

Request for Research Funding for FY 2019-2020

Requesting Office	SMO	Priority	#6 of 11
Proposed Title	Effect of High Temperatures on Mass Concrete Durability		
Justification	<p>There have been reports from the field of a number of structural elements with cores exceeding 180°F and remaining above 170°F for ≥ 5 days and above 160°F for ≥ 10 days, and having core temperatures more than 50°F above ambient for more than 14 days. Some drilled shafts have exceeded 195°F at the cage, with core temperatures estimated to be 220° to 240°F. Also, the limited data available prior to the specification of the maximum temperature of 180°F (2010) shows that some mass concrete elements developed core temperatures in the range of 190° to 210°F.</p> <p>It is generally accepted in the literature that higher curing temperatures reduce strength and increase porosity, and temperatures above 160°F can lead to delayed ettringite formation (DEF). In addition, these temperature profiles are extremely inconsistent with the time-temperature profiles predicted in the Mass Concrete Control Plan and are of great concern.</p> <p>ACI 201.2R-16 Guide to Durable Concrete Table 6.2.2.2 "Recommended measures for reducing potential for DEF (Delayed Ettringite Formation) in concrete exposed to elevated temperatures at early ages" lists DEF prevention criteria. For temperatures expected up to 185°F, common prevention protocol involves the use of adequate quantities of SCMs. However, the references used to compile these criteria range from 10 to 40 years old. The characteristics and specifications for the raw materials used over this period of time have changed significantly, and it is reasonable to expect that the validities of the criteria have changed. Temperatures above 185°F are not allowed.</p> <p>Research is needed to establish what changes occur to the concrete microstructure when exposed to high temperatures for extended times, and what PC-SCM combinations are most resistant to those changes. Of particular interest is determining the effects of the high temperatures and long residence times on the permeability/penetrability and strength of the concrete, and how the microstructural changes affect the properties, particularly long-term durability.</p>		
Impact	Without research, the durability of a number of structures in the field would be in question since the effects of high temperatures and long periods at high temperatures are not known. The data from the research will be used to guide specification changes to ensure that FDOT concrete mixes are designed and cured to provide reliable long-term durability.		
Affected Offices	SMO, Construction, Program Management		
Existing Work	There has been some relevant research, but none addressing the high temperatures and times at temperature that have occurred on some FDOT projects.		
Keywords Used In Existing Work Search (Cannot leave blank)	Mass concrete, maximum temperature, delayed ettringite formation, durability		
Related Contracts (Give contract numbers)	BC 354-29		
Funding Request	\$360,000	Anticipated Duration	36 months
Project Manager	Pat Upshaw	Contracting Method	Direct of RFP
Urgency	1	Comments The long-term durability of some structures may have been compromised due to high temperatures, and their condition needs to be addressed by this research	
Implementability	1	Comments There are no roadblocks to implementation of results, which would be in the form of specification changes	

Project Benefits (Succinct, complete explanation)

The results will enable the production of structural concrete that will not be compromised by high temperatures

Proper temperature controls will avoid the detrimental effects of high temperatures and reduce maintenance costs.

Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc...if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits
<input type="radio"/> Materials Enhancement	Yes	Improved long-term durability by avoiding detrimental temperature effects
<input type="radio"/> Materials Savings	Yes	Reduced maintenance and rejection of elements
<input type="radio"/> Time Savings		
<input type="radio"/> Lives Saved/Injuries Prevented		
<input type="radio"/> Other (Explain)		

*Comments should explain and support urgency, financial benefit, and implementability scores