Abiy F. Melaku

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AREAS OF EXPERTISE

- Computational wind load evaluation on buildings using CFD
- Structural analysis
- Scientific computing with C++ and CUDA
- Modeling, simulation, and analysis of random fields

EDUCATION

May. 2016 - Present | PhD Candidate in Civil Engineering and Scientific Computing, Western University (UWO), Canada
Dissertation topic: *A computational framework for unsteady aerodynamic and aeroelastic modeling of tall buildings under wind*
Advisor: Professor Girma Bitsuamlak (Western University)

Feb. 2014 - Feb. 2016 | MASc in Computational Structural Engineering, Chungbuk National University, South Korea
Thesis topic: *Fatigue assessment of intermittent fillet weld for vertical web stiffener of steel box girder bridge*
Advisor: Professor Jung Kyoung-Sub

Sep. 2008 - Jun. 2013 | BSc in Civil Engineering with Very Great Distinction, Adama Science and Technology University, Ethiopia
Thesis topic: *Development of Structural Analysis and Design Software(ESADS) for Ethiopian Building Code of Standards(EBCS)*
Advisors: Dr. Beka Hailu and Eng. Ayele Zewdu

WORK EXPERIENCE

Sept. 2017 - Dec. 2017 | Research Intern
Company: FM Global Research, Norwood, Massachusetts, USA
Supervisor: Dr. Lakshmana Doddipatla
Project title[1]: *Enhancing OpenFOAM's wind engineering modeling capability*

Sept. 2019 - Dec. 2019 | Research Intern
Company: FM Global Research, Norwood, Massachusetts, USA
Supervisor: Dr. Lakshmana Doddipatla
Project title[2]: *Large-eddy simulation of wind loads on roof-top equipment mounted on low-rise building*

July. 2014 - Feb. 2016 | Construction Engineer (*Part time*)
Industry project: *Operating on CAD, testing construction materials, conduct regular safety inspection in construction site.*
Company: Daelim Industrial Co. Ltd, Namyangju, South Korea

[1] This project involves a C++ implementation of a ground surface and inflow boundary conditions in OpenFOAM that are particularly important for simulating wind loads on low-rise buildings using CFD.
[2] I did a parametric study changing the elevation and location of the roof-top equipment on the roof. The final result from the CFD were validated with experimental data.

RESEARCH EXPERIENCE

May. 2016 - Present

Graduate Research Assistant, Western University, Canada

Advisor: Professor Girma Bitsuamlak

Projects at Boundary Layer Wind Tunnel Laboratory (BLWTL) and WindEEE Dome[4]:

Research project 1: *Simulation and measurment of a scaled ABL flow characterstics in the wind tunnel*

Research project 2: *Aerodynamic wind tunnel tests of the CAARC building*

Research project 3: *Probabilistic serviceability performance assessment of tall mass-timber buildings subjected to stochastic wind loads*

Research project 4: *Large-eddy simulation of wind loads on a tall building located in a city center*

Research project 4: *Large-eddy simulation of wind loads on a tall building located in a city center and validation with experimental data*

[3] Wind tunnel facilities that are capable of testing tall buildings under turbulent wind loads and Wind Engineering program are not available at the University of British Columbia (both Vancouver and Okanagan campuses). Hence, the school of graduate studies at UBC granted me a residency waiver to conduct the wind tunnel tests and complete part of my PhD studies at Western University, Canada.

[4] All of the listed research projects are part of my PhD study. In the research projects, I prepared the wind tunnel test plans, designed aerodynamic and aeroelastic models, instrumented and calibrated pressure scanners, accelerometers, and load-cells, conducted the wind tunnel tests, post-processed the wind tunnel tests data, and prepared MATLAB scripts to perform structural reliability analysis of wind-excited tall mass-timber buildings by orchestrating the frequency-domain linear-modal structural analysis, uncertainty modeling, and Monte-Carlo simulation. To the best of my knowledge, the reported results from these research projects in the form of journal and conference publications were not reported before by others and could be considered significant.

[5] In collaboration with Moses Structural Engineers, this research project aimed to understand the essential seismic response characteristics of Cross Laminated Timber (CLT) wall systems, the effects of aspect ratio, and gravity loading in mass-timber buildings. For this purpose, I developed the OpenSees finite element (FE) models of typical sub-assemblies of a mass-timber buildings. The numerical modeling and validation were carried out for bracket and hold-down connectors, 1-storey CLT shear wall with bracket connections, 1-storey coupled CLT shear walls with bracket connections, and a 2-storey platform type CLT wall with bracket and hold-down connections. Experimental test results obtained from FPInnovations were used to validate the numerical models. The calibrated shear wall and connection models were used to study the seismic responses 3-, 6-, 8-, and 12-storey mass-timber buildings using static pushover and nonlinear time history analysis methods.

[6] In this research project, I conducted the wind tunnel tests of 10-, 15-, 20-, 30, and 40-storey mass-timber buildings at BLWTL, Western University. Using a time-domain analysis approach, I quantified the structural responses of the studied buildings and assessed their serviceability performance. Moreover, I helped to develop and debug the OpenSees FE program to quantify the seismic collapse risk of a 10-story hybrid mass-timber building.

[7] In this project, in parallel to my PhD studies, I performed probabilistic seismic hazard assessment for the city of Vancouver and developed ground motion catalogue for FPInnovations. The developed ground motion records are helping the scientist at FPInnovations to design timber buildings.

[8] In this research project, I conducted static pushover and incremental dynamic analysis (IDA) to develop overstrength and ductility-related force reduction factors for hybrid timber-steel buildings using the collapse risk assessment approach outlined in FEMA P695.

[9] In this project, I was responsible for conducting the wind climate analysis for the city of Toronto. The directional wind speeds for various return periods were estimated using the BLUE extreme value analysis approach using the historical wind data collected at Billy Bishop and Pearson International Airports between 1975 and 2020.

[10] As part of enhancing resilient reconstruction in Dominica, in this project, the design check of one, two, and three bedrooms reinforced concrete houses was conducted. I was responsible for developing finite element models of the houses and quantifying structural demands when the houses are subjected to Category-5 hurricanes and extreme subduction type earthquakes.

SCHOLARSHIPS AND AWARDS

May. 2016 - May. 2020	Ontario Trillium Scholarship[2] Amount: $40,000/year
Mar. 2012	ASTU Certificate of Academic Excellence Adama Science and Technology University, Adama, Ethiopia
Mar. 2010	AU Annual High Scoring Students' Award, Adama Science and Technology University, Adama, Ethiopia

REFEREED JOURNAL PUBLICATIONS

1. **Melaku, A. F.** & Bitsuamlak, G. T. (2021). A divergence-free inflow turbulence generator using spectral representation method for large-eddy simulation of ABL flows. *Journal of Wind Engineering and Industrial Aerodynamics*.
2. **Melaku, A. F.** & Jung, K. S. (2017). Evaluation of welded joints of vertical stiffener to web under fatigue load by hotspot stress method. *International Journal of Steel Structures*.
3. **Melaku, A. F.**, Geleta, T. N. & Jung, K. S. (2015). Application of object-oriented finite element method in structural mechanics. *Journal of the Institute of Construction Technology*.

[2] The Ontario Trillium Scholarships (OTS) program is an important initiative to attract top international students to Ontario,Canada for their PhD studies.

CONFERENCE PUBLICATIONS

1. **Melaku, A. F.**, Doddipatla, L. S., Bitsuamlak & G. T. (2021). Large-eddy Simulation of Wind Loads on a Roof-mounted Cube: A Means to Interpolate Experimental Data In *The 6th American Association for Wind Engineering Workshop*, Clemson University, Clemson, SC, USA.

2. Geleta, T. N., Elshaer, A., **Melaku, A. F.** & Bitsuamlak, G. T. (2018). Computational Wind Load Evaluation of Low-Rise Buildings with Complex Roofs Using LES. In *The 7th International Symposium on Computational Wind Engineering 2018.*, Seoul, Republic of Korea.

3. **Melaku, A. F.**, Bitsuamlak, G. T., Elshaer & A., Aboshosha, H. (2017). Synthetic inflow turbulence generation methods for LES study of tall building aerodynamics. In *The 13th Americas Conference on Wind Engineering (13ACWE)*, Gainesville, Florida, USA.

4. Adamek K., **Melaku, A. F.**, Bitsuamlak, G. T. & Sadeghpour, F. (2017). Wind Safety Assessment During High Rise Building Construction. In *The 13th Americas Conference on Wind Engineering (13ACWE)*, Gainesville, Florida, USA.

TECHNICAL REPORTS

1. **Melaku, A. F.**, Geleta, T. N., Birhane, T. H., & Bitsuamlak, G. T. (2021). Enabling OpenFOAM® for wind load evaluation. Prepared for *FM Globa Research*, Norwood, Massachusetts, USA.

JOURNAL PAPERS UNDER PREPARATION

1. **Melaku, A. F.**, Doddipatla, L. S. & Bitsuamlak, G. T. Large-eddy simulation of wind loads on a rooftop equipment: assessment of the loading mechanism and the effect of equipment location. In preparation for *Journal of Wind Engineering and Industrial Aerodynamics*.

2. **Melaku, A. F.** & Bitsuamlak, G. T. Computationally efficient simulation of multivariate stochastic processes using Nyström approximation. In preparation for *Probabilistic Engineering Mechanics*.

3. **Melaku, A. F.** & Bitsuamlak, G. T. LES based dynamic respose of on tall building . In preparation for *Journal of Wind Engineering and Industrial Aerodynamics*.

[11] Poster presentation and extended abstract can be found from https://ctbuhconference.com/presentations/?paper$_id$ = 203.
[12] Shortlisted for the 2019 CSCE best student paper competition.
[13] Winner of the Young Scientist Award at the 2018 World Conference on Timber Engineering (WCTE 2018).
[14] Tall timber buildings covered in this design guideline are beyond the height limits of the 2015 National Building Code of Canada. This guide is intended to be used by architects, design engineers, construction teams, and urban planners. We were invited by FPInnovations to prepare Chapter 4.3.1 of the guide titled *Analysis and design of tall timber buildings for wind loads*.

CODES

2018 - Present	Divergence-free Spectral Representation (DFSR) Github link: https://github.com/abiyfantaye/DFSR Discription: *Computationally efficient inflow turbulence generation method developed for large-eddy simulation of the atmospheric boundary layer(ABL) flows. The method is developed for LES-based wind load evaluation using OpenFOAM.*
2019 - Present	Pressure Integration Model(PIM) Github link: https://github.com/abiyfantaye/PIM Discription: *A python script that analyses pressure data for buildings and report estimated wind loads and structural response. Compatable with wind tunnel and CFD data.*
2020 - Present	Multi-DOF fluid-structure interaction for tall buildings Discription: *A C++ library to perform fluid-structure interaction using OpenFOAM's unsteady solver and in-house developed multi-degree of freedom(MDOF) structural solver. In addition, the code implements a direct load and displacement transfer mechanism for efficient computation.*

TEACHING EXPERIENCE

Jan. 2018 - Apr. 2018	Graduate Teaching Assistant, Western University Course: Computational Methods for Civil Engineering Course Mentor: Dr. Martha Dagnew
Sep. 2018 - Dec. 2018	Graduate Teaching Assistant, Western University Course: Computational Wind Engineering Course Mentor: Professor Girma Bitsuamlak
Sep. 2017 - Dec. 2017	Graduate Teaching Assistant, Western University Course: Engineering Statics Course Mentor: Dr. Ayman M. El Ansary
Sept. 2013 - Feb. 2014	Graduate Assistant Lecturer, Debre Berhan University, Ethiopia Courses: Engineering Mechanics I

PROFESSIONAL MEMBERSHIP

1. Student member of Canadian Society for Civil Engineering (CSCE) Structures Division
2. Student member of American Society of Civil Engineers (ASCE)
3. Member Graduate Engineering Society (GES) at Western University

[15] This graduate-level course introduces students to the fundamentals of the wind loading process and the design and analysis of tall buildings for wind. The course covers wind climate analysis, bluff-body aerodynamics, quantification of structural responses under wind load, aeroelasticity and the associated instabilities, wind tunnel experimental techniques, and wind load standards in building codes. Under the supervision of Professor Girma Bitsuamlak, I also developed part of the course material.

From Academia

1. Professor Girma Bitsuamlak, Ph.D., P.Eng., F CSCE
   Canada Research Chair in Wind Engineering
   Site-leader for Sharcnet - high performance computing center
   Director (Research) Boundary Layer Wind Tunnel Laboratory
   Director (Research) WindEEE Research Institute
   Civil and Environmental Engineering, Western University
   ACEB Room4478 - London, ON, Canada
   Email: gbitsuam@uwo.ca
   Phone: +1 (519) 661-2111 x 88028
   Website: http://www.eng.uwo.ca/civil/faculty/bitsuamlak_g/index.html

From Industry

1. Lakshmana Doddipatla, Ph.D.
   Lead Research Scientist
   FM Global Research
   Email: lakshmana.doddipatla@fmglobal.com
   Phone: +1 (781) 255-4988
   Website: https://www.researchgate.net/profile/Lakshmana-Doddipatla

2. Zoheb Nasir, Ph.D., P.Eng.
   Wind Engineer
   AIR Worldwide
   Email: Marjan.Popovski@fpinnovations.ca
   Phone: +1 (604) 222-5739