Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 189 (2017) 252 – 257

Procedia Engineering

www.elsevier.com/locate/procedia

Transportation Geotechnics and Geoecology, TGG 2017, 17-19 May 2017, Saint Petersburg, Russia

Assessment of varve clays sensitivity to natural structure disturbance

Klemyatsionok P.L.[a], Kolmogorova S.S.[a], Kolmogorov S.G[b] *

[a]*Emperor Alexander I State Transport University, 9 Moskovsky ave., St. Petersburg, 190031, Russia*
[b]*Saint-Petersburg State Agrarian University, 2, sh. Petersburg, Pushkin, Saint-Petersburg, 196601, Russia*

Abstract

The article deals with the problem of sensitivity of varve clays to disturbance of natural structure. Soil sensitivity can be determined by any method, enabling to make soil tests in the conditions of natural and disturbed structure. The testing method, the kind of the applied impact and the kind of deformations caused by this impact will influence assessment of sensitivity.
While assessing clay soils sensitivity the case of varve clays shows the necessity to use different methods. Applied to a number of tests the article introduces the term of sensitivity range for the soil of a particular genetic type.

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology

Keywords: sensitivity; varve clays; range sensitivity

Introduction

Nowadays extensive information on physical-mechanical properties of soils has been accumulated. The relevant task is the analysis and generalization of available data in two directions:

- applied to different types of soils in terms of genesis, composition and structural-textural features;
- applied to various methods of testing.

* Corresponding author. Tel.: +7-921-312-25-74.
E-mail address: Kolmogorovsg@list.ru

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology
doi:10.1016/j.proeng.2017.05.040

The rational methods should be based on the correlation of these two directions. And these methods should expand the possibility of considering genesis and soil natural characteristics in the analysis of the results of their tests. This will ensure the accuracy of the determined values.

Features of varve clays are non-compactness, soil cohesion due to water-colloidal structural bonds and sensitivity to disturbance of natural structure [1-5]. The testing method, the kind of the applied impact and the kind of deformations caused by this impact will influence assessment of sensitivity. Following various test results the paper analyzes varve clays sensitivity to disturbance of natural structure.

Main part

In the work [4] the effect of disturbance of a structure under compression is given in two forms:

Compressibility coefficient and modules of varve clay settlement with initial soil porosity coefficient for undisturbed and disturbed structure are accordingly 1,108 and 1,045 at a pressure of 0....0,2 MPa. According to these data the sensitivity is $S_{tm}=S_{tMo}=2,7$.

Compression curves of samples of varve loam and varve clays (figures 1a, 1b). Data analysis leads to sensitivity soil values: for varve loam the sensitivity $S_{t\varepsilon}$ is 3,2…1,7, for varve clay the sensitivity $S_{t\varepsilon}$ is 2,3….2,2. Soil sensitivity naturally decreases with pressure increase.

Comparing varve clays compression curves of undisturbed and disturbed structure at W=50% and e=1,46 was first done by S. A. Rosa in 1950. According to him at pressure of 0,1 MPa the sensitivity $S_{t\varepsilon}$ is 4,6.

Therefore, under compression sensitivity interval can be taken $S_{tmo}= S_{t\varepsilon}=2,7….5$.

The results of direct shear [4] are presented in Fig 2. It shows that strength in undisturbed and disturbed structure can be compared only for the interval of water content W=36.....42%. And in the specified interval disturbed structure has $\varphi_d= 0$. The results of calculations are shown in table 1.

Table 1. Results.

Water content W, %	$tg\varphi_u$	Cohesion of undisturbed soil C_u, MPa	Cohesion of disturbed soil C_d, MPa	Sensitivity $S_{tg\psi}$	Sensitivity S_{tC}	Friction angle φ_u°	Sensitivity $S_{t\sigma}$
1	2	3	4	5	6	7	8
36	0,46	0,017	0,0065	7,3	2,6	14	3,3
38	0,38	0,016	0,0045	8,8	3,4	12	4,2
40	0,35	0,015	0,0032	11,4	4,7	10	5,6
42	0,33	0,014	0,0025	13,8	5,6	9	6,6

Table 1 shows the increase in sensitivity by both measures with increasing of water content. At the same time it is likely to have overestimation of the calculated sensitivity values by tangent of shear angle $S_{tg\psi}$ which is indicated by high values of angle of internal friction in undisturbed structure $\varphi_u=18…25°$. It can be assumed that in the experiments under taken pressures significant soil compaction took place. This is confirmed by the following data:

According to regional construction norms TSN 50-302-2004 SPb (Fig. E. 1 Application) when W=38%, $J_L=1,2$ the resulting values are $\varphi_u=11°$, $c_u=0,01$ MPa and consequently reduction of sensitivity: $S_{tg\psi} = (0,1 \cdot 0,19 + 0,01)/0,0045 = 6,4 < 8,8$

According to recommendation of NIIOSP [6], developed on the basis of quick shear of unconsolidated samples of varve clays when $J_L=1,2$ and e=1,15 the resulting values are $\varphi_u=12,5°$ and $c_u=0,005$ MPa, which gives $S_{tg\psi} = 6,0$.

Therefore, the obtained in tab. 1 values Stgψ must be reduced by 30%, so the interval of their change is 5,1.....9,7 on previous values S_{tc} (column 6 of tab.1).

Let′s study given in [4] the results of undisturbed and disturbed samples parallel testing using methods of uniaxial compression, cone Boychenko and direct shear at P=0. The data are summarized in table. 2. The Numerator specifies experimental values for undisturbed structure, and the Denominator – for disturbed structure (columns 3-5). Columns 6, 7 show the assessment of sensitivity.