Evaluation of effectiveness of methyl methacrylate as retarder additive in polymer concrete

Nur Hafizah A. Khalid a, Mohd Warid Hussin a, Mohammad Ismail b, Norazah Basar c, Mohamed A. Ismail d, Han-Seung Lee d,⇑ Azman Mohamed e

a Construction Research Centre (UTM CRC), Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 Johor, Malaysia
b Department of Structure and Materials, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 Johor, Malaysia
c Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 Johor, Malaysia
d School of Architecture and Architectural Engineering, College of Engineering Sciences, Hanyang University, ERICA Campus, Republic of Korea
e Department of Geotechnics and Transportation, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 Johor, Malaysia

HIGHLIGHTS

• Methyl methacrylate performs effective retarder additive for polymer concrete in room ambient of 30 ± 2 °C.
• Retarder additive of methyl methacrylate could improve properties of polymer concrete.
• Retarder additive of methyl methacrylate was not affected curing process of polymer concrete.

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ABSTRACT

It is a known fact that most thermoset resins are very sensitive to hot temperature, which hinders its ability to produce polymer-based products in a large scale. This study aims to investigate the potential of manufacturing polymer concrete in ambient room temperature of 30 ± 2 °C. A laboratory test was conducted with the introduction of polyester retarder additive into polyester resin formulation. All tests were carried out strictly in ambient room temperature (30 ± 2 °C). For comparison purpose, polyester resin without retarder additive was prepared as the control formulation under identical condition. Visual inspection was done on the fresh working life of polyester resin with 0%, 0.1%, 0.15%, and 0.2% of retarder additive in two different types of polyester resin-isophthalic and orthophthalic. Characterization on retarder additive was conducted under X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR) and, 1H and 13C Nuclear Magnetic Resonance (NMR). Investigation on the effects of polymer retarder additive on the physical and mechanical properties of polymer resin, polymer blended, and polymer concrete showed that the retarder additive had prolonged the working life and improved properties of polymer concrete. These proved the potential of adding retarder additive in polymer concrete in ambient room temperature of 30 ± 2 °C.

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1. Introduction

Thermoset polymer resin such as epoxy, vinyl ester, and unsaturated polyester resin are some typically available commercial resins which are solely used as a binder in polymer concrete (PC) and preferred over thermoplastic polymers due to its higher strength and stiffness [1–3]. However, since epoxy and vinyl ester resins are more expensive than polyester resins, most researches tend to opt for unsaturated polyester resin as a binder [4], even when it is very sensitive toward temperature [4,5]. Due to this reason, PCs are less popular in most Southeast Asia and equatorial countries. High temperatures tend to accelerate the polymerization process [4,6] and jeopardizes the early strength development of PC while causing other related problems such as poor workability, high porosity, honeycomb, and weaker material bonding [7]. This can be solved by casting the PC in a cool room, but this does not make the PCs more cost competitive since the polymer itself is already expensive [8]. Therefore, this paper intends to discuss on a modification done on resin formulation to produce competitive PC with desirable strength.

The main objective of this research, which is to modify polymer binder formulation, is achieved by incorporating retarder additive of methyl methacrylate (MMA) in ambient room temperature.