CRITICAL EVALUATION OF AVAILABLE PREDICTIVE MODEL FOR ROOT PERMEATED SOIL STRENGTH USING NUMERICAL MODELING

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Soil bioengineering combines plants' root systems to prevent erosion and stabilise slopes, offering sustainable, nature-based solutions for environmental restoration. Shear strength evaluation of soil bioengineering is discussed under mechanical and hydrological aspects but remains unimproved, highlighting a significant research gap. This research presents a comprehensive investigation on the shear strength improvement of soil through soil reinforcement, focusing on the use of vegetation roots as a reinforcement material. The study combines experimental testing and numerical modelling using Abaqus software to assess the effectiveness of root reinforcement in enhancing soil stability. The experimental phase involved conducting tensile strength tests on natural Alstonia Macrophylla roots. Performing large-scale direct shear tests with roots can be a challenging endeavour. Roots have a significant impact on the mechanical behaviour of soil and introduce complexities into the testing process. In this research, Finite Element Analysis (FEA) was implemented in Abaqus to model large-scale direct shear tests involving soils with roots. This approach offered a versatile and powerful means to simulate the complex interplay between roots and soil behaviour. Obtained experimental data, including the Young's modulus value of the root, were utilized for the numerical model calibration. In the experimental phase of the study, a practical approach to quantify the tensile strength of roots was employed. This was achieved using a Universal Testing Machine (UTM), a widely used apparatus for measuring the mechanical properties of materials. However, certain properties such as Poisson's ratio and density for the root were obtained from relevant literature due to the unavailability of specific data. For validation purposes recently conducted direct shear tests results on Alstonia Macrophylla root permeated soil were adopted. The numerical model was established using a solid model approach, simulating the actual size of the soil samples, and employing appropriate material properties. The simulation accounted for soil-soil and soil-root contacts using appropriate contact models. In simulating the direct shear test, a "Surface-to-Surface contact" approach modelled soil and root interactions. Soil surfaces were defined as "Master" and "Slave," using a "Penalty formula" for tangential friction and a "hard" contact type for normal behaviour. Roots were treated as embedded bodies with ABAQUS constraints, ensuring realistic contact representation. The results of the numerical simulation demonstrated the stress concentration within the soil, particularly in regions in contact with the root, indicating significant shear strength improvement due to root reinforcement. The obtained shear stress-displacement relationship allowed for the determination of the shear strength of the system. Simulation and experiments showed root-soil shear strength enhancement. Accurate parameters and 3D modelling were vital for reliability. This study's findings provide guidance for root growth regulation and slope protection research. Overall, this research contributes to the understanding of soil reinforcement mechanisms and provides valuable insights into the use of Soil bio engineering as an effective means of enhancing soil stability.

Keywords: Soil reinforcement, Shear strength improvement, Alstonia Macrophylla root, Numerical modelling, Direct shear test, Contact modelling, Soil stability

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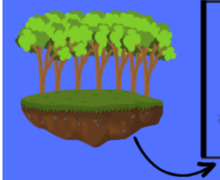
CRITICAL EVALUATION OF AVAILABLE PREDICTIVE MODELS FOR ROOT-PERMEATED SOIL STRENGTH, USING NUMERICAL MODELLING

Introduction

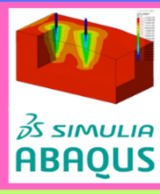


- Performing Large scale direct shear tests is one approach to measure both mechanical and hydrological effect fro tree roots.

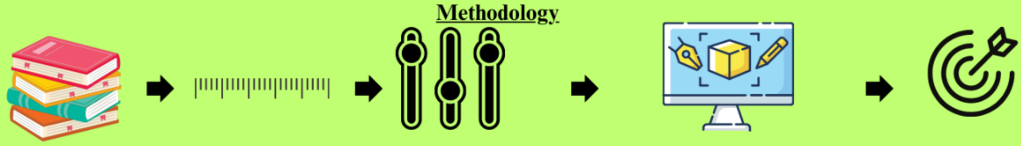
soil bioengineering is a technique that uses living plants to provide engineering functions such as slope stabilization, erosion control, and water quality improvement. performing large scale direct shear test for various types of vegetation to create data base to use in soil bio engineering work is very time consuming and costly work.

Summary

- **SO, as a solution Finite element modeling of large direct shear test will be done using ABAQUS FEM software will used in numerical modeling. Finite element model will be able to use in the industry as a graphical user interface with further development.**



Methodology



Literature Review
- Mechanical and Hydrological Behaviour
- FE Modelling

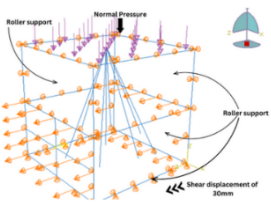
Idealization
- Software
- 3D Idealization

Obtaining Parameters
- Experiment
- Literature Review

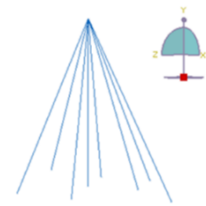
FE Modelling & Validation
- Mechanical and Hydrological Behaviour
- FE Modelling

Objectives & Analysis

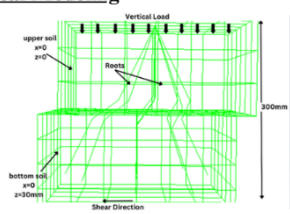
Numerical Modeling



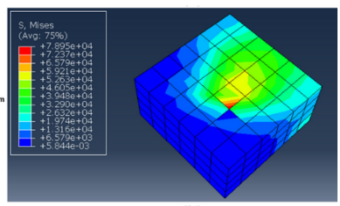
Boundary conditions



Idealized root

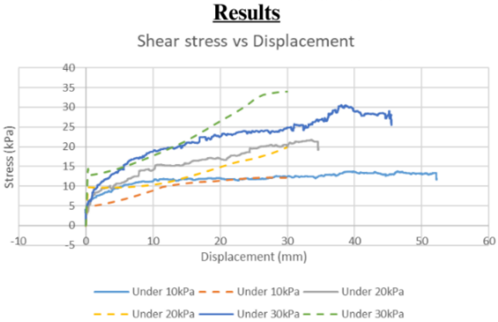


Deformed shape



Shear strength in shear plane with root

Results



Conclusion

- Alstonia macrophylla (Attonia Tree) roots enhance soil shear strength significantly.
- Plant roots resist shear force, improving shear resistance in root-soil composite.
- Shear strength has a linear relationship with vertical pressure using the same root method.