

Illuminated Pedestrian Crosswalk

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Abstract

Pedestrian safety is a critical concern, particularly at night when poor lighting conditions make it difficult for drivers to detect pedestrians at crossing points and intersections. More than half of road accidents involving pedestrians occur at intersections lacking adequate pedestrian infrastructure. Additionally, insufficient street lighting and poorly maintained or faded road markings reduce visibility at pedestrian crossings, thereby increasing the risk of road accidents. This research investigates the use of illuminated crosswalks as a countermeasure to reduce pedestrian-related accidents occurring under low-light conditions. A pilot study was conducted to evaluate the illumination duration of various types of paint. The results indicate that a combination of standard road line paint, phosphorescent powder, and sodium aluminate compound produces a significantly longer-lasting glow. The results shows that the application of phosphorescent paint on pedestrian crossings can substantially enhance night-time visibility, thereby improving pedestrian safety. This approach offers a cost-effective and sustainable solution for enhancing road safety in poorly lit areas.

Key Words: *Pedestrian Safety; Poor Lighting; Pedestrian Infrastructure; Illuminated Crosswalks*

1. Introduction

According to the World Health Organization (WHO), there were approximately 270,000 pedestrian deaths worldwide in 2013 (Cazacu-Stratu, 2021), which is an average of 740 pedestrian deaths per day. More than one-fifth of the people killed on the world's roads each year are pedestrians, not travelling in a car, on a motorcycle or even on a bicycle (WHO, 2013). However, according to the Malaysian Institute of Road Safety Research (MIROS, 2020), there were 7,152 accidents involving pedestrians in Malaysia in 2020, resulting in 6,551 injuries and 534 fatalities. Several factors contribute to accidents involving pedestrians in Malaysia, including insufficient or less of pedestrian infrastructure. Many roads in Malaysia lack proper pedestrian infrastructure, such as sidewalks, crosswalks, and pedestrian signals, making it difficult and dangerous for pedestrians to cross. On the other hand, pedestrian safety is less considered as one of the factors in road design, such as narrow lanes or poor lighting in some areas. Pedestrian behaviour itself turns into accidents involving pedestrians, especially the well-known practice of 'jaywalking', which involves avoiding designated pedestrian crossings with potentially dangerous repercussions, is the contrast of regular crossings. Zebra crossings, which are meant to offer safe passage, frequently end up as the front line where vulnerability meets visibility. Nevertheless, the complexity of intersection dynamics increases the severity of collisions. Approximately 50 per cent of pedestrian deaths happen at these critical intersections, highlighting the necessity of all-encompassing safety precautions. The studies also show that the number of accidents at crosswalks is higher 18% than at other locations (Elvik et. al,2009). Moreover, as pedestrian is the most vulnerable road user, the exposure to vehicular traffic is considered as risky as compared to the other transportation network user especially when involve crossing activities. As reported in the Malaysian Road Safety Plan for 2014-2020, the pedestrians' deaths and injuries in 2013 were recorded at the third place after motorcyclists and passenger car road users (Ismail et. al,2023).

Pedestrian safety is crucial in urban areas, especially at locations with poor lighting under dark conditions. The poor lighting will contribute to accidents involving pedestrians and other vehicles due to the limited vision of motorists to spot pedestrians. Therefore, the innovation of illuminated pedestrian crosswalks will enhance the safety of pedestrians, especially at night.

Pedestrian safety is worldwide problem which need to be addressed particularly at night. The are lighted pedestrian crossings made of reflecting or phosphorescent materials have

become safety symbols in the US, UK, and Japan. These bridges serve as a nocturnal marriage of utility and urban charm, absorbing sunlight throughout the day and casting a brilliant illumination at night. The existing study has been investigated and shows that the application of glow line markings in a road environment can contribute to a reduction of traffic accidents at nighttime (Lee et al,2015)

The problem statement in this research is poorly painted or faded road markings, which are less visible to pedestrians and drivers, making it less effective for pedestrians. Therefore, high-quality and long-lasting paint will be more effective in making road markings and crosswalks clear and visible to ensure pedestrian safety. Also, poor lighting has contributed to the difficulty for drivers to see pedestrians. The objective of this study is to develop a prototype with a mixture of various types of paint and to evaluate the duration of illumination.

2. Materials and Methods

The safety of pedestrians can be improved with innovation to brighten crosswalks in Malaysia. Our study focuses on improving pedestrian safety, especially at night. The Illuminated pedestrian crosswalk study investigates the pedestrian's safety using different reflecting materials and phosphorescent paint. The research question will be how various lighting materials affect pedestrian visibility.

2.1 Materials and Equipment

The main goal is to create and test an illuminated pedestrian crosswalk prototype with different materials such as reflecting materials and phosphorescent paint. Existing research shows that luminescence materials such as phosphoric powder, fluorescent and novel Strontium aluminate compounds are all designed to produce shining crosswalks. Luminescent materials or phosphors emit light once they absorb it from a light source and are classified in chemical group, excitation source and can be used as an application (Munikanana, V et.al, 2021).

A glow-in-the-dark material simply requires chemicals that store energy when exposed to light. Among those types of glow-in-the-dark materials, (strontium aluminate compound, SrAl_2O_4), the phosphorus glow, which is also known as photoluminescent glow material, is the best to be applied to achieve the objective. Thermoplastic powder and glow-in-the-dark powder need to be mixed well to produce a better mixture solution. Adding the dark material to the mixture requires a new mixing ratio of the materials. The SrAl_2O_4 material can absorb surrounding light and then slowly emit the light. Materials that practice this method and technology can glow in the dark for years if they are exposed to adequate light. This gives an advantage in the argument of the material selection (Munikanana, V et.al, 2021).

Road marking paint, also known as road marking paint, is a special type of paint to mark roads, sidewalks, and another traffic surfaces. Road line is formulated for high visibility and provides clear guidance to vehicles, pedestrians and bicyclists on the road. It also has the ability to dry quickly and minimise traffic disruption during application. Road line durability is designed to withstand the wear and tear of vehicular traffic and to ensure that signs remain visible over the long term. In terms of cost efficiency, road paints often less expensive than alternative road marking materials which making them the preferred choice.

Acrylic paint is a water-based paint made by suspending pigments in an acrylic polymer emulsion. It has the advantage of withstanding heavy traffic and harsh weather conditions without fading. Meanwhile, phosphorescent powder is a type of pigment that can absorb and store light energy from various sources, such as the sun and artificial light and slowly release

it in the form of visible light over time. This material acts as phosphorescent and can be used to create glow-in-the-dark materials. The strontium aluminate compound absorbs and stores energy from light and then emits visible light over a longer period to produce a glow which last for a longer period.

3. Results and Discussions

Pedestrians should feel safe to cross the streets, especially in low light or under dark conditions. Therefore, this research will investigate illuminated pedestrian crosswalks to improve the safety and visibility of pedestrians in low light. The main objective of this study is to evaluate several paint combinations for brightness at pedestrian crossing. The main component of this study is the methodical observation of glow times and properties characteristics of paint mixture or blends, such as road line paint, phosphorescent powder and strontium aluminate compound.

Our investigation is to find a countermeasure for pedestrians to cross at conventional pedestrian crossings with illumination at night and feel safer. Also, our goal is to create a solution that improves visibility while being resistant to environmental changes and time. The Figure 1 shows a mixture of strontium aluminate compound, while figure shows a mixture of strontium aluminate and strontium aluminate compound at day and at night.



Figure 1: Strontium aluminate compound



Figure 2: Strontium aluminate and strontium aluminate compound

The study's main objective is to evaluate several paint formulations that have been carefully chosen to give pedestrian crossings durability and brightness. The main component of this study is the methodical examination of glow times and unique properties displayed by a variety of paint blends, such as road line paint, phosphorescent powder and strontium aluminate compound and their combinations. The table 1 provide a thorough breakdown of glow times for several paint mixture. Adding strontium aluminate compound and

phosphorescent powder, the material's possible effects on longevity and visibility were highlighted by the differing glow durations.

Table 1: Duration of Paint Mixtures

Paint Mixture	Ratio	Glow Duration
Road line paint	N/A	0
Road line paint plus phosphorescent powder	1:1	30 minutes – 1hour
Road line paint plus strontium aluminate compound	1:1	3 Hours
Road line paint plus phosphorescent Powder and strontium aluminate compound	1:1	3.5 Hours

Based on table 1, although the choice of road line paint is the best option due the durability, visibility and cost effectiveness, but it does not glow. Meanwhile, Phosphorescent powder plus road line paints show that the glow lasts around 30 minutes 1 one hour. In another hand, road line paint plus strontium aluminate compound has produce glow for three hour which showing promise as a possible substitute. In the last test of our research, road line paint mixed with phosphorescent powder and sodium aluminate compound, producing a glow that lasted for 3.5 hours. This hybrid strategy creates opportunities to improve our glowing pedestrian crossings.

Our research into various glowing paints for pedestrian crossings has yielded promising results. Certain combinations, particularly when mixed with road line paint and specific reflective powders, produced a glow that lasted significantly longer. This suggests great potential for improving crosswalk visibility for pedestrians, even at night.

4. Conclusions

The objective of this research is to investigate the use of illuminated crosswalks as a countermeasure to reduce pedestrian-related accidents occurring under low-light conditions. The findings show that phosphorescent powder contribute to glow for period of three and half hours with ratio 1:1. As our study is to improving visibility in low light has been achieved with through this study. Using the ratios employed in the studies, you would probably methodically explain these results, describing the glow durations and characteristics of the various paint mixtures (road line paint, phosphorescent powder, strontium aluminate compound, and their combinations).

The strontium aluminate compound consistently outperforms other additives in terms of glow duration. This interpretation emphasises that the extended light attained is directly correlated with the selection of luminescent materials. It confirms that improving road surface safety visibility, especially in low light, is one of our project's original goals. From the first phosphorescent powder tests to the three and a half hours in the 1:1 ratio investigation, the patterns of glow duration become important. Our goals of improving visibility in low light are perfectly aligned with these patterns.

The strontium aluminate compound consistently outperforms other additives in terms of glow duration, supporting the conclusion to favour it. This interpretation emphasises that the extended light attained is directly correlated with the selection of luminescent materials. It confirms that improving road surface safety visibility, especially in low light, is one of our project's original goals. The results are noteworthy, indicating that the Strontium Aluminate Compound alone or in combination may be the secret to producing road markings that not only fulfil but also exceed the requirements listed in our study's objectives. To put it simply, our analysis of the data acts as a benchmark for future research aimed at maximising the use of these reflective materials to provide safer and more visible driving conditions.

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