BIOCLIMATIC DESIGN IN TÜRKİYE: A COMPARISON OF THE TRADITIONAL WITH THE CONTEMPORARY

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Summary

Emphasizing the impact of bioclimatic design elements on the energy performance of dwellings, this paper aims at comparing traditional houses with the contemporary to learn from the past experiences and implement them in new design practice. This paper's focus is on the architectural design phase. Significant design elements mentioned in the literature are introduced. Two case study dwellings are selected from the region of Safranbolu, as representatives of the two neighbourhoods, i.e. the old part built with the "traditional" and the new part with "contemporary" architectural approach. A building performance simulation program has been used to generate data for the study. The comparison is based on the bioclimatic design elements and the thermal performance of both buildings. It is claimed that traditional Turkish houses have a better understanding of climatic responses compared to contemporary design approach, which is tested in this study.

Keywords: bioclimatic design, energy efficiency, thermal comfort, Safranbolu houses

1 Background

Improving the energy performance of dwellings is a major issue in reducing the energy consumption and the research in this area points to a wholistic approach that covers a process from pre-design to post-occupancy. Architectural design phase is where most of the decisions are made about the dwelling and influence the energy performance a great deal. In Türkiye, a variety of design approaches could be observed in different regions considering the different climate properties and the local materials available for construction. In this context, traditional dwellings should be analyzed in terms of the collective design approach, which is assumed to be crucial to learn from the experience so far, to improve the energy efficiency of contemporary dwellings.

Architectural design elements, that the value of energy savings depends on, are climate, orientation, layout, building type and age, insulation, air tightness and shading of the envelope, thermal mass, natural ventilation, and daylight [Davidson, 2006]. In addition, Smeds and Wall [2007] emphasize the key design features of high-energy performance houses in Sweden as area/volume ratio of the house, and the window properties. Effect of landscaping, thermal mass, windows, airtight construction, renewable energy technologies, lighting elements lead to net zero energy solar houses in Quebec, Canada [Charron et al, 2006].

In Türkiye, İnanıcı et al [2000] made a study about the building aspect ratio [BAR] and south window size [SWS], in Türkiye and they found out that the optimum BAR for 25% SWS is 1:1.2 in Ankara. Regarding the optimization of SWS, keeping the BAR constant in Ankara, optimum SWS is 50%. Bedir [2006] made a research on developing the energy performance of the dwellings in Ankara, and found that air tightness has the biggest impact on the energy performance [50%], and wall composition, window composition, and insulation thickness reduce the energy loss through envelope by 25%, 14% and 10%, respectively. Sözen et al [2007] made a study on the traditional Diyarbakır houses about the sensitivity of the architecture to hot-dry climate, energy efficiency and environment, and concluded that the layout of the house with organization of open, semi open and closed spaces gives the opportunity to benefit from the climate to full extend in terms of passive heating and cooling. Compact building forms reduce the transmission losses and the high volume/area ratios of spaces provide the chance to reduce the impact of high day-night, winter-summer temperature differences.

2 Description of the Climate and the Dwellings

2.1 Description of the climate characteristics

Safranbolu [41° 16’ north latitude- 32° 41’ east longitude], located between Black Sea and Central Anatolia regions, shows the characteristics of both, temperate-humid and hot-arid. Hottest months are July and August [max 40°C], and the coldest months are January, February and March [min -10°C]. During the day, the biggest temperature differences are 21.2 °C in summer and 17.5 °C in winter. The rainiest months are January, February, and June [average 50 mm/month] and the driest days are July, August, and September [average 22 mm/month]. Average humidity is 60%.

2.2 Description of the dwellings

2.2.1 Site, form and organization

The traditional house selected from the old neighbourhood , was constructed in 1870 and located nearby a water stream. Reflecting the lifestyle of the time, the street level façades have small windows above the eyelevel. Spatial organization follows the same principle, consisting of general rooms like the barn, the common kitchens and the ‘hayat’, which is a common room to serve the general needs of the house, facing the street façades.. First floor, defined as the ‘winter section’ in the house has three rooms, and a common kitchen to serve the entire house. Rooms in this floor and in the second floor are self-sufficient units, including the douche, oven, storage, and kitchenette. Rooms on the first and second floors are collected around ‘sofa’s, spaces that are for socializing as well as circulation [Ulukavak et al, 2005].

The contemporary house selected from the new neighbourhood, was constructed in 1982. It has two levels above the ground; the basement floor consists of the technical rooms, storage, and a kitchen. In the first floor there are two big living rooms and another kitchen, and in the second floor, three bedrooms.

2.2.2 Envelope properties

In the traditional house, ground floor walls have stone load bearing wall construction, and above them the wood skeleton structure raises with adobe brick infill. Windows have shutters for shading in summer. The structural system of the contemporary house is reinforced concrete with gas concrete brick infill walls. Both houses have wooden doors and window frames. Also the roof structures and materials of the houses are identical, i.e. wooden structure with brick roof tiling [Table 1 and 2].

Tab. 1 Envelope properties of the traditional dwelling

Building element	**Materials**	**Thickness [cm]**	**U value [W/m^{2}K]**
Wall [1]	Wooden skeleton, adobe brick infill, adobe plaster	25	0.7
Wall [2]	Natural stone load bearing wall	50	0.81
Slab	Wood	20	2.16
Window	Wood frame with single glazing		5
Door	Wood		2.36

Tab. 2 Envelope properties of the contemporary dwelling

Building element	**Materials**	**Thickness [cm]**	**U value [W/m^{2}K]**
Wall	Reinforced concrete construction, gas concrete brick wall, plaster cover inside and outside	30	0,90
Slab	Reinforced concrete	32	0.89
Window	Wood frame with double glazing		2,90
Door	Wood		2.36

3 Results

3.1 Comparison of the bioclimatic design elements

Surrounding landscape for both houses is advantageous to avoid over heating. The traditional house has a very compact form, with a high ceiling on the ground floor, whereas the contemporary house is elongated on the north-south axis with the same ceiling height on all floors. In this climate both building forms are acceptable, but the traditional house is more advantageous, since it is more compact.

The shed and the common kitchen on the ground floor with stonewall and high ceiling create a big thermal mass for the house. The smaller ceiling height of winter section on the first floor reduces the heating demand and also the heat losses. The individual heaters in each room also help for space heating as well as being used for cooking and hot water. The heating concept of the traditional house is based on conserving the heat generated in the house. The contemporary house does not have this kind of an approach; the layout of the house reflects the lifestyle of the occupants only, namely, living rooms and kitchen on the ground floor, and the bedrooms on the first floor. Since there is a central heating system implemented in the house, occupants perceive heating of the house as based on the central heating system, which also supplies hot water.

In terms of the envelope configuration, the contemporary house envelope has better heat resistance values, and double glass windows are an important factor. Distribution of the windows over the façades is quite homogenous on the north and south and disregarding orientations in general. The traditional house has a very bioclimatic approach with small and less windows on the north, big number of windows on the south. Thermal resistance of the building envelope is quite weak compared to the contemporary house.

3.2 Comparison of thermal performance of 'traditional' with 'contemporary' house

From the beginning of November till the and of April, and in July- August, the period that heating or cooling needed in total, contemporary house shows a higher value [10%]. May-June, and September- October are almost identical in terms of the period that the houses are in the thermal comfort zone [Figure 1 and 2]. It could be said that, there is not too much difference in total, between the 'traditional' and the 'contemporary' in terms of the durations that heating or cooling is necessary, but these periods shift. The similarity of the days of heating-cooling demand necessity, could be because of the higher thermal resistance of the wall composition in the contemporary house, that leads to similar thermal performance with the traditional. The thermal mass and zoning of the traditional house might lead to the period shift in thermal comfort and the differences in passive heat gain and loss [Table 3].

Tab. 3 Passive heat gains and losses distribution in traditional and contemporary house

	Traditional house		**Contemporary house**	
	Gain [%]	Losses [%]	Gain [%]	Losses [%]
Fabric	94.4	0.8	41.5	0.6
Sol-air	-	76.1	-	6.9
Solar	-	9.8	-	20.8
Ventilation	4.6	0.1	43.4	0.7
Internal	-	12.0	-	70.8
Inter-zonal	1.0	1.2	15.1	0.2

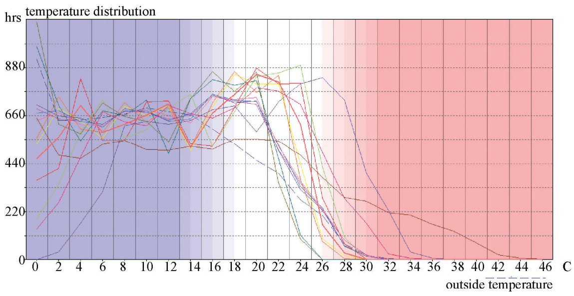

Fig. 1 Temperature distribution 'traditional'

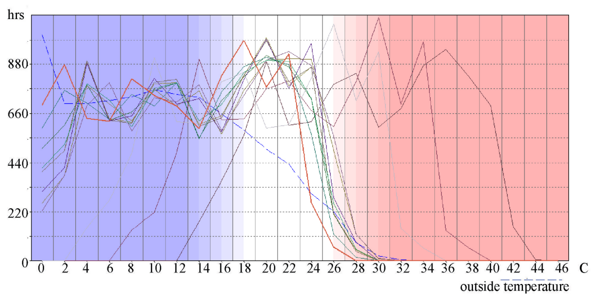

Fig. 2 Temperature distribution 'contemporary'

4 Conclusion

The main finding of the study is that the heating concept of the traditional house is based on conserving the heat generated in each zone and in the house in total. The contemporary house does not have this kind of an approach. The combination of a better heat resistant envelope, together with the passive design principles of the traditional house should be studied in terms of the thermal performance. Energy efficient design is highly contextual so this study's results mainly concern Safranbolu. Thermal resistance and thermal mass show similar results in terms of the heating demand of the houses, which emphasize the importance of energy performance calculation method. This point, comparison of steady state and dynamic simulation should also be researched further. Lastly, the results of this study should be tested with actual consumption levels.

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