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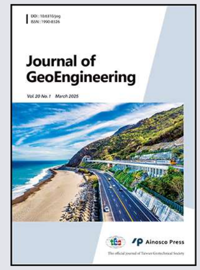

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Estimating Preconsolidation Pressure: Comparative Analysis of Multiple Linear Regression and Neural Network Models

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ABSTRACT

The pre-consolidation pressure (P_c) is one of the most important geotechnical properties, determining the stress history of fine-grained sediments and governing their future behavior. This paper presents a comparative analytical study that develops predictive models using artificial neural network (ANN) and multiple linear regression (MLR) techniques for the determination of the P_c of fine-grained sediments based on soil index variables. Soil data were gathered from the eastern part of the Basra region, southern Iraq, as a case study. A dataset consisting of 110 samples includes P_c as the dependent variable and independent variables consisting of liquid limit, water content, overburden pressure, and void ratio. Both models were analyzed using Python in this work. The best correlations in the study of MLR and ANNs were identified by using three independent variables for each model. The ANN models have been trained and compared. An accuracy test revealed that the ANN model performed more effectively. Both models are valuable tools for determining P_c, while ANN performs well in predicting complex soil behavior.

Keywords: *Pre-consolidation pressure, clay soil, multiple linear regression, artificial neural networks, settlement, soil index*

1. INTRODUCTION

Pre-consolidation pressure (P_c) is a vital parameter that helps in understanding the stress history and settlement behavior of cohesive soils. This is considered the maximum effective stress of the soil that it has withstood during its geological life; this critical value defines the boundary between recompression and virgin compression. It represents the critical state that, if exceeded, will produce large and generally irreversible settlements in the supporting soil (Persson 2017; Soltani *et al.* 2019). P_c is indicative of the history of stress oscillations during the generation of the soil, and the maximum past effective stress obtained from it is an important input to calculations of settlement (Ural and Uğur 2021). The ability to accurately predict P_c is of extreme importance for safe design and reliable analysis of settlement performances (Terzaghi 1943; Das and Sivakugan 2018).

Traditionally, P_c is determined using laboratory-based tests such as the one-dimensional consolidation test (Oedometer, ASTM D2435) and the isotropic triaxial test (ASTM D4767) on undisturbed samples. Several graphical interpretation methods, such as those proposed by Casagrande, Schmertmann, Janbu, Tavenas, Butterfield, and Senol, are commonly used to estimate P_c from $e - \log(\sigma')$ plots, where e and σ` are the void ratio (e_0) and the effective stress, respectively. However, these techniques often have poor accuracy due to various factors, including soil swelling, cementation, mineralogy, and original structure (Ladd 1991; Ural and Uğur 2021). Moreover, these tests are time-consuming, expensive, and prone to subjective interpretation. Thus, since the 1950s, several research findings have been carried out to ascertain settlement, an important criterion for the consideration of structural stability. Most of these research studies focus on soil compressibility, although a few base their discussions on P_c as an important factor in predicting settlement. While compressibility is important, P_c is also important since it represents the soil's highest historical stress, which has a direct impact on the strength of the structure.

To overcome these challenges, researchers have utilized empirical-statistical methods for the estimation of P_c from easily determinable soil index properties such as liquid limit (LL), plasticity index (PI), water content (W_n), specific gravity (G_s), and initial e_0. Multiple linear regression (MLR) has been used very commonly for establishing such correlations (Kogure and

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