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INNOVATION IN ROAD RENOVATION AND CONSTRUCTION

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Abstract: In this paper is presented an innovative product and procedure for road renovation and construction called nanoSTAB. The comparisons of these product and procedure with the conventional product and procedures are shown.

Key words: ground stabilisation, road construction, road renovation.

1. INTRODUCTION AND GENERALITIES

The nanoSTAB procedure is a method for ground stabilisation using the nanoSTAB product.

Using the nanoSTAB procedure the ground is stabilized without having to excavate or exchange the soil layers of the ground, or having to refill the ground with ballast.

It is especially suited for the base layer of roads, parking lots, all kinds of traffic space and for railway tracks as well airports including airstrips.

Forming a base layer usually requires removing the existing soil and disposing the latter in a landfill. Next, various gravel and/or rubble layers are realized and covered with an asphalt layer having a thickness of up to 34cm.

The nanoSTAB mostly eliminates these sumptuous, expensive and time-consuming steps.

Depending on the machines deployed, nanoSTAB enables you to realise up to 2km of finished base layer independently of the road width.

The existing soil is simply intermixed adding the amount previously determined by a laboratory of cement and polymer especially developed for this purpose using special machines and covered with asphalt as required. This procedure even enables reducing the asphalt thickness in most cases thanks to the high pressure resistance of this nanoSTAB layer.

This procedure creates a homogenous layer that replaces all other layers, like e.g. the frost protection layer.

The layer is extremely tough and can bear higher loads than conventional road base layers, while however keeping a certain flexibility that can absorb intermittent loads and vibrations, thus significantly limiting or completely eliminating crack formation.

The nanoSTAB procedure is ideally suited for both new constructions and renovations.

With the nanoSTAB procedure constructions and renovations are performed significantly faster and more cost effectively than with conventional procedures.

The nanoSTAB procedure is a major step forward in the global goal of reducing environmental impact by reducing CO_2 emissions.

The nanoSTAB product is a non-toxic, environmentally friendly and water-soluble polymer additive.

In the nanoSTAB procedure the nanoSTAB product is milled together with hydraulic binders (cement) into the ground to be stabilized or renovated.

The nanoSTAB product purpose a largely water-impermeability and therefore significantly contributes towards reducing frost damages.

Given its rapid reactivity combined with the hydraulic binder (cement), grounds worked in this way reach a high early hardness, which means these can be opened for further works after a very short time.By ingredients of the polymer the hydration process is influenced in a way that results in a significantly higher density in the compound and thus in a higher load capacity.

In addition, ingredients of the polymer ensure the permanent elasticity of the individual particles. The nanoparticles included in the polymer ensure that even the smallest pores are filled, eliminating voids that potentially could absorb water.

The nanoSTAB layer can be treated and recycled at any time, if required. It is environment-neutral and can even immobilise hazardous substances contained in soil.

2. BASIC STEPS OF NANOSTAB PROCEDURE

2.1 Preliminary Survey

The proper installation procedure depends on the conditions on-site. Therefore, an assessment of the climate conditions as well as the existing soil and the relevant subsoil is performed. If relevant a status analysis of the old roads is performed.

The correct formulation for the polymer/cement/water mixture is determined by a laboratory.

An expert team develops a project-specific installation procedure based on a large number of collected information. The machine requirements according to the road width and the required construction speed are determined.

2.2 Ground Stabilization

The existing surface is milled through, where the milled material is broken down and crushed into very small pieces. This employs milling machines specially developed. There are different milling machines available, adapted to the specific requirements such as soil type and milling depth. These milling machines can also be adapted and optimized for special requirements at short notice

The nanoSTAB product and the hydraulic binder are mixed into the milled material. The milling machines combine all components to become a highly homogenous layer, depending on the previously determined required thickness. The binder is applied by a gritter. The polymer is added through adjustable nozzle bars immediately in front of the mill or within the mill cavity.

The roadbed worked in this manner is levelled off and then thoroughly compacted.

A grader serves to ensure an even surface that is compacted with corresponding rollers and finally treated with the grader again for fine-levelling.

The surface can be opened to traffic or cleared for further works after a very short time:

- The layer is resilient only after one day.
- The asphalt can be applied after 2 days.

2.3 Quality Assurance

The ***Quality Assurance*** is performed by:

- internal quality management
- highly experienced independent institutes for quality assurance from the outset

Everything is logged in greatest detail and supervised by independent institutes:

- specially calculated formula for the mixture

- provision of the optimum machine fleet
- construction supervision with regular sample analyses
- final and follow-up inspections at agreed intervals

That way, even the slightest deviations from the installation procedure can be responded to immediately

3. COMPARISON OF THE NANOSTAB METHOD AGAINST THE TRADITIONAL METHOD FOR ROAD RENOVATION

A comparison of the nanoSTAB method against the traditional method for road renovation is presented in the following:

Criteria	nanoSTAB	traditional method
Construction Duration	Construction with nanoSTAB method is approximately 5 times faster than the conventional construction method. For example, construction time for 1 km road (10 m width) with nanoSTAB method is 2 days	Construction time for 1 km road (10m width) with conventional method is 10 days (base course and binder course)
Material	nanoSTAB method used with any kind of soil except soils with high organic contents. For renovation works existing asphalt layers can be used.	Existing soil and/or asphalt layers must be removed and disposed and new material must be used for the conventional construction method.
Load Bearing Capacity	With adjustment in nanoSTAB/cement-mixture ratio any required load bearing capacity can be achieved.	Load bearing capacity is limited in accordance to existing material. Achieving high load bearing capacitiy requires increase in asphalt layer thickness.
Flexibilty	The nanoSTAB layer has high bending tension strenght. Vibrations, especially those created by high load achses are absorbed and do not affect the durability of the layer. The layer is finalized and steady after finishing but still has some flexibility which provides the high bending tension strenght.	Lack of bending tension strenght in conventional method results risk of cracks due to high short load impuls peaks and vibrations which generates movement of the single particles and stones. Layer is not finalized and steady after finishing, it will always have movements inside, which creates holes and later also settlements which can result in cracks on the surface of the asphalt layer.
Durability	High durabilty achieved with the nanoSTAB method because the air voids are filled with nano particles and this creates high water-impermeability. Strong bonding between each particle and stones prevents movement of stones and particles and this therfor prevents the settlement on road surface.	In conventional method water can create micro damages caused by the high permeability of the system and therefor significantly reduce the durability. System is not finalised and will always allow changes and movement within due to the air voids not filled with bitumen. Once particles and stones are moving, bigger holes are created within the layer, which can result settlements and holes on the surface of the asphalt.

Criteria	nanoSTAB	traditional method
Local environment	asphalt and any other existing contaminants are immobilized, no need to dispose the old material	Asphalt and other possible contaminants must be disposed somewhere
Density	very high density is achieved with nanoSTAB method as the air voids even in nanoscale are filled with nanoparticles instead of remaining empty. Air voids allow movement of particles and/or water absorbtion.	lower density because air voids are filled with water or remain empty which allows movement of the particles and this causes changes in asphalt layer all the time.
Overall environment	nanoSTAB method reduces the CO2 emission by reducing the construction period. For example: In a 17km highway repair work the CO2 is 37,673 kg.	Due to the longer construction duration the CO2 emission for the same work with the conventional method is 863,537 kg.
Resistance to temperature variations	Due to high water-impermeability, high resistance to temperature variations between day and night and summer and winter is achieved with nanoSTAB method. The tendency to form cracks is minimized.	Due to permeability, low resistance to temperature variations between day and night and summer and winter. The tendency to form cracks is maximized in conventional method.

4. CONCLUSION

The nanoSTAB procedure and product have the following advantages:

Significant time savings and substantial cost savings during construction
Workforce and machinery employment times at least 5 times shorter, elimination of a significant amount of the fuel costs and extremely reduced capital expenditure for the required equipment, reduction of the Asphalt base course, re-use of material.

The CO2 emissions are reduced by as much as 90% during construction
By reducing the amount of heavy transport and the quantities of fuel normally required, by drastically shortening the construction time for the project, and by significantly shortening traffic jam times.

An enormous savings potential with regards to maintenance costs and effort
Prevention of frost damages given the low water permeability of the prepared roadbed. Given the high compressive strength and flexural tensile strength of the roadbed.

REFERENCES

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