Physical, chemical and morphology characterisation of nano ceramic powder as bitumen modification

Ahmed Abdulameer Hussein[a], *Ramadhansyah Putra Jaya*[b], *Haryati Yaacob*[a], *Norhidayah Abdul Hassan*[a], *SalammRidha Oleiwi Aletba*[a], *Ghasan Fahim Huseien*[a], *Ekarizan Shaffie*[c] *and Mohd Rosli Mohd Hasan*[d]

[a]School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia
[b]Faculty of Civil Engineering & Earth Resources, Universiti Malaysia Pahang, Gambang, Malaysia
[c]Institute for Infrastructure Engineering and Sustainable Management (IIESM), Universiti Teknologi MARA, Shah Alam, Malaysia
[d]School of Civil Engineering, Universiti Sains Malaysia, Nibong Tebal, Malaysia

ABSTRACT

The physical, chemical and morphology characteristics of the ceramic source enable its waste to be a novel modifier for bitumen. This study employed the top-down approach via dry grinding in a mechanical ball mill to generate a nanoceramic powder (NCP). As a result, NCP was successfully generated with an optimum duration of 15 h and optimum Ball-to-Powder Ratio (BPR) of 10:1. The results also indicated that the particle size of NCP was significantly decreased to less than 100 nm. XRD pattern and Scanning Electron Microscopy (SEM) of the NCP-modified bitumen (NCPMB) indicated good dispersion of the NCP within the bitumen matrix. This improvement led, in turn, to decrease in the penetration and to increase in softening point and rutting resistance factor (G*/sin δ) of the NCPMB. In addition, the contact angle results indicated that the presence of NCP increased the number of heteroatoms and, hence, the polarity of the modified bitumen, thereby improving the adhesion of bitumen toward the aggregate. A small difference in softening point between the top and bottom is an indicator of NCPMB with good high-temperature storage stability. Asphalt Pavement Analyser (APA) outcomes reaffirmed the structural improvement of the modified asphalt mixture and rutting resistance was increased.

KEYWORDS
Nanoceramic; modified bitumen; chemical; physical; contact angle

DOI: https://doi.org/10.1080/10298436.2019.1650277

FUNDING

This work was supported by RDU UMP [grant number 1803160].