



TERRA-3000®

**Railway-traces -
railway-subgrade -
construction**

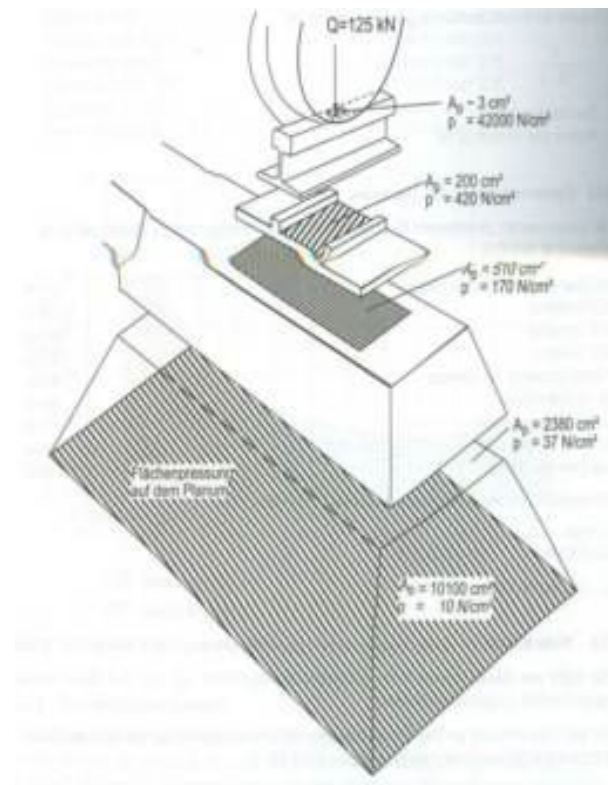




Rail routes are linear structures, which are claimed by static and dynamic loads from the trains, as well as weather conditions such as rain, snow, frost and strong sunlight.

The loads and forces from the movement of trains are transferred by the vehicles into the roadway.

The resulting vertical-, horizontal transverse- and longitudinal- forces, must be absorbed harmless by the track, substructure and underground, to guarantee safe movements of trains with high comfort at any time! The vertical forces generate pressures and tensions in to the sub, which must be removed in it!

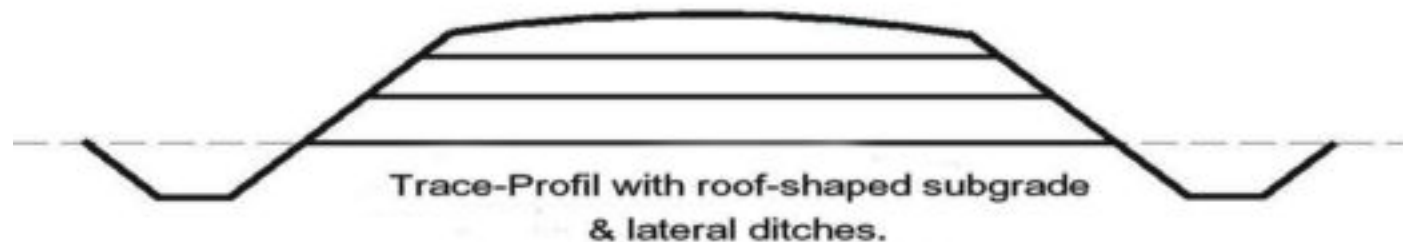




The substructure is the entirety of the structures, which safely absorb the forces from the track!

The substructure construction has a major task: The safe inclusion of all the loads from the track resting upon them.

We call the surface of the substructure, which is applied to the track, subgrade.



Constructed by 3 layers with TERRA-3000®

About reasons of safety waterremoval, the subgrade must be roof-shaped!



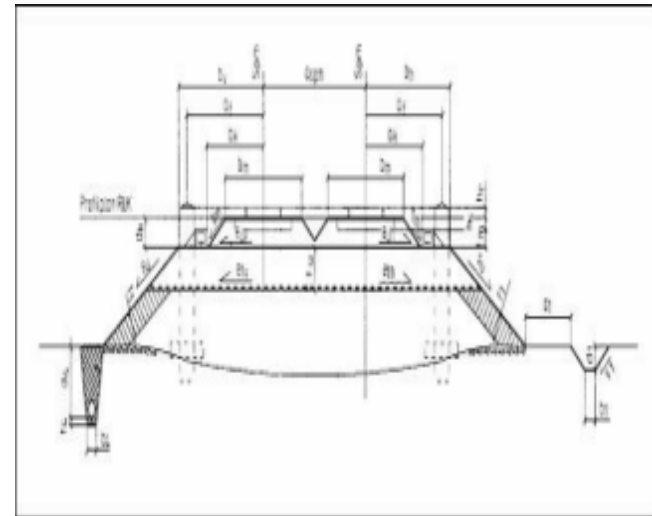
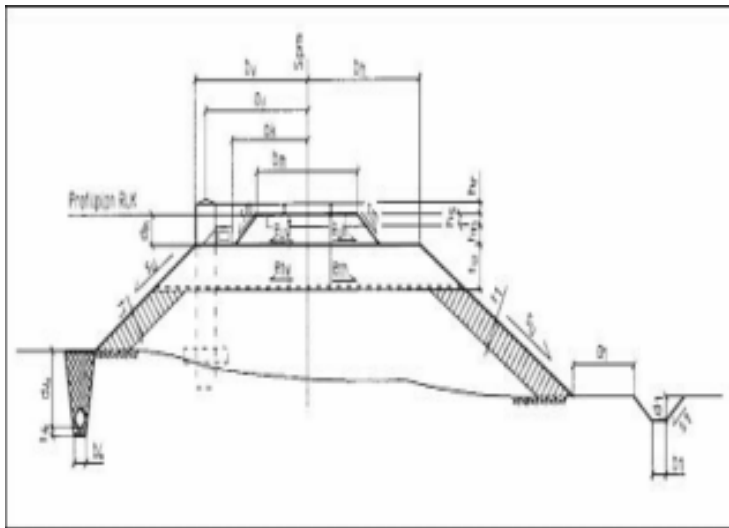
Open routes will be always constructed, even if they are in the lowlands, on more or less low railway-dams!



The important thing is a good water-drainage of the railway-construction! The foundation / subgrade has, among other things, the task of safe water drainage into the lateral ditches, canals or drainages!



About the loads of the trains , a pressure area outcomes below the track at an angle of 45° to reaches about 5m below the bedplate-edge. It is therefore necessary that between the base of natural soil or rock and the ground, a stable and well compacted sub-structure is build!



Optimal would be an subgrade what is relatively waterproof and also got a high load capacity!



An railway- embankment, subgrade or sub-structure consists of mostly compacted sand, grit and cohesive material such as loam / clay.



The traffic loads are able, in the individual soil types, through the influence of weather and major stress points of the substrate, to causes deformation and damage to the subgrade.



Causes of damage to the subgrade are:

- * poor substrate = unfavorable soil types °
- * high static and dynamic load on the foundation°
- *unfavorable compaction of the subgrade and other volume losses of the substrate°
- * inadequate water-drainage of the subgrade °
- *flooding and floods°
- *high ground water level°
- *dry cracks which can fill with water °
- *rail shapes of insufficient capacity for the prevailing operating loads °
- *much to wide track-distance & and tracks with to small contact surface and too large weight °
- *faulty condition and performance of building structures °
- *deformations caused by frost uplifts °



Consequences of damage to the subgrade

Damage to the subgrade have elevated track works and clean-up costs results.

Concrete-ties will be strained and cracked because of soft subgrade.

Thereby increasing the uneven subsidence of the tracks under load, effect an overuse of the rails and premature fatigue of the rail steel and thus a costly shorten of life of the rails.



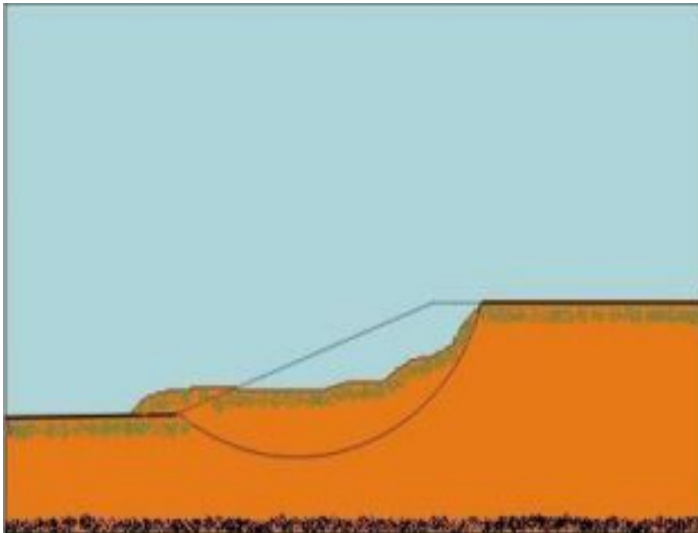


Consequences of damage to the subgrade

In silt and clay soils, by pushing gravel into the foundation over the years, results gravel bags, where the rain water is dammed back.

This yields the ground in the area around the gravel bags up to great depths and exerts a side pressure.

This can lead to bulges and slope breaks through material crawling.

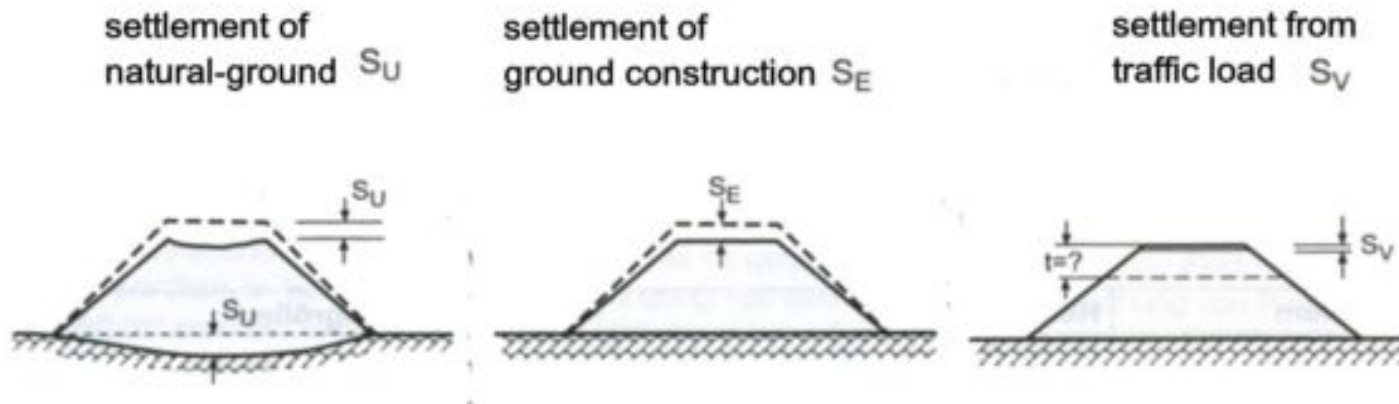




Deformation of the surface and the subgrade

Deformations can be divided into three parts in terms of their causes:

1. Deformation of the subgrade by loading & releasing
2. Deformation of earth construction by self-weight
3. Deformation by dynamic effects





There is an high demand at the railway-network capacity.

It is be fulfilled only, if a sufficiently flat, solid and safe railway is ensured in all seasons and no base damage occurs.

Damage to the track and resulting speed restrictions and renovations, have an impact on the growing performance requirements significantly interfere.

It is therefore important to avoid damage to foundations and the maintenance of a sufficient and permanent viability of the railway subgrade to a very high importance!

The design of the railway subgrade are essentially based on the laws of soil mechanics, the economy and the geotechnical.



The Geotechnical Engineering recognizes several methods by which the physical properties of soils in relation to the application-specific requirements can be positively influenced.

One of such method that has proven itself, especially in road construction and in soil stabilization is the liquid ion-changer and catalyst

TERRA-3000®





TERRA-3000® for soil stabilization is Trendsetting!

The bearing capacity of the soils, which are treated after TERRA-3000®, exhibit a higher stability and sustainability, as with lime-cement-treated soil mixture only.

A 25 to 30cm loam / clay-sand-gravel soil layer, with TERRA-3000® reaches a capacity of $\geq 100 \text{ MN} / \text{m}^2$.

The capillary action of the soil is extensive interrupted and so how relatively weather-and waterproof.

A soaking and freezing is no longer possible .

The optimally and properly treated soil with TERRA-3000®, is agglomerated and remains irreversible in this state.

The like this treated soil got a water permeability of kf- value 10^{-10} and is water-impermeable.

A relative elasticity of the treated soil layers with TERRA-3000® counteract large forces.



TERRA-3000® - Development and Installation

Railway-dams, which are armed with TERRA-3000®, are more resistant against floods and water influences! By the treatment with TERRA-3000® and the high compacting of the earthworks, a relative impermeability is created.

A rapid maceration is decelerated or even prevented .

Railway-dams are so much ruggedized against floods!





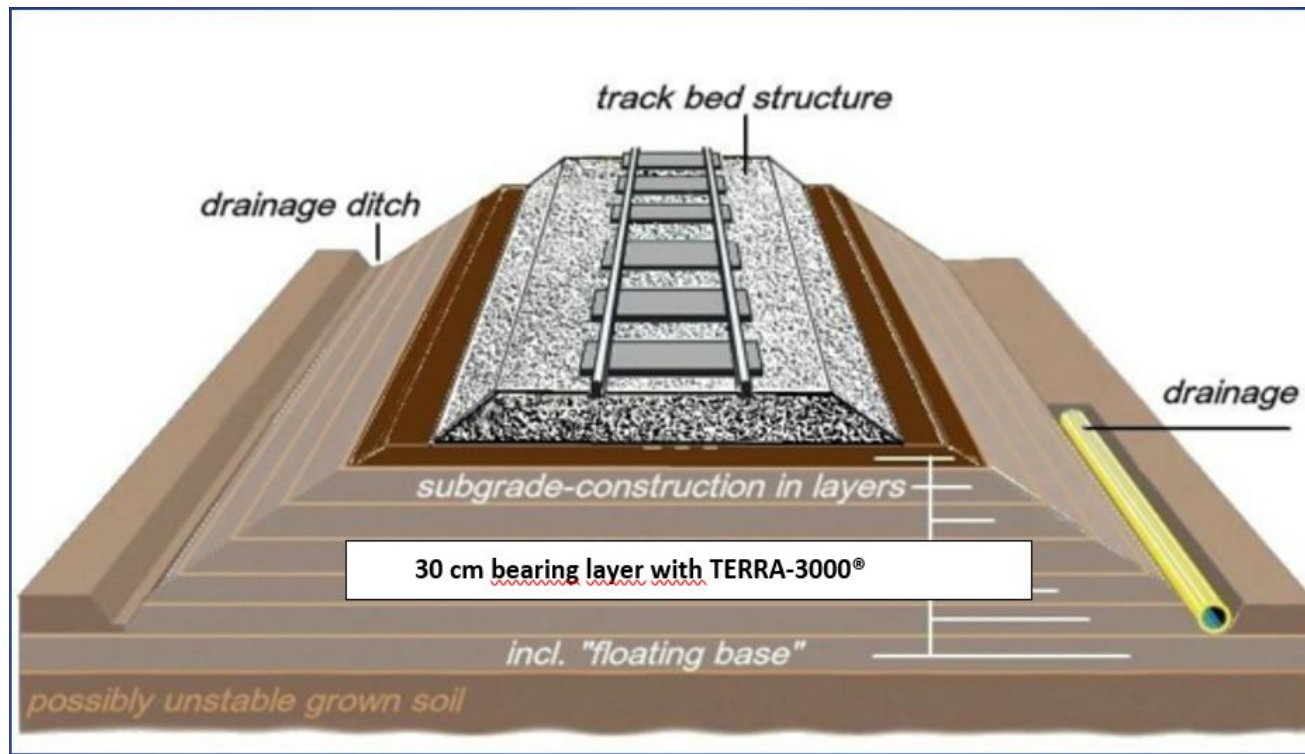
The subgrade constructed by the TERRA-3000® is thus relatively water- and frost resistant and also has high bearing capacity!



highly stable sustainable railway-substructure with an upper relatively resilient and water-frost resistant upper bearing layer, after TERRA-3000®.



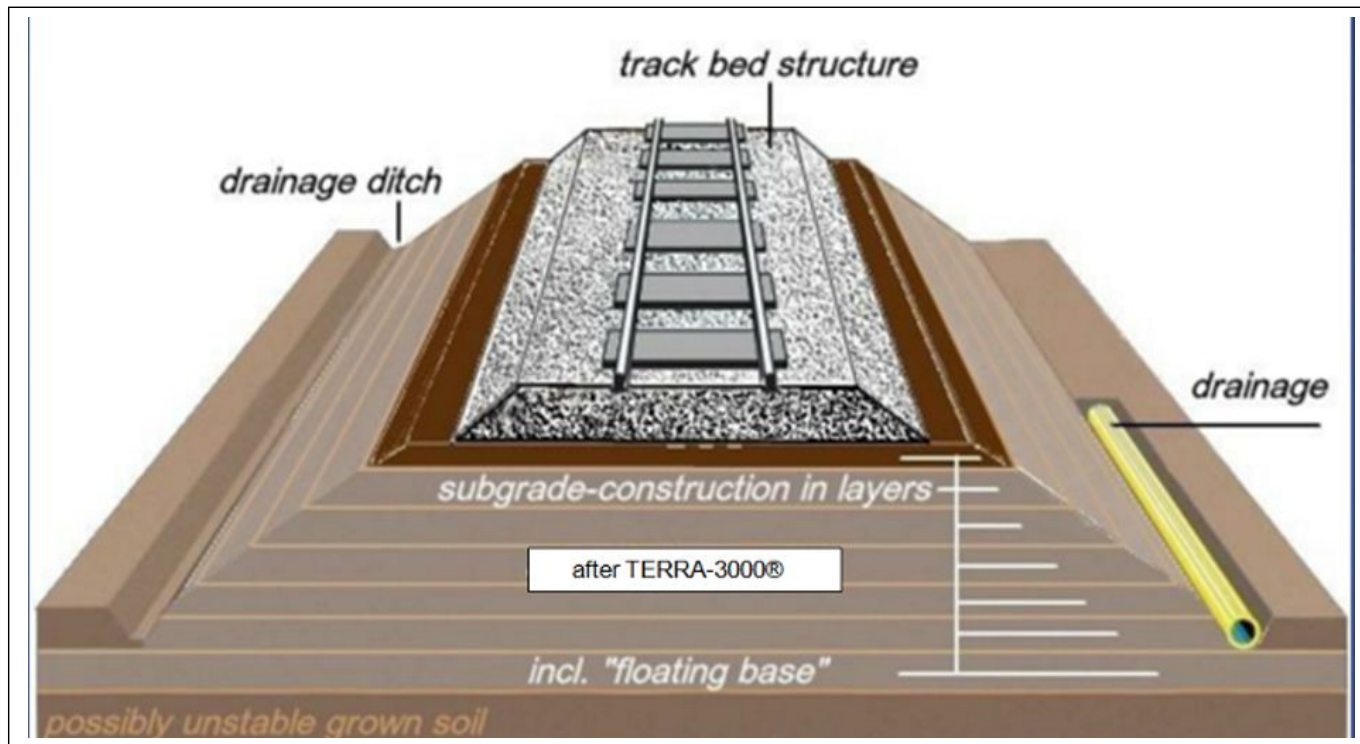
TERRA-3000® - Development and Installation



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TERRA-3000® - Development and Installation



complete rail-substructure, constructed in several stable high bearing, relatively resilient and water-resistant layers on possible unstable subsoil, constructed with TERRA-3000®.



What makes the soil stabilization with TERRA-3000® so interesting for railway- traces and dam construction, is relatively simple. Time-saving and cost-effective design and after all the very stable and efficient result!



A softening of the subgrade-body or the stabilized upper layer of the railway-dam during flood, is by the interruption of the capillary and by arriving of a kf- value (permeability) of 10^{-10} largely eliminated!



Construction Methods

Basically two methods for railway-subgrade constructions with TERRA-3000® offering themselves.

* The subgrade can be built up to a subgrade-body, made up of several 30 cm soil-TERRA-3000®-layers, piece by piece. This method is recommended because of its stability!

The base of the fill should be based on natural ground without Humus! The respective layer, treated with TERRA-3000®, is applied to the dam-layer soles and should be compacting with 15 tons minimum on every layer!

The higher the compression, the higher the CBR values can be achieved!

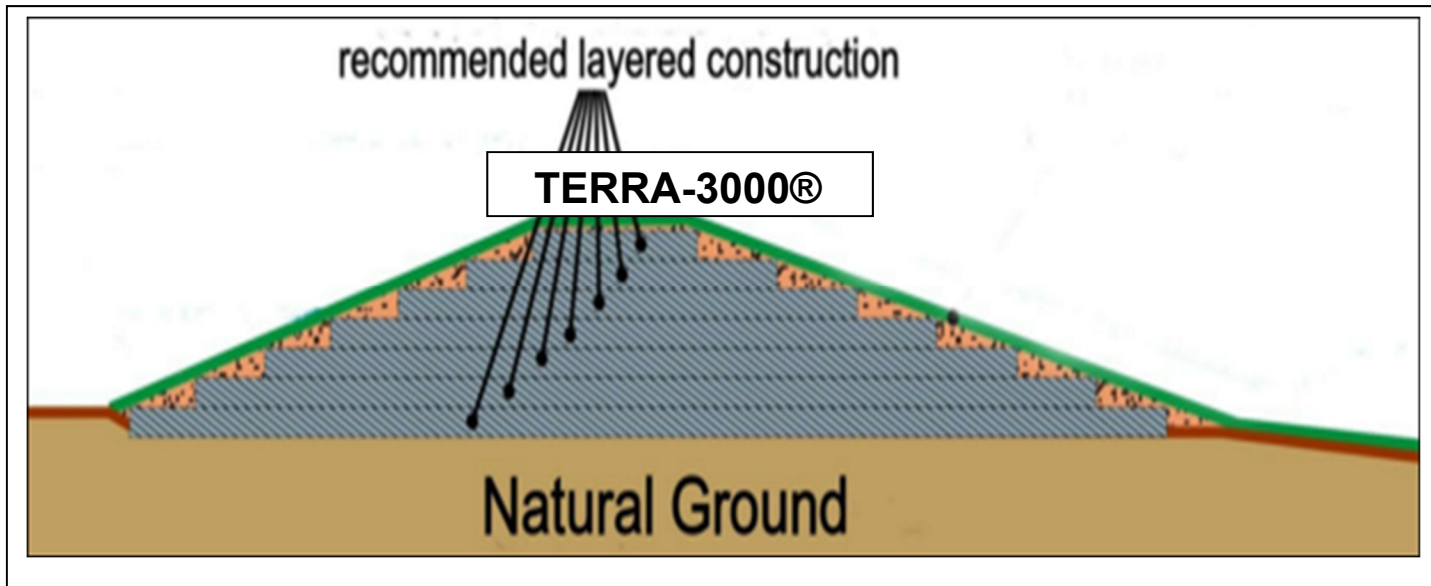
The use of a Sheep foot roller, about the kneading of the clay material, is an advantage.

The first layer, the dam-layer sole, should be lay 30cm minimum under the dyke reaching stratum. With this, a possible undercutting of the dam body is prevented.



Construction Methods

Basically two methods for railway-subgrade constructions with TERRA-3000® offering themselves.



Recommended construction of the railway subgrade in accordance with TERRA-3000® for highest load capacity and bearing capacity! A soil layer can be charged at the correct composition of the material and installation method, with more than $100 \text{ MN} / \text{m}^2$. The thus produced subgrade has a relative elasticity in order to counteract high forces.



Construction methods

Another option for existing railway-dams with relatively high bulk cubature, the complete existing subgrade can be covered with one or, depending on the requirements, two or more layers of each 30cm

Soil-TERRA-3000®-Mixture.

The subgrade-core may consist of untreated cohesive embankment fill material, which should be well compacted. In every case, the dyke-base should consist of a TERRA-3000®-Soil-Layer and are applied as described above!

If this is not possible, the subgrade-tongue should be constructed much deeper as the adjacent upper soil-layer which reaches the dam.

With that a possible undercutting of the dam will prevent.

The development of the stabilizing layer or layers of this, is identical to the previously described procedure, except that the subgrade with the stabilized soil will be irreversibly coated and sealed !



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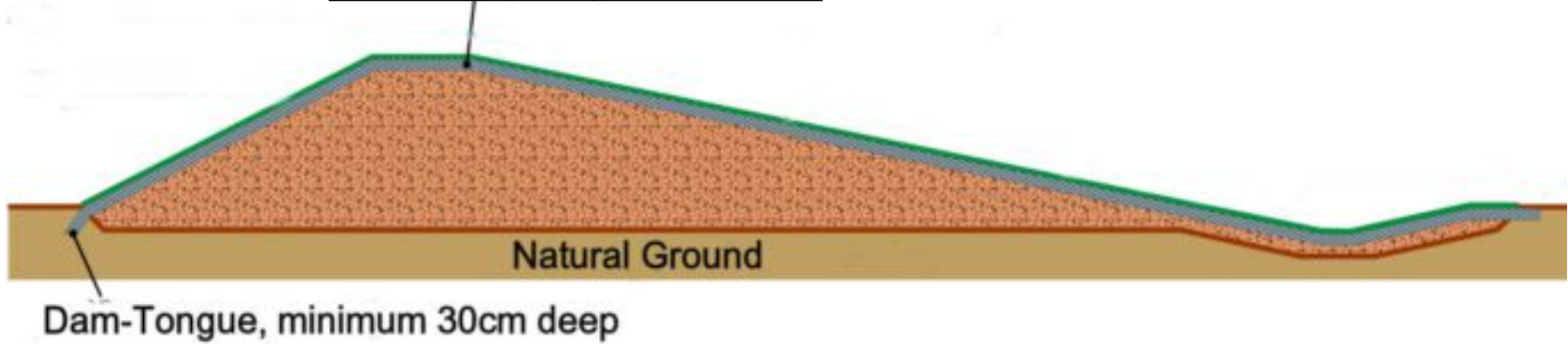
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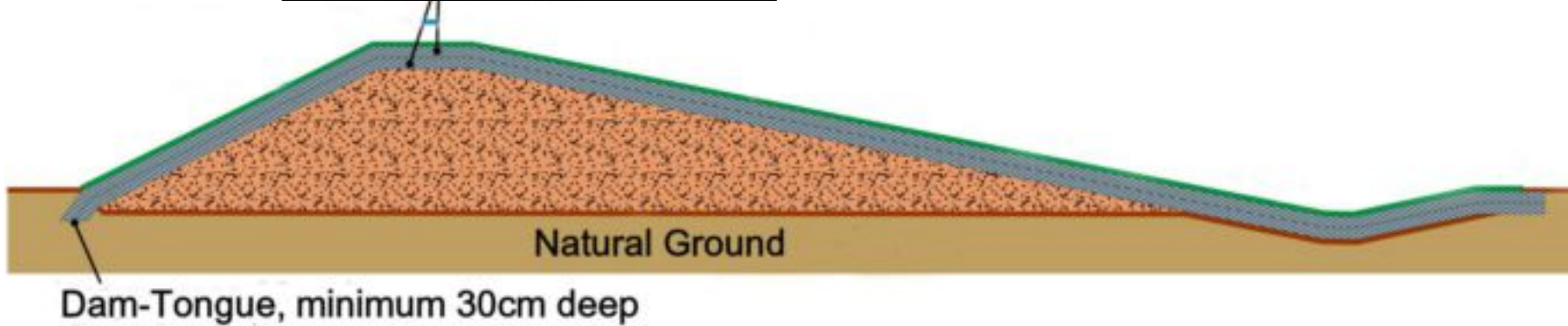


Construction methods

TERRA-3000® - Single layer



TERRA-3000® - double-ply





TERRA-3000® is environmentally friendly and almost CO2 neutral!

The determination of the biodegradability of the product sample “TERRA-3000®” was named after the directive OECD Guidelines for Testing of Chemicals “Inherent Biodegradability: Zahn-Wellens/EMPA Test 302 B”. Adopted 17th July 1992 and after German unification procedures for water, wastewater and sludge investigation, testing procedures with aquatic static test according to DIN EN 29888 (L25).



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