The study of factors affecting the occurrence of light pollution that comes from the park.

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Abstract

This project aims to study the shapes of lamps that maximize reflection and determine the road surfaces that most effectively reduce light pollution. Conclusion is a rectangular pyramids base reflects light onto the ground most effectively. Additionally and black-tinted concrete demonstrated the highest reduction in light reflection from the lamp to the sky.

Research background

Light pollution is the light that arises from human activities during the night, encompassing the pollution resulting from the excessive use of light. This includes the inappropriate design and installation of electric bulbs or lamps, leading to adverse effects on both humans and the environment.

In Currently, light pollution is consistently on the rise, primarily due to urban expansion. This trend has significantly impacted astronomical observations, making them increasingly challenging. Additionally, nighttime light interference also disrupts the lives of wildlife.

Our team is interested in studying the factors influencing the occurrence of light pollution originating from public parks. Our team plan to conduct experiments comparing various shapes of light fixtures to identify the shape that can most effectively reduce light pollution. Additionally, they aim to compare the reflection characteristics of different road surfaces, such as asphalt and concrete, to find the road surface that minimizes light pollution most effectively.

Method

1.Study and gather information regarding the regulations for installing lights in public parks.

2. Design and cut plastic boards according to the shapes of the light fixtures. As shown in Fig 1.

3. Apply foil to the inner surface of the light fixtures.

4. Test the light reflection of each shape of the fixtures to find the most efficient design in terms of energy conservation and brightness enhancement for public parks. Install the fixtures at a height of 2 meters and measure the brightness on the ground at points corresponding to the center of the light bulb, on the road surface directly under the light, and on the road surface at distances of 1, 2, 3, and 4 meters away from the pole in a horizontal direction. Measure the brightness using a lux meter, As shown in Fig 2.

5. Once you have the best shape for the lamp, for the fixtures is determined, proceed to conduct experiments to test the reflection on road surfaces, including asphalt and concrete. Measure the brightness values reflected upward. As shown in Fig 3.

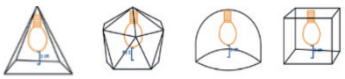

Fig 1 : shows the shape of the lamp in various forms

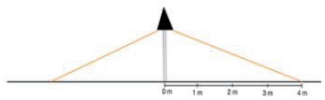

Fig 2 : shows the distance for measuring the reflection of each shape of lamp

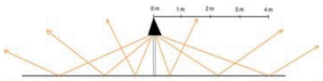

Fig 3 : shows the measurement range for reflectivity of various types of road surfaces

Result

SHAPE	MEASUREMENT PLANE DIRECTION	BRIGHTNESS AT DISTANCES ALONG THE HORIZONTAL PLANE FROM THE LIGHT FIXTURE POSITION (LUX)				
		0 m	1 m	2 m	3 m	4 m
SQUARE BASE PYRAMID	RIGHT	61.90	40.10	13.85	3.15	0.42
	45°	61.20	42.40	15.69	4.63	1.16
	LEFT	60.70	43.40	17.45	4.62	1.07
SEMI – CIRCULAR SHAPES	RIGHT	22.35	19.07	9.25	3.32	1.50
	45°	21.90	19.85	10.48	3.70	1.84
	LEFT	22.79	18.41	8.37	3.08	1.67
GYROELONGATED PENTAGONAL PYRAMID	RIGHT	25.33	29.28	10.60	3.51	1.53
	45°	24.16	24.61	7.49	3.03	1.59
	LEFT	24.16	23.15	6.72	1.07	1.42
RECTANGULAR PRISMS	RIGHT	23.64	20.76	10.84	4.42	2.13
	45°	22.57	19.87	9.07	4.23	2.08
	LEFT	22.97	17.58	6.91	3.16	1.72

Table 1 Shows the results of the experiment on the reflection of surfaces inside the light fixture.

TYPE OF ROAD SURFACE	EP.	BRIGHTNESS AT THE DISTANCE IN THE HORIZONTAL PLANE FROM THE POSITION OF STREETLIGHT (LUX)					
		0 m	1 m	2 m	3 m	4 m	AVERAGE
ASPHALT ROAD	1	13.90	4.58	2.54	1.40	0.50	3.84
	2	8.83	4.20	2.72	1.31	0.99	
	3	7.34	4.31	2.76	1.64	0.59	
CONCRETE ROAD	1	12.00	6.93	5.27	2.52	1.14	5.87
	2	13.30	7.29	4.82	2.85	1.51	
	3	13.80	7.33	4.78	2.95	1.55	
CONCRETE ROAD PAINTED BLACK	1	7.43	2.80	1.61	0.82	0.56	3.22
	2	11.20	2.09	1.06	0.42	0.41	
	3	10.9	6.07	1.67	0.81	0.39	

Table 2 presents the results of the experiment on the reflection of each type of road

Results and Discussion

Conclusion From the experimental study to find the most efficient shape of light fixtures that can help reduce light pollution, it was found that the most efficient light fixture is the pyramid-shaped one with a rectangular base. (From the results in Table 1.)This fixture provides better brightness values and minimizes light reflection the most. This is due to the extensive light dispersion of this pyramid-shaped fixture, which results from the lower internal reflection angles compared to other shapes. When light is directed downward onto the ground, it yields the highest brightness values

From the experiments, it was found that the type of road surface with the least amount of light pollution from the ground to the sky is Black-topped colored concrete This type of road surface showed the least brightness in terms of reflection. (From the results in Table 2.) As for the concrete road surface, it has a smoother texture compared to asphalt and is white, resulting in more light reflection. This led to a higher level of light reflection compared to black-topped concrete. In the case of the asphalt surface, it exhibited a higher level of light pollution, especially when it had a similar black color to Black- colored concrete Consequently, this results in a higher rate of Light pollution compared to the black-topped colored concrete road. Black-colored concrete is not harmful to Light pollution.

Summary

The results from the experiment indicate that a square base pyramid shape can achieve the maximum ground reflection of light. Additionally, it was found that roads made of black-tinted concrete can minimize the rate of reflection of light from overhead lamps to the greatest extent.

Reference

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