NHDOT SPR2 PROGRAM
RESEARCH PROGRESS REPORT

Project # 42372M		**Report Period** Year 2024 ☐ Q1 (Jan-Mar) ☐ Q2 (Apr-Jun) ☐ Q3 (Jul-Sep) ☒ Q4 (Oct-Dec)
Project Title: Reduce Concrete Cracking through Mix Design		
Project Investigator: Eshan Dave, University of New Hampshire **Phone:** 603-862-5268 **E-mail:** eshan.dave@unh.edu		
Project Start Date: 4/12/2023	**Project End Date:** 12/31/2025	**Project schedule status:** ☐ On schedule ☐ Ahead of schedule ☒ Behind schedule

Brief Project Description:

Concrete cracking affects the long-term condition and performance of both bridge and culvert structures. Shrinkage cracking is perceived to be a deterrent to placing exposed decks/slabs during bridge and culvert rehabilitation and replacement projects. Concrete cracking during bridge construction allows oxygen, moisture and salts into the structure accelerating corrosion and deterioration. Understanding methods to avoid cracking at the mix design level will allow exposed decks to be more often considered as a viable option. This is especially critical as more rapid bridge projects are proposed.

Different construction and specification methods have been previously explored to reduce concrete cracking at bridge curb locations. This research will explore alternates to current mix design practice including lightweight concrete, changes to PCC and pozzolan content, etc., to reduce concrete cracking. Stand alone, off structure concrete placement like sidewalks, concrete slabs, etc., could be used as test areas for observation. The Bureau of Bridge Maintenance will work with researchers at those locations and consider placement in bureau projects.

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

During the reporting quarter, the research team focused on the execution of the laboratory experimental plan for the study. This primarily involved manufacturing various batches of concrete and conducting tests on them. Further, significant effort was spent in identifying and sampling of light weight fine aggregate. One of the fine aggregate sampled in previous quarter had to be regraded in the laboratory since the sampled material did not meet the gradation requirements.

Samples for both the Troy 101- 088 baseline mixture and the corresponding concrete with 15% reduction of cementitious materials (CM) of this baseline have been tested in this quarter. The research team was able to test the compressive and tensile strength development, surface resistivity, free shrinkage and Young′s modulus of both these mixes. The compressive strength of the baseline cylinders aligned closely with the data provided from the NHDOT (sampled and tested during the construction). Additionally, although weaker, samples with lower CM were still able to reach the mix design strength of 4 ksi as shown in figure 1.1.

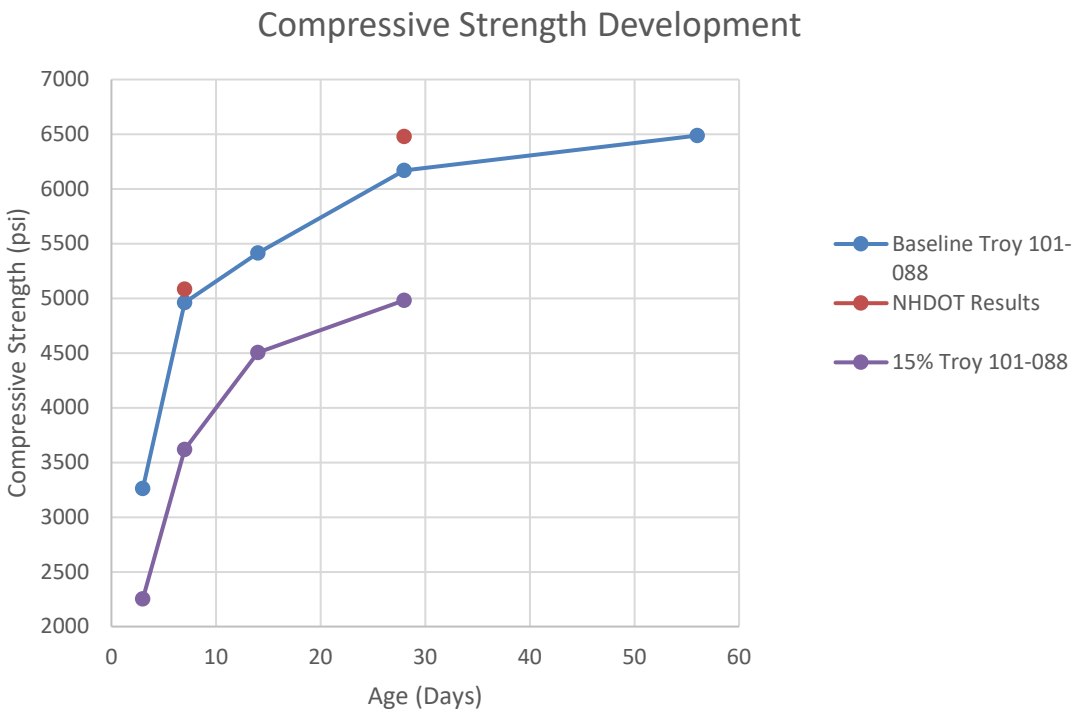

Figure 1.1: Concrete Compressive Strength Development

The tensile strength of the tested samples mobilized a fraction of their compressive strength, with the baseline reaching 555 psi at 28 days and the 15% reduced CM reaching 387 psi at 14 days. These results are in line with the physical properties of concrete expected by the researchers. Surface resistivity generated by the lab batch of the Troy 101-088 baseline concrete fell below the NHDOT results from construction sample. The baseline generated 25.3 kohm–cm of resistance at 56 days in contrast to the 39.4 kohm–cm the NHDOT observed. In comparison the 15% reduced CM batch has been observed to generate 25.8 kohm–cm of resistance at 28 days. The Young's moduli of both batches were also measured with the baseline and 15% reduced CM generating exhibiting moduli of $0.32X10^6$ psi and $0.38\ X10^5$ psi respectively. Additionally, free shrinkage beams were also created from each batch with the 15 % reduced CM sample exhibiting 37 microstrain in comparison to 51 microstrain of the baseline. Further testing of these and subsequent variations will continue into the next quarter.

Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc…):

Following information has been requested from the project TAG:

- List of potential bridge maintenance construction projects for Winter 2024 as well as Spring 2025.

Anticipated research next three (3) months:

During the first part of the upcoming quarter, the research team will continue with the experimental program testing the strength, ionic resistance and free shrinkage of the concrete from both mix designs. Further, ring shrinkage test hardware and software will be finalized to begin testing the effect of restrained shrinkage. The research team is also processing data and information that was obtained from NHDOT in the previous quarter. The research team has also undertaken an expansion of the literature review that was initially prepared. Information available from FHWA's EPIC^2 (Enhancing Performance with Internally Cured Concrete) program is currently being incorporated within the literature review. Thus, a more comprehensive Task-1 deliverable is currently underway and it planned to be completed in the first part of the upcoming quarter.

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Circumstances affecting project:

There was a delay in the Task 1 of the project and a delay in Task 2. Most of the delay is associated with the delay in recruitment of the graduate student for this study as well as obtaining initial information from the project panel. Additional factors delaying the experimental program included sourced materials not meeting specification. While tasks 1 and 2 are delayed, we do not expect an overall delay in the project end date or timeline for other tasks.

Tasks (from Work Plan)	Planned % Complete	Actual % Complete
Task 1 Literature and Current Practice Review	100	90
Task 2 Mix Design and Lab Evaluation	30	12
Task 3 Survey of Study Sites for Cracking Performance	0	0
Task 4 Analysis of Results and Recommendation Development	0	0
Task-5 Final Report and Poster	0	0

Barriers or constraints to implementing research results

Nothing to report.