# Beyond the cubic law: Inertial, turbulent, and transient flow behaviours in hydraulic fractures

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**Thursday, March 9, 2023, 9 a.m. Central Time**

Bruce Gee is a PhD candidate in the Department of Civil and Environmental Engineering at the University of Waterloo. His presentation will be at 9:00 Central Time on Thursday, March 9, 2023. The topic is **"Beyond the cubic law: Inertial, turbulent, and transient flow behaviours in hydraulic fractures."**

## Abstract

Hydraulic fracturing simulations rely almost exclusively on the cubic law (Poiseuille flow) to model the fluid behaviour. The cubic law contains the ingrained assumptions of laminar steady-state flow through parallel plates, but the typical flow rates involved in hydraulic fracturing operations bring these assumptions into question. When the fracture aperture is time and/or spatially varying, flow is transient, and/or flow rates are modest (Re > 1), cubic law predictions can deviate substantially from true fluid behaviour. In this talk, we present the GG22 flow model [1]: a new flow model derived from the two-dimensional Navier-Stokes equations which is capable of capturing inertial, transient, and turbulent behaviours beyond the effects of surface roughness. We demonstrate that the GG22 model conserves energy where the cubic law does not but recovers the cubic law under the appropriate conditions. We examine the application of the GG22 flow model to hydraulic fracturing in two-dimensional KGD-like and axisymmetric radial fractures to determine where, when, and how these fluid phenomena manifest in typical hydraulic fracturing scenarios.

[1] B. Gee, R. Gracie, Beyond Poiseuille flow: A transient energy-conserving model for flow through fractures of varying aperture, Advances in Water Resources 164 (2022) 104192. doi:10.1016/j.advwatres.2022.104192

## Biography

Bruce Gee is a PhD candidate in the Department of Civil and Environmental Engineering at the University of Waterloo under the supervision of Dr. Robert Gracie. His research area is computational geomechanics with a focus on developing novel extensions to the cubic law for inertia dominant flows through non-uniform fractures and investigating the role of fluid inertia in hydraulic fracturing and geothermal systems. Bruce's previous research includes the development of multiphysics models for enhanced geothermal systems, and validation of numerical fracture models with experimental data. He has presented

at conferences across North America and Europe and is the primary author of five published peer-reviewed papers.

Bruce received his BASc in civil engineering with honours from the University of Waterloo in 2018. He continued his graduate studies at the University of Waterloo where he was awarded the prestigious Engineering Excellence Fellowship and NSERC Alexander Graham Bell Canada Graduate Scholarship. He is currently the holder of an NSERC Canadian Graduate Scholarship doctoral award and intends to complete his PhD in 2023.