

**STEP BY STEP
WORKING PLAN
FOR
TERRASYSTEM® ROADS**

Presented by:



1. PREPARATION OF THE ROAD

1.1 Addition of Missing Fraction

Aspire a mixture of soil in the ratio of 1/3 clay and silt (<0,063mm), minimum 15% clay(<0,002mm) must be, 1/3 sand(0,063-2mm), and 1/3 stones (2-50mm).

Borrowed material for the improvement of the mechanical strength/ stability of the in-situ soil must be added and mixed in before treatment of **TERRA-3000®** can start.

1.2 Stable Sub-base

Before the **TERRA-3000®** can be applied, some preparatory work has to be carried out on the road:

Take care that the sub-grade and sub-base is properly compacted to allow building up the treated base course without problems.

And

The embankment at the sub-base level has to be fully stable - under traffic there must be no movement of the embankment otherwise it would be impossible to compact the treated base course properly.

IF the sub-base is moving, compact it with the sheepfoot roller until it is stable.

If the sub-base is too wet for compaction, you have two choices:

- Let the moisture dry out and assist the drying process by turning (mixing) the soil,
- or mix into the soil enough lime hydrate to obtain a compactable stage. Lime hydrate used in this layer will not cause any adverse effects.

1.3 Water Drainage

Take care that the whole embankment can drain off the surface water. For this purpose, the road embankment should have ditches on both sides deep enough to take the water from a heavy rain.

The diameter of these ditches should respect the quantity of water to be expected after heavy rains. Avoid steep slopes in the ditches wherever possible. A ratio 1:3 will in most cases be flat enough to avoid soil erosion, but bear this possibility in mind, because a too high speed of the running-off water can cause underwashing of the road. If necessary, lay pipes from the ditch to the other side of the road. The pipes must be deep enough that the mixer does not destroy it.

In flat areas, the road should lie at least 40 - 50 cm above the surrounding land level to allow the water in the embankment to drain out.

Make sure that the down side of the embankment is stable and cannot be eroded by water, otherwise a wall must stabilise it.

If this suppositions exists and you to not have to touch the sub-base or sub-grade, then you can begin with the application of the **TERRA-3000®** on the road.

2. TREATMENT OF THE BASE COURSE

2.1 Preparation of the Base Course Layer

Prepare with the grader the proper level of the base course, which is with loose soil approx. 35% higher than with compacted soil.

Frequently the base course cannot be built with the in-situ soil only; and we have to add borrowed material (coarse material, gravel sand or crushed stones) in the base course layer to flatten the sieve curve of gap-sized material.

- Here we start by ripping-off the base course layer of in-situ soil or bring it back from the side, if we had it to put aside for previous compaction of the sub-base.
- Pulverise the material to the required depth of approx. 250 mm. Lumpy soil cannot be treated.
- If the soil is too moist or if the mixing equipment does not allow good pulverisation, it is advisable to add 2 to 3% lime hydrate to dry out the soil and allow better pulverisation of the soil.
- **ADD LIME HYDRATE INTO THE BASE COURSE ONLY IF OTHERWISE YOU CANNOT GET WORKABLE CONDITIONS**

Prior laboratory tests have shown that in despite the possibility to control the shrinkage property of the in-situ soil in a high extent, addition of lime may reduce the water resistance of the treated soil. However, if there is no other possibility, this drawback is outweighed by the advantages of the treatment with **TERRA-3000®**.

The soil is now ready and prepared for the treatment with the **TERRA-3000®**

2.2 Treatment of the Base Course with **TERRA-3000®**

2.2.1 Preparation

Prepare the required quantity of **TERRA-3000®** solution by adding **TERRA-3000®** as much water as required to get the soil near to the Optimum Moisture Content (OMC).

How much water for the dilution of **TERRA-3000®** is actually required can be calculated from the Natural Moisture Content (NMC) in the soil **AND** the Optimum Moisture Content. Both values have previously been evaluated in laboratory.

Example: N.M.C. is 12%
O.M.C. is 14%

You could add 2% water to get the desired 14% moisture content.

Volume of soil : $1\text{m}^3 = 0,3 \cdot 0,3\text{m}^3 \cdot 2\% = 0,006\text{m}^3$
= 6 liters / m² 30 cm thick

You take 6 liter water/m², add the required 0.05 litres **TERRA-3000®** and apply this quantity per m².

If the soil to be treated is more or less at OMC then use only 4 litres water for the dilution of the 0.05 litres **TERRA-3000®** pro m² to avoid overmoistening. 4 litres of solution per m² increases the moisture content in the soil approx. 1%.

Do not use **TERRA-3000®** without deluding with minimum 1:40 with water, because it is too difficult to bring each soil particle in contact with **TERRA-3000®**.

2.2.2 Calculation of Water

Calculate the proper quantity of solution needed by multiplying m² x litre solution, respecting the size of your tank car.

2.2.3 Mixing Soil

START MIXING immediately after the start on sprinkling **TERRA-3000®**-solution in order to avoid that the surface soil is overmoistened.

Much better is the use of a modern special mixing mill with integrated Injection



Proper mixing is of the utmost importance
no lumps - material must be all fine and homogeneous as possible

2.3 Addition of Coarse Material

Depending upon the kind of in-situ soil, latest before applying the **TERRA-3000®** solution, the addition of any borrowed material for the improvement of the mechanical strength/stability of the in-situ soil is carried out.

3. LEVELLING

Carried out with the grader, it has to be observed that the shape of the road is already at the time of construction more or less at right level in order to avoid the cutting into low level treated material in the final stage of construction.

The final level should have a gradient of 3-5% towards the sites of the road and shoulder, which should be treated in the top 100 mm too.

4. COMPACTION

Compaction starts immediately after the mixing in of the additive with the sheepfoot roller and should be continued during levelling with the grader.

When the sheepfoots come out of the material – a sign of good compaction – the rolling is interrupted for the final levelling with the grader and continued with a flat roller.

At this stage the levelling blade of the grader is turned backwards to "shave" the surface for fine-tuning of the surface.

Now the treatment of the base course layer of the road is terminated and should have a very smooth surface on the road as well as on the treated shoulder.



Sheepfoot roller

5. FINAL WORK ON THE ROAD

You have built now a high quality base course, which should be protected with a wearing course against abbreviation of the traffic.

5.1 Wearing Course

There are different wearing courses possible.

5.1.1 Single Stone Layer

It is possible to put a single stone layer of crushed rock (20 to 30 mm) on top before final compaction and roll it into the base course at the end of compaction. Such a layer will protect the base course to a high extent against damages when properly made, and will be an excellent basis.

5.1.2 Bitumen Layer with Chips

A surface coating with bitumen emulsion, covered with 4 to 12 mm chips (crushed little stones) after the treated soil has dried back once. Such a surface coating can also be applied directly on the dried back and dust free base course layer, if desired.

5.1.3 Asphalt concrete layer

The best wearing course is an asphalt layer. The asphalt layer should be 40 to max 60 mm thick. The treated soil must dry back once and must be dust-free. We recommend to use a primer before applying the asphalt layer.

5.2 Main Reasons for a Wearing Course

A base course should never be used as a wearing course, because it is designed to carry the load and not the abrasive effects of the traffic, therefore only a wearing course can prevent the abrasion of the base course. Otherwise, sooner or later the necessity of rebuilding the base course would arise.

Another very important reason for applying a wearing course is given if you have to deal with any clayey soil. Since clayey fines are no longer washed away, a treated layer becomes slippery when wet or dusty when dry. A wearing course can satisfactorily avoid this drawback and secure a long durability of the road. Due to the fact that already a very thin layer of asphalt can act as wearing course, in most cases the savings achieved pays off the costs for **TERRA-3000®** with IN-SITU Soil.