THE USE OF EPOXY RESIN AS STAINED GLASS MATERIAL WITH CLASSIC AND MODERN TOUCHES

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Abstract

The Al Wustho Mangkunegaran Mosque's usage of stained glass is the subject of this study's field research findings. Stained glass is still produced today using antiquated techniques that are time-consuming and relatively expensive. This research suggests epoxy resin as a substitute material for stained glass. Epoxy resin was used because of its capacity to imitate stained glass, keeping a traditional appearance while providing the benefits of contemporary materials. Furthermore, the UV-resistant color pigments and epoxy resin utilized in this study have a great durability against exposure to sunshine and different environmental conditions. Compared to conventional stained glass techniques, the manufacturing process is simpler and more effective, which lowers production costs. In addition, the made-to-order manufacturing process enables product customization to satisfy customer expectations or particular decorative requirements. These results show that design solutions that are both culturally relevant and responsive to global demands can be produced by fusing traditional elements with cutting-edge technology. This method should shorten the lead time and lower the cost of producing stained glass while maintaining a comparable level of visual appeal.

Key words: Stained Glass, Epoxy Resin, contemporary innovation

INTRODUCTION

Stained glass has a long-standing history in both art and architecture, particularly within places of worships, where it plays a significant role in shaping architectural aesthetics and spiritual ambiance. In the context of Masjid Al Wustho

Mangkunegaran, stained glass serves not only as a decorative element but also as a natural lighting regulator, influencing the mosque's interior atmosphere. Observations reveal that the stained glass in the mosque produces two primary lighting effects: “colored" and “diffused.” The “diffused” effect softens illumination by scattering light and minimizing shadows, while the “colored” effect imparts subtle hues to incoming light, depending on the stained glass’s pigments. Ensuring the optimal function of these effects requires ongoing maintenance and attention to the stained glass's physical condition.

RESEARCH METHODS

The research method is carried out with a descriptive qualitative approach, namely by prioritizing the application of empathetic design principles that can be applied in visual communication design to support sustainable products. These principles include a human-centred approach, local cultural prototyping, and a business perspective, each implemented in three main applications: inclusive design, immersive visual communication, and sustainable product design. The following is a table of methods that combine empathetic design principles with the application of visual communication design:

Figure 1. Stained glass in Al Wustho Mangkunegaran Mosque
Source: Author, 2024

Traditionally, stained glass is produced by joining colored glass pieces with lead, and the hues are achieved through the inclusion of metallic elements—copper for green, cobalt for blue, and gold for red. Although these techniques

yield exquisite and unique works of art, they are time-consuming and demand a high level of craftsmanship. Furthermore, the findings at Masjid Al Wustho Mangkunegaran highlight the functional value of stained glass, including its ability to regulate heat and minimize excess light reflection. Despite these advantages, the reliance on traditional methods presents challenges, particularly in terms of production efficiency and the dependency on skilled artisans.

The influence of Gothic architecture on stained glass design is particularly relevant to this study. Gothic cathedrals are renowned for their use of stained glass to manipulate natural light, creating a mystical and awe-inspiring atmosphere. The stained glass in these structures not only allowed for colorful lighting but also diffused sunlight in ways that emphasized the spatial qualities of the interiors. (Santoso, 2014) Inspired by these precedents, the stained glass at Al Wustho Mosque similarly enhances interior illumination by filtering natural light to generate subtle, colored effects. However, maintaining this balance between aesthetic appeal and functional efficiency in modern times requires innovative solutions. To address these challenges, this study explores the use of epoxy resin as an alternative material to stained glass. Epoxy resin was chosen for its transparency and pliability, offering the potential to replicate the visual qualities of traditional stained glass with greater manufacturing efficiency. (Tauvana et al., 2020) This research aims to discover a creative solution that not only preserves the artistic appeal of stained glass but also simplifies the production and maintenance processes, aligning with contemporary demands for efficiency and innovation.

RESEARCH METHODS

This study employed an experimental methodology to assess the cause-and-effect relationships between the variables under investigation. (Em, 2024) Data collection involved field surveys and interviews with epoxy resin practitioners and other relevant stakeholders. Additionally, supplementary information was obtained from electronic

sources, including online databases, as well as printed materials such as reference books on epoxy resin and stained glass. In exploring epoxy resin as an alternative material to stained glass, the research also utilized a descriptive approach, focusing on the material's texture, color, and strength characteristics. In the early stages of the research, a literature study was conducted to understand the types and characteristics of resins, epoxy resin hardening agents, types of resin color pigments, and resin treatment methods. The results of this literature study are summarized as follows:

1. Types and Characteristics of Resins
   Epoxy resin is extensively used in mechanical, electrical, chemical, and civil engineering applications due to its high bond strength—reaching up to 2000 psi—and its resistance to wear, cracking, corrosion, moisture, and heat. Its transparent color and smooth texture make it a suitable alternative for replicating the aesthetic qualities of traditional stained glass. Polyurethane (PU) resin, recognized for its excellent abrasion resistance and durability, is commonly utilized across various industries. Similarly, melamine formaldehyde (MF) resin offers significant resistance to water and heat, making it ideal for electrical and mechanical components. (Utomo et al., 2021)

2. Epoxy Resin Hardener
   Epoxy resin hardeners are essential additives that accelerate the curing process, ensuring the resin solidifies effectively. Achieving the correct proportion of resin to hardener is crucial; an improper ratio can result in brittleness, compromising the strength and durability of the final product. (Ozeren Ozgul & Ozkul, 2018) The optimal mix not only ensures a strong bond but also maintains the resin's flexibility and visual clarity, which are essential for replicating the aesthetic qualities of traditional stained glass.

3. Color Pigments for Epoxy Resin
   Epoxy resin color pigments are essential for achieving the

desired visual effects, with different types offering unique characteristics. (Ozeren Ozgul & Ozkul, 2018) Liquid pigments provide transparent color with just a few drops, ensuring an even distribution throughout the resin. Metallic powder pigments add a shimmering luster due to their reflective particles, though they require thorough mixing to avoid inconsistencies. Powder pigments, by contrast, deliver bold and vibrant hues, making them ideal for more opaque designs. Paste pigments, known for their high concentration, are used to create intense, solid colors.

4. The Maintenance
   Maintaining epoxy resin involves several essential practices to preserve its appearance and durability. Regular cleaning with a soft cloth and mild soapy water helps remove dirt and debris, while re-polishing restores its original luster. (Rahman & Akhtarul Islam, 2022) Since epoxy resin can be vulnerable to UV exposure, applying UV-protective coatings is recommended to prevent discoloration and material degradation over time. This additional layer of protection ensures the resin maintains its aesthetic appeal and structural integrity, particularly in applications exposed to sunlight or other environmental factors.

5. Epoxy Resin Stained-Glass Manufacturing Process
   The manufacturing process of epoxy resin stained glass involves several essential steps, beginning with model and mold design. The design is created using specialized software, such as Adobe Illustrator, to serve as a precise guide for shaping the stained glass mold.

In the molding preparation stage, a 3 mm thick brass-copper sheet is cut using a laser machine and carefully smoothed to ensure accurate shaping and proper fit. The tools and materials used in this process include epoxy resin, hardener, color pigments, and various equipment such as stirring machines, copper molds, and plastic cups.

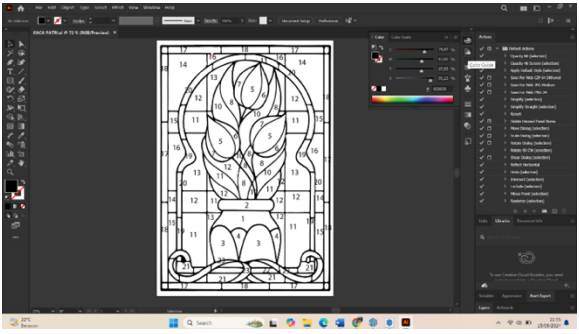

Figure 2. Design creation process with Adobe Illustrator software
Source: Author 2024.

Figure 3. Epoxy resin, hardener and liquid pigment
Source: https://www.epresin.art/

Figure 4.Stained glass and epoxy resin crafts
Source: https://www.pinterest.com

The manufacturing steps are as follows:

1. Mix the epoxy resin and hardener in a 2:1 ratio, ensuring thorough blending.
2. Divide the mixture into several containers, adding pigments to achieve the desired colors.

3. Pour the mixture into the prepared mold and allow it to dry for 8 to 12 hours.

Finally, the finishing step involves smoothing the surface with sandpaper, if necessary, to achieve a polished, glossy finish that mimics the appearance of traditional stained glass.

Visual Appearance and Light Distribution of Epoxy Resin

The visual effects and light distribution properties of epoxy resin, when used as an alternative to modern stained glass, stem from its unique optical and chemical characteristics. With its high refractive index, epoxy resin can refract light similarly to glass, creating comparable sparkle and dynamic color play. However, one of the primary challenges lies in achieving the right balance between color intensity and transparency. Careful selection and precise application of pigments are essential to attaining the desired optical qualities.

Traditional stained glass has the unique ability to disperse natural light evenly, while reducing excess heat and reflections. The use of color and texture in stained glass allows for soft light diffusion and even room lighting. This light distribution, especially if the stained glass windows are installed laterally, provides lighting with a natural yellowish effect and changes throughout the day according to the position of the sun. (Hartanti & Setiawan, 2014)

Although epoxy resin does not naturally offer the same level of light diffusion as stained glass, strategic pigment use and surface texture adjustments can mimic these qualities. Pigments control transparency and light transmission, while altering the surface texture can enhance the diffusion effect. As a result, epoxy resin demonstrates significant potential as a viable alternative material, particularly in applications that demand controlled light transmission and effective heat distribution similar to traditional stained glass.

Aesthetic and Functional Comparison between Stained Glass and Epoxy Resin

The findings of this study align with previous research, which identifies epoxy resin as an effective material for

replicating the appearance of stained glass. When combined with appropriate pigments, epoxy resin can produce color and lighting effects comparable to those of traditional stained glass. A key advantage of epoxy resin lies in its flexibility, both in application and color control, due to its high refractive index, which enables light refraction similar to that of glass.

However, the use of epoxy resin also presents challenges, particularly regarding its vulnerability to UV exposure, which can impact its color quality and transparency over time. While traditional stained glass demonstrates greater resistance to environmental factors, epoxy resin compensates with enhanced adaptability, offering comparable aesthetic results. This makes epoxy resin particularly advantageous for contemporary designs that require the visual appeal of stained glass but benefit from more flexible, cost-effective production methods.

RESULT

Figure 3. Epoxy resin stained glass results
Source: Author 2024

When applying epoxy resin on porous substrates such as concrete, wood, or plaster, it is essential to use a primer as a

base coat to enhance adhesion. The primer must fully cure before the resin is applied to prevent defects or imperfections in the final coating. Since porous materials tend to absorb the primer extensively, it is important to allow sufficient time for the initial coat to set effectively. The drying time of the primer varies based on ambient temperature: at 20°C, it requires 8-12 hours; at 30°C, 6-8 hours; and at 40°C, 4-6 hours. Adhering to these drying times ensures optimal performance and bonding, which is crucial for achieving a smooth and durable epoxy resin finish.

DISCUSSION

Excessive use of color pigments in epoxy resin can result in overly intense coloration, undermining efforts to achieve the desired transparency needed to replicate the qualities of traditional stained glass. Highly concentrated pigments hinder the translucent effect that defines stained glass, diminishing both the aesthetic appeal and functionality of epoxy resin as an alternative material. Therefore, careful adjustments in pigment usage are essential to strike the right balance between color vibrancy and transparency. Moreover, proper management of solvents during the epoxy application process is crucial to ensure safety and prevent health risks. Direct contact with the skin or eyes, as well as prolonged inhalation of vapors, must be avoided. The use of personal protective equipment (PPE), including gloves, goggles, and protective creams, is strongly recommended. Additionally, ensuring adequate ventilation—especially in confined spaces—is vital to minimize exposure risks during the application process.

The findings of this study indicate that, with precise pigment control and appropriate application techniques, epoxy resin can successfully mimic the optical effects of stained glass. However, achieving optimal results depends on several key factors, including careful regulation of coating thickness, color intensity, and transparency. While epoxy resin offers significant potential as an alternative to traditional stained glass, special attention must be given to the application process and material settings to ensure the desired aesthetic and functional outcomes.

CONCLUSION

This study demonstrates that epoxy resin offers considerable potential as an alternative material to traditional stained glass, particularly in modern applications requiring flexibility and cost-efficiency. When combined with appropriate pigments and applied using the right techniques, epoxy resin can replicate the aesthetic qualities and light effects of stained glass. However, achieving optimal results requires balancing color intensity with transparency, ensuring the resin maintains the desired visual and functional properties.

The study also highlights the importance of proper substrate preparation, emphasizing the role of primers in enhancing adhesion on porous surfaces. Adhering to recommended drying times is essential to prevent defects and ensure a smooth, durable finish. Furthermore, the use of personal protective equipment (PPE) and adequate ventilation during the application process is critical for maintaining safety and minimizing exposure to harmful solvents.

While epoxy resin offers advantages in flexibility, customization, and ease of application, it remains sensitive to environmental factors such as UV exposure. Therefore, additional protective coatings may be necessary to maintain its appearance and performance over time. Ultimately, epoxy resin presents a promising alternative for modern stained glass applications, provided that careful attention is given to its formulation, application, and maintenance.

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