World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:19, No:01, 2025

Understanding the Damage Evolution and the Risk of Failure of Pyrrhotite Containing Concrete Foundations

Authors : Marisa Chrysochoou, James Mahoney, Kay Wille

Abstract : Pyrrhotite is an iron-sulfide mineral which releases sulfuric acid when exposed to water and oxygen. The presence of this mineral in concrete foundations across Connecticut and Massachusetts in the US is causing in some cases premature failure. This has resulted in a devastating crisis for all parties affected by this type of failure which can take up to 15-25 years before internal damage becomes visible on the surface. This study shares laboratory results aimed to investigate the fundamental mechanisms of pyrrhotite reaction and to further the understanding of its deterioration kinetics within concrete. This includes the following analyses: total sulfur, wavelength dispersive X-ray fluorescence, expansion, reaction rate combined with ion-chromatography, as well as damage evolution using electro-chemical acceleration. This information is coupled to a statistical analysis of over 150 analyzed concrete foundations. Those samples were obtained and process using a developed and validated sampling method that is minimally invasive to the foundation in use, provides representative samples of the concrete matrix across the entire foundation, and is time and cost-efficient. The processed samples were then analyzed using a developed modular testing method based on total sulfur and wavelength dispersive X-ray fluorescence analysis to quantify the amount of pyrrhotite. As part of the statistical analysis the results were grouped into the following three categories: no damage observed and no pyrrhotite detected, no damage observed and pyrrhotite detected and damaged observed and pyrrhotite detected. As expected, a strong correlation between amount of pyrrhotite, age of the concrete and damage is observed. Information from the laboratory investigation and from the statistical analysis of field samples will aid in forming a scientific basis to support the decision process towards sustainable financial and administrative solutions by state and local stakeholders.

Keywords : concrete, pyrrhotite, risk of failure, statistical analysis
Conference Title : ICCCCT 2025 : International Conference on Cement, Concrete and Construction Technology
Conference Location : Bali, Indonesia
Conference Dates : January 14-15, 2025