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CHARACTERISTICS OF PHOTO-LUMINESCENT (PL) POWDER APPLIED WITH POLYESTER RESIN AS GLOW-IN-THE-DARK EMERGENCY SIGNAGE

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ABSTRACT

During a disaster, the rescuer must reach the disaster area within the fastest time with the help of navigation tools. However, there might be some obstacles during the nighttime that make the evacuation of the victims difficult especially due to the bad weather. Hence, an attempt to produce glow-in-the-dark emergency signage to ease the evacuation process and to enhance visibility during nighttime is necessary. In this present study, particular emphasis is given to investigate the characteristic of photo-luminescent (PL)powder applied with polyester resin as glow-in-the-dark emergency signage. Five samples of signage were fabricated with different percentage of PL powder, i.e. 20%, 40%. 60%, 80% and 100% and mixed with 150g polyester resin. Three types of luminance test were performed to check the workability of the samples. The tests are physical appearance, one-hours illuminance test and afterglow duration tests. The result showed that the maximum lux meter reading was recorded in Sample of five (5) with six (6) lux luminosity and provided the longest glow duration of the sample before completely off after 12-hours. Results proved that the highest percentage of the PL powder content, the longer the afterglow duration will be achieved. It also noted that the polyester resin could be a good binder of PL powder for producing the glow-in-the-dark emergency signage.

1.0 INTRODUCTION

Disaster is an unexpected event that causes great damage and loss of life. Three categories of a disaster are natural, human-made and hybrid disasters [1]. Natural disasters are unpredictable catastrophic occasions such as volcanic eruption, typhoon and earthquakes. On the other hand, man-made disaster refers to any non-natural cataclysm such as structure collapse, production failures and transportation disaster. Meanwhile hybrid disaster results from both natural and man-made hazards. The example of hybrid disaster is a broad clearing of forest which causes the soil disintegration and subsequently severe landslide due to heavy rainy season [1-2].

In Malaysia, one of the frequently occurred disasters is a flash flood [3]. Flooding occurs when the water of a river flew over the artificial bank or any part of the river system. When the water level exceeds the limitation, the water will spread over the floodplain and becomes a danger to the society [4]. As reported by the Malaysian Metrological Department (2017), Malaysia had experienced severe flood on 17th December 2014, and during the event, a total of 3390 and 4209 victims was evacuated in Kelantan and Terengganu respectively [5]. The endless precipitation caused the water level rose up quickly at almost all the river in Kelantan, Terengganu, Pahang and Perak and the evacuation's victims reached about a total of 60,000 people. It showed that the response phase is one of the critical phases during the disaster and have slowed down the evacuation process of the victims. Though in Malaysia, the navigation system has been used to locate the flood area, but the system operates manually based on the previously

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installed data [6]. The rescuer may receive the wrong information about the emergency if the data not being updated [7]. Besides, during an emergency, a rescuer team must reach the scene with the fastest time. However, the difficulty to reach the exact emergency locations at night and bad weather condition may delay the rescue process. Thus, a new navigation system should be developed more effectively to ease the emergency rescue team to spot the victims with as fastest time required.

Current development of the Life Trail Traffic Signs is an example of signage innovation for emergency purpose (Figure 1). As shown in Figure 1(a), the emergency signage looks like a common road signage. However, when disaster occurs, the signage will be activated by the Disaster Prevention Centre as an emergency sign [8]. The signage will change its mode that emit light and sound to guide people or victims to the most efficient route to the nearest a safer place or shelter and relief centre as illustrated in Figure 1(b)). In case, the route is blocked, the sign will change its direction immediately to a safer place.

(a)

(b)

Figure 1. The signage function before and during the emergency, a) Before the emergency situation, b) During emergency situation (Ma et al., 2014)

Figure 2 shows the detail feature of the life trail emergency signage. The signage capable to rotate and lead victims to the direction of nearest shelter with help of the LED flashlight and warning sound. Besides, the signage contains solar panel can be charge using sunlight [8]. This invention clearly prove that an emergency signage utilization is essential for preparation to upcoming emergency and to avoid loss of life or properties.

2.0 METHODOLOGY

The methodology for this study is divided into two stages: (i) preparation of the samples, and (ii) laboratory testing (i.e. luminance test). Five samples of signage were fabricated with different percentage of glow-in-the-dark powder. The photo-luminescent (PL) powder was chosen as glow powder used in this study. The percentage of PL powder is based on the total amount of binder (i.e. 150 g polyester resin) used in this study. Therefore, in this study, five different percentage of glow powder was selected i.e. 20% (30g), 40% (60g), 60% (90g), 80% (120g) and 100% (150g). The samples were mixed with 150g polyester resin. Figure 3 shows the step-by-step process for sample preparation. The process was repeated five times with different percentage of PL powder.

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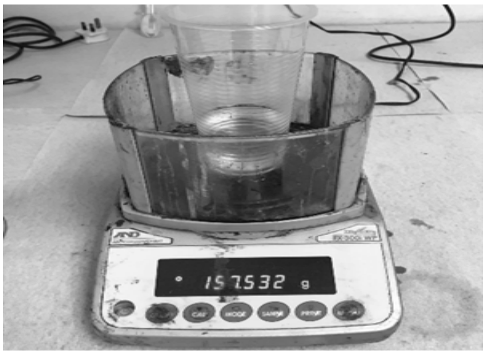
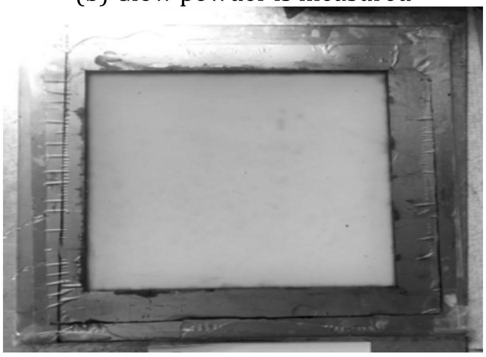


(a) Polyester resin is weighed

(b) Glow powder is measured

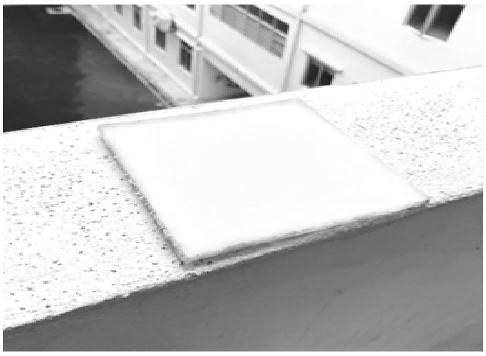
(c) Mixing process



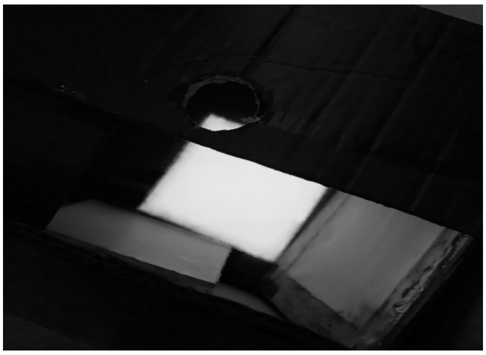
(d) Sample is moulded

Figure 3. Step-by-step preparation of the sample

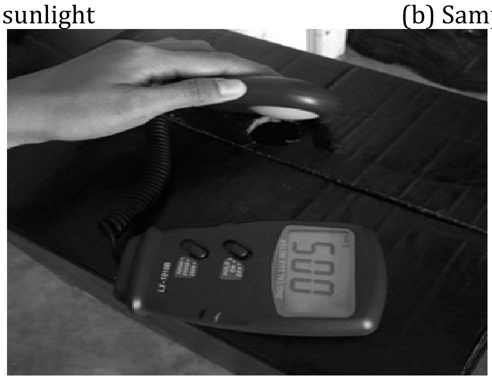
After the samples is hardened, the samples were left under the sunlight for an hour prior conducting the laboratory testing. The luminance test was conducted to measure the amount of light produced by the samples. During the testing, the sample will be placed in the dark box and the reading was recorded using a lux meter model L×1010B. From the testing, the luminosity and glow duration of each sample was determined. The procedure for luminance test is presented in Figure 4 below.



(a) Sample under sunlight



(b) Sample placed in dark



(c) Lux reading is recorded

Figure 4. The process of luminance testing and afterglow durations

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3.0 RESULTS AND DISCUSSION

3.1 The Physical Appearance of The Photo-Luminescent (PL) Sample

The end result of each sample after four (4) hours of the hardening process is presented in Figure 5 to Figure 9. In the figures, the physical appearance of the samples when placed under light and in the dark place can be clearly seen. It is noted that the signage sample with the highest percentage of PL powder provided brighter glow than the lowest percentages. Besides, from the figures, it can be seen that the glow powder has completely bonded with polyester resin. Thus, this proved that polyester resin can be a good binder for the PL powder in producing the emergency signage.

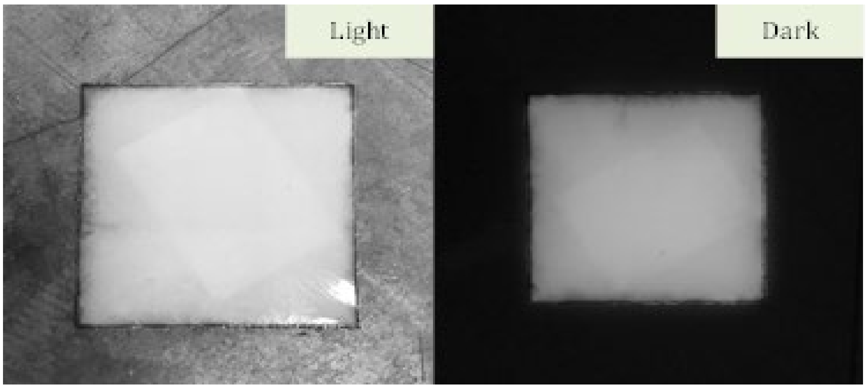

Figure 5. Sample 1 with 20% (30g) of PL powder

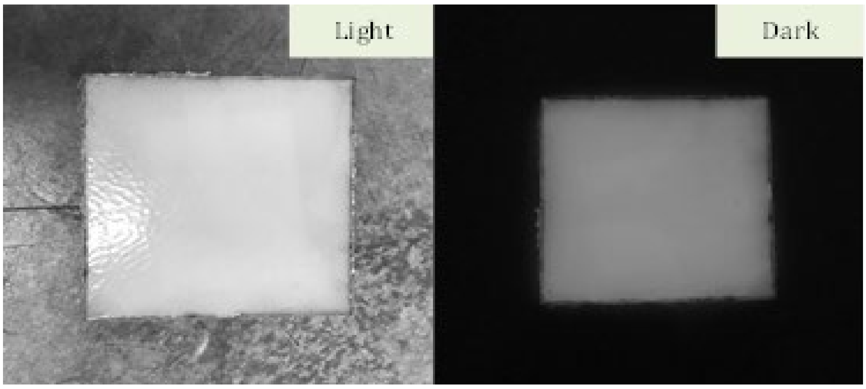

Figure 6. Sample 2 with 40% (60g) of PL powder

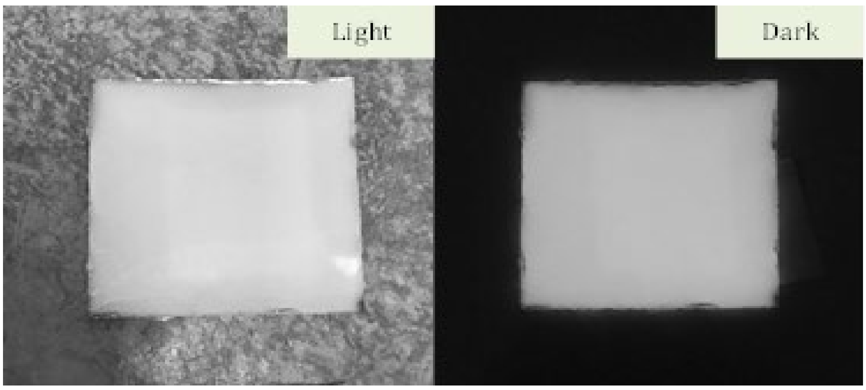

Figure 7. Sample 3 with 60% (90g) of PL powder

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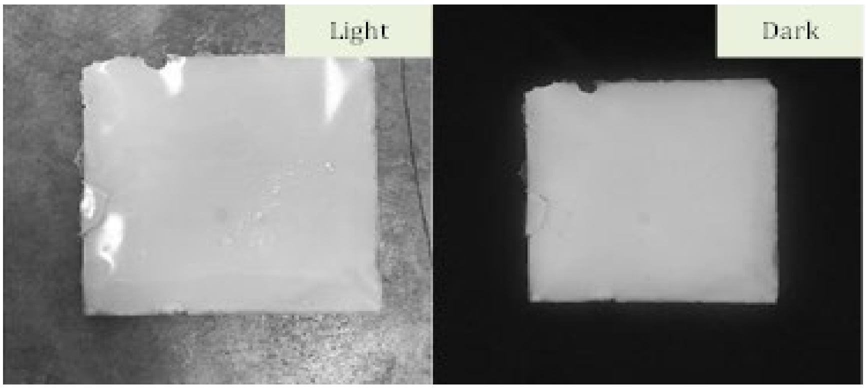

Figure 8. Sample 4 with 80% (120g) of PL powder

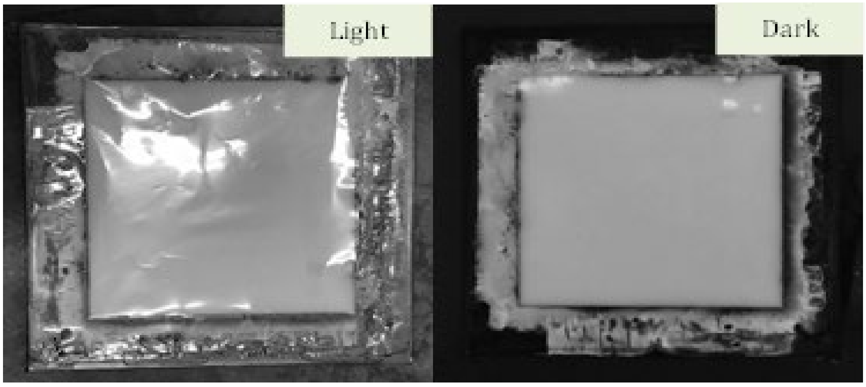

Figure 9. Sample 5 with 100% (150g) of PL powder

On the other hand, during sample preparation, it is found that when the amount of PL powder is lesser than the catalyst (i.e. polyester resin), the powder will sink to the bottom of the polyester resin when hardened. Therefore, it is recommended that the total of PL powder should have same amount as the binder or more to produce better emergency signage.

2.2 The Illuminance of The Sample

As mentioned in previous, each sample have been tested its illuminance by using lux meter after having been charged under the sunlight at approximately 1-hour. The result of the illuminance of the samples are shown in Table 1. According to the table, the reading of the lux meter decreasing every minute for each sample and remain constant at the last few minutes until reached zero value. The lowest reading of the lux meter was recorded in Sample 1 with reading taken only 1 lx that last only for two minutes. While the highest reading is 6 lx was recorded in Sample 5, which sustained the illuminance up to 11 minutes. Similar trend was noted the remaining sample, whereby, for the highest percentage of PL powder stored more source of power from sunlight compared to the samples with lowest percentage of PL powder.

Table 1. Lux meter reading per minutes of different PL powder percentages

Sample	PL (%)	Lux meter reading (lx) per min														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	20	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	40	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0
3	60	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0
4	80	5	4	3	1	1	1	1	0	0	0	0	0	0	0	0
5	100	6	4	2	1	1	1	1	1	1	1	1	0	0	0	0

3.0 RESULT OF PL AFTERGLOW DURATIONS

Afterglow is defined as a glow that remains after the light has disappeared. In this test, the afterglow duration of each sample was evaluated. Fig. 10 presents the linear relationship of afterglow duration and percentage of PL powder for five samples prepared in this study. It can be seen that the afterglow

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durations are increasing with increment of PL powder in the samples. The results showed that although the samples have been charged for only 1 hour, the samples still can glow continuously until it completely disappeared for minimum of 1.5 hours until maximum of 12 hours. The results provided similar agreement with previous study obtained by several authors [9-10]. Therefore, it is proved that the highest percentage of the PL powder content, the longer the afterglow duration of the samples.

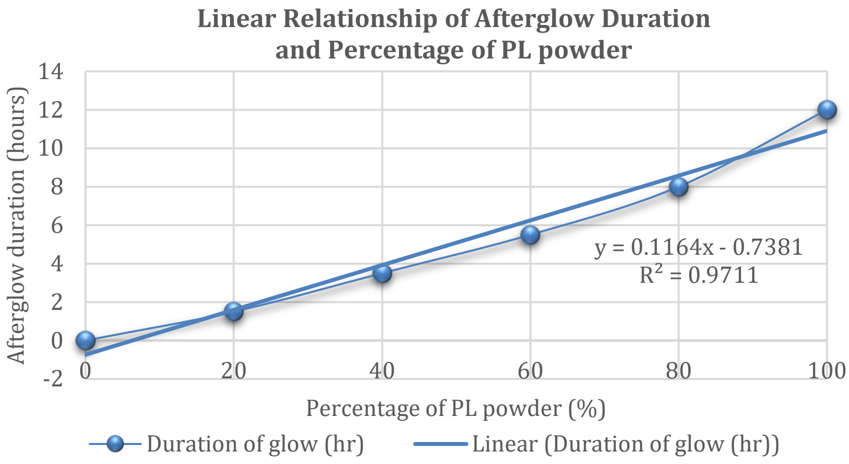

Figure 10. The graph of afterglow duration against the percentage of PL powder

4.0 CONCLUSION

The comprehensive methodologies for an attempt to produce glow-in-the-dark emergency signage to ease the evacuation process and to enhance visibility during nighttime is presented herein. In this present study, particular emphasis is given to investigate the characteristic of photo-luminescent (PL)powder applied with polyester resin as glow-in-the-dark emergency signage. Total of five samples of signage were fabricated with different percentage of PL powder i.e. 20% (30g), 40% (60g). 60% (90g), 80% (120g) and 100% (150g) before mixing with the 150g polyester resin. A luminance testing was conducted to measure the amount of light that produced by the samples after an hour charged under the sunlight. The result showed that the maximum lux meter reading of the sample is 6 *lx* which provided the longest glow duration of the sample before completely off after 12-hours. In addition, the result recorded for afterglow duration proved that the increment percentage of PL powder mixed with polyester resin will increase the afterglow duration as determined in Sample 5. It can be concluded that the photo-luminescent (PL)powder applied with polyester resin can be adopted to produce a glow-in-the-dark emergency signage. Further study may require investigating the durability of the proposed signage to ensure the efficiency of the signage during emergency.

5.0 ACKNOWLEDGEMENTS

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