

Danilo Borges Cavalcanti

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Research profile

Computational geomechanics researcher with experience in finite element formulations for coupled processes in fractured porous media. His research combines numerical method development and scientific code implementation, with particular focus on the modeling of strong discontinuities for subsurface engineering applications. He has experience in C++, MATLAB, and Python, and is interested in applying computational mechanics to problems across civil, geotechnical, and energy-related engineering.

Professional experience

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| 2023 – Present | Research Engineer
CIMNE – International Centre for Numerical Methods in Engineering, Barcelona, Spain |
| 2022 – 2023 | Ph.D. researcher
Tecgraf Institute (Multiphysics Simulation and Modeling Group), Rio de Janeiro, Brazil |
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Education

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| 2026 | Dual-award Ph.D. in Civil Engineering / Structural Analysis
Cotutelle doctorate between Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil and Universitat Politècnica de Catalunya (UPC), Spain
Thesis: Finite Element Method with Embedded Strong Discontinuities for Coupled Hydro-Mechanical Problems
Supervisors: Deane Roehl, Luiz Fernando Martha, Ignasi de Pouplana
Distinction: Cum Laude |
| 2022 | M.Sc. in Structural Analysis
Federal University of Goiás, Goiânia, Brazil.
Thesis (In Portuguese): Topology optimization of structures with nonlinear elastic behavior
Supervisors: Daniel de Lima Araújo and Sylvia Regina de Almeida |
| 2021 | B.Sc. in Civil Engineering
Federal University of Goiás, Goiânia, Brazil.
Final Project (In Portuguese): A hybrid topology optimization formulation for identifying force paths in reinforced concrete structures
Supervisor: Sylvia Regina de Almeida |
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Professional training

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| 2025 - 2026 | MentorFirst Programme – University Teaching Training
Universitat Politècnica de Catalunya (UPC), Barcelona, Spain
Tutor: Ignasi de Pouplana |
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2025	SMILE Summer School: Geoenergies for the Ecological Transition SMILE MSCA-DN, University of the Balearic Islands, Mallorca, Spain
2023	CIMNE Winter School: An Excursion into Computational Methods International Centre for Numerical Methods in Engineering (CIMNE), Barcelona, Spain

Publications

Peer-reviewed journal articles

1. **CAVALCANTI, D.**, MEJIA, C., SOUZA, C., MENDES, C. A., DE-POUPLANA, I., CASAS, G. & ROEHL, D. (2025). Behavior of Cohesive Stresses in Embedded Finite Elements Based on the Strong Discontinuity Approach. *Finite Elements in Analysis and Design*, 253, 104485. <https://doi.org/10.1016/j.finel.2025.104485>
2. **CAVALCANTI, D.**, MEJIA, C., ROEHL, D., DE-POUPLANA, I., & OÑATE, E. (2024). Hydromechanical embedded finite element for conductive and impermeable strong discontinuities in porous media. *Computers and Geotechnics*, 172, 106427. <https://doi.org/10.1016/j.compgeo.2024.106427>
3. **CAVALCANTI, D.**, MEJIA, C., ROEHL, D., DE-POUPLANA, I., CASAS, G., & MARTHA, L. F. (2024). Embedded Finite Element formulation for fluid flow in fractured porous medium. *Computers and Geotechnics*, 171, 106384. <https://doi.org/10.1016/j.compgeo.2024.106384>

Submitted manuscripts

CAVALCANTI, D., RANGEL, R. L., MENDES, C. A., OLIVELLA, S., VILARRASA, V., MARTHA, L. F., ROEHL, D., DE-POUPLANA, I., & CASAS, G. PorousLab: a modular finite element framework for simulation of fractured porous media models. Manuscript submitted for publication.

Participation in R&D Projects

1. Assessment of geological fault reactivation risk by CO₂ injection processes in geological deposits. Funding entity: *ExxonMobil*. Principal investigators: Prof. Deane Roehl and Prof. Eugenio Oñate. Period: 07/2023 – 01/2027. Amount: 940.259,50 €.
2. SECCO2: Open-source software for the digitalization of the CO₂ storage process. Funding entity: *Spanish Ministry of Science, Innovation and Universities* (MCIU). Period: 12/2022 - 11/2024. Principal investigators: De-Pouplana, I.; Casas, G. Amount: 135,355 €.

Conferences

1. **CAVALCANTI, D.B.**; SOUZA, C., MENDES, C. A., MEJIA, C.; POUPLANA, I.; CASAS, G.; ROEHL, D. Three-dimensional hydromechanical simulation of naturally fractured reservoirs using an embedded finite element approach. In: XVIII International Conference on Computational Plasticity (COMPLAS), Barcelona, Spain, September 2--5, 2025.
2. **CAVALCANTI, D.B.**; MEJIA, C.; ROEHL, D.M.; MARTHA, L.F.; POUPLANA, I.; CASAS, G., Assessment of geological fault reactivation using a fully coupled hydromechanical embedded finite element approach. In: Proceedings of the 9th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2024), Lisboa, Portugal, Jun. 2024.

3. **CAVALCANTI, D.B.**; MEJIA, C.; ROEHL, D.M.; MARTHA, L.F.; POUPLANA, I.; CASAS, G., An improved embedded finite element formulation for investigating fluid flow behavior in fractured porous media. In: Proceedings of the XLIV Ibero-Latin-American Congress on Computational Methods in Engineering (CILAMCE 2023), ABMEC/FEUP, O Porto, Portugal, Nov. 2023. Paper ID: 760, p. 7.
4. **CAVALCANTI, D.B.**; MEJIA, C.; ROEHL, D.M.; MARTHA, L.F., Numerical experiments to assess the behavior of finite elements with embedded strong discontinuities. In: Proceedings of the XVII International Conference on Computational Plasticity. Fundamentals and Applications (COMPLAS 2023), Barcelona, Spain. CIMNE, 2023.
5. **CAVALCANTI, D.B.**; RANGEL, R. L. M. MARTHA, L. F. Nonlinear analysis of inelastic frames considering a corotational approach and plasticity by layers: a discussion about computational implementation. In: Nonlinear analysis, stability and structural dynamics (CILAMCE 2022), Foz do Iguaçu, Paraná. Anais....Foz do Iguaçu: ABMEC, 2022.
6. **CAVALCANTI, D.B.**; RANGEL, R. L. M. MARTHA, L. F. Numerical experiments to assess the performance of different formulations and solution algorithms for geometrically nonlinear analysis of two-dimensional frames. In: Nonlinear analysis, stability and structural dynamics (CILAMCE 2022), Foz do Iguaçu, Paraná. Anais....Foz do Iguaçu: ABMEC, 2022.
7. **CAVALCANTI, D.B.**; ALMEIDA, S. R. M. ARAÚJO, D. L. Multi-material continuum topology optimization with multiple volume constraints and material nonlinearity. In: Topology optimization of multifunctional materials, fluids and structures (XLII CILAMCE and III PANACM, 2021), Rio de Janeiro, Rio de Janeiro. Anais....Rio de Janeiro: ABMEC, 2021

Invited Talks

2026

Invited speaker, Workshop on the Limits and Promise of Geo-Energies

Organized by IMEDEA (CSIC-UIB)

Talk: Challenges in the numerical modelling of fractured and faulted geological media

Palma de Mallorca, Spain. June 1st and 2nd, 2026.

Open-science

PorousLab |

Developer of an open-source, MATLAB-based, object-oriented finite element framework for multiphysics simulations in porous and fractured media. The framework is designed for the rapid prototyping, verification, and extension of new numerical formulations, supporting mechanical, hydraulic, two-phase flow, and coupled hydro-mechanical models, with embedded finite element capabilities for modeling fractures and faults.

Role: Creator and main developer.

Technical Skills

Scientific programming

Experienced in scientific programming with C++, Python, MATLAB, Lua, and Tcl, and in the implementation of new numerical formulations in computational frameworks such as [GeMA](#) and [Kratos](#). Also experienced in the development of graphical user interfaces and pre-/post-processing tools for numerical simulations.

Numerical methods and modeling

Background in finite element methods, nonlinear analysis, coupled multiphysics problems, and the modeling of discontinuities such as fractures and faults. Additional experience includes structural and topology optimization, as well as the use of commercial finite element software such as Abaqus and DIANA.

Languages

Portuguese native speaker, fluent in English, with advanced working proficiency in Spanish and Catalan.