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Research Article

Specific Features of Geotechnical Properties of Peat in the Marshy Areas of the Tyumen Region

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ABSTRACT.
The results of studies of peat at the construction site of the prospective rotators' camp community of the Urnenskoye deposit in the Tyumen Region of Russia are presented. The characteristic of a widespread problem of construction in the marshy territories of Western Siberia is given. Modern methods of solution are provided. The geomorphological, hydrogeological and geotechnical conditions of the site are considered. The peat thickness at the deposit reaches 3.5 m. Peat is underlain by clayey deposits, represented by loam with a bluish-gray heavy silty soft-plastic consistency. The groundwater level at the site is 0.20 m. The absolute elevations of the earth's surface reach 100.5 m.
The authors present the results of field and laboratory tests of peat, according to which peat is highly decomposed, with normal ash level, does not possess an angle of internal friction and is characterized by weak strength properties. The considered soil will become a weak and strongly deformable foundation, and therefore the use of a sand bed is recommended as the artificial base of the community facilities.

Keywords: Peat, Peat ash level, Waterlogging, Geotechnical surveys, Boggy deposit.

INTRODUCTION

The construction in swamps and marshy areas is the problem of developing excessively wetted areas and partly territories within which wetland deposits can be spread. In this regard, it is quite often necessary to address the issues of strengthening the soil foundation when building infrastructure facilities for hydrocarbon deposits in Western Siberia[1-3].

As is already known, according to the geotechnical classification, boggy deposits belong to formations of special composition, state and properties, characterized by specific properties[4-6], requiring special research methods and individual assessment. In construction, they are considered to be weak formations, strongly and unevenly compressible. When choosing the location of structures, plots created by such deposits are tried to be avoided. All of the above indicate that construction in swamps and marshy areas is considered construction in special conditions.

This task should be solved, firstly, by carrying out a set of land reclamation activities aimed at improving these areas and, secondly, by applying special methods for erecting buildings and structures [7-9].

METHODS

In the course of this study, the properties of peat widespread in the Urnenskoye field of the Tyumen Region of the Russian Federation were studied. In the course of laboratory tests, the following peat properties were obtained: the degree of ash content and decomposition, the

value of humidity, density, and porosity coefficient.

Under field conditions, soil tests were carried out using the rotational slice method in order to obtain the mechanical characteristics of peat. This method is used to determine the shear resistance of weak soils: soft, clay, unstable consistency, loose water-bearing sands, peat, silt, etc.[4, 5].

The tests were carried out using bladed instruments (impellers).

RESULTS

The following characteristics of peat were obtained as a result of the research (both laboratory and field): it is highly decomposed, with normal ash level, does not have an angle of internal friction. A standard and calculated value of adhesion and total strain modulus were also obtained.

The large capacity of peat in the field (3.3-3.5 m) and its weak strength properties give reason to recommend the use of sand bed as an artificial soil foundation in the construction of community facilities at the deposit. But this issue must be ultimately resolved by the designers.

DISCUSSION

Administratively, the site is located in the north-eastern part of the Uvatsky district of the Tyumen Region, 270 km to the southeast of the district center of Uvat, in the territory of the Urnenskoyedeposit.

The terrain of the site for the prospective rotators' camp community is relatively flat (an undulating plain with a general incline to the south towards the Demyanka River). This is a typical accumulative plain, composed almost exclusively of loose and semi-consolidated deposit masses. The absolute elevations of the earth's surface fluctuate insignificantly, from 99.75 to 100.49 m.

In the geological structure of the site with an area of 2.2 hectares, a significant part is occupied by peat, with a capacity of 3.5 to 3.7 m. Peat is predominantly highly decomposed. Further on, the clay deposits, represented by loam with a bluish-gray heavy silty soft-plastic consistency, are deposited over the entire depth of the profile pit being searched. According to the geotechnical surveys, the geological and lithological section of the plot (site) has the following structure (from top to bottom):

The modern Quaternary deposits (QIV) are represented by a soil-plant layer with a thickness of 0.2 m. The bottom is located at a depth of 0.2 m, and the limits of the absolute elevations are 99.67-100.25 m.

Modern Quaternary deposits (bQIV) are represented by dark brown peat, of normal ash content, strongly decomposed, of biogenic origin. It is deposited in the form of 3.3-3.5 m thickness layer. The bottom of the layer is located at a depth of 3.5-3.7 m, within absolute marks of 96.27-96.85.

Upper Quaternary sediments (alQIII) are represented by bluish-gray, heavy, and soft-plastic loam. It lies directly under the peat layer. The penetrated thickness of the layer is 8.3-8.5 m. The bottom is located at a depth of 12 m (it is a mine face) within the marks of 87.87-88.45.

The groundwater of this area is confined to biogenic, as well as to modern alluvial deposits, is penetrated at a depth of 0.20 m.

Geotechnical Properties of Peat at the Site. Waterlogging as a geological process is predominantly spread in this area leading to the large peat thickness throughout the considered site.

The task of building in such territories should be solved, firstly, by implementing a set of land reclamation activities aimed at improving these territories and, secondly, by applying special methods of erecting buildings and structures. This requires data that fully reflect the geotechnical conditions of the territories, the structure of the wetlands and adjacent areas, their water supply characteristics, taking climatic, geomorphological and other natural conditions into account.

The conditions for construction on peat and peaty formations continue to be studied by many organizations and specialists. Available observations show that the yield of foundations of buildings erected on such formations can reach several meters with high irregularity.

Since peat surfaces throughout the study area of the site with a capacity of 3.5-3.7 m, the main issue for the engineer-geologist at this stage is the study of peat construction properties. The problem of development is associated with their excessive watering and spreading of weak, highly compressible and unstable marsh deposits.

The degree of the ash content of the studied peat is Dds = 0.17 unit fractions, therefore peat is normally ash.

The degree of decomposition of the studied peat is 58%, peat is highly decomposed. The moisture content of peat was W = 1.66 unit fractions, the density of peat particles was ρs = 1.64 g/cm^3, the natural density was ρ = 0.90 g/cm^3, the density of dry peat was 0.26 g/cm^3, the porosity coefficient was e = 3.945 unit fractions.

It should be noted that peat has high humidity in conditions of natural deposit. At this site, it varies from 85 to 95%, but can reach 2000% depending on the botanical composition of peat, its degree of decomposition, climatic conditions, area drainage degree, etc. Natural humidity of studied peat is 166%.

The density of organic and mineral part and peat as a whole varies from 0.7 to 1.8 g/cm^3. Its highest values are characteristic mainly for buried, more compacted and higher ash level differences.

The density of the soil studied varies from 0.87 to 0.92 g/cm^3.

Peat has high porosity due to its low density. The studied peat has high porosity, which varies from 4.865 to 3.060 unit fractions.

The definition of bearing capacity by the method of rotational slice is the most important for peat characterization.

Special device – the impeller – is used (Fig. 1).

The impeller consists of two identical rectangular mutually perpendicular plates arranged in a vertical plane and mounted on a vertical axis (see Fig. 1).

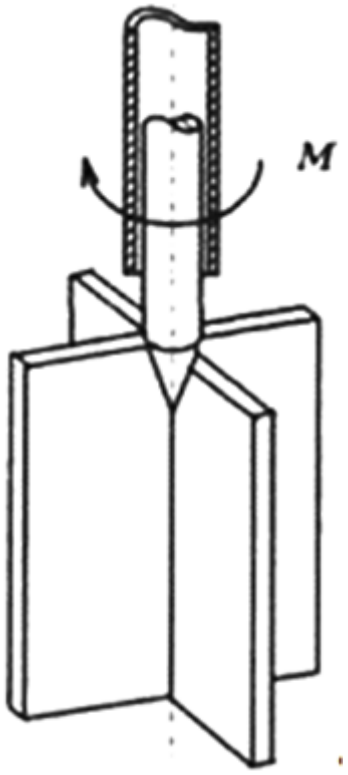

Fig. 1 Schematic diagram of the impeller device.M – torque.

The torque M is applied to this axis and its limit value is measured. The torque was used to calculate peat shear resistance. Thus, it was found that its resistivity varies from 0.1359 kgf/cm^2 to 0.0672 kgf/cm^2. Tests were conducted at depths of 1 and 3 meters. At a depth of 1 meter, the maximum carrying capacity of 0.083 kgf/cm^2 is observed at the center of the plot and decreases uniformly in all directions with the minimum value in the north-west (0.057 kgf/cm^2). All values increase at a depth of 3 meters, with the maximum value of 0.112 kgf/cm^2 observed in the north-east and the minimum value of 0.1064 kgf/cm^2 observed in the south and in the central part. An increase in specific resistance with depth is traced. At a depth of 1 meter, it amounts to 0.084 kgf/cm^2 (well No. 15), and at a depth of 3 meters, it reaches a maximum of 0.112 kgf/cm^2 in the north-eastern part of the site. It can be concluded that the denser peat is located in the northern part of the study area at a depth of 3 meters.

The strength characteristics of the studied peat are presented in Table 1.

Table1: Mechanical properties of the studied peat

Soil description	Specific adhesion,[kPa (kgf/cm^2)]			Coefficient of variation	Angle of internal friction, [grad]			Coefficient of variation	Deformation modulus,[MPa (kgf/cm^2)]
	C_n	C^{II}	C^I	V	φ_n	φ^{II}	φ^I	V	E
Dark brown, highly decomposed peat with normal ash level	9.60	9.41	9.23	0.21	0	0	0	-	0.31
	0.096	0.094	0.092						3.1

Note:C^I, φ^I– values of specific adhesion and the angle of internal friction at a confidence coefficient α=0.95;C^{II}, φ^{II} – values of specific adhesion and the angle of internal friction at a confidence coefficient α=0.85.

Thus, according to the results of laboratory research, peat is dark brown, highly decomposed, with normal ash level, does not possess an internal friction angle, so its indicators are equal to 0. The standard adhesion value is 0.096 kgf/cm^2; design value at α = 0.85 is 0.094 kgf/cm^2, design adhesion indicator at α = 0.95 is 0.092 kgf/cm^2. The modulus of deformation is 0.31 MPa.

It should be noted once again that peat is a soil, which by its properties is much different from ordinary mineral soils, leading to significant changes in the operation of foundations. Peat is extremely uneven and long-compressible formation.

CONCLUSION

Designing foundations for peat ground requires initial research of the conditions. When assessing peat foundations, the condition of peat bedding is important – peat can be buried or bare. There is only bare peat at the site, which can serve as a basis for light buildings. Such permanent facilities should be arranged on sand beds or piles. The final decision on methods of strengthening the soil foundationin the territory of the Urnenskoye deposit should be made by the designers on the basis of data obtained during this study.

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