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

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК РЕСПУБЛИКИ КАЗАХСТАН»
ЧФ «Халық»

N E W S

OF THE ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
«Halyk» Private Foundation

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

6 (467)

NOVEMBER – DECEMBER 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 6. Number 467 (2024), 67–83
https://doi.org/10.32014/2024.2518-170X.461

UDC 624
IRSTI 67.13.19

©I.S. Brovko[1], D.Zh. Artykbaev[1*], K.S. Baibolov[2], M. Karatayev[3], E. Polat[1], 2024.
[1]M. Auezov South Kazakhstan University, Shymkent, Kazakhstan;
[2]Zh.A. Tashenev University, Shymkent, Kazakhstan;
[3]University of Nottingham, England.
E-mail: artykbaev_d@mail.ru

THE PRACTICE OF CONSTUCTING EARTHWORKS IN THE SOUTH OF KAZAKHSTAN

Brovko Igor Stepanovich – Doctor of Technical Sciences, Professor M. Auezov South Kazakhstan University, Shymkent, Kazakhstan E-mail: brovkoi56@mail.ru, https://orcid.org/ 0000-0003-0159-232X;
Artykbaev Darkhan Zhaksylykovich – PhD, M. Auezov South Kazakhstan University, Shymkent, Kazakhstan, E-mail: artykbaev_d@mail.ru, https://orcid.org/0000-0003-4794-8707;
Baibolov Kanat Seitzhanovich – Professor, Rector of the University Zh.A.Tasheneva, Shymkent, Kazakhstan, E-mail: kanat-bai@mail.ru, https://orcid.org/ 0000-0003-0342-6587;
Karatayev Marat – associate professor, University of Nottingham, England, E-mail: m.karataev@gmail.com, https://orcid.org/0000-0002-2760-6323;
Polat Erbolat – student, M. Auezov South Kazakhstan University, Shymkent, Kazakhstan, E-mail: erbolat0401@icloud.com.

Abstract. The results of an analysis of a number of aspects and methods of constructing earthworks in the engineering-geological and climatic conditions of southern Kazakhstan are presented. The humidity levels for optimal compaction of a soil mass consisting of different types of soil are shown. Methods of soil compaction and the technological equipment and devices used are analyzed. Examples from industrial practice are considered, where specialists encountered problems in choosing the type of soil for the construction of a soil structure and the method of work to ensure the required performance characteristics. The material presented is accompanied by photographs and Figures.

The development of the soil mass, movement, laying and the necessary compaction is almost always carried out during the construction of buildings and structures. This entire complex of construction processes, including preparatory and auxiliary activities, creates certain problems that require scientific justification. Through excavation work, structures such as pits, trenches, embankments, excavations in the ground, dams, embankment of territories are constructed, as well as planning work is carried out to create the required soil surfaces in accordance with design solutions.

Excavation work, as noted in is significant in cost, which corresponds to 15%, and in difficult geological conditions reaches 20-25% of the total cost of work on the facility. Labor intensity is also high - 18-20% and worker employment - 10%.

Keywords: earthwork, climatological conditions, soil compaction, pit, earthen embankments, landslide.

©И.С. Бровко[1], Д.Ж. Артыкбаев[1*], К.С. Байболов[2], М. Каратаев[3], Е. Полат[1], 2024.

[1]М. Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан;
[2]Ж.А.Ташенов университеті, Шымкент, Қазақстан;
[3]Нотингем университеті, Ұлыбритания.
E-mail: artykbaev_d@mail.ru

ҚАЗАҚСТАННЫҢ ОҢТҮСТІГІНДЕГІ ЖЕР ҮЙМЕРЕТТЕРІН ҚҰРУ ПРАКТИКАСЫ

Бровко Игорь Степанович – техника ғылымдарының докторы, профессор, М. Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан, E-mail: brovkoi56@mail.ru, https://orcid.org/ 0000-0003-0159-232X;
Артықбаев Дархан Жаксылыкович – PhD, М. Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан, Болашақ. E-mail: artykbaev_d@mail.ru, https://orcid.org/0000-0003-4794-8707;
Байболов Канат Сейтжанович – профессор, Ж.А. Ташенев университетінің ректоры, Шымкент, Қазақстан, E-mail: kanat-bai@mail.ru, https://orcid.org/ 0000-0003-0342-6587;
Каратаев Марат – қауымдастырылған профессор, Ноттингем университеті, Ұлыбритания. E-mail: m.karataev@gmail.com, https://orcid.org/0000-0002-2760-6323;
Polat Erbolat — студент, М. Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан. E-mail: erbolat0401@icloud.com.

Аннотация. Оңтүстік Қазақстанның инженерлік, геологиялық және климаттық жағдайларында жер жұмыстарын салудың бірқатар аспектілері мен әдістерін талдау нәтижелері берілген. Әртүрлі грунт түрлерінен тұратын грунт массаларының оңтайлы тығыздалуы үшін ылғалдылық деңгейі көрсетілген. Грунттарды нығыздау әдістері және қолданылатын технологиялық жабдықтар мен құрылғылар талданады. Өндірістік тәжірибеден мысалдар қарастырылады, мұнда мамандар грунт құрылымын салу үшін грунт түрін және қажетті өнімділік сипаттамаларын қамтамасыз ету үшін жұмыс әдісін таңдауда қиындықтарға тап болды. Ұсынылған материал фотосуреттермен және сызбалармен қоса көрсетілді.

Грунт массасының дамуы, қозғалуы, төселуі және қажетті тығыздауы әрқашан дерлік ғимараттар мен құрылыстарды салу кезінде жүзеге асырылады. Дайындық және көмекші әрекеттерді қоса алғанда, құрылыс процестерінің бұл тұтас кешені ғылыми негіздеуді қажет ететін белгілі бір мәселелерді тудырады. Қазба жұмыстары арқылы шұңқырлар, ұзын орлар, үйінділер, жер астындағы қазбалар, бөгеттер, аумақтардың жағалаулары

сияқты құрылымдар салынады, сонымен қатар жобалық шешімдерге сәйкес қажетті грунт беттерін жасау үшін жоспарлау жұмыстары жүргізіледі.

Қазба жұмыстары, өзіндік құны бойынша маңызды, ол 15% сәйкес келеді, ал күрделі геологиялық жағдайларда объектідегі жұмыстардың жалпы құнының 20-25% жетеді. Еңбек сыйымдылығы да жоғары – 18-20% және жұмысшылардың жұмыспен қамтылуы – 10% құрайды.

Түйін сөздер: жер жұмыстары, климатологиялық жағдайлар, грунтты тығыздау, қазаншұңқыр, грунт үйінділері, көшкін.

©И.С. Бровко[1], Д.Ж. Артыкбаев[1*], К.С. Байболов[2], М. Каратаев[3], Е. Полат[1], 2024.

[1]Южно-Казахстанский университет имени М. Ауэзова, Шымкент, Казахстан;
[2]Университет имени Ж.А. Ташенева, Шымкент, Казахстан;
[3]Университет Ноттингем, Англия.
E-mail: artykbaev_d@mail.ru

ПРАКТИКА УСТРОЙСТВА ЗЕМЛЯНЫХ СООРУЖЕНИЙ НА ЮГЕ КАЗАХСТАНА

Бровко Игорь Степанович – доктор технических наук, профессор, Южно-Казахстанский университет имени М. Ауэзова, Шымкент, Казахстан, E-mail: brovkoi56@mail.ru, https://orcid.org/ 0000-0003-0159-232X;

Артыкбаев Дархан Жаксылыкович – PhD, Южно-Казахстанский университет имени М.Ауэзова, Шымкент, Казахстан, E-mail: artykbaev_d@mail.ru, https://orcid.org/0000-0003-4794-8707;

Байболов Канат Сейтжанович – профессор, Ректор университета имени Ж.А. Ташенева, Шымкент, Казахстан, E-mail: kanat-bai@mail.ru, https://orcid.org/ 0000-0003-0342-6587;

Каратаев Марат – ассоциированный профессор, Университет Ноттингема, Англия, E-mail: m.karataev@gmail.com, https://orcid.org/0000-0002-2760-6323;

Polat Erbolat — студент Южно-Казахстанского университета имени М.Ауэзова, Шымкент, Казахстан, E-mail: erbolat0401@icloud.com.

Аннотация. Приводятся результаты анализа ряда аспектов и методов устройства земляных сооружений в инженерно-геологических и климатических условиях южного Казахстана. Показаны влажности для оптимального уплотнения грунтового массива, состоящего из разных видов грунта. Анализируются методы уплотнения грунта и применяемое технологическое оборудование и устройства. Рассматриваются примеры из производственной практики, где специалисты столкнулись проблемами по выбору типа грунта для возведения грунтового сооружения и метода производства работ для обеспечения требуемых эксплуатационных характеристик. Излагаемый материал сопровождается фотографиями и чертежами.

Разработку грунтового массива, перемещение, укладку и необходимое уплотнение производят практически всегда при возведении зданий и сооружений. Весь этот комплекс строительных процессов, включая подготовительные и вспомогательные мероприятия, создает определенные проблемы, требующие научного обоснования. Посредством ведения земляных работ устраиваются такие сооружения как: котлованы, траншеи, насыпи, выемки в грунте, дамбы, обваловка территорий, а также выполняются планировочные работы для создания требуемых поверхностей грунта в соответствии с проектными решениями.

Земляные работы, как отмечается значительны по стоимости, которая соответствует 15%, а в сложных геологических условиях достигает 20-25% от общей стоимости работ по объекту. Так же высока трудоемкость – 18-20% и занятость рабочих – 10%.

Ключевые слова: земляные работы, климатологические условия, уплотнение грунта, котлован, земляные насыпи, оползень.

Introduction

You can minimize the cost of excavation work by: a. design solutions with the least amount of soil development, b. eliminating multiple transfers of soil from place to place, c. use of effective methods of work production and advanced mechanization means.

Currently, at construction sites, soil is developed using a variety of earthmoving and transport vehicles, using the method of hydromechanization and directed explosion. At small construction sites, as well as in inaccessible places of large pits, manual labor is used, which leads to sharp labor costs - 20-30 times less than mechanized labor.

Excavation work requires a comprehensive approach, since several operations are performed in the sequence established by the project - excavating soil, moving it, laying it and, if necessary, compacting it, cleaning the bottom of the pit, forming slopes with a certain angle of inclination, etc. All these operations can be performed by a certain set of specialized earth-moving equipment (Subhradeep Dhar, et al, 2019).

The efficiency of the work performed depends on the choice of soil development method and the selection of a set of machines. For this purpose, a technical and economic comparison and selection of the optimal solution are carried out. Next, we will consider the design of earthen structures depending on their purpose in construction practice (Yi Lu, et al, 2023).

Earth embankments, soil cushions and conditions for their formation. The formation of an embankment depends on its purpose and is carried out by laying soil in the right place and in the required quantity, followed by its compaction. In some cases, compaction is not required, for example, when constructing dumps of excess (reserve) soil (Sanjay Shukla, et al, 2013).

The stability of embankments during their further operation is ensured by the correct choice of soils composing them, the method of their laying and compaction. In difficult geological conditions, the number of preparatory activities and types of excavation work increases.

In sloped areas with a slope of 1:5 to 1:3, in order to prevent the formation of landslide masses of soil, ledges 1-4 m wide and up to 2 m high are made.

Literature review

When constructing an embankment on water-saturated foundations, before the soil begins to move, it is necessary to drain and ensure water drainage. To increase confidence in the chosen method of forming the embankment, experimental work is carried out to clarify the thickness of the laid layer and the required number of passes along one track of the compacting mechanisms. Standard and reference data on optimal moisture content for different types of soils are given in Table 1.

Table 1.

Data on optimal humidity for different types of soils

Type of soil	Optimum humidity %
Sands	8—12
Sandy loam	9—15
Loams	12—18
Clays	18—25

Embankments are formed from homogeneous soils, backfilled in horizontal or slightly inclined layers, the thickness of which depends on the power of the tamping agents used. In the geological conditions of the South of Kazakhstan, heavy rammers can compact clay soils to a thickness of 1.5 - 2.0 m. Rolling with heavy vehicles as well as vibrating rollers provides effective compaction of 30 - 40 cm in depth, and the use of light mechanization means (manual rammers used in hard-to-reach places or with small volumes of compacted soil): 15 – 20 cm. All these conditions must be strictly specified in design solutions.

Clearing of the territory and drainage of surface water is carried out within the area established by the project. Valuable tree species are transplanted to a new location, the rest are cut down (Mohamed Khemissa, et al, 2017). The operation of felling and uprooting trees is carried out using brush cutters, uprooters, and bulldozers. Trees with a trunk diameter greater than 0.1 m can be felled by special machines. Next, the trees are cleared of twigs and branches and stored in this form in specially designated areas. Stump uprooting is usually carried out using mechanized or explosive methods. Mechanized method (for stump diameter up to 0.5 m) - tractors, bulldozers, winches. For large stump diameters, the explosive method is used.

Surface water drainage is carried out to intercept upland waters along the boundaries of the construction site and ensure the drainage of water entering the territory. Drainage is carried out using temporary and permanent devices. For temporary drainage, drainage ditches or bunds are installed along the boundaries of the construction site in its elevated part, or the area is planned with a slope (Marco Rosone, et al, 2019).

Temporary devices must be designed to handle storm water and snow melt for a period three times longer than the planned construction period. Digging of ditches is carried out by excavators (bucket and ditch diggers), cutting of small ditches by bulldozers. Water is released from the ditches into low-lying areas outside the construction site into natural reservoirs. (Artykbaev, et al, 2024)

Taking into account modern requirements for the production of work, this manual provides technologies for performing earthworks when constructing earthworks in various climatic conditions, as well as the necessary information about soils and mechanization means (Artykbaev, et al, 2020). The construction of any buildings and structures necessitates soil processing, which includes their development, movement, placement and compaction. The whole complex of these processes is called earthworks.

The share of excavation work in the total volume of construction and installation work is very large and amounts to about 15% in cost and up to 20% in labor intensity. Earthworks account for about 10% of all labor resources employed in construction. The volume of excavation work is constantly growing and amounts to over 15 billion m3 per year. Processing such a quantity of soil is possible only under the condition of comprehensive mechanization and effective technology for the work.

One of the important reserves for reducing the volume of earthworks, and therefore the cost of construction, the use of which completely depends on the architect, is ensuring the alignment of buildings and designing a vertical layout taking into account the terrain.

Currently, excavation work is mainly carried out by mechanized complexes, and manual excavation is provided only in places inaccessible to machines, since the productivity of manual labor is 20...30 times lower than mechanized labor, which significantly affects the overall labor costs. (Truong, et al 2021)

Under some circumstances, if required by the production situation arising from the natural geological conditions of construction, embankments or backfilling of the pit are intentionally made in layers of different types of soil. As an example, we will give the construction of a two-layer embankment made of coarse material in the lower part and a gravel layer on top, built at one of the objects in the city of Shymkent, in water-saturated soils (Fig. 1). A special feature of this construction site was that groundwater, due to the presence of a hydraulic gradient, had a fairly high flow rate and flow rate.

And, if in such conditions a waterproof embankment is created, then a rise in the groundwater level will be observed, as if a dam had been created in front of the water. Therefore, to allow the passage of underground water in the direction of its natural flow, large rubble stone (40 - 70 cm in diameter) was laid in the lower part of the embankment (pillow) (Abelev, 2002). This ensured the creation of conditions for maintaining the free flow of underground water, preventing flooding of the underground premises of the building and the possibility of excavation work at higher elevations. In the upper part, gravel soil was used to level the site and create the necessary density.

Figure 1. View of a two-layer embankment made of rubble stone and gravel.

Figure 2. Device for backfilling soil into the cavities of the pit of a ring foundation at the Standard-cement plant in South Kazakhstan region

Materials and methods

One of the types of work with soil masses is filling various excavations with soil - trenches, low natural areas of land, leveling excavations and pit cavities. In all these cases, as well as in the previously discussed options, it is necessary to compact the loose soil. But the difference is that in these conditions, work is inevitably constrained, which does not allow large-sized machines to reach the required location.

Therefore, in most cases, manual vibrating rammers of varying power are used. If the required thickness is observed, as well as the optimal moisture content of the compacted soil layer, this method gives density results comparable to the work of heavy equipment (Mohamed Khemissa, et al 2017). In Fig. Figure 2 shows a view of the device for backfilling soil into the sinuses of the pit of a ring foundation at the Standard-Cement plant in the Turkestan region. In this case, as you can see, local gravel soil with sand aggregate was used. Thanks to the high-quality work carried out at this site, results were obtained that corresponded to the design specifications.

To achieve the required density parameters in soil embankments and backfills, work is carried out layer by layer. Under normal humidity conditions, the filling of layers of embankments is carried out from the edges to the middle. In waterlogged soils, in order to increase water extraction, the reverse order is recommended, from the middle to the edges. In this case, the transport transporting the soil must move across the entire width of the soil being laid to ensure uniform compaction.

The next layer of soil is poured only after reaching the required density of the underlying massif. Cohesive clay soils are better compacted by rolling, while sandy, non-cohesive soils are better compacted by vibration methods. Thus, soils with a clay fraction content of less than 6% by weight and gravel-sand soils can be successfully compacted by self-propelled vibration mechanisms (Marco Rosone, et al, 2019). For which, the most favorable conditions are rectilinear flat sections of the surface 50 - 100 m long, with small width grips.

The depth of vibration compaction depends on the type of mechanism and ranges from 0.5 – 0.8 m to several tens of meters (Brovko, 2011).

There is a known method of deep vibration compaction of sandy foundations, widely used in the United Arab Emirates, which performs operations in the following sequence:

- the vibrating projectile is hung by means of the mechanism's boom in a vertical position above the dive site, while just before the dive the electric motor of the vibration installation is turned on and water is supplied under pressure to the lower part of the unit to wash away the base soil;

- a vibrator, under the influence of its own weight, is embedded in the base, creating a compaction zone in the natural soil at the side and below, and a funnel, near the immersion site;

- after reaching the design immersion depth, the vibrator with the lower water supply nozzle closed and the upper one open, is pulled out in the reverse order with stops every 30 - 50 cm. The resulting funnel is filled with sand, which is also compacted.

Results and discussion

Regardless of the compaction method, rolling or tamping with a falling projectile, each subsequent trace must be made overlapping the previous one.

Good results in compacting weak soil caused by its water saturation are obtained by preliminary pre-construction creation of an embankment at the site of construction of the building. This method has been known since ancient times and its logic is as follows: if the base is compacted with a weight of soil equal to the weight of the future building, then possible deformations will occur in advance and the object will not be threatened by additional precipitation (Brovko, 2006).

To implement this method, a large amount of soil is required in order to create an embankment of great height and, accordingly, weight. This method should be combined with the creation of vertical drains to drain water from the base. There are a large number of drain options, which are vertical wells to the entire depth of the compacted base. The drainage material can be very diverse - from clean washed sand or crushed stone to special paper material used in Japan. In Shymkent you can often see mounds (cavaliers) of soil rising to a considerable height (Fig. 3).

Figure 3. Embankments (cavaliers) of soil in Shymkent.

However, this is not a temporary embankment to compact the underlying soil mass, but simply dumps of soil from deep pits, most often dug for high-rise buildings. The described method is not widely used in the south of Kazakhstan due to its significant cost and labor intensity, as well as due to the long period of curing of embankment compaction, lasting 3–5 months.

Soil dams, features of their design and operation. In some practical cases, soil structures are required to prevent water from entering a certain construction site, that is, to represent a barrier of compacted soil (Mohamed Khemissa, et al, 2017). Typically, such structures are called dams and, unlike dams, they absorb water pressure only occasionally and, as a rule, are much smaller in size. Often dams perform temporary protective functions, but the possibility of further progress in construction often depends on their proper operation.

Such earthen structures (dams) should not change their size and shape during operation, be eroded by atmospheric and flowing waters, sag and be stable when construction equipment moves over them. Among the various geotechnical situations in the construction conditions of southern Kazakhstan, there are cases when it is necessary to prevent water from entering, for example, into already opened pits, when long-term soaking of the foundation is carried out at a number of objects under construction (Marco Rosone, et al, 2019). In some cases, dams are erected temporarily to make it possible to carry out certain work on the water from them without the use of floating devices.

Let's consider the case of constructing a temporary dam across the Syr Darya River in the Chardara region of the South Kazakhstan region during reconstruction work to restore gas pipeline supports. The supports of this gas pipeline, made of metal pipes (Fig. 4), lasted for several years until, in one of the cold winters, they were damaged by the movement of a thick layer of ice during ice drift (Brovko, 2023). To restore the supports of the overpass, it was necessary to drive the piles across the river area.

There were no floating facilities for this work, and it was decided to carry out the work from a temporary dam. The main question when constructing the dam was what kind of soil to make the body of the temporary earthen structure from. Gravel was considered as an accessible material, which had to be delivered from afar; loam – from a quarry (from a distance of 30 km); and actual sand from the bottom or banks of the river (Bijayananda Mohanty, et al 2013).

At first, loam was the main option, as it is a cohesive soil and was considered more appropriate given the formation of an embankment over which heavy equipment would have to move for piling work. However, in the course of detailed studies of methods for constructing embankments and laboratory analysis of methods for compacting sandy soil, we came to the conclusion that it was possible to create a temporary dam from local medium-sized sand using a hydromechanical method, that is, alluvium.

The hydromechanical method ensures the production of excavation works in a continuous manner, that is, the operations: soil development, its transportation, dumping in the right place and compaction are carried out sequentially one after another using water energy. For this, a hydraulic monitor is used, which, using the pressure of a water jet, first erodes the soil mass, and then, through a suction pipe, moves and places the hydraulic mixture in the required place (Fig. 5, 6).

In the case under consideration, the soil was mined in the working faces under water and transported through pipes laid on the surface of the water using pontoon means to the release site (Fig. 5). The hydraulic mixture (pulp), formed from bottom sand and river water, spontaneously separates when placed in the dam body and, as a result, sand accumulates in the place provided for by the design, and water flows into the river water area (Sreelekshmypillai, et al, 2017).

Due to the natural sorting of particles by size during the laying process, when small particles of sand get stuck in the spaces (pores) between larger particles, an artificial mass is formed - a dam body with a high density sufficient to solve practical problems posed in a given production situation. In Fig. 7-8 show Figures of the plan and section of a temporary dam.

This method also justified its use by the fact that after the completion of the pile work, the temporary dam was easily destroyed by erosion by river water naturally without any additional work.

Figure 4. General view of the gas pipeline on metal supports

Figure 5. Pumping station on a floating pontoon

Figure 6. Formation of the body of a temporary dam using the alluvium method across the Syr Darya River in the Chardara region of the South Kazakhstan region

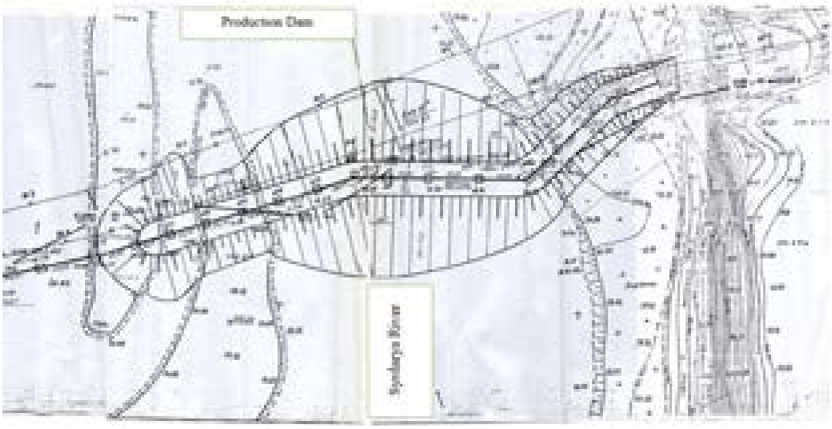

Figure 7. Design plan for a temporary dam for the reconstruction of a gas pipeline

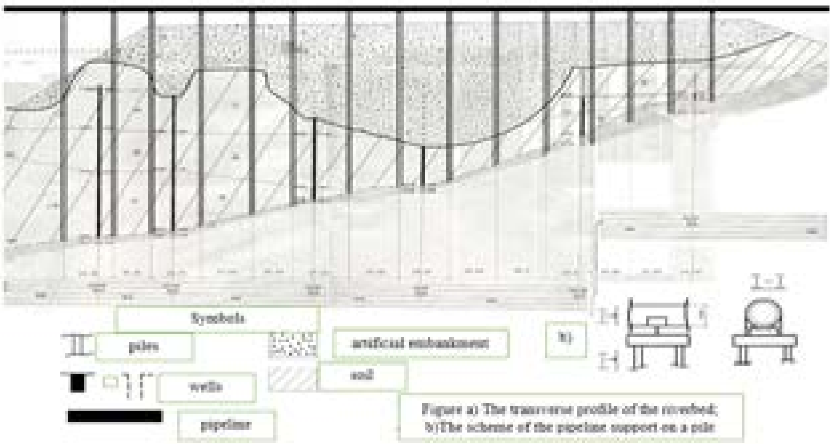

Figure 8.Cross-section of the river bed and temporary dam

Artificial ground cushions as compensators for deformations of building foundations. Soil cushions are the type of earthen structures most often used in the engineering-geological conditions of the South of Kazakhstan and represent a replacement for weak soils under the base of the foundations being built. We can say that this is a compensation geotechnical system designed to dampen additional stresses that arise in the soil layer under the buildings and structures being erected.

The construction of soil cushions is especially important if the soils, in terms of their bearing capacity and deformability, do not correspond to the loads that are transmitted to the foundation by heavy buildings, for example, high-rise ones.

Soil cushions are made from a layer of compacted soil, which is poured in layers and also compacted layer by layer, within the deformable zone under building structures. Ground cushions are very diverse and are classified according to: functional purpose (load-compensating structures or low-permeability screens); the type of soil used (in the south of Kazakhstan it is most often gravel-sand or local loamy soil); by compaction method (heavy tampers, soaking or rolling); geometric dimensions (in plan and in depth), etc.

Soils intended for the construction of artificial foundations must not contain debris, vegetation roots, organic waste, waste of building materials and structures, lumps of frozen soil and generally comply with the requirements of regulatory documents.

First, before installing the ground cushion, a pit is torn off, the bottom of which is the supporting plane for the future cushion. Therefore, before directly filling the soil material, the bottom of the pit is subjected to compaction to ensure high-quality work and reduce the deformability of the soil below the bottom of the pit.

Soils intended for the construction of artificial foundations must not contain debris, vegetation roots, organic waste, waste of building materials and structures, lumps of frozen soil and generally comply with the requirements of regulatory documents.

First, before installing the ground cushion, a pit is torn off, the bottom of which is the supporting plane for the future cushion. Therefore, before directly filling the soil material, the bottom of the pit is subjected to compaction to ensure high-quality work and reduce the deformability of the soil below the bottom of the pit.

b. perform a “shortfall” of soil when excavating a pit, which will allow you to reach the desired level after compaction. So, for example, during the construction of the Nursat microdistrict in Shymkent, local loam of optimal moisture, poured in a layer of 1.8 m, after compacting with a heavy tamper, was compressed by 30 cm and turned into a layer 1.5 m thick.

Figure 9 Gravel-sand cushion, made to one level

Figure 10. Terracing of a soil cushion at one of the workshops of the Standard-cement plant in South Kazakhstan region

Depending on the space-planning and design features of the buildings or structures being erected, the shape and depth of artificial soil cushions are designed (Mainak Majumder, et al, 2019). To do this, the pit is prepared under one mark or with separate terraces (Fig. 9, 10).

After completing the installation of the first layer of the soil cushion, the quality of its production is monitored. To do this, the artificially created soil layer is tested using laboratory methods or full-scale soil testing in a pit.

Laboratory methods involve taking soil samples using the "Cutting Ring" method, which can only be performed in fine-grained soils - clay or sand. In soils with a coarse granulometric composition, for example, in gravel-sand, tests are carried out using the "Volume Substitution Method", or by stamp tests. Note that the "Cutting Ring" method and the "Volume Substitution Method" can only obtain soil density, and the stamp test method can determine deformation characteristics.

It is believed that the optimal soil moisture W0 can be determined during compaction using the formula

$$W0 = Wp - (0{,}01 + 0{,}03); \qquad 1.1$$

where: Wp - humidity at the lower limit of plasticity (rolling).

In case of rolling W0 = Wp.

If the soils poured into the pit are affected by any external factors (rain, snow, freezing, water runoff from adjacent areas), this must be taken into account in the projects. In completely unforeseen cases, experimental compaction tests should be carried out and, based on the results obtained, the following should be established: the maximum possible thickness of the soil layers being compacted, the number of impacts of the rammer or the number of machine passes over one place, the duration of vibration exposure, etc.

During the rainy season, the perimeter of the pit is protected with a small dam, and the bottom is made with a slight slope towards the drainage trench and the sump well.

Artificial ground cushions are most efficient from an economic point of view when they are made from local material. For example, when a gravel pit is located in accessible proximity (Fig. 11), or from the same soil that was extracted from the pit. Sometimes it is allowed to use industrial waste (slag, ashes, etc.), but for this the necessary permits and approvals must be obtained.

But in a number of cases, soil cushions are designed in places where there is no occurrence of the necessary non-metallic materials, for example, gravel, at a close distance. Then the transportation costs for delivering the necessary soil become very high and dramatically increase the cost of zero-cycle work. In such cases, measures should be sought that would reduce the increasing costs.

One of these areas is the use of mixtures of different types of soil and their proportions, which would save materials that are scarce in a given region, but without compromising the bearing capacity of the artificial soil cushions being created. This postulate forms the basis of the research and predetermined the chosen direction in which the properties of soil mixtures of gravel-sand soil and loam are experimentally studied.

Figure. 11. Construction of shallow foundations on an artificial cushion of local gravel-sand soil in one of the pits of the South Kazakhstan region

Conclusions

- Review and analytical studies in this material show that earthworks in the form of soil dams, embankments, artificially created cushions are widely used in the construction of buildings and structures in South Kazakhstan.
- The stability of soil structures is determined by the correct selection of the soils composing it, methods of their laying and compaction, which significantly affect the long-term operational reliability of the construction projects being built.
- One of the scientific and practical directions is the use of mixtures of different types of soil and their proportions in the created soil cushions, which saves scarce non-metallic materials. This predetermined further scientific research to optimize the implementation of rational methods for constructing soil foundations in the southern region of Kazakhstan.

ACKNOWLEDGEMENTS/SOURCE OF FUNDING

The study was conducted using private sources of funding.

References

Subhradeep Dhar & Monowar Hussain. The strength and microstructural behavior of lime stabilized subgrade soil in road construction. Pages 471-483 | Received 05 Feb 2019, Accepted 19 Mar 2019, Published online: 12 Apr 2019. https://doi.org/10.1080/19386362.2019.1598623

Yi Lu, Eng-Choon Leong, Liang Zeng, Changhao Xu, Bingcheng Li. Suitability charts to select stabilizer for excavated soils and rocks (ESR). Pages 108-123 | Received 31 May 2022, Accepted 08 Feb 2023, Published online: 21 Feb 2023. https://doi.org/10.1080/19386362.2023.2182500

Sanjay Shukla, Nagaratnam Sivakugan, Braja Das. A state-of-the-art review of geosynthetic-reinforced slopes. Pages 17-32 | Published online: 04 Sep 2013. https://doi.org/10.3328/IJGE.2011.05.01.17-32

Mohamed Khemissa, Abdelkrim Mahamedi, Lakhdar Mekki. Laboratory investigation of the treatment effects by hydraulic binders on the physical and mechanical properties of an overconsolidated expansive clay. Pages 594-607 | Received 28 Feb 2017, Accepted 20 Jul 2017, Published online: 25 Sep 2017. https://doi.org/10.1080/19386362.2017.1376816

Marco Rosone, Bartolomeo Megna,Clara Celauro. Analysis of the chemical and microstructural modifications effects on the hydro-mechanical behaviour of a lime-treated clay. Pages 447-460 | Received 02 Apr 2019, Accepted 28 Jun 2019, Published online: 11 Jul 2019. https://doi.org/10.1080/19386362.2019.1639351

Artykbaev, D.Zh., Ibragimov, K., Aubakirova, F.Kh., Karatayev, M., Polat, E. Research and laboratory methods for determining coarse soils at the experimental site during the construction of an earth dam. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, 2024, 2024(2), страницы 8–23.

Artykbaev D.Zh., Baibolov, K., Rasulov, H. Stability analysis of fine soils from a road project, M 32 Samara – Shymkent (Russia-Kazakhstan). International Journal of GEOMATE, 2020, 19(76), стр. 205–212.

Truong Le, David Airey, Jamie Standing. Creep behaviour of structured clays in triaxial stress space: theory and experimental investigation.Pages 682-699 | Received 09 Jul 2021, Accepted 01 Dec 2021, Published online: 29 Dec 2021. https://doi.org/10.1080/19386362.2021.2014686

Abelev M.Yu. Study of the features of construction on macroporous water-saturated clay soils: Sat. works M.: GASIS, 2002. https://www.dissercat.com/content/fundamenty-i-inzhenernye-kommunikatsii-sooruzhenii-na-lessovykh-prosadochnykh-gruntakh-nasys

Mohamed Khemissa, Abdelkrim Mahamedi, Lakhdar Mekki. Laboratory investigation of the treatment effects by hydraulic binders on the physical and mechanical properties of an overconsolidated expansive clay. Pages 594-607 | Received 28 Feb 2017, Accepted 20 Jul 2017, Published online: 25 Sep 2017. https://doi.org/10.1080/19386362.2017.1376816

Marco Rosone, Bartolomeo Megna,Clara Celauro. Analysis of the chemical and microstructural modifications effects on the hydro-mechanical behaviour of a lime-treated clay. Pages 447-460 | Received 02 Apr 2019, Accepted 28 Jun 2019, Published online: 11 Jul 2019. https://doi.org/10.1080/19386362.2019.1639351

Brovko I.S. Geotechnical problems of construction in cramped conditions. Publishing Center of SKSU named after. M. Auezova. Shymkent 2011. 276 p. https://auezov.edu.kz/rus/stranitsy-ru/433-transactions-m-auezov-sksu

Brovko I.S. Comprehensive justification for solving geotechnical problems of mutual influence of foundations constructed with soil displacement, and their interaction with foundations in the geological conditions of the South of Kazakhstan // Industrial-innovative development - the basis of a sustainable economy of Kazakhstan: materials of the international. scientific-practical Conf. – T.2. – Shymkent, 2006. – P. 300-301. https://bulletin-geography.kaznu.kz/index.php/1-geo/article/view/180

Mohamed Khemissa, Abdelkrim Mahamedi, Lakhdar Mekki. Laboratory investigation of the treatment effects by hydraulic binders on the physical and mechanical properties of an overconsolidated expansive clay. Pages 594-607 | Received 28 Feb 2017, Accepted 20 Jul 2017, Published online: 25 Sep 2017. https://doi.org/10.1080/19386362.2017.1376816

Marco Rosone, Bartolomeo Megna,Clara Celauro. Analysis of the chemical and microstructural modifications effects on the hydro-mechanical behaviour of a lime-treated clay. Pages 447-460 | Received 02 Apr 2019, Accepted 28 Jun 2019, Published online: 11 Jul 2019. https://doi.org/10.1080/19386362.2019.1639351

Brovko I.S. Geotechnics of Southern Kazakhstan. Shymkent 2023. Publishing House “Ontustik Polygraphy” 620 s. http://e-lib.dulaty.kz/lib/document/TARGU/73BD7737-2D38-4D8F-A4F8-C6B3D4C51869/

Bijayananda Mohanty, Padala Kumar, Nihar Patra, Sarvesh Chandra. Evaluation of residual strength and liquefaction potential of pond ash. Page 119 | Published online: 04 Sep 2013. https://doi.org/10.3328/IJGE.2011.05.01.119

G. Sreelekshmypillai, P. Vinod. Prediction of CBR value of fine grained soils at any rational compactive effort. Pages 560-565 | Received 11 Jul 2017, Accepted 29 Aug 2017, Published online: 25 Sep 2017. https://doi.org/10.1080/19386362.2017.1374495

Mainak Majumder, Sayan Bhattacharyya. An alternate arrangement of geofoam blocks and air pocket to mitigate confined blast induced vibration. Pages 52-65 | Received 30 Oct 2019, Accepted 22 Nov 2019, Published online: 02 Dec 2019. https://doi.org/10.1080/19386362.2019.1698219

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 described work 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 Cross Check originality detection service 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 only 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 сайтах:
www:nauka-nanrk.kz
http://www.geolog-technical.kz/index.php/en/
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Директор отдела издания научных журналов НАН РК *А. Ботанқызы*
Редакторы: *Д.С. Аленов, Ж.Ш.Әден*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 15.12.2024.
Формат 70x90$^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
14,5 п.л. Тираж 300. Заказ 6.

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