The Effect of Urban Heat Islands and Traffic Wheel Pressure on the Performance of Asphalt Pavements

Chun-Hsing Ho, Ph.D., P.E., and Kaiqi Zhang
Northern Arizona University
Flagstaff, AZ

Conventional asphalt pavements are impervious, which can reach peak summertime surface temperatures of 120–150°F (48–67°C) (Pomerantz et al., 2000). These surfaces receive heat energy from solar radiations and transfer heat downward to be stored within the pavement layers (pavement layer, subbase, and subgrade), where the heat stored is remitted back to the air at night. These effects known as urban heat islands have been seen as a part of factors that has affected the performance of asphalt pavements. Although mechanical responses of traffic loading on pavement properties have been widely researched, however, relevant work in the effect of urban heat islands on the behavior of asphalt pavements have not yet well studied. In combination with wheel pressures, this project is being implemented to study the relationship between the properties of asphalt pavements and the combined wheel pressure/urban heat islands. The objectives of the project are to (1) quantify the effect of urban heat islands on the performance of asphalt pavements, and (2) analyze stresses of asphalt pavements imposed by wheel pressure, and (3) study the properties of asphalt pavements affected by both urban heat islands and wheel pressure. Autodesk Vasari is used to build a 3 dimensional model to simulate the impact of solar radiation on buildings and pavement surfaces. Thermal stresses occurred as a function of time in shadowed and unshadowed areas are analyzed separately. Tensile stresses caused by vehicle movements within the pavement layers are computed. The data obtained from these analyses are used to determine the effect of urban heat islands and wheel pressure on the properties of asphalt pavements. A series of thermal and wheel pressure analyses are performed and the results show that pavement properties are obviously influenced by solar radiations, surface temperature changes, and wheel pressures. Shadowed and unshadowed pavements caused by the geometric location of roads could have a significant impact on the heat energy absorption and thermal stress calculation. The project further recommends a further investigation to be conducted to evaluate the impact of landscaping and vegetation of roadways on the increase of life cycle of asphalt pavements.

Key Words: Heat island effect, pavement performance, shadowed and unshadowed pavement