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Soil stabilization technology "ANT"

Technology "ANT"- is an innovative technical solution in the field of soil stabilization. It is intended for creation the road bed and road carpet made of man-maid and residual soils. This technology differs from those available on the international market of soil stabilization technologies in a number of factors. Initially, "ANT" technology was developed for the construction of roads in severe climatic conditions , such as: a large amount of precipitations in the form of rain and snow, a large number of cycles of freezing and thawing of the road during the winter period, the air temperature from $+40^0$C up to -50^0C, heavy loads from transport. Today more than 1000 km of roads are operated in different climatic zones of the World, from the tropics of India to the Polar circle. A distinctive feature of "ANT" soil stabilization technology is high physical and mechanical properties of stabilized soil, low construction cost, ease of technology use and 100% safety for humans and the environment.

Field of technology "ANT" application :

- creation of the upper road bed for roads with high traffic;

- creation of the upper layers of coating for rural roads, industrial, quarry and other, do not require a layer of asphalt or concrete;

- construction of airport runways;

- construction of industrial sites and roads with a high load on the axis of vehicles or tracked vehicles.

The main element of the technology is the preparation of soil binder "ANT". It is produced by catalysis method of natural organic substances and is completely safe for humans and nature. Soil binder "ANT" at the molecular level initiates oxidation-reduction reactions in the soil, resulting in the formation of new crystalline compounds between individual particles of the soil and the soil acquires the properties of solid material. This reaction repeats the processes of formation of sedimentary and metamorphic mineral aggregates in nature, such as limestone, dolomite, sandstone and others.

The uniqueness of the technology “ANT”

1. Soil binder "ANT" is an environmentally friendly product made of organic materials and it is not dangerous to humans and the environment. Binder "ANT" is the initiator of oxidation-reduction reaction and its action is completely repeated natural processes of formation of sedimentary and metamorphic mineral aggregates.
2. The result of the technology "ANT" appliance is a monolithic, durable, stone slab, which have both high strength and water resistance, but also high deformation resistance, preventing the formation of cracks.
3. For the construction of roads used natural soils as well as man-made soils in the form of waste crushing of mineral aggregates, low-strength rocks, various industrial waste.
4. High physical and mechanical properties of the stone slab allow to apply this technology in all climatic zones of the World, from the tropics to the polar circle.
5. "ANT" technology can be used in the construction of roads of all technical categories, from rural roads to highways, as well as for the foundation and coatings of industrial facilities of wide range of use.
6. The use of ANT technology reduces the estimated cost of road construction from 30% to 70%.
7. Traffic on the stone slab, created with the use of "ANT" technology, can be opened immediately after compaction. It is not required to close the traffic or care for the layer (to prevent evaporation of the layer).

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8. From the moment of mixing the soil with an aqueous solution of the binder "ANT" and cement, the construction company has 6 hours to complete soil compaction.

Usage rate of soil binder "ANT", water and cement

Soil binder "ANT" is a concentrated liquid and it is used for work with water. Water is used to water the soil up to optimum moisture content when compacting and transporting the stabilizer "ANT". The required amount of water is calculated on the basis of natural and optimal soil moisture and soil mass.

The recommended usage rate of the "ANT" stabilizer is 0.007% of the soil weight. The stabilizer is mixed with water and introduced into the soil. In practice, under different climatic conditions and soil moisture, the coefficient of binder dissolution with water is from 1:250 to 1:1500 (one liter of soil binder "ANT" on the number of liters of water).

Approximate usage rates of soil binder "ANT" for 1m^2 of stabilized soil depending on the thickness of the layer			
h = 15 cm	h = 20 cm	h = 25 cm	h = 30 cm
0,02 litres	0,027 litres	0,033 litres	0,04 litres

During works, we recommend to use the cementing materials. The most widespread and most often used material is cement. "ANT" binder oxidizes the cement and its minerals are going to create a greater number of crystalline bonds between particles of soil. Cement usage rate for different climatic zones is from 1% to 5% of the mass of the material used for the production of works.

Which materials and soils can be used to create stone roads?

1. **Natural soils.**
   For road construction using "ANT" technology it is recommended to use soils containing clay particles in an amount from 5% to 30% (particle size less than 0.005 mm). If necessary, you can change the granulometric composition of the soil by adding sand to it (reducing clay particles) or clay soils (increasing the number of clay particles). The best results are obtained on sand and gravel soils and sandy loam soils. For example, in mountainous areas, we often use the upper layers from the surface of the mountains, which, if necessary, sift through a sieve 70mm or crush. On the plains we use the soils available on site or in nearby quarries.

2. **Waste crushing of the stone.**
   There is a large amount of waste in the form of primary and secondary screenings crushing in the quarries

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of sedimentary and metamorphic rocks (limestone, shell rock, dolomite, sandstone, flask, etc.). In most cases, these wastes have no commercial value, as they are not used for the production of building materials (asphalt, concrete) and are not suitable for construction. The technology of "Stone roads "ANT" allows you to apply these wastes to create foundations and toppings of roads. The use of crushing waste in conjunction with the "ANT" technology allows not only to simplify the processes of work, but also to have a large amount of homogeneous material .

3. Quarries and mines waste.

Quarries and mines waste – a natural stone materials formed as a result of mining activities. There is a huge amount of such waste in all quarries that do not represent any market value. In most cases, the waste of mines and quarries appear to be environmentally hazardous materials that pollute the environment. These materials can be used to create foundations and road topping using the technology "Stone road "ANT". After the work we will get a solid, monolithic slab that will solve a number of technical and environmental issues.

4. Inductrial wastes.

There are wastes in the form of slags formed as a result of melting of steel, aluminum, copper and other materials at the enterprises of metallurgical production. The use of these wastes is possible after preliminary crushing and subsequent mixing with natural clay soils. The addition of clay soils is necessary to increase the number of plastic particles smaller than 0.005 mm. The use of slag together with natural soils can solve a number of technical and environmental issues.

Analysis of the effectiveness of the stabilizer "ANT"

Used material:

- screening of limestone crushing ;
- cement;
- soil binder "ANT";
- water in the amount necessary to achieve optimal soil moisture during compaction.

Name of indicators of physical and mechanical properties according to technical standards	**Compositions of stabilized soil**	
	Screenings + 5% cement + water	Screenings + 5% cement + 0.007% ANT + water
Actual stress at facture after full saturation with water within 48 hours	4.75 MPa	7.29 MPa
Water saturation in water by weight	10,5 %	6,8 %

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The number of cycles of freezing and thawing at-20^{0}C and full water saturation of samples. Determination is made to reduce the lashing properties for 25%.	15 cycles	40 cycles
Modulus of material elasticity	430 MPa	850 MPa

Analysis of the economic efficiency of "ANT" technology in the construction of 1 km of road

Initial data for the calculation of road contruction.
The lowest temperature in winter - minus 35^{0}C
The lowest temperature in summer - minus 35^{0}C
Estimated service life of the road to repair - 15 years
Fictitious load for axle of freight transport– 100 kN
Required modulus of elasticity on the surface of the coating – not less than 250 MPa
The total number of vehicles for the entire period – 2,000,000 units
Width of asphalt covering is - 6 meters
The width of the foundation is 8 meters.

"ANT"	**The use of mineral aggregates**
Road structure: 1. Dense asphalt - layer thickness 5cm 2. Foundation made of stone crushing screening, stabilized 0.007% ANT and 5% 3. cement - 20cm Earth roadbed	**Road structure:** 1. Dense asphalt - 5 cm 2. Open-type asphalt -6 cm 3. Crushed agent - 30 cm 4. Sand - 20 cm Earth roadbed
Number of materials per 1 km of road Dense asphalt - 729 tons x 60€ = 43 740€ Stone crushing screening – 2400 tons × 6€ = 14 400€ Soil binder "ANT"- 246 litres × 45€ = 11 070€ Cement -	**Number of materials per 1 km of road** Dense asphalt - 729 tons x 60€ = 43 740€ Open-type asphalt - 792 tons × 45€ = 35 640€ Crushed agent fractions 0-45 – 3240 tons × 8€ = 25 920€ Sand -

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176 tons × 95€ = 16 720€ Water - 80 tons × 3€ = 240€ **Total: 86 170€**	1680 tons × 6€ = 10 080€ **Total: 115,380€**

The difference is 29 290€.

Not including transport expenditures.
Transport expenditures:
Using "ANT" technology, all materials will need to be transported
(3385 t. : 25 t) = 135 trips
Using the current technology you will need
(6441 t. : 25t) = 257 trips
Let's say one trip costs 100 euros. In addition, it will cost 12 200 euros of transport expenditures.
We save (previously) about 40 000 € on the construction of 1 km of road.
P.c. We calculated the materials only for stabilized area.

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