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**Transportation Infrastructure Precast Innovation Center**

**(TRANS-IPIC)**

**University Transportation Center (UTC)**

*Exploring Fungal-Induced Carbonate Precipitation (FICP) for Healing Concrete Cracks*

*LS-23-RP-03*

*69A3552348333*

Quarterly Progress Report

For the performance period ending *09/30/2024*

**Submitted by:**

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**Collaborators / Partners:**

*None*

**Submitted to:**

TRANS-IPIC UTC

University of Illinois Urbana-Champaign

Urbana, IL

**TRANS-IPIC Quarterly Progress Report:**

**Project Description:**

1. Research Plan - Statement of Problem

*This research aims to explore fungal-induced carbonate precipitation (FICP) to heal cracks and improve the durability of concrete. FICP is a natural biomineralization process involving calcifying fungi's metabolic activities to induce CaCO3 precipitation.*

1. Research Plan - Summary of Project Activities (Tasks)

***Task 1. Comparing the performances of three fungal strains on CaCO3 precipitation.***

*The research team assessed the performance of three fungal strains, Aspergillis niger (ATCC 9029), Neurospora crassa (FGSC 2489), and Trichoderma reesei (ATCC 13631), on mineral precipitation. The X-ray powder diffraction (XRD) analysis results (Figure 1) show that Neurospora crassa can form calcite (CaCO3). Aspergillis niger can produce calcium oxalate. And Trichoderma reesei cannot precipitate calcium-based minerals.*

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*Figure 1. XRD results of assessing mineral types formed by three fungal strains.*

*The research team is measuring the concentration of NH4+ with time, which is an indicator of the rate of the mineral precipitation by fungi. Next, Scanning Electron Microscopy (SEM) imaging will be used to evaluate the morphology of fungal mycelia at micro-scale.*

***Task 2. Investigating the performance of three fungal strains to induce CaCO3 precipitation on the mortar surface.***

***Task 3. Healing artificial concrete cracks using the optimized fungal strain.***

*The research team would like to combine Tasks 2 and 3 together since we plan to heal cracks in the cement mortar/concrete samples (Task 3). Then there is no need to investigate the fungal induced CaCO3 precipitation on the mortar surface (Task 2). In the next reporting period, the research team plans to investigate the feasibility of fungal healing cement mortar cracks using two fungal strains from Task 1 that show calcite and calcium oxalate precipitation. Also, one bacteria strain that can precipitate calcite will be used to compare the healing efficiency of fungi. The following samples will be prepared.*

*Untreated cement mortar*

*Cement mortar + bacteria (S. Pasteurii)*

*Cement mortar + Neurospora crassa*

*Cement mortar + Aspergillis niger*

*Cement mortar + cellulose based fiber (0.45 % of the mortar volume)*

*Cement mortar + cellulose based fiber + bacteria (S. Pasteurii)*

*Cement mortar + cellulose based fiber + Neurospora crassa*

*Cement mortar + cellulose based fiber + Aspergillis niger*

*Cement mortar + cellulose based fiber + Neurospora crassa + bacteria (S. Pasteurii)*

*Cement mortar + cellulose based fiber + Aspergillis niger + bacteria (S. Pasteurii)*

*The research team is working with Dr. Yen-Fang Su, an assistant professor in concrete research at LSU, to develop the test procedure and perform the self-healing tests soon.*

**Project Progress:**

1. Progress for each research task

*Task 1 progress [90% completed].*

*Task 2 and Task 3 progress [10% completed]*

*The research team would like to request a 6-month extension of this project so that tasks 2 and 3 can be fully performed.*

1. Percent of research project completed

*50% of total project completed through the end of this quarter*

1. Expected progress for next quarter

*Finish Task 1 and 70% of Tasks 2 and 3*

*In the next quarter, as discussed above, the research team plans to investigate the healing capability of fungi on cement mortar cracks using two fungal strains from Task 1 that show calcite and calcium oxalate precipitation. Compression tests, S-and P-wave velocity measurements, and crack size measurements will be performed to evaluate the healing performance.*

1. Educational outreach and workforce development

*Planning outreach activity*

*LSU ENGAGE (research demonstrations for middle school students)*

*LSU college of engineering*

*March 2025*

1. Technology Transfer

*None*

**Research Contribution:**

1. Papers that include TRANS-IPIC UTC in the acknowledgments section:

*Lin, H. (2024). “Harnessing Fungal Mycelia for Sustainable Soil Improvement: Opportunities and Challenges.” Biogeotechnics, will submit by mid-October.*

1. Presentations and Posters of TRANS-IPIC funded research:

*TRANS-IPIC September Monthly Research Webinar, title: Exploring Fungal-Mediated Carbonate Precipitation for Healing Concrete Cracks, Presented by Dr. Hai Lin*

1. Please list any other events or activities that highlights the work of TRANS-IPIC occurring at your university (please include any pictures or figures you may have). Similarly, please list any references to TRANS-IPIC in the news or interviews from your research.

*None*

**References:**

*None*