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# Multiscale Evaluation of Paving Asphalt Binders Under Different Aging Environments

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## Abstract

Aging of the asphalt binder can affect the durability of the asphalt pavement during its lifetime. The purpose of this study is to evaluate the performance of asphalt binders based on microscopic data under various aging environments. In this study, a Performance Grade (PG) 64-22 binder (control), collected from two different crude sources along with their modified counterparts were evaluated. For microscopic evaluation, an Atomic Force Microscopy (AFM) tool was used to measure the aging effects on the binders' rheological and mechanical properties at the molecular level. Additionally, the Rotational Viscosity (RV) and Dynamic Shear Rheometer (DSR) tests were performed on the asphalt binder samples. All binder samples were tested under three different aging conditions namely, unaged, short-term aged, and long-term aged. The AFM test results showed that the microstructures presented on binder's surface were largely affected (e.g., dispersed and/or reformed) because of the aging, resulting in variations of mechanical properties (e.g., modulus, adhesion, deformation, etc.). The modulus and adhesion values were found to increase, whereas deformation was decreased due to aging. The DSR test results showed that the complex (dynamic) modulus increased for all binders irrespective of the extent of aging and binder's crude sources. Such observations agree with the AFM test results. The findings of this study will help the asphalt industries and pertinent transportation agencies to gain micro-level knowledge into the aging effect on the properties of the asphalt binders.

## Keywords
Multiscale, asphalt binder, morphology, atomic force microscope, aging, mechanical properties.

## Biographies
**Sumon Roy** is a Ph.D. student in environmental science at Arkansas State University (A-State). His research focus has been in the area of recycling of construction materials primarily used in transportation infrastructures. He received his Master of Science in Engineering from A-State in 2019. He received his Bachelor of Science in Civil Engineering from Khulna University of Engineering and Technology. He has published his research findings in multiple journal and conferences. He also received multiple awards including his Ph.D. fellowship and travel grants for his outstanding performance at A-State.

**Zahid Hossain** is an Associate Professor of Civil Engineering at Arkansas State University (A-State). He has over ten years of experience in research and scholastic activities, with an emphasis on the development and characterization of sustainable concrete and geotechnical materials using various waste materials and nano-fillers through mechanistic and surface chemistry approaches. Dr. Hossain's research has been supported by various federal, state, and local agencies that include the National Science Foundation, the US Department of Transportation, and the Arkansas Department of Environmental Quality. Among different awards of Dr. Hossain, the 2019 A-State Faculty Award for Advising, 2014 Ralph E. Powe Faculty Enhancement Award from Oak Ridge Associated Universities, and the 2013 A-State Faculty Award for Scholarship are noteworthy to mention. Dr. Hossain has coauthored over 60 peer-reviewed journal articles and 70 refereed conference papers. Dr. Hossain has served in various capacities (Editor, Reviewer, and Member) of several international and national level professional journals, symposia, academies, and scientific boards. Dr. Hossain is a Professional Engineer in Arkansas.