ISSN 2518-170X (Online)
ISSN 2224-5278 (Print)

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ
АКАДЕМИЯСЫ» РҚБ

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН»

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

4 (465)

JULY – AUGUST 2024

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА» РҚБ Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

«Известия РОО «НАН РК». Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ39VPY00025420,** выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соеденений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).
The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420,** issued 29.07.2020.
Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*
Periodicity: 6 times a year.
Circulation: 300 copies.
Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19
http://www.geolog-technical.kz/index.php/en/

NEWS of the National Academy of Sciences of the Republic of Kazakhstan
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224–5278
Volume 4. Number 466 (2024), 185–196
https://doi.org/10.32014/2024.2518-170X.434
UDC 624.13.003.12

© A.N. Muta[1,2*], R.B. Baimakhan, G.I. Salgarayeva[2], N. Kurmanbekkyzy[3], A. Tileikhan[2], 2024
[1]U. Joldasbekov Institute of Mechanics and Engineering, Almaty, Kazakhstan;
[2]Kazakh National Women's Pedagogical University, Almaty, Kazakhstan;
[3]Kazakh-Russian Medical University, Almaty, Kazakhstan.
E-mail: mutita@mail.ru

STUDY OF THE STRENGTH PROPERTIES OF SOILS COMPOSING THE GEOLOGICAL STRUCTURE OF THE KOK TOBE MOUNTAIN

Muta A.N. — Junior Researcher at the U. Joldasbekov Institute of Mechanics and Engineering, Doctoral student at Kazakh National Women's Pedagogical University, Almaty, Kazakhstan
E-mail: mutita@mail.ru; https://orcid.org/0000-0002-5123-2042;
Baimakhan R.B. — Doctor of Technical Sciences, Professor
E-mail: brysbekbai@gmail.com; https://orcid.org/0000-0003-4042-1689;
Salgarayeva G.I. — Candidate of Technical Sciences, Professor at Kazakh National Women's Pedagogical University, Almaty, Kazakhstan
E-mail: gulnaz.salgara@gmail.com; https://orcid.org/0000-0001-9477-6245;
Kurmanbekkyzy N. — Candidate of Physical and Mathematical Sciences, Professor at Kazakh-Russian Medical University, Almaty, Kazakhstan
E-mail: nura_20@mail.ru;
Tileikhan A. — Junior Researcher at the U. Joldasbekov Institute of Mechanics and Engineering, Master's student at Kazakh National Women's Pedagogical University, Almaty, Kazakhstan
E-mail: talmagl@bk.ru.

Abstract. The study of the strength properties of soils composing the geological structure of Kok Tobe Mountain is important for assessing its stability and safety. It is important for the construction of the safety of this area to ensure the safety of structures and to prevent possible hazards associated with precipitation, collapses or ground shifts. By conducting various studies, the density, humidity and compressibility of soils are determined. In addition, the geomechanical condition of the TV tower and its foundation, the soil foundations near and under the foundation are being studied, there are traces of landslides formed on the eastern slope 30–40 years ago. It can be activated and destroyed by participating in the movement under the foundation. Then the foundation collapses along with the TV tower. A landslide mass of enormous size, the expansion of a crack on the western slope of Kok Tobe creates a landslide threat that can overwhelm the village located on the western slope and at the foot of Kok Tobe. A thorough study of the geological structure of the Kok Tobe Mountain is needed in order to solve these issues. Also, to study in depth and in detail the engineering and technical design of the TV tower, their materials and the size of the foundation, the structure of the foundation soil and the tower part. The article provides an overview of the results of theoretical and experimental work devoted to the determination of the physico –mechanical and strength properties of soils composing the geological structure of the Kok Tobe Mountain. The results of a comprehensive analysis are formulated in the form of new conclusions, an improved algorithm for calculating the elasticity coefficients for soils of the Kok Tobe mountain of an obliquely layered structure with the compilation of a computer program is proposed.

Keywords: strength, soil, anisatropic structure, mountain slope, Kok tobe

Acknowledgement. This research is funded by the fundamental research of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No.BR20280990).

© А.Н. Мүтә[1,2*], Р.Б. Баймахан, Г.И. Салгараева[2], Н. Құрманбекқызы[3], А. Тилейхан[2], 2024

[1]Ө. Жолдасбеков атындағы Механика және машинатану институты, Алматы, Қазақстан;

[2]Қазақ ұлттық қыздар педагогикалық университеті, Алматы, Қазақстан;

[3]Қазақ-Ресей медициналық университеті, Алматы, Қазақстан.

E-mail: mutita@mail.ru

КӨК ТӨБЕ ТАУЫНЫҢ ГЕОЛОГИЯЛЫҚ ҚҰРЫЛЫМЫН ҚҰРАЙТЫН ТОПЫРАҚТЫҢ БЕРІКТІК ҚАСИЕТТЕРІН ЗЕРТТЕУ

Мүтә А.Н. — Ө. Жолдасбеков атындағы Механика және машинатану институтының КҒҚ, Қазақ ұлттық қыздар педагогикалық университетінің докторанты, Алматы, Қазақстан
E-mail: mutita@mail.ru; https://orcid.org/0000-0002-5123-2042;
Баймахан Р.Б. — техника ғылымдарының докторы, профессор
E-mail: brysbekbai@gmail.com; https://orcid.org/0000-0003-4042-1689;
Салгараева Г.И. — техника ғылымдарының кандидаты, Қазақ ұлттық қыздар педагогикалық университетінің профессоры, Алматы, Қазақстан
E-mail: gulnaz.salgara@gmail.com; https://orcid.org/0000-0001-9477-6245;
Құрманбекқызы Н. — физика-математика ғылымдарының кандидаты, Қазақ-Ресей медициналық университетінің профессоры, Алматы, Қазақстан
E-mail: nura_20@mail.ru;
Тилейхан А. — Ө. Жолдасбеков атындағы Механика және машинатану институтының КҒҚ, Қазақ ұлттық қыздар педагогикалық университетінің магистранты, Алматы, Қазақстан
E-mail: talmagl@bk.ru.

Аннотация. Көк Төбе тауының геологиялық құрылымын құрайтын топырақтың беріктік қасиеттерін зерттеу оның тұрақтылығы мен қауіпсіздігін бағалау үшін өте маңызды. Бұл құрылымдағы топырақтың жауын-шашынға, құлауға немесе ығысуына байланысты ықтимал қауіптердің алдын алу үшін осы аумақтың қауіпсіздігін қамтамасыз ету маңызды. Әртүрлі зерттеулер жүргізу арқылы топырақтың тығыздығы, ылғалдылығы және сығылуы анықталады. Сонымен қатар, телемұнара мен оның іргетасы, іргетас маңайындағы және астындағы топырақ негіздерінің геомеханикалық күйі зерттеледі, себеі, Шығыс беткейінде 30–40 жыл бұрын пайда болған көшкіннің іздері бар. Ол іргетас астындағы қозғалысқа қатыса отырып, белсендіріліп, құлап кетуі мүмкін. Содан кейін теледидар мұнарасымен бірге іргетастың құлауы болады. Үлкен көлемдегі көшкін массасы, Көк Төбенің батыс беткейіндегі жарықтың таралуы Батыс беткейде және Көк Төбенің етегінде орналасқан елді мекенді басып қалуы мүмкін көшкін қаупін тудырады. Осы мәселелерді шешу мақсатында Көк Төбе тауының геологиялық құрылысын мұқият зерделеу қажет.

Сондай – ақ, телемұнараның инженерлік-техникалық құрылымын, олардың материалдары мен іргетас өлшемдерін, іргетас астындағы топырақ пен мұнара бөлігінің құрылымын тереңірек және егжей-тегжейлі зерттеу. Мақалада Көк Төбе тауының геологиялық құрылымын құрайтын топырақтың физика-механикалық және беріктік қасиеттерін анықтауға арналған теориялық және эксперименттік жұмыстардың нәтижелеріне шолу жасалады. Жан-жақты талдау нәтижелері жаңа тұжырымдар түрінде тұжырымдалады, компьютерлік бағдарламаны құрастыра отырып, Көк Төбе тауының топырақтарына арналған серпімділік коэффициенттерін есептеудің жетілдірілген алгоритмі ұсынылады.

Түйін сөздер: беріктік, топырақ, анизотропты құрылым, тау баурайы, Көк төбе

© А.Н. Мута[1,2*], Р.Б. Баймахан, Г.И. Салгараева[2], Н. Курманбеккызы[3], А. Тилейхан[2], 2024

[1]Институт механики и машиноведения имени У. Жолдасбекова, Алматы, Казахстан;
[2]Казахский национальный женский педагогический университет, Алматы, Казахстан;
[3]Казахско-Российский медицинский университет, Алматы, Казахстан.
E-mail: mutita@mail.ru

ИЗУЧЕНИЕ ПРОЧНОСТНЫХ СВОЙСТВ ГРУНТОВ, СЛАГАЮЩИЕ ГЕОЛОГИЧЕСКОЕ СТРОЕНИЕ ГОРЫ КОК ТОБЕ

Мута А.Н. — МНС Института механики и машиноведения имени У. Жолдасбекова, докторант Казахского национального женского педагогического университета, Алматы, Казахстан
E-mail: mutita@mail.ru; https://orcid.org/0000-0002-5123-2042;
Баймахан Р.Б. — доктор технических наук, профессор
E-mail: brysbekbai@gmail.com; https://orcid.org/0000-0003-4042-1689;
Салгараева Г.И. — кандидат технических наук, профессор Казахского национального женского педагогического университета, Алматы, Казахстан
E-mail: gulnaz.salgara@gmail.com; https://orcid.org/0000-0001-9477-6245;
Курманбеккызы Н. — кандидат физико-математических наук, профессор Казахско-Российского медицинского университета, Алматы, Казахстан
E-mail: nura_20@mail.ru;
Тилейхан А. — МНС Института механики и машиноведения имени У. Жолдасбекова, магистрант Казахского национального женского педагогического университета, Алматы, Казахстан
E-mail: talmagl@bk.ru.

Аннотация. Изучение прочностных свойств грунтов, слагающих геологическую структуру горы Кок Тобе, имеет важное значение для оценки ее устойчивости и безопасности. Это важно для строительства безопасности этой территории, чтобы обеспечить безопасность сооружений и предотвратить возможные опасности, связанные с осадками, обрушениями или сдвигами грунта. Путем проведения различных исследований определяется плотность, влажность и сжимаемость грунтов. Кроме того, изучается геомеханическое состояние телебашни и ее фундамента, грунтовых оснований вблизи и под фундаментом, имеются следы оползней, образовавшихся на восточном склоне 30–40 лет назад. Он может активироваться и разрушаться, участвуя в движении под фундаментом. Затем происходит

обрушение фундамента вместе с телебашней. Оползневая масса огромного размера, разрастание трещины на западном склоне Кок Тобе создает угрозу оползня, которая может накрыть поселок, расположенное на западном склоне и у подножия Кок Тобе. Нужна тщательное изучение геологического строения горы Кок Тобе с целью решения данных вопросов, а также глубже и подробно изучить инженерно-техническую конструкцию телебашни, материалы и размеры фундамента, строения подфундментного грунта и башенной части. В статье приводится обзор результатов теоретических и экспериментальных работ, посвященных определению физико-механических и прочностных свойств грунтов, слагающих геологическое строение горы Кок Тобе. Результаты всестороннего анализа формулируются в виде новых выводов, предлагается усовершенственный алгоритм вычисления коэффициентов упругости для грунтов горы Кок Тобе, наклоннослоистого строения с составлением компьютерной программы.

Ключевые слова: прочность, грунт, анизотропное строение, склон горы, Кок Тобе

Introduction

The main cause of landslides on the slopes of the mountain is the infiltration process associated with the penetration of rain and snow water into the inclined layers of the soil. The layers differ from each other not only in composition and structure, but also in physical, mechanical and strength properties. The main volume of rainwater flows down the inclined surface of the soil, some of it evaporates. They have been accumulating in various strata for tens of thousands of years. When they come to the surface of the slope, the soils turn into a plastic state and due to gravitational compression, destruction occurs, that is, the landslide process begins. If such phenomena occur in the soils of the substructure base of the TV tower, then even the 60-meter concrete foundation base of the TV tower does not save the tower. This whole system is rolling down with the tower toppling over. The answer to the question of the possibility of such a scenario is given only by a thorough scientific study of the stability of the entire system of the substructure ground base of the TV tower.

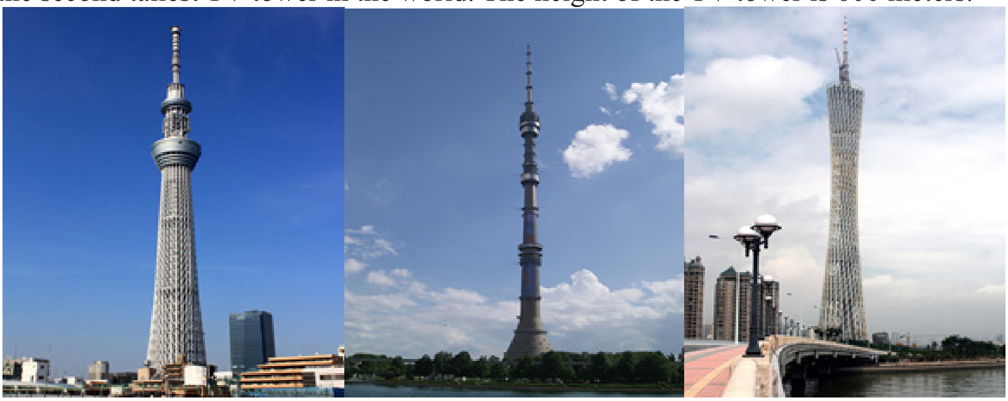
At the same time, depending on the density and fracturing of the surface layer, a certain part of the water penetrates into the soil and causes water saturation and moistening of the soil. This is a long and slow process. At the junction of such local zones, a litter is formed, which contributes to the displacement of the landslide mass along the slope. Water penetrates into the soil through weak points of connection – the forces of adhesion between particles (Baimakhan et al., 2021).

One of the important issues of studying the causes and mechanisms of landslide processes is the study and determination of the structure and physico-mechanical properties of the cover soils. The study of anisotropic properties is especially important. The content of such studies was systematized by A.K. Bugrov and A.I. Golubev (Bugrov et al., 1993). Later, such Kazakhstani scientists as R.B. Baymakhan dealt with these issues (R. Baimakhan et al., 2021), N. Kurmanbekkyzy (Kurmanbekkyzy et al., 2010), A.K. Rysbaeva, A.A. Seinasinova, A.R. Baymakhan (Baimakhan et al., 2020) and others (Baimakhan et al., 2016).

The condition of the slope of Kok Tobe Mountain has always caused alarm and today causes concern among residents of the eastern part of Almaty due to landslide danger, not to mention modern high-rise buildings and structures built along Dostyk Avenue directly at the foot of the mountain, and the densely populated western slope and built-up areas.

The landslide condition of this mountain has not yet been investigated by modern methods of mathematical modeling, computational mathematics, computer graphics, geomechanics, as well as by drilling ultra-deep wells in the underlying rock. The height of Kok Tobe Mountain is 250 m, and the height of the TV tower, built on its western slope on loose soils, is 372 m, the total height relative to Dostyk Avenue is 622 meters. Regarding the Kok Tobe TV tower, nature has already given formidable signals. For example, in 1985, the slopes of Kok-Tobe Mountain were washed away by rains, mudslides and dangerous processes of sliding of the ground base of the tower came down. In the early spring of 2005, after heavy rains on Kok Tobe, an emergency situation occurred – significant cracks appeared on the surface of the mountain, the ground began to slide and buildings collapsed. The Kok Tobe sank 2 meters down. There was a real threat of a landslide on nearby residential areas (Baimakhan et al., 2020).

Figure 1 shows the tallest TV towers in the world. Today, the Sky Tree TV tower in Tokyo is the tallest, its absolute height is 634 m, commissioned in 2012, the highest in Russia and Europe is the Ostankino TV Tower - 540 m, 1967. Guangzhou China TV Tower is the second tallest TV tower in the world. The height of the TV tower is 600 meters.



а б г

Figure 1— The tallest TV towers in the world: a) Tokyo Skytree; b) Ostankino TV Tower; c) Guangzhou TV Tower.

There is already an example of the collapse of a tall TV tower. In 2002, one of the world's tallest television towers in western Nebraska, 596 m high, collapsed in the United States.

If we analyze the Eastern slope of Kok Tobe Mountain relative to the TV tower, then frankly it is frightening, the slope is even more sharply steep in places, the laying angle almost reaches 90 ^ 0. On such a small piece of the top of Kok Tobe there is a 372-meter TV tower with an absolute height.

As mentioned above, the mountain slope of Kok Tobe sat 2 meters down. Protective measures were urgently taken. To stop the landslide process, the builders drilled and concreted 395 wells with a depth of 9 to 24 meters. The protective measures were stopped there. No scientific research has been conducted to uncover the secrets and causes of these landslides so far. The scientific direction on landslide processes has not yet been developed in Kazakhstan. To illustrate the problematic conditions of the Kok Tobe TV tower, Figure 2 below shows its dangerous location relative to the slopes of the mountain.

The expected social and economic effect is determined by reducing the likelihood of a sudden landslide slide of the TV tower, its tilting and collapse, reducing the risk of loss of human lives, and preserving a strategically important object.

Figure 2- The frightening current state of the mountain slope with a too narrow peak and the dangerous location of a 372-meter-high TV tower on it

The study of the geological structure of the Kok Tobe mountain and engineering and technical data, design features of the TV tower. Before delving into the strength properties of soils, it is extremely important to have a comprehensive understanding of the engineering and technical design and geological structure of Kok Tobe Mountain. This knowledge will lay the foundation for analyzing soil behavior and identifying any potential problems or risks.

One of the biggest problems during the construction of the TV tower was the loose loamy soil that makes up the Kok Tobe slope (Baimakhan et al., 2020). It was decided to reduce the weight of the tower by building it from metal beams and aluminum cladding. This design feature made it possible, on the one hand, to achieve a unique ratio of the diameter of the trunk base (18 meters) to the height of the tower, and on the other hand, to give the tower a light and elegant appearance. A drainage system was built to prevent soil erosion at the base of the foundation (Kazakhstan Today, 2019).

The design of the construction of the Kok Tobe TV tower was carried out by the Central Research Design Institute of Building Metal Structures named after Melnikov together with Fundamental Project (Sokolova, 2023).

Another constructive solution to increase stability was a significant shift of the center of gravity of the TV tower downwards. The height of the concrete base of the tower is 60 meters. The base weighs 45 thousand tons with a total weight of 50 thousand tons (metal beams of the trunk - 4558 tons, aluminum cladding - 800 tons) (Secrets of the Almaty TV Tower, 2019).

In addition to the soil features, the builders had to take into account the high seismicity of the region, as well as structural fluctuations in wind gusts. In order to protect the structure from destruction, in addition to building a strong foundation, a new technology was used for that time – four dynamic vibration dampers were installed in the upper cup of the TV tower. Extinguishers are massive blocks operating on the principle of a pendulum. When the building vibrates, they sway in the opposite direction, absorbing energy.

The construction of the TV tower began in 1978. First, the site was thoroughly rammed and leveled, then the digging of a 19-meter excavation began. For waterproofing purposes, asphalt was poured under the base. Behind it was a 1 meter thick concrete cushion on which a metal frame was mounted.

By the end of construction, the height of the tower was 372 meters. The height of the antenna mast is 114 meters. The signal of 6 TV and 4 radio channels was transmitted from the TV tower. The Kok-Tobe TV tower broadcast to 199 localities.

The tower was put into operation in 1984. Just a few months later, a serious fire broke out at the TV tower – due to errors in calculating the power of radio emission, the feeders of the TV transmitters caught fire. Thanks to the prompt power outage, the fire was eliminated quickly enough. In 1985, the slopes of Mount Kok-Tobe were washed away by rains, a mudslide occurred. The process of sliding the tower began. The builders were forced to further strengthen the foundation and build a new, more efficient drainage system.

In 2001, the TV tower was reconstructed – the walls of the interior were plastered, the observation deck was finished with siding, some of the glass blocks were replaced, the equipment of transmitters and antennas was updated. After the reconstruction, the TV tower began broadcasting 14 television and 14 radio channels.

The study of the geological data of the structure of the Kok Tobe mountain. The types and classifications of soils that make up the mountain have been found and established (Tsytovich, 1963).

Clay soil: A cohesive soil with the property of plasticity due to the content of mineral particles of clay and dusty fractions**.**

dispersed soil: A soil in which mechanical, physical and physico-chemical structural bonds prevail.

coarse-grained soil: An incoherent mineral soil in which the mass of particles larger than 2 mm is more than 50 %.

soil array: The volume of soil located at the base of a building/structure or containing it, the size of which is not less than the zone of influence of the building /structure, or allocated for solving special tasks.

swelling soil: Clay soil having a relative swelling deformation of 0.04 in conditions of free swelling or developing a swelling pressure in conditions of limited swelling exceeding 0.01 MPa.

sandy soil (sand): Mineral loose soil containing by weight more than 50 % of particles ranging in size from 0.05 mm to 2 mm.

subsidence soil: The soil, which, under the influence of external load and/ or its own weight, when soaked with water, has a relative deformation of 0.01 subsidence.

heaving ground: Dispersed soil, which increases in volume during freezing due to the crystallization of pore and migrating water and has a relative deformation of 0.01 frost heaving.

cohesive soil: A dispersed soil with a predominance of physical and physico-chemical structural bonds.

rocky ground: A soil in which structural bonds of a chemical nature prevail.

Methods for studying the physical– mechanical and strength properties of soils. The physico–mechanical and strength properties of soils composing the geological structure of the Kok Tobe Mountain have been studied (Table 1) (**Полищук А.И.**, 2007) .

Table 1 - Varieties of coarse-grained and sandy soils

Soils	Particle content	
	size, mm	% of the total mass of dry soil
Coarse-grained: boulder (with a predominance of uncoated particles, blocky)	> 200	> 50
pebbly (with a predominance of uncoated particles, crushed stone)	> 10	> 50
gravel (with a predominance of uncoated particles, gravel)	> 2	>50
Sandy: gravelly	>2	> 25
Large	> 0,5	> 50
medium size	> 0,25	> 50
Small ones	>0,1	≥75
Dusty	>0,1	<75

According to the density of addition, sandy soils, depending on the value of the porosity coefficient, are divided into dense, medium density and loose (Table 2).

Table 2 - Classification of sandy soils by density of addition

Sandy soils	The porosity coefficient of the sands		
	dense	medium density	loose
Gravelly, large and medium-sized	<0,55	0,55—0,70	>0,70
Small ones	<0,60	0,60—0,75	> 0,75
Dusty	<0,60	0,60 — 0,80	>0,80

According to the consistency, characterized by a fluidity index, clay soils are divided into the following varieties:

Sandy loam: solid......... IL <0

plastic........ 0 ≤IL ≤l

fluid.......... IL > 1
Loams and clays:
solid.......... IL <0
semi-solid........ 0 ≤IL ≤0,25
refractory....... 0,25 < IL ≤0,50
soft-plastic....... 0,50< IL ≤0,75
fluidplastic...... 0,75 < IL ≤ 1,00
fluid.......... IL > 1,00

Soil densities were also studied depending on the degree of humidity. Some of the results of these studies, depending on the degree of soil moisture, are shown in Figure 3.

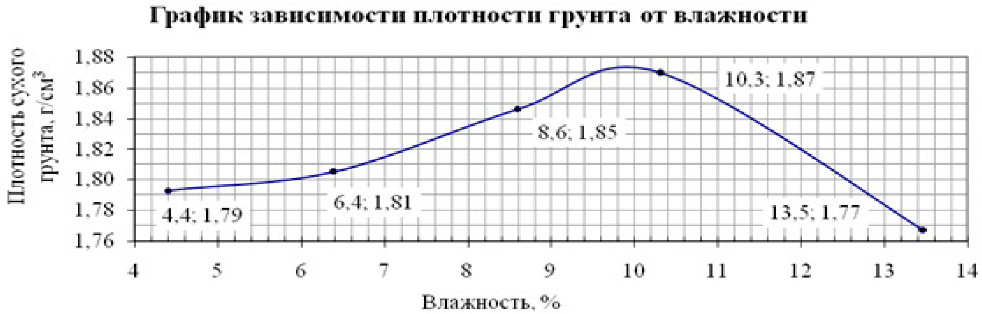


Figure 3 – Graph of the dependence of soil density on humidity

The results obtained

The Kok Tobe mountain range consists of: clay, dispersed, coarse-grained, mineral, swelling, incoherent, sandy, subsident, heaving, cohesive, rocky soil.

To determine the dynamic state of the mountain range, a mechanical and mathematical model will be used, where the main data of the model are the geological structures of soils.

On the basis of a mechanical and mathematical model, it is possible to determine the influence of external and internal factors affecting the stable and durable state of the Kok-Tobe mountain slope massif.

When calculating the parameters determining the stress-strain state of the mountain range, the characteristics of the environment are taken into account.

If elastic properties in an isotropic medium are determined by two parameters: the Young's modulus - and the Poisson coefficients , then for a medium of a transtropic (transversely isotropic) structure they are determined by five elastic properties: , , , , . The algorithm for obtaining the values of the anisotropy parameters of the soil of the slopes of Mount Kok Tobe was calculated by the I. Minchev method using the following formulas:

$$G_2 = \frac{\sum_{k=1}^{n} h_k}{\sum_{k=1}^{n} \frac{h_k}{G^k}} \qquad E_2 = \frac{\sum_{k=1}^{n} h_k}{\sum_{k=1}^{n} \frac{h_k}{E^k}}, \; E_1 = \frac{\sum_{k=1}^{n} h_k E^k}{\sum_{k=1}^{n} h_k},$$

$$\nu_2 = \frac{\sum_{k=1}^{n} h_k}{\sum_{k=1}^{n} \frac{h_k}{E^k}} \cdot \frac{\sum_{k=1}^{n} \nu^k h_k}{\sum_{k=1}^{n} h_k E^k}.\ \nu_1 = \frac{\sum_{k=1}^{n} \nu^k h_k E^k}{\sum_{k=1}^{n} h_k E^k}, \qquad (1)$$

where h_k – thickness k–th isotropic layer; n – number of layers; E^k, ν^k, G^k – elastic characteristics k – th isotropic layer; $G^k = \frac{E^k}{2(1+\nu^k)}$. The degree of anisotropy of the soil is determined by the deviation of the anisotropy parameters k, n, l from the corresponding parameters of the isotropic soil: $k = 1,\ \ n = 2,\ \ \ l = 1$.

The anisotropy parameters are calculated using expressions

$$n = \sqrt{2k + \frac{\frac{E_1}{G_2} - 2\nu_2(1+\nu_1)}{1-\nu_1^2}},\ \ k = \sqrt{\frac{\frac{E_1}{E_2} - \nu_2^2}{1-\nu_1^2}},\ l = \sqrt{\frac{E_1}{2(1+\nu_1)G_2}}. \qquad (2)$$

Taking into account the reference book, some average values of the elastic properties of soils are shown in Table 3 (Ержанов, 1971). Calculated using formulas (1) and (2), the given values of the elastic constants of the equivalent-transtropic array and the anisotropy parameters for different layer arrangements (Table 4.). These data on the value of the deformation modulus perpendicular to the layer h^k can be conditionally attributed to three different soil conditions.

Table 3 - Elastic properties of soils and the thickness of their layers

Layer k	The ground	Elastic constants		Thickness
			ν^k	h^k, m
1	Bulk	7,0	0,40	2,8
2	The loam is solid	30,0	0,36	2,2
3	Loam with pebbles	25,0	0,28	3,3
4	Gravel Pit	85,0	0,21	2,7
5	Boulder soil: with gravel;	120,0	0,27	3,2
6	with pebbles	80,0	0,35	4,8
7	Loam is semi-solid	50,0	0,25	6,5
8	Medium-sized sand	22,0	0,36	4,5
9	Pebbles with boulders	200,0	0,32	5,1
10	The clay is hard	300,0	0,31	5,9

Таблица 4 - Приведенные параметры эквивалентно - транстропного массива

Layer k	The order of the isotropic layers	Equivalent Parameters					Anisotropy parameters		
		E_1	E_2	G_2	ν_1	ν_2	k	n	l
1	1,2,3,4,5,6,7,8,9,10	96,609	28,32	10,76	0,31	0,09	1,94	3,55	1,85
2	10,1,2,3,4,5,6,7,8,9	6,26	28,21	10,74	0,31	0,09	1,94	3,55	1,85
3	9,10,1,2,3,4,5,6,7,8	91,30	23,41	8,77	0,31	0,08	2,07	3,78	1,99
4	8,9,10,1,2,3,4,5,6,7	94,21	23,88	8,95	0,31	0,08	2,09	3,80	2,01
5	7,8,9,10,1,2,3,4,5,6	102,77	29,24	11,11	0,31	0,09	1,97	3,60	1,88
6	6,7,8,9,10,1,2,3,4,5	102,44	28,12	10,74	0,31	0,08	2,01	3,65	1,91
7	5,6,7,8,9,10,1,2,3,4	100,16	27,77	10,61	0,31	0,09	2,00	3,63	1,90
8	4,5,6,7,8,9,10,1,2,3	102,41	28,09	10,69	0,31	0,08	2,01	3,65	1,91
9	3,4,5,6,7,8,9,10,1,2	105,01	27,82	10,58	0,31	0,08	2,04	3,71	1,95
10	2,3,4,5,6,7,8,9,10,1	100,02	28,17	10,69	0,31	0,09	1,98	3,61	1,89

Conclusion

The literature and the main parameters of the Kok Tobe mountain range have been studied. During the study, the types of soils were studied and based on this, the classification of soils of the Kok Tobe mountain component was determined. Geological and engineering data on the structure of the Kok Tobe Mountain have also been studied. The physical– mechanical and strength properties of soils composing the geological structure of the Kok Tobe Mountain have been established. Algorithms have been developed for reducing the soil layers of the slopes of the Kok Tobe mountain of a layered isotropic structure to a more developed model of the medium to an environment of an equivalent anisotropic structure.

REFERENCES

Antonov S. (2015). Secrets of the Almaty TV tower.

Bugrov A.K., G. A. I. (1993). Anisotropic soils and foundations of structures.

Baimakhan A.R., Rysbayeva A.K., Seinassinova A.A., Rysbayeva G.P., Kulmagambetova Z.K., Aliyeva A.M., & Baimakhan R.B. (2016). Calculation of the stress state of certain elements of engineering structures. — *International Journal of Applied Engineering Research*, — *11*(12).

Baimakhan A., Seinassinova A., Baimakhan R., Rysbayeva A. & Moldakunova N. (2020). Determining the physical and mechanical properties of two-phase soil for landslide slopes of the northern Tien Shan. — *International Journal of Engineering Research and Technology*. — *13*(4). https://doi.org/10.37624/ijert/13.4.2020.699-705

Baimakhan R., Kadirova Z., Seinassinova A., Baimakhan A. & Abdiakhmetova Z. (2021). Mathematical Modeling of the Water Saturation Algorithm of the Mountain Slope on the Example of the Catastrophic Landslide of the Northern Tien Shan Ak Kain. — *Mathematical Modelling of Engineering Problems*. — *8*(3). — — Pp. 467–476. https://doi.org/10.18280/mmep.080318

Elena SOKOLOVA. (2023, June 24). What the TV tower is silent about.

Yerzhanov J.S. (1971). STABILITY OF HORIZONTAL WORKINGS IN AN OBLIQUELY LAYERED ARRAY.

Kazakhstan Today. (2019, October 14). *Жители 60 домов в Алматы оказались в зоне риска из-за опасности схода оползня*. https://www.kt.kz/rus/society/zhiteli_60_domov_v_almaty_okazalis_v_zone_riska_iz-za_1377890090.html

Kurmanbek kyzy N. (2010). Stability of mountain slope systems, taking into account landslide and seismic hazards. Abstract of the candidate's thesis.

Polishchuk A.I., N. A. V. (2007). Assessment of the ground conditions of the construction site.

Tsytovich N.A. (1963). Soil mechanics.

CONTENT

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the originality detection service Cross Check http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will onh accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайте:
www:nauka-nanrk.kz
ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)
http://geolog-technical.kz/en/archive/

Подписано в печать 15.08.2024.
Формат 60x88 $^{1}/_{8}$. Бумага офсетная. Печать - ризограф.
15,0 п.л. Тираж 300. Заказ 4.

РОО «Национальная академия наук РК» 050010,
Алматы, ул. Шевченко, 28, т. 272-13-19