Analysis of LED Luminer for Street Lighting Based on lamp Housing, Drivers and Optics to get Luminous Efficacy

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Abstract. This study aims to determine whether the lights on street lighting can be optimized by changing the lamp housing, LED electronic drivers and even the use of optical lenses to make lighting brighter and save energy. Assisted by a partner making street lighting by providing a few examples of experiments that have been carried out by these partners to be able to do an analysis of the products that have been produced and made by these partners. Its production is CSL14 code which has a tendency to use glass as a function to protect the LED chip, but it turns out the glass actually reduces the intensity of light. CSL19 code is starting to appear there is an update by using optical lenses with anti-dust and waterproof materials, it seems that the intensity of street lighting can be more optimally. CSL19 product is proven better than CSL14. Based on measurements it was found that the use of optics can increase optimization and lighting can be more scattered. The use of glass lampshades actually also proved to have worse consequences than the measurement of light intensity on CSL19. CSL19 products are equipped with LED driver technology that is able to do adjustable dimming so that the light intensity is proportional to the desired power.

1. Introduction

Fatal accidents can occur if in a state that tends to dark [1]. Lighting is very important here in reducing the risk that is not desirable. Lighting in public places is also a part in making the night atmosphere not scary so some people can enjoy and do activities such as morning and afternoon. Lighting does not apply to the night only, but more precise lighting is needed for dark times where lighting is felt less and even needed. Road lighting on toll roads or in public places is felt to have the right lighting standards. Current lighting technology is LED technology where lighting becomes more energy efficient. Referring to lighting standards that can be made day by day the level of lighting can be made brighter and more economical [2].

The goal of lighting science is to study street lighting is to analyze patterns at the horizontal and vertical levels of the lighting object. The driver's eyes are expected to be able to comfortably see objects both near and far on a road based on the brightness of the object and the background lighting around the object could have been through the reflection of light from the road surface or shadow. Lighting design is related to the selection of lighting and the location of the lighting where it is placed so as to provide better visibility and whether it can improve safety with the final consequence of maximizing efficient energy use. There are two basic lighting design concepts, namely the concept of illumination and the concept of light [1]. The concept of illumination that is generally used in the United States of America based on a certain level of lighting on uniform distribution and satisfying visibility. The concept of

light generally exists in parts of Europe and its method is based on the visibility of exposure to street lighting and objects on the road.

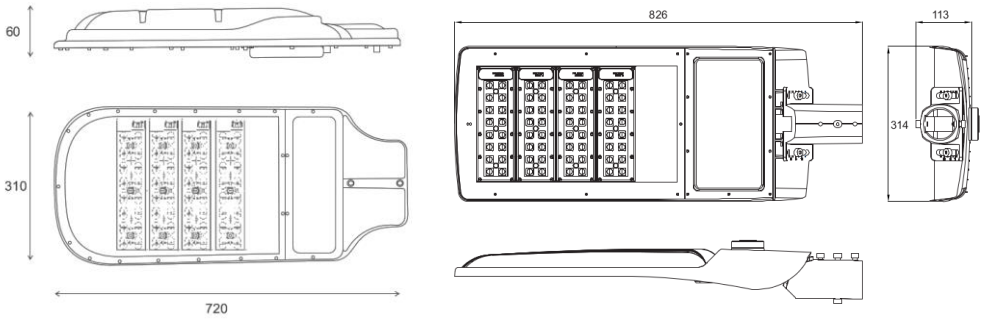

Figure 1. CSL14 (Left) and CSL19 (Right)

We collaborate with partners in this research where partners are manufacturing plants for lighting on public roads and toll roads. In this case the partner has made several product samples for the lighting of toll road lights several times in this decade. Partners also welcome our research well if the results of their creations can also be reviewed and analyzed by and from the lighting science section. Based on the work of partners there are 2 types that can be examined, namely CSL14 and CSL19 where both of these products already use LED chip lights for the main part of lighting.

There are two products to be analyzed, namely CSL14 and CSL19, where the two types are identical, but the difference is in the lamp shades that use glass in CSL14 (Figure 1). In order to achieve the protection index category of IP 65, this is a big challenge for CSL19 products to be able to achieve the conditions of the protection index. IP 65 protection index means having a resistance to anti-dust and anti-blast of water from all directions (raining protection) [3].

Luminous efficacy is a measurement commonly used in lighting technology that measures the ability of a light source to emit its magnitude of light power compared to the total power used. Basically the goal of all lighting products is the efficacy of light luminance with the smallest possible power source and the maximum amount of light output [2]. Therefore, CSL14 products need research to be able to improve the efficacy of light in a variety of ways.

2. Method and Analysis

2.1. *Luminaires based on lamp housings*

The lamp housing can be said to be the outer portion of the lamp which protects the electronic components inside and the eyes from the LED lights used. This lamp house has a function as a heat extinguisher for electronic components and as a barrier to rain or water that will get wet. Generally, this lamp housing is made of aluminum-containing material which can dissipate heat rather than the electronic components inside. CSL14 and CSL19 use lamp housings made of closed figures for installation of side entry poles. Top and bottom die-cast aluminum housing. CLS14 and CSL19 products use the same Fast Flex T2S1502 optical lens, but in the CSL14 lamp housing the initial design used glass as a shield from the optics and LED lights. To improve the efficacy of the luminous, the design is changed to CSL19 which is stiffer and better structured than CSL14, but the results of the measurements carried out did not have a satisfying impact. In the CSL19 lamp housing there are also slots for more lamp modules, a maximum of 5 lamp module slots. Whereas the CSL14 only uses a maximum of 4 lamp module slots, shown in Figure 2.

(a) (b)

Figure 2. Lamp housing of LED Luminer for Street Lighting (a) CSL14 and (b) CSL19

2.2. *Luminaires based on LED Drivers*

LED drivers have a difference with the power adapter that is generally used. LED driver uses technology that can emit a constant electric current, but the magnitude of its voltage becomes changeable. The adapter uses technology that keeps the output voltage always constant, but the electric current that is issued varies according to the utility load.

LED driver technology uses a type of isolated topology where energy transformers are used in the form of analog technology (transformer) and digital technology (photocoupler / optocoupler). Therefore if the LED driver is dismantled as shown in Figure 3, many transformers are used to convert both high voltage to low voltage. It should be noted that the LED driver must produce a constant electric current.

LED driver has a maximum power of 150 Watt with a current of 0.7 A (constant electric current). On measuring power using a constant current of 0.7A, an LED driver will produce a voltage based on a load from 85 Volts to 214 Volts Maximum. In the current study, based on the use of the led light module, the current driver used is the right module. However, if the usage per lamp module has different current consumption, then a different LED driver module is needed. At the core of the LED driver module must be adjusted to the use of the required constant current, this is reasonable because in assembling the LED light circuit is a series of series so that the current used will be the same based on the laws and theories of electric current.

Figure 3. Position LED Drivers in Lamp Housing

2.3. *Luminaires based on Optic*

Optics plays an important role in the distribution of light [4]. An optic determines the form of light distribution. Shown in Figure 4 where in the optical selection used the Fast Flex version of T2S1502 which produces light such as the appearance of a wing looks suitable for light distribution in public places. CSL14 and CSL19 use the same optical type. But on

CSL14 protected again with a glass to reach IP65. In CSL19 the glass layer is removed and is not used. The results of the light CSL14 and CSL19 are compared between using and not using a glass coating. Based on data retrieval in the field, we will get the data in the test and results.

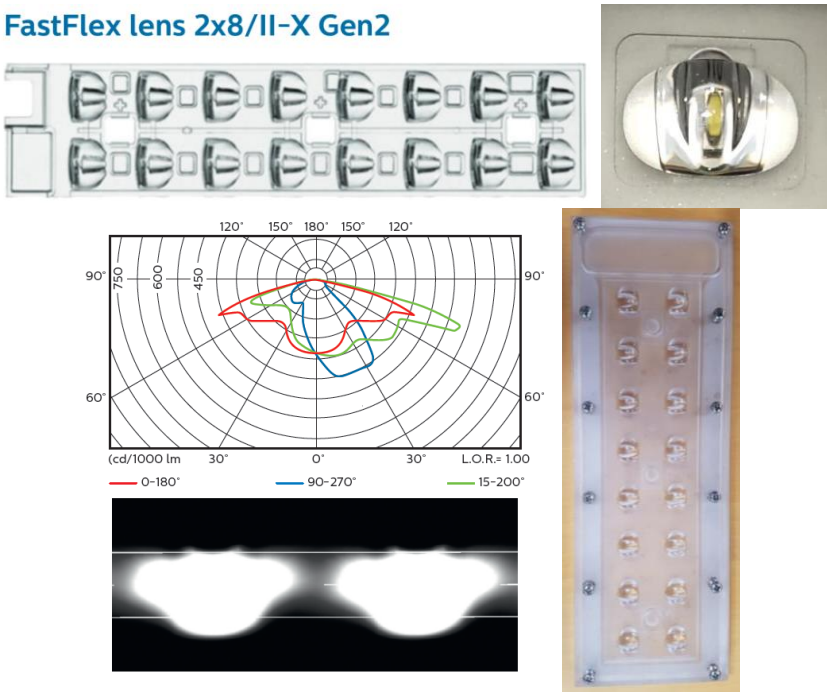

Figure 4. Optics for CSL14/CSL19 and scattered of light on lenses [6]

3. Results and discussion

3.1. Mockup and Test in Field Test Cengkareng-Batu Ceper-Kunciran Toll Road for CSL 14 Luminer type.

CSL14 luminer type was tested in the *Cengkareng-Batu Ceper-Kunciran* toll road test field with a power of 120 watts, pole height of 13 meters with a distance between the light poles of 35 meters, and 40 meters. The result test of Iluminance (Lux) and Luminance (Candela/m^2) of CSL14 in the field, shown in Figure 1. The results of measurements in the field states that at a distance of 40 meters has an average of Iluminance (E_{av}) is 16.98 Lux and average of Luminance (L_{av}) is 1.46 cd/m^2, which means greater than the Indonesian national standard of 15 Lux and 1,5 cd/m^2. The results of measurements in the field also mentioned that at a distance of 35 meters has an E_{av} of 18.8 Lux and L_{av} is 1.60 cd/m^2 which means it is also bear more than the standard of 15 Lux and 1,5 cd/m^2.

3.2. Iluminance and Luminance Analysis for CSL19 Luminer Type.

There are 3 types of lamp power circulating in the market for public street lighting [5] , i.e. the power of 90 watts, 120 watts, and 150 watts, for the types of collector roads, arterial roads, highways/toll roads, and flyovers. CSL19 luminer type was tested in the Cinere - Serpong toll road test field with a power of 120 watts, pole height of 13 meters with a distance between the light poles of 40 meters. The result test of Iluminance (Lux) of CSL19 luminer type in the field shown in Table 2 and Luminance (Candela/m^2) in Table 3. The results of measurements in the field states that at a distance of 40 meters has an average of Iluminance (E_{av}) is 22,26 Lux and average of Luminance (L_{av}) is 1.912 cd/m^2, which means

the greater than the Indonesian national standard of 15 Lux and 1,5 cd/m^2, and also the greater than E_{av} and L_{av} of the CSL14 luminer type.

Base on this study of product CSL14 luminer type, to develop a new product was called CSL19 luminer type which no used glass as a protector. To pursue the IP65 protection index, CSL19 has a waterproof rubber protection technology in the form of a white silicone adhesive to prevent water from entering into the gaps of the electronic device. Final tests on CSL19 luminer type products are as follows, the output power is 120 watt, luminous flux is15600 lumens, and luminous efficacy is 137.5 lumens/watt.

Table 1. The result test of Iluminance in Lux (a) and Luminance in Candela/m^2 (b) of CSL14 Luminer type in the Field

	LANE 1	LANE 2	LANE 3		
Pole 10	28.30	23.32	18.22		
	26.25	21.73	16.73		
	23.12	19.68	15.59		
	19.20	16.64	13.02		
	15.01	13.32	11.76		
	12.22	11.86	10.47		
	11.52	11.09	10.11	40 m	
	11.89	11.55	10.56		
	13.39	12.52	11.06		
	16.12	14.52	12.73		
	19.85	17.25	14.34		
	23.32	20.28	16.37		
	26.93	22.94	17.80		The distance between longitudinal measurement points is 2.85 m
Pole 09	28.39	23.50	18.39		
	28.53	23.63	18.37		
	26.80	22.60	17.70		
	23.36	16.62	16.44		
	19.76	17.01	14.53		
	16.52	14.51	12.31		
	15.57	13.78	12.38	35 m	
	16.10	14.22	12.75		
	17.95	15.43	13.53		
	20.65	17.51	14.90		
	24.62	20.40	16.60		
	28.03	23.67	18.06		The distance between longitudinal measurement points is 2.9 m
Pole 08	29.37	25.62	19.50		

	LANE 1	LANE 2	LANE 3		
Pole 10	1.321	1.09	1.027		
	1.163	1.157	0.977		
	1.244	1.376	0.975		
	1.263	1.294	1.687		
	1.26	1.345	1.237		
	1.378	1.588	1.232		
	1.29	1.783	1.114	40 m	
	1.641	1.59	1.074		
	1.723	1.636	1.462		
	2.063	1.663	1.444		
	1.919	1.926	1.148		
	2.079	1.817	1.418		
	2.06	1.478	1.331		Distance between longitudinal measuring points is 2.85 m
Pole 09	1.794	1.6868	1.518		
	1.389	1.066	1.212		
	1.874	1.728	1.699		
	2.223	1.664	1.532		
	1.44	1.37	1.62		
	2.369	2.161	1.43		
	2.375	2.018	1.464	35 m	
	2.249	1.695	1.464		
	2.189	1.807	1.412		
	2.053	1.61	1.238		
	1.766	1.513	1.14		
	1.02	1.107	1.683		Distance between longitudinal measuring points is 2.9 m
Pole 08	1.275	0.93	0.91		

Table 2. Iluminansi Result Test (Lux) of CSL19 luminer type

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
a	18.98	19.12	19.04	18.73	18.07	17.62	17.29	17.34	17.95	18.65	19.04	19.25	19.59	19.87	19.75	19.59	19.20	18.44	18.54	18.67	19.07	19.92	20.29	20.84	21.05
b	23.07	23.14	23.45	24.28	23.59	23.03	22.70	22.65	23.00	22.89	22.80	23.05	23.22	23.56	23.77	24.23	24.45	24.00	24.19	24.35	24.53	25.25	24.70	24.92	25.03
c	23.28	22.97	23.40	24.17	24.32	23.84	23.29	23.27	23.61	23.53	22.94	22.09	23.05	23.09	23.50	24.45	24.81	24.87	25.12	25.29	25.35	25.54	24.93	24.71	24.51
	Eav	**22.26**		**Emin/Eav**		**0.78**																			
	Emax	**25.54**		**Emin/Emax**		**0.68**																			
	Emin	**17.29**																							

Table 3. Luminansi Result Test (candela/m2) of CSL19 luminer type

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	2
a	2.049	2.089	2.023	1.863	1.832	1.845	1.853	1.952	1.948	1.967	1.877	1.601	1.647	1.584	1.229	1.605	1.557	1.576	1.602	1.585	1.623	1.659	1.645	1
b	2.331	2.252	2.209	2.251	2.066	2.270	2.248	2.050	2.138	2.313	2.105	1.772	1.949	1.383	2.032	2.167	2.051	2.066	1.948	1.866	2.128	2.208	2.248	2
c	2.024	2.090	2.106	2.073	2.082	2.210	2.179	2.037	2.238	2.309	2.179	1.901	2.072	1.947	2.659	1.962	1.951	2.015	2.103	1.979	2.171	2.306	2.115	2
	1.651	1.698	1.600	1.680	1.750	1.798	1.794	1.310	1.321	1.382	1.186	1.295	1.895	1.847	1.716	1.654	1.811	1.784	1.825	1.901	1.880	1.927	1.792	1
	Lav	**1.912**		**Lmin/Lav**		**0.620**																		
	Lmax	**2.659**		**Lmin/Lmax**		**0.446**																		
	Lmin	**1.186**																						

4. Conclusion

The conclusion obtained from this analysis is that with optics it is clear that the results of the light distribution will be very influential. Optics have a very big influence where with the same type of eye LED lights will certainly have differences between the use of different optics. The second thing that can be concluded is that the use of low power, of course this is the goal for all the use of lamps with low power but as much light is produced. The results obtained based on the trial of CSL19 products the luminous efficacy increased from 120 lumens/watt (CSL14) to 137.5 lumens/watt. This is an improvement and learning that glass will not necessarily be a better light distribution.

5. Acknowledgment

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