

# Abiy F. Melaku

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## FOCUS AREAS

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- Numerical simulation of atmospheric boundary layer flows
- Wind load evaluation on buildings using CFD
- Scientific computing
- Fluid-structure interaction

## EDUCATION

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May. 2016 - Present	<p>PhD Candidate in Civil Engineering and Scientific Computing, Western University (UWO), Canada</p> <p>Dissertation topic: <i>A computational framework for unsteady aerodynamic and aeroelastic modeling of tall buildings under wind</i></p> <p>Advisor: Professor Girma Bitsuamlak (Western University)</p>
Feb. 2014 - Feb. 2016	<p>MASc in Computational Structural Engineering, Chungbuk National University, South Korea</p> <p>Thesis topic: <i>Fatigue assessment of intermittent fillet weld for vertical web stiffener of steel box girder bridge</i></p> <p>Advisor: Professor Jung Kyoung-Sub</p>
Sep. 2008 - Jun. 2013	<p>BSc in Civil Engineering with Very Great Distinction, Adama Science and Technology University, Ethiopia</p> <p>Final project topic: <i>Development of Structural Analysis and Design Software(ESADS) for Ethiopian Building Code of Standards(EBCS)</i></p> <p>Advisors: Dr. Beka Hailu and Eng. Ayele Zewdu</p>

## RESEARCH EXPERIENCE

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May. 2016 - Present	<p>Graduate Research Assistant, Western University, Canada</p> <p>Advisor: Professor Girma Bitsuamlak</p> <p>Wind tunnel and CFD projects conducted<sup>1</sup></p> <p>Research project 1: <i>Development of a new inflow turbulence generation method for atmospheric boundary layer (ABL) flows and comparison with wind tunnel measurements</i></p> <p>Research project 2<sup>2</sup>: <i>Preparation of aerodynamic database for the CAARC building conducting a wind tunnel test at the Boundary Layer Wind Tunnel Laboratory (BLWTL)</i></p> <p>Research project 3: <i>Predicting the wind-induced response of the CAARC building using large-eddy simulation and dynamic analysis</i></p> <p>Research project 4<sup>3</sup>: <i>Large-eddy simulation of wind loads on a tall building located in a city center</i></p> <p>Research project 5: <i>Development of fluid-structure interaction framework for predicting the aeroelastic response of tall buildings under wind excitation</i></p>
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<sup>1</sup> All of the listed research projects are part of my PhD study. In the research projects, I developed numerical models for wind load simulation and conducted wind tunnel tests for validating the models.

<sup>2</sup> Existing aerodynamic data sets for tall buildings are often not complete enough for validating CFD models. In this project, I conducted a wind tunnel test on the CAARC building and prepared detailed aerodynamic and wind field data for three exposure conditions. This database is finally used to validate the numerical models I developed.

<sup>3</sup> In collaboration with Thornton Tomasetti, this research project aimed to develop a numerical procedure to assess wind induced response of high-rise buildings with 500m radius proximity model. Experimental test results obtained from BLWTL were used to validate the numerical models.

## SCHOLARSHIPS AND AWARDS

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May. 2016 - May. 2020	Ontario Trillium Scholarship <sup>4</sup> 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

## WORK EXPERIENCE

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Sept. 2017 - Dec. 2017	Research Intern Company: FM Global Research, Norwood, Massachusetts, USA Supervisor: Dr. Lakshmana Doddipatla Project title <sup>5</sup> : <i>Enhancing OpenFOAM's wind engineering modeling capability</i>
Sept. 2019 - Dec. 2019	Research Intern Company: FM Global Research, Norwood, Massachusetts, USA Supervisor: Dr. Lakshmana Doddipatla Project title <sup>6</sup> : <i>Large-eddy simulation of wind loads on roof-top equipment mounted on low-rise building</i>
July. 2014 - Feb. 2016	Construction Engineer ( <i>Part time</i> ) Project site: <i>Namyangju-Byeolnae Road Construction Site(555-Gwangjeon-ri, Byeolnae-myeon, Namyangju-si, Gyeonggi-do, South Korea)</i> Company: Daelim Industrial Co. Ltd, Seoul, South Korea

## REFEREED JOURNAL PUBLICATIONS

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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*.

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<sup>4</sup> 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 large-eddy simulation.

<sup>5</sup> I did a parametric study of the variation of wind loads on roof-top equipment depending on its elevation and location on the roof. The final results from the CFD simulations were properly validated against wind tunnel measurements and included in the Company's aerodynamic database.

<sup>6</sup> The Ontario Trillium Scholarships (OTS) program is an important initiative to attract top international students to Ontario, Canada for their PhD studies.

1. **Melaku, A. F.**, Doddipatla, L. S., Bitsuamlak & G. T. (2021). Large-eddy simulation of wind Loads on a roof-mounted cube: contribution to experimental database 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 Global 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. Predicting the wind induced responses of a high-rise building using LES and dynamic analysis: Validation with wind tunnel data. In preparation for *Journal of Wind Engineering and Industrial Aerodynamics*.

## CODES

2018 - Present	<p>Divergence-free Spectral Representation (DFSR)</p> <p>Github link: <a href="https://github.com/abiyfantaye/DFSR">https://github.com/abiyfantaye/DFSR</a></p> <p>Description: <i>Computationally efficient inflow turbulence generation method developed for large-eddy simulation of the atmospheric boundary layer(ABL) flows. The method is developed targeting LES-based wind load evaluation application on structures.</i></p>
2019 - Present	<p>Pressure Integration Model(PIM)</p> <p>Github link: <a href="https://github.com/abiyfantaye/PIM">https://github.com/abiyfantaye/PIM</a></p> <p>Description: <i>A python script that analyses pressure data for buildings and report estimated wind loads and structural response. Compatible with wind tunnel and CFD data.</i></p>
2020 - Present	<p>Multi-DOF fluid-structure interaction for tall buildings</p> <p>Description: <i>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.</i></p>

## HPC TRAINING

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July 2016	Ontario High Performance Computing Summer School University of Toronto, Ontario, Canada
July 2018	Compute Ontario Summer School on High Performance and Technical Computing Western University, Ontario, Canada

## PROGRAMING LANGUAGES

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Languages	C, C++, C#, Python, MATLAB
Parallel Programming	MPI, OpenMP, CUDA, OpenCL
Shell Programming	bash, tcsh

## SOFTWARE SKILLS

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CFD	OpenFOAM, Star-CCM+
Grid generation	HEXPRESS, OpenFOAM snappyHexMesh
Structural analysis	SAP 2000, ETABS, Midas Civil, Abaqus FEA
CAD Modeling	AutoCAD, SALOME
Visualization	ParaView

## TEACHING EXPERIENCE

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Jan. 2018 - Apr. 2018	Graduate Teaching Assistant, Western University Course: Computational Methods for Civil Engineering Course Mentor: Dr. Martha Dagneu
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

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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

### 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  
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2. Professor Hassan Peerhossaini, PhD  
Western Research Chair in Urban Resilience and Sustainability  
Cross-appointed at Department of Mechanical & Materials Engineering, and  
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### From Industry

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