Thermal Properties of Asphalt Mixtures

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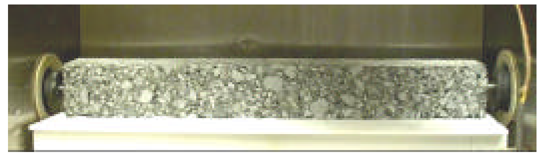
The objectives of this study were to determine the thermal coefficient of expansion, thermal flow parameters of volumetric heat capacity (*C*), and thermal conductivity (*k*) for a variety of asphalt mixtures.

A laboratory procedure was developed and used to determine the thermal coefficient of expansion and contraction of asphalt mixtures. Among the laboratory and field asphalt mixtures, a crumb rubber modified asphalt mixture was also included in the testing program. In addition, a reference compacted specimen consisting of an 80% crumb rubber and 20% urethane (all-rubber) was also tested.

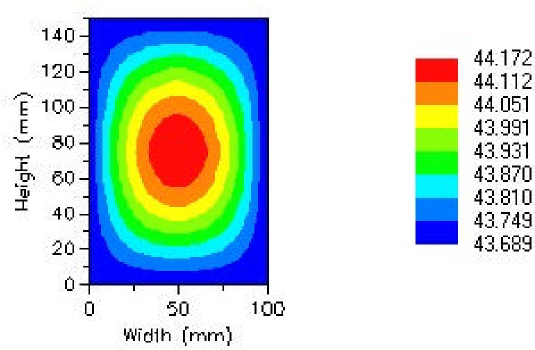
The thermal coefficient values of the various mixtures ranged between 2.046 and 6.321 x 10^{-5}/°C (1.137 and 3.512 x 10^{-5}/°F). The thermal coefficients were dependent on the material type and method of compaction. The all-rubber specimen showed higher coefficient values than any other mixture, and was consistent with values reported for common rubber materials. The coefficients of thermal *expansion* of the asphalt mixtures were slightly larger than the coefficients of thermal *contraction*. The asphalt mixture had lower thermal coefficients of expansion and contraction than the crumb rubber asphalt mixture. The field and laboratory compacted specimens seemed to have a large effect on the values obtained for the thermal coefficients, probably because of the lab difficulty in accurately simulate field compaction.

A heat flow computer program was used to simulate lab temperature measurements and calculate the *C* and *k* values of the asphalt mixtures. The program was also used to estimate the required temperature stabilization times to change temperatures according to the laboratory test protocols. The typical *C* value ranged from 650,000 Cal/m^3.^{o}C to 1,150,000 Cal/m^3.^{o}C, whereas the *k* value ranged from 600 Cal/m.h.^{o}C to 1,200 Cal/m.h.^{o}C. No unique optimum *C* or *k* values were obtained, but a linear relationship between *C* and *k* values was determined. A band of possible optimum *C* and *k* values was developed. The temperature stabilization time to change the temperatures according to some laboratory test protocols were also recommended.

Specimen During Testing



Temperature Profile (Degree C)



Conclusions

1. The thermal coefficient values of the various mixtures ranged between 2.046 and 6.321 x 10^{-5}/°C (1.137 and 3.512 x 10^{-5}/°F).
2. The coefficients of thermal *expansion* of asphalt mixtures were slightly larger than the coefficients of thermal *contraction*.
3. The asphalt mixtures had lower thermal coefficients of expansion and contraction than the crumb rubber mix. Field observations, however, show that asphalt rubber has less cracking than conventional mixes because of its flexibility of stretching in tension to a large extent without breaking.
4. The typical *C* value ranged from 650,000 Cal/m^3.^{o}C to 1,150,000 Cal/m^3.^{o}C (40 to 72 Btu/ft^3.^{o}F), whereas the *k* value ranged from 600 Cal/m.h.^{o}C to 1,200 Cal/m.h.^{o}C (0.40 to 0.80 Btu/ft.h.^{o}F).
5. Optimum *C* and *k* values are related according to the following equation:
   $C = 833.33\,k + 163330$
6. The heat flow program can be used to estimate the required stabilization times to change temperatures according to some laboratory test protocols. *For more information contact Mamlouk@asu.edu.*