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ON THE INFLUENCE OF DIFFERENT FRACTIONS ON THE MAXIMUM DENSITY AND OPTIMUM HUMIDITY OF THE FINE-GRAINED COMPONENT OF THE GROUND MIXTURE

Abstract. *The research results are presented, according to the experimental assessment of the influence of the content (by weight) of various fractions of fine soil on its maximum density and optimal moisture content. It is shown that by increasing a certain fraction, it is possible to achieve the highest density and the lowest moisture content of fine soil with its required amount in the mixture. To select the optimal composition of soil mixtures for the construction of bulk earth dams, it is recommended to carry out similar laboratory tests.*

Keywords: *dam, soil mixture, fine earth, particles, sample, mass, dry density, optimum moisture content.*

Introduction

As it is known, both natural and artificially improved soil mixtures are used for the construction of bulk earth dams. The reliability of these structures is largely determined by the composition and properties of the coarse-grained (coarse-grained) and fine-grained (fine-grained) components of the mixtures. In this case, fine earth, in the general case, includes a set of soil particles with sizes less than 1-5mm [1]:

– gravel (fine or very fine) or grit (with a particle size of more than 2 mm and less than 5 mm);
– sand particles (with sizes of 0.05-2 mm);
– dusty particles (with a particle size of 0.005-0.05 mm);
– clayey (with dimensions less than 0.005 mm).

The quality state of dam's soil mixtures depends on many factors, including the quantity, density and moisture content of fine earth. So from the standpoint of ensuring the suffusion strength of cohesive soil mixtures, the content of fine earth in them by volume should be at least 50% and its density should be at least 92-95% of its maximum density in a dry state [2]. For soil mixtures, consisting of gravel-pebble and clayey soils, it is allowed that the amount of clayey fine earth is 50-35% of the total volume of the mixture [3]. But, as the researchers note, when the amount of fine earth is less than 50%, the volume of free pores in the mixture increases, which negatively affects its properties. Thus, the content of clayey fine earth less than 35% (23-30%) in the composition of the crushed-clay mixture of the Orto-Tokoiskaya dam caused the mixture to stratify during filling and contributed to an increase in its permeability due to the lack of clayey fine earth [4]. The amount of fine earth also affects its density and the density of the soil mixture [3, 5-9]. Thus, an increase in the content of clayey fine earth (loam) leads to a nonlinear decrease in the density of the soil mixture, in which coarse soil acts as coarse soil [5]. Moreover, this regularity is characteristic both for the process of rolling the mixture with rollers and for compaction with a falling rammer. For proluvial deposits, which are natural soil mixtures, an increase in the content of fine soil (from 50 to 80%) is accompanied by a linear decrease in the density of both the fine soil itself and the mixture as a whole [8]. Studies of model (artificial) mixtures of coarse-grained soils (with a particle size of 50 mm or less) have revealed that the optimum in terms of maximum density is a mixture at which the content of fine earth in it is 40% [9]. The authors also found that an increase in the moisture content of fine earth causes an increase in its density to a certain limit, after reaching which the density decreases. As is known, a similar dependence takes place for clay and sandy soils during their standard tests to determine the maximum density [10].

From the above analysis, it follows that the content of fine earth and its density-moisture state predetermine the suffusion and filtration strength of soil mixtures, as well as their mechanical compaction. Therefore, it is recommended to judge the quality of compaction of soil mixtures in the body of the dam by the quality of compaction of their fine earth [6, 8, 11].

The important role that fine earth plays in the composition of the soil mixture dictates at the present stage the need for a deeper and more detailed study of other unexplored properties of fine earth, including those that are caused by a change in the amount of various fractions of solid particles in it. The results of such studies will make it possible to select the optimal fractional composition of fine earth, both in terms of the compacting effect and in terms of deformation and strength characteristics. Taking into account the value and novelty of such studies, in the geotechnical laboratory of the NJSC "Dulaty University", the corresponding complex research works are carried out.

This paper presents the results of studies on the experimental assessment of the influence of the content (by weight) of various fractions of fine earth on its maximum density and optimal moisture content.

Materials and methods

The studies were carried out using artificial compositions of mixtures obtained on the basis of heterogeneous coarse gravel soil (mass of particles larger than 2 mm - 53.65%) with sandy loam aggregate (clay filler content - 30.65%), lying on the territory of Baizak district of Zhambyl region of the Republic of Kazakhstan. The granulometric composition of coarse soil was established in accordance with the requirements of the standard [11] (Table 1).

Table 1 — Granulometric composition of coarse gravel soil

Particle size, mm	>10	10-5	5-2	2-1	1-0.5	0.5-0.25	0.25-0,1	0.1-0.05	0.05-0.01	0.01-0.002	< 0.002
Particle mass,%	30.75	14.90	8.0	5.25	4.25	3.45	2.74	17.2	8.78	2.6	2.08

By means of dosed sampling and additives, six groups of test samples of fine earth with different content of control fractions were compiled (Table 2):

Table 2 — Content of control fractions in test samples of fine earth

Sample group number	1	2	3	4	5	6
Fine earth content,%	50	55	60	65	70	75
Fraction content, %: m_{5-2}	3.65	8.65	13.65	18.65	23.65	28.65
m_{2-1}	0.9	5.9	10.9	15.9	20.9	25.9
$m_{1-0,5}$	0.0	5.0	10.0	15.0	20.0	25.0
$m_{0,5-0,25}$	0.0	4.1	9.1	14.1	19.1	24.1
$m_{0,25-0,1}$	0,0	3.45	8.45	13.45	18.45	23.45
$m_{<0,1}$	26.25	31.25	36.25	41.25	46.25	51.25

The increase in the percentage of the control fine-grained fraction was carried out by reducing the percentage of coarse-grained fractions. At the same time, the percentage of the remaining fractions in the test sample of fine earth did not change.

Tests of samples to determine the maximum density and optimum moisture content of fine earth were carried out in accordance with the requirements of the standard [10]. Compaction of the samples to the effect of shock loading was carried out using a PSU-A device (Figure 1).

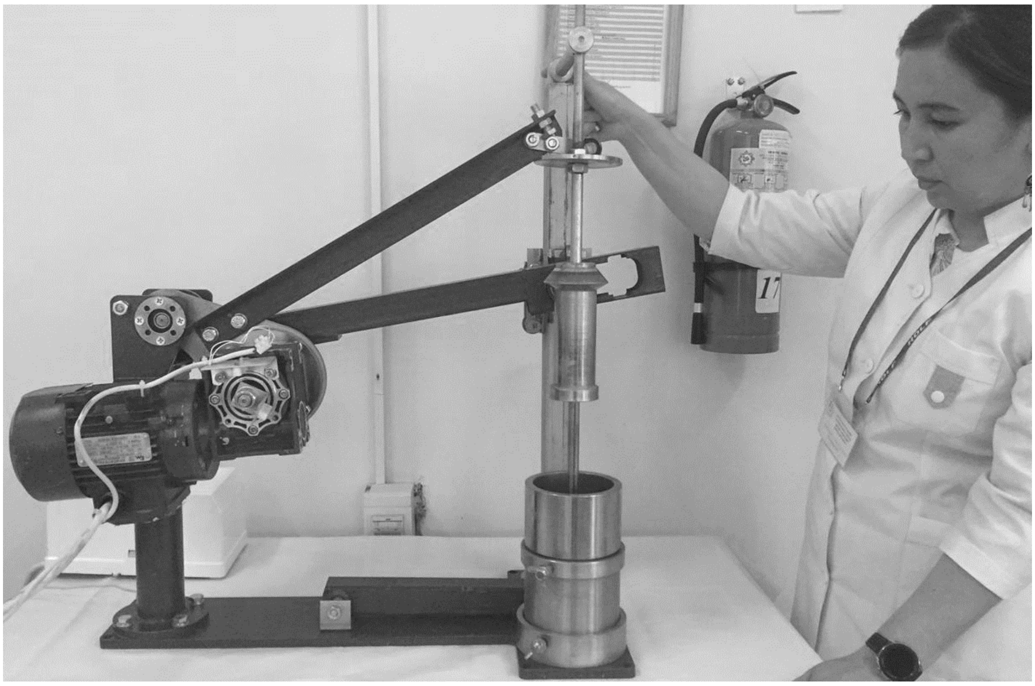


Figure 1 – Sealing device PSU –A

Results and discussion

The experimental results are shown in Figures *2-13*. Analyzing dependency graphs $m_m = f(lgd)$ (where: m_m– percentage of particles of the mixture by weight; d - particle diameter of the mixture, mm) it was found that an increase in the content of fine earth fractions leads to a decrease in the coefficient of heterogeneity $К_{60/10}$ soil mixture. Thus, an increase in the content of fine earth from 50 to 75% due to an increase in the mass of the fraction m_{5-2} (from 3.65 to 28.65%), accompanied by a decrease in the coefficient of heterogeneity $К_{60/10}$ from 296.0 to 114.8, i.e. 1.23-2.58 times (Figure 2). The largest decrease in this coefficient from 296.0 to 27.8 (by 1.23-10.65 times) occurs with an increase in the content of fine earth due to an increase in the mass of the fraction $m_{0.5-0.25}$ (from 0 to 24.1%) and the mass of the fraction $m_{0.25-0.1}$ (from 0 to 23.45%) (Figure 3). Thus, by changing the amount of fine soil fractions, it is possible to significantly change the degree of heterogeneity of the soil mixture.

An increase in the mass of individual fractions in the composition of fine earth affects the shape of the dependences $\rho_d = f(w)$ (where: ρ_d - density of fine earth in a dry state, t/m^3; w - moisture of fine earth in percent). When introducing larger fractions into fine earth, the zones of inflections of the indicated dependencies, in the general case, become flat, without special "crowding". This is especially true for the faction m_{5-2} (Figure 4). Further, with a decrease in the size of the particles introduced by the fractions, the flatness of the dependence curves turns into a bulge, and the crowding of the sections of their inflections becomes higher, which is clearly seen from Figure 5. The research results made it possible to establish that the dependencies $\rho_{d,max} = f(m_f)$ (where: $\rho_{d,max}$ — maximum density of fine earth in a dry state, t/m^3; m_f the content of fine earth as a percentage of the mass of the mixture) can be increasing or decreasing, as well as a complex non-linear character (Figure 6, 7).

Introducing fractions into fine earth m_{5-2}, m_{2-1} и $m_{1-0.5}$ causes an increase in the maximum density of fine earth (with an increase in its content in the mixture from 50 to 75%) by 0.76-5.77%, 0.65-5.46% and 0.40-4.65%, respectively (Figure 6) Highest density values $\rho_{d,max}$, equal to 2.019-2.113 t/m^3, typical for samples of fine earth, the content in the mixture of which increases due to the fraction $m_{1-0.5}$, and the smallest, equal to 1.975-2.089 t/m^3 - for samples of fine earth, the content in the mixture of which increases due to the fraction m_{5-2}.

Introducing fractions into fine earth $m_{0.5-0.25}$ и $m_{0.25-0.1}$ leads to a change in the form of dependencies $\rho_{d,max} = f(m_f)$. So the density of fine earth $\rho_{d,max}$ as its content in the mixture increases, it increases to a certain value, and then decreases (Figure 7). In this case, the highest density value $\rho_{d,max}$, equal to 2.07 t/m^3, corresponds to fine earth, the content of which in the mixture is 65% (when the fraction $m_{0.5-0.25}$).When adding a fraction to the fine earth $m_{0.25-0.1}$ highest density value $\rho_{d,max}$, equal to 2.055 t/m^3, is achieved at 60 percent fine earth content in the mixture. Addiction $\rho_{d,max} = f(m_f)$ when adding a fraction to the fine earth $m_{<0.1}$ has a decreasing character (Figure 7). An increase in the content of fine earth in the mixture from 50 to 75% due to the introduction of this fraction leads to a decrease in the density of fine earth $\rho_{d,max}$ by 0.15-1.22%.

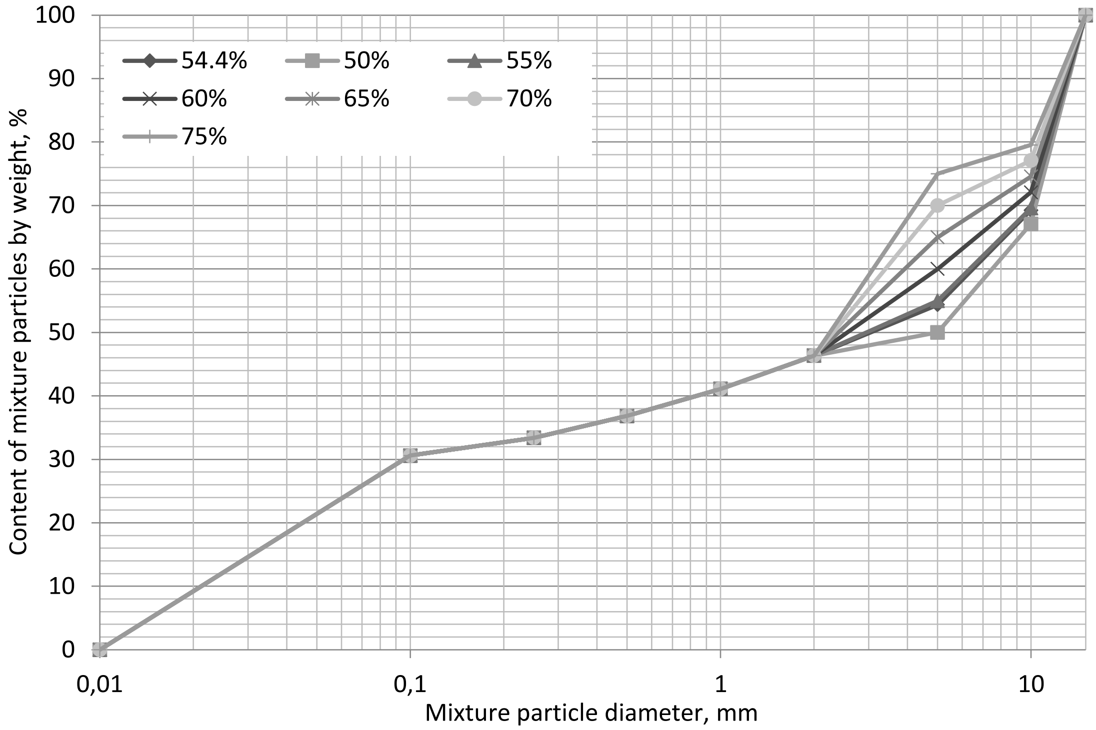


Figure 2 – Curves of homogeneity of the mixture with an increase in the content of fine earth in it from 50 to 75% due to an increase in the mass of the fraction in m_{5-2}.

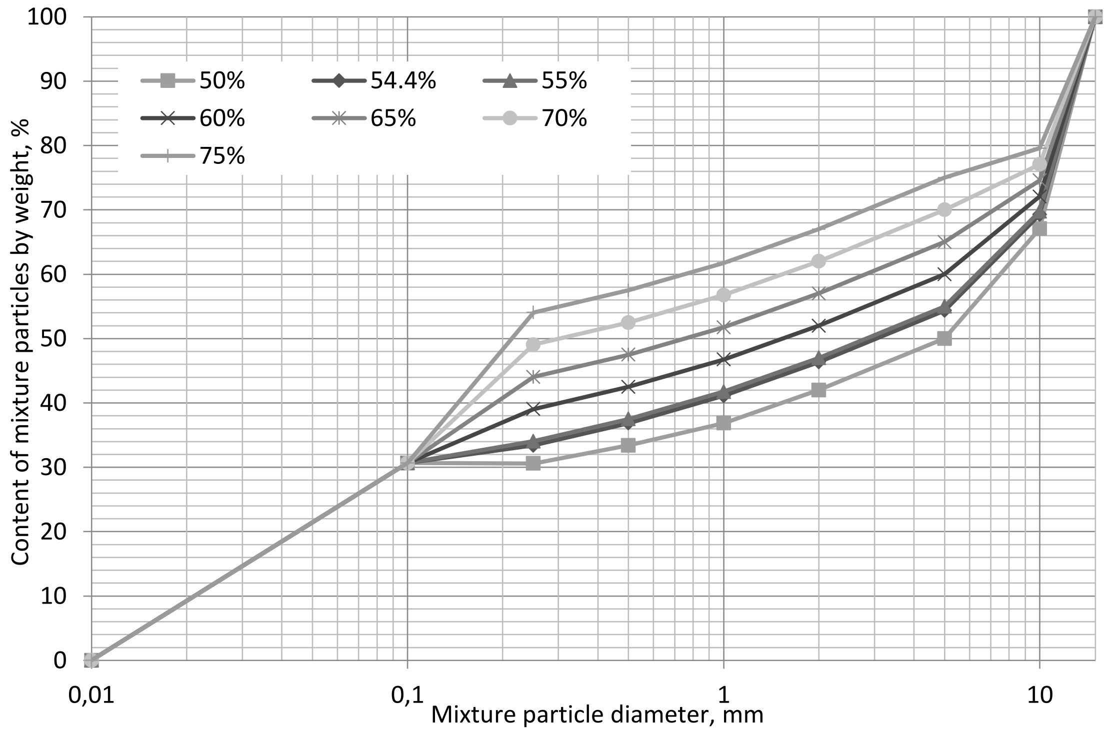


Figure 3 – Curves of homogeneity of the mixture with an increase in the content of fine earth in it from 50 to 75% due to an increase in the mass of the fraction $m_{0.25-0.1}$.

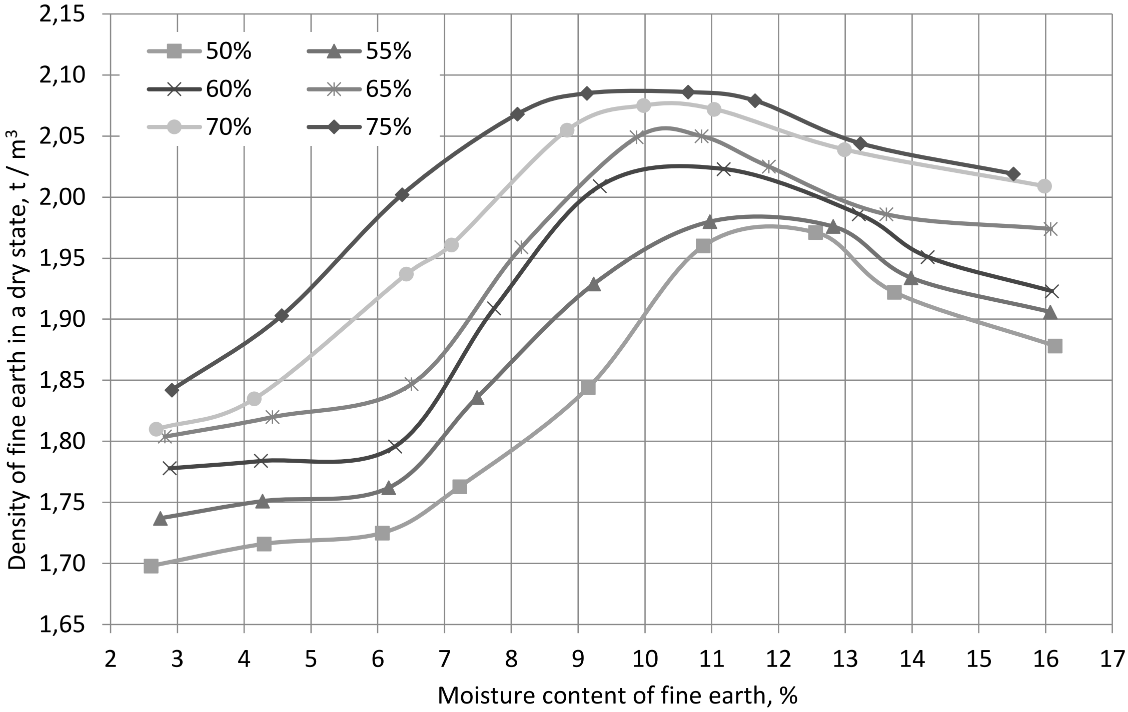


Figure 4 – Dependence of the density of fine earth in a dry state on moisture with an increase in the content of fine earth in the mixture from 50 to 75% due to an increase in the mass of the fraction m_{5-2}.

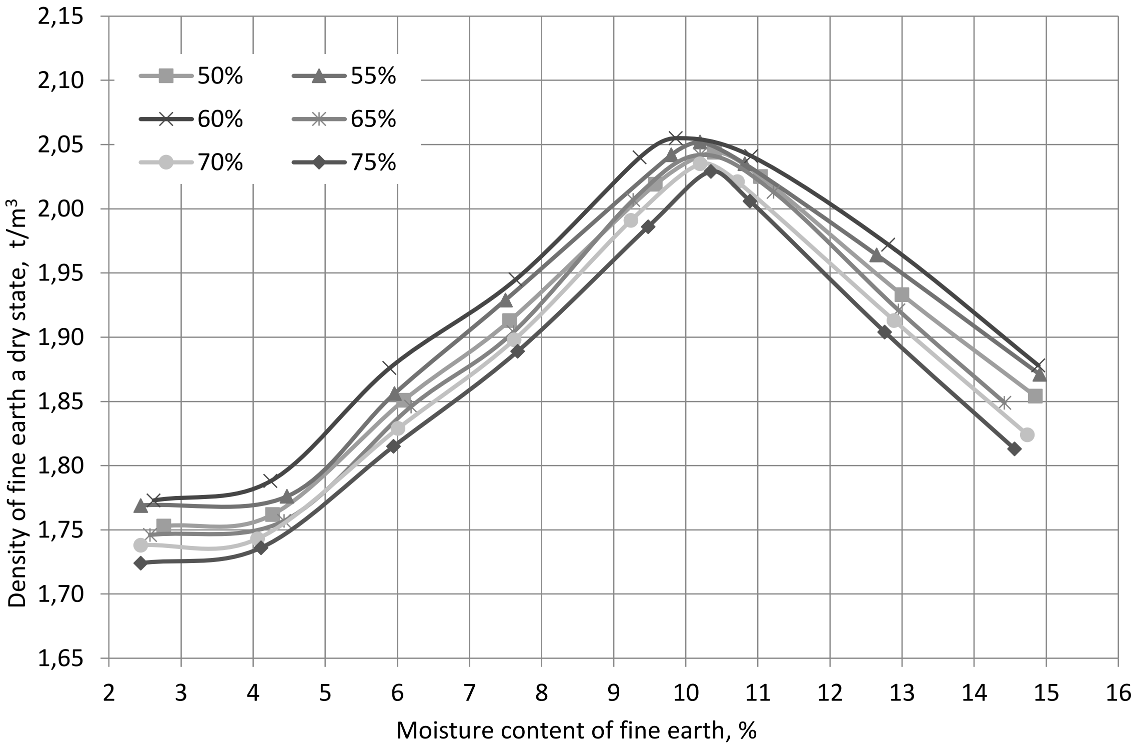


Figure 5 – Dependence of the density of fine earth in a dry state on moisture with an increase in the content of fine earth in the mixture from 50 to 75% due to an increase in the mass of the fraction $m_{0.25-0.1}$.

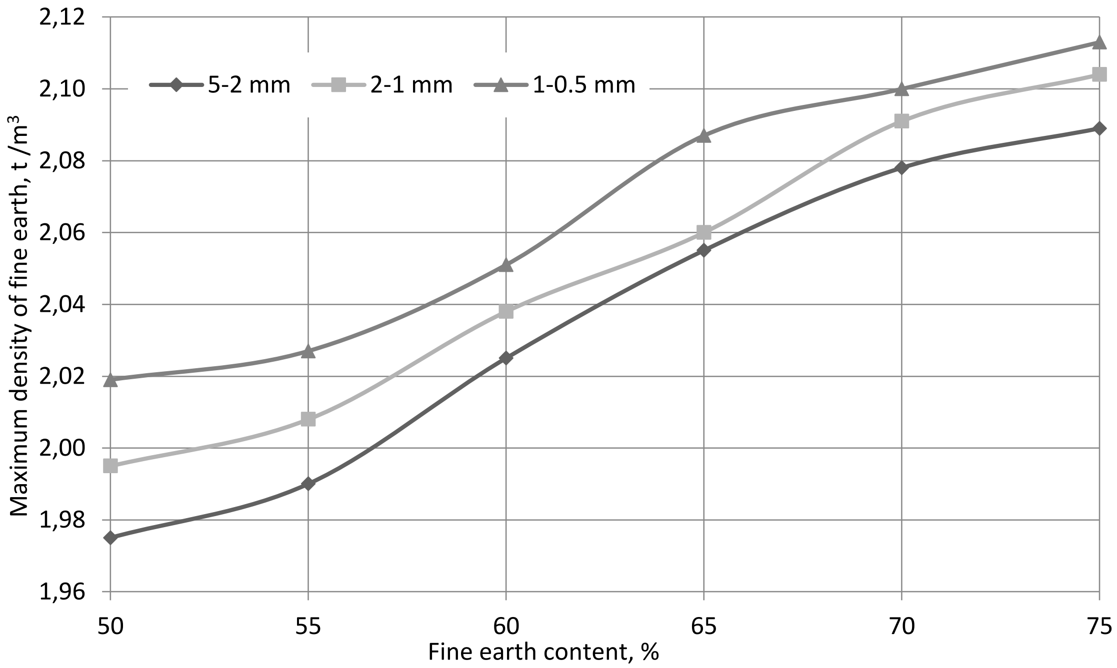


Figure 6 — Change in the maximum density of fine earth in a dry state, as its content in the mixture increases (due to an increase in the mass of fractions m_{5-2}, m_{2-1} and $m_{1-0.5}$).

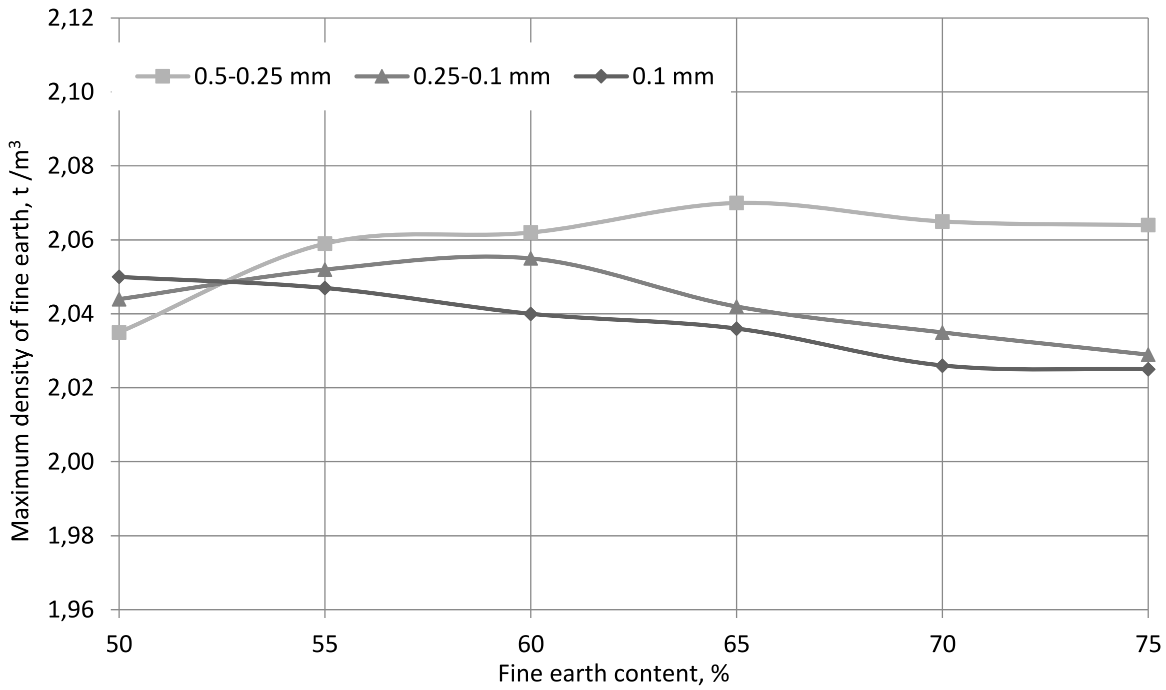


Figure 7 – Change in the maximum density of fine earth in a dry state, as its content in the mixture increases (due to an increase in the mass of fractions $m_{0,5-0,25}$, $m_{0,25-0,1}$ and $m_{<0,1}$).

Thus, the presented research results indicate that in order to achieve the highest values of the maximum density of fine earth $\rho_{d,max}$ it is advisable to increase its content in the mixture due to the content of fractions m_{5-2}, m_{2-1} and $m_{1-0.5}$. Moreover, the finer the fraction and the greater its content, the higher the density of fine earth $\rho_{d,max}$.

According to the research results, graphs of dependencies $w_0 = f(m_f)$ (where: w_0 – optimum moisture content of fine earth in percent), presented in Figures 8 and 9. As can be seen when introducing fractions into the composition of fine earth m_{5-2}, m_{2-1} and $m_{1-0.5}$ these dependences are of a decreasing nature (Figure 8). The presence of these fractions leads to a decrease in the optimal moisture content of fine soil w_0 (as its content in the mixture increases from 50 to 75%) by 5.51-16.68, 3.81-16.64 and 3.21-15.96%, respectively. The highest values of the optimum humidity w_0, equal to 10.14-12.17%, typical for samples of fine earth, the content in the mixture, which increases due to the fraction m_{5-2}, and the smallest, equal to 8.9-10.59% - for fine earth samples, the content in the mixture, which increases due to the fraction $m_{1-0.5}$.

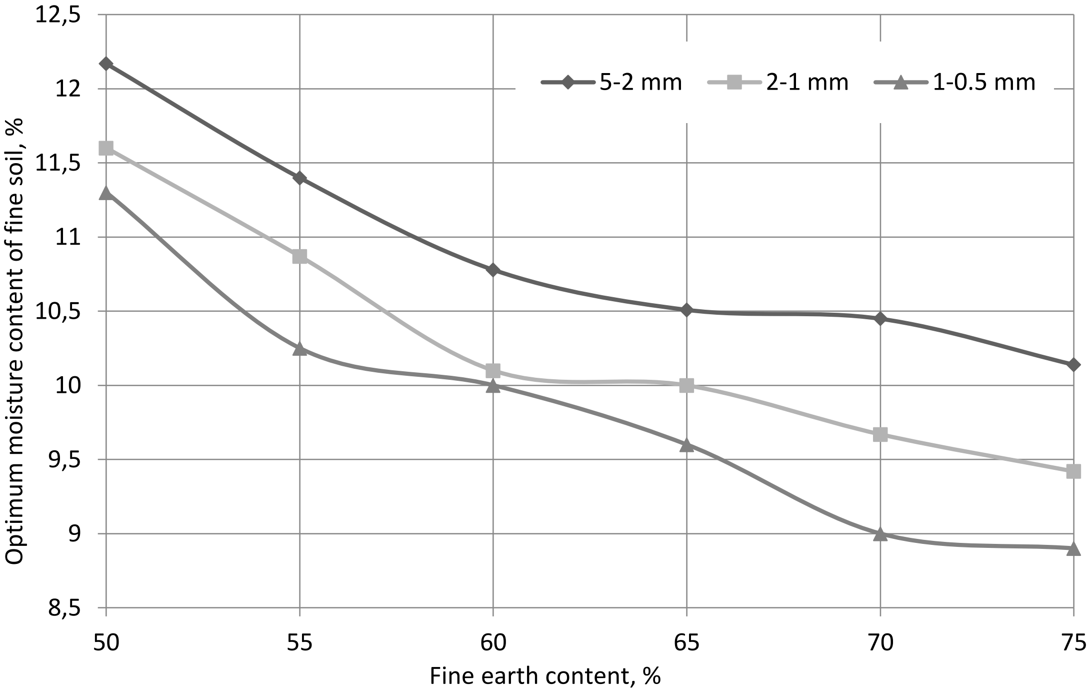


Figure 8 – Change in the optimum moisture content of fine earth as its content in the mixture increases due to an increase in the mass of fractions in m_{5-2}, m_{2-1} and $m_{1-0,5}$.

Introducing fractions into fine earth $m_{0.5-0.25}$ and $m_{0.25-0.1}$ gives dependencies $w_0 = f(m_f)$a complex shape, which is expressed in the presence of decreasing and increasing areas. So the optimum moisture content of fine soil w_0 as its content in the mixture increases, it increases to a certain value, and then decreases (Figure 9). At the same time, the lowest value of the optimal humidity w_0, equal to 9.61%, corresponds to fine earth, the content of which in the mixture is 60% (when adding the fraction $m_{0.5-0.25}$). When adding a fraction to the fine earth $m_{0.25-0.1}$ the lowest value of the optimum humidity w_0, equal to 9.86%, is also achieved with 60 percent fine earth in the mixture.

Addiction $w_0 = f(m_f)$ when adding a fraction to the fine earth $m_{<0.1}$ has an increasing character (Figure 9). An increase in the content of fine soil from 50 to 75% due to the introduction of this fraction leads to an increase in the optimal moisture content of fine soil w_0 by 2.47-6.93%.

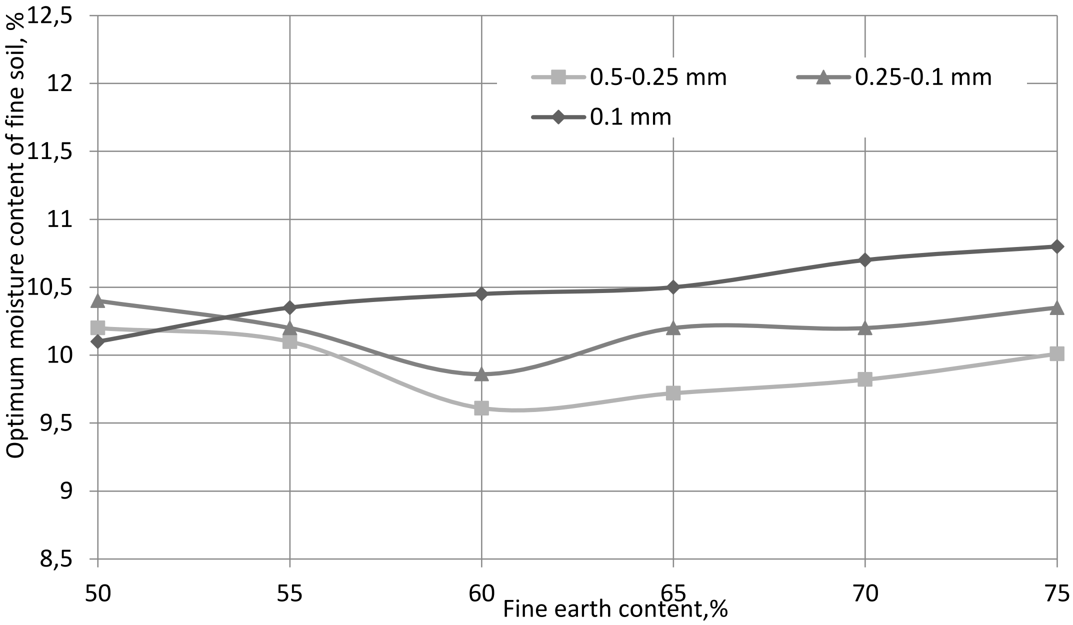


Figure 9 – Change in the optimum moisture content of fine earth, as its content in the mixture increases due to an increase in the masses of fractions in $m_{0,5-0,25}$, $m_{0,25-0,1}$ and $m_{<0,1}$

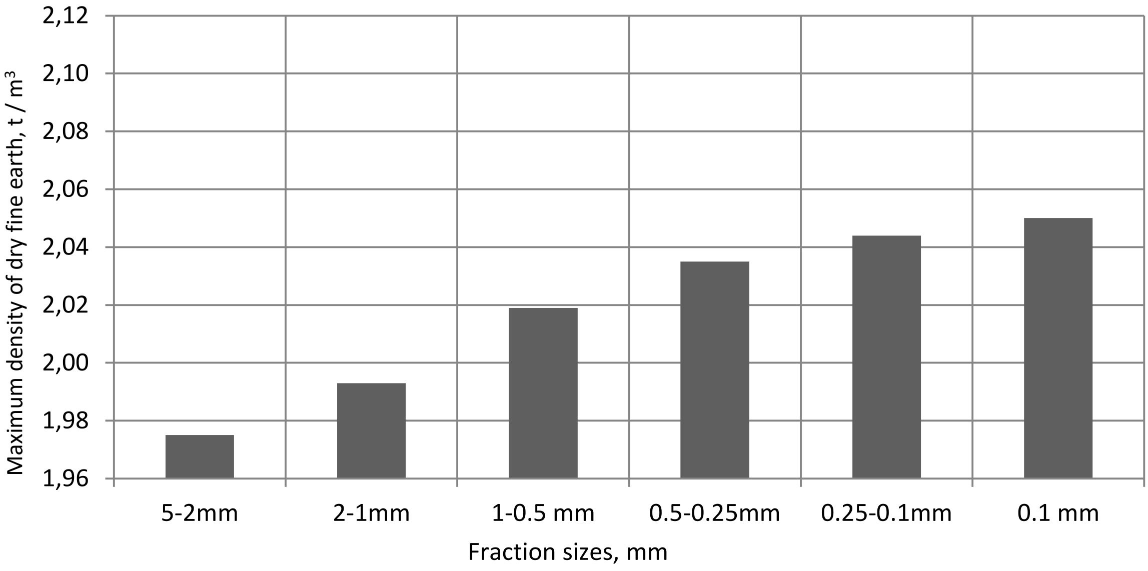
The stated research results indicate that in order to achieve the lowest values of the optimum moisture content of fine soil $w_0$it is advisable to increase its content in the mixture due to fractions m_{5-2}, m_{2-1} and $m_{1-0.5}$. Moreover, the finer the fraction and the greater its content, the lower the value of the optimum moisture content of fine soil w_0.

Analysis of the change in maximum density $\rho_{d,max}$ test samples of fine earth with the same content in the mixture allows us to distinguish the following regularities (Figures 10 and 11):

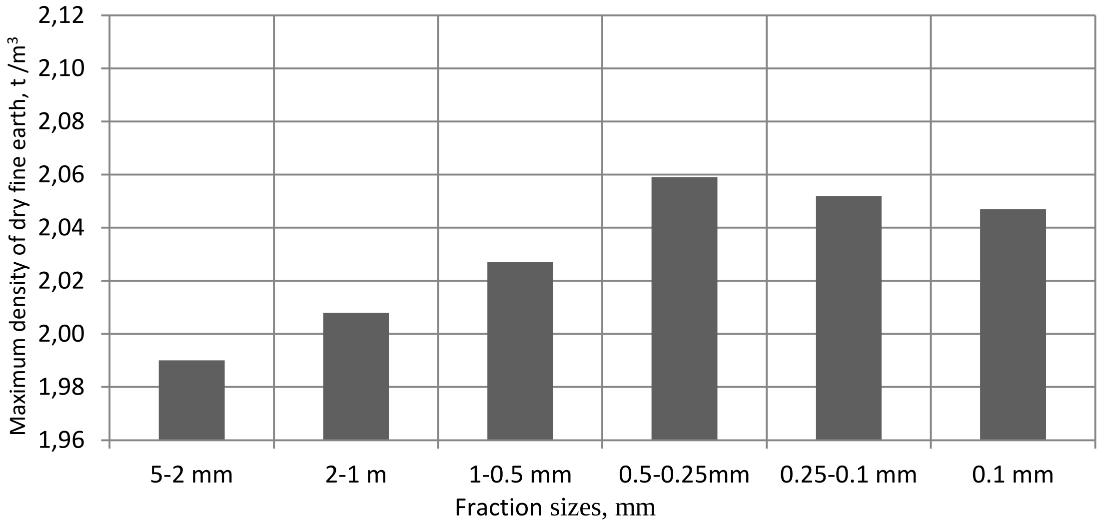
1) At 50% fine earth content in the mixture with a decrease in the size of fractions, the density $\rho_{d,max}$ increases. Unit density gain $\Delta_\rho = (\rho_{d,max,i+1} - \rho_{max,i})$ ($i, i+1$ -respectively, the previous and subsequent fractions) decreases from 0.02 to 0.006 t/m^3. Highest density value $\rho_{d,max}$ takes place for a sample of fine earth, 50% content (in the mixture) of which is ensured by introducing a fraction into $m_{<0.1}$.

2) At 55% fine earth content in the mixture, the density $\rho_{d,max}$ as the particle size decreases, the fractions increase to a certain value and then decrease. Highest density value $\rho_{d,max}$ typical for a sample of fine earth, 55% content (in the mixture) of which was achieved due to the introduction of a fraction into $m_{0.5-0.25}$. Unit density gain $\Delta_{r\rho}$ increases from 0.018 to 0.032 t/m^3, and a single decrease in density $\Delta_{s\rho} = (\rho_{d,max,i+1} - \rho_{max,i})$ decreases from 0.007 to 0.005 t/m^3.

3) At 60% fine earth content in the mixture, the general nature of the density change $\rho_{d,max}$ persists. Highest density value $\rho_{d,max}$ takes place for a sample of fine earth, 60% content (in the mixture) of which is also provided due to the introduction of a fraction into $m_{0.5-0.25}$. The difference is that a unit increase in density $\Delta_{r\rho}$ no longer increases, but decreases from 0.013 to 0.011 t/m^3. A single decrease in density $\Delta_{s\rho}$ grows in size from 0.007 to 0.015 t/m^3.



(a)



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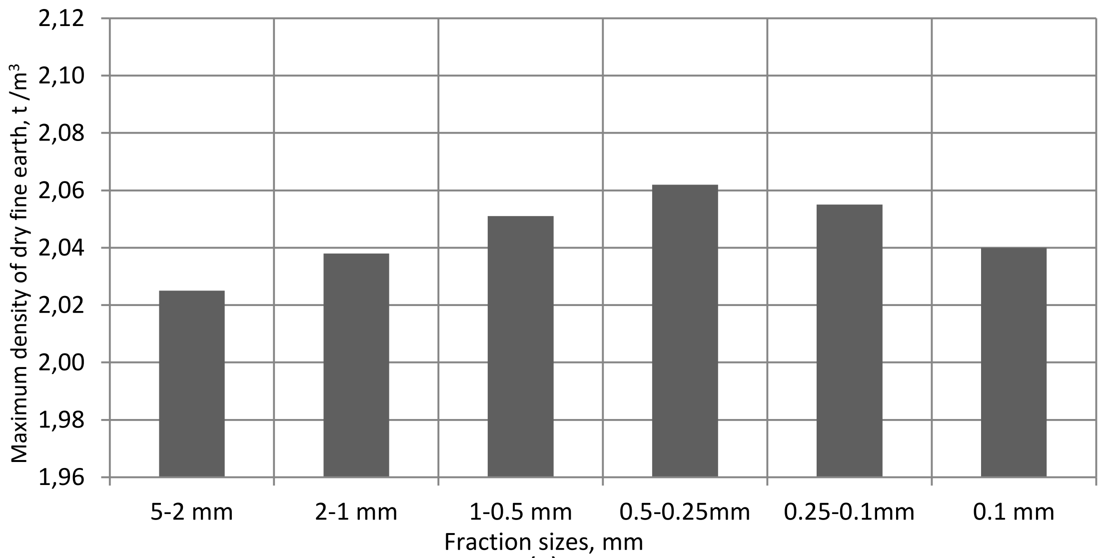


(c)

Figure 10 – Change in the maximum density of fine earth in a dry state with an increase in the size of fractions, at 50% (a), 55% (b) and 60% (c) the content of fine earth in the mixture.

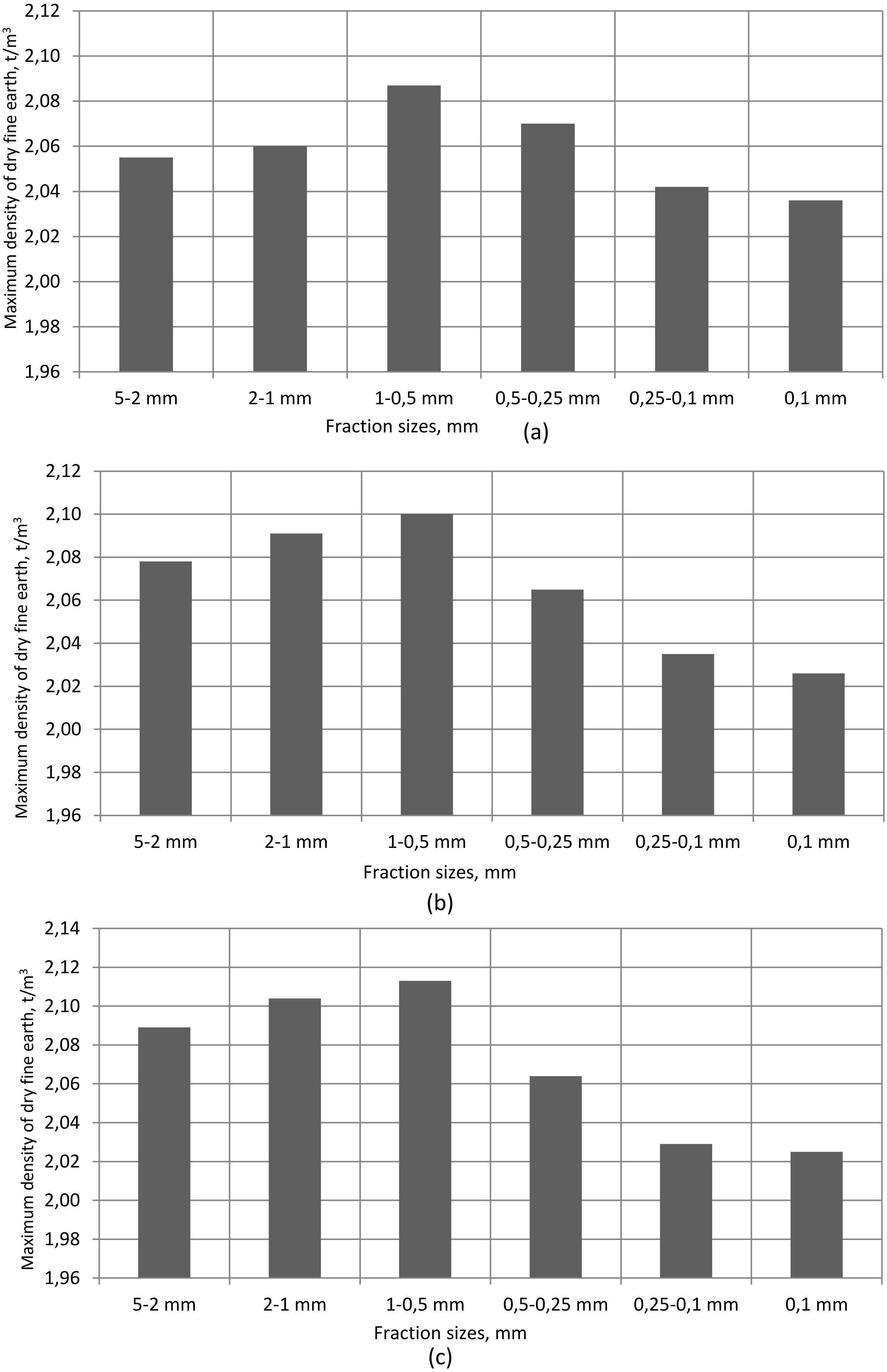


Figure 11 – Change in the maximum density of fine earth in a dry state with an increase in the size of fractions, at 65% (a), 70% (b) and 75% (c) the content of fine earth in the mixture.

4) At 65% fine earth content in the mixture, the nature of the density change $\rho_{d,max}$ remains the same. The difference is that the highest density value $\rho_{d,max}$ there is already a place for a sample, 65% of which (in the mixture) is provided by introducing a fraction into $m_{1-0.5}$. Unit density gain $\Delta_{r\rho}$ increases from 0.005 to 0.027 t/m^3. Single density reduction $\Delta_{s\rho}$, at the beginning, it increases from 0.017 to 0.028 t/m^3, and then decreases to 0.06 t/m^3.

5) At 70% fine earth content in the mixture, the highest value of its density $\rho_{d,max}$ is also achieved by introducing a fraction into $m_{1-0.5}$. The difference in the nature of the change in density $\rho_{d,max}$ is that the unit increase in density $\Delta_{r\rho}$ it does not increase, but decreases from 0.013 to 0.009 t/m^3. And, a single decrease in density $\Delta_{s\rho}$, does not increase, but decreases immediately from 0.035 to 0.009 t/m^3.

6) At 75% fine earth content in the mixture, the highest value of its density $\rho_{d,max}$ is also achieved by introducing a fraction into $m_{1-0.5}$. The nature of the change in density $\rho_{d,max}$ differs in that the unit density increase $\Delta_{r\rho}$ and a single decrease in density $\Delta_{s\rho}$ decrease, respectively, from 0.015 to 0.009 t/m^3 and from 0.049 to 0.004 t/m^3.

Analysis of the change in the optimal moisture content of the test samples of fine soil with its equal content in the mixture allows us to note the following regularities (Figures 12 and 13):

1) With a 50% content of fine earth in the mixture with a decrease in the size of particles introduced into it fractions, its optimal moisture content w_0 decreases to a certain value, and then increases, followed by a slight decrease. The highest value of the optimum moisture content w_0 takes place for a fine soil sample, 50% of which is ensured by introducing the fraction m_{5-2}, and the smallest due to the introduction of the fraction $m_{<0.1}$. The difference between these values of humidity w_0 is 2.07%.

2) At 55% fine earth content in the mixture, the nature of the change in its optimal moisture content w_0 takes on a stable form, regardless of the fine earth content in the mixture. The highest value of the optimum moisture content w_0 takes place for a sample of fine earth, 55% of which is also ensured due to the introduction of the fraction m_{5-2}, and the smallest, already due to the introduction of the fraction $m_{0.5-0.25}$. The difference between them is 1.3%, which is 1.59 times less than with 50% fine earth content.

3) At 60% fine earth content in the mixture, the difference is that the difference between its highest and lowest values of moisture w_0 becomes even less and is equal to 0.67%. In addition, the value of moisture w_0 of fine earth, when the fraction $m_{<0.1}$ is introduced into it, approaches the highest value of moisture w_0, which is characteristic of the sample with the introduction of the fraction m_{5-2}. The difference between them is 0.33%.

4) At 65% fine earth content in the mixture, the minimum moisture content w_0 occurs for the sample with the introduction of the fraction $m_{1-0.5}$. The difference between the highest and lowest values of humidity w_0 increases and is 0.91%. The highest value of the optimum moisture content w_0, which takes place for the sample with the introduction of the fraction m_{5-2}, differs from the value of the moisture content w_0 characteristic of the sample with the introduction of the fraction $m_{<0.1}$, by only 0.01%.

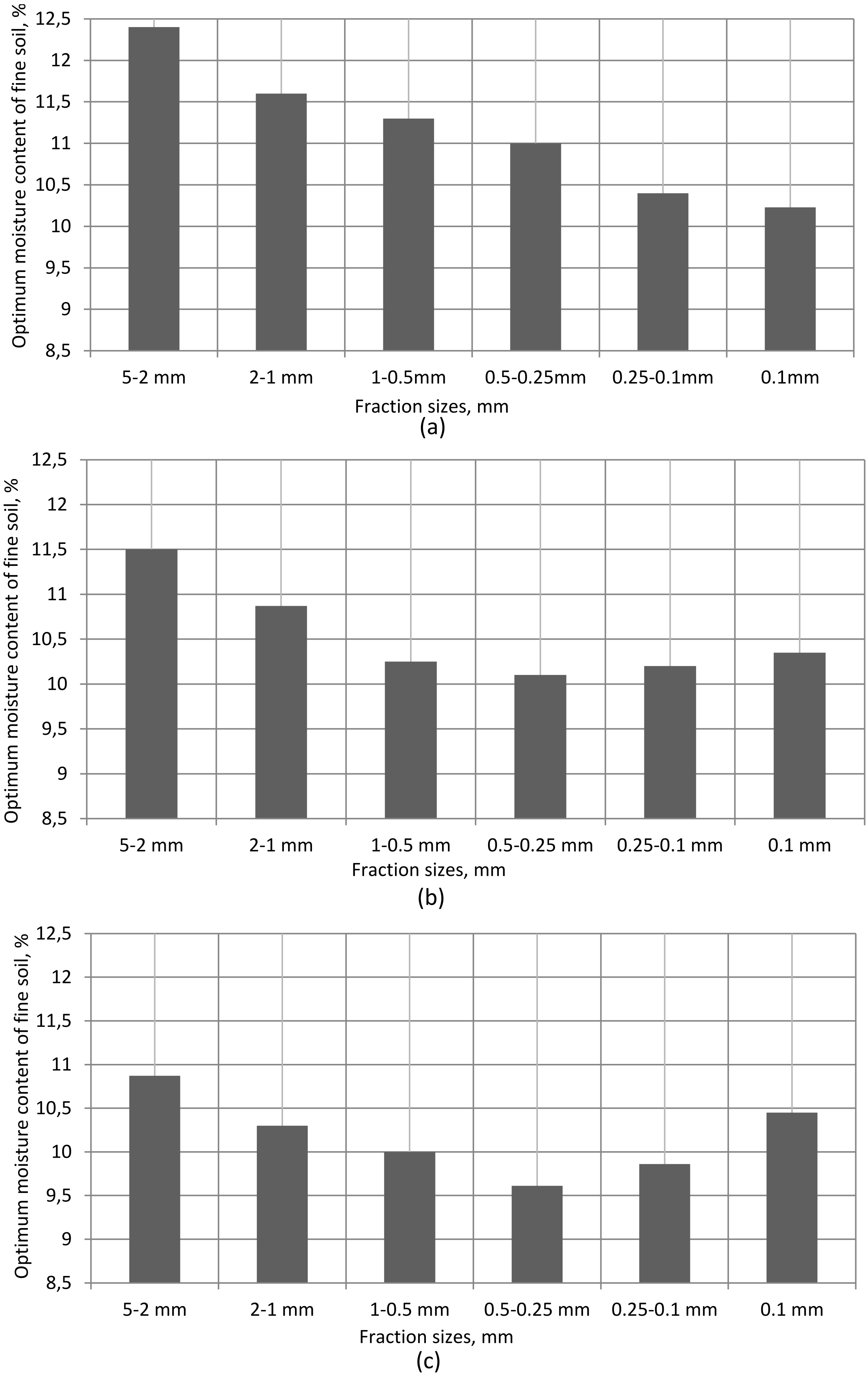
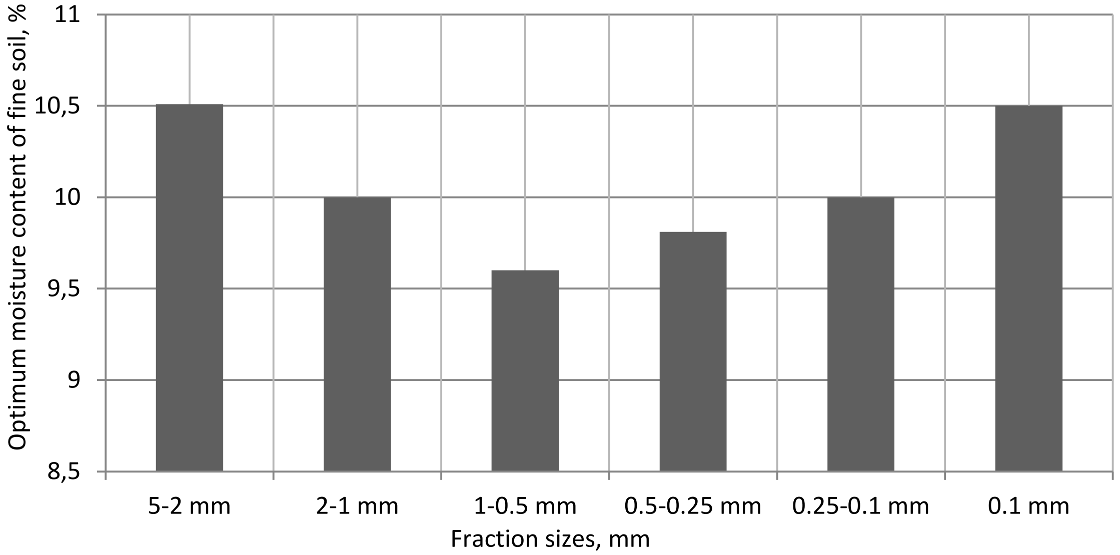
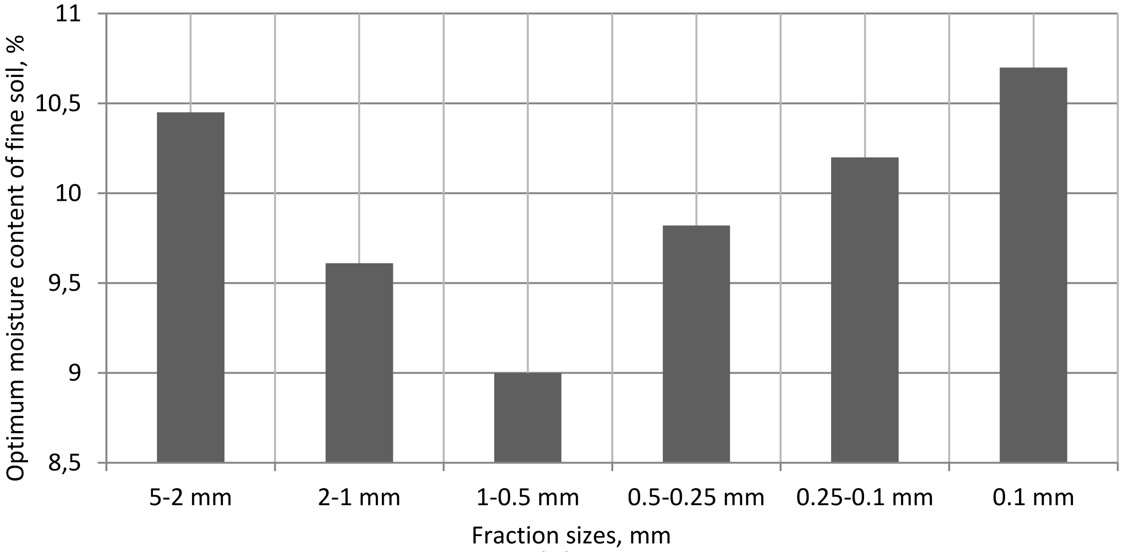


Figure 12 – Change in the optimal moisture content of fine earth with an increase in the size of fractions, at 50% (a), 55% (b) and 60% (c) the content of fine earth in the mixture.



(a)



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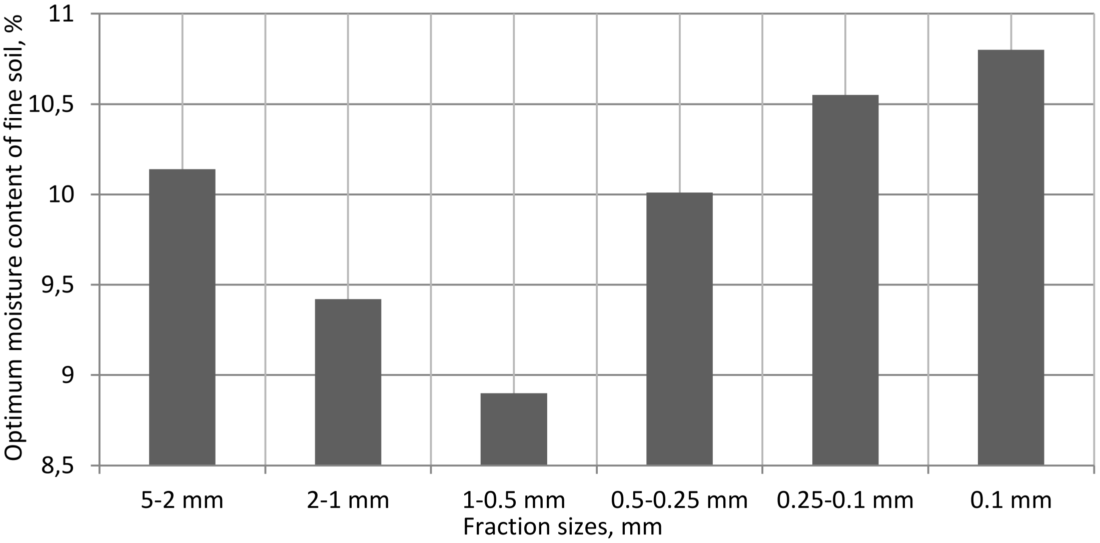

(c)

Figure 13 – Change in the optimal moisture content of fine earth with an increase in the size of fractions, at 65% (a), 70% (b) and 75% (c) the content of fine earth in the mixture.

5) At 70% fine earth content in the mixture, the highest value of moisture w_0 corresponds to the sample with the introduction of the fraction $m_{<0.1}$.

6) The difference between the highest and lowest values of humidity w_0 is already 1.7%. The moisture value w_0 of the fine soil sample with the introduction of the fraction $m_{<0.1}$ is 0.25% higher than the value of the moisture content w_0, which is characteristic of the sample with the introduction of the fraction m_{5-2}

7) At 75% fine earth content in the mixture, the highest value of moisture w_0 corresponds to the sample with the introduction of the fraction $m_{<0.1}$. The difference between the highest and lowest values of humidity w_0 increases and is 1.9%. The value of moisture w_0 of a fine soil sample with the introduction of the fraction $m_{<0.1}$ exceeds the value of the moisture content w_0, which is characteristic of the sample with the introduction of the fraction m_{5-2}, by 0.66%.

From the diagrams in Figures 10 and 11 it follows that the highest value of the density of fine earth $\rho_{d,max}$, equal to 2.05 t/m^3 can be achieved at 50% content of fine earth by introducing a fraction into $m_{<0.1}$. At 55% and 60% fine earth content, the highest density values $\rho_{d,max}$, equal to 2.059 and 2.062 t/m^3, respectively, are achieved by introducing the fraction $m_{0.5-0.25}$, and at 65-75% fine earth content, the highest density values $\rho_{d,max}$ equal to 2.087–2.113 t/m^3 — due to the introduction of the fraction $m_{1-0.5}$.

From the diagrams presented in Figures 12 and 13, it follows that the minimum values of humidity w_0, equal to 10.2-9.61% correspond to samples of fine soil, 50-60% of which in the mixture was achieved due to the introduction of the fraction $m_{0.5-0.25}$. Samples of fine earth, 65-75% content, in the mixture of which is provided by the introduction of the fraction $m_{1-0.5}$, corresponds to the minimum humidity values w_0, equal to 9.6-8.9%.

Thus, the highest density value $\rho_{d,max}$ and the lowest moisture value w_0 fine earth depends both on its content in the mixture and on the particle size of the fractions introduced into it. In general, the diagrams presented in Figures 10-13 show by increasing which fraction it is possible to achieve the highest density value and the lowest moisture value at the required fine earth content in the mixture. Therefore, the construction of such diagrams should be practiced to select the optimal composition of soil mixtures for the construction of bulk earth dams.

Conclusion

Dosed introduction of various fractions into the composition of fine earth affects its density-moisture state when exposed to shock loads. Moreover, the influence of this factor has a greater effect on the optimal moisture content than on the maximum density of fine earth. Based on the results of the justified introduction of certain fractions, it is possible to select the required values of the maximum density and optimal moisture content of the fine earth used in the composition of soil mixtures. An increase in the content of various fractions in fine earth leads to a significant decrease in the coefficient of heterogeneity of the soil mixture. By changing the amount of fine soil fractions, it is possible to significantly change the degree of heterogeneity of the soil mixture.

For a comprehensive (multi factorial) choice of the optimal composition of fine earth, it is important to conduct studies to assess the effect of dosed introduction of various fractions on the filtration capacity of compacted fine earth, as well as on its resistance to shear and compression under load.

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ТОПЫРАҚ ҚОСАСЫНЫҢ ҰСАҚ ТҮЙІРШІКТІ КОМПОНЕНТІНІҢ МАКСИМАЛДЫ ТЫҒЫЗДЫҒЫНА ЖӘНЕ ОҢТАЙЛЫ ЫЛҒАЛДЫҒЫНА ТҮРЛІ ФРАКЦИЯЛАРДЫҢ ӘСЕРІ

Андатпа. *Ұсақ түйіршікті топырақтың әртүрлі фракцияларының құрамы (салмақ бойынша) оның максималды тығыздығы мен оңтайлы ылғалдылығына әсерін эксперименталды бағалау бойынша зерттеулердің нәтижелері берілген. Қоспадағы қажетті мөлшерде ұсақ түйіршікті топырақтың белгілі бір фракцияны ұлғайта отырып ең жоғары тығыздығына және ең төменгі ылғалдылығына қол жеткізуге болатыны көрсетілген. Топырақ бөгеттерін тұрғызу кезінде топырақ қоспаларының оңтайлы құрамын таңдау үшін осындай зертханалық сынақтарды жүргізу ұсынылады.*

Түйін сөздер: *бөгет, топырақ қоспасй, ұсақ түйіршікті топырақ, бөлшектер, үлгі, масса, құрғақ күйдегі тығыздық, оңтайлы ылғылдық.*

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О ВЛИЯНИИ РАЗЛИЧНЫХ ФРАКЦИЙ НА МАКСИМАЛЬНУЮ ПЛОТНОСТЬ И ОПТИМАЛЬНУЮ ВЛАЖНОСТЬ МЕЛКОЗЕРНИСТОГО КОМПОНЕНТА ГРУНТОВОЙ СМЕСИ

Аннотация. *Представлены результаты исследований по экспериментальной оценке влияния содержания (по массе) различных фракций мелкозёма на его максимальную плотность и оптимальную влажность. Показано, что за счет увеличения определенной фракции можно добиться наибольшего значения плотности и наименьшего значения влажности мелкозёма при его требуемом количестве в смеси. Для подбора оптимального состава грунтовых смесей при возведении насыпных земляных плотин рекомендуется проводить аналогичные лабораторные испытания.*

Ключевые слова: *плотина, грунтовая смесь, мелкозём, частицы, образец, масса, плотность в сухом состоянии, оптимальная влажность.*