5 CHEMICAL AND PHYSICAL CHARACTERISTIC OF NANO CHARCOAL ASH FROM COCONUT SHELL IN BITUMEN AS ALTERNATIVE BINDER

Ramadhansyah Putra Jaya, Siti Nur Amiera Jeffry, Norhidayah Abdul Hassan, Haryati Yaacob, Ekarizan Shaffie and Ahmad Kamil Arshad

5.1 INTRODUCTION

Good quality of pavement should have high structural integrity, which provides a strong, smooth, and safe riding surface for road users. In Malaysia, a common type of distress in asphalt pavement is permanent deformation, which is rutting. Rutting is the type of distress that is easily influenced by climate conditions, traffic volume, and axle loadings because of its viscoelastic behavior. The average temperature in Malaysia is 27 °C, but it can reach up to 35 °C in the afternoon. At such temperatures the asphalt pavement becomes so hot that it causes the bitumen to soften and deform when pressure from vehicle tires is exerted on it (Astana, 2010). Rutting occurs when the viscosity of the bitumen is increased and the elasticity is decreased. This phenomenon decreases the efficiency and safety of the asphalt pavement and reduces its service life. This problem can

be solved in two ways, namely, to modify the bitumen or to provide a new mix design (Hainin *et al.*, 2013). The properties of virgin binder are insufficient to resist the distress, which requires considerable research regarding asphalt modification.

Various types of materials are used as bitumen modifiers. The most popular method nowadays is by using agricultural waste materials, such as palm oil fuel ash, rice husk ash, coconut shell, bamboo, rattan, etc. These agricultural wastes are abundantly available in Malaysia which leads to environmental problems. Hence, one of the ways is to reuse them by incorporating them to bitumen modification. Through this alternative, the environment can be protected by reducing the wastes and the construction costs. The incorporation of these waste materials as modifiers is adopted mostly in concrete structures and asphalt pavements. However, no or rare studies are conducted using coconut shell as modifier in bitumen. Nanotechnology has been utilized by researchers for many years, but its usage remains limited (Yang and Tighe, 2013). Researchers also have investigated the use of nano-sized particles in composites because the physical and chemical properties of materials can be improved, including bitumen (Rajak *et al*., 2015; Shafabakhsh and Ani, 2015)including asphalt binders. As an economically efficient material, hot mix asphalt (HMA. The sizes of nano-sized particles range from 1 nm to 100 nm (Jamshidi *et al.*, 2015; Rajak *et al*., 2015; Yang and Tighe, 2013). A small material size typically leads to a high surface area. Accordingly, nanoparticles have higher reactivity than other common–sized particles. Jamshidi *et al*. (2015) reported that, nanoparticles can improve both the rheological and engineering properties of bitumen and mixtures.

A workshop by the National Science Foundation in 2006 indicated that, nanoscience and nanotechnology could lead to improvements in the asphalt pavement technology (Fang *et al*., 2013). Therefore, this study attempts to fill the gap by investigating NCA from coconut shell