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"SMART ENGINEERING FOR FUTURE CITIES"

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TARUMANAGARA UNIVERSITY
Main Building, Campus I, Jl. Letjen S. Parman No 1, Jakarta Barat
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Tarumanagara University

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ICET 2017
CONFERENCE PROGRAM

Day 1: Wednesday, October 4th, 2017

	Time	Activity
1	08.00-08.30	Registration + coffee break
2	08.30-09.30	Opening ceremony - Opening remarks from ICET 2017 chairperson - Opening remarks from the Dean of Engineering Faculty - Opening remarks from the Rector of Universitas Tarumanagara
3	09.30-12.00	Keynote Speaker I Prof. Dr. Stephen Cairns, Program Director od the Future Cities Laboratory, ETH Zurich *"Urban Transformations in Asia: Responsive Knowledge Strategies, Design Scenario, and Action Plans"*
		Keynote Speaker II Prof. Dr. Tech. Ir. Danang Parikesit, M.Sc. (Professor of Transportation Planning and Engineering UGM, Chair – Transportation Technical Committee, National Research Council) *"Updates on The Progress of Intelligent Transportation System for Indonesian Urban Areas"*
		Discussion (moderator: Dr. Danang Priatmodjo)
4	12.00-13.00	Lunch break
5	13.00-15.00	Parallel session I
6	15.00-15.15	Coffee break
7	15.15-17.00	Parallel session II

Day 2: Thursday, October5th, 2017

	Time	Activity
1	08.00-08.30	Registration + coffee break
2	08.30-10.30	Parallel session III
3	10.30-10.45	Coffee break
4	10.45-12.15	Parallel session IV
5	12.15-12.30	Closing
6	12.30-end	Lunch break

Note :
- Opening ceremony and plenary session: Main Building, Auditorium 3rd floor
- Parallel session: Main Building, 14th floor

TABLE OF CONTENTS

LIST OF PAPERS

The 3rd International Conference on Engineering of Tarumanagara (ICET) 2017
Faculty of Engineering, Tarumanagara University, Jakarta-Indonesia, October 4-5th, 2017
ISBN: 00-00-00-00-00

DESIGN OF TUNNEL LIGHTING MODEL FOR VEHICLE DURING NIGHT TIME

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Abstract

Tunnel lighting should be well designed, to ensure the safety and security of vehicles passing through the tunnel. One way is to provide the level of illuminance and luminance according to the standard for the tunnel lighting during day time and night time. This research is focused on designing model of tunnel lighting system for vehicle at night. The reference data is taken from previous research that has been done in 2015. The Pasar Rebo tunnel data is used to design the tunnel lighting system model. The design of this tunnel lighting system model has a feature that the tunnel illuminance can be changed in accordance with the presence or absence of vehicles passing through the tunnel. Another objective of this design is to provide energy saving by turning off the unnecessary lamps. Based on testing of the tunnel lighting system model that has been realized, the model can provide tunnel lighting simulation in accordance with the planned features. The weakness of the model is that the use of RGB LEDs can not represent the actual lamps installed in the actual tunnel.

Keywords: Tunnel lighting, Pasar Rebo tunnel, tunnel lighting model, tunnel illuminance, energy saving.

1. INTRODUCTION

The tunnel is part of a highway that is used to facilitate the flow of vehicles traffic. Just like the highway, the tunnel also requires lighting so that road users can pass through it safely and comfortably. Street lighting is only necessary at night, but in long tunnels it takes daylight and nighttime illumination [1]. To determine whether the lighting level in the tunnel has been in accordance with the standards set by the government, then lighting level of several tunnels in Jakarta (Cibubur Tunnel, Pasar Rebo Tunnel and Cijantung Tunnel) are measured. The measurement show that the illuminance, luminance and uniformity level of the three tunnels are not in accordance with the standards determined by SNI (Indonesian National Standard) [2].

The difference is caused by several factors, among others are the mounting of the lamps in the tunnel does not consider the tunnel zones and their luminance level, and the installation of different lamp characteristics so that the uniformity level is under the specified limits[2]. To solve this problem, it is proposed to construct a tunnel lighting model so that it can simulate the mounting of the lamp and its luminance level to achieve standard requirements. From previous research, also obtained that there is no difference between day time lighting and night time lighting in the tunnel. The lamps in the tunnel are fully lit for 24 hours, there is no mechanism to turn off or turn on the lamps. According to lighting standard, there should be a difference between day time and night time lighting in the tunnel. As a tunnel model, Pasar Rebo tunnel is selected as the basis of the design because of its simple form, which is a long straight tunnel. At first the model will be develop for night time lighting only. Then the model will be developed to cover day time lighting as well.

ISBN: 00-00-00-00-00

2. RESEARCH METHOD

2.1 Tunnel Lighting

Tunnel is covered structures road in which natural light is blocked such that the driver can not see anything. The tunnel can be divided into "long tunnel" and "short tunnel" is based on the clarity of vision. Short tunnel is a tunnel that is clearly visible the other end of tunnel from a point right in front of the tunnel entrance, when no vehicles pass. Usually the length of short tunnel is limited to 75 meters. The long tunnel on the contrary, one can not see the other end of the tunnel [1]. The long tunnel need both daylight and night time lighting.

The purpose of the tunnel lighting is to provide sufficient visibility and convenient for drivers so that they can pass through the tunnel safely, both in day time and at night time. To achieve these objectives, there are several things to be considered [2]:

1. Lighting should provide sufficient illuminance level and uniformly for the driver along the tunnel both in dry and wet conditions.
2. The angle of the light relative to the driver's eyesight should provide a high level of vision to the road markings in all weather conditions.
3. The bottom of the tunnel must have adequate lighting levels
4. Lighting should not cause glare
5. The lighting should not flicker

To achieve those objectives, there are several factors to be considered in designing tunnel lighting [5]:

1. Lighting Control: luminance produced by lighting in the tunnel must meet the standards of the percentage of the access zone luminance.
2. Glare can reduce visibility so that glare should be minimized. Glare is called Threshold Increment (TI), and it must be less than 15 percent for all zones except exit zone when the sun shines.
3. Uniformity: the road surface and tunnel walls must have good uniformity illumination so that both can help to detect obstacles in the path of the vehicle in the tunnel. Road surface and the wall of height 2 meter should have a ratio of the overall luminance (L_{min} / L_{av}) is greater than 0.4. Average luminance on the wall should not be lower than the average luminance on the adjacent road, without eliminating the curb of the road. Luminance ratios longitudinally along the center line of each lane (L_{min}/L_{max}) should be greater than 0.6. The high uniformity is not recommended for long distance, because it can lead to driver's fatigue and loss of contrast.
4. Flicker: luminaire installed on lines that criss-cross along the tunnel can produce a flicker in the eyes of the driver. Flicker is caused by light from the luminaire itself and by the reflection of light on shining luminaire surfaces, such as: the bonnet of a vehicle and the back of another car being followed.

2.2 Pasar Rebo Tunnel

Pasar Rebo Tunnel also known as TB Simatupang tunnel is located on Jalan TB Simatupang, Jakarta. This tunnel is a two-way tunnel separated by a dividing wall or called a divided tunnel. Each direction has 3 lanes of road with 14.5m wide, 5m high and 270m long (see fig 1). In each tunnel are 61 High Pressure Sodium (HPS) lamps with CCT 2000 K and 5 LED lamps with CCT 5000K [4].

The measured results during night time of illuminance were between 58 lux to 155 lux with uniformity of 0.32 [4]. This result is higher than the SNI requirement of 20 to 25 lux for illuminance and uniformity of 0.2 [3].

This difference is due to lack of proper lighting installation, the lights are installed alternately by way of luminaires mounted on the upper wall of the tunnel which flashed

ISBN: 00-00-00-00-00

downward and a wall-mounted luminaires on which shone a bit to the middle of the road surface. Overall the system of installation of lamps in TB Simatupang tunnel called wall mounting system asymmetrical lighting (see fig.2)

The existence of 2 kinds of lamps mounted on this tunnel cause uniformity of light in the tunnel to be less good. HPS lamps produce yellowish light as LED lamps produce white light (see fig 3).

Previous study shows that Pasar Rebo tunnel does not meet the lighting standard issued by SNI [4]. To assist the tunnel manager, in this case Dinas Penerangan Jalan Umum (Public Street Illumination Service) and PT Jasa Marga Tbk, in order for the lighting in this tunnel to be in accordance with the standard requirements, the tunnel lighting model is designed. The model is designed in addition to improving the lighting system, so it will equipped with an automation system to turn on/off the lamps in order to support government policy in energy saving.

Fig.1 Pasar Rebo tunnel at night [4]

Fig.2 Wall mounting asymetrical lighting [4]

Fig. 3 HPS and LED lamps [4]

2.3. Proposed Designed

Tunnel lighting automation system model is designed using light emitting diode (LED) lamps instead of actual tunnel lamps. The tunnel model will be designed for night lighting. Night illumination corresponds to road lighting conditions around the tunnel. Night lighting system there are two features that is when there is and no motor vehicle passing through the tunnel. When there is a vehicle, the intensity of light is higher than when there is no vehicle. This is intended to save the use of electrical energy when the tunnel is not used.

Before designing the hardware, the design of tunnel lighting using the Dialux software (available for download from the internet), in accordance with the provisions of the 20-25 lux SNI lighting level at night and for daylighting using International standards are ANSI/IES Rp-22-11, 2011 and NPRA, 2004. The design of lighting will consider the

ISBN: 00-00-00-00-00

height and width of the tunnel, as well as the distance between lamp / luminaire and power (watt) in order to produce the lighting level in accordance with SNI and ANSI standards/IES Rp-22-11, 2011. The design with dialux software will give a picture of the tunnel lighting that is in accordance with the actual condition of the tunnel. Furthermore, based on this result will be obtained luminous flux of the type of light used which is useful for the design of hardware tunnel system model, so that in making the model of the tunnel system can approach the actual results. The block diagram of the system model to be designed can be seen in Fig. 5. The design module of the realized system model is the microcontroller module, the light sensor module, the module of the car detecting sensor and the power supply module. The design specification is to use a 5 VDC power supply for the entire system module, using a 12 VDC power supply for LED lights, using LDR sensors, and photodiode. The tunnel model designed for this tunnel system has dimension of 120 cm long, 14.5 cm width and 120cm height. It has 1 (one) vehicle track with 3 lanes, north-south oriented tunnel, ceiling mounting lamp configuration with 2 line lines, and road surface reflection coefficient is 0.3 (light gray).

The design of the tunnel lighting system model includes lighting design for the night time. The desired conditions at night are luminance (L) or illuminance (E) along the tunnel is the same. The amount of L or E in the tunnel is not much different from L or E outside the tunnel. In order to save energy, then when there is no car, then the tunnel lighting will be dimmed.

The block diagram of the tunnel lighting system model can be seen in Fig. 4. The block is realized with the LDR sensor, photodiode sensor, Arduino uno and RGB LED. Arduino uno is a circuit board that contains microcontroller (minimum system). This microcontroller board has a small size, almost the size of a credit card, equipped with a number of pins that can be used to communicate with other equipment.

The design of roof, base bottom and tunnel wall can be seen in Fig. 5.a. In order for this model is not affected by the light from the surrounding so it can simulate the night time, the model is placed under a 150 cm long enclosure box (see fig. 5.b).

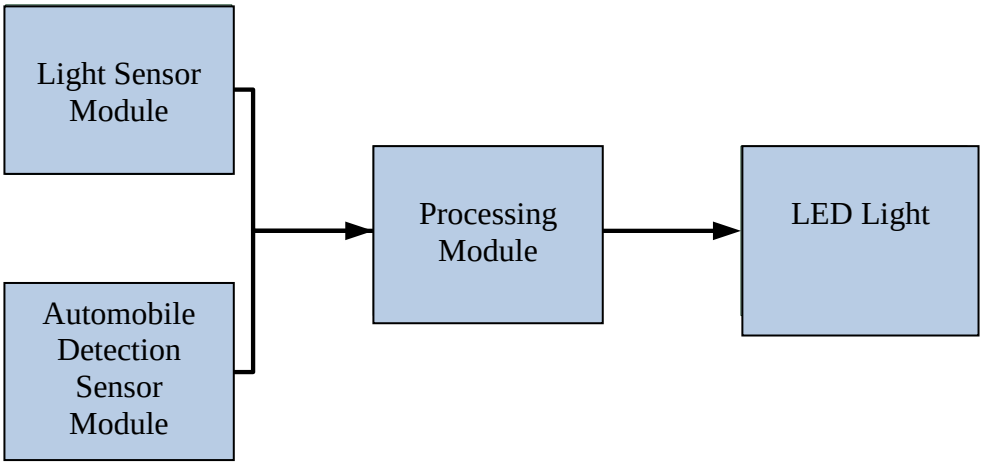
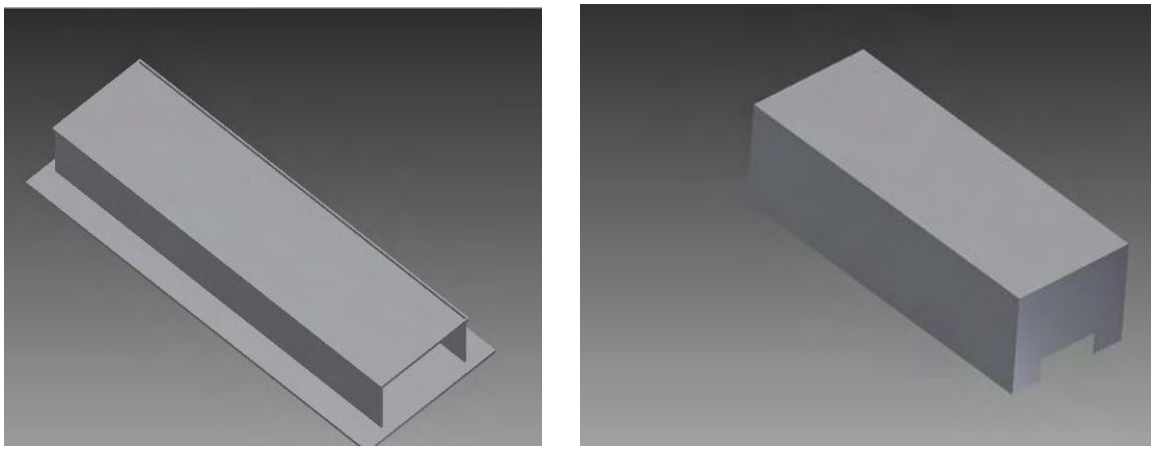


Fig. 4 Block diagram of tunnel lighting system model for Pasar Rebo tunnel

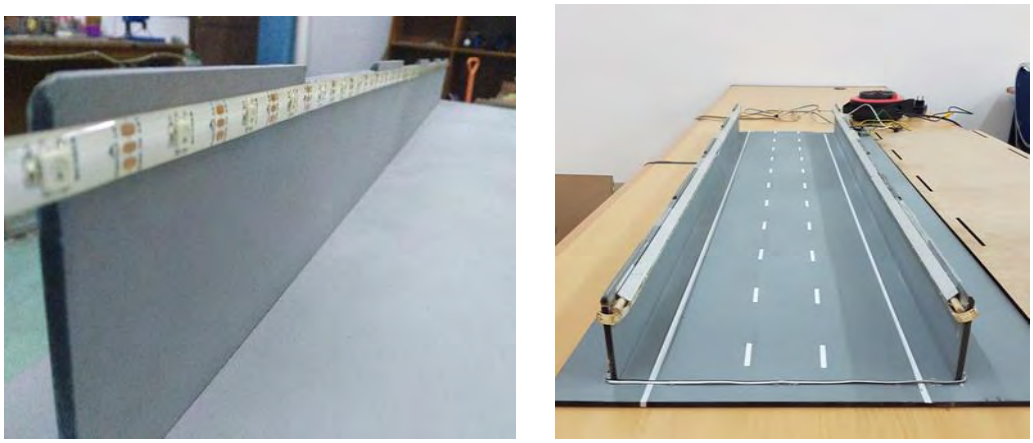
ISBN: 00-00-00-00-00



(a) (b)

Fig. 5 Design of tunnel lighting system model and its enclosure

The lamps used to realize this tunnel lighting model are the Red, Green and Blue Light Emitting Diode (RGB LED) series, to replace the LED lamps and HPS lamps attached to the Pasar Rebo tunnel. In this design use RGB LED type WS2812 which is a simple RGB LED with integrated control circuit hidden or embedded in one package. Figure 6.a is a RGB LED string consisting of 35 RGB LEDs mounted on each of the tunnel model walls, so the total RGB LEDs used are 70 pieces (see Figure 6.b.).



(a) (b)

Fig. 6 LED lamps attached to tunnel lighting model

3. RESULTS AND DISCUSSION

This tunnel lighting system model is tested with several conditions aimed at

optimizing the use of electrical energy. The first condition is the automation of nighttime lighting when there is a passing vehicle or not. The design result of this model is made to meet all conditions and if this model can be implemented in Pasar Rebo and other tunnels, it is expected that there will be energy savings.

The tunnels at night time have the same lighting condition in all tunnel zone and have smaller illuminances than during the day. At night time, the tunnel lighting simply follows the lighting conditions outside the tunnel, which correspond to the street lighting before entering or exiting the tunnel. The model of the night tunnel lighting system is divided into two features, first there is no car passes through the tunnel (see Figure 7) and secondly, when a car passes through the tunnel (as in Figure 8).

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The first feature is tested and showed that the sensor can detect the absence of a car so it will dim the lights automatically. After that, the model is tested with the second feature by putting the car in front of the tunnel model. The sensor can detect the car and gradually turn on all the lights so that the tunnel illuminance reaches maximum. The reduction of illuminance in this model of tunnel lighting system is done by reducing the intensity of light (ie by dimming) of all RGB LEDs in the tunnel.

Fig. 7 Realization of the tunnel lighting model when no car pass through

Fig.8 Realization of the tunnel lighting model when a car pass through

4. CONCLUSIONS

Based on the testing and analysis that had been done, it could be drawn some conclusions, namely:

1. Tunnel lighting system model could be realized in accordance with its specifications.
2. Tunnel lighting system model could meet night time lighting in the tunnel.
3. Tunnel lighting system model had feature for the saving of electrical energy by dimming the light when there was no car passing by.
4. The weakness in this system was the use of RGB LEDs that were used instead of the actual lamp type (LED lamp) that could not follow the specifications of the LED lamp.
5. The model could be expanded to cover the day time tunnel lighting by adding external lamp to simulate sun ray during day time.

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