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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*

Quarterly Progress Report

For the performance period ending *06/30/2024*

**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

*Concrete structures can develop cracks during early-stage curing and long-term aging processes, reducing load-bearing capacity and affecting the service life of concrete structures. 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. This research investigates the performance of several fungal strains (e.g., their growth behavior and efficiencies of FICP versus time) on the surface of cement mortar. The optimal fungal strain will be used to assess its healing capability on concrete cracks.*

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

*Two research objectives were proposed for this research.* ***Objective I****: Investigating the performance of several fungal strains (e.g., their growth behavior and efficiencies of FICP versus time) on the surface of cement mortar. The Objective I will help to find the optimal fungal strain that can grow quickly and induce the most significant amount of CaCO3 precipitation on the cement mortar surface. The optimal fungal strain will be used in Objective II to heal concrete cracks.* ***Objective II****: Assessing the healing capability of the optimal fungal strain on the concrete cracks. This objective will evaluate the feasibility of fungi for healing concrete cracks, which will be compared to the capability of bacterial induced carbonate precipitation.*

*Below are the planned tasks of this research:*

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

*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.*

*During this reporting period, the research team focused on Task 1, investigating the capability of CaCO3 precipitation of three fungal strains, including Aspergillis niger (ATCC 9029), Neurospora crassa (FGSC 2489), and Trichoderma reesei (ATCC 13631). Stock cultures of these fungal strains were prepared during the first reporting period and stored in the -80oC freezer for future use. During this reporting period, each fungal strain was obtained from the stock culture and inculcated into the 250 mL of growth medium (see Table 1). After ten days of growth, three fungal strains were harvested using a centrifuge (4,000 g for 30 min). After the centrifuge, the supernatant solution in the centrifuge tubes was removed. The solids left in the centrifuge tubes were added into the cementation media (250 mL) to evaluate the fungal capability of CaCO3 precipitation. The conditions of fungal strains in the cementation media will be assessed using Scanning Electron Microscopy (SEM) and X-ray powder diffraction (XRD). SEM will be used to evaluate if there were mineral precipitations on fungal mycelia. XRD will be used to determine if the precipitations were CaCO3. SEM and XRD tests will be performed in July. In addition, the research team has searched for additional fungal strains that may heal concrete cracks, which will be explored in the next reporting period if the currently selected strains fail the expected outcome.*

*Table 1. Summary of Media Recipe.*

|  |  |
| --- | --- |
| ***Media Name*** | ***Constituents*** |
| *Growth medium* | *Potato dextrose broth (PDB): 24 g granulated PDB per liter of*  *deionized water, then autoclave* |
| *Cementation medium* | *20 g Urea*  *2.12 g Sodium Bicarbonate*  *20 g NH4Cl*  *3 g granulated PDB*  *15 g CaCl2 - 2H2O*  *130 mL of 1M Tris buffer pH=9*  *Add distilled H2O to make a 1000 mL solution*  *Mix*  *pH must be at 6. Raise with 5M HCl*  *Filter sterilize* |

**Project Progress:**

1. Progress for each research task

*Task 1 progress [80% completed]. The research team has been working on Task 1 to compare the performances of three fungal strains on CaCO3 precipitation. The progress was slow due to two reasons. First, the PhD student who worked on fungal research has graduated this spring semester. The new student will join my research group in Fall 2024. Second, the PI had to travel overseas due to family issues in June and will be back in mid-July. The PI plans to catch up on the research progress in the next reporting period, working with the new PhD student.*

*Task 2 progress [0% completed]*

*Task3 progress [0% completed]*

1. Percent of research project completed

*40% of total project completed through the end of this quarter*

1. Expected progress for next quarter

*Finish Task 1 and 80% of Task 2*

1. Educational outreach and workforce development

*None*

1. Technology Transfer

*None*

**Research Contribution:**

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

*None*

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

*None*

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*