Engineering Structures 33 (2011) 1195–1204

Contents lists available at ScienceDirect

Engineering Structures

journal homepage: www.elsevier.com/locate/engstruct

# Preconsolidation, structural strength of soil, and its effect on subsoil upper structure interaction

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ARTICLE INFO

*Article history:*
Received 15 August 2010
Received in revised form
5 November 2010
Accepted 29 December 2010
Available online 16 February 2011

*Keywords:*
Influence zone
Preconsolidation
Structural strength
FEM
Triaxial test
In situ testing
Deep foundation
Layered subsoil
Modified Cam clay model
Kantorovich method
Theory of convolution

ABSTRACT

When constructing a building, manufactured materials are used. That is the reason for their excellent material properties. In the case of the foundation, the natural condition of the soils must mostly always be respected. The geostatical stress plays a significant role on the subsoil behavior because it is the de facto natural form of the soil compaction. The soil has a memory of the highest stress that has ever been loaded on it. The soil can be considered incompressible if the magnitude of a surcharge is lower. In engineering practice the construction of higher buildings is founded in a deeper hole so that the depth of the influence zone achieves an acceptable value for the future surcharge of the upper structure. For very tall buildings, the deep hole foundation must be prolonged by piles. In particular, this article deals with laboratory testing that provides the preconsolidation. In Czech, we term it the structural strength of soil. The test provides the initial void ratio as well as the initial coefficient of fully saturated hydraulic conductivity. The isotropic consolidation test with the triaxial test apparatus and consequent knowledge of the pore pressure course was chosen to determine the initial soil properties, including the preconsolidation level. Derived theory together with the genetic algorithms provide an efficient tool for the determining parameters. Good knowledge of the influence zone is crucial when solving soil structure interaction. The progress of the influence zone was considered from the extensive research carried out at the University of Brasília, Brazil. Thus, using the measurements, the preconsolidation and its effect were verified in situ. The derived formulas and presented graphs for influence zone depth estimation have considerable importance for civil engineering practice. The Kantorovich method together with the strategy of convolution was used to reach dimensional reduction when deriving analytical formulas. Recommended results and formulas were verified against FEM code ADINA.


## 1. Introduction

It has been experimentally confirmed that a soil substantially changes its material properties when subjected to external loading. Apart from that, the soil, when subjected to a certain loading history, has the ability to memorize the highest level of loading mathematically represented by the over-consolidation ratio, and the initial void ratio. In its virgin state, the soil deformability is relatively high. In contrast, following the unloading/reloading path shows almost negligible deformation until the highest stress state the soil has ever experienced before is reached [1–3]. To study this behavior of soil, we performed several small laboratory tests. Transport processes were observed carrying out isotropic consolidation with triaxial test apparatus. Employing genetic algorithms, soil parameters were determined comparing the pore pressure course (measured and calculated) [4,5]. In the large scale, the effect of over-consolidation was simultaneously investigated by way of rigid plate and pile working diagram analysis. Both the finite element technique and elastic layer theory were employed in back analysis of the measured data. The great effect of overburden was observed on the depth of the influence zone in deep hole foundations [6,7]. This study is in general focused on the description of preconsolidation effects by self weight of overburden and on selection of the main parameters characterizing this memory of the subsoil.

## 2. Preconsolidation, structural strength, in laboratory testing

The test was arranged in two runs, loading/reloading. Readings were taken of the highest level of effective mean stress. Referring to experimental measurements carried out with the triaxial apparatus, the isotropic consolidation can be viewed as a one phase flow in a fully saturated deforming medium undergoing small deformation. When neglecting the body forces, the hydrostatic state of stress maintained during the experimental measurement gives

$$\sigma_x(x, y, z, t) = \sigma_y(x, y, z, t) = \sigma_z(x, y, z, t) = \sigma_m, \quad (1)$$

where $\sigma_m$ is the total mean stress. Following the Terzaghi–Fillunger concept of effective stresses, this quantity can be expressed in

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0141-0296/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engstruct.2010.12.041