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Enhancing Visibility of Polyvinyl Chloride (PVC) Survey Markers Using Fluorescent Paint

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Abstract: ***This study, entitled Enhancing the Visibility of Polyvinyl Chloride (PVC) Survey Markers Using Fluorescent Paint, aimed to determine whether applying fluorescent paint can improve the visibility and field usability of PVC markers commonly used in land surveying. The research focused on how marker visibility changes with distance and viewing angle, and on comparing the performance of fluorescent-painted markers with unpainted ones using information gathered from existing studies. A descriptive, literature-based research design was used, where journals, technical reports, and industry references were reviewed to understand how fluorescent and high-visibility coatings affect detection and recognition in outdoor environments. To ensure accuracy and reliability, the study synthesized findings from multiple credible sources discussing color perception, luminance, reflectivity, and marker detectability in varying field conditions. Findings from the reviewed literature showed that fluorescent coatings generally increase brightness, make markers easier to distinguish from surrounding terrain, and improve visibility under different lighting conditions. These improvements were linked to shorter search time, fewer errors in identifying survey points, and more efficient field operations, especially in cluttered or low-visibility environments. The reviewed studies also highlighted practical benefits such as improved workflow, reduced surveying delays, and better point identification during fieldwork. However, the literature also noted that there is limited local testing on how these coatings perform under Philippine field conditions, particularly regarding durability under heat and rainfall, long-term color retention, and cost-effectiveness in actual surveying projects. Because of this, the study recommends conducting future field-based experiments to measure actual performance, durability, and practicality in real surveying situations, and to develop standardized guidelines for the effective use of fluorescent-painted PVC markers in geodetic engineering applications.***

Keywords: Fluorescent Paint, PVC Survey Markers, Visibility Enhancement, Distance, Viewing Angle, Land Surveying, Geodetic Engineering

I. INTRODUCTION

Surveying is an essential process in engineering, construction, land development, and geospatial mapping. It involves the accurate measurement and determination of positions on the Earth's surface. One of the most important tools in land surveying is the survey marker, which serves as a reference point for locating boundaries, structures, and geographic features. Survey markers are often made from durable materials such as concrete, metal, or Polyvinyl Chloride (PVC). Among these, PVC is frequently used due to its low cost, light weight, resistance to corrosion, and easy availability.

Despite its many advantages, PVC has a major disadvantage when used as a survey marker. Its natural color and surface properties make it difficult to see under many real-world conditions. In grassy areas, the marker may blend with vegetation. In muddy or dusty environments, it may become covered. In areas with poor lighting, such as early mornings, late afternoons, or shaded areas, the marker may not be clearly visible. This poor visibility causes significant problems for surveyors because they rely on clear and identifiable markers to perform accurate measurements.

In the Philippines, the problem is even more evident due to the country's tropical climate. Heavy rainfall, fast vegetation growth, flooding, and frequent typhoons can easily hide or wash away survey markers. Moreover, in urban areas, construction, traffic, and human activities often disturb or remove these markers. When a survey marker is not visible, surveyors are forced to spend more time searching for it, which delays the project and increases labor costs.

Researchers and engineers have long studied methods of improving visibility in outdoor environments. In road construction, for example, high-visibility paints and reflective materials are used to make lanes, signs, and barriers easier to see.

One type of material that has proven to be highly effective is fluorescent paint. Fluorescent paint has the ability to absorb invisible ultraviolet (UV) light and emit it as visible light, making it appear brighter compared to ordinary colors.

This research was conducted to explore the possibility of using fluorescent paint as a solution to improve the visibility of PVC survey markers. The study adopts an action research approach through descriptive analysis of existing literature. Instead of performing actual experiments, it examines previous studies and documented findings to determine whether fluorescent coatings are effective in increasing visibility.

This research is highly relevant to Geodetic Engineering students and professionals. By improving the visibility of markers, surveying tasks can be completed more efficiently, safely, and accurately. Furthermore, this study promotes innovation by proposing a simple and affordable improvement to a commonly used surveying material.

This study is anchored on the concept that increasing the brightness and contrast of an object enhances its visibility in various environments. The application of fluorescent paint on PVC survey markers is assumed to increase their luminance and color intensity. This enhancement is expected to make the markers more distinguishable from their surroundings.

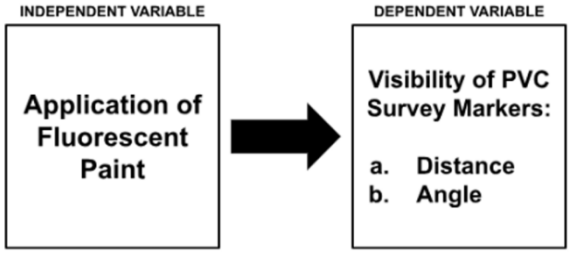

Figure 1. *Research Paradigm*

II. OBJECTIVES

The general objective of this study is to determine the effectiveness of fluorescent paint in enhancing the visibility of Polyvinyl Chloride (PVC) survey markers.

Specifically, this study aims to:

1) Compare the visual detectability of fluorescent-painted PVC survey markers and unpainted PVC markers at varying distances.
2) Determine how the angle of observation affects the visibility of fluorescent-painted PVC survey markers.
3) Identify whether the application of fluorescent paint produces a noticeable improvement in the overall visibility of PVC survey markers.
4) Analyze documented studies to support the application of fluorescent coatings in field surveying practices.
5) Provide practical recommendations for surveyors and engineering institutions in using fluorescent-painted markers.

III. MATERIALS AND METHODS

A. Research Design

This study used a descriptive research design under an action research approach. Action research focuses on solving a specific and practical problem encountered in a real-world setting. In this case, the problem is the poor visibility of PVC survey markers in field conditions. The proposed solution is the application of fluorescent paint.

No physical experiments were conducted. Instead, the study was based on a systematic analysis of existing literature, academic papers, and related studies. Descriptive research was used because the purpose of the study was to explain, analyze, and synthesize existing information regarding visibility enhancement.

B. Sources of Data

This study relied solely on secondary data gathered from reliable sources, including:

- Engineering and geodetic surveying journals
- Scientific articles on PVC materials
- Publications about fluorescent and reflective paint
- Studies on object visibility and detection in outdoor environments

These sources provided scientific explanations and evidence regarding how brightness, contrast, and reflectivity affect an object's visibility.

C. Data Gathering Instrument

The primary research instrument of this study was a structured literature review matrix developed by the researchers to document and compare the findings of selected academic sources. This matrix was used to record essential details such as author, year of publication, research objective, methods used, materials studied, and reported outcomes related to marker visibility and fluorescent paint effectiveness.

D. Data Gathering Procedure

Data was gathered by collecting appropriate academic sources such as scholarly articles, engineering manuals, theses, and technical reports through online libraries and open educational resources. The researchers organized the gathered information according to marker condition (painted versus unpainted), distance ranges, viewing angles, and reported visibility effects. The procedure focused on systematically reviewing, summarizing, and synthesizing relevant research findings to support the descriptive comparison implemented in this study.

IV. RESULTS AND DISCUSSION

This section presents the synthesized findings on the visibility of PVC survey markers based on existing literature, focusing on the effects of distance, angle of observation, and the enhancement provided by fluorescent paint. The discussion incorporates both local and international studies on visibility, material reflectivity, signage detectability, and PVC behavior under various lighting conditions.

A. Visibility in Terms of Distance

Distance is one of the most influential factors affecting the detectability of objects in outdoor environments. According to Bullough and Liu (2020), long-distance visibility decreases drastically when objects lack sufficient luminance contrast or retroreflective qualities. This is consistent with Blake's (2018) findings in Metro Manila road environments, where low-brightness markers and signs were frequently overlooked by motorists due to poor contrast and environmental blending.

PVC markers, in their unpainted state, typically have muted or neutral tones, causing them to visually merge with soil, foliage, rocks, and concrete. Studies on PVC optical behavior show that PVC absorbs significant amounts of ambient light due to its surface characteristics, reducing its visibility at extended ranges (Bitay, 2019). This makes unpainted PVC markers particularly vulnerable to long-distance visual loss when placed outdoors.

International visibility research highlights that color brightness and reflectance play crucial roles in distance-based detectability. Saleem and Hosoda (2021), in developing glow-in-the-dark pavement markers, demonstrated that increased luminance can significantly extend detection range, even in low-light environments. Their findings reinforce the idea that markers with enhanced brightness maintain visibility at farther distances.

Similarly, Wang et al. (2024) observed that plastics with higher reflectance spectral values remain distinguishable across wider coverage areas when contrasted against natural backgrounds. Their study, although focused on floating plastics, supports the broader principle that improved surface reflectance increases detectability at range.

In the Philippine context, Dacanay et al. (2023) documented recurring challenges in identifying road markers and monitoring elements due to environmental interference, vegetation overgrowth, and material fading. These challenges mirror the difficulty surveyors face when locating dull or unpainted PVC markers in field conditions.

Given these findings, the application of fluorescent paint offers an effective solution. Fluorescent pigments absorb ultraviolet radiation and re-emit visible light, producing high luminance and color saturation. This allows fluorescent-coated PVC markers to stand out strongly from natural backgrounds and remain visible at greater distances compared to unpainted PVC.

B. Visibility of PVC Markers in Terms of Viewing Angle

Besides distance, the viewing angle significantly affects the visibility of survey markers. According to the principles of visual perception, objects viewed at oblique angles reflect less light toward the observer, reducing their perceived brightness (Goldstein, 2014). Similar phenomena were observed in Bullough and Liu's (2020) evaluation of pavement markers, where detection accuracy diminished sharply at shallow approach angles.

PVC, being cylindrical or semi-cylindrical when used as a marker, suffers even more from angle-related visibility problems. Bitay (2019) found that PVC surfaces exhibit directional reflectivity—meaning visibility is highest when viewed head-on and weakest when the observer stands at an angle. This is problematic during surveying because surveyors often approach markers from varying directions due to terrain constraints.

The challenge is also validated by Blake (2018), who reported that non-reflective road signage in Metro Manila is often missed when viewed from side angles or when lighting does not strike the sign directly. This reinforces the importance of enhanced luminance in maintaining visibility across multiple orientations.

Fluorescent paint, however, offers a major advantage in this area. Unlike ordinary pigments, fluorescent pigments do not rely solely on reflected light. Instead, they emit visible light after absorbing UV radiation, allowing them to maintain brightness even when observed from less favorable angles. Studies by Saleem and Hosoda (2021) confirm that luminance-emitting materials retain visibility over wider angles of approach.

Furthermore, high-color markers have been used internationally for tracking wildlife and identifying objects in complex natural environments. Yaneva et al. (2019) demonstrated that colored PVC rings used for tracking Lesser Kestrel birds remained identifiable from multiple viewing orientations due to their vivid hues, supporting the idea that color intensity enhances multi-angle visibility.

C. Overall Visibility Improvement from Fluorescent Paint

PVC materials exposed to outdoor environments undergo discoloration, dulling, and surface degradation, all of which negatively impact visibility (Bitay, 2019). This is especially true in tropical climates like the Philippines, where intense sunlight, humidity, and rainfall accelerate surface fading (Dacanay et al., 2023).

Fluorescent paint provides a dual function:

1) Enhancing visual brightness, and

2) Protecting PVC surfaces from environmental dulling.

International studies emphasize the importance of luminance-enhancing coatings in visual detection. Saleem and Hosoda (2021) found that glow-in-the-dark markers maintained visibility even after prolonged environmental exposure. Similarly, Wang et al. (2024) demonstrated that high-reflectance surfaces maintain optical detectability across varying coverage densities.

In field applications, fluorescent colors are consistently associated with improved recognition and safety. Blake (2018) highlighted their crucial role in road signage effectiveness, while Bullough and Liu (2020) reinforced their superiority over non-luminant materials for guiding visual attention.

Local studies support these findings as well. Dacanay et al. (2023) argued that many Philippine monitoring elements fail not because of design issues but due to inadequate visibility treatments. This strengthens the rationale for using high-visibility coatings—even in surveying.

Taken together, these studies strongly indicate that fluorescent paint significantly enhances the visibility of PVC markers by:

- Increasing brightness and color contrast
- Standing out from natural landscapes
- Being detectable at longer distances
- Maintaining visibility from wider viewing angles
- Resisting environmental fading

V. CONCLUSIONS

This study examined whether the application of fluorescent paint can significantly improve the visibility of Polyvinyl Chloride (PVC) survey markers when evaluated in terms of distance, angle of observation, and overall detectability. Through a descriptive and literature-based analysis of both local and international sources, the research confirms that fluorescent paint provides a meaningful and practical improvement in the visual performance of PVC survey markers under a wide range of real-world field conditions. The evidence strongly indicates that visibility, which is essential for efficient and accurate surveying, increases considerably when PVC markers are coated with fluorescent paint.

Unpainted PVC markers naturally have low contrast against common outdoor backgrounds such as soil, vegetation, rocks, and concrete. Their neutral color and limited ability to reflect light cause a rapid decrease in visibility as distance increases. This situation creates difficulties for surveyors who depend on quick and accurate identification of markers during fieldwork.

Poor visibility results in delays, increased labor, and potential measurement errors. These challenges highlight the importance of improving the visual detectability of survey markers.

The findings shows that fluorescent paint effectively addresses this problem by producing a level of brightness and color intensity that exceeds ordinary paint. Fluorescent pigments absorb ultraviolet light and re-emit visible light, creating a high-luminance effect that allows markers to remain noticeable at longer distances. This improvement is especially important in Philippine field settings where tall grass, uneven terrain, and dense vegetation commonly obstruct ground-level markers.

The study also found that the angle of observation affects marker visibility. Unpainted PVC markers tend to lose clarity when viewed from the side or from non-ideal angles. Fluorescent-coated markers, on the other hand, maintain visibility across a wider range of angles. The emitted light from fluorescent pigments helps markers stay recognizable even when their surface is not directly facing the observer. This advantage is critical in field situations where surveyors may not always be able to approach markers from a central or ideal viewpoint due to landscape conditions or obstructions.

Environmental exposure further affects marker performance. PVC surfaces deteriorate when subjected to prolonged sunlight, rainfall, dirt, and moisture. Fading and discoloration reduce visibility over time. Fluorescent paint provides both improved illumination and an added protective layer. This helps maintain color quality and enhances the durability of the marker's surface. As a result, fluorescent-coated markers remain visible for longer periods and require less frequent maintenance or replacement.

Taken together, the findings clearly support the conclusion that fluorescent paint is a highly effective and practical enhancement for PVC survey markers. Whether the concern involves long-distance detection, unfavourable viewing angles, or environmental degradation, fluorescent-painted markers consistently perform better than unpainted ones. Improved visibility leads to faster detection, reduced search time, improved accuracy, and more efficient field operations.

Overall, the study concludes that fluorescent paint significantly enhances the visibility and usability of PVC survey markers in land surveying practice. Although this research used descriptive and literature-based methods, the consistent agreement among sources provides strong support for recommending fluorescent coating as a standard visibility enhancement. Future research may include experimental field testing, comparisons of different fluorescent colors, or luminance measurement using instruments. Despite the need for further empirical testing, the existing literature already demonstrates that fluorescent-painted PVC markers represent a simple, affordable, and highly beneficial innovation for the surveying profession.

VI. RECOMMENDATIONS

Based on the findings from this study, the researchers present the following recommendations.

Instructors and Field practitioners: Field demonstrations and hands-on activities will use fluorescent-painted PVC markers to show students how better visibility of the markers reduces the time spent searching and improves accuracy in locating survey points.

Academic Institutions: Schools and programs can support the use of fluorescent-painted markers by providing materials and guidelines for incorporating this practice into fieldwork. Even slight improvements in marker visibility can significantly improve the efficiency and safety of field operations.

Students: Fluorescent-painted markers are recommended for students during training activities to emphasize the importance of visibility in real surveying tasks. Simple observations at different distances or angles will help them build practical skills and boost their confidence in identifying markers.

Future Researchers: Future studies should conduct actual field testing under Philippine conditions to measure detection distance, durability, and color retention over time. The results will strengthen the evidence and help develop practical guidelines for long-term surveying use.

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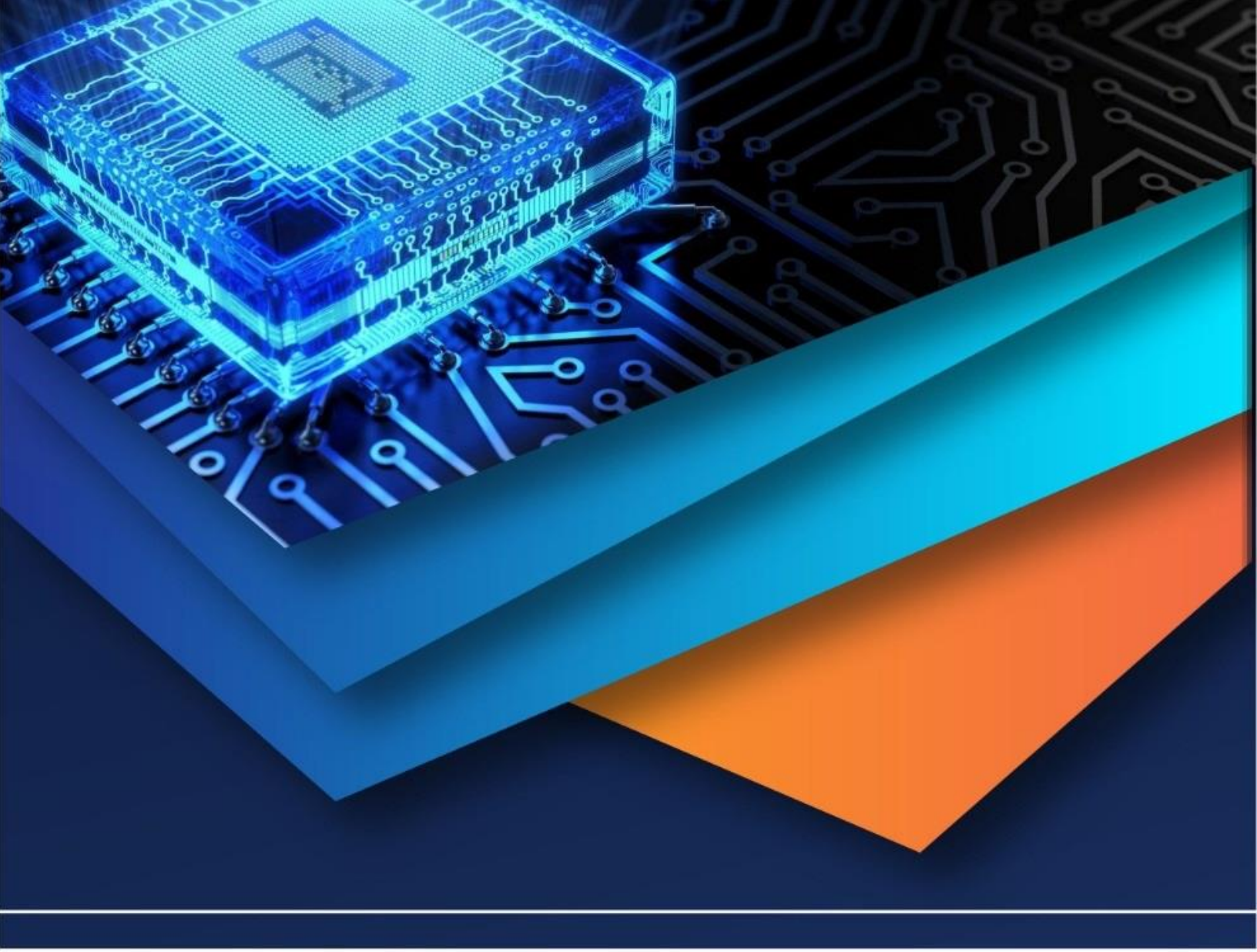

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