



PHD THESIS

GEOTEXTILE SELECTION METHODS FOR THE LITHUANIAN ROAD AND  
STREET STRUCTURES

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**Abstract.** This summary of the author's PhD thesis supervised by Prof Dr Alfredas Laurinavičius and defended on 7 December 2007 at the Vilnius Gediminas Technical University. The thesis is written in Lithuanian and is available from the author upon request. In chapter 1 describes the existing problem, the need for the use of geotextiles for the separation of road and street structures. Also, the relevance of the research, the scientific novelty and originality of the dissertation, its aim and practical importance. Chapter 2 presents analysis of the geotextile selection methods for the separation of structural layers. In chapter 3 presented experimental research of the use of geotextiles for the separation of roads and streets pavement structure layers. Finally in chapter 4 the geotextile selection method for the use in the Lithuanian roads and streets pavement structures is presented. Developed geotextile selection method reflects the need for the use of geotextile, takes into consideration the factors having the impact on the occurrence of geotextile damages during pavement installation and in the course of road operation.

**Keywords:** separation, geosynthetics, geotextile, geotextile damage, pavement structure, specifications.

**State of the problem**

The structural strength of roads and streets as well as the uniformity of strength are ensured by a design strength of subgrade, subbase and pavement layers, characterized by a deformation modulus, the value of which depends on the properties of materials used for the pavement structural layers and thickness of the layers. During construction of road or street pavement structure and its operation the continuous static and dynamic vehicle loads may cause the intermixing of the subgrade soil with the frost blanket course. Analogical process could happen between the frost blanket course and the subbase constructed from the large particles of aggregate. Eventually, the intermixed materials of the different structural layers of road or street can have the impact on the strength and durability of the whole structure.

In order to prevent the aggregates of different structural layers from becoming intermixed during road or street construction or in the phase of operation the geotextile inter-layers have been world-widely used in the recent 15 years. Based on the recommendations of USA researchers the geotextiles used for the separation of structural layers

should be selected according to the existing formulas. However, these formulas are valid only for the road structures without asphalt concrete pavement. Another method for selecting geotextiles – specifications and recommendations of different countries. At present there are no generally accepted European specifications regulating the selection of geotextiles intended for separating road or street pavement layers. The reason is that different European countries have different climatic and geological conditions. Thus, each or several countries, where these conditions require separation of pavement structural layers by the geotextile, have their own normative documents or recommendations.

Lithuania has only been using geotextiles in road and street construction and reconstruction during the last decade. In 1998 Lithuanian Road Administration adopted the temporary regulations on *Using Geotextiles and Geogrids for Road Construction*, which are still being used by road designers and suppliers of geosynthetics. The regulations are based on the German experience and their specifications for the use of geotextiles on roads. However, when adapting these regulations no experimental research

was carried out or evaluation of their suitability to Lithuanian conditions.

In recent five years the increased number of vehicle ownership and the growth of traffic volume on Lithuanian roads and streets caused the need to construct new roads and streets. To ensure the durability of new roads and streets, safety and comfort for the road users it is necessary to apply new advanced technologies. One of them – separation of structural layers by using geotextiles. The need for the use of geotextiles and the need to identify a suitable method of geotextile selection for the Lithuanian roads and streets determines the topicality of this work.

**Aim and tasks of the work.** The aim of this work – to increase the durability of road structures by developing the geotextile selection method for the Lithuanian road and street structures.

The following tasks must be solved to achieve the aim of the work:

- to analyze the impact of geotextile damages on the ability to fulfil the function of separation;
- to analyze and assess the world-wide used methods for the selection of geotextiles;
- to assess the main factors influencing the occurrence of geotextile damages during the road or street construction and operation;
- to develop a theoretical geotextile selection method for Lithuanian conditions;
- to carry out experimental research with a purpose to justify or to deny the assumptions of a theoretical model;
- based on the analysis and assessment of the results of experimental research to suggest the geotextile selection method for the fulfilment of the function of separating aggregate layers of the Lithuanian road and street pavement structures;
- to carry out the evaluation of economic effect of the use of geotextiles to fulfil the separation function.

**Scientific novelty.** The novelty of this scientific work is that until now no investigation has been carried out on the intermixing of aggregates of the road structural layers during road construction and operation due to static and dynamic vehicle loads under Lithuanian conditions and it was analyzed for the first time. Also, for the first time a detail analysis and assessment was performed of the need of geotextiles and the geotextile selection method for the separation of structural layers.

A comprehensive experimental research made it possible to determine the suitability of geotextiles for performing the function of separation during construction and operation of roads and streets. The determined main factors, having the impact on the geotextile damages and the fulfilment of separation function, as well as the developed geotextile selection method make the relevance of the scientific work.

**Methodology of research** includes the development of a theoretical geotextile selection method, the planned experimental research, analysis and assessment of the results of experimental research, correction of the developed theoretical method.

**Practical value.** The geotextile selection method, developed on the basis of the analysis of the results of experimental research, will be put into practice. The use of geotextiles, selected on the basis of the developed geotextile selection method for the separation of structural layers, is cost effective.

**Defended propositions.** Geotextile damages having occurred during the installation of structural layers of the road pavement over the geotextile have no significant impact on the fulfilment of the function of layer separation.

The main factors having the impact on the occurrence of geotextile damages during the geotextile installation and road operation are as follows: a) loads during the installation of road pavement structure (traffic of the road building mechanisms on the layer constructed over the geotextile); b) grading and size of the largest aggregate particle of the layer constructed over the geotextile; c) thickness of the structural layers over the geotextile; d) traffic loads during the road operation.

Mechanical properties of the geotextiles are directly dependent on the degree of geotextile damage.

### Road structures, their strength and durability

When the road is in operation the road structure weight and temporary loads lead to two simultaneous processes between the construction layers (i. e. between the subbase and the frost blanket course and between the subgrade and the frost blanket course): first, the subgrade soil particles migrate into the frost blanket course and second, large particles of the aggregate of the road subbase and the frost blanket course migrate into the weaker lower layer. As a result, at the beginning the filtering properties of the frost blanket course decrease, and then the strength of the upper layers is reduced.

A geotextile inter-layer can be an effective measure for separating road structural layers of unbound materials. However, separation of the road structural layers of unbound materials by using a geotextile inter-layer can be implemented only when constructing a new or reconstructing an old road structure. Scientific research in the field of separation of road pavement structure using geotextile shows positive effect of such usage. In full-scale test roads where various geotextiles were seen to prevent base contamination seen in sections without geotextile (Berthelot *et al.* 2009; Collins, Holtz 2005; Sifuentes 2010; Vaitkus *et al.* 2010; Watn, Hoff 2010).

### Analysis of the geotextile selection methods for the separation of structural layers

Until now there have been no generally accepted normative documents in Europe regulating the selection of geotextiles intended for the separation of structural layers. Geotextiles are usually selected on the basis of specifications and recommendations of a particular country or based on the experience of designers and manufacturers. In 2002 the Nordic countries developed a unified system for specification and control of geotextiles in roads and other

trafficked areas (*NorGeoSpec*) (Eiksund *et al.* 2002). The system is aimed at the North European countries.

Since 1980 Germany has been successfully using a Geotextile Robustness Classification (GRC). At first, it classified the robustness of geotextiles against mechanical damage into 4 classes. Later, having adopted a Norwegian proposal in 1994, the classification was extended to 5 classes. To find out a GRC for a given site, Germans classify the fill material into 5 levels according to the diameter and the sharpness of aggregates. The types of loading are classified into 4 levels and depend on the installation and construction works (Wilmers 2002).

Lithuania has only been using geotextiles for road construction and reconstruction over the past 15 years. In 2005–2006 started research of geosynthetics use in road pavements (Laurinavičius *et al.* 2006; Laurinavičius, Oginskas 2006; Vaitkus *et al.* 2006). In 1998 Lithuanian Road Administration adopted the temporal regulations *Using Geotextiles and Geogrids for Road Construction*, which are still used by road designers and suppliers of geosynthetics. The regulations are based on the experience of German specialists and their standards specifying the use of geotextiles on roads, however, no on-site research or adoption to local conditions has ever been done. Therefore, to ensure a proper use of geosynthetics in the pavement structure of Lithuanian roads and streets, the specifications should be revised. Also, it is important that the experimental research is carried out.

The *NorGeoSpec* (Eiksund *et al.* 2002), a system of geotextile selection and control used in the Nordic countries, specifies the strength characteristics of non-woven geosynthetics and max tolerance. However, the static puncture strength and mass per unit area, the characteristics of utmost importance for German and Lithuanian designers when selecting geotextiles, have only tolerance values specified. Some researchers have proved a direct dependency between the mass per unit area and the static puncture strength.

In order to develop a rational geotextile selection method for separating different layers of road and street pavement structures the following questions have been raised:

- between which layers the geotextile inter-layer shall be installed?
- in what cases the geotextile inter-layers shall be installed?
- what type of geotextiles shall be used for the separation inter-layers?
- which geotextile properties are the most important for the fulfilment of the separation function?
- what are the factors having the largest impact on the occurrence of geotextile damages?

The answers to the above questions will give a possibility to develop a comprehensive geotextile selection method under Lithuanian conditions.

### Experimental research of the use of geotextiles for the separation of road and street structural layers

Having analyzed a number of literature sources the main factors having the impact on the occurrence of geotextile damages and on the failure to perform the separation function were determined. Taking these factors into consideration, experimental research was divided into three parts:

- to assess the dependency of geotextile damages and fulfilment of the separation function on the loading during installation;
- to identify and assess the dependency of geotextile damages and fulfilment of the separation function on traffic loads during road operation, on the materials used for the installation of pavement structure and on the thickness of pavement structure over the geotextile;
- to identify and assess the dependency of mechanical properties of the geotextiles on the variation in the amount of geotextile damages.

Part of the experimental research to identify and assess installation damages. Investigations were carried out in 2005 on the main road of the Republic of Lithuania A1 Vilnius–Kaunas–Klaipėda. On the investigated road section, within the pavement lane to be widened, two 15 m long test sections were selected. In each of them 5 types of separating geotextile were installed, produced by different manufacturers. Their mass per unit area was 110 g/m<sup>2</sup>, 130 g/m<sup>2</sup>, 170 g/m<sup>2</sup>, 200 g/m<sup>2</sup> and 300 g/m<sup>2</sup>, respectively. In the first test section the separating geotextiles were placed between the subgrade and the frost blanket course. In the second – between the frost blanket course and the subbase. Road pavement structure is given in Fig. 1. In the first test section a 45 cm thick frost blanket course was constructed of the frost resistant gravel of a good structure (the largest particle size 30–35 mm). The course was erected by separately compacting two 30 cm and 15 cm thick layers. For both layers a vibratory roller of 12 t was used for sand compaction, which rolled on each layer 5 times forth and back. In the second test section the 27 cm thick subbase of the crushed dolomite 0/63 was constructed over the geotextile. The largest particle size of the layer amounted to 60 mm. The layer over the geotextile was compacted by a vibratory roller of 8 t by rolling over it 5 times.

After the installation of relevant structural layers over the geotextiles in both test sections and after their design values of static deformation modulus were reached by compacting the layers, the excavation and sampling works were carried out. To avoid the damage of the test materials during excavation all the works were performed manually. In the process of investigation, damages of the separating geotextiles were assessed on the basis of the visual on-site assessment methodology of the British Standard *BS 8006:1995 Code of Practice for Strengthened/Reinforced Soils and Other Fills*. The following geotextile damages were identified in the test sections: general abrasion, cuts and puncturing. The most frequent damage of the test geotextiles was puncturing, therefore, a percentage expression of the sum of the total punctured area (%), if compared to the total area of un-

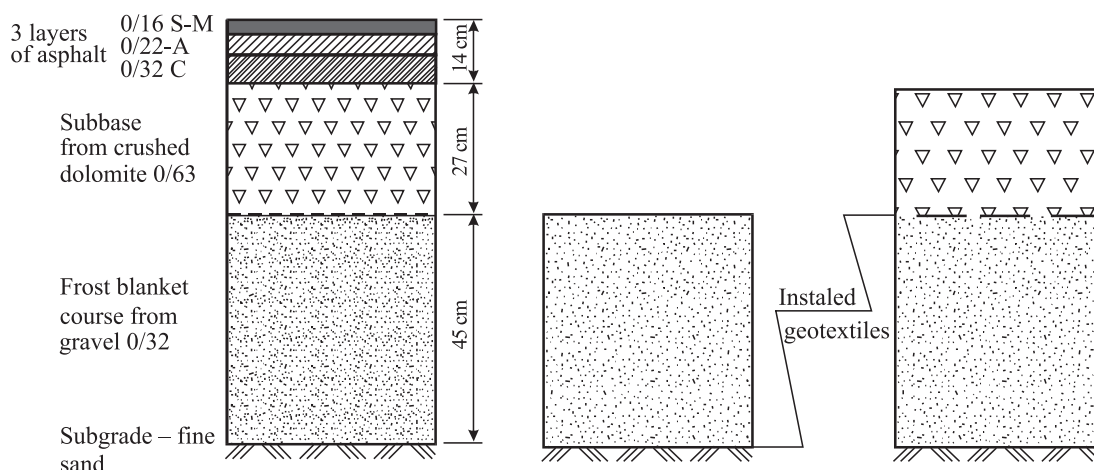


Fig. 1. Road pavement structure and the levels of geotextile installation: a - road pavement structure; b - geotextile separating the subgrade and the frost blanket course; c - geotextile separating the frost blanket course and the subbase

damaged material, was selected as a comparative indicator of geotextile damages. The obtained comparative indicators were given by Vaitkus *et al.* (2006).

In the result of investigation it can be stated that all the damages in geotextiles, having occurred during installation of pavement structural layers over the geotextiles, had no significant impact on the fulfilment of the separation function of the layers. A visual assessment of the test geotextiles indicates that geotextile puncturing is the most significant damage having a negative impact on the separation of the structural layers of the road pavement. The results of experimental research deny the propositions of the scientists, that the main damages in geotextiles occur in the process of their installation. The results of this investigation showed that even the weakest geotextile used for the separation function is able to carry the loads of installation and to perform the separation function of the layers (in a typical structure of the Lithuanian road pavement). Therefore, it is necessary to undertake another experimental research to identify and assess the dependency of geotextile damages and fulfilment of the separation function on the vehicle loads during road operation, the materials used for the installation of pavement structure and on the thickness of pavement structure over the geotextile.

Part of the experimental research to identify and assess damages caused by vehicle loads during road operation. Part of the experimental research to identify and assess damages caused by vehicle loads during road operation was started on 31 July 2006 and finished on 14 April 2007. For the research purposes a gravel road of local importance was selected under continuous heavy loading (about 150 vpd/day). This part of the experimental research was further divided into two parts: one of them – aimed at the assessment of tendencies in the occurrence of geotextile damages and fulfilment of the separation function, depending on the materials used for the construction of the subbase, when the road structure has asphalt concrete pavement, the other – has no asphalt concrete pave-

ment. This experimental research was carried out to assess the tendencies in the occurrence of geotextile damages and fulfilment of the separation function, depending on the materials used for the construction of the subbase and on the number of equivalent standard axel loads (ESALs) estimated to 100 kN. Overall experiment conditions and results presented by Vaitkus *et al.* (2007).

A full factorial experiment was chosen, during which every factor and the factor product influence on the quest value will be determined. The quest value is the geotextiles damage –  $GTX_{dmg}$ . Geotextile damage is taken as a percentage expression of the total damage (puncturing) area compared to the undamaged material, (%). The factors, assessed during the experiment, having the impact on the damage in the geotextile, and its scale, are as follows:

- MM – the type of the subbase material;
- h – the thickness of the asphalt pavement, cm;
- A – ESALs (estimated to 100 kN).

While planning the experiment the supposed established point was chosen, at which the results are the best (it was considered as the main level). The ranges of factors variation were chosen according to the purpose to get experimental points symmetrical to the main level. The levels of factors and ranges of their variation, where the main level and range of variation for the type of subbase material isn't determined, are presented in Table 1, functional dependency of geotextile damages.

Table 1. The levels of factors and ranges of their variation

Rate	Factors		
	MM	h, cm	A, ESALs
Main level	-	3	51 000
Range of variation	-	±3	±17 000
Upper level	MM <sub>ncrd</sub>	6	34 000
Lower level	MM <sub>crd</sub>	0	68 000

Note: MM<sub>ncrd</sub> – non-crushed material (granite – sand mixture 0/45); MM<sub>crd</sub> – crushed material (crushed granite 16/32).

Function for geotextile damages:

$$GTX_{dmg} = f(MM, h, A) \quad (1)$$

The first rate polynomial was chosen for the experiment:

$$GTX_{dmg} = b_0 + b_1MM + b_2h + b_3A + b_{12}MMh + b_{13}MMA + b_{23}hA + b_{123}MMhA. \quad (2)$$

Having done a full  $2^3$  factorial experiment, eight coefficients of mathematical model were determined. On the main level the coefficient is:

$$b_0 = \frac{\sum_{i=1}^N GTX_{dmg(i)}}{N}, \quad (3)$$

where  $GTX_{dmg(i)}$  – the scale of geotextile damage, determined by  $i^{\text{th}}$  test, %;  $N$  – number of tests.

Other coefficients of the selected mathematical model are calculated by the formula:

$$b_j = \frac{1}{N} \sum_{i=1}^N X_{ij} GTX_{dmg(i)}, \quad (4)$$

where  $j = 0, 1, 2, 3 \dots 7$  – factorial number;  $i = 0, 1, 2, 3 \dots N$  – number of the test;  $X_{ij}$  – coded values in a row of a matrix.

For both geotextiles a matrix of a full factorial experiment is written (Table 2). In this matrix “+” and “-” gives the levels of factors, indicating the higher and the lower level, respectively. In the process of experiment 4 combinations of different road pavement structures and two geotextiles were assessed after the passage of a different number of ESALs.

Based on the matrices of a full factorial experiment on 29–30 July 2006 on the existing road with a gravel pavement two 56 and 28 meters long test sections were constructed. Width of the newly erected road pavement structure was 8 m. Before placing the geotextile the existing road surface was

profiled and provided with 5 cm thick sand layer. Over the geotextiles three different-type 25 cm thick subbase layers of crushed granite and sand mixture 0/45, crushed granite 16/32 and crushed dolomite 16/45 were constructed. In 28 m long section, the asphalt concrete 0/16-Vn layer was erected 6 cm thick and 6 m wide. Two types of the nonwoven needle punched polypropylene geotextiles were chosen for the experiment: GTX1 – one of the strongest needle punched geotextiles used for the separation of the layers of pavement structure (its mass per unit area 300 g/m<sup>2</sup>); GTX2 – one of the weakest (its mass per unit area 110 g/m<sup>2</sup>).

The first excavation of geotextiles after the passage of 34 000 ESALs was carried out on 21 October 2006, the second – on 14 April 2007 after the passage of 68 000 ESALs. During each excavation the samples of geotextiles with the size of 2.0×6.0 m were taken out from the road pavement structure, based on the relevant codes of geotextile damage matrices and loads, and were visually assessed. From each of the geotextile samples in an accidental order 6 specimens of the same area (30×30 cm) were cut out. Each specimen was placed on a light spreading base and the area of punctures was calculated as well as the sum of the punctured areas. Punctures with a diameter < 3 mm were not taken into consideration.

A constant member of the mathematical model of the geotextile GTX1, selected for experimental research, was calculated on the main level according to the Eq (3) and is equal to  $b_0 = 0.34$ . Other coefficients of this model were calculated according to the Eq (4). In this case a mathematical model, described by a polynomial, which reflects the degree of the geotextile GTX1 damage due to the above mentioned factors, their scale and interaction will have the following expression:

$$GTX_{dmg}^1 = 0.34 - 0.06MM - 0.24h - 0.04A - 0.04MMh - 0.04MMA - 0.04hA + 0.11MMhA. \quad (5)$$

A constant member of the mathematical model of the geotextile GTX2, selected for experimental research, was calculated on the main level according to the Eq (3) and is equal to  $b_0 = 1.23$ . Other coefficients of this model were calculated according to the Eq (4). In this case a mathematical model, described by a polynomial, which reflects the

**Table 2.** The matrix of a full factorial experiment

Code of load and structure		Factors and factors product						
GTX1	GTX2	MM	h	A	MM×h	MM×A	h×A	MM×h×A
1-No. 5	2-No. 5	-1	-1	-1	+1	+1	+1	-1
1-No. 6	2-No. 6	-1	+1	+1	-1	-1	+1	-1
1-No. 7	2-No. 7	+1	-1	+1	-1	+1	-1	-1
1-No. 8	2-No. 8	+1	+1	-1	+1	-1	-1	-1
1-No. 1	2-No. 1	+1	-1	-1	-1	-1	+1	+1
1-No. 2	2-No. 2	+1	+1	+1	+1	+1	+1	+1
1-No. 3	2-No. 3	-1	-1	+1	+1	-1	-1	+1
1-No. 4	2-No. 4	-1	+1	-1	-1	+1	-1	+1

degree of the geotextile GTX2 damage due to the above mentioned factors, their scale and interaction will have the following expression:

$$GTX_{dmg}^2 = 1.23 - 0.82MM - 0.08h - 0.25A + 0.05MMh + 0.09MMA - 0.11hA + 0.04MMhA. \quad (6)$$

The analysis of the results of experimental research showed that the main factors having the influence on the occurrence of geotextile damages during its installation and in the phase of road operation are as follows:

- loads during the installation of road pavement structure (traffic of the road building mechanisms on the layer constructed over the geotextile);

- grading and size of the largest aggregate particle of the layer constructed over the geotextile;
- thickness of the layers of road pavement structure over the geotextile;
- traffic loads during the operation of road pavement structure.

### Geotextile selection method for the use in the Lithuanian road and street structures

The recommended procedure for the determination of the need for the use of separating geotextile and for the selection of geotextile is given in Fig. 2.

During geotextile installation as well as the road operation the inter-layer of the separating geotextile falls under

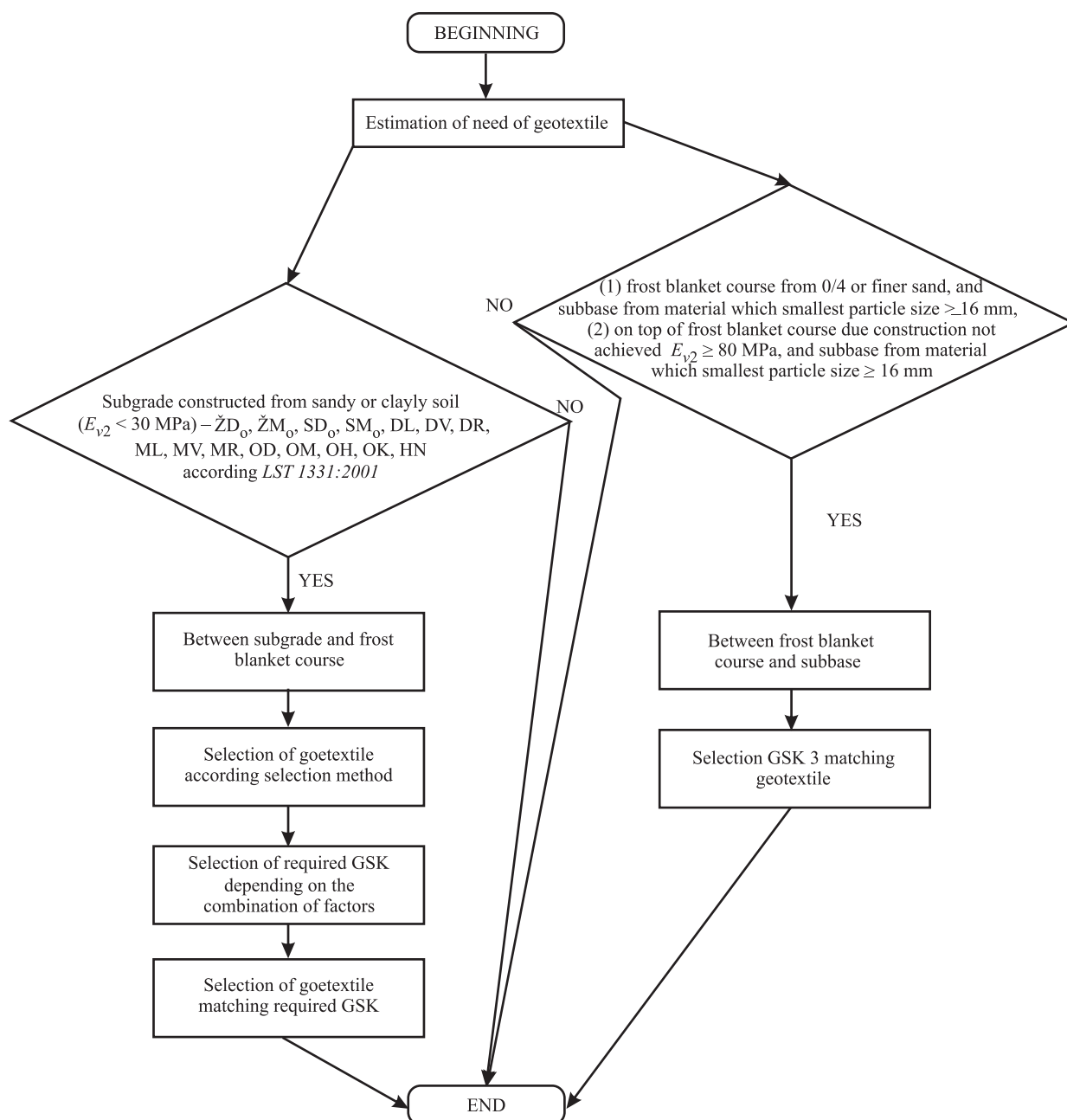


Fig. 2. Procedure for the determination of the need for the use of geotextiles and for the selection of geotextiles

the effect of certain factors, which have the impact on the occurrence of geotextile damages or the failure of partial or full fulfilment of the separation function. These factors are divided into the levels of the damage factors, which are corresponded by the five geotextile strength classes (GSK1, GSK2, GSK3, GSK4 and GSK5).

On the basis of the geotextile selection method the following factors are marked out having the impact on the geotextile damages and fulfilment of separating function:

Strength of the subgrade soil:

- low – subgrade from DR, MR, OD, OM, OH, OK, HN soil in accordance with the standard *LST 1331:2002 Automobilių kelių gruntai. Klasifikacija* [Soils for Road Construction. Classification];
- medium – subgrade from DL, DV, ML, MV soil in accordance with the standard *LST 1331:2002*;
- high – subgrade from ŽD<sub>o</sub>, ŽM<sub>o</sub>, SD<sub>o</sub>, SM<sub>o</sub> soil in accordance with the standard *LST 1331:2002*.

Loads due to the installation of the layer over the geotextile:

- low – the layer is constructed by the light-weight construction machines and compacted by vibrating panels or rollers with the weight of  $\leq 5$  t;
- medium – the layer is constructed by the heavy construction machines and compacted by vibrating rollers with the weight of  $\geq 5$  t;
- high – the layer is constructed by the heavy construction machines and compacted by vibrating

rollers, the traffic of construction machines is allowed.

Thickness of the layers of road pavement structure over the geotextile:

- low – the total thickness of structural layers over the geotextile  $\leq 50$  cm;
- high – the total thickness of structural layers over the geotextile  $> 50$  cm.

Loads due to the operation of road pavement structure:

- low – index of heavy traffic  $< 18\ 000$  or design load  $A < 10$  mln;
- high – index of heavy traffic  $\geq 18\ 000$  or design load  $A \geq 10$  mln.

Dependency of geotextile strength classes on the combinations of factors, having the impact on the structure during its installation and operation, is given in Table 3. Based on this table the required geotextile strength class is chosen.

Based on Table 4 the geotextile is selected, corresponding to the respective GSK. This table gives the required geotextile properties identified from the analysis of the results of experimental research, carried out by the scientists. Most of these properties are set in the standard *EN 13249:2000 Geotextiles and Geotextile-Related Products. Characteristics Required for Use in the Construction of Roads and Other Traffic Areas (Excluding Railways and Asphalt Inclusion)*.

**Table 3.** Geotextile strength classes depending on the combinations of factors, having the impact on the geotextile damages and on the fulfilment of the separation function

Installation loads	Layers thickness over the geotextile	Road operation loads	Strength of the subgrade soil		
			Low	Medium	High
High	Low	High	GSK 4	GSK 5	GSK 5
		Low	GSK 3	GSK 4	GSK 5
	High	High	GSK 3	GSK 4	GSK 5
		Low	GSK 3	GSK 4	GSK 5
Medium	Low	High	GSK 3	GSK 4	GSK 5
		Low	GSK 2	GSK 3	GSK 4
	High	High	GSK 2	GSK 3	GSK 4
		Low	GSK 2	GSK 3	GSK 3
Low	Low	High	GSK 1	GSK 3	GSK 3
		Low	GSK 1	GSK 2	GSK 3
	High	High	GSK 1	GSK 2	GSK 2
		Low	GSK 1	GSK 1	GSK 2

**Table 4.** Required values for the geotextile properties on the basis of geotextile strength classes

Geotextile characteristic	Max tolerance	Geotextile strength class				
		GSK1	GSK2	GSK3	GSK4	GSK5
Required geotextile characteristics						
Tensile strength*, kN/m	-10%	5	7	10	13	15
Elongation at max load, %	-15%	60	55	55	50	50
Min energy index, kN/m	-	1.4	1.8	2.5	2.9	3.4
Max cone drop diameter, mm	+20%	33	28	24	19	14
Static puncture strength, kN	-15%	1.1	1.6	2.2	2.7	3.2
Min velocity index, $10^{-3}$ m/s	-25%	120	100	100	80	70
Characteristic opening size, $\mu\text{m}$	+25%	150	150	130	100	100
Max tolerance for mass per unit are, %	-	-12	-12	-12	-10	-10

Note: \* values along geotextile tensile direction

Evaluation of the economic effect was divided into three parts:

- 1) when geotextile inter-layer is installed between the subbase and the frost blanket course;
- 2) when geotextile inter-layer is installed between the frost blanket course and the subgrade;
- 3) when geotextile inter-layer is installed between the subbase and the frost blanket course and between the frost blanket course and the subgrade.

Evaluation of the economic effect shows that the use of geotextile inter-layers selected on the basis of the developed geotextile selection method for constructing and reconstructing Lithuanian roads and streets is cost-effective. The costs of geotextile and its installation are paid back already in the phase of installation. This is obvious from the cost-benefit ratio which, in individual cases, varies from 1.76 to 2.12.

### General conclusions

The analysis of the results of experimental research showed that the geotextile damages caused during the installation of road pavement structure layers over the geotextile have no significant impact on the fulfilment of the separation function. It was also determined that the most significant geotextile damages having a negative impact on the separation function are punctures. The damages (punctures) of the tested geotextiles make 0–0.035%, if compared to the area of undamaged geotextile.

The analysis of the results of experimental research aimed to determine the geotextile damages caused by traffic loads during the road operation showed that during road operation the geotextile is damaged 200 times more, if compared to the geotextile damages caused during the installation of road pavement structure layers. The damages (punctures) of the tested geotextiles make 0.01–6.7%, if compared to the area of undamaged geotextile.

The main factors were identified having influence on the occurrence of the geotextile damages during pavement installation and in the phase of road operation, i.e.:

- grading and size of the largest aggregate particle of the layer constructed over the geotextile;
- thickness of the pavement layers over the geotextile;
- loads during the pavement installation (traffic of the road construction machines on the layer constructed over the geotextile);
- traffic loads during the operation of the road.

The analysis of the results of experimental research aimed to define the change in the mechanical properties of the geotextiles indicated a high correlation between the degree of damages in the geotextile specimens and the average values of static puncture strength (CBR). Correlation coefficient of GTX1 indices is (–0.84), of GTX2 – (–0.88). Knowing the degree of geotextile damages it is possible to predict (calculate) the resistance of geotextile to CBR, when a geotextile inter-layer is placed between the frost blanket course and the subbase.

Developed geotextile selection method reflects the need for the use of geotextile, takes into consideration the factors having the impact on the occurrence of geotextile damages during pavement installation and in the course of road operation. The use of geotextiles for separation function selected based on the developed method is cost-effective. The costs of geotextile and its installation are paid back already in the phase of road construction, the cost-benefit ratio varies from 1.76 to 2.12.

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