

# Application of geosynthetic materials for road structures

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**Abstract.** In this article, the authors examines the application of geomaterials in road constructions, it economic indicators, the dependence of surface density and unit cost, as well as strength and unit cost, are analyzed. The economic and technical advantages of using woven geomaterials are shown. Geosynthetic materials allow increasing the strength of road structures and reducing the cost of construction while maintaining strength and reliability. Geogrid road has all the permits and technical documentation: the calculation methods are developed for the solution of road construction. Woven geomaterials are the best to use and have a number of advantages, but now nonwoven geomaterials are usually used in Russia, which is caused by imperfect design methods that do not take into account the strength of the geomaterial and reduce the density of pavement when using thick geomaterials. Geomaterials are geosynthetic products for strengthening slopes, slopes, coastal zones, road surfaces and other territories that need strengthening of soils. Geomaterials, among other things, are an excellent protection against erosion, environmentally safe, reliable, have a long useful life and are easily installed. Depending on the needs and type of territory, geogrids, geomaterials and road geosets are used.

## 1 Introduction

Modern trends in the development of the construction industry are aimed at the introduction into practice of construction and installation works of geomaterials. They can significantly reduce the consumption of resources, since the life of such materials is up to 120 years, and also have a number of unique properties, such as: high strength and low deformability, water resistance; biostability; resistance to ultraviolet, acid and alkaline media; temperature resistance and most importantly - durability. More than 400 kinds of geotextile materials are currently produced in the world, two thirds of which are used in road construction [1]. Technical aspects of the use of geomaterials in construction have now been worked out in sufficient detail, but the economic indicators of production and application of these materials remain poorly understood, as they have appeared recently in the Russian market. In this regard, it becomes relevant to analyze the economic aspects of the application of geomaterials in construction practice.

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The objectives of this article are:

1. Conduct a comparative economic analysis of the woven materials market.
2. Identify the economic benefits of using woven materials.

Technical characteristics and scope of geomaterials are presented the authors in [2].

Despite the fact that woven geomaterials have a number of advantages, but currently, non-woven geomaterials are more often used in the Russian Federation, which is caused by imperfect design techniques that do not take into account the strength of the geomaterial and reduce the density of pavement when thick geomaterials are used.

## 2 Methods

The current research uses the methods of observation, comparative legal studies, formal logic, description and interpretation. The goal of research is to show that show the types of modern geomaterials used in construction.

The concept of geomaterials includes building materials that, in one way or another, perform their functions in contact with the soil and / or other building materials in geotechnics or other areas of construction [3-8].

Geomaterials serve for:

- strengthening unstable soils;
- roadway reinforcement;
- protection of soil from natural erosion, destruction due to the impact of groundwater;
- separation and filtration of various materials;
- arrangement of drainage systems;
- design of landscape design.

Types of geomaterials.

By origin, the geomaterials are divided into:

Not synthetic. These are metal gabions and nets, fiberglass products (nets, fabrics, fibers, etc.).

**Synthetic.** These include materials made on the basis of polymers (geotextiles, geomembranes, various films, etc.).

Currently, the range of geomaterials includes more than 600 varieties of products, differing in density, thickness, structure and other parameters. The most popular products are:

**Geonet.** This is a synthetic polymeric fabric with a cellular structure that withstands high tensile stresses. Geogrid is supplied in rolls. It is used when laying roads, to strengthen the soil.

**Geomats.** They are made of polypropylene fibers and are used mainly to protect the slopes from natural erosion. Geomats keep ground particles, increasing its stability.

**Geogrid.** Such materials are made of metal and are modular systems characterized by considerable flexibility. They are used for reinforcing slopes, banks of water bodies, bridges, strengthening roads and sites.

**Geotextile.** This fabric is made of polypropylene fibers produced by a woven or non-woven method. Geotextile is resistant to biological influences, moisture and chemicals. Geotextile is used in erosion and drainage systems, in the construction of roads.

**Geomembranes** - are a synthetic material with low permeability, made of polyethylene and resistant to ultraviolet and chemical substances. Such membranes prevent soil contamination, protect it from soil water. They are also used in treatment systems and in the construction of reservoirs.

### 3 Results

#### *Biaxial geogrid "STREN-D".*

Geogrids STREN-D is a flat web material made of polypropylene by extrusion with subsequent biaxial orientation. In the production process, the mesh is stretched in two directions to obtain high strength characteristics at low creep rates.

Geogrids STREN-D is a flat web material made of polypropylene by extrusion with subsequent biaxial orientation. In the production process, the mesh is stretched in two directions to obtain high strength characteristics at low creep rates [9-11].

Flat polypropylene mesh with rectangular mesh, specially designed to increase the ability of structures to withstand high dynamic and static loads, including in construction on weak soils, having close (not more than 20%) mechanical properties in the longitudinal and transverse directions.

Practical use:

- construction of sites for high loads;
- reinforcement of interlayers in the construction of highways;
- strengthening of roadsides;
- stabilization of the base when constructing industrial floors (Tabl.1).

**Table 1.** Specifications

STREN	Cell size (mm)	Breaking load (kN / m)	Density (g / m <sup>2</sup> )	Roll size (m)	Colour
Д-20/39	39x39	20/20	220	4 x 50	black
Д-30/39	39x39	30/30	330	4 x 50	black
Д-40/39	39x39	40/40	530	4 x 50	black
Д-20/65	65x65	20/20	230	4 x 50	black
Д-30/65	65x65	30/30	340	4 x 50	black
Д-40/65	65x65	40/40	540	4 x 50	black

#### *Advantages of using the geogrid STREEN-D:*

- high degree of strength;
- low elongation at maximum permissible load;
- reinforcement of the base during the construction of winter roads;
- the possibility of carrying out construction work in the Far North and equivalent territories;
- reduces the dynamics of accumulation and the magnitude of residual deformations;
- the structural layer of the bearing base (crushed stone) is not mixed with an additional layer of the base (sand), which increases the time between roads and roads;
- crushed stone does not go into the sand, so in such constructions the rut and dips are significantly reduced.

The draining layer of sand remains intact for the entire service life due to the exclusion of crushed stone falling into it.

It allows to reduce the layer of rubble by 20-40%, which gives significant savings to the cost and terms of construction.

Economic effect. Guarantees a real economic effect, reduced costs due to a smaller amount of filler used in the formation of the roadway.

#### *The uniaxial geogrid "STREN-O"*

Geogrids STREN-O is a flat web material made by extrusion with subsequent uniaxial orientation from low pressure polyethylene. The material is polyethylene mesh with long narrow holes oriented in one direction to create high tensile strength [11-12].

Geogrids STREN-O is a flat web material made by extrusion with subsequent uniaxial orientation from low pressure polyethylene. The material is polyethylene mesh with long

narrow holes oriented in one direction to create high tensile strength. According to the calculations in the projects geogrids with different strength characteristics from 50 to 160 kN / m are used.

Practical application of the geogrid STREN-O:

Reinforcement of soil structures, retaining walls, foundations of bridges, slopes, earthen dams;

Creation of slopes with an angle of laying up to 90 °;

Construction of embankments on weak soils;

Restoration of landslide slopes;

Erosion control.

Economic effect

Guarantees a real economic effect, reduced costs due to a smaller amount of filler used in the formation of the roadway (Tabl.2).

*Specifications.*

**Table 2.** Physical and mechanical properties of the geogrid STREN-O

STREN	Cell size (mm)	Breaking load (kN / m)	Density (g / m <sup>2</sup> )	Roll size (m)	Colour
STREN-O50/235	22x235	50	420	1x 50	black
STREN-O80/235	22x235	80	600	1x 50	black
STREN-O90/235	22x235	90	680	1x50	black
STREN-O110/235	22x235	110	800	1x50	black
STREN-O120/235	12x235	120	940	1x50	black
STREN-O140/235	13x235	140	1150	1x50	black
STREN-O160/235	16x235	160	1310	1x50	black

Advantages of geogrid application STREN-O:

stabilizes the design in conditions of high dynamic and statistical loads;

high degree of strength of the material;

resistant to UV exposure;

not toxic;

long-lived.

*Volumetric geogrids "STREN-R".*

This type of geomaterials is a honeycomb structure, obtained by stretching a packet of welded polyethylene tapes of different widths. After stretching the bag into a working position, a stable honeycomb frame is formed. As a filler of geomaterials, it is possible to use sand, soil, gravel, concrete, etc. Designed to strengthen various types of land. So, the geogrid is able to stop the collapse of the banks of water bodies, slopes and ravines, and also to maintain the necessary form of small both artificial and natural reservoirs. Also installed on a steep slope, the geogrid protects against falling, shedding or slipping of the ground [13-14]. Geogrids are an indispensable basis for any landscape design operations, from road construction to strengthening of various slopes. The use of geogrids today is the guarantee of the strength and durability of any structure or structure, because it will not allow the ground to be exposed on the site. At the same time, our products, having the ability to pass moisture, will not cause the formation of puddles, therefore, you can not be afraid of swamping the terrain. It should also be noted that geogrids can be used on all types of soils.

Economic effect.

Using a 3D geogrid allows you to reduce the cost of filler for the roadway, and also allows you to forget about any (often very costly) measures to bring the landscape to the

required state after caving in or landslides. The geogrid does not require care or maintenance due to its strength and protection from aggressive environmental factors.

Benefits.

The use of a volume geogrid reduces the cost of filler for the roadway, while maintaining its strength and durability.

Prevents the destruction of surfaces and the displacement of soil.

Compact and easy to carry.

Unlimited lifetime.

Over time, the geogrid only increases its strength due to the root system of surrounding plants.

Resistant to all types of effects - from ultraviolet to corrosive.

Temperature range - from -60 to +60 degrees Celsius.

*Specifications.*

In the production of geogrids volumetric, spot ultrasonic welding is used. The length of the tape of our geogrids is from 3.5 to 4 meters. Our products can be purchased in batches of up to 100 tapes. We also offer geogrids of different widths: 50, 75, 100, 150 and 200 mm. The thickness of the tape is 1.4 mm with an error of not more than 0.05 mm.

Geogrids are three-dimensional in structure much like bee honeycombs, with the only difference being that the rhombi from which the ribbon consists are perforated. This increases the strength of the structure, improves its adhesion, and also reduces its weight.

Polyester mesh (with bitumen or PVC coating). Geogrids of polyester yarns are designed to reinforce asphalt concrete. Damage caused by temperature fluctuations and associated with vehicle loads can lead to cracks in asphalt pavements. Asphaltic concrete has a small breaking strength, which can be exceeded even with small stretches. As a result, cracks are formed. The polyester geomembrane PSD is a flat web material formed by elastic ribs made of high-strength polyester yarn bundles, fastened at the knots by a sewing thread with the formation of cells. In the manufacture of geogrids treated with bituminous composition or PVC coating. Geogrids are produced on German equipment, using the latest technologies of weaving and impregnating high-strength polyester yarns, have been certified by the Federal Road Agency, comply with Russian standards and used throughout Russia.

*The main areas of application of the geogrid.*

Polyester geonet is widely used in various industries. The main areas are:

Road construction:

- Reinforcement of asphalt-concrete coatings;
- Ground reinforcement (slope arrangement);
- Strengthening of slopes (protection against erosion);
- Construction of mounds on weak grounds;
- Reinforcement of the foundations of the roadbed in permafrost zones;
- Separation of layers and drainage.

Railway construction:

- Fill on weak grounds;
- Installation of retaining walls and slopes;
- Reinforcement of the foundations of the roadbed in permafrost zones;
- Anti-erosion protection slopes.

Construction of landfills;

Construction of retaining walls;

Hydraulic construction;

Airports.

*Benefits of using a polyester geogrid.*

Polyester geogrid DPD is characterized by a number of advantages:

- Increasing the bearing capacity of the base, which allows you to build objects even on very weak grounds;
- Acceleration of soil consolidation;
- Reducing the cost of excavation, including the removal and replacement of weak soils;
- Increase in the service life of the facilities (Tabl.3);
- Reducing the deformation of materials at large temperature changes and in severe frosts

**Table 3.** Specifications. Name for the main brands of geogrids

Indicator name	Name for the main brands of geogrids					
	(50x50) 32x38	(46x40) 25x25	(35x30) 25x25	(45x40) 40x40	(35x30) 40x40	(50x45) 32x42
Average distance between roving: on the basis, mm: by the weft, mm:	32 ± 3 38 ± 3	25 ± 3 25 ± 3	25 ± 3 25 ± 5	40 ± 5 40 ± 5	40 ± 5 40 ± 5	32 ± 3 32 ± 42
Maximum breaking load along the length, kN / m, not less than	50	45	35	45	35	50
Maximum breaking load in width kN / m, not less than	50	40	30	40	30	45
Elongation in the transverse direction at max. load,%, not more than	up to 15	up to 13	up to 13	up to 15	up to 15	up to 15
Elongation in the longitudinal direction at max. load,%, not more than	up to 13	up to 12	up to 12	up to 13	up to 13	up to 13
Thermal stability, ° C, not less than	190	190	190	190	190	190

Polyester geonet has an acceptable cost. We are ready to offer a wide range of goods, as well as help in choosing the necessary material.

*Geocomposite STREN-ASGEO.*

The geocomposite "STREN-ASGEO" is a fundamentally new material developed by a group of Novopolymer specialists by thermally combining three layers of polymer materials designed to protect the isolated surface of pipelines during construction, reconstruction and overhaul in flooded, waterlogged and marshy areas [15-16].

The geocomposite "STREN-ASGEO" is a fundamentally new material developed by a group of Novopolymer specialists by thermally combining three layers of polymer materials designed to protect the isolated surface of pipelines during construction, reconstruction and overhaul in flooded, waterlogged and marshy areas. Thanks to the textile insert, the film adsorbs the remains of steam, moisture and promotes their weathering through ventilation gaps. An irreplaceable material in the construction of metal roofing.

*Application area:*

- protection of the insulated surface of pipelines during construction, reconstruction and overhaul in flooded, waterlogged and wetlands;
- construction of solid waste landfills;
- protection of the insulation from moisture (waterproofing);
- thermal insulation of the roof and bearing walls of the building;
- temporary warming of civil and construction sites.

## 4 Conclusions

In foreign construction practice the term geomaterials was introduced into practice in the 90s of the twentieth century, as a term that replaced the definition of geotextiles. Geotextiles were the first representatives of technical textiles and fabrics, which began to be used in construction and in particular geotechnics.

More than 40 years of development of the geotextile industry, aimed at developing new types of materials, as well as the introduction of new technologies for the production of plastic products (extrusion, various types of rolled products, laser welding, etc.) led to the emergence of new types of geotextiles, geotextiles related products, geomembrane and geocomposition materials. This circumstance caused the need to identify these materials in an independent group of building materials - geosynthetic materials.

This term unites a wide group of materials that are used in geotechnics in contact with soil or other building materials. Geomaterials are used in the construction of environmental facilities - landfills, wastewater sludge, oil storage tanks, are widely used in hydrotechnical, road and underground construction, as well as stabilization of erosion processes of soils and soils, and restoration of urbanized areas. Due to the fact that geosynthetic materials are made of polymers, they have high durability and resistance to aggressive influences - chemical, biological, thermal, etc. Depending on the operating conditions, a material made of the polymer that most closely meets the requirements. Geosynthetics have replaced natural mineral materials, the resource of which is not unlimited, their use makes it possible to reduce transportation costs and labor input. The application of geomaterials allows to ensure the guaranteed quality of engineering solutions.

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