

Enhancing the Performance of Petroleum Bitumen 60/70 through Modification with Crude Naphthalene

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Abstract

Bitumen, a viscous mixture of hydrocarbons, is a key substance in the asphalt mixtures due to its binding and heating qualities. Most common challenges in asphalt pavements such as rutting, cracking, and deformation at moderate to high temperatures persist in asphalt pavements, necessitating the to enhance performance of bitumen. Modification of 60/70 penetration grade bitumen, by adding naphthalene was studied to mitigate the distresses appear on local road surfaces; mainly age hardening cracks and plastic deformations. As a modifier, Naphthalene is a polycyclic aromatic hydrocarbon, is introduced into the bitumen matrix through physical blending. Due to its aromatic structure, naphthalene can potentially interact with the bitumen components via π - π stacking interactions and lead to changes in rheological properties of bitumen without altering the fundamental structure of bitumen molecules. The primary goals are to obtain finely structured bitumen, to maximize aggregate coating ability, to obtain workable asphalt mixtures at low bitumen content, to find cures for common asphalt mixture diseases, and to achieve environmental and economic benefits. The methodology for this modification is that crude naphthalene was blended with the base 60/70 bitumen at varied quantities under controlled ambient and laboratory conditions. This modification mainly changes the rheological properties of bitumen such as viscosity, softening point, penetration and resistance to temperature variations which intended to increase bitumen's resistance to deformation under load, especially at high temperatures, thus improving the overall performance and durability of asphalt pavements. Most importantly naphthalene modified bitumen can increase the aggregate coating ability of asphalt mixtures significantly. A more uniform dispersion of the resulting structure can lead to a reduction in the formation of weak spots within the asphalt mixture, thereby improving its overall durability and longevity. With this more arranged structure bitumen surface can achieve more visually fine texture and clear appearance such as mirror surfaces while maintaining the skid values. By evaluating performance grade values, this is the cheapest but yet effective binder modification. Because of the homogeneity of the structure, adhesion is improving and leads to work as a moderate raincoat effect on the surface of asphalt. Moreover, it is expected to exhibit increased stiffness, which enhances the stability of the Marshall mix. Naphthalene's stiffening effect on bitumen enhances the mixture's ability to distribute loads evenly, reducing the likelihood of localized stress and pavement damage. The flow values of the modified asphalt mix may decrease due to the stiffening effect of naphthalene on the bitumen and that suggests a less plastic and more rigid mix, which could be beneficial in reducing permanent deformation. Low flow values contribute to a higher load-bearing capacity for asphalt pavements. Considering to its low bitumen content, this will be the optimal solution for fuel delivery and an answer to the increased cost of materials as a result of the present economic downturn. Also, the resulted darker asphalt surface absorbs more solar radiation, leading to higher surface temperatures. This natural heat absorption can help facilitate the self-healing

properties of the asphalt. This research contributes to the growing body of knowledge on bitumen modification and offers practical insights into the use of naphthalene as an effective and economical additive for improving overall asphalt performance.

Keywords: *naphthalene modified bitumen, low bitumen content, extra black asphalt, bitumen mirror surface, great aggregate coating ability*

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