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Experimental investigation of the rheological behaviors of bitumen and stone matrix asphalt mixtures using waste material

Jing Luo ^a, Qian Li ^b, Masood Ashraf Ali ^c, As'ad Alizadeh ^d, Amir Raise ^e,
Abdulrhman Fahmi Alali ^f, Sattam Fahad Almojil ^g, Abdulaziz Ibrahim Almohana ^h,
Khaled Twfiq Almoalimi ^f

Abstract

The mechanical performance characteristics of bitumens and mixtures can be improved by the utilization of various modifiers, such as liquid rubber and natural bitumen. In the current study, the effect of liquid rubber and natural bitumen on the rheological behaviors of natural bitumen and liquid rubber/natural bitumen modified samples and Stone Matrix Asphalt (SMA) mixtures was evaluated. In this regard, 0, 5, 15, 25 and 35% natural bitumen as well as 7, 9, 11, and 13% liquid rubber by weight of binder were used to modify virgin binder. Also, to evaluate asphalt binder characteristics, rotational viscosity (RV), dynamic shear rheometer (DSR), multiple stress creep recovery (MSCR), and linear amplitude sweep (LAS) tests were applied. Furthermore, modified natural bitumen and liquid rubber/natural bitumen mixtures were evaluated by four-point beam fatigue (FPBF), resilient modulus (Mr), indirect tensile strength (ITS), dynamic creep, and wheel track experiments. The results indicated that the use of natural bitumen reduces the low-temperature cracking resistance of bitumens, while adding liquid rubber into natural bitumen modified bitumens, the low-temperature cracking of modified bitumens enhances. Moreover, application of natural bitumen resulted in a reduction in the resistance of bitumens against fatigue cracking, while using liquid rubber in natural bitumen modified samples, the fatigue life of bitumens increases. Also, natural bitumen enhances the resistance of bitumens to permanent deformations, while liquid rubber decreases it. The mixtures' test results indicated that natural bitumen increases Mr, permanent deformation resistance, tensile strength, fracture energy, and intermediate temperature performance of mixtures. Moreover, liquid rubber has a negative effect on performance of natural bitumen-modified specimens.