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

ХАБАРЛАРЫ

ИЗВЕСТИЯ

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

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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.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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COARSE-GRAINED SOILS COMPACTION AT THE EXPERIMENTAL SITE DURING THE CONSTRUCTION OF THE EARTHEN DAM

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Abstract. The article details the results of laboratory and field studies on the compaction of coarse materials and clastic soils. The laboratory used a 300 mm diameter vibration machine and a standard compaction device. In the field, compaction was carried out with a 27-ton SANY smooth roller. To determine the highest density and preferred humidity, the laboratory created a diagram of the dependence of the density of dry soil on humidity and found the best result of the obtained dependence, corresponding to the required values of the maximum density and the required humidity. As a result, the work done presents the results of soil compaction in field conditions, with a layer thickness of 50.70, 80 cm, density 2.19 t/m3, 2.05 t/m3, 2.13 t/m3, respectively. The soil was compacted with a 27-ton roller in 6-8 passes along one strip. In addition, the article shows the effectiveness of using the drilling and blasting method in a quarry to obtain stone material of the required grain composition.

Keywords: coarse-grained soils, earthen dam, pit, grain composition, model mixtures

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ЖЕР БӨГЕНІН ҚҰРУ КЕЗІНДЕГІ ТӘЖІРИБЕЛІК АЛАҢДАҒЫ ІРІСЫНЫҚТЫ ТОПЫРАҚТАРДЫ ТЫҒЫЗДАУ

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Аннотация. Мақалада дөрекі материалдар мен сынық топырақтарды нығыздау бойынша зертханалық және далалық зерттеулердің нәтижелері егжей-тегжейлі сипатталған. Зертханада диаметрі 300 мм вибрациялық машина мен стандартты нығыздау құрылғысы қолданылды. Далада нығыздау 27 тонналық SANY тегіс роликпен жүргізілді. Ең жоғары тығыздық пен қолайлы ылғалдылықты анықтау үшін зертхана құрғақ топырақтың тығыздығының ылғалдылыққа тәуелділік диаграммасын құрды және максималды тығыздық пен қажетті ылғалдылықтың қажетті мәндеріне сәйкес келетін алынған тәуелділіктің ең жақсы нәтижесін тапты. Нәтижесінде, орындалған жұмыстар егістік жағдайында топырақтың тығыздалу нәтижелерін береді, сәйкесінше қабат қалыңдығы 50,70, 80 см, тығыздығы 2,19 т/м3, 2,05 т/м3, 2,13 т/м3. Топырақ 27 тонналық роликпен бір жолақ бойымен 6–8 өтумен нығыздалған. Сонымен қатар, мақалада қажетті астық құрамының тас материалын алу үшін карьерде бұрғылау және жару әдісін қолданудың тиімділігі көрсетілген.

Түйін сөздер: ірісынықты топырақтар, топырақ бөгеттері, шұңқырлар, түйіршік құрамы, үлгі қоспалар

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УПЛОТНЕНИЕ КРУПНООБЛОМОЧНЫХ ГРУНТОВ НА ОПЫТНОЙ ПЛОЩАДКЕ ПРИ СТРОИТЕЛЬСТВЕ ГРУНТОВОЙ ПЛОТИНЫ

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Аннотация. В статье подробно изложены результаты лабораторных и полевых исследований по уплотнению крупнообломочных грунтов. В лаборатории использовалась вибрационная машина диаметром 300 мм и стандартное уплотняющее устройство. В полевых условиях уплотнение осуществлялось 27-тонным гладким катком SANY. Для определения наибольшей плотности и предпочтительной влажности в лаборатории создали график зависимости плотности сухого грунта от влажности и нашли лучший результат полученной зависимости, соответствующий требуемым значениям максимальной плотности и необходимой влажности. В результате проделанной работы представлены результаты уплотнения грунта в полевых условиях при толщине слоя 50,70, 80 см, плотности 2,19 т/м3, 2,05 т/м3, 2,13 т/м3 соответственно. Уплотнение грунта производилось 27-тонным катком за 6–8 проходов по одной полосе. Кроме того, в статье показана эффективность использования буровзрывного метода в карьере для получения каменного материала необходимого зернового состава.

Ключевые слова: крупнообломочный грунт, грунтовая плотина, шурф, зерновой состав, модельная смесь

Introduction

In recent years, coarse-grained soils are widely used in various elements of soil structures. In industrial, civil, hydrotechnical, water and road construction, their share is 75 % or more. An important task is to ensure quality laying of the ground (Shakirov, 2014; Denikin et al., 2016).

The quality of laying materials for these structures is determined by their density, strength, deformability and filtration characteristics. In order to fulfill these requirements, it is necessary to individually establish the control parameters of soil laying on each object and conduct large-scale experimental studies to substantiate these parameters in the dam.

Materials and methods

Coarse-grained soils are considered one of the most promising materials for the construction of earthen dams. It is known that to strengthen the base of stone-earth structures, coarse-grained soils are often used, which constitute approximately 70 % of the total volume of the dam.

For rock-earth dams, studies of the behavior of coarse-grained materials under heavy loads, the choice of soil characteristics used in the construction of an earthen dam are of particular importance, and this is one of the main stages of construction, since the reliability and efficiency of the structure will depend on this.

To determine soil density in laboratory conditions, the standard compaction method was used.

Under the conditions at the experimental site, the density was determined by the pit method. In this case, the volume of the pit was determined by pouring water onto a pre-positioned polyethylene film 0.2 mm thick (Fig. 1) (Teltayev et al., 2021: 174–179).

Figure 1 – Determination of the density by the “pit-hole” method of the first layer after two passes with a smooth roller with a vibrator turned on

The purpose of the research was to create and select a method for developing, laying and compacting dam soil materials in a natural environment, ensuring maximum density and minimum filtration coefficient of materials.

These goals were achieved by constructing experimental embankments and performing

the minimum required laboratory tests. Before the start of construction, preliminary laboratory experiments were carried out at the experimental sites, which made it possible to determine the relationship between humidity and soil density for various efforts expended.

The compaction process in laboratory conditions differed from field conditions in that it was not carried out by rolling, and soil compaction was carried out with a standard compaction device.

For reasons of economy, backfilling of the embankment under study was carried out directly at the construction site on the left bank of the Pskem River.

On the horizontal section, the vegetation layer was removed, leveled and the surface was compacted with a smooth "SANY" roller weighing 27 tons. The marking of the base was carried out taking into account possible deviations of up to 5 cm.

The selected area measuring 100x100 m was carefully compacted using a vibratory roller in 6–8 passes. Next, the prepared site was leveled at marking points every 10 m. The site layout included an experimental embankment for a thrust prism and filters of the first and second layers, as well as the active zone. Landmarks were set along the contour. To mark the sites and routes, F16ASH reinforcement was used - 40 pieces, 1.5 m long. The density of the base was determined by the cutting ring method. The dam consisted of a persistent stone prism, filters from the first and second layers of pebbles, and a core of loamy soil (Petrov et al., 1993; Zhambakina et al., 2020: 133–141).

Currently, among other types of high earthen dams, rock-earth dams are most widespread. For high rock-earth dams, studies of the behavior of coarse-grained materials under heavy loads are of particular importance. The choice of soil characteristics used in the construction of an earthen dam is one of the most important design stages, since the strength and stability of the structure will depend on it.

Determination of the soil density of the pressure prism at the experimental site was carried out as follows.

The retaining prisms of the Pskem hydroelectric power station dam are planned to be built from a mountain range. It is planned to use a deposit located upstream on the left bank, 2.0–3.0 km from the dam site, as a quarry for pressure prisms.

The soil was transported by a heavy BELAZ dump truck with a lifting capacity of up to 40 tons.

Laboratory and field compaction of coarse soils was carried out at the experimental site.

At the site, the soil was leveled with a bulldozer in uncompacted layers 50, 70, 80 cm thick. After leveling, the soil was watered with water from a water truck at the rate of 200 liters per 1 m3. Compaction was carried out with a smooth roller weighing 27 tons, turned on at low speed. After every second pass, the density was determined using the pit method, two pits for each layer. (Figure 2).

Sampling of stone materials and processing of measurement results were carried out according to the method described below. Sampling from the layer was carried out from the surface of its occurrence as follows:

- a carefully leveled horizontal platform of 1.5x1.5 m is prepared, inside which a metal frame of 1.1x1.1 m is installed and a "hole" is sunk to the depth of the density determination horizon;

- the material selected from the pit was weighed and distributed into fractions. The volume of the pit was measured by filling it with water onto a pre-lined polyethylene film (Baluyev et al., 2015).

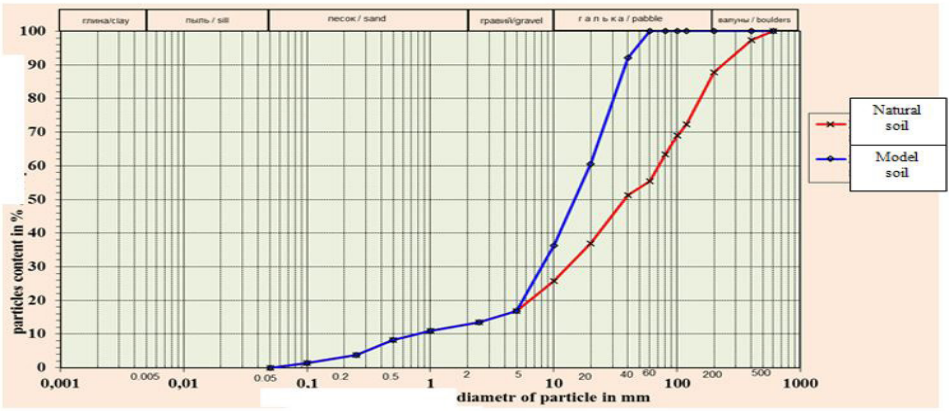


Figure 2 - Soil modeling method (developed by Hydroproject JSC)

The volumetric weight of the soil is determined as the ratio of the weight of the samples to the volume of the pit:

$$p\frac{w}{d} = \frac{P}{V}$$

where: p-weight of ground, kg; V-volume, l; $p\frac{w}{d}$ - volumetric weight of the wet soil.

In light of the fact that moisture in the stone material has little effect on its density, it can be neglected. However, if the content of fine earth (particles less than 5 mm in size) exceeds 5 %, it is necessary to determine the moisture content and adjust it for all samples by subtracting the amount of water contained from the total mass of the sample.

The moisture content of the selected material is determined by taking samples and drying them in a special oven with a mass of 2 kilograms of a fraction less than 20 millimeters.

Checking the representativeness of the sample depends on the volume of the well depending on the maximum size of inclusions and is regulated by GOST 28514–90.

A general assessment of the quality of the laid natural soil is made according to the summary curve of the grain composition, determined by the sieving method in the experimental area. The use of coarse-grained soils requires reliable knowledge about their physical and mechanical properties and construction features. The use of these soils is complicated by a number of specific factors: labor intensity, large particle sizes, and the need to use large-sized instruments.

A preliminary assessment of the compactability of coarse-grained soils is carried out using a standard compaction technique that meets regulatory requirements on a typical compaction device.

At the same time, the size of some fractions reaches 700–1000 mm. This study of coarse soils in laboratory conditions forces us to move on to modeling the grain composition of natural soils and carry out experimental determinations on model mixtures.

To achieve the goal of modeling soil composition, it is necessary to consider the use of model mixtures in small laboratory instruments, which should be as close as possible in characteristics to natural soil (Tilloyev et al., 2019; Abirov et al., 2022: 159–173).

The study of soils of large particles allows us to draw a conclusion about the ratio of the device diameter to the maximum fraction size, which should be at least five $d_{device} \geq 5\ d_{max.}$

For a device with standard size d_{max} = 300 mm, the maximum particle size should be

60 mm.

When specifying the composition of model mixtures, it is recommended to keep the percentage of fractions in them less than 5 mm or 10 mm. Thus, two points are fixed on the graph of the composition of the model mixture - the proportion of fine earth and the maximum fraction. The method for modeling large particle soils was developed by the “Hydroproject” JSC.

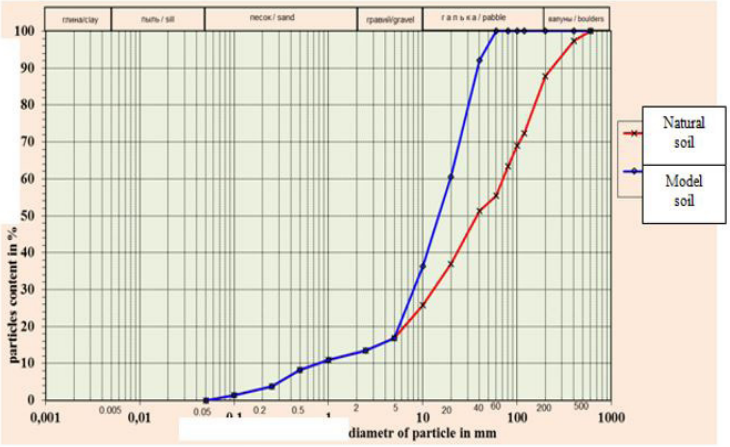


Figure 3 - Method for modeling coarse-grained soil developed by “Hydroproject” JSC

To achieve the same composition of particles less than 5 mm in size in the test soil sample and in natural soil using the coarse soil modeling method, it is necessary to determine the maximum particle size based on the size of the container. On the graph of the grain composition of the model mixture, two points are marked - the content of small particles and the maximum particle. For this purpose, a modeling method is used that excludes the random distribution of particles ranging in size from 5 to 60 mm. Intermediate values on the graph are calculated by proportionally reducing the particles to match the grain composition of natural soil, according to a given formula:

$$P\frac{m}{d} = \frac{Pi - P<5}{p\frac{H}{I} - P<5}(100 - p < 5) + p < 5$$

where: $P\frac{m}{d}$ percentage of fractions in the model mixture;

p<5- percentage of the fraction < 5mm;

$p\frac{H}{I}$ -percentage of fraction in natural soil.

For each type of material, experimental mixtures are prepared and tested on a standard compaction installation. Before compaction, the material is moistened so that the moisture content in the fine earth is at least 5–6 %.

Afterwards, the solution is poured into the container of the vibration unit (Fig. 4), then it is leveled and the distance between the soil surface and the top of the device is measured with a measuring ruler at five points. After this, measurements are carried out by rotating the measuring ruler by 90 ° and measuring five more points on the soil surface (Belov et al., 2021).

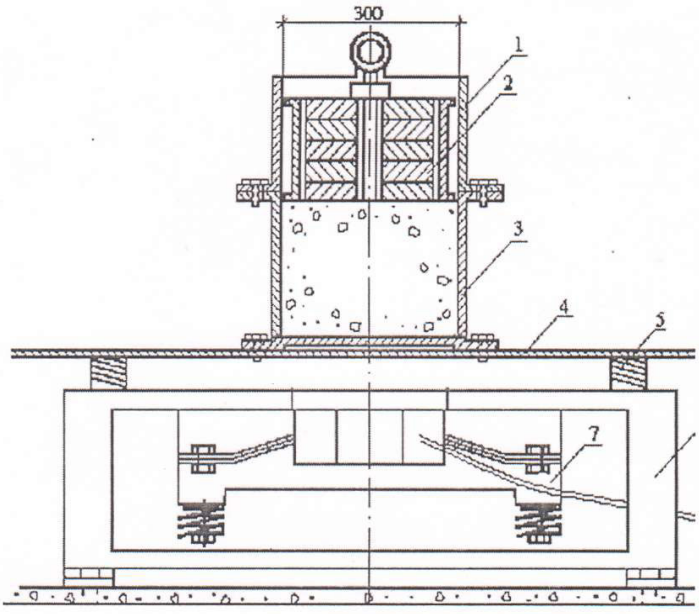


Figure 4 - Installation of vibratory soil compaction: 1-directing cylinder; 2-load; 3-container; 4-metal plate; 5-spring; 6-frame; 7-vibrator

The average of the 10 points determines the position of the top of the tool sample, and the difference between the location of the bottom and the ground determines the height of that sample.

After assembling the installation, the vibrator attached to the bottom of the platform is turned on, and the container vibrates for 8 minutes. Then remove the additive package and rubber gasket, measure the surface at ten points from the top edge of the container to calculate the volume of the compacted sample and the maximum (Brovko, 2018; Imashev et al., 2014: 286–289).

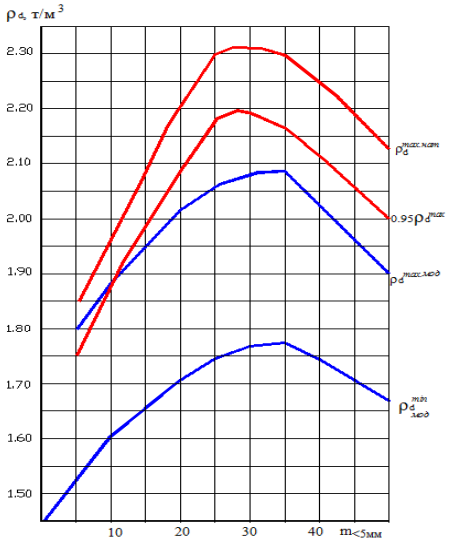


Figure 5 - Diagram of the dependence of the maximum densities of additives in the composition of soil with a fraction d<5 mm

The study of the influence of fine earth content on the density of model grain mixtures made it possible to establish the relationship between these two parameters. During the experiment, the maximum density of the additive was determined for each mixture composition, which made it possible to construct a graph of the dependence of density "p_d" on fine earth content "m".

The graphically presented dependence demonstrates the presence of an extreme value of density at a certain content of fine earth in the mixture. This means that there is an optimal ratio of fine earth at which the density of the mixture reaches its maximum. Carrying out tests with different fine earth contents allows us to determine this optimal value, which is visualized in Figure 5.

Compaction results for model mixtures, including maximum admixture densities and maximum natural soil densities, indicate that a placement density equal to $0.95p^{max}_{d}$ of the maximum natural soil density is required to achieve optimal compaction.

Table 1

Results of compaction of modular mixtures

No.No. of mixtures	The content of fr. <5mm, in %	The content fr. <20mm, in %	Density of model mixtures, t/m³		Nature ground ρ_d^{max}, t/m³	Required densities ρ_d^{mp}, t/m³
			ρ_d^{mix}	ρ_d^{max}		
3	10	33	1,63	1,88	2,00	1,84
2	18	64	1,68	1,98	2,13	2,02
1	25	35	1,74	2,06	2,25	2,18

Using the results of Table 1, we obtain the relative density of spent quarry stone for grain compositions with a fine earth content of 10 to 25 %.

Table2

Results based on experimental data

On experimental data	Fine earth content, %	Relative density, t/m³			
		I_d=0,70	I_d=0,75	I_d=0,80	I_d=0,85
	25	1,95	1,97	1,99	2,00
	18	1,88	1,90	1,91	1,93
	10	1,80	1,81	1,82	1,84

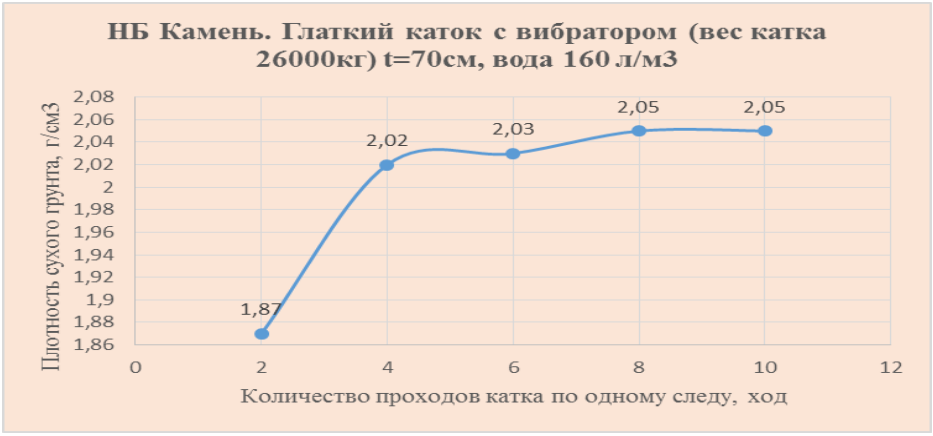
The graphs (Fig. 6, 7, 8) show the results of the experimental determination of soil density obtained using a thrust prism. The data demonstrates the dependence of soil density on the number of roller passes and the thickness of the soil layer.

The number of passes of the rink on one track, stroke

Figure 6 – Dependence graph of the dry soil density with a layer thickness of 50 cm on the passes number of a smooth roller (26000 kg.) with the vibrator turned on, water irrigation 160 l/m^3, stone.

The number of passes of the rink on one track, stroke

Figure 7 - Dependence graph of the dry soil density with a layer thickness of 80 cm on the passes number of a smooth roller (26000 kg.) with the vibrator turned on, water irrigation 160 l/m^3, stone



The number of passes of the rink on one track, stroke

Figure 8 – Dependence graph of the dry soil density with a layer thickness of 70 cm on the passes number of a smooth roller (26000 kg.) with the vibrator turned on, water irrigation 160 l/m^3, stone

Consequently, abutment prisms (stones) from the rock mass were laid in layers of 50, 70 and 80 cm thick, then watered from a water source and compacted with a 27-ton roller in 6–8 passes. Therefore, the average density was p_{dcp}=2.19t/m^3, p_{dcp}=2.05t/m^3, p_{dcp}=2.13t/m^3.

These data were obtained from a test site with a particle size distribution that included particles with a maximum diameter of up to 200 mm (Fig. 9).

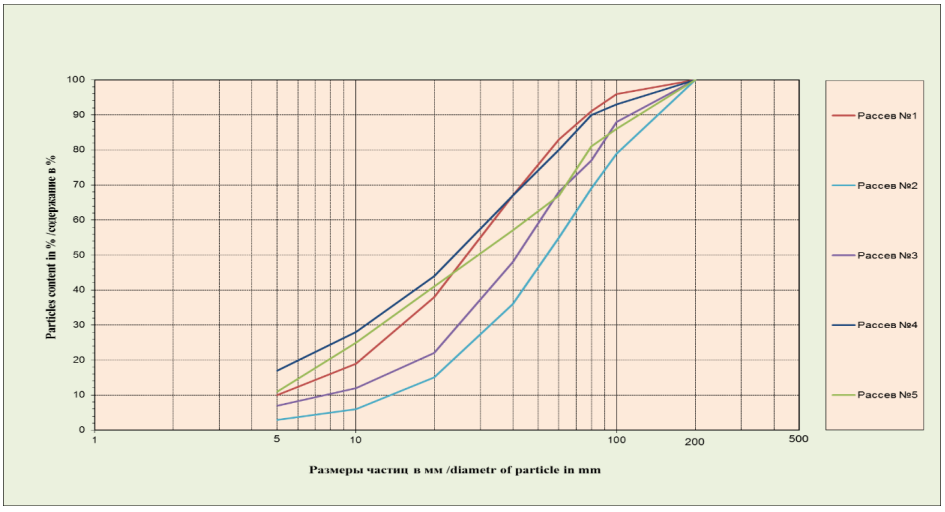


Figure 9 – Granulometric composition and density of stone material laid in an experimental embankment

When developing stone quarries using the explosive method, it is possible to evaluate the grain composition of the resulting stone material based on the results of experimental curves. This allows us to judge the effectiveness of the method used to maintain the stone material with the required grain composition.

To fully understand the grain composition of the stone material, it is recommended to carry out experimental blasting operations, during which the optimal blasting method will be determined to obtain the required fractions (Balykov, 2014; Ibragimov et al., 2021; 2021; et al., 2021).

Based on the data obtained, the optimal way to ensure high density is to lay stone material in layers no more than 1 meter thick with preliminary wetting with water, a flow rate of 150–300 l/m^3 and subsequent compaction with a vibration mechanism with a large radius of action.

To prevent destruction, it is recommended to use heavy-duty dump trucks capable of evenly distributing the material over the surface of the layer and further leveling it with a bulldozer (Ibragimov et al., 2021; Artykbaev et al., 2020: 205–212; Artykbaev et al., 2019: 1259–1262; et al., 2017: 238–243).

From the granulometric compositions and densities of the stone material laid in the experimental embankment, it is clear that the relative subsidence of the layer of stone material decreases with an increase in the proportion of small fractions (less than 5 mm) in the soil. At loads of 4.0 MPa, the sediment also decreases from 8.6 mm to 6.2 mm, but with a significant content of finely dispersed rock mass, it remains high, which leads to deformation of the material. The optimal value of the proportion of fine-grained fractions in the soil composition is 18–25 %, while the amount of precipitation does not exceed 6 mm (Rassulov et al., 2019: 60–63; Valeyev et al., 2019: 195–205; Teplitsky et al., 2020).

Conclusions

The following results were obtained during the study:

1. Thrust rock prisms were laid in layers 50, 70 and 80 cm thick, followed by watering and compaction with a 27-tonne roller in four to six passes. At the same time, with a thickness of 50 cm, the density was 2.19 t/m^3, with a thickness of 70 cm - 2.10 t/m^3, and with a thickness of 80 cm - 2.05 t/m^3. These data were obtained on an experimental site with a grain composition that included particles with a maximum diameter of up to 200 mm.
2. When developing stone quarries using the explosive method, it is possible to evaluate the effectiveness of the drilling and blasting method used, which ensures the extraction of stone material with the required grain composition.
3. To achieve high density, the method of laying stone material in layers no more than 1.0 meters thick is used with preliminary watering, with a flow rate of 150–300 l/m^3 and subsequent compaction with a long-range vibration mechanism.
4. To prevent delamination of the stone material, it is proposed to lay it using large-capacity dump trucks with uniform distribution over the surface of the layer and further leveling with a bulldozer.

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