ARPA-I Ideas and Innovation Challenge Concept Summary

Project Title:

Rapid Flood Damage Mitigation and Resilience Through Modular Biocement Infrastructure

Vision Statement:

What if we could deliver fast, cost-effective, and resilient flood protection by transforming local soils into permanent infrastructure through microbial biocementation?

Flooding causes up to $9.7 billion in annual damage to U.S. transportation infrastructure, threatening roads, bridges, ports, and railways. Broad implementation of effective flood damage mitigation strategies is needed to protect these vital infrastructure components from damaging flood events. Effective flood mitigation strategies typically involve construction of levees, elevated roadbeds, and concrete flood barriers to prevent floodwater intrusion and increase the resilience of infrastructure components located in flood prone areas. Current methods rely on transporting massive volumes of aggregates and Portland cement to job sites, which is logistically intensive, costly, and environmentally damaging. In addition, concrete structures degrade rapidly in marine environments, significantly reducing expected service life. A new approach is needed that accelerates construction timelines and increases resilience of flood mitigation and transportation infrastructure.

To address this need, this project aims to develop a novel, modular construction system using Microbial Induced Calcite Precipitation (MICP) to build permanent flood mitigation infrastructure using locally available soils and bioengineered sandbags. The system leverages biologically hardened materials to reduce costs, accelerate deployment, and improve long-term durability, particularly in flood prone or marine environments. Development of the modular MICP-based construction system is distributed across three phases: 1) biological product/process development, 2) bioengineered sandbag design and fabrication, and 3) integration into the complete MICP construction system. The proposed system is compatible with existing workflows already in use by emergency crews and military engineers who already deploy modular barrier systems like sandbags and Concertainers for temporary structures, making these groups ideal early adopters and transition partners for the proposed technology.

If successful, this technology will enable rapid, low-carbon construction of resilient infrastructure in vulnerable regions, using only native substrates and biologically compatible materials. It reduces aggregate dependence, logistical burden, and long-term maintenance costs directly supporting the USDOT's Resilient & Climate-Responsive Infrastructure thrust and the ARPA-I vision for constructing infrastructure safer, faster, more cost-effectively, and with a longer lifespan.