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Title: Characterization of the relationship soil density and simple compression resistance of silty soils

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Introduction

- Shear resistance is the fundamental property of soils that is taken into account when designing any geotechnical structure (Rojas et al., 2011). A typical experimental observation of soils as construction materials, is that the strength to shear stresses of these materials depends on the confinement stress to which they are subjected (Alonso et al., 1990).

$$\tau = \sigma_3 \tan \phi + c \qquad (1)$$

Introduction

- Under field conditions in which geotechnical structures are not confined, the condition $\sigma_3 = 0$ is met. This state of stress is known as "unconfined" and is present in a variety of geotechnical schemes. Such is the case of vertical cuts in excavations without casings or lateral retention structures. In such a case, the strength of the structure made with soil will depend exclusively on the strength to shear stress quantified as cohesion (Lu et al., 2017):

$$\tau = c \qquad (2)$$

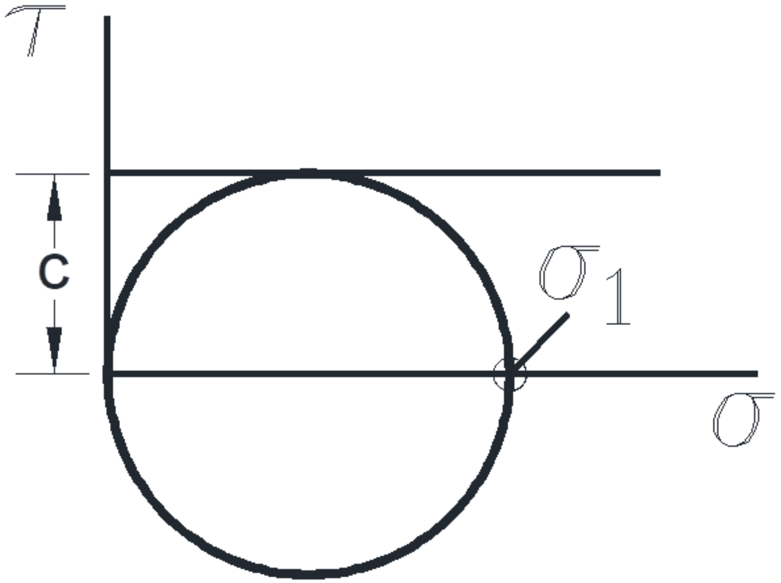

Figure 1. *Mohr's circle corresponding to an unconfined stress state.*

Methodology.

- The triaxial compression equipment used in the development of the research is a Triaxial Press with analog triaxial configuration (Figure 2).
- The cell and the transducer send signals that are continuously automatically interpreted and recorded, allowing to track the evolution of the axial stress vs. axial deformation.

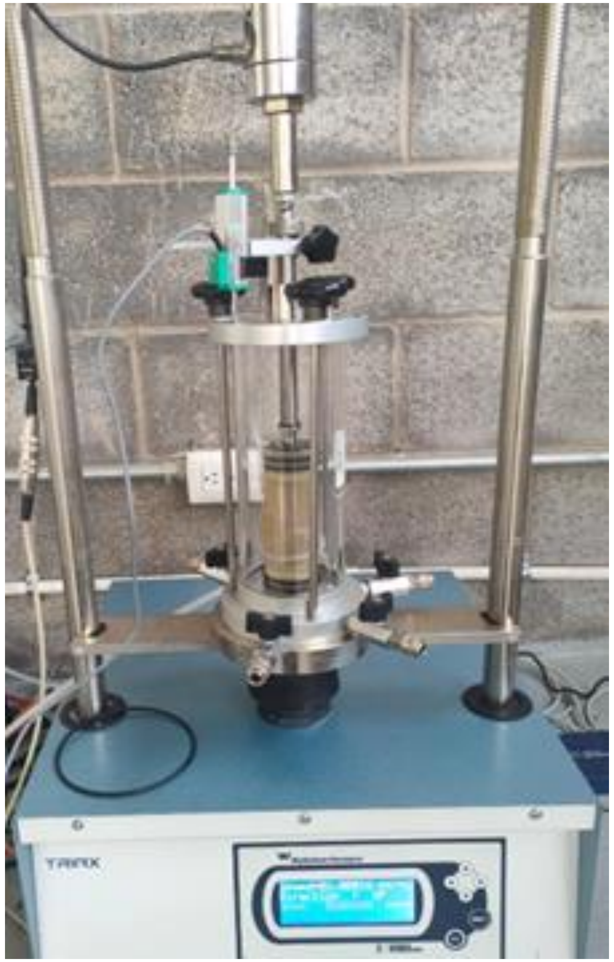

Figure 2. *TRIAX 28-WF-4001 Triaxial Press with analog triaxial configuration.*

Methodology

- The soil is a highly compressible silt, classified with the notation MH (according to the Unified Soil Classification System (SUCS) (Braja M. Das, 2010)).

Figure 3. *Left: MH1 with a 15% moisture content. Central: MH1 with a 20% moisture content. Rigth: MH1 with a 30% moisture content.*

Methodology

- It is proposed to study the behavior to unconfined compression under increasing densities 13 kN/m3, 15 kN/m3 and 17 kN/m3, all of them under a moisture content of 15%.

Figure 4. *Soil sample after compaction in the used mold.*

Results

- Figure 6 shows the cylindrical samples after failure, that is, once the shear strength has been reached under unconfined compression conditions.

Figure 6. *Soil samples at different densities γ driven to failure. Upper: γ = 13 kN/m^3; Central: γ = 15 kN/m^3; Right: γ = 17 kN/m^3.*

Results

- Figure 7, Figure 8 and Figure 9 show the mechanical behavior to strength of samples at different densities. Two sequences can be distinguished (solid line and dotted line) which show the evolution of the deformations for two identical samples under the same densities. This was done in order to corroborating the results obtained for a sample.

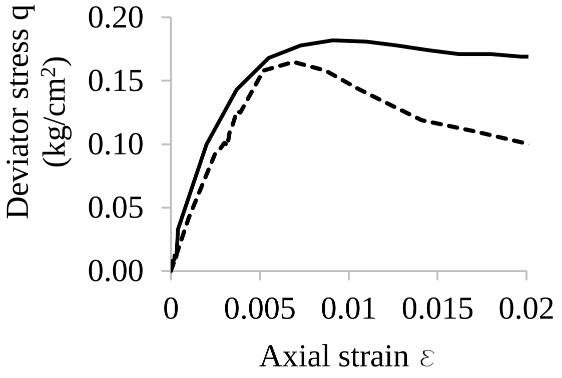

Figure 7. *Deviator stress-axial strain relationship for compacted soil samples to* $\boldsymbol{\gamma = 13\ kN/m^3}$.

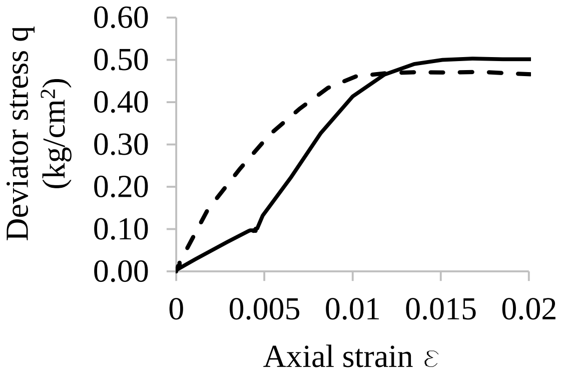

Figure 8. *Deviator stress-axial strain relationship for compacted soil samples to* $\boldsymbol{\gamma = 15\ kN/m^3}$.

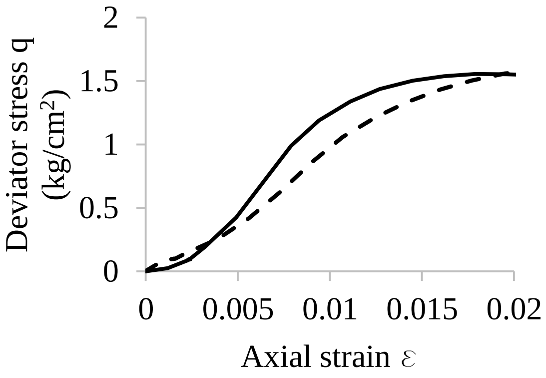

Figure 9. *Deviator stress-axial strain relationship for compacted soil samples to* $\boldsymbol{\gamma = 17\ kN/m^3}$.

Results

- Figure 10 shows the relationship between density and the maximum deviator stress that was sustained. The best fit was retrieved by linear regression, where a clear correlation can be seen between density and unconfined compressive strength, whose equation depicts an exponential nature $q = C_1 e^{C_2}$.

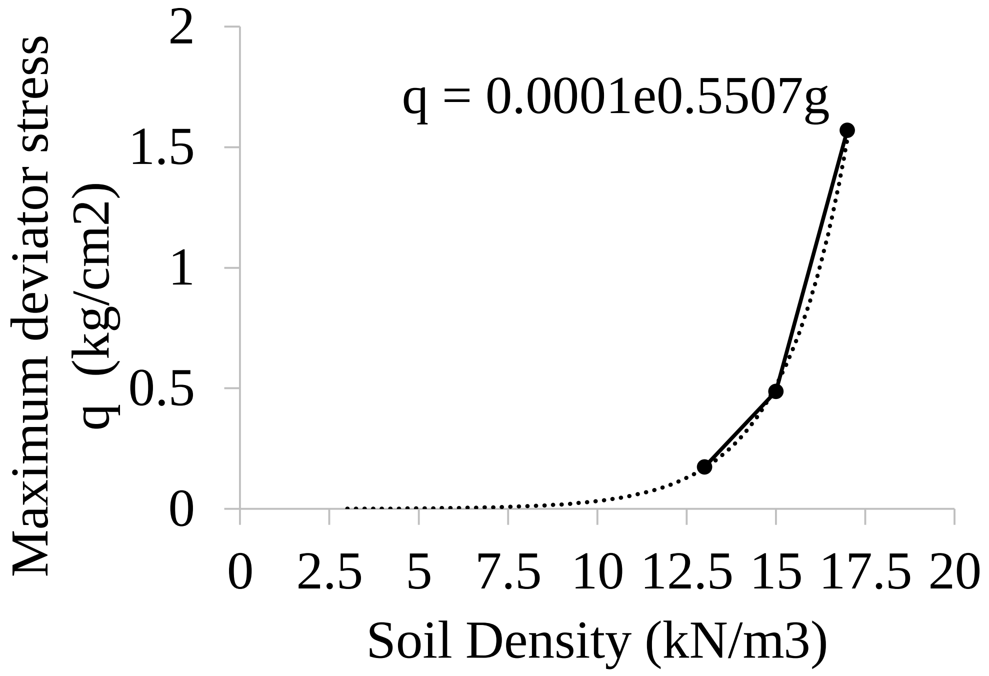

Figure 10. *Graphical relationship between soil density and the máximum deviator stress sustained by the samples.*

Conclusions

- A semi-empirical correlation has been established to relate the density of a silty soil, with its strength in unconfined conditions at constant moisture.
- The physical nature of the failure zones in the samples evidences through inclined cracks.
- Future work should consider the behavior of these materials under densities greater than 17 kN/m^3 and at different moisture contents to corroborate the empirical law of variation of material resistance with density. This empirical law must therefore be calibrated for empirical applications where at least two series of tests must be conducted to calibrate the constants C_1 and C_2 of the linear regression model applicable to these materials.

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