National Infrastructure Protection Plan
NIPP Challenge

Biopolymer-Stabilized Earth Materials for Resilient and Adaptable Infrastructure

SITUATIONAL AWARENESS

Earthen infrastructure in the U.S. comprises around 85,000 earthen dams, also known as embankment dams or earth filled dams, and most of the 100,000 miles of levees. Many earthen dams and levees face considerable risk from both natural and man-made hazards. Rehabilitation of these aging infrastructures relies mainly on the same materials used decades ago to build and reinforce the structures. Failure of any of these structures could result in major negative impacts on the U.S. economy and threaten the health and safety of surrounding communities.

METHODOLOGY

This project conducted by scientists at Stony Brook University (SBU) sought to increase the resiliency of the national earthen infrastructures by developing a new approach through the use of biopolymers to stabilize the surrounding soil of these earthen infrastructures. This innovative approach exploited the unique properties of biopolymers, notably their ability to adapt to changes in the environment.

The goal of the project was to determine whether the use of biopolymers strengthened the earthen materials and better protected and mitigated threats to these structures. The project team focused their efforts for this project on identifying potential biopolymers that would improve various soil types based on surface interactions, bioavailability, chemical stability, and identification of biopolymer-soil systems for in-dept studies. Through this work, the team tested different combinations of soils and biopolymers to determine the best combination of mixtures that would reveal the best results during later field tests. The types of biopolymers selected for this project was determined by their cost-effectiveness and non-cementitious properties.

The information collected by the team to determine the performance of each of the biopolymer mixtures included rheological measurements, contact angle goniometry, strength measurements, and computational analysis to optimize the selected combinations. They then focused on assessing the degradation of biopolymer-stabilized soils experimentally using an accelerated environmental degradation chamber and using computational models. Additionally, the project team designed and constructed an approach for field experiments using biopolymer-stabilized earthen infrastructures.

Source: FEMA Photo Library

The design included a lifetime design procedure based on the controlled degradability rates, performance measures, and recommended modeling methods. The project team conducted online webinars to federal and non-federal agencies to explain and present the details of the proposed biopolymer-stabilized soils for earthen dams and levees.

RESULT

The project resulted in the determination that two types of clay fillers paired best with the use of biopolymers. Because of the early promising results, the Wayne County, NY Water Authority agreed to develop a project plan in FY2020 to test the effects of biopolymers on soil stabilization. The SBU project team continues to work with the U.S. Army Corps of Engineers' Engineer Research and Development Center (ERDC) to seek additional funding to implement the proposed biopolymer- soil stabilization in federal and non-federal earthen dams and levees.

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