<u>Bi-Monthly Progress Report</u>:
Project Number and Title: Alternative Cementitious Materials (ACMs) For Durable and Sustainable Transportation Infrastructures
Research Area: New Materials for Longevity and constructability
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Reporting Period: *06/01/2019 – 31/07/2019*
Date: *31/07/2019*

Overview:

Alternative cementitious materials (ACM), specifically, carbonation activated binder, can enable CO_2 sequestration and a high volume of industrial by-products usage in concrete. The overall carbon footprint of concrete produced by carbonation activation is around 50% lower compared to the traditional concrete depending on the exact mix proportions and curing conditions. The goal of this project is to evaluate the performance of carbonation activated concrete with a high volume of industrial by-product for transportation infrastructure applications.

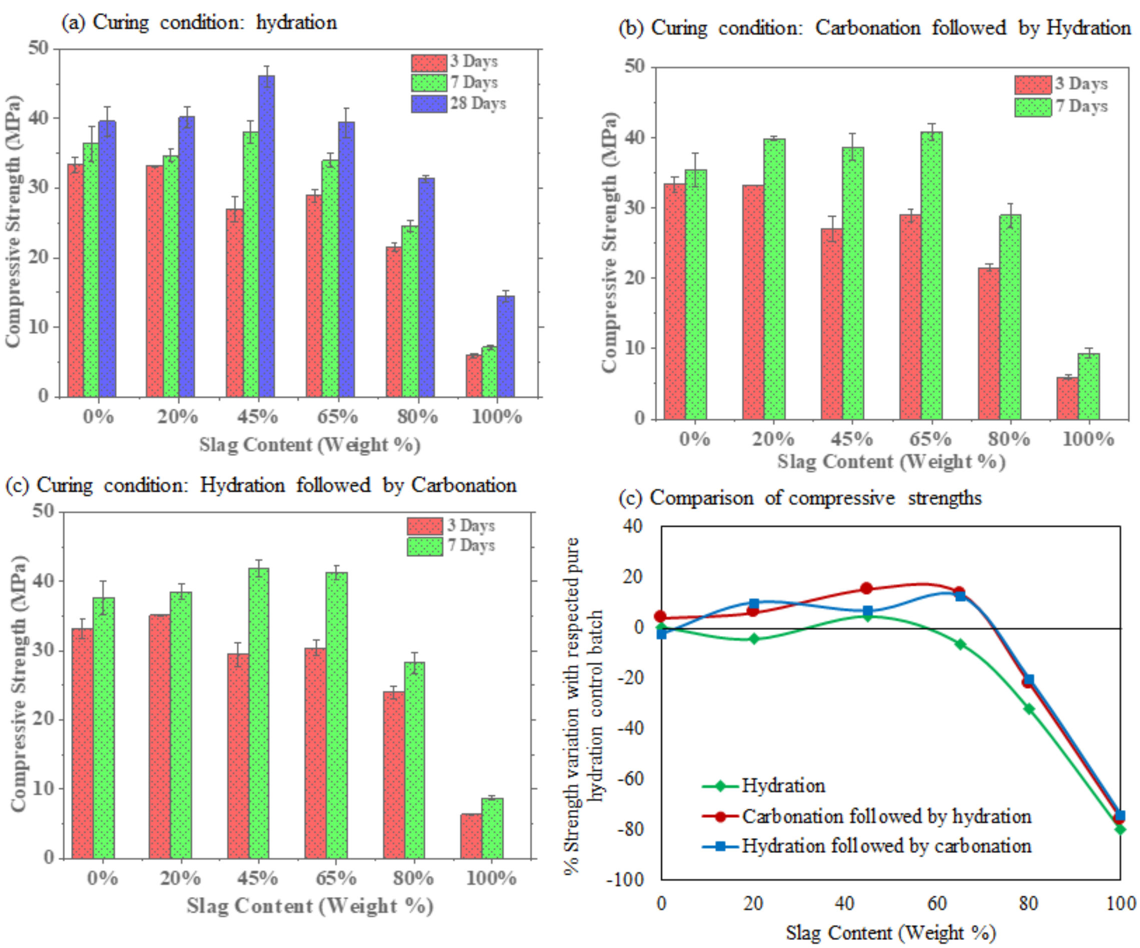

Figure 1: Compressive strength (MPa) of concrete for different curing conditions: (a) hydration, (b) carbonation followed by hydration, (c) hydration followed by carbonation and (d) % strength variation of concrete samples for different curing conditions and slag contents.

This project was started on 06/01/2019. The first stage of this project involved recruiting a graduate student (Rakibul Khan), procuring raw materials, and collecting information from MaineDOT on common practices and challenges of concrete infrastructure at Maine. Based on the needs of MaineDOT, carbonation activated binder was produced by replacing Ordinary Portland Cement (OPC) with Ground Granulated Furnace Slag (GGBFS) (120 Grade, Ladle Slag) in concrete and subjecting it to carbonation curing. Six batches of concrete mixtures were produced using 0% (control), 20%, 45%, 65%, 80% and 100% by weight of OPC replaced by GGBFS. The concrete cylinders (4 in by 8 in) were then exposed to three different curing scenarios, including (i) hydration (sealed), (ii) hydration (sealed) followed by carbonation, and (iii) carbonation followed by hydration (sealed). The weight change and compressive strengths of the concrete cylinders were measured after 3 days and 7 days of curing.

The compressive strengths of the concrete batches exposed to different curing conditions are given in Figure 1. Based on the strength data after 7 days of curing, incorporation of carbonation curing increased the strength of concrete batches up to 20% compared to the traditional hydration curing. Further, in the case of hydration, up to 45% by wt. of OPC can be replaced by GGBFS without causing any significant strength loss of concrete mixtures (Figure 1(a)). Whereas in case of carbonation curing batches, any decrease in compressive strength was not observed until 80% by wt. of OPC was replaced with GGBFS (Figure 1(b) and (c)). Figure 1 also shows that 28 days strength in case of pure hydration can be achieved within 7 days by incorporating carbonation curing.

Planned Activities:

Next stage of this project will include the strength determination of paste samples containing GBBFS with carbonation curing, obtaining concrete strength after 28 days of curing, thermogravimetric Analysis (TGA), and X-ray Diffraction (XRD) for microstructural evaluation.

Publications:

Abstract accepted for presentation in ACI Fall 2019 convention, Cincinnati, October 20 -20, 2019.