USA CERATECH
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Technical Report

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Scientific Breakthrough Provides Superior Air Entrainment and Freeze-Thaw Durability in Concretes Utilizing Fly Ash with Activated Carbon

Air entrained concrete contains a finely dispersed system of microscopic air bubbles that relieve hydraulic pressure caused by the expansion of water when freezing. Air entrained concrete has become a requirement to mitigate damage created by freeze-thaw cycles and greatly improve durability of concrete exposed to cold weather conditions. Concrete practitioners have a wide variety of readily available air entraining agents (AEAs) to help them meet air entrainment requirements. However, these AEAs have been optimized to perform within ordinary portland cement concrete (OPCC) systems. Regardless, a number of these AEAs show excellent performance in non-portland cement concretes utilizing recycled fly ash like CERATECH™ Cement concretes.

In particular, AEAs based on synthetic chemicals such as Microair and Multiair 25, have consistently demonstrated the ability to provide durable air void systems with low Loss On Ignition (LOI) fly ash typically utilized in CERATECH™ Cement.

In March 2011, CeraTech, Inc. conducted freeze-thaw durability testing per ASTM C 666 on three prisms of ekkomaxx™ cement concrete utilizing non-carbon activated fly ash entrained with 1.5 oz./Cwt. of Microair AEA, which generated 5.5% air. The samples produced an average durability factor of 94.1% after 300 cycles; validating that an air-void system could be generated in ekkomaxx™ cement concrete using an industry standard AEA. However, their effectiveness is significantly reduced when unburned carbon is present, as is the case in a number of fly ashes (source dependent). As environmental requirements impact the utility industry, it is anticipated that more sources will begin to produce Activated Carbon Injected (ACI) fly ash. The presence of the activated carbon makes the fly ash unmarketable for ordinary portland cement systems.

Through extensive research, CeraTech's Research and Development group created an AEA that effectively entrains air in CERATECH™ Cement concretes utilizing fly ash with high concentrations of activated carbon. The AEA demonstrates the ability to effectively entrain air in concretes utilizing both low and high LOI fly ash. A dosage rate of 0.3 to 0.7 oz./Cwt. of this material generates 4% to 7 % air void system within low LOI fly ash. When using fly ash containing activated carbon, a dosage of 2 to 3.5 oz./Cwt. generates approx. 4% to 7 % air. As with most commercial AEA's, there is no standard dosage, trial mixes should be run to determine the optimum dosage for any particular fly ash and/or mix design. The addition of this material increases concrete workability and ease of placement without impacting concrete set time. As with all air entrained concrete mix designs, consideration should be given to the marginally lower strengths that result from an air entrained mix.

In March 2013, CeraTech Inc. contracted with the National Ready Mixed Concrete Association's (NRMCA) Research Laboratory to test ekkomaxx™ concrete with the new AEA material for freeze-thaw durability and air-void analysis, per ASTM C 666 and C 457, respectively. Two air entrained ekkomaxx™ concretes were tested, one using Activated Carbon Injected (ACI) fly ash from Will County, IL, and the other using a low LOI fly ash from Scherer. ***Both of the air-entrained concretes demonstrated a durability factor of 100% after completing 600 freeze-thaw cycles (twice the required 300 cycles).*** The concrete samples showed an appropriate air void distribution factor and good specific surface in the air-void analysis.

The NRMCA Research Laboratory's third party industry standard test results validate the position that CeraTech's new air entrainment material provides a stable air-void system with CERATECH™ Cement concretes, resulting in excellent resistance to freeze-thaw cycles. While continuing to effectively utilize existing AEA's (when required) CeraTech is in the process of commercializing this new AEA to ensure the superior durability of air entrained concretes utilizing ACI fly ash.