Relation of Urban Transformation Projects with Locality and Their Effects on Energy Conservation: The Case of Diyarbakır

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Abstract

Urban transformation projects which started for the urbanization of newly constructed cities in the history of Turkey are generally appears to build new housing projects for last years. Large amount of housing need caused by rapid increase in urban population has changed the face of the cities with these new constructions. These changes in the cities have increased the need for energy and pointed out the efficient and correct use of energy resources. Local resources are the simplest, accessible and efficient references of passive energy systems for energy conservation and play a major role in revealing the distinctive characteristics of cities.

To show how the local features of a city contributes to decrease the energy consumption amount increased by urban transformation projects, two sample projects designed for the same climatic region were analyzed. First of these projects in the selected city Diyarbakır was designed by the traditional architecture principles and the second project was designed without references from the city's local sources. Traditional design principles used in the first project were applied to the second project to improve the annual cooling and heating energy demand and show how these principles change the results. The principles used in these projects were assessed with comparative energy analyses.

Keyword: Urban Transformation; Energy Conservation; Local Architecture Principles.

1. Introduction

"*The future will be predominantly urban, and the most immediate environmental concerns of most people will be urban ones."* is the statement declared in Brundtland Report, Our Common Future, in 1987 (World Commission on Environment and Development, 1987:255).

Population growth with migrations to cities has brought many important consequences in social, economic, cultural and environmental terms throughout the world. According to the UN report, while nearly 25% of Turkey's population was living in urban areas in 1925, this value reached 65% in 2000, and 75% in 2018. The same study results show that 78% of the country's population in 2025 and 86% of the population in 2050 will live in urban areas (Figure 1).

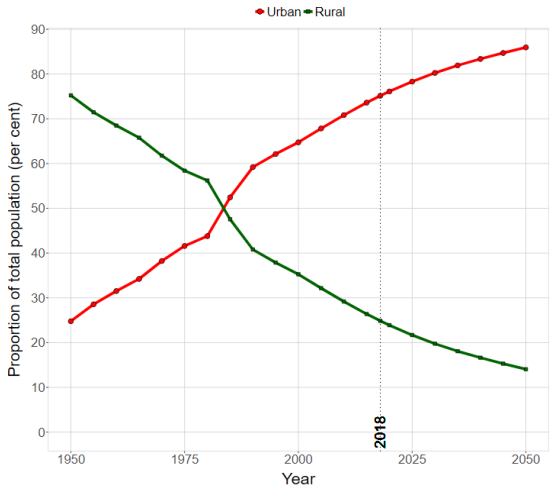

Figure 1: Percentage of population in urban and rural areas in Turkey (URL 1)

The need for construction of fast-growing cities has increased the energy need and caused to new problems. The fact that 36% of the total energy consumption and 39% of the CO_2 emission in the world is made by the building sector shows the importance of the energy efficiency policies to be used in the construction sector (URL 2). In Turkey, which is one of the countries where the urban population increase most rapidly, the number of urban housing production is increasing under the name of "urban transformation".

Urban transformation projects in terms of housing are also applied for revitalization and reconstruction of the buildings whose economical, physical, cultural or social life-span are expired. With the Urban Transformation Law No. 6306 which was enacted in 2012, it was aimed to renew 6.5 million houses in the planned 20-year period, in Turkey. While there are projects covering the design of millions of houses at a time when decreasing energy sources and increasing consumption are on the agenda, urban transformation and energy conservation concepts cannot be considered independently of each other. The new buildings and settlements to be built are an opportunity to apply energy efficient and sustainable design strategies. But with the increasing demand for fast and low-cost production techniques, the production of a single type of housing increased and the climatic link between the buildings and the environment is lost.

The implementation of urban transformation projects with the design and construction decisions far away from the locality constitutes the cities that have the problem called “disidentification”. The identity of the city is not only an aesthetic and functional need but also a concept that should be considered in terms of energy efficiency. The disidentification problem that we use to express that

spaces are disconnected from locality can be overcome by using local resources and historical references.

Even when a single structure is intended to be energy efficient, it cannot be considered independent of its surroundings. Therefore, the energy policies that will be applied should be evaluated by considering the surrounding structures. Because the buildings have a very important role in the formation of the physical city form, the city's energy efficiency can only be ensured with the right urban forms and urban design decisions.

It is seen that the effect of climatic data is very dominant when the historical cities and settlements are examined. The climatic and geographic characteristics that affect the lifestyles and needs of societies has also determined the building materials and construction patterns. These principles based on observation and needs are pushed into the background; even though energy efficient structures are aimed to be built, insulation properties are focused on and building form and urban texture effects are ignored.

In this study, the importance of urban identity, locality, sustainability and energy conservation is aimed to be emphasized. For this purpose, an urban transformation project based on the climatic characteristics and architectural identity of the city and another project that exemplify the definition of disidentification from the same climatic region are compared in terms of energy consumption to reveal the importance of locality. These two projects were selected from Diyarbakır because the city has very good and new examples whose one of them is in the historical town hosting the initial examples of the traditional settlement texture and architectural characteristics.

2. Characteristics of Diyarbakır

2.1 Climate

Diyarbakir is located in the South East Anatolia Region of Turkey and in the south of the Southeastern Taurus Mountains. The summers are hot and dry, and the winter months are warmer than the Eastern Anatolia Region because the mountains cut the northeast winds. While the average minimum temperature value is -2, 3 degrees in January, the highest average temperature is 38,3 degrees in July.

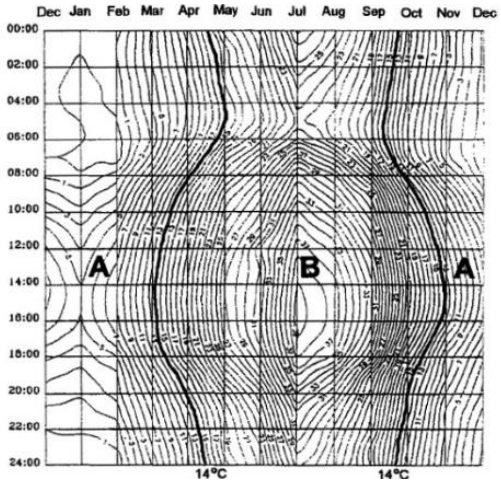

Figure 2: Heating needs graph for months in Diyarbakır according to The Scientific and Technical Research Council of Turkey (as cited in Gedik, 2004).

A: Time period that require artificial heating

B: Time period that do not require artificial heating

As the summer days are dry, the temperature difference is very high between the day and night. Because the summer season lasts longer, the summer climate represents the dominant climatic characteristics of the region. Due to the predominant hot and dry climate characteristics, as it is seen in Figure 2, cooling is needed more than the heating in the region.

2.2 Architectural Characteristics of the Settlement in terms of Building Physics

2.2.1 Settlement texture

Traditional settlement of Diyarbakır has organic shapes, the buildings are very close to each other and the streets are narrow to provide shading effect (Figure 3).

Figure 3: Traditional settlement of Sur, Diyarbakır (URL 3)

2.2.2 Building Form

The most distinctive characteristic of the houses in this climatic region is the courtyard form. As a result of social, cultural, religious and climatic features, the courtyards are the center of the space organizations in these buildings. The need to remove the air warmed during the day and take the cool air into the building at night is achieved by the courtyard (Figure 4).

Another common feature of the buildings is the semi-open part called “iwan”, locating in front of the summer space that need cooling effect. These areas were built to meet the shading and cooling need in summer (Figure 4).

The staircase connecting the ground floor to the upper floor from the courtyard and the landing in front of the rooms is the other important element. This element is used for access between the upper floor rooms (Figure 4).

Figure 4: From left to right; courtyard, iwan and staircase patio examples (Bekleyen, Dalkılıç, 2011)

Windows have large reveal depths because they are placed at the back of the window recesses. This helps to increase shading effect of the rooms and lower the greenhouse effect (Sözen & Gedik).

Figure 5: Window examples from traditional houses (Yıldız).

2.2.3 Building Envelope

The main building material used in traditional houses is the basalt stone which is commonly found in the region. Thanks to the physical properties of this stone and the thicknesses used, they show climate-

sensitive reactions to reduce the effects of high temperature changes throughout the day. The bearing masonry stone walls on the facades are nonporous in the inner and the outer cladding is the porous basalt stone. Exterior walls which are generally between 50-80 cm in thickness have high heat capacity and delay the penetration of the increased air temperature into the houses. The roof with wooden beams is filled with compressed earth mortar and it is designed as a clay roof. In this way, the soil with high heat capacity keeps the heat under the influence of high temperature air at daytime and releases the heat stored in the evening with the cooling air. Therefore, it decreases the cooling load the buildings need during the day.

3. Evaluation of the Sample Projects

Traditional architectural characteristics of settlements give some social and climatic clues as there is deep knowledge in the background. Because the needs of today's world and cities have changed, it is not convenient to keep the traditional architectural references as they are. With the changing features of the settlements such as increase in the population, changes in social needs of society, use of motor vehicles and safety rules requiring larger streets result with the changing city textures. But these experiences and knowledge about traditional settlements can be advanced and adapted to current needs by generating new ideas and using today's innovations and technology.

For this reason, the sample project intended to be improved in terms of energy demand is compared not with the traditional examples, but with an example meeting today's social and physical needs while using traditional architectural references at the same time. The sample project which needs to be improved represents the typical housing projects built by TOKİ (Housing Development Administration of Turkey) with urban transformation policies all around the country (Figure 6).

Figure 6: Images of the compared projects (left: locally adapted project, right: test project to be improved (URL 4))

This study aims to demonstrate some interventions about how traditional architecture properties in terms of energy efficiency can be adapted to new building types to decrease the energy demand while

preserving the cities' identity. For this reason, the projects' main properties that would be evaluated were determined, and the strategies how to implement these features were defined.

3.1 Locally Adapted Project and Its Physical Properties

Almost all of the buildings in Sur county are going to be rebuilt with urban transformation projects in order to get Sur's new appearance because most of the houses were destroyed. The common feature of the new structures that are going to be built in this area which is defined as a world heritage site by UNESCO is that they have settlement characteristics in accordance with the Conservation Development Plan prepared in 2016. The organic traditional settlement plan is protected, while there are some changes in terms of organization of building units. Within the scope of this study, the city block number 202 from 4th region of the site has been evaluated to be compared and adapted to the sample block which does not have traditional references (Figure 7).

Figure 7: (left) City block no 202 in organic settlement of Sur
(right) Street widths around the city block

In this project;

- Streets around the block are narrow and their dimensions are between 4m and 7,5m (Figure 7).
- Courtyards are still the main element of the houses. Iwan and patio configurations are designed with a different approach. Staircase patios which are connecting the floors as open elements are integrated to the houses as indoor spaces. Because new elementary family lifestyle of the community necessitates this configuration. Iwans still exist in most of the houses while some of them does not have (Figure 8).

Figure 8: Iwans and staircase patios in the houses

- Windows' outside reveal depths are wide like the traditional ones (Figure 9).

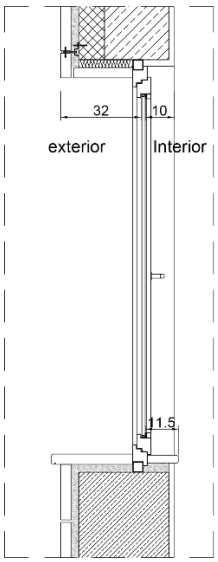

Figure 9: Window reveal depths

- Windows have 160cm height starting 80 cm above the floor slab. Thus, the total window/wall ratio is 12,76%.
- Main materials used in the building envelope are reinforced concrete structure and aerated concrete blocks. Basalt stone is used as cladding material of the exterior walls. On the upper floors some exterior surfaces have exterior wall paint instead of basalt. All surfaces' U values are appropriate according to TS 825 Thermal Insulation Requirements in Buildings.

3.2 Sample Test Project that needs to be Improved and Its Physical Properties

The sample project pretended to get lower energy demand is "TOKİ Çölgüzeli Houses" located 13 km away from the Suriçi example. The settlement, building form and envelope properties defined for Suriçi Project are aimed to be adapted to this project. This project has no characteristic features from the traditional settlement except the basalt stone cladding used only on the ground floor's exterior wall surfaces. It is a typical example of housing projects built around the country. There are 31 blocks with two types, the blocks are 21 meters in height and parallel to each other in the northeast-southwest direction. One of these blocks having similar distances to its each surrounding block is selected to be analysed (Figure 10).

Figure 10: Site plan and selected building of the project improved with small interventions

On each floor in this block, there are four residences with the same layout as the symmetry of each other. These flats have 2 + 1 plan scheme and have gross 90 m^2 area. Each room has windows with 200cm height and different widths. The window openings are also same in the 4 residences of the blocks without considering the direction of the sun (Figure 11).

Figure 11: Typical floor plan

In this project:

- The distance between the housing blocks change from 20 to 60 meters (Figure 12).

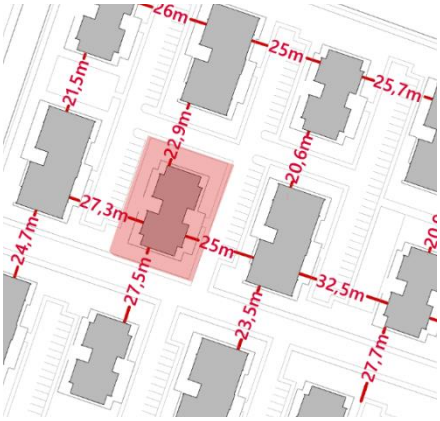

Figure 12: Distances between blocks

- There is not any representation of courtyard, iwan or patio forms to protect interior spaces from excessive sunlight and heat.
- Windows' outside reveal depths are narrow, 16 cm, so they cannot block the sunlight coming through the windows. Because the residences are symmetric to each other, the window openings are also symmetric and they were designed without taking the sun direction into the consideration (Figure 13).

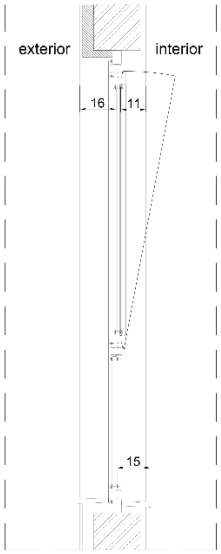

Figure 13: Window reveal depths

- There is not a standard percentage value for window/wall ratio in traditional Diyarbakır houses, but the windows of this project have 200 cm height and the window/wall ratio is 21,08%.
- Materials used in the building envelope and their appearance do not represent the local characteristics of traditional Diyarbakır houses. Reinforced concrete and hollow brick walls have painted surfaces except the entrance floor. The entrance floor has local stone cladding with same wall layers.

4. Methodology

These form based properties and material choices are suggested to be improved in several comparative steps in terms of settlement texture, building form and building envelope. The proposed alternative models were evaluated with Design Builder simulation program and the results were compared.

4.1 Alternatives

4.1.1 Settlement Texture Alternative

It is not possible to construct the 21m height blocks with the same street dimensions between 6m height blocks. The dense land use configuration with narrow streets and adjacent blocks of traditional texture are taken as reference and the building distances are decreased in an appropriate way while keeping the same residence capacity. Density of the locally adapted city block is almost 65%, while the test project's is 28,5%. Within the limits, floor numbers are decreased while having more buildings to raise the land density. Finally, a new pattern with 42,75% density and more narrow distances between the buildings was created. This configuration is proposed as an alternative to provide shading effects.

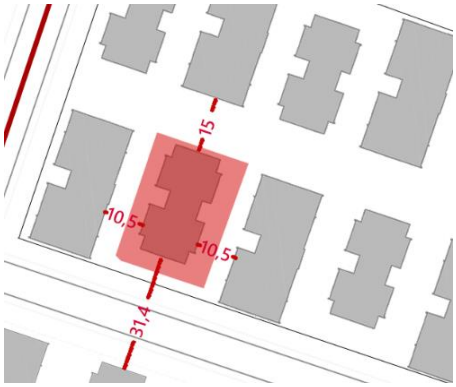

Figure 14: New distances around the building

4.1.2 Building Form Alternatives

Because the courtyards and iwans are used to have shading effects, it is possible to interpret these forms in different ways for multi-storey buildings. For this purpose, it has been proposed to add balconies to the building facades in multi-storey blocks and the proposed forms were simulated. The dimensions of the balconies were defined according to the existing balconies: first balcony alternative is 74 cm and the second is 1m larger (174 cm) around all sides.

Figure 15: Different size of balcony alternatives (left:74cm, right:174cm)

The outside reveal depth of the first project's windows is larger than the second project. These dimensions of the first project are adapted to the second one and the energy demands of the buildings were measured. The thickness of the wall in the test project is not as large as the locally adapted one. So, the outside reveal depth could be increased 6 cm as an alternative.

4.1.3 Building Envelope Alternatives

Because window/wall ratio is critical for heat conduction, as the first building envelope alternative, window dimensions were changed and tried to be adapted by lowering the heights. With this change, the building had 16,31% window/wall ratio instead of 21,08% (Figure 16).

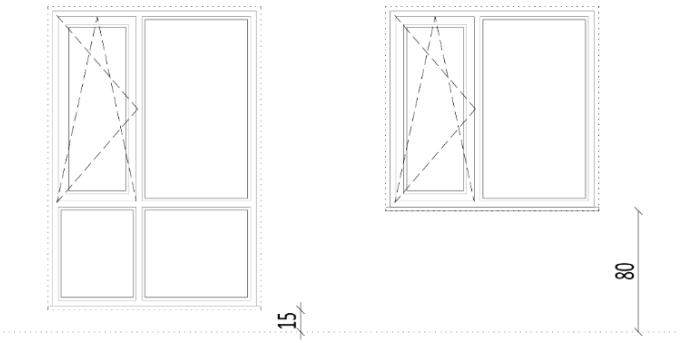

Figure 16: Alternative window design principle

The first project's wall layers are the typical materials used in many buildings. Because the important point of this study is evaluating local architecture principles, basalt stone was examined as cladding material. So, only the last layer of the building envelope was changed and basalt stone applied to see how the energy demands change.

4.2. Results

Alternatives for settlement, building form and building envelope properties were applied.

Table 1: Annual energy consumption values of generated alternatives

	Annual energy consumption (kWh/m^2)		
	cooling load	**heating load**	**total cooling + heating load**
ect (Locally Adapted Project)	30,2	41,13	71,33
ect (Test Project)	48,06	32,53	80,59
ed land use density from 28,5% to %	41,35	34,62	75,97
dditional 74 cm balconies	45,26	33,94	79,2
dditional 174 cm balconies	39,27	35,1	74,37
creased outside reveal depth of windows	46,83	32,85	79,68
sed window height (window/wall ratio 21,08& to 16,31%)	40,3	32,94	73,24
stone cladding instead of plaster+paint	49	33,47	82,47

The results show that the adaptation of local architectural principals has more positive impact on cooling loads instead of the heating loads. According to the simulation results, the tested settlement density alternative provided 13,96% decrease in cooling load, while increasing the heating load 6,42%. Building form interventions on existing blocks decreased the cooling loads 18,29%. This test resulted with 7,9% increase on heating load, but the total advantage is 7,72%. Less use of window surfaces is also positive to have lower energy demand. The alternative design tested in this study showed us

16,15% decrease in cooling demand is possible, while 9,12% in total. Using local material basalt stone as a cladding material is not advantageous without implementing other envelope properties.

5. Conclusion

It is clear that traditional architecture principles and local climatic properties are important references for the cities' identities and also for energy conservation. In this study, energy conservation concerns were evaluated with urban transformation context using the guidance of a sample project that is locally adapted. Settlement, building form and building envelope properties of the sample project were adapted another urban transformation project which do not designed using local references. New alternatives were formed by means of these adaptations.

The results show that even very limited and a single intervention applied to a typical housing block can change cooling energy demand around 18% and total cooling and heating energy demand almost 10%. That it is possible to design settlements and buildings having lower energy demands in terms of cooling and heating load by adapting traditional architecture properties.

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