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Investigating the effect of protrusion and orientation of the building on self-shading of the building in hot and humid climate (Case study: four-story buildings on Kish Island)

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Abstract
Shading and using shade to cool the building has long been considered by humans ,and self-shading of buildings is a good solution for passive cooling. The shape of the building is an important factor in self-shading. The angle of orientation and placement of the building is another very effective item that can affect the amount of self-shading and, consequently, the amount of energy received. This article intends to study the self-shading in different angles of the building orientation and the desired amount of protrusion of the floors in the facade to obtain the maximum amount of shading. The studied city is Kish Island in the hot and humid climate of Iran. The research method is descriptive-analytical ,in which simulation has been done with the help of Ecotect software. The results show that the four-story building with the protrusion of the floors by 0.3 meters relative to each other, with an angle of 30 degrees to the west, is considered the optimal model.

Keywords: Self-shading, Self-shaded façade, Building orientation, Climatic design.

1. INTRODUCTION

In hot and humid climates, the cooling need of the building is one of the most important parts of energy consumption in the building. Due to the high amount of energy consumption and the consequent cost, reducing energy consumption should be considered both at the design idea stage of the building and when using the building. For this reason, today there is a general tendency to use special methods and design tricks that can reduce this load. In this regard, using different simulations and examining the effects of different design variables according to the amount of energy consumed can be very useful [1].

Due to the fact that the facade of the building is one of the most important parts of the sun's radiant energy absorber in the building, the shape and position of the body and facade can have a significant impact on the amount of light absorbed by the walls and heat transferred into the building. Followed by the amount of cooling load. Therefore, if the facade of the building is designed in such a way that it leads to self-shading on the walls, an effective step can be taken towards static cooling [2].

The orientation of the building is also an important factor that directly affects the thermal comfort inside the building because the angle of the sun's rays and the facade surface can determine the amount of radiation on the walls and the heat transferred into the building through the walls. The orientation angle of the building will play an important role in shading and daylight [3].

In this regard, the present study examines the effect of the shape and orientation of the building facade in the form of two variables. The first variable is the degree of protrusion of the floors relative to each other and the second variable is the angle of the building relative to the geographical south. Finally, a comparative comparison of self-shading and the received radiant energy is performed in different cases. The result of the research indicates the optimal condition of the facade in terms of the degree of protrusion of the floors and the orientation angle of the building in the hot and humid climate of Kish Island.

2. MATERIAL AND METHOD

The research method in this research is descriptive-analytical in which with the help of relevant software simulation and investigation of the effect of the degree of protrusion of the floors and change of placement angle according to the shading and the amount of radiant energy received in the building in Kish Island with hot and humid climate has been examined. The models studied in this study include single four-story blocks with basic dimensions of 6 x 10 meters and the height of each floor is equal to 3 meters, considering that the purpose of the article is to investigate the effect of form and pre Depending on the self-shading and the amount of radiant energy received by the walls, and secondly, a comparative comparison will be made between different models, the installation of windows has been omitted. Due to the insignificance of internal partitions and vertical connections and similar elements in the amount of radiant energy received, regardless of these elements, each floor is considered as an integrated space and therefore does not correspond to the real example; In addition, in order to better study the formal features of the building and its shading potentials, the existence of shady neighborhoods around the building has been omitted. Modeling and data analysis in this research has been done in two stages; In the first stage, the degree of protrusion of the floors in a four-stage model with north-south orientation in five different modes without protrusion (zero protrusion) and the protrusions of 0.3, 0.6, 0.9 ,and 1.2 meters of each floor relative to the lower floor. Self, compared and analyzed. In the next stage, the optimal model of the first stage is rotated once to the east and once to the west at angles of 15, 30, 45 and 60 degrees, and again the amount of radiant energy received and shading of the building in a south-facing position (zero degree angle). And the mentioned rotation angles have been compared with each other to determine the best model in terms of the minimum received radiation (more shadow) according to the degree of sequential protrusion of the floors and also the angle of placement of the whole building.

3. Results and Discussion

The results of data analysis are as follows:

1. The data simulation results showed that in the summer solstice and on the first day of July in Kish Island, the emergence of protrusions in the classes has a significant effect on the rate of self-shadowing compared to the model without protrusions.

2. The results show that the average shade levels on all days of the year in the models with different protrusions are significantly different, so that in BASE and COR-0.3, COR-0.6 and COR-0.9 models And COR-1.2 is 61%, 85%, 76%, 78% ,and 80%, respectively; However, the change in orientation relative to the east and west and also the difference in the placement angle do not cause a significant change in the average annual amount of shaded areas, so that in this case the difference between the maximum and minimum amount of shaded areas in the models is only 2%.

3. Regarding the average received radiant energy ,the simulation results show that among the models with zero, 0.3, 0.6, 0.9 ,and 1.2 m protrusions, the COR-0.3 model with 0.3 m protrusions has the lowest amount and the BASE model has the highest amount of radiant energy reception without preamplification. Another result of this simulation is that in models with protrusions of 0.6, 0.9 ,and 1.2 meters, despite the fact that the shading of the floors (building self-shading) increases compared to the COR-0.3 model, but Due to the simultaneous increase in the area of the irradiated surfaces of the building, more radiant energy is received.

4. Analysis of the simulation results shows that by changing the angle of the optimal model in terms of protrusion (COR-0.3) to the east and west and with angles of 15, 30, 45 ,and 60 degrees, the amount of radiant energy received in contrast to the average annual levels Under the shade, there is a dramatic change; So that in the rotation mode with an angle of 30 degrees to the west (model C0.3-R30W) has the lowest and in the rotation mode 45 degrees to the east (model C0.3-R45E) has the highest amount of radiation received.

5. According to what was mentioned, in the climate of Kish Island, when the building is located at an angle of 30 degrees to the west and its floors are 0.3 meters relative to each other, the amount of radiant energy received by the building during the year is at its lowest. Will your mode.

4. Conclusions

In this study, the appropriate angle of the building to minimize radiative energy in hot seasons of hot and humid climate of Kish Island on the one hand and the appropriate degree of protrusion of the floors relative to each other for effective self-shading in the building and reduce energy received from the sun has been studied. Is.

The results of the simulations and their analysis indicate that in the first stage and the creation of protrusions of 0.3, 0.6, 0.9 ,and 1.2 meters, the model with a protrusion of 0.3 meters has better results than other models and the model without protrusion, in the case of recieving less solar energy. In the next stage, this model was selected as the first stage, rotated to the east and west at angles of 15, 30, 45 ,and 60 degrees, and their self-shading and radiant energy were compared comparatively with each other and with the model facing south. In this case, the results showed that the model which rotated 30 degrees to the west is the best model, and the optimal angle of the building for less receiving of radiant energy is 30 degrees to the west.

Thus, the overall evaluation and conclusion of the results indicate that if each of the floors of a four-story building is 0.3 meters ahead of each other and the building rotates to an angle of 30 degrees to the west, the amount of radiant energy received by the building and heat The resulting transfer will be at its minimum.

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