Pyritic Expansion of Local Crushed Shale Stone

Shoreham, Vermont
Owners  Nop’s Metal Works
Client  Larrabee Point Lakehouse, LLC

OVERVIEW
• Scope of work was to evaluate the potential for damage to a constructed boat wharf due to pyritic expansion of crushed stone.
• Nearby constructed facilities have been damaged by expanding crushed stone known to be from the same rock quarry.
• Chemical analyses revealed Pyritic Oxidation was causing the damage to the built facilities. This phenomenon occurs when carbonate rock (e.g., shale stone), that contain pyrite, is exposed to water, oxygen, and a certain type of autotrophic bacteria at which point a chemical chain reaction occurs resulting in the formation of gypsum. The gypsum formation creates forces in the shale platelets causing the stone to expand.

MEETING CLIENT NEEDS
• Work was completed on time and on budget.
• Developed strategy to avoid future potential damage to the constructed boat wharf, which included leaving the existing crushed stone backfill surface (i.e., not pouring a concrete slab).
• Monitoring program was put in place to measure horizontal displacement of steel sheet piles used for the wharf construction.
• Owner expressed complete satisfaction with work.

NEW APPLICATIONS/INNOVATION
• Testing of crushed stone was done on rock samples that appeared to be in different phases of pyritic expansion.
• Testing included laboratory determination of total sulfur, sulfide, and sulfate concentrations (by-products of the chemical reactions), measurement of bulk specific gravity (i.e., quantitative weight comparison), and positively identifying and quantifying (by percent weight) the crystalline mineral (i.e., pyrite).
• The percentage (by weight) of pyrite in crushed stone was determined by using sophisticated laboratory X-ray diffraction (XRD) and X-ray Fluorescence (XFR) techniques.
• Pyritic oxidation occurred in the crushed stone and ultimately caused the structural damage to the residential home.

SOCIAL ECONOMIC CONSIDERATIONS
• By determining the presence of pyritic crushed stone in Vermont, future projects can avoid damage caused by expanding crushed stone.

COMPLEXITY
• Forensic analysis was implemented to evaluate residential home structural damage.
• Procedure included an in-situ soil evaluation below the constructed foundations, followed by a foundation and slab evaluation and ending with an assessment of the construction products used.
• When the crushed stone was observed to have different colors, weights, and strengths, the need for sophisticated laboratory testing was established. Pyritic Oxidation phenomenon was then determined to be the cause of damage.

VALUE TO PROFESSION
• Project brings awareness to practicing engineers in the State of Vermont regarding the use of crushed stone for civil construction work.