**Impactful Resilient Infrastructure Science and Engineering**

**(IRISE)**

**-Project Scope of Work-**

**(FY 2021-22 Annual Work Program)**

**SUMMARY PAGE**

**Project Title:** Integrating Additive Manufacturing with Accelerated Bridge Construction Techniques

**Person Submitting Proposal:** Amir H. Alavi

**Proposed Funding Period:** 10/01/2021 - 09/30/2023

**Project Duration:** 24 months

**Project Title: Integrating Additive Manufacturing with Accelerated Bridge Construction Techniques**

**Project Objectives:**

The primary purpose of this study is to explore the feasibility of integrating additive manufacturing with accelerated bridge construction (ABC) techniques in Pennsylvania. In particular, this study would focus on identifying, fabricating and mechanical testing of a range of 3D printable prefabricated bridge elements currently used in ABC projects.

**Project Scope:**

We will first conduct a comprehensive literature search to identify the application of 3D concrete printing (3DCP) in construction and building domains. This phase will involve identifying different additive manufacturing techniques and materials for construction. We will investigate how the current 3DCP practice in construction and building areas can be adapted for prefabricated bridge elements in ABC projects. We will then 3D print a range of small-scale prefabricated bridge elements commonly in use in ABC practice. Further testing will be performed on the 3D printed PBES to benchmark their mechanical properties against conventionally cast components. Finally, we will prepare a set of recommendations for the implementation of additive manufacturing in ABC.

**Proposed Work:**

The objectives of this project will be realized through the completion of the following tasks:

**Task A – Review of the stat-of-the-art of 3D concrete printing** **research**

This task will focus on conducting an extensive literature review to identify recent advances in 3DCP techniques, equipment, cement-based materials and mix designs, and computer modeling. The goal is to determine the 3DCP practices that are most suitable for the additive manufacturing of PBES in ABC projects.

**Task B – Developing optimal 3DCP mixture designs for bridge prefabricated elements**

The primary objective of this task is to develop suitable concrete mixtures for 3D printing of PBES in ABC projects and evaluate their material characteristics through experimental studies. Based on a comprehensive review in Task A, we will collect a list of recommended 3DCP mixture designs.

**Task C – 3D printing of prefabricated elements in ABC systems at small-scale**

The main goal of this task will be to 3D print and test a range of small-scale prefabricated bridge elements currently used in ABC.

**Task D: Development of Recommendations**

The final outcome of this task would be a series of recommendations regarding the application of additive manufacturing and technical challenges and solutions surrounding in ABC. The cost benefit of the additive manufacturing technology in ABC projects will be discussed throughout the final report.

**Task E: Final Report**

A draft final report will be prepared and distributed to IRISE Steering Committee representatives 21-months after project initiation. The report will include a state-of-the-art review of 3D concrete printing research including key areas of material research and fabrication techniques, as well as a series of recommendations for implementation of additive manufacturing in ABC projects, as described in Task D. Final recommendations will be further drafted as suggested revisions to PennDOT publications and or provisions (such as Publication 238 Bridge Inspection Manual and/or Pub 15M Design Manual Part 4).

**Deliverables:**

* Task A – A literature review summary to be discussed at a progress review meeting with IRISE Steering Committee representatives, including PennDOT representatives, 2-months after project initiation.
* Task B - A technical memorandum summarizing the mixture design characterization and results of the compression testing to be discussed at a progress review meeting with IRISE Steering Committee representatives, including PennDOT representatives, 6-months after project initiation.
* Task C – A technical memorandum summarizing the results of the comparison of the testing of the 3D printed components against conventionally cast components to be discussed at a progress review meeting with IRISE Steering Committee representatives, including PennDOT representatives, 18-months after project initiation.
* Task D - The draft list of recommendations will be included in the draft final report and discussed with IRISE Steering Committee representatives, including the PennDOT SME team, as described in Task E.
* Task E – Draft final and final reports, due 21 and 24 months after project initiation.

In addition to the deliverables listed above, it is also anticipated that the findings of this research will be published and presented at key technical conferences (e.g. TRB, ASCE Structural Congress, among others) and journal publications.

**Key Personnel:**

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