Naval Facilities Engineering Command
Engineering and Expeditionary Warfare Center
Port Hueneme, California 93043-4307

TechData Sheet

TDS-NAVFAC EXWC-CI-1409 December 2013

High Volume Fly Ash Concrete for Navy Structures

Technology Description

Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) engineers demonstrated and evaluated the usage of high volume fly ash (HVFA) concrete mixtures under full-scale production processes containing 50% less Portland cement while achieving increased durability and maintaining strength properties. By replacing 50% of the Portland cement with Class F fly ash, reduced cracking, decreased permeability, and increased electrical resistivity of the concrete can be achieved. All of these properties lead to a more durable material and a decrease in corrosion related deterioration while maintaining compressive strength properties. HVFA mixtures are placed using the same tools and procedures as those used in conventional concrete construction. Additionally, by replacing half of the Portland cement with fly ash, there is a large reduction in the amount of CO_2 emissions associated with the material.

Value to the Warfighter

Concretes made with HVFA mixtures have been shown to have increased durability and longer expected service life. Increased electrical resistivity and decreased permeability of the material both lead to a reduction in corrosion of embedded steel reinforcement. The frequent need for corrosion related repairs of Navy concrete structures contributes to down time and adversely effects the operations and mission of the Navy. A pier in disrepair is a safety hazard to our personnel due to spalling of the concrete. Moreover, as maintenance is deferred the rate of corrosion in the affected steel reinforcing increases as more of it becomes exposed to the environment due to cracking and spalling of the concrete. All of this is directly related to the corrosion of the reinforcing steel. Utilizing high volume fly ash concrete will slow the ingress of chloride ions and propagation of reinforcement corrosion, thereby extending the service life of reinforced concrete facilities and resulting in less downtime for concrete repairs and premature facility replacement.

Economics of the Technology

Since HVFA replaces 50% of the Portland cement with fly ash, and industrial waste by-product of coal burning power plants, there can be an initial savings in material costs. This savings varies depending on location and availability of suitable fly ash. The largest cost savings results from the increased durability and electrical resistivity of the concrete. Corrosion of embedded steel reinforcement is a leading cause of concrete deterioration in U.S. Navy waterfront structures. By significantly reducing the occurrences of reinforcement corrosion, HVFA concretes greatly reduce life-cycle maintenance costs of a structure.

Technology Transition Documentation

Use of high volume fly ash concrete mixtures has been incorporated into the August 2012 revision of the Unified Facilities Guide Specification (UFGS) 03 31 29 Marine Concrete. Its use is highly encouraged as a way to meet performance based requirements of the specification.

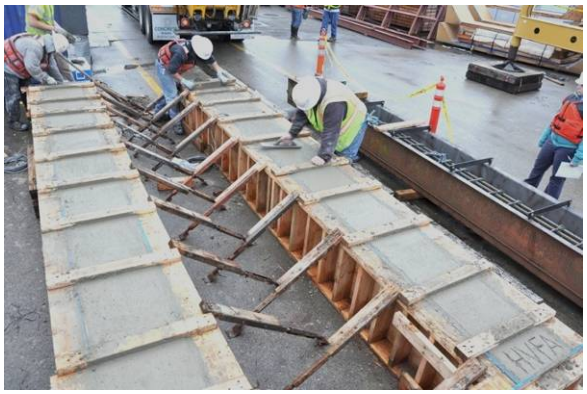
NAVFAC EXWC has prepared two reports that cover the advancements in HVFA concrete. SSR-3648-SHR Demonstration of High-Volume Fly Ash Concrete, was submitted to the OSD Corrosion Prevention and Control Program and contains lessons learned during the 2009 HVFA Test Beam placements in Bremerton, WA. TR-NAVFAC EXWC-CI-1314, High Volume Fly Ash Concrete for Navy Structures – An Environmentally Friendly

Solution for U.S. Navy Infrastructure Needs, includes additional work and findings since the OSD report and is available for public release.

NAVFAC EXWC also presented an overview of previous and on-going work with HVFA concrete at the 2013 DoD Corrosion Conference.

Site Implementation

NAVFAC EXWC demonstrated the placement of HVFA concrete at placements in Bremerton, WA and Port Hueneme, CA. A series of Test Beams designed to mimic pile caps found on Navy piers were cast in December 2009 in Bremerton and transported to Port Hueneme for long-term exposure testing and monitoring. To date these beams have shown no signs of cracking and there have been no measureable corrosion rate readings from the embedded monitoring instrumentation.



Finishing the surface of the high volume fly ash concrete Test Beams poured in Bremerton, WA

HVFA concrete was also used to construct a 78-foot by 50-foot concrete slab for a biodiesel plant at Naval Base Ventura County, Port Hueneme, CA. This placement was successfully accomplished by a local contractor who did not have any previous experience working with 50% fly ash mixtures. The contractor was very pleased with the ease of placing and finishing the material and plans to use it on future projects.

Specific Applications

High volume fly ash concrete can be used in virtually any U.S. Navy structure constructed using concrete. It is especially beneficial for structures exposed to the harsh marine environment or structures that contain large (greater than 3 feet thick) mass concrete elements.

High volume fly ash concretes also provide a method for engineers to achieve the longer service lives commonly being specified in performance based specifications such as UFGS 03 31 29 Marine Concrete. Due to the improved transport properties of the HVFA concrete material, STADIUM® modeling results have shown increased service life for HVFA concrete when compared to conventional Portland cement mixtures.

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