Bi-Monthly Progress Report

TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

Project Number and Title: Development and Testing of High / Ultra-High Early Strength Concrete for durable Bridge Components and Connections

Research Area: New materials for longevity and constructability

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Reporting Period: 03/31/2018 – 05/31/2019
Date: 05/31/2019

Overview:

For the first part of the research, the necessary materials were identified and purchased from the respective suppliers. The properties of aggregates, cementitious material and admixtures were studied and quantified. Since, the properties of aggregate varies from source to source, the material properties such as gradation, absorption, specific gravity, rodded and loose density of the aggregates were identified. Based on the mix proportions from NETC 13-1 report, the mixture design sheet was finalized with the materials available in the Storrs area. A few trial batches of concrete had been casted so far. These concrete batches included two selected concrete mixtures developed by Professor Brena's group at the University of Massachusetts. The results are pretty similar as it can be seen in Fig 1.

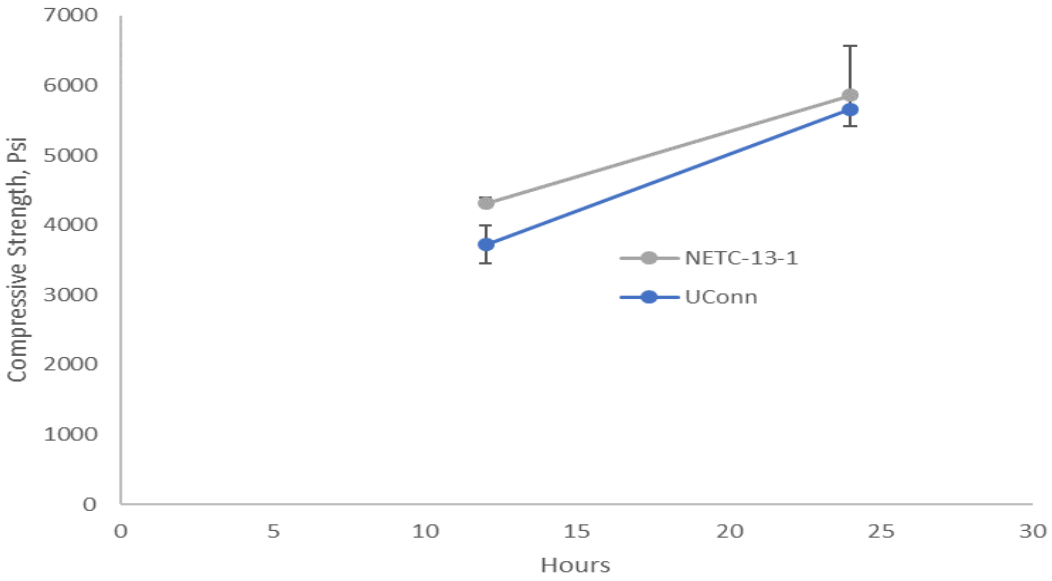

Figure 1: Compressive strength

In existing HES concrete, the curing temperature was 80 degree Fahrenheit, while in this research the curing temperature is 73 Fahrenheit and relative humidity more than 95%. Another reason behind this difference is that the research has utilized locally available material in both the cases which means the material properties could not be exactly same to yield same results.

The fresh properties of the concrete were: Slump ≥ 9" and spread 23". The concrete looked too flowably and gluey initially but after half an hour it became difficult to cast. It indicates that the concrete is workable in the field. But, it would need to be pumped or cast immediately after mixing otherwise problems of choking might occur. Additionally, it needs good vibration for consolidation.

In case of mixing the concrete, the ingredients can be charged in incremental order as mentioned in ASTM C192 NOTE 13 while the machine is rotating. This facilitates the mixing process of mixtures with very low w/cm ratio as used here.

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Provide context as to how these activities are helping achieve the overarching goal of the project…
Up to now, the research works basically comprises finalizing the properties of ingredients used in the concrete mixtures and followed by casting the concrete. Since the first part of the research emphasizes the enhancement of the robustness to the suggested concrete mixtures, these procedures of repeating the same mixture proportions with locally available materials is important. In the recommendation section in the NETC final report, it has suggested to use locally available material. And, it is usual practice to use locally available material as it is cost effective. Therefore finalizing the properties of mixture ingredients and comparing with that of the existing HES ingredients helps to confirm other further results.

Describe any accomplishments achieved under the project goals…
A few batches of the concrete had been cast. The concrete mixture had been proportioned as per the NETC report 13-1 but locally available material had been utilized. First, the properties of aggregates such as gradation, absorption, specific gravity and density were determined (see Table 1 and Figure 2). Then, the concrete mixture design sheet was followed using the dry density of the material.

Table 1: Properties of the aggregates

	Aggregate Properties	
	1/2"	Fine
Absorption	1.4	2.5
Specific Gravity, SSD	2.68	2.78
Specific Gravity, OD	2.65	2.74
Rodded Density, lb/ft3	95.2	105.2
Loose Density, lb/ft3	86.1	96.76

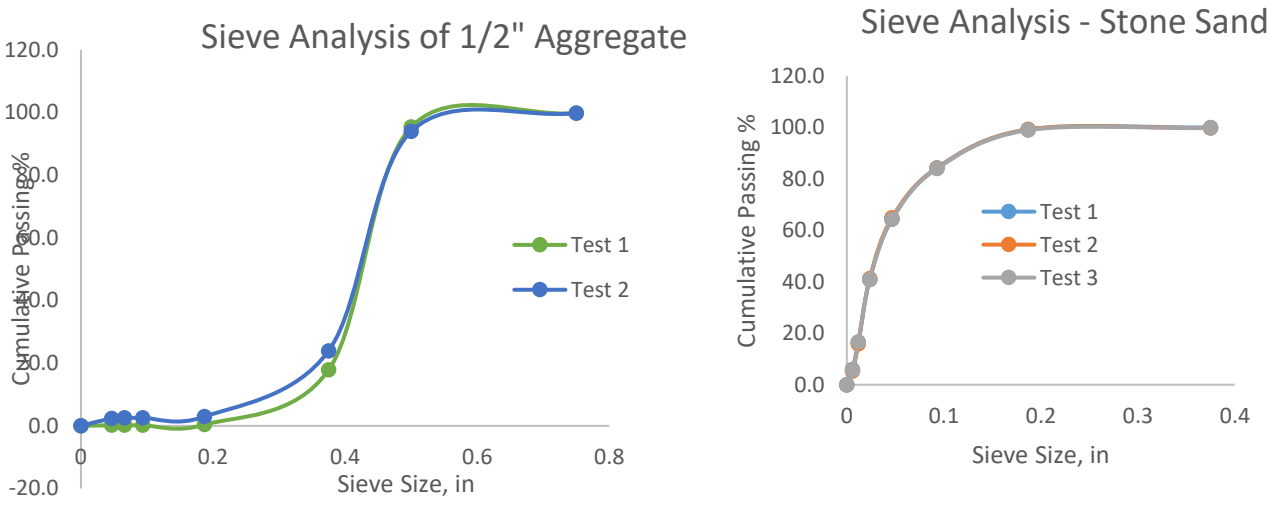

Figure 2: Properties of the aggregates

In addition we have been working on the third objective "Expand the applicability of high / ultra-high performance concrete to other critical bridge elements such as parapets" by working together with Raymond Basar from Conn DOT through an independent research. An independent research report has been completed and finalized.

Describe any opportunities for training/professional development that have been provided…
The graduate student has attended the regular UConn team TIDC meetings, is working with the UHPC group members in the Advanced Cementitious Materials and Composites (ACMC) group at UConn which includes weekly research meetings with advisor. In addition to that, the graduate student is attending the TIDC annual workshop on June 6 to 7th.

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)…

Encouraged to add figures that may be useful (especially for semi-annual reporting by the project manager and management team)…

Figure 4: Compression Test

Participants and Collaborators:

List all individuals who have worked on the project
PI: Kay Wille, Ph.D., Associate Professor
Co-PI: Ramesh Malla, Ph.D., F. ASCE, Professor
Bijaya Rai, Ph.D. Student

List all students who have participated in the project.
Bijaya Rai, Ph.D. Student
In the future, few undergraduate students will be included in the research team.

What organizations have been involved as partners on this project?
UTC-TIDC
Conn DOT
New England DOTs
Maine DOT

Have other collaborators or contacts been involved? If so, who and how?
Contacts to the research group of Assistant Professor Stefan Schaffoener at the University of Connecticut has been established and potential collaborations have been initiated.

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them…
Bijaya has joined our research group in January 2019 and had her first finals in May first weeks.

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Discuss and changes in approach and the reasons for the change…

Planned Activities:

Description of future activities over the coming months.
The first phase of the research will be completed in a few months and the second phase objective will be pursued afterwards "Develop the next generation of non-proprietary HES concrete mixture design specifications" by investigating the incorporation of nano-sized materials and the application of a novel high particle packing concept.

The results of the independent research project with Raymond Basar from Conn DOT titled "Ultra-High Performance Concrete for Highway Bridge Parapets" will be further disseminated.