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The Study of the Proper Dimensions of the Window to the Outer Wall of Educational Spaces

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Abstract

Windows as the providers of light and thermal comfort have a highlighted and undeniable role. In a developing country like Iran, focusing on an element like the window not only could affect the speed in passing and correcting the path of sustainable architecture principles, but it will also reduce the usage of fossil and electric fuels. In this way, schools as the first educational infrastructures of the society would be a proper choice to do the experiences, so that by providing enough lightening for students a big step would be taken in the path of sustaining schools as well as creating physical and mental health for them. This step will also be taken in teaching the principles of sustainability and optimizing fuel consumption in the most infrastructural space of the society. Therefore, by comparing the dimension of the windows in the classrooms it is tried to measure the amount of needed light for the classroom by adjusting the size of the windows. It is determined that by using windows which cover the 40% of the outer wall, this aim will be achieved.

Keywords: daylight, stimulation, window, educational space, classroom, Ecotect

Introduction

In every time and place on planet earth, human beings have also built their homes in accordance with different geographical circumstances and against powers of nature. In other words, the philosophy of building a structure has always been in accordance with the nature and during centuries and in different regions it has passed the road of evolution (Namazian, 2010).

Indeed, the history of window is the history of architecture. It began from the era of the raw and simple opening around the primitive homes which were opened to the outside and surrounding environment to the era of the windows with one opening gate inside the walls, or one side of the building which led the light and air in primitive windows to be developed before the invention of glass. Therefore, primitive windows were opened to the outer space or they were closed with a sort of gate which was closed at nights to reduce the waste of energy.

During the medieval wooden gates were installed from the inside to adjust the air stream behind the windows. Windows have been developed through the time but the main goal of leading the daylight into homes have been remained the same. The opening of the window is used as a tool to adjust the inner weather of the home (Philips, 2004).

Designing window for modern buildings is one the important primitive goals because it will not only define the primary issues, but it will also be used as the main tool to control the environment of a building. Generally, the features of the modern windows are these:

a. Utilizing the daylight

b. Solving the mechanical control issues of the air conditioning system of the building without making current.

c. Providing enough thermal insulation.

d. Providing enough acoustic insulation for normal and regular situations.

e. Controlling the absorption of solar energy and reducing the radiation. (Mansour, Sopian, Zain Ahmed and Reimann, 2006)

Originally, energy consumption of the building is related to the responding way of designing of the building to the climate. For example, the situation of the windows in the building has high importance, because it will directly affect the amount of light absorption, cooling and conditioning (Barzegar & Heydari, 2012).

Using solar energy in the case of naturalizing the technology will play a constructive role in the industrial independence of a country. In addition, due to the geographical location of Iran, the background for solar energy independence is already provided. Due to the fact that solar energy is one of two sources of energy which do not need any advanced and costly technology, this source should be used more than other sources and as an efficient source of energy in different parts of the world (Goel & Munshi, 2009).

The first step in evaluating the energy efficiency provided by the daylight is to measure the exact amount of entered light to the building. The exact amount of illuminance of daylight in a room is completely affected by the amount of illuminance and the sky pattern in line with sight of the window in that moment. Manual and computer (stimulation) measuring method are usually used to measure the daylight factor (DF). Computer simulation tools could be used to simulate the rooms with different geometrical pattern. They can also remake the pattern of illuminance in that room.

World commission on environment and development defined the sustainability in this way: “Sustainable development is to meets the needs of the present without compromising the ability of future generations to meet their own needs”. Most of school managers still believe that a sustainable building is highly costly and it takes more time to be built. New economic researches show that the benefits of sustainable buildings are ten times more than the regular ones (Heschong, Wright & Okura, 2008).

Research methodology

Simulation is the process of designing a model based on real system to do experiments to find the behaviors of the model or evaluating different strategies in a short term. Computer simulation is the modeling process by using mathematical relations and logics as well as performing the model with the computer. This is also a method to cognate the results of recommended ideas before the performance (Ghiabakloo, 2012).

Using computers for simulating the efficiency of a building expanded the territories of this background. The existential philosophy of computer simulation refers to the creation of a whole building in similar circumstance with real model in which the effect of different variables could be measured. In addition to providing the ability to compare the efficiency of different models, the simulation software reduces the risk of inefficiency of the system and also shows the utility of a method.

The aim of correlation method is to foretell the efficiency of the building with considering all complicated relationships which simultaneously exist in a building. In order to provide the evidences in correlation method, different forms by using different variables are calculated by advanced soft wares. The basis of these calculations is to determine different variables by designer to measure the efficiency of the building based on them. The most complete method which can assist architects and engineers in different steps of designing is simulation. According to multiple a suitable background to codify more general rules. There is no doubt that in primary steps of designing simulation will have serious effect on improving the efficiency of the building by considering energy consumption. Although, this idea might look simple and general, simulation will give this chance to designing group to cognate the exact performance of the building in different levels of design so that, they could improve the efficiency by covering various causes of this

perform. The importance of this issue will be doubled in the small private projects performed in small and average offices (Sadeghipoor, 2008).

Ecotect

Ecotect software was designed in 1994 for simulating the energy of the building. Since 2009 the concession of this software was owned by Autodesk Company. The special characteristic of this software in calculations is related to the solar energy. Manifesting direct sun rays on the windows and different surfaces in different time periods, calculating daylight coefficient and brightness anywhere in the model and also displaying the shadows and reflections are some of the capabilities of this software for daylight (Ghiabakloo, 2012).

Ecotect was designed by the architects for the architectures. Powerful ergonomic graphical interface is what distinguishes this software form the others. This software is not only designed to calculate the exact consumed energy by the building, but also to compare different alternatives. Ecotect uses simpler equations to simulate and transition method algorithms to solve the equations (Sadeghipoor, 2008).

Testing subjects

In this research window as the main source of incoming light to the classroom and also as the regulator of the light has been tested from different dimensions. During these experiments dimensions of window were studied in comparison to external surface of the wall, so that the covering area by the window or the covering areas of windows in each classroom in providing the needed daylight factor (DF) and standards would be determined.

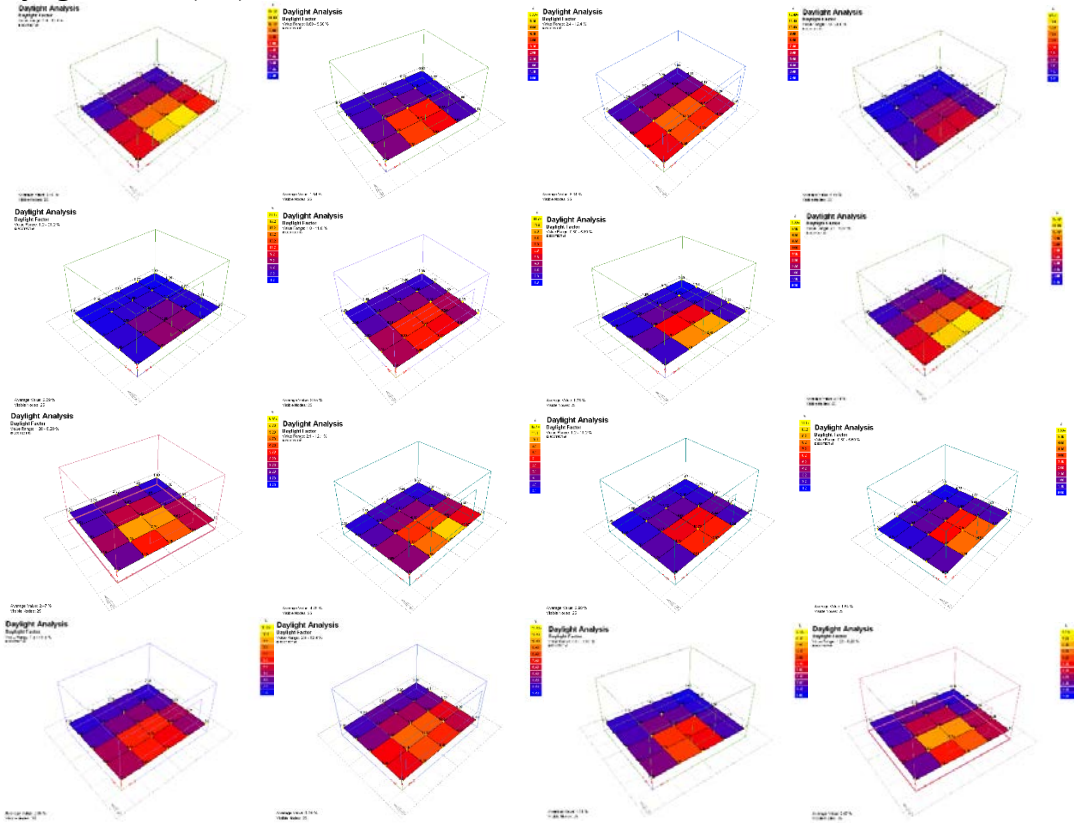

Figure 1. DF analysis sheets in Ecotect

The area of the window is various and it covers 10 to 40% of the walls. All of the windows in this research are faced to the south. Kerman was chosen as the simulation location. Also, the climate reports of Kerman were used for simulation.

After all, all models are simulated with Ecotet and illuminance rate of each model is attained.

Results

The outcome amounts of DF in different models with WWR are shown in the following figure. In this phase of the research, window to wall ratio (WWR) was examined. According to the following figure it can be seen that entered light to the classroom is directly related to the surface area of the window.

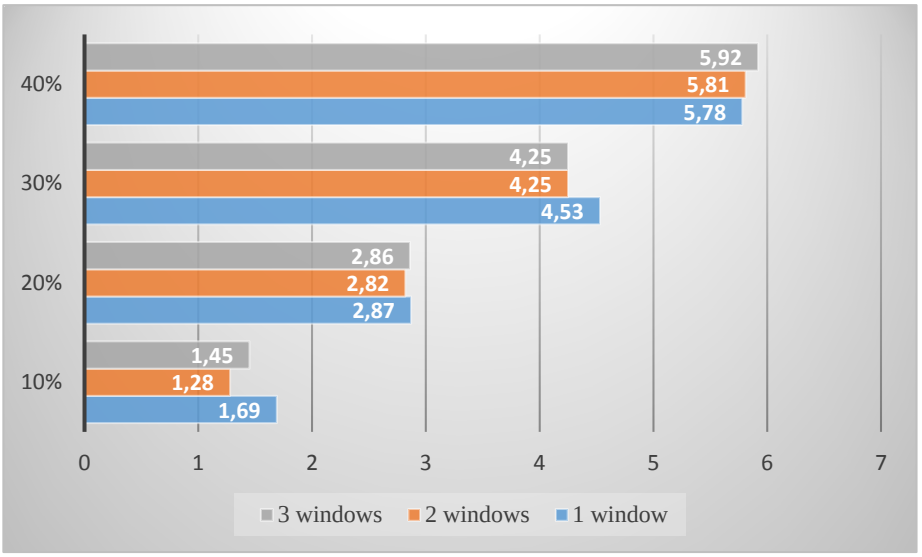

Figure 2. The outcome amounts of DF in different models

Table 1. Ratio of windows to wall

Window to wall ratio	1 window	2 windows	3 windows
10%	1.69	1.28	1.45
20%	2.87	2.82	2.86
30%	4.53	4.25	4.25
40%	5.78	5.81	5.92

However, the desirable amount of DF for educational spaces is from 2 to 5. This amount could be attained by devoting a certain percent from the surface of the wall to the window.

Conclusion

In this research windows with the 40% coverage have the highest rate of lightening and closest DF amount to the desired condition. In a way that windows with the WWR of 40% meet the needed DF amount very well. After attaining the desired WWR, the effect of the number of the windows on the DF of the classroom was studied. In this phase it can be concluded that the number of the windows with the same WWR does not have any significant effect on the lightening of each classroom. Although, by increasing the number of the windows the amount of lightening in the case of 2 and 3 windows does not change so much, this condition totally differs from the condition with 1 window. However, 1 window provides the better DF but in some of the educational spaces more windows are needed to scatter the light. Therefore, light scattering will be more symmetric.

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