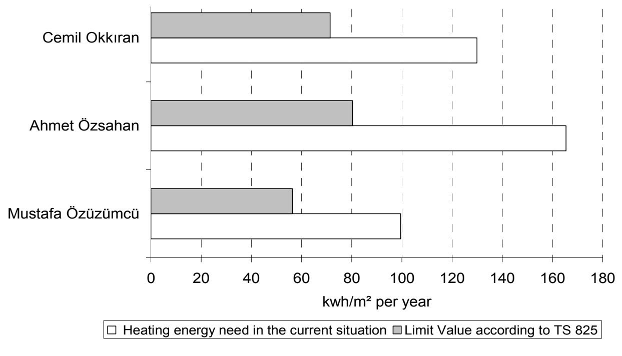

Figure 22: Comparison between the heating energy need and limit values according to TS 825 in the modern applications.

6. CONCLUSIONS

Traditional house architecture in this part of Turkey has been accommodated with weather characteristics. They have architectural characteristics that are appropriate to present conditions. With the usage of architectural formation and the local material in a logical way, the comfort both for the winter and the summer is provided in a natural way. The sensibility seen in every scale of the design is the optimal architectural solution which is a result of a long try and sees period. Such a sensibility is not seen in the other common types of buildings. There is a gap between the past and today from the point of understanding. The most important reason of this is the over reliance on the technology and is to believe in proving energy need by using this technology. Although an environmental and progressing sensibility all over the world has started it has been seen that it is difficult to quit attitude and habits as in Gaziantep scale.

When temperature values of traditional Gaziantep houses for winter term is calculated, it has been found out that they are in a better condition when they are compared with modern houses. Four traditional Gaziantep houses require an average of 47% less heating energy in winter when they are compared with three modern houses that are examined. Parallel with this, they have an average of 18% less yearly heat loss. The details which are developed for typical Gaziantep houses are approaches which do not require advanced technology. However, instead of using such details, in modern houses air conditioning, which is not ecological, is preferred. Fixed light structures, ceilings and floors that have little thickness, built with the effect of modernization, increase the heat loss. Moreover, the thermal tightness of the walls for summer has been overlooked. For cooling the building, dependence on energy sources which are not renewable has increased with these applications.

The study shows that with a sustainable approach, traditional architecture should be used in the best way to be able to make our buildings more energy active in providing winter and summer comforts.

ACKNOWLEDGEMENTS

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7. REFERENCES

[1] Baird M. Smith, Conserving Energy in Historic Buildings, is available at this internet address: http://www.cr.nps.gov/hps/tps/briefs/brief03.htm
[2] The Chamber of Turkish Machine Engineers web site: www.mmo.org.tr
[3] Anonym, TS 825, Thermal Insulation in Buildings, 1998, Turkish Standard Institution, Ankara, Turkey.
[4] www.gaziantep.gov.tr
[5] aird M. Smith, Conserving Energy in Historic Buildings, is available at this internet address: http://www.cr.nps.gov/hps/tps/briefs/brief03.htm
[6] T. Ayata and O. Yıldız, Investigating the potential use of natural ventilation in new building designs in Turkey, Energy and Buildings, 2005, 5, paper also available at
www.elsevier.com/locate/enbuild