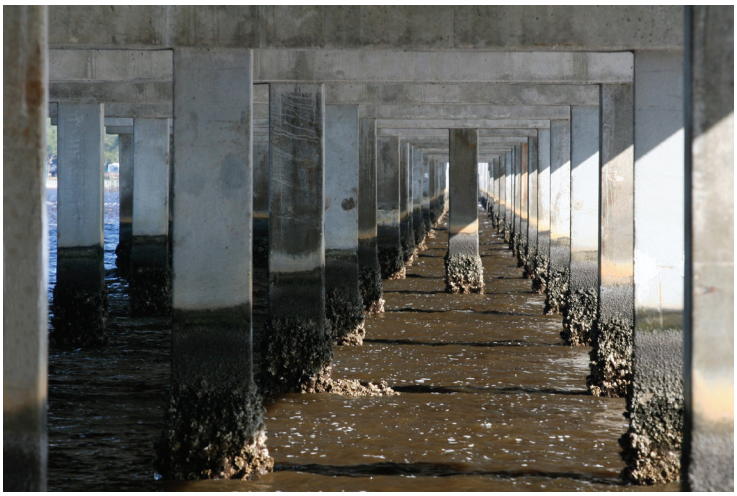
Florida Department of Transportation Research

Durabilitly and Mechanical Properties of Ternary Blend Concretes
BD545-35

Concrete exposed to harsh marine environments needs to be durable and resistant to chloride – the most corrosive component of salt. Current guidelines allow a blend of three materials to produce concrete: Portland cement, fly ash (a residue generated from the combustion of coal), and silica fume (a by-product in the manufacture of silicon metal and alloys).The lack of availability and high cost of silica fume has prompted a search for a substitute. Ground granulated blast furnace slag (GGBFS) produced from iron slag (a byproduct of iron and steel production) may contain properties similar to silica fume.



Bridge piles at low tide

Researchers from the University of Florida prepared test concrete mixtures using Portland cement with varying amounts of fly ash and GGBFS to evaluate durability and mechanical tests. They compared the results to mixtures using silica fume. Researchers also used X-ray diffraction to examine the microstructure of the materials as they reacted with water to form concrete.

In addition, the research compared concrete mixtures using Portland cement prepared according to the American Association of State Highway and Transportation Officials (AASHTO) M85 standard with cements meeting the American Society for Testing and Materials (ASTM) International C150 standard. This study used the specifications set prior to the efforts of these organizations to harmonize the differences between the standards.

Researchers found mixtures with higher fly ash content (30 to 40 percent by replacement of cement weight) had delayed gains in compressive strength. Increasing quantities of GGBFS (and associated decrease of Portland cement) produced a slight decrease (<10 percent) in the average seven-day compressive strength. Specified 28-day strength requirements of Class IV and Class V concretes typically used in moderately to extremely aggressive environments were exceeded by all of the mixtures. Overall ranking of the durability results indicated the 20 percent fly ash + 7 percent silica fume and 10 percent fly ash + 60 percent furnace slag mixtures provided the best resistance to chloride penetration.

Consequently, GGBFS could be used in these proportions to replace silica fume in harsh environments. However, the underlying behavior at the microstructure level is not fully understood. This study recommends further microstructural research on ternary blends to better understand the hydration process of the materials and the effect of varying their proportions. The relationship of microstructure and physical performance can be translated to more durable and better performing concrete systems.

FDOT Contact: Mike Bergin, FDOT State Materials Office
Principal Investigator: H. R. Hamilton, University of Florida
For more information, visit http://www.dot.state.fl.us/research-center