



# The Open Civil Engineering Journal

Content list available at: <https://opencivilengineeringjournal.com>



## RESEARCH ARTICLE

### Morphological and Physical Characteristic of Stone Mastic Asphalt Mixture Incorporating Nano Silica

Khairil A. Masri<sup>1,2</sup>, Ramadhansyah Putra Jaya<sup>1,\*</sup>, Ahmad K. Arshad<sup>3</sup> and Mohd Zul H. Mahmud<sup>4</sup>

<sup>1</sup>Department of Civil Engineering, College of Engineering, Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia

<sup>2</sup>Earth Resources and Sustainability Centre (ERAS), Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia

<sup>3</sup>Institute for Infrastructure Engineering and Sustainable Management (IIESM), Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

<sup>4</sup>School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310, Johor Bahru, Malaysia

#### Abstract:

#### Introduction:

Asphalt binder plays an important role in contributing to the good performance of asphalt mixture. However, the interlocking structure of asphalt binder is delicate and sensitive due to surrounding temperature and moisture.

#### Methods:

Previously, asphalt binder usually modified with polymer modifier. But, this type of modifier has low temperature susceptibility. To overcome this, nanomaterial is introduced to enhance the performance of virgin asphalt binder. Among the crucial evaluation of nano-modification is to evaluate its microstructural changes through morphological property evaluation. The addition of nanomaterial then will significantly improve the inner structure of asphalt binder and reduce the effect of those problems.

#### Aim:

Thus, the aim of this study was to assess the morphological properties of nanosilica modified asphalt binder to determine the inner structured properties of modified specimen.

#### Results:

Among the morphological tests conducted for asphalt binder in this study were Scanning Electron Microscope (SEM), X-Ray Diffraction (XRD) and Atomic Force Microscope (AFM). From SEM image analysis and XRD evaluation, the existence of Nanosilica (NS) inside the asphalt binder was well dispersed and from these two tests, the existence of NS inside asphalt binder was verified. From AFM results, most of NS-MB images before and after ageing conditions displayed the typical bee structure (Catana Phase).

#### Conclusion:

It was also concluded that the addition of NS in asphalt binder improved its surface stiffness. The overall surface stiffness of the asphalt binder after aging was increased and the surface became more solid.

**Keywords:** Morphological, Physical, Nano silica, Bitumen, Stone mastic asphalt, Catana phase.

#### Article History

Received: January 06, 2020

Revised: March 18, 2020

Accepted: April 15, 2020

## 1. INTRODUCTION

Nowadays, asphalt is mainly used as a binder for mineral aggregates in the paving industry. It is a complex hydrocarbon with composition are divided into four main components, lighter components such as aromatics and saturates and heavier

components, asphaltenes and resins [1]. Although only a small amount of asphalt binder is used in a typical asphalt mixture, it plays an integral role in the performance of asphalt mixtures [2]. When the asphaltic materials do not satisfy the requirements for constructing a well-performing bituminous structure, modification usually is adopted as one of the best and most attractive strategies for meeting the desired properties of used materials [3]. It has been confirmed that asphalt aging is

\* Address correspondence to this author at the Department of Civil Engineering, College of Engineering, Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia; E-mail:ramadhansyah@ump.edu.my