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Maximize Natural Lighting In Simple Buildings With The Use Of Roof Windows

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A B S T R A C T

Lighting is one of the utilities that must be fulfilled in a building. Based on the source, lighting is divided into two, namely natural lighting and artificial lighting. Natural lighting is lighting that comes from the sun. To find out the lighting standards that a room must have in Indonesia, we can look at the data in the Indonesian National Standard (SNI) 03-6197-2000. Meanwhile, measurements or simulations can be carried out using the Dialux Evo software. This study was conducted to determine the effect of roof windows on the lighting in a room in a simple building. This research was performed using the observation method with a quantitative research approach. The data obtained will be compared with the existing SNI for further evaluation. In a room with more or less lighting than SNI, a solution will be given to overcome it. Some of the answers are the use of roof windows for rooms that have lighting levels below SNI. Meanwhile, for rooms with a lighting level of more than SNI, a solution will be given in the form of using curtains to filter the incoming light.

A R T I C L E I N F O

1. INTRODUCTION

According to a prominent architect in the 1st century BC, Marcus Vitruvius Pollio, good architecture is an architecture that has three main aspects, namely firms (strength), venustas (beauty), and utility (comfort) (Roosandriantini, 2019). Architecture is the science of building design that must prioritize the convenience of the occupants. Because architecture is a place for human needs and activities. Therefore, in designing a building, it is necessary to pay attention to various aspects that can affect the comfort of residents, one of which is lighting (Idin, Munir, & Afifuddin, 2018).

In utility, lighting is divided into two, namely natural lighting and artificial lighting. Natural lighting comes from the sun, which is light or light in electromagnetic waves at a frequency of 380 – 780 nanometers, part of the visible spectrum. Thus, it allows the human eye to capture the shadows of objects illuminated by the light (Pangestu, 2019). Meanwhile, artificial lighting is generally sourced from lamp light (electrical energy). Based on its function, artificial lighting functions as a light source at night when there is no sunlight.

Natural lighting must be considered in designing buildings (Wijaya, 2017) because a suitable building is a building that does not require artificial lighting during the day because the lighting has been met by natural lighting. In addition, the positive impact of optimizing natural lighting is energy saving in buildings and being able to accommodate natural potential (Thojib & Adhitama, 2014). The reason is, lighting or lighting in a building consumes about 30% of the total energy needed. So, it is expected to save quite a lot of energy (Amin, 2011). In addition to saving energy, sufficient natural lighting is also essential for eye health. Because good lighting can avoid negative impacts such as eye fatigue due to reduced eye work efficiency, complaints of soreness around the eyes, and headaches (Tongkukut, 2016). If this continues, the occupants can experience eye damage such as myopia (nearsightedness).

Based on the description above, the opening must be considered in designing a building, whether it's about the size, direction, or position. So that each room will have natural lighting by the lux unit according to the Indonesian National Standard (SNI) 03-6197-2000. However, problems arise when the utility of a building is not designed correctly, and the building is already built. So, in this case, an engineering design is needed to meet SNI and occupant comfort.

Apertures in Buildings According to Lechner

According to Lechner (1968: 329), several design methods are often used to enter light into a room, namely as follows.

a. Top Lighting

Top lighting is the most effective step to enter light into the room because the light that enters will be more evenly distributed throughout the room and can minimize the use of glass.

b. Side Lighting

Side lighting is a window that we usually encounter in various buildings. The light that enters through the side openings is natural light, which saves energy throughout the day. In addition to serving as meeting the basic needs of a building, these openings also play a role in building aesthetics, surrounding views, light entry media, ventilation, sound insulation, and emergency doors. In its application, side lighting on the wall can be in the form of a clerestory window, which is a window located between two sloping or stacked roofs that functions to enter sunlight into a high-ceilinged room. And the ribbon window is a window whose arrangement is elongated like a ribbon, it can be made in segments or continuously (Mumpun, Widayat, & Aryani, 2017).

Dialux Evo

In practice, determining the number, size, shape, and position of openings in a building can be done by making a simulation first. This simulation can be done on the Dialux Evo software. Dialux Evo is software with several programs, one of which is to simulate natural lighting and artificial light in a room. Dialux Evo is a free lighting design program growing fast and is supported by more than 135 lighting companies (Satwiko, 2011). Thus, it can perform simulations with various specifications of lamps and can provide accurate data.

This study aimed to determine the amount (lux) of natural lighting in a room. So, you can assess whether the room has met SNI or not. Thus, the response that is given to the room can be determined.

2. METHOD

The method used in this research is the observation method with a quantitative research approach. This observation was carried out on a simple building that functions as a residence in Cukang Padung Hamlet, Panjalu Village, Panjalu District, Ciamis Regency, West Java. The technique used is the Dialux Evo simulation. This simulation will obtain data showing the state of natural lighting on the building object. These data can be identified which rooms have and have not met SNI 03-6197-2000. Furthermore, for rooms that do not meet SNI, design engineering will be carried out to meet SNI.

3. RESULTS AND DISCUSS

3.1 Case Study

The object of the building is the second floor of a dwelling. So there are only a few rooms. The right side of the structure is attached directly to other facilities. Thus, it cannot be opened. Therefore, the openings are only on the front and left sides of the building. The building is located at a longitude of 108.15 and latitude of -7.8. It is in the UTC + 07:00 time zone and has a north alignment of 325°. The simulation date was chosen on March 21, 2021, because that date is one of the longest days in a year. Meanwhile, for the timing of 07:00, 12:00, and 17:00, these are three phases: morning, afternoon, and evening.
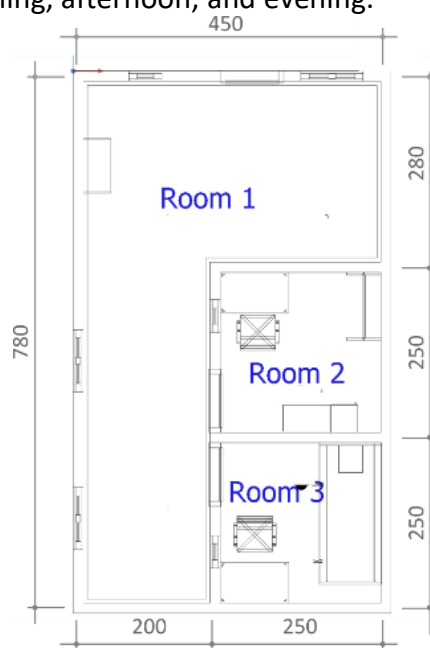

Figure 1. Building plan
(Source: Author, 2021)

Based on Figure 1, there are three room 1 is the family room, room 2 is the work spacworkspace, room 3 is the bedroom. Based on SNI 03-6197-2000, the three rooms must have standard lighting of 120-250 lux. So, it is necessary to measure to determine the amount of lighting that each room has. These measurements will be carried out using the Dialux Evo. Further evaluated and given solutions if there were problems.

3.2 Natural Lighting Measurement Results Using Dialux Evo

Baird on the measurements that have been made using the Dialux Evo with Evo date setting on March 21, 2021, and the time was set at 07:00, 1,2:00 and, 17:00. Then the following results are obtained.
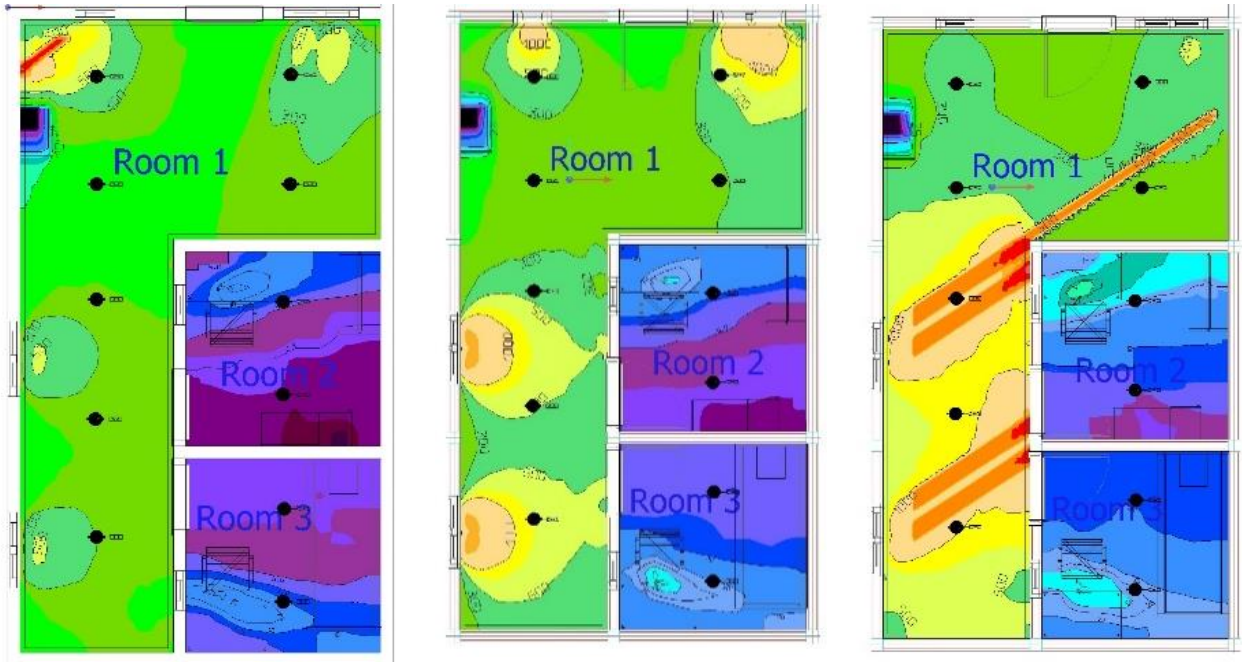

Figure 2. From left to right,falsecolore calculations at 07:00, 12:00, and 17:00
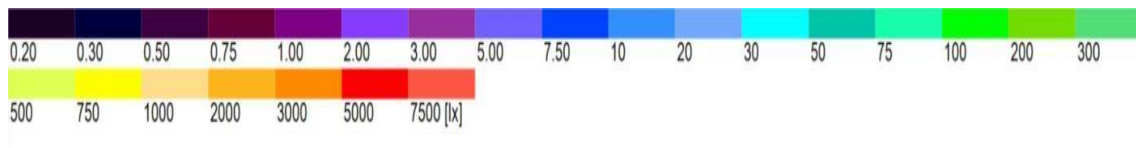(Source: Author, 2021)

Figure 3. The color scale
(Source: Dialux Evo, 2021)

Table 1. Natural Lighting Measurement Results

Room	Time			Target (SNI)
	07:00	**12:00**	**17:00**	
Room 1	282 lx	468 lx	895 lx	120 – 250
Room 2	4,25 lx	7,41 lx	18,4 lx	120 – 250
Room 3	5,58 lx	11,5 lx	15,2 lx	120 – 250

Source: Author 2021

Based on figure 2 and table 1, room 1 has lighting exceeding SNI, more than 250 lux. Meanwhile, room 2 and room 3 have lighting that is far below SNI. Therefore, it is necessary to design engineering in the building to adjust the natural lighting in each room to comply withbydation

Based on the existing problems, several solutions are needed. However, it is essential to remember beforehand that the research object is a ready-research object hanging or reducing the structure and construction of buildings is not recommended. Because it will be very detrimental to the building owners, some of the solutions that can be applied to the building are as follows. The first, to deal with excessive lighting in room 1, the most effective way is to apply window curtains. The use of these curtains aims to filter and reduce light, so that the incoming light is not excessive.
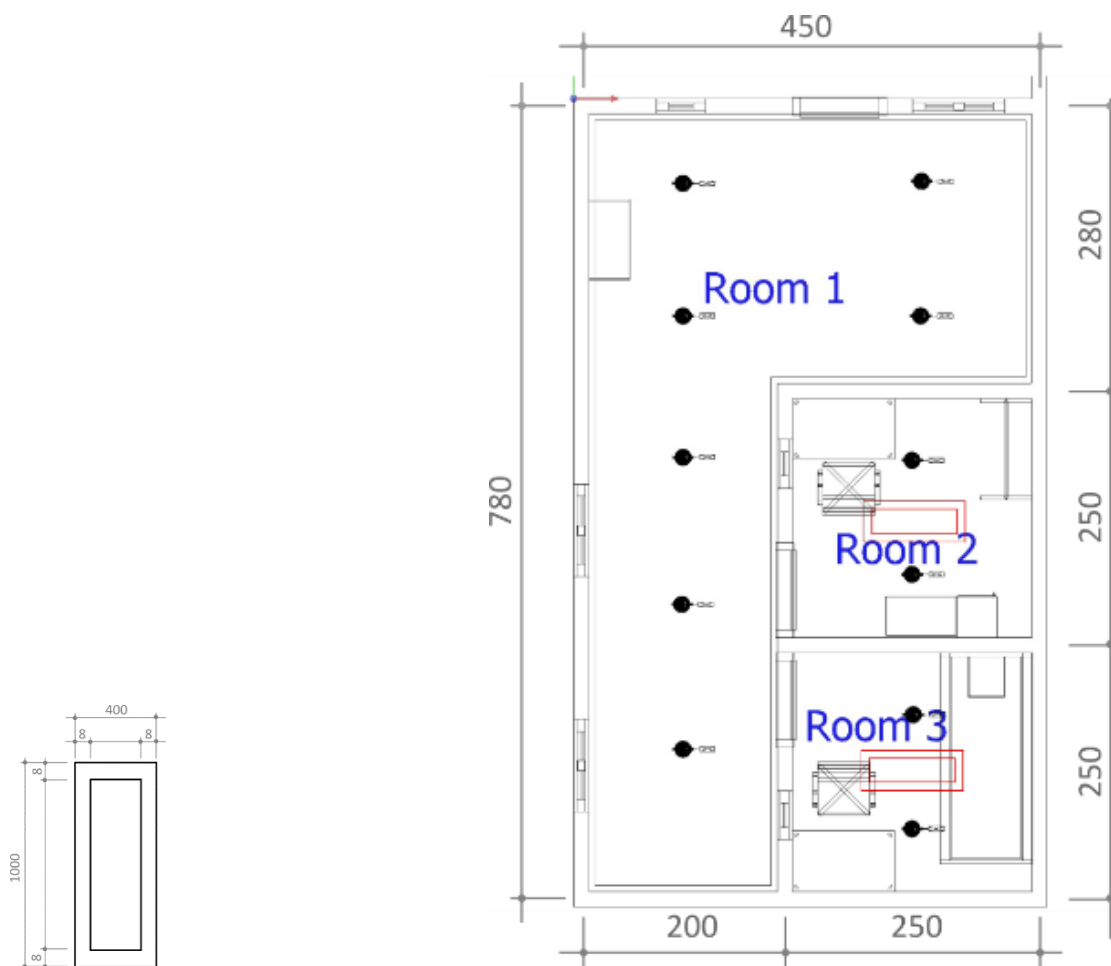

Figure 4. Roof window design recommendations (Source: Author, 2021)

Figure 5. Floor plan with roof windows (Source: Author, 2021)

Second, to overcome the minimal lighting in rooms two and room 3, the most effective way is to apply a roof window (figure 4). Because it is attached directly to other buildings on the right side of the building, it cannot create openings on the right side of the building. Therefore, the most likely space is from the top, namely the roof. In addition, the manufacture of roof windows does not change the structure and construction of the building too much compared to the manufacture of ordinary wall windows. The size of the outer roof window is 40x100 cm with a frame thickness of 8 cm. Meanwhile, the thickness of the glass is 3 mm. The position and location of the roof window can be seen in Figure 5.

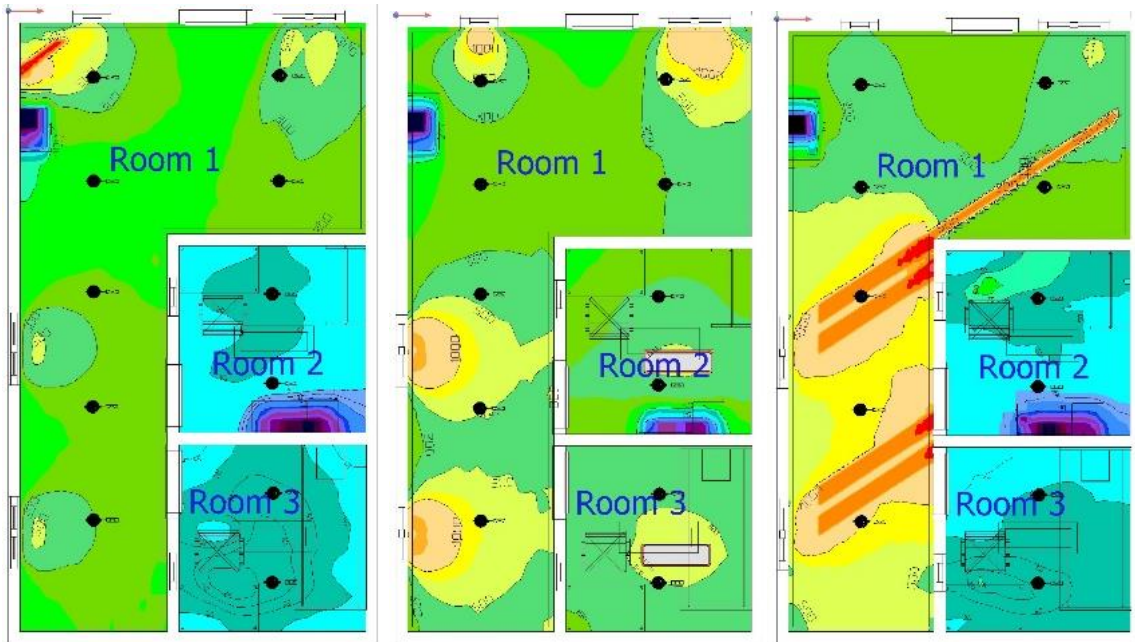The results simulation of roof windows in room 2 and room 3 are as follows.

Figure 6. From left to right, false color coloration at 07:00, 12:00, and 17:00
(Source: Author, 2021)

Table 2. Natural lighting measurement results

Room	Time			Target (SNI)
	07:00	12:00	17:00	
Room 1	282 lx	468 lx	895 lx	120 – 250
Room 2	41,7 lx	2306 lx	46,5 lx	120 – 250
Room 3	53,9 lx	2431 lx	53,0 lx	120 – 250

Source: Author 2021

Based on figure 6 and table 2, room 2 and 3 have a higher lighting level than the data in figure 2 and table 1. At 07:00 and 17:00, both rooms have below standard lighting levels. However, this is understandable because the sun was not above the building at that time. In addition, these times are not busy times for residents. So it doesn't need a lot of light. Meanwhile, at 12:00, room 2 and 3 have very high lighting levels. This happens because the sun is at its peak or is right above the window, and the roof window size is quite large. If the lighting at 12:00 is to be adjusted to SNI, then the roof window size must be reduced. However, this will lower the lighting level at other hours. Thus, even though the recommended roof window size (figure 4) the lighting level at 12:00 is considered too high, the lighting level at other hours can be following SNI. Therefore, this measure is used to fulfill the lighting from morning to evening.

4. CONCLUSION

The roof window is a building component that can be used to overcome a room that lacks natural light. By the simulations that have been carried out and described above. But even so, it is necessary to pay attention to the size/dimensions of the roof window. Because if it is too big, it will make the room have very high lighting. Vice versa, if it is too small, the space will still lack light. So the use of the roof window must be adjusted to the size and function of the room.

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