



CONSOLID UK LTD
5 2003
THE REASONS FOR SOIL STABILISATION

How the CONSOLID SYSTEM differs from all other methods in use for this purpose (5)

This time we will look at a special aspect of soil stabilisation with – the CONSOLID SYSTEM the difference in costs and the capacity of savings.

Due to the fact that the CONSOLID SYSTEM allows a complete change in the design of a road or earthwork, we have to discuss several aspects, which altogether lead to substantial cost savings already during construction.

- **Using as much as possible in-situ soils saves a lot of costs.**
- **Upgrading sub-grade soil to sub-base and even base course, performance reduces the costs for excavation of sub-grade soil and disposal costs substantially.**
- **Less borrowed material will be required – another substantial saving factor.**
- **Converting the bridging effect of the embankment to the treated soil layers allows reducing the wearing course thickness considerably and reduces construction costs remarkably.**

There exists no other method that allows so mighty changes in a design at the construction stage and permanent improvements and upgrading of all kinds of existing soils as the CONSOLID SYSTEM. Respecting all advantages of the system leads already **during construction** to cost savings in the range of 20%+ compared with the same kind of construction in a conventional way.

The entire savings are much higher, because it is obvious that the permanence of the treatment with the CONSOLID SYSTEM counts additionally by greater durability, combined with lower requirements for maintenance – this must be added to the saving potential of the job carried out with the CONSOLID SYSTEM.

We often hear the question:

- **How much does 1 m² of a road built with the CONSOLID SYSTEM cost?**

We cannot answer this question indicating a certain sum, because each project has its specific parameters, other requirements to be respected in the design, other cost factors for material and transportation, to name only a few. The only possible answer is based on decades of experience:

- **Irrespective of the development degree of the country the use of the CONSOLID SYSTEM will always allow savings already during construction in the range of 20% and more, compared with conventional construction costs.**

20%+ is a lot in terms of savings...

... only on construction costs, not considering the additional savings which originate from greater durability and lower maintenance costs, which will become visible only with time. But as mentioned above, you will get an optimum of savings only if your design respects all aspects of possible improvements.

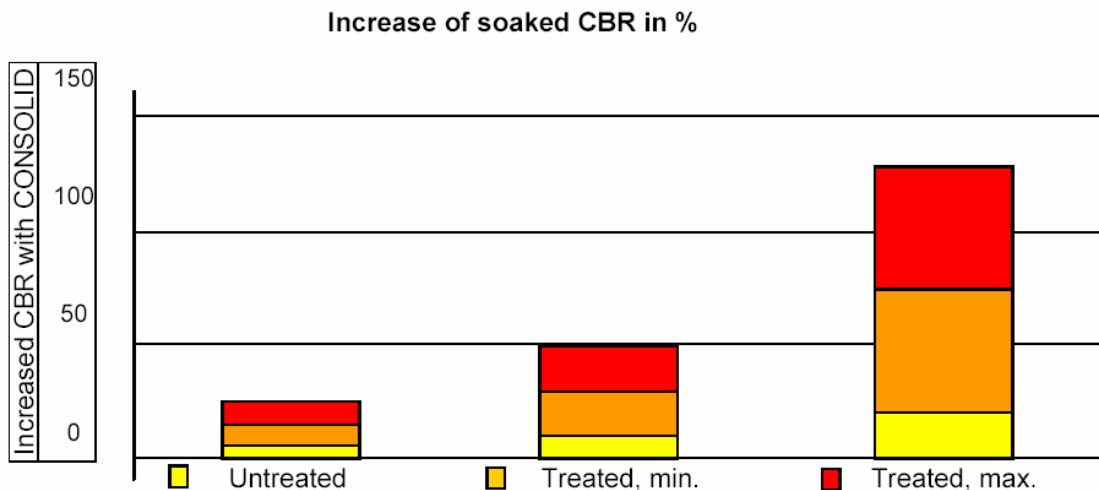
Therefore the calculation of a job site has always to respect the entire construction work and not only the costs of a single treated soil layer, (if possible compared with a layer of the same untreated soil).

The savings are substantial anyway.

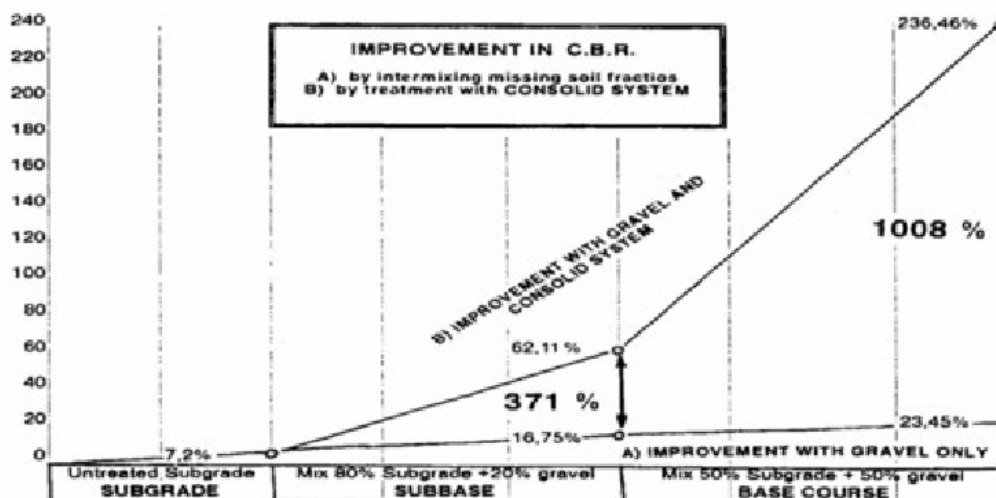
- You will have to exchange no or much less in-situ soil for borrowed material; this will substantially show in material and transportation costs.
- A stable soil embankment secures lowest figures in deformation and deflection; you can avoid reconstruction due to these reasons.
- The treated embankment will be to a high degree water-resistant and can be brought, if necessary, to fully impervious performance; not so a conventional embankment.
- A fully stable soil embankment is the bridge you need for the take-up of loads. This allows to reduce the wearing course to a much thinner layer with a great saving capacity and opens the opportunity to work with high-quality, light pavements, preventing the problem of accumulated heat in thick asphalt layers or expansion cracks due to great differences in temperature.

Based on the criteria of C.B.R. requirement, which is easily comparable with any other design method, the following pages show some examples of differences between conventional cross sections and those where the advantages of the CONSOLID SYSTEM are respected:

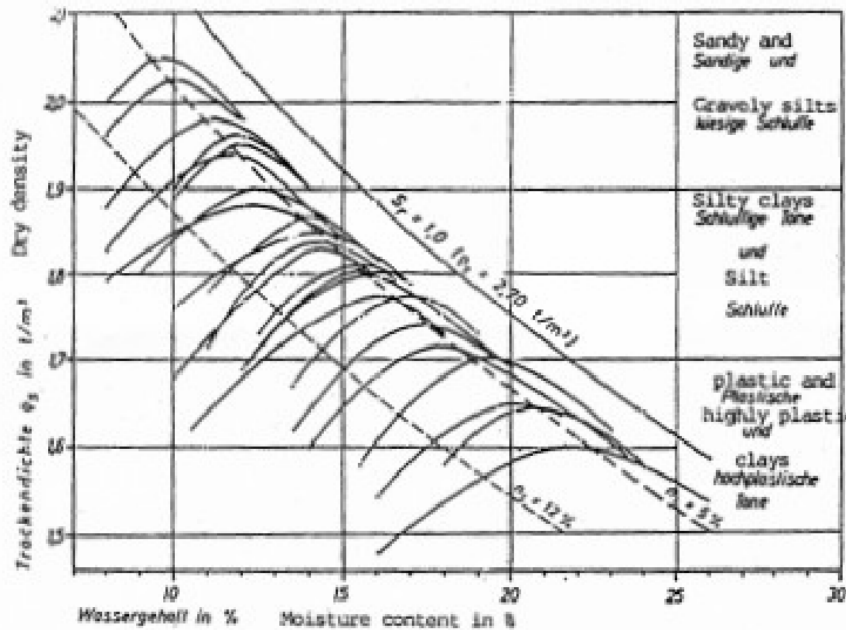
The following graph shows that any type of soil can be improved with the CONSOLID SYSTEM with regard to soaked C.B.R. values at least 3 to 5 times – this improvement can be much higher, the lower the soil quality for construction purposes is. Clayey and silty soils could in many cases be improved up to 30 times of the soaked C.B.R. of the same untreated material – the improvement has really an open end...



With the same costs any soil can be further improved substantially by improving the sieve curve, i.e. adding missing fractions, as shown in the graph below.



The CONSOLID SYSTEM improves the treated soil in a permanent way by upgrading the material towards better materials, often seen in an increase of the density and the reduction of the OMC of the treated soil. But even if these changes are small, the treated soil performs similar to a higher classified material and this can and will be the **big difference between** in-situ material and borrowed material and one reason for substantial savings.



And as already mentioned before, any in-situ soil can be further improved at lowest costs only by adding missing fractions, which you can usually find easily and at low costs around the construction site. The cost for the treatment with the CONSOLID SYSTEM will remain the same, but the improvement will increase substantially. It is particularly important to have sufficient clayey fines in a soil mix to enable a very dense packing and thus to reduce the voids in the compacted soil mix as far as possible – the lack of voids is one of the reasons for the stability of rock.

This adds also impressively to the possible cost savings.

For Rural Roads and many other plain earthwork projects, a soaked C.B.R. value of 35% is usually specified. To get this figure in a conventional way on the top of the base course you will have to start in a depth of 500 mm (29") with a C.B.R. of 5 to 9%, at a depth of 250 mm (10") you need already C.B.R. 13 to 15% to get on top the desired C.B.R. of 35%.

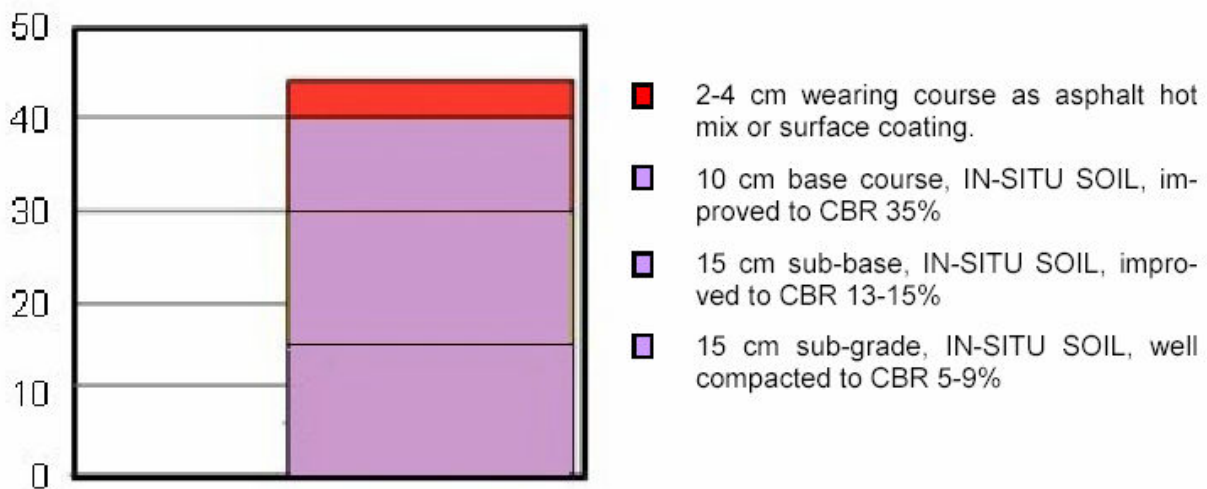
Conventional Cross Section CBR 35



- 2-4 cm wearing course as asphalt hot mix or surface coating.
- 10 cm base course, borrowed material, improved to CBR 35%
- 15 cm sub-base, improved with borrowed material to CBR 13-15%
- 15 cm sub-grade, IN-SITU SOIL, well compacted to CBR 5-9%

With the CONSOLID SYSTEM you can easily bring any in-situ soil to the required soaked C.B.R. values and with an in-situ soil of C.B.R. 5 - 9% you get with the treatment often without adding borrowed material the desired top value of C.B.R. 35%. If you still have to add borrowed material, the quantity will be very small.

CONSOLID Cross Section CBR 35



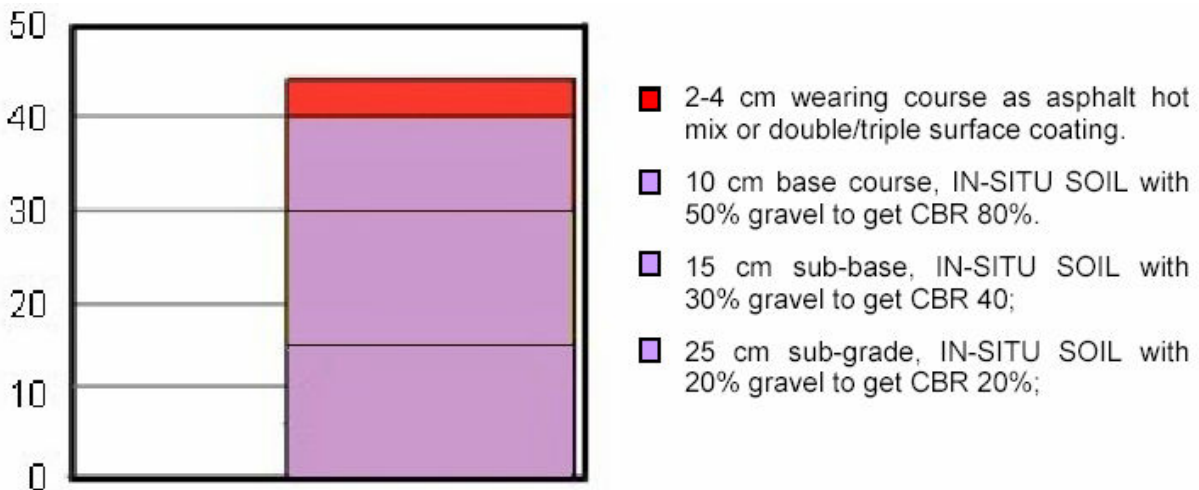
Main Roads, Highways, Motorways and many other constructions exposed to more and heavy traffic require a higher loading capacity, and this is often specified with a **soaked C.B.R. of 80%**. To achieve this figure, the in-situ material will in most cases not be sufficient. Layers of borrowed material are necessary to get in a conventional construction close to the specification.

Conventional Cross Section CBR 80



The CONSOLID SYSTEM opens the way to realise the construction with as much as possible in-situ soil, because any in-situ soil in the range of C.B.R. 15 to 20% can be upgraded with the treatment to the desired C.B.R. 80% and more, allowing substantial savings in borrowed material.

CONSOLID Cross Section, CBR 80



The examples presented above show that there is a huge potential for cost savings by using the CONSOLID SYSTEM for the upgrading of in-situ soils to risk-free construction material, which can save already during construction more than 20% on costs. This applies to any roadwork or similar applications as in railroad embankments, air strips, run and taxiways, but also for protection layers in landfills, for erosion control, linings against seepage, etc. There the savings can become even higher, especially if the excavated in-situ material is polluted and will otherwise have to be disposed in special, expensive landfills for polluted materials.

**Summary of conventional methods versus the CONSOLID SYSTEM
Construction of roads, railroad, airstrips and other plain areas:**

SUB-GRADE:

The sub-grade will be the basis for the embankment and has to be stable enough to take up the sub-base, base course and wearing course and allow their appropriate construction and compaction.

<p>Conventional:</p> <p>The sub-grade has to be properly compacted, in case it is not stable enough, it has to be stabilised with cement or lime or excavated and replaced with better material.</p>	<p>With the CONSOLID SYSTEM:</p> <p>In most cases the treatment allows an upgrading of the in-situ soil in the sub-grade to the requirements of the sub-base; if additional material is needed to add missing fractions, any material close to the site will do the job, even if it is polluted with clayey fines.</p>
<p>SUB-BASE:</p> <p>Conventional:</p> <p>If the in-situ material is not acceptable as sub-base material and cannot be improved sufficiently by stabilisation with cement and lime it has to be exchanged by borrowed material.</p>	<p>With the CONSOLID SYSTEM:</p> <p>If it is not stable enough it can be improved to obtain the soaked CBR increased 3 to 5 times, which will in most cases not only be more than sufficient for the sub-grade but allow to take the same soil in the sub-base. Borrowed material must be imported to get the desired loading capacity.</p>
<p>BASE COURSE:</p> <p>Conventional:</p> <p>Base course material will be always borrowed material if the in-situ material does not have the required quality. Mostly gravel or crushed stones must be added, a layer particularly sensitive to the dynamic forces of the traffic, which leads to movements of the loose material (vibration sieving).</p>	<p>With the CONSOLID SYSTEM:</p> <p>The in-situ, soil, especially if it is cohesive, can become very well the main basis for the base course too and the requirement for borrowed material, reduced to the correction of the sieve curve by missing fractions.</p>

CONCLUSION:

The use of the in-situ soil in all layers of an embankment when treated with the CONSOLID SYSTEM reduces the requirement for soil exchange, borrowed material and their transportation substantially and allows substantial savings and protection of scarce resources. The graph puts together the remarks stated in this letter. To realise a durable soil construction, the CONSOLID SYSTEM makes it possible to obtain the desired and specified C.B.R. values for each layer, in most cases with the in-situ soil, even if this soil has a low soaked C.B.R. value. This enables the use of in-situ soils in large quantities and leads to substantial savings in material, at the same time protecting resources of gravel and crushed stones for purposes where they will be needed anyway.

Respecting all advantages of the CONSOLID SYSTEM already in a modified design opens the way to substantial savings at the construction stage, which will be in the range of 20%, but can run up to 50% of the costs of an adequate conventional construction.

