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The Effect of Radiant Energy from Climate Elements on Architecture

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Abstract

Since radiant energy is one of the important resource of clean energy, it can scientifically been obtained from the sun. In research, areas and scientific development and managing the optimized consumption of fossil fuels and their high costs some measures can be taken to be evidences towards obtaining the integrated management of optimized consumption of energy. Geographical location of different areas are in close relationship with architectural directions of buildings such as establishment of the buildings and their heights, direction of passage, size of furniture capable of being opened and other cases. The purpose of this paper is only human comfort and the base of comfort is using scientific findings in related topics.

Keywords: climate, radiant energy, architecture, establishment direction of buildings

1. Introduction

Nowadays, considering the importance of energy supply and its determinative role in daily life, issues concerning optimized consumption of energy, and taking their high costs into account, the present research studies climatic elements of the sun's radiation. It also focuses on the effects of this climatic element which has the main role in determining the establishment direction of buildings, dimensions of windows and other under use materials.

The point to be considered is that, although, all buildings are influenced by climatic elements and principles used in this paper apply to them, in using these principles, it should be taken into account that in some special buildings it is possible for climatic elements to have fewer effects than interior factors of buildings (for example, the heat due to different kinds of thermal devices or glow lights that radiate more heat) and not have determinative roles in this regard. Thus, results from this paper apply those buildings that main interior factors are not involved in them.

2. Radiation from the Sun and Its Effects on Buildings and Their Environments

Light from the sun is always necessary for creating natural light in the building. But, since this light finally changes into heat, required radiation rate in case of every single building should be specified with regard to its type and climatic conditions of the place.

It is of use to make some points about BTU (abbreviation of British Thermal Units). BTU is unit of energy. This definition is in relation to the storage of the heat. BTU is the heat amount that one pound of water (1.92 cups) absorbs to increase its heat as much as 1º Fahrenheit. Since, BTU is defined on the basis of other units (mass and heat) using a simple calculation it is concluded that about 170 BTU is needed to heat one pint (about 0.568 litre) of 50º Fahrenheit piped water to boiling point and 1010 BTU energy is required to boil all of it and change it into steam. In less scales one BTU is needed to increase the temperature of one tablespoon water to 13º Fahrenheit and thus, 5 BTU energy increases the heat of one tablespoon water from 58º Fahrenheit to its boiling point and causes other 32 BTU to be changed into steam.

Other units of thermal energy are capable of being changed into each other and also into BTU. In the past, calorie or gram (small calorie) has been common among chemists and biologists, but at the present time and in international unit system calorie has given its place to Joule. Calorie is defined as: one calorie is the amount of energy that increases the temperature of one gram water (one out of thousand litre or 1.5 teaspoon water) as much as 1º Celsius. So, Compared to BTU, calorie is a less unit. 252 calories equal to one BTU. One kilocalorie is the heat amount that increases the temperature of one kilogram (one litre) water as much as 1º Celsius and this is about four BTU.

In building engineering, heat current from interior surface of the building is calculated in terms of BTU/hr/ft2 or Wm^2. But biologists measure the current of body temperature in terms of kcal/m^2 (hr) or in terms of Met. One Met is equal to 50 kcal/m^2 (hr), that is, the heat amount that individual's body produces at sitting state. The total heat amount that an individual's body produces depends on the size of its body's surface. Husky individuals produce more heat than midgets. Using the following formula size of the body surface of an individual can be calculated in terms of one digit approximation.

$$A = 0.202\ (0.425\ Wt)(0.725ht)$$

where A is the area of body surface in terms of m^2, Wt is the weight in terms of kilogram, and ht is the tallness in terms of m.

For instance:

Surface area of an individual's body with 145 pounds (66 kilograms) weight and 5 feet and ten inches (1.78 meters) tall is 20 (ft^2 1.86m^2).

The heat amount that the sun produces at the distance of 148 million kilometers (93 million miles, the sun's distance to the Earth's orbit) at the level perpendicular to its beam is 1.94 calorie/cm^2 (429 BTU/h/ft^2) which is called the fixed solar figure. Of course, The Earth absorbs less amount of the heat because some of the beams of the sun is reflected upwards due to bumping against the surface of clouds and some of them is absorbed by carbon monoxide, steam and ozone present in atmosphere. Also a specified amount of the sun's beams is released around due to bumping against the molecules in the air. Of course, some of these beam's from the sun that have been released around in the sky due to bumping against the molecules in the air, again glow to the Earth.

Therefore, intensity of sunshine and heat from it at one point of the Earth to the distant to be followed by sun's rays depends on the thickness of the cloud and pollution conditions in the air. That is why intensity of sunshine in a place is in proportion to its height from sea level, and in the highlands because the sun's rays follow less distance of atmosphere, it creates more heat. In addition, in the area of local noon, the sun is at its most vertical position to the land of that area and the distance is less. Intensity of sun's rays will be more in the morning and evening when the sun is in its most tilted state to the land of under consideration place. With regard to above said materials we found that the sunshine intensive at any pointof ground level depends on the location of sun to that region. Since, because of rotational and orbital motion of the Earth, the sun's location is different in different hours, days and seasons in order to study the sunshine intensity on different levels and the heat from it the sun's location to under consideration place should be known in different times. For this purpose sun's position is studied.

The first effective factor in calculation of angles of the sun's position is the angle of rotation of the earth. This is the angle, which is created between the plane that passes through equator and the line that connects the center of the earth and the sun together, and during the year it changes from 23.5 degrees to the top of equator plane to 23.5 degrees to the bottom side of equator plane, i.e. 47 degrees (Figure 2). Other factors effective in determination of radiation angle and the direction of radiation are latitude and under consideration time. With this information the two under consideration angles can be calculated using the following relations.

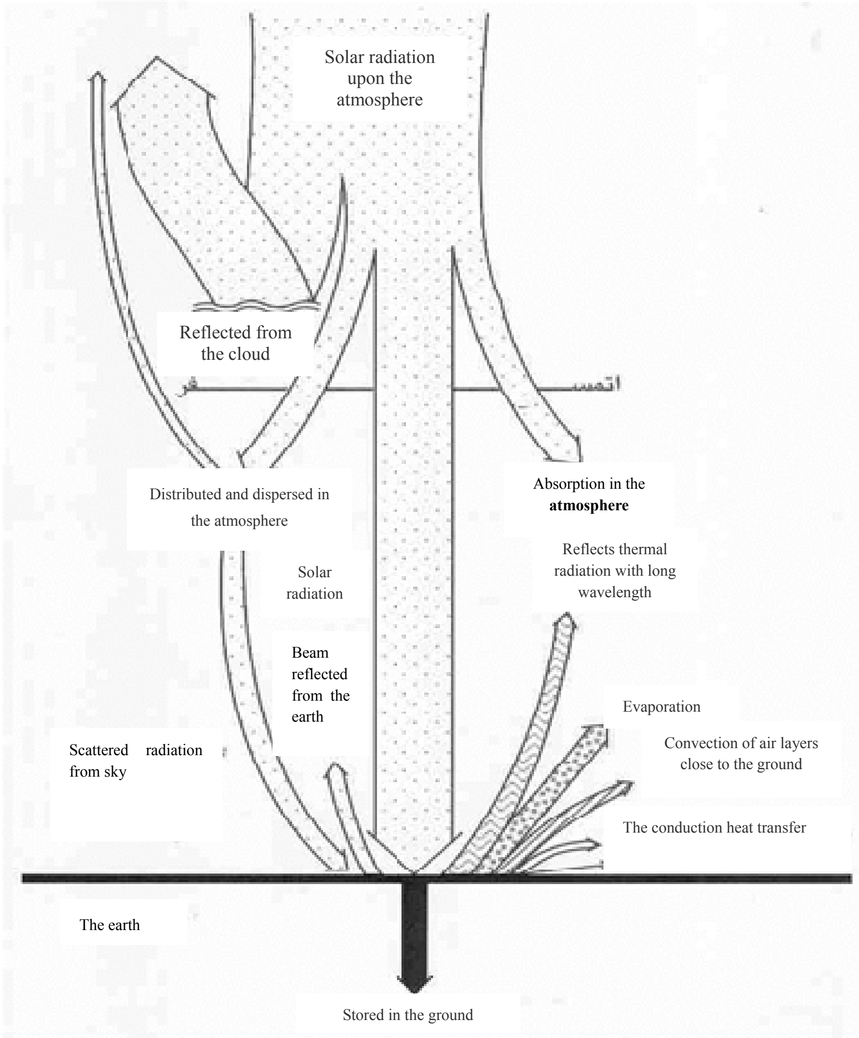

Figure 1. Released beams that glow to the Earth

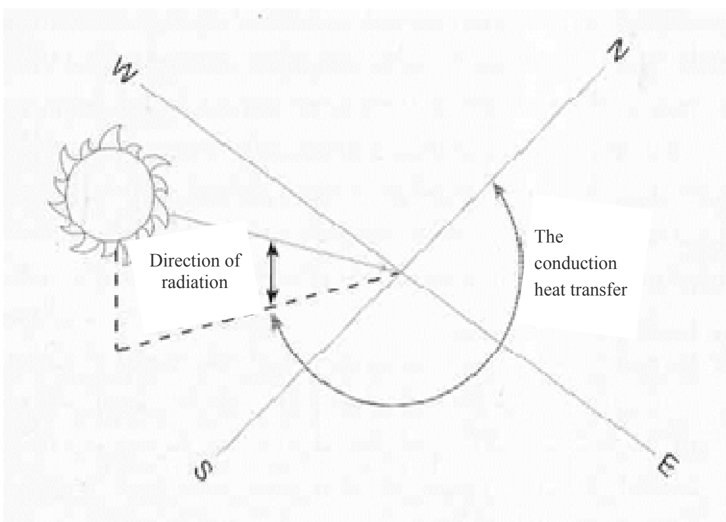

Figure 2. Direction of sun beams and their radiation angles

3. Emission Rates for Specific Times and Days

The best way to calculate the solar energy and dimensions of the canopy is the diagram of sun's movement path. In this diagram, the horizon is a circle that the building is located in its center and path of the sun's movement in the sky has been plotted in curve shapes that have been stretched from the east of horizon circle to its west. By taking the advantages of these figures, the sun's position can be determined in every day and every hour. Radiation angle between 0° and 90° have been shown in the form of concentric circles that each one of them is ten degrees apart from each other and the emission direction is in the form of lines that have been connected to the centers of the circles (i.e. the position of the building) and have been divided between zero and 180 in North and South. Each one of the sun's pathways is related to the days that have been shown in the figure. It is clear that if under consideration time is not on these curves, using the mean of the two curves under consideration angles for that time are obtainable (Figure 3).

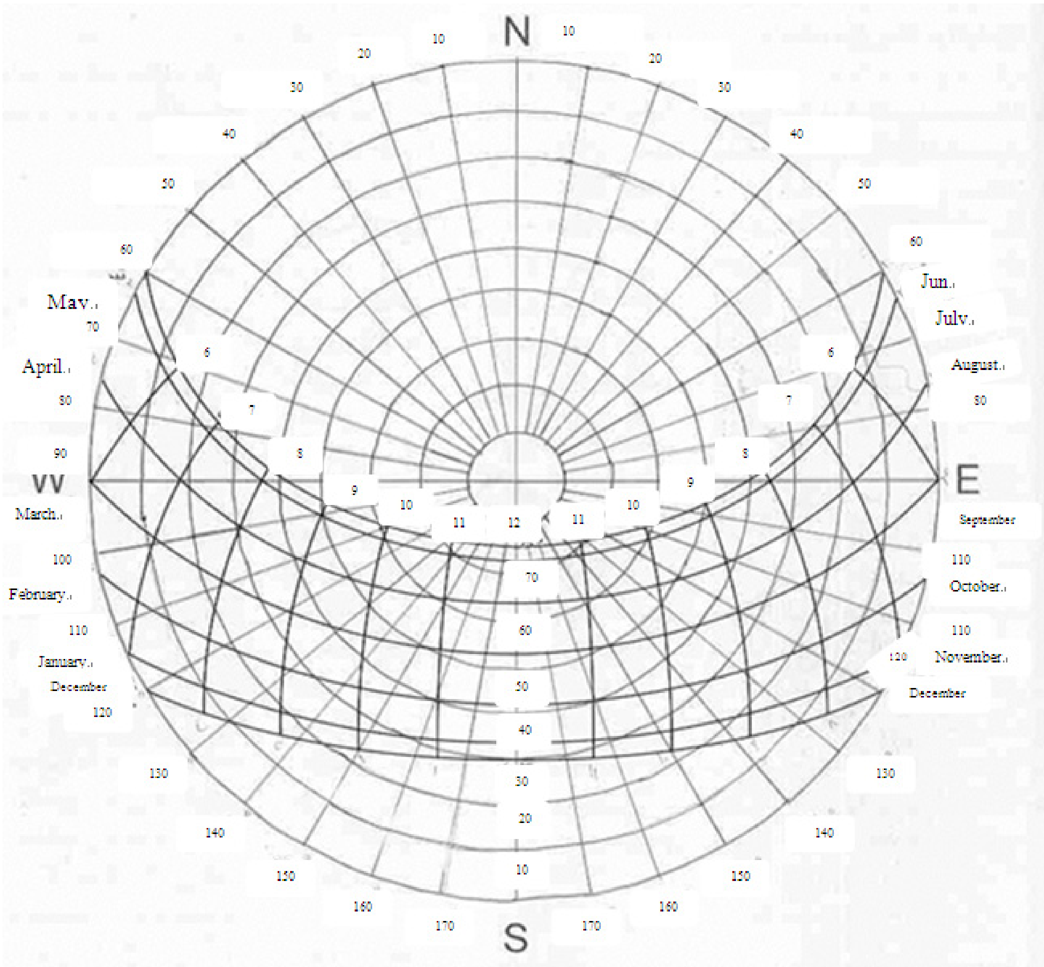

Figure 3. Position and Radiation Angles of the sun in the locality with latitude 38° (Northern Degree)

4. Sun's Radiation

In general, radiation of sun influences the building by emitting five kinds of beams.

These five kinds of beams are, in order of importance, as follows:

1) Direct beam with short wave length sunshine
2) Scattered beam from the sky with short wavelength
3) Reflected beam from around levels with short wave
4) Radiation emitted from the earth and warmed bodies with long wavelength (heat reflecting)

5) Radiation emitted from the building to the sky with long wave length (heat reflecting) (Kesaee Morteza, 2003)

Radiation levels for specific times and days

$$Sinh = (sind\ X\ Sin\ \varphi) + (Cos\ D\ X\ Cos\ \varphi)$$

$$H = 15\ X\ (T_t - 12)$$

$$T_t = T_{Ls} + [(L_+ : L_0) : 15] + (E : 60)$$

In this relation:

H = hour angle

T_{LS} = official clock of the country

L (For Iran: 52:5) = base longitude

L_0 = local longitude

E (fixed 12/2) = time equation

T_t = real time

ARC SIN H = Angleof radiationfora specificdayandtime

4.1 Radiation Reflected from Surrounding Surfaces

In hot summer days the amount of solar energy that falls to horizontal surfaces, is almost two times greater than the solar energy that falls to vertical surfaces. Thus, the horizontal surfaces around a building may reflect a large amount of solar energy to it. This amount depends on ability of under consideration levels. Table 1 shows percentages for various materials. In order to reduce the amount of this kind of radiation to the buildings, levels around the buildings should be covered with surfaces that enjoy less percentage of reflection.

Table 1. Percentage of reflection of the sun's radiation on different surfaces

Reflecting percentage	Type of material
10-25	Dry wasteland
8-9	Wet wasteland
18-30	Dry sand
9-18	Wet sand
14	Soft, dark, dry soil
8	Soft, dark, wet soil
12-15	Stone
32	Dry grass
3-15	Vegetated land
25-32	Green Leaf
5	Forest levels
24-28	Desert
42	Salt marsh
23-48	The color of brick with regard to its color
15	Asphalt
10	City campus

4.2 Radiation Emitted from the Earth and Warm Bodies

Land and objects close to the buildings that are exposed to the sun's radiation, may absorb much heat. Inhot and dry regions andhot summer days temperature of these levels almost fluctuates beteeen 54 (when the air temperature is 34 °C) and 65 °C (when the air temperature is 44 degrees Celsius) at the same levels between 54 (when the air temperature is 34 °C) and 65°C (when the air temperature is 44 degrees Celsius). Even at 71°C for the surface of land in the seare as has been reported. It is evidentthat the building located in the vicinity of such surfaces will get plenty of heat. Of course, it is difficult to accurately measure the amount of heat because this amount depends on both the type of materials used in building and the amount of radiation that falls between the two levels-that will change according differences in their temperatures.

5. Diagram Method

Also, usingcomputationalmethods, Victor Olgey has presented some conveyor graphs that help us achieve the amounts of direct, distributed and reflected solar energy that radiate on exterior surfaces of a building with various situations and different width.

The conveyor for calculating solar energy is in the form of a cirular that has been divided into to parts. The curves of its lower part indicate the amount of energy radiated on the walls and vertical surfaces. The conveyor for calculating solar energy is the size of graph position of the sun and by puting it side by side with graph position of the sun radiated solar energy on different horizontal and vertical levels in all latitudes can be obtained.

For example, if we want to obtain the amount of radiated solar energy on the walls of a building that has been located in 38 degrees north and its direction is 25 degrees east (the line vertical to the west wall of the building is tilted 25 degrees from the south axis towards the east), we put the conveyor for calculating the solar energy on graph position of the sun on the lattitude of 38 degrees so that its vertical axis rotates 25 degrees towards the east of south axis of graph position of the sun. The intersection points of curves of lower part of the conveyor with the curves of the sun's position show radiated solar energy on the southern wall of the building for desired hours and days. Similarly, if the conveyor is rotated on graph position of the sun, the amounts of radiated solar energy on other walls of this building will be obtained (Figure 4).

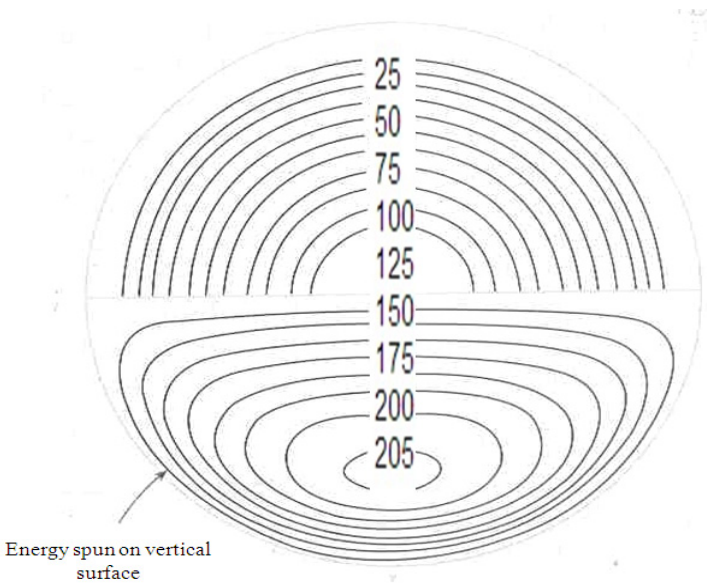

Figure 4. The conveyor forcalculating energy

6. The Effect of Sunshine on Interior Heating of the Building

The roofandside wallsof buildings, separate their interior spaces from the surrounding environment and thus prevent direct effects of climatic elements such as temperature, andhumidity, wind, sun radiation, snowandrain on their interior spaces. But in any case, each of these factors impact on the external walls of buildings and consequently, influence their indoor air. For example, the heat absorbed on exterior surfaces of a building by sunlight, bearing some changes is transfered to internal surfaces and finally to internal air and causes increase in temperature. On the whole, heat transfer may take place in four forms of conductanc (conductivity), convection, radiation and evaporation.

Heat transfer in heat exchangers may be of various shapes. For example, in heat transfer from outside to inside the buildingat first, heat producer rays of the sun radiates on external walls and are absorbed by them. Heat absorption on outer surfaces causes them to be heated and additional heat is transmitted to inner surfaces of the walls in a conductive manner. In case of double side walls the heat is transmitted in the form of convection and radiation from one side of the wall to its other side, then it is transferred to internal surface of the wall and causes it to be heated. Also, internal surfaces after being heated, tranfer their own heat into the internal air and other surfaces in the form of conviction and radiation.

6.1 Heat Capacity

Heat capacity of materials depends on their densities and their specific heats. The more the gravity of an object is the more its thermal capacity will be. In addition, thermal capacities of the walls depend on the thickness and compaction of materials. For example, the time during which the heat resulted from sun radiation and warm air from external surface, is transferred to internal level of an iron sheet and a thick stone wall is about a few minutes and a few hours, respectively (Table 2).

The more heat capacity of the wall is the less will be the exit speed of the heat from outside to inside. As a result the internal surfaces with great delay reach their maximum temperature compared to outer surfaces. This delay causes the penetrated heat into the outer wall to be stored there during hours with maximum temperature, and goes out in the evening and at night when it is relatively cool. During the night, stored heat in materials of a building is released with high thermal capacity. As a result, the rate of inside heat transfer to the outside is decreased. That is, the building is gradually cooled during the night and its minimum nighttime temperature becomes intensively less than the minimum nighttime temperature of buildings with low thermal capacity. Thus, thermal capacity of building materials causes decrease in the amount of heat transfer from outside to inside and vice versa. And consequently, the changes in indoor air temperature of the building is decreased.

In winter, especially in regions with cold weather where outside air temperature is generally lower than the temperature of internal hot air, thermal capacity of building materials causes decrease only in its amplitude of indoor air temperature and has no effect on motion direction and mean air temperature. But in summer and in warm regions with hotter temperature of exterior surfaces of the building in the daytime and colder at night than internal surfaces, thermal capcity influences both decrease in exchanging interior and exterior air temperature and movement direction of the heat.

So, in regions with high changes in daytime air temperature and with intense sunlight (hot and dry areas) a building with high thermal capacity can significantly control the conditions of its internal air temperature.

Table 2. Resistance and capacity of building material

Type ofmaterial	Thickness (cm)	Conductioncoefficient (BTU/h/ft^2)	Delay time (hours)
Stone	20	0.67	5.5
	30	0.55	8
	40	0.47	10.5
	60	0.36	15.5
Concrete	5	0.98	1.1
	10	0.84	2.5
	15	0.74	3.8
	20	0.66	5.1
	30	0.54	7.8
	40	0.46	10.2
Brick	10	0.60	2.3
	20	0.41	5.5
	30	0.31	8.5
	40	0.25	12
Wood	1.25	0.68	0.13
	2.5	0.48	0.45
	5	0.30	1.3
View brick	10	0.77	2.4
Insulation board	1.25	0.42	0.08
	2.5	0.26	0.23
	5	0.14	0.77
	10	0.08	0.217
	15	0.05	5

6.2 Determining the Heat Capacity of Different Walls

Heat capacity of wall materials causes delay in passing the heat from its outer surface to its inner surface and consequently, the modified heat in cool wether and coldness of the night is transferred to the interior part during the warm hours of the day. Generally, in areas where there is more fluctuation in temperature (about the half of the day of delay tim), the transfer of heat and cold at night and day time causes thermal equilibrium in indoor air of different parts of the building. Here, delay time should be determined more accurately.

In order to evaluate the calculation and determine the thermal properties of building materials in an area, changes in air temperature over the year, should be studied according to the cofort zone.

If the annual air temperature reaches the maximum possible extent, appropriate thermal resistance for building materials, i.e. required thermal insulation can be determined. Also, upon the determination of the amplitude of daytime air temperature, thermal capacity of roof and wall materials of the desired building can be determined.

Concerning the required thermal capacity in different climates "Leroks" believes that in areas with daily flunctuations in air temperature amounting to 6-8 degrees centigrade using heavy materials such as concrete, brick, and stone weighting about 300kg per cubic meter is appropriate. He believes that if this swing is 10 to 12°C, it is necessary to use materials weighting 600-700 kg per cubic meter and if the daily temperature fluctuation of the air is more than 20°C, it is better to use materials wighting 1200 kg per cubic meter, for example, the daily fluctuation of temperature in concerned city is about 12.41°C. Thus, using materials weighting 600 to 700 kg per cubic meter is appropriate.

Olgey has approved the above results in theory and in principle but has criticized their application. Concerning the choice of building materials in proportion to climate, he has proposed the following method.

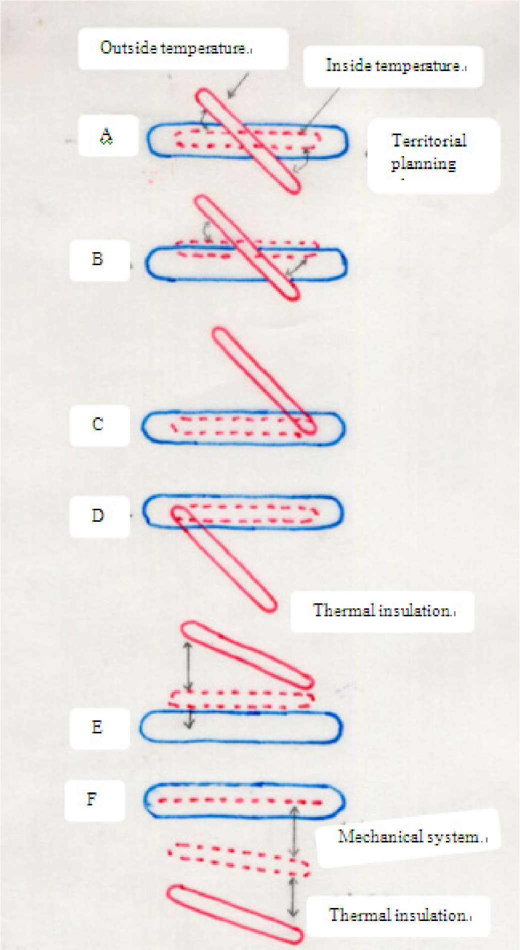

Figure 5. The effect of capacity and thermal resistance of materials on indoor air temperature of the building

In this method, as shown in Figure 5, the relationship between comfort zone and daily temperature changes is studied. If fluctuation in air temperature is high, thermal capacity of materials is of importance. In this case, thermal capacity causes the air inside the building to be settled in the comfort zone (A and B). If the average temperature is 29 degrees centigrade or more, using heavy materials alone is not enough and causes indoor air of the building to be settled out of the comfort zone. But in this case, using both the properties of the strength and thermal capacity of materials, it will be possible to create comfort zone inside the building (C and D). In this case by keeping the windows closed during the hours when the weather is in its most critical condition, creating comfort conditions in interior spaces is a possibility. In areas where seasonal and daily variations in air temperature is very high, taking the use of capacity and thermal resistance of materials is of high importance and using plant systems to create comfort zone within the building is necessary. In this case, daily variation of temperature is ignored. However, if the scope of these changes is high, using materials with high thermal capacity in internal surfaces of the walls is effective and causes the internal air temperature to be kept at equilibrium rate during the day (W) (Kasmaei & Morteza, 2003).

6.2.1 Thermal Resistance

Thermal resistance of the wall is the resistance that the wall creates against heat transfer from its one side to its other side. Therefore, temperature fluctuations of interior level of the walls of a building depend on thermal resistance of materials used in those walls. The less the thermal conductivity coefficient (unlike the thermal resistance) of materials used in a wall is the more its thermal resistance will be and consequently, the amount of transferred heat from it will be less. The still air is the best thermal barrier and generally, light building materials that include very thin holes and layers bear high thermal resistance (Table 2, Kesmaei & Morteza, 2003).

7. Choosing the Placement Direction of the Building Using the Radiation Angle

Generally, Choosing the placement direction of the building depends such factors as natural situation of the land, the amount of need for private spaces, control and reduction in noise and the two factors of wind and sunshine. Considering that the desired point is on georaphical situation of 38°15′ north lattitude and it has very cold winters and moderate summers and enjoys prevailing wind from the east and prevailing proctor wind from the south west, it has special properties in different seasons of the year. So, choosing the right direction with regard to environmental special characteristics seems necessary.

Considering the amount of radiated solar energy on vertical surfaces and at angles 45, 30 and 15 degrees east and west in summer and winter days at different hours of the days, establishment direction of the building that seems appropriate may be selected.

According to radiated energy diagram on vertical surfaces of the building with a deviation of 15 degrees east the amount of obtained energy by the four direction walls in summer and winter days is as follows. The north wall with more than 200 BTU/h/ft^2 receives the highest energy in winter almost between 7°45′ and 16°30′ pm will receive the highest energy. Subsequently, the western wall receives energy between hours close to the noon time almost and 16°30′. Its highest amount is 150 BTU/h/ft^2. Under this angle in summer, the eastern wall receives the highest energy for about seven and a half hour of the day with 218 BTU/h/ft^2. Then, the western wall during 7 hours of the day receives energy with 200 BTU/h/ft^2. The minimum energy is received by the northern wall and eastern wall in summer and winter, respectively.

7.1 Building with Northern and Southern Direction

The highest amount of energy and its lowest amount is received by the southern and eastern walls in winter, respectively. In summer the eastern and western walls almost receive the same amount of energy. The northern walls obtain the least amount of energy in summer and by the northern and western walls in winter.

7.2 Building with 30 Degrees East

In this direction the amount of obtained energy by the four-direction walls on summer and winter days is as follows. In winter, the southern wall obtains the highest amount of energy during about 7 hours with its high obtainable limit amounting to 180 BTU/h/ft^2, and the northern wall receives no energy. Also in summer, the eastern wall within the most hours of the day receives the highest amount of energy and walls in other directions almost receive energy close in amount to each other.

7.3 Building with 45 Degrees East

Walls with the four directions under this angle, receive energy as follows. In winter the southern wall and then the western wall receive the highest amount of energy. The lowest amount of energy belongs to northern and eastern walls. Meanwhile, in summer the southern wall within 8 hours receives the highest amount of energy at the peak of 160 BTU/h/ft^2 and other directions almost receive the same amount of energy.

7.4 Building with 15 Degrees West

In winter, the southern and then the eastern walls of the building receive the highest amount of energy and its lowest amount belongs to the western wall. Also, in summer the highest amount of energy belongs to the eastern and then to the western wall. Northern wall receives the lowest amount of energy.

7.5 Building Direction with 30 Degrees West

Under this angle, and concerning the solar energy radiated on vertical surfaces during summer days, the eastern and then the western wall receive the highest amount of energy and its least amount belongs to the northern wall. Also, in winter the southern and western walls receive the highest and the lowest amounts of energy, respectively.

7.6 Building Direction with 45 Degrees West

Concerning the four direction walls, in summer southern and eastern walls receive the highest amount of energy and in winter also, southern and eastern walls receive the highest amount of energy. The least amount of energy belongs to the northern and western directions.

8. How to Place the Canopies and Openings with Regard to Sunshine

The sky light direction of a building should be designed in such a way that it can enjoy the most skylight during the cold times of the year and the lowest radiant heat during the warm days (some descriptions have been giving in this regard in above mentioned materials concerning the determination of direction of a building on a considered point), and this is among the first priorities of designing for a building. To do so, the sun-path diagram and Table 3 have been used. The highest amount of radiation angle (H) at noon on the 22nd day of June is 35: 75 degrees and the least angle for noon on the 22nd day of December is 35: 28. Radiation angle for noon time of 23rd September and 21st March the times when the sun is on equinoxes is 85: 51 and 85: 51 degrees, respectively. Accordingly, and considering the building's need for sunlight, openings with special conditions can be used so that we have the maximum use of solar radiation.

If we are to use openings for a four- meter high building so that it enjoys the minimum radiation in summer and the maximum radiation in winter and this building faces south, then we should define the positions of openings as follows. (If we wouldn't like the balcony stretch to be more than 40 cm). Radiation angle of the sun is maximum in summer and since the building faces south, its Azimuth is zero (Z= 0). Radiation angle is 35/75°C and in January it is 35/28 degrees centigrade. In order to determine the extent of openings the following formula is used (Ghayur & Hasanali, 1988).

$$\text{tang } 75.35 = \frac{\text{bound of opening to downward}}{\text{balcony stretch}}$$

since is 40 cm, final bound of the sun in summer and winter specifies the situation of openings, which are as follows:

$$\text{tang } 75.35 = \frac{\text{lower bound of the sun}}{40 \text{ cm}} \qquad \text{lower bound of the sun} = 1.5 \text{ meters}$$

4-1.5=2.5 meters height of openings from ground floor

$$\text{tang } 28.35 = \frac{\text{upper bound of the sun}}{40\text{cm}} \qquad \text{upper bound of the sun} = 0.21 \text{ meter}$$

1.5-0.21=1.29 meters the height of openings

Now, if we want to set the openings 70 meters higher than the ground floor, we should compute firstly, the stretch of balcony and secondly, the final bounds of openings from below of the ceiling:

$$\text{tang H} = \frac{\text{lower bound of the openings}}{\text{balcony stretch}}$$

since the building is 4 meters high, lower bound of openings from below of the ceiling is calculated using the following formula:

final bound of openings from the floor = (4 X 100) – 70 = 330 cm

$$\text{tang } 75.35 = \frac{330 \text{ cm}}{\text{stretch of the balcony}}$$

height of openings from under the ceiling is equal to:

balcony stretch=86.38

$$\text{tang H} = \frac{\text{upper bound of openings from under the ceiling}}{\text{balcony stretch}}$$

$$\text{tang } 28.35 = \frac{\text{upper bound of openings}}{86.38}$$

upper bound of openings from under the ceiling=46.6

Now, if we want the dirction of the 2nd subject to face Kebleh, we determine the position of openings. Since the direction of Kebleh in relation to the desired city is 26 degrees from the south to the west side and its Azimut is 206 degrees, and since the direction of sunshine changes 15 degrees per hour, 206 degrees Azimut will be equal to 13: 35 o'clock.

Maximum radiation angle at this time on 22nd June is 61 degrees and on 22nd December it will be 22. 48 degrees. Taking this two amounts for the two angles at 13: 45 o'clock, we solve the problem using the precedure for the previous subject and in this case the answers are as follows:

$$\text{tang } 61 = \frac{330cm}{\text{balcony stretch}} = 1.82$$ balcony stretch=1.82

$$\text{tang } 22.46 = \frac{\text{upper bound of openings}}{1.82} = 0.75$$

upper bound of openings from under the ceiling = 0.75 m

height of openings = 4 - (0.75 + 0.3) = 2.95

Table 3. The amount of received energy at a level related to the under consideration Station

	Deviation Orbit	Angle of radiation	The amount of radiant energy received at a surface
Month	D=23.5×Sin d	α	Ih = I sin d
Apr.	23.5×Sin 0 = 0	90 - (38.15 - 0) = 51.85	Ih = 1.98 × Sin 51.85 = 1.55
May	23.5×Sin 30 = 11.75	90 - (38.15 – 11.75) = 63.6	Ih = 1.98 × Sin 63.6 = 1.77
June	23.5×Sin60 = 20.25	90 - (38.15 – 20.35) = 72.2	Ih = 1.98 × Sin 72.2 = 1.88
July	23.5×Sin 90 = 23.5	90 - (38.15 – 23.5) = 75.35	Ih = 1.98 × Sin 75.35 = 1.91
Aug.	23.5×Sin 120 = 20.35	90 - (38.15 – 20.35) = 72.2	Ih = 1.98 × Sin 72.2 = 1.88
Sep.	23.5×Sin 150 = 11.75	90 - (38.15 – 11.75) = 63.6	Ih = 1.98 × Sin 63.6 = 1.77
Oct.	23.5×Sin 0 = 0	90 - (38.15 - 0) = 51.85	Ih = 1.98 × Sin 51.85 = 1.55
Nov.	23.5×Sin 210 = 11.75	90 - (38.15 – 11.75) = 40.1	Ih = 1.98 × Sin 40.1 = 1.27
Dec.	23.5×Sin240 = 20.35	90 - (38.15 – 20.35) = 31.5	Ih = 1.98 × Sin 31.5 = 1.03
Jan.	23.5×Sin 270 = 23.5	90 - (38.15 – 23.5) = 28.35	Ih = 1.98 × Sin 28.35 = 0.94
Feb.	23.5×Sin300 = 20.35	90 - (38.15 – 20.35) = 31.5	Ih = 1.98 × Sin 31.5 = 1.03
Mar.	23.5×Sin330 = 11.75	90 - (38.15 – 11.75) = 40.1	Ih = 1.98 × Sin 40.1 = 1.27

9. The Rooms' Designs with Specific Functions in Compliance with Direction of Sunshine

If the building plan is designed so that daily activities are according to sun path, better savings will come to existence in energy consumption. If indoor spaces of the house are divided into two warm and cold spaces, the above-mentioned system's competence will be more effective. By putting the warm spaces in the pass of the sun, these spaces will be able to gain required heat for themselves from the sun and consequently, using mechanical instruments will be minimized.

Some examples of appropriate directions include southeast windows up to 30 degrees and up to 15 degrees east for bedrooms, kitchens and breakfast rooms. In this case, these rooms can take advantage of morning sun in winter. Windows facing the southern sun are appropriate for sitting room and daily activities. Solar rooms and/or solar walls may be the western part. The west is not more suitable for residential rooms. Thus, beginning from spring to autumn these rooms will be very hot in the afternoon (Ghobadian et al., 2003).

Table 4. Some suggestions for directions of the room at 37 degrees north latitude with a height of 1500 meter sabove sea level

	N	NE	E	SE	S	SW	W	NW
Bedroom*	×	×		×	×			
Bath*	×	×	×	×	×	×	×	×
Kitchen			×	×	×			
Dining room			×	×	×	×		
Sitting room			×	×				
Family room*			×	×	×			
facilities and laundry	×	×						×
Maintenanceroom*	×	×						×
Store*	×						×	×
Sundeck			×	×	×			

* The best direction for these rooms depends on how the climate of the region considering the coldness or heat, direction of winter and summer winds, etc. is.

10. Conclusion and Suggestions

Choosing the appropriate time for construction activities with regard to the prevailing cold on the region in cold seasons of the year and freezing that occurs in some months of the year can reduce additional costs and probable damages on construction activities.

Selecting the establishment direction of buildings and streets in an appropriate geographical direction with regard to geographical location and the amount of received solar energy. The maximum amount of energy is received on 22nd July and its minimum amount is received on 22nd December. Then it will be possible to take most advantage of received solar energy.

The most suitable direction for establishing the buildings and streets is 15-30 degrees southeast.

Modern architecture that is used today, is much influenced by the economic role and position of the land and how to use it. This has lead to fadedness of architectural activities to be in consistent with the climate. Being inspired by architecture of other regions, where in most cases are not identical concerning the natural position and being in harmony with climate, but constructions are similar. These factors cause heavy and larger-scale costs for individuals and society. Thus, the following should be considered in designing the buildings and streets:

1) Combat against the cold weather: 6 months and 4 months of night and day, respectively in order to prevent wasting the created heat in building.
2) Freezing is one of the important effects in architecture and causes considerable damages for roads and buildings. Therefore, considering the minimizing the length of the shadow and determining an appropriate direction to make use of radiated solar energy in cold months of the year reduce the severity of freezing in streets.
3) Considering the discussions about radiation of sun and coldness conditions in Ardebil, directions 15-30 degrees southeast receive the highest energy in the year and they are suitable for building.
4) Directions 15 degrees south east and south west are the most appropriate directions for all agents.
5) Because of receiving low energy and presence of cold winds, directions 45-75 degrees southwest are the most unsuitable directions for cold days of the year.

6) Placing water tubes at appropriate depths to prevent freezing and burst and also to prevent placement of water-meter in the north direction and the shadow-building point by building.
7) Avoiding the placement of large windows in north and west parts of the building.
8) Considering windows with average sizes, double-glazing in north and west parts of the building.
9) Selecting heavy materials with delay amounting to more than 8 hours for the walls, floor and roof of the building, light materials with appropriate thermal insulation.
10) Using suitable hoods, for openings.
11) Planning for the building so that the maximum amount of ventilation is created in its interior, above and below parts.
12) Using permeable materials in floor-construction of around the building.
13) To avoid creating the window in east views, especially, the west views. Otherwise, limiting the number and area of such windows and predicting vertical and horizontal shades for them.
14) Controlling the moisture resulted from plants or water views by creating an air flow between areas of dense vegetation and buildings.
15) Creating full ventilation in kitchens, bathroom sand places that create moisture.
16) To avoid anticipating water-views and green spaces in some parts of the premises that wind may lead the moisture resulted from them to the interior spaces.

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