

Investigation of the Physical and Rheological Properties of Carbon Black Modified Bitumen

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Abstract

Traveling and transport is an essential part of the day to day life. All kinds of users from pedestrians to a vast range of vehicles, expect a comfortable and controllable movement through the road. To provide a smooth, durable and quality surface for these users, pavement performance is very important. But reasons such as different environmental conditions, tire pressure and high traffic volume may lead pavement to rutting, low temperature cracking and fatigue. As a solution to enhance the performance of pavements and avoid these distresses, modifying the bitumen properties has been considered from the earlier days of asphalt pavement technology. Vast range of studies have tried out on bitumen to eliminate the material properties and increase the overall performance. Further, polymer has become the commonly used medium for bitumen modification as a pavement performance enhancing method. Styrene butadiene styrene (SBS) and styrene butadiene rubber (SBR) are some frequently used modifier types. In Literature, it is clearly observable that both physical and rheological properties of the base bitumen have significantly improved by polymer modifiers. Although polymer modified bitumen types are effective in performance, they are economically less effective. The major imperfection of polymer modifiers is degradation of polymer due to aging and incompatibility. Therefore, the researchers pay their attention towards more effective modifiers. Vermiculite, waste oil modifiers, crumb rubber modified, rock asphalts, asphalt rubber and nanoparticles/polymer are some of additives which were tried on bitumen as modifiers. Moreover, the capability to improve the pavement performance using mineral fillers; dust from crushing and screening of aggregates, lime, Portland cement, fly ash and carbon black (CB) has attracted the attention of the world nowadays. Among the above mineral fillers, Carbon black is a waste material which is extracted from waste tires or petrochemical waste. Carbon Black is a black powder which has particles of irregular shapes and large specific surface area. Carbon elements are the main components while oxygen, hydrogen, sulfur and other impurities may be contained in Carbon Black. Modified bitumen with carbon black has a good influence on high temperature permanent deformation and aging properties. Several studies have mixed additional materials altogether with Carbon Black to address some issues in modified bitumen. Further, Carbon black is much cheaper and environmentally friendly than polymer modifiers. Therefore, diving more into these carbon black Bitumen modifications is important. This paper presents a series of experiments which performs to evaluate the properties of Carbon Black modified bitumen. Scanning electron microscope (SEM) and X-ray energy dispersive spectroscopy are used to observe the topography and the chemical composition of the Carbon black. Mixing time, mixing temperature and Carbon Black content varies while modifying by melt blending with a high shear mixer to obtain the optimum parameters. Penetration, Ductility, Softening Point, Viscosity, Dynamic shear rheometer (DSR) test, bending beam rheometer (BBR) test identify the physical and rheological parameters of modified bitumen. All the Tests perform according to the ASTM standards. It can observe significant impact on physical and rheological properties of the bitumen after analyzing these results. Further, low temperature cracking resistance of bitumen decreases

with the addition of Carbon Black and high- temperature deformation resistance has developed. This paper provides a thorough study of properties of carbon black modified bitumen and emphasizes the further research requirement regarding this area.

Keywords: *Bitumen modification, Carbon Black, high shear mixing, pavement performance*

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