CHAPTER 1
INTRODUCTION

1.1 General background

Polymer-modified mortar (PMM) is an ordinary mortar with added polymer in latex form that are used in applications such as paving and waterproofing materials, floorings, grouting wall and floor tile, patch and repair, and anticorrosive linings. This is because the use of polymer latex in mortar usually improves the tensile and flexural strengths, adhesion, extensibility, and durability of the ordinary mortar by waterproofness and chemical resistance (Ohama & Ramachandran, 1996). In the present, the polymer types that are used in mortar can be divided into two types as synthetic and natural polymers. Examples of synthetic polymers such as polyacrylate (PAE), styrene butyl acrylate (SBA), ethylene vinyl acetate (EVA), carboxylated styrene butadiene rubber (XSBR), styrene butadiene rubber (SBR), chloroprene rubber (CR), polyvinyl alcohol (PVA), etc. For the natural polymer as natural rubber (NR) (Ohama & Ramachandran, 1996; Zhang et al., 2021). However, the compressive strength of most PMM is lower than ordinary mortar. To resolve this issue, the use of silica combined with polymer in mortar is an alternative way. This is because the use of silica in mortar usually improves the compressive strength of ordinary mortar by having a pore-filling effect (Aggarwal et al., 2015).

Currently, several industries, including the construction industry are focused on using local and natural materials from renewable resources to produce products with the required properties. Thus, the development of PMM to be more effective and sustainable with the use of materials from natural sources is an interesting approach. For example, the use of natural rubber latex (NRL) combined with silica extracted from natural sources. NR is a natural polymer that is obtained from the *Hevea brasiliensis* tree or Para rubber tree in latex form and consists mainly of two components are small particles of rubber and water. Additionally, some minor components such as proteins,

lipids, carbohydrates, and inorganic components. In the present, NR in latex and solid forms is used as raw material to produce the many products that cover several industries such as automotive, medical, and others. Examples of NR products include tires, belts, seals, gloves, tubes, etc. (Rajan et al., 2006). This is because it has high resilience, good tensile strength, good tear resistance, etc. (Chuayjuljit et al., 2015; Vu et al., 2015). For the silica is currently extracted from several natural sources such as corn cob, sugarcane bagasse ash, bamboo, rice straw, rice husk ash, and others. The preparation of silica using rice husk ash (RHA) is an interesting approach because normally it contains a high silica content of over 60%. Furthermore, RHA is the by-product of the process of rice husk (RH) pyrolysis for energy production, which is usually dumped in landfills, leading to air and water pollution. To reduce this issue and increase the value of this material, the current use of RHA is in many applications such as fertilizer, adsorbent and catalyst in the form of activated carbon or silica, and in the cement and concrete industries in the form of silicate or silica, etc. (Pode, 2016; Shen, 2017; Shen et al., 2014). However, it is known that NR and silica are generally incompatible due to the non-polarity and polarity of materials. Thus, to improve the functionality of materials, requiring the use of vinyltriethoxysilane (VTES) as a compatibilizer or XSBR combined in the system may reduce this issue.

In this research, the aim is to develop NR as a polymer latex combined with silica extracted from RHA by the precipitation method for producing PMM that is effective and sustainable. The rice husk silica (RSi) was compared with commercial silica (CSi) before being used as a filler in the rubber matrix. Additionally, VTES or XSBR in latex form was used to improve the functionality between NR and RSi.

1.2 Research objectives

The main objectives of this research work are as follows:

1.2.1 To study the chemical and physical properties of prepared RSi compared with CSi.

1.2.2 To study the effects of RSi content on cure characteristics, mechanical properties, and morphological properties of rubber composites.

1.2.3 To study the effects of polymer content on mechanical, durability, and morphological properties of PMM.

1.3 Scope and limitation of the study

The RSi that was prepared from RHA by the precipitation method is compared with CSi in terms of chemical and physical properties by using the Fourier transform infrared spectrometer (FTIR), energy dispersive X-ray fluorescence spectrometer (EDXRF), X-ray diffractometer (XRD), Branauer-Emmett-Teller (BET) analysis, dynamic light scattering (DLS) measurement, and field emission scanning electron microscope (FESEM).

The addition of RSi at the contents of 0, 5, 10, and 20 phr in NR was studied on cure characteristics, mechanical properties, and morphological properties by using the moving die rheometer (MDR), universal testing machine (UTM), hardness tester, and FESEM. The comparison of using VTES and XSBR in combination with NR and RSi with the RSi contents at 0, 5, 10, and 20 phr were also studied on cure characteristics, mechanical properties, and morphological properties. For NR/VTES/RSi composites, the use of VTES with RSi was fixed at a ratio of 1:10. For NR/XSBR/RSi composites, the blending of XSBR in NR was fixed at a ratio of 2:1. All the rubber composites were first prepared by wet-mixing and drying to obtain the rubber composite sheets. Then the previous rubber composite sheets were compounded with chemicals using a two-roll mill and vulcanized using a compression molding machine.

Based on the mechanical properties of all rubber composites, the rubber composite with the optimal mechanical properties was selected to be used as a polymer in further study. The polymer was added to cement at the polymer to cement (P/C) ratios of 0.00, 0.05, 0.10, and 0.20 to obtain PMM. All the samples were mixed according to ASTM C305 and cured in water for 28 days before testing. The mechanical, durability, and morphological properties were studied.