Sustainable Design under the Effects of Climatic Parameters (Case Study: Nur City, Mazandaran, Iran)

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***Abstract*—**The importance of climate on building design, requires the necessity of a comprehensive study and research in this field. Particularly for Iran having many climatic varieties, a vast study in the field of harmonic architecture is needed because of its special climate; it seems that a proper and desirable designing for any kind of area and climate, requires an appreciation of challenges that architecture need it to reach a sustenance. Thus, in this paper, the environmental, geographical and climatical features and also the architectural characteristics of Nur city are studied by analyzing and depicting present situations and studying the outcomes of previous researches in this field. Meanwhile subjects such as sustenance, architecture and sustainable designing principles are studied by practical researches for a better designing. The suggested approaches for climatic designing on the buildings of Nur City in accordance with sustainable design patterns are presented as well. What was gained as a result was that by combining the rules and traditional approaches with modern techniques, we can impress on designing sustainable buildings with more impressive and appropriate function in Nur City.

***Keywords*—**Architecture; Building; Climate; Nur City; Sustainable.

***Abbreviations*—**World Commission of Environment and Development (WCED).

I. INTRODUCTION

THE theory of sustainable development and the following theory of sustainable architecture is one of the most controversial subjects of contemporary architecture. The necessity of building connection with the environment in which it is located is obvious and unquestionable. The challenging feature is the kind and the state of this connection [Asadpoor & Ali, 2006]. Nowadays the idea of sustainable architecture is being put to answer this question. In different parts of the world there are areas having same climates but special circumstances which bring considerable differences that are important in architecture, so architects should consider them for designing. Thus, these elements should be extracted for designing in each area and the designer should present a sustainable plan in accordance with necessary information compatible to same climate. Here are the climatic elements like air temperature, relative moisture, annual raining, the intensity and angle of sun radiation which are considered significantly important [Olgyay & Victor, 1963].

Sustainable development is highly different from the traditional meaning of development which mainly focuses on economic growth. Development planning has to rely upon real definition of national needs. In fact, it can be said that a suitable and sustainable development intends to provide strategies and tools so that it can response to fundamental needs like primary environmental ones of human and reaching social justice. Thus, this research, accordance with conducted studies in Nur City, is a targeted effort to study climatical designs in Nur City concentrating on human welfare to reach a sustainable development, since sustainable architecture, namely, harmonic architecture to climatical features, cause to reach the minimum resources consumption and make it possible to continue to use these resources.

II. THE CONCEPTION OF SUSTAINABILITY

2.1. The Term of Sustainably

The verb “Sustain” has been applied in English language since 1290 derived from a Greek root “sub” and “tenere” meaning upholding or maintaining. Also, within centuries

there have been other meanings and forms of the word "Sustain". But it is in the recent decades that the word "sustain" has been used with its common meaning- able to be continued to exist in the future [Bahreini et al., 2001].

In "Sokhan Encyclopedia" and "Moein Encyclopedia" the word "sustenance" means "to maintain" and "resistance". For its adjective form we have words such as stability, everlasting and resistance. Thus, this word, equaling "Sustainability", is selected and devoid of its modern meaning and relies on maintenance and stability. The meaning of the word having in mind here is "what can continue to exist in future" [Asadpoor & Ali, 2006].

2.2. Sustainable Development

In order to better appreciate the meaning of sustainable architecture, it is required to have clear definition of "Sustainable Development" [Mellatparast & Mohammad, 2009]. The most common definition of sustainability is the one presented by World Commission of Environment and Development (WCED). The commission has defined "sustainable development" as a development meeting the needs of the current generation without damaging the ability of the next generation to provide the person's need. According to this meaning, before a society manages to reach to sustainability, it has to provide the justice between generations. The social and economic development should be met in a way that an expenditure is not imposed on the next generation at any time, and the economic affects ought to reach a minimum. When the current vital and necessary activities imposes extra expenditures on posterity (for example, excavating unrenewable minerals) the damages have to be compensated completely [Kasmai & Morteza, 1993]. Thus, sustainable development includes a comprehensive meaning and relates to all aspects of human life; additionally, conducting sustainable development patterns requires fundamental and underlying changes in national and international policies. Generally, environmental sustainability aiming to maintain their environment insists on cases such as the reduction of energy waste, the reduction of affective production on human health and elimination of poisons of materials [Mellatparast & Mohammad, 2009]. Consequently, all the designings that are carrying out relations to sustainable systems should conduct necessary anticipations for future. For instance, a building should be designed in a way that its further usage and even its constructing parts have to be considered. This providence will be useful for rectifying the needs of posterity as well [Soleimani & Maysam, 2008].

III. SUSTAINABLE ARCHITECTURE

The usage of concepts of sustainability and sustainable development in architecture has created the so-called sustainable architecture subject. The main ideas of sustainable architecture are applying competences of usage change and flexibility and hidden energy (the energy used for producing material and materials) [Soleimani & Maysam, 2008]. Sustainable architecture, like other architectural subjects, includes its special principals and rules and contains three steps: frugality in resources, designing for recycling and designing for human kind. These steps have their own strategies, though the understanding and recognizing these strategies leads the architect to appreciate the environment in which he has to implement its design in [Soleimani & Maysam, 2008].

IV. SUSTAINABLE DESIGNING PRINCIPLES

Some structures contain features and characteristics which are considered among sustainable ones. The principles that have to be observed till a structure is categorized as a sustainable architecture are:

Principle 1, energy maintenance: the structure should be built in a way to reach the minimum usage of the fossil fuels

Principle 2, compatibility to the climate: the structures should be designed in a way to compatibility to the climate and the current energy resources on the site of construction.

Principle 3, reduction in the use of new resources of materials: the structures should be designed in a way that reduces the use of new resources as much as possible, to be used as new resource for building new construction at the end of its useful life.

Principle 4, complying residents' needs: in sustainable architecture, the preparation of physical and mental needs of residents are considered very important.

Principle 5, compatibility to the site: the construction should be laid gently on its site and suit to the surrounding environment.

Principle 6, holism: all sustainable architectural principles have to be pictured in a full process leading to a healthy environment [Ghiasvand & Javad, 2006].

V. ENVIRONMENTAL, GEOGRAPHICAL AND CLIMATIC FEATURES OF NUR CITY

5.1. Geographical and Environmental Features

Nur city with a total area of 2675 square kilometers laying off the west of Mazandaran Province, Iran. This town is surrounded by the Caspian Sea from the north, Nowshahr city from the west, Amol city from the east and Tehran city from the south (figure 1). Nur's longitude and latitude are 50 51' to 52 10' N and 36 35' to 36 10' N. Topographically, this town is divided into two parts: the mountainous and the plain part. The mountainous lays off in the south covering 80% of the area and the rest is the plain which is located between the Caspian Sea and the Alborz mountain. Baladeh city is located in the mountainous part and the towns of Nur, Royan, and Chamestan are located in the plain part. The general slope of Nur following Morph stretches from south to north. In this town there are many rivers and because of the short distance between cesspit and catchment area has less alluvium region [Davarinaejad & Muhammad Reza, 2009].

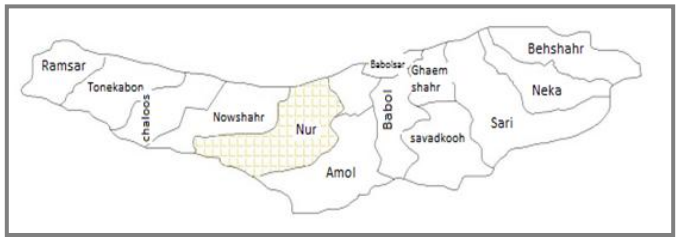

Figure 1: The Position of Nur in Mazandaran

5.2. Climatical Features

5.2.1. Weather

The weather of Nur city in northern lowlands is dependent on climatical conditions of the Caspian Sea and in southern mountainous part relies on conditions resulting from Alborz Mountain. The weather conditions in the north (plain coasts) differentiate from the ones in south (mountainous) due to two parameters of height and humidity so that in mountainous area the cold to very cold semi- humid climate and Alp climate govern, but in northern coasts, winters are mild and the climate is humid or very moderate humid. Regarding Nur is in lack of synoptic and climatology stations, the statistics and data obtaining from Nowshahr or Chamestan having similar climatic features to Nur are applied. As shown on related tables, the amount of rainfall in Nowshahr and Chamestan stations 799 and 1272 mm on average respectively ; therefore, the average of long rainfall in Nur changes from 400 mm in southern heights to 1100 mm in Nur coasts yearly [Davarinaejad & Muhammad Reza, 2009].

The average maximum and minimum temperature are 19/9 and 12/8 centigrade respectively during a year; the average of minimum and maximum of relative humid were 72% and 95% respectively in Nowshahr station in 2000. According to 30-year statistics (1965-95) of Nowshahr and Chamestan station, the average of rainfall and daily mean temperature on different months are shown on table 1. (A master plan of the country water, 2001) According to the statistics of Nowshahr station in 1982 to 1993, the average minimum and maximum humidity and of yearly temperature are about 94/5, 68/2, 10/5 and 22% respectively. The number of rainy days, according to these statistics, is about 136 days a year. (Table 2) From the total amount 1272 mm of average rainfall in Nowshahr station about 43/1 in fall, 22/4 in summer, 21/6 in winter and 12/9 in spring happen (Table 3) [Davarinaejad & Muhammad Reza, 2009].

Table 1: Average of Rainfall and Temperature in Nowshahr and Chamestan Stations

Parameter	Weathers Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Rainfall (mm)	Noshahr	124	112	94	63	49	53	47	70	128	197	185	148	1272
	Chamestan	61	72	68	49	47	39	52	42	74	120	93	81	799
The mean temperature (°C)	Noshahr	7.8	7	8.2	11.7	16.6	21	24.3	25	23.1	19.1	14.7	10.6	15.8
	Chamestan	6.9	5.9	7.4	12.6	16.2	21.1	22.8	24.3	22.7	17.6	13.4	9.5	15.1

Table 2: Average of Climate Condition in Nowshahr Station from 1982-1993

Month	Rainfall (mm)	Temperature (Percent)		Humidity (°C)		Number of Rainy Days
		Minimum	Maximum	Minimum	Maximum	
January	118.4	62.4	94.4	1.6	15.52	11.4
February	109.9	64.3	93.6	1.1	14.2	11.6
March	78.6	69.4	95.2	3.1	16	20.5
April	55.9	70.9	96.9	6.13	20.6	12.4
May	52	67.3	95.4	14.2	20.5	10.4
June	33.7	67.9	93.4	16.4	27.1	8.5
July	45.8	65.9	92.8	19.7	29.7	7.5
August	80.6	74	89.8	21.7	28.5	8.4
September	133	70.9	94.9	17.5	27.8	10.6
October	255.8	69.8	95.9	13.1	25	11.2
November	182.8	69.2	96.4	8.6	21.5	11.5
December	140.1	67.2	95.9	1.4	17.2	12
Annual	1286	68.2	94.5	10.5	22	136

Table 3: Amount of Rainfall and Relative Temperature in Nowshahr Station in 2000

Month	Rainfall (mm)	Relative Humidity (Percent)			
		Absolute Minimum	The Average Minimum	Absolute Maximum	The Average Maximum
January	92.7	18	69	100	94
February	130.5	45	68	100	95
March	87.4	31	67	98	94
April	45.5	49	74	100	96
May	80.8	53	75	100	96
June	0	49	68	98	94
July	61.8	53	71	98	94
August	3.2	62	73	97	94
September	135	65	79	100	96
October	130.6	50	72	98	95
November	436.2	44	72	98	96
December	174.2	57	71	98	97
Annual	1377.9	18	72	100	95

5.2.2. Wind

In coastal area of the Caspian Sea are two dominant currents:

A. Coastal Wind

This kind of wind blows from the Sea to the coast in day, early in the morning till noon and contrariwise in night because of the presence of high-pressure center in sea and low-pressure center on coast. This wind causes the vapor resulting from sea move to southern plain and heights of the area.

B. Regional Wind

- West wind (Mediterranean) is dependent upon Mediterranean air mass and is rain-bearing. The regime of rainfall from this type of wind is continuous and low-violent.
- Northwest wind (Polar- European) is dependent polar air mass of northern Atlantic and comes into country from west north. It seems that the rainstorms in spring and fall and snow in winter depend on this wind. The plentitude of the wind current has been recorded 7/3 in percent in Nowshahr station during a four-year period.
- North and east-north wind (Siberia) depend on Siberia polar air and blow from mid-fall till late in spring. This winds are dry and cold by themselves but when striking against the Mediterranean air mass cause to much rain and snow in the region. The region affected from above-mentioned wind and air masses and the main direction of the wind blowing in spring and summer is from the west-north and west and in fall and winter is from west-north and east-north [Davarinaejad & Muhammad Reza, 2009].

VI. PRACTICAL STUDIES

6.1. The General Form of the Structure

Orientation: Generally "east-west with much stretching" especially on coastal bands, stretching against the Sea and southern sunlight.

Footing: Constructing a footing to separate the ground from the building, using a visible foundation and laying the elements of the building's ground on them.

Veranda: Veranda as an important element has a special place in the houses of the area. Veranda can be considered as a way for the building to protect the building against humidity. Veranda expresses the outer feature of the houses of moderate and humid area of Iran and is considered as a place where it is the center of many works and activities done by people and it is safe against rain because of being located under the bulged gable roof and connects interior spaces like rooms which makes it free of the need to go in the yard or another point of house spaces; considering it gains more significance importance when it is raining. The varieties of positions of veranda against the rooms are shown in figure 2.

Figure 2: Veranda in South Axis of Building

The Covering of Roofs: Gable roof made of 1- Granite 2- Galvanized layers 3- Ceramic

The Height and Slope of Roof: the height of the roofs in houses built near sea is more than the ones far from the sea meanwhile the slope is much more in these roofs. Obviously it is for rain that is heavier near the Caspian sea.

Urban and rural Texture: dispersion of houses and spaces between buildings; dispersion of urban and rural texture is to create air current between houses and buildings so that air can easily flow among houses.

Masonry materials: light materials with low-heat capacity; wood, masonry materials with low-heat capacity; cement block, stone, thin wall (resistance to lateral forces).

6.2. Air Flow and Sunlight

Sun Radiation: The main light-getting façade of the most rooms and verandas are south also the main yard is in this side. When the sun is in the most perpendicular position to the earth and its distance from the earth is less, the intensity of sun radiation is than when it lays in an inclined position. This feature can be seen especially at noon and in the afternoon.

Natural Ventilation: the most important problem of the houses of the area is to resist to extensive humidity. Openings are mounted to create current. These openings can be considered in two ways: in two different sides and two parallel sides.

We should have in mind that as creating openings is important, it cannot be on every side and it sometimes may cause a problem. As a result of the above issue, the design of window position are very important and it gets much more importance in the coastal areas due to the vast important of current in the region. If windows position causes more air circulation in an interior space, it is meant that the windows are positioned in an ideal way. So the location of the windows is designed according to the direction of wind (figure 3).

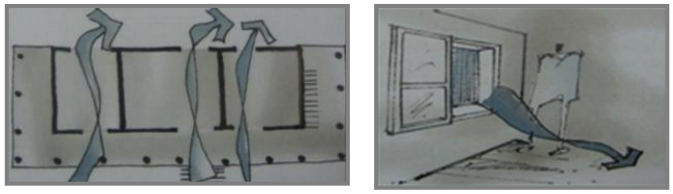

Figure 3: Proper Orientation of the Houses for Air Current and Natural Ventilation

Air Flow: to use air flow as much as possible in some points, buildings are organized in the city in a non-concentrated and desperate way (figure 4).

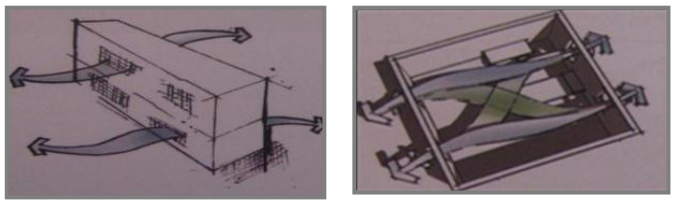

Figure 4: Desperate form of Some Building in the Region

VII. Architectural Design in Compatibility to Sustainable Patterns in Form of Solutions for Sustainable Design in Nur City

- Less width of the building: maximum usage of inclined sun in winter in the south façade of the building, reduction of thickness and friction of air inside of the building to simplify the bilateral air current in the building.
- Designing building facing appropriate wind direction for summer: using air current inside the building during warm months of year.
- Laying the building on pilot: to prevent humidity from penetrating to the floor of the building
- Using pilot as a greenhouse to provide a part of the building heating energy within cold month of the year.
- No using of the basement as a living space: the possibility of bilateral current in basement is difficult, the humid and heavy air in summer is a problem in basement.
- Determining the usage of rooms according to season changing.
- The veranda all over the four sides of the building: prevent building from getting wet by inclined raining, using veranda as a proper space during warm months of the year to create a shadow over southern, western and eastern facade of the building during warm months of year.
- Putting openings on both longitude sides of the building: using bilateral air current inside the building
- Thermal Isolation of outer layer of the building: prevent wasting energy
- Materials: using optimal practical approaches cause to less waste construction materials. Using modern materials, taking advantages of produced materials through nano-technology.
- Ventilation: ventilation through the facade, form design in order to take advantages of appropriate ventilation
- Sloping roof: to direct rain water- spaces under sloping roof can be used as greenhouse to provide a part of building's heating energy in winter. By stretching the roof on west side of the building we can somewhat lessen the problem of humidity resulting from inclined raining from west (figure 5). Problem of humidity resulting from inclined raining from west (figure 5).

Figure 5: Preventing from West Inclined Rain by Stretching the Roof on West

VIII. Conclusion

Nowadays the creativities of designing are obvious in design and construction of most of buildings designs in Nur city because it is formed according to environmental and climatical conditions and has its own special regional identification, so what has comprehensively put about sustainable architecture, in its origin ends to refer three basic

principles that draw mangers' and performing planners' attention: 1- attention to the environment 2- Quality-caring and enhancement of human life quality 3- concerning the next generation.

Thus, the features of designing of materials used in every building impress on building responses to climatic factors. So by combining rules and traditional approaches and modern techniques, we can have a greater and better impression on designing sustainable buildings; it also follows benefits such as maintaining of natural resources and building, enhancing durability and useful lifelong of the building, increasing welfare and satisfaction of the consumer with the construction, frugality in energy using and materials and prevent environment being depleted and eliminated.

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