Azadeh Riahi, Ph.D., P.Eng.
NSERC Post-Doctoral Fellow
Rocscience Inc., 780-439 University Avenue
Toronto, Ontario M5G 1Y8

1-416-598-3338 ext. 10
1-416-816-3834
azadeh.riahi@rocscience.com
http://individual.utoronto.ca/azadehriahi/
Permanent Canadian resident

Education

Ph.D., Civil Engineering   Sept. 2003 – Sept. 2008
(Computational Geomechanics)
University of Toronto, Toronto
Thesis: 3D finite element Cosserat continuum simulation of layered geomaterials
Supervisor: Professor J.H. Curran

M.A.Sc., Civil Engineering   Sept. 2001 – Aug. 2003
(Mechanics of Structures and Materials)
Sharif University of Technology, Tehran
Thesis: Error estimation and adaptivity technique in finite element plasticity problems
Supervisor: Professor A.R. Khoei

B.A.Sc., Civil Engineering   Sept. 1996 – Feb. 2001
University of Tehran, Tehran

Research Interests

Computational Geomechanics

- Physics and simulation of brittle spalling of hard rocks around underground excavations

- Discrete element and hybrid finite element-discrete element numerical techniques

- Cosserat theory and its application to numerical simulation of blocky and layered geomaterials

- Buckling analysis of stratified materials

- Constitutive behaviour of jointed rock masses

Advanced Numerical Techniques in Computational Mechanics

- Adaptive re-meshing techniques for finite element analysis of problems with localized features (such as shear bands in granular materials)

- Extended finite element method (X-FEM) and its application to 3D analysis of jointed and fractured rock masses

Publications

Journal Papers

- Riahi, A., Curran, J.H., Hammah, R.E., Comparison of the finite element explicit joint model with the discrete element techniques, accepted, Mathematics and Mechanics of Solids, 2010.

- Riahi, A., Curran J.H., Comparison of layered Cosserat continuum to finite element interface models, in press, *Scientica Iranica*, Volume, 17, 2010 (invited article).
- Riahi, A., Curran, J.H., Bidhendi, H., Buckling analysis of 3D layered structures using a Cosserat continuum approach, *Computers and Geotechnics*, 36, 1101-1112, 2009.
- Riahi, A., Curran, J.H., Full 3D finite element Cosserat formulation with application in layered structures, *Applied Mathematical Modeling*, 33, 3450-3464, 2009.
- Khoei, A.R., Gharehbaghi, S.A., Tabarraie, A.R., Riahi, A., Error estimation, adaptivity, and data transfer in enriched plasticity continua to analysis of shear band localization, *Applied Mathematical Modelling*, 31(6), 983-1000, 2007.

Conference Proceedings

- Bidhendi, H., Riahi, A., Curran, J.H., Application of Cosserat continuum model for analysis of layered rocks, submitted to the 63rd Canadian Geotechnical Conference and 6th Canadian Permafrost Conference, Calgary.
- Riahi, A., Hammah, R.E., Curran, J.H., Limits of applicability of the finite element explicit joint model in the analysis of jointed rock problems, accepted in the 44th ARMA Conference, Salt Lake City.
- Hammah, R.E., Yacoub, T., Riahi, A., Corkum, B., Curran, J.H., Prediction of failure mechanisms of open pit slopes in blocky rock masses using finite element analysis, accepted in the 44th ARMA Conference, Salt Lake City.
- Riahi A., Curran J.H., Application of Cosserat continuum approach in the finite element shear strength reduction analysis of jointed rock slopes, in *Proceedings of the 12th International Conference of International Association for Computer Methods and Advances in Geomechanics (IACMAG)*, 110-118, Goa, India, 2008.
- Riahi A., Curran J.H., Application of Cosserat theory to the buckling analysis of laminated plates, in *Proceedings of the 3rd Canadian Conference on Nonlinear Solid Mechanics*, 367-376, Toronto, Canada, 2008.
- Riahi, A., Curran, J.H., Effect of characteristic length in the finite element solution of elastic deformation of layered materials, in *Proceedings of the 1st Canadian-U.S Rock Mechanics Symposium*, (1), 403-410, Vancouver, Canada, 2007.
- Khoei, A.R., Riahi, A., Re-meshing technique and data transfer in adaptive analysis of localization problems, in *Proceedings of the 5th Euro-Mechanics Solid Mechanics Conference (ESMC 5)*, Thessaloniki, Greece, 136-145, 2003.

Professional Experience

Research Experience

NSERC Industrial Research & Development Fellow (IRDF)   Sept. 2008 – Present
Rocscience Inc., Toronto

- Physics and simulation of brittle spalling in hard rocks
- Application of hybrid finite element method-discrete element method (FEM-DEM) to geomechanics and geotechnical engineering

- Studied fundamental formulation of discrete element methods
- Studied Discontinuous Deformation Analysis (DDA)
- Reviewed FEM-DEM code's potential for commercial application to rock engineering
- Collaborated with Prof. Grasselli's group to improve shear behaviour of interfaces (joints) in FEM-DEM program

- Evaluation of plate and shell elements for three-dimensional analysis of tunnel linings, and development of two types of elasto-plastic shell elements
- Research on application of extended finite element method (X-FEM) to simulation of jointed rock masses
- Studied underlying theories, algorithms, data structure, and source code of Keck Geomechanics Code (KGC), Phase2, and FEM-DEM Y

Research Assistant   Sept. 2003 – Aug. 2008
University of Toronto, Computational Geomechanics Group

- Application of Cosserat theory to simulation of elastic and elasto-plastic response of materials with microstructures
- Formulation of new elastic and elasto-plastic finite elements for 3D Cosserat layered materials
- Development of Cosserat finite element approach for simulating buckling (kinematic instability) in stratified materials
- Modelling of anisotropic constitutive behaviour of jointed rocks using continuum and discontinuum approaches
- Development of algorithms and C++ classes for elastic and elasto-plastic analyses of transversely isotropic and orthotropic materials in Keck Geomechanics Code (KGC)
- Studied underlying theory and application of commercial numerical modelling packages including FLAC2D, FLAC3D, UDEC, 3DEC, ANSYS, PFC, and Phase2
- Gained expertise in C++ object oriented programming

Research Assistant   Sept. 2001 – Aug. 2003
Sharif University of Technology

- Evaluation of error estimation, adaptive re-meshing, and data transfer techniques for finite element solution of elastic problems
- Extension of Superconvergent Patch Recovery (SPR) approach to elasto-plastic problems
- Implementation of adaptive re-meshing algorithm for elasto-plastic problems in source codes of SWANDYN and STUD-DAM (finite element programs)

Teaching Experience

Sessional Lecturer   Sept. 2008 – Dec. 2009
University of Toronto, Department of Civil Engineering

- Introduction to Geotechnical Engineering I (CME 321), Fall 2009
  - Taught basic Soil Mechanics including clay mineralogy, basic soil properties, shear

strength theory, seepage analysis, and consolidation theory

- Taught design of geotechnical structures including retaining walls, earth dams, drainage and dewatering systems, and soil improvement techniques; created course module on application of numerical modelling tools to geotechnical analysis

- Coordinated and designed lab/experimental sessions, tutorials, quizzes and exams

- Mechanics (CIV100), Fall 2008

  - Taught 2D and 3D vector algebra, statics, analysis and design of structural components such as trusses and beams;

  - Designed tutorials, quizzes, and midterm; collaborated with Prof. Kuhn to implement course syllabus and design final exam

Teaching Assistant   Sept. 2003 – Jun. 2008
University of Toronto

- Geotechnical Design (CIV523S), Civil Engineering Department, Winter 2007

- Geomechanics (CIV321F), Civil Engineering Department, Winter 2004, Fall 2005, Fall 2006, Fall 2007

- Foundations and Earthworks (CIV424S), Civil Engineering Department, Winter 2006, Winter 2008

- Engineering Mathematics I (CIV261F), Civil Engineering Department, Fall 2004

- Fundamentals of Computer Programming (APS107), Mechanical Engineering Department, Summer 2007

Industrial Experience

Structural Engineer   Jun. 2001 – Jul. 2003
Sazeh Co., Tehran

- Design of regular and heavy industrial structures for the Pars natural gas and oil refinery

  - Designed steel structures according to standards; used SAP software

  - Designed welded and bolted connections

  - Designed single, strip, and spread footings for structures

Professional Membership and Services

- Registered member (P.Eng.) of Professional Engineers of Ontario

- Reviewer for *Journal of Computational Material Science, Journal of Applied Mathematical Modelling, International Journal of Solids and Structures,* and *Finite Element in Analysis and Design*

- Member of Canadian Geotechnical Society (CGS)

- Member of American Society of Civil Engineers (ASCE)

Presentations

- University of Waterloo, Mechanical and Megatronic Department, Waterloo, Cosserat continuum theory for elastic, elasto-plastic and large deformation problems, October 2008.
- 3rd Canadian Conference on Nonlinear Solid Mechanics, Toronto, Application of Cosserat theory to the buckling analysis of laminated plates, June 2008.
- 1st Canadian-US Rock Mechanics Symposium, Vancouver, Effect of the characteristic length in the finite element solution of elastic deformation of layered materials, June 2007.
- Lassonde Institute, Toronto, Advances of the computational geomechanics group, December 2007.
- Sharif University of Technology, Tehran, Error estimation and adaptive re-meshing technique, June 2003.

Scholarships and Awards

- NSERC Industrial Research and Development Fellowship   Nov. 2008 – Nov. 2010
- Ontario Graduate Scholarship in Science and Technology   Sept. 2007 – Aug. 2008
- Civil Engineering Departmental Graduate Scholarship   Sept. 2003 – Aug. 2007
- Ranked 6th out of 300,000 participants in 1996 nationwide Iranian university entrance exam for undergraduate studies

Papers in Progress

Journal Papers

- Riahi, A., Curran, J.H., Corkum, B., Numerical modelling of brittle spalling in underground openings – continuum-based techniques, under revision.

Conference Abstracts

- Khan, M.S, Riahi, A., Curran, J.H., Effects of time step size on the computational efficiency of DDA and DEM solution in jointed rock problems, accepted in the 2010 ISRM Symposium and 6th Asian Rock Mechanics Symposium.