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Geosynthetics impact recognition on soil bearing capacity in the Geotechnical Laboratory Testing Field

K. POSPISIL & P. ZEDNIK
CDV – Transport Research Centre, Lisenska 33a, 636 00 Brno, Czech Republic

ABSTRACT: Geosynthetics exploitation for sub-base reinforcement on soft subgrade is used very often. Functionality principles are not still quite clear. Reinforcing asset (not separation or filtration role) is clarified for unpaved roads and in relation to given types of geosynthetics only. This paper is contribution to understanding of reinforcing relevance in dependence on thickness of sub-base layer. Experiments have been done in the new built Geotechnical Laboratory Testing Field

1 INTRODUCTION

Functionality and ways of geosynthetics using are familiar, e.g. review McGown (2000). Computing methods are being improved continuously but they cannot be generalized usually. Enquiry of sub-base reinforcement is still a frequently discussed task, e.g. Vanggaard (1999), Bloise & Ucciardo (2000), Schad (2001). In the face of described fact it is opened to use for studying of reinforcing element impact in-situ tests. In-situ tests are hard-executable in general therefore tests on experimental sections or testing field are preferred. There is a condition for this kind of experiments, which is full-scale testing.

The problem of reinforcing functionality has not been answered satisfactorily mainly regarding to parameters of reinforcing element and conditions of using. Empirical approach is one of a possible way to explain the problem, e.g. Saathof & Horstmann (1999).

The Geotechnical Laboratory Testing Field was built recently in a laboratory complex of Transport Research Centre (CDV), where experiments concerning to verification of geosynthetics contribution on bearing capacity has been started, Pospisil (2001).

2 GEOTECHNICAL LABORATORY TESTING FIELD (GLTF)

The GLTF allows to measure in a laboratory some geotechnical quantities which are usually measured in field (such as plate test, dynamics loading test, penetration test, etc.) on various soils and soil layers for different compaction rate and for different water regime.

GLTF, see figure 1, consists of concrete pit split by removable dividers into separated measuring (testing) spaces and a watering/dewatering drain channel separated by removable dividers too. There is a drain layer placed on the bottom of each measuring space atop closed by a grate with a drainage (filter) geotextile. Both the concrete pit and the drain channel are interconnected at their bottoms. A moveable frame can be slide in longitudinal direction along a guide-way (rails) fastened on the top of the pit. The moveable frame serves for mounting or supporting of measuring equipment (plate test, CBR in situ test equipment etc.) and can be blocked in both horizontal and vertical directions during testing.

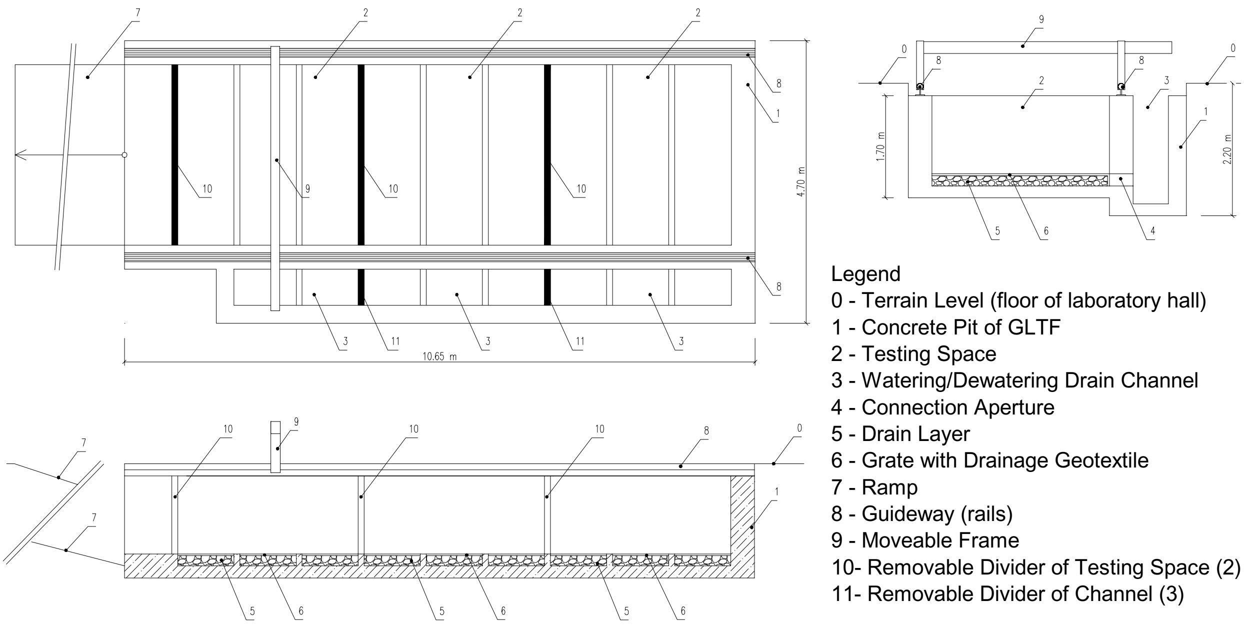

Figure 1. Geotechnical Laboratory Testing Field (GLTF)

3 PRESSUMPTIONS AND PARAMETERS

Experiments are being performed regarding to following conditions:

Subgrade: softsoil (simulating in GLTF by 70cm thick bad of loess) - compacted layer by layer to 95 % Proctor Standard (PS) compaction rate. Measurement was presupposed on sub-soil with law bearing capacity (E_{v2} = 5 – 25 MPa), because reinforcing influence is higher in this case. Sub-soil bearing capacity is possible to change by loess moisture.

Sub-base layers: There were selected materials being up to standard for road and railway sub-base using (unbounded soil). It was presupposed testing by 20 cm thick layers compacting to at least I_D = 0,8.

Geosynthetics: Six kinds of geosynthetics were tested for present and future experiments. There were woven geotextile, knittel geogrid, fiber geogrid, strap-hot-sealing geogrid, extruded HDPE geogrid and reinforcing geocomposite.

Table 1. Subgrade measurement

Measuring space	No.	Static plate test		Dynamic plate test	
		E_{v2} [MPa]	Φ E_{v2} [MPa]	E_{dyn} [MPa]	Φ E_{dyn} [MPa]
I. (unreinforced)	1	4,29	7,02	4,4	5,38
	2	4,54		4,6	
	3	4,62		4,6	
II. (reinforced)	1	6,05		6,5	
	2	7,35		5,2	
	3	9,00		5,1	
III. (reinforced)	1	6,46		5,3	
	2	12,43		6,0	
	3	8,48		6,7	

Table 2. Sub-base – the first layer measurement

Measuring space	No.	Static plate test		Dynamic plate test	
		E_{v2} [MPa]	Φ E_{v2} [MPa]	E_{dyn} [MPa]	Φ E_{dyn} [MPa]
I. (unreinforced)	1	18,61	17,90 (100 %)	20.5	18.9
	2	16,31		18.7	
	3	18,77		17.5	
II. (reinforced)	1	25,17	23,23 (130 %)	21.6	19.6
	2	23,33		18.0	
	3	21,20		19.1	
III. (reinforced)	1	26,50	24.90 (139 %)	17.5	21.6
	2	21,30		25.9	
	3	26,89		21.4	

Table 3. Sub-base – the second layer measurement

Measuring space	No.	Static plate test		Dynamic plate test	
		E_{v2} [MPa]	Φ E_{v2} [MPa]	E_{dyn} [MPa]	Φ E_{dyn} [MPa]
I. (unreinforced)	1	70.75	66.49	47.3	46.2
	2	68.52		43.4	
	3	60.20		47.8	
II. (reinforced)	1	61.66	63.76	42.6	40.7
	2	67.50		40.3	
	3	62.11		39.3	
III. (reinforced)	1	63.38	62.08	45.8	44.4
	2	58.91		44.0	
	3	63.96		43.5	

4 EXPERIMENT METHODOLOGY

The GLTF pit was divided into three measuring spaces (size 3 x 3 m) consistently with Figure 1. Soft soil was put into the empty GLTF on the grate with geotextile in 70cm final thick layer. This soil was compacted 15cm – by – 15cm layers by jumping rammer. Modulus of deformation E_{v2} measurements (according to DIN 18134) were carried out on the final top (in about half of GLTF vertical size), three times in each of the three measuring spaces.

The first measuring space remained gesynteticsless for comparison, woven geotextile was put up into the second measuring space and the extruded HDPE geogrid into the third one.

Twenty centimeter thick layer of unbounded soil was spread on the geosyntheticsless surface in the first measuring space and on the top of geosynthetics in the second and third measuring spaces.

Soil compaction was carried out using a plate vibrator. On the top of 20cm thick soil layer (above 70 cm of soft soil bed) plate test was performed three times, see Figure 2. Hereafter every measuring space was replenished by additional 20cm thick layer of unbounded soil and measurment was repeated.

Figure 2. Static plate test in GLTF

5 RESULTS

They were performed standard soil tests as soil classification tests, Proctor Standard Test, static plate test – modulus of deformation and dynamic plate test – dynamic modulus.

Results of plate tests on the top of:

- subgrade are collected at Table 1,
- the first layer of unbounded soil are collected at Table 2,
- the second layer of unbounded soil are collected at Table 3.

As mentioned subgrade material was loess classified as clay with high plasticity (CH). They were found out these parameters: w_{opt} = 21,5 %, ρ_{max} = 1,570 kg/m^3, w_L = 51 % and I_p = 34 %. Subgrade was compacted with compaction rate 99,9 % PS by 24 % of moisture and density ρ_d = 1,970 kg/m^3.

Sub-base material was crushed stone 0-32 mm with parameters: $\rho_{d,max}$ = 2,210 kg/m^3, $\rho_{d,min}$ = 1,670 kg/m^3. Both the first and the second layer in each of three measuring spaces were compacted with the nearly same achievement of I_D = 1,0 by ρ_d = 2,230 kg/m^3 and w = 2,6 %.

6 DISCUSSION OF RESULTS

6.1 *First layer*

Results shown at Table 2 reflect in comparison with unreinforced soil in the first measuring space that geotextile in the second testing field increasing bearing capacity expressed by modulus of deformation nearly by 30 % and geogrid in the third measuring space even 40 %.

6.2 *Second layer*

Table 3 reflects quite different results measured on the top of second layer. Results are very similar for unreinforced and reinforced measuring spaces. It seems that reinforced influence of geosynthetics finishes somewhere between the first and second layer.

Table 4 shows comparison of reinforced influence expressed by ratio between subgrade modulus and the first layer modulus and between subgrade modulus and the second layer modulus.

Table 4. Reinforced influence

Measuring space	Subgrade	Sub-base 1st layer	Sub-base 2nd layer
I. (unreinforced)	1,0	2,55	9.47
II. (reinforced)		3.31	9.08
III. (reinforced)		3.55	8.84

7 CONCLUSION

Presented results show that reinforced influence of selected geosynthetics is limited. While influence of reinforcement is evident on the first 20 cm thick sub-base layer, influence on 40 cm sub-base layer is unwarrantable. This survey is in antagonism with a lot of information of geosyntertics producers.

Our research is still continuing with various geosynthetics by different conditions and very preliminary results validate this conclusion so far. Other results should be presented during oral presentation.

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