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Strategies for climatic design for sustainable urban housing development (case study of Nur City, mazandaran, Iran)

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Abstract. In the modern age, given the important function of cities in the current instability,the theory of sustainable urban development has taken on a critical importance, particularly when sustainable urban development assumes a greater importance in housing sector due to the far-reaching effects of housing on urban environment in an attempt to realize the goals of sustainable urban development. The topic of the establishment of thermal equilibrium between body and the environment is one of the basic requirements for human comfort, in that such equilibrium depends on a mix of different ecological and physiological factors. Thus, the climate study of architecture in every region is required to be in accordance with the climate conditions of the region, because design has its own unique characteristics in every region, in that it conforms to principles and natural and ecological characteristics of its bed with respect to the criteria of visual beauty. As a result, with a documentation study and field survey, the study attempts to offer strategies for climatic design in the city of Nur so as to develop sustainable buildings, which has been accomplished. Nur City can provides the best compatibility with the environment by means of certain climatic potentials in its region in the face of the constraints and facilities of its design bed, as well as suitable environmental conditions for residents; therefore, its urban fabric is shaped in line with climatic and ecological conditions so as to achieve the goals of urban sustainable development with better and more effective function.

Keywords: Urban sustainable development, housing, temperate and humid climate, climatic design, Nur City

1. INTRODUCTION

Housing is one of the most basic human needs. Urban housing has substantially grown in Iran's cities due to a variety of reasons (Bazi et al, 2010; 36). Because of the growing concentration of population and economic activities in urban centers, especially in the underdeveloped countries, sustainability of urban development has received more attention (Drakakis, 1996: 3). Thus, today with uneven population growth and development of urbanity and its consequences have caused irreversible damages to the environment and natural habitats on Earth. To address the issue, there is a need for consideration to the preservation of God-given natural resources, environmental pollution, level and ways of fossil fuel consumption and means of compatibility with climatic and natural conditions (Kosari and Majidi, 2013: 2). However, in this regard, the matter of climatic circumstances is believed to be the most contributing factors in shaping of urban fabric parallel with other factors. Any sort of the manipulation of environment is largely subject to climatic conditions (Shakibamanesh and Ghorbanian, 2005). In this respect, in the light of principles governing vernacular architecture and urbanity, the application of sustainable development theory, which attempts to address the problem through putting more efforts into establishing a coexistence and relationship between building and natural environment, can allow for more effective solutions (Kosari and Majidi, 2013: 2).

Traditional buildings are perceived to be dynamic edifices, because they meet their requirements in the site with respect to water and energy, in the sense that they are not only compatible with their site and climate, but they also find themselves contributing to environmental changes, in that they work without causing pollution and creating waste of any sort which might be harmful to other type of building procedure or cannot be recycled directly in the environment. In the

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vernacular architecture, all the principles of sustainable architecture will be incorporated into the construction of a healthy environment in a complete process. In a holistic viewpoint, every component serves as a greater whole and interact with one another dynamically. From netting and blocking of cities to buildings units to shape and size of land plots, to techniques of construction are all explainable holistically which leads to the integration and cohesion of the whole set unity (Saflaee, 2003: 2). In a traditional life followed by a traditional architecture, the environment seeks conformity to the nature or kind of equilibrium between human, nature and architecture, in which the least damage and pollution are inflicted to the environment, as it makes use of the nature to deal with problems. In fact, Iran's traditional architecture was kind of an architecture that was oriented to a sustainable architecture, as its sustainability was derived from a full recognition of each region and design parallel with the requirements of each region; however, unfortunately the modern architecture caused us to disengage from vernacular architecture and obviously the environment by providing faster and easier solutions. Thus, the vernacular-oriented basis is shaped in such a way that human and the nature are reconciled (Zahedi and Izadi, 2013: 2). Accordingly, an attempt is made in this paper to explore the contributing components of sustainability matter and how these components come into play in the elements of Nur's urban architecture. Moreover, the architectural components of temperate and humid houses will be analyzed. Finally, by matching these components to the dimensions of sustainability, some strategies for the reapplication of the architectures are offered with respect to the modern requirements.

Definitions and concepts

Sustainability: terminology

The verb "*to sustain*" has been used in the English language since 1290 and the Latin roots *sub* and *tenere* refers to holding or maintaining. Other meanings and forms of the term *sustain* were used over centuries, but it is just in the past few decades that the word *sustainability* has come into use in the sense referring to the ability to last in the future (Dehghani and Haghpanah, 2013: 2).

In the Persian Encyclopedias *Sokhan* and *Moei, Paydari* (sustainability) refer to being stable and resistance from the infinitive "*Payesh*" meaning to be resistant and impervious. For Paydari, these adjectives are suggested; able to be stable, everlasting, and impervious. Therefore, the term *Paydari* which is chosen as equivalence of sustainability is devoid of the modern sense as it relies on maintenance and stability. The meaning of paydari discussed here includes what can continue in the future (Asadpour et al, 2013: 2).

Sustainable development

Following a sustainable society, such concept as development protection has come up to let the planet ensure survival and well-being of people. Although, at this point in time development itself could be a threat if resources were not protected as desirable as they should be. Thus, some investigations led to a report entitled "common future" in 1987. At the time of Cold War and discovery of Ozone Layer in 1985, and a year after the Chernobyl disaster, the report laid an emphasis on a central point, i.e. most processes of contemporary developments could make many people more poor and vulnerable and cause damage to the environment. Hence the question was how such development could be operative with a population twice as much the present size. Therefore, we need a track of development through which human progress is ensured not only for a few years in some locations, but for the whole planet and distant future; this was the case by which one of the most acceptable development has come into existence. Sustainable development is development that satisfies the contemporary requirements of the world without jeopardizing the future generation's ability to meet its needs (Ghobadian, 2003: 57).

Sustainable architecture

The application of sustainability and sustainable development concepts in architecture have raised the discussion about sustainable architecture. The main ideas of sustainable architecture include the use of the ability to change application, flexibility, and hidden energy (i.e. energy used for producing materials (Soleymani, 2008: 16). Like other architectural categories, sustainable architecture have certain rules and principles, which include three stages: resource saving, return to life cycle designs, designs for human beings; each entails its own special strategy, as the recognition and study of these measures drive architecture to better understand the environment that has to be designed (Davarinejad, 2009: 483-494).

Sustainable design principles

Some buildings benefit from features and characteristics that make them fit into the best sustainable buildings. Principles that have to be observed to make a building classified as a sustainable architecture include:

The first principle: energy conservation: a building should be constructed in such a way that it reduces the requirements for fossil fuels to the minimum.

The second principle: compatibility with the environment: buildings should be designed as they are in harmony with climate and energy resources available in the site of construction.

The third principle: reduction of new material resource use; buildings should be designed in such a way that the use of new resources is reduced as much as possible, and they are being used as new source until the end of their useful lifetime for new construction.

The fourth principle: fulfilment of residents' needs; satisfying residents' mental and physical requirements takes on a special importance in regard to a sustainable architecture.

The fifth principle: compatibility with the site; building should be gently placed on the ground of the site, in that it fits the surrounding environment.

The sixth principle: holism; the whole principles of sustainable architecture should be embodied in a complete process that helps to build a healthy environment (Asadpour et al, 2013: 3).

Definitions of housing

Housing constitutes a far-reaching and complicated concept which encompasses a variety of dimensions. Thus, it is hard to offer a comprehensive and unified definition. Housing is considered a physical place serving as the basic shelter for a household. In this shelter, some basic requirements of a household or an individual are met; sleep, rest, protection from weather conditions, environmental conditions, and above all the nature (Ahari et al, 1988: 7). In addition to its physical structure by which a household is sheltered, the concept of housing constitutes the entire residential environment ranging from all services to social facilities to essential public facilities required for wellbeing of a household, to employment projects, and individuals' education and health (Mokhber, 1984: 18). In the second United Nations Conference on Human Settlements held in Istanbul, a good housing was defined as follows (Dalalpour and Mohammadi, 2000: 3); a shelter is much more than a roof over your head—it is instead a place for comfort, security, ownership, stability and durability of structures, lighting, ventilation and good heating system, good sanitary elements, as well as a good place accessible to workplace and basic facilities, all of which have to be met with respect to people's financial power.

Sustainable housing

Housing is part of a relationship between society, environment and economy. Function and foundation of housing constitute a large quantity of natural resources in land, water energy, and building materials. Overall, when it comes to production and wastes, air and water pollution on the one hand, housing itself is subject to many constant environmental effects and threats, natural disasters, and environmental changes, on the other hand. These dimensions are remarkably crucial to the stability of housing. Concerning housing, a complicate network of internal relations between sustainability and housing are concerned through policies of sustainable housing; the policies apply a range of sustainable conditions in the development of housing (including aspects of environmental, social, cultural, and economic sustainability). Like climate and environmental changes in house evolution, there are other matters to be dealt with; economic activities relating to housing and its linkage with broader economy, cultural and social fabric in society, effects of housing on poverty relief, social development, and quality of life. Although, housing sustainability often goes hand in hand with prosperity, it never requires the current form; sustainable housing obviously addresses those who can afford to have it, which is a necessary condition for moving toward sustainable housing. Thus, affordable housing has never come into existence if these negative effects exerted on the environment or life; affordable housing link with other circumstances make sense in the discussion about sustainable housing (Medadi and Asadi, 2013: 8).

Environmental, Geographical and climatic characteristics of Nur City

Geographical and environmental characteristics

Nur Province with an area of 2.675 square kilometers is located in the west of Mazandaran Province. In figure 1, the province is bordered by the Caspian Sea on the north, Amol Province on the east, Noshahr Province on the west, and finally Tehran on the south. In terms of geographical longitude and latitude, the province is located at 50 degrees and 51 minutes to 52 degrees and 10 minutes east longitude and 36 degrees and 35 minutes to 36 degrees and 10 minutes north latitude. Topographically speaking, it is divided into mountainous and plain parts. Mountainous part is located in the south of the province, covering almost 80% of the entire area of the province, as the remaining 20% constitutes the plain part, which is located between the Caspian Sea and Albour Mountains. The cities Nur, Royan, Chamestan are situated in this part, as Baladeh is located in the mountains region. The overall slope of the city stretches from the south to the north following the morph of the region. In this province, there are a lot of rivers which include less alluvial area due to short distance from watershed and basin and the great height difference between these two areas (Hadi Nur Project, 2005).

Climate features

Weather

The weather of Nur province follows the climatic conditions of the Caspian Sea in the lowlands in the southern part and the conditions of Alborz Mountains in the mountainous part on the south. The weather condition of the province has considerable difference in its north side (plain coastline) and south side (mountainous part), which is due to height and humidity parameters; that is, mountainous regions have a weather ranging from semi-humid cold to very cold where alpine-like weather dominates, but in the northern coasts winter is mild and its climate ranges from humid to very humid and temperate. Given the fact that Nur is devoid of a synoptic and climatology station, the statistics of Nushahr and Chamestan stations where they have a weather condition almost the same as Nur. As presented in the related tables, the average rainfall rate of Nushahr and Chamestan stations are 1272 and 799 mm, respectively, but the average long-term

rainfall of the entire Nur province ranges from about 400 mm in the southern highlands to about 1100 mm per year in Nur's coasts (Hadi Nur Project, 2005).

The average maximum temperature is 19.9 t ° C throughout a year, and the average minimum temperature is 12.8 ° C, and the average maximum and minimum relative humidity stood at 95 and 72 percent respectively throughout 1999 in Nushahr station. According to the 30-year statistic (1964-1994) of Nushahr and Chamestan stations, the average rainfall and average daily temperature in different months are presented in table 1 (Comprehensive National Water Project, 2000). According to the statistic of Nushahr station from 1981 to 1992, the average minimum and maximum humidity stood at about 68.2 and 94.5 percent, and the average minimum and maximum annual temperature stood at 10.5 ° C and 22 ° C. the number of rainfall days was about 136 days per year according to this statistic (table 2). From a total of 1272 mm average rainfall in Nushahr station, about 43.1 percent rainfall is received in fall, 22.4 percent in summer, 21.6 percent in winter, and 12.9 percent in spring (table 3) (Hadi Nur Project, 2005).

Wind

In the Caspian Sea's coastal region, there are two kinds of winds:

Coastal winds

The winds often blows from the sea to the shore from the early morning until noon due to a high pressure center in the sea and a low pressure center on the shore, as it blows from the shore to the sea by night. These winds make water vapor from the sea travel to the southern plain and highland in the region.

Regional winds

- West winds (Mediterranean) are affected by Mediterranean air masses, causing them to rain. Precipitation regime from the winds are continuous with low intensity.

- Northwest winds (Polar-European) affected by polar air masses in the North Atlantic come from the northwest side of the country. It seems that torrential downpour in spring and fall and snow in winter come under the influence of these winds. The frequency of the wind blowing is equal to 7.3 percent during a four-year period recorded in Nushahr station.

- North and northeast winds (Siberia) which is under the influence of polar air masses keep blowing from mid-fall to late spring in the region. The winds themselves are dry and cold, but they cause heavy precipitation of rain and snow when coming into contact with Mediterranean air masses; the region is under the influence of the forgoing air masses and winds, and the direction of the winds is mainly from the northwest and the west in spring and summer, and the northwest and the northeast in fall and winter (Hadi Nur Project, 2005).

Architectural design with a sustainable pattern for traditional houses in order to design the contemporary buildings of Nur, Architectural characteristics of vernacular houses in temperate and humid regions, Extraversion

The vernacular architecture of the region blends in perfectly with the nature and matches the climatic condition, in the sense that it can be called nature-oriented architecture. Architecture is called extrovert architecture when used for being matched to the environmental and climatic conditions. The reason for the establishment of extrovert buildings in the region is to benefit from air current in the first place so that inert humidity is prevented inside the building. Another reason is the maximum use of humidity and creation of a good view and monitoring of the yard's range (Gorji and Daneshvar, 2010: 135-145). Extrovert typology has to do with type of house

architecture dealing with characteristics such as direct visual and physical connection with exterior house space, lack of yard, expansion in the height, and spatial organization compared to another space such as opposite corridor (Zandieh and Parvardinejad, 2010: 135-145).

Orientation

In these areas, we can use free and even cross-shaped forms in these regions. However, building form should be stretched over an east-west axis so that the necessary air current is provided (figures 3 and 4) (Gorji and Daneshvar, 2010: 135-145). The main front of most room and porch skylight is on the south direction. The main yard of the building is located on the south side (figure 5). In general, plans are extensive and open as their physical form are mostly in geometric, long and narrow shapes. In order to make the best use of wind blowing for the purpose of ventilation inside rooms, the orientation of buildings has been set with respect the direction of the sea breeze. In the points where strong wind comes, the sides facing building's current of air are completely shut (figure 6) (Zandieh and Parvardinejad, 2010: 135-145).

Building materials

Due to a fairly sufficient amount of wood and mud, the construction of wooden-stratiform buildings is commonplace, in the sense that walls were in the form of enclosure, and the floor and ceiling were made of wood. Wood also placed as a bundle in the spaces of stratiform walls in order to perform coating for enhancing the resistance of structure (Kasmaee, 2008: 23). Sloped ceiling coated with mud, stubble, leaf, clay and gable roof. Different types of slopes used for the rooftop of the buildings include: steep, flat, two-sided, four-sided, enclosed, all of which vary in the number of trolleys and direction (Figure 7).

Recycling

For the architecture of the region utilizing the natural elements most, there is no element disposable. That is, each element is used at best. As mentioned before, rice stalks (kulash or alam) are used for roof coating; the stalks are used for making a type of rope applicable as a connection instead of metal nails and wires. There is a tree bark called Lorak used for making type of rope called Lorak Kul. Even rice paddy is used for making kind of coating called Fal-Gel a mixture of clay, water and crushed rice grain hull (Yusefnia, 2006: 57). Such application of natural elements would help building waste to inflict the least harm to building bed both at the time of construction and demolition, because a building is part of the bed and arise from the heart of the nature.

Climatic study of inappropriate constructions in Nur

For instance, the constructions underway at Imam Khomeini Blvd. on Sahel St have been studied (Figure 8). The buildings marked at the specified area of figure 9 are devoid of eastern elongation, yet they have northern-southern elongation, as they have the least advantage of good light on the south and current of air. Moreover, as figure shows, the permissible space is maintained but air current has lost on both the north and the south sides for both buildings, which caused northern buildings to get insufficient light.

Placement of openings in the western side of the buildings caused drumming and decaying as a result of high humidity and penetration of rain water (figures 11 and 12).

Composite installation after the completion and operation of the building and netting on the west and northeast sides in order to prevent rain from penetration, because the type of arch employed in the area are extremely problematic, because an inappropriate pattern of construction and its spread across Nur Province has been pursuing without regard to climatic issues, disrupting

residents' comfort; and it was deemed to be necessary to take measure for controlling it as much as possible in the stage of operation (figure 13).

Given the placement of openings on the west and east sides, inappropriate adjacency caused insufficient lighting due to the shades received from residential units (figure 14).

Suggested strategies for designing a sustainable climate for contemporary buildings of Nur City

- Low building width: make the best use of crooked sunlight in the winter from the south of building, thickness and air friction reduction inside the building in order to facilitate air current on both sides of building
- Design a building facing appropriate wind in summer: use air current inside the building during the warmer months in a year
- Lay building on a pilot: prevention from humidity penetration into the floor, use of pilot as a living space over the warmer months in a year
- Use pilot as greenhouse to provide building heat during the cold months in a year
- Do not use basement as dwelling; it is difficult to provide air current on both sides, humid and heavy airflow are also problematic in the basement in summer
- Determine the function of rooms based on season change
- Build a porch all around the four sides of building: to prevent the body of the building from getting wet by sloping rain, use porch as a good living space during the warmer months in a year, create a shade on the south, east, west body of the building during the warmer months in a year (figures 15 and 16).

- Place openings on both longitudinal sides of building: use a dual side air current inside building—to control summer's sunlight it is necessary to use a canopy as follows:

1. Windows facing south and southeast with horizontal canopy

2. South and southeast windows with horizontal canopy

3. Windows of north front with a vertical canopy next the window, especially in the west side

4. Windows facing east, west and directions near to them with horizontal canopy and vertical canopy facing the window, as the calculations indicate that it is necessary for the width of horizontal canopy of the windows facing south and southeast to be about 4.0 to 5.0 m high in these regions.

- Insulation (thermal): outer shell of building: to prevent energy from being lost
- Materials: use optimized operation methods which cause less waste of building materials, use new materials, and apply materials produced by nanotechnology in architecture.
- Ventilation: ventilation through the façade, design the form in order to make use of a good ventilation

Pitched roof: to direct rainwater, we can use the space of the pitched roof as a greenhouse to provide part of the building's heating in winter. Moreover, for the problem of humidity caused by the west sloping rain streams, we can elongate ceiling in the western part so that the problem will be fixed to some extent (Figure 17).

- Full and empty space: presence of open spaces around a building would help wind move easily between them and inert humidity is avoided. However, it is recommended that their west and northwest fronts be protected from cold breeze in winter (Figure 18).

- Create open space: building should benefit from winds at war time, so the space between walls and buildings located on the north, east, and south should not be less than 4 times their heights (Figure 19).
- Use natural ventilation: (Figure 20), the use of natural ventilation by day until it hits the right temperature would help:

1. To cool building's indoor air by moving or removing it by outdoor air until outdoor air gets cooler than indoor.

2. To cool the structure of the building

3. To directly cool the human body through convection and evaporation

2. CONCLUSION

In the study, strategies for a sustainable design were investigated in the traditional buildings of a humid and moderate climate. According to this, the conclusion was drawn that the environment seeks conformity to the nature with respect to traditional life followed by a traditional architecture; hence there comes along a tradeoff and equilibrium between human, nature, and architecture, in which the least damage and pollution incurred by the environment, in that the nature itself is used to deal with its problems. As a matter of fact, Iran's traditional architecture was a kind of architecture which tended to sustainability, and its sustainability was due to the thorough recognition of each region, and a design developed in parallel with the requirements of a climate. Unfortunately, according to samples studied in Nur City, new constructions have caused us to detach ourselves from vernacular and local architecture, the nature, and the environment. Meanwhile, Nur City can adapt itself to the environment at best and provide good environmental conditions for its residents through its certain climatic potentials in the face of limitations with the help of further facilities so that urban fabric can be in good agreement with climatic conditions and ecology with respect to the objectives of urban sustainable development. Therefore, the region can be more influential with better function by combining traditional strategies and rules and new techniques for designing sustainable buildings, thereby bringing the following advantages: protecting natural and building resources, increasing sustainability and useful lifetime of buildings, increasing consumer's comfort and satisfaction with building, saving energy consumption and materials used, preventing natural environment pollution and eliminating it.

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Figure 1. Location of Nur province in Mazandaran Province

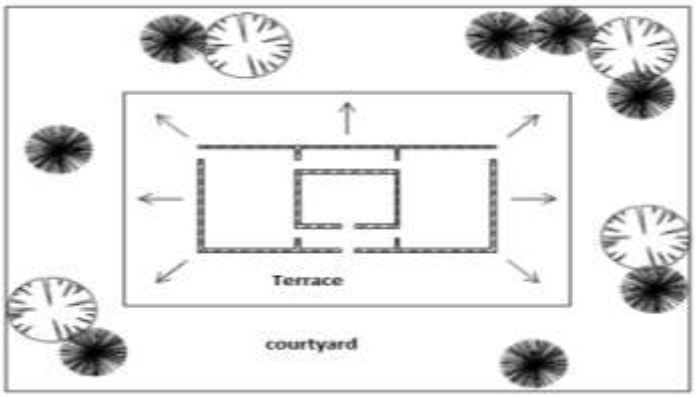

Figure 2. access hierarchy

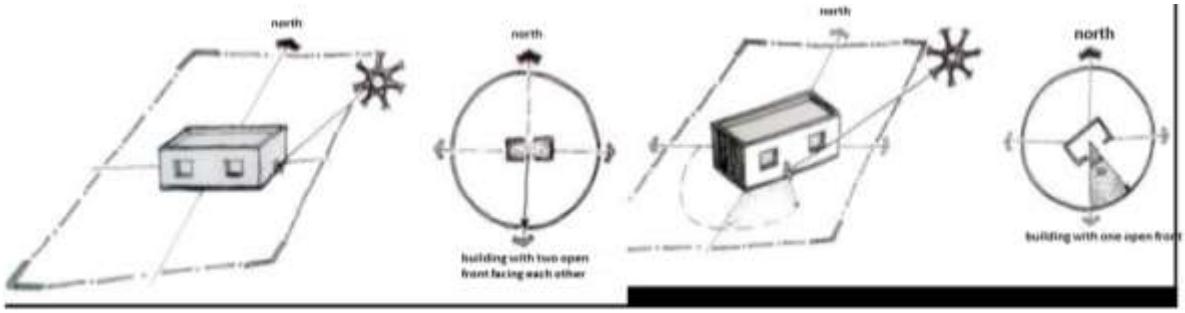

Figure 3. Kllbuilding orientation and form

Figure 4. Building form and direction

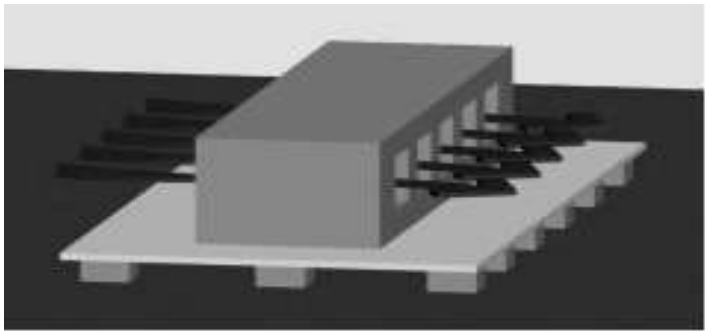

Figure 5. Yard and opening form

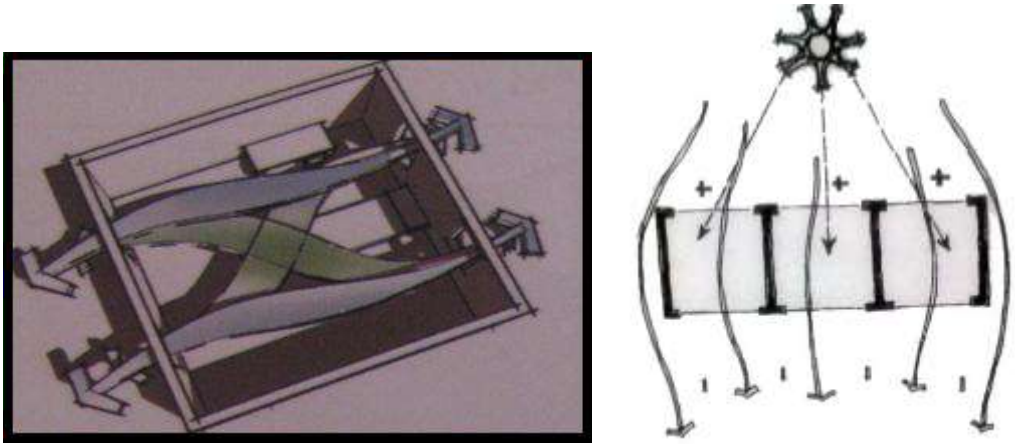

Figure 6. proper direction of building for current of air and ventilation

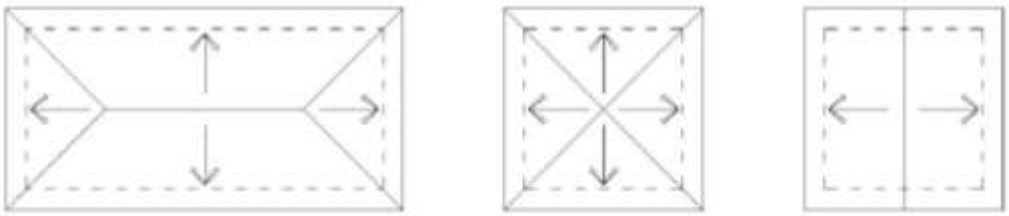

Figure 7. From right to left: two-sided, equal four-sided, rectangular four-sided

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