Harkirat Singh

CONTACT INFORMATION

Solid Mechanics
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RESEARCH INTERESTS

Theoretical and Computational Mechanics

EDUCATION

Brown University
Ph.D. in Solid Mechanics — 2018 - present
MS in Solid Mechanics — 2018

Indian Institute of Technology (IIT), Kanpur
Bachelor's and Master's (Dual degree) in Mechanical Engineering — 2016

RESEARCH EXPERIENCE

Graduate Student Researcher — 2018 - present
Advisor: Prof. David Henann
Solid Mechanics, *Brown University*

Research Assistant — 2016-17
Advisor: Prof. Venkatesan
Department of Aerospace, *IIT Kanpur*

Research Assistant — 2015-16
Advisor: Prof. Pankaj Wahi
Mechanics & Applied Mathematics Group, *IIT Kanpur*

TECHNICAL SKILLS

Computational: Finite element analysis, Structural analysis, Numerical methods, Molecular dynamics.

Programming languages: MATLAB, Python, Fortran, C.

Softwares: Abaqus, LAMMPS, Mathematica, Ovito, Maple.

PHD THESIS

Constitutive modeling of size segregation-flow in dense granular materials (May' 18 - Present)

- Formulated constitutive equations for segregation dynamics in bidisperse granular mixtures
- Coupled the model for segregation dynamics with rheological constitutive equations for dense granular mixtures by developing a novel continuum-scale model that enables predictive modeling at large length scales
- Generalized the coupled model in a finite-deformation, elasto-plastic framework which facilitates simulating the segregation/flow dynamics under different loading conditions
- Implemented the coupled continuum framework in the commercial finite-element code Abaqus using a user element (UEL) subroutine
- Used Python scripting in Abaqus to automate several pre/post-processing operations

Discrete element method (DEM) modeling of dense granular mixtures (May' 18 - Present)

- Performed large-scale particle-level simulations which enabled extraction of high fidelity information at small length scales to inform and assess the development of the coupled continuum model for size segregation and flow
- Studied diverse boundary-driven and gravity-driven flows using LAMMPS
- Developed coarse-graining methods to map grain-scale information to continuum-scale

Pressure sensitive shear zones in hydrogel suspensions (May' 22 - Present)
Collaborators: Zohreh Farmani and Joshua Diksman, Wageningen University. Nazanin Ghods, TU Graz

- Used nonlocal continuum modeling to study shear localization in dense hydrogel suspensions in a boundary-driven flow geometry
- Implemented nonlocal granular rheology model using Abaqus UEL subroutine
- Tested model performance against MRI-PIV experimental measurements and DEM simulations

Masters Thesis

Modeling the dynamics of the string vibrating against a rigid obstacle (May '15 - Jul '16)

- Derived the equations of motion for the system using extended Hamilton's principle
- Performed reduced order modeling using Galerkin projection method
- Perfomed stability anaylsis of equations with periodic coefficients using Floquet theory

Selected Projects

Torsional properties of beams with arbitrary cross section (Sep'16 - April'17)

- Studied the discrepancy in torsional frequency of I-beams between FEM and analytical solutions
- Developed series solutions estimating the torsional rigidity of beams with arbitrary cross-section

Conferences / Talks

New England Granular Workshop, UMass Amherst, US. *Contributed Talk*. 2023
New England Mechanics Workshop, Northeastern University, US. *Talk*. 2023
Indian Institute of Science, Bangalore, India. *Seminar Talk*. 2023
Society of Engineering Science (SES) Annual Meeting, Texas, US. *Talk*. 2022
Gordan Reserch Conference, Granular Matter, Stonehill college, US. *Poster*. [Poster] 2022
American Physics Society (APS) March Meeting, Chicago, US. *Talk*. [Link] 2022
Society of Engineering Science (SES) Annual Meeting. *Virtual*. [Poster] 2021
9th European Nonlinear Dynamics Conference, Budapest, Hungary. *Talk*. [Paper] 2017
International Congress of Theoretical and Applied Mechanics , Montreal, Canada. [Poster] 2016
International Conference on Structural Nonlinear Dynamics and Diagnosis, Marrakesh, Morocco. *Talk*. [Paper] 2016
International Conference on Advances in Dynamics, Vibrations and Control, NIT Durgapur, India. *Talk*. [Paper] 2016

Journal Publications

Coupled continuum modeling of size-segregation driven by shear-strain-rate gradients and flow in dense, bidisperse granular media, with Daren liu and David Henann. *Under Review*. [arxiv]

Continuum modeling of size-segregation and flow in dense, bidisperse granular media: Accounting for segregation driven by both pressure gradients and shear-strain-rate gradients, with Daren liu and David Henann. *To be Submitted*. [arxiv]

Finite element implementation of segregation dynamics coupled with nonlocal granular rheology , with Shihong Li and David Henann. *In Preparation.*

Pressure sensitive non-local behaviour in hydrogel suspension, with Zohreh Farmani, Nazanin Ghods, David Henann and Joshua Diksman. *In Preparation.*

Harkirat Singh and Pankaj Wahi. *Non-planar vibrations of a string in the presence of a boundary obstacle*. Journal of Sound and Vibration, 389, 326-349.[PDF]

Harkirat Singh and Pankaj Wahi. *Role of curvatures in determining the characteristics of a string vibrating against a doubly curved obstacle*. Journal of Sound and Vibration, 402, 1-13. [PDF]

Awards / Honors

Poster award at SES conference 2021
President Fellowship at Brown University 2017-20
4 year Doctoral fellowship at UBC (**not pursued*) 2017
Cambridge India Ramanujan Scholarship (**not pursued*) 2017

Teaching Experience

Teaching assistant for Advanced Solid Mechanics (ENGN 1750) (Sep '20 - Dec '20)
Teaching assistant for Mechanics of Solids and Structures (ENGN 0310) (Sep '19 - Dec '19)

Relevant Courses

Continuum Mechanics
Computational Mechanics
Fracture Mechanics
Non-Linear Vibration
Solid Mechanics
Plasiticity
Stress Waves in Solids
Aeroelasticity

Reference

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