

BARNEY H. MIAO

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Academic Experience

University of Calgary Assistant Professor, Civil Engineering **August 2026 – Present**
Department of Civil Engineering
Research focus: sustainable materials, artificial intelligence, structural health monitoring, and computational models.

Education

Stanford University PhD Civil and Environmental Engineering **April 2023 – June 2026**
Computer Science (CS) PhD Minor *GPA: 3.96/4.0*
Thesis: "Life cycle design and manufacture of Engineered Biopolymer Composite"
PhD Advisor: Dr. Michael D. Lepech
Committee Members: Dr David J. Loftus, Dr. Anne Kiremidjian, Dr. Sarah Billington

Stanford University Masters (MS) Structural Engineering **September 2021 – April 2023**
Advisors: Dr. Haeyoung Noh and Dr. Michael D. Lepech *GPA: 3.94/4.0*

University of Calgary Bachelor of Science (BSc) in Civil Engineering **September 2017 – May 2021**
Minor in Structural Engineering *GPA: 3.98/4.0*
Graduated with distinction
Advisors: Dr. Saied Saidi and Dr. Qi Zhou

Professional Experience

Stanford University *Graduate Research Assistant* **2022 – Present**

- Conducting graduate-level research in Civil and Environmental Engineering, working with three research groups:
 - **Lepech Research Group [2022-present]**: Developing lignin-based and biopolymer construction materials, design methodologies, manufacturing tools, and computational models under the **Smart Circular Building Materials (SCBM)** framework.
 - **Baker Research Group [2022]**: Modeled spatial cross-correlation of ground motion intensity measures; developed MATLAB scripts for analysis of NGA-West 2 ground motion data.
 - **Structures as Sensors Lab [2022]**: Created adaptive digital twins integrating physics-based models and sensor data; conducted human identification research using vibration data; work recognized with Best Poster Award (Runner-Up) at BuildSys 2022.

University of Calgary *Undergraduate Research Assistant, NSERC CREATE* **2020 – 2021**

- Conducted undergraduate research under the NSERC CREATE program.

Student Union, University of Calgary *Schulich School of Engineering Faculty Representative* **2019 – 2020**

- Represented and advocated for 3,500 undergraduate students in the Schulich School of Engineering.
- Participated in six weekly committees and leadership meetings.
- Mentored a first-year refugee student by providing academic guidance and course planning support.

Halbro Construction Ltd. *Project Coordinator* **2017 – 2021**

- Ensured projects adhered to prescribed frameworks and maintained proper documentation of work activities.
- Identified project risks and proposed mitigation strategies.
- Assisted in maintaining and monitoring project plans and schedules.

Research Interests

Research Framework: Smart Circular Building Materials (SCBM)

Developing design methods and manufacturing tools for decarbonization of the built environment. Topics of interest are part of a larger framework of Smart Circular Building Materials (SCBM), which envisions the introduction of new materials and construction practices to facilitate a green transition of the built environment. Current research interests align with the following:

1. Development of sustainable and alternative construction materials, namely biopolymer-based composites.

2. Investigating durability, degradation, and life-cycle performance of civil engineering materials under varying environmental, mechanical, and climatic conditions.
3. Developing design methods and computational models for smart, multifunctional, and resilient construction materials.
4. Characterizing materials at multiple scales using experimental testing, analytical techniques, and data-driven approaches.
5. Studying materials for transportation and infrastructure systems, including pavements and bridges.
6. Exploring recycling, reuse, and circular economy approaches in construction materials.
7. Implementing vibration-based sensors and quality control techniques for early-life monitoring of novel materials.
8. Integrating AI and large language models into the design, performance prediction, and sustainable manufacturing of construction materials.

Publications

Peer-Reviewed Journal Articles

Published

- [J1] **B. H. Miao**, R. J. Headrick, Z. Li, L. Spanu, D. J. Loftus, M. D. Lepech, "Life cycle assessment and design of LignoBlock: A lignin bound block on the path towards a green transition of the construction industry," *Journal of Cleaner Production*, vol. 474, 143610, 2024. **Impact factor = 10.7**
- [J2] **B. H. Miao**, R. J. Headrick, Z. Li, L. Spanu, D. J. Loftus, M. D. Lepech, "Development of biopolymer composites using lignin: A sustainable technology for fostering a green transition in the construction sector," *Cleaner Materials*, vol. 14, 100279, 2024. **Impact factor = 12.7**
- [J3] **B. H. Miao**, D. Woo, D. Javan, E. J. Garboczi, R. J. Headrick, A. C. Lesh, Z. Li, D. J. Loftus, M. D. Lepech, "Recycling of lignin-based biocomposites: Improving sustainability and enhancing material strength," *Resources, Conservation and Recycling*, vol. 215, 108104, 2025. **Impact factor = 10.4**
- [J4] **B. H. Miao**, D. Woo, A. C. Lesh, D. J. Loftus, M. D. Lepech, "Solvent selection enables sustainable and affordable lignin biocomposite for cement-free construction," *Cleaner Materials*, 100371, 2026. **Impact factor = 12.7**
- [J5] **B. H. Miao**, Y. Dong, A. Theissler, A. C. Lesh, D. J. Loftus, M. D. Lepech, "AI-powered non-destructive testing for smart manufacturing of carbon-negative biopolymer-bound soil composite," *Communications Engineering*, 2026. **Impact factor = 7.0**

In Revision & Under Review

- [J6] K. Sutton, E. Jung, S. Lombardo, S. Snow-hill, Z. Li, H.W. Lee, M. D. Lepech, **B. H. Miao**, "Life cycle assessment of biocomposites produced from ethanol waste: A sustainable alternative to clay-fired bricks," In revision at *Journal of Renewable Materials*.
- [J7] **B. H. Miao**, A. C. Lesh, P. Hart, S. Song, D. J. Loftus, M. D. Lepech, "Engineered biopolymer composites as an affordable cement-free alternative to structural concrete," Under Review.
- [J8] A. Teymouri, Y. Momeni, **B. H. Miao**, H. Rajani, H. Guzman, R. Khosnazar, "Engineering performance and pore structure analysis of carbon nanofiber-reinforced cement mortar," Under review.

Under Review & In Preparation

- [J9] **B. H. Miao**, Y. Dong, A. Theissler, A. C. Lesh, H. Noh, D. J. Loftus, "Acoustic vibration sensing for nondestructive characterization of strength evolution in bio-based composites," In preparation.
- [J10] **B. H. Miao**, Y. Dong, A. Theissler, A. C. Lesh, H. Noh, D. J. Loftus, "Life-cycle monitoring of engineered biopolymer composite using vibration-based sensing," In preparation.
- [J11] **B. H. Miao**, A. C. Lesh, P. Hart, D. J. Loftus, "Microstructural analysis and durability of recyclable engineered biopolymer composite," In preparation.
- [J12] A. C. Lesh, **B. H. Miao**, S. Song, B. Kim, S. Oh, D. J. Loftus, M. D. Lepech, "Development of lignin biopolymer-bound composites using in situ regolith for lunar construction," In preparation.

- [J13] A. C. Lesh, **B. H. Miao**, S. Song, B. Kim, S. Oh, D. J. Loftus, M. D. Lepech, “Design and environmental assessment of CornBlock: A zein protein-based block on the path toward sustainable construction,” In preparation.
- [J14] Z. Li, Y. Chen, **B. H. Miao**, A. C. Lesh, D. J. Loftus, M. D. Lepech, “Generative adversarial networks for generating periodic multi-phase models of biopolymer-bound soil composite,” In preparation.
- [J15] M. Yu, **B. H. Miao**, A. C. Lesh, Y. Pan, K. Law, J. Wang, M. D. Lepech, “LLM-assisted discovery and optimization of biopolymer-bound composites,” In preparation.
- [J16] A. C. Lesh, C. Moose, K. Liu, **B. H. Miao**, R. Dauskardt, G. Fuller, D. J. Loftus, M. D. Lepech, “Multiscale characterization of thin films for modeling candidate binders,” In preparation.

Peer-Reviewed Conference Papers

Published

- [C1] **B. H. Miao**, Y. Dong, Z. Y. Wu, B. N. Alemdar, P. Zhang, M. D. Kohler, H. Noh, “Integration of physics-based building model and sensor data to develop an adaptive digital twin,” Proceedings of the 9th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation, pp. 282–283, 2022. **Best Poster (Runner-up) award at BuildSys '22.**
- [C2] **B. H. Miao**, Y. Dong, A. Theissler, A. C. Lesh, D. J. Loftus, M. D. Lepech, “Biosys: efficient quality control system for manufacturing of sustainable biopolymer composites,” Proceedings of the 11th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation, pp. 11–21, 2024.
- [C3] **B. H. Miao**, S. Saidi, “Development of public transit measures to mitigate the impact of COVID-19 on pedestrians and station performance using PTV Vissim simulation,” *Transportation Research Procedia*, vol. 82, pp. 2294–2312, 2025.
- [C4] **B. H. Miao**, A. C. Lesh, D. J. Loftus, M. D. Lepech, “Taking advantage of biological binders to solidify granular material: manufacture and recyclability of lignin-based biopolymer composites,” Biologically Inspired Materials, Processes, and Systems (BIMPS) 2025, vol. 13430, pp. 81–94, SPIE, 2025.
- [C5] **B. H. Miao**, A. C. Lesh, P. Hart, D. J. Loftus, M. D. Lepech, “Engineered biopolymer composite: an affordable, cement-free material for sustainable construction,” Biologically Inspired Materials, Processes, and Systems (BIMPS) 2026, SPIE, 2026. **Craig F. Bohren Best Student Presentation Award (1st Place).**
- [C6] **B. H. Miao**, A. Theissler, Y. Dong, A. C. Lesh, H. Y. Noh, D. J. Loftus, M. D. Lepech, “SingSys: acoustic vibration sensing for strength monitoring and characterization of engineered biopolymer composite (EBC),” Proceedings of the 13th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation, Association for Computing Machinery, 2026.
- [C7] **B. H. Miao**, “PhD Forum Abstract: Promoting smart and sustainable built environments through the SCBM research framework,” Proceedings of the 13th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation, Association for Computing Machinery, 2026.
- [C8] M. Yu, **B. H. Miao**, A. C. Lesh, K. Law, J. Wang, M. D. Lepech, “Comparing graph-based RAG strategies for material science knowledge retrieval: a systematic evaluation in biopolymer structured composites,” Proceedings of the 13th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation, Association for Computing Machinery, 2026.

Accepted

- [C9] **B. H. Miao**, A. C. Lesh, D. J. Loftus, M. D. Lepech, “Solvent optimization for a cement-free building material using lignin,” *Earth and Space* 2026, ASCE, 2026. Accepted.
- [C10] A. C. Lesh, C. Moose, K. Liu, **B. H. Miao**, R. Dauskardt, G. Fuller, D. J. Loftus, M. D. Lepech, “Microscale characterization of candidate biopolymers for soil biocomposites,” *Earth and Space* 2026, ASCE, 2026. Accepted.
- [C11] A. Teymouri, Y. Momeni, **B. H. Miao**, H. Rajani, H. Guzman, R. Khosnazar, “Compressive strength, hydration reactions, and pore structure of cement paste incorporating carbon nanofibers,” *Canadian Society for Civil Engineering (CSCE)* 2026, 2026. Accepted.
- [C12] P. Hart, **B. H. Miao**, A. C. Lesh, D. J. Loftus, M. D. Lepech, “Developing workflows for advanced nano characterization of engineered biopolymer composites leveraging micro-CT and ultramicrotomy,” *Microscopy & Microanalysis (M&M)* 2026, 2026. Accepted.

Under Review

[C13] M. Yu, Y. Pan, J. Gao, **B. H. Miao**, A. C. Lesh, K. Law, J. Wang, M. D. Lepech, “Enhancing RAG using evidence-grounded typed KG in local small language models for emerging material science,” Conference on Empirical Methods in Natural Language Processing (EMNLP 2026), 2026. Under review.

Patents

[P1] M. D. Lepech, **B. H. Miao**, “Composite Materials Having Natural Granular Materials or Soils and Hydrophobic Biologically-derived Binders,” US Patent Application 19/069,771, filed September 11, 2025.

[P2] **B. H. Miao**, A. C. Lesh, D. J. Loftus, M. D. Lepech, “Use of Plant-Based Additives to Enhance Composite Materials Consisting of Natural Granular Materials or Soils and Biologically-derived Binders,” US Provisional Patent, filed March 6, 2026.

Invited Talks and Conference Presentations

13th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (BuildSys) **Spring 2026**

- Presented “Comparing Graph-Based RAG Strategies for Material Science Knowledge Retrieval: A Systematic Evaluation in Biopolymer Structured Composites.”

13th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (BuildSys) **Spring 2026**

- Presented “PhD Forum Abstract: Promoting Smart and Sustainable Built Environments Through the SCBM Research Framework.”

13th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (BuildSys) **Spring 2026**

- Presented “SingSys: Acoustic Vibration Sensing for Strength Monitoring and Characterization of Engineered Biopolymer Composite (EBC).”

ASCE Earth and Space Conference

Spring 2026

- Presented “Solvent Optimization for a Cement-Free Building Material Using Lignin.”

SPIE Smart Structures + NDE

Winter 2026

- Gave a talk on “Engineered Biopolymer Composite: an affordable, cement-free material for sustainable construction.” *Craig F. Bohren Best Student Presentation Award 1st Place.*

Invited department Seminar at University of British Columbia, Vancouver, Canada

Fall 2025

- Gave a teaching seminar titled “Cement, Carbon, and Climate: Towards Sustainable Construction” and a research seminar titled “Engineered Biopolymer Composites: Cement-Free Building Materials for Decarbonizing the Built Environment”.

Invited department Seminar University of Calgary, Calgary, Canada

Spring 2025

- Gave a teaching seminar titled “Introduction to Application of Generative Adversarial Networks in Civil Engineering” and a research seminar titled “AI-powered Life Cycle Design and Manufacturing of Carbon-Negative Building Materials”.

Engineering Mechanics Institute and Probabilistic Mechanics & Reliability Conference (EMI) **Spring 2025**

- Will give a presentation titled “A Solvent Selection Framework for Promoting Efficient Manufacture of Lignin Biocomposites”.

SPIE Smart Structures + NDE

Winter 2025

- Gave a talk on “Taking advantage of biological binders to solidify granular material: manufacture and recyclability of lignin-based biopolymer composites”

11th ACM International Conference on Systems for Energy Efficient Buildings, Cities, and Transportation (BuildSys) **Fall 2024**

- Gave a talk on “BioSys: Efficient Quality Control System for Manufacturing of Sustainable Biopolymer Composites”.

Engineering Mechanics Institute Conference and Probabilistic Mechanics & Reliability Conference (EMI/PMC) **Spring 2024**

- Gave a presentation titled “A framework for sustainable building materials using lignin biopolymer bound soil composites”.

16th World Conference on Transport Research (WCTR)

Spring 2023

- Gave a talk on “Development of Public Transit Measures to Mitigate the Impact of COVID-19 on Pedestrians and Station Performance using PTV Vissim Simulation”.

9th ACM International Conference on Systems for Energy Efficient Buildings, Cities, and Transportation (BuildSys) **Fall 2022**

- Gave a talk on “Poster Abstract: Integration of Physics-Based Building Model and Sensor Data to Develop an Adaptive Digital Twin”. *Best Poster (Runner-up) award at BuildSys '22*

Other talks

Stanford Synthetic Biology for Sustainability Symposium

Spring 2025

- Presented a poster on “Design and sustainability assessment of lignin biocomposite”.

Blume Center and SURI Affiliates and Alumni Meeting

Spring 2025

- Presented a poster on “Vibration-based sensing for efficient quality control and smart manufacturing of biocomposites”.
- Presented a poster on “Development of Lignin Biopolymer-Bound Composites For Construction”.

CEE 226 Life Cycle Assessment for Complex Systems

Fall 2024

- Presented a talk on “Development of biopolymer composites using lignin: A sustainable technology for fostering a green transition in the construction sector”.

CEE Summer Student Seminar Series

Summer 2024

- Presented a talk on “A Framework for Sustainable Building Materials Using Lignin Biopolymer-Bound Soil Composites”.

Stanford Doerr School of Sustainability Research Review

Spring 2024

- Presented a poster on “Development of Circular Lignin Biopolymer-Bound Composites (BSC) for Construction”. *Best poster award for Stanford Doerr School Research Review '25*

Stanford Energy Research Showcase

Spring 2024

- Presented a poster on “Development of Circular Lignin Biopolymer-Bound Composites (BSC) for Construction”.

CEE 226 Life Cycle Assessment for Complex Systems

Fall 2023

- Presented a talk on “Solvent considerations for developing sustainable lignin-based biocomposite”.

Blume Center and SURI Affiliates and Alumni Meeting

Fall 2022

- Presented a poster on “Integration of Physics-Based Building Model and Sensor Data to Develop an Adaptive Digital Twin”.

Research Experience

Lepech Research Group *Graduate Researcher*

October 2022 – Present

↔ Dr. Michael D. Lepech (PhD advisor)

Stanford University

- Conducting research on developing lignin-based building materials to accelerate sustainability progress in the construction sector.
- Developed design methodologies, manufacturing tools, and computational models under the **Smart Circular Building Materials (SCBM)** research framework.
- Invented two nature-based building materials using waste-derived biopolymer binders.

Baker Research Group *Research Assistant*

September 2022 – December 2022

↔ Dr. Jack Baker

Stanford University

- Modeled spatial cross-correlation of ground motion intensity measures using principal component and geo-statistical analyses.
- Developed MATLAB scripts to extract and analyze ground motion data from the NGA-West 2 database to perform principal component analysis.

Structures as Sensors Lab *Research Assistant*

January 2022 – September 2022

↔ Dr. Haeyoung Noh

Stanford University

- Developed an adaptive digital twin integrating physics-based models and sensor data to adapt building behavior to real-time conditions.
- Resulting work was presented at BuildSys 22' and published as <https://doi.org/10.1145/3671127.3698165>. *Best Poster Award (Runner-Up)*.
- Conducted research on cross-structure human identification using frequency response functions of footstep-induced vibrations on concrete and wood platforms.
- Initiated as a course project and extended into independent research.

Transit Network COVID-19 Simulation *Undergraduate Research Assistant*

May 2021 – September 2021

↔ Dr. Saied Saidi

University of Calgary

- Investigated the effects of COVID-19 on public transit networks at Marlborough Station in Calgary, Alberta.
- Developed a pedestrian flow simulation to evaluate mitigation strategies involving behavioral and physical layout modifications.
- Resulting work is published as [doi:10.1016/j.trpro.2024.12.187](https://doi.org/10.1016/j.trpro.2024.12.187).

Fluid Mechanics & Flow Classification Research *Undergraduate Research Assistant* May 2020 – September 2020

↔ Dr. Qi Zhou

University of Calgary

- Evaluated the Thorpe scale using experimental data obtained by dragging a spherical object through water.
- Developed a convolutional neural network (CNN) image classifier to identify flow profiles and estimate eddy viscosity.

Teaching Experience

Damage and Failure Mechanics of Structural Systems [CEE 305]	Spring 2025
• Teaching Assistant, Stanford University	
Life Cycle Assessment for Complex Systems [CEE 226]	Fall 2024
• Teaching Assistant, Stanford University	
Finite Element Methods in Structural Dynamics [CEE 284]	Fall 2024
• Teaching Assistant, Stanford University	
Damage and Failure Mechanics of Structural Systems [CEE 305]	Spring 2024
• Teaching Assistant, Stanford University	
Life Cycle Assessment for Complex Systems [CEE 226]	Fall 2023
• Teaching Assistant, Stanford University	
Damage and Failure Mechanics of Structural Systems [CEE 305]	Spring 2023
• Teaching Assistant, Stanford University	
Probabilistic Models in Civil and Environmental Engineering [CEE 203]	Fall 2022
• Teaching Assistant, Stanford University	
Accounting, Finance, & Valuation for Engineers & Constructors [CEE 244]	Summer 2022
• Teaching Assistant, Stanford University	
Engineering Statics [ENGG 202]	Winter 2021
• Learning Assistant, Engineering Academic Success Center (EASC), University of Calgary	
Fundamentals of Fluid Mechanics [ENME 341]	Fall 2020
• Learning Assistant, Engineering Academic Success Center (EASC), University of Calgary	

Awards and Fellowships

Craig F. Bohren Best Student Presentation Award 1st Place	2026
SPIE Smart Structures + Nondestructive Evaluation 2026	
Best Poster Award, Stanford Doerr School of Sustainability Research Review	2024
Stanford Doerr School of Sustainability	
Leavell Fellowship on Sustainable Built Environment (\$ 93,000)	2024
Stanford Department of Civil & Environmental Engineering	
Best Poster (Runner-Up), 9th ACM International Conference for Energy Efficient Buildings, Cities, and Transportation (BuildSys '22)	2022
ACM BuildSys	
School of Engineering Graduate Fellowship (\$ 76,000)	2021
Stanford Department of Civil & Environmental Engineering	
Dean's List	2018–2020
Schulich School of Engineering	
Louise McKinney Scholarship	2019–2020
Government of Alberta	
NSERC Research Award	2020
Natural Sciences and Engineering Research Council of Canada	
Alex Bakshan Memorial Scholarship	2020
Alberta Chapter of the American Concrete Institute	
Japex/Jacos Scholarship in Engineering	2020
Japex	
Calgary Construction Association (CCA) Member's Scholarship	2019–2020
Calgary Construction Association	

Canadian Society for Civil Engineering (Calgary Section) Scholarship Canadian Society for Civil Engineering	2019
TransAlta Corporation Memorial Scholarship TransAlta Corporation	2018
Jason Lang Scholarship Government of Alberta	2018
Alexander Rutherford Scholarship Government of Alberta	2017

Research Student Supervision

Seoyoung Oh MS Graduate Research Mentee, Stanford University	2026–Present
Brian Kim MS Graduate Research Mentee, Stanford University	2026–Present
Steven Song MS Graduate Research Mentee, Stanford University	2025–Present
Muran Yu PhD Graduate Research Mentee, Stanford University	2025–Present
Silvia Josefina Lombardo MS Graduate Research Mentee, Stanford University	2025–2026
Viaronic Ishmale Snow-Hill MS Graduate Research Mentee, Stanford University	2025–2026
Eunice Jung PhD Graduate Research Mentee, Stanford University	2025–2026
Keith Sutton MS Graduate Research Mentee, Stanford University	2025–Present
Daria Fontani PhD Graduate Research Mentee, Stanford University	2024–Present
Farah Shahbaz PhD Graduate Research Mentee, Stanford University	2024–Present
Ava DeConcini Undergraduate Research Mentee, Stanford University	2024–Present
Darius Bradford Javan MS Graduate Research Mentee, Stanford University	2023–2025
Daniel Woo MS Graduate Research Mentee, Stanford University	2023–2025
Joshua Lin MS Graduate Research Mentee, Stanford University	2023–2024
Chween An Beh MS Graduate Research Mentee, Stanford University	2023
Kimberly Wong MS Graduate Research Mentee, Stanford University	2022–2023
Peter Hariyanto MS Graduate Research Mentee, Stanford University	2022–2023
Yinjian Li MS Graduate Research Mentee, Stanford University	2022–2024

Outreach & Professional Development

- Student Union** **2019-2020**
- Schulich School of Engineering Faculty Representative
- Emerson Consequential Scholars Program** **2024-2025**
- Introduced the entrepreneurial mindset and its incorporation into professional development and research. Illustrated the clear link between entrepreneurship and innovation in research.
- Journal Peer Review**
- Cleaner Materials [IF = 12.7]
- Cleaner Environmental Systems [IF = 5.3]
- Construction Innovation, Process, Management [IF = 3.9]
- Clean Technologies and Environmental Policy [IF = 5.1]
- Scientific Reports [IF = 4.9]
- Discovery Sustainability [IF = 5.2]
- Professional Memberships**
- Canadian Society for Civil Engineering (CSCE)
- Society of Photo-Optical Instrumentation Engineers (SPIE)
- Sigma Xi