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Daylighting Performance Evaluation of a Heritage Building in Braga Street, Bandung

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ABSTRACT
There are many historical buildings in Indonesia, especially in huge cities such as Bandung. The state protects these buildings because of the historical value and to maintain the form as the original design by its first built. However, with the change of ownership, the function of the building was also adapted. A problem regarding this development is the interior lighting performance. With the special opening characteristics of heritage buildings, the owners expect the light intensity could fulfill the needs or can be a justification for determining the function of the room under the existing standards and regulations. This paper evaluates the lighting performance from a case study located in the corridor of Braga Street, Bandung City. The method is the computer simulation using Velux Daylight Visualizer from the existing's building form. With the original condition of the building since it was founded in the 1980s, the results show the average daylight factor value is 3.43%. This value is sufficient to meet lighting standards for several building functions, one of which is an office.

Keywords: *Daylighting performance, Heritage building, Bandung.*

1. INTRODUCTION

Bandung has many historical buildings, which mostly built by the Dutch in colonization era. Some of the historical buildings are now acknowledged as heritage building that should be preserved. Whereas, some of the buildings are changed or demolished. For the preserved heritage buildings, they have intensively attracted tourism due to its unique discern among other buildings. This is causing a huge prompting from tourism industry to use the building as a restaurant or cafeteria. The building facade also turned out into unoriginal following the function change. Some owners made it fancier by widen the wall opening ratio.

Nonetheless, heritage buildings are presumed to be climate responsive and comfortable for the occupants [1]. Therefore, any change made for the buildings, whether followed by the functional change or not, should maintain its quality. The quality preserved is not only in aesthetic, but also in terms of environmental performance.

Furthermore, there are many parameters for environmental performance, both quantitatively and qualitatively. One the important parameters is lighting level. Lighting affects human health, productivity, comfort, and psychology [2]. Thus, analysis of lighting performance of a changed heritage building is important. If in the initial condition, the heritage building is presumed as climate responsive, it should have a good daylighting performance. It means the building does not rely mostly on artificial lighting in day time. Hence, the renovation, or recycle of the building, should be as good as the initial building in terms of daylighting performance.

This research analyzes the daylighting performance of a heritage building in Bandung that had been modified. The analysis focuses on illuminance level of the current building. Illuminance level is expected to meet the requirement from Indonesia National Standardization Bureau for working activity (SNI) [3].

2. METHODS

2.1. Object Study

This building is located at Jalan Braga, Bandung. The building is owned by National Electricity Company (PT. PLN) and rented to restaurant company. The building was founded in 1896 as a printing and

publishing office. In 1998, the government assessed this building to be classified as a heritage building that protected by the laws of the Republic of Indonesia (See Figures 1 and 2).

Figure 1 Building façade.

Figure 2 Digital modeled building.

2.2. Study Method

This study attempts to grasp the behavior of the light on the heritage building using software simulation. The advantage of this method is able to overcome the constraints that occur in the measurement with the model of physical study. The software used in this simulation is Timbre SketchUp 2016 to create object geometry and Velux Daylight Visualizer 2.0 for natural lighting simulation.

Velux Daylight Visualizer 2.0® has got validation from CIE (International Commission on Illumination). This validation aims to test the accuracy of this software in calculating the natural lighting and rendering quality. By the result, the CIE concluded that Velux Daylight Visualizer 2.0® only had 1.63% of the average error, while the maximum error was 5.54%. To conclude, Velux Visualizer 2.0® is capable to predict the accurate level of natural lighting [4].

The primary data is done by doing an observation to the building to know the dimension of the building and other related elements. Next, this data is modeled in digital form for simulation.

The rendering method used by Velux Visualizer is a photon map. The photon map is rendering in both directions by tracing the path of illumination from both the light source and from the point of view [5]. Light source will get photon energy. This photon energy will carry the amount of light from the light source and get stuck in the data structure.

The results of the Velux Visualizer 2.0® rendering illustrate the natural daylighting conditions of the room by exposing the daylight factor as a reference for the quality of the natural lighting factor in the room. The results of natural lighting factors are expressed in percent (%). In this study, the simulation results will be displayed with Iso Contour and False Color. Iso Contour is the result of rendering that is displayed with the contour of light that is, by displaying the colored lines stating the value or light level on the simulation results. Contour lines start from red (high light levels) to blue (low light levels). False Color is a rendering result that displays color gradations in the simulated area to clarify the lighting levels in the area. The color shown is the value in the illumination, for example the blue gradation has a lighting level of 0.00% up to 1.00% [6].

In architecture, a daylight factor (DF) is the ratio of the light level inside a structure to the light level outside the structure. It is defined as:

$$DF = (Ein / Ext) \times 100\% \quad (1)$$

Where:

DF – Daylight Factor (%);

Ein - illuminance due to daylight at a point on the indoors working plane;

Ext - simultaneous outdoor illuminance on a horizontal plane from an unobstructed hemisphere of overcast sky.

In this building, the window used has dimensions of 140 x 350 cm located on the front side of the building. The space used has dimensions of 1630x1300 cm (Figure 3). The frame material used is wood and window cover material is glass with 78% transmittance. More variables can be seen in Table 1.

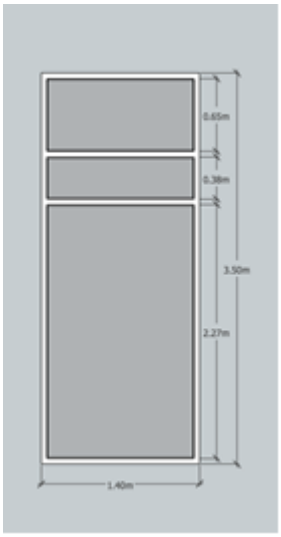

Figure 3 Window dimension.

Table 1. Input parameters

No	Elements	Existing
1	Sky Condition	
	Altitude	110 cm
	Latitude	6.9175
	Longitude	107.6191
	Sky model	*Overcast*
	Ground Reflectance	*Organic, Concrete*
2	Building Form	
	Dimension	1630 x 1300 cm
	Orientation	East
	Window Dimension	140 x 350 cm
	Number of Window	10
	Window in East Side	6
	Window in South Side	4
3	Material	
	Window Opening	*Window Glass, Transmittance 78%*
	Wall	*Plastic, White Paint (Matte)*
	Floor	*Tile*
	Ceiling	*Plastic*

3. RESULTS AND DISCUSSION

The results of this analysis indicate that the average daylight factor in the study object is 3.43%. This indicates that the room is in accordance with SNI standards to be used as office space. The mean value of DF analysis is 2.97%. Then, the minimum value of DF is 1.29% while the maximum value of DF is 13.93% (See Figures 4 and 5).

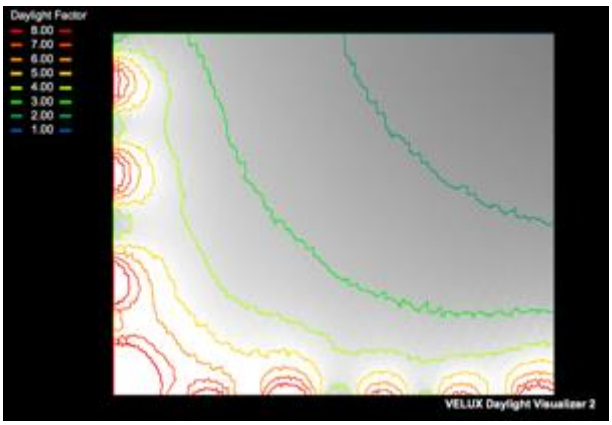

Figure 4 Simulation result in Iso Contour.

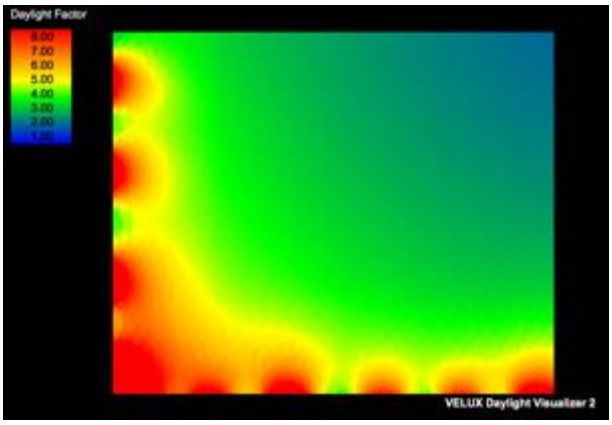

Figure 5 Simulation result in False Color.

Table 2. Simulation result

	Daylight	Result (%)
Average Daylight Factor	Dav	3.43
Median Daylight Factor	Dm	2.97
Minimum Daylight Factor	Dmin	1.29
Maximum Daylight Factor	Dmax	13.93
Uniformity 1	Dmin/Dav	1 : 2.65 (0.38)
Uniformity 2	Dmin/Dmax	1 : 10.77 (0.09)
Above Value	2.5	82%

DF standard for a restaurant in SNI is 2.5 [3]. By the simulation result, it can be obtained that 82% of the restaurant area fulfilled the DF standard. This result shows that the heritage building is filled up the daylight factor requirement for the restaurant.

From the above simulation results (Table 2), there are several things that are similar to the cause of inequity of natural light reception in the room area. First, the depth of space and the size of the openings is not able to distribute natural light evenly. The ideal depth to obtain optimal natural light from openings on the wall is 15 feet (approximately 4.50 meters) [7]. While in the office space has a depth of space up to 13 meters. However, although the condition of the depth of space does not meet the standards, room area can achieve the good condition of lighting by the dimensions and openings of existing windows.

4. CONCLUSION

This building has characteristic of cultural heritage buildings that are protected by the government. Models of window openings can provide an average daylight factor rate of 3.43%. This indicates that this condition meets the SNI standard. Then the percentage of the area that meets the standard in the room is 82%.

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