Modeling and Analysis of Freeze-Thaw Cycles in Asphalt Pavements

Cristina Pilar Martin Linares, MSc. and Chun-Hsing Ho, PhD., P.E.
Northern Arizona University
Flagstaff, Arizona

Freeze Thaw-Cycles are fluctuations of temperature above and below 0°C. This thermal load impacts the resistance of asphalt pavements and it may accelerate the process of thermal fatigue. When temperature drops below 0°C, the water within the air voids in asphalt freezes and expand in volume. Thus, tensile stresses are created in the media that surrounds the voids. Understanding the effect of F-T cycles in asphalt is important to design more durable pavement materials. A novel testing method, ASTM C666, is used to simulate freeze-thaw cycles in asphalt specimens. Then, specimens are tested in the bending beam rheometer (BBR) to measure the change in stiffness. Viscoelastic analysis is performed to model the non-linear response of the asphalt and calculate the change in relaxation modulus. Heat transfer modeling of the asphalt pavement computes temperature distribution due to F-T cycles. A couple thermo-mechanistic problem is then solved to calculate thermal stresses in the asphalt from the values of relaxation modulus calculated. The results from this research aims at providing guidelines for more durable asphalt pavements and support the developed testing methodology.

Keywords: Freeze-Thaw Cycles, Asphalt Pavements, Thermal Stresses, Thermal Analysis, Modeling