

**Guidelines to the construction
of pavement layers
and stabilized materials
using
AnyWay Natural Soil Stabilizer (ANSS)**

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The following project specifications have been written to cover all phases of work normally required for the stabilization of materials or pavement layers using ANSS. The document has been structured in such a way as to present the three phases of any project; pre-application, the application itself, and post-application procedures. Their objective is to be able to produce uniform results throughout the world. The document is intended as a guide for practicing engineers and leaves room for engineering judgement to be administered.

Pre-Application Procedures

1. Prior to stabilization

Prior to the application beginning there are several aspects that need to be addressed. Firstly, a survey needs to be established, which should include the climatic conditions, traffic requirements, loads, and a soil survey. Based on the results an appropriate road design should be created.

1.1 Sampling and testing

Tests should be conducted by the party carrying out the application, both before and during the progress of the work, to ensure compliance with the requirements of the project specification outlined by a reputable consulting engineering firm experienced in the aspects of pavement layer design. Results of the testing are the responsibility of the client's lab and the client's consulting engineer.

All samples of soil and general materials should be taken in accordance with the standard methods specified. The standard methods that should be utilized for testing include:

- (a) The specifications of the American Society of Testing and Materials (ASTM)
- (b) The specifications of the American Association of State Highway and Transportation Officials (AASHTO)
- (c) British Standards Institute Specifications (BS)
- (d) Standard methods for testing road construction materials (TMH1 and TMH6) and for calibration (TMH2), compiled by the Committee of Land Transport Officials (COLTO)

In addition to the above standard methods of testing, standard specifications or test methods of other bodies may also be referred to in these specifications, or test

methods may be described where no acceptable standard method exists.

Samples for laboratory testing should be fully representative of the material to be stabilized with ANSS.

1.1.1 Untreated material

The following tests should be conducted on the natural or untreated soil/material before construction of any pavement layer proceeds. The results should be forwarded to a consulting engineer or engineering firm and AnyWay Solid Environmental Solutions for review:

- (a) Gradation, particle size distribution and particle size analysis
- (b) Plasticity (Atterberg Limits)
- (c) Group Classification
- (d) Maximum Dry Density (MDD) and Optimum Moisture Content (OMC)
- (e) California Bearing Ratio (CBR) and/or Unconfined Compressive strength (UCS)

1.1.2 Treated material

The following tests should be conducted on the soil/material to be stabilized with ANSS before construction of any pavement layer proceeds (i.e. prior to project initiation):

- (a) Evaluation of strength (CBR and/or UCS) versus ANSS stabilizer content at differing dosages
- (b) Atterberg limits at varying dosages (Atterberg Limits)

(c) MDD (Modified) and OMC at varying dosages

1.2 Properties tested

1.2.1 Particle size distribution

The particular packing arrangement for a material is normally represented by the particle size distribution (gradation) curve based on proportions (by mass) assing successive sieves. A lack of coarse or finer particles would produce an unbalanced gradation or distorted gradation curve resulting in poor mechanical stability and unsatisfactory compaction. Therefore, an improvement in gradation and in the reduction of oversized material will result in more uniform strength development, uniform mixing and compaction. It is preferable to have a gradation with a continuously smooth curve from the maximum particle size to the smallest particle size with no excess or lack in certain particle fractions.

1.2.2 Particle size analysis

The particle distribution of the finer material passing the 2 mm sieve has a marked effect on the compactability and bearing strength of the material.

1.2.3 Atterberg limits

Plasticity gives an indication of the materials' clay reactivity (active clay content) and affinity to water (moisture content), which will affect the variability in strength development and the possible need for increasing the stabilizer content.

1.2.4 Group classification

The group classification is useful in determining the relative quality of the soil material for use in earthwork structures, embankments, sub-grades, sub-bases and bases.

The classification is based on laboratory determinations of particle size distribution, liquid limit and plasticity index.

1.2.5 Moisture-density relationships

The determination of the relationship between water content and density of soils is used in determining the compaction of the material. The purpose of compaction is

to arrange the particles in such a way as to achieve the highest possible density for the layer with minimum voids. By achieving high densities, not only is the shear strength and elastic modules improved but also the ingress of water is reduced or eliminated.

1.2.6 Strength

The strength of soils or cohesive materials can be assessed by the determination of the CBR and/or UCS.

- (a) CBR test: used to evaluate the potential strength of sub-grade, sub-base and base-course material.
- (b) UCS test: used to provide an approximate value of the strength of cohesive soils in terms of total stresses and is used to quickly obtain the approximate compressive strength of soils that possess sufficient cohesion to permit testing in the unconfined state.

In order to establish the required stabilizer content required to produce a mixture conforming to either a specific CBR or UCS, specimens shall be prepared at three (3) different stabilizer contents, and CBR or UCS determinations shall be made for each specimen. The three contents are usually in increments of two (2) percentage points e.g. 2%, 4% and 6% by mass of the total oven-dried material.

1.2.7 CBR and UCS determinations: additional Provisions

The CBR and UCS tests shall be conducted in accordance with the methods described in the Standard Methods as specified, subject to the following additional provisions.

The purpose is to facilitate conditions in the field and to allow sufficient strength gain to take place.

- a) Preparation of the specimens
 - The calculated amount of ANSS stabilizer additive should be admixed with the raw or untreated material thoroughly to a uniform color before the optimum water or moisture content is added.
- b) Curing of the specimens
 - After completion of the compaction effort, the specimens should be cured for seven (7) days in a

suitable curing room, exposed to air. At no stage whatsoever during the seven (7) day period should the compacted specimens be submerged under water.

- The compacted specimens can either be placed under damp hessian bags or wood chipping to prevent the compacted specimens from drying out too quickly and thus preventing adequate strength gains from taking place.

- After the seven (7) day curing period, the specimens should be removed from the curing room and submerged in water for the four (4) day soaking period, for the determination of the CBR. The compacted UCS specimens shall be immediately crushed to total failure on removing the compacted specimens from the curing room.

1.3 Foundation and drainage

Before commencement of stabilization of materials or pavement layers, assessment of the foundation and drainage should be carried out.

1.3.1 Foundation

The stabilized layer should be constructed on a stable, durable, adequately compacted foundation layer or underlying pavement structures, depending on the type and amount of traffic load. The following problems should be addressed and eliminated before any stabilization of a material or pavement layer is initiated:

- (a) Excessive volume changes which occur in some soils as a result of moisture change (eg. expansive soils and soils with a collapsible structure).
- (b) Flaws in structural support (eg. sinkholes and slope stability).
- (c) Non-uniform support that results from wide variations in soil types or states.
- (d) Biological activity (eg. moles, termites etc.).
- (e) Organic material (eg. humus, vegetation etc.).
- (f) Non-compaction of underlying layers.
- (g) Low and insufficient bearing capacity of the underlying layers.

1.3.2 Drainage

The compacted layers should be adequately drained and shaped (design specification) to prevent standing water from scouring the completed work.

Open drains should be excavated within the road prism (medium drains and side drains) either by hand or special excavating equipment (brackets, draglines or similar equipment) to control the free water by effective drainage. Open drains will prevent the damage of the stabilized layer and its foundation from free water.

All existing open drains shall be cleared out, and where necessary, shaped by removing the sediment and turning the floors and sides.

All backfilling that is required for excavation of open drains and concrete linings, should be of suitable material and compacted to at least 90% of Mod. AASHTO density or higher.

All reasonable precautions should be implemented to prevent the material or the road from becoming excessively wet as a result of rain, groundwater or storm-water.

Where material or existing layers are too wet to comply with the requirements in regard to moisture content during construction, the material shall be dried out until it is adequately suitable for compaction, stabilization, and all other aspects associated with ANSS application.

1.4 Construction limitations

ANSS should be applied to an area of such size that all operations, dry mixing through cutting final grade, to be completed within 6 hours. Perform all operations in a continuous manner and complete all operations during daylight hours.

Any rain falling on the working area during the process of stabilization may be sufficient cause to require re-commencement of the process.

No material for the stabilized layer may be placed if the underlying layer has been softened by excessive moisture.

Depths in excess of 150 mm can be compacted provided that the correct equipment and compactor is utilized that can achieve an effort large enough to compact the lower regions of the layer. Commonly, depths of more than the maximum of 150 mm should be constructed in two

separate layers in order to ensure that the minimum compaction requirement is obtained.

Only apply stabilizer when the ambient air temperature is at least 5 °C (41 °F) in the shade and rising. Do not mix stabilizer with frozen soils or with soil containing frost.

Stabilization Procedures

2. Stabilization using ANSS

Stabilization using ANSS (the process of improving the engineering properties of a material by means of the addition of ANSS) is subject to the quality of materials available and the impact of the environment (traffic, climate, etc.) on the structural design.

Stabilization with ANSS endeavors to increase the quality of the project and reduce construction costs by improving the properties of substandard, readily available material to comply with the relevant specifications.

2.1 Materials

2.1.1 ANSS Natural Soil Stabilizer

ANSS should be kept under cover and protected from moisture from the time of purchase to the time of use.

If ANSS has been left exposed to environmental elements, consult an ANSS representative. ANSS is manufactured under ISO 9001:2000 Standard.

Documentation or other acceptable evidence of the quality of ANSS shall be provided upon request.

2.1.2 Soil

It is preferable to stabilize a soil with a continuously smooth gradation curve from the maximum particle size to the smallest particle size with no excess or lack in certain particles. All soil should be tested prior to the project or application to determine the dosage of ANSS to produce the designed strength.

2.2 Water

The characteristics of the water that is sought for stabilization are that it is soft, reasonably clean, and free from oil, acid, alkali, organic and other impurities. Water that is thought to encourage adverse reactions should be approved for compatibility with ANSS by a member of AnyWay's technical staff.

2.3 Construction process

2.3.1 Prior to the construction of the stabilized layer

Stabilized layers should be constructed only where the underlying layer or foundation meets all specified requirements.

Before construction of any stabilized layer and before any transported material for stabilization is dumped on the road, the underlying layer should be investigated to establish whether there is any damage, wet spots or other defects. Any defects to the layer should be rectified before the stabilized layer is constructed.

Where the stabilized layer is constructed on the floor of a pavement excavation or on the top of an existing pavement layer i.e. where the underlying layer has not been reworked or reconstructed, the floor of the excavation or the top of the existing pavement layer should first be watered and the compaction of the layer should be verified.

2.3.2 Preparing the layer

The material to be stabilized should be placed, or in the case of an existing pavement layer, scarified to the full depth specified, broken down, watered if necessary and mixed to achieve a homogenous layer. Any oversize material ($> 1/3$ the thickness of the layer to be stabilized) should be removed.

2.3.3 Applying ANSS

Dosage determination should be performed prior to product application.

After the layer of soil or stabilized material has been prepared the product should be spread uniformly over the full area of the layer by means of an approved type of mechanical spreader or by hand. Material that has been exposed to the open air for a period of 4 hours or more should not be used.

If application is administered by hand, pockets or bags of the product should be accurately spaced at equal intervals along the section to be stabilized so that the specified rate of application can be achieved. The stabilizing agent should be spread as evenly as possible over the entire surface.

Do not apply ANSS when wind conditions, as determined by the on-site engineer or project manager, are such that the stabilizer becomes airborne in such a manner as to become hazardous to traffic, workmen, adjacent workers, adjacent property, or results in adverse impact upon the public.

2.3.4 Dry-mixing ANSS

Immediately after the product has been spread it should be mixed with the soil/material to the full depth of treatment. Special attention should be taken not to disturb the compacted layer underneath and especially not to mix the stabilizing agent in below the desired depth. Mixing should continue for as long as necessary and repeated as often as required to ensure homogeneity and thorough mixing of the soil/material with ANSS over the full area of the application site.

Mixing should be done using a rotovator (soil recycler or agricultural), grader or equivalent equipment over successive passes of the layer. Specific attention should be made to ensure that the mixing device does not cycle ANSS and relocate the majority of the powder on the bottom of the layer to be constructed.

2.3.5 Watering

The water supply and watering equipment should be adequate to ensure that all the water required is added and mixed with the soil/material being treated within the prescribed period to enable compaction to be completed.

Uniform mixing of the product and water is paramount to the success of the stabilized layer. The number of passes required for ANSS stabilization to obtain adequate mixing is based on the type of soil and experience of the contractor.

Immediately after ANSS has been properly mixed into the layer, the pre-determined moisture content (OMC) should be administered.

Each application or increment of water should be well mixed with the material so as to avoid concentration of water near the surface or in pockets within the layer.

Particular care should be taken to ensure satisfactory moisture distribution over the full depth, width and length of the section being stabilized and to prevent any portion of the work from getting excessively wet after the stabilizing agent has been added. Ensure that the

moisture content of the mixture is not below the specified optimum moisture or more than 2 percent above the specified optimum moisture content, and less than the quantity that causes the roadbed to become unstable during compaction and finishing.

If any portion of the work becomes too wet after the stabilizing agent has been added and before the mixture has been compacted, as during rain or downpour, the application shall be rejected. These portions should be allowed to dry out to the required moisture content and then be scarified, re-stabilized, re-compacted and finished off.

2.3.6 Compaction

Initiation and completion of compaction of the material in the pavement layer should be carried out within 4 hours. In colder climates, a cool soil may slow the setting of ANSS and this should be taken into consideration in the design stage.

The type of compaction equipment to be used and the amount of rolling to be done should be such as to ensure that specified densities are obtained without damage being done to lower layer structures. Selecting the right compaction equipment is typically carried out by the contractor.

The compacted layers should be adequately shaped (design specification) to prevent standing water from scouring the completed work. The process of shaping should be completed by an experienced grader operator and should be facilitated by shaping the road to reflect the required camber without excessive removal from or addition to the thickness of the layer.

Compaction should be carried out in a series of continuous operations covering the full width of the layer concerned. The length of any section of a layer being compacted shall, wherever possible, not be more than can be properly compacted with the available equipment. During compaction, the layer should be maintained to the required shape and cross-section, and holes, ruts and laminations should be removed.

During compaction, loss of moisture from evaporation should be corrected by further light applications of water over the surface.

The minimum compaction required shall be 98% of Mod AASHTO density for the stabilized layer and the sub-base or immediate underlying layers.

During final compaction, field density determinations should be done to determine accurately the applied compaction effort and to ensure the minimum compaction requirement has been obtained. Density testing should be carried out within 24-hours of compaction having been completed.

2.4 Sampling and testing

The following tests should be determined by the party carrying out the application on the stabilized material or constructed pavement layer during the stages of application.

Prior to compaction of the layer, after ANSS and water addition:

- Plasticity (Atterberg Limits)
- MDD (modified) and OMC
- CBR and/or UCS

Care must be taken to ensure that the sample material is taken to the full depth to be stabilized and placed immediately in marked sealed containers to prevent the loss of moisture. Samples for lab testing have to be fully representative of the stabilized section with ANSS.

2.5 Curing the stabilized work

The stabilized layer should be protected against rapid drying out for 3 days following completion of the layer. Advanced setting and hardening of the layer can be reduced through continuously keeping the layer wet or damp by watering at frequent intervals. During this period the application of water should be controlled so that it will not unduly wet the layer but, at the same time, will not allow the layer to dry out. Layers allowed to dry out too quickly may adversely affect the stabilization mechanism. During the curing period the stabilized layer should be protected against heavy rain and flooding. While a moderate amount of gentle rain on the stabilized,

compacted surface will not harm the layer (and may in fact assist in the reaction), a heavier rainfall or flooding will erode the layer before it has had an opportunity to cure, and may otherwise interfere with the reaction.

2.6 Provision for traffic

Traffic may be allowed onto the surface (pavement layer or sub-grade) provided that strict speed controls are posted and there is no likelihood of rain. The provision of traffic signs and flag-persons during construction should be established by the party carrying out the application so that signs and procedures do not hinder the safety of the construction crew and the road users. In some instances the road may require full closure to expedite work.

Typically the work is executed so that each section of roadway is completed to full width at the end of the days work.

2.7 Post-application sampling and testing

The following tests should be completed after the application has been completed:

(a) layer densities

The layer density's should be controlled by means of nuclear density and moisture gauge, operated by a suitably trained technician complying with the statutory regulations governing the use of the gauge. The gauge should be certified to be suitably calibrated.

(b) layer thickness and long term strength

The stabilized layer thickness will be controlled by random test holes or core sampling. Core samples are to be taken 56 days after completion of the project unless otherwise specified. The average thickness will be the design depth with a tolerance of 10%.