

How Contrast Climatic Zone Impact on Achieving Sustainability in Modern Building of Iran

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Abstract: Day by day demand for sustainability is rapidly growing and thus make it a significant debate. For attaining sustainability, saving energy is one of the main criteria on the sustainable building performance and consumption of energy in hot dry and cold area of Iran, climate have at most effect. Iran's cold and mountainous regions consumes excessive energy consumption for the comfort of its residents, and so it is a problem for residential complexes. In spite of the fact that in this field lot many researches are already done. These problems cause environmental pollution alongside causes crisis of energy in future time.

The study done in this research paper describes the basic principle and idea of attaining sustainability in buildings. Further, explains the climatic design of building for hot and humid, and cold climate with reference to the conditions in three cities of Iran which are Kahrizak, Mahallat and Hamedan. Additionally, in the paper there is an introduction and explanation of case studies focused on different strategies of designing. In their building facades and what part, they render in building sustainability enhancement. Facade can be understood as the buildings one of the foremost components and a building consumption of energy is extremely affected by it and according to region climatic zone.

Keywords: sustainable design, orientation, building envelop, courtyard, climate responsive design, traditional architecture design strategies, comfort conditions, Façade, Iran.

1. INTRODUCTION

For society buildings are notable patrons of environment's materials and energy. Therefore, sustainable practices in building environment are essentially required to enhance comfort zone in working areas of the building. The countries which are developing and have rapid growth of economy with development of the building have necessity to raise sustainable buildings. Sustainability intensifies the quality of life and derive to live in a healthy environment. When we focus on achieving sustainability of building, climate is a crucial factor. And, achieving sustainability in a building becomes more challenging in deserted and mountainous areas. In these regions climatic responsive design techniques and construction strategies are used for procuring sustainability.

This paper highlights the building in deserted and mountainous regions. In Iranian region high plateau and mountains are one of the four climatic divisions, there is a major difference in the day and night temperature; heavy snow with coldest month of the year have temperature below 0 degrees. Iran is famous in the world for highly arid and warmer area its 1/6 area is deserted with the temperature of 70 degrees Celsius and inhabitant areas near have 54 degrees Celsius and have strong winds and storms.

Therefore, at the first of this research explains the basic principles and ideals of attaining sustainable building and through the observation and former research explain the hot and humid, and cold region climate design of building in three cities of Iran.

2. THE CONCEPTS OF SUSTAINABLE BUILDING

The definition of Sustainable building is "those buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting." The whole life of buildings, future values into account, functional quality and taking environmental quality considered into sustainable design. In addition, to convey concern for the traditional aesthetics of proportion scale massing, light, texture, orientation and Shadow. The team which designs the building has to be concerned about long-term cost and impact by environment. The building practices which strive for integral quality which includes social, economic and environmental performance in a broad way, this can be defined as action by Sustainable buildings.

For a sustainable design to be successful, it requires integrated approach since operational practices and building systems are dependent on solar access and light penetration, product specification, siting and architectural design. How the interaction of building with building activities, system and environment around it, this approach to design examines it. Thus, the appropriate management of the building stock and natural resources rational use will contribute in reducing energy consumption, saving scarce resources and improving quality of the environment.

There Five major objectives of Sustainable building are as follows :

- 1) efficiency of energy
- 2) Harmonization with environment.

- 3) Efficiency of resources.
- 4) Systemic and integrate approach.
- 5) Prevention of pollution.

For achieving these objectives, sustainable building must be non-polluting and non-wasteful, resource-efficient, highly adaptable and flexible for long-term functionality including Greenhouse gas emissions reduction. Including these sustainable buildings should also be easy to maintain and operate. And the well-being of the occupants and should be supportive of the productivity, including noise abatement and good indoor air quality.

The following categories of criteria are often used to bring the objectives into practice and access the building performance.

- 1) Renewable energy and Energy Efficiency
- 2) Management of materials and waste
- 3) Sustainable site
- 4) Quality of indoor environment
- 5) Water conservation

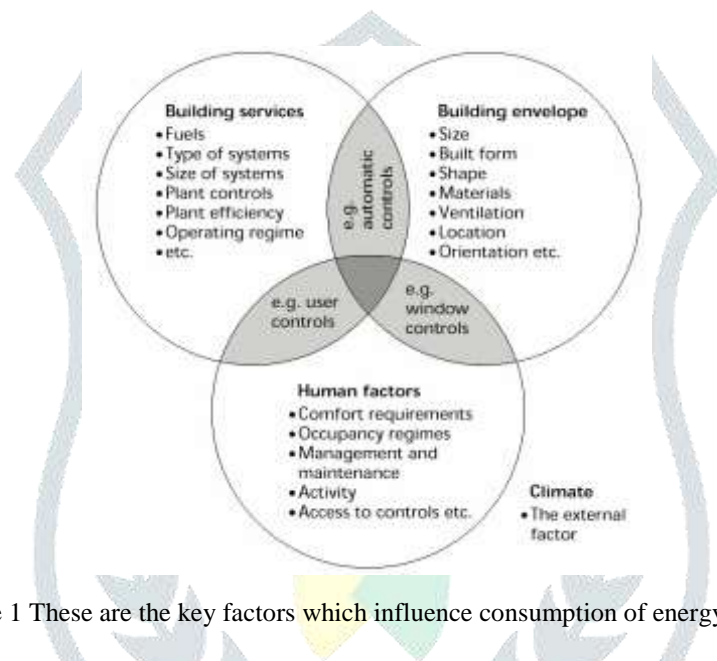


Figure 1 These are the key factors which influence consumption of energy in building

3. PRINCIPLES OF CLIMATIC DESIGN CLIMATE RESPONSIVE DESIGN

High importance was given to the climate consideration in human history in building and urban design. However, the process of climatic design is frequently overlooked with the emerging of building service system and modern architecture. There are two basic philosophies on which climate responsive design depends. One is building environmental performance Optimization and another one is the climate influence's evolution and in other words, by external climate Co-operation, there is a trail resource consumption reduction and environmental impact minimization.

Following areas should be examined systematic approach establishment.

- 1) Outdoor climate
- 2) Indoor climate

3.1. Outdoor climate of building

There is the requirement of careful consideration of local characteristics and climatic condition. For sustainable design of building and building service system. It is not remotely possible to ensure efficient building service operation and optimal building design without sufficiently good understanding and information on the local climate. It is important for Iran to establish detailed and accurate climatic data, to achieve energy sustainability and efficiency in building. The climatic data and information's quality will determine the accuracy of design load and effectiveness of building design and energy calculation.

Table 1 Climatic design conditions in Iran different regions

Location	Kahrizak	Hamedan	Mahallat
Latitude	35.5174° N	34.7989° N	33.9086° N
Longitude	51.3601° E	48.5150° E	50.4553° E
Cooling design DB/MCWB (1%)	38.2°C/18.9°C	36.2°C/20.6°C	39.5°C/24.6°C
Heating design DB (99%)	5.9°C	-18.1°C	-20.4°C
Wind speed MCWS (summer)	9.8 Kmph	9.5 Kmph	16.1 Kmph
MCWS (winter)	7.1 Kmph	7.4 Kmph	6.2 Kmph
Wind direction	East or southeast	North or northwest	North or northeast

Notes:

1. Abbreviations:

DB = Dry bulb temperature

MCWB = Mean coincident wet bulb temperature

MCWS = Mean coincident wind speed

3.2. Indoor climate of building

The focus of indoor climate is on these physical conditions of environments which are created inside built environments that promote working productivity and improve human performance and that provide for a healthful and comfortable experience. And typical conditions of indoor environment include visual conditions, temperature, ventilation and relative humidity. In building to active comfort 'bio-climate' is a sustainable way. form on local climate commit to spaces and buildings design its focus is to provide thermal comfort and visual comfort by the other environmental sources use and Solar Energy in the flow of the natural energy.

Passive solar system is the basic elements of bioclimatic design, which are incorporated into the building and utilization of environmental sources such as air, ventilation, soil, water, Sun, Sky for heating, lighting and cooling the building. Usually, at the early stage of design, some easy decisions on bioclimatic design can be help in saving the usage of energy later on.

4. CLIMATE RESPONSIVE DESIGN IN HOT AND HUMID REGION

In building scale most significant design parameters which affects indoor energy conservation and indoor thermal comfort are building form, self-efficiency, distance between the building, building envelope design in building materials and thermo-physical & optical properties of the building envelope. Building envelope design among these parameters is so much importance, because it separates the indoor and outdoor. Every parameter associated from each and other and depends on others value, and by which each optimum value must be determined. the optimum combination must determine according to the region's weather characteristics.

4.1. Building form in hot and humid region

One of the most preferred houses plans in Iran is a Courtyard because of its hot and dry climate. for less affected area by solar radiation, compact forms are selected. Shady areas can be procured by putting in order of those forms. The Courtyards floor temperature can reduce by surrounding high walls, for courtyards evaporative cooling plant and water helps. the area which is open in the Courtyard can be used in daytime and the remaining area which is in Shade can be used for Channels cooling for water poured out from pool. For maintaining the courtyards evaporative cooling water is spread by channels onto courtyards floor which are made of porous stone. courtyards have different forms which depends on the landscape of housing, but Courtyards are always on the ground floor.

4.2. Building envelope in hot and humid region

A thing which is highly affected by the building's skin are sustainability and Energy Efficiency. A building which is located in kahrizak, Iran. Their key elements are material, choosing amount of surface area and insulation strategies. The building is built to minimize outdoor ratio surfaces of building for the space required instead of habitation and Architects tried to build the building in cubic form. The cubic form of a building provides minimum exposure to warm weather.

4.3. Self-efficiency in materials in hot and humid region

To reduce the expenditure of energy during the occupation the use of local materials is a sane decision because it will reduce the initial embodies the energy with the cost and transportation cost especially. The towns which are established into deserted areas use mud and its derivatives for buildings composition. Because of zero presence of other materials for building in this region, mud and mortar can be only used. for attainment of self-sufficiency in the region of deserts all the excavated occurs from Earth in form of mud is used in housing construction. Meantime, with very little additional heat Chambers is warmed during cold reasons and even the walls which are made up from unbacked bricks turn into intact and massive blocks after drying and they are fully hardy and resistant.

The materials of building absorb heat from the sun and later when the sun goes down makes heat available, during the very hot temperature and we can understand it by other way; for around 8 hours energy of Sunlight is retained on the outer surface of walls and the other part of the building envelope and it gradually transfers to the walls inner part. In desert regions, especially at night the absorbed temperature of wall serves as an isolation barrier protecting the inside air from being affected by winter deserts chilly climate. Because the temperature is absorbed by a wall during daytime. And by building, although outside the air is cold and house inside remains warm. The absorbed temperature creates a problem in the hot reason, the conditions inside the building for residence provide full comfort people like to sleep on the roofs during night time for comfort. In Iran buildings, the concerns of architecture are used vernacular materials like brick and Adobe. In Iran there are various example of vernacular materials like public baths, mosques, schools and various kinds of buildings.

4.4. Optical and thermo-physical properties of building envelope

In examples of traditional architecture in Iran where climatic area is hot and dry, in the building envelope to benefit from time lag of temperatures, greater thermal mass materials have been chosen. For continental climates, these types of thermally massed envelope details are extremely convenient, when the summer are high swings and very severe in daily temperature variations. The heat transfer from the envelope will be slowed down by the big thermal mass and as daytimes higher temperature will reach Indoors although the temperature of outdoor air is much lower and eventually it will be providing more stable Indoor thermal conditions. And to prevent next day from getting cooler, heat energy is rapidly losing by thermal mass by the nights radiation because outer side have higher surface temperature. by the traditional examples, we can perceive that there is use of high heat capacity and thick materials in the building's part which are opaque. And, by this the building transparency ratio is minimized. The opaque component's capacity of high heat provides high time lag. For transpiring outside temperature in internal area, while the direct solar radiations which are gained by the window are minimized Low transparency ratio.

The high heat capacity of the building reduces the consequences of outside temperature, and results into a cooler internal area in daytime. Therefore, the combination of material such as stone, calcareous rock, limestone and mud are also preferred in such climate.

- 1) Minimization of Windows number in this area.
- 2) Window to be constructed at higher level for blocking floor radiation.
- 3) By choosing light or white color paints the absorption of heat by facades is minimized.
- 4) Especially at the time of nights providing natural ventilation.
- 5) In the summer in this area when the temperature is high, below the grade a part of the house is constructed as it remains cooler from the temperature of the outside.

5. CLIMATE RESPONSIVE DESIGN IN COLD AND MOUNTAINOUS REGION

In these mountainous and cold climate reasons in the major part of the year have utmost cold weather. And, for residential to attend comfort have to make use of protection of heat, absorbing maximum sunlight, by fluctuation of daily temperature and to protect from cold wind of winter so to cope with extreme cold weather the building form is constructed and designed.

5.1. Building form in cold and mountainous region

In the cold central regions of Iranian plateau there is usually traditional house which have yards in the center and other parts are set around the yard. In the cold season of winter to make use of heat and direct sunshine in yards, the room is situated in the Northern direction in comparison to other parts they are larger and the main sitting room or hall is also in the same north direction. Because of the short temperature summer, the buildings Southern part is not in much use. So, if in Eastern, southern and western direct these is available of any room. They are used as service area like a servant's room, store room or bathroom. different from the temperature and humidity regions of capital sea of South coasts, the houses which are located in these regions built short ceiling basements Beneath the winter room in summer the basement room are used because of they are cool room comfortable for house habitants.



Figure 2 central yard in Termeh office building, Iran

5.2. Building shapes and elements in cold and mountainous region

The majority of daily activities are done in the rooms because in the Mountainous regions most days of the year are extremely cold. So, the yard size in this region is comparatively smaller than the Central Iranian plateau region. In comparison to the southern regions of the country, building which are in these regions have verandas but their depth is far lesser, and as those of Caspian region that don't have sitting room, they are used for building entrances rain and snow protection. In cold region the floor of building yards is 1 to 1.5 meters below to sidewall level for directing the current water of brook or creeks towards the garden the yard or in the cellars water reservoir and on the other hand to preserve the heat inside the building. As a heat insulate the ground surrounds the building, and put a stop to thermal exchange between the environment and building.

5.3. Buildings plan and direction in cold and mountainous region

In Mountainous and cold region, the building has a compact texture and a plan. Buildings formation to prevent the transmit heat inside to the outside must do in a way that reduces building contact surface with outer chill. For reducing the buildings surface of outside, there is use of shapes like cube and cubic rectangle in its inner volumes relation and keep the outer surface of the building as minimum as possible in the wind shade of one another, the building is established between 45 degrees to the east and 20 degrees to the west, along the north-south axis and out of each other sunshade.

5.4. Buildings opening in cold and mountainous region

In the region of this building, there is the use of small openings in less quantity for reduction of thermal exchange of both sides of the building. It is necessary to apply shading if there are large Windows. To take most advantage of sunlight, in the south side the openings are larger and longer. The openings shouldn't be settled on the direction of cold winds. For minimization of thermal exchange double walled Windows are a good option. To prevent for breeze in the building and exiting out the inner heat. In the meantime, the rate of natural ventilation and internal air exchange should be minimized as much as possible. In this region compared to warm and dry regions, the dimensions of openings are increased to make use of Sun energy.

5.5. Building materials in cold and mountainous region

Like in other regions, the materials used in traditional building in mountainous and cold regions are from the materials which are easily available there. To keep the building warmer in inner area the materials which are being used should have a good thermal capacity and resistance. so, the timber and cob are used for roofing and stone, Cob motor, Adobe, wood and bricks are used to make the body of the building to prevent moisture. Heavy materials are used for base course in some part and for building foundation stone and heavy resistant materials are used. Anyways, in these regions the buildings are usually built on the ground.

5.6. Design strategies used in cold and mountainous region

There is some important principle which is listed below which have been thought of adoption, according to the climate conditions of their regions.

- 1) Making heaped and compacted texture in complexes and as much as possible using common walls.
- 2) To prepare compact and compressed planes.
- 3) Forming the building so that in winter receives proper heat and, in the summer, create shade.
- 4) Heat generating spaces such as kitchen should be placed in the center.
- 5) In cold or sides parts of the building non important spaces like a store room as heat insulator should be considered.
- 6) On Outer wall and especially in the roof there should be use of appropriate heat insulator.

- 7) For night and cold times, using bed below the rooms which reserve some extra heat in the floor and release this saved heat when required.

6. CASE STUDY

6.1. Kahrizak residential building by CAAT studio (hot and humid region)

In the south west of Tehran, which is the capital city of Iran, the six- Storey building is located; the architects in this building mainly focused on the southern facade in the recessed balconies, they designed series of the sloping brick. These structures of brick allow natural light, provide shadows on Windows & Perforated ones, allows fresh air to pass through the Facade. There are Full height window, which supply's adequate daylight in each apartment.

The design of the brick modules was based on the geometric patterns highly founding traditional architecture of Iranian for creating comfortable interiors, the modules were shaped in a way that they by gathering or partly blocking sunlight separate periods of day, there will be having enough day lightning in space behind the southern facade because of proper brick arrangement. Shade for this housing block, ventilation & assist in moderating the hot and dry climate of the city for its users is provided by angled screens of perforated brick. To minimize the cost of the project the Architects had to use locally produced material to engage local people because of the Limited budget of the client for this project



Figure 3 Kahrizak residential building by CAAT studio, Iran

In this building a significant parameter in sustainability enhancement is the choice of material used in this building; as materials were locally available it greatly reduced energy time and overall project. Besides this its arrangement created minimizing energy consumption while creating the high-quality interior spaces.

6.2. Termeh office building (cold regions)

Hamedan, a city in Iran, where Termeh building is featured with a roof looks like a wave by the utilization of mixed-use facades, general public sit, walk and play the slideshow in here.



Figure 4 Termeh office building, Iran

This building is influenced by many of its public squares and are linked by wide boulevards, and it is designed in a way which connect it to the public realm of the city. The ground floor retail unit's interior is displayed by the large Windows in the case of Termeh, to inviting the street passersby to step off Street into the building. To protect the interior of Termeh from the Western sunlight, the narrow vertical Windows of the above office block are helpful. Accessible surface is formed by the brick cladding which extends from Windows which are above the ground floor sweeps down towards the street. The access to the upper level of the building is also provided by the undulating brickwork, there is an office entrance. Around the corner from the main boulevard positioned office second entrance, from the boulevard where is a typical staircase, which ascends from parking entrance level to the workplace. Lining stone-filled beds are featured on the roof terrace by the staircase which continues till roof for the use of office occupants, on roof terrace the space can be used for parties and presentations.

Under the highest point of sweeping roof forms a ribbed ceiling in the space which is for retail that accommodates a mezzanine. Mehdizadeh told Dezeen that “the building performs two different functions that are normally connected to the public space through a central core, so we wanted to decentralize the access.” Termeh is the Iranian traditional handwoven cloth which is evoked by undulating form, the building Termeh is title after this. The facades found on many neighborhood building matches with local brick laid in traditional patterns.

6.3. Apartment no. 1 by AbCT (cold region)

By useless off-cuts from local stone cutting business, this Apartment block of five - story constructed. In that region stone cutting is one of the largest trades in which more than half of its produce is discarded and which has a wasteful process. Therefore, the architect come across the thought to recycle the useless material and to use it as cladding on the building.

To form a wall, it is easy to put the pieces together in rows because the thickness of these waste pieces is all identical. To protect the small Windows from direct sunlight the wall is angled towards outside in same Parts of the façade. Timber shutters have designed for large Windows, which manufactured by local wood and at the hottest time of the year its asset controlling temperature & light.



Figure 5 Apartment no. 1 by AbCT, Iran

6. CONCLUSION

Sustainable buildings are all and all build for construction of a standard building quality and should be easy to maintain. Throughout the lifecycle of the building there should be considered resources efficiency and well-being of its occupants. In regions of hot and humid climate to attain and apply sustainable building, use of the following techniques is needed; orientation of the layout and building, distance between buildings and form; elements of climate like courtyards central area, wind catchers, Eyvan and much more.

Iran is the region of mountains with low temperature, in order to provide comfort to the residents of the building following techniques must be used; applying good thermal covering and capacity materials, compact plans, reduction of exchange of inner air, against the covered volume minimizing surface of outside and natural ventilation techniques are used with minimum fossil energy. Consequently, in Iran strategies applied by architecture have proven highly efficient in designing sustainable building. The aim of sustainable architecture is achieved by taking the benefits of the Above maintained techniques.

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