

## Short Bio

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Salma Mozaffari is a doctoral researcher advised by Prof. Thomas Vogel at the Institute of Structural Engineering (IBK) at ETH Zurich. She is also affiliated with the Polyhedral Structural Laboratory (PSL) at Weitzman School of Design at the University of Pennsylvania, working with her co-advisor, Prof. Masoud Akbarzadeh. Her doctoral research focuses on developing Algebraic Graphic Statics formulations and applying Layout Optimization algorithms to generate Strut-and-Tie Models to design two- and three-dimensional reinforced concrete structural components. During her masters' studies, she researched System Identification algorithms and statistical data processing techniques in developing equations for damping ratio estimation of buildings. She also investigated the application of data analysis algorithms in the health monitoring of bridges to mitigate the environmental influences on the sensor-measured data. Mozaffari's professional experience in the United States and Switzerland, including various projects on the design, rehabilitation, and restoration of buildings and bridges, has prepared and motivated her to engage industrial partners with real-world engineering problems in her future research projects.

## Research Interests

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- Interdisciplinary research at the interface of structural engineering, architecture, and digital fabrication
- Resource-aware structural design and optimization
- Algebraic and computational geometry for conceptual structural and architectural design
- Adaptation of historical construction principles with innovative fabrication techniques
- Data-driven evaluation and damage detection of existing structures
- Monitoring, assessment, and rehabilitation of infrastructures

## Education

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- Expected 2021 **Swiss Federal Institute of Technology (ETH)**, Zurich, CH  
Doctor of Sciences, Department of Civil, Environmental, and Geomatic Engineering
- 2012 **Northeastern University (NEU)**, Boston, US  
Master of Science in Structures, Department of Civil and Environmental Engineering
- 2008 **K. N. Toosi University of Technology (KNTU)**, Tehran, IR  
Bachelor of Science in Civil Engineering, Department of Civil Engineering

## Academic Experience

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- Jul. 2016-  
Present **Doctoral Researcher**, ETH, Institute of Structural Engineering, Zurich, CH  
Chair of Structural Design and Existing Structures  
Dissertation: *Development of Strut-and-Tie Models for Reinforced Concrete Components*  
Advisors: *Prof. T. Vogel, Prof. M. Akbarzadeh, and Prof. J. Schwartz*
- Investigating and developing novel computational methods for the generation of strut-and-tie models and stress fields for reinforced concrete design based on algebraic graphic statics and truss optimization algorithms
- Jan. 2017-  
Jul. 2019 **Co-Advisor**, ETH, Institute of Structural Engineering, Zurich, CH  
with *Prof. T. Vogel*  
Master Project (101-0198-01): *Structural Design of Office Building, Stans, CH, Spring 2017*

- Master Thesis (101-0010-00): *Structural Analysis of CaixaForum*, Madrid, ES, Spring 2018  
 Master Thesis (101-0010-00): *Computational Generation of Strut-and-Tie Models*, Spring 2019, In collaboration with the Chair of Structural Design (Prof. J. Schwartz)
- Formulated project definition, problem statement, and objectives
  - Planned project tasks and arranged field trips
  - Co-advised students on research development and step-wise assignments
  - Evaluated and graded theses and final reports

- Sep. 2016-  
Dec. 2019 **Teaching Assistant**, ETH, Institute of Structural Engineering, Zurich, CH  
 Course: *Plate and Shell Structures* (101-0149-00), Fall 2016, 2018, and 2019  
 Instructors: Prof. T. Vogel and Prof. S. Fricker
- Assisted in course planning, lecture notes improvement, and lecture preparation
  - Prepared and graded assignments
  - Assisted students with assignments and course material
  - Organized workshops on finite element analysis of folded plates using SOFiSTiK

Course: *Conceptual Design for Bachelors* (101-0007-01), Fall 2017  
 Project: *Design of bus station expansion*, Birmensdorf, CH  
 Instructor: Prof. T. Vogel

Course: *Conceptual Design for Masters* (101-0007-00), Fall 2016  
 Project: *Design of detour road Julierstrasse H3a*, Cunter-Savognin, CH  
 Instructors: Prof. T. Vogel, H. Figi, and H. Schnetzer

- Assisted in course planning, lecture preparation, and field trip organization
- Co-advised students groups on the design assignments in class and during office hours
- Planned and organized mid and final reviews (with guest critics)
- Evaluated and graded assignments and final reports

- Dec. 2012-  
Feb. 2013 **Construction Assistant**, Massachusetts Institute of Technology, Boston, US  
 Project: *Exhibition at National Building Museum in Washington, D.C. titled "Palaces for the People: Guastavino and America's Great Public Space,"* part of the Guastavino Project at MIT  
 Advisor: Prof. J. Ochsendorf
- Assisted in material preparation and construction of the tile vault

- Jan. 2011-  
Feb. 2013 **Researcher**, NEU, Dept. of Civil and Environmental Eng., Boston, US  
 Research Project: *Linear Projection Techniques in Vibration-based Damage Detection* (Thesis)  
 Advisors: Prof. D. Bernal and Dr. M. Döhler
- Researched the efficiency of statistical linear projection techniques in vibration-based structural damage detection under changing environmental conditions

Research Project: *Equivalent Modal Damping Ratios from Response of Instrumented Buildings*  
 Advisor: Prof. D. Bernal

- Performed system identification algorithms and statistical analysis on the response acceleration data of sensor-instrumented buildings to develop equations for predicting the damping ratios of concrete, steel, and masonry buildings

- Dec. 2010-  
Apr. 2011 **Lab Supervisor**, NEU, Dept. of Civil and Environmental Eng., Boston, US  
 Project: *ASCE National Concrete Canoe Competition*
- Supervised a team of undergraduate students during the construction of the canoe

- Spring 2011 **Teaching Assistant**, NEU, Dept. of Civil and Environmental Eng., Boston, US  
 Course: *Structural Analysis II* (CIVE 3522)  
 Instructor: Prof. A. Youssef
- Assisted in assignments preparation and grading
  - Assisted students with assignments and course material

## Awards

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- 2016      **Research and Teaching Assistantship**, ETH, Institute of Structural Engineering
- 2011      **Research Assistantship**, NEU, Department of Civil and Environmental Engineering, funded by California Strong Motion Instrumentation Program (CSMIP)
- 2010      **Teaching Assistantship**, NEU, Department of Civil and Environmental Engineering
- 2004      **Iranian National Scholarship for Undergraduate Education**, ranked as top one percent students in the nation-wide university entrance exam for undergraduate education and awarded the National Scholarship

## Professional Experience

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- Feb. 2015-  
Jun. 2016      **Caprez Ingenieure AG**, Zurich, CH  
Structural Engineer  
*Main Projects:*
- Design competition for the Second Hinterhein Bridge, Reichenau, GR
  - Earthquake safety assessment and inspection of Rotbuchstrasse residentials, Zurich, ZH
  - Recalculation and redesign of reinforced concrete components of a residential, Davos, GR
  - Inspection and assessment of existing bridges, Gossau, SG
- Mar. 2013-  
Nov. 2014      **STV Incorporated**, Boston, US  
Structural Engineer  
*Main Projects:*
- Rehabilitation of Longfellow Bridge, Boston-Cambridge, MA
  - Design of new pedestrian bridge to the Esplanade, Boston, MA
  - Design of a bus terminal for Worcester Regional Transit Authority, Worcester, MA

## Publications

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- 2022      M. Hablicsek, **S. Mozaffari**, M. Akbarzadeh, "Algebraic formulation for polyhedral graphic statics," *Book Chapter* In Akbarzadeh, et al., editors, *3D Graphic Statics*, Cambridge University Press, In preparation
- 2021      **S. Mozaffari**, M. Hablicsek, M. Akbarzadeh, T. Vogel, "Polyhedral graphic statics in a continuum: 3D strut-and-tie models for reinforced concrete," *Computers and Structures*, In preparation
- 2021      **S. Mozaffari**, M. Hablicsek, M. Akbarzadeh, T. Vogel, "Developing a polyhedral graphic statics formulation for tetrahedral truss analysis," *IASS Symposium*, Guildford, UK, accepted
- 2020      **S. Mozaffari**, M. Akbarzadeh, T. Vogel, "Graphic statics in a continuum: strut-and-tie models for reinforced concrete," *Computers and Structures* 240:106335
- 2019      **S. Mozaffari**, M. Akbarzadeh, T. Vogel, "Generation of strut-and-tie models and stress fields for structural concrete components," In *Proceedings of Structures Congress 2019: Blast, Impact Loading, and Research and Education* 353-361, Orlando, US
- 2018      **S. Mozaffari**, M. Akbarzadeh, T. Vogel, "Development of three-dimensional strut-and-tie models for structural concrete components," In *Proceedings of the 12<sup>th</sup> fib International Ph.D. Symposium in Civil Engineering* 609-615, Prague, CZ
- 2015      D. Bernal, M. Döhler, **S. Mozaffari**, K. Kwan, Y. Liu, "First mode damping ratios for buildings," *Earthquake Spectra* 31.1: 367-381

- 2013 **S. Mozaffari**, D. Bernal, M. Döhler, “Change detection under environmental variability,” In *Proceedings of the 5<sup>th</sup> International Operational Modal Analysis Conference (IOMAC) 674-681*, Guimarães, PT
- 2013 **S. Mozaffari**, M. Döhler, D. Bernal, “Linear projection techniques in damage detection under a changing Environment,” In *Proceedings of the 31<sup>st</sup> Conference and Exposition on Structural Dynamics (IMAC-XXXI)*, Springer, Topics in Modal Analysis, 7:325-332, Garden Grove, US
- 2012 **S. Mozaffari**, “Examination of linear projection techniques for mitigation of environmental effects in vibration-based damage detection,” *Master Thesis*, Northeastern University, Boston, US
- 2012 D. Bernal, **S. Mozaffari**, K. Kwan, M. Döhler, “Damping identification in buildings from earthquake records,” In *Proceedings of the Seminar on Utilization of Strong-Motion Data (SMIP12)*, 39-56, Sacramento, US
- 2012 **S. Mozaffari**, D. Bernal, “An examination of some aspects of Factor Analysis in damage detection,” In *Proceedings of the 30<sup>th</sup> Conference and Exposition on Structural Dynamics (IMAC-XXX)*, Springer, Topics in Modal Analysis, 6:399-404, Jacksonville, US

## Presentations

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- May 2021 **Reinforced concrete design - development of truss models**, *Lecture in ARCH 739 - MS Capstone*, Taubman College of Architecture and Urban Planning, University of Michigan, Ann Arbor, US
- Feb. 2021 **Development of strut-and-tie models for reinforced concrete**, *Research Colloquium*, Chair of Concrete Structures and Bridge Design, IBK, ETH, Zurich, CH
- Oct. 2019 **Graphic statics in a continuum: strut-and-tie models for reinforced concrete**, *IASS Symposium*, Barcelona, ES
- Apr. 2019 **Generation of strut-and-tie models and stress fields for structural concrete components**, *Structures Congress*, Orlando, US
- Mar. 2019 **Generation of strut-and-tie models for reinforced concrete**, *Research Colloquium*, Chair of Structural Design and Existing Structures, IBK, ETH, Zurich, CH
- Aug. 2018 **Development of three-dimensional strut-and-tie models for structural concrete components**, *12<sup>th</sup> fib International Ph.D. Symposium in Civil Engineering*, Prague, CZ
- Jul. 2018 **Development of strut-and-tie models based on layout optimization and algebraic graphic static**, *Research Colloquium*, Chair of Structural Design and Existing Structures, IBK, ETH, Zurich, CH
- Jun. 2017 **Development of 3D strut-and-tie models for structural concrete components**, *Research Colloquium*, Doctoral Research Proposal, Chair of Structural Design and Existing Structures, IBK, ETH, Zurich, CH
- Apr. 2014 **Structural surfaces**, *Parametric Design Practices Symposium and Workshop*, Washington State University, Pullman, US
- Sep. 2014 **Hot-Dip galvanization**, *Special Research Topics Presentation Series*, STV Inc., Boston, US
- Jun. 2013 **Longfellow bridge rehabilitation**, *Structures Group Seminar Series*, NEU, Boston, US

- Apr. 2012 **Examination of factor analysis for mitigation of environmental effects in vibration-based damage detection**, *23<sup>rd</sup> Annual Communication and Digital Signal Processing (CDSP) Research Conference*, Poster Presentation, NEU, Boston, US
- Mar. 2012 **Examination of factor analysis for mitigation of environmental effects in vibration-based damage detection**, *Research Innovation Scholarship Expo (RISE)*, Poster Presentation, NEU, Boston, US
- Feb. 2012 **An examination of some aspects of factor analysis in damage detection**, *30<sup>th</sup> Conference and Exposition on Structural Dynamics (IMAC-XXX)*, Jacksonville, US
- Nov. 2011 **Factor analysis in damage detection**, *Structures Group Seminar Series*, NEU, Boston, US

## Guest Critic

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- May 2021 **Mid-rise Timber Structural Design Research Studio** (ARCH 705-001), *final review*, Weitzman School of Design, University of Pennsylvania (instructor: Prof. M. Akbarzadeh)
- Apr. 2021 **Systems Engagement** (ARCH 708), *final review*, Taubman College of Architecture and Urban Planning, University of Michigan (instructor: Prof. A. Adel)
- Mar. 2021 **Mid-rise Timber Structural Design Research Studio** (ARCH 705-001), *mid-review*, Weitzman School of Design, University of Pennsylvania (instructor: Prof. M. Akbarzadeh)
- Dec. 2020 **Structural Design** (101-0123-00L), *final review*, Department of Civil, Environmental, and Geomatic Engineering, ETH Zurich (instructors: Prof. P. Block, Dr. P. D'Acunto, and Dr. P. Olhbrock)
- May 2020 **Structural Design IV** (052-0608-00L), *final review*, Department of Architecture, ETH Zurich (instructors: Prof. J. Schwartz and Prof. P. Block)
- May 2019 **Structural Design IV** (051-0414-00L), *final review*, Department of Architecture, ETH Zurich (instructors: Prof. J. Schwartz and Prof. P. Block)

## Skills

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### Software

- Structural Analysis: *SOFiSTiK, Cubus, STAAD.Pro, Karamba3D*
- Programming: *Python, MATLAB, C#*
- CAD/Parametric: *AutoCAD, Rhinoceros, Grasshopper*
- Others: *LaTeX, InDesign, Illustrator, Mathcad, Microsoft Project, Microsoft Office*

### Language

- Fluent: *Farsi, English, and German* (CI certificate)
- Basic: *Turkish and French*

## Certificates - Extracurricular Courses

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- Spring 2021 **Fostering Interaction in Lectures for Large Classes**, ETH Zurich, *certified*
- Spring 2020 **Karamba 3D Workshop**, McNeel Europe, *certified*
- Spring 2019 **Presentation Skills**, University of Zurich, *certified*
- Fall 2019 **Principles of Computing (Part2)**, Rice University, Coursera, *certified*
- Spring 2018 **Project Management for Research**, University of Zurich, *certified*

- Spring 2018     **Deterministic Optimization**, Georgia Tech University, edX, *certified*
- Spring 2017     **Principles of Computing (Part I)**, Rice University, Coursera, *certified*
- Spring 2016     **Introduction to Computer Science and Programming Using Python**, edX, *certified*
- Fall 2013        **Building Structural Systems II (4.463)**, Audited at MIT, with *Prof. J. Ochsendorf*
- Spring 2013     **Analysis of Historic Structures (4.448)**, Audited at MIT, with *Prof. J. Ochsendorf*
- Fall 2012        **Building Structural Systems I (4.462)**, Audited at MIT, with *Prof. J. Ochsendorf*
- Winter 2012    **Machine Learning (CS 229)**, Stanford University Online Course, with *Prof. A. Ng*
- Summer 2011    **Linear Algebra (18.06)**, MIT Online Course, with *Prof. G. Strang*
- Fall 2011        **Finite Element Analysis of Solids and Fluids I (2.093)**, Audited at MIT, with *Prof. K.J. Bathe*

## Organizations

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- Sep. 2016 - Present     Member, **Association of Scientific Staff at ETH Zurich (AVETH)**
- Mar. 2013 - Oct. 2014   Member, **Advancing Women in Transportation (WTS-Boston)**
- Feb. 2012 - Aug. 2013   Member, **Society for Experimental Mechanics (SEM)**

## References

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### Thomas Vogel

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[vogel@ibk.baug.ethz.ch](mailto:vogel@ibk.baug.ethz.ch)

### Masoud Akbarzadeh

Assistant Professor, Polyhedral Structures Laboratory, Weitzman School of Design, University of Pennsylvania, Philadelphia, US  
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### Dionisio Bernal

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### Joseph Schwartz

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### Márton Hablicsek

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