

The Microstructural and Mechanical Characterization of Organo-Clay-Modified Bitumen, Calcareous Aggregate, and Organo-Clay Blends

Authors : A. Gürses, T. B. Barın, Ç. Doğar

Abstract : Bitumen has been widely used as the binder of aggregate in road pavement due to its good viscoelastic properties, as a viscous organic mixture with various chemical compositions. Bitumen is a liquid at high temperature and it becomes brittle at low temperatures, and this temperature-sensitivity can cause the rutting and cracking of the pavement and limit its application. Therefore, the properties of existing asphalt materials need to be enhanced. The pavement with polymer modified bitumen exhibits greater resistance to rutting and thermal cracking, decreased fatigue damage, as well as stripping and temperature susceptibility; however, they are expensive and their applications have disadvantages. Bituminous mixtures are composed of very irregular aggregates bound together with hydrocarbon-based asphalt, with a low volume fraction of voids dispersed within the matrix. Montmorillonite (MMT) is a layered silicate with low cost and abundance, which consists of layers of tetrahedral silicate and octahedral hydroxide sheets. Recently, the layered silicates have been widely used for the modification of polymers, as well as in many different fields. However, there are not too much studies related with the preparation of the modified asphalt with MMT, currently. In this study, organo-clay-modified bitumen, and calcareous aggregate and organo-clay blends were prepared by hot blending method with OMMT, which has been synthesized using a cationic surfactant (Cetyltrimethylammonium bromide, CTAB) and long chain hydrocarbon, and MMT. When the exchangeable cations in the interlayer region of pristine MMT were exchanged with hydrocarbon attached surfactant ions, the MMT becomes organophilic and more compatible with bitumen. The effects of the super hydrophobic OMMT onto the micro structural and mechanic properties (Marshall Stability and volumetric parameters) of the prepared blends were investigated. Stability and volumetric parameters of the blends prepared were measured using Marshall Test. Also, in order to investigate the morphological and micro structural properties of the organo-clay-modified bitumen and calcareous aggregate and organo-clay blends, their SEM and HRTEM images were taken. It was observed that the stability and volumetric parameters of the prepared mixtures improved significantly compared to the conventional hot mixes and even the stone matrix mixture. A micro structural analysis based on SEM images indicates that the organo-clay platelets dispersed in the bitumen have a dominant role in the increase of effectiveness of bitumen - aggregate interactions.

Keywords : hot mix asphalt, stone matrix asphalt, organo clay, Marshall test, calcareous aggregate, modified bitumen

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