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Evaluation of the Thermal Performance of Contemporary High-Rise Buildings with Infrared Ti20 Fluke Camera in Kerman City

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Abstract

The present research discusses a comparative analysis of the thermal surface temperature of high-rise apartments built in Kerman. In Kerman, apartments are divided into two categories: high-rise apartments and medium-sized apartments. High-rise apartments are residential buildings located in the city of Kerman in the area of Esteghlal Street and Khajo intersection, which have more than five floors and are equipped with elevators, while medium-sized apartments have a height of 3 to 5 floors and do not have elevators. The results of this study provide information on the thermal surface of some such apartments. The research results increase the level of awareness of sustainability in architectural styles and facade design in the tropical context of Kerman. This analysis of the thermal level increases the design awareness of the architects who built the buildings according to the context of Kerman and according to the climatic conditions of Kerman. These buildings are modern buildings with a geometric design with a range of simple to complex roof structures that emphasize the abstract geometric model in building design. In this study, two apartments with a very modern design have been selected as case examples. Thermal surface information has been measured by a thermal device named Fluke Ti20 infrared camera. This camera records the thermal images of the facade of the apartment. Based on the investigations, it was found that the facade designs of both apartments are not capable of controlling the sunlight, because the surface temperature recorded in the field data is 43.4°C higher than the maximum average temperature of the environment. It is foreign. As a result, in the design of modern residential apartments in Kerman, it is obvious to consider awnings for buildings.

Key words: *urban sustainability, infrared camera, thermal model, Kerman city.*

Introduction and statement of the problem

The purpose of this research is to analyze the thermal surface of a number of apartments using field studies and using a thermal imaging camera in the city of Kerman. The findings of this fundamental research study provide useful data that architects who work in the field of building facade design can use the solutions presented in this article to reduce the amount of sunlight on the building facade. Is to use Therefore, the proper design of buildings can reduce the energy consumption of mechanical cooling systems inside the building. Also, in this design, the exchange data about the knowledge model

of apartment facade design is investigated, and the importance of covering the building with the least problems of heat absorption inside the building is clearly shown, and finally, the knowledge obtained is used in practice. It can be here, we examine the apartments built for upper-middle-income families and low-income families to find out how much energy consumption can be saved according to the design of the facade of the building. His correct and principled design of the facade of the buildings in a way that prevents the direct sunlight, prevents the energy loss in the houses to a great extent and can reduce the cost of electricity consumption in view of the energy crisis in Iran, especially in the city of Kerman. Reduce. With the correct facade design, you can create shadows that prevent the penetration of sunlight into the apartments. Residential apartments have been chosen as researched apartments because they are one of the most popular types of houses built in the city, which have a high population density according to each hectare of exploited land. In general, this research examines two issues: ♣ *Measuring the intensity of sunlight on the surface of apartments and using field tools to measure the thermal level of building facades in Kerman city;* ♣ *Providing an optimal design guide to deal with solar radiation on the facade of the building and providing information on the amount of heat absorption according to the facade covering of buildings in Kerman city.* When the facade of the building is exposed to sunlight, the external temperature of the building facade increases and the interior space of the building also faces an increase in temperature under the influence of this radiation. With the radiation of solar energy, the heat is transferred from the external walls of the building to the interior space, and this increases the temperature of the rooms and creates an unpleasant feeling for the residents of Kerman city apartments. The problem is that the facades of most of the designed buildings are poorly designed and lack awnings. Most people with average income cannot afford to install air conditioning systems in all their rooms due to the high cost of electricity. Using awnings on the facade of the house largely prevents the intensity of sunlight on the facade of the building. Two cases of apartments in Kerman have been selected for study.

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Research methodology and background

This type of design can be the foundation of future designs and all these projects have been designed and built by the companies and according to the weather changes and temperature of Kerman. In addition to local factors, the climate of Kerman city, factors such as altitude and Lot desert play a major role. All existing factors have caused this city to have a dry to very dry climate. The climate and temperature of an area depends on the mathematical location and local natural geographical features, and also one of the important local factors in the climate of Kerman is the height and distance from the sea. One of the characteristics of this type of climate is the extreme difference in temperature in the cold and hot seasons and even in the night and day, which is due to the movement of air from the mountains around the plain to the parts of the Kerman plain and vice versa, in addition to creating air currents. It has a variable temperature and there is a big difference between the maximum and minimum temperature. According to the 18-year climatic statistics of the synoptic station of Kerman in the years 1359-1377, the average annual temperature of this city is 15 degrees Celsius, the hottest month of the year is July and the coldest month is January. The average annual maximum temperature is 24.7 degrees Celsius and the minimum temperature is 6.7 degrees Celsius. The average annual rainfall of Kerman during the 18-year period is 149.1 mm, and 59% of the annual rainfall occurs in winter.

The highest monthly rainfall is 40 mm in March. Precipitation is mostly in the form of rain, which snows in the high altitudes in winter when the weather is cold. Rainfall in the city usually starts from mid-autumn and continues until early spring. A little rainfall has led to the instability of permanent rivers in Kerman region. Kerman province is affected by various regional and local winds. The blowing of these winds causes its weather to undergo many transformations and changes. These winds are mainly monsoon and dry and they blow in the months of March, Farvardin and May, and their direction is from southwest to northeast and east. These winds bring a lot of dirt and sand with them to the city of Kerman and cause the relative humidity of the air to decrease. Also, west and north-west winds cause rain in winter and spring. In relation to architecture and climate, there have been a number of studies, each of which has emphasized the importance of climate solutions in the construction of buildings. Some of these researches include: 1. Kasmai and Ahmadinejad (2012) in the book Climate and Architecture, have examined the principles of building design in relation to the climate of different regions of Iran. 2. Saseh (2004) has studied climate-compatible housing modeling for Chabahar city. 3. Gurji Mehlbani et al. (2004) have studied the design principles of traditional houses in Kashan city and the architectural features of this city according to the climatic conditions. 4. Kaviani (1372) prepared a map of Iran's human bioclimate using important climatic elements. 5. Kasmai (1372) specified the comfort zone and different bioclimatic conditions in relation to temperature and relative humidity. In the bioclimatic table of Olgi, temperature and relative humidity, the most important factors were expressed due to their direct effect on human comfort (Razjovian, 1367). 6. Tavousi et al. (2007) have tried to determine the architectural indicators appropriate to the climate of Isfahan city, analyze the compliance level of the newly built schools of this city with the standards, and by complying with these standards, bring the educational spaces closer to human comfort limits. There are other similar studies in this field, almost all of them have been conducted in the framework of the mentioned experiences.

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Research literature

Microclimate and architectural design and urban space in examining the effects of different climate scales, the climate scale can be divided into three main categories: macro, medium and micro. According to the encyclopedia of environment (Bortman, et al., 2003), climatic factors are the macro-scale weather characteristics of a geographical area, while micro-climate is the weather characteristics of a region. Or a specific and surrounded space is referred to. The adaptation and alignment of the plan with the microclimate can also improve the indoor comfort conditions and the heating and cooling requirements of the building (Sabri and Saneyi, 2011, p. 163). When the urban space is located in the comfort zone, the desire to be present and perform behavior in this urban space increases (Bahrini and Khosravi, 2014, p. 465). Therefore, climate wisdom has an effect on meaning and identity. Based on the need for recreation and leisure, people are often directly exposed to different climates to see the outer urban space (Tzu-Ping Lin, 2009:1).

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Thermal comfort

The dialectic approach believes that humans are simultaneously influenced by the environment and are influenced by it, and it is known as the "organismic approach" in anthropology (Reeve et al, 2003). In this approach, one of the aspects that humans have made great efforts to adjust is bad climatic conditions. It can be easily claimed that climate comfort can be easily found in most human interventions in nature, in other words, in most architectural and urban works of world history (Rapoport, 1990). It is believed that the definition of comfort is not a simple definition; because many environmental and specific factors are involved in its occurrence. There are also different interpretations in the definition of the term "thermal comfort" (Bashartizadeh, 2010, p. 24). The opinion of many science researchers is that thermal neutrality is a more accurate interpretation of thermal comfort, because in such an environment, the human body does not feel cold or hot (Watson, 2012, p. 29). "Olgi" stated a range for thermal comfort and defined the range of thermal comfort based on that. According to him, thermal comfort is a condition where the minimum amount of energy consumption is used to create a favorable environment. Thermal comfort is divided into three categories according to the type of environment: 1. Thermal comfort in the open (outside), 2. Thermal comfort in a semi-open space, 3. Thermal comfort in indoor space (Forgiarini Rupp & et al, 2015: 181). Thermal comfort in the external environment depends on thermophysiology, physiology and thermal balance of the human body (Taleghani, 2015: 65).

Expression of research findings

This research plan includes two parts of investigation and analysis*: ♣ Field research will be conducted in selected apartments ♣ to record the temperature, a thermal imaging tool called the Fluke Ti20 camera, which is a heat-sensitive camera, was used to record the surface temperature of the apartments during 13-18 hours.* In this period of time, a number of photos are taken of the surface of the apartments, which show the amount of heat absorbed by the surface. Finally, these images are reviewed and analyzed by researchers. To achieve the correct results, the camera is set at a distance of 50 meters from the building and at eye height, and the cloudy and rainy weather of August is also considered as an external factor. Kerman province is located in the southeast of Iran and its heights are the sequence of the central mountain range of Iran, which starts from the volcanic folds of Azerbaijan and extends to Baluchistan, and its sequence is in the central plateau, Domestic and desert posts are interrupted several times. The climate diversity of Kerman province is noteworthy due to its special climatic conditions. As a result of these climatic conditions, the climate is dry in the north, northwest and central regions, and hot and humid in the south and southeast. The rainfall regime is mostly in the form of rain and it is in the range of November to May, and it is fed by the western and northwestern winds of the region, which are often monsoonal and dry, and due to the accumulation of a lot of soil and sand, it reduces the relative humidity of the air. The maximum temperature is in Shahdad, which exceeds 50 degrees Celsius. The obtained results will help the architects to a great extent in designing the facade of the buildings and will provide them with valuable information. Knowing how to design buildings to reduce sunlight absorption and air conditioning will have a significant impact on reducing electricity consumption and household costs. The view of the buildings and the coordinates that we have considered for checking the temperature have been

specified. These coordinates are selected according to the distance from the roof of two apartments. By dividing the facade of the buildings, we considered the same coordinates to compare the temperature and recorded and checked the temperature of the divided spaces according to the image.

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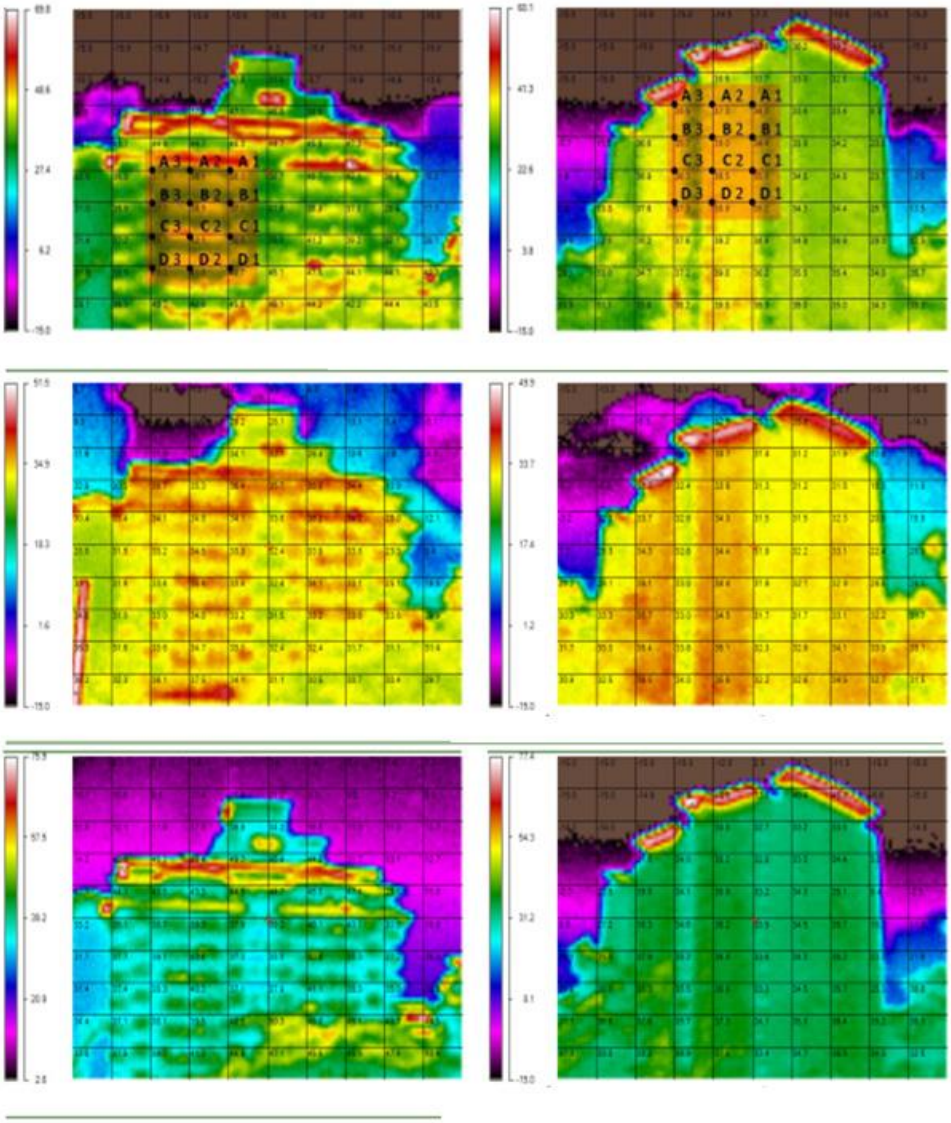

Charts 1 to 6. Infrared camera results in selected apartments of Esteghlal (X) and Khajo (Y); Source: research findings.

The analysis shows that: At 13:00 in the afternoon, the average surface temperature for sample X at point A is 32.43 degrees Celsius, then point B is 32.7 degrees, point C is 33.03 degrees, and point D is 10.32 degrees Celsius compared to the sample. Y is at point A with 33.34 degrees Celsius, at point B with 33.57 degrees Celsius, at point C with 34.07 degrees Celsius and at point D with 0.33 degrees Celsius. • At 14:00 in the afternoon, the average surface temperature in sample X increased by 1.32 degrees Celsius from 32.82 degrees Celsius to 34.60 degrees Celsius, while this increase for sample Y was 4.5 degrees. Centigrade and it was from 38.57 degrees Celsius. • At 15:00 in the afternoon, there was an increase of 1.91 degrees Celsius in the average surface

temperature for sample X from 30.34 degrees to 36.51 degrees Celsius, while for sample Y this value was 1.03 and from It is 38.57 degrees Celsius to 39.60 degrees Celsius. • At 16:00 in the afternoon, the average surface temperature of sample X increased from 36.51°C to 43.71°C, with an increase of 7.2°C. On the other hand, the amount of this increase in the sample 2.10, Y degrees Celsius, which has increased the temperature from 39.60 degrees Celsius to 49.80 degrees Celsius. • At 17:00 in the afternoon, sample X increased the average surface temperature from 43.71 degrees Celsius to 50.04 degrees Celsius with an increase of 6.33 degrees Celsius, while in sample Y the temperature increased from 49.80 degrees Celsius to 77. 43.0 degrees Celsius dropped to 6.03 degrees Celsius. • At 18:00 in the afternoon, both X and Y samples had a decrease in average surface temperature. Sample X from 50.04 degrees Celsius to 35.23 degrees Celsius, a temperature drop of minus 14.81 degrees Celsius compared to sample Y with a temperature drop from 43.77 degrees Celsius to 35.40 degrees Celsius. It was minus 8.37 degrees Celsius.

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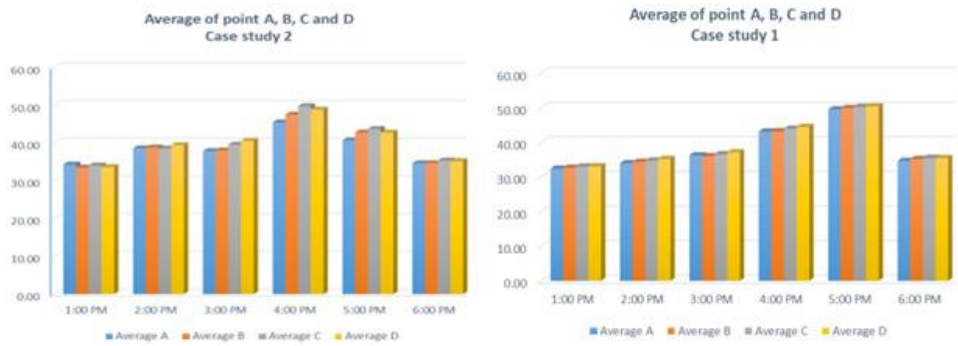

Charts 7 and 8. Analysis at different hours in the heat of selected apartment facades of Esteghlal (X) and Khajo (Y); Source: research findings.

Conclusion and summary

Urban spaces are the places where social life crystallizes and the arena of mutual interaction of people, where all people should be able to freely attend and engage in activities; According to Cremona, the success of an urban public space is also in attracting as many citizens as possible. Convenience is one of the key factors in the amount and type of presence of people in a public urban space; several factors such as light, sound, temperature, smells that exist in the environment and visual values can influence the feeling and perception of the comfort of the space. It is mentioned under the title of thermal comfort. In fact, weather conditions and microclimates, including space, are an ever-present factor in urban spaces, and this, especially in places with severe weather factors (such as air temperature, sunlight, wind, and humidity), can determine time. The type of activity and people referring to a space and their sense of belonging should be very effective. The atmospheric conditions governing the environment can be considered a potential or a threat in the direction of the prosperity of the urban space and the attraction of pedestrians. Therefore, many researches have been conducted in the field of improving the thermal comfort conditions of people in indoor and outdoor spaces. But generally in the world and especially in Iran, the relationships between mental and perceptual issues such as psychological adaptation to climate conditions have been studied in a very limited way, and in general, the researchers conducted in the field of thermal comfort have focused more on physical issues and physical interventions. While the studies have shown that the conditions of

the outer and inner spaces are very different in terms of the level of psychological adaptation of people and their perception of thermal comfort, and therefore this potential can be used in the direction of greater prosperity and attraction of people to public urban spaces. . Therefore, in the places where it is possible to detect and solve local environmental comfort problems physically, with design solutions, the existing problems can be improved, but knowing the mental and perceptual factors effective in thermal comfort and the psychology of thermal comfort can be improved through Social, behavioral solutions and activities planning and visual changes improved the thermal comfort perceived by people and their psychological adaptation power, especially in urban spaces with severe climatic conditions and thermal comfort problems or in spaces that There is no possibility of many physical interventions. In addition, this trend can help to reduce the costs of physical interventions with the aim of improving the thermal comfort of people in public urban spaces. Considering many details in urban design can correct and improve the city's temperature, wind conditions, and receiving solar radiation energy for buildings and urban spaces. In fact, the indicators of urban morphology in different scales, such as the shape, height and dimensions of buildings, the materials used and their color, building density and occupancy level, segmentation, block size and shape, geometry and shape of land slope, direction Streets and buildings, the surface of open spaces and the type and color of their floor materials are factors that, in addition to affecting the amount of energy demand in urban contexts, affect the urban microclimate, which means the weather condition around buildings. According to the studies conducted in this article, psychological adaptation is the most important factor in improving the perception of thermal comfort in urban public spaces, which unfortunately has been neglected in the domestic researches of our country. In the example of global experiences, the most complete and concentrated of them is related to Nikolopoulos; 6 main factors: 1) the naturalness of the space, 2) expectations, 3) experience, 4) duration of presence, 5) perceptual control and 6) environmental stimulation have been proposed, based on the studies carried out in this thesis, other factors affecting adaptation Psychological factors in order to achieve thermal comfort in the open space can be attributed to the following factors: 7) culture, 8) visual and aesthetic factors, 9) native and non-native factors, 10) the time factor of changes and 11) the mutual effect of psychological adaptation. In the behaviors and activities of pedestrians in urban public spaces in various conditions of thermal comfort. This study concludes that the level of sustainability awareness of architects in the design of apartments (samples) for compliance with environmental conditions was not complete. The existing design is unable to meet the standards and with a minimum surface temperature of 47.4 c°, which is the highest average in the open space in the city, it is not suitable for reducing energy consumption in normal ventilation inside the building. The findings of this study, by providing analytical data, show that the facade design of the building could not fully match the tropical region of Kerman, and this data can be used to guide architects and those who design Buildings have activities to face the sun's rays, they are useful to be located on the facade of the building. The data show that efforts should be made to raise awareness among architects about the need for passive shading in facade design to combat solar radiation, as well as the need to understand the importance of the building's front cover. The heat of the interior space and the use of this knowledge in practice are emphasized.

Declaration of no conflict of interest

The authors declare that there was no conflict of interest for them in conducting this research. (Conflict of interest refers to a situation where the material or non-material personal interests of the author or authors are in conflict with the research results and this affects the research process or the honest announcement of the results).

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