NISTTech

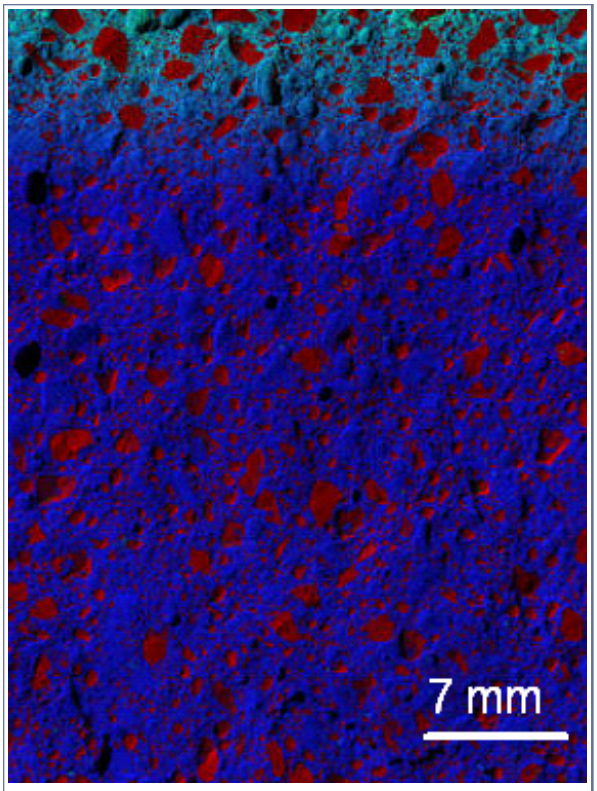
Doubling the Service Life of Concrete

Protects concrete from chloride and sulfate penetration from road salt, sea water and soils

Description

This approach increases the service life of concrete structures by reducing the infiltration rates of deleterious ions. The key is a nano-sized additive that slows down penetration of chloride and sulfate ions from road salt, sea water and soils into the concrete. Conventional approaches have focused on producing a more impermeable matrix by reductions in water-to-cementitious materials ratio and the addition of fine particles such as silica fume. In the new approach, focus is shifted to changing the properties of the viscosity of the solution in the concrete at the microscale to reduce the speed at which chlorides and sulfates enter the concrete. Viscosity modifiers are used to substantially increase the viscosity of the concrete pore solution, and proportionally decrease the rate of diffusive transport. Thus, a doubling of the service life of structural concrete can be achieved by increasing the pore solution viscosity by a factor of two.

Images



The blue-green area at the top of this X-ray image of concrete with the nanoadditive shows that very few chloride ions (in green) penetrate into the concrete.

Applications

- **Concrete structures**
  Nano-sized particle can be added to concrete mixtures and used in countless applications

Advantages

- **Extended life**
  Doubles the typical untreated lifespan of concrete
- **Increased pore solution viscosity**
  Nano-sized additive increases the pore solution viscosity by a factor of two, thereby doubling the life of concrete
- **Reduced diffusion rates**
  Reduces the diffusion rates of harmful substances (i.e. sulfates, chlorides, and alkalis) by increasing the hydrodynamic friction of the concrete

Abstract

The invention consists of a unique method to reduce diffusion rates in concrete by increasing the hydrodynamic friction on ionic

species in the concrete pore solution. This novel approach involves changing the properties of the pore solution, rather than the microstructure. Conventionally, diffusion rates for concrete structures have been reduced by densifying the cement paste matrix component of the concrete via a reduction in water-to-cement ratio and/or the addition of fine pozzolanic materials such as silica fume and/or fly ash. Still, in every case, the pathways for diffusion are through the interconnected pore solution that saturates the porosity at all scales. By appropriately increasing the hydrodynamic friction, the diffusion rates of all ionic species (sulfates, chlorides, alkalis) can be reduced. Theory indicates that these diffusion rates will be inversely proportional to the solution's hydrodynamic friction coefficient, so that doubling the hydrodynamic friction will reduce the diffusion coefficients by a factor of two, which in turn should lead to a doubling of the service life for many degradation modes (sulfate attack, corrosion, etc.).

Inventors

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Citations

1. D.P. Bentz, M.A. Peltz, K.A. Snyder and J.M. Davis. VERDICT: Viscosity Enhancers Reducing Diffusion in Concrete Technology. Concrete International. 31 (1), 31-36, January 2009.
2. D.P. Bentz, K.A. Snyder, L.C. Cass, M.A. Peltz. Doubling the service life of concrete structures. I: Reducing ion mobility using nanoscale viscosity modifiers. Cement & concrete composites, 30, 674-678. 2008.
3. D.P. Bentz. Influence of shrinkage-reducing admixtures on early-age properties of cement pastes. Journal of Advanced Concrete Technology, Vol 4, No 3, October 2006.

Related Items

- Poster Presentation: Doubling the Service Life of Concrete- A Nanotechnology Solution
- Article: Viscosity-Enhancing Nanomaterials May Double Service Life of Concrete

References

- U.S. Patent Application #20090075053 filing date 09-09-2008
- Docket: 07-025

Status of Availability

available for licensing

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