# TERRASYSTEM®

The scarcity and occasional exhaustion of conventional construction materials make it necessary to use in increasing quantities in-situ soil in road construction and road maintenance and in any other earthwork to protect nature and environment, save the ending resources of gravel and crushed rock and avoid waste of valuable materials.

# DESCRIPTION OF TERRA-3000®

TERRA-3000® is an chemical product that reduce the surface tension of the water around the soil particles so that the barrier film surrounding the particles is dispersed in order for the surfaces of the particles to associate to each other. This causes an agglomeration of fines (mainly the minus 0,06mm fraction). TERRA-3000® is not a binding compound, but improves certain soil characteristics through the waterproofing effect. TERRA-3000® is moderately acidic (pH = 6), has an ammonia odour. The process is permanent and irreversible once dried. The material (soil) treated with TERRA-3000® has the following properties compared to untreated material:

## PROPERTIES

- Reduced resistance to compaction due to the loss of pore water.
- Reduced rising of capillary water.
- Reduced permeability.
- The optimum moisture content is lower and the density is higher for treated material. In such cases where density and optimum moisture content are the same as in the untreated material it has shown that the voids in the treated material have increased due to the agglomerating effect of TERRA-3000®.
- Continued process of the agglomeration of fines with time.
- Reduced water sensitivity (higher water resistance).
- Larger increase in dry density by after-compaction, even if compacted at a high moisture content.
- Lower water penetration (better waterproofing).
- Reduced plasticity and swell.

The pavement layer is normally mixed to a depth of 250 to 300mm. Larger quantities of TERRA-3000® are not harmful. The mechanism of stabilisation is basically the formation of cautions during evaporation. Higher strengths are achieved by keeping the soil dry.

TERRA-3000® is supplied in 25 liter cans.

TERRA-SYSTEM Bodenstabilisierung Betriebsges.m.b.H.
Phone: + 43-(0)3118-5110, email: terra.system@aon.at , http //www.terra-3000.com

Costs

The cost of TERRA-3000® depend on the application rate and on the quality of the in-situ soil. In respect of cost comparison it is in our opinion misleading to compare the costs of TERRA-3000® with treatments of cement/lime or bitumen, since the latter treatments do not permanently change the soil and therefore comparisons are not the same.

Our findings state that the cost of a treated soil with TERRA-3000® provide substantial savings (as opposed to a conventional construction of the same road). Due to the fact that a much higher portion of in-situ soil can be used and that the wearing course can be reduced, contributes the major overall savings. Hundreds of truckloads can be saved because by carrying in-suit soil to a dumping ground and clean sand and gravel from a quarry back to the construction side. Also less truckloads of asphalt concrete are needed because the thickness of the layer can be reduced to 5 to 7 cm.

These savings using TERRA-3000® has shown cost savings between 20 and 50%. The construction costs are similar to those of conventional treatments (e.g. cement, bitumen) except that curing is normally not required.

# AREAS OF APPLICATION

## THE MAIN AREAS OF APPLICATION ARE

PAVEMENTS
Any type of roads
Agricultural, forest-roads
Road shoulders
Railroad embankments
Industrial areas
Parking lots
Road rehabilitation:
Airports

Sub-base for problematic soils

EROSION CONTROL
Embankments
Reforestation
Re-cultivation

SEEPAGE CONTROL
Water reservoirs
Dams
Water channels
Irrigation
Dikes
Lake sealing
Fish ponds sealing
Landscaping

MINING
Underground roadways
Loading areas

OTHERS, INCLUDING
Play grounds
Sports fields
Refuse dumping ground

This report deals with the use of TERRA-3000® in pavements used by vehicles, aircraft, or trains.

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USES, ADVANTAGES AND DISADVANTAGES

According to our research and independent laboratory test results most soils can be treated to improve its properties. The following are exceptions: non-cohesive soils, heavy clays and soils with less than about 15% of particles smaller than 0,002 mm. Non-cohesive soils can be mixed with clay and silt and successfully treated, while heavy clay can be mixed with sand or gravel to improve workability.

The advantages of TERRA-3000® can be summarised as follows:

IMPROVEMENT OF MATERIAL PROPERTIES
reduces permeability and capillary rise
reduces plasticity index (PI)
reduces optimum moisture content
increases LOAD CAPACITY (Evd) as well as unconfined compressive strength and stiffness
increases maximum dry density
reduces swell and linear shrinkage
prevents water from softening the soil (after curing). The moisture content remains low during soaking and the dry strength is retained.
Strength is gained by the evaporation of moisture. TERRA-3000® works in arid as well as in areas with high humidity. The general conditions regarding compaction have to be respected under all circumstances, which means compaction at PO/OMC or slightly above.

COMPACTION
enhances compaction
remarkable increase of density by compaction after construction under traffic
reduces drying period.

CONSTRUCTION
simple application
robust in that application rates do not have to be exact
can be stockpiled/premixed
construction can be interrupted by rain without negative consequences.

GENERAL
Improves frost resistance
upgrades inferior soils
prevents softening of clayey material during wet seasons.

The DISADVANTAGES are

A surfacing is normally required, as it is required for any other type of treated or untreated base course/top layer to prevent mechanical abrasion.

TERRA-3000® provides a non-erosible base course or sub-base with high bridging effect under any type of wearing course and with the possibility of reducing the wearing course substantially, because the treated layers will take over most of the required bridging effect for the road.

To improve marginal material by doing one or more of the following:
Increase bearing capacity of sub grade
Reduce Plasticity Index (PI)
Reduce permeability of sub grade with drainage for the surface water
Reduce capillary action (e.g. on wet areas)
To improve compaction and workability

Excellent results uses for:
Use where the reuse of the materials is possibility (as opposed to a cementitious product).

Use where shrinkage cracking is a problem (versus cementitious stabilisation).

Use where treated material has to be stored (as opposed to cementitious) or hauled long distances.

Where proper mixing is a problem.

On road shoulders to protect moisture from increasing into the outside metre of the pavement.

Underground mining roadways in collieries, gold, diamond and other mineral mining activity.

Sealing lakes, reservoirs, irrigation, dumping grounds, etc. to prevent seepage.

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Recommended Machinery

To build a road fast and with good quality, we recommend the following equipment. What we need is at least a soil stabilizer for mixing in the TERRA-3000® and a compactor for compacting the treated soil.

With modern equipment, it is possible to build 1 to 1.5 km road per day, ready for the traffic to use the road.

Machines:

Wirtgen : All WR – Types or
Bomag : Mph 121 or
RACO : 350 - 550 or
a tractor-towed stabilizer from wirtgen or FAE

We mix the TERRA-3000® with the soil.

With the grader we plane the sub-base.

Shepsfoot roller

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Machinery work

Finally we protect our work
with a wearing course.

ALTERNATIVES FOR SOIL MIXING

THE MIX-IN-PLACE TREATMENT

This alternative is recommended when in-place soils are to be used or if the use of a mixing plant is not justified. This method reduces material handling and transportation costs. Mixing the soil with the correct quantity of compaction water, containing TERRA-3000®, is performed on the site.

THE MIX-IN-PLANT PRE-TREATMENT (FIXED OR MOBILE)

This alternative is recommended when the required construction material has to be transported from deposits or when material handling is inevitable. This method reduces mixing costs, eliminates the loss of fines and allows storage of treated soil without loss of effectiveness of the treatment.

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CONSTRUCTION WITH TERRA-3000®

The area to be treated is prepared as follows:

. Break up the layer thoroughly by running the grinder through the layer to be treated. The depth is between 250 mm and 300mm. Layers can be moved aside .
. From the laboratory results and determined start values, calculate the following:

- The quantity of water for optimum compaction.
- The minimum quantity of water in order to secure a sufficient distribution of TERRA-3000® in the soil.
- The mixing proportion of the TERRA-3000® solution.
- The entire quantity of TERRA-3000® for the area to be treated.
- The entire quantity of water for the area to be treated.

. The TERRA-3000® is mixed into the soil to the required depth with a grinder. TERRA-3000® is surface active; therefore the solution must obtain the best possible contact with all soil particles.

Proper mixing and compaction are of the utmost importance

FAE - milling machine with automatic injection

Sheepfoots roller

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LABORATORY AND IN-SITU TESTING

The effectiveness of TERRA-3000® is confirmed by testing any kind of in-situ soils. It was the aim of TERRA-3000® to enable an improvement of any kind of soils with more or less the same quantity of additive.

After testing different kinds of soils it can be asserted that TERRA-3000® allow the upgrading of any kind of cohesive soil and that the overwhelming majority of soil types can be treated within the standard application range for the additive.

The following main characteristics have to be respected:

The soil should have a minimum of fines content of 15% (< 0,002mm) and should have no lumps for the treatment.
Avoid gap-sized material or add the missing fractions to obtain the best possible mechanical stability (strength) prior to the treatment.
The treatment with TERRA-3000® costs the same but yields much better effects if you respect this recommendation.

RECOMMENDED TESTS:

Any kind of soil test specified for laboratory testing of soils can be used, as long as you respect the modification of curing (drying back) the test blocks to at least 50% OMC before testing is started.

Due to the fact that water is the greatest enemy for stability, any laboratory test showing improvements in behaviour with water. It will be an impressive way to see the high effectiveness of TERRA-3000®.

LABORATORY TESTS

Capillary rise of water ,
Penetration tests,
Linear Shrinkage,

FIELD TESTS
In the field any standard test can be carried out and will show the improvement in remarkable figures.

PLATE BEARING PRESSURE,
PENETROMETER TEST,

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to name a few, will show the fact that in most cases the values obtained in the field out perform the test results in the laboratory.

Very impressive is the fact that under traffic the treated soil is further improved and increases the density.

Field test bearing capacity


Sieve analysis

## ENVIRONMENT

During the development of TERRA-3000® greatest care was taken to avoid any pollution of the environment with the additive, provided they are correctly applied, see the safety data sheet