Climate Design and Determination of the Optimal Orientation of Buildings and Streets with Respect to Radiation in Mashhad

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Extended abstract

1. Introduction

The issue of climate comfort and urban locations is one of the fundamental issues of sustainable development. Due to not using the climate principles such as solar radiation in building establishments and passages, energy consumption has increased to adjust the temperature and led to the reduction of the presence of people in open spaces. This is particularly true for cities such as Mashhad with cold climate which is of a special significance.

2. Theoretical Framework

Climate design can be considered as one of the branches of applied climatology. By it, making changes in the physical environment can create comfort condition through changing the climatic elements of any location. Creating comfort conditions is the establishment of thermal balance between the body and the surrounding environment and making climate adaptation is essential for this goal. For this purpose, it is necessary to recognize the comfort zone first. One of the effective factors on providing climate comfort is controlling the amount of energy received during cold and hot periods. Accordingly, scientific methods, including the method used in this research should be used to design houses and passages compatible with the climate. Making such a process while providing comfort will save expenditure and is a long step towards sustainable development.

3. Methodology

To achieve the aim of this research, with the use of synoptic meteorological station data like temperature, relative humidity, cloudiness of the sky, and wind speed in Mashhad during a period of 30 years and with the use of two thermal indices of PET and PMV, Rayman software model, and also setting of the frequency distribution table, the climate prevailing tension was determined. Heat Indices calculation measures comfort situation and prevailing stress conditions of temperature, but it is not applied to determine the amount of energy in each of the directions by vertical surfaces. So, to determine this, the computational approach of

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the Law of Cosines was used. In this way, using the relevant formulas and transfering them to the tables, the amount of energy received in each month for 24 of the geographical direction was determined. Then using the effective temperature chart and determining the temperature of 21 degree, the cold and warm periods of Mashhad in the whole year was obtained. Then, in order to understand more easily the radiation values in different directions for hot and cold periods in separation, the radiation values chart was drawn on different directions of buildings over the year. Considering that the aim of this study was to determine the best direction for the establishment of buildings and streets, the difference between cold and warm periods was calculated based on $BTU/h/ft^2$ in a table. This makes it easier to prioritize the main facade of the buildings direction to get more radiation during the period of cold and less during the period of warm. With regard to the mentioned priorities, the chart of determining the best direction for the establishment of buildings was drawn. Finally, one part of the city map was introduced as a pattern consistent with the research results.

4. Results and Discussion

Based on the output of the calculation of PET and PMV indices, all tension classes with the exception of extreme heat stress can be seen during the year in Mashhad. On the basis of calculated thermal indices, in 55% of cases and more in the city of Mashhad, the dominant tension is the type of cold. A review of the findings of the calculations table, related to the amount of real incoming energy, showed that the month of September receives utmost energy 13320 BTU throughout the year. However, due to the lack of uniformity in energy received over the years, the volume of energy received cannot be considered as a criterion in the orientation of buildings and streets. Hence, the distribution of energy over the year will be the real criterion for the decision. On the basis of the studies of the calculated tables, the highest and the lowest amount of energy during the cold period belong to directions of +150 and -15 and warm to -105 and north. In spite of this, considering that the best direction is to get the minimum energy in times of hot and maximum in cold situation, according to the difference between the hot and cold periods in any of the directions, the most suitable direction for the establishment of the main facade of buildings is south east. Because, despite receiving less energy in cold periods relative to the direction of +150, less energy is received with respect to the same direction in the warm time. For the next priorities, +120 and +150 degrees can also be taken into consideration. Therefore, the best stretch for the streets will be northeast and southwest and in the next priorities it will be the azimuth degrees of 30 -210 and 60 -240. In the end, after reviewing the current state of the city map, among the 5 selected polygons A, B, C, D, and E, case A was introduced as a pattern compatible with the results of the research based on its proximity to the optimal state.

5. Conclusion and Suggestions

The calculation of heat indices PMV and PET showed that the city of Mashhad is placed in the range of cold stress. Thus, to adapt to such a situation and achieve the desired goals, especially its application in building design, by using the Law of

Cosines, it was determined that south east is the best direction for one-sided buildings, and the best elongation is north east to the south west. Also, studying the urban map and comparing it with the optimal pattern of this study showed that the new and old textures of this city do not follow its radiant optimal climate conditions. Therefore, it is suggested that the results of this research be considered in the orientation of buildings and the elongation of streets and passages in new designs and rebuilding the old urban texture.

Key Words: Climatic design, Radiation, Mashhad, Orientation of buildings, Elongation of streets

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