Dr. Qi Zhang

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Professional Appointments

2022 – on   **Research Assistant Professor**
Department of Civil and Environmental Engineering
Faculty of Construction and Environment
The Hong Kong Polytechnic University, Hong Kong

2021 – 2022   **PolyU Distinguished Postdoctoral Research Fellow**
Department of Civil and Environmental Engineering
Faculty of Construction and Environment
The Hong Kong Polytechnic University, Hong Kong

Education

2018 – 2021   **Ph.D. in Department of Civil and Environmental Engineering**, Stanford University, USA

2016 – 2018   **M.Sc. in Department of Civil and Environmental Engineering**, Stanford University, USA

2012 – 2016   **Undergraduate Minor in Applied Mathematics**, Tongji University, China

2012 – 2016   **B.Eng. in Civil Engineering**, Tongji University, China

Interests

Academic   I am interested in understanding and controlling the fundamental poro-mechanical processes that determine the formation and recovery of earth resources from sedimentary rocks to achieve energy and environmental sustainability. At present, my research is focused on formulating innovative theories and developing advanced numerical methods to investigate the **multi-scale** pore structures, **multiple** fluid flow patterns, and complex **multi-physics** processes. Additionally, I am exploring the effects of bedding-induced **anisotropy**. This comprehensive investigation is aimed at facilitating a transition towards sustainable energy practices, and our results should be applicable to general porous media with slight modifications. By integrating rock experimental testing data (such as the poroelasticity constants) with poromechanics and solid mechanics theory, my team and I aim to build predictive models that can enhance our understanding of shale behavior and contribute to more efficient and sustainable energy extraction practices.

Teaching   My primary teaching objective is to equip students with a solid foundation in geomechanics, fostering their ability to think critically and innovatively. This will enable them to meet the increasing societal demands for energy and environmental sustainability. I am passionate about nurturing their capabilities and enthusiasm for advancing fundamental knowledge in geomechanics. I am keen on teaching both fundamental and applied courses in areas such as rock and soil mechanics, solid mechanics, finite element method, and elasticity and inelasticity. I also aim to offer general courses in geotechnical engineering to cultivate the upcoming generation of leaders in the field of geomechanics.

Grants & Fellowships

2023 – 2024   "Development of a novel geomechanical model for MHBS that incorporates effects of viscoplasticity, temperature, anisotropy, and non-Darcy flow". **PI**: **Zhang, Q.** Main Funding Body: Start-up Fund for RAPs under the Strategic Hiring Scheme. Award Number: P0043879. Total Awarded Amount: HK$250,000

2022 – 2025   "Finite-Discrete modeling of mechanical behaviors of heterogeneous rocks with irregular inclusion or voids from micro to macro with experimental validation". PI: Yin, Z.-Y.; **Co-I**: **Zhang, Q.** Main Funding Body: Shenzhen Poxon Machinery Technology Co.,Ltd. Award Number: P0038726. Total Awarded Amount: HK$360,000

2024 – 2025   "High-Pressure Temperature-Controlled Triaxial Apparatus". PI: Yin, Z.-Y.; **Co-I**: **Zhang, Q.** Main Funding Body: PolyU Large Equipment Fund. Award Number: P0050936. Total Awarded Amount: HK$1,142,100

2022   RGC Postdoctoral Fellowship Scheme (PDFS). **Zhang, Q.** Main Funding Body: University Grants Committee (UGC). More information: List of Awardees (2022/23). The **first awardee** in the Department of Civil and Environmental Engineering at PolyU.

2021   PolyU Distinguished Postdoctoral Fellowship. **Zhang, Q.** Associated Project Title: "On the Constitutive Modeling of Natural Gas Hydrate Bearing Sediment and Multi-physics Coupling in Gas Production".

Open Science

Open-source Software

2024 – on   **Point simulation** | ⌘
This repository summarized several elastoplastic constitutive models, which are given in the time-integrated fully implicit form. Some classical stresss point simulations are also provided. Following constitutive models are considered: (1) ideal Drucker-Prager plasticity; (2) Modified Cam-Clay in which the isotropic elastic matrix is updated explicitly; (3) anisotropic MCC model for transversely isotropic rocks such as shale; (4) saturation-dependent anisotropic elasticity.
Role: Creator, main developer, project leadership

2022 – on   **GEOKEYFEM_HM** | ⌘
Smoothed Finite Element Methods (S-FEM) tools for hydromechanical analysis that could consider rigid-to-soft contact, transverse isotropy induced by sedimentary rock bedding, double porosity, and gas compressibility.
Role: Creator, main developer, project leadership

2021 – on   **COMSOL for double porosity** | 📈
COMSOL Mutliphysics implementation for the preferential flow patterns induced by transverse isotropy and non-Darcy flow in double porosity media.
Role: Creator, main developer, project leadership

Academic Service

Editor

2022   Guest Editor of Special Feature Multiscale Multiphysics Modeling in Geotechnical Engineering, *Journal of Zhejiang University - SCIENCE A*
Yin, Z.-Y., **Zhang, Q.**, LAOUAFA, F.

2022   Guest Editor of Special Issue Exploitation of Geological Resources in Unconventional Reservoirs, *Energies*
Yan, X., **Zhang, Q.**, Liu, L.

2021 – 2023   Youth Editorial Board, *Advances in Geo-Energy Research*

Memberships in Professional Societies

2016 – 2020   Student member, *Chinese Society for Rock Mechanics & Engineering*.

Reviewer

- Acta Geotechnica
- Applied Energy
- Computers and Geotechnics
- European Journal of Environmental and Civil Engineering
- Gas Science and Engineering (Formly known as *Journal of Natural Gas Science and Engineering*)
- Geoenergy Science and Engineering (Formly known as *Journal of Petroleum Science and Engineering*)
- Géotechnique Letters
- International Journal for Numerical and Analytical Methods in Geomechanics
- International Journal for Numerical Methods in Engineering
- International Journal of Environmental Science and Technology
- International Journal of Geomechanics
- International Journal of Rock Mechanics and Mining Sciences
- Journal of Cleaner Production
- Journal of Zhejiang University-SCIENCE A
- KSCE Journal of Civil Engineering
- Mathematical Methods in the Applied Sciences
- NeurIPS ML4PS workshop (ml4physicalsciences.github.io)
- Renewable Energy
- Rock Mechanics and Rock Engineering
- Soils and Foundations

Conference Convener

2024   Mini-symposium: Computational Geomechanics.
            Wang, Y.T., Wang, Y.D., Liu, F.S., Zhu, C.W., **Zhang, Q.**, Semnani, S.J., Wu, W., Borja, R.I.
            EMI 2024 IC, TU Wien, Vienna, Austria.

2023   Mini-Symposium S25: Computational Geomechanics and Multiphysics Coupling in Porous
            Media.
            Zhang, Q., Yan, X., Zhang, K., Zhang, Z., Jin, Y.-F.
            ICCES2023, Shenzhen, China.

Awards & Honors

2020 – 2021   **John A. Blume Research Fellowship**, Stanford University

2018 – 2020   **Charles H. Leavell Graduate Student Fellowship**, Stanford University

2016 – 2018   **Stanford School of Engineering Graduate Fellowship**, Stanford University

2016   **Outstanding Bachelor Thesis Award**, Chinese Society for Rock Mechanics & Engineering

2016   **Excellent Graduate of Shanghai**, Shanghai Municipal Education Commission

2014 – 2015   **National Scholarship of China** $\times$**2**, Ministry of Education of the People's Republic of China

2013 – 2015   **First-Class Academic Scholarship of Tongji University** $\times$**3**, Tongji University

2013   **Excellent Student of Tongji University**, Tongji University

2015   **First Prize** in the National Pei-Yuan Zhou **Mechanics Contest** of Shanghai Division, Chinese
               Society of Theoretical and Applied Mechanics

2014   **First Prize** in the National **Mathematics Contest** (Finals), Chinese Mathematical Society

2013   **First Place** in the National **Mathematics Contest** of Shanghai Division, Shanghai Mathematical
               Society

2013   **First Prize** in the Regional College Students **Physics Contest**, Shanghai Physical Society

Teaching

Graduate Courses

2023 – 2024   CSE583: Analytical and Numerical Methods in Geotechnical Engineering   Teaching
               Teaching introductions to vectors and tensors, fundamentals of solid mechanics, evaluation
               ultimate state analysis, and slope stability analysis. (40% of module)   4.8/5.0
               The Hong Kong Polytechnic University

2023 – 2024   CE620: Research Methods
               Teaching basics of probability, point estimation, confidence interval, and hypothesis
               testing. (25% of module)
               The Hong Kong Polytechnic University

2022 – 2023   CSE583: Analytical and Numerical Methods in Geotechnical Engineering   Teaching
               Teaching introductions to vectors and tensors, fundamentals of solid mechanics, evaluation
               ultimate state analysis, and slope stability analysis. (40% of module)   4.9/5.0
               The Hong Kong Polytechnic University

Teaching Assistant

2018   CEE 294: Computational Poromechanics
             Give tutorials on the use of ANSYS to solve boundary-value problems, hold weekly
             office hours, and grade homework submissions.
             Stanford University

Student Supervision

Ph.D. mentored

2021 – on   Xian-han WU
             Research topic: *Implicit SNS-PFEM with dual mortar method for thermo-hydro-mechanical large
             deformation submarine pipeline-soil interaction problems*.
             The Hong Kong Polytechnic University & Southern University of Science and Technology
             Advisor: Prof. Yin, Z.-Y.; Prof. Feng, W.Q.

2023 – on   Zi-qi TANG
             Research topic: *Coupled thermo-hydro-chemo-mechanical modeling in gas hydrate production*.
             The Hong Kong Polytechnic University
             Advisor: Prof. Yin, Z.-Y.

## M.Sc. in Civil Engineering

2023 – on   Zi-kang HUANG
             Thesis: *Formulation and implementation of fully implicit 2D reservoir simulator considering
             permeability anisotropy and heterogeneity*.
             The Hong Kong Polytechnic University

Publications

Peer-reviewed Papers

2024   Shao, J., **Zhang, Q.***, Zhang, W., Evolution of mining-induced water inrush disaster
             from a hidden fault in coal seam floor based on a coupled stress-seepage-damage
             model, *Geomechanics and Geophysics for Geo-Energy and Geo-Resources*,
             doi:10.1007/s40948-024-00790-w.

             Zhu, X., **Zhang, Q.***, Zhang, W., Jin, L., Li, Z., Solid waste slurry grouting transformation
             mechanism of loose sand layer based on slurry-water replacement effect, *Physics of
             Fluids*.

             Jin, Y.-F., Wang, Z.-Y., **Zhang, Q.**, Yin, Z.-Y., Wang, Y.-Z., A novel approach for
             hydromechanical soil-structure interaction analysis with stable node-based smoothed
             PFEM, *International Journal for Numerical Methods in Engineering*.

             Tang, Z.-Q., Zhou, X.-W., Jin, Y.-F., Yin, Z.-Y., **Zhang, Q.**, A novel coupled
             bES-FEM formulation with SUPG stabilization for thermo-hydro-mechanical
             analysis in saturated porous media, *Computers and Geotechnics*,
             doi:10.1016/j.compgeo.2024.106454.

2023 **Zhang, Q.**, Yin, Z.-Y., Yan, X., Anisotropic continuum framework of coupled gas flow - adsorption - deformation in sedimentary rocks, *International Journal for Numerical and Analytical Methods in Geomechanics*, doi:10.1002/nag.3674.

Zhang, Q., Yin, Z.-Y., Yan, X., Material Constants of Anisotropic Poroelasticity and Its Impacts on Shale Gas Production, *Energy & Fuels*, doi:10.1021/acs.energyfuels.3c02656.

2022 **Zhang, Q.**, Wang, Z.-Y., Yin, Z.-Y., Jin, Y.-F., A novel stabilized NS-FEM formulation for anisotropic double porosity media, *Computer Methods in Applied Mechanics and Engineering*, doi:10.1016/j.cma.2022.115666.

Wang, Z., **Zhang, Q.***, Zhang, W., A novel collaborative study of abnormal roof water inrush in coal seam mining based on strata separation and wing crack initiation, *Engineering Failure Analysis*, doi:10.1016/j.engfailanal.2022.106762.

Zhang, Q., Yan, X., Li, Z., A mathematical framework for multiphase poromechanics in multiple porosity media, *Computers and Geotechnics*, doi:10.1016/j.compgeo.2022.104728.

2021 Wang, Z., **Zhang, Q.**, Shao, J., et al., Mathematical Evaluation on the Control of Mining-Induced Ground Subsidence in Thick Loose Strata, *ACS Omega*, doi:10.1021/acsomega.1c04970.

Zhang, Q., Strip load on transversely isotropic elastic double porosity media with strong permeability contrast, *Advances in Geo-Energy Research*, doi:10.46690/ager.2021.04.02.

Zhang, Q., Wang, Z., Spatial prediction of loose aquifer water abundance mapping based on a hybrid statistical learning approach, *Earth Science Informatics*, doi:10.1007/s12145-021-00640-3.

Zhang, Q., Yan, X., Shao, J., Fluid flow through anisotropic and deformable double porosity media with ultra-low matrix permeability: A continuum framework, *Journal of Petroleum Science and Engineering*, doi:10.1016/j.petrol.2021.108349.

Zhang, Q., Borja, R.I., Poroelastic coefficients for anisotropic single and double porosity media, *Acta Geotechnica*, doi:10.1007/s11440-021-01184-y.

Yan, X., Sun, H., Huang, Z., Liu, L., Wang, P., **Zhang, Q.**, Yao, J., Hierarchical Modeling of Hydromechanical Coupling in Fractured Shale Gas Reservoirs with Multiple Porosity Scales, *Energy & Fuels*, doi:10.1021/acs.energyfuels.0c03757.

Shao, J., **Zhang, Q.***, Zhang, W., et al., Effects of the borehole drainage for roof aquifer on local stress in underground mining, *Geomechanics and Engineering*, doi:10.12989/GAE.2021.24.5.479.

2020 Wang, Z., **Zhang, Q.**, Shao, J., et al., New Type of Similar Material for Simulating the Processes of Water Inrush from Roof Bed Separation, *ACS Omega*, doi:10.1021/acsomega.0c03535.

Zhang, Q., Hydromechanical modeling of solid deformation and fluid flow in the transversely isotropic fissured rocks, *Computers and Geotechnics*, doi:10.1016/j.compgeo.2020.103812.

Shao, J., **Zhang, Q.**, Wu, X., et al., Investigation on the Water Flow Evolution in a Filled Fracture under Seepage-Induced Erosion, *Water*, doi:10.3390/w12113188.

Yan, X., Huang, Z., **Zhang, Q.**, et al., Numerical Investigation of the Effect of Partially Propped Fracture Closure on Gas Production in Fractured Shale Reservoirs, *Energies*, doi:10.3390/en13205339.

Zhu, X., **Zhang, Q.**, Zhang, W., et al., Experimental Study on the Basic Properties of a Green New Coal Mine Grouting Reinforcement Material, *ACS Omega*, doi:10.1021/acsomega.0c01626.

Shao, J., **Zhang, Q.**, Sun, W., et al., Numerical Simulation on Non-Darcy Flow in a Single Rock Fracture Domain Inverted by Digital Images, *Geofluids*, doi:10.1155/2020/8814327.

2019   **Zhang, Q.**, Choo, J., Borja, R.I., On the preferential flow patterns induced by transverse isotropy and non-Darcy flow in double porosity media, *Computer Methods in Applied Mechanics and Engineering*, doi:10.1016/j.cma.2019.04.037.

2018   **Zhang, Q.**, Zhu, H., Collaborative 3D geological modeling analysis based on multi-source data standard, *Engineering Geology*, doi:10.1016/j.enggeo.2018.10.001.

Peer-reviewed Conference Proceedings

2020   **Zhang, Q.**, Chen, Y., Yang, Z., Darve, E., Multi-Constitutive Neural Network for Large Deformation Poromechanics Problem, Presented at the *Proceedings of the Machine Learning and the Physical Sciences Workshop, 34th Conference on Neural Information Processing Systems (NeurIPS)*.

Editorial

2023   Yin, Z.-Y., **Zhang, Q.**, LAOUAFA, F., Multiscale multiphysics modeling in geotechnical engineering, *Journal of Zhejiang University - SCIENCE A*, doi:10.1631/jzus.A22MMMiG.

Preprints

2024   Wu, X.-H., **Zhang, Q.***, Feng, W.-Q.*, Yin, Z.-Y.*, Fang, H.-C., On the novel thermo-hydro-mechanical coupling theory for saturated porous media and its implicit SNS-PFEM framework considering multi-physics contact, *International Journal of Mechanical Sciences*.

Zhu, X., **Zhang, Q.***, Ma, J., Zhang, W., Li, Z., Development of multi-source synergistic green sand-fixing grouting materials and diffusion characteristics of deep-well grouting.

2023   **Zhang, Q.**, Yin, Z.-Y., Yan, X., Wang, X., Gas flow and solid deformation in unconventional shale.

2020   **Zhang, Q.**, Chen, Y., Yang, Z., Data Driven Solutions and Discoveries in Mechanics Using Physics Informed Neural Network. doi:10.20944/preprints202006.0258.v1

Thesis

2021   **Zhang, Q.**, Mathematical Modeling of Unconventional Geomaterials, *Stanford University Ph.D. Thesis*, Dissertation Reading Committee: Prof. Ronaldo I. Borja (Primary Advisor), Prof. Louis J. Durlofsky (NAE member), Prof. Christian Linder.

2016   **Zhang, Q.**, Multi-source data standard of road tunnel and three-dimensional geological modeling analysis (in Chinese), *Tongji University Final Year Project*, Advisor: Prof. Hehua Zhu (CAE member).

Presentations

Invited

2024.06   *Computational poromechanics on geomaterial anisotropy and multi-physics modeling*, Department of Civil and Environmental Engineering, Faculty of Science and Technology, Universidade de Macau, Macau, China. (www.fst.um.edu.mo/events/2024-06-25/)

2023   The Third Energy Science and Engineering Young Scholars Forum, China University of Petroleum (East China).

2022   *On the poroelastic coefficients and low-velocity non-Darcy flow of shale*, SPE Student Chapter, China University of Petroleum (East China).

2021   *Mathematical Modeling of Unconventional Geomaterials*, Geoinvention Group, The Hong Kong Polytechnic University.

2019   *Multiscale poromechanics: double porosity, transverse isotropy, and non-Darcy flow*, College of Energy and Mining Engineering, Shandong University of Science and Technology.

Topical Conferences and Meetings

2024   Wu, X.-H., **Zhang, Q.***, Feng, W.-Q., Yin, Z.-Y., Fang, H.-C. Implicit SNS-PFEM with dual mortar method for thermo-hydro-mechanical large deformation problems, *EMI 2024 IC*, TU Wien (Vienna University of Technology), Vienna, Austria. [Talk]

2023   **Zhang, Q.**, Yin, Z.-Y., Yan, X. Anisotropic poromechanics of gas flow in sedimentary rocks, *COMPLAS 2023*, Universitat Politècnica de Catalunya (Barcelona Tech), Barcelona, Spain. [Talk]

2020   **Zhang, Q.**, Chen, Y., Yang, Z., Darve, E. Multi-constitutive neural network for large deformation poromechanics problem, *Proceedings of the Machine Learning and the Physical Sciences Workshop, 34th Conference on Neural Information Processing Systems (NeurIPS)*, Virtual (Online). [Poster]

        Zhang, Q., Borja, R.I. Fluid flow through anisotropic and deformable double porosity media with ultra-low matrix permeability: A continuum framework, *InterPore2020*, Virtual (Online). [Talk]

2019   **Zhang, Q.**, Choo, J., Borja, R.I. Multiscale poromechanics: double porosity, transverse isotropy, and non-Darcy flow, *Engineering Mechanics Institute Conference 2019*, California Institute of Technology, Pasadena, California, USA. [Talk]

2018   **Zhang, Q.**, Choo, J., Borja, R.I. Multiscale poromechanics: double porosity, transverse isotropy, and non-Darcy flow, *6th Berkeley/Stanford CompFest 2018*, Stanford University, USA. [Talk]

Glossary

These are the meanings of the symbols used throughout this document:

ə   Indicates that a publication is open-access

    Link to a code repository on GitHub

    Link to an open-access PDF, usually a preprint or postprint

    Link to a video on YouTube

    Link to a data archive

    Link to presentation slides

    Link to a poster