Swift Stabiliser Solutions Australia PTY LTD

SSSA 4000

AN INTRODUCTION

Stabilizing with **SSSA 4000** Ionic Soil Stabilizer improves the physical and mechanical characteristics of the soil. When applied to roads & hard stand areas, **SSSA 4000** creates a resistance to the action of weather and dynamic loads.

SSSA 4000 chemically changes soil particles so that the particles can no longer absorb water. Adsorbed water makes clay soils unsuitable for construction. The adsorbed water acts as a lubricant on the soil particles thus preventing compaction of the soil. **SSSA 4000** releases this layer of adsorbed water and the soil can then be compacted to 100% plus. The treatment is permanent and the soil can no longer absorb water. Adsorbed water is one of the primary reasons for road deterioration as it expands and contracts as it freezes and thaws. **SSSA 4000** virtually reduces all such swelling and shrinking.

Using **SSSA 4000**, the densities required for clay soils can easily be achieved where as, in the past, it was necessary to use expensive and cumbersome lime or aggregate. **SSSA 4000** is a cost-effective alternative for gravel roads. An **SSSA4000** base with a dust seal requires no maintenance, except perhaps resealing about once a year. Thus, the cost of treating a road with **SSSA 4000** will be more than recouped by the savings on gravelling and grading within only a few years In addition, the reduction in dust (up to 70%),

The fact that it is impervious to water and the higher quality of an **SSSA 4000** road makes for a safer and more usable road for forestry, farming and other rural applications.

SSSA 4000 is 100% organic. It is derived from combined organic sulphur and buffered acids that are combined as bi-suiphates **SSS A 4000** is a true catalyst, it is not consumed in its function but coutmues and perpetuates its action as long as water is present **SSSA 4000** is non-toxic in diluted form and poses no threat to ground water supplies or wildlife

SUITABLE SOIL TYPES FOR SSS 4000 APPLICATION

Soil types for application include A-4 A-5, A-6 and A-7

Any soil with a Plasticity Index of between 6 and 30 and not more than 80% solids (clay) passing the 200 sifter is suitable for use with **SSSA 4000**. Application should not, however, include solids (clay) of less than 10% passing the 200 sifter.

SSSA 4000 improves soil properties in soils GC, SC, ML, CL, MH and CH. Soils GM, SM and OL should only be processed when they contain a plasticity of less than 50%

WATER VOLUME CALCULATIONS

AREA TO BE STABILIZED

Calculate the total area of road to be stabilized with **SSSA 4000** to give the total in meters squared to be treated.

WATER VOLUME

About 0.5 litres of water per 1 cm depth per 1m squared is required. However, this can vary by 10 to 20% according to the initial moisture content of the soil and weather conditions

SSS A 4000 VOLUME

0.03 Litre of **SSSA 4000** per meter squared is required for each depth of 15 cm

MIXING

The total amount of water required divided by the capacity of water truck equals the total number of truck loads of water. Divide the total amount of **SSSA 4000** required by the number of truck loads. Start filling the water truck, add the required amount of **SSSA 4000** and complete filling the water truck.

EXAMPLE

Stabilization of a road 1 km long X 7 m wide X 15 cm deep, using a water truck with a capacity of 5000 Litres.

Area to be stabilized: 1000 X 7 = 7000 m2.

Volume of water required: 7000 m2 X 15 cm = 105,000 X 0.5 L = 52,500 L of water.

SSSA 4000 required: 7000 m2 X 1.0 L = 210L of SSSA 4000 (i.e. 1 drum).

Mixing: 52,500L ÷ 5000L = 10.5 loads of water

SSSA 4000 per water load: 1,000L ÷ 10.5 = 666L per water truck load of water.

NOTE: If optimum moisture content is obtained before the last load of **SSSA 4000** mixture has been applied, the excess load should be applied during or after compaction. If however optimum moisture content has not been obtained after the last load of **SSSA 4000** mixture has been applied, a water load without **SSSA 4000** having being added may be used.

“How SSSA 4000 functions as an ion exchanger and how it acts upon colloidal particles during application?”

In general in soil mechanics, it is usual to draw a distinction between two phenomena of water: static water and water in motion. The latter in particular (where the motion is caused by penetration or by the action of gravity) greatly helps accelerate many reactions initiated by treatment with **SSSA 4000.** Static water, though it does not move under the actions of gravity, is nevertheless not completely motionless. Generally speaking, the motion caused by osmotic forces or molecular movement is very slight but, over a long period of time, considerable masses of water may nevertheless be transported as a result of this — either as a liquid or as a gas (evaporation). Static water remaining in the soil can be subdivided into four categories differing from one another chiefly in the order of magnitude of the force with which they adhere to the soil particles.

With the exception of chemically combined crystalline water, all the above-mentioned types of water are involved in the **SSSA 4000** reaction process. Since the main function of **SSSA 4000** is to reduce the amount of water held in the soil in order to form voids for optimum compaction and, alternatively, to decrease the swelling capacity of the individual soil particles, the characteristics of these various categories of water in the soil will now be briefly discussed.

Chemical water

This water, which is incorporated in the crystal structure and thus chemically combines with the soil minerals, forms only a very minor proportion of the water in the soil. It cannot be expelled from it by drying with temperatures above 1100 C. From the technical construction point of view, this water can be regarded as an integral constituent of the soil itself and can be ignored in construction.

Adsorbed water

Water adhering to the surface of the soil particles can be partly, but not entirely, driven out by drying in an oven. When soil dried in this way is allowed to cool, it will reabsorb water in amounts dependent on the humidity of the ambient air.

Water held by surface tension

Most of the water retained in soils is derived from water which has been held by surface tension at the points of contact between particles or which otherwise can move as pore water or as free water in the capillaries and larger voids.

Capillary water

This is water lodged in the pores between the soil particles; it can be partly or entirely removed by seepage, evaporation or water extraction with suitable equipment. The most difficult problem is raised by the adsorbed water which adheres to the whole surface of the soil particle and almost forms part thereof. This film of water enveloping the particles, which ultimately governs the expansion and H20. H + 0H shrinkage of colloidal soil constituents cannot be completely eliminated by purely H20 mechanical methods. However, by means of temperature effects and the addition or removal of water with mechanical pressure, it is possible to vary the amount (hydronium) of water held in this manner. Such variations are attended by swelling or shrinkage. This provides an ideal point of operation for **SSSA 4000.**

To obtain a better understanding of this, the principle on which the action of **SSSA 4000** is based will be explained. In this context, the electrostatic characteristics of soil particles will also have to be considered. As a result of a lowering of the dipole moment of the water molecule, there occurs dissociation into a hydroxyl (—) and a hydrogen (+) ion. The hydroxyl ion in turn dissociates into oxygen and hydrogen, while the hydrogen atom of the hydroxyl is transformed into a hydronium ion. The latter can, in the nascent state, accept or reject positive or negative charges, according to circumstances.

Normally, the finest colloidal particles of soil are negatively charged. The enveloping film of absorbed water contains a sufficient number of positively charged metal ions such as sodium, negatively charged nucleus ions potassium, aluminium and magnesium which ensure charge equalisation with respect to the electrically negative soil ion.

Absorbed or hydroscopic water

Absorbed or hydroscopic water is, as already stated, mainly responsible for the swelling and shrinking properties of soils. A soil particle comprising only chemically combined water cannot absorbed water swell, i.e. it cannot alter its structural density.

Only the film of absorbed water adhering firmly to the particle surface can expand in volume as a result of further water absorption when the soil is wetted. This effect is more particularly prominent in fine-grained soils, such as clays. Since this absorbed water is held in a “stable” form on the clay particles, thickening of this water film will involve a displacement of the centres of the particles toward one another with the overall effect that the volume of the mass of soil increases. Therefore, in order to achieve the densest possible packing of the clay particles and to obviate the undesirable swelling and shrinking behaviour of such soil, it is necessary merely to reduce the thickness of the water film (which, as has already been pointed out, is held very firmly to the particles) or to break the film.

The only possible way to do this economically and permanently is by ion exchange. Because of its electro kinetic properties, the **SSSA 4000** solution acts upon the positive and the negative charges of the soil particles.

The effects of this action are threefold:

1. The film of the absorbed water is greatly reduced and in fact entirely broken.

2. The soil particles acquire a tendency to agglomerate.

3. As a result of the relative movement, the surface area is reduced and less absorbed water can be held thereby, so that this in turn reduces the swelling capacity. Moreover, these three factors facilitate compaction of the soil or indeed make it in fact possible.

In bringing about this phenomenon, the positive charges of the hydronium ion or of the negatively charged hydroxyl ion will normally combine with the positive charge to exert adequate pressure on the positively charged metal ions in the absorbed water film.

As a result of this, the existing electrostatic potential barrier is broken. When this reaction occurs, the metal ions migrate into the free water which can be washed out or removed by evaporation. Thus the film of absorbed water enveloping the particles is reduced. The particles thereby lose their swelling capacity and the soil as a whole acquires a friable structure. This is an irreversible process.

The hydrogen ions which are liberated in the dissociation of the water molecules can once again react with free hydroxyl ions and form water along the gaseous hydrogen. It is important to note that the moisture content of the soil affects the surface tension and is thus a factor affecting compaction.

It should furthermore be pointed out that dry soil is poorly suited for compaction only because of the surface tension of the water contained in it. This is the reason why a certain total quantity of **SSSA 4000** solution is necessary for processing the area of ground in question. This is important, for if less than the total required quantity of solution is applied, its penetration into the ground will be adversely affected. These two phenomena (gas and water formation and surface tension) can be reduced by an increase in moisture content.

If the forces involved are reduced as a result of increased moisture content, the **SSSA 4000** solution can penetrate more easily into the capillary structure of the soil and the ion exchange process can take place more rapidly. The water released in consequence can therefore either seep away or be expelled by the kneading action of, for instance, a sheepsfoot roller and then evaporate at the surface. **SSSA 4000** therefore creates favourable conditions for compaction by changing the zeta potential of the clay and silt particles.

The zeta potential (electro kinetic potential) decreases with increasing concentration of the ions of opposite charges from the **SSSA 4000** solution. The cations and anions are liberated from the diffuse double layer, which reduces the swelling properties of the soil.

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The most notable properties of **SSSA 4000** and the effects on the soil therefore are:

1. Reduction of the dipole moment which has a water repelling effect on the individual soil particles and at the same times reduces the swelling capacity.

2. The electro kinetic phenomenon causes the stabilisation of the soil particles. As a result, the soil acquires a higher shearing strength and its compact ability is significantly improved. In general, the soil particles align themselves parallel to one another and, because of the formation of an electrical cushioning, cause a sliding effect that takes place in the horizontal molecular structure.
3. Broadly speaking, a soil of colloidal character has a structure comparable to a house of cards. Because of this, the soil can contain a fairly large amount of voids which are filled either with water or with air. During treatment with **SSSA 4000**, these voids must in any case be filled with pore water derived from the static water. Only in this way can ion exchange by higher valency cations take place and the dipole moment of the soil particles be reduced.
   When the reaction has occurred, less water can accumulate in the soil than was originally possible. As a result, the swelling capacity is reduced and the internal moisture of the soil is reduced. Subsequent additions of water cannot reverse this process and once the latter has been accomplished, the swelling capacity is destroyed and the shearing strength is increased. For the processing solution to function correctly, the minimum requirement is that the soil should have optimum water content. Slightly higher water content will intensify the reaction but on no account must the amount of water in the soil approach the saturation limit for this will result in the reduction in penetration power and the effectiveness of the process. A further problem that can arise if the soil water content reaches saturation is that the surface of the ground becomes sealed off by the original swelling effect.

PLASTICITY

Plasticity Index is used to describe the condition where clays exist. It is common practice to discard densely graded bases with a P1 in excess of 6. There are some exceptions to the rule that the higher the P1 of the clay, the more difficult it is to stabilize. However, it is almost universally believed that clays can only be improved by reducing the plasticity index.

In order to understand P1, let us define it. Plastic limit denotes that percentage of moisture by weight that must be added to dry clay in order to cause it to begin to lose its coefficient of friction and, instead, to be bound together by the cohesiveness of thin films of water. Liquid limit is the percentage of moisture that must be added to dry clay in order to cause it to flow at a certain rate because of the increased thickness of the water film between adjacent soil particles. The difference between them is the plastic index.

It should be borne in mind that only clays on or near the surface of the earth are free to exhibit these characteristics. When under compression, because of other soil, base material, paving or overburden or because of mechanical compactive effort, or both, clay cannot absorb much water in excess of that required to fill the voids that exist between the particles. Therefore, except for those clays found on the shoulders and slopes and in the ditches along the right-of-way, clay that is normally encountered during road building operations is not subject to the physical laws by which plasticity index is determined.

P1 is usually reduced by adding sand or other granular material, lime or cement. While some chemical reactions do occur in the soil when lime or cement is added, they perform essentially the same function as sand, that of reducing the proportion of the particles possessing colloidal or surface active characteristics. Finely divided clays have both. Sand has neither.

Lime or cement must be added to clay at a rate of at least 6% by weight if significant practical results are to be obtained. Often higher rates are needed, and there are clays that cannot be; satisfactorily stabilized regardless of the amount used.

Where sand or other granular material is used, the amount added must be from a minimum of 10 to as high as 50% These massive quantities of lime, cement or sand increase bearing values and improve the internal drainage of the clay While P1 is also reduced,, it is actually only a measuring guide It is the fact that bearing values are higher and that internal drainage is improved so that soft spots and frost lensing do not occur

There are some chemical formulae that will reduce P1 drastically. Unfortunately, they also reduce the bearing values of clays. To use a chemical that would reduce the PI of clay from 20 to 6 while also reducing the CBR from 10 to 5 would obviously be foolish. Therefore, the statement that is sometimes made in regard to clay that the only thing of importance is to reduce the P1 is completely unfounded.

SSS A 4000® Soil Stabilizer will, when used in accordance with instructions increase the bearing values and reduce the moisture content permanently. It also, to some extent, reduces the P1. However, it should be kept in mind that, with this system of stabilization, it is possible to correct the problems of clays without reducing the PI to the same extent as would be necessary when using the other methods described above.

It has been said that, to treat a clay soil primarily for the purpose of reducing the P1, is like trying to cure a fever instead of the disease that is the cause. The afflictions of clays are low bearing values when wet and poor moisture equilibrium. When these are properly treated to the level required in base or sub base with **SSSA 4000**, the plasticity index that results is only a statistic.

Construction Procedure for **SSSA 4000®** (per 150mm layer):

Plant:

Motor grader (with fitted scarifiers)

Water bowser (of known volume)

Vibratory roller (10 t minimum)

Disc harrow or rotary mixer (optional)

1. Scarify area to 150 mm depth.
2. Large clods to be broken to max 50 mm.
3. **SSSA 4000** at 1.0 lt/m2 per 150 mm layer (6.60 lt / m3) or the required application rate must be added directly to the water bowser with the moisture needed to bring the material to optimum moisture content (OMC) for compaction. If the material is at OMC, a minimum amount of 1lt water/m should be used.
4. The **SSSA 4000**-water mixture must be evenly sprayed over the entire area in multiple passes.
5. The area is to be thoroughly mixed until 0MG is achieved.
6. Should more moisture be required after the application of the ISS to achieve 0MG, clean water is to be used.
7. At 0MG, the area should be leveled and compacted to required density.
8. Subsequent layers may then be placed
9. Any exposed **SSSA 4000** treated areas should be lightly watered twice daily for three days or until covered.

Water/SSSA 4000 volume calculations

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APPLICATION OF SSSA 4000

1. AREA TO BE STABILISED

Calculate the total area to be stabilised with **SSSA 4000** giving the total m2 to be treated.

2. WATER VOLUME

SSSA 4000 is applied together with the water required to bring the material to optimum moisture content. About 0.5lt for every 1cm of depth per m2 is required but may vary according to the material's in-situ moisture content and weather conditions.

If the material is already at or above optimum, a minimum of 1lt per m2 of water must be used.

3. SSSA 4000 VOLUME

Standard application rate for **SSSA 4000** is 1.0 lt per m2

The area in m2 is multiplied by the **SSSA 4000** application rate to give the quantity of **SSSA 4000** required.

Example: Area to be stabilized 7000 m2

SSS A 4000 application rate 1.00 ltr/ m2

7000 m2 x 1.0 ltr / m2 = 7,000lt of **SSSA 4000**

4. MIXING

The total amount of water required to bring the material to optimum moisture is divided by the capacity of the water truck to estimate the total number of water loads. It is advisable to only add the **SSSA 4000** to the first two-thirds of the required water loads. Note: If optimum moisture content is obtained before the last load should be applied, the excess load should be applied during or after compaction. If however optimum moisture content has not been obtained after the last load of **SSSA 4000** mixture has been applied, clean water without **SSSA 4000** must be used.

Where suitable gravels exist, the treatment of these materials with **SSSA 4000** minimises deterioration should penetration of water beneath the seal occur. Should potholes etc occur with an **SSSA 4000** treated road, the integrity of the road foundation remains intact and maintenance and repair work is restricted to that of the seal.

Unlike conventional stabilisers, there is no working period or time limit when stabilising a layer with **SSSA 4000**. This adds a further potential cost saving to users during the rainy season or in the event of machinery downtime.

Construction/Application

The application of **SSSA 4000** requires no specialised machinery or construction procedure and the standard method for the construction of a gravel layer is followed using a water truck, motor grader and compactor/roller (see Construction procedure).

SSSA 4000 uses

1. **Unsealed road**: With an unsealed (gravel or dirt) road, a wearing course of material needs to be selected that contains a certain amount of clay to assist in binding the material. **SSSA 4000** neutralises the negative aspects of this clay content and allows far greater densities to be achieved with the same material. This higher density results in a greater resistance to abrasion and lowering material loss at the surface and thus reducing dust.

The **SSSA 4000** treated layer does not absorb water and mud and other associated wet weather problems are minimal during wet seasons. Because of this the required maintenance to the road is greatly reduced (often eliminated), thereby creating a substantial cost saving to the road authority.

The life of an unsealed ISS is dependent on the material, traffic type and volume and design (the provision of adequate drainage is essential).

2**. Sealed road:** With a sealed road, the main requirement for the selection of a suitable material is its bearing capacity. Materials with a clay content have a tendency to absorb water after compaction, resulting in a low bearing capacity. **SSSA 4000** corrects this problem so that these materials retain these compacted densities and become suitable. As treatment with **SSSA 4000** is permanent, the only required maintenance to an **SSSA 4000** sealed road is that to the seal.

SSSA 4000 APPLICATIONS

- Streets and roads in rural and residential areas
- Haul roads
- Roads in game reserves
- Road shoulders
- Construction sites
- Quarries

  Mine dumps and workings
- Temporary bypasses
- Sports fields

- Parking areas
- Dust sensitive agricultural and forestry roads

SSSA 4000 ADVANTAGES

- Improved road standards - dust-free road surfaces ensure safer and more comfortable driving
- Cost-effectiveness - requires the minimum construction and road preparation efforts to create a positive life cycle/cost ratio
- Easy application - spray with standard spray equipment, without the necessity of specialised Equipment
- Easy and affordable maintenance - normal maintenance to the surface can be achieved with the minimum expertise and standard equipment. Rejuvenation can be done as and when required
- Quick drying - penetrates rapidly and the road can be opened to traffic immediately
- Improved quality of life - less dust

ENVIRONMENTALLY FRIENDLY

SSSA 4000 has no negative impact on the environment and is safe to handle. It is non-toxic and non-hazardous.

SUMMARY

Many insitu soils that are extremely difficult to stabilise can now be treated in a cost effective method using Swift Stabiliser Solutions Australia products. Advantages of using **SSSA 4000** are:

- Less gravel required
- Stable pavement with reduction in water penetration;
- Increase in strength
- Semi flexible-rigid pavement;
- Ease of application with limited man-handling of chemical;
- Reduction in road construction and maintenance costs as well as providing safety and ride quality benefits

Swift Stabiliser Solutions Australia PTY LTD

- Distributors of **SSSA 4000** products
- On-site consultancy
- Technical advice on **SSSA 4000** product, Stabilising methods , Laboratory testing Procedures and soil analysis

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