Thermal Effects During the Curing of Concrete Pavements

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This project used fundamental heat and mass transfer principles to predict the temperature, water content, and unreacted cement profiles that exist during the first 72 hours of curing in concrete pavements and bridge decks. A two-dimensional model of a bridge deck was developed and model results compared with actual experimental data. Traditional concrete and concrete containing flyash and microsilica additives were considered. Where possible, the information from this program will be used to calculate the thermal stresses in the concrete.

The goal was to predict the temperature of concrete pavements and bridge decks exposed to different environmental conditions. The researchers considered diurnal and seasonal variations in absorbed solar radiation, changes in convective heat transfer as a function of variable wind speeds and changes in conductive heat transfer as a function of roadway construction (slab thickness, bed condition and cornposition. etc.).

The experiments included measurements on a bridge deck placement over the Mourningkill in Saratoga County. Temperature profiles, wind speeds, net radiation fluxes and relative humidity were measured both above and below the bridge deck. The most interesting aspect of the data is the difference in temperature profiles between the two positions. Above the support beam temperatures are noticeably cooler reflecting the fact that the supports act as heat transfer fins removing more heat from the sections directly above them. The relatively low thermal conductivity of the concrete prevents the cooling process to extend much beyond the area immediately above the support beams.

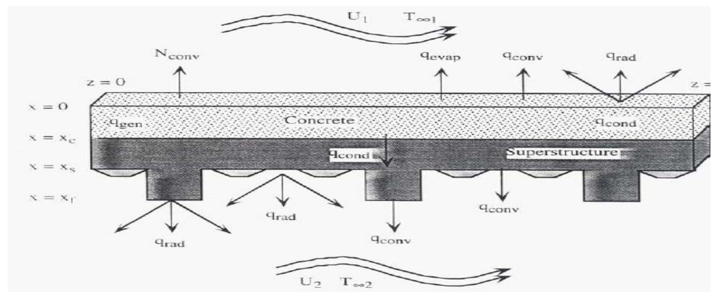

Figure 9 Standard, single-span, bridge deck with associated heat and mass transfer mechanisms.

After a one dimensional model was successfully developed to predict profiles in concrete pavements, a two dimensional model was developed for the bridge deck system. The two dimensional model was based on the one dimensional formulation and used the same basic set of equations for temperature profile, water content, and cement reaction. This is not strictly valid since high performance concrete containing a significant quantity of flyash was used in the bridge deck. Flyash alters the reaction rate and heat evolution. The model results were in the same ballpark as the data, but more research needs to be done on the effect of flyash on the reaction rate and heat evolution.

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