JOINT TRANSPORTATION RESEARCH PROGRAM

Principal Investigator: Tracy Branam, Indiana University, tbranam@indiana.edu, 812.855.8390

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-3728

2016

Sulfates in Indiana Substrates

Introduction

The Indiana Department of Transportation (INDOT) conducts tests for sulfate in soils as a requirement for road construction projects. This is primarily due to the potential formation of sulfate-containing minerals that can cause swelling and cracking of road materials. Because of the large number of soil samples requiring sulfate testing, INDOT is incurring time and cost issues that it would like to see reduced. The Indiana Geological Survey (IGS) conducted an investigation where optimization of sulfate testing and screening methods were evaluated in an effort to provide INDOT with a more time- and cost-efficient procedure for sulfate testing in soils.

In addition, existing databases for soil sulfate and shallow groundwater sulfate were compiled, from which GIS maps were constructed. These maps provide information regarding the location of potential “hot spots” of high sulfate concentrations and a visual guide for where more data needs to be acquired for a more complete areal distribution of sulfate in soils and groundwater.

Findings

- The current INDOT test method for sulfate in soils, ITM 510, uses a 1:20 soil/water ratio for leaching, a minimum 12 hour leaching time, and a turbidimetric sulfate analysis method. The IGS investigation determined that no significant improvements are obtained from altering the soil/water ratio or the extraction procedure by heating. A consistent length of time for leaching is important as this produces some variability. The turbidimetric method for sulfate analysis is cheaper and correlates very well with ion chromatography. The IGS study confirms that this portion of ITM 510 should be retained.
- A conductivity screening test for soluble sulfate in soil extracts proved to be very beneficial. Many soil

samples in Indiana have very few soluble anions due to the amount of annual rainfall across the state. As a result, sulfate concentration correlates closely with conductivity in soil leachates. By preparing a conductivity–sulfate concentration curve, conductivity measurement of soil leachates can quickly be determined and correlated to sulfate concentrations.

This screening step eliminates the need to analyze every soil sample for sulfate concentration by the turbidimetric method. Depending on the soil sulfate threshold value (1000 ppm or 3000 ppm), it is estimated that over 50% to as much as 75% of samples will not require sulfate determination by turbidimetric measurements.

- A GIS map of Indiana with concentration contours of sulfate in shallow groundwater (<100 ft, or 30.5 m) shows large areas of minimal data in the southern and western part of the state. The largest area of high-sulfate groundwater occurs south and east of Ft. Wayne. The large area of high sulfate along the Ohio River is due to sparse data.
- A GIS map of Indiana with concentration contours of sulfate in soils contains fewer data points than the groundwater map. As a result there are more areas with insufficient data points for an accurate representation of sulfate distribution in Indiana soils. However, there are a few locations of high sulfate concentrations coinciding with high groundwater sulfate. One is in the vicinity of Parke County; the other southwest of Ft. Wayne. This map in particular requires more data points in order to provide useful patterns of sulfate distribution in soils.
- A literature search revealed that variations in soil/water ratios exist among state and federal agencies conducting soil sulfate analyses. Most states establish 3,000 ppm as the action threshold for requiring special treatment. Most agencies used the turbidimetric method for sulfate analysis. None use

a conductivity screening procedure, although it was investigated in Texas.

Implementation

Recommendations from this study include a modified soil sulfate test procedure. An example procedure written in ITM format incorporates the preparation of a conductivity–sulfate concentration calibration curve and a conductivity screening step along with the steps found in ITM 510. The screening step reduces the number of samples requiring sulfate testing by turbidimetry, reducing the amount of time and materials cost for soluble soil sulfate determinations.

Data used for generating GIS maps is provided to INDOT personnel so that map updates can be made as more data is added to the data set.

Recommended Citation for Report

Branam, T., Green, R., Wittman, O., & Ayre, A. (2016). *Sulfates in Indiana substrates* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2016/19). West Lafayette, IN: Purdue University. <http://dx.doi.org/10.5703/1288284316342>

View the full text of this publication here: <http://dx.doi.org/10.5703/1288284316342>

Published reports of the Joint Transportation Research Program are available at <http://docs.lib.purdue.edu/jtrp/>.