Procedia Engineering
Volume 143, 2016, Pages 566–573
Advances in Transportation Geotechnics 3 . The 3rd International Conference on Transportation Geotechnics (ICTG 2016)

A Data-Driven Approach for q_u Prediction of Laboratory Soil-Cement Mixtures

Joaquim Tinoco[1*], António Alberto[2], Paulo da Venda[2], António Gomes Correia[1], and Luís Lemos[2]
[1]*University of Minho, Campus de Azurém, Guimarães, Portugal*
[2]*University of Coimbra, Coimbra, Portugal*
jtinoco@civil.uminho.pt, aalberto@dec.uc.pt, pjvo@dec.uc.pt, agc@civil.uminho.pt, llemos@dec.uc.pt

Abstract
In this paper a new data-driven approach is proposed for uniaxial compressive strength (q_u) prediction of laboratory soil-cement mixtures. The proposed model is able to predict q_u over time under different conditions, e.g. different cement contents or soil types, and can be applied at the pre-design stage. This means that the model can be applied previously to the preparation of any laboratory formulation. The designer only needs to collect information about the main geotechnical soil properties (grain size, organic matter content, among other) and select the binder composition to prepare the mixture.
Based on a sensitivity analysis, the key model variables were identified and its effect quantified. Thus, it was caught by the model the most relevant variables in q_u prediction over time and very high prediction capacity with an overall regression coefficient higher than 0.95.

Keywords: Soil-cement mixtures; Laboratory formulations; Uniaxial compressive strength; Data mining; Neuronal networks; Sensitivity analysis

1 Introduction

The uniaxial compressive strength (q_u) of soil-cement mixtures is a fundamental design parameter necessary for many transportation geotechnics applications. This mechanical property is obtained through laboratory tests requiring time, which is generally very limited. Consequently, is very useful to have at this stage, at least pre-design, prediction tools to obtain this design parameter. However, this not taken into account the number of variables that affect q_u and obviously the traditional statistical analysis is unable to deal with.

[*] Corresponding author e-mail: jtinoco@civil.uminho.pt

Selection and peer-review under responsibility of the Scientific Programme Committee of ICTG 2016

doi:10.1016/j.proeng.2016.06.073

Aiming to overcome this limitation, a first and successful attempt was recently made, taking advantage of the high learning capabilities of Data Mining (DM) techniques (Tinoco et al.; 2011; Tinoco et al., 2014; Gomes Correia et al, 2014). Although a good performance have been achieved for both strength and stiffness prediction of laboratory soil cement mixtures (see Figure 1), there are some limitations that still need to be overcome. In particular, the model dependence on the mixtures proprieties, such its porosity, is one of its main drawbacks. As can be observed in Figure 2, which shows and compare the relative importance of the input variables in q_u and E_0 (young modulus) prediction, the mixture porosity has a relative importance around 15% in q_u prediction and higher than 20% in E_0 prediction.

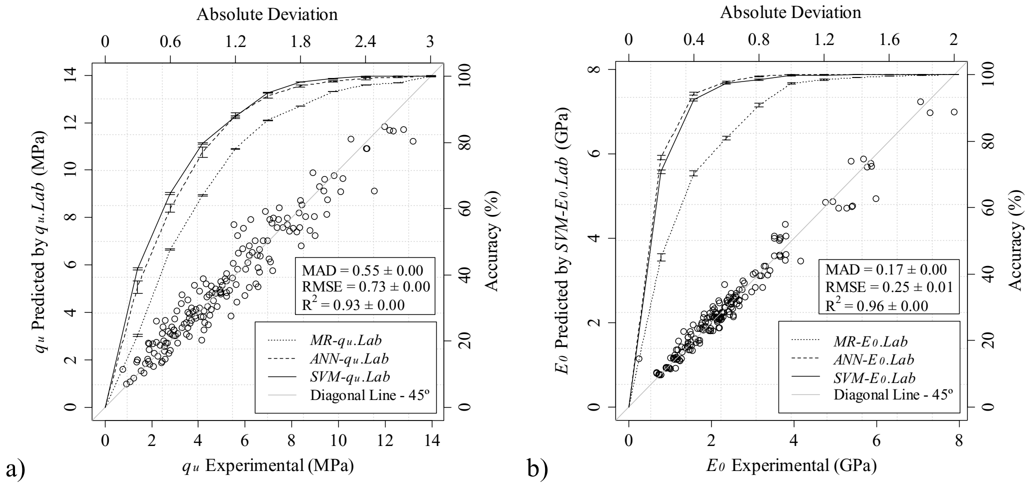

Figure 1: Data mining models performance in laboratory soil cement mixtures - mechanical properties prediction (Gomes Correia et al, 2014): a) q_u and b) E_0

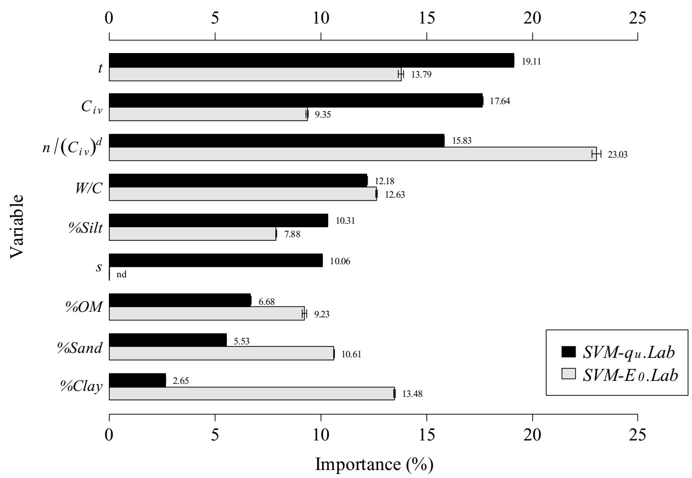

Figure 2: Comparison of the relative importance of each input variable in laboratory soil cement mechanical properties prediction according to SVM-q_u.Lab and SVM-E_0.Lab models (Tinoco et al., 2014).