E-BOOK OF EXTENDED ABSTRACT

THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025

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THERMAL ACTIVATION OF RECYCLED PLASTER OF PARIS AT 160°C WITH SILUBIT G80 ADDITIVE FOR ENHANCED MATERIAL PROPERTIES

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ABSTRACT

The increasing demand for environmentally sustainable materials has driven interest in the recycling and reuse of industrial waste, particularly in the ceramics and moulding industries. This study explores the enhancement of Recycled Plaster of Paris (RPOP) by using Silubit G80 as an additive, with the goal to improving its physical properties and achieving characteristics comparable to New Plaster of Paris (NPOP). The aim of this study is to improve the setting time, compressive strength, porosity and absorption of RPOP 160℃ accompanied by the presence of Silubit G80 as additive. The recycling process involves collecting used Plaster of Paris moulds, then crushed, sieved, and drying temperature at 160°C for one hour. This drying process facilitates the partial removal of crystallised water, rendering the material reusable. The processed powder is mixed with water at a ratio of 40:60 (water and material), and Silubit G80 is introduced in incremental concentrations of 0.1%, 0.3%, 0.5%, 1.0%, 1.5%, and 2.0% to evaluate its impact on the material's performance. The study demonstrates that the addition of Silubit G80 significantly enhances the structural characteristics of RPOP, improving its setting time and reducing both porosity and water absorption. These improvements contribute to making RPOP a viable and sustainable alternative to NPOP. Furthermore, the findings encourage awareness of the potential to recycle and reuse Plaster of Paris, which in turn supports environmental conservation by reducing solid waste generation in the moulding and ceramic industries. Ultimately, this approach facilitates waste reduction and fosters the adoption of sustainable practices in the ceramic and moulding industries.

Keyword: Recycle Plaster of Paris (RPOP), Temperature, Drying, Silubit G80, mould

1. INTRODUCTION

Recycle is one of the processes to pass again through the several processes for regaining other material for humans use for daily use or factory use for production according Merriam-Webster. Even though the percentage of the ceramic category in the waste management hierarchy is only 5%, it has a significant negative impact on the environment. On the other hand, the focus of this research is solid waste. Plaster of Paris (POP) is classified as solid waste. According to Mineral Commodity Summaries 2001, (2001), POP is uncontaminated to recycle by cutting the set of plaster into small pieces, putting in the roasting and heating it at 325% to remove the water inside the body of plaster. Then it is ready to be reused when the small pieces of POP are grand and become powder.

According to Hamdan et al., (2023), recycled plaster of Paris (RPOP) can be reprocessed by thermal activation at 160°C to restore some of its usability after the initial hydration. Although RPOP can perform like brand-new plaster, advancements to RPOP properties are being researched to determine how RPOP will react when mixed with additives.

2. METHODOLOGY

RPOP comes from solid waste mould obtained from the Perbadanan Kemajuan Kraftangan Malaysia Perak Branch and waste mold must be crushed using a crusher to create a fine powder. Then, sieve with 1.25(µm) mesh and drying in oven at 160°C and the powder RPOP will drying in oven for 1hours. As shows as in Figure 2.1, the preparation of recycled plaster of Paris (RPOP) powder involves multiple stages to ensure that the material remains clean and suitable for reuse. Initially, plaster moulds from previous applications or unused stock are collected after fulfilling their original functions. These moulds, typically composed of plaster of Paris, are selected due to the material's excellent ability to capture fine details and its widespread use in mould-making.

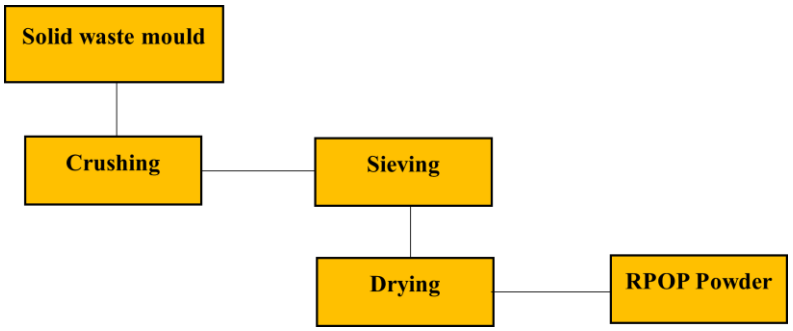

Figure 2.1 Process Recycle Plaster of Paris (RPOP)

2.1 Characterization Test

Figure 2.2 shows the procedure used to measure the setting time of Recycled Plaster of Paris (RPOP) treated at 160°C.

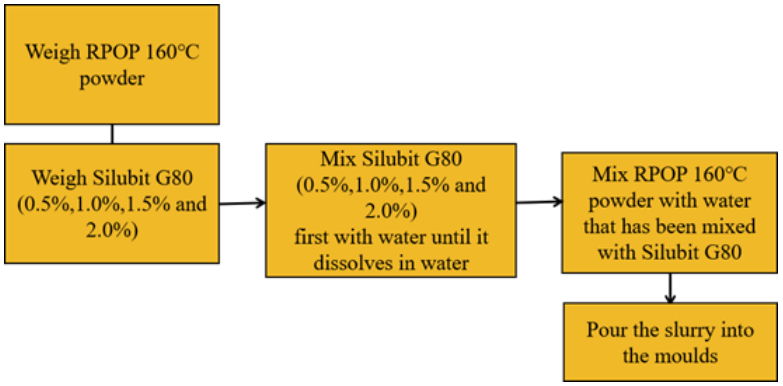

Figure 2.2 Process setting test using Recycle Plaster of Paris (RPOP) 160°C with Silubit G80 (0.5%, 1.0%, 1.5%, and 2.0%)

Figure 2.3 shows the process of recycling old plaster of Paris (POP) moulds was the first step in creating a finished product utilising RPOP, which is activated at 160°C.

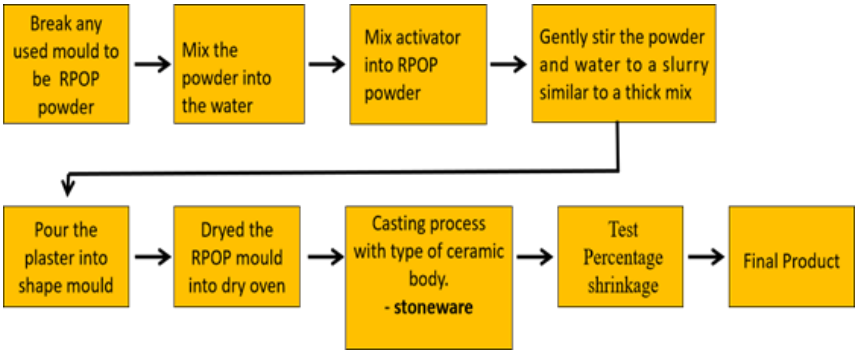

Figure 2.3 Process making final product using Recycle Plaster of Paris (RPOP) 160°C

3. FINDINGS

This section presents the findings obtained from the experimental investigation on recycled plaster of Paris (RPOP) activated thermally at 160°C and combined with different percentages of Silubit G80 additive (0.5%, 1.0%, 1.5%, and 2.0%). The primary objectives of this study were to evaluate the setting time and compressive strength of RPOP compared to natural plaster of Paris (NPOP), and to assess the effect of Silubit G80 on enhancing the material properties of RPOP.

3.1 Setting Time

One important characteristic of plaster of Paris (POP) that affects its use, especially in the mould-making and casting processes, is its setting time. Setting durations for Natural Plaster of Paris (NPOP), Recycled Plaster of Paris (RPOP), and RPOP added using different activator concentrations (0.10% to 2.00%) are compared in the bar graph provided as shows in Figure 3.1.

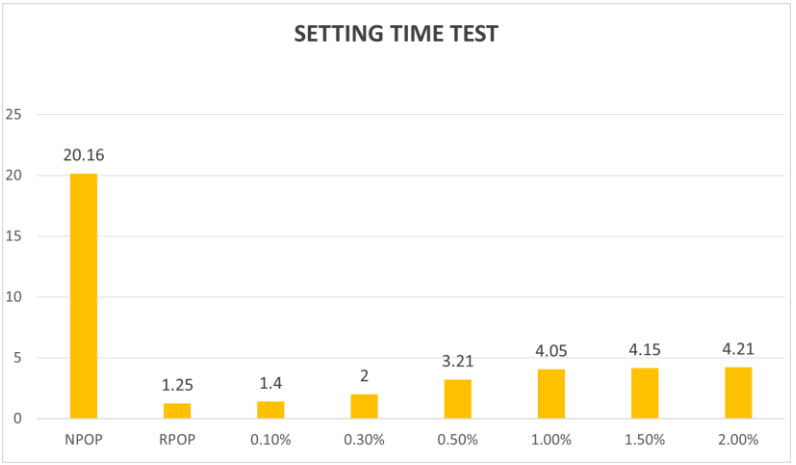

Figure 3.1 The setting time of NPOP and RPOP 160°C with additive Silubit G80 (0.5%, 1.0%, 1.5%, and 2.0%)

According to Figure 3.1, NPOP exhibits the longest setting time at 20.16 minutes, which is expected due to its unchanged chemical structure and full hydration potential. In contrast, RPOP without any activator sets faster, taking only 1.25 minutes. This drastic reduction in setting time is a known phenomenon in recycled gypsum-based materials. After the plaster is initially set and then dehydrated during thermal reactivation (such as at 160°C), its particle morphology and rehydration behavior change.

4. CONCLUSION

This study successfully investigated the RPOP using thermal activation at 160°C combined with the addition of Silubit G80 activator to improve its setting and mechanical properties. The experimental findings demonstrated that RPOP shows promising potential for reuse, but also highlighted several challenges and limitations associated with its recycling process.

The setting time analysis revealed that untreated RPOP exhibited a significantly faster setting time compared to NPOP, primarily due to structural changes caused by repeated dehydration and rehydration cycles. The addition of Silubit G80 activator proved effective in slowing down the setting reaction, with higher concentrations producing longer setting times that approached those of NPOP. This adjustment provides greater workability and practical handling time during the casting process, making RPOP more suitable for industrial and artistic applications.

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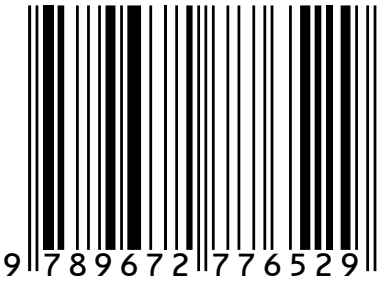

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