Florida Department of Transportation Research

Rheology Limits for Grout Materials Used for Precast Bent Cap Pile Pockets in Hot Weather

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Current Situation

The use of prefabricated bridge elements and systems (PBES) saves time and money, both for transportation agencies and the traveling public. PBES is an emphasis area in the Federal Highway Administration's *Every Day Counts* program in which FHWA and state partners create innovations in transportation construction, planning, and safety. Several PBES projects in Florida have indicated a need for materials and processes that are better suited to Florida's hot, humid environment.

Precast piles fit into grouted sockets in the horizontal precast bent cap which supports the bridge deck.

Research Objectives

Florida State University researchers examined the behavior of grout in pile socket connections to explore broader performance limits for grout acceptance and still ensure quality construction.

Project Activities

Of the many pile-to-bent cap connection types, this project focused on FDOT's proposed Index D20710 series: an unreinforced grouted connection between a square pile and the bent cap. The grout that fills the space between the pile head and the bent cap socket must meet certain requirements. The researchers created a laboratory mockup of the pile-cap structure that closely simulates field conditions in order to understand the behavior of the grout. Thus, the project evaluated both grout properties in pile-cap connections and the effectiveness of the geometry of the proposed Index D20710 design.

Mockups were produced for a nominal 24" × 24" pile head with several different gap sizes ranging from 0.5" to 7.5" width. Bent cap mockups were built with and without tapered roofs. The inner formwork, simulating the pile head, was made of concrete in one case and plywood in all others. The outer formwork, simulating the socket, was an open plywood structure lined with clear acrylic, which allowed the researchers to observe how the grout flowed as simulated pile head and socket were joined. The acrylic also allowed observation of trapped air. Thermocouples were used to monitor temperature development in the curing grout.

In addition to examining the grout behavior in different pile and cap geometries, the researchers tested various grout formulations in the simulated pile and bent cap mockups. Grout was prepared according to manufacturer specifications. For one mockup, every other batch was colored with a standard concrete coloring agent to aid in examining the interaction between grout layers. All formulations were also subjected to compressive strength testing.

In general, the materials and structures performed within specification requirements, but recommendations were made regarding adjustments to the bent cap geometry. Also, the researchers recommended that the gap between the pile head and bent cap be no more than 4 inches to prevent high temperatures during curing, especially in hot weather conditions.

Project Benefits

Improved procedures for grout materials used in PBES construction will help assure more durable Florida bridge structures that require less maintenance or repair.

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