

Multiscale Dynamic Behavior of Heterogeneous Materials: In-situ X-ray and Optical Imaging

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ABSTRACT

Understanding the behavior of geomaterials, like naturally occurring granular sand, rocks, and artificial concrete, has critical applications in modern-day society, from defense to industry. The macroscopic response of these materials under dynamic loading is dictated by mechanisms at lower length scales and the inherent heterogeneity of the microstructure. Traditional methods in experimental mechanics provide surface measurements which are often averaged over large length scales, therefore are unable to shed light on local mechanisms inside the material. Recent advances in X-ray imaging techniques have enabled us to nondestructively probe the in-situ material response at the smallest length and time scales necessary to unravel the underlying physics of dynamic compression. The first part of this talk will reveal the use of X-ray Phase Contrast Imaging (XPCI) to infer the 3D time-resolved kinematics and kinetics of granular materials like sand when subjected to rapid compaction. The next part will shed light on using X-ray imaging and optical tracking to study high-velocity projectile impact in concrete at the lab-scale. Finally, the use of X-ray Diffraction measurements (XRD) to reveal the internal structure of materials and local stress-strain response will be highlighted. Together, these research thrusts substantially advance our understanding of how these important materials respond under dynamic loading across multiple length scales, paving the way for interrogating classical theories, validating high-fidelity numerical models and informing constitutive model discovery.

ABOUT THE SPEAKER

Dr. Sohanjit Ghosh's expertise lies in using X-ray based imaging and measurement techniques to study the multiscale behavior of materials under different loading conditions. He completed his B.Tech in Aerospace Engineering from IIST Shibpur in 2019 and his M.Tech. in Mechanical Engineering from IIT Kanpur in 2021. During his PhD at Johns Hopkins University, Dr. Ghosh developed novel experimental techniques and computational models to understand deformation in geomaterials such as rocks, sand, and concrete under hypervelocity impact (velocities ~ few km/s). Currently, as a postdoctoral researcher at the California Institute of Technology, he is developing experimental capabilities to assess the fracture properties of mechanical metamaterials. All of his work has major aerospace, defense and industrial applications.

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