Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 5, Issue, 12, pp.3813-3816, December, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

THE STUDY OF TRADITIONAL ARCHITECTURE OF IRANIAN COLD MOUNTAINOUS REGIONS A CONGRUENT STEP TOWARDS SUSTAINABLE DESIGN

***,[1]Foad Rahmani and [2]Chiman Hosseini**

[1]Department of Art Architecture, Shabestar Branch, Islamic Azad University, Shabestar, Iran
[2]Department of Archaeology, Abhar Branch, Islamic Azad University, Abhar, Iran

ARTICLE INFO

Article History:
Received 04th September, 2013
Received in revised form
30th October, 2013
Accepted 15th November, 2013
Published online 02nd December, 2013

Key words:
Climate,
Sustainable Development,
Building Architecture,
Cold and Dry Regions.

ABSTRACT

Modernity and its consequences are the factors that have caused in contemporary period, the designing principle compatible with climate like many of traditional architectural principle are trampled. Proper design of buildings and urban structure based on its surrounding climate is a contemporary topic. And this principle, that is, consistent with the climate was established as the basis for the formation of local architecture in many parts of the world. Iranian traditional architecture in the mountainous areas have a strong background and fruitful aspects of sustainability, so that it can utilize the best form of natural surroundings and facilities in order to provide comfort and protect itself from climatic factors. In this paper we have tried to study the architecture in mountainous areas of west and northwest of Iran by climate approach, and by using the past experiments and getting assistance of traditional architecture values which are compatible with modern concepts in constructing contemporary buildings better than before in the architecture field, and according to the principles of sustainable architecture, we utilize the proposed strategies for designing of buildings in cold and dry climates by using the principles which were observed in the past and the needs of buildings in this climate. To do this, the technique of documentary study for collecting data and descriptive-analytical method for analysis of data were used.

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INTRODUCTION

The term "sustainable" was used for the first time in 1986 by the World Commission on Environment development as meeting the present needs without compromising the resources of future generations to meet their needs, and every day its scope and dimension are increased (Rahimi, 2009). From onside by studying local buildings in each climate, we clearly understand that all local buildings have been designed and built entirely based on climate principles, and to get maximum use of natural energies and protecting against disturbing cold and heat which this fact is completely compatible with the culture of people of each region and has been defined as a local architecture and ecology (Ghobadian, 1998: 42) that includes a set of applied and scientific principles, that considering these principles in designing buildings by designers and architects can result in designing the optimum spaces in terms of people comfort and saving energy. Climate designing is a method to reduce multilateral energy consumption in a building; building design is the first defensive area against building external climatic factors.

Corresponding author: Foad Rahmani
Department of Art Architecture, Shabestar Branch, Islamic Azad University, Shabestar, Iran

Statement of problem

Indiscriminate use of limited fossil energy has led to increasing greenhouse gases in the atmosphere; accordingly, the issue of proper design of buildings and urban frames based on the surrounding climate is the topic of the day. In this connection, according to wideness of mountainous cold climate, and according to designing buildings, the urban frame of the cold mountainous climates that are considered as the main consumers of fossil energy can reduce a major part of consumption and as a result reduce the pollutions resulting from consumption.

Importance and objectives

Urban planning for land use and its effects on the place and density, designing residential houses and neighborhood units plays an important role in achieving sustainable development (Bulkeley and Betsill, 2003: 176). One of the main characteristics of sustainable urban environments is their consistency and compatibility with the local climate characteristics (IPENZ, 2007:3). Therefore, knowing, understanding and controlling the impacts of climate change in urban areas are considered the main prerequisite for planning and designing urban spaces that it is necessary before implementation of projects and designs, a special attention

should be paid to it by planners and designers (Biket, 2006: 262).

Review of literature

Among scientific studies have been done on this subject, the following may be mentioned:

- Kasmaee(1998) in his book, Climate and Architecture has mentioned some subjects about identification of climatic factors, climate and human, climate, and building.
- Kaviani (2001) in his book has studied modifications resulting from the construction of buildings in different climates, and has analyzed changes resulting in the location of building in the situation of radiation of light, heat, moisture and aerodynamic characteristics of the environment.
- De la Espriella (2002) in an article entitled "Improvement of relaxation using climatic design" has analyzed climatic factors in connection with urban environments, buildings and human living conditions.

MATERIALS AND METHODS

The present research is mainly an analytical one that a big part of its information has been collected through library research. First, strategies of designing buildings in cold mountainous climate are analyzed and then a description of the cold mountainous climate is done, and finally the solutions were used in this region are discussed.

Cold mountainous climate

As after arid and desert part, a vast area of our country is the cold mountainous region, and Alborz Mountains in the north and central parts and Zagross Mountains in west of Iran are the main regions of these cold and mountainous area (Mohammad Nia Qaraei and Naser Javdani, 2003), the average temperature in the warmest month of the year in this region is more than 10°C and the average temperature of the coldest month is less than -3°C. The valleys are extremely hot in summer and mild in winter. The sun radiation is high in summer and low in winter. Winters are long, cold and hard, and for many months of the year, the region is covered with ice. Spring is short and separates the winter and summer (Donald Watson and Cont Lab, 1977). The cold starts from early December (Azar, in Iranian calendar) and continues more or less to late April (Farvardin). In these areas, rainfall is low in summer and high in winter, and is more as snowfall. More frequent snow covers the peaks. At altitudes above 3000 meters, there is always snow and the mountains are the source of rivers and canals in the country. Snow in northern and northwestern areas is more than the southwest areas. Despite abundant rainfall, humidity is low in this region. The western mountain ranges such as a barrier also prevents the penetration of Mediterranean moist air into the Iranian plateau keep the moisture in the feet of mountains. Unlike the northern areas of Iran and the Caspian coastal lands that air concentration is high due to lowness of the land and precipitation, in cold climate, the concentration is lower and thus reduces the amount of natural ventilation of air (Madani Pour, 2000).

Architecture of cold and mountainous regions

According to the extreme cold weather, at the most of the year in these areas, using the maximum sun radiation, use of daily fluctuations in temperature, heat protection and regularly preventing cold wind in the residential environment is essential. General urban characteristics in mountainous regions are:

- Small and confined urban spaces.
- Dense urban frames and buildings joined together.
- The sun direction and topography are determinant factor in the establishment method, development and overall appearance of the city.
- Alleys and main streets are parallel to the ground level and with the low width.

Due to abundant cold in a big part of the year in theses regions, urban contexts are connected to each others in order to reduce the contact of hot residential surfaces with cold outside environment. Urban spaces as small as possible and are confined in order to protect the penetration of cold winds into these spaces, in addition the heat radiation from the external surfaces of the buildings hot walls to some extent cause moderation in cold urban spaces and being theses spaces small is one of the advantages of these places (Gobadian,1998: 9).

Methods of climate control in buildings according to the cold climate area

Some elements and characteristics of urban design such as building density and form of the city can reduce energy consumption in urban areas and influence on local climate (Bulkeley and Betsill, 2003: 17). The important subject for understanding the value of architecture of each age and regional climate is to know how to comply the buildings of that area with specific climate of that region, that is, how the building utilizes from the sun, breeze and green space and how the architect creates a micro climate that all these are the reasons and indications of the designer's skills and knowledge. Thus, the methods of using energy and natural resources to create comfort conditions inside the building can be divided into several categories:

Scope of the research

It is optimum that the buildings are constructed singularly and densely adjacent to each other. Arrangements that create wind tunnel and frozenness should be avoided. The buildings should have western-eastern direction and the distance between buildings is set so that they have the maximum rate of the sun light absorption, and create the less combinative shadow.

Building orientation

Building designers can select the direction of the buildings so that the rate of the solar radiation absorbed, does not cause overheating of buildings; in cold regions, the direction of the buildings should be selected so that the maximum amount of solar energy absorbed take place. Buildings should be constructed between 20 degrees toward west and 45 degrees toward east and in the shadow of each others wind and out of

each others the sun shadow, on the north- south axis (Shi'a, 1999).

Plan and form of building

In cold and mountainous climate, the buildings have dense plan and context. The form of the building must be such that makes its contact surface with the outside cold lower in order less temperature is transferred from the inside to outside. Therefore the forms such cube or cube rectangular are used to reduce the proportion of the external surface to the internal volume and keep it at minimum possible level (Shi'a, 1999).

Small rooms with low height

In these regions the ceiling is made lower than similar rooms in other climate areas to reduce the volume of the room and external surface is minimized in proportion to the building volume. The low height of ceiling in halls, important rooms, and the roof of continuous markets and small stores of this region are also well known (Majedi, 2003).

Small openings

Dimensions of openings in this climate area are to use the thermal energy from the increased sun radiation (Zargar, 1996). To prevent heat exchange between the inside and outside of the building, we should use the small openings and with few in number. If the windows are large, using awnings is required. Openings on the south side are much larger and more elongated for using more of the sunlight. Also, the openings are used to prevent the penetration of cold wind. Double-glazed windows are more appropriate for conveying heat exchange to a minimum. In addition, in order to avoid burning inside and transfer the internal temperature of the building to outside, the air exchange inside the building and natural air ventilation should reach to minimum.

Flat roofs

Selecting a flat roof does not create a problem in cold climates because keeping snow on the roof acts as thermal insulation against the cold outside that its temperature is several degrees lesser than that of snow (Zekavt, 1996).

Relatively thick walls

Thick walls keep daily sun radiation and heat throughout the night and help to adjust the indoor temperature of the building (Shah Hosseini, 2000). The standards of architecture in cold and mountainous climate and hot and arid climate are approximately similar and the only their difference is in their source of heat, that in hot and arid climate, the source is located outside the building and in cold climate it is located inside the building. Therefore in this climate by contributing construction materials, the wall thickness is increased in order these walls be able to act as a heat source inside the building.

Type of material

Materials must have good thermal resistance and heat capacity to keep the interior heat of the building. Therefore the frame of these buildings includes stone (or wood, thatch mortar, raw brick and brick) roof covers are wooden beams and thatch (Ghazban Pour, 2000).

Constructing buildings adjacent

In cold and mountainous areas, adjacent houses should not make shadow on each other.

Paint of materials

In cold regions, the outer surface of houses should have a dark color and its type should have high absorption.

The greenhouse effect

In cold regions to use more solar energy, porches with elongated windows are designed at south side of the house and exposed to the sun. Sunlight shins through the windows into the porch, and where are absorbed into the walls and floor (which are usually dark in color).

Radiative cooling

All objects that absorb sunlight and heat during the day, as they have temperatures more than the atmosphere, during the night, they begin to lose heat by radiation. Architects use this principle to keep buildings cool during the night and called this process the radiative cooling.

Fighting against the negative effects of wind

Blowing the wind on external walls of the house causes to increase the rate of heat transfer to the outside walls or the waste heat. Thus in cold and windy areas the houses should be protected from the wind blow as much as possible.

Utilization of wind and air movement (ventilation)

This method of ventilation includes moving the air, and replacement of the air inside with the air outside.

The applicable procedures to this area

To avoid the heat transfer, in addition to reducing low resistant surfaces such as windows and doors, the proportion of the sum of the building exterior surfaces to the building's volume should be minimized. Exterior walls should be equipped with thermal insulation. In order to reduce the difference of inside optimum temperature and unfavorable external temperature, we should be careful in choosing the location and design of buildings to reduce heat exchange and its rate by creating an appropriate microclimate. If possible, a cellar must be provided, and even if the condition allows, we can construct the building inside the ground, in order the ground acts as an insulation to prevent heat exchange (Gholami Beiragh Dar *et al*., 2000). The penetrative air from doors and windows and the construction joints cause the inside air to become dry, irritation of skin and uncomforting, and from one side, waste the thermal energy within the building. Also, to prevent cold air into the building, we should pay enough attention to the location of the building, design of the environment and

Table 1. Architectural solutions for cold mountainous areas, Reference: writters

The way of building connection with ground	The type of roof	Material type	The rate of using natural ventilation	The surface and number of windows	The type of external paint	The context	orientation	The type of plan	The type of climate
On the ground	flat	High thermal capacity and resistance	low	low	dark	dense	South-eastern to South-western	condensed	cold

orientation of constructing building to wind pressure. In traditional buildings in order to prevent air penetration, entrance, vestibule and indoor corridors were used (Gholami Beiragh Dar *et al*., 2000). Building wall masonry should be selected so that its heat capacity is high. For this purpose, building materials such as bricks, stones and tiles that are highly capable of absorbing solar radiation can be used (Gholami Beiragh Dar *et al*., 2000).

Conclusions

Based on observations and analyses done on the cold mountainous climates we conclude that a designer should know how much her/his interventions in the nature are conformed with natural systems, that is, these interventions result in less destroy in ecotourism or renewable resources are used by caution and the systems be designed that are coexisting and compatible with ecosystem process, and their consideration are to find the proper approaches for future. Based on these studies done, we can summarize the important architectural recommendations which are compatible with this region climate as following:

- Maximum use of solar heat should be done in the winter.
- Building form should be elongated in the east-west direction.
- Designing a compact space.
- Preventing cold air infiltration into the building.
- Heat transfer through the walls of the building should be minimized.
- The mechanical cooling system should be used in winter.
- Prediction of the airflow is not necessary.
- Using small or medium sized exterior windows.
- Using heavy materials for walls and floor with a delay of more than 8 hours.
- Roof design with high latency over 8 hours.
- Transferring the indoor humid air to outside that prevents perspiration and wetting of internal walls.

The following table shows the results obtained for the architecture in harmony with the climate in this cold mountainous region which acts as a guide.

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