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Experimental investigation of performance properties of asphalt binder and stone matrix asphalt mixture using waste material and warm mix additive

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Abstract

Many distresses occur in the pavement due to the increase in traffic and changes in weather conditions through the year (hot to cold). Asphalt binder modification is the best way to control these stresses. On the other hand, utilization of warm mix asphalt additives has significant environmental benefits. This research investigates the influence of simultaneous usage of two waste material (ground tire rubber (5%, 10% 15%, and 20% by weight of asphalt binder) and natural bitumen (10%, 20%, 30%, and 40% by weight of asphalt binder)) on performance behavior of asphalt binders and mixtures containing warm mix asphalt additive. Performance behavior of binders and mixtures were evaluated by several tests such as; conventional asphalt binder tests, linear Amplitude Sweep (LAS), Multiple Stress Creep Recovery (MSCR), Bending Beam Rheometer (BBR), Dynamic Shear Rheometer (DSR), storage stability, resilient modulus, indirect tensile strength, dynamic creep, hamburg wheel track, and four point beam fatigue (FPB) tests. The statistical analysis was performed to investigate the additives have significant effect or not. Results revealed that fatigue and rutting performance of samples were improved by combination of waste materials. Addition of waste natural bitumen led to decreases the low-temperature behavior of asphalt binder, while addition of waste ground tire rubber improves the resistance against low-temperature cracking. Addition of natural bitumen up to 10% has positive impact on storage stability of binder and by adding more content of additive, phase separation occurred. Warm mix additives improve the fatigue and rutting resistance of mixtures containing waste materials. Adding 20% CR to 30% Gilsonite -modified binder causes an enhanced the high temperature characteristics of about 34%. Based on outcomes, waste ground tire rubber enhances the fatigue resistance of mixtures containing natural bitumen. In general, utilization of waste materials in combination with warm mix additives improve the performance properties of asphalt binder and mixture. Mr of mixtures, containing 40% Gilsonite, was 52% greater compared to base mixture. Nonetheless, 30% Gilsonite as well as 5% CR had Mr values nearly 44% higher compared to base mixture. Also, based on statistical analysis, addition of mentioned additives has significant effect on improving the performance of specimens.