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 implementation of the experimental program to begin work preparing and testing samples. The first task associated with this phase of the project was the acquisition of course and fine aggregates used in the PCC mix designed used in Alton 076 - 277 and Troy 101 - 088 bridges. The aggregates from Coleman Concrete's site in Conway NH were used in Alton 076 – 277. For Troy 101 – 088, Carroll Concrete's site in Brattleboro VT was the source of the aggregate used. These materials were then tested to determine their bulk density and relative density for use in proportioning and calculating absorption respectively. Three to five replicate tests were performed on each aggregate until the variability of measurements were reduced. This information was used to verify the properties shown on the batching sheets (to ensure that sampled materials are representative of the contractors and adequately adjust the amount of free water added to the batch. The gradation of both fine aggregate samples was also tested to ensure compliance with ASTM C33 for use in the concrete. Fine aggregate from the Coleman concrete site did not meet this criterion and thus it was decided therefore to begin testing with the Troy 101 - 088 mix design. The testing of the Troy mix design started with trials to match the fresh properties reported by the contractor before producing samples for testing of hardened concrete. Two trials have been conducted to test both the slump and air content of the concrete to limited success. The first trial was conducted with the specified amount of both the air entrainment and water reducing admixtures resulting in the concrete falling below target. The second trial resulted in the batched concrete exceeding the design requirements. The challenges that were exposed during these trials were both the size of the batch and the limited time available from the start of hydration to the initial set of the concrete. To remediate these problems the team will be preparing smaller batches as well as mobilizing additional members of the team for sample preparation.

Commercially available ring shrinkage test (restraint shrinkage test) apparatuses were found to be to cost prohibitive to acquire. It was thus decided by members of the research team to in-house develop the test setup by leveraging the

resources at the university. The hardware and software associated with the test are currently being produced with the expected completion date before the end of 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 and begin 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. Thus, a more comprehensive Task-1 deliverable is currently underway and it planned to be completed in the first part of the upcoming quarter.

Circumstances affecting project:

There was a delay in the Task 1 of the project and a minor 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. 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	25	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.