This topic is "practice ready." ☐ **Yes** ☒ **No**

A method to quantify soluble sulfate and chlorides from carbonate using handheld XRF

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Abstract

Mechanically Stabilized Earth (MSE) walls are retaining walls with artificial reinforcing, commonly galvanized steel. Traditionally the backfill material is composed of soil which is used to stabilize the steel structures that provide support to the wall. In Iowa, quartz sand and limestone have also been used for backfill material. During rain events, water can react with the backfill material, potentially dissolving and mobilizing reactive chemical species. The design of MSE structures is predicated on the fill material exhibiting a specified range of electrochemical properties. The Iowa DOT places specification limits on the electrochemical properties of the backfill to minimize potentially harmful ions, such as sulfates (SO_4) and chlorides (Cl-), which will corrode the steel used to support the wall. Available sulfate can lead to the formation of sulfuric acid which will degrade steel and chloride corrodes metal through chemical reactions with steel.

Modified AASHTO methods T 290 and T 291 provide chemical testing procedures for quantifying available sulfate and chloride in soil. These methods involve time consuming wet chemistry that can be skewed by chemical artifacts. For example, it has been found that clay associated with soil and limestone can be misinterpreted as sulfate during mass based analysis. The work performed in this study proposes an alternative method to measure soluble SO_4 and Cl- from limestone backfill using a handheld XRF (HHXRF). The HHXRF is an element specific analysis that is less vulnerable to chemical interferences. Additionally the HHXRF provides expedited analysis when compared to benchtop chemical methods.

Several well characterized carbonates were tested using the traditional AASHTO method and compared to the proposed HHXRF method. As a control, artificial samples with known concentrations of SO_4 and Cl- were created, these samples were known to be free of chemical interferences, such as clay. Both methods were successful in measuring the artificial samples accurately. Unknown samples from the field were then tested using both AASHTO and HHXRF methods. When testing unknowns both methods performed well when testing chloride, however disagreement was found when comparing SO_4. Using thermogravimetric analysis (TGA), analytical XRF, and scanning electron microscope (SEM) techniques to characterize the limestone, it was found that clay fines skew the AASHTO method making it unreliable for some backfill material. In contrast the HHXRF was able to exclusively measure SO_4

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providing a more accurate method. The study determined that the HHXRF can dramatically reduce testing time and yield test results with improved accuracy.

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