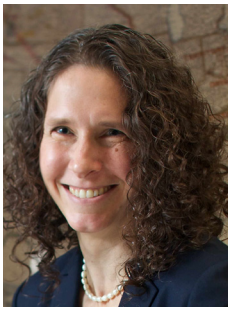
UNIVERSITY TRANSPORTATION CENTER

RESEARCH BRIEF

PROJECT TITLE: Development of 3D Printed Materials for Rapid Fabrication of Pedestrian and Bicycle Infrastructure to Increase Mobility

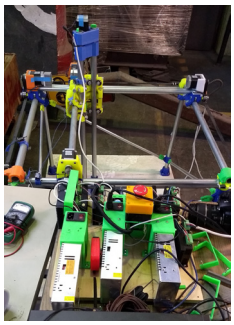
PRINCIPAL INVESTIGATOR: Dawn Lehman (UW), Mark Ganter (UW)

INSTITUTION: SINGLE-INSTITUTION PROJECT
ESTIMATED COMPLETION DATE: AUGUST 2020
SPONSORS: THE PACIFIC NORTHWEST TRANSPORTATION CONSORTIUM, UW



Background

America's infrastructure is in a state of severe deterioration, but the vast majority of these bridges are for vehicle transportation; with limited funds available to upgrade or replace bridges; there is almost no funding to support infrastructure construction for other transportation modes. The cost of constructing a bridge cannot solely be computed based on material quantities; transportation of prefabricated structural components, costly equipment and labor, and impact on traffic flow are a larger and larger part of the true construction cost. This proposal is the first phase in developing a new construction and structural solution for building pedestrian and bicycle bridges. It is well known that 3D printing is going to revolutionize the construction industry. This proposal will expedite that revolution through the development of engineered, FRCMs suitable for 3D printing. To date, research has not addressed the rheological properties of unhardened (green) concrete, which determines the printing process, or the structural properties of hardened, printed concrete, which determines design. The results of this research will enable printing of pedestrian and bicycle bridges, saving time, money and bringing new infrastructure to all communities.



Research Project

The research program will investigate the construction of fiber reinforced cementitious material (FRCM) components using extrusion-based 3D printing. Where conventionally formed concrete structures rely on the formwork for strength and stability during the hardening process, components constructed using 3D printing must rely on their green strength (i.e., strength during the time when the concrete has set but not appreciably hardened) and stiffness to resist instability, such as buckling and creep, during construction. As such, this proposal will investigate 3D printing from the point of view of materials and structural engineering, rather than construction. This study will result in engineered, 3D printed FRCMs meeting required quality control and engineering properties (from fresh to fully hardened) to simulate the response of the materials during construction (printing) and in their hardened state. The study is separated into the following research tasks to meet these specific objectives, as follows:

1. Design and fabricate material extrusion-based 3D printer for construction of FRCM components. (Task 1)
2. Develop a quality control protocol to investigate voids and fiber alignment of 3D printed FRCM components using x-ray tomography (Task 1).
3. Investigate fresh-state properties of FRCMs fabricated using 3D printing (Task 2)
4. Investigate hardened engineering properties of FRCMs fabricated using 3D printing (Task 3)
5. Disseminate research findings to the construction and structural engineering communities through partnership with Lafarge and the City of Seattle. (Tech Transfer)