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Research paper

Investigation of physical and mechanical properties of peat

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Abstract

The article describes results of laboratory tests of weak water-saturated soils (remote from day surface) in stress-strain state under influence of compression with double-sided filtration of pore's water. The experimental device with console-lever system of load transfer and potential of double-sided filtration was made for current research. The compression specification was controlled with the strain gauge sensor element of general pressure (i.e. the load cell).The deformation in sample were measured with the motion detecting transducer that based on indicating gage. The excessive pore pressure was measured with strain gauge sensor elements and digital manometer. Also the plots of compression deformation against pressure and changes of excessive pore pressure during the time on different load degrees were drawn. Although, authors made the new experimental device for research of the water saturated peat mechanics properties with excessive pore pressure.

Keywords: *Weak Organo-Mineral Soil; General and Excessive Pore Pressure; Peat Macro Sample; Compression.*

1. Introduction

There are a lot of territories with peaty high water table soils in Russia. Nowadays Russia took the first position in swamp areas quantity [1]. The peculiarity of south of Tyumen region is that spread of peaty soils more than 15% of whole territory.
The building of engineering facilities on peaty soils is a complexity process, so in this case, it is necessary to make the constructions more complicate and that leads to price rise. It is very important for development of new effective construction of foundation to explore train-stress distribution and evaluation of mechanical specifications that will fully describe the water-saturated peat as a basis for engineering facilities.
Nowadays Russia is the first in quantity of marshes. Moreover, it has continued to grow. According the predictions of scientists, the whole territory of West Siberia will be marshed and mucked in the next ten thousand years. It connected with the irreversibility of marsh formation in modern climate conditions. About 0.86 million square kilometers became the marsh areas in the last 500 years. Scientists have proved the fact that growth of the marshes areas and width of the peat deposits make it stable and autonomous as a whole system.High stability of marshes ecosystems makes an irreversibility the marsh formation process and makes the progress in autonomous of marsh formation process in particular territories [2, p.5].
The most important thing in evaluation of foundation on peat soils is a peat bedding conditions. There are two types of peat bedding. The first one is opened, the second one is buried. The opened type of bedding uses only for lightweight timber buildings. This type of buildings based on a sand blankets or piles. While as the fundamental structures based on cutting organic soils, sand blankets or piles. The physical mechanical properties of peat have the same standards of evaluation as organic soils.
It is impossible to make analysis of excessive pore pressures influence on physical mechanical properties of sample in the GOST (All-Union State Standard) [3] methods because of a small size of the sample. It is also impossible to apply sensors of soil pore pressures and to measure pore pressures because of sample's height.
By the way, peat properties is different in comparison to organic soils. This is due to property of the peat to keep much more water volume in bounded condition than volume of its particular minerals. The relative degree of humidity of peat in natural conditions of water saturation is more than 96%. It cannot be less than 85% even after the long deep dewatering with filter drain. It connected with the high dispersity level and particular friable fibriform structure of the peat.

2. Subjects and method

The experimental device [4 - 6] (Fig. 1) for investigation of stress-strain state and pore pressures in a water-saturated peat sample has been invented in interdepartmental experimental science lab in TSUACE.

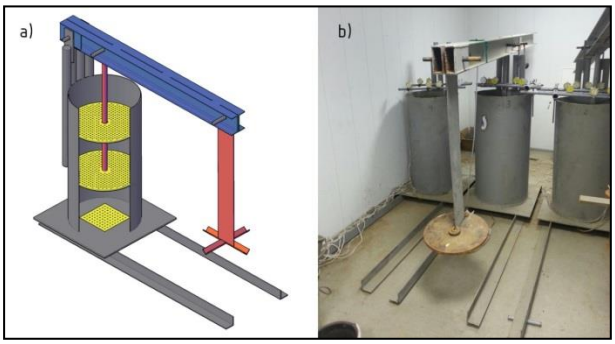

Fig. 1: An Experimental Device: A - 3d-Model, B - Development Prototype.

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Experimental device is a steel pipe with hard sidewalls, it has a diameter - 510 mm and height - 1020 mm. Above the sample of peat (with the 400 mm of height) has made a solid of coarse sand that simulate overlying soils. Perforated slab has set at the bottom of tray for drainage of water into pallet that connected with digital manometer. The load on a sample transfers through the round perforated press-tool #1. Press-tool #2 was made heavier for combined settlement and prevention of sand catching. In this case, load transfers through the console-lever system. Easy-deformable plastic membrane has set on a pipe's sidewalls, solid oil has used as a grease between them. Membrane have used for friction of reduction between soils and the sidewalls of device (Fig. 2).
During the process of research of sample consolidation, the next characteristics were measuring: general and excessive pore pressure, press-tools movement and indoor temperature.

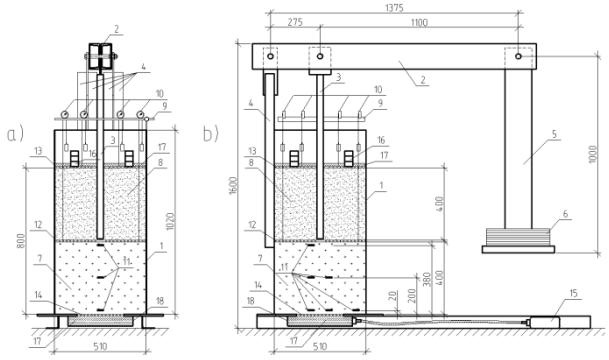

Fig. 2: Device Structure: 1 – Body; 2 – Lever; 3 –Charging Rod; 4 – Pillar; 5 – Charging Platform; 6 – Set of Weights; 7 – Sample; 8 – Coarse Sand; 9 – Fixed Holder; 10 – Deformation Sensor; 11 – General and Excessive Pore Pressure Sensors; 12 – Perforated Press-Tool #1; 13 – Perforated Press-Tool #2; 14 – Perforated Bottom of the Device; 15 – Manometer; 16 – Weight; 17 – Water; 18 – Pallet.

The weak organo-mineral soil with disturbed structure (sand-clogged mud-peat) was used for referencing purposes. The samples was taken in Borovskiy village of Tyumen region. During the process of packing the sample was compressed and it has the next characteristics: ρ = 1.23 – 1.31 g/cm2, W = 181 – 189%, peat decay degree – 45%, ash-content – 67%. Sample proportions: diameter – 510 mm, height – 400 mm. Hs=400 mm. The coarse sand used as a soil lock, Hs=400 mm.
The height of the peat sample was set as 400 mm for comparison of characteristics between standard methods that not consider remoting from the day surface and the considerations about importance of smaller samples that not only a point-counter value and can characterize system as a whole [7]. In addition, during the tests of standard samples (from 40 to 80 mm in diameter and from 20 to 30 mm in height) after 75-95 minutes the odometer reading in a clay soils became zero because of small height of samples [8]. For peat soils, this process passes faster.
The membrane-type strain gauge sensor elements of general pressures (the load cell, 34 mm in diameter) were set in sample for monitoring of conditions implementation of methods of compression. The load cell calibration were made in balloon tank. Device ITC-03p-40 was used as a unit record equipment. The motion detecting transducer (bases on indicating gage with 0.1 mm scale gradation) used for measuring of deformation. The membrane-type strain gauge sensor elements (34 mm in diameter) of pore pressures and digital manometer CPG1000 (precision till 1 kPa) that connected with pallet. The load on a sample was transferred by 2.5 kPa steps (for two first steps) and 5kPa till stabilization at adjusted load. The criteria of conditional stabilization were a sample's characteristics of incremental strain that were less than 0.05% (0.2 mm) for the last 24 hours of monitoring [3].

3. Results

The below graphs bases on results of tests. Fig. 3 is graph for the unit deformation against the pressure. Fig. 4 is graph that shows the changes of on the excessive pore pressure during the time on a different steps of loading using the load cell at 380 mm depth. And fig. 5 for the measuring with manometer in a sample.

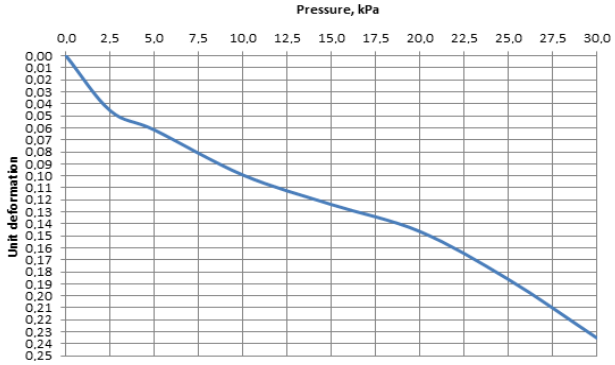

Fig. 3: Unit Deformation-Pressure Diagram.

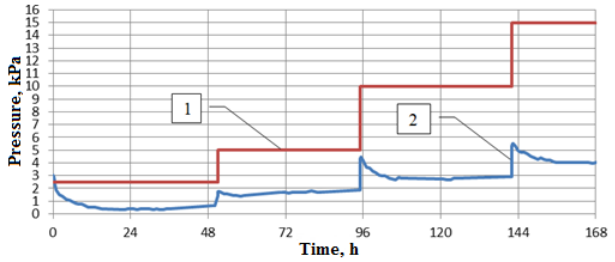

Fig. 4: Graph of Excessive Pore Pressure by the Load Cell at 380 Mm Depth Against the First Week of Tests On Sample Pressure. 1 Is for the Pressure Under Press-Tool, 2 Is for Excessive Pore Pressure.

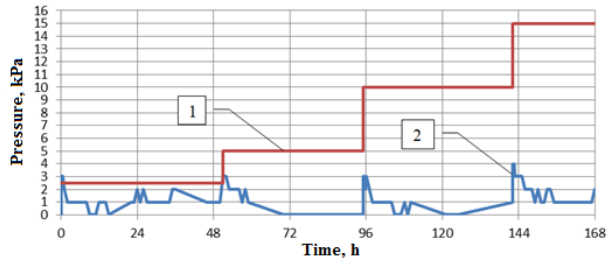

Fig. 5: Graph of Excessive Pore Pressure by the Manometer Against the First Week of Tests on A Sample Pressure. 1 Is for the Pressure Under Press-Tool, 2 Is for Excessive Pore Pressure.

4. Conclusion

1) The difference between indicators of sensors of general pressures is not more than 10%, it means that mitigation of friction force measures of sidewalls was useful and conditions of compression method has done.
2) The unit deformation of testing sample is 0.235;
3) The final value of unit deformation by steps: 0.046 at P1=2.5 kPa; 0.062 at P2=5 kPa; 0.099 at P3=10 kPa; 0.124 at P4=15 kPa; 0.146 at P5=20 kPa; 0.186 at P6=25 kPa; 0.235 at P7=30 kPa;
4) The residual excessive pore pressure measured with the manometer reading has become 11% from the pressure after 30 days pass the last step, it is important to note the necessity of using more accurate manometer;
5) The residual excessive pore pressure, measured with load cell at depth of 200 and 380 mm has become 16 and 22% from the pressure after 30 days pass the last step;
6) The value of full scale residual excessive pore pressures, measured with load cell at depth of 200 and 380 mm (in ap-

plied of load moment) have become 38 and 43% from the sample pressure;

7) The criteria of conditional stabilization includes not only a change of incremental strain but also, stabilization of readings in the residual excessive pore pressures, individually on every step.

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