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CU-Soil is a patented material and must be purchased from a licensed supplier. Amereq (http://www.amereq.com/) licenses the manufacturing of CU-Soil to ensure quality control of installations.

Carolina Stalite is composed primarily of a manufactured component available from Carolina Stalite Company (Salisbury, NC). It is available through the horticultural division of Carolina Stalite (www.permatill.com).
CU-Soil Specification and Mixing Procedure

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1.01 SAMPLES AND SUBMITTALS

A. At least 30 days prior to ordering materials, the Contractor shall submit to the Engineer's representative samples, certificates, manufacturers literature and certified tests for materials specified below. No materials shall be ordered until the required samples, certificates, manufacturers literature and test results have been reviewed and approved by the Engineer. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. The Engineer reserves the right to reject, on or after delivery, any material that does not meet these specifications.

B. Submit two - one half cubic foot representative samples of Clay Loam and two - two cubic foot representative samples Structural Soil mixes in this section for testing, analysis and approval. Submit one set of samples for every 500 CY of material to be delivered. In the event of multiple source fields for Clay Loam, submit a minimum of one set of samples per source field or stockpile. Samples shall be taken randomly throughout the field or stockpile at locations as directed by the Engineer and packaged in the presence of the Engineer. Contractor shall deliver all samples to testing laboratories and shall have the test results sent directly to the Engineer. Samples shall be labeled to include the location of the source of the material, the date of the sample and the Contractor's name. One of the two samples is to be used by the testing laboratory for testing purposes. The second sample of all Clay Loam and Structural Soil shall be submitted to the Engineer at the same time as test analysis as a record of the soil color and texture.

1. Submit the locations of all source fields for Clay Loam.
2. Submit a list of all chemicals and herbicides applied to the Clay Loam for the last five years and a list of all crops grown in the Clay Loam source fields for the last three years.

C. Submit soil test analysis reports for each sample of Clay Loam and Structural Soil from an approved soil-testing laboratory. The test results shall report the following:

1. The soil testing laboratory shall be approved by the Engineer. The testing laboratory for particle size and chemical analysis may be a public agricultural extension service agency or agricultural experiment station.
2. Submit a particle size analysis including the following gradient of mineral content:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>USDA Designation Size in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel</td>
<td>+2 mm</td>
</tr>
<tr>
<td>Sand</td>
<td>0.05-2 mm</td>
</tr>
<tr>
<td>Silt</td>
<td>0.002-0.05 mm</td>
</tr>
<tr>
<td>Clay</td>
<td>minus 0.002 mm</td>
</tr>
</tbody>
</table>

Sieve analysis shall be performed and compared to USDA Soil Classification System.

D. Submit a chemical analysis, performed in accordance with current AOAC Standards, including the following:
   a. pH and Buffer pH.
   b. Percent organic matter as determined by the loss of ignition of oven dried samples.
   c. Analysis for nutrient levels by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, manganese, iron, zinc, calcium and extractable aluminum. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil as calculated by the amount of material to be added per volume of soil for the type of plants to be grown in the soil.
   d. Analysis for levels of toxic elements and compounds including arsenic, boron, cadmium, chromium, copper, lead mercury, molybdenum, nickel, zinc and PCB. Test results shall be cited in milligrams per kilogram.
   e. Soluble salt by electrical conductivity of a 1:2 soil/water sample measured in Millimho per cm.
   f. Cation Exchange Capacity (CEC).

1. Submit 5-point minimum moisture density curve AASHTO T 99 test results for each Structural Soil sample without removing oversized aggregate.

2. Submit California Bearing Ratio test results for each Structural Soil sample compacted to peak standard density. The soaked CBR shall equal or exceed a value of 50.

3. Submit measured dry-weight percentage of stone in the mixture.

4. The approved Structural Soil samples shall be the standard for each lot of 500 cubic yards of material.
5. All testing and analysis shall be at the expense of the Contractor.

1.02 DELIVERY, STORAGE, AND HANDLING
A. Do not deliver or place soils in frozen, wet, or muddy conditions. Material shall be delivered at or near optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698). Do not deliver or place materials in an excessively moist condition (beyond 2 percent above optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698).

B. Protect soils and mixes from absorbing excess water and from erosion at all times. Do not store materials unprotected from large rainfall events. Do not allow excess water to enter site prior to compaction. If water is introduced into the material after grading, allow material to drain or aerate to optimum compaction moisture content.

2.01 CLAY LOAM
A. Clay Loam / Loam shall be a "loam to clay loam" based on the "USDA classification system" as determined by mechanical analysis (ASTM D-422) and it shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than one-half inch, lumps, plants and their roots, debris and other extraneous matter over one inch in diameter or excess of smaller pieces of the same materials as determined by the Engineer. It shall not contain toxic substances harmful to plant growth. It shall be obtained from areas which have never been stripped of top soil before and have a history of satisfactory vegetative growth. Clay Loam shall contain not less than 2% nor more than 5% organic matter as determined by the loss on ignition of oven-dried samples.

B. Mechanical analysis for a Loam / Clay Loam shall be as follows:

<table>
<thead>
<tr>
<th>Textural Class</th>
<th>% of total weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel</td>
<td>less than 5%</td>
</tr>
<tr>
<td>Sand</td>
<td>20 - 45%</td>
</tr>
<tr>
<td>Silt</td>
<td>20 - 50%</td>
</tr>
<tr>
<td>Clay</td>
<td>20- 40%</td>
</tr>
</tbody>
</table>

C. Chemical analysis: Meet or be amended to meet the following criteria.
1. pH between 6.0 to 7.6
2. Percent organic matter 2 -5% by dry weight.
3. Nutrient levels as required by the testing laboratory recommendations for the type of plants to be grown in the soil.
4. Toxic elements and compounds below the United States Environmental Protection Agency Standards for Exceptional
Quality sludge or local standard; whichever is more stringent.
5. Soluble salt less than 1.0 Millimho per cm.
6. Cation Exchange Capacity (CEC) greater than 10

2.02 CRUSHED STONE
A. Crushed Stone shall be a DOT certified crushed stone. Granite and limestone have been successfully used in this application. Ninety-100 percent of the stone should pass the 1.5 inch sieve, 20-55 percent should pass the 1.0 inch sieve and 10 percent should pass the 0.75 inch sieve. A ratio of nominal maximum to nominal minimum particle size of 2 is required
B. Acceptable aggregate dimensions will not exceed 2.5:1.0 for any two dimensions chosen.
C. Minimum 90 percent with one fractured face, minimum 75 percent with two or more fractured faces.
D. Results of Aggregate Soundness Loss test shall not exceed 18 percent. Losses from LA Abrasion tests shall not exceed 40%.

2.03 HYDROGEL
A. Hydrogel shall be a potassium propenoate-propenamide copolymer such as that which is manufactured under the name Gelscape by Amereq Corporation. (800) 832-8788

2.04 WATER
A. The Contractor shall be responsible to furnish his own supply of water to the site at no extra cost. All work injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor’s responsibility to correct. Water shall be free from impurities injurious to vegetation.

2.05 STRUCTURAL SOIL
A. A uniformly blended mixture of Crushed Stone, Clay Loam and Hydrogel, mixed to the following proportion:

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>UNIT OF WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushed Stone</td>
<td>80 units dry weight</td>
</tr>
<tr>
<td>Loam (screened)</td>
<td>as determined by the test of the mix. (Approx. 20 units dry weight)</td>
</tr>
<tr>
<td>Hydrogel</td>
<td>0.03 units dry weight/100units stone</td>
</tr>
<tr>
<td>Total moisture</td>
<td>(AASHTO T-99 optimum moisture)</td>
</tr>
</tbody>
</table>

B. The initial mix design for testing shall be determined by adjusting the ratio between the Crushed Stone and the Clay loam. Adjust final mix
dry weight mixing proportion to decrease soil in mixture if CBR test results fail to meet acceptance (CBR > 50).

CONSTRUCTION METHODS

3.01 SOIL MIXING AND QUALITY CONTROL TESTING
A. All Structural Soil mixing shall be performed at the Contractor's yard using appropriate soil measuring, mixing and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios. No mixing of Structural Soil at the project site shall be permitted. Portable pugging may be used

1. Maintain adequate moisture content during the mixing process. Soils and mix components shall easily shred and break down without clumping. Soil clods shall easily break down into a fine crumbly texture. Soils shall not be overly wet or dry. The contractor shall measure and monitor the amount of soil moisture at the mixing site periodically during the mixing process.

2. A Mixing procedure for front-end loader shall be as follows:
   a. On a flat asphalt or concrete paved surface, spread an 8 inch to 12 inch layer of crushed stone.
   b. Spread evenly over the stone the specified amount of dry hydrogel. Water the hydrogel on the stone before adding the soil.
   c. Spread over the hydrogel and crushed stone a proportional amount of clay loam according to the mix design.
   d. Blend the entire amount by turning, using a front-end loader or other suitable equipment until a consistent blend is produced.
   e. Add moisture gradually and evenly during the blending and turning operation as required to achieve the required moisture content. Delay applications of moisture for 10 minutes prior to successive applications. Once established, mixing should produce a material within 1% of the optimum moisture level for compaction.

3. A pugging operation mixing procedure may be as follows:
   a. Feed a known weight of crushed stone into the mixing trough.
   b. Add hydrogel as a slurry into trough and mix slurry and stone into a uniform blend.
   c. Meter in soil in proper proportion of Clay loam soil
While stone-slurry mixture is in motion.

d. Add water to bring mixture to target moisture content after factoring in water from the slurry and the Clay-loam moisture.

e. Auger out to stock pile or transport vehicle (or into pit if using a portable pugging operation).

B. The Contractor shall mix sufficient material in advance of the time needed at the job site to allow adequate time for final quality control testing as required by the progress of the work. Structural Soil shall be stored in piles of approximately 500 cubic yards and each pile shall be numbered for identification and quality control purposes. Storage piles shall be protected from rain and erosion by covering with plastic sheeting.

C. During the mixing process, the Contractor shall take two - one cubic foot quality control samples per 500 cubic yards of production from the final Structural Soil. The samples shall be taken from random locations in the numbered stockpiles as required by paragraph 1.03.B of this specification. Each sample shall be tested for particle size analysis and chemical analysis as described in Paragraph 1.03. C.2 and 3 above. Submit the results directly to the Engineer for review and approval.

D. The quality control sample Clay Loam-Crushed Stone ratio's shall be no greater or less than 2% of the approved test sample as determined by splitting a known weight of oven dried material on a #4 sieve. In the event that the quality control samples vary significantly from the approved Structural Soil sample, as determined by the Engineer, remix and retest any lot of soil that fails to meet the correct analysis making adjustments to the mixing ratio's and procedures to achieve the approved consistency.

3.02 INSTALLATION OF STRUCTURAL SOIL MATERIAL

A. Install Structural Soil in 8 inch lifts and compact each lift. (Minimum of 24" total structural soil depth, preferably 36" recommended).

B. Compact all materials to peak dry density from a standard AASHTO compaction curve (AASHTO T 99). No compaction shall occur when moisture content exceeds maximum as listed herein. Delay compaction 24 hours if moisture content exceeds maximum allowable and protect Structural Soil during delays in compaction with plastic or plywood as directed by the Engineer.

C. Bring Structural Soils to finished grades as shown on the Drawings. Immediately protect the Structural Soil material from contamination by toxic materials, trash, debris, water containing cement, clay, silt or
materials that will alter the particle size distribution of the mix with plastic or plywood as directed by the Engineer.

D. The Engineer may periodically check the material being delivered and installed at the site for color and texture consistency with the approved sample provided by the Contractor as part of the submittal for Structural Soil. In the event that the installed material varies significantly from the approved sample, the Engineer may request that the Contractor test the installed Structural Soil. Any soil which varies significantly from the approved testing results, as determined by the Engineer, shall be removed and new Structural Soil installed that meets these specifications.
Carolina Stalite Structural Soil Specification

Section 02911 INSTALLATION GUIDELINES - STALITE STRUCTURAL SOIL MIX FOR TREES

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 MATERIALS

A. STRUCTURAL SOIL MIX

1. The Structural Soil Mix shall be Stalite Structural Soil Mix (a special pre-mixed blend of 80% 3/4" graded "STALITE" Expanded Slate Aggregate and 20% approved sandy clay loam).

B. TREE PIT BACKFILL PLANTING MIX

1. The tree pit backfill planting mix shall be high quality topsoil PermaTill mix.

PART 3 - EXECUTION

3.1 PREPARATION

A. GENERAL

1. The paving contractor shall obtain necessary approvals before placing each SSM layer.

2. The paving contractor shall use adequate numbers of skilled workmen who are thoroughly trained in the necessary crafts and are completely familiar with the specified requirements and methods needed for proper performance of the work in this section.

3. The contractor must provide access for and cooperate with the testing laboratory.

4. Adequacy of the final compaction of all elements requiring compaction shall be determined in the field by the engineer to achieve the minimum specified compaction level.

B. PREPARING SUBGRADE

1. The subgrade shall be prepared according to the following procedure:
   a. Remove all organic matter, debris, loose material and large rocks.
   b. Dig out soft and mucky spots and replace with suitable material.
   c. Loosen hard spots and uniformly compact the subgrade to 95% of its maximum dry density.
C. PERFORATED UNDERDRAIN SYSTEM

1. The underdrain system shall be installed, including soak or soil separator fabric, according to drawing and specifications, and connected to the storm drain.

3.2 PLACING STRUCTURAL SOIL MIX BY PAVING CONTRACTOR

A. GENERAL

1. Adequacy of the final compaction shall be determined in the field by the engineer by proof roll.

2. The soil vents and drains shall be installed as specified and structural soil compacted under and around each pipe.

3. Optional – If wooden tree pit forms are used, they shall be installed as directed by the Landscape Architect.

4. The SSM shall be placed in approximately uniform lifts over the entire area of project and each lift compacted, including the open tree pit areas. Construction equipment, other than for compaction, shall not operate on the exposed structural soil mix. Overcompaction should be avoided. No foot or equipment traffic should be allowed on the compacted material until the paving is placed.

5. The drip irrigation system is to be installed and tested during the installation to avoid disturbing the compaction of the mix.

B. COMPACTING

1. Use of portable vibratory plate compacting machine (Recommended)

   a. Place structural soil mix in horizontal lifts not exceeding 12 inches of compacted depth. Use a minimum of two passes, of not less than 10 seconds per pass, before moving the vibratory plate to the next adjacent location. Additional passes may be required and should be determined in the field by the engineer to insure stability of the layer. Continue placing and compacting 12” lifts until the specified depth is reached.

2. Use of vibratory steel roller (Recommended)

   a. For large spaces, a vibratory steel roller weighing no more than 12 tons static weight can be used. Horizontal lifts should not exceed 12” compacted. The minimum number of passes is two and maximum number is four. Additional passes may be required and should be determined in the field by the engineer to insure stability of the layer.

3.3 PLACING PLANTING MIX

A. GENERAL
   1. All necessary approvals shall be obtained from the contractor before placing the
      Surface planting mix.
   2. Place planting mix directly on the structural soil.
   3. Do not place planting mix against the trunks of existing trees.

3.4 MULCH PLACEMENT

A. Mulch can be placed as specified directly on the compacted structural soil.

PART 4 - TREE PLANTING

4.1 PLANTING PIT PREPARATION BY LANDSCAPE CONTRACTOR

A. PLANTING PIT EXCAVATION

   1. The Landscape Contractor shall excavate the tree pit using these procedures:

      a. Excavate the structural soil mix to a depth equal to the height of the root ball of the
         tree to be planted. Remove the SSM to within two feet of the edge of the paved area.

      b. Place the tree in the pit and backfill as soon as possible, as recommended in
         section “B”. No tree pit shall remain excavated for more than 2 hours unless forms are
         used.

B. TREE PIT BACKFILL PLANTING MIX

   1. The landscape contractor shall backfill the tree pit by using these procedures:

      a. Remove any optional wooden forms. Immediately place the tree in the pit as detailed
         and mix the excavated structural soil 50:50 with the specified topsoil backfill planting
         mix in one foot lifts and tamp until firm.

      b. Tamp the planting mix in one foot lifts until the pit is filled to the specified grade
         above the planting.

      c. Dispose of the excavated structural soil mix (do not re-use as structural soil).

      d. Attach drip irrigation as specified.
Carolina Stalite Mixing Specification

PART 2 - PRODUCTS

2.1 STRUCTURAL SOIL

A. Provide a Structural Soil mix using the two components listed below that will meet the ASTM standards as follows:

- ¾" Stalite Expanded Slate  80%
- Sandy Clay Loam *  20%

*Percentages of sand and clay may vary to meet testing requirements

1. Air Filled Porosity: 10% - 15% by volume

2. Water Retention (ASTM D2325) at 0.1 bar: minimum of 10% - 12% by volume, up to 30%

3. Permeability (Hydraulic Conductivity) (ASTMD2434 or D5084): Minimum 1/4" - 1/2" per hour

2.2 Structural Soil Components

A. ¾" Stalite Rotary Kiln Expanded Slate

1. ASTM C29 Unit Dry Weight loose (48 lbs/cf to 55 lbs/cf)
   Saturated Surface Loose (55 lbs/cf to 60 lbs/cf)

2. ASTM C127 Specific Gravity to meet 1.45 to 1.60 Dry Bulk

3. ASTM C330 to meet the ASTM Gradation ¾" - #4 size

   ¾" to #4
   % Passing

   1"  100
   ¾"  90 - 100
   ¾"  10 - 50
   #4  0 - 10

4. Test for degradation loss using Los Angeles Abrasion testing in accordance with ASTM C-131 modified method FM 1-T096. No more than 28% of the weight of the aggregate must be lost to degradation.
1. Texture

40%-65% sand
15%-25% silt
20%-35% clay
2%-5% Organic matter

2.2 MIXING OFFSITE

A. Structural Soil

1. Mechanically mix the sand and loam thoroughly if mixing is necessary to meet the specifications.

2. Saturate the 3/4" Expanded Slate with water and mechanically mix the sandy clay loam until the slate particles are completely coated.

4. When stockpiling the finished mix, cover the pile with a plastic tarp to prevent drying out or soil separation from rain.

5. Install the mix within 48 hours of mixing.