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EXPERIMENTAL FOREST ROAD CONSTRUCTION WITH GEOTEXTILE MATERIALS IN TELEKHANY FORESTRY STATE FORESTRY INSTITUTION

The article summarizes the experience of construction of cost-effective road structures with geosynthetic materials, local soils and logging wastes used for this purpose. New road structures are proposed for various conditions in terms of soils and hydrological characteristics. The stages of process operations for road surface construction and road-building machines used within the scope of these works are described.

Introduction. One of the methods for reduction of expenses and for quicker construction of forest roads is an application of geosynthetic materials for road pavements. This method is especially effective when, in combination with geosynthetic materials, waste woods and local soils applicable for construction are used. At the Forest Transport Department, BSTU, new road structures have been developed that can be used in various conditions, in terms of soils and hydrological characteristics, to make wood transportation possible throughout a year. The notable characteristics of these structures include their low cost and relatively simple construction technology for which the expensive road-building machinery is not necessary.

Main part. For the purpose of analysis of the mode of operation of forest motor roads, with the view of improvement of their operability, the forest transport network was inspected in Malo-Plotnitskoye Forestry District, Telekhany Forestry, hydrological conditions were surveyed, and the forest soil road was chosen in Quarters No.4 and No.8 where two experimental plots were expected to be allocated. New cost-effective road structures were to be built at these plots, with wood wastes and geosynthetic materials used for this purpose. *Typar SF-40* geosynthetic material was used for research purposes.

Soils are primary local materials for forest road construction. They are used as bases of road structures and as materials for roadbed. Soils applicability for road construction purposes, roadbed stability and pavement service life depend significantly on soils grain distribution and their physical and mechanical purposes.

The primary local road-building material applicable for the construction of experimental facilities is a fine sandy soil. It can be used to build the roadbed and pavement base.

The sieving test procedure was applied to determine the grain distribution. For the grain distribution description, see the table below.

As a result, the soil was classified as a fine sandy soil.

The land plots for pits necessary to maintain forest roads were allocated in accordance with the Land Code of the Republic of Belarus, Article 54, and the Mining Code of the Republic of Belarus, Article 30. In accordance with these articles, local Executive Committees may permit the state forestry institutions, subject to their substantiated application, to use the forest fund land plots for open-pit soil extraction, with the extraction depth not exceeding 2 m.

Such a permission was obtained from Bobrikovo Rural Executive Committee (Permission No.77, 26 September, 2011

Ground was broken for sand quarries in Quarters No.4, 8, 9, 11. The distance for soil transportation was 1 km max.

Depending on bearing capacity of road bases at each road segment, the pavement structures as follows shall be recommended. For peaty bogged areas, felling debris shall be laid as a road base; over the resulting brush layer, transversal deck shall be placed, connected by longitudinal strips of non-woven geosynthetic material (see Fig. 1). This structure is proposed as the most effective.

Here, the road design is as follows. The road structure base is composed of a weak peaty soil. The second component is a brush layer composed of felling debris laid over the weak base surface. The next basic component of the road structure is the deck consisting of transversal wooden elements placed butt-to-top and connected by longitudinal strips of geosynthetic material. These strips envelop each wooden element, one by one, making quite hard interlayer that, at the same time, prevents spillage over the soil dumped into the pavement.

Soil grain distribution test results

Parameters	Sieve hole diameter (mm)									Tray
	10	7	5	3	2	1	0.5	0.25	0.1	
	Soil fraction size (mm)									
	>10	10…7	7…5	5…3	3…2	2…1	1…0.5	0.5…0.25	0.25…0.1	<0.1
Fraction percentage	–	–	–	–	0.075	0.300	0.215	2.275	90	6.64

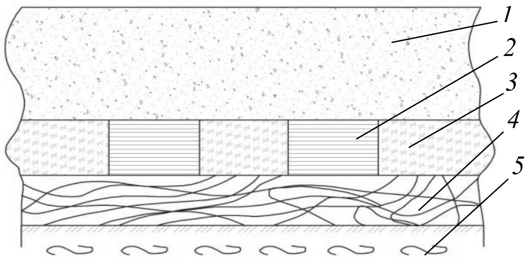

Fig. 1. Road design for boggy peaty areas (cross-section):
1 – road surface; *2* – transversal wooden elements; *3* – longitudinal strips of geosynthetic material; *4* – brush layer composed of felling debris; *5* – weak peaty base

The second most common option, proposed for forest roads with various soil bases (these soils, as a rule, are sandy or sandy-loam), is a road structure in which the logging wastes, geosynthetic materials and local soils are used (see Fig. 2). This structure is quite simple and most appropriate for forestry enterprises.

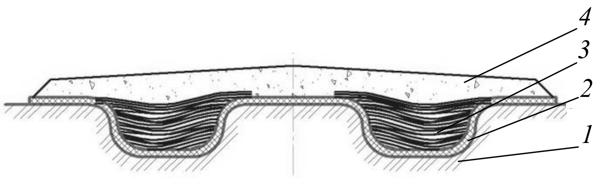

Fig. 2. Rutted pavement with geosynthetic materials and brush layer for forest motor roads:
1 – weak soil base; *2* – geosynthetic material; *3* – brush layer composed of felling debris; *4* – road surface

For the road structure based on the brush layer and geosynthetic material, see Fig. 3. On the road section where the track *3* appears, throughout the full width of the carriageway *1*, felling debris shall be laid and subsequently compacted; the resulting brush layer *2* shall be covered with the interlayer of nonwoven synthetic material *4* fastened along the carriageway edges. Over this structure consisting of the layers of brush and nonwoven synthetic material, the soil layer *5* shall be dumped, leveled and compacted.

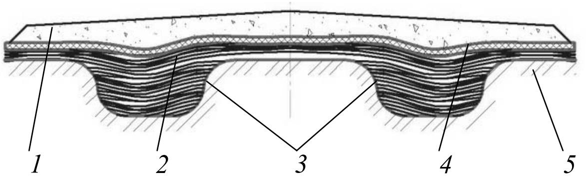

Fig. 3. Service road for boggy areas (cross-section):
1 – roadbed; *2* – brush layer; *3* – rut;
4 – flexible nonwoven synthetic material interlayer;
5 – dumped soil

The construction of experimental facilities included the stages as follows:

- glade cleaning, 10 m width. For this purpose, *Husqvarna* gasoline-powered saws were used. The time consumed for this work was 15.6 man-days and 7.8 shifts of saw operation;
- soil base leveling, including placement of felling debris over the leveled base. The amount of material moved was 32 m^3, and the work time was 1.1 man-days.

Within the scope of earthmoving, *Amkodor* front loader was used to excavate soil from the quarry and to transport it to the roadbed; 480 m^3 of soil was moved. Also, MTZ-1221 tractor with PST-9 dump semitrailer (see Fig. 4) was used for soil transportation. The transportation distance was up to 1 km. The amount of soil moved was 140 m^3.

Fig. 4. Soil transportation and dumping

Within the scope of soil leveling on laid felling debris carried out in order to flat the soil base for geosynthetic material placement, the leveled area was 1008 m^2.

The area of geosynthetic material laid manually (see Fig. 5) was 698 m^2.

Fig. 5. Experimental road segment with geosynthetic material and brush layer

The deck was made of round coniferous timber (see Fig. 6), 4.0 m length, 6…13 cm upper cut diameter, interlaced with geosynthetic material. This deck, 310 m^2, was made manually.

Fig. 6. Experimental road segment with a transversal deck interlaced with geosynthetic material

Fig. 7. *Amkodor* loader used to level the surface

A tractor, MTZ-1221, with PST-9 dump semi-trailer, was used to transport soil to the roadbed and to dump it over the geosynthetic material.

Amkodor front loader (see Fig. 7) was used for road leveling and final preparation, 1,008 m^2.

The road surface area compacted by *Amkodor* front loader was 700 m^2.

Conclusion. As demonstrated by the results of field tests carried out for road structures, the condition of carriageway at experimental segments is satisfactory.

Within the scope of tests, real strength of road surface, rutting rate and deformation properties were investigated. As compared with the segments where geosynthetic materials were not used, experimental facilities have demonstrated high serviceability and were found to be appropriate for the expected timber transportation amount, more than 2,000 m^3.

Thus, application of cost-effective road structures with interlayers made of geosynthetic materials results in significant reduction of use of road-building machinery and makes the construction time shorter due to the reduction of work amounts. Geosynthetic materials demonstrate maximum effectiveness on weak and variable-strength soil bases.

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