TERRASYSTEM®

TERRA-3000® Soil stabilization

TERRA-SYSTEM
Bodenstabilisierung
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TERRASYSTEM®

High-Performance
Soil Stabilizer, water retainer, composting

TERRASYSTEM®,

the leader in development, distribution and application of organic liquid polymers and amine formulation for soil stabilization needs in multiple construction sectors.
TERRASYSTEM® products are the result of over 30 years of research and development and have been used in multiple countries with great success.
TERRASYSTEM® 's vision reflects our world-wide commitment to sustainable road building technology. We want to make sustainable road technologies work to help the industry build better infrastructure.
The company's primary field of activity is providing sustainable and green road building solutions using nano technology.

Another business area of **TERRA**SYSTEM® is water retainer " **WET-SORB** "

Human activities require more and more resources - among them water is certainly the most precious. Modern agriculture consumes almost two thirds of the waters pumped worldwide. For this reason, more and more people are seeking ways to conserve it.
WET-SORB is a water retainer that, when incorporated into a soil or a substrate, absorbs and retains large quantities of water and nutrients.
Unlike most products that become hydrated, **WET-SORB** has the property of easily releasing the absorbed water and nutrients, thereby allowing the plant to have water and nutrients available at will as a function of the absorption - release cycles.

TERRASYSTEM® is also involved in the composting

Composting is nature's process of recycling decomposed organic materials into a rich soil known as compost. Anything that was once living will decompose.
Basically, backyard composting is an acceleration of the same process nature uses.
By composting your organic waste you are returning nutrients back into the soil in order for the cycle of life to continue.
Finished compost looks like soil–dark brown, crumbly and smells like a forest floor.

In this context **TERRA**SYSTEM® also working to avoid the odors they emit waste and the composting process.

A introduction to **TERRA**SYSTEM®

1. Characteristic

The **TERRA**SYSTEM® was specifically developed for soil stabilisation.
Every cohesive soil possesses the characteristic to petrify. It only needs high pressure over a long period of time. Through the addition of catalysts, we can activate treated soils toward this process. The **TERRA**SYSTEM® does not react as a binder or oxidant.
The **TERRA**SYSTEM® speeds up the natural process of induration or petrification with all kinds of cohesive soil and this has a favourable influence on the soil properties.

2. **TERRA-3000®**

TERRA-3000® is an organic chemical substance, which breaks up the adhering water film and leads to an irreversible agglomeration of the fine particles, substantially reducing the capillary rise of water. It allows better compaction of the treated soil and increases the desired density during the time of construction and later under traffic.

In comparison with untreated soil,

TERRA-3000® has the following characteristics:

- Better compactibility by reducing the sensitivity of the soil towards water
- Strong reduction of water absorption through reducing the capillary activity
- The Proctor Optimum of treated soil is usually lower and the density is higher
- Significant reduction of swelling and shrinking behaviour

3. Suitable Soils for the **TERRA**SYSTEM®

In principle all cohesive or semi-cohesive soils lead to a permanent soil stabilisation.
Non-cohesive soil becomes cohesive by adding clay (<0.002mm).

The optimal soil mixture is
1/3 loam less 0.063 mm ,
1/3 sand (0.063 – 2 mm), and
1/3 gravel and stones (2 – 30 mm),
but 15% from all must be clay - smaller than 0.002 mm .

Missing fractions are easily mixed in from nearby soils.

User Manual

TERRA-3000®

Aim of the **TERRA-3000®** development is an alternative construction method which at comparable quality is more economical and can be passed faster to its determination than conventional construction methods.

This affordable method is an adequate alternative to conventional construction methods especially when it comes to construction roads, rural roads, parking lots, outdoor facilities, etc. **TERRA-3000®** can be used to build new roads and to refurbish already existing roads.

In general:

Basically **TERRA-3000®** can be used for all kinds of soil. This takes effect for cohesive soils with a larger content of fines (<0,063mm) but also all other types of soil (gravel, shingle, sand) can be stabilized permanent with **TERRA-3000®** by adding the missing fine fractions of clay (0,002mm). In the case of heavy clay soils, which usually have a very high swelling and shrinkage potential, it is possible to emaciate the soil by adding non-cohesive material for example sand.

Important for the successful use of **TERRA-3000®** are analysis of the existing soil. According to these analyses the required material can be supplied to achieve the best results.

After the addition of the missing fractions the optimal Proctor-value for the subsequent compaction has to be determined.

The natural moisture has to be measured in regular intervals (for example: every 50 – 100 meters) during the assembly and the moisture content has to be aligned to the Proctor-value (Optimum Moisture value) by adding water to reach a good compaction.

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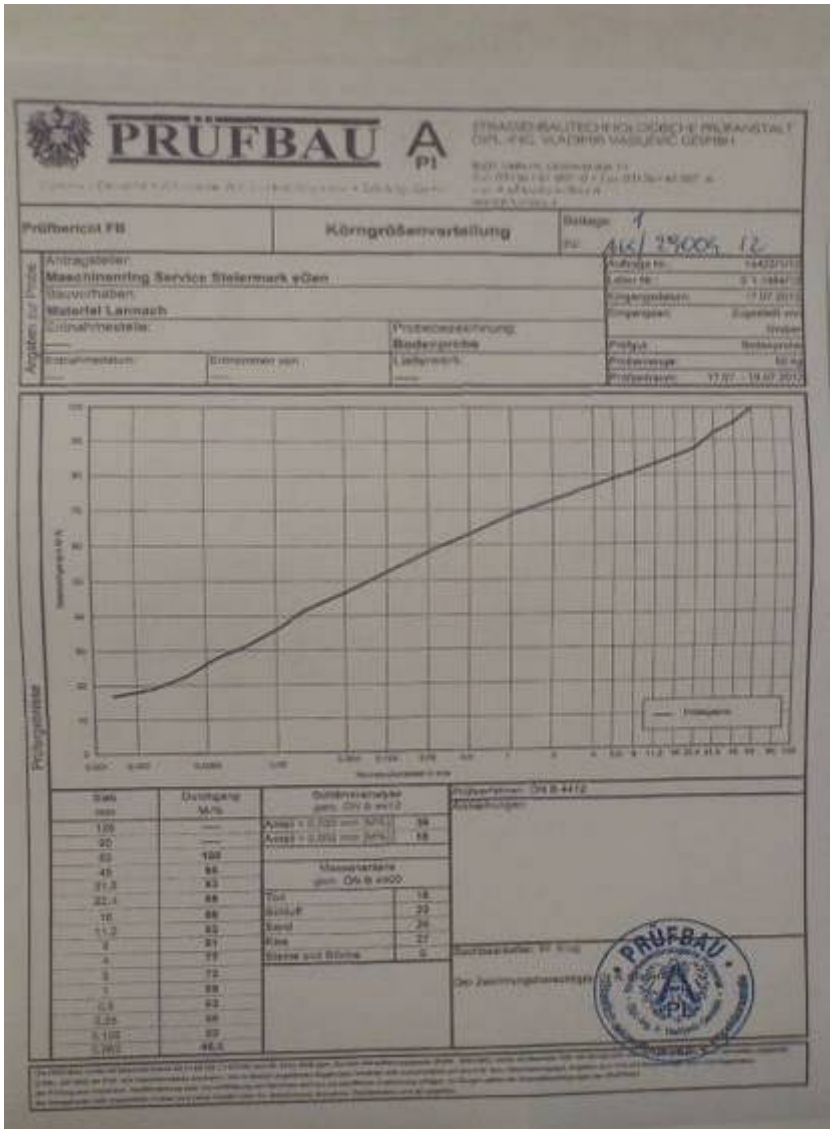
Necessary soil tests:

Screen analysis: determination of the optimal grain distribution by sieving
Sieving area: 0,063 up to 30mm

Hydrometer analysis: determination of the clay quantity (<0,002mm) by use of an aerometer

Additional analysis: Whether the fine components are really clay: by determining the plasticity (Atterbergsche limits: coasting or yield point) and by determination of the water absorption capacity

Creation of an optimal grading curve (example)



Optimal grain distribution for the use of TERRA-3000®

1/3 fines (less 0,063mm)

1/3 sand (0,063 – 2mm)

1/3 gravel (2 – 30mm)

absolutely necessary

clay (less 0,002mm)

more than **15 %**

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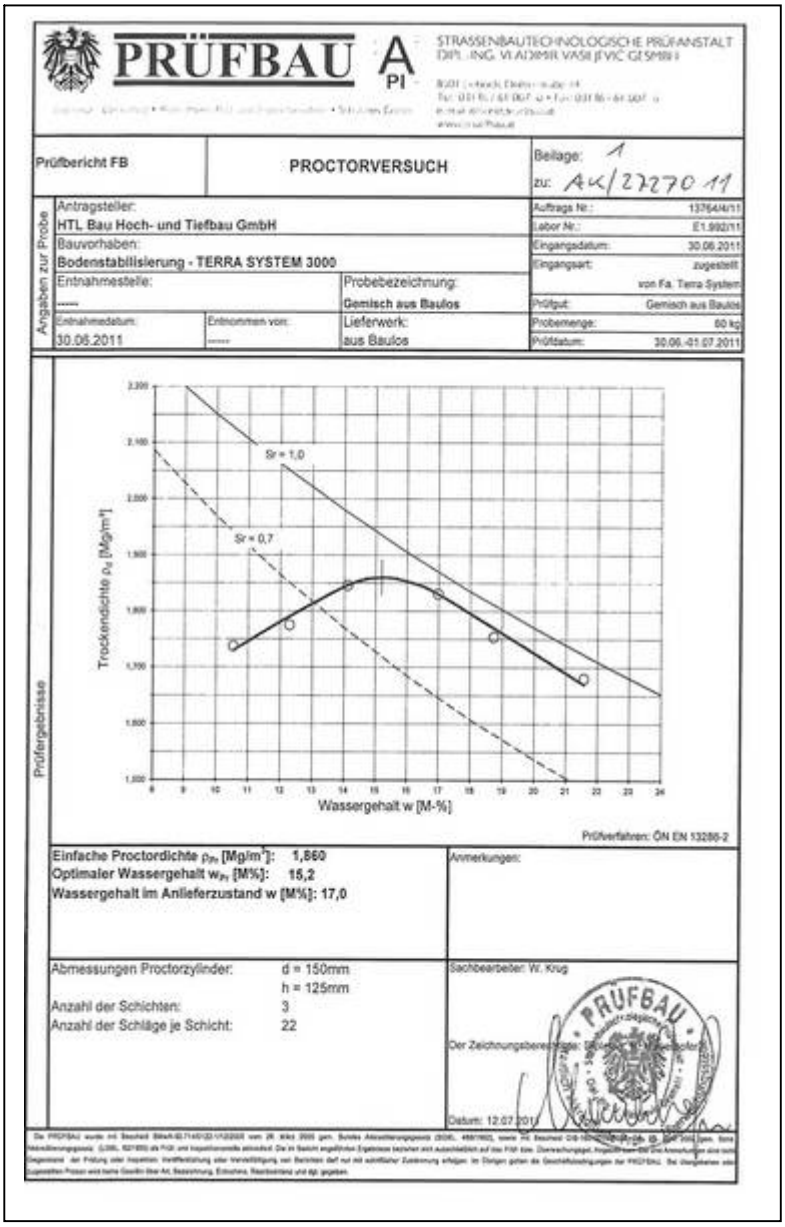
Determination of the optimal moisture (OMC)

Optimal moisture (Proctor-value) is the percentage value at which the material (soil) can be best compacted.



PRÜFBAU A PI

STRASSENBAUTECHNOLOGISCHE PRÜFANSTALT
DIPL. ING. VLADIMIR VASILJEVIĆ GESMBH

Prüfbericht FB	PROCTORVERSUCH	Beilage: 1 zu: AK/27270 11

Angaben zur Probe

Antragsteller: HTL Bau Hoch- und Tiefbau GmbH		Auftrag Nr.:	13764/4/11
Bauvorhaben: Bodenstabilisierung - TERRA SYSTEM 3000		Labor Nr.:	E1.992/11
Entnahmestelle: -----	Probebezeichnung: Gemisch aus Baulos	Eingangsdatum:	30.06.2011
Entnahmedatum: 30.06.2011	Entnommen von: -----	Eingangsart:	zugestellt von Fa. Terra-System
	Lieferwerk: aus Baulos	Prüfgut:	Gemisch aus Baulos
		Probemenge:	60 kg
		Prüfdatum:	30.06.-01.07.2011

Prüfergebnisse

Prüfverfahren: ÖN EN 13286-2

Einfache Proctordichte ρ_{Pr} [Mg/m³]: 1,860
Optimaler Wassergehalt w_{Pr} [M%]: 15,2
Wassergehalt im Anlieferzustand w [M%]: 17,0

Anmerkungen:

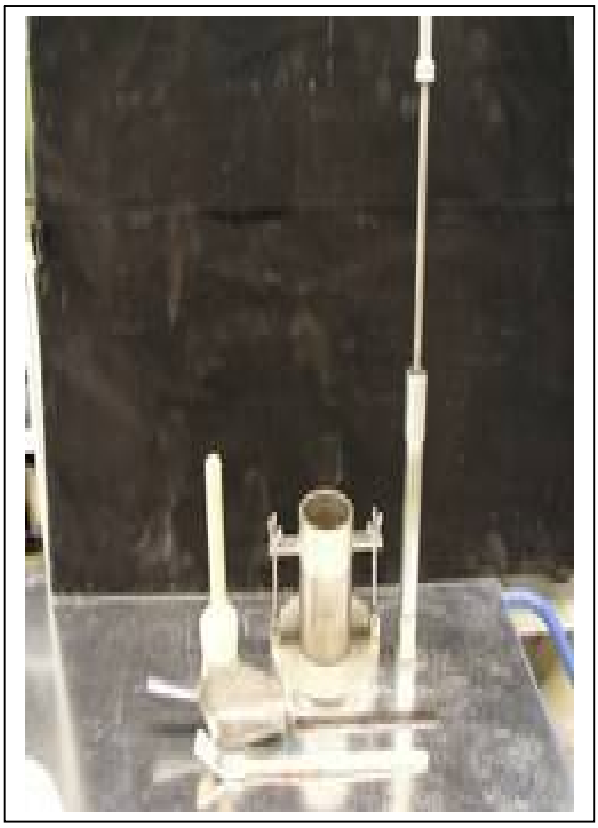
Abmessungen Proctorzylinder: d = 150mm, h = 125mm
Anzahl der Schichten: 3
Anzahl der Schläge je Schicht: 22

Sachbearbeiter: W. Krug

Der Zeichnungsberechtigte:

Datum: 12.07.2011

Proctor - TEST



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Determination of the natural moisture (NMC)

CM Moisture meter / Carbid
Complete-Set for fast and reliable determination of moisture content in building materials, locally and without additional aids
Set-contents:
Precision spring scale up to 100 g; cradle cups 2 piece; complete tool set for sample preparation;
Ball set of 4 steel balls; 20 piece Carbid ampoule;
3 test ampoule for leak testing; 3 replacement seals for manometers and pressure bottle, spoon and cleaning brush; clear instructions plus quick-use-index; metal case

Technical Features:
Accuracy of the pressure gauge: 1.6
Measuring range: 0 – 1,6 bar
max. Error (mbar) ± 25.4
Direct reading of the CM%-Moisture: 20/50/100 g

Calculation of the amount of water:

The amount of water that has to be additioned to the ground together with **TERRA-3000®** has to be adapted in the case of deviations of the natural water content, for example after heavy rain or extreme drought.
However the amount of **TERRA-3000®** is maintained.

Example:	OMC (optimal moisture content)	10, 3%	
	NMC (naturel moisture content)	8,3 %	
	Difference	2 %	Moisture of the weight of the soil

Volume calculation : 1m²/30cm strong = 0,3m³ x 2 % = 0,006 m³ = 6 lit. water

Amount TERRA-3000® :

The difference in liter, to the optimum water content /m² : + 0,05 lt TERRA-3000®.
TERRA-3000® are mixed minimum 1:20 with water per m² at a working depth of 30cm that means:

25 Liter Can TERRA-3000® suffices for 500m²/30 cm strong.

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Determination of organic content:

If large quantities of wood and other organic materials can be seen, please determine the organic content by loss of ignition.
Organic content has to be less than 5 %.

Necessary Equipment:

- Graders with scarifiers
- Special milling machine for the incorporation of **TERRA-3000®**
- Rubber tyred or pad foot roller or for coarse compaction of cohesive soils
- Smooth-drum-rollers for fine compaction

Working Steps:

Humus layer is removed, rough planning with height level is established;
Surface drainage by sufficient longitudinal and transverse slope on the subgrade;
Drainage of the roadbed on both sides by drainage ditches or troughs;
Permanent water drainage at the low points of the trenches and troughs is protected; Stability of the slopes at the cuts and embankments is guaranteed;

TERRA-3000® mixed with water

make a mixture of **TERRA-3000®** and the calculated amount of water, mix well!!!

blend the **TERRA-3000®** - mixture in the sub-grade using a special milling machine

- *** IMPORTANT – MIX WELL ***
-

if necessary perform 2. maybe even 3. milling operations

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Fine Planum

Produce fine planum using grader, sufficient cross slope to drain the surface water, roll sub-grade with roller

Compact

Compact Planum using a pad foot roller or a wheel roller with a total weight of more than 20 tons

Do not vibrate!

Several rolling procedures are needed for static compaction

Control of the compaction:

Determining the achieved bearing capacity of the subgrade, using the static or dynamic plate load test, capacities are measured with the dynamic load disk device > 100MN/m² are achievable.

Wearing Surface

After a drying time which depends on the weather (about 2 to 5 days), the ready built and compacted earth roads have to be provided with a wearing layer (bitumen sprayed ceiling, asphalt layer) in order to avoid mechanical abrasion of said layer and the formation of dust.
Since the treated layer has a very good carrying capacity, the wearing layer can be kept much thinner and conveniently which results in massive savings.

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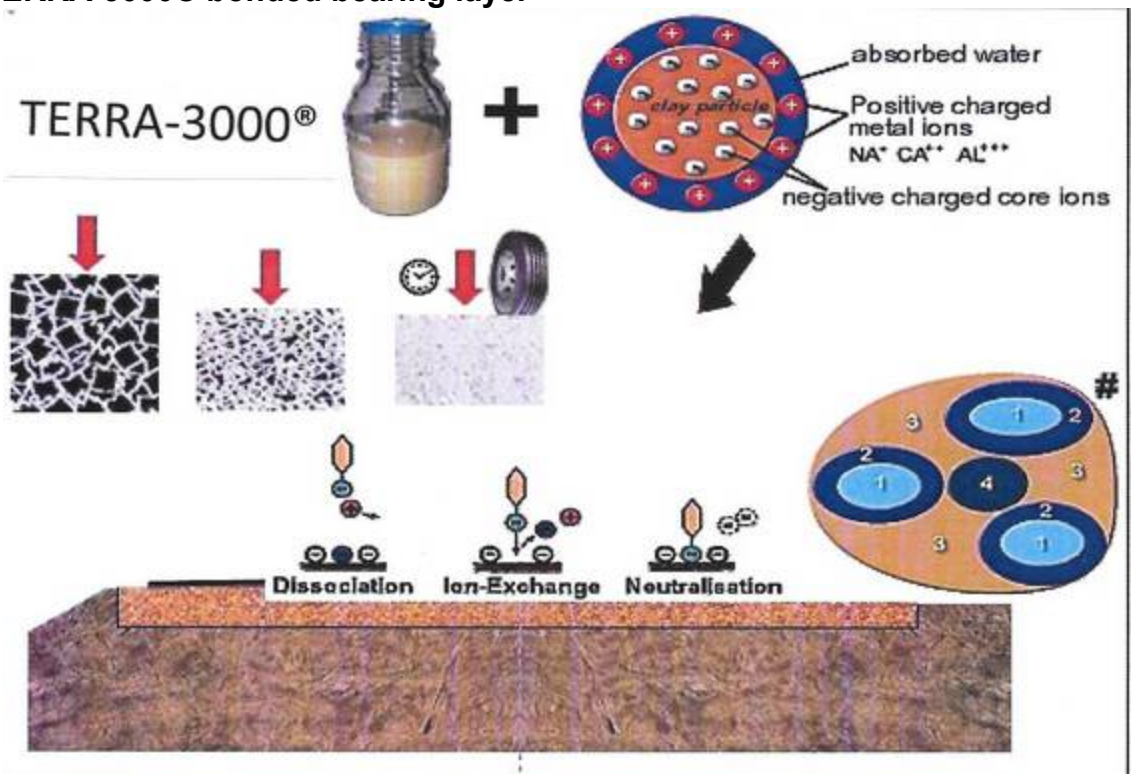
TERRA-3000® - Conventional Technology

Road Construction in Comparison

TERRA-3000® bonded bearing layer

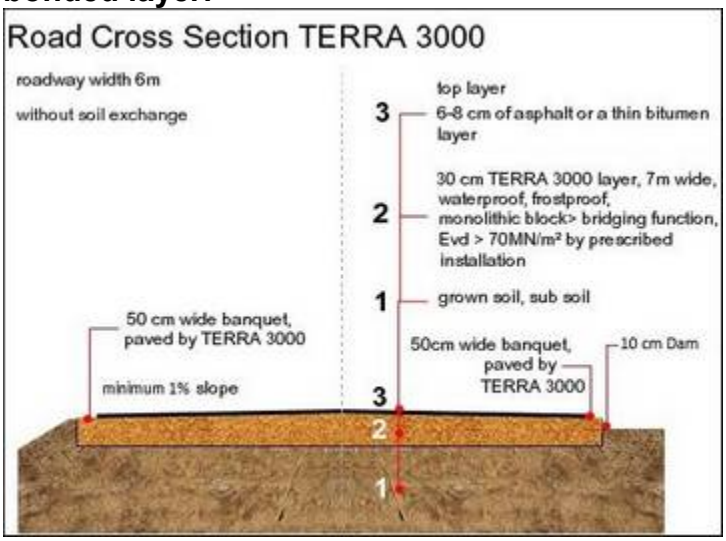


1. **Chemical water bound within the crystalline structure of the soil.**
2. **Absorbed water which is held on the surfaces of the soil particles.**
3. **Water which is bound by surface tension to the points of contact of the soil particles.**
4. **Capillary water in the pores between soil particles.**

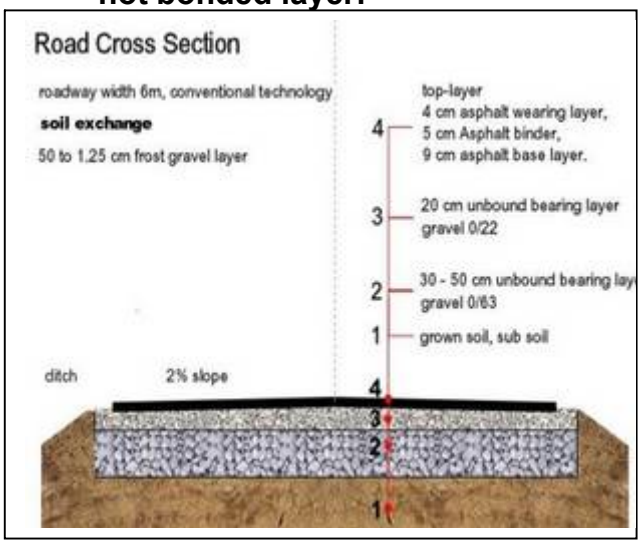
Except for molecular water (point 1), which is chemically combined, all of the above water categories are involved in the TERRA-3000® reaction process.
The main purpose of TERRA-3000® is to reduce the amount of water held in the soil, which forms voids in the soil.
Result of water reduction are voids which are closed by the compacting of the soil and thus ensures optimum compaction.
In addition to the water reducing, the swelling capacity of the individual soil particles will be extremely limited and the electrical charge of soil molecules polarity reversed by ion-exchange to make a still further accretion of the soil particles possible.

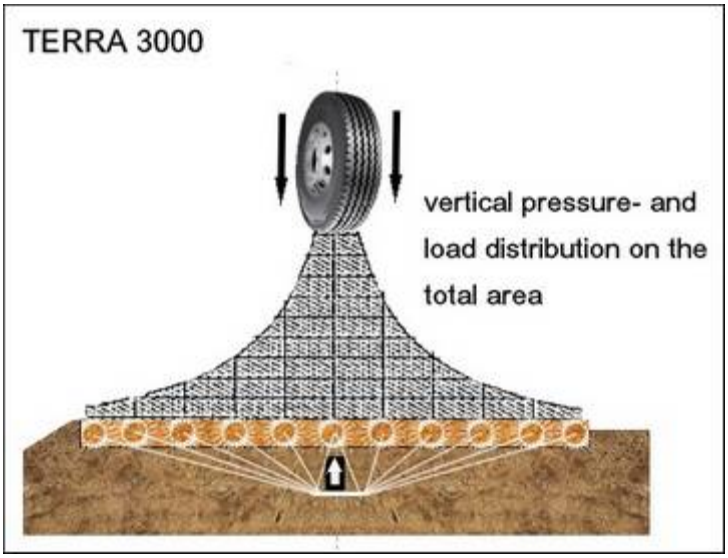
Difference

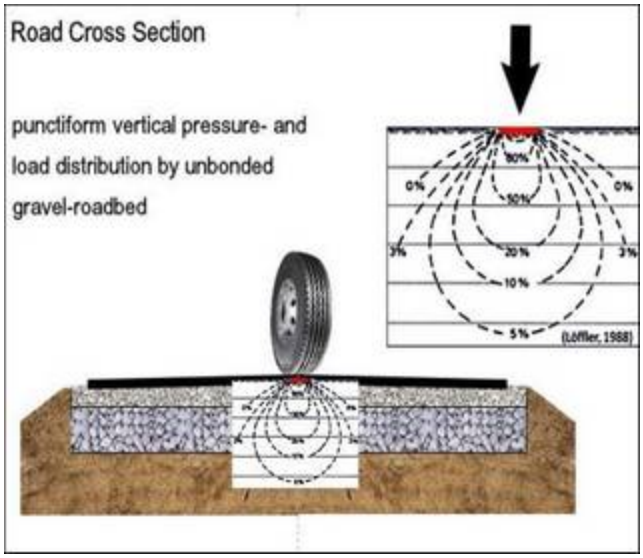
bonded layer:

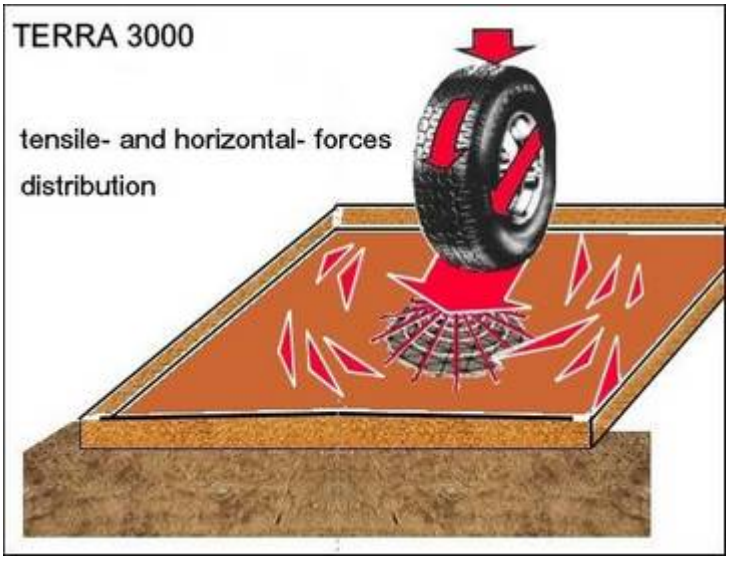


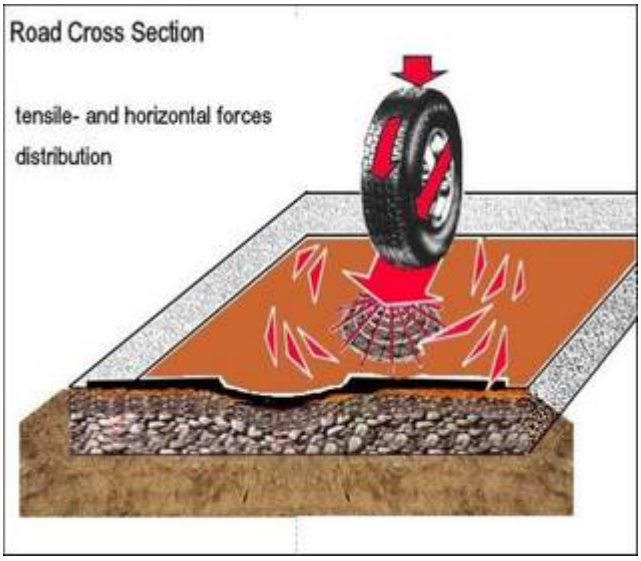
not bonded layer:







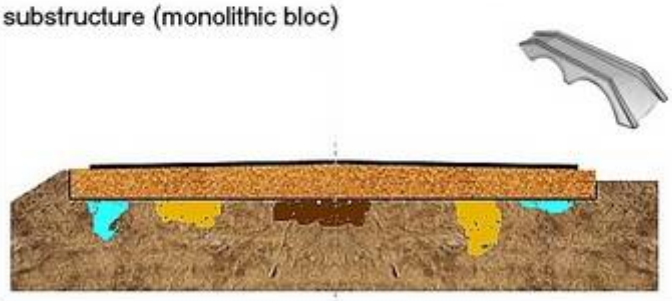




TERRASYSTEM®

Road Cross Section TERRA 3000

given bridging (bridging function) over
material settlements, mud-, sand- and water- pockets in the
sub-soil (grown-soil) by the bound,
waterproof, high load capacity and relatively elastic
substructure (monolithic bloc)



Road Cross Section

no bridging function because of unbound substructure;

fine and coarse material displacement;
breakthroughs in grown soil despite geotextile possible,
because of unbound substructure by fine
and coarse material displacement;

Straßenquerschnitt TERRA 3000

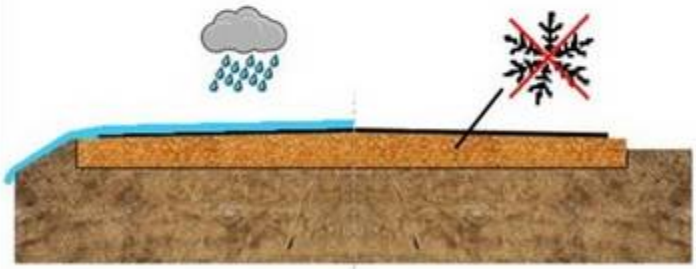
monolithic bearing layer;
no geotextile required;
fine fraction does not gets to the top;

Road Cross Section

unbound bearing layer;
Geotextile necessary to stop fine fraction upward movement

Road Cross Section TERRA 3000

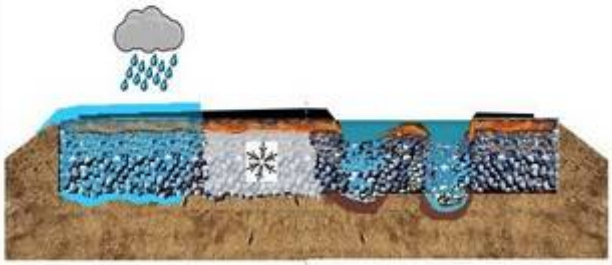
no frost protection layer required,
good insulation function,

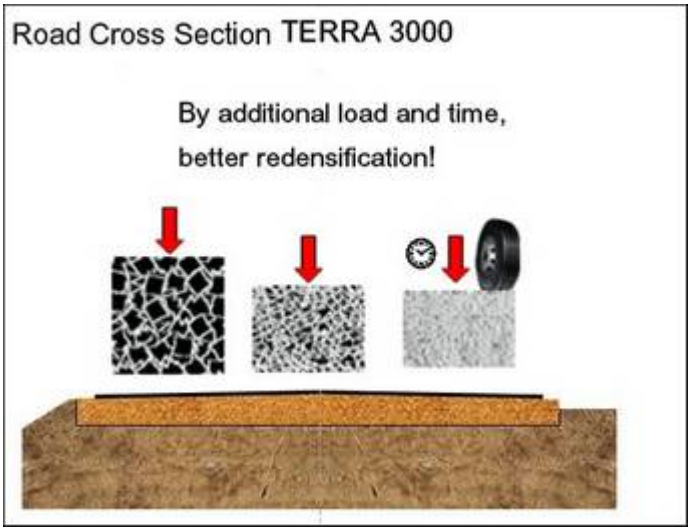


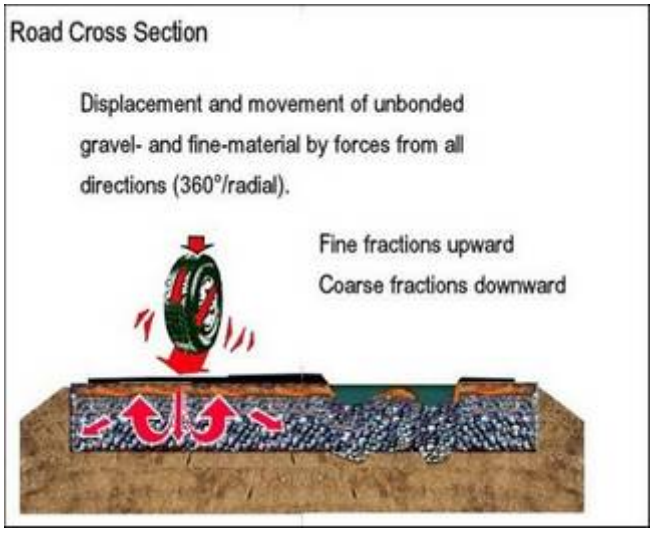
Road Cross Section

Frost protection layer to the soil freezing depth,
poor insulation function,

water permeable, water collects at the bottom
and soften up subsoil (grown soil).







Other relevant differences which result in significant cost reductions:

bound layer	not bound layer
no soil replacement needed, local soil material can be used , conserves resources, significant shorter construction times, less machine and work expended, thinner and more inexpensive wear layers possible (bitumen, bitumen- emulsion) 6 - 8 cm asphalt, maintenance, repair intervals: hardly frost damages by the better quality of the base, low maintenance costs, no potholes and ruts.	soil exchange to depth of frost, removal, transport and landfill disposal, exchange-gravel for unbonded base, higher asphalt-base and higher asphalt-binder and higher asphalt-wearing course necessary, potholes and ruts, maintenance- and cost intensive, frost damages, more water damages.

<u>Result:</u>
The technology / system comparison clearly shows the benefits of the TERRA-3000®-Technology.

Roads
be built easier, faster, more cost-efficient, more stable and more gentle on the environment after TERRA-3000®.

As practical experience shows, are the savings
- depending on the type of the road -
in between 30% to 70%.

TERRA-300®, is a very unique and green environmentally product that has been in business since over 25 years. We are the inventor and producer of this product, and believe that it would provide the people tremendous benefits such as:

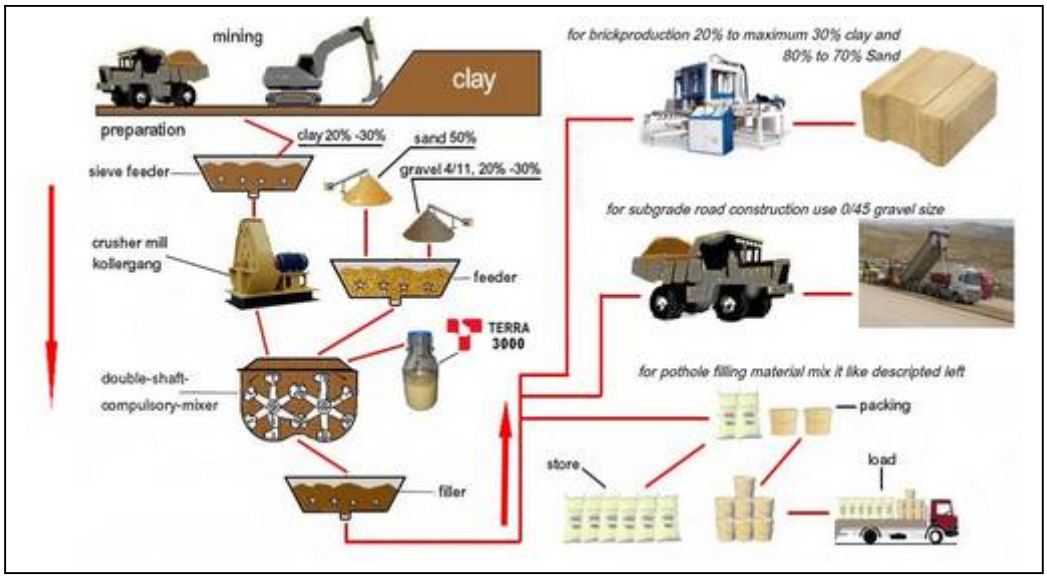
- Safer roads due to no potholes, thus preventing road accident deaths by up to 40%
- Renovate existing roads by making them water proof and thus prevent them from being washed away with heavy rain and floods
- New water proof roads connecting all, which can be built at much faster speeds than your current methodology
- Prevention of deaths, commodity damages and infrastructural damages from floods, via solid flood embankments, dams and dyke's solutions
- Renovate existing railroad embankments and make them water proof thus preventing rail accidents due to heavy rain and flooding
- Water resistant bricks that can prevent water from seeping into Homes in villages
- Prevent toxic dump areas from leaking toxic materials by sealing off toxic dumps with a guaranteed water proof covering
- Build airports and runways on solid waterproof foundation with **TERRA-3000®**

All of these applications are based out of the unique nanotechnology provided by **TERRA- 3000®.**

We would welcome the opportunity to work with your ministry as well as a nominated contractor, and prove these benefits for the people. Austrian quality with the highest levels of safety and security is the promise we offer.

We are also open to a public private partnership model, or any other mode of operations based on your guidance.

With a one-time investment of 300,000 USD for the necessary equipment all of the above applications can be implemented in the country.



TERRA POTHOLE (TP) MANAGEMENT

Road traffic accidents (RTA) have silently become an epidemic .
Inadequate attention to road safety is adversely affecting the state's socio-economic health.

Whilst Alcohol does account to a certain number of deaths, it is an absolutely alarming trend, which deserves immediate attention.

One of the low hanging fruits to ensure that roads are safe to drive upon, is to ensure that there is an efficient functional pothole solution. This would imply that there should be no potholes on the surface of the roads, thus preventing unnecessary emergency braking, sudden swerving movements, or losing control of the car.

With the TERRA POTHOLE Solution, we can guarantee you a functional self-sustaining water proof solution for potholes, with the following benefits:

- Very simple easy to use solution with no special scientific or technical „know-how“ required
- Very fast implementation, with no curing period required
- Waterproof solution, which would not be managed with heavy rains or heavy traffic loads
- Cost effective solution which can be easily standardized nationally for your country.

TERRA ROAD (TR)
RENOVATING EXISTING ROADS AND BUILDING NEW ROADS & HIGHWAYS

UPGRADING OF IN-SITU SOILS FOR ANY KIND 0F ROAD- AND EARTHWORK.

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.

The biggest challenges in road construction and renovation lies in the speed at which work is carried out, an average of 300m2 a day, which is too slow to create a positive impact in preventing road deaths.

With the **TERRA**SYSTEM® and **TERRA-3000®** your peoples would have the following advantages:

- Reduction in existing construction costs, by at least 30%.
- Guaranteed waterproofing of Subbase, therefore increasing life of roads, by at least 300%.
- Construction of at least 6000m2 of subbase a day, when applied with TERRA-Pre-Mixing System
- No curing period required
- Reduction in maintenance costs, thereby giving a realistic chance to clear maintenance backlog and really have a positive impact in lowering road accident related deaths caused due to bad roads

.

A conventional road

A **TERRA**SYSTEM® road

Pictures of **TERRA**SYSTEM® Roads built in Austria

TERRASYSTEM® Road with any wearing course 15 years old with no potholes or any damage, inspite of rain, snow and frost

TERRASYSTEM® Road in Bogota (Colombia) 2013

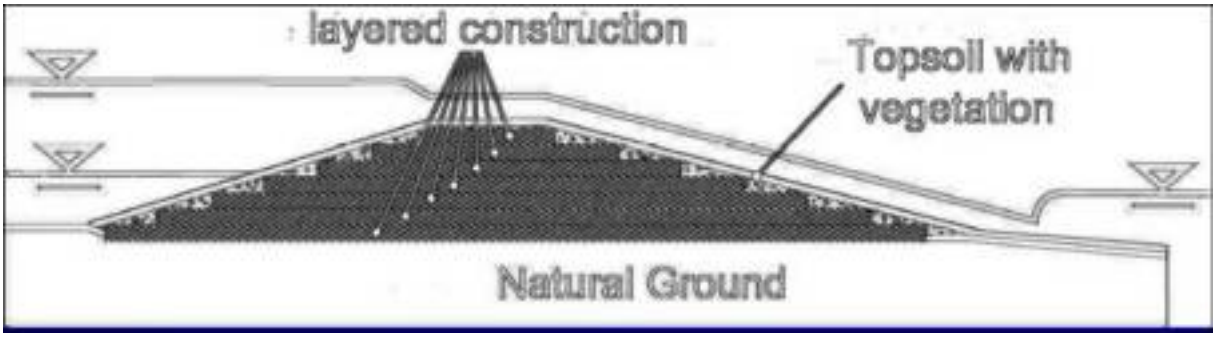
TERRA FLOOD CONTROL (TF)

SOLUTIONS
Flood embankments, Dykes and Dams

Seasonal floods belong to a natural chains of events alongside rivers, however Heavy rainfall events can constitute flood waves. During such a flood catastrophe, not only human lives are at risk, but also significant loss of commercial and infrastructural values are at high risk. Remote villages are isolated and thus children's lives are also at risk. All this has serious political ramifications if not considered in advance.

By using the **TERRA**SYSTEM® one cannot not only build cost effective flood embankments, dams and dykes, but also guaranteed long lasting solutions that will have a positive impact on saving lives during such catastrophic events.
Flood dams or dikes are usually made of a sand core, which is then covered with a one to two-meter-thick layer of cohesive materials such as clay/loam. Grass plantations prevent erosion, and increase the stability of the construction.

The soil stabilization with **TERRA-3000®** improves the fitting ability and compressibility of cohesive clay loam soils.
This guarantees a long-term sustainability, durability, and stability whilst being water resistance.



Layered Construction with **TERRA-3000®**

Conclusion:

Dams and dykes which are attached or built with **TERRA-3000®** resisting floods better! Treatment with **TERRA-3000®** and the high compaction ensures a higher relative impermeability of the earthwork.

A rapid softening is delayed or prevented. The dams and dykes are stable and withstand the flood for longer period of time.
An enormous environmental damage in your country local economy can be prevented, as well as countless inhabitants lives can be saved!

TERRASYSTEM® laboratory test

We have made our laboratory tests with the soil from you and the results are

fantastic. In the following pictures you can see how the sample on the left is soil untreated with **TERRA-3000®**, and the sample on the right is soil treated with **TERRA-3000®**, where no water has penetrated the soil, making the base solid and not disintegrating like the one on the left

After 1 hour

After 3 hours

After 24 hours

TERRA RAILWAY (TR) EMBANKMENT

The **TERRA**SYSTEM® allows the upgrading of any existing railway embankment and tackles the problems where they come from – the soil beneath the ballast, which tends to soften with time, and is integrating into the ballast making the once stable material unstable. This leads to inevitable repairs replacing the now useless ballast with new ballast and also having to dispose of the old ballast creating vast amounts of disposable material.

The ability of the **TERRA**SYSTEM® to treat the time and use-worn ballast saves not only time and money but also the environment by not having the need for vast amounts of disposable material.

Ballast removed from railroads for reasons of instability can be treated in-plant and stockpiled for use at a later date. Treated material remains treated and can be used at any time.

In a green field site situation treating the in-situ soils with the **TERRA**SYSTEM® will eliminate any problems in the future.

SUMMARY:

- TREATED MATERIAL REMAINS TREATED AND IMPROVES WITH USE
- PROVEN OVER MANY YEARS IN DIFFERENT PROJECTS
  SAVES ON CONSTRUCTION TIME AND COSTS
- LESS NEED FOR QUARRIED MATERIAL
- OTHERWISE USELESS MATERIAL CAN BE USED NOT DUMPED
- CAN BE STOCKPILED AND RE-USED AT A LATER DATE
- CONTRIBUTES TOWARDS ENVIRONMENTAL FRIENDLY CONSTRUCTION

This difficult section on the main railway line Hungary - Austria was treated with TERRA-3000® in order to increase the bearing capacity to values required for higher speed. An increase of the E2-Module in the range of 3 to 10 times compared to the existing figures in not unusual.

TERRA BRICKS (TB)
Pressed and unburned water-resistant bricks

The **TERRA**SYSTEM® replaces burned bricks and mortar by the use of **TERRA-3000®** manufactured bricks, which are bonded to each other with the same soil material diluted with water and liquid **TERRA-3000®** catalyst.
The **TERRA**SYSTEM® is a unique technology which allows relatively easy, upcoming locally available soil, enhance in an acceptable raw material for the brick production.

The water sensitivity of such unburned bricks is brought under control and even up to the complete impermeability (by adding missing grain fractions - clay or sand).

Benefits of TERRA BRICKS

- water resistant, no capillary action, remains dimensionally stable in case of
- moisture,
- high breaking strength of the bricks > 12N/mm² = 12 MPA
- energy saving, no burning, no time-consuming and costly transportation, locally available clayey loam soil is the main raw material
- Excellent thermal features, excellent thermal capacity, almost twice as efficient as burned adobe bricks,
- Environment friendly, **TERRA**SYSTEM® acts as a catalyst, very low application rate, environmentally certified,
- simple processing, also possible by unskilled staff

Energy saving:

- no expensive and complicated burning, brick is pressed hydraulically or mechanically, no high energy costs, no energy consumption through long transports.

Material Savings:

- no mortar or cement required to be used for binding bricks in a wall
- Specially formed profile bricks using an interlocking system fixed by diluting with the same catalyst material and water for bonding.

TERRA SEALING (TERRA -S)

TOXIC DISPOSAL & DUMP SOLUTIONS
SEEPAGE CONTROL, IMPERMEABILITY OF WATER PONDS, IRRIGATION CHANNELS AND LANDFILL AREAS

The **TERRA**SYSTEM® has been used to build several disposal areas after it has shown excellent performance in achieving impermeability with in situ soil.

A typical characteristic of in-situ soils is that they allow not only seepage of water but also other liquids. The former leads to the loss of water, a particularly undesired side effect in irrigation projects, the latter very likely results in heavy pollution of the ground water.

In conventional constructions, seepage has to be prevented by methods, which often work with artificial, dense coatings or linings. The solutions offered range from plastic linings to asphalt coatings, from concrete pavements to soil admixtures with certain types of minerals (Bentonites, Montmorillonites) which allow to 'tighten' a soil by their enormous swelling effect.

These methods are not sustainable, they are expensive and not environmental friendly.

A soil is rendered impermeable if its k-value is in the range of 1.10^{-9} to 1.10^{-10}. Hardly ever such soil performance can be found in nature. The **TERRA**SYSTEM® allows upgrading any soil by a simple treatment with the additives.

This is significant for any type of construction dependent on it:

- soil embankments of roads and railroads will not be softened and deformed by meteor water;
- water basins, artificial lakes, irrigation channels, dikes and dams can be prevented in losing too much water by seepage. Since the **TERRA**SYSTEM® does not harm the environment, there is no undesired side effect on water involved;
- landfill areas require dense, impermeable layers to prevent the passing of effluents from the stocked waste material into the ground water, they can however also be covered with treated soil to avoid the seeping-in of meteor water from the top

TERRA AIRPORTS (TA)

When it comes to constructing airports, a significant amount of money is spent on stabilizing the foundation of the main airport buildings, all airport side roads, including the take-off and landing runways.
By using TERRA-3000® one can build a solid foundation for the entire airport areal ensuring that no damages are made in the sub-base which would then result in expensive maintenance works.
All the foundation area of the main building, airport side roads as well as runways would have a water resistant sub-base at a very cost effective price and with a very high speed of construction.
The following pictures shows the areas at an airport which can be stabilized with TERRA-3000®

Airport , built with **TERRA**SYSTEM®