

**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:** 04.01.2021 to 06.31.2021

**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 experimental research on the avalanche study between the basalt fiber and cement matrices.
2. PI Tan has processed the experimental data obtained from 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).

*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 variations affect the durability of fiber reinforced concrete, in which this part focused on the basalt fiber reinforced concrete

1. Mathematical processing of the high-resolution data using Wiener filter
2. Use mean-field model to explain how the stress variations related to the durability of basalt fiber reinforced concrete

*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 flexure.

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

<b>Table 1: Task Progress</b>			
<b>Task Number</b>	<b>Start Date</b>	<b>End Date</b>	<b>% Complete</b>
Task 1: Basalt fiber reinforced concrete avalanche measurements	4/01/2021	7/30/2021	90
Task 2: Mathematical modeling	05/01/2020	8/31/2021	40
Overall Project:	Initial Start Date	Planned End Date	

<b>Table 2: Budget Progress</b>		
<b>Project Budget</b>	<b>Spend – Project to Date</b>	<b>% Project to Date</b>
\$179,377	\$110,000	61%

*Opportunities for training/professional development that have been provided*

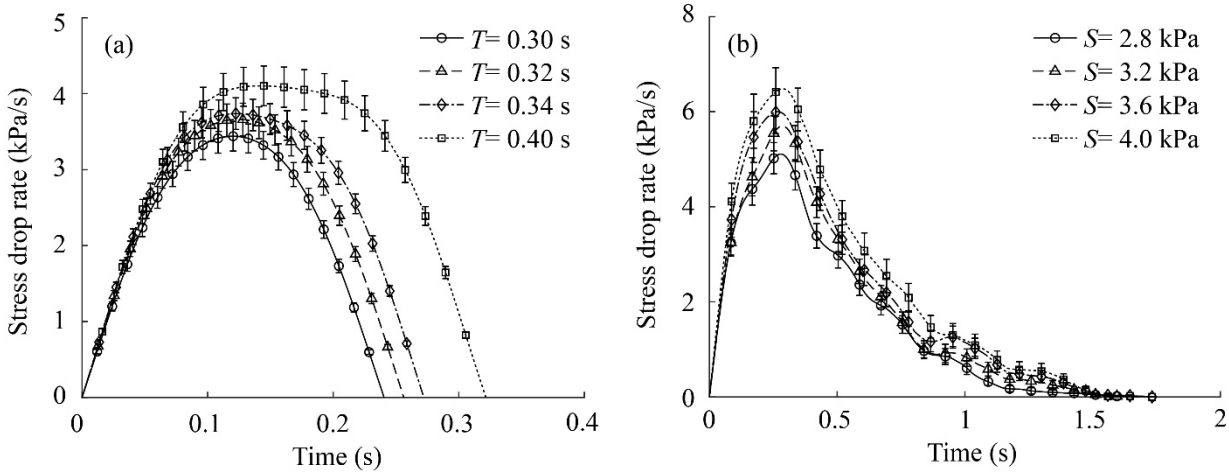
UVM engineering graduate Zhuang Liu participated in the avalanche study during the spring 2020.

*Activities involving the dissemination of research results*

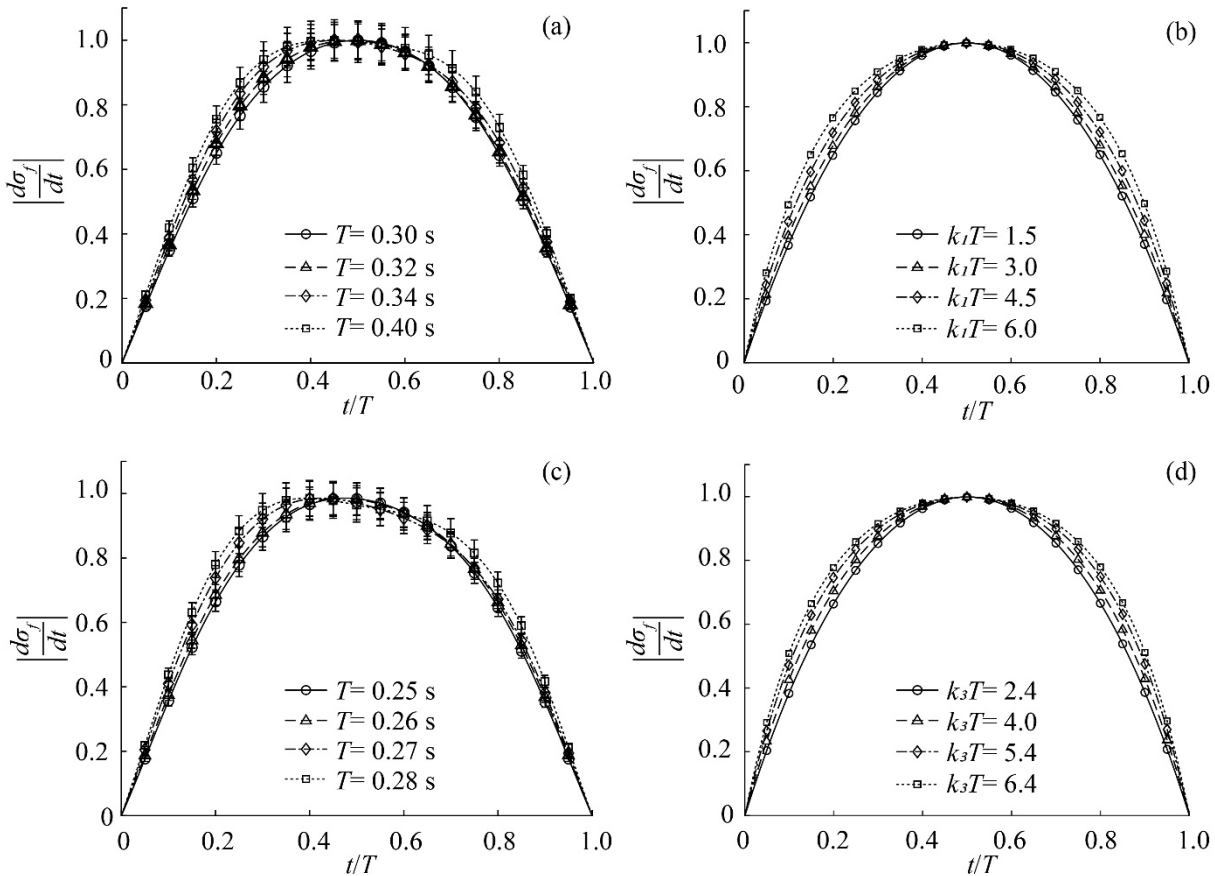
<b>Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events</b>				
<b>Title</b>	<b>Event</b>	<b>Type</b>	<b>Location</b>	<b>Date(s)</b>
Presentation title	Name of event (i.e. TIDC 1 <sup>st</sup> Annual Conference)	i.e. Conference, Symposium, Seminar,		

<b>Table 4: Publications and Submitted Papers and Reports</b>				
<b>Type</b>	<b>Title</b>	<b>Citation</b>	<b>Date</b>	<b>Status</b>
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, <i>Materials and Structures</i> , 53, 76, 2020	0	May, 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”, <i>Journal of Cleaner Production</i> , 279, 123695.	0	January, 2021	Published

*Figures*



**Fig. 1.** Unscaled average flexural stress drop rates of small avalanches in the scaling regime, i.e.,  $\frac{d\sigma_f}{dt}$ , from a representative beam with 1.0% fiber fraction tested at 0.76 mm/min (a) different avalanche duration  $T$ , and (b) different avalanche size  $S$ .



**Fig. 2.** Flexural stress drop rates of small avalanches in the scaling regime, average flexural stress drop rate scaled by its maximum over the avalanche duration T, where  $\left| \frac{d\sigma_f}{dt} \right| = \left( \frac{d\sigma_f}{dt} \right) / \left( \frac{d\sigma_f}{dt} \right)_{max}$ . Measurements were listed in the left column for groups (a) 1.0% fiber volume fraction, 0.76 mm/min loading rate; (c) 0.5% fiber volume fraction, 0.76 mm/min loading rate. (b, d) Predictions with different weakening parameters k were listed in the right column, respectively.

**Participants and Collaborators:**

<b>Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members</b>			
<b>Individual Name</b>	<b>Email Address</b>	<b>Department</b>	<b>Role in Research</b>
	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.

<b>Table 6: Student Participants during the reporting period</b>				
<b>Student Name</b>	<b>Email Address</b>	<b>Class</b>	<b>Major</b>	<b>Role in research</b>
	Email is not included in the external report and is only used for internal purposes.	(i.e. Junior, Master's Ph.D)		

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

<b>Table 7: Student Graduates</b>			
<b>Student Name</b>	<b>Role in Research</b>	<b>Degree</b>	<b>Graduation Date</b>
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.

<b>Table 8: Research Project Collaborators during the reporting period</b>						
<b>Organization</b>	<b>Location</b>	<b>Contribution to the Project</b>				
		<b>Financial Support</b>	<b>In-Kind Support</b>	<b>Facilities</b>	<b>Collaborative Research</b>	<b>Personnel Exchanges</b>

		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.