

## **Analysis of Atrium Design Parameters with Emphasize on the Functional Similarities with the Central Courtyard of the Central Plateau of Iran; Case Study: Traditional Houses of Yazd**

### **Abstract**

Despite the significant role of natural air ventilation in the atrium, internal thermal conditions and reducing the load of energy use such as the central courtyard system show the weaknesses of how different design parameters affect the thermal conditions. The complexity of the natural air ventilation design of the atrium, which also has a structural similarity with the central courtyard of the hot and dry climate of Iran, cannot be limited to its simulation design alone. In the past few years, researchers proposed various methods, such as model presentation, research and configuration calculations, to identify the heating and ventilation functions of the atrium. However, the diversity in the presentation of modeling, considering all the common parameters in the atrium design, makes it difficult to achieve the desired result. This research was carried out using quantitative and qualitative method and relying on library data. With a brief review of previous studies, regarding the role of natural air ventilation in atrium buildings in different climates, it provides effective design parameters and their application to improve thermal performance and reduce energy consumption. These parameters include the configuration of different atriums and its different components such as geometry, features of the opening, roof, materials and its interior. The size of the external seams is the most influential parameter that affects the internal heating conditions and the air ventilation functions of the atrium and as a result reducing the energy consumption.

### **Research objectives:**

1. Investigating the central courtyard in the existing architecture in the central plateau of Iran.
2. Investigating the role of the atrium in natural ventilation and the similarity of its functions and components with the central courtyard.

### **Research questions:**

١. What role did the central courtyard play in the building's internal air ventilation and how did it function?

٢. What parameters can be effective in the design of the atrium in the optimal functioning of the ventilation of the building?

**Keywords:** atrium, central courtyard, natural air ventilation, design parameters, cooling.

## **Introduction**

In the architecture of the Atrium, the Latin word (the plural of which is Atria) refers to the large and open space between the building. The atrium was one of the most used in ancient Roman houses in order to install the necessary light and internal ventilation. Today's atriums, which developed from the late ١٩th and early ٢٠th centuries, typically have several stories, heights, and a glass roof with large windows, often located immediately after the main entrance. Atriums are known to be one of the most popular designs due to their sense of openness and light. Controlling possible fires are one of the main challenges of designing atriums since their poor design can allow the fire to spread quickly to the upper floors. In the modern era, its design has changed in a way that it is usually covered with glass walls and roof that creates a common middle space with adjacent galleries and floors inside a central building. This space and courtyards are placed in buildings for natural air ventilation and cooling purposes and both of them form the main parts of the building and connect them to the outside environment. This is through the provision of natural air ventilation and sunlight through the exchange of indoor air with outdoor air. The atrium provides an impressive aesthetic space that exposes the adjacent interior spaces to sunlight and maximizes the benefits of direct sunlight and increases the activity and interactions of its residents. The modern atrium is located in areas with moderate climate and were first developed in the early ١٩٩٠s, and then developed and multiplied by their aesthetic factors in different areas with more unfavorable climates and without suitable materials and conditions. The interest in using new technology and glass walls, especially in commercial buildings, led to ignoring environmental potentials (radiation, wind and other natural conditions). Therefore, despite all the advantages mentioned above, providing thermal comfort in the atrium requires a high amount of energy, which is due to excessive solar heat during the summer and lack of heat during the cold seasons through

large walls and currents. Energy consumption in this type of buildings with optimal design is below  $100 \text{ kWh/m}^2$  per year in some areas of Europe. Natural ventilation in such buildings plays a key role in providing the desired quality of indoor air circulation in the building and maintaining an acceptable level of thermal comfort without the need to use mechanical systems such as heaters, air conditioners and coolers (HVAC). Therefore, natural air conditioning is able to reduce HVAC energy consumption, which has a significant contribution to the amount of energy saving in buildings with more than 60% of the total energy consumption (Bryan-1993). The traditional houses in Yazd are architectural works in which examining the feature of atrium is necessary.

The review of the background of the research indicates that so far no independent work has been published in this field. However, some works have investigated the atrium as a solution for providing lighting in some hot and dry climates. Kazemzadeh (2014) in his thesis entitled "Atrium Rahnagar Creating Lighting in Hot and Dry climate (Atrium and Natural Lighting for Mid-Level Office Buildings in Kerman to Reduce Energy Consumption)" has pointed out the beneficial role of this design in tropical regions. However, he did not mention the traditional houses of Yazd independently. Therefore, the current research, which has been carried out using quantitative and qualitative method and relying on library data, scrutinizes this issue.

## **Conclusion**

This research displays how mentioned parameters can be used to provide better thermal conditions for the atrium and adjacent spaces. This research examines models that implement natural air ventilation such as wind as the main passive air ventilation technique with or without other auxiliary air airing techniques to improve their internal thermal conditions. It begins with a brief overview of the evolution of the atrium throughout history, its new design approaches and its problems; moreover, it provides information about the importance of natural air ventilation and its potential ability to replace the current mechanical air conditioning systems with high energy consumption. This study emphasizes the importance of atrium configurations and components such as design parameters and their use to improve indoor heating and air conditioning conditions. The ability of each parameter is summarized by its efficiency, conditions and limitations. Studies on the effective parameters of atrium design and their thermal effects can provide a strong outlook for further research, which is necessary to develop empirical rules for future atrium designs.

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