Effect of Mercerization and Acetylation on Properties of Coconut Fiber and its Influence on Modified Bitumen

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***Abstract*— Coconut fiber, one of many types of natural fibers, is an agricultural waste which is left unutilized after the coconut fruits and juice are extracted. In this research, the effect of the different chemical treatments on the morphological, chemical and physical properties of coconut fiber and its influence on the properties of the modified bitumen were studied. The mercerization effectively altered the surface morphology and reduced the diameter of the coconut fiber. The waxy layer present on the surface of the coconut fiber was significantly reduced after mercerization. Acetylation reported minor reduction on the waxy layer and did not cause any significant changes on the diameter of the coconut fiber. The chemical characterization reported that the hemicelluloses were present only on the surface of the natural coconut fiber whereas the peak of Fourier Transform Infrared spectra associated with the presence of waxes was observed for natural and chemically treated coconut fibers. The bitumen modified with chemically treated coconut fibers exhibited lower penetration values and higher softening point. From the analyses of penetration value, softening point and penetration index, the bitumen modified with 10% NaOH and 50% CH_3COOH treated coconut fibers resulted in enhanced properties for paving binders to be used in warmer region.**

***Keywords*:** Coconut fiber, Mercerization, Acetylation, Modified bitumen

I. Introduction

NOWADAYS, the environment degradation due to fossil based resources is common and inevitable, thus, there is a need to reduce the burden from product that causes adverse effect on the environment and the use of recyclable, biodegradable and sustainable materials such as natural fibers is important to achieve improvement in environmental quality. Bitumen is a complex mixture of organic liquids that is highly viscous, black, and sticky of a predominantly hydrocarbon nature and is the major material used in the construction of road [1]. Bitumen is produced from distillation process of crude oil and only a small fraction comes from natural resources [1]. Bitumen is one of the major materials in asphalt concrete mixtures. Performance of asphalt concrete will deteriorate with respect to time and climate condition; hence by improving the properties of bitumen, it can greatly enhance its performance and lifespan to achieve better pavement performance. Therefore, modification of the bituminous binder is one approach that has been used to improve the performance of asphalt pavement [2]. The utilization of fiber in improving the performance of the asphalt matrix has been recognized from previous researches. It has been reported that fibers can increase the optimum asphalt content in the mixture design and prevent asphalt leakage due to its absorption of asphalts [3]. The use of fiber in the asphalt changes the viscoelasticity, improves moisture susceptibility, creeps compliance and rutting resistance as well as improving low-temperature anti-cracking properties, fatigue life, durability, tensile strength, material toughness and reducing the reflective cracking of asphalt concrete mixtures and pavements [3]. Therefore, based on the literature, it can be deduced that the addition of fiber in asphalt concrete mixture is able to improve its performance. Since most of the previous researches [2-3] were conducted using synthetic fibers that might pose negative environmental impacts, thus, the utilization of coconut fiber which can be obtained from agricultural by-products to improve the properties of bitumen is one of the alternatives to achieve sustainable development. Coconut fiber is one of many types of natural fibers available and it is a renewable and sustainable resource. Besides, coconut fiber is abundantly available in tropical countries such as Malaysia and is amenable to chemical treatment to alter its morphological, chemical and physical properties. This work aims to investigate the effect of mercerization and acetylation treatments on coconut fiber in altering its morphological, chemical and physical properties as well as the influence of the chemically treated coconut fiber on the properties of modified bitumen.

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