Designing residential and commercial complex based on Article 19 of the National Building Regulations with the approach of sustainable architecture (studied region: Shirvan)

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Abstract

Sustainable architecture is a method of designing which reduces the use of nonrenewable resources and optimizes the use of renewable sources and suggests that what we need for survival, can be obtained from the environment and it defines the view about the world by clever and compassionate use of resources and considering the quality of life of future generations. In the leading world it can be said that energy, in fuel sense, means power and stability, and architecture is one of the effective areas in this important section, and stability and security and health of a society depend on that. Understanding the capabilities of energy and saving in energy use in construction has a huge role in urban management. Residential and commercial complex designing with a view to practical and urban climate solutions, not only is not a matter of ornamentation, but also it is a way to respond to our search for providing better safety, comfort, and environment. In this study, by investigating and analyzing the climatic elements in sustainable architecture in order for amending the energy consumption pattern in buildings, we investigate the use of materials' thermal capacity, solar greenhouse, double walls, and other practical strategies of the article 19. In this study we selected a research area of North Khorasan in order to improve energy consumption pattern by applying the article 19 of National Building Regulations. And all relevant information was collected in a four-month period; then using OUT CAD software, the data was registered, processes, integrates, and analyzed and designed such that all climatic elements in sustainable architecture were considered in designing the studied area and the final design of the optimal pattern of energy consumption in the building was resulted according to the article 19 of National Building Regulations.

Keywords: article 19 of National Building Regulations, optimal pattern of energy consumption, sustainable architecture.

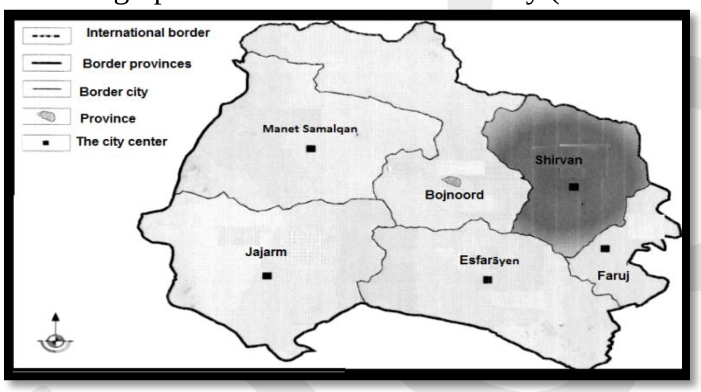
1. Introduction

In recent decades, a serious sense of responsibility in optimizing energy consumption, increasing its efficiency and the issue of protecting the environment has been created and energy management and amending consumption pattern have turned to inevitable issues. In addition, according to studies, between 15 to 20 percent of total energy consumption of each country has been devoted to consumption of residential spaces that this amount represents huge cost, destruction of natural resources and destruction of the environment in wide scale. On the other hand, excessive dependence of our revenues in Iran, on oil and gas resources, has turned the issue of energy to one of the most important and most strategic areas in macro policy of the country and achieving sustainable development. What is very important in this case is the issue of directing the consumption of energy bearers due to their increasing role in the country and the world's energy basket. The growth rate of energy bearers' consumption between 1980 and 2006 had been 1.98 percent in the world and 6.3 percent in Iran (The Statistics of Iranian Fuel Conservation Organization, 2010). In other words, in the mentioned period, the growth rate of energy bearers' consumption in Iran had been three times more than its global value. Intensity of energy consumption also in our country is estimated to be more than four times more than the world average. Thus, with continuing the trend in energy consumption in the country, in 2025, Iran will turn from a net exporter of energy, to an importer country and relative advantages of the huge revenues from energy exports will be lost (Shah Hoseini, 2008). Therefore, it is impossible to ignore the need for energy consumption management. Proper management of energy consumption requires understanding of the current situation and the energy consumption patterns, planning and control for optimizing and modifying consumption patterns (Khademi, Zare', and Akhavan, 2008, 8; Tolooeeyan, 2006). The purpose of energy management is reduction and rationalization of energy consumption in a way that has economical reasoning and at the same time does not lead to negative effects on the welfare and comfort (Zhang and Pattuwo, 1998, 37). According to available statistics, residential and commercial buildings in Iran are the country's largest energy consumer (Riazi and Hosseini, 2011: 1). At the other hand, not only the potential for energy saving in the building and home sector is generally more than other sectors, but also reducing energy use in this sector is easier and is achievable with less investment compared to other sectors (Nasrollahi, 2010:1). Therefore, in order to reduce energy consumption in the world and especially in Iran, one of the most effective policies can be reducing energy consumption in residential and commercial sectors (Tolooeeyan, 2006). Reducing energy consumption of residential buildings in Iran, especially on a large scale, will have a major impact on the country's total energy consumption. In this regard, correcting the pattern of energy consumption in buildings according to the article 19 of the National Building Regulations will be a very effective step. In recent years, buildings with low energy consumption have been paid much attention. In this context, most of the researches have focused on the architectural features of the building (construction techniques) as well as alternative sources of energy (Pahlavan et al, 2012: 173). Since energy consumption profile in residential sector is complex and interconnected, appropriate designed models for evaluation of technological and economic effects and efficiency of renewable energies suitable for home consumtion is required (Tso et al, 2007: 1762; Aydinalp et al., 2002: 91).

2. Study area

The studied area in this research is the city of Shirvan, a city in North Khorasan province, with an area of 3789 square kilometers which in the north is limited to Turkmenistan country, and in the south is limited to Esfaraien city and in the east is limited to Faruj city and in the West is limited to Bojnoord.

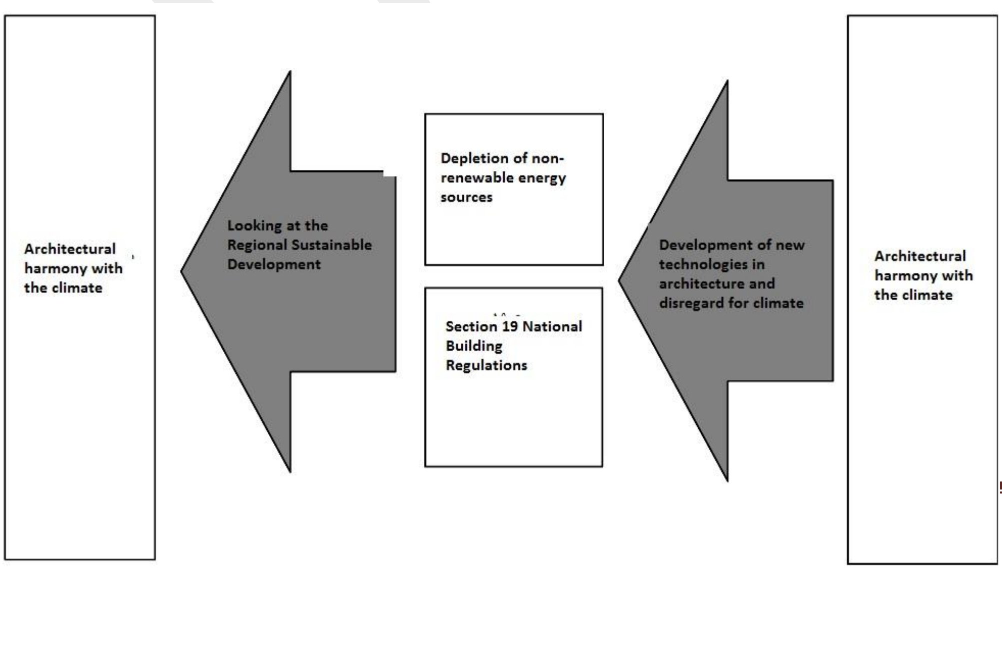
Figure 1: Geographical location of Shirvan city (North Khorasan)



3. Methods of study and General research outline

The field questionnaire regarding the public's inclination towards energy saving and observing the strategies for inactive saving in the building was prepared based on the article 19 of National Building Regulations and then according to the answers of the respondents about energy based on the article 19 of National Regulations, and factor's preferences based on the climatic conditions of the area, after studying the considered site and doing required analysis of the site, the plan was designed and the related regulations were considered.

Figure 1: Schematic of study



3.2. Terms used from the article 19 of National

Building Regulations

1. The general positioning of the blocks in order for maximum skylights and solar power at the site.
2. Attention to the cold winds from the north and northeast and placement of the blocks so that there will be minimum contact of the walls with the wind.
3. Locating in approximately natural slope and maximum use of solar energy.
4. Layout of the blocks with minimal ghosting to each other.
5. Often the north wall of the buildings is in the shadow and the most energy waste is there; thus the use of double wall with polystyrene insulation materials helps to fix the problem.
6. Use of the shell of south and multi-layer double view.
7. Use of high thermal capacity of materials such as stone in cold climate.
8. Use of double glazed windows.
9. Use of the greenhouse effect in the southern view.
10. Use of vertical awnings on the south side in order to prevent exposure to nasty morning and evening sunshine, and also a basis for the installation and use of horizontal awnings in the future.
11. Creating terrace on the north side in order to reduce the effect of the cold north winds and creating a filter in the way of cold air entry to the building.
12. Use of materials with a dark color.
13. Use of bilateral North-South flood and appropriate ventilation during short warm months in this area.
14. Use of heat source at the center of the building and walls with heavy materials in order for energy storage.
15. Trombe wall on the south side.
16. Use of photovoltaic cells in order to resolve the energy for some parts of the collection.

3.3. Designing plan site based on the article 19 of National Building Regulations

3.3.1. Climatic and weather conditions

The general climate of the region is as follows:

A. Severe coldness in winter and moderate weather in summer
B. Enormous differences in temperature between night and day temperatures
C. Heavy snowing
D. Low air humidity

Like the central areas of Iran plateau, the houses have a central courtyard and other parts are arranged around the courtyard. The rooms located at the north part of the yard are bigger than the other parts and the hall or the main living room is also located at this part of the yard so that it can use the direct sunshine and heat of the sun at the cold winter. The south side of the building, because of the short and moderate summer is less used. Thus the southern rooms and the eastern and western rooms - if any – are used as warehouses or service spaces such as servants' rooms or bathrooms. Unlike mild and humid southern coast of the Caspian Sea areas, the houses in this area often have a low-ceilinged cellar that due to its cool air in the summer are used for residency and welfare of the residents.

3.3.1.1. Weather conditions

Climatic indices of Shirvan city from 1968 to 1976 have been studied with the average of 9 years. It should be noted that due to monthly statistics defect, some parameters are less than 9 years and sometimes 6 to 7 years.

1. Temperature

In terms of average monthly temperature, July with 23.5 ° C is the hottest month of the year and January with -5 ° C is the coldest month of the year. Shirvan city's average annual temperature is 11.7 ° C. The range of average monthly temperature fluctuations is 28.5 ° C. The absolute maximum temperature is 40 ° C in July and the absolute minimum is -23.5 ° C in February that the range of changes of absolute maximum and minimum annual temperature reaches 73.5 ° C. According to statistics, the city's weather is mild in summers and cold in winters.

2. Rainfall

Shirvan city's annual rainfall is about 2.5 mm. March with 41 mm rainfall and August with about 1 mm rainfall have the highest and lowest monthly rainfall respectively. In terms of the seasonal distribution of rainfall, 41.6 percent of rainfall falls in the winter, about 30 percent in the spring, 26 percent in autumn, and 2.5 percent falls in the summer. Thus, winter with more than 41% of the total rainfall, is the most humid season of the year. From May to October we are faced with drought.

Table 1: The amount of rainfall

Rainfall season	Rainfall value	Rainfall percent
Spring	81.5	41.6
Summer	7.1	3.6
Autumn	31.9	16.3
Winter	75.3	38.5

3. Relative humidity

The maximum monthly relative humidity of March is recorded as 99% and in June the monthly minimum relative humidity is 19%. In terms of the average relative humidity, the highest values are in March which at the times of 06.00, 12.30, and 18.30, local time, are 87, 73, and 78 percent respectively and the lowest values are in August as 60, 31 and 41 percent respectively. By looking to relative humidity statistics and the temperature it can be seen that in the summer, this area needs wind blowing so that the humidity be reduced and also in the winter, there is need to mechanical heating facilities in order to reduce the severity of coolness of the region.

4. Evaporation rate

Annual evaporation rate from the evaporation plate at the three-one water station of Shirvan has been reported to be 1306 mm. July, with 263 mm, has the highest monthly evaporation; after that, there is August with 236 mm. December with 20 mm has the least monthly evaporation. In winter because of frost, no statistics has been reported.

3.3.2. Using porch and small yard in the building

Since in most days of the year, the mountainous areas are cold or very cold, most of the daily activities are carried out in the rooms. Thus the yard dimensions in these areas are somewhat smaller than the areas of the central plateau of Iran. Buildings in this climate have porches but their depth, compared to the porches of southern areas of the country, is somewhat less and like the porches of Khazar region, they are not for sitting function and are only used for keeping the entrances of the buildings away from snow and rain. Another point is lower floor of the courtyard of the buildings in cold climates as much as 1 to 1.5 meters from the sidewalks so that the water flowing in streams and rivers can be guided to the courtyard garden or water-houses located in the underground and on the other hand, earth, like a thermal insulation has surrounded around the building and prevents heat exchange between the building and its environment and keeps the heat inside the building.

3.3.3. Map, shape and placement of the building

In the cold mountainous climate, buildings have dense map and tissue. The building shape must be such that reduces the contact area with outside coolness so that less heat will be transferred from the inside out. Therefore, volumes such as cubes are used to reduce the ration of the outer surface of the building to its internal volume and keep it as low as possible.Buildings are located between 20 degrees to the west and 45 degrees to the east and in the wind shadow of each other and out of sun shadow of each other, at the North – South axis.

4.3.3. Small rooms with low height

In cold and snowy areas, making big rooms and inside spaces in the building should be avoided because with the increase of their contact area with the cool outside space, warming this vast space will be difficult. So in these areas, the roof is lower than in other climatic areas so that the size of the room will be reduced and the outer surface becomes the minimum amount, compared to the volume of the building. Low ceiling height in the halls and important rooms and chambers and market chambers is also well known in these regions. Small openings: in these areas in order to prevent heat exchange between the interior and exterior building, small openings with low numbers are used. In case of large windows, use of awning is necessary. Openings on the south side are selected to be larger and longer in order to make the most use of the sunshine. Also establishment of the openings in the direction of cold winds should be avoided. Double-glazed windows are also more suitable for minimizing heat exchange to the less possible amount. In addition, in order to prevent creation of coolness in the internal space and exiting of the internal heat to the outside, the amount of indoor air change and natural conditioning must reach to a minimum. Compared to the arid climate, the dimensions of the openings in this climatic area have been increased in order for use of thermal energy resulted from the sun shining.

5.3.3 Relatively thick walls

Large diameter of the walls also prevents the heat exchange between the interior space of the building and outside environment of the building. Architectural criteria of cold mountainous climates and warm and dry climates are virtually the same and the only difference is in the heating sources which in the arid climate, this source is from the external side of the building and in the cold climate, from the interior space. Therefore, in this climate, with the help of the construction materials, walls' diameter must be increased so that this wall can act as a source of heat storage inside the building.

Thick walls maintain the heat and sunlight temperature of the day during the night and will help the indoor temperature adjustment. In the local architecture of these regions, as much as possible it is tried to heat the building naturally or by the use of heat and steam resulting from the presence of persons, animals or cooking.

Flat roofs:

Sloping roofs, if having appropriate coverage, are better than flat roofs because they far away the rain water rapidly from the roof. But in case of the thatched roof covering, its strength against moisture and rain and specially snow will be greatly weakened. Because the water resulting from gradual melting of snow will enter into the thatched roof and the building will become moist and damp. For this reason, as soon as snow fall, it is shoveled out from such a roof and the roof is again rolled with a small stone roller so that its thatched cover again becomes condense the holes caused by water infiltration become blocked.

Selecting flat roofs in cool climate does not create any problem since with keeping snow on the roof, it can be used as a heat insulation against great coldness of the outside weather which is several degrees lower than the snow temperature and also the space below the truss structure, which has storage function, is a good insulation between the interior and exterior space of the building. Thus the double glazed roof of the building is important in this climate to retain heat of the building.

Figure 1: Designing the recommended plan based on the rules of article 19 of National Building Regulations

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6. Guidelines for designing open residential spaces

Security, comfort, ease of access to opportunities for meeting others, pluralism, and development of creativity are from the important aspects of performance of open housing spaces. To achieve the desired conditions there are a number of design guidelines mentioned below.

1. It is needed that the factors for stimulating the senses of sight, hearing, smell and touch be considered in more detail in the design of open spaces so that understanding the environment will be done properly.

In order to stimulate senses of sight and smell, we can plant various kinds of plants that are different with each other in terms of leaf tissue, appearance, and aroma of flowers, in the green space of the housing areas.
The colors of yellow, orange, and red can be used in places that color distinction is desired.
Tactile sensory clues are very important which can be applied as change in the tissue of sidewalks floor (color, kind, and form), the place of paths facing each other, or before the stairs.

2. In the design of open residential spaces it is better that we use patterns that are easy to understand and detection.

Finding the entry and exit paths be easy.
Use of determined emphasis points in open residential spaces for creating sensual clues causes creation of an organized mental picture of the space.
The view of each space compared to other spaces must be such that people with the help of signs can detect their situation from the rest of the complex.
Sensual and visual clues can be used in finding the path in open spaces; for example use of color for determining the entrances and spaces, drawing arrows in the flooring and sensual clues on the handles.

3. In designing open residential spaces, issues related to small climate need to be considered.

In order to reduce the reflection of dazzling light in the summer, dark and non-reflective materials must be used in various surfaces such as floorings.
Problems related to the annoying winds can be resolved by putting sunshade, windward barriers, and planting trees and plants in the sidewalks.
It is better that the places for sitting in the sidewalks or green spaces of the streets, be subject to

summer breezes or winter pleasant sunshine. This point is especially important in very hot or very cold regions. It is necessary to provide the possibility of sitting in places with shadow or sunshine in different times during the day.
Creating indoor spaces (porch or pergola) or at least putting some sunshades along with sitting places in the parks and open residential spaces creates the possibility of more use of these spaces.

7. Conclusions and recommendations

Given the importance of energy and economic and global issues in building residential, industrial and commercial functions in the country and for alignment with reasonable policies of the country, this plan tries to pay further attention to the national building regulations and in particular article 19, which in recent years, more attention has been paid to it and has become more complete and tries that, before entrance to the use of photovoltaic sun systems with high price which needs time passage and governmental macro-structures, can with a common strategy and in fact with reliance on more traditional methods, creates the introduction to entrance to the green era and makes the users more optimistic and confident. Maximum use of sun shine or use of inactive sun systems and climatic and functional and low-cost factors in order to reduce fuel costs are from the goals of this project. In order to reach the expected evaluations of this article which is saving and use of functional climatic strategies in cold areas, with reference to many books on the topic of energy, attention to coherent strategies that can be met with the current construction.

Figure 1: A cross-sectional design based on article 19 of National Building Regulations

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