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USSR Report

ENERGY

(FOUO 21/81)

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USSR REPORT

ENERGY

(FOUO 21/81)

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ENERGY CONSERVATION

GEOTHERMAL CONDITIONS, THERMAL WATERS OF GEORGIA

Tbilisi GEOTERMICHESKIYE USLOVIYA I TERMAL'NYYE VODY GRUZII in Russian 1980 (signed to press 4 Nov 80) pp 1-4, 207

[Annotation, table of contents and preface from monograph "Geothermal Conditions and Thermal Waters of Georgia", by I. M. Buachidze, G. I. Buachidze, N. A. Goderdzishvili, B. S. Mkheidze and M. P. Shaorshadze, Izdatel'stvo "Sabchota sakartvelo", 1000 copies, 207 pages]

[Text] Annotation. The authors of this monograph examine the patterns of distribution and formation of thermal waters in the territory of Georgia. On the basis of precise temperature measurements in deep conditional boreholes, determination of the thermophysical properties of rocks, and also generalization of industrial geophysical data it was possible to characterize the heat field in Georgia and the eastern part of the Black Sea surface. Deep heat flows were computed and it was possible to discriminate the most heated sectors of the earth's crust. A many-sided investigation of hydrogeological and geothermal conditions makes it possible to predict promising areas for obtaining highly thermal waters, considerable resources of which are the basis for the effective use of the energy in the earth's deep layers in the economy of Georgia. The monograph is intended for workers at scientific, planning and production organizations concerned with geological and geophysical problems and the detection of new renewable energy sources.

Contents

Preface

The exploitation of the earth's deep heat for practical economic needs is one of the cardinal energy problems of the present day. The Soviet government, taking into account the great effectiveness of use of thermal waters and their role in preserving the environment from contamination in every possible way is facilitating the development of scientific research and exploration-operational work, as is reflected in the corresponding decrees of the USSR Council of Ministers and the Council of Ministers Georgian SSR.

A scientific generalization of studies of ground water in Georgia has been made by I. M. Buachidze in 1950 and in 1956 he was the first to define the thermal horizons in Western Georgia. In 1961 I. M. Buachidze and S. S. Chikhelidze compiled the first summary on the thermal waters of Georgia. Later intensive studies developed at both scientific research (Sector on Hydrogeology and Geological Engineering, Georgian Academy of Sciences, and others) and in production enterprises (Georgian Geological Administration, "Gruzneft'" Trust, Georgian Production Administration on Use of the Earth's Deep Heat, and others). The monograph "Gidrogeologiya SSSR, t X, Gruzinskaya SSR (Hydrogeology of the USSR, Vol X, Georgian SSR) appeared in 1970. This monograph presented summarized data on thermal waters and some geothermal elements. Thus, the thermal waters of Georgia are some of the best studied in our country. This is indicated, in particular, by the circumstance that among the predicted resources of thermal waters in a volume greater than 8000 liters/sec about 7% fall in the industrial categories approved by the appropriate state committee.

A knowledge of the heat field patterns is of decisive importance for detecting and exploring thermal waters. The scientific value of geothermal investigations is expressed, in turn, in the fact that the principal parameter -- the temperature distribution in the earth's crust and upper mantle -- is necessary for general geological-geophysical constructions, for the needs of such disciplines as geotectonics, geology of ore deposits, presence of petroleum and gas, etc. Without a knowledge of the forecasted temperatures it is impossible to carry out mining work, to drill deep boreholes and exploit deposits. The intensive use of thermal waters in the national economy requires detailed investigations of geothermal conditions for the prediction of changes in their parameters. Finally, the detection of heat field patterns will make it possible to approach on a realistic basis a solution of the problem of creating artificial circulation systems for the removal of heat from "dry" rocks.

This monograph is a result of more than ten years of work at the Geothermy Section of the Sector on Hydrogeology and Geological Engineering, Academy of Sciences Georgian SSR (G. I. Buachidze, M. P. Shaorshadze, N. A. Goderdzishvili and B. S. Mkheidze). I. M. Buachidze, corresponding member Georgian Academy of Sciences, had overall scientific direction and participated personally. The materials generalized in the monograph reflect the actual status on 1 January 1977.

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FUELS

UDC [622.233:622.271.02](035)

HANDBOOK FOR DRILLING OPERATIONS AT SURFACE MINES PUBLISHED

Moscow SPRAVOCHNIK PO BURENIYU NA KAR'YERAKH in Russian 1981 (signed to press 2 Mar 81) pp 1-4, 267-270

[Annotation, introduction and table of contents from the book, "Handbook for Drilling at Surface Mines," edited by B. A. Simkin, professor and doctor of engineering sciences, Izdatel'stvo "Nedra," 7,200 copies, 270 pages].

[Text] The book sets forth the physical and mechanical properties of rock and its effect on the effectiveness of drilling blast holes at surface mines. The methods of drilling and the design and technical characteristics of the drilling equipment--domestic and foreign--are described. The classification and area of application of drilling tools and methods for computing drilling parameters and regimes are cited. Questions of automated control of the drilling process and of drill equipment drives, the reliability of drilling equipment and tools, and methods and means for dealing with dust during hole drilling are examined. The technical and economic indicators and the standards for drilling work are cited, and recommendations are made for the scientific organization of the work of drill-equipment operators.

The handbook is intended for engineers and technicians of mining enterprises and scientific-research and design organizations, and it will also be useful to instructors and students of mining and construction vuzes.

Introduction

When excavating for useful minerals by the surface method, the drilling of blast holes is a top-priority, complicated and labor-intensive process. During open-cast excavation for coal, iron ore, nonferrous metals and raw materials for chemicals, the drilling of blast holes is extremely important. The annual amount of hole drilling at open cuts comes close to 60 million meters.

Essential changes have occurred in the structure of drilling equipment at surface mines in the past 10 years. Instead of cable-tool drilling machines, milling drills are being used widely, the share of which in overall drilling is about 70 percent. In the past decade more than 3,000 drilling machines for surface mining have been manufactured. About 50 percent of them are SBSh's--milling type drills (including the new 2SBSh-200, 2SBSh-200N, SBSh-250MN and SBSh-320 drills and others), while the remainder are SBR- and SVB-type rotary drills. At coal strip mines milling-type drills make up about 40 percent of the whole drilling machinery pool.

The design and the quality of manufacture of milling-type bits has been improved. The mining industry is now the largest customer for this type of rock-destroying tools. Equipment for rotary cutting drilling, which predominates at coal strip mines, has been improved. New type bits--DR-160Sh, DL-160Sh, NPI-6/160 and others--are being introduced.

Along with the rotary drilling of holes of small diameter (115 and 160 mm) with auger removal of the drilling fines, the drilling of holes 214 and 243 mm in diameter with pneumatic cleaning is being used increasingly widely, the DR-214V and DRV-214 drill bits being used.

The bodies of the drill bits have begun to be manufactured by pressworking. Replaceable cutting tools are being used widely. Semiautomatic machines that use high-frequency current have begun to be used to braze cutting tools.

Combined cutting-and-milling and cutting-and-percussion tools, hole reamers, mine-face shock absorbers, and various (for example, electric vibrators) intensifiers of the drilling process have been tested. Submersible pneumatic strikers have been improved. At some surface mines the drilling machines are tended by one operator. Cost indicators have been improved, and the productivity of the machines as well as the durability of the drill bits have been increased.

Methods for computing optimal drilling regimes are of special significance, since the economic and technical indicators of milling and other methods for drilling holes depend greatly upon the drilling regimes. Choice of optimal drilling regimes and their correlation with the technical paramaters of automated drills is acquiring great importance. Milling drills with manual control operate in a rational regime of 8-50 percent net drilling time, since manual control is difficult, because of continuous random variation in the properties of the rock being drilled. Even when the operator uses rational drilling programs, with manual regulation, deviations of the regime's parameters from the optimal values are 15-25 percent and, in this case, considerably degrade the technical and economic indicators for drilling.

Furnishing drills with automated control systems (SAU's) will enable optimal drilling regimes to be realized. A test model of a machine for milling-type drilling, the 3SBSh-200N, with automated control of the drilling regime, has been created.

The integrated mechanization of the excavation of deposits of useful minerals involves the creation of new equipment for drilling work, the scale of which is increasing in intensity.

Many deposits are marked by complicated hydrogeological conditions in the deposition and structure of the covering rock masses, and the frequent alternation of strong and weak rock, where serially produced, narrowly specialized drills do not provide the required technical and economic indicators, especially when drilling slanted holes 320-400 millimeters in diameter up to 60 meters deep. Under specific mine-geology conditions of the deposits, combined drills are preferred.

The trend toward the construction of high-capacity mines, an increase in the number of excavators with bucket capacities of 12-100 cubic meters, and the use of transport means of high load capacity predetermine an increase in the working parameters of drills, their power-to-weight ratios and productivity, and also the diameter and depth of the holes. Because of this, it is especially important that the parameters of the equipment correspond to the operating conditions and to an optimal drilling regime.

The circumstances noted will cause at the next stage of development of drilling equipment and technology the creation of drills for drilling holes 125-400 millimeters and more in diameter which are characterized by optimal relationships of the design and the operating parameters.

The choice of parameters for drilling equipment and its adaptation to changing conditions can be optimal only on the basis of the method of engineering optimization and the use of current experimental research and the generalization of years of experience. Taking into account what has been set forth in the handbook, systematized data are cited about the bases for the creation and operation of drilling equipment and tools at surface mines.

The authors will accept with gratitude the remarks and recommendations of readers, and we ask that they be sent to: Moscow, 125047, pl. Belorusskogo vokzala, 3, izd-vo "Nedra."

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GENERAL

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STUDYING SEISMICITY IN GEORGIA

Tbilisi ISSLEDOVANIYE SEYSMICHNOSTI I SEYSMICHESKOGO REZHIMA NA TERRITORII GRUZII in Russian 1980 (signed to press 2 Mar 80) pp 3-4, 97-98

[Annotation and table of contents from collection of articles "Investigation of Seismicity and the Seismic Regime in the Territory of Georgia", edited by O. V. Lursmanashvili, Izdatel'stvo "Metsnitereva", 400 copies, 98 pages]

[Text] Annotation. This collection contains articles based on investigations of the energy and spectral characteristics of seismic waves of earthquakes occurring in the neighborhood of construction of the Inguri Hydroelectric Power Station. Also examined are problems relating to seismotectonics, changes in the seismic regime of different regions in Georgia, mapping of seismic elements of earthquakes using an electronic computer and model investigations of seismic waves in inhomogeneous media. Other articles deal with the horizontal inhomogeneity of the crystalline basement and give new data on the seismogeological structure of regions with increased seismic activity. The results of investigation of the efficiency of operation of seismic stations in the neighborhood of the Inguri Hydroelectric Power Station are given.

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GENERAL

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SEISMIC ENGINEERING IN PERMAFROST

Leningrad SEYSMOSTOYKOYE STROITEL'STVO NA VECHNOMERZLYKH GRUNTAKH in Russian 1980 (signed to press 3 Dec 80) pp 1-6, 79-80

[Annotation, preface and table of contents from monograph "Seismic-Resistant Construction in Permafrost", by Vadim Andreyevich Kharitonov, Stroyizdat, Leningradskoye otdeleniye, 2580 copies, 180 pages]

[Text] Annotation. The author describes the characteristics of construction under conditions of a combination of permafrost and seismicity in different regions of the northern climatic zone. It is noted that the manifestation of seismic phenomena in frozen, thawed and thawing ground governs the specifics of planning of buildings and structures capable of reliable performance and capable of withstanding the effect of earthquakes which are 7-9 units on the seismic scale. Materials are presented which describe the performance of foundations and the principal supporting elements of buildings and structures under different seismogeological conditions and recommendations are given on economic-optimization tasks and the organization of seismic-resistant construction work in regions where permafrost prevails. The monograph is intended for planners and engineering-technical workers concerned with problems relating to the construction and performance of buildings and structures in seismic regions of the northern zone of the country.

Preface. About 30% of the entire territory of the Soviet Union is occupied by seismic regions (Fig. 1). Most of these are situated in zones with a severe climate [1, 2]. The breakdown of the area of the entire country by seismic zones (Table 1) in accordance with official data shows that Siberia and the Far East (numbers 6-11), constituting more than 60% of the entire territory of the Soviet Union, are regions with extremely strong earthquakes.

In addition, it must be taken into account that the 10-unit Oymyakonskoye earthquake, occurring in 1971 [3], indicated that our concepts concerning the seismicity of the northern zone of the country are still incomplete and a number of regions, earlier considered aseismic, in actually should be assigned to the category of seismically active with a high earthquake intensity.

For a long time no serious attention was given to the problems involved in seismic-resistant construction in the northern construction-climatic zone. In part this is attributable to the historically weak population of the territory and the absence here of considerable volumes of major construction. In addition, traditionally in these regions the construction material in common use has been wood, making it possible, without special strengthening measures, to build one- or two-story residential and industrial buildings which have been adequately seismic-resistant.

Table 1

Distribution of Area (1000's of km^2) of Seismic Zones in USSR Between Regions With Different Earthquake Intensity

Zones	Areas of regions with different scale units					Total
	6	7	8	9	10	
1. Ciscarpathia	87	47	7	--	--	141
2. Crimea	8	4	1	--	--	13
3. Caucasus	82	204	68	--	--	354
4. Central Asia	413	291	264	275	--	1243
5. Altay and Sayany	362	172	89	3	--	626
6. Eastern Siberia	533	307	171	192	20	1223
7. Verkhoyanskaya zone and Magadan region	1418	494	66	---	--	1978
8. Chukotka	178	16	--	---	---	194
9. Primor'ye	81	10	--	---	---	91
10. Sakhalin	18	35	--	---	----	53
11. Kamchatsko-Kuril'skaya zone	257	104	48	46	5	460
Total	3437	1684	714	516	25	6376
In % of entire territory of USSR	15.5	7.5	3.2	2.3	0.1	28.6

Notes: 1. The data in the table were obtained in accordance with [1]. 2. The area in numbers 1-5 is 2 377 000 km^2, and in points 6-11 it is 3 999 000 km^2.

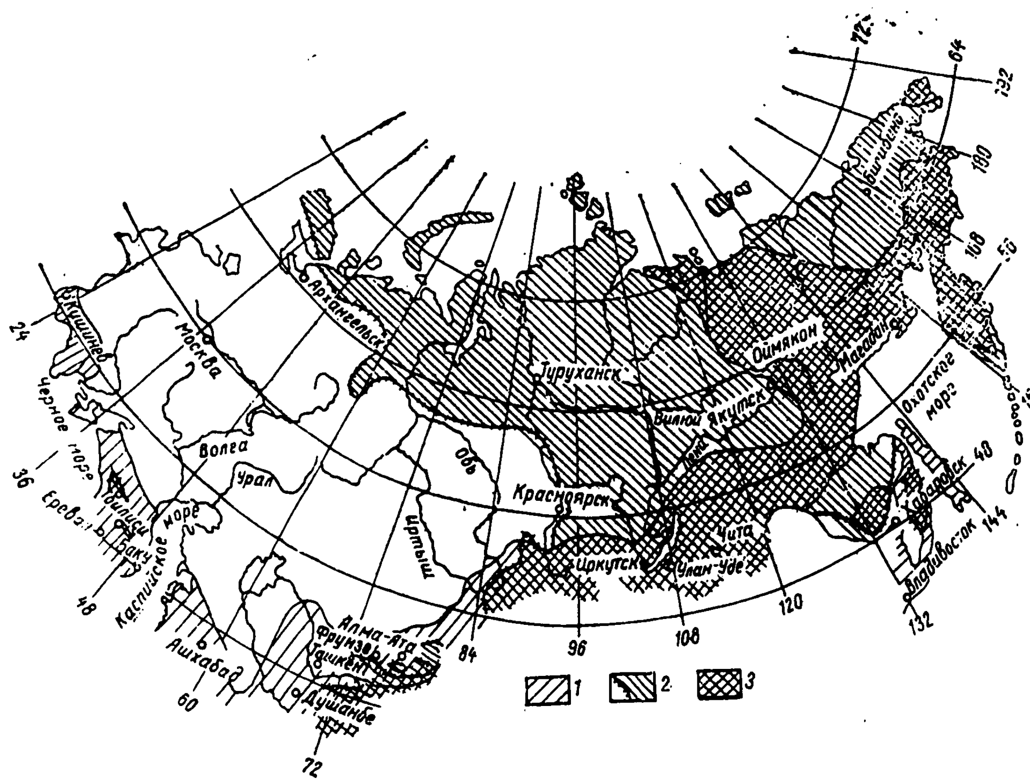

Fig. 1. Map of seismic regions in permafrost region of USSR. 1) seismic region (intensity of earthquakes 6 units and above); 2) region of permafrost development; 3) seismic regions in permafrost zone.

The first mention of a scientific approach to the problems involved in seismic-resistant construction on permanently frozen ground and ground with deep seasonal freezing is found in the reports at the First Kray Scientific Research Congress in Eastern Siberia [4], although, evidently, the practical experience in the construction of fortresses, churches, docks, commercial-industrial and other structures accompanying the occupation and exploitation of Siberia was taken into account and was transmitted from generation to generation and was used in construction, as has been repeatedly noted in materials published on investigations of the aftereffects of strong earthquakes in the Siberia and Far East regions [5, 6, 7].

The planned and purposeful solution of the problem of seismic-resistant construction under the special conditions of the northern zone began only in the 1960's in connection with the industrial exploitation of the northern and eastern regions. During this period specialists of the Krasnoyarsk Scientific Research Institute on Construction, USSR Academy of Construction and Architecture (later the Promstroyniiproyekt in the system of the USSR Ministry of Heavy Construction) and the Institute of the Earth's Crust, Siberian Department, USSR Academy of Sciences (Irkutsk), began many-sided investigations of the problems involved in rational construction in the Baykal seismic zone at construction sites with deep and prolonged (up to nine months per year) seasonal freezing of the ground and with permafrost [8].

A major series of investigations, including those made under field conditions, indicated that for industrial year-round construction of seismic-resistant buildings it is necessary to carry out a complex of special measures which can guarantee the reliability of the erected structures. Among the most vulnerable places and specific problems, for the considered zone it is necessary to mention the following:

-- the thorough freezing of excavated basins and trenches, and as a result, the heaving of the ground and its subsequent nonuniform settling during thawing;

-- the thorough freezing of masonry and nonuniform deformation during its thawing, which usually begins on the southern side and ends on the northern shaded side;

-- absence of reliable adhesion of masonry to metal components and individual reinforcing rods strengthening the masonry;

-- the brittleness of metal construction parts and connecting elements of ordinary steel in prefabricated reinforced concrete construction;

-- the short lifetime of ordinary construction materials and fabricated objects caused by periodic freezings and thawings of pore moisture in the material itself and especially in juncture points.

A considerable contribution to solution of these problems has been made by the Central Scientific Research Institute of Seismic Construction, LenZNIIEP /Leningrad Zonal Scientific Research Institute for Experimental Design of Housing and Public Building/, Scientific Research Institute of Foundations and Underground Structures, Scientific Research Institute of Concrete and Reinforced Concrete, Proyektstal'konstruktsiya, and also the Glavvostoksibstroy, Glavdal'stroy and other construction organizations.

The northern construction-climatic zone, including the regions of the Far North and Northeast of the country, differs sharply from the middle zone with respect to a number of factors which exert a substantial influence on the choice of methods for construction and constructive solutions for buildings and structures [8, 9].

The climatic characteristics caused by the severity of climate vary in a broad range in different regions of the northern zone. In the coastal regions, where the influence of North Atlantic currents is operative, the climate is milder, whereas in the central parts of the continent it has a sharply continental character.

The characteristics and diversity of the natural-climatic conditions in the zone of permafrost occurrence made it necessary to subdivide it into three subzones [10], for which there is formulation of special requirements on buildings and structures, for which appropriate construction norms are prepared, etc.

Subzone I. Permafrost over the greater part of its territory. In individual regions seismicity not greater than 7 units. In mountain regions there are sectors with a danger of avalanches and mudflows. Some of the territory is subject to creep processes and karst phenomena are noted. The winter is prolonged with a polar night, low air temperatures and strong, prolonged winds, creating snowdrifts. The summer is short, cold and moist.

Subzone II. Permafrost over the entire territory. In individual regions seismicity up to 8 units. There are sectors in which karst occurs, where mudflows take place and which are subject to creep processes with a danger of avalanches. The winter is severe and prolonged with extremely low air temperatures. Considerable solar radiation and short warm summer.

Subzone III. Insular permafrost. Seismicity of individual regions up to 10 units. There are sectors with a danger of avalanches, where karst and mudflows are manifested and which are subject to creep processes. Prolonged cold winter and warm short summer.

In accordance with the zoning for each zone provision is made for corresponding planning solutions for populated places and industrial complexes; technological schemes for the layout of buildings and structures are prepared, corresponding for each zone to the load and effect. For each zone specialists have developed and are developing special rational procedures for production processes ensuring the reliable performance of the erected structure under the conditions prevailing in the northern climate zone.

A special place in the engineering problems of construction in the northern climate zone is occupied by microseismic regionalization, taking into account the geocryology of the construction site and the peculiarities in development of permafrost processes in the construction and operation of erected structures, as well as the influence of completed and prolonged permafrost processes on the seismic resistance of construction objects [9].

Experience has shown that underallowance for a number of physicomechanical characteristics of the frozen ground of foundations which are in a stage of gradual thawing can create serious additional deformations and damage to the supporting elements of buildings and structures even prior to an earthquake. In order to validate the choice of construction principle, in addition to ordinary engineering characteristics, it is necessary to have data on prediction of the possibility of a change in permafrost conditions determined on the basis of thermophysical computations with allowance for the properties of different types of ground and their permafrost characteristics.

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GENERAL

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DESIGN FEATURES OF FOUNDATIONS IN WESTERN SIBERIAN OIL REGIONS

Leningrad OSOBENNOSTI PROYEKTIROVANIYA FUNDAMENTOV V NEFTEPROMYSLOVYKH RAYONAKH ZAPADNOY SIBIRI in Russian 1981 (signed to press 11 Nov 80) pp 1-4, 166-168

[Annotation, preface and table of contents from monograph "Design Features of Foundations in Western Siberian Oil Regions", by Aleksandr Aleksandrovich Konovalov and Lidiya Tarasovna Roman, Stroyizdat, Leningradskoye otdeleniye, 1760 copies, 168 pages]

[Text] Annotation. The book analyzes the design features of buildings and other structures in the northern regions of Western Siberia. The indices of the climatic and permafrost conditions of the region necessary for this purpose are systematized. Measures for increasing the supporting capacity of earthen foundations are examined. A method for thermal computations made in the planning of structures of different purpose and configuration is presented. The book is intended for design engineers, engineering field workers and construction men engaged in the economic exploitation of the northern part of Western Siberia and regions adjacent to it.

Preface. The northern part of Western Siberia is one of the richest regions in the world with respect to natural resources. The economic exploitation of this territory, especially the construction of industrial and residential structures, is made difficult by the specific permafrost-ground conditions: the great water saturation and peatiness of the territory, the presence of permafrost, having primarily an insular distribution and present in a plastic-frozen state.

Under such conditions it is particularly important to make engineering surveys of construction areas and to develop measures for implementation of this construction, taking into account the specifics of permafrost conditions and the objective trends in their change as a result of the building-up of an area.

As is well known, due to considerable compressibility and prolonged consolidation under a load peaty ground can be put into the "weak" category. Sites made up of peaty ground are used for construction only in individual cases, for the most part after consolidation or replacement of peat by stronger mineral ground or after the implementation of other measures precluding the direct use of peats of natural bedding as foundations for structures. This circumstance, evidently, can explain the fact of a considerable lag in study of the construction properties (deformative, strength, thermophysical) of peaty ground, especially frozen ground.

Measures precluding the direct use of peaty ground as foundations are extremely expensive. For example, in the Surgut region the replacement of 1 m^3 of peat by sand costs about 4 rubles. Accordingly, failure to use peaty ground as foundations in the northern part of Western Siberia, where in individual zones peat bogs occupy up to 80% of the area with a thickness up to 10 m, is virtually impossible. It is necessary to formulate detailed investigations of the construction properties of peaty ground in thawed and frozen states for the purpose of determining the possibilities of using them as foundations for buildings and structures.

A determination of most of the mentioned construction properties by field and laboratory methods is time consuming and involves great time expenditures. Therefore, it is of practical importance to develop indirect methods making it possible to establish the quantitative characteristics of these properties using correlations with the simplest physical properties (such as humidity and mass volume), easily ascertained under laboratory conditions.

The presence of insular permafrost, on the one hand, and the requirements of Chapter SNiP [Construction Specifications and Regulations] II-18-76, not allowing the application of construction principles I and II within the confines of a single construction site, on the other, determine still another feature of construction in the northern part of Western Siberia, making necessary additional material expenditures: the need for reducing the ground to a thermophysically homogeneous state -- thawed or frozen.

Permafrost in the greater part of Western Siberia falls in the category of plastic-frozen ground, having increased deformational properties. Thawed ground, usually peaty or water saturated, is also characterized by a high compressibility and therefore there is a need for preliminary strengthening. This is a third feature also leading to increased costs of construction in the northern part of Western Siberia.

The enumerated features in the designing and construction work in the northern regions of Western Siberia determine the following three timely directions in research:
-- study and systematizing of data on the construction properties of frozen and thawed peaty ground;
-- improvement in existing or development of new methods for computing the temperature fields of freezing or thawing ground during the economic exploitation of sites;
-- development of methods for increasing the supporting capacity of the ground, used in both frozen and thawed states.

In this book we set forth the results of investigations in these directions carried out by the authors at the Krasnoyarsk Promstroyniiproyekt and give practical recommendations obtained on their basis. The results of other investigations for regions with similar climatic and permafrost conditions are also used.

The preface, #1.1-1.3 were written jointly by the authors; #1.4, 2.2, 2.3, Chapters 3 and 4, #7.1 were written by A. A. Konovalov, #2.1, Chapters 5 and 6, #7.2, 7.3 were written by L. T. Roman.

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