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вечномерзлые грунты; - применить теплоизоляцию земляного полотна на пучинистых участках железнодорожных путей и автодорог; - провести противопучинную мелиорацию грунтов (засоление различными растворами солей); -обеспечить устройство насыпи из непучинистого грунта и устройство фундамента уже на ней; -произвести частичную или полную замену пучинистого слоя на непучинистый, путём создания подушек из крупного или среднего песка с высоким коэффициентом фильтрации; -понизить влажность грунта (путём использования геотекстиля для снижения капиллярного подсоса, устройства дренажа, глиняных замков и отмосток, понижение уровня подземных вод, отвод поверхностных вод от здания посредством устройства вертикальной планировки, водосборных канав, лотков, траншей, дренажных прослоев и т.п.).

Таким образом, в виду широкого распространения на территории России грунтов, подверженных сезонному промерзанию, необходимость определения степени пучинистости таких грунтов в составе инженерно-геологических изысканий очевидна. Лабораторный метод определения относительной деформации пучения представляет собой экспресс-метод получения достоверной информации о степени пучинистости, его применения на месторождении выявило присутствие всех категорий пучинистости грунтов (от непучинистых до чрезмернопучинистых). Но, для приблизительной оценки степени пучинистости достаточно проанализировать физические характеристики грунта, чтобы предсказать его поведение при сезонном промерзании-оттаивании, в связи с чем выявленные нами взаимосвязи весьма актуальны.

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RESEARCH ON CORRELATION BETWEEN COMPRESSION INDEX (Cc) WITH OTHER PROPERTIES OF SOIL FOR GEOTECHNICAL DESIGN IN SIHANOUKVILLE CITY

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International scientists have proposed many correlations between physical and mechanical properties of soil for geotechnical design. But, only some of them are suitable for construction area in Sihanoukville city of Cambodia. This research will find out and propose some suitable correlations between some physical and mechanical properties of very soft greenish grey sandy lean Clay in this area. This weak soil layer has wide distribution and great thickness and greatly affects stability and settlement of construction works, but methods of taking sample, sample transportation, quality of laboratory testing equipment, laboratory staff experience and in-situ tests performed in the layer do not often meet the technical requirements for geotechnical design in Sihanoukville city.

Compression index (Cc) is mentioned in a lot of construction standards in many countries in the world. It takes an important role in settlement prediction for engineering foundation. So, the evaluation and determination of correlation between C_c and other properties of soil have extremely important meaning in geotechnical design.

Sihanoukville city locates in the south of Cambodia with area about 868 km^2 and had a population of around 89,800 people and approximately 66,700 in its urban center in 2008. It is about 230 kilometers southwest of the Phnom Penh - Cambodian capital, in a small Peninsula on the Gulf of Thailand. The city has a tropical climate - warm and humid. The economy of Sihanoukville is based primarily in its port for imports and exports to the national economy.

The geological formation of research area is generally constitutes of soft and loose detritus material deposited during recent geological time through natural transportation. In there, layer 1a is very soft greenish grey sandy lean Clay with shell fragments/organic matter. Table 1 shows some main physic-mechanical parameters of 1a soil layer.

Table 1

Main physico-mechanical parameters of 1a soil layer

No.	Parameter	Unit	Symbol	Average value
1	Natural moisture content	%	W	38.5
2	Void ratio	-	e_o	1.17
3	Liquid limit	%	W_L	34.5

No.	Parameter	Unit	Symbol	Average value
4	Plastic limit	%	W_P	24.9
5	Plasticity index	%	I_P	9.6
6	Unconfined compressive strength	kG/cm^2	q_u	0.252
7	Compression index	-	$C_{c(1-2)}$	0.251
8	The number of the tested samples	Nos.	n	30

There are so many formulas in the world that used for forecasting the compression index from void ratio (e_0), moisture content (W), liquid limit (LL) or plastic index (PI). Table 2 includes some formulas used for forecasting the compression index from initial parameter.

Table 2

Some correlation between C_c and other properties of soil

Formula	Proposed by
$C_c = 0.007(LL - 7.0\%)$	Skempton (1944)
$C_c = 1.15(e_0 - 0.35)$	Nishida (1956)
$C_c = 0.29(e_0 - 0.27)$	Hough (1957)
$C_c = 0.009(LL - 10.0\%)$	Terzaghi and Peck (1967)
$C_c = 0.006(LL - 9.0\%)$	Azzouz et al. (1976)
$C_c = 0.037(e_0 - 0.003LL - 0.34)$	Azzouz et al. (1976)
$C_c = 0.01(W - 7.549\%)$	Herrero (1983)
$C_c = 0.009(LL - 8.0\%)$	Tsuchida (1991)
$C_c = 0.014(PI + 3.6\%)$	Sridharan and Nagaraj (2000)

Based on data received from the geotechnical investigation results in Sihanoukville city carried out in 2016, correlation between C_c and other properties of weak soil layer in here is analysis.

Some formulas in table 2 and a formula proposed by authors [$C_c = 0.35(C_c - 0.23)$] are used for analysis. The values of C_c determined by these formulas are compared with C_c received from laboratory testing results. The C_c received from laboratory testing results is considered as standard values for analysis.

Analysis results are shown in tables and figures below:

Table 3

Determination of C_c at Sihanoukvillecity of Cambodia

Sandy lean Clay	PI (%)	e_0	LL (%)	(g/cm^3)	Sridharan and Nagaraj	Hough	Tsuchida	Skempton	Terzaghi and Peck	Proposed by Authors	Lab.
Average value	13.8	1.58	41.1	1.64	0.24	0.38	0.30	0.24	0.28	**0.47**	**0.47**

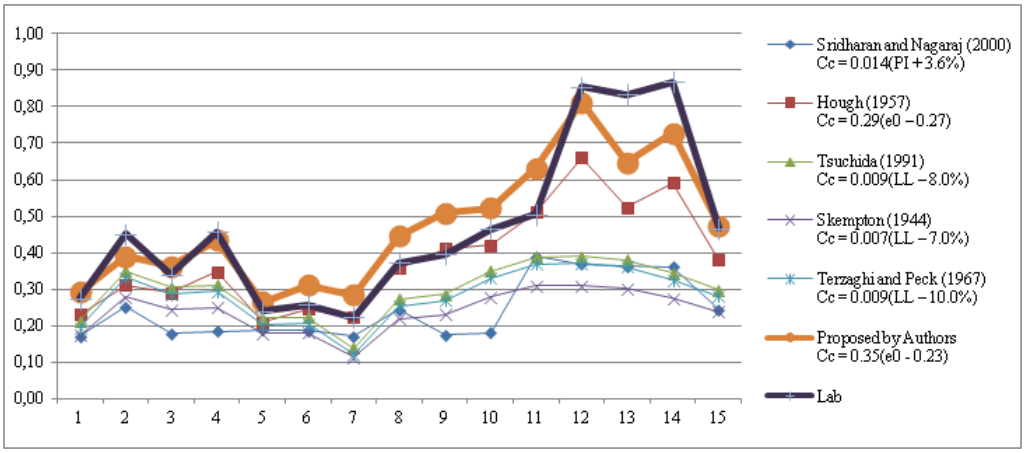

Fig. 1. Correlation between Cc & other properties of soil at Sihanoukville city

The research results show that the value of e_0 received from Hough's formula is close to e_0 received from laboratory testing results; and e_0 received from formula proposed by the authors is not deferent from e_0 received from laboratory testing results.

Conclusion and recommendation:

In Sihanoukville city area, there is a thick, very soft marine greenish grey sandy lean Clay layer which creates dangerous engineering-geological processes, including land subsidence and deformation of buildings and other structures.

Compression index (e_0) takes an important role in settlement prediction for engineering foundation. Value of e_0 depends heavily on methods of taking sample, sample transportation, quality of laboratory testing equipment, laboratory staff experience. These works are not well controlled in developing countries such as Cambodia.

The research focuses on correlations between C_c and other properties of the layer. Research results show that the correlation between e_0 and Void Ratios (R_{eo} is the tightest. The formula proposed by Hough (1957) is suitable correlation between e_0 and e_o of the layer in research area.

Based on Hough's formula, the authors propose a new formula [$C_c = 0.35(e_0-0.23)$]. The research results show that this formula is the most suitable one for the correlation between Cc and e_0 of the layer in research area.

We recommend to use the correlation $C_c = 0.35(e_0-0.23)$ for the clay layer in Sihanoukville city.

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