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**Transportation Infrastructure Precast Innovation Center**

**(TRANS-IPIC)**

**University Transportation Center (UTC)**

Evaluating Scanning Technology for Process Monitoring and Quality Control in Precast Concrete Fabrication

LS-23-RP-02

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Quarterly Progress Report

For the performance period ending September 30, 2024

**Submitted by:**

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Mechanical and Industrial Engineering

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**Collaborators / Partners:**

Tindall Corp and FARO Technologies

**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

The main objective of this project is to evaluate and propose an efficient quality control (QC) method incorporating state-of-the-art scanning technology that ensures consistent, high quality precast concrete (PC) products delivered to site.

Companies producing PC products are expected to continuously increase production capacity, maintain high product quality, and use a flexible pricing policy. However, to expand to markets such as transportation, PC companies must not only guarantee high quality of the manufactured goods but also sell them at attractive prices. PC fabrication plants have yet to realize the full benefit of a controlled manufacturing environment as some operations are still using old/onsite approaches. Currently, operators use tape measures to obtain critical overall dimensions and embedded part locations. While providing quantitative measurements, this approach is not accurate and efficient enough to constantly fabricate high quality PC products. Operators may deviate in measurements and methods, and other factors may affect measurement precision. The current approach is not sustainable or cost efficient and is a time-consuming task that requires some experience. This QC approach results in product quality inconsistency and increased risk for alteration after fabrication or having to scrap a product resulting in waste onsite.

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

Task 1. Document current QC processes in a PC facility, document any deficiencies or areas for improvement in the process.

Task 2. Document transportation and installation steps of PC components once they leave the facility. Document any major QC checks and “pain points”.

Task 3. Collect historical QC records as baseline data, including QC issues on site after delivery.

Task 4. Select scanning measurement technology and pilot test in the PC facility for feasibility.

Task 5. Develop QC process incorporating scanning measurement technology using a kaizen approach, including transporting and installation in the field.

Task 6. Test the QC process on an actual project and measure impact at the facility and in the field by noting any QC issues.

**Project Progress:**

1. Progress for each research task

Task 1. The team is in the process of documenting the current QC processes in a PC facility, document any deficiencies or areas for improvement in the process (100% completed).

* The team met with Tindall Corp’s Director of Industrial Engineering to discuss the project scope and identify the plant for the study. The Mississippi plant and employees that will support the project were identified, including the General Manager and Quality Director.
* An initial meeting was held with Tindall Corp’s General Manager of the Mississippi Division. The QC process and main issues and deficiencies were discussed. The team identified several documents and data needed. Tindall Corp will provide this data in January.
* LSU team visited the Mississippi plan on March 22. The team took a tour of the facilities and discussed the production and QC processes with the Quality Director and process engineer.
* The team created documentation to illustrate the QC process and potential “hot spots” for quality problems to occur.
* The LSU research assistants visited Tindall to shadow the daily QC process April 15, 2024.

Task 2. Document transportation and installation steps of PC components once they leave the facility. Document any major QC checks and “pain points” (20% completed).

* The team, jointly with Tindall Corp, identified the data needed.
* The LSU team is gathering data on the transportation and installation process. The QC process and main issues and deficiencies were discussed with the general manager.
* Tindall Corp will provide this data in October 2024.

Task 3. Collect historical QC records as baseline data, including QC issues on site after delivery (90% completed).

* The team jointly with Tindall Corp identified the data needed. The company provided records of the past year for QC issues found on site, which were presented during the webinar and workshop.
* The team received several documents containing all nonconformances for the past year and other quality metrics from the Tindall QC personnel.
* The team analyzed Tindall’s nonconformance records, from production to installation, to identify most frequent quality issues.
* Tindall will provide time study data on the current QC process (received Sep. 27, 2024)

Task 4. Select scanning measurement technology and pilot test in the PC facility for feasibility (90% completed).

* On June 5, the team visited Tindall, the Mississippi plant, to meet with a representative from Faro and view a demonstration of their scanning and tracking technology.
* The team conducted research on other existing scanning companies and summarized the pros/cons of each technology.
* On July 24, the team observed a full-scale demonstration of the Faro laser tracker. We collected 4 datasets for 3 stages of QC checks.
* The remaining work is to determine the accuracy of the laser tracking technology compared to the current QC process. We plan to obtain estimates of this if we are unable to have another demonstration from Faro.

Task 5. Develop QC process incorporating scanning measurement technology using a kaizen approach, including transporting and installation in the field (50% completed).

* Based on the Faro demonstration, we mapped the new process for incorporating the laser tracker QC steps in the manufacturing facility
* We will request data from Tindall regarding the potential QC process for transportation and installation in the field

Task 6. Test the QC process on an actual project and measure impact at the facility and in the field by noting any QC issues.

1. Percent of research project completed

Estimate 75% of total project completed through the end of this quarter. A summary of the analyses at the manufacturing site is provided in the following table for Tasks 1, 3, 4, and 5. Tasks 2 and 6 will be the focus for the final quarter of the project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Data/Eval Methods** | **Traditional QC Plan**  **(Tasks 1 and 3)** | **Laser Tracker QC Plan**  **(Tasks 4 and 5)** | **Current Status** |
| **Observations** | Performed observations to map out the current processes of the pre and post pour processes | Performed observations on different FARO scanning tech. to determine what will be optimal for Tindall use and evaluate use for other tech within the transportation industry | Complete |
| **Implementation Plan** | Using the current process map, an implementation plan of how and where the laser tracker would be used in the current process was created | | Complete |
| **Time Studies** | In progress, data received from Tindall Sep. 27, 2024 | Laser Tracker time study was conducted on the pre-pour Check 1 only due to canceled production for the day and post pour check 1 as the check 2 was already completed when arrived. Obtained four data sets for each check. | In Progress: Breaking down the laser tracker time study from the different checks for each action can give enough data to estimate how long the other checks in each stage would take. |
| **Accuracy** | Can be obtained from historical data | Only the length, width, depth, and skewness were recorded for 4 different beds in the first pre-pour check due to canceled production. This is not enough data points to perform the accuracy measure as planned. | New Plan Needed: Can attempt to organize another visit with FARO, or use results based off an incremental percent change in non-conformities |
| **ROIs** | Will be performed using the time study data for labor costs which can be found using US labor statistics for QC inspectors and general laborers. Can additionally use the percent change in non-conformities to assess different payoffs at different target reductions for non-conformities. | | In Progress |

1. Expected progress for next quarter

The team expects to complete Tasks 2 – 6 by the end of next quarter, which is also the project completion (December 2024).

1. Educational outreach and workforce development

The team plans to hold an educational meeting with Tindall Corp’s employees to share issues found and key improvements, including a rationale for selecting the measurement technology, steps of the QC process, and description of how to analyze and interpret the resulting data. This meeting will be scheduled once the data analysis is completed.

The team partnered with LSU College of Engineering existing summer camps to showcase this project, in particular, how Industrial Engineers can support the Precast industry to improve our Transportation system. The team conducted two sessions during this summer including Recruiting into Engineering High-Ability Multicultural Students (REHAMS) on June 26th, 2024, and eXploration Camp Inspiring Tomorrow’s Engineers (XCITE) scheduled for July 17th, 2024.

* XCITE is a 7-day camp for rising 9th-12th grade female students that encourages them to pursue engineering/computer science/construction management careers. All girls will reside on campus in a residential hall while supervised by college student counselors. Participants will explore, create, experiment, build, code, design, and compete while learning about a variety of engineering majors and college life. LSU faculty and engineering students will interact with attendees in Engineering 101 information sessions and activities.
* REHAMS camp is for 10th–12th grade male and female students from all backgrounds who want to learn about various disciplines of engineering during a 7-day camp while residing on campus.

1. Technology Transfer

The team plans to develop guidelines for integrating scanning technology in the process for monitoring and quality control in precast concrete fabrication.

**Research Contribution:**

1. Number of papers

Planned: Manuscript on project results submitted to quality management journal such as *Journal of Manufacturing Technology Management*

1. Number presentations (when, where)

* 2024 TRANS-IPIC UTC Workshop, April 22, 2024
* TRANS-IPIC Webinar June 2024

Planned: IISE Annual Conference, Atlanta, May 2025 (abstracts due Nov. 11)

**References:**

*[List all the references associated with this research project]*