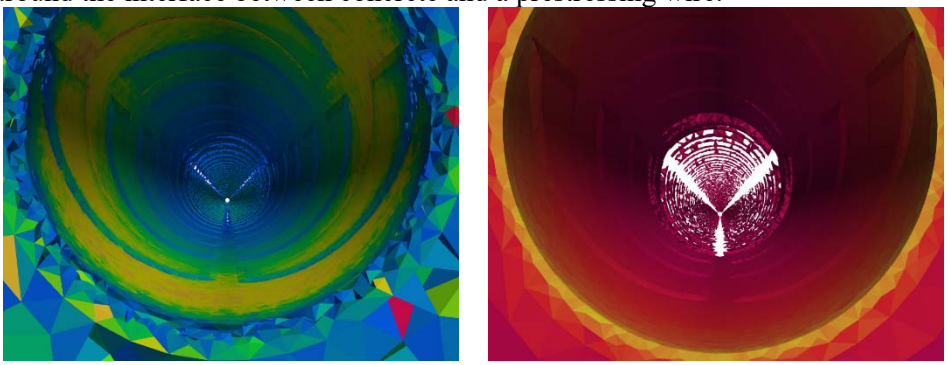
Quarterly Progress Report:
Project Number and Title: 3.5 Prevention of Stress-Induced Failures of Prestressed Concrete Crossties of the Railroad Track Structure
Research Area: New Systems for Longevity and Constructability
PI: *Moochul Shin and Western New England University*
Co-PI(s): *ChangHoon Lee and Western New England University*
Reporting Period: ***10/1/2020~12/31/2020***
Submission Date: *12/31/2020*

Overview: (Please answer each question individually)

Due to the COVID-19 pandemic, the research activities have been significantly disrupted. Limited numerical analyses and lab experiments have been conducted. During the reporting period, the WNEU research team has been working on Tasks 2, 3, and 4.

- Upon de-tensioning prestressing wires, the performance of prestressed concrete crosstie models including damaged length, area, and volume due to the compression and tensions were investigated. The numerical simulation results indicate that the damage due to tension is greater than the compression damage. The compression damage tends to be localized nearby each indentation and at the end of the time. Figure 1 shows the damage around the interface between concrete and a prestressing wire.



(a) (b)

Figure 1. Damaged concrete due to (a) tension and (b) compression.

- The influence of ground granulated blast furnace slag (GGBFS) on the rate of strength development is explored. Particularly, the acceleration of hydration due to GGBFS compromises the impact of Type III cement as demonstrated by Figure 2

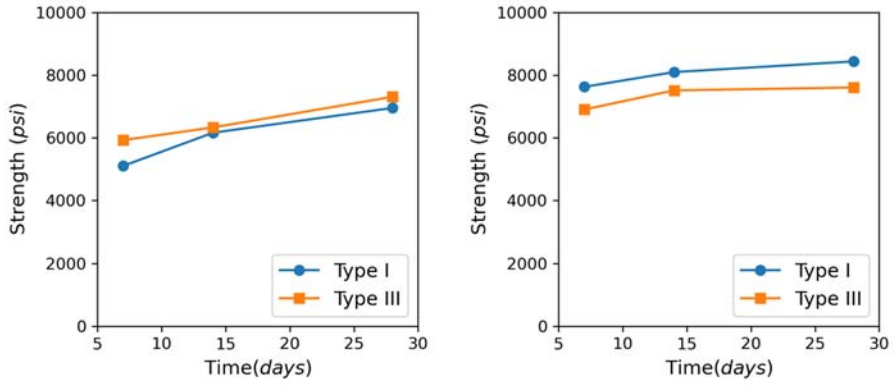


Figure 2. Influence of Ground-Granulated Blast Furnace Slag (GGBFS) interacting with cement types: (a) Specimens without GGBFS, (2) Specimens with GGBFS

- The qualitative durability performance test for an engineered cementitious material (ECM) was performed via the accelerated corrosion chamber test shown in Figure 3. The ECM cylinder survived after 48 hours in the chamber, while the regular concrete cylinder was completely damaged by the corrosion damage. The combination of dense microstructure (i.e., lower diffusivity) and the improved tensile strength prevented splitting failure induced by expansion of corrosion products.

Figure 3. Accelerated corrosion test results: (a) ECM cylinder and (b) regular concrete cylinder

Table 1: Task Progress			
Task Number	**Start Date**	**End Date**	**% Complete**
Task 1: 3D FE Models	09/01/2018	12/30/2020	99 %
Task 2: 3D FE Models on HPC	03/01/2019	3/30/2021	90 %
Task 3: Crosstie Models	06/01/2020	09/30/2021	40 %
Task 4: Introduction of Engineered Cementitious Materials	12/01/2018	05/30/2021	75 %
Overall Project:	09/01/2018	09/30/2021	65%

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***
$385,000	$236,645.17 to 11/30/2020	61.5 % to 11/30/2020

Include the date the budget is current to.

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
n/a				

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

Participants and Collaborators:

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
Moochul Shin	moochul.shin@wne.edu	Civil and Environmental Engineering	Leading Tasks 1, 2, and 3
Chang Hoon Lee	changhoon.lee@wne.edu	Civil & Environmental Engineering	Leading Task 4.

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
Georgii Tifaniuk		Junior	Civil Engineering	Experimental Testing
Cameron Cox		Senior	Civil Engineering	Experimental Testing
Andrew Masullo		Senior	Civil Engineering	Experimental Testing
Jacob Eberli		Senior	Civil Engineering	Experimental Testing

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**
Nicolas Pantorno	Concrete mixing and testing	Civil Engineering	12.21.2020

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**
National Center for Supercomputing Applications	Urbana, IL		x			
Texas Advanced Computing Center	Austin, TX			x		

The in-house parallel algorithm code was mainly developed by Dr. Kwack (currently at Argonne National Laboratory) when he was a staff member of the Blue Waters sustained-petascale computing project, which is supported by the National Science Foundation (awards OCI-0725070 and ACI-1238993) and the State of Illinois. In addition, this work partially used the XSEDE resource – Stampede2-TACC through allocation #MSS180002.

Table 9: Other Collaborators			
Collaborator Name and Title	**Contact Information**	**Organization and Department**	**Contribution to Research**

JaeHyuk Kwack	jkwack@anl.gov	National Center for Supercomputing Applications (currently at Argonne National Laboratory)	Technical support and advice for high performance computing
Hailing Yu	Hailing_yu@yahoo.com	Volpe Center (currently at STV)	Technical champion

Who is the Technical Champion for this project?
Name: Hailing Yu
Title: Mechanical Engineer (Engineering Specialist)
Organization: Volpe center (currently at STV)
Location (City & State): Cambridge, MA (Boston, MA)
Email Address: hailing.yu@dot.gov (hailing_yu@yahoo.com)

Changes:

The concrete lab has been temporarily closed during the winter break, and the research team is expecting to reopen the lab when the 2021 spring semester begins. A 3~6 month delay is expected.

WNEU is expected to hold most of the classes on-ground (face-to face) for 2021 Spring. In order for the campus to remain open, everyone has to follow the COVID safety and health guidelines such as face covering, social distancing, etc.

Abdoulaye Diallo, who just graduated with the master's degree in Civil Engineering has been working for the project as a temporary post-graduate researcher since June, 2020.

Nicholas Pantorno in Civil Engineering has just graduated.

Jacob Eberli, senior in Civil Engineering has just joined the research team.

Planned Activities:

1. Large-scale prestressed concrete crosstie models will be further developed with multiple wires in order to investigate the overall responses using the HPC.

2. The research team will be monitoring the safety guidelines of the lab environments.

3. The research team will continue developing ECM for the railroad crossties. The use of high volume paste can be a potential risk for shrinkage crack despite denser microstructure. The research team investigates the performance of concrete with respect to combinations of the paste volume and the size distribution of aggregates.