

## Request for Research Funding for FY 2019-2020

<b>Requesting Office</b>	SMO	<b>Priority</b>	#2 of 11
<b>Proposed Title</b>	Effects of Slag Composition on the Cracking Tendency and Long-Term Durability of Structural Concrete		
<b>Justification</b>	<p>This is a Phase II follow-up project based on the findings from Project BDV25-977-02 Effects of Chemical and Mineral Admixtures on Performance of Florida Structural Concrete. Slag cements currently used by FDOT were observed to impart a higher early-age cracking tendency in portland cement concretes than pozzolans such as class F fly ash. In addition, the long-term durability of concrete containing slag cements with high Al<sub>2</sub>O<sub>3</sub> contents may be compromised if the sulfate balance of the concrete is inadequate.</p> <p>Blast furnace slag is used extensively in structural concrete in Florida to reduce initial concrete temperature rise, improve durability, and increase service life. However, for large structural portland cement-slag cement concrete elements in the last 2 years, there have been occurrences of rapid early-age temperature rise, very high maximum temperatures, and very slow cooling.</p> <p>Temperature rise and the resulting early-age cracking potential of concrete containing slag are a function of slag reactivity, which is related to its physical and chemical properties. The slags predominantly used in Florida are foreign-sourced and contain 13-14 wt% Al<sub>2</sub>O<sub>3</sub> (alumina). ASTM C989 is vague in its evaluation of the effects of alumina content, listing 11% as low alumina and 18% as high alumina, and stating that high-alumina slag adversely affects the sulfate resistance.</p> <p>The two primary slag suppliers in Florida intergrind sulfate with the slag to optimize strength, with the assumption that this also provides sufficient resistance to sulfate attack. Previous research has shown that these 14% alumina slags have poor sulfate resistance without the addition of interground sulfate. Additional research has shown that the thermal cracking tendency of the concrete increases with alumina content, and the MgO content has a mitigating effect.</p> <p>Research is needed to establish the effects of slag cement composition, especially alumina content, and sulfate type and content on the early-age thermal cracking tendency and the long-range sulfate durability of concrete containing slag cement. This involves determining the best materials and methods to optimize the sulfate content of concrete containing slag cement to prevent cracking, and to determine the slag cement compositions that will provide the best long-range durability (resistance to sulfate attack and chloride intrusion). This research will include studying the effects of alumina content of slag cement on tendencies for thermal cracking, shrinkage cracking, and sulfate expansion of concrete containing slag cement, and the effectiveness of balancing the sulfate content on the mitigation of these detrimental effects. Recommendations will be made for specification changes that will ensure the long-term durability of structural concrete containing slag cement.</p> <p>Implementation will mainly be in the form of recommendations for specification changes that ensure the expected concrete performance when incorporating slag cements with high alumina contents</p>		
<b>Impact</b>	Without this research, the integrity and durability of many existing large structural elements cast with portland cement-slag cement will remain unknown. The potential problems from the use of relatively high-alumina slag cements in structural concrete cannot be avoided without the knowledge that would be obtained from this research, potentially putting the quality and long-term durability of the elements at risk.		
<b>Affected Offices</b>	SMO, Construction, Program Management		
<b>Existing Work</b>	Very little research has been done on the compositional effects high-alumina slag cements on the properties and long-term durability of portland cement-slag cement concretes, and on optimizing the sulfate balance of the cementitious system for sulfate resistance.		
<b>Keywords Used In Existing Work Search (Cannot leave blank)</b>	Slag cement, high-alumina slag, sulfate durability, sulfate balance		
<b>Related Contracts (Give contract numbers)</b>	BDV25-977-02		
<b>Funding Request</b>	\$390,000	<b>Anticipated Duration</b>	36 months
<b>Project Manager</b>	Jose Armenteros	<b>Contracting Method</b>	Direct to USF