Prajwal Kammardi Arunachala

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Education and Training

Johns Hopkins University, Baltimore, U.S. Current
Postdoctoral Researcher | Advisor - Dr. Somnath Ghosh

Stanford University, Stanford, U.S. September 2024
Ph.D. in Civil and Environmental Engineering | Advisor - Dr. Christian Linder *GPA: 4.08/4*
Dissertation Committee - Dr. Ronaldo Borja, Dr. Gregory Deierlein, Dr. Renee Zhao, Dr. Wendy Gu

Stanford University, Stanford, U.S. April 2019
M.S. in Civil and Environmental Engineering *GPA: 4.07/4*

Indian Institute of Technology Bombay, Mumbai, India May 2017
B.Tech. (with Honors) in Civil Engineering | Minor in Computer Science Engineering *GPA: 9.65/10*

Honors and Awards

Juan C. Simo Best Thesis Award 2024
- Awarded by the Mechanics & Computation Division, Department of Mechanical Engineering, Stanford University

Finalist, Robert J. Melosh Medal Competition 2024
- Annual competition for best paper on finite element analysis by Duke University

Rising Stars in Computational & Data Sciences 2024
- Selected for the prestigious workshop at the Oden Institute of Computational Engineering and Sciences, The University of Texas at Austin

Runner-up, Modeling Inelastic and Multiscale Behavior (MIMB) Competition 2023
- Annual student paper competition at Engineering Mechanics Institute (EMI) Conference

Travel Awards for U.S. National Congress on Computational Mechanics 2021,2023

Leavell Fellowship at Stanford University 2020-2022

Stanford School of Engineering Graduate Fellowship 2017-2018

Institute Silver Medal, Vidyasagar Nehra and Prof. Madhav Kulkarni Gold Medals 2017
- Awarded for graduating from IIT Bombay as Civil department topper of the batch with Honors

S.C.Mehrotra Prize, Institute Academic Prize 2014-2016
- Awarded consecutively for three and two years respectively for academic excellence at IIT Bombay

Undergraduate Research Award (URA01) 2016
- Awarded for excellence in research at IIT Bombay

National Talent Search (NTS) Scholarship 2009-2016
- Recepient of the venerated National level merit scholarship awarded by the National Council of Education Research and Training, Government of India

Kishore Vaigyanik Protsahan Yojana (KVPY) Scholarship 2013
- Selected for the prestigious National Program of Fellowship in Basic Sciences awarded by the Department of Science and Technology, Government of India

Karnataka Common Entrance Test (KCET) 2013
- Topped the state engineering entrance examination among 100,000 students

Major Research Experiences

Johns Hopkins University, Baltimore, U.S. Sep'24-Current

Postdoctoral Research | Guide - Dr. Somnath Ghosh

- Studying fatigue behavior of complex polycrystalline materials like aluminum and titanium alloys
- Investigated the effects of microstructural morphologies like grain size, orientations, boundaries, and misorientations on short-crack growth in the crystal structure
- Developed state-of-the-art coupled crystal plasticity-phase field models accounting for dislocation motions and interactions, anisotropic crack paths, and degradation of toughness with cyclic loading
- Utilizing multi-time scaling methods to simulate even high cycle fatigue behavior and parametrically upscaling of these microscale models for large-scale industrial applications
- Validated the model by collaborating with experimentalists in Brazil and achieved less than 10% error in crack paths within complex polycrystalline microstructures

Stanford University, Stanford, U.S. Apr'19-Sep'24

Doctoral Thesis | Guide - Dr. Christian Linder

- Thesis title -"*Computational modeling of fracture behavior of rubber-like materials*"
- Proposed the first multiscale models in literature for quantitatively capturing the effect of strain-induced crystallization phenomenon on fracture initiation and propagation of rubber-like materials
- Accounted for key microscale properties like molecular bond distortions, polymer chain entropy, crystalline phase interface energy, bond rupture, and crystallite distortion
- Modified kinematically compatible and even anisotropic network models for damaged chain applications
- Fabricated samples and performed experiments to study fracture behavior of PDMS rubber
- Validated the models using data from 10 different experimental studies with high accuracy
- Awarded with Juan C. Simo Best Thesis Award for outstanding contributions to the mechanics field

Indian Institute of Technology Bombay, Mumbai, India Jul'15-Apr'17

Undergraduate Thesis | Guides - Dr. Amit Das & Dr. Mandar Inamdar

- Thesis title - "*Mechanical formulations of plates on elastic foundations*"
- Developed an extended formulation of the von-Karman theory by accounting for shear deformations
- Incorporated effects of temperature and moisture, and studied effect of different elastic foundations
- Modeled joints and slab-subgrade contact for an improved prediction of the durability of pavements
- Validated the model for different size-thickness ratios with accuracy greater than 95%
- Awarded with Undergraduate Research Award (URA01) for excellence in research

École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland May'16-Jul'16

Summer Research Internship | Guide - Dr. Ian Smith

- Modeled the folding of an active tensegrity structure as an application to deployable bridges
- Obtained optimum control command for its deployment utilizing a stochastic search algorithm
- Included features like continuous cables and non-conventional boundaries to simulate test conditions
- Performed static, modal and damage detection analysis to verify mechanical stability during deployment

University of New South Wales, Sydney, Australia May'15-Jul'15

Summer Research Internship | Guides - Dr. Brian Uy & Dr. Vipulkumar Ishvarbhai Patel

- Modeled the behaviour of axially loaded concrete filled steel tubular using finite element model
- Automated the process by using a `Python` script to run multiple simulations on `Abaqus` software
- Developed a code to find the load-strain behaviour by nonlinear inelastic analysis
- Validated the model by comparing with experimental data with an accuracy greater than 98%

Multi-Institute Collaboration Projects

NASA Space Technology Research Institute (STRI) Sep'24-Current

Guide/PI - Dr. Somnath Ghosh, Johns Hopkins Univ. & Dr. Anthony Rollett, Carnegie Mellon Univ.

- Institute name - "*Institute for Model-based Qualification and Certification of Additive Manufacturing*"
- Part of the team focused on multiscale modeling with uncertainty quantification for fatigue life prediction of additively manufactured Ti-6Al-4V and Inconel 718 alloys
- Understanding the interaction between defect structure and crystallographic morphology, and their effects on the short-crack growth behavior
- Developing novel coupled crystal plasticity-phase field models incorporating effects of multiple phases, crystallographic morphology, and pores on driving the fatigue behavior
- Actively collaborating with researchers across various universities and institutions for modeling microstructure, validation studies, optimizing numerical efficiency, and quantifying uncertainty

Predictive Science Academic Alliance Program (PSAAP) III Oct'20-Sep'24

Guide/PI - Dr. Christian Linder, Stanford Univ. & Dr. Richard Regueiro, Univ. of Colorado Boulder

- Center name - "*Multi-disciplinary Simulation Center (MSC) for Micromorphic Multiphysics Porous and Particulate Materials Simulations Within Exascale Computing Workflows*"
- Part of the team evaluating the utility of continuum formulations in generalized continua to model experimentally observed macroscale fracture behavior of mock high explosive material
- Evaluated the utility of embedded finite element method (EFEM) in simulating their fracture behavior
- Investigated and integrated contact formulation along with micropolar gradient damage approach
- Collaborated to obtain DNS upscaled data using filtering domains and incorporated this heterogeneity in material properties to enhance modeling capacity for these granular materials

Journal Publications

J.15 **P.K.Arunachala**, S.Ghosh, Generalized coupled crystal plasticity-phase field framework for fatigue short crack propagation in polycrystalline metallic alloys [*In preparation*]

J.14 **P.K.Arunachala**, J. Stickel, T.R.F.Cavalcante, J.A.A.Díaz, S.Ghosh, Microstructure-informed fatigue short-crack propagation model for polycrystalline rolled aluminum alloys [*In preparation*]

J.13 **P.K.Arunachala**, S.Abrari Vajari, C.Linder, A multiscale phase field fracture approach for strain-crystallizing rubber-like materials [*In preparation*]

J.12 **P.K.Arunachala**, S.Abrari Vajari, C.Linder, A multiscale mixed three-field finite element formulation coupled with phase field fracture for incompressible rubber-like materials, *International Journal for Numerical Methods in Engineering* [*In review*]

J.11 S.Abrari Vajari, M.Neuner, **P.K.Arunachala**, C.Linder, A micropolar phase field fracture model for elastoplastic solids with application to concrete failure, *International Journal for Numerical Methods in Engineering* 2025:126(19), e70140

J.10 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, J.S.Sim, R.Zhao, C.Linder, A multiscale anisotropic polymer network model coupled with phase field fracture, *International Journal for Numerical Methods in Engineering* 2024:125(13), e7488

J.9 H-C.Wu, S.Nikzad, C.Zhu, H.Yan, Y.Li, W.Niu, J.R.Matthews, J.Xu, N.Matsuhisa, **P.K.Arunachala**, R.Rastak, C.Linder, Y-Q.Zheng, M.F.Toney, M.He, Z.Bao, Highly stretchable polymer semiconductor thin films with multi-modal energy dissipation and high relative stretchability, *Nature Communications* 2023:14(1), 8382

J.8 S.Abrari Vajari, M.Neuner, **P.K.Arunachala**, C.Linder, Investigation of driving forces in a phase field approach to mixed mode fracture of concrete, *Computer Methods in Applied Mechanics and Engineering* 2023:417, 116404

J.7 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, C.Linder, A multiscale phase field fracture approach based on the non-affine microsphere model for rubber-like materials, *Computer Methods in Applied Mechanics and Engineering* 2023:410, 115982

J.6 Y.Qiu, **P.K.Arunachala**, C.Linder, SenseNet: A physics-informed deep learning model for shape sensing, *Journal of Engineering Mechanics* 2023:149(3), 04023002

J.5 M.Neuner, S.Abrari Vajari, **P.K.Arunachala**, C.Linder, A better understanding of the mechanics of borehole breakout utilizing a finite strain gradient-enhanced micropolar continuum model, *Computers and Geotechnics* 2023:153, 105064

J.4 S.Abrari Vajari, M.Neuner, **P.K.Arunachala**, A.Ziccarelli, G.Deierlein, C.Linder, A thermodynamically consistent finite strain phase field approach to ductile fracture considering multi-axial stress states, *Computer Methods in Applied Mechanics and Engineering* 2022:400, 115467

J.3 **P.K.Arunachala**, R.Rastak, C.Linder, Energy based fracture initiation criterion for strain-crystallizing rubber-like materials with pre-existing cracks, *Journal of the Mechanics and Physics of Solids* 2021:157, 104617

J.2 W.Wang, S.Wang, R.Rastak, Y.Ochiai, S.Niu, Y.Jiang, **P.K.Arunachala**, Y.Zheng, J.Xu, N.Matsuhisa, X.Yan, S-K.Kwon, M.Miyakawa, Z.Zhang, R.Ning, A.Foudeh, Y.Yun, C.Linder, J.B-H.Tok, Z.Bao, Strain-insensitive intrinsically stretchable transistors and circuits, *Nature Electronics* 2021:4(2), 1-8

J.1 V.I.Patel, B.Uy, **K.A.Prajwal**, F.Aslani, Confined concrete model of circular, elliptical and octagonal CFST short columns, *Steel and Composite Structures, An International Journal* 2016:22(3), 497-520

Presentations and Posters

Conference Presentations

P.20 **P.K.Arunachala**, J.Stickel, S.Ghosh, Fatigue short crack propagation in polycrystalline microstructures using a coupled crystal plasticity-phase field model, *U.S. National Congress on Computational Mechanics (USNCCM)*, Chicago, July 2025.

P.19 **P.K.Arunachala**, C.Linder, A multiscale phase field formulation for capturing the fracture behavior of rubber-like materials, *Engineering Mechanics Institute (EMI) Conference*, Chicago, May 2024.

P.18 **P.K.Arunachala**, W.Xue, M.Neuner, C.Linder, Multiscale phase field mixed formulation for predicting fracture behavior in incompressible rubber-like materials, *U.S. National Congress on Computational Mechanics (USNCCM)*, Albuquerque, July 2023.

P.17 **P.K.Arunachala**, M.Neuner, C.Linder, Capturing anisotropy in network response in rubber-like materials using a multiscale phase field formulation, *Engineering Mechanics Institute (EMI) Conference*, Georgia Institute of Technology, Atlanta, June 2023.

P.16 **P.K.Arunachala**, M.Neuner, S.Abrari Vajari, C.Linder, Multiscale phase field approach for modeling fracture behavior in rubber-like materials, *Engineering Mechanics Institute (EMI) Conference*, Johns Hopkins University, Baltimore, June 2022.

P.15 **P.K.Arunachala**, R.Rastak, C.Linder, Multiscale mechanical model coupled with an energy-based criterion for predicting fracture initiation in strain-crystallizing rubbers, *U.S. National Congress on Computational Mechanics (USNCCM)*, Virtual, July 2021.

P.14 **P.K.Arunachala**, R.Rastak, C.Linder, Effect of strain-induced crystallization on fracture of rubber-like materials, *Engineering Mechanics Institute (EMI) Conference*, California Institute of Technology, Pasadena, June 2019.

Invited Talks, Seminars, and Review Meetings

P.13 S.Ghosh, **P.K.Arunachala**†, Coupled phase field frameworks for micromechanical fracture crack propagation in metallic alloys and composites, *CHiMaD Phase Field Workshop XIX*, Northwestern University, Evanston, November 2025 [*Scheduled Invited Talk*].

P.12 S.Ghosh⋆, **P.K.Arunachala**⋆, Coupled phase field-crystal plasticity FEM framework for fatigue crack propagation in polycrystalline materials, *Extraordinary Materials for Extreme Conditions (ONR) Annual Review*, Duke University, Durham, August 2025.

P.11 **P.K.Arunachala**, S.Ghosh, Fatigue crack growth with CPFEM and phase field modeling in additively manufactured Ti-6Al-4V and 718 Alloys, *Institute for Model-Based Qualification & Certification of Additive Manufacturing (NASA STRI) Annual Review*, Johns Hopkins University, Baltimore, August 2025.

P.10 **P.K.Arunachala**, C.Linder, A multiscale phase field formulation for capturing fracture behavior of rubber-like materials, *Robert J. Melosh Medal Competition*, Duke University, Durham, October 2024.

P.9 **P.K.Arunachala**, C.Linder, [*Poster*] Computational modeling of fracture behavior of polymers, *Stanford-IIT Bombay Workshop on Sustainability*, Stanford University, Stanford, July 2024.

P.8 **P.K.Arunachala**, C.Linder, Multiscale framework for fracture modeling in rubber-like materials, *Rising Stars in Computational & Data Sciences*, Oden Institute, Austin, May 2024.

P.7 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, C.Linder, A multiscale fracture model for rubber-like materials, *School of Sustainability Research Review*, Stanford University, Stanford, May 2023.

P.6 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, C.Linder, Non-affine multiscale fracture model for rubber-like materials, *Berkeley/Stanford Computational Mechanics Festival (CompFest)*, Stanford University, Stanford, December 2022.

P.5 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, C.Linder, [*Poster*] A multiscale fracture model using phase field approach, *Blume/SURI Affiliate and Alumni Meeting*, Stanford University, Stanford, October 2022.

P.4 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, C.Linder, [*Poster*] A multiscale fracture model using phase field approach, *Center for Micromorphic Multiphysics Porous and Particulate Materials Simulations with Exacale Computing Workflows, Advanced Simulation and Computing (PSAAP III) Annual Review*, University of Colorado, Boulder, September 2022.

P.3 **P.K.Arunachala**, M.Neuner, S.Abrari Vajari, C.Linder, Multiscale fracture model for rubber-like polymers, *CEE Summer Student Speaker Series*, Stanford University, Stanford, July 2022.

P.2 **P.K.Arunachala**, S.Abrari Vajari, M.Neuner, C.Linder, Embedded Finite Element Method in MOOSE for modeling crack propagation, *Center for Micromorphic Multiphysics Porous and Particulate Materials Simulations with Exacale Computing Workflows, Advanced Simulation and Computing (PSAAP III) Annual Review*, Virtual, September 2021.

P.1 **P.K.Arunachala**, R.Rastak, C.Linder, Energy criterion for fracture initiation in strain-crystallizing rubbers, *Berkeley/Stanford Computational Mechanics Festival (CompFest)*, Virtual, August 2020.

† Presenter ⋆ Joint presentation

Teaching Experiences

Finite Element Methods (EN 560.730.01), Johns Hopkins University Autumn 2025

Guest Lecturer | Instructor - Dr. Somnath Ghosh

- Delivered lectures on solvers commonly utilized for finite element methods

Computational Fracture Mechanics (CEE 306), Stanford University Spring 2024

Instructor-in-charge

- Instructed a class of 14 students as the primary instructor of the course
- Restructured course content, prepared lectures, modified assignments, and refined custom projects
- Mentored students in performing the complex fracture simulations for their projects
- Quality of instruction received mean 4.5/5 and median 5/5 among 12 end-term course evaluations

Solid Mechanics (CEE 291), Stanford University Autumn 2019,2020,2023

Guest Lecturer, Teaching Assistant | Instructor - Dr. Christian Linder

- Provided guest lectures on thermodynamics laws, FEM, plasticity modeling, 3D mathematical concepts
- Redesigned the course tutorial lectures and formulated programming examples to help students better understand `Julia` language for completing their programming tasks
- Provided many off-hour one-on-one help sessions, especially during the Covid-19 lockdown, to assist students with their conceptual difficulties
- Teaching effectiveness received mean 4.36/5 and median 4.5/5 among 14 end-term evaluations in 2019

Computational Fracture Mechanics (CEE 306), Stanford University Spring 2021

Teaching Assistant | Instructor - Dr. Christian Linder

- Assisted the instructor in rebasing the finite element framework for the course from the `deal.ii`-based in-house code to the open-source library `MOOSE` by restructuring the programming assignments
- Developed tutorial lectures and led office hour discussions to aid students with conceptual understanding
- Designed default course projects involving fracture simulations with structured deliverables
- Mentored student groups in understanding, implementing and performing simulations for their projects
- Teaching effectiveness received mean 4.57/5 and median 5/5 among 7 end-term course evaluations

Continuum Mechanics (CEE 312/ME 338), Stanford University Spring 2020

Teaching Assistant | Instructor - Dr. Christian Linder

- Adapted the teaching technique for facilitating a seamless course experience for students during the Covid-19 lockdown while holding virtual tutorial lectures and office hours
- Revamped the course tutorial lectures to ensure easy and comprehensive understanding of the `deal.ii`-based in-house code for finite element implementations during assignments

Engineering Mechanics (CE 101), IIT Bombay Spring 2015,2017

Teaching Assistant | Instructors - Dr. Arghadeep Laskar, Dr. D.M.Dewaiker

- Led the tutorial sections for helping students with solving problems and clarifying conceptual questions
- Initiated the formation of a Facebook group for informal interactions and additional material sharing
- Provided off-hour group help sessions to aid students with their conceptual questions

Mentoring Experiences

Mentor, USNCCM18 Mentoring Program Jul'25

- Volunteered as a mentor for a Ph.D. student, providing academic and career advice

Graduate Student Mentor, Stanford University & Johns Hopkins University Sep'22-Current

- Mentoring junior Ph.D. students of my research groups in their academic and research phases

Undergraduate Student Mentor, IIT Bombay Apr'16-Mar'17

- Selected as a part of a 24 member group under the *Department Academic Mentorship Program*
- Mentored a group of 6 sophomores in their academic and co-curricular pursuits
- Part of the ideation team of the *Department Open House* to increase student-teacher interaction
- Contributed to online course blogs to assist decisions of future batch students while selecting courses

Leadership and Service

U.S. Association for Computational Mechanics (USACM) Student Chapter 2023-2024

Member-at-Large, Student Leadership Board

- Selected as a part of the inaugural 10 member team across U.S. to launch and shape its future goals
- Part of the planning and execution team of *Student Meet and Greet* socializing event at the *U.S. National Congress on Computational Mechanics (USNCCM) 2023* for increasing the outreach
- Initiated the *Computational Mechanics Student Mentorship Program (CMSMP)* to help students in the field get proper guidance regarding career and graduate journeys
- Actively reached out to various R1 and R2 universities, and successfully matched 42 mentee-mentor pairs, with more than 35% of them belonging to underrepresented minority groups
- Program experience was rated 5/5 by 7 out of 9 mentees who submitted the annual feedback form

Stanford Hindu Students Association 2019-2021

President/Financial Officer, Student Leadership Board

- Worked with the *Office of Student Engagement* and *Office for Religious & Spiritual Life* at Stanford to foster a sense of belonging to the Hindu community through spiritual events and celebrating festivals
- Organized events ensuring inclusivity to all students by even collaborating with other religious groups
- Led a team of 8 members in planning, collaborating with four other Stanford student groups, incentivizing, procuring funding and executing the virtual *Stanford Diwali 2020* celebrations during the pandemic
- Integral part of the 8-10 member organizing leaderships of the *Stanford Diwali 2019 & 2021* events, each attended by 1000+ people from the Stanford community
- Participated in the interfaith celebrations during the *Stanford Interfaith Harmony Week 2019*, aimed at exchanging traditions and working towards collaborative multifaith events

Academic Volunteering

- Peer-reviewer for *Journal of the Mechanics and Physics of Solids*, *International Journal for Numerical Methods in Engineering*, *Mechanics of Materials*, *Sensors*, and *Polymer Bulletin*
- Volunteered during the *U.S. National Congress on Computational Mechanics (USNCCM) 2023*
- Part of the organizing research lab of the *Berkeley/Stanford Computational Mechanics Festival (CompFest) 2018 & 2022*, and helped with the execution and technical support during the meet