Quarterly Progress Report:
Project Number and Title: 2.5 - Development and Testing of High / Ultra-High Early Strength Concrete for durable Bridge Components and Connections
Research Area New materials for longevity and constructability
PI: Kay Wille, Ph.D., Associate Professor, University of Connecticut, Department of Civil & Environmental Engineering, Storrs, CT
Co-PI Ramesh Malla, Ph.D., F. ASCE, Professor, University of Connecticut, Department of Civil & Environmental Engineering, Storrs, CT
Reporting Period: 12/30/2020– 03/31/2021
Submission Date: 03/31/2021

Overview: (Please answer each question individually)

- Emphasis has been placed on mixing and testing of New England UHPCs.
- Emphasized fiber optimization based on paste optimization UHPCs.
- Carried out direct tensile test and fiber pullout test.

Provide context as to how these activities are helping achieve the overarching goal(s) of the project…
In the first step, research was primarily focused on developing the optimized paste in terms of performance and cost with the use of locally available materials. Based on the newly developed optimized paste, now, the research has geared towards fiber optimization utilizing different fiber volume and different fiber types along with different aggregate cement ratio. Use of fibers enhanced the mechanical properties along with durability properties of the concrete. Since, fiber is the most expensive ingredients in the UHPC; the research has been directed towards fiber optimization recently. Current mixes use locally available materials in the New England area. Our preliminary test results are promising and confirm that we are heading in the right direction. This is an essential step towards the goal of this project to develop a non-proprietary cost-efficient UHPC for the New England area. The research will be continued by investigating other durability properties.

Describe any accomplishments achieved under the project goals…
Several concrete mixes using type II/V cement along with slag replacement, fly ash and use of glass powder have produced very good spread and the compressive strength of more than 20 ksi in 28 days. The research has continued by the utilization of different fiber volume fraction, different fiber types and different aggregate cement ratio. We are able to get good spread, compressive strength, direct tensile test results and fiber pullout test results. In addition, we are able to achieve more than 1000 k-ohm-cm resistivity in two and half months with New England UHPCs without fibers and also ultra-high performance concretes with fibers produced pretty good electrical resistivity despite the fact that it has steel fibers inside the concrete which could have affected the conductivity of the concrete. Such results indicate that newly developed UHPCs are impermeable. This would have very less durability issues in long run. The consequences of COVID19 significantly set back our research activities and continues to impact us in our efficiency to carry out lab experiments and having fruitful in person discussions.

Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed, make sure you complete the Overall Project progress row and include all tasks even if they have ended or have not been started)…

Table 1: Task Progress

Task Number	Start Date	End Date	% Complete
Task 1: Literature review	01/01/2019	03/31/2021	75%
Task 2: Testing and Investigating the Performance of current HES	03/01/2019	03/31/2021	100%
Task 3: Developing the next generation of HES mixture designs (Shifting towards New England UHPC)	01/01/2020	03/31/2021	50%

Task 4: Knowledge transfer and practical application	12/01/2019	03/31/2021	15%
Overall Project:	*Enter Actual Start*	*Enter Planned/Actual End*	

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***

Include the date the budget is current to.** **Information in Table 2 is to be determined.

Describe any opportunities for training/professional development that have been provided…

Due to COVID19 the lab still operates under strict COVID19 measures. Despite the challenging situation, following undergraduate students: Cydney-Alexis Delarosa, Jeet Rosa, Ethan Beattie, Corey Walker and Dominic Parciasepe continued working during this reporting period since last fall semester.

Describe any activities involving the dissemination of research results (be sure to include outputs, outcomes, and the ways in which the outcomes/outputs have had an impact during the reporting period. Please use the tables below for any Publications and Presentations in addition to the description of any other technology transfer efforts that took place during the reporting period.)… Use the tables below to complete information about conferences, workshops, publications, etc. ***List all other outputs, outcomes, and impacts after the tables*** *(i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings).*

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
The Effects of Resonant Acoustic Mixing on the Microstructure of UHPC		Journal		Currently working on it

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**

Encouraged to add figures that may be useful (especially for the website)…
Following are the test set up for the mechanical and durability properties investigation, right now:

Fig:- Direct Tension Test Setup

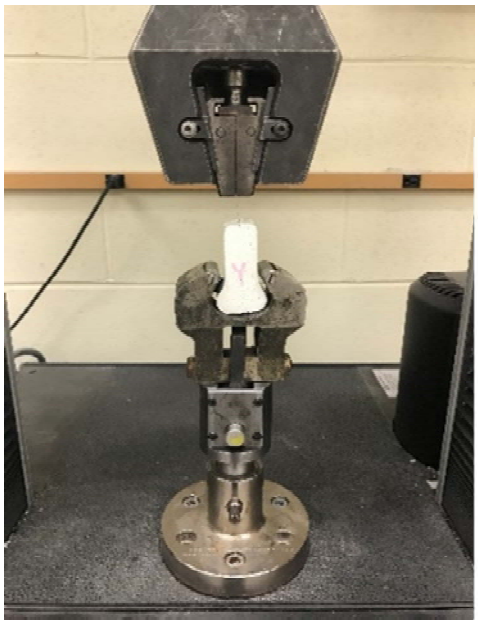

Fig:- Fiber Pullout Test Setup

Fig:- Air Content Test Apparatus

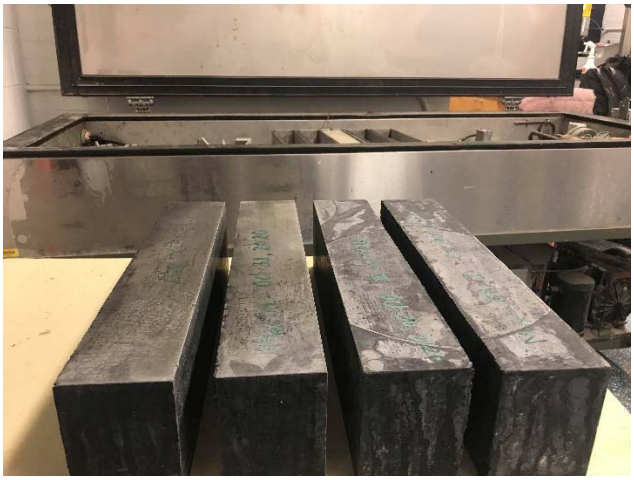

Fig:- Freeze Thaw Table

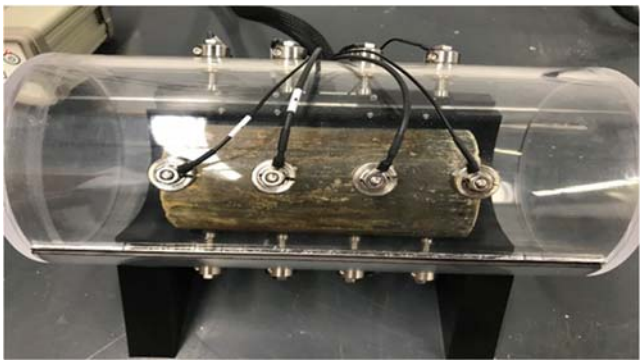

Fig:- Surface Resistivity Test Setup

Participants and Collaborators:

Use the table below to list all individuals who have worked on the project.

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
Kay Wille, Ph.D., Associate Professor	kay.wille@uconn.edu	Civil Engineering	Principal Investigator

Ramesh Malla, Ph.D., F. ASCE, Professor	ramesh.malla@uconn.edu	Civil Engineering	Co- Principal Investigator

Use the table below to list all students who have participated in the project during the reporting. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.)

Table 6: Student Participants during the reporting period

Student Name	Email Address	Class	Major	Role in research
Christopher Boisvert-Cotulio		Master Student	Civil Engineering	Grad-RA
Jeet Rosa		Undergraduate-Senior	Material Science	Undergrad-RA
Cydney-Alexis Delarosa		Undergraduate-Junior	Biomedical Engineering	Undergrad-RA
Dominic Parciasepe		Undergraduate-Sophomore	Environmental Engineering	Undergrad-RA
Corey Walker		Undergraduate-Senior	Civil Engineering	Undergrad-RA
Ethan Beattie		Undergraduate-Senior	Civil Engineering	Undergrad-RA

Use the table below to list any students who worked on this project and graduated during this reporting period.

Table 7: Student Graduates

Student Name	Role in Research	Degree	Graduation Date
Bijaya Rai	Leading the research works	Ph.D.	TBD

Use the table below to list organizations have been involved as partners on this project and their contribution to the project.

Table 8: Research Project Collaborators during the reporting period

Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges

List all other outputs, outcomes, and impacts here (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings). Please be sure to provide detailed information about each item as with the tables above.
Not applicable at this time.

Have other collaborators or contacts been involved? If so, who and how? (This would include collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations.)
Keeping the good rapport with the previous suppliers, contacts have been made with different fiber suppliers (HiperFiber, Ductal and Dramix), with Lehigh Cement for Type II/V cement. In addition to that, Norchem Silica Fume has offered us to carry out PSDs analysis as in-kind support for cementitious materials that has been used in the research.

Who is the Technical Champion for this project?
Name: Mary Baker
Title:
Organization: Connecticut DOT
Location (City & State): Newington, CT
Email Address: Mary.Baker@ct.gov

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them…
Research works are continue under the strict COVID19 rules and regulations. The new normal is still affecting the research in many ways; everyone has to follow the COVID lab safety plan with a restricted time schedule, social distancing while performing the experiments, contact tracing, and many other regulations to prevent the spread of the virus.

Discuss any changes in approach and the reasons for the change…
Still, research activities had been shifted towards addressing the consequences due to the COVID19 pandemic. During the process of paste investigation, it was found that Lafarge Holcim Type II/ V cements are not available in the east coast. It took a while to find out another cement company, which would supply Type II/V cement with similar properties. In addition to this, due to the drastic changes in the relative humidity and temperature, there was some delays in the concrete mixing.

Planned Activities:

Description of future activities over the coming months.
Right now, the research is mainly focused on fiber optimization based on the newly developed optimized paste and investigation of mechanical properties such as compressive strength, direct tensile strength, fiber pullout strength and other durability properties such as surface resistivity, freeze thaw durability, air content investigation in the New England UHPCs. Therefore, other planned activities include as follows:

- Characterizing the fiber pull out behavior and direct tensile behavior of various fibers embedded in UHPC
- Continue obtaining locally available materials for tailoring the UHPC for the New England area.
- Investigating durability properties of newly developed UHPC