Curriculum Vitae

Thang Nguyen Dao, Ph.D., M.ASCE

Updated Jan 2021

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Biographical Summary

Dr. Dao is working in a research area at the boundary between various fields of science and engineering including wind and earthquake engineering. In the last five years, he has been the PI and Co-PI of several research projects funded by federal and industrial organizations with **$603.9K external and $339.5K internal funding totals**. His research involves in Performance-based Engineering for Wind and Earthquake, mostly for wood buildings. He has established a Wind Hazard Simulation Testing Laboratory at the University of Alabama, including the design and construction of an Atmospheric Boundary Layer Wind Tunnel, and established a Debris Cannon Lab. He participated in several post-disaster studies in the aftermath of recent major high wind events such as Tuscaloosa - AL tornado in 2011, Moore - OK tornado in 2013, and hurricane Harvey in 2017. In Earthquake Engineering, he is leading a four-year research project funded by National Science Foundation to develop a new hybridized wood structural system for earthquake-prone regions that combines traditional light-frame wood shearwalls with cross laminated timbers. As results of his research projects, he has published **29 articles and 2 book chapters** in scholarly journals and publishers such as *ASCE Journal of Structural Engineering*, *ASCE Journal of Performance of Constructed Facilities*, *ASCE Natural Hazards Review*, *Engineering Structures*, *Wind and Structures*, and others. In addition, he has published and presented **20 peer-reviewed conference papers, 4 technical reports,** and **11 other publications**. In teaching, he has taught **seven different courses in at the University of Alabama** (two undergraduate, two cross-listed, and three graduate courses), including creating a new **graduate course *CE541- Wind and Earthquake Engineering***. His goals in an academic career are to continue working in multi-hazard engineering: primarily wind and earthquake engineering. Specifically, he is providing the technical support, i.e. developing methodologies that enable the built environment to be more resilient and sustainable. Dr. Dao is currently a member of *American Society of Civil Engineering* and serving as a member of two ASCE Technical Committees: *ASCE Design of Wood Structures Committee of the Technical Administrative Committee on Wood* and *SEI Technical Activities Division Multi-hazard Mitigation Committee*. He is also serving as Reliability Analysis Specialist for Reliability Based Design Task Group of American Wood Council.

Professional Preparation

Ph.D., Civil Engineering, Colorado State University, August 2010
M.S., Civil Engineering, Colorado State University, December 2005
B.S., Civil Engineering, Hanoi Architectural University, August 1999

Appointments

Associate Professor, the University of Alabama (Aug 2019 – Present)
Assistant Professor, the University of Alabama (Aug 2012 – Aug 2019)
Postdoctoral Scholar, the University of Alabama (Aug 2010 – July 2012)
Graduate Research Assistant, Colorado State University (Jan 2007-Aug 2010), Ph.D.
Teaching Assistantship, Colorado State University (Aug 2006 – Dec 2006), Ph.D.
Vietnamese Overseas Education Scholarship (2004-2005), M.S. student
Structural Design Engineer, Hanoi Architectural University, Consulting Office (September 1999 – December 2003; January 2006 – July 2006)

Professional Interests

Performance-Based Engineering
Structural Reliability
Earthquake/Wind Loading
Multi-Hazard Mitigation
Structural Damage Models
Light-Frame Wood Structures
Structural Dynamics
Finite Element Methods/Numerical Model
Structural Resiliency and Sustainability.

Memberships/Awards

- First Price, Crimson Startup, The University of Alabama, Spring 2020.
- Alabama Power Innovation Award in Engineering, The University of Alabama undergraduate Research and Creative Activity Conference, April 2018, University of Alabama.
- Member of ASCE Design of Wood Structures Committee (2017 – Present).
- Member of ASCE Multi-Hazard Mitigation Committee (2016 – Present).
- Member of American Society of Civil Engineering (2016 – Present).
- Gold and Bronze Medals, US – Japan wood truss contest (2009).

Courses taught at The University of Alabama

Fall 2019, 2020 – CE 436/536: Wood Structure Design
The purpose of this course is to introduce students to the design of wood structures and update on wood research. The course will lead student through the complete design of a wood structure

and recent wood research by putting together examples of practical building design using current codes and standards and recent wood research.

Spring 2013 – CE 591: Wind Engineering and Wind Effects on Structures
This research-oriented class is motivated by the need to provide a rational description of the phenomena involved and to develop appropriate analytical and design tools for structural engineering. The course attempts to present a synthesis of the main trends of specialized literature in Wind Engineering.

Fall 2013, 2014, 2016, and 2017 – CE 331: Introduction to Structural Engineering
This class gives an introduction and principles of structural analysis of determinate and indeterminate structures. Students will learn to analyze the response of typical civil engineering structures to gravity and sideways loads, including the loads on a component (e.g. truss, beam or column) of a typical civil structure. Students will also learn how to estimate the internal forces and deflections of the component due to combined dead loads, movable live loads and sideways loads as specified in typical building codes, interpret the analysis results and determine if the component meets code-specified strength and serviceability requirements.

Spring 2014, 2015, 2016, 2017, 2018, 2019, 2020, and 2021 – CE 432/532: Matrix Structural Analysis
The objective of this class is to develop an understanding of the basic principles of the matrix methods of structural analysis, so that they can be efficiently implemented on modern computers. Focusing on the stiffness approach, this class covers the linear analysis of two- and three-dimensional framed structures in static equilibrium. This class also helps students develop their skills in programing structural analysis software using Matlab.

Fall 2015, 2018, and Spring 2021 – CE 632: Structural Reliability
Despite what we often think, the parameters of the loading and the load-carrying capacities of structural members are not deterministic quantities (which are perfectly known). They are random variables, and thus absolute safety (or zero probability of failure) cannot be achieved. Consequently, structures must be designed to serve their function with a finite probability of failure. The knowledge taught in this course is to provide the background needed to understand how reliability-based design (including LRFD, Load and Resistance Factor Design) criteria were developed and to provide a basic tool for structural engineers interested in applying this reliability-based design criteria to other situations.

Spring 2016 – CE 541: Wind and Earthquake Engineering (created new at U.A.)
The goal of the course is to prepare future practicing structural engineers and researchers to understand typical lateral loads on Civil Engineering structures and to analyze the structural response to those loads. This research-oriented course focuses on Wind and Earthquake engineering theories and their applications in load estimation and structural design. In this course, students will learn the basic concepts of Wind and Earthquake engineering and how to analyze structural response to Wind and Earthquake loads. Some special techniques used in structural design for Wind and Earthquake loading are also included.

Spring 2017, 2018, 2019, and 2020 – AEM 250: Mechanics of Materials

In this course, students will learn how to extend equilibrium analysis to deformable bodies, specifically to various members that make up structures and machines. Student will learn to apply the three fundamental concepts of solid mechanics: (1) Equilibrium, (2) Force-Temperature deformation behavior of materials, and (3) Geometry of deformation. The course also helps students to learn how the external forces applied on a body are distributed throughout the body, and whether the body will fail under the action of the applied forces (the topic of stress); how the body will deform under the action of the applied external forces and temperature changes (the topic of strain); what material properties affect the way that body responds to the applied forces and temperature changes and other important solid mechanics topics.

Graduate Students:

Student	Degree	Role	Program	Period
Michael Wendlandt	M.S.	Advisor	CE	01/2013 – 12/2013 (Completed)
Tu Trung Nguyen	Ph.D.	Advisor	CE	08/2013 – 12/2017 (Completed) Currently Postdoc. at Marshall University
Tu Xuan Ho	Ph.D.	Advisor	CE	08/2014 – 08/2019 (completed) Currently Postdoc. at Oregon State University
Ahmed Eldeeb	M.S.	Advisor	CE	08/2017 – 12/2018 (Completed)
Farhan Ahmed Chowdhury	Ph.D.	Advisor	CE	02/2020 - Present
Taelor Wallace	M.S.	Advisor	CE	1/2021 – 5/2021

Undergraduate Research Students:

Student	Degree	Role	Program	Period
Justin Ahalt	BS	Advisor	CE	1/2015 – 5/2015
Evan Brannon	BS	Advisor	CE	1/2016 – 5/2016
Wilson Haworth	BS	Advisor	CE	8/2016 – 5/2018
Eric Mueller	BS	Advisor	CE, REU student	5/2017 – 7/2017
Blythe Johnston	BS	Advisor	CE	8/2017 – 5/2019
Joshua Hunt	BS	Advisor	CE, Honors College	8/2017 – 5/2020

Supervised Postdoctoral Trainees and Visiting Scholars:

Student	Role	Description	Period
Tu Trung Nguyen	Supervisor	Postdoc	1/2018 – 7/2018
Jing Zang	Supervisor	Visiting Scholar	3/2016 – 2/2017
Hu Hui	Supervisor	Visiting Scholar	1/2016 – 12/2016

Service as Dissertation/Thesis Committee Member:

Student	Degree	Program	Completion/Expected	Role
M. Omar Amini	MS	CE	08/2012	Committee member
Shane Crawford	M.S.	CE	8/2014	Committee member
Alireza Kashani	Ph.D.	Constr. Eng.	12/2014	Committee member
Nguyen Duong	Ph.D.	Math	05/2015	Committee member
Saeid Hayati	Ph.D.	CE	12/2017	Committee member
Tu Trung Nguyen	Ph.D.	CE	12/2017	Committee chair
Shane Crawford	Ph.D.	CE	08/2018	Committee member
Blair Butler	MS	CE	12/2018	Committee member
Tu Xuan Ho	Ph.D.	CE	12/2018	Committee chair
Md Korbir Hossain	Ph.D.	CE	05/2019	Committee member
Wilson Haworth	M.S.	CE	05/2019	Committee chair
Farhan Ahmed Chowdhury	Ph.D.	CE	08/2021	Committee chair
Wei Pan	M.S.	CE	12/2020	Committee member
Amruthkiran Hegde	Ph.D.	AE	5/2022	Committee member

Service as Other Committee Members:

Committee	Organization	Role	Period
Graduate Recruitment Committee	Department of Civil, Construction, and Environmental Engineering – University of Alabama	Committee member	08/2012 – 07/2014
FE Exam Preparation Committee	Department of Civil, Construction, and Environmental Engineering – University of Alabama	Committee member	01/2017 - Present
Wind Driven Rain Committee	American Society of Civil Engineering	Committee member	04/2011-03/2016
Design of Wood Structures Committee	American Society of Civil Engineering	Committee member	01/2017 - Present
SEI Technical Activities Division Multi-Hazard Mitigation Committee	American Society of Civil Engineering	Committee member	1/2016 - Present
Reliability Based Design Task Group	American Wood Council	Committee member	11/2020 - Present
Research Grants Committee	The University of Alabama	Committee member	Fall 2021 – Fall 2022

Research Experience

Externally funded Projects:

1) **NSF Award #1903486: RAPID: Assessing the Performance of Elevated Wood Buildings, including Manufactured Housing, in Florida during 2018 Hurricane Michael ($44,615.00; Co-PI, 27%, December 1, 2018 - November 30, 2019)**

This Grant for Rapid Response Research (RAPID) will investigate the wind performance of elevated site-built and manufactured housing during Hurricane Michael, which made landfall in Florida on October 10, 2018, just a few miles per hour (mph) below a Category 5 hurricane. This hurricane was the strongest to hit the continental United States since Hurricane Andrew in 1992. The observed impact of Hurricane Michael presents a unique and important opportunity to investigate the wind performance of elevated site-built and manufactured housing, given that recorded wind speeds reached and exceeded design winds at the coast and further inland. Florida has one of the largest inventories in the United States of manufactured housing, the most vulnerable residential structure to hurricanes, which also often houses the most socially vulnerable households. While damage to manufactured housing has been widely noticed following major hurricane events, this type of structure has received minimal research attention. Manufactured housing is a subset of elevated housing, where elevated site-built homes are also very common in the areas impacted by Hurricane Michael. The influence that the elevation height, stilt distribution, and foundation type have on wind loading and damage experienced by elevated site-built and manufactured housing structures is presently unknown. This project will investigate these fundamental knowledge gaps through ephemeral data collection of the performance of elevated housing following Hurricane Michael. Damage to housing is often responsible for half of the disaster losses following major hurricane events notwithstanding the widespread disruption it causes through household dislocation. Findings from this study will be shared with national and state-level codes and standards committees to improve the resilience of common, but understudied, residential buildings, in order to promote continuity in national welfare and prosperity following a hurricane event. Data collected through this grant will be shared on the NHERI Data Depot and Reconnaissance Portal (https://www.DesignSafe-ci.org) for broad use by the engineering community.

The Hurricane Michael wind field had a wide range of inland wind speeds, and thus presents the opportunity for on-site damage investigation of different types of residential building structures, including elevated site-built and manufactured homes. Current codes and standards do not account for the air flow that occurs underneath elevated residential buildings. Preliminary research has shown that different elevations could amplify the wind pressures measured on the wall and roof surfaces, suggesting unconservatism in current code-based design approaches. This RAPID award will assess damage to a range of elevated and non-elevated homes, and make comparisons based on elevation height, stilt distribution, and foundation type in areas that experienced design-level and higher wind speeds during Hurricane Michael. Furthermore, manufactured homes in the Hurricane Michael impacted areas are designed for either Zone II (100 mph) or Zone III (110 mph) peak wind speeds, as well as for 75 mph sustained wind for transportation on highway/interstate purposes. Most wind loads used in design currently consider three-second gust wind speed, which is an instant wind load that assumes structural component and material behaviors stay in the linear range during an extreme wind event. Examining damage to manufactured housing at the sites where wind speeds were sustained at 75 mph or less will advance missing knowledge on whether failures are initiated by fatigue, caused by sustained wind loads, and progress into catastrophic failure of the unit. This gained knowledge will direct future research foci for manufactured housing studies to have better damage mitigation plans for both retrofit (old) and design (new) of manufactured homes. The reconnaissance team will enter areas in Florida affected by Hurricane Michael and collect on-site data, including images of damage and building information, for analyses and advancement of fundamental knowledge on elevated site-built and manufacturing housing.

2) **Alabama Power Innovation Award in Engineering for Undergraduate Research: Pressure Changes in Homes During the Failure of Garage Doors in High Wind Events. ($5,000.00, PI, 100%, 09/15/2018 – 08/31/2019).**

Abstract:

Limitations on wind load analysis have resulted in a limited understanding of building performance due to extreme wind events. Performance-based wind engineering needs to consider the non-linear interactions between wind and structures in extreme wind events, including the change in wind load under the change of building conditions. This project aims to study the effects of sudden failure of building envelope, doors, or windows to the internal pressure in residential buildings. By observing the effects of high wind loads causing component failure on a building prototype, inductions can be extrapolated to the full-scale model and provide the insight necessary to consider the non-linear interactions of wind and building components. Using AutoCAD and 3D printing, a realistic prototype can be printed and installed in a wind-tunnel for testing. Pressure taps monitor the changes in internal and external pressure, and a simulated garage door provides the point of failure for study. This allows for structure component failure under high wind pressures to be studied and the changes in pressures to be analyzed.

3) **NSF Award #1537788: Enabling Next Generation Hybridized Wood Buildings for Resilient and Sustainable Construction ($418,054.00, PI, 50%, 10/1/2015 – 9/30/2019; and material donation of $11,500.00 retail price total, 100%, for this project).**

Abstract:

Earthquake damage to buildings, with the potential for substantial economic losses, highlights a need to focus on developing earthquake resilient and sustainable buildings. As the result of rapid population growth and urban densification, there is a need for taller buildings that are also sustainable and can perform better than simply adequate in moderate to large earthquakes by sustaining only minimal damage. Further, it is critical that such buildings have minimal interruption to allow people to remain in their residences and community following an earthquake event. These types of buildings will be investigated in this project by considering a new type of seismic force resisting system that combines a new technology known as Cross-Laminated Timber (CLT) and a conventional Light Wood Frame System (LiFS). Each of these systems has its own beneficial features that, when combined, will create a more resilient and sustainable structural system for buildings in seismic zones in the United States. This research will address the challenges that arise when combining these two structural systems into a hybridized wood building system. This project will contribute toward a fundamental understanding of long-term loading effects on CLT and develop an optimal combination of CLT and LiFS to produce a financially viable solution for the seismic design of tall wood buildings. The research will produce new basic knowledge needed to design safer, more resilient wood buildings in seismic regions and thus contribute to seismic hazard mitigation in the United States and in other countries that use similar construction.

This research will investigate the seismic performance and optimization of a hybridized, self-centering wood system termed "CLT-LiFS," which uses unbonded post-tensioning tendons, CLT rocking walls, and light-frame wood walls to enable the design of resilient tall wood buildings. In this system, the CLT panel anchored with unbonded post-tensioning will be optimally combined with the light wood frame system to utilize the beneficial features of each. While the unbonded post-tensioning in the CLT will self-center the system, the connections in the light-frame wood will provide the necessary energy dissipation. Preliminary studies on CLT-LiFS have shown its excellent seismic performance with minimal structural damage, but key research challenges focused on its compatibility remain. In order to make this system a reality, optimal configurations of CLT-LiFS systems, performance of connection details between the CLT and the light-frame wood, and long-term behavior of CLT under sustained loading need to be better understood. The fundamental contributions of this research will be the following: 1) experimentally validated analytical models for the creep behavior of CLT under different environmental conditions, and its inclusion into analytical models for tall wood buildings, 2) the use of reliability concepts for performance assessment of the hybrid system, 3) experimental quantification of secondary systems impact on the behavior of tall buildings with CLT-LiFS systems, and 4) development of connections between the CLT-LiFS system and secondary systems. This research will lead to a fundamental understanding of how the hybridized system performs under earthquake loading compared to each of the individual systems, thereby serving as the foundation to develop the seismic design methodology and procedures to meet pre-specified resiliency and sustainability building requirements for this new building type. This research will facilitate a new generation of improved performance-based building systems to achieve resiliency and sustainability goals.

4) **NSF Award #1362045: Planning Grant: I/UCRC for Windstorm Hazard Mitigation ($11,500.00; Co-PI, 33%, April 15, 2014 - March 31, 2015):**

Abstract:

The planned I/UCRC for Windstorm Hazard Mitigation intends to undertake functions at the interface between basic and applied research and between private and public interests. Working with its members, the Center will focus on seeking solutions to real world problems encountered by industry members and improve their performance and competitiveness; enhancing government agencies and NGOs capabilities to prepare for and respond to future windstorms; transferring findings from federally sponsored research to products and intellectual properties that benefit researchers, university, and industry; and facilitating collaboration between Center members by developing long-term strategies for enhancing community resiliency to wind and other hazards.

The planned center aims to protect homeowners, businesses, and communities through collaborative research in windstorm mitigation and the implementation of innovations will enhance the Nation's resiliency to future disasters. Integrated in the project are several initiatives aimed at increasing diversity and collectively they contribute to the development of a more diverse workforce and business environment. Meanwhile, the planning activities provide a unique opportunity for students to interact with the industry, improve their communication skills, and enhance their employment potentials. The project helps develop students with strong problem solving, marketable capabilities. The project also helps train Center faculty on how to work with the industry.

5) **NSF Award #1345311: RAPID: Engineering Damage Assessment in the Aftermath of the 2013 Moore, Oklahoma Tornado ($19,791.00; Co-PI, 33%, 07/15/2013 – 06/30/2014):**

Abstract:

This Rapid Research Grant (RAPID) provides funding to collect structural damage data that was caused by the EF 5 tornado in the city of Moore, Oklahoma on May 20, 2013. The damage path of this tornado overlaps the damage paths of two previous tornadoes of 1999 and 2003. It would be interesting to see how the houses reconstructed after the previous tornadoes perform in this tornado. Even though there are close to 1,000 tornadoes recorded each year, typically less than 10 tornadoes are rated EF 4 and EF 5. When an EF 5 tornado impacts a city there is a unique opportunity to document and learn from the building damage. This tornado damaged two schools, dozens of commercial buildings, and over one thousand residential structures. RAPID funding provides an opportunity to document the structural damage before cleanup efforts remove the debris.

The project team worked with other RAPID grantee teams in the field to improve coverage of the damage area and avoid duplication. The team of faculty members and students will travel to the damage site and document failure modes, materials of construction, location of structures with respect to the center of the path, and debris impacts for each documented structure. Social media (twitter) will be used to obtain photos and comments made by citizens. The mining of the social media will enhance damage documentation at specific locations. The RAPID team will develop contour maps of EF ratings and wind speeds based on observed Degrees of Damage. These maps will be compared with past tornado studies to evaluate the similarities and differences. This comparison will contribute to the understanding of the spatial characteristics of tornado wind

forces on structures. Building failure progression will be determined in different wind speed zones. The benefits and challenges of using social media to improve disaster assessment will be determined.

6) **Vietnamese International Education Development: Initial Study of new Hybrid Wood Construction of CLT and Light-Frame Wood Shearwalls ($54,000.00; PI, 100%; 08/15/2013 – 08/14/2015).**

Abstract:

CLT-LiFS is an innovative hybrid structural system. This type of structure has emerged as a promising structural system for mid-rise to tall wood buildings in the seismic areas. CLT - LiFS is made by integrating post-tensioned Cross Laminated Timber (CLT) panels with Light-Frame Wood Systems (LiFS). The post-tensioned CLT panels can provide excellent load bearing and self-centering capacity. And the LiFS can dissipate a large amount of energy through the slip of fasteners when it deforms. The behaviors of CLT-LiFS have been studied through a series of experimental tests under cyclic loading protocols and earthquake motions at different hazard levels using real-time hybrid simulations. Results from the experimental tests showed that the CLT-LiFS performed well under MCE (Maximum Considered Earthquake) hazard and showed a promising alternative construction option for wood buildings.

7) **NSF Award #1160097: US-Vietnam Workshop on Multiple Natural Hazards Assessment and Mitigation under the Impact of Climate Change ($39,450.00; Co-PI, Travel expenses for the workshop and follow-up trips, 05/15/2012 – 04/30/2014):**

Abstract:

This project supported the US scientists and engineers to participate in a workshop on multiple natural hazards assessment and mitigation under the impact of climate change. This workshop was held in the summer of 2012, on the campus of the Hanoi Architecture University (HAU) in Hanoi, Vietnam.

Asia is the most populous region of the world; home to 58% of the worlds' population. Most coastal areas in Asia are susceptible to one or more natural hazards, such as typhoons, tsunamis, costal inundation or river flooding. In fact, more than 50% of the world's major natural disasters occur in Asia. With the steady increase in population and wealth in coastal areas of Asia, there is an evident increase in risk of potential typhoon and flood damage, which is often exacerbated by the lack of proper mitigation practices. In Vietnam, for example, 59% of the land area is at risk to typhoons and floods. Between 1990 and 2009, economic losses due to natural hazards averaged about 1.31% of GDP per year, while 13,000 lives were lost. As a result, Vietnam ranks #5 among the countries most affected by climate risk from 1990 to 2009. In the coming years, global climate change may result in changes in the sea surface level as well as an increase in typhoon and flood intensity and/or frequency. Vietnam is listed among five hardest-hit countries by climate change. If sea level rises one meter, 5% of Vietnam’s land, 11% of its population and 7% of its agricultural land would be affected with the losses estimated at 10% of GDP. How climate change will affect regional climates and the built environment and sustainability is not well known, limiting the ability to predict and adapt to consequential effects. Southeast Asia is particularly vulnerable.

The goal of the workshop is to facilitate the initiation of long-term collaborative research activities focused on hazard mitigation and graduate education supported by both the US and Vietnam. The workshop will provide a venue for exchange of information, contribute to developing professional collaborative relationships, and will strengthen scientific and engineering research. The objectives are 1) to identify challenges and barriers to more cost-effective hazard mitigation strategies in developing countries, which are at risk of multiple natural hazards and vulnerable to potential impacts from climate change; and 2) to facilitate and encourage research and educational collaboration between researchers from Vietnam and the US. The workshop will address a need to improve our understanding and ability to predict and respond to the impacts of natural hazards and climate change on the built environment, and to work toward more sustainable and resilient coastal communities in Vietnam and similar regions. It is envisioned that through the future collaborations fundamental methods for multi-hazard mitigation practices will be developed and applied by graduate students from both countries working together.

Internally Funded Projects:

8) **Insurance Institute, University of Alabama Award: Debris Cannon Testing System. ($339,500.00, PI, 09/01/2016-08/30/2017).**

Abstract:

In the last few years, several research centers have conducted a number of testing programs on windborne debris impact like Florida State University, The University of Florida, and Texas-Tech University. In their experimental programs, the missiles used in the tests were 2×4 wood studs with different weights (either 9 lbs. or 15 lbs.). Most of these tests were conducted by shooting 2×4 wood studs into building external envelopes such as walls, roofs, and shelters. The aims of these tests were to develop the new requirements for design to ensure the integrity of the building envelope during an extreme wind event. As the results of these studies, several national and regional building codes have adopted the missile impact testing procedure for specification of minimum debris resistance acceptance criteria of the external envelope for buildings (ASCE-7 2002, SBC 200, FBC 2001).

With the new facility in Large Scale Structural Lab in the department of Civil, Construction, and Environmental Engineering at the University of Alabama, it is possible to extend the research program on the effects of windborne debris impact. In this new Large Scale Structural Lab, a hybrid testing system allows us to simulate the building response under a lateral dynamic loading. This will allow us to study the building envelope successive failures by shooting debris into building envelopes (which are parts of the building being tested) while the building is being loaded with simulated wind force applied through the hybrid testing system. To do this, a new pneumatic debris cannon needs to be built and serval other components of the testing systems need to be purchased. This new debris testing system should have the capacity of shooting a pack of debris with the weight ranging from 15 lbs to 20 lbs with a muzzle speed ranging from 35

mph to 120 mph; this debris speed is designed to represent tornado wind speeds up to 250 to 300 mph. The results from this research extension will allow us to calibrate the performance-based wind engineering design procedures which is being under the development in the past few years. The performance-based wind engineering allows us to design for new or retrofitted buildings subjected to high wind events to mitigate the losses due to damage of structural and non-structural components.

Ph.D./Postdoctoral Research Projects:

9) **The Prescient Companies (TPC) Unified Truss Construction System (UTCS) – Testing and Modeling (Co-PI, Supported by TPC for Postdoctoral research, 2 years)**

Abstract:

Light-gauge cold-formed steel (CFS) is being used more and more as an economical yet high performing construction material. This report examines the performance of an innovative light-gauge cold-formed steel system called the uniform truss construction system (UTCS), which includes floor trusses, open panels, V-braced panels, columns, and connections between components. The performance of the system to earthquake and wind load is investigated separately. The floor trusses carry dead load and live load from the floor and transfer these loads to open panels and V-braced panels. The open panels and V-braced panels transfer the load from floor trusses to columns. A series of reversed-cyclic tests of sub-assembly structures (V-braced panels) were conducted to provide the key information needed to numerically model the performance of the system under cyclic loading. The test data was then integrated into a numerical model for non-linear time history analysis. Non-linear time history analysis of the UTCS subjected to earthquake ground motion was conducted using a suite of 22 prominent earthquakes recorded from around the world. The results show that the UTCS performs very well compared with the ASCE Standard 41 required performance criteria at the system level. The system was shown to also perform very well when subjected to wind loads in excess of the ASCE7-10 (2010) wind loads. Based on the phase I testing and analysis, it was concluded by the research team that the UTCS developed by Prescient is a viable system all regions including high wind and high seismic areas. Additional research is suggested to develop an R-factor per FEMA P-695.

10) **Doctoral Dissertation: The Development of Performance-based Wind Engineering for Residential Structures – From Concept to Application (4 years).**

Abstract:

The majority of buildings and approximately 90% of residential structures in North America are light-frame wood construction. Many of these structures are subjected to high winds along the eastern seaboard and Gulf Coast and as a result routinely suffer damage resulting in significant financial losses. Losses for residential wood construction during hurricanes occur for a variety of reasons, i.e. from different sources. These include sources such as (a) the failure of structure due to high wind loading; (b) water intrusion as a result of high uplift pressures on the roof system resulting in gaps or as a result of a loss of roof coverings and/or roof sheathing panels; and (c) debris impact from windborne debris. A relatively new paradigm in earthquake engineering is

performance-based design (PBD). PBD is, by and large, felt by most to be a system-level philosophy that allows inclusion of system level behavior including the improvement in performance as a result of this assertion. However, in wind engineering most failures are understood to be at the component and sub-assembly level. This study outlines and demonstrates the development of performance-based wind engineering for residential structures based on losses to the owner. To date, this is the first time a mechanistic model has been used to develop fragilities for performance expectations related to all levels of performance: occupant comfort, continued occupancy, life safety, structural integrity, and manageable loss.

Refereed Journal Publications

Published or In Press

At UA:

1) Hossain, K., Aaleti, S., Dao, T.N. (2021) "Experimental Investigation and Finite-Element Modeling of an Aluminum Energy Dissipater for Cross-Laminated Timber Walls under Reverse Cyclic Loading", *ASCE Journal of Structural Engineering*, 2021, 147 (4): 04021025.

2) Anandan, Y.K., van de Lindt, J.W., Amini, O.M., Dao, T.N., Aaleti, S. (2021) "Experimental Dynamic Testing of Full-Scale Light-Frame-CLT Wood Shear Wall System", *ASCE Journal of Architectural Engineering*, 2021, 27 (1): 04020042.

3) Kim, J.H., Moravej M., Sutley, E.J., Chowdhury, A., Dao, T.N. (2020) "Observations and Analysis of Wind Pressures on the Floor Underside of Elevated Buildings", *Engineering Structures;* 221 (2020): 111101.

4) Sutley, E.J., Vazquez, K., Kim, J.H., Dao, T.N., Johnston, B., and Hunt, J. (2020) "Performance of Manufactured Housing during Hurricanes Irma and Michael", *ASCE Journal of Performance of Constructed Facilities*, 2020, 34(4): 04020078.

5) Dao, T.N. and Ho, T.X. (2020). "Nonlinear Numerical Model of Elastic Post-tensioned Rocking Panels for Application in Building Structural Analysis"; *ASCE Journal of Structural Engineering*, 2020, 146 (2): 04019202.

6) Nguyen, T.T., Dao, T.N., Aaleti, S., Hossain, K., Fridley, K.J. (2019). "Numerical Model for Creep Behavior of Axially Loaded CLT Panels", *ASCE Journal of Structural Engineering*, 2019, 145 (1): 04018224.

7) Nguyen, T.T, Dao, T.N., Aaleti, S., van de Lindt, J.W., Fridley, K.J. (2018). "Seismic Assessment of a Three-story Wood Building with an Integrated CLT-Lightframe System using RTHS". *Engineering Structures*, 167 (2018), p 695-704.

8) Dao, T.N., van de Lindt, J.W., Ho, T.X. (2017). "New Nonlinear Lateral-Vertical Coupled Shear Element Model for Use in Finite Element Structural Analysis Applications". *Engineering Structures;* 140 (2017), p 98-109.

9) Gromala, D.S., Line, P., Murphy, J.F., Dao, T.N. (2017). "Historical Approach Making a Comeback: Closed Form Equations to Determine LRFD Reliability Indices (β) and Resistance Factors (φ)". *Wood Design Focus – A Journal of Contemporary Wood Engineering*, Volume 27, No 1 (Spring 2017), p 28-33.

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