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ACTUALIZATION AND APPLICATION OF RENEWABLE GOST «SOIL. CLASSIFICATION» BY THE EXAMPLE OF GEOLOGICAL CONDITIONS IN PHNOM PENH (CAMBODIA)

Statement of the problem. In the end of 2010, the project of National standard of Russian Federation «Soils. Classification» was developed in the framework of activity of National Union of Researchers in Normative and Methodical Activity and Document Unification. The project is based on State Standard (GOST) 25100-95. Renovation of the standard is caused by the necessity of harmonization of the documents with international standards, especially with Eurocodes.
Results and conclusions. Principal problems related to the use of classification of soils by Russian GOST are considered compared to classifications adopted in foreign standards (American standard ASTM D 2487 and international standard ISO 14688). The comparison of soil classifications adopted in Russia and in Cambodia is undertaken by the results of processing of field data on mean values of structure parameters of the main sand types in Phnom Penh. The recommendations on mutual interference between principal international standards of classifications of sand and clayey soils.

Keywords: classifications of soils, problem of harmonization, ISO 14688, ASTM D 2487, GOST 25100, cumulative curve, textured triangle.

Introduction

Engineers are now facing a number of scientific, engineering and technical problems associated with the development of underground spaces of big cities. Underground spaces are becoming increasingly important for the construction of large amenity accommodation, multistorey underground parking spaces, shopping businesses, subsurface spaces of high-rises and therefore engineering drainage as well as underground mains are becoming deeper. Hence deeper subgrades are now an emerging topic of study and research. There is a need to revisit the classification set forth by overseas colleagues.

The Regional Development Ministry of the Russian Federation was handed the task of making the national standards and guidelines more relevant in 2010 so that all the documents introduced are in accordance with the international guidelines on construction and innovations and more importantly, with the Eurocode. National unions of engineers, designers and developers were involved in the initiative.

The Section of Engineering Geology was created in the Department of Engineering Geology of Soils and Subgrades in the districts of subsidence as part of the commitment of the National Developers Union to carry out some methodological work and unification. With the participation of the faculty of the Department a new national project of the Russian Federation “Subgrades. Classification: was developed in the late 2010 which was largely based on the GOST (ГОСТ) 25100-95 issued 15 years ago.

Particular attention should be given to the efforts to make the GOST in compliance with the international standards which was a complex challenge which involved addressing the issues of the development and construction of buildings and structures. The standards ISO 14688-1:2004 and ISO 14688-2:2004 which are referenced in the guidelines as EN 7, Chapter 2, and they were examined.

Thus, the standards for cliff soils in the international standards are identical to those applied in the current GOST and therefore there is no need to make it in accordance. There is no classification of frozen soils in the EN standards.

1. Reasoning behind the relevance of practical uses of the revisited guidelines

For disperse groups the principles of the classification as set out in the GOST 25100-95 are identical. They involve grouping soils according to their granulometric content for non-cohesive soils and plasticity and granulometric content for cohesive soils. Although there are large differences in the terminology used and numerical values of the criteria applied to group soils as well as in the method of defining new classification characteristics of soils that are in fact the following:

1. A particle of a different size (with a different set of standard sieves) is identified in the granular metric analysis of non-cohesive soils in the current GOST 25100-95, ISO 14688-1:2004 standard and ASTM D 2487-85 standard;

2. For cohesive soils a cone is used to establish the humidity in the fluidity interface in the domestic practices. In ISO/TS 17892 standard this is also a cone but with other parameters and submergence level and in ASTM D 4318-95 standard these are tools and methods by A. Casagrande. There are also some differences in the size of the analyzed fractions. If this is the case, the obtained numerical results are different;

3. A low plasticity index is determined using the identical method with some differences in the size of the analyzed fraction. This does not have a great effect on the results of the analysis and therefore the results of determining a low plasticity index can be considered identical.

4. Based on the above it can be concluded that there is no direct accordance of the names of disperse soils as defined in the guidelines which makes it necessary to develop a system of recalculation which would allow us to correlate the names of soils defined in different classifications.

2. Comparison of the used classification of soils in Cambodia and Russia

It is necessary that in practical tasks of geotechnical engineering accurate classification names of soils based on their characteristics and state are used. In the Russian standard GOST 25100-95 there are the following classification names: type — group — subgroup — type — kind — form. In groups and subgroups genetic properties of soils are identified which is not much relevant in the mechanics of soils. The most common sand and clayey soils are identified according to different properties (Table 1).

The American ASTM standard adopted in Cambodia to classify soils uses a texture triangle using which and knowing the relative proportions of the three soil components (sand, clay and organic materials) it is quite easy to define its name in the classification (Fig. 1).

The base of the triangle (sands), left and right faces (clays and organic materials respectively) are divided into scales 0…100 %. Relative proportions of each of the components in the direction of three arrows of the diagram define the area of the triangle and thereby the name of a soil.

Table 1

Classification Properties of Sand and Clayey Soils

Soil	Type	Kind	Form
Sand	According to the granular metric content	According to density	According to humidity S_R
Clayey	According to a plasticity index	According to supplements used	According to fluidity I_L

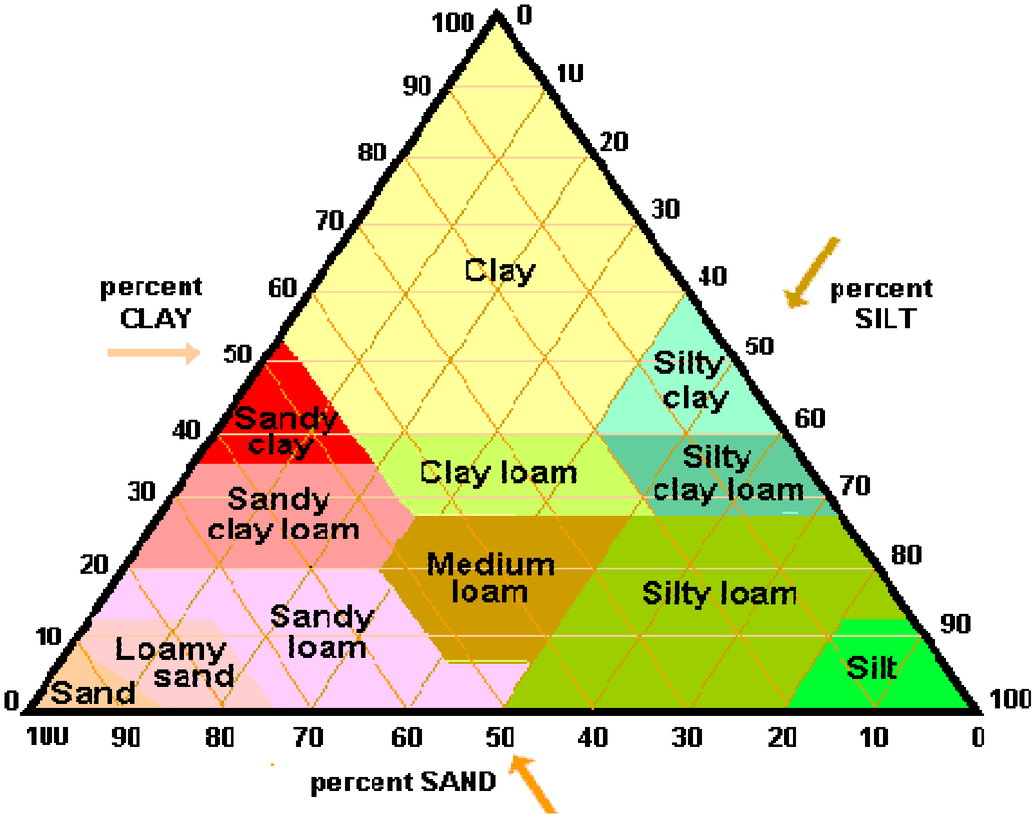

Fig. 1. Texture triangle

The name of sand soils in the ISO 14688 and ASTM D 2487 standards are defined according to their granular metric content, fraction and curvature which are defined using the parameters *d*60, *d*30 and *d*10 and cumulative particle-size distribution curve (Fig. 2).

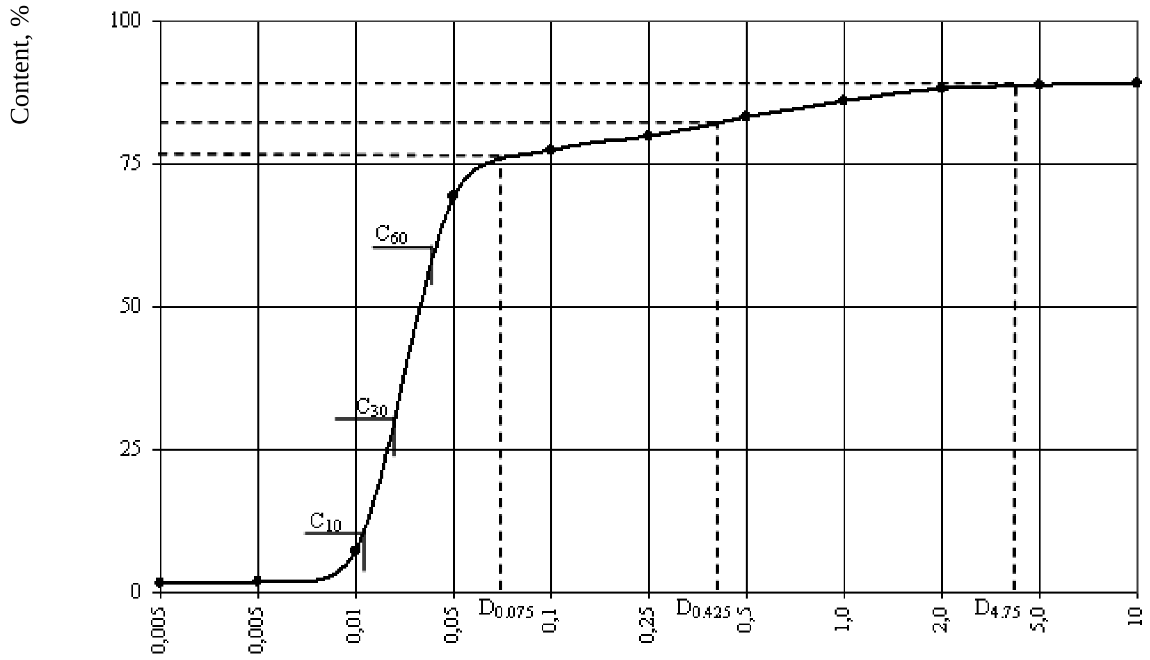

Fig. 2. Cumulative particle-size distribution curve of sand soils

Mutual correspondence of different size fractions of soils in GOST 25100, ISO 14688 and ASTM D 2487 standards [4.5,6.7] are shown in Fig. 3.

SANDS																
Particle size, mm	4,75	2	0,63	0,5	0,425	0,25	0,2	0,1	0,075	0,063	0,05	0,02	0,063	0,005	0,002	
ГОСТ		Sand										Silt			Clay	
		Coa-rse	Large		Medium		Fine		Silty							
ASTM	Sand									Silt						Clay
	Coarse		Medium			Fine										
ISO			Sand								Silt					Clay
			Coarse	Medium				Fine			Coarse		Medium	Fine		

Fig. 3. Mutual correspondence of fractions according to different standards

Bulk density of sands can be determined using dynamic testing (Table 2).

Fine dispersed soils are classified based on the plasticity of soils. The values of a low plasticity index *WP* and *PL* are accepted to be identical.

The results of calculating fluidity index are calculated again using the method by Vasiliev (W_L according to GOST 25100) and Casagrande (*LL* according to ASTM D 2487) by means of correlation equation using the following [3]:

$$LL = 1,48 \times W_L - 8,3;$$

$$W_L = (LL + 8,3) / 1,48.$$

After W_L and *LL* are calculated again, and so are *PI*, *IP*, *IL*, *IC* the methods of the relevant standard are used for the classification.

Table 2

Assessment of the bulk density of large and medium sands using the value *e* and the results of dynamic testing [1, 2]

Type of sand	Porosity coefficient *e*			
	Coarse, large and medium sands	Fine sands	Silty sands	Number of load penetrations *N*
Dense	<0.55	<0.60	<0.60	>30
Medium	From 0.55 to 0.70 inclusive	From 0.60 to 0.75 inclusively	From 0.60 to 0.80 inclusively	9…29
Coarse	>0.70	>0.75	>0.80	1…9

Using the above results in processing the field data of engineering and geological surveys in the construction site in Pnom-Pen (Cambodia) the graph (Fig. 4) and comparative results (Tables 3—4) below are obtained.

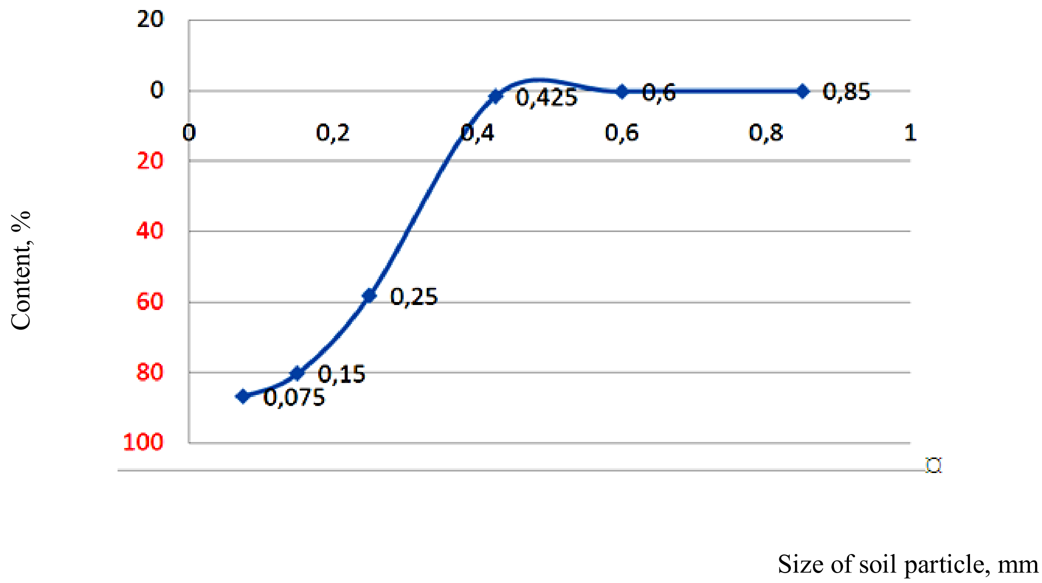

Fig. 4. Graphs of the sizes of rheological soils

Table 3

Average structure parameters of major sands of the site

Depth, m	ASTM sands	GOST 25100-95	Diameter of particles, mm	Porosity coefficient *e* and characteristics of the bulk of sands	SPT (Standard Penetration Test) Number of penetrations *N*
4-6	Loose fine sand	Silty	0.075	0.81, coarse	8-10, coarse
8-9	Loose fine sand	Silty	0.075	0.80, coarse	8-10, coarse
10	Medium dense medium sand	Medium	0.158	0.72, medium	18, medium
11	Dense medium sand	Medium	0.3	0.56, very dense	48, very dense

End of Table 3

Depth, m	ASTM sands	GOST 25100-95	Diameter of particles, mm	Porosity coefficient *e* and characteristics of the bulk of sands	SPT (Standard Penetration Test) Number of penetrations *N*
12-15	Medium dense medium sand	Medium	0.475	0.57, medium	26-33, medium
16-19	Very dense medium sand	Medium	0.475	0.53, very dense	>50, very dense

Note: heterogeneity coefficient >6, very heterogeneous.

Table 4

Comparative classification of soils according to ASTM and GOST 25100-95 standards

ASTM D 2487						GOST 25100-95
Name of a soil	Class of soils	Plasticity index *PI*, %	Fluidity index *PL*, %	Water saturation coefficient *Sr*	Porosity coefficient	Name of a soil
Soft lean CLAYEY	CL	16.69	0.20	—	0.81	Hard silty semi-solid loam
Soft silty CLAYEY	CL-ML	6.45	>1	—	0.80	Silty fluid loam
Loose fine SAND	SM	—	—	0.96	0.81	Silty coarse water-saturated loam

End of Table 4

ASTM D 2487						GOST 25100-95
Name of a soil	Class of soils	Plasticity index *PI*, %	Fluidity index *PL*, %	Water saturation coefficient *Sr*	Porosity coefficient	Name of a soil
Very soft silty CLAYEY	CL-ML	6.76	>1	—	—	Silty fluid clay loam
Loose fine SAND	SM	—	—	0.88	0.80	Silty coarse water-saturated sand
Medium dense medium SAND	SM	—	—	0.90	0.72	Medium water-saturated sand
Dense medium SAND	SM	—	—	0.74	0.56	Medium dense water-saturated sand
Medium dense medium SAND	SM	—	—	0.77	0.57	Medium dense water-saturated sand
Very dense medium SAND	SM	—	—	0.88	0.53	Medium water-saturated sand

Conclusions

As a result of the performed comparative analysis that sought to bring together the Russian and overseas classifications and to make a transition from one classification to the other in the GOST 25100-95, the following can be concluded.

1. For disperse non-cohesive soils (coarse aggregates and sands) it is necessary to design cumulative particle-size distribution curve which can make it necessary to make a transition to diameters of any particles, determine its proportion and its name in any international classification;
2. For disperse cohesive soils a focus should be on a close correlation of fluidity interfaces as wet out in the GOST 5180-84 and ISO 14688 and ASTM D 2487 standards. The project of the GOST 25100-95 in question presents the correlation equation to make a transition from one classification to another using fluidity interfaces and plasticity index.

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