Li Ai

Research Assistant Professor
Department of Civil and Environmental & Mechanical Engineering
College of Engineering and Computing
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Education

2021	Ph.D. in Civil Engineering,	University of South Carolina, SC
2016	M.Eng. in Civil Engineering,	Stevens Institute of Technology, NJ
2014	B.S. in Civil Engineering,	Zhengzhou University, China

Research Interests

- Structural health monitoring
- Nondestructive testing/evaluation
- Damage diagnosis and prognosis
- Acoustic emission monitoring
- Fiber optic monitoring
- Structure rehabilitation and strengthening
- Load rating
- Finite element modeling
- Digital twins
- Ai for engineering

Technology Specialties

Programming:	Python, Matlab, C/C++, Fortran
Modeling:	Abaqus, ANSYS, COMSOL
Machine Learning:	Develop ML/DL models on platforms, i.e., TensorFlow, PyTorch
Typography:	Microsoft Office, Latex

Working Experience

Research Assistant Professor, Nov 2023 – present
University of South Carolina

Post-Doctoral Fellow, Sept 2021 – Oct 2023
University of South Carolina

Graduate Research Assistant, Jan 2017 – Aug 2021
University of South Carolina

Graduate Teaching Assistant, Aug 2016 – Dec 2016
Stevens Institute of Technology

External Funding

Externally sponsored funding as Co-PI/senior personnel (including pending proposals)

1. Cost-effective screening, assessment, and repair of timber piles, sponsored by SCDOT, $420,000, Co-PI. Pending

2. Intelligent Asset Management for Improved Mobility: Technology Transfer for South Carolina, sponsored by C^2M^2/Clemson, $166,987, senior personnel. 10/01/2023 - 09/30/2024.

3. Digital Twins for Inspection and Maintenance of Transmission Power System (Phase 1), sponsored by CEATI, $48,897, senior personnel. 06/01/2023 - 02/28/2025.

Research Project Experiences

Projects involved as key participant

1. Digital Twins to Increase Mobility in Rural South Carolina, sponsored by C^2M^2/Clemson.

- Developed finite element models for concrete slab bridges.
- Conducted field monitoring for slab bridges (fiber optic strain gauges, acoustic emission sensors) and developed an automated load rating framework using digital twins.

2. Field Trials for Cost-Effective Strengthening of SC Load Posted Bridges, sponsored by SCDOT.

- Investigated different strengthening approaches for concrete girders, including fiber reinforced polymers and supplemental concrete deck toppings should be considered.
- Compared different strengthening approaches in terms of material cost, labor time, traffic closure cost, and ease of application in the field.

3. Safe and Cost-Effective Removal of Load Postings for SC Bridges, sponsored by SCDOT.

- Investigated the methods for strengthening the concrete slabs from above that have the potential to improve both the flexural strength and ductility of slabs,
- Investigated the cost-effectiveness analysis compared to the existing methods.

4. Building Smarter Cities via Intelligent Asset Management: South Carolina Case Study using IBM Maximo Application, sponsored by C^2M^2/Clemson.

- Conducted drone-based bridge inspection.
- Developed a crack detection and depth prediction framework for bridges using computer vision.
- Developed an automated load rating approach assisted by digital twins.

5. Innovative Manufacturing, Operation, and Certification of Advanced Structures for Civil Vertical Lift Vehicles, sponsored by NASA ULI.

- Conducted monitoring for urban air mobility helicopters with fiber optic and acoustic emission sensors.
- Developed a deep learning-based framework for automated monitoring of barely visible impact damage (BVID) in urban air mobility helicopters components.

6. Structural Health Monitoring (SHM) of Composite Structure for Airplanes and Helicopters based on Passive Sensing of Acoustic Emission, sponsored by GKN-Fokker.

- Developed a monitoring framework for aircraft elevators with acoustic emission sensors.
- Developed the algorithm for low velocity impacts localization and impact energy identification using acoustic emission signals and deep learning.

7. Acoustic emission wave propagation simulation of stress corrosion cracks in stainless steel nuclear spent fuel storage systems, sponsored by EPRI.

- Developed finite element simulation of elastic wave propagation in stainless steel.

- Developed an algorithm for non-destructive monitoring of stress corrosion cracking in dry cast storage system (DCSS) canisters based on acoustic emission.

8. Online health monitoring and assessment of alkali-silica reactive expansion cracks in concrete, sponsored by USDOE/NEUP.

- Investigated the monitoring of ASR expansion of concrete structures using acoustic emission sensors
- Developed online ASR damage diagnostics and prognostic methods using deep learning.

9. TC1 2C18: Progressive Damage Analysis, sponsored by NASA.

- Developed advanced methods to capture the effect of defects generated during manufacturing processes of composite laminates.
- Employed Acoustic emission to investigate correlations between mechanical properties and damage propagation during tension and 3-point bending tests.

Professional Service

Editorial Board:

Associate editor, *Practice Periodical on Structural Design and Construction-ASCE*
Editorial board, *Civil Engineering Journal*
Editorial board, *International Journal of Engineering Sciences and Technologies*
Youth editorial board, *Journal of Intelligent Construction*
Young academic editor, *Journal of Traffic and Transportation Engineering*
Review editor, *Frontiers in Aerospace Engineering*
Guest editor, *Measurement Science and Technology*
Guest editor, *Journal of Intelligent Construction*
Guest editor, *Journal of Engineered Fibers and Fabrics*
Guest editor, *Coatings*
Guest editor, *Materials*

Reviewer:

Practice Periodical on Structural Design and Construction-ASCE
Structural Health Monitoring-SAGE
Construction and Building Materials
IEEE Sensor Journal
Expert System with Applications
Measurement Science and Technology
Neurocomputing
Engineering Structures
Journal of Testing and Evaluation
Structures
Case Studies in Construction Materials
Structural Concrete
Probabilistic Engineering Mechanics
Journal of Low Frequency Noise, Vibration and Active Control
Transportation Research Record
Transportation Research Board Annual Meeting
Journal of Supercomputing
Journal of Materials in Civil Engineering-ASCE
Journal of Electronic & Information Systems

Awards

2022, Adrian Pollock Student Award, AEWG-63 – The Acoustic Emission Working Group Annual Meeting

2021, M. Bert Storey Graduate Fellowship, Department of Civil and environmental Engineering, University of South Carolina.

2020, Outstanding Paper Award, CAMX – The Composites and Advanced Materials Expo. CAMX Conference Proceedings

Presentations

2023, Transfer Learning for Acoustic Emission Zonal Localization on Steel Plate-Like Structures. *The 64th Meeting of the Acoustic Emission Working Group, Princeton Junction, NJ*

2022, Determination of Vehicle Loads on Bridges by Acoustic Emission and An Improved Ensembled Artificial Neural Network. *The 63rd Meeting of the Acoustic Emission Working Group, Huston, TX*

2022, Temporal Diagnosis of ASR Expansion in Simulated Nuclear Containment Leveraging Convolutional Neural Networks and Acoustic Emission. *The 63rd Meeting of the Acoustic Emission Working Group, Huston, TX* (Adrian Pollock Student Award)

2022, Temporal ASR Damage Evaluation of Concrete Structures Leveraging Convolutional Neural Networks and Acoustic Emission. *ACI Spring Convention, Orlando, FL*

2021, A Bridge Automated Load Rating Procedure Using Digital Twins. *The Fifth Annual Fall Conference of USDOT Center for Connected Multimodal Mobility (C^2M^2), Virtual*

2021, Assessment of Impact Damage Level for Composite Aircraft Components Using Acoustic Emission. *The Composites and Advanced Materials Expo (CAMX 2021), Dallas, TX*

2020, Minimally Intrusive Sensing in Various Media enabled through Artificial Intelligence. *The 62nd meeting of the Acoustic Emission Working Group, Virtual*

2020, A Minimally Intrusive Impact Detection System for Aircraft Moveable using Random Forest. *The Composites and Advanced Materials Expo (CAMX 2020), Virtual*

2020, Deep Learning Source Localization of Impact on Thermoplastic Control Surface. *The ASME 2020 Conference on Smart Materials, Adaptive Structures and Intelligent Systems, Virtual*

2020, Data-Driven Source Localization of Impact on Aircraft Control Surfaces. *IEEE Aerospace Conference, Big Sky, MT*

2018, Finite Element Modeling of Acoustic Emission in Dry Cask Storage Systems Generated by Cosine Bell Sources. *45th Annual Review of Progress in Quantitative Nondestructive Evaluation, Burlington, VT*

2018, Finite Element Modeling of Acoustic Emission in Steel Plate. *The 60th Meeting of the Acoustic Emission Working Group, Charleston, SC*

Publications *(✉ refers to corresponding author)*

A. Published journal articles

1. **L Ai**; V Soltangharaei; B Greer; M Bayat; P Ziehl. Structural Health Monitoring of Stainless-Steel Nuclear Fuel Storage Canister Using Acoustic Emission. *Development in the Built Environment. 2023*. accepted.
2. E Elbatanouny; **L Ai (✉)**; E Deaver; P Ziehl. Impact of Graphene on Microstructure and Compressive Strength of Cement Mortars Utilizing Two Different Dispersion Methods. *Practice Periodical on Structural Design and Construction-ASCE*. in press, accepted on Oct 19, 2023. https://doi.org/10.1061/PPSCFX/SCENG-1404

3. Laxman K C; A Henderson; E Elbatanouny; A Ross; **L Ai (✉)**; B Ross; T Cousins; P Ziehl. Cost-effective Methods for Flexural Strengthening of One-way RC Precast Flat Slab Bridges in South Carolina. *Construction and Building Materials*. 2023. Vol.408: 133675. https://doi.org/10.1016/j.conbuildmat.2023.133675
4. X Yan; H Su; **L Ai**; V Soltangharaei; X Xu; K Yao. Study on Stage Characteristics of Hydraulic Concrete Fracture Under Uniaxial Compression Using Acoustic Emission. *Nondestructive Testing and Evaluation*. 2023. PP.1-30. https://doi.org/10.1080/10589759.2023.2255362
5. H He; S E; **L Ai**; X Wang; J Yao; C He; B Cheng. Exploiting Machine Learning for Controlled Synthesis of Carbon Dots-based Corrosion Inhibitors. *Journal of Cleaner Production*. 2023. Vol.419:138210. https://doi.org/10.1016/j.jclepro.2023.138210
6. **L Ai**; B Zhang; P Ziehl. A Transfer Learning Approach for Acoustic Emission Localization on Steel Plate-like Structure Using Numerical Simulation and Unsupervised Domain Adaptation. *Mechanical Systems and Signal Processing*. 2023 June 1;192:110216. https://doi.org/10.1016/j.ymssp.2023.110216
7. **L Ai**; M Bayat; P Ziehl. Localizing Damage on Stainless Steel Structures Using Acoustic Emission Signals and Weighted Ensemble Regression-based Convolutional Neural Network. *Measurement*. 2023 Apri;211:112659. https://doi.org/10.1016/j.measurement.2023.112659
8. **L Ai**; S Flowers; T Mesaric; B Henderson; S Houck; P Ziehl*****. Acoustic Emission-Based Detection of Impacts on Thermoplastic Aircraft Control Surfaces: A Preliminary Study. *Applied Sciences*. 2023 May 29;13(11):6573. https://doi.org/10.3390/app13116573
9. Laxman K C; N Tabassum; **L Ai (✉)**; C Cole; P Ziehl. Automated Crack Detection and Crack Depth Prediction for Reinforced Concrete Structures using Deep Learning. *Construction and Building Materials*. 2023 Mar 17;370:130709. https://doi.org/10.1016/j.conbuildmat.2023.130709
10. Laxman K C; A Ross; **L Ai (✉)**; A Henderson; E Elbatanouny; M Bayat; P Ziehl. Determination of Vehicle Loads on Bridges by Acoustic Emission and an Improved Ensembled Artificial Neural Network. *Construction and Building Materials*. 2023 Jan 18;364:129844. https://doi.org/10.1016/j.conbuildmat.2022.129844
11. **L Ai**; V Soltangharaei; P Ziehl. Developing a Heterogeneous Ensemble Learning Framework to Evaluate Alkali-silica Reaction Damage in Concrete using Acoustic Emission Signals. *Mechanical Systems and Signal Processing*. 2022 Jun 1;172:108981. https://doi.org/10.1016/j.ymssp.2022.108981
12. **L Ai**; V Soltangharaei; P Ziehl. Evaluation of ASR in Concrete Using Acoustic Emission and deep learning. *Nuclear Engineering and Design*. 2021 Aug 15;380:111328. https://doi.org/10.1016/j.nucengdes.2021.111328
13. **L Ai**; V Soltangharaei; M Bayat; M van Tooren; P Ziehl. Detection of Impact on Aircraft Composite Structure Using Machine Learning Techniques. *Measurement Science and Technology*. 2021 May 19; 32(8):084013. https://doi.org/10.1088/1361-6501/abe790
14. **L Ai**; V Soltangharaei; M Bayat; B Greer; P Ziehl. Source Localization on Large-Scale Canisters for Used Nuclear Fuel Storage Using Optimal Number of Acoustic Emission Sensors. *Nuclear Engineering and Design*. 2021 Apr 15;375:111097. https://doi.org/10.1016/j.nucengdes.2021.111097
15. **L Ai**; V Soltangharaei; M van Tooren*****; P Ziehl. A Smart Impact Detection System for Thermoplastic Aircraft Components based on Acoustic Emission and AdaBoost Algorithm. *International Journal of COMADEM*. 2021 Jul. 24(3):27-34. https://apscience.org/comadem/index.php/comadem/article/view/278
16. V Soltangharaei; **L Ai**; R Anay; M Bayat; P Ziehl. Implementation of Information Entropy, b-value, and Regression Analyses for Temporal Evaluation of AE Data Recorded During ASR Cracking. *Practice Periodical on Structural Design and Construction-ASCE*. 2021 Feb 1;26(1):04020065. https://doi.org/10.1061/(ASCE)SC.1943-5576.0000550

17. V Soltangharaei; R Anay; **L Ai**; ER. Giannini; J Zhu; P Ziehl. Temporal Evaluation of ASR Cracking in Concrete Specimens Using Acoustic Emission. *Journal of Materials in Civil Engineering-ASCE*. 2020 Oct 1;32(10):04020285. https://doi.org/10.1061/(ASCE)MT.1943-5533.0003353
18. V Soltangharaei; JW Hill; **L Ai**; R Anay; B Greer; M Bayat*****; P Ziehl. Acoustic Emission Technique to Identify Stress Corrosion Cracking Damage. *Structural Engineering and Mechanics*. 2020;75(6):723-736. https://doi.org/10.12989/sem.2020.75.6.723

B. Journal articles under review

1. **L Ai (✉)**; R Krol; A Henderson; V Soltangharaei; B Ross; T Cousins; P Ziehl. Rehabilitation of Timber Piles Using FRP: A Study of Acoustic Emission Characteristics Under Uniaxial Compression. *Engineering Structures*, under review.
2. **L Ai (✉)**; Laxman K C; E Elbatanouny; M Bayat; M Bayat; M van Tooren; P Ziehl. Monitoring and Automatic Characterization of Low-velocity Impacts on Composite Components Through Acoustic Emission. *Expert Systems with Application*, under review.
3. E Elbatanouny; **L Ai (✉)**; A Henderson; Laxman K C; P Ziehl. An Automated Load Determination System for Bridges based on Acoustic Emission and Machine Learning Techniques. *Measurement*, under review.
4. E Elbatanouny; A Henderson; **L Ai (✉)**; Laxman K C; B Ross; T Cousin; P Ziehl. Full-Scale Experimental Investigation of Prestressed Concrete Channel Bridge Girders Strengthened with Aluminum Channels. *Construction and Building Materials*, under review.
5. E Elbatanouny; A Henderson; **L Ai (✉)**; P Ziehl. Condition Assessment of Prestressed Concrete Channel Bridge Girders Using Acoustic Emission and Data-Driven Methods. *Structures*, under review.
6. C Wu; Y Hu; S Zhou; D Zhu; **L Ai**. Investigating the Constitutive Relationship of Steel-fiber-reinforced Recycled Fine Aggregate Concrete under Uniaxial Compression. *Journal of Engineered Fibers and Fabrics*, under review.
7. Y Shi; J Li; X Lv; **L Ai**; X Tan; C Wu. Research and Application of Feeding-hoisting Equipment for Sealing Leakage in Concentrated Inlets of Earth-rock Dams. *Practice Periodical on Structural Design and Construction-ASCE*, under review.

C. Journal articles in preparation

1. **L Ai (✉)**; Laxman K C; E Elbatanouny; P Ziehl. Assisting Concrete Bridge Load Rating through Digital Twins and Field Monitoring Data, in preparation.
2. **L Ai (✉)**; E Elbatanouny; Laxman K C; P Ziehl. Application of Digital Twins in Smart Cities: A State-of-the-Art Review, in preparation.
3. X Yan; H Su; **L Ai**. Self-supervised Learning Framework for Fracture Damage Assessment of Hydraulic Concrete Based on Acoustic Emission Signals, in preparation.
4. X Yan; H Su; **L Ai**. Estimation of Cracking and Damage Mechanisms in Hydraulic Concrete under Three-point Bending by Moment Tensor Analysis of Acoustic Emission, in preparation.
5. X Yan; H Su; **L Ai**. Numerical Simulation Method of Acoustic Emission for Hydraulic Concrete Failure Considering Material Heterogeneity, in preparation.
6. Y Shi, S Zhou, Y Li, X Lv, L Liu, C Zhang, W Jiang, **L Ai (✉)**, C Wu. Preparation and Performance Testing of Thermal-sprayed Ceramic-based Coating on Concrete Surfaces, in preparation.

D. Published conference proceedings

1. **L Ai**; B Henderson; S Houck; S Dickson; P Ziehl. Identifying the Energy of Low-velocity Impacts on Composite Components Using Acoustic Emission. *2023 IEEE Aerospace Conference*. 2023 Mar 4. (pp. 1-6). IEEE. https://doi.org/10.1109/AERO55745.2023.10116008
2. **L Ai**; M Bayat; G Comert; P Ziehl*****. An Autonomous Bridge Load Rating Framework Using Digital

Twins. *The 13th International Workshop on Structural Health Monitoring (IWSHM 2021)*. https://doi.org/10.12783/shm2021/36365

3. **L Ai**; E Elbatanouny; Laxman K C; M Bayat; V Soltangharaei; M van Tooren; P Ziehl*****. Detection and Evaluation of Impact Damage on Aircraft Control Surface Using Acoustic Emission and Convolution Neural Network. *The 13th International Workshop on Structural Health Monitoring (IWSHM 2021)*. https://doi.org/10.12783/shm2021/36329
4. **L Ai**; Laxman, K C; E Elbatanouny; V Soltangharaei; M van Tooren; P Ziehl*****. Assessment of Impact Damage Level for Composite Aircraft Components Using Acoustic Emission. 2021 Sept 21; *CAMX 2021*. TP21-0000000329. https://www.nasampe.org/store/viewproduct.aspx?id=19536582
5. **L Ai**; V Soltangharaei; W de Backer; P Ziehl*****; M van Tooren. A Minimally Intrusive Impact Detection System for Aircraft Moveable using Random Forest. 2020 Sept 21; *CAMX 2020*.TP20-0000000091 (Outstanding Paper Award). https://www.nasampe.org/store/viewproduct.aspx?id=17609643
6. **L Ai**; V Soltangharaei; R Anay; M van Tooren; P Ziehl*****, Data-Driven Source Localization of Impact on Aircraft Control Surfaces. *2020 IEEE Aerospace Conference* 2020 Mar 7 (pp. 1-10). IEEE. https://doi.org/10.1109/AERO47225.2020.9172742
7. **L Ai**; B Greer; J Hill; V Soltangharaei; R Anay; P Ziehl*****, Finite Element Modeling of Acoustic Emission in Dry Cask Storage Systems Generated by Cosine Bell Sources. May 2019, *AIP Conference Proceedings* 2102(1):13000. https://doi.org/10.1063/1.5099851
8. V Soltangharaei; R Anay; **L Ai**; Y Le Pape; Z John Ma; P Ziehl*****, Monitoring Alkali Silica Reaction of Large and Medium Scale Concrete Specimens Using Acoustic Emission, *SMIRT 25*. 2019 https://repository.lib.ncsu.edu/bitstream/handle/1840.20/37935/SMiRT5-3-2019-Final.pdf?sequence=1

E. Book chapter

1. V Soltangharaei; **L Ai**; P Ziehl. Implementation of Data-Driven Approaches for Condition Assessment of Structures and Analyzing Complex Data. Leveraging Artificial Intelligence in Engineering, Management, and Safety of Infrastructure 2022 Nov 17 (pp. 91-119). CRC Press. https://doi.org/10.1201/9780367823467-5

F. Technical report

1. J Zhu; H Sun; C Malone; P Ziehl; **L Ai**; M Bayat; Y Zhang; Taeyong Shin, and Eric Giannini. Online Monitoring System for Concrete Structures Affected by Alkali-Silica Reaction. No. DOE-UNL-NE8544. Univ. of Nebraska, Lincoln, NE (United States), 2021. https://doi.org/10.2172/1838356

Teaching Experience

University of South Carolina

Teaching assistant/grader:

2021 Fall	ECIV-327 Reinforced Concrete Design
2021 Spring	ECIV-320 Structural Mechanics
2019 Fall	ECIV-327 Reinforced Concrete Design

Stevens Institute of Technology

Teaching assistant/grader:

2016 Fall	CE-519 Advanced Structure Analysis

Students Mentoring *(* Assisting Dr. Paul Ziehl)*

PhD students

2023	Elhussein Elbatanouny

Dissertation: *Load Determination, Strengthening, and Behavior Study of Prestressed Concrete Channel Bridge Girders*

2023 Laxman K C
Dissertation: *Cost-effective Strengthening and Automated Inspection of One-way Precast Reinforced Concrete Flat Slab Bridges in South Carolina*

Master students

2022 Allen Ross
Thesis: *The Classification of Acoustic Emissions Data into Load Steps Using an Artificial Neural Network*

2022 Nishat Tabassum
Thesis: *Image-Based Crack Detection by Extracting Depth of the Crack Using Machine Learning*

2021 Elhussein Elbatanouny
Thesis: *Impact of Graphene on Microstructure and Compressive Strength of Cement Mortars utilizing Two Different Dispersion Methods*

2021 Rebekah Krol
Thesis: *Rehabilitation of Timber Piles using Fiber Reinforced Polymers Analyzed with Acoustic Emission*

Undergraduate research assistants

Craig Moore (expected, 2025), Sydney Flowers (expected, 2025), Tanner Mesaric (expected, 2024), Bryson Henderson (2023), Sydney Houck (2023), Samuel Dickson (2023), Raekwon Heyward (2023).