

CLIMATIC DESIGN CONCEPT AND GREEN ARCHITECTURE PRINCIPLES IN HOT CLIMATIC CONDITIONS

In the recent years, several architectural studies dealt with the concepts of Climatic Design as one of the most vital aspects of the design of the built environment. Climatic design is defined as "design and organization of the buildings or urban spaces in a way that conforms to the local climatic conditions through the use and respect of the architecture traditional components in the design and to working on minimizing the need for power. There are a lot of researches about the minimization of polluting energy and achieving thermal comfort conditions, which are aimed to make a building design that fulfills functional efficiency, aesthetic creation and thermal comfort.

Keywords: *climatic design, hot zone, solar radiation, thermal comfort, sun breakers*

The Climatic Design Concept:

Climatic factors are the main factor that effect of building performance and how a building is adapted and respondent to them, the Climatic design, from the green architecture perspective, means to respond to the climatic factors objectively in a manner to save the operation and maintenance costs, minimizes the power consumption and provides users with the physical and psychological comfort. Climatic factors mainly effects the building performance and how a building is adapted and respondent to them; the Climatic design, from the green architecture perspective, means to respond to the climatic factors objectively in a manner to save the operation and maintenance costs, minimizes the power consumption and provides users with the physical and psychological comfort. We have to clear the borders between Climatic Design, Environmental Design and Power-Saving Architecture. Climatic Design does not give much care to the effect of the architectural solutions proposed or building materials selected, but the Environmental Design respects environment and gives it top priority, while Power-saving Architecture considers the necessity of the conservation of energy and latent energy. However, the climatic design has to consider the environment and natural resources, which is harmonized with green architecture principles and compatible with site conditions and circumstances. The most important climatic design solutions proposed to reach the ideal thermal performance which is that affects the operation cost and power consumption are:

1. Thermal insulation system:

Thermal insulation materials of building are profitable economic investment, since it saves power, limits the use of mechanic equipment and protects buildings against adverse impacts leading to increasing building value and life time. The importance of insulation is most prominent in the buildings established in difficult climatic factors; either in hot or humid zones taking into consideration, in ordinary; the thermal insulation system cost less than 5% of the cost of building construction [1].

2. Adapting with Climatic Factors:

The climate generally comprises certain essential elements such as Solar Radiation, Temperature, Wind, Relative Humidity and difference of pressure resulting from different temperatures and others. We are going to concentrate on the climatic factors criteria, which highly effects of the buildings architecture design and

increase a remarkable positive effect on operation costs in return. To adopt environmental policies that tends to control thermal flow in and out of building through the following:

- 2-1 - Standards of solar radiation control.
- 2-2 - Standards of natural ventilation control.
- 2-3 - Standards of natural lighting control.

2-1-Standards of solar radiation control:

The Solar Radiation, Temperature is playing of main effects of the architecture design concepts in dry hot and hot humidity zones and the Architects& Designer have to adopt environmental policies that tend to control thermal flow in and out of building through the following:

- Minimization of heat gained in hot zones and used the power saving for the useful needed.
- Relationship between solar radiation and building spaces has to be studied before making design-related decision and best methods of controlling climatic factors have to be followed for achievement of Green Building principles. Some points that should be observed by designer to make a good passive solar design [3].
- ❖ Strength of the sun's heat and sun's radiation effects in the site location in the different times of the year, by studying the Sun Bath diagram.
- ❖ Thermal capacity that has to be available in the building compared to solar gain to achieve thermal comfort of the occupants.
- ❖
- ❖ Additional requirements needed for controlling solar gain concerning direct radiation, convection and connectivity and how they integrate with envelope performance, structure form and ventilation [4].

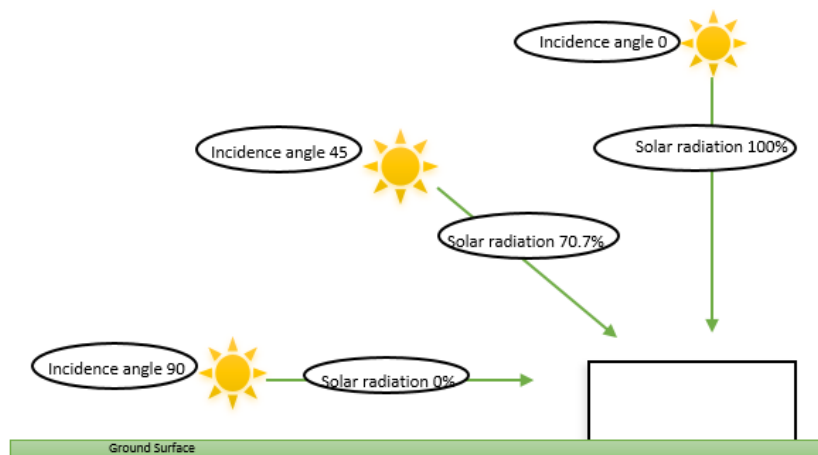


Fig. 1. Relationship between Solar Radiation and Solar Incidence Angle

Further to, the following strategies and standards that to be considered by the architects and designers during studying, planning and designing phases in order to apply of standards of Green Architecture Building and Climatic design concept:

2-1-1 Building Orientation:

Building orientation refers to situating building on a site to control the climate elements to fulfill the thermal requirements of the building and psychological needs of human being in its specific social context, the following are some of the factors influencing building orientation has to be considered by the architects [2]:

- Physiological factors: the factors which affect human senses:
 - Thermal influencing factors such as sun, prevailing wind and humidity.
 - Visual influencing factors (natural lighting and natural ventilation).
 - Audio influencing factors and disturbance.
 - Others, such as environmental pollution.
- Psychological factors: the factors which affect human psychological status and daily conduct:
 - Nature of the surrounding view.
 - Privacy, which has such a vital role in building orientation and internal design.

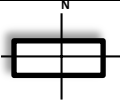
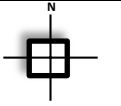
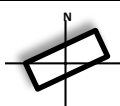
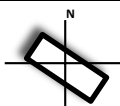


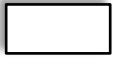

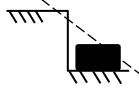

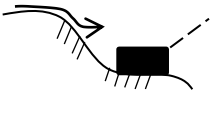
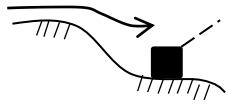
As above mentioned we have observed and based on climatic considerations Building Orientation is an influencing factor on climatic architectural design specialist in hot zones, the following considerations should be taken into account:

- Urban planning design and streets are designed to take a compacted -shaped design. They are stacked and close to limit exposure to solar radiation and utilize adjacent buildings shade as to allow wind and cold breeze into buildings and in between them to refresh air and improvement of hot weather.
- The internal courtyard buildings layout is preferred in hot zones, and openings of buildings in residential complexes have to be inward.
- Designer should study the surrounding topographic factors, which may affect the location negatively, mountains, desert, and wade.

Table 1 summarizes the influencing factors on choosing building location in accordance with the conditions of the location:

Table 1

Influence of climatic factors on choosing building location [6]

Influencing Factor	Hot zones	Hot humidity zone	Temperate zones	Cold zones
Building Orientation				
Building length to width- Building shape				
Location & Land topography (sloping land)				

2-1-2 External Building Design and Shape:

The shape of building determines the areas external surfaces and spaces exposed to the natural climate. Thus, building altitude and surface form (horizontal outline) and space arrangement have to be taken into consideration during the design works.

Choice of building shape (Shelter) aims at minimizing the influence of the difference of external climatic factors on the internal sphere.

We are seeking that building spaces conform to its functions, with consideration of the environment issue, on condition that it does not conflict with the functions and comfort needs, which are believed to be important psychological factor.

In fact; the climatic factors are the major effects of building shape and architectural design. Here some standards that should be observed by the architect designers upon the creation of design and outlining the building shape.

- Design of building has to minimize heat transmission efficiency.
- External shape of building and main openings of building should be placed based on the site location and building functions and orientation.
- Ideal form of building, which receives less amount of sun radiation, differs in accordance with the climatic conditions. In hot dry zones, surface area to building volume has to remain limited to minimize heat absorption.
- After intensive study of all building forms, various researches referred to the rectangular form as the ideal form in hot and relatively hot zones because it fulfills the requirements for power saving and minimization of heat gain while these researches indicated that semi square form is the ideal form in the cold zones because it relies on the minimization of heat loss.
- One-level buildings with large area have to be avoided as well because they allow more utilization of land and less utilization of natural light and ventilation in the internal spaces [5].
- In general, rectangular form wherein length to width is 1,3:1 is the most suitable form of building in hot zones. Under all conditions, the optimum form is the form which is extended in the direction of the east-west axis.
- Minimization of glass area in eastern and western building faces and use of sun breakers and horizontal frames to eliminate heat gain and provide minimum view and daylight.

For Building Top Roof design: In hot zones, building surface design creates problem in terms of climate as they receive high amount of solar radiation falling on buildings causing increase of temperature in top roof level.

- Designer should make sure that ceilings are inclined or sloping towards the right direction (northward) to eliminate direct solar radiation falling on ceiling;
- Designer should make sure that ceilings receive the least solar radiation and heat compared to horizontal plain ceilings.
- Reflective materials are recommended for roofs to minimize heat convection or leakage from surface to building.


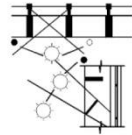
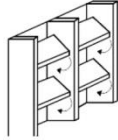
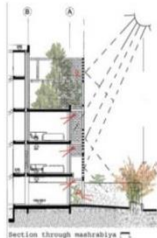
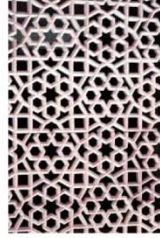
Moreover, Green roofs (in addition to thermal insulation) can form a shield against solar radiation. As for the external painting works, materials used should be highly reflexive with high emission indicator to minimize the possibility of heat gain during hot months of the year and should be of light colors and low heat absorbent.

2-1-3 Standards of using Sun Breakers (Shade methods):

Direct Sunlight & Solar radiations should be avoided to enter into the windows and openings at the building especially during the hot summer periods, either by plants or moveable or immovable, built or inbuilt sun breakers to reduce air conditioning power cost. Based on the difference of sun angles and sun change of position during the constant movement all the day long in hot zones, sun rays have to be controlled and used using the shading means and sun breakers, which allow the entrance of sunlight during winter and prevent it during summer based on the knowledge of sun angles, Sun bath diagram. The table (2) explains the types of the sun breakers.

Sun Breakers Types [6]

Horizontal Sun Breaker are placed on the southern faces.			
<p>Horizontal Sun breakers: Horizontal sun breakers prove efficiency when placed on the southern face or to the north direction.</p>			
<p>Horizontal Slides Style: Horizontal panel Slides are placed in parallel with walls in the different directions to help ventilate the face.</p>			
<p>Horizontal panel with Slides Type: Horizontal panel installed in front of windows to protect openings when the sun falling with low angles is the most preferable.</p>			
<p>Moveable horizontal panels: Sloped angle can be adjusted in accordance with solar angle.</p>			
Vertical sun breakers: Used on the east and west side. They are installed in a way to be inclined towards the north to ease heat coming from the south.			
<p>Vertical panels or blades: Used efficiently in the east and west directions and other near directions.</p>			
<p>Vertical inclined immoveable panels or blades: Give symmetric shades. Being set separately from the wall gives chance for heat transmission prevention from in to out and vice versa.</p>			
<p>Vertical moveable panels or blades: May be used to cast shades on a whole wall and can be directed in accordance with the sun position in sky.</p>			
Two-Way Sun breakers (Egg-Crates): Used on the eastern south and western south faces of building. They are recommended in hot zones or low latitudinal zones.			
<p>Two-Way Sun breakers (Egg-Crates): Prevent horizontal and vertical interference of solar radiation.</p>			
<p>Two-Way Sun breakers (Egg-Crates) with wider vertical blades than the horizontal blades: Give asymmetric shades.</p>			

<p>Two-Way Sun breakers (Egg-Crates) with moveable horizontal blades:</p> <p>Highly efficient shading, hence, mostly used in hot zones. The rotating mechanism is placed in the guide rail on the drive side and comprises two movable strips.</p>			
<p>Mashrabia Is a projecting oriel window enclosed with carved wood latticework located on the second floor of a building or higher.</p>			
<p>Mashrabia:</p> <p>Projecting alone from part of the room and not reaching to the room floor, hence allowing for a sitting area in front of the window.</p>		 <p>mashrabia pattern</p>	

The following points have to be taken into account upon shading [3]:

- In the hot zones, Vertical sun breakers are used on the eastern and western north facades with large glass areas
- Moveable sun breakers are preferred on the west and northern west facades as the sun angle changes rapidly;
- Sun breakers should be installed in a manner that avoids the falling of the radiation reflected by the sun breakers on any part of building;
- Sun breakers should be made of light materials that do not absorb heat in order to avoid being heated and therefore, avoid the reflection of such heat on the building façade.
- Small space has to be left between sun breaker and the façade on which it is installed to allow the quick passage of hot air and eliminate heat transmission based on the connection between the sun breaker and façade.
- Colors which reflect the highest amount of sun radiation and match the aesthetic appearance of building are preferable.
- Presently, there are a variety of sun breakers, which are moved mechanically or manually, improve thermal performance and attain many benefits

2-1-4 Standards of Green Area and landscaping use:

In general; Trees and green areas plays a vital role in controlling solar radiation based on following considerations:

- Trees provide good shade in suitable time; particularly deciduous trees, which provide shadowing in summer and allow sun radiation to reach building during the cold times of the year upon shedding their leaves.
- Trees absorb the sun radiation falling thereon and eliminate its reflection on buildings and people in the surroundings.
- Trees are used as shelterbelts around building in desert zones to act as a shield against wind carrying sand, purify air from smoke, dust and organic and inorganic substances carried therewith.

- Good choice of type and location of plants, trees and green surfaces essentially shows designer's success in making use of trees in controlling and eliminating adverse effects of climatic factors.

As for the external painting works, materials used should be highly reflexive with high emission indicator to minimize the possibility of heat gain during hot months of the year and should be of light colors and low heat absorbent.

2-2 Natural ventilation control standards:

Natural ventilation is one of the most vital elements of controlling climatic factors and providing comfortable environment for building users and is responsible for users' good health and feeling of comfort. Ventilation is defined as the change of air inside space with air from outside of it either mechanically or naturally. Natural ventilation and prevailing wind plays an essential role to achieve thermal comfort. Ventilation functions can be summarized as follows:

1. Human Healthy purposes (providing oxygen, fresh air and expelling smells)
2. Thermal comfort.
3. Building services purposes (Building cooling and temperature control).

Natural ventilation and air movement mechanism:

Main dynamics causing natural ventilation and Air flow of buildings depend on the differential pressure on both sides of building envelope, which is produced due to wind pressure or temperature difference (chimney effect) or both of them. Air flow and Cross ventilation basically takes place between negative and positive pressure zones. First empirical rule in design says, openings have to be distributed among the different surfaces and facades of the envelope of building. Moreover, Natural ventilation and leakage increase by pressure and absorption (negative pressure) through building envelope. Building shape and orientation to the prevailing wind are directly pertinent to the way air flows around masses (volumes).

There are many factors influencing air current flowing into building as follows:

- Openings orientation.
- Surrounding external factors (breakers, trees,).
- Incidental ventilation.
- Opening design
- Opening size and shape
- Opening location
- Opening pattern
- Breakers and frames
- Opening control

Cross ventilation is ideal for rooms with openings in different sides. For rooms with openings in two adjacent sides, the highest average of wind speed is achieved when wind direction and entrance opening form perpendicular tilt angle.

Air movement pattern inside buildings is influenced by the opening size, opening location and the way they are opened, in addition to the elements attached to these openings such as breakers, architectural frames or others. Figure 2 shows the influence of opening location on the ventilation pattern and air movement inside building.

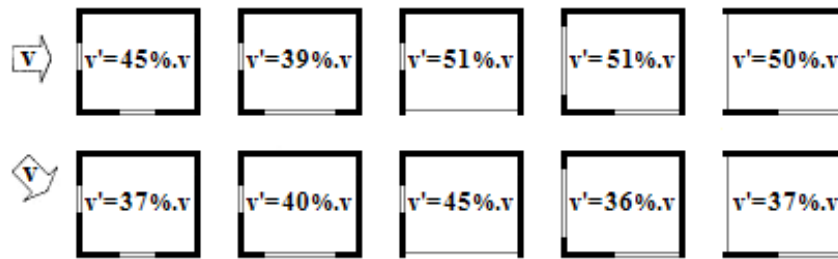


Fig. 2. Influence of Opening Located in Adjacent Walls & Distribution of Internal Air (Giovani 1976, after Bettencourt 1993) [7]

2-3: Standards of natural lighting

Natural lighting is a strategic option used to minimize power consumption and cost. It depends on the good design of windows and building openings, which allow natural lighting with certain treatments that eliminate direct solar radiation. The design should take into account window location and conformity with the view requirements; particularly in the light of the development of glass, transparent materials and plastics manufacturing and availability of materials, which guaranty privacy and good view and allow efficient penetration of light and low penetration of heat and sun.

Natural light allows human to be more productive and encourages hosts and renders internal environment human spaces full of vitality and enthusiasm. The study made by psychologists Rachel and Stephen Kaplan in University of Michigan showed that revealed that employees whose offices have a view on natural spaces are more satisfied with their work, less stressed and better protected against diseases. Furthermore, reliance on natural daylight in trade malls leads to increasing sales. Heschong Mahone Group, Inc. (HMG) specialized in providing professional consulting services in the field of building energy efficiency in California found that sales of marketing warehouses lightened by skylights increased by 40%, while the performance of students in classrooms naturally lighted improved by 20% [8].

The amount and form of lighting needed in every space relies directly on:

- Space function
- Space of parts occupied and Space volume
- Space form
- Decorations
- Type of light that serve space function.

Therefore, lighting design is created in a deliberate manner under the supervision by specialists.

Natural lighting forms are limited to three types:

1. Direct light: Light that comes directly from the sun and enters through windows and openings. It is the strongest form of natural light and is called glare.
2. Reflected light: Facades and plots surrounding building;
3. Diffused light: Light passing through frosted glass or curtain placed behind window glass in a form of soft fainted light of no shades.

The following points have to be considered in natural lighting design:

- Study of window location, area and form from the perspective of space orientation and function. Wide windows of low height distribute light equally to the near areas. However, if the area of wide window is divided into number of vertical ones, distribution of light near window is irregular, but it spreads into the inner depth of space. Positioning windows near to the ceiling help distribute light to a larger area of space because ceiling in this case acts as a reflexive surface that contributes to delivering light into the far away parts inside space [9].

- Avoid heat gain and brightness resulting from solar radiation.
- Design of location should take into account building height and distances. This crystallizes the importance of studying the different sun angles throughout the year especially in residential complexes.
- Integration of natural lighting and artificial lighting systems to acquire the level of lighting required and achieve best reduction of power consumption.
- Window distribution and selection of location to get the most natural light.
- Designer should determine window shapes and location on facades in accordance with the internal design of spaces.

Conclusion:

- The mission of designer may be hard and difficult when he is required to take the different factors into consideration at the same level of importance. These factors were inconsistent and conflicting with one other. The designer's role would be easy if the nature of location requires focus on one or two of these factors and considerations.
- Therefore, the Climatic Design and solutions aims for **providing** a comfortable internal environment for the longest time possible, **Improving** thermal performance of building, **Reducing** the use of technological systems (mechanic equipment) and **Decrease** of power consumption.

Չարֆլի Բասսամ

ՇՈՋ ԿԼԻՄԱՅԱԿԱՆ ՊԱՅՄԱՆՆԵՐՈՒՄ ԿԼԻՄԱՅԱԿԱՆ ԴԻԶԱՅՆԻ ՀԱՅԵՑԱԿԱՐԳԸ ԵՎ ԿԱՆԱԶ ԸԱՐՏԱՐԱՊԵՏՈՒԹՅԱՆ ՍԿԶԲՈՒՆՔՆԵՐԸ

Վերջին տարիներին ճարտարապետական հետազոտությունների ոլորտում ի հայտ եկած Կլիմայական դիզայն հասկացությունը կենսական նշանակություն է ստանում մարդու կենսագործունեության միջավայրի նախագծման համար: Կլիմայական դիզայնի հայեցակարգի հիմնական սկզբունքները, դրա տեսական նշանակությունը և գործնական կիրառումը նպատակաուղղված են քաղաքային տարածքների և շենքերի նախագծման հետ կապված խնդիրները տեղական ավանդույթներին և բնակլիմայական պայմաններին համապատասխանեցմանը՝ նվազագույնի հասցնելով կողմնակի ռեսուրսների կիրառման անհրաժեշտությունը: Քննարկվել են աղտոտող էներգիայի ազդեցությունը նվազեցնելու և նախագծման ֆունկցիոնալ արդյունավետության, ջերմային հարմարավետության, կառույցների գեղագիտական տեսքի բարելավմանն ուղղված հետազոտությունների արդյունքները:

***Առանցքային բառեր.** կլիմայական դիզայն, շոգ գոտի, արեգակնային ճառագայթում, ջերմային հարմարավետություն, արևապաշտպան միջոցներ*

Чарфли Бассам

КОНЦЕПЦИЯ КЛИМАТИЧЕСКОГО ДИЗАЙНА И ПРИНЦИПЫ ЗЕЛЕННОЙ АРХИТЕКТУРЫ В УСЛОВИЯХ ЖАРКОГО КЛИМАТА

В последние годы в архитектурных исследованиях большое внимание уделяется понятию климатического дизайна, как одному из самых жизненно важных аспектов проектирования окружающей среды современных поселений. Климатический дизайн характеризуется как метод

проектирования и организации зданий и городских поселений, основные принципы которого направлены на приведение искусственной среды в соответствие с местными традициями и климатическими условиями, снижения до минимума потребности энергии. Приводятся результаты исследований, направленных на усовершенствование методов проектирования, повышения функциональной эффективности и улучшения эстетического вида зданий, в связи с минимизацией загрязнения и создания теплового комфорта в условиях жаркого климата.

Ключевые слова: климатический дизайн, жаркая зона, солнечная радиация, тепловой комфорт, солнцезащитные устройства

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