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Lighting Design of Energy Efficient Building in Office Building

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Abstract **-** Climate change led to the issue of global warming and have an impact also on increasing energy load of the building. The designer Architect instrumental in designing buildings with attention to environmental impact, namely temperature, wind and light. Solar radiation causing the high load of electrical energy for air conditioning, so the Architects as the designer should be able to minimize the radiation of heat into the building. In addition, the sunlight will be able to enter into the building so that the load of the electrical energy for the artificial lighting can be minimized as well. Energy efficient building design is a great thing to note, with consideration of comfort in activities so that an increase in labor productivity. The purpose of this research is to analyze the lighting in the Office building of the Wisma Kalla in Makassar. Energy-efficient architecture is based on the idea of minimising energy use without limit or change the function of the building, comfort, and productivity of the user space. This research analyzes the energy load of electric lighting setting design appropriate spaces with attention to the standard level of illumination is recommended. Quantitative research methods using ecotect program to find out the values of illumination and energy consumption on used point lights. Results of the study concluded that the utilization of natural lighting can minimize the load on the building energy consumption but taking into account the recommendations of the standard illumination on the work space Office.

Key words: *Energyefficient , Office building, Lighting*

1. Introduction

The successful of a building planning is not just valued from the aesthetical point of view , but there are also three factors that influence the good value, which are: visual comfort, thermal comfort, and acoustical comfort. This study report the analysis is focused on visual comfort in the high offices buildings.

Indonesia is a moist-tropical country which the level of light relatively high so the sunlight should be maximally absorbed into the building, particularly with the room which is directly connected with the facade/ cover of building. Unfortunately, when the level of illumination are too much gets into the building , some negative effects will be occur, like glare, brightness, and thermal. Some of offices building planning are design with various of shapes of facade which aiming the aesthetical value of the buildings. The design of building facade, if too much will create barriers to avoid the light to get in.

Visual Comfort is also influenced by the level of illumination in the working area whereas stated by the Director of Building and Environment SNI 03-2396-2001 which produce the rule of illumination level standardized on high building which is 350 lux for working room with constantly activities of reading and writing. The standard condition is not the only thing to be concerned with, but there have to be created the lights intensity on the working room.

2. Literatur Review

Energy use in office buildings is relatively large for artificial lighting, air conditioning and other appliance. Distribution of energy consumption in building is for the air conditioning that is 50-70%, lighting 10-25% and elevators 2-10% (Sugijanto,1998). Although the energy consumption to artificial lighting is smaller compared to the air conditioning but by minimizing energy usage for lighting, meaning energy consumption in buildings can be reduced so that the lighting sydtem should be of particular concern in the early stages of lanning to create energy efficient buildings that meet tha requirements of visual comfort.

Lighting design is an essential element in an office and a very significant impact on the user space. Also, light has an important role in creating the atmosphere of a room, such as the mood of the space and satisfaction of space user. In this case, the design procedure of lighting systems used by designers as reference to create visual space. The lighting design plays an important role in enhancing the productivity of labor, especially in the office workspace.

Visual comfort in an office room, created if the user can perform activities well and can feel comfort in the activities. The activity conducted on the work space office is very related to the level illuminance. In general, the designer created lighting design base on the level of illumnance that has been recommended by SNI 03-6575-2001 about the design of the system of artificial lighting in the building and standard level of iluminance on office room is the 350 lux

Recommendations of illumination standard of office workspace refers to the values recommended by the CIE (Commission International de I'Eclaire) and IES (Illuminating Enginers Society) which is the National and International standards for lighting design (UNEP, 2006). Recommended illumination standards differ in several countries, among others: CIE (ISO standard, 2002) at 500 lux, European Standard (2002) at 500 lux, CIBSE Code (1997) of 500 lux, IESNA (2004) at 300-500 lux and Indonesian of 350 lux recommended.This suggests that each country has a different standard of illumination and Indonesian recommend the lowest value compared to other countries.

This theoretical framework , outlines the factors visual performance. There are several variables in the study of visual performance include: contrast, ratio, glare, visual angle, illuminance, luminance, brightness, reflectance and age. Approach to research that has been done is "Study of natural lighting in the central library building UNHAS (Nurul, 2001) and the results showed that the level of illumination in the reading room of the library is not in accordance with the recommended standards ISO 03-6575-2001 illumination of 250 lux, but visitors can move well. Other research approach entitled "Studies Lecture Room Department of Architecture and Planning Gadjah Mada University" (Nurul, 2010) explains that although most of the classrooms do not meet the standard recommendation illumination, students can move well. The next approach to the study entitled "Visual Comfort Studio Space Images by Using Echotect Program" (Nurul, 2012), explains that the level of illumination in the room does not meet the standard studio illumination, which is 160-299 lux, whereas that of 750 lux is recommended, but students still can move well. The research of visual performance (Nurul 2013) analyzed the level illuminance on the workspace office to design setting of the lighting on the room experiments. This study concluded that there was no influence of illuminance level on visual performance and user can be a wee at a rate of level illuminance is 150 lux.

The several approach of this study, is the view that the standard recommendation illumination is not an absolute value that must be followed, so that in this study to analyze the level of illumination in the room workspace. Based on previous research, so that the research conducted is to design energy-efficient buildings to reduce energy usage for

artificial lighting and to use natural lighthing in offices building Wisma Kalla in Makassar.

3. Methode Research

Methodology of research is literatures study, buildings surveying and then analysing data by using echotec program. The analysis result shows that the level of illumination in the buildings pictured in the form of colour degradation according to the intensity of light lux, then being analysed again by adding amount of artificial lighting into the room to fulfil the illumination standard, in order to know the amount of artificial light in the analysed building. This study conducted design two models to analyze energy on office buildings homestead Kallla in Makassar.

4. Result Of Analysis

Wisma Kalla offices building consists of 12 floors with a total building area of 21.273 m2. Rentable space consist of rentable retail space, rentable office space and comercial rentable space. Rentable retail space located on floors 5^{th} - 9^{th}, rentable retail space on the floor 1^{st},2^{nd} and 3^{rd} and comercial rentable space on the floor 3^{rd} and 4^{rd}. The extent of 327,6 m2 Floor 1^{st}, floor 2^{nd} at 214,2 m2 and 3^{rd} floor amounted to 75,6 m2. Rentable office space located on the third floor is a floor area of 176,4 m2 and typikal is 5^{th} - 9^{th} with a floor area of each floor is of 976,9 m2.

This study is to analyze the ratio of electrical energy consumption according to amount armature used and to analyze the level of illumination on the typical floor. The first analysis calculates the amount of electrical energy consumption by as much as 109 units armature consisting of 2 x 36 watt. Furthermore, conducting lighting design in typical floor by reducing amount of armature. Figure 1 shows the site plan, first floor and typical floor.

Figure 1. Site plan, first floor and typical floor

This study is using Ecotect program to be analyzed quantitatively. This study analyzed the utilization of natural and artificial lighting in office buildings. Wisma Kalla is a 12 floors offices building. On this building there are several room types, namely office room, meeting rooms and restaurants. The offices rooms are on typical floor on the floor 5th-9 th and orientation of the building toward the north south.

Figure 2. Wisma Kallla Office building in Makassar

Analysis of the level of illumination in offices building Wisma Kalla in Makassar is using Autodesk Ecotech Analysis program. The office rooms are located on a typical floor and illumination design of Armatur lamp as in Figure 3 below. Design illumination on typical floor is using lamp TLD (2 x 36 watt), Type 369 / D6 with Philips Artolite specification and in the lobby of the building using light Down Light PLC 18 watt.

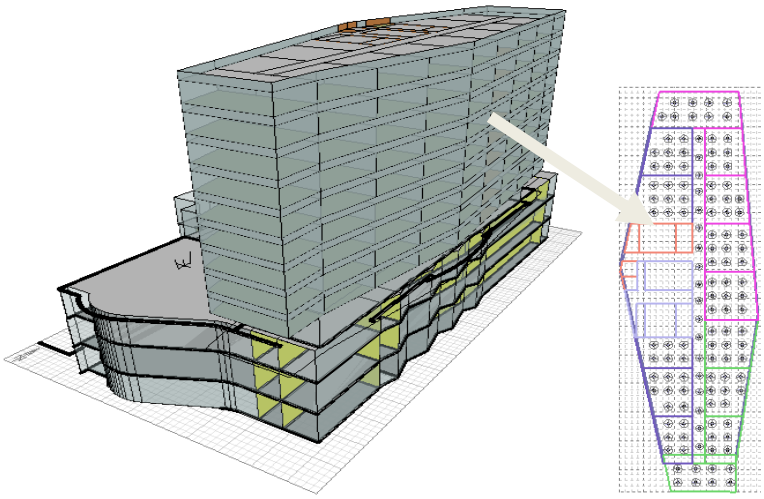
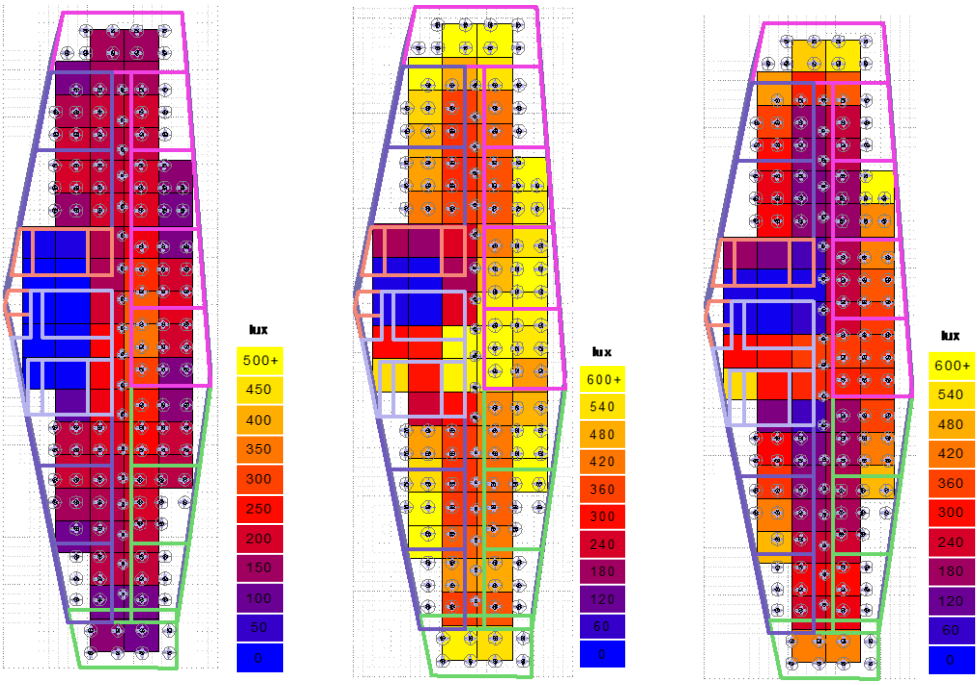


Figure 3. Design illumination office room on typical floor (Model 1)

EcoTech calculation indicates the level of illumination on the floor typically based on overall light levels, electrical light levels and daylight level as shown in figure 4, namely; (A) electric light level is between 0-600 lux illumination level, the average value of 148,48 lux; (B) overall level is 0-500+ lux light levels, and the average of 512,02 lux and; (C) daylighting level is 0-600 lux levels and average 363,54 lux.



(A) Electric light level (B) Overall light levels (C) Daylighting levels

Figure 4. Lighthing Analysis on typikal floor (Model 1)

The simulation results show the level of illumination on office work is daylighthing level within 266.70 lux to 656.57 lux with a mean value of 363.54 lux. overall light level within 426.62 lux to 805.40 lux with a mean value of 512.02 lux while the electric light level from 64.83 to 250.83 lux and the average value 148.48 lux.

Table 1 shows the results of the simulation program EcoTech is energy use for eac month on a typical floor. Total armature in each typical floor totaling 109 pieces and using a fluorescent lamp (2 x 36 watt). Office building Wisma Kalla has several function rooms, and in this study analyzes only the office room that located on a typical floor. The use of electricity as a source of artificial lighting for the months are different and the total energy used for one year on typical floor is 79.575.840 Watt.

Table 1. Resource usage - daily energy use (Model 1)

Month	Electric (Wh)
Jan	6,758,496
Feb	6,104,448
Mar	6,758,496
Apr	6,540,480
May	6,758,496
Jun	6,540,480
Jul	6,758,496
Aug	6,758,496
Sep	6,540,480
Oct	6,758,496
Nov	6,540,480
Dec	6,758,496
TOTAL	79,575,840

This study analyzed the level of illumination in office room is making two models. The second model is to reduce the use of lights and change the type of armature lamps in Figure 5 below.

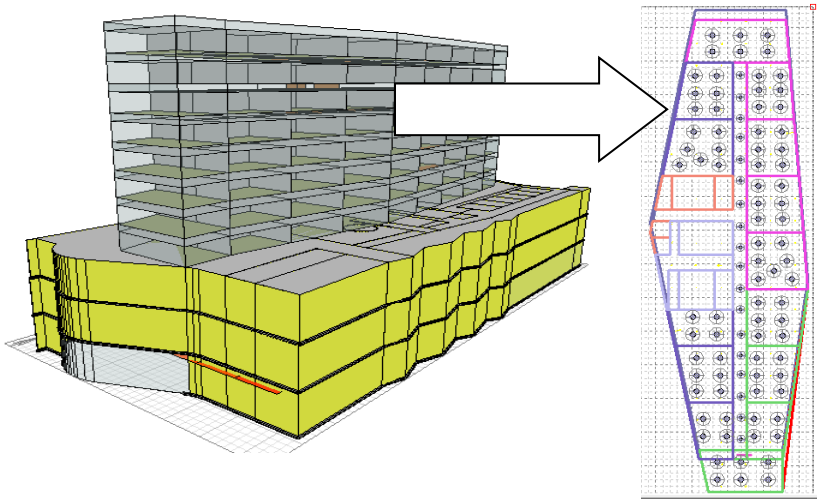
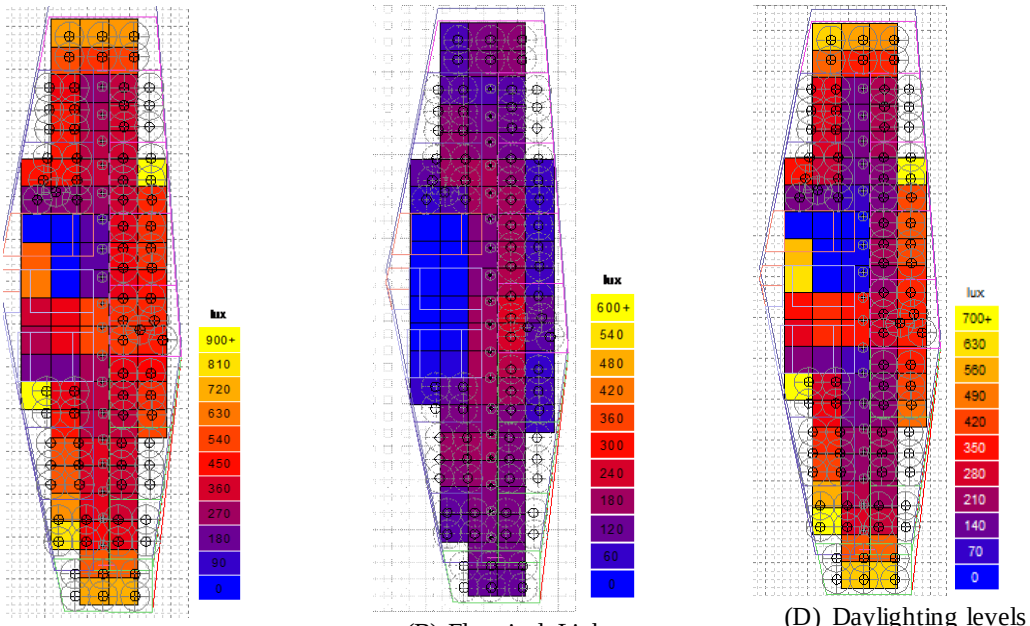


Figure 5. Design illumination office room on typical floor (Model 2)

Figure 6 shows the simulation results of office work space on a typical floor is calculation of overalls (daylighthing and light electrical) and electrical light. Results of the analysis of overall yield maximum value amounted to 693,6 lux illumination, amounting to 267,4 lux minimum and average of 535,33 lux. Results of the analysis showed electrical light illumination level at 101,6 lux minimum, maximum 250,5 lux at 106,03 lux for average.



(A) Overall (B) Electrical Light (D) Daylighting levels

Figure 6. Lighthing analysis on typikal floor (Model 2)

Table 2 shows the results of the simulation program EcoTech that is energy use for each month on a typical floor. Total armature in each typical floor totaling 80 pieces by using fluorescent lamp 36 watt. Offices building Wisma Kalla has several function rooms, and in this study analyzes the office room only that is located on a typical floors. The use of electricity as a source of artificial lighting per month are different and the total energy used for one year on typical floor is 33.323.040 Watt

Table 2. Resource usage – daily energy use (Model 2)

Month	Electric (Wh)
Jan	2,830,176
Feb	2,556,288
Mar	2,830,176
Apr	2,738,880
May	2,830,176
Jun	2,738,880
Jul	2,830,176
Aug	2,830,176
Sep	2,738,880
Oct	2,830,176
Nov	2,738,880
Dec	2,830,176
TOTAL	33,323,040

5. Conclusion

This research indicated about the level of illumination on typical floor in Wisma Kala building and electrical energy consumption for artificial lighting. This study, analyze two models of lighting design office room. The first design is to plan the placement and number of point-type lamps Fluorescent Prismatic Lence as much as 109 armature (2x36 watt). The second design plan 80 Armature (1x36 watt) type Fluorescent lamp strip unit. The analysis of the two models of lighting design is the model 1 shows the electricity consumption per year on a typical floor (floors 5-9) amount to 79.840.416 watt and the model 2 of 33.323.040 watt. This research concluded that the analysis on both these models can decrease for one year to electrical energy consumption is 41.74 percent.

This study concludes that the lighting design by reducing the amount of lamp and selected the type of armature can be diffuse light and reduce electrical energy consumption so can be create energy-efficient buildings. Natural light can get into space is one contributing factor in creating an energy-efficient building, but keeping in mind the comfort of activity in the office room so that work productivity is increasing.

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