ABSTRACT

Bridge construction projects with large concrete placements (typically in substructure components) are at risk for problems due to the heat of hydration generated after concrete placement. Concrete subject to heat of hydration problems is generally defined as mass concrete. There are two primary concerns with mass concrete heat of hydration. One concern is delayed ettringite formation (DEF), where excessive heat leads to unstable hydration, a long-term problem with DEF cracking that may not show up for years after construction. The second concern is thermal cracking due to temperature differential in the mass of concrete. Tensile strain in the concrete caused by temperature gradients between hot interior portions and the cooler exterior portions of the concrete can cause cracking if the strain exceeds the capacity of the curing concrete.

This presentation will be a general overview of mass concrete with a case study presented. The case study is I-80 over the Missouri River Bridge. The bridge, a $56 million construction project, has significant mass concrete placements due to the large substructure elements required in a border river bridge crossing with a long center span of 425 ft for navigation clearance. The Iowa Department of Transportation applied a special provision to the project with generally accepted practices of limiting maximum temperature and temperature differential among other requirements to reduce the risk of concrete cracking problems associated with mass concrete. The contractor chose to submit a Value Engineering (VE) proposal for a performance-based thermal control plan. The contractor hired a specialty consultant to develop the performance-based thermal control plan that took into account the specific mix design and materials used on the project. The mix was tested for adiabatic temperature rise and a thermal control model was created for the various mass concrete placements. Placement restrictions and methods, including internal cooling, were defined based on the thermal control model. The presentation will summarize the performance-based thermal control plan and results.

Key words: bridge construction—heat of hydration—mass concrete—substructure