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THE IMPORTANCE OF INTRODUCING FOREIGN STANDARDS IN DETERMINING THE DEGREE OF COMPACTION OF THE SUBGRADE SOIL

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Abstract: This article analyzes the limitations of existing regulatory documents for coarse-grained soils when determining the degree of compaction of subgrade soils during road construction. It also highlights the problems that arise in determining the compaction coefficient due to the failure to apply the current GOST 22733-2016 standard to soils with grain sizes larger than 20 mm. Since technical specifications used in international projects contain clear requirements for the density of foundations, a method for adjusting the density of coarse-grained soils based on AASHTO T 224 and ASTM D 4718 standards was studied. Using these standards, correction formulas for the relationship between the site and laboratory densities were calculated using a practical example. The study's results confirm that the implementation of international standards for the density of coarse-grained soils improves the accuracy of compaction assessment. The relevance of improving quality control in road construction, equipping it with modern equipment, and integrating international standards is also substantiated.

Key words: subgrade soil, degree of compaction, large fractions, GOST 22733-2016, AASHTO T 224, ASTM D 4718, adjustment method, maximum dry density
technical specification, quality control

Determining whether construction and installation work at a road construction site complies with regulatory requirements is the responsibility of laboratory services. The quality of a road construction project depends on the degree of compaction. Therefore, if the compaction of the roadbed and road structure layers at the site is good, the road's quality and durability are improved.

To determine the degree of compaction, it is first necessary to determine the maximum compaction at optimal moisture content using a sample taken from the object. This test is conducted in accordance with the current regulatory document GOST 22733-2016 "Soils. Laboratory Method for Determining Maximum Density" (Determining Maximum Density in Laboratory Conditions).

If the soil does not contain fractions larger than 20 mm and has a homogeneous composition, determining the compaction coefficient presents no obstacles. However, problems arise in determining the compaction coefficient when fractions larger than 20 mm and varying amounts of these fractions. This is due to the fact that when determining the maximum density in laboratory conditions, according to clause 1 of the scope of GOST 22733-2016, it is not used for organic mineral and organic soils containing fractions larger than 20 mm. Therefore, according to the requirements of the current regulatory document, it is impossible to assess the

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degree of compaction of soils used for roadbeds and layers used for road structures containing fractions larger than 20 mm.

According to paragraph 7.36 of SHNK 3.06.03-08 "Highways," when rolling a 10-15-ton roller on crushed stone-sand or gravel-sand bases, the quality of compaction is determined by the absence of marks on the surface, the occurrence of rises before the valances, and the crushing of stone dropped under the base. However, this method determines the degree of compaction solely by visual inspection. This method cannot be used if a compaction degree indicator is required.

The current regulatory documents do not contain requirements for the compaction coefficient for road bases.

However, technical specifications are currently being developed for facilities built under international designs. These documents include a requirement for foundation compaction.

Technical specifications are an integral part of the tender documentation. They are developed for specific projects and serve as documents regulating the rules for performing work on site, as well as measurements, acceptance, and payment. Specification requirements are developed based on international experience in the construction, reconstruction, and repair of highways and other structures.

International road construction projects require foreign engineering consultants to determine the degree of compaction for the foundations specified in the project specifications.

Tests to determine the degree of compaction of layers containing large fractions can be conducted by implementing international standards. Let's consider the methods described in AASHTO T 224-01 and ASTM D 4718.

AASHTO (American Association of State Highway and Transportation Officers) - American Association of State Highway and Transportation Officers.

ASTM (American Society for Testing and Materials) is an American international organization that develops and publishes voluntary standards for materials, products, systems, and services. It was founded in 1898 in the United States and previously focused on railroad standards. ASTM maintains approximately 12,000 standards, which consist of 77 volumes. Membership in the organization is open to anyone interested in this work. Its members include more than 32,000 representatives of manufacturers, users, consumers, governments, and academia from over 100 countries. Standards are reviewed and reissued at least every five years. More than 5,000 ASTM standards are adopted as national standards outside the United States, and more than 60 countries use ASTM standards as the basis for their regulatory frameworks.

Standard Test Method for Adjusting for Coarse Fractions in Soil Compaction Test. According to the standards of AASHTO T 224 and ASTM 4718.

This method describes how to adjust the density of soil and soil aggregates to compensate for the varying percentages of coarse fractions retained on 4.75 mm or 19.0 mm sieves. When conducting an experiment to control this compaction, the wet density should be adjusted to the dry density using laboratory density. Comparisons are determined based on the density in the sample and the maximum dry density.

1.1. There are two methods for correction. In the method described in Section 4.1, the density determined in the laboratory is corrected to match the density of the sample. In the

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method described in Section 4.2, the wet density of the sample is adjusted to the dry density of the fine particles, adjusting for the density determined in the laboratory.

1.2. This crushing method is used for soil materials where the 4.75 mm sieve residue according to Section A or B of T99 or T180 is 40% or less, or where the 19.0 mm sieve residue according to Section C or D is 30% or less. The residual amount on the sieves is considered coarse fractions.

1.3. As stated in the section, this method is used for soils containing a large amount of coarse particles. However, for soils with a low coarse particle content, this method may be of little practical value. If the minimum coarse particle content is not determined, it can be assumed to be less than 5%.

1.4. All limits set in this standard are calculated with an accuracy of 10 kg/m3 (0.01 g/cm3).

1.5. The values stated in SI units are taken as the standard.

4.2. Method of adjusting the density of an object to the maximum density in the laboratory.

4.2.1. The wet density of the sample is corrected for the dry density of the various percentages of coarse fractions retained on 4.75 mm or 19.0 mm sieves. This corrected dry density is compared with the maximum density determined using T99 or T180.

4.2.2. Determine the moisture content of the fine and coarse fractions of the sample. Moisture content can be determined using T265, T217, or T255. The moisture content of the coarse fractions can be equal to 2 % in most cases. If drying is possible in a drying unit, T265 can be calculated in the laboratory using the specified calculations.

According to paragraph 4.2.5, the density of fine fractions in a sample in a dry state is determined by the following method:

$$D_f = D_d G_M G_W P_f / (100\, G_M G_W - D_d P_c)$$

Here:

D_f = dry density of adjusted fine fractions;
D_d = total density of dry sample;
P_f = percentage of fine fractions by weight;
P_c = percentage of large fractions by weight;
G_M = average density of large fractions;
G_W = density of water.

Let's look at an example of a test performed on an object :

Table 1

No		
1.	Weight of sandblasting machine before testing	15260 g
2.	Soil mass from the hole	8885 g
3.	Weight of sandblasting machine after testing	8070 g
4.	The mass of large grains of soil from the hole	2455 g
5.	The density of the sand fill used in the test	1.33 g/cm ^{3}
6.	Volume of the hardware funnel	1382 cm ^{3}
7.	Volume of the hole	4024 cm ^{3}
8.	Wet soil density	2.21 g/cm ^{3}
9.	Moisture content of fine soil fractions	11.9%

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10.	Moisture content of large soil fractions	2.2 %
11.	wet mass of fine fractions	6430 g
12.	dry mass of fine fractions	5746 g
13.	dry mass of large fractions	2402 g
14.	Total dry mass of soil	8148 g
15.	total density of dry sample	$D_d = 1.97$ g/cm ^{3}
16.	percentage of fine fractions by weight	$P_f = 70.5\%$
17.	percentage of large fractions by weight	$P_c = 29.5\%$
18.	average density of large fractions.	$G_m = 2.63$ g/cm ^{3}
19.	density of water	$G_w = 1.0$ g/cm ^{3}

$$D_f = D_d G_M G_W P_f / (100\, G_M G_W - D_d P_c)$$

$D_f = (1.97x2.63x1x70.5) / ((100x2.63x1) - (1.97x29.5)) = 1.79$ g/cm ^{3}

If we determine the degree of compaction by the maximum density $P_{dmax} = 1.81$ g/cm ^{3}, found in the laboratory:

Df/ Pdmax=1.79/1.81=0.99

To test this method, we will check the correction of the density found in the laboratory to the density in the object according to paragraph 8.4 of GOST 22733-2002:

$P'_{dmax} = (P_{dmax} G_M) / (G_M - 0.01\, P_c (G_M - P_{dmax}))$

$P'_{dmax} = (1.81x2.63) / (2.63-0.01x\ 29.5x\ (2.63-1.81)) = 1.99$ g/cm ^{3}

If we determine the degree of compaction by the corrected value $P'_{dmax} = 1.99$ g/cm ^{3} of the maximum density found in the laboratory:

Dd/ Pdmax=1.97/1.99=0.99

From this it is clear that the standard method for adjusting large fractions in testing to determine the degree of soil compaction should be carried out according to the standards of AASHTO T 224 and ASTM 4718.

Conclusion

A great deal of work is currently being done in our country in the field of road construction. The quality and durability of roads under construction depend on quality control. Most current regulatory documents remain unchanged since the former Soviet Union. These regulatory documents contain various inaccuracies regarding testing. To ensure accurate test results, it is advisable to adopt and implement equivalents of foreign and international standards with requirements no lower than current regulatory requirements. At the same time, special attention should be paid to equipping laboratories with modern testing equipment and its practical application.

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