# REGARDING THE SIZING OF FLEXIBLE ROAD SYSTEMS EQUIPPED WITH GEOSYNTHETICS, USED IN FOREST ROADS

**R. BEREZIUC**[1] **V. ALEXANDRU**[1] **V. CIOBANU**[1]

***Abstract:*** *This work presents different variants of sizing, which are obtained from mathematical operations, when a geo-textile which leads to a mitigation of thickness for the foundation and increase of traffic capability is used in road systems.*

***Key words:*** *road system, geo-grid, geo-textile, sizing.*

## 1. Introduction

The geo-synthetics are industrial materials which are more and more used for road construction, to consolidate the roadways as well as for protection-bracing purposes.

From the category of geo-synthetic materials, there can be mentioned: geo-grilles, geo-grids, geo-textiles, geo-membranes and geo-composites.

The **geo-grilles** and **geo-grids** are used to reinforce road systems, the **geo-textiles** have draining and filtering functions while the **geo-membranes** ensure sealed surfaces, and the **geo-composites** are combinations of the above-mentioned materials (and even sometimes involving other materials), combinations made to fulfill multiple functions [3].

Their use on public roads in Romania has been done for several years and now they have started to be used also for forest roads. Starting from 2001, several materials have been tried for the forest road network, such as geo-grills, geo-grids as well as geo-cells, combined with geo-textiles because the latter can be introduced into road structures in order to consolidate the roadway.

The road construction technique knows several methods (empiric, semi-empiric, theoretical) to size flexible road systems. In the case of forest roads which, as a rule, are like cobblestoned roads, a great spread is given to the semi-empiric method of critical deformation, because it is considered to be the real way in which deformation and yield point occurs under traffic [1].

The introduction in classic road systems of geo-synthetics materials created new conditions of traffic movement of flexible road systems with repercussion on their behavior under traffic, and sizing method [2].

The effective research performed with high tech gear demonstrated that the use of geo-synthetics in the structure of flexible road system allows the decrease of thickness by approximately 33...35% and the reduction of the base layer with approximately 40%.

[1] Dept. of Forest Engineering, *Transilvania* University of Braşov.

In view of this situation, at road systems dimensioning which include one geo-synthetic situated on the level of the way bed (geo-grid with reinforcing role of the foundation layer or a geo-textile with drainage role), it is estimated that in making standard use of road systems for forest roads, the presence of the geo-synthetic is considered at sizing in the following way:

- *in case of installing a new grid*, as reinforcing element between foundation layer and the base it is considered that the thickness of the base layer resulting from the critical deformation method, can be reduced with 35% (Figure 1);

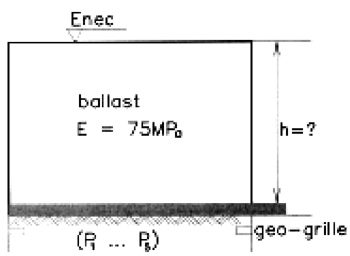


Fig. 1. *One-layered road system from ballast on the geogrid*

- *in case of using a new geo-textile* at the level of the base, with drainage and anti-contamination role, it is estimated that its presence increases the deformation module by 20...25% (Figures 2 and 3).

For exemplification of all the above the sizing results for 4 types of road systems (2 classic and 2 with geo-synthetics) are given in Figures 4, 5, 6 and 7. Thus:

- *in Figure 4* the reduced road system composed of a ballast layer, situated on the base is rendered, and in the next table (Table 1) the thickness for different soil types ($P_1$...$P_5$) with different deformation modules and for varying sizes of the necessary deformation module is presented; it is observed that the thickness of the ballast layer varies between 9 and 61 cm;

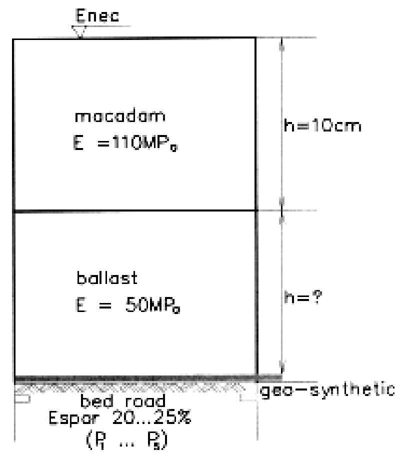


Fig. 2. *Two-layered road system of macadam and ballast over geo-textile*

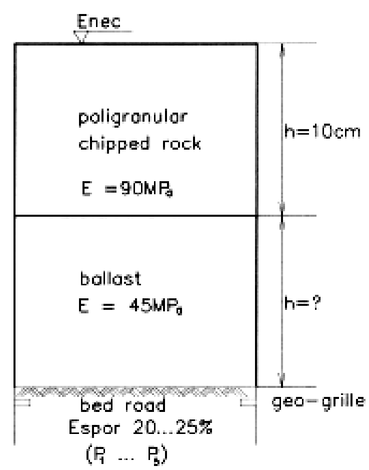


Fig. 3. *Two-layered road system of polygranular chipped stone and ballast on geo-textile*

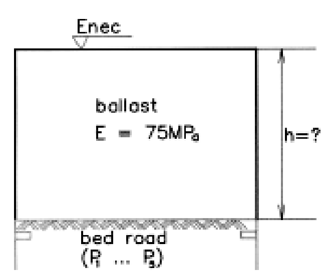


Fig. 4. *The reduced road system, composed of a ballast layer, situated on the base*

*The thickness for different soil types* ($P_1$...$P_5$) Table 1

| **Necessary deformation module ($E_{nec}$) $MP_a$** | **Type of soil / Type of deformation [$MP_a$]** | | | | |
|---|---|---|---|---|---|
| | **$P_1$ 15** | **$P_2$ 12** | **$P_3$ 8** | **$P_4$ 5** | **$P_5$ 4** |
| | **Foundation thickness (*h*), in cm** | | | | |
| 20 | 9 | 14 | 22 | 36 | 38 |
| 25 | 15 | 19 | 29 | 44 | 46 |
| 30 | 21 | 27 | 39 | 53 | 56 |
| 35 | 29 | 35 | 46 | - | - |
| 40 | 36 | 42 | 53 | - | - |
| 45 | 43 | 51 | 61 | - | - |
| 50 | 50 | 59 | - | - | - |

- *in Figure 5* the road system is composed of two layers, clothing of macadam and foundation of ballast, placed directly on the way bed; thickness of the foundation layer, according with the table attached to the figure, varies between 3 and 58 cm;

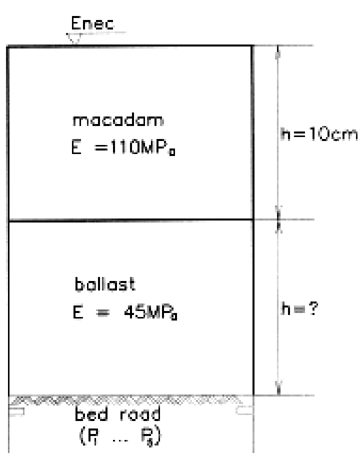


Fig. 5. *The road system composed of two layers, clothing of macadam and foundation of ballast*

- *in Figure 6* the road system is composed of a traffic layer and a ballast wear layer placed on a geo-grid situated on the way bed; thicknesses of the ballast layer are between 6-40 cm;
- *in Figure 7* the road system is composed of macadam and foundation of ballast placed on a geo-textile spread on the way bed; thicknesses of foundation are between 3 and 53 cm (Table 4).

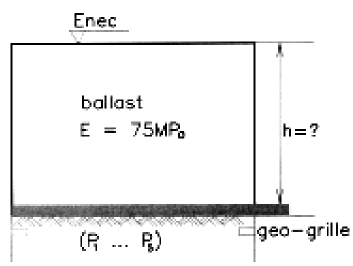


Fig. 6. *The road system composed of a traffic layer and a ballast wear layer placed on a geo-grille situated on the way bed*

From all of the above it results that usage of geo-synthetics leads to a reduction of the foundation layer.

The sizing of the road systems shown in Figures 4, 5, 6, 7 and 8 has been acomplished through the critical deformation method applying graph-analitical procedure, based on usage of specifical nomogram and on analitical calculus (see Tables 1…4).

As it is observed, have been considered different hypotheses have been considered regarding the deformation module of the soil from the way bed, respectively 15-12-8-

*The thickness for different soil types* ($P_1$...$P_5$) Table 2

| **Necessary deformation module ($E_{nec}$) $MP_a$** | **Type of soil / Type of deformation [$MP_a$]** | | | | |
|---|---|---|---|---|---|
| | **$P_1$ 15** | **$P_2$ 12** | **$P_3$ 8** | **$P_4$ 5** | **$P_5$ 4** |
| | **Foundation thickness (*h*), in cm** | | | | |
| 20 | 3 | 9 | 18 | 27 | 29 |
| 25 | 10 | 17 | 25 | 39 | 43 |
| 30 | 16 | 22 | 30 | 45 | 46 |
| 35 | 27 | 33 | 44 | 61 | 63 |
| 40 | 36 | 44 | 56 | - | - |
| 45 | 51 | 58 | - | - | - |
| 50 | 71 | - | - | - | - |

*The thickness for different soil types* ($P_1$...$P_5$) Table 3

| **Necessary deformation module ($E_{nec}$) $MP_a$** | **Type of soil / Type of deformation [$MP_a$]** | | | | |
|---|---|---|---|---|---|
| | **$P_1$ 15** | **$P_2$ 12** | **$P_3$ 8** | **$P_4$ 5** | **$P_5$ 4** |
| | **Foundation thickness (*h*), in cm** | | | | |
| 20 | 6 | 9 | 14 | 23 | 25 |
| 25 | 10 | 12 | 19 | 29 | 30 |
| 30 | 14 | 18 | 25 | 34 | 36 |
| 35 | 19 | 23 | 30 | - | - |
| 40 | 23 | 27 | 35 | - | - |
| 45 | 28 | 33 | 40 | - | - |
| 50 | 33 | 38 | - | - | - |

*The thickness for different soil types* ($P_1$...$P_5$) Table 4

| **Necessary deformation module ($E_{nec}$) $MP_a$** | **Type of soil / Type of deformation [$MP_a$]** | | | | |
|---|---|---|---|---|---|
| | **$P_1$ 15** | **$P_2$ 12** | **$P_3$ 8** | **$P_4$ 5** | **$P_5$ 4** |
| | **Foundation thickness (*h*), in cm** | | | | |
| 20 | - | - | 10 | 22 | 23 |
| 25 | 3 | 11 | 20 | 29 | 35 |
| 30 | 9 | 14 | 24 | 37 | 53 |
| 35 | 17 | 22 | 34 | 51 | 54 |
| 40 | 24 | 41 | 43 | 58 | 61 |
| 45 | 35 | 44 | 53 | - | - |
| 50 | 48 | 56 | 67 | - | - |

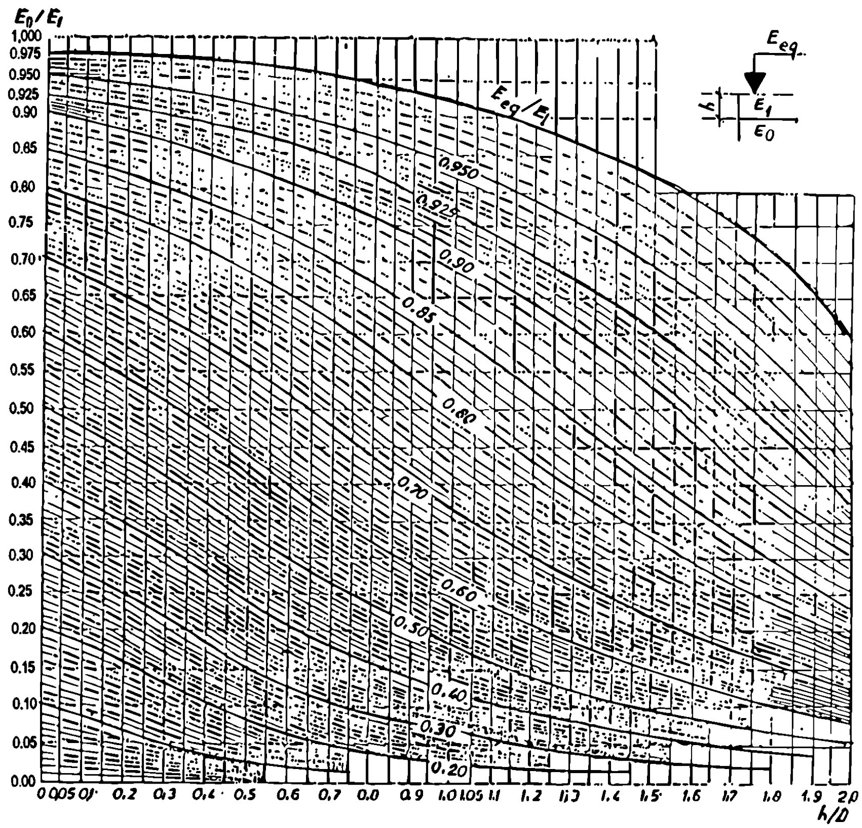


Fig. 8. *Abacus for sizing flexible road systems*

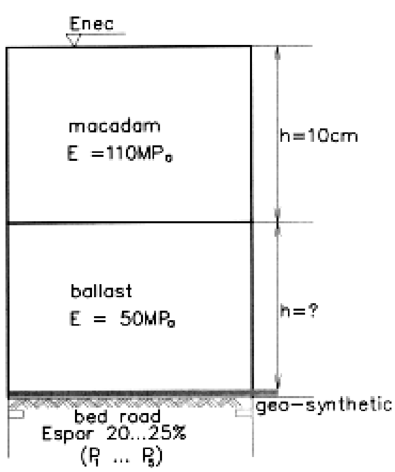


Fig. 7. *The road system composed of a macadam and foundation of ballast placed on a geo-synthetic spread on the way bed*

5-4 MPa, also the necessary deformation module, respectively 20-25-30-40-45-50 MPa. In the case of analitical calculation a large scale of deformation modules for soils $P_1 \ldots P_5$ has been utilized.

Seeing that the nomogram readings are not quite accurate, even in case of using large format nomograms ($A_3$), the calculations have to be redone on calculator, using the algorithm of the base relation for the necessary deformation module. Comparing the two values obtained after using the nomogram and calculator has shown more rapid and extended results through the use of the algorithm. The insignificant differences between the values justify the use of analitical calculation.

## References


1. Alexandru, V.: *Construcţia şi întreţinerea drumurilor forestiere* (*The Construction and Maintainance of the Forest Roads*). Braşov. Informarket Publishing House, 2000.
2. Bereziuc, R., Alexandru, V., Ciobanu, V., Ignea, Gh.: *Elemente privind fundamentarea normativului de proiectare a drumurilor forestiere* (*Elements Regarding Normative Sub-stantiation of Forest Roads Design*). Braşov. *Transilvania* University Publishing House, 2008.
3. Ciobanu, V.: *Cercetări privind utilizarea geo-grilelor pentru consolidarea platformei drumurilor forestiere construite pe teren argilos* (*Researches Regarding the Utilization of Geo-Grills in Order to Consolidate the Platform of the Forest Roads Built on Aluminous Terrain*). In: Ph.D. Thesis, *Transilvania* University of Braşov, Braşov, Romania, 1998.