# Bhavesh Shrimali

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#### Summary

- 7+ years of experience in solid mechanics; specifically in developing nonlinear multiscale finite element codes for incompressible hyperelasticity, viscoelasticity, fracture and homogenization
- 2+ years of experience working on PINNs, Scientific Machine Learning, Neural Operators, Generative Models and Optimization
- Published 6 papers in peer-reviewed journals (*JMPS*: IF 5.582, *EML*: IF 4.728, *IJNLM*: IF 3.336, *J. Elast.*: IF 2.161)

#### RESEARCH Interests

- Computational Mechanics: Nonlinear Finite Elements; Fracture Mechanics; Viscoelasticity; Non-convex Optimization Algorithms
- Deep Learning: Scientific ML; Physics-Informed Neural Networks (PINNs); Optimization

#### **EDUCATION**

#### University of Illinois Urbana-Champaign

- Ph.D., Computational Mechanics (CEE), May 2017 April 2023 (expected)
   Advisor: Prof. Oscar Lopez-Pamies
   Minor: Computational Science and Engineering (CSE)
- M.S., Computer Science Aug 2021 April 2023 (*expected*) 3.98/4.0
- M.S., Civil Engineering (minor: CSE), 2015-17

#### 4.0/4.0

# Indian Institute of Technology (IIT) Guwahati

9.22/10.00

- B.Tech, Civil Engineering, 2011-15
- Ranked 1<sup>st</sup> in the department

#### Publications

- [7] **Bhavesh Shrimali** and Oscar Lopez-Pamies. The delayed fracture test for viscoelastic elastomers. arXiv preprint arXiv:2301.10490, 2023 [preprint]
- [6] **Bhavesh Shrimali** and Oscar Lopez-Pamies. The "pure-shear" fracture test for viscoelastic elastomers and its revelation on griffith fracture. *Extreme Mechanics Letters*, page 101944, 2022
- [5] **Bhavesh Shrimali**, Kamalendu Ghosh, and Oscar Lopez-Pamies. The nonlinear viscoelastic response of suspensions of vacuous bubbles in rubber: I—gaussian rubber with constant viscosity. *Journal of Elasticity*, 2021 [pdf]
- [4] Kamalendu Ghosh, **Bhavesh Shrimali**, Aditya Kumar, and Oscar Lopez-Pamies. The nonlinear viscoelastic response of suspensions of rigid inclusions in rubber: I—gaussian rubber with constant viscosity. *Journal of the Mechanics and Physics of Solids*, page 104544, 2021 [pdf]
- [3] **Bhavesh Shrimali**, Matteo Pezzulla, Samuel Poincloux, Pedro Reis, and Oscar Lopez-Pamies. The remarkable bending properties of perforated plates. *Journal of the Mechanics and Physics of Solids*, 154, 2021 [pdf]
- [2] **Bhavesh Shrimali**, William J. Parnell, and Oscar Lopez-Pamies. A simple explicit model constructed from a homogenization solution for the large-strain mechanical response of elastomeric syntactic foams. *International Journal of Nonlinear Mechanics*, 2020 [pdf]
- [1] **Bhavesh Shrimali** and Victor Lefèvre and Oscar Lopez-Pamies. A simple explicit homogenization solution for the macroscopic elastic response of isotropic porous elastomers. *Journal of the Mechanics and Physics of Solids*, 122:364 380, 2019 [pdf]

TECHNICAL SKILLS .

Languages: Python, C++, Julia, Fortran

FE Libraries: FEniCS, Firedrake, scikit-FEM, NGSolve, GridAP.jl, Ferrite.jl

Commercial FE Packages: ABAQUS, COMSOL (pre-processing)

HPC Libraries: MPI, OpenMP, CUDA

Miscellaneous: Bash, Git, pybind11, Gmsh, Netgen

**DL** frameworks: PyTorch, JAX, Flux.jl

Awards &

Achievements

• Travel Fellowship: Awarded to present my research at WCCM-ECCOMAS, 2020 ['20]

• Outstanding TA: Ranked as an excellent TA for Structural Mechanics ['17, '19]

• Institute silver medal, IIT Guwahati: Ranked first in the graduating class ['15]

• **DAAD-WISE fellowship**: Selected among 150 students in the country to pursue a summer research internship in Germany ['14]

• **IET India Scholarship**: Selected among 170 students from select universities in India based on a nationwide scholastic exam ['14]

• **OPJEMS**: Among the top 50 students selected from all over India for the scholarship ['13]

• **Dhrishti 2012**: Among the *top 5* teams who proposed novel unconventional energy solutions for meeting India's future energy needs ['12]

• Institute Merit Scholarship, IIT Guwahati: Awarded annually to the top ranked student in each department based on the year round academic performance ['12-'15]

• Indian National Olympiads: Selected for the national rounds in Math, Physics and Astronomy ['11]

• KVPY Fellow: Ranked among 209 students from all over the country ['10]

• NTSE Scholar: Secured an All India Rank (AIR) of 324/1000 ['07]

Undergraduate Research Internships

## Technische Universität Braunschweig

[Summer '14]

Advisor: Prof. Dr. Klaus Thiele

Solved an inverse problem to determine the optimal location of a damper to suppress the higher order modes (eigenvalues) of a cable-stayed bridge Nijmegen bridge in Netherlands.

#### Hong Kong University of Science and Technology

[Summer '13]

Advisor: Prof. Christopher K Y Leung

I worked on tuning the proportion of elastomeric and steel fibres in high performance concrete to enhance the post peak softening response. I also worked on validating a FE analysis of a notched beam subject to 3-point bending with the in situ experiments.

Courses

- **Mechanics** Nonlinear Continuum Mechanics, Mechanics of Composites, Constitutive Modeling
- Numerics: Numerical Methods for PDEs, Nonlinear Finite Elements, XFEM, Fast Algorithms and Integral Equations, Multigrid Methods, Computational Inelasticity
- Deep Learning: Deep Generative Models, Machine Learning, Data Mining

**PROJECTS** 

#### "Pure-Shear" rupture of viscoelastic solids

Advisor: Oscar Lopez-Pamies, (CEE) UIUC

[code, Arxiv, paper]

- Developed a theory and a "generalized Griffith" criticality condition for the nucleation of fracture in viscoelastic solids
- Designed a robust nonlinear solver and an adaptive FE code to numerically predict the onset of fracture

#### Delayed Griffith Fracture in viscoelastic solids

2021-

2021-

Advisor: Oscar Lopez-Pamies, (CEE) UIUC

[code, Arxiv]

- Developed a new theory to predict the delayed propagation of fracture in viscoelastic solids
- Numerically and theoretically demonstrated the predictive capabilities of the theory

#### Solving Nonlinear PDEs using Deep Learning

2021-

Advisor: Arindam Banerjee, (CS) UIUC

- Developed a sufficient condition for the convergence of Neural Operators (DeepONets) based on overparameterization
- Empirically verified the theoretical analysis with numerical experiments on a variety of PDE's

# Homogenization of Gaussian rubber with constant viscosity

2020-202

Advisor: Oscar Lopez-Pamies, (CEE) UIUC

[code, paper, paper]

- Developed a closed-form solution for the effective behavior of rubber viscoelastic composites
- Validated the theory with numerical experiments on different classes of rubber composites

### Numerical Homogenization of Multiscale PDEs

2016-2019

Advisor: Oscar Lopez-Pamies, (CEE) UIUC

[code, paper, paper]

- Developed approximate analytical solutions for the effective behavior of porous rubber foams
- Proposed an effective mean-field theory for the mechanical behavior of syntactic foams

#### Conforming/Non-Conforming FE for Perforated Plates

2018-2020

Advisor: Oscar Lopez-Pamies, (CEE) UIUC

paper

- Developed an analytical solution for the effective behavior of perforated Kirchhoff plates
- Computationally validated the theory for plates containing different types of holes; and with different types of loading conditions

#### Multigrid Finite Elements in Hyperelasticity

2018

Guide: Luke Olson, (CS) UIUC

[code, report]

- Implemented a vectorized nonlinear FE code (in pure NumPy) with multigrid solvers from **PyAMG**
- Fine tuned multilevel solvers to achieve comparable performance to direct solvers from scipy