

Abstract

Phase change materials (PCMs) can be used as thermal regulation units to prevent thermal diseases of asphalt pavements. However, the effects of PCMs on the thermal and rheological properties of asphalt binders still need to be further studied. Therefore, the influence of an expanded graphite/polyethylene glycol composite phase change material (EP-CPCM) on the thermal and rheological performance of a Pen 60/80 base binder and a SBS modified binder were investigated in this research. Various experiments were conducted, and the thermal constants analyses show that the thermal conductivity gaps of the EP-CPCM modified base and SBS asphalt binders are lower than 8%, indicating a favorable compatibility between EP-CPCM and the asphalt binders. The thermal conductivity and thermal diffusivity of base and SBS binders are doubled after the incorporation of EP-CPCM, which ensures a rapid heat exchange with the ambient environment. Differential scanning calorimeter (DSC) results indicate that the melting and crystallization enthalpies of the EP-CPCM modified base binders are 13.77 J/g and 10.22 J/g respectively, meanwhile, the melting and crystallization enthalpies of the SBS binders are 14.63 J/g and 13.59 J/g respectively. The heating and cooling rate of the modified binders are separately reduced at the temperature range of 40–50 °C and 35–25 °C because of the phase transition of EP-CPCM. Dynamic shear rheometer (DSR) results reveal that both the rutting parameter $G^*/\sin\delta$ and the fatigue parameter $G^*\sin\delta$ of the modified binders are increased when the EP-CPCM is added, indicating the rutting resistance is improved while the fatigue resistance is damaged. Bending beam rheometer (BBR) tests show that the addition of EP-CPCM results in the decrease in the creep rate and the increase in the creep stiffness of the modified binders, and both effects are detrimental to the prevention of low-temperature cracking.