Quarterly Progress Report:
Project Number and Title: 2.3: Avalanche study of the fiber-reinforced cementitious composites
Research Area: Thrust 3 Use New Materials and Systems to Build Longer-lasting Bridges and Accelerate Construction
PI: *Ting Tan, University of Vermont*
Co-PI(s): *Dryver Huston, and University of Vermont*
Reporting Period: *01.01.2021 to 03.31.2021*
Date: *Date*

Overview: (Please answer each question individually)

Overview and summary of activities performed during previous three months
The primary activities have been:

1. Perform research project – PI Ting Tan has been working with a graduate student Zhuang Liu for the avalanche study between the basalt fiber and cement matrices.

2. For the experiments, PI Tan and graduate student Zhuang Liu has performed four-point bending experiments for basalt fiber reinforced concrete beams with 0.5 % and 1.0% fiber volume fractions at different loading rates (0.03 and 0.15 in/min). High resolution stress-time curves were collected.

Context as to how these activities are helping achieve the overarching goal of the project

The research objectives of this project are to understand how the stress-time avalanche behavior affect the durability of fiber reinforced concrete, including

1. Experimental measurements on stress-time avalanches between basalt fibers and cementitious matrices using high-resolution measurement systems

2. Processing of the high temporal resolution data using Wiener filter

Accomplishments achieved under the project goals

The accomplishments are primarily the results reported above, i.e., experimental measurements on stress-time avalanches between basalt fibers and cement matrices, and analyze the stress-time behavior of basalt fiber reinforced concrete during flexture.

Complete the following tables to document the work toward each task and budget

Table 1: Task Progress

Task Number	Start Date	End Date	% Complete
Task 1: Basalt fiber reinforced concrete avalanche measurements	01/01/2021	03/31/2021	75
Task 1: Basalt fiber reinforced concrete avalanche modeling	01/01/2021	03/31/2021	75
Overall Project:	01/01/2021	08/31/2021	

Table 2: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date
$179,377	$110,000	61%

Opportunities for training/professional development that have been provided

UVM engineering graduate Zhuang Liu participated in the avalanche study during the spring 2020.

Activities involving the dissemination of research results

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
Presentation title	Name of event (i.e. TIDC 1st Annual Conference)	i.e. Conference, Symposium, Seminar,		

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
i.e. Peer-reviewed journal, conference paper, book, policy paper	Publication title	Full citation		I.e. Submitted, accepted, under review
Peer-reviewed journal	Z. Liu, R. Worley, C, Giles, F. Du, M. Dewoolkar, D. Huston, T. Tan. Avalanches during flexure of early-age steel fiber reinforced concrete beams, *Materials and Structures*, 53, 76, 2020	0	Jan, 2020	Published
Peer-reviewed journal	Z. Liu, R. Worley, C, Giles, F. Du, M. Dewoolkar, D. Huston, T. Tan* (2021), "A study on avalanches of early age basalt fiber reinforced concrete beams during flexure", *Journal of Cleaner Production*, 279, 123695.	0	Oct, 2020	Published

Figures

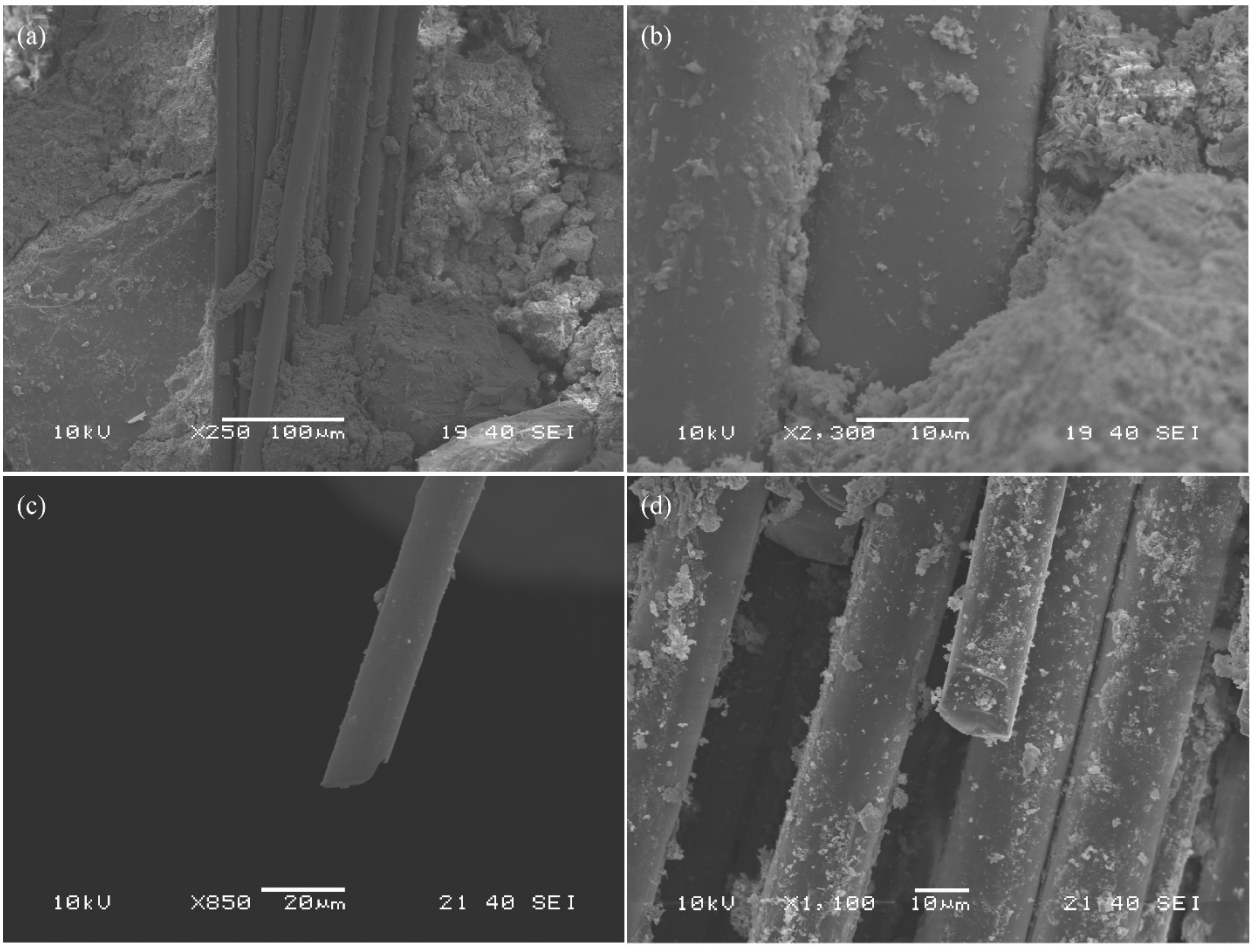

Fig. 1. Scanning electron microscopic images of (a) delaminated basalt fiber bundles from cementitious matrices, (b) exposed basalt fibers with residual of cementitious matrices on the surface, (c) a single fractured basalt fiber away from cementitious matrices, (d) a basalt fiber with exposed fractural surface.

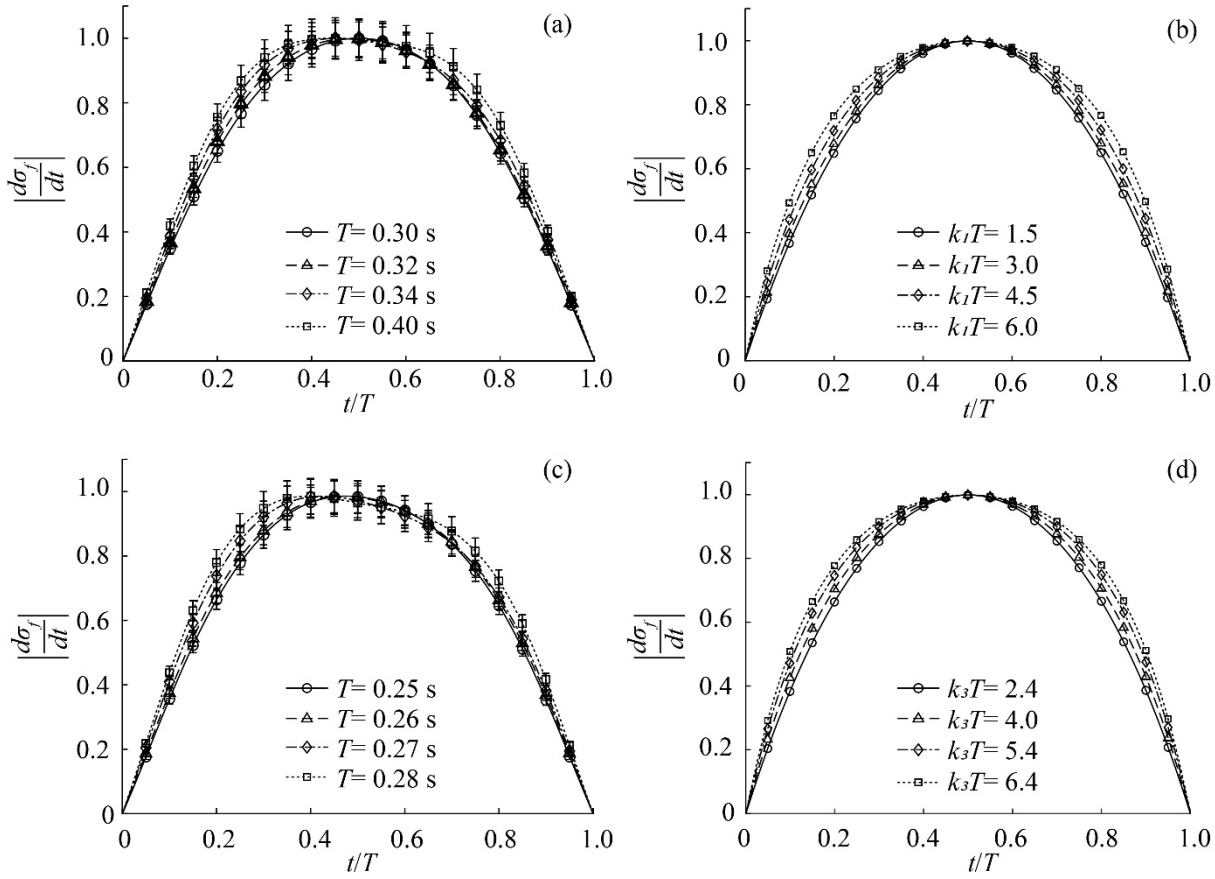

Fig. 2. The average flexural stress drop rate scaled by its maximum over the avalanche duration. Measurements w

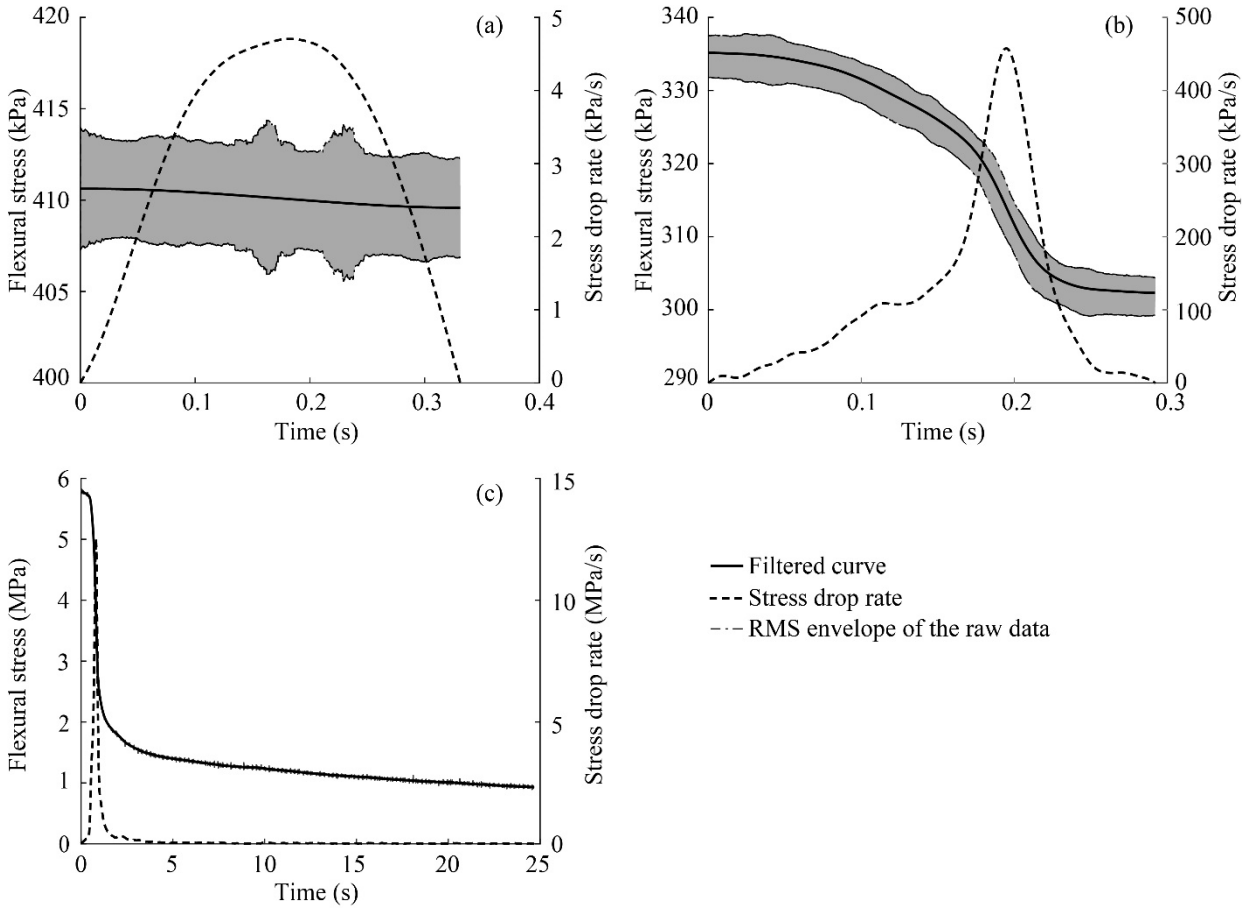

Fig. 3. Flexural stress and stress drop rates for a beam with 0.5% fiber volume fraction tested at 0.76 mm/min loading rate. (a) a representative small avalanche in the scaling regime; (b) a representative large avalanche beyond the scaling regime; and (c) a representative avalanche occurred at the cracking of bottom concrete. Root Mean Square (RMS) envelope of raw data are presented.

Participants and Collaborators:

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
	Email is not included in the external report and is only used for internal purposes.		
Ting Tan	Ting.Tan@uvm.edu	Civil and Environmental Engineering	PI
Dryver Huston	Dryver.Huston@uvm.edu	Mechanical Engineering	Co-PI

Use the table below to list all students who have participated in the project.

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
	Email is not included in the external report and is only used for internal purposes.	(i.e. Junior, Master's Ph.D)		
Zhuang Liu		Ph.D	Civil Engineering	Perform experiments on avalanche study

Use the table below to list any students who worked on this project and graduated during this reporting period.

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**
N.A.	N.A.	N.A.	N.A.

Use the table below to list organizations have been involved as partners on this project and their contribution to the project.

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**
		Mark the appropriate contribution with an "x"				
Fen, Du, Vermont Tech College	Randolph Center, VT	N.A.	N.A.	X	X	X

.

Changes:

Actual or anticipated problems or delays and actions or plans to resolve them

PI Tan started a new project on avalanches of fiber-reinforced cementitious materials during flexure. No changes have been made

Changes in approach and the reasons for the change: N.A.

Planned Activities:

Planning for the research – Experimentally, we will test other types of fiber-reinforced cementitious materials to compare their avalanche behavior.