Title: Presentation of an Elasto-Plastic Model of Unsaturated Fine-Grained Soil Based on the Barcelona Basic Model (BBM)

Introduction The behavior of unsaturated fine-grained soils is a critical aspect of geotechnical engineering, influencing the design and stability of structures. My doctoral research aimed to develop an advanced elasto-plastic model for these soils based on the Barcelona Basic Model (BBM), addressing the limitations of existing models in predicting soil behavior under varying moisture conditions.

Research Problem Despite the extensive use of the BBM in modeling unsaturated soils, its application to fine-grained soils requires further refinement to account for their unique properties. My research sought to bridge this gap by presenting an enhanced model that improves predictive accuracy and practical applicability.

Methodology The research involved a combination of experimental studies, theoretical analysis, and numerical simulations. I conducted a series of laboratory tests to characterize the mechanical behavior of unsaturated fine-grained soils under different conditions. The experimental data informed the development of an elasto-plastic model, which was then implemented and validated through finite difference simulations.

Innovations and Techniques I leveraged my expertise in continuum mechanics, constitutive models, and computational modeling to delve into elasticity, plasticity principles, and numerical techniques using FLAC and Python. A significant aspect of my work involved modifying the constitutive model equation to control the elastic zone in the model at higher suctions. Additionally, I developed and optimized elasto-plastic models for soil-structure interfaces, incorporating factors such as anisotropy, non-linear apparent tensile stress, and stress paths. My programming skills in C++ and Python enhanced computational efficiency and facilitated the integration of machine learning and deep learning techniques into geotechnical analysis. I also addressed the challenges of modeling large deformation problems in unsaturated soils.

Key Findings The developed model demonstrated superior performance in capturing the stress-strain behavior and moisture-dependent characteristics of fine-grained soils compared to traditional models. Key findings include the model's ability to predict soil collapse behavior and its response to cyclic loading with high accuracy, as well as its capability to handle large deformation problems effectively.

Conclusion and Future Directions The proposed elasto-plastic model provides a robust tool for geotechnical engineers, enhancing the understanding and prediction of unsaturated soil behavior. Future research could extend the model to other soil types and explore its application in large-scale geotechnical projects.