Florida Department of Transportation Research

Maximum Heat of Mass Concrete – Phase 2

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Project Manager
Michael Bergin
FDOT Materials Office

Principal Investigator
Mang Tia
University of Florida

Current Situation

Concrete hardens through a chemical reaction that produces heat and expansion, followed by contraction as the concrete cools. Concrete near the edge of a pour cools faster and shrinks earlier than concrete further from the edge. Most concrete pours are not thick enough for this effect to cause problems, but in large pours – called mass concrete pours – such as foundations or bridge columns – the difference in rates of contraction can cause cracking. Also, the heat itself can damage the concrete if internal temperatures exceed certain levels. The amount of heat that develops in setting concrete and the rate at which it can dissipate depend on the ingredients used in the concrete and the shape of the structure . Data regarding the development and dissipation of heat in mass concrete pours are needed to calibrate software that engineers use to design concrete structures in order to better understand when heat is a critical issue.

Excessive heat buildup can damage large concrete components if they are not correctly designed.

Research Objectives

In this project, University of Florida researchers extended their previous work on mass concrete to develop data, equations, and software to facilitate design involving mass concrete placements.

Project Activities

The first of six project objectives was to compile rates of heat production for a range of cement blends used in Florida. The researchers tested the heat production of each blend and compiled the results to facilitate their use in computer analysis of mass concrete structures. In a second cement-related objective, the researchers tested the strength development of three-part concrete mixes (ternary blend mixes) used in Florida to develop equations for determining compressive strength at 28 days, based on measurements of compressive strength tested at later times. They found that the blends could be divided into four categories, and they developed an equation for each category.

Two other objectives focused on heat issues in specific structural components used in Florida: segmental pier segments and drilled shafts. The researchers determined which designs should be treated as mass concrete, establishing dimensions where heat issues were likely to be important. They also found that alternative cement-forming materials tended to reduce heat production.

Another objective structures tested the insulating properties of different soil types under various moisture conditions to develop parameters for use in thermal analysis of mass concrete structures placed on the soils. The researchers found that increasing moisture significantly reduces insulating ability and that variation in temperature had little effect.

Finally, the researchers developed an interface that will allow users who are not trained in finite element methods to perform thermal analysis of rectangular concrete footings and cylindrical concrete drilled shafts using basic information to perform complex evaluations.

Project Benefits

Continued research on mass concrete will provide a more complete design for concrete structures and deliver a more durable concrete structure.

For more information, please see dot.state.fl.us/research-center