David Potyondy – ITASCA Minneapolis

Senior Geomechanics Engineer

Expertise	Computational Structural Mechanics, Rock Mechanics, Fracture Mechanics, Continuum and Discontinuum Numerical Methods, Software Development
Education	Ph.D. (Civil Engineering), 1993 M.S. (Civil Engineering), 1990 Cornell University B.S. (Civil Engineering), 1987 University of Minnesota
Professional Affiliations	Member: American Rock Mechanics Association, American Society of Civil Engineers, International Society of Rock Mechanics
Honors	University of Minnesota Center for Transportation Studies 2018 Research Partnership Award for Geogrid Reinforced Aggregate Base Pavement Design, which includes a series of projects from the early 2000s to present (team member, 2012–2018). American Rock Mechanics Association 2005 Award for Research in Rock Mechanics for the paper "A Bonded-Particle Model for Rock," Int. J. Rock Mech. Min. Sci., 41(8), 1329-1374 (2004). NASA 1996 Group Achievement Award, to Fuselage Structural Integrity Analysis Team at Langley Research Center (team member, 1990-1993) Graduate Research Assistant Award, 1991-1993, NASA Airframe Structural Integrity Program Graduate Fellowship, 1987-1990, National Science Foundation National Winner: SAMPE Scholarship, 1985 and 1986, Society for the Advancement of Material and Process Engineering; ACEC Scholarship, 1985 American Consulting Engineers Council

Professional Experience

	ITASCA Minneapolis
2005 – Present	Senior Geomechanics Engineer
2004 – 2005	Associate
1994 – 2003	Project Engineer, Director of Software Development
1983, 1985 – 1986	Engineering Software Consultant
2004 – 2005	University of Toronto, Department of Civil Engineering, Canada Assistant Professor
1993 – 1994	Georgia Institute of Technology, Postdoctoral Fellow
1990 – 1993	Fracture Analysis Consultants, Inc., Ithaca, New York Engineering Software Consultant

1990 – 1993	Cornell University, Graduate Research Assistant
1988 – 1990	Cornell University, Research Assistant
1985 – 1986	University of Minnesota Department of Civil and Mineral Engineering Summer Academic Intern

Project Experience

Research and Development

Discontinuum Modeling — University of Minnesota Center for Transportation Studies 2018 Research Partnership Award to Geogrid Reinforced Aggregate Base Pavement Design, which includes a series of projects from the early 2000s to present (team member, 2012–2018). These projects led to design procedures and modified construction specifications that better utilize a geogrid reinforcement for flexible pavements to build financially effective roadways. Through the projects, a Geogrid (Gain) factor was also created for modeling and understanding the best use of the material throughout Minnesota. ITASCA developed the commercial software framework (pavement-design package within *PFC3D)* that embodies the methodology.

Research and development projects to support ongoing development of novel techniques for applying micro-mechanical discontinuum models (*PFC2D* and *PFC3D*), which represent a solid as a bonded assembly of circular/spherical particles, to fracture-related boundary-value problems. Fundamental research was funded by Atomic Energy of Canada Limited as part of the Thermal-Mechanical Stability Study (1995-2001), one aim of which has been to improve fundamental understanding of short- and long-term rock-mass behavior around underground openings at ambient and elevated temperatures. The result of this work has been the development and verification of the *PFC* Model for Rock — a mechanistically based numerical model for predicting excavation-induced rock-mass damage and long-term strength (based on a stress-corrosion mechanism) in Lac du Bonnet granite. Model enhancements (funded by Svensk Kärnbränslehantering AB, SKB) include breakable, deformable polygonal grains joined by cement.

Developed a *PFC* model of lithophysal tuff and used this model to better understand the effect of lithophysae (hollow, bubble-like voids) on the mechanical properties of this rock, including the time-dependent damage processes induced by stress corrosion. These studies address the tunnel-stability issues in the license application for a monitored geological repository for high-level radioactive waste at Yucca Mountain in Nevada.

Continuum Modeling — Assisted in developing an analysis methodology and software infrastructure (FRANC3D) at Cornell University. The methodology is based on solid modeling principles, interactive computer graphics and automatic mesh generation and supports arbitrary-directional, discrete crack-growth simulation in both solid and thin-shell structures utilizing both finite- and boundary-element analysis techniques.

Developed the stiffened, thin-shell capabilities of the FRANC3D code by coupling it with STAGS, a geometrically non-linear finite-element code as part of the NASA Airframe Structural Integrity Program (ASIP) in collaboration with researchers at NASA Langley Research Center and Lockheed Palo Alto Research Laboratory; verified the approach for simulating growth of long cracks in pressurized fuselage structures by comparing with full-scale pressurized-panel tests conducted by Boeing Commercial Airplane Group; co-facilitated the FRANC3D User's Group Workshop to train ASIP and industry personnel in use of the code.

Supervised a Master's student (Georgia Institute of Technology) in the development of a finite-element-based methodology for computing non-linear fracture parameters of a bulging crack in a pressurized fuselage structure incorporating material non-linear behavior.

Software Development — Direction of all aspects of development and provision of training courses for the Particle Flow Codes (*PFC2D* and *PFC3D*); development, implementation and documentation of the structural-element logic in the *FLAC3D* code, which provides shell, beam, pile, cable, geogrid and liner elements that support non-linear grid interaction, including slip and separation.

Consulting

Fracture of a Discontinuum — Served as a consultant to clients interested in applying the *PFC* codes to a multitude of problems. In these projects, *PFC2D* and *PFC3D* were applied to simulate pull-out tests in reinforced concrete, ice-structure interaction, tool-rock interaction during rock cutting, blade-hair interaction during shaving and acoustic emissions during chalk compaction, and to predict borehole breakout, excavation damage in hard rock, stability of undercut backfill, density gradients in powder-compacted specimens and dense-phase pneumatic conveying. Served as a consultant to Sandia National Laboratories in evaluating the spallings conceptual model used in performance assessment of the Waste Isolation Pilot Plant to predict surface release arising from human intrusion via drilling into a pressurized waste panel.

Fracture of a Continuum — Applied FRANC3D to simulate three-dimensional, non-planar fatigue crack growth in a turbine blade root and compared results with laboratory data; installed FRANC3D and provided user training to simulate hydraulically induced fracture for reservoir stimulation for Schlumberger Cambridge Research Laboratory; installed FRANC2D and provided user training for Grumman Aerospace and GTE Laboratories, for Fracture Analysis Consultants, Inc.

Teaching

Short Courses — Co-taught ARMA 2018 Short Course "Microstructural Modeling of Rock Fracture: Bonded-Particle Modeling with *PFC* and Bonded-Block Modeling with *3DEC*" with Tryana Garza-Cruz at the 52nd U.S. Rock Mechanics/Geomechanics Symposium, Seattle, USA, 17–20 June 2018.

PFC Short Course (August 24, 2008) at the First International *FLAC*/DEM Symposium on Numerical Modeling, Minneapolis, MN. Focus: new features in *PFC* 4.0, bonded-particle modeling, applications of smooth-joint logic, and fluid-flow capability.

Co-taught NARMS98 Short Course "The Role of Numerical Models in Rock Mechanics Problem Solving" with Loren Lorig (June 2, 1998) at the Third North American Rock Mechanics Symposium, Cancun, Mexico.

Software Training Courses — Developed and presented more than 38 (3-5 day) training courses on the application of the *PFC* codes to various research groups in industry and academia.

University Courses — Taught two courses at the University of Toronto during the 2004–2005 academic year.

> Developed and taught graduate course (in 2004): *Micromechanical Modeling Using Discrete Element Methods*. Discrete-element methods (DEM) allow one to simulate the movement and mechanical interaction of tens of thousands of discrete bodies. The macroscopic behavior of such models is an emergent property of the system that arises from a small set of microproperties for the particles and the particle-particle interactions. These models provide a scientific tool to investigate the micro-mechanisms that combine to produce complex macroscopic behaviors and have been used to study the mechanical behavior of many materials and systems that cannot be expressed adequately by existing continuum theories. After introducing the formulation of the general DEM and reviewing current applications areas, the focus will shift to bonded-

particle models applied to study damage processes in rock or other brittle materials. This type of modeling is in its infancy compared to continuum modeling, and thus it is important to develop a proper modeling methodology that involves careful numerical experimentation and qualitative comparison with physically observed micro- and macro-mechanisms as well as quantitative comparison with measured properties. This will be achieved through a balance of lectures, case studies and hands-on modeling exercises using a flexible DEM code with an embedded programming language that provides circular particles with simple bonding schemes. As a final project, students will develop and implement a methodology by which the code could be applied to a research area of their choosing.

Taught undergraduate course (in 2004): *APS106, Fundamentals of Computer Programming*, taken by all first-year students in Civil, Mechanical, Chemical and Materials Engineering programs. The APS106 course is designed to introduce first-year engineering students to computer programming. Students will learn how to design and implement algorithms using the C programming language.

Co-taught NARMS98 Short Course "The Role of Numerical Models in Rock Mechanics Problem Solving" with Loren Lorig (June 2, 1998) at the Third North American Rock Mechanics Symposium, Cancun, Mexico.