Optimizing building orientation establishment in the city of Kashan, based on climatic conditions

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Extended Abstract

Introduction

One solution to reduce such problems relates to using clean energies. Solar energy is a safe and more suitable supplying energy resource of current era, and has been used by humans in different ways. Because of energy crisis and destructive effects of fossil fuels in recent years, people have welcomed using renewable energies such as solar energy in order to decrease and save energy, control energy supply and demand and decrease polluting gases. Since the start of human life on earth, construction of buildings, which are compatible with geography, and climate of the region have always been considered of high importance. So from that time, attempts were based on creating climate-friendly buildings to achieve suitable heat condition through using natural materials and proper orientation of building.

Materials and Methods

There are different calculating methods, to calculate solar heat energy on different surfaces. This research has chosen the below formula (law of cosines or Stevenson) for this intention:

$$I_S = I_N COS\ \theta \qquad \text{Formula 1}$$

In the above formula I_S is equal to Radiation on surface (BTU.H. FT 2) and I_N is equal to Solar radiation over vertical surfaces (BTU.H. FT) and θ is equal to the angle between sun radius and vertical line on. In the above formula (1) the amount of IN would be calculated through the below formula;

$$I_N = A/\exp(B/sin\beta) \qquad \text{Formula 2}$$

In the above formula:

I_N is equal to heat resulted from direct and vertical solar ra¬diation and A, B is equal to extinction coefficient and β is equal to angle of solar radiation. In addition, θ is the angle of intersection of sun and vertical line (on a wall) which will be determined through spherical cosine equation

$$COS\theta = COS \propto \times COS(\psi - \phi) \qquad \text{From 6 to 12 noon} \qquad \text{Formula 3}$$

$$COS\theta = COS \propto \times COS(\psi + \phi) \qquad \text{From 13 to 18 afternoon} \qquad \text{Formula 4}$$

In this formula:

∝ is equal to sun zenith angle, ∅ is equal to Azimuth Angle, and Ψ is equal to wall angle in a clockwise direction from the north, measured in degree. The sun zenith angle ∝ may be computed from

$$SIN \propto = (COS\emptyset \times COS\ \delta \times COS\ h) + (sin\emptyset \times sin\delta) \qquad \text{Formula 5}$$

Here ∝,∅, δ and h are the geographical latitude, the solar declination and the solar Hour angle, respectively. The solar declination angle is given in radians by:

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$$\delta = -23.45 \times \cos\{\frac{360(\mathrm{tj}+10)}{365}\}$$ Formula 6

The solar hour angle is given in degrees by

$$h = 15 * (12 - hour$$ Formula 7

Using the above mentioned equations determine the amount of energy intake on vertical surfaces, for various months, in 24 geographical orientations for Kashan

Discussion and Results

The importance of solar radiation in climatic design depends on climate and the seasons. In warm conditions, the lowest solar energy is needed and the building should be directed in a way that the lowest sun light is taken by it. On the other hand, in cold conditions, the orientation of a building should be in a way that it took the most solar radiation, preventing the sun ray from reaching the interior spaces. The aim of this study is optimized for building deployment in Kashan city. The city most days of the year, is hot and dry and it is necessary to determine the best direction to protect the building from the sun in hot times and also Cold when the sun was enjoyed. In this study, the amount of solar energy that falls on the vertical surfaces of buildings as real and theoretical with computational methods law of cosines (Stevenson) have been.

Conclusions

In this study, using cosine law method, the numerical value of solar radiation was calculated on different directions of the building. Compared to other studies for the separation of hot and cold courses, the Erbs method has been used which, in comparison with the method of calculation of effective temperature, has a higher accuracy. Due to sunlight, the results showed that the most ideal way for the main facade of the building in the direction with the minimum energy when heating and cooling; occurs the most energy intake. Accordingly, the direction of 180 degrees and south can receive 53.6 percent of the energy received in cold times and 41.7 percent of the total energy in hot time's looks an appropriate direction to choose. Suitable direction is double-sided buildings on the north - south. Because in warm times, 41.7% of the energy and also in cold times the greatest amount of energy received is 53.5 percent. The best direction for a four-sided building, especially apartment complexes is -30, +60, -120 and 150+. Because it receives 52.8% of energy in hot times and 38.4 % of energy in cold times.

Keywords: direction building, the law of cosines, solar energy, Kashan.

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