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: *10.01.2020 to 12.31.2020*
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.

3. For modeling, PI Tan and graduate student Zhuang Liu used the mean-field model to analyze the measured avalanche data.

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: Steel fiber reinforced concrete avalanche measurements	7/01/2020	10/30/2020	100
Task 1: Basalt fiber reinforced concrete avalanche measurements	09/01/2020	12/31/2020	50
Overall Project:	Initial Start Date	Planned End Date	

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

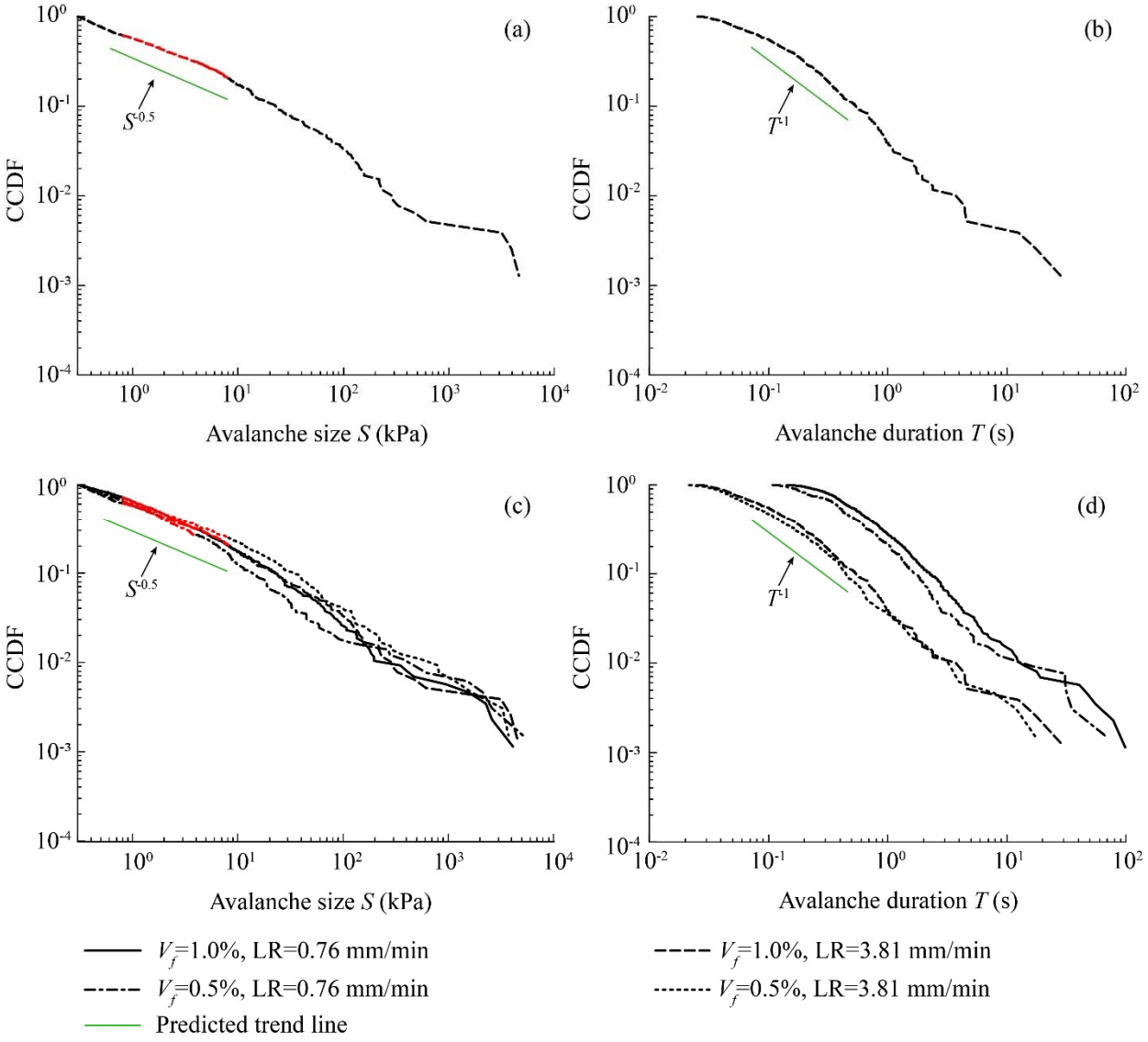

Fig. 1. Complementary cumulative distribution functions (CCDF) of (a) avalanche size and (b) avalanche duration for the group with 1.0% fiber fraction tested at 3.81 mm/min. Overlapped complementary cumulative distribution functions of (c) avalanche size, and (d) avalanche duration. Scaling regimes were highlighted in red.

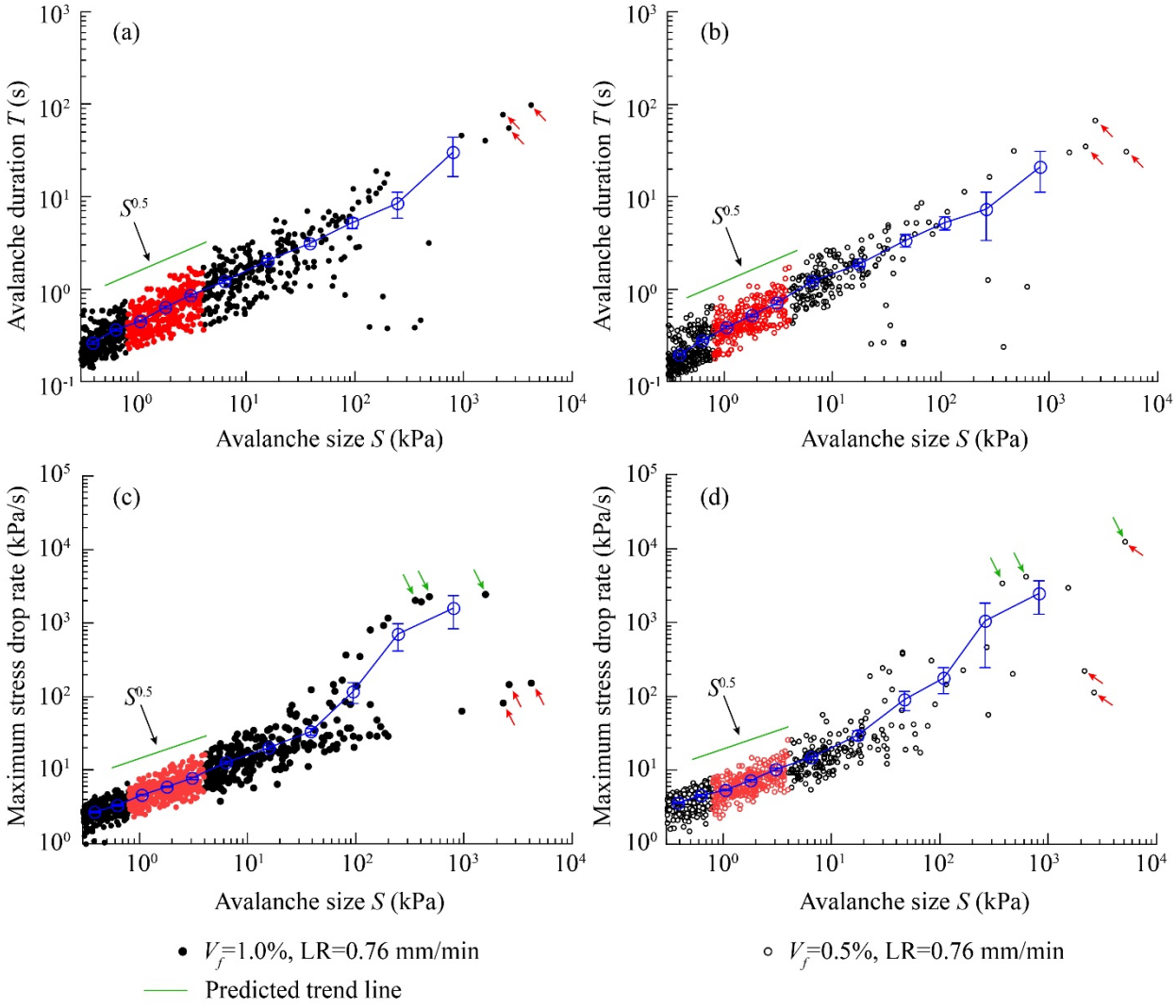

Fig. 2. (a, b) Avalanche sizes versus durations; (c, d) Avalanche sizes versus maximum stress drop rates. Scaling regimes were highlighted in red.

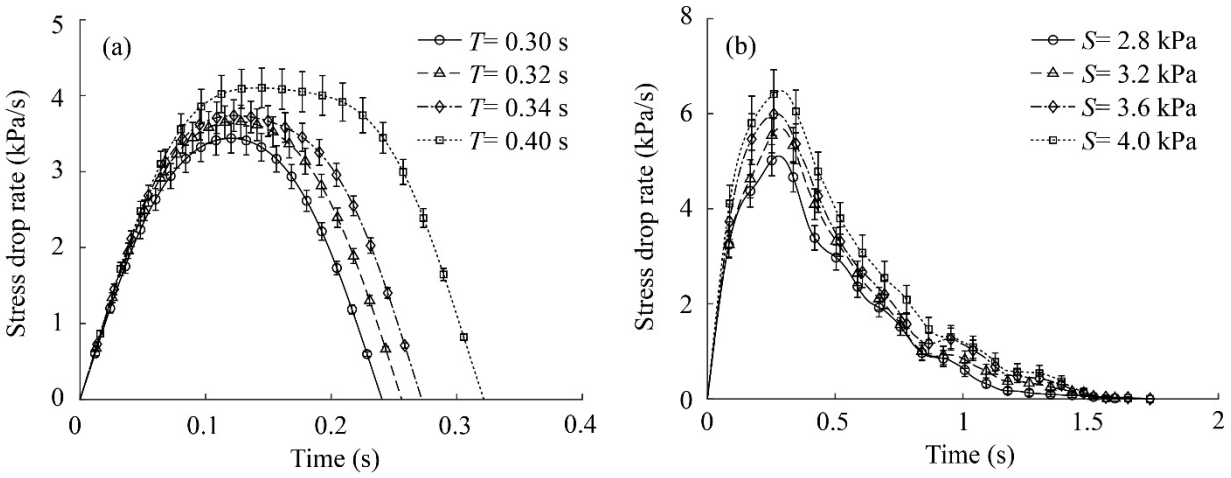

Fig. 6. Unscaled average flexural stress drop rates of small avalanches in the scaling regime, i.e., $\frac{d\sigma_f}{dt}$, from a representative beam with 1.0% fiber fraction tested at 0.76 mm/min (a) different avalanche duration *T*, and (b) different avalanche size *S*.

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.