2012 SERVICE CATALOGUE

SOLUM CONSULTANTS LABORATORY SERVICES

Solum Consultants Ltd is specialized in geotechnical engineering and soils and aggregates testing. The company was originally established in 2003 operating under the name of Solum Testing performing soils and aggregates testing using ASTM and AASHTO procedures.

In 2006 the company was transferred to Saad A.M. Farag Ph.D., P.Eng. Mr. Farag is a geotechnical and structural engineer with over 20 years of experience in geotechnical engineering and material testing. Significant developments and improvements have been steadily achieved in all aspects of procedures leading to distinguish quality production. Solum Consultants Ltd. possesses the capacity to *simultaneously* run twenty-eight consolidation tests (ASTM D2435), thirty Tri-axial shear tests with pore water pressure measurements (ASTM D4767), five fully computerized Direct Shear test (ASTM D3080), and thirty-seven Hydraulic Conductivity Tests (permeability) (ASTM D5084). These developments enable Solum Consultants to effectively and efficiently handle large projects where turnaround time is of great concern. Recently, pneumatic conductivity or air permeability tests have been developed using either rigid-wall or flexible-wall methods, ASTM D6539, as well as thermal conductivity/resistively test, ASTM D5334.

Why Choose Solum for Your Geotechnical Laboratory Testing Needs?

1. Solum uses industry accepted ASTM (American Society of Testing and Materials) as well as Corps of Engineers procedures for laboratory testing.
2. Solum offers quick turn around times on testing. Ninety-percent of our testing projects are completed in less than 6 business days; it is not uncommon to transmit preliminary results to our clients located at the construction site immediately after testing is completed.
3. Competitive prices.
4. Our testing results are well organized and clearly presented. **Please refer to Appendix II for a sample laboratory testing report.**
5. Our testing results are transmitted electronically via email. We can also deliver results by conventional means (ie. mail, fax) if desired.

The following package will assist in determining what testing services Solum provides or what services can be arranged. If you do not see a listing of the test you require, please contact us. All samples and data are handled in the strictest confidentiality.

CONTACT INFORMATION

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WATER (MOISTURE) CONTENT– ASTM D2216

LABORATORY PROCEDURE USED: ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

RESULTS GIVEN: Water (Moisture) Content in Percent (%) by Mass

REQUIRED SAMPLE SIZE FOR TESTING:

Maximum Particle Size	Minimum Test Sample Size, g
4.75 mm (No.4) or smaller	150
9.5 mm (3/8 in.)	750
19.0 mm (3/4 in.)	1500

MAXIMUM PARTICLE SIZE: The smallest sieve through which 100 percent of the soil-aggregate sample particles pass.

ATTERBERG LIMITS – ASTM D4318

LABORATORY PROCEDURE USED: ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. Method A – Multipoint Liquid Limit

RESULTS GIVEN:

1.) Liquid Limit (LL), Plastic Limit (PL), Plasticity Index (PI) and Flow Curve.
2.) Soil classification group symbol per plasticity chart (ASTM D2487). Please refer to page 4 for soil classification group symbol descriptions. If the soil is “nonplastic” (ie. sands or silts) the liquid limit, plastic limit, plasticity index, flow curve and group symbol of the fine fraction cannot be determined.

*** Refer to Appendix II for a sample laboratory testing report.**

REQUIRED SAMPLE SIZE FOR TESTING: 450g

BACKGROUND INFO:

When water is added to a dry soil, each particle is covered with a film of water. If the addition of water is continued, the thickness of the water film on a particle increases. The thicker the water films around the particle the easier for the particles to move past each other. Depending on the amount of water in the soil, a fine-grained soil can exist in any of several states:

Liquid Limit (LL): The boundary between the semi-liquid and plastic states; measured in percent water (moisture) content.

Plastic Limit (PL): The boundary between the plastic and semi-solid states; measured in percent water (moisture) content.

Shrinkage Limit (SL): The boundary between the semi-solid and solid states; measured in percent water (moisture) content.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (UNIFIED SOIL CLASSIFICATION SYSTEM) – ASTM D2487

LABORATORY PROCEDURE USED: ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

RESULTS GIVEN:

1.) Group Symbol (please refer to page 4 for descriptions of group symbols);
2.) Group Name, upon request since some organizations don't recognize the group name descriptions (ie. fat or lean clay) as per ASTM D2487.

NOTE: Solum determines the group symbol and group name (upon request) free of charge if the required testing, as stated below, is completed.

REQUIRED TESTING:

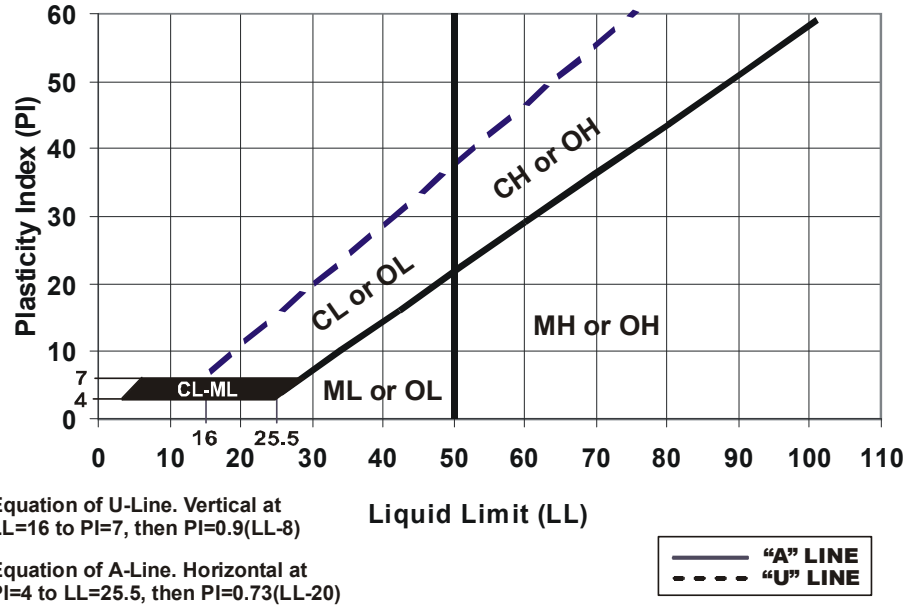
Atterberg Limits – ASTM D4318 and one of the following:

1.) Particle-Size Analysis of Soils (Full Gradation) – ASTM D422; or,
2.) Greater Than No. 200 (0.075 mm) Sieve Analysis – ASTM C136

BACKGROUND INFO:

PLASTICITY CHART

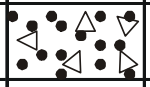
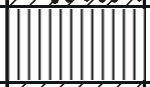
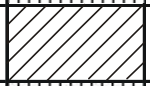
FOR CLASSIFICATION OF FINE-GRAINED SOILS AND FINE-GRAINED FRACTION OF COARSE-GRAINED SOILS



Equation of U-Line. Vertical at LL=16 to PI=7, then PI=0.9(LL-8)

Equation of A-Line. Horizontal at PI=4 to LL=25.5, then PI=0.73(LL-20)

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GRAPHIC SYMBOL	TYPICAL DESCRIPTIONS
HIGHLY ORGANIC SOILS			PT		Peat, Humus and Other Highly Organic Soils
COARSE-GRAINED SOILS More than 50% retained on No. 200 (0.075 mm) sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 (4.75 mm) sieve	CLEAN GRAVELS Less than 5% fines	GW		Well-graded Gravels, Gravel-Sand Mixtures, < 5% Fines *
			GP		Poorly-graded Gravels, Gravel-Sand Mixtures, < 5% Fines *
		GRAVELS WITH FINES Greater than 12% fines	GM		Silty Gravels, Gravel-Sand-Silt Mixtures, > 12% Fines *
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures, > 12% Fines *
	SANDS More than 50% of coarse fraction passing No. 4 (4.75 mm) sieve	CLEAN SANDS Less than 5% fines	SW		Well-graded Sands, Gravelly Sands, < 5% Fines *
			SP		Poorly-graded Sands, Gravelly Sands, < 5% Fines *
		SANDS WITH FINES Greater than 12% fines	SM		Silty Sands, Sand-Silt Mixtures, > 12% Fines *
			SC		Clayey Sands, Sand-Clay Mixtures, > 12% Fines *
FINE-GRAINED SOILS 50% or more passes the No. 200 (0.075 mm) sieve	SILTS AND CLAYS Liquid Limit less than 50	INORGANIC	ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty Sands of Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		ORGANIC	OL		Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50	INORGANIC	MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils
			CH		Inorganic Clays of High Plasticity, Fat Clays
		ORGANIC	OH		Organic Clays of High Plasticity

UNIFIED SOIL CLASSIFICATION SYSTEM (Continued)

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)				
		MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS		> 300	> 12	---
COBBLES		300 - 75	12 - 3	---
GRAVEL	COARSE	75 - 19	3.0 - 0.75	3.0" - 3/4"
	FINE	19 - 4.75	0.75 - 0.19	3/4" - NO. 4
SAND	COARSE	4.75 - 2.00	0.19 - 0.08	NO. 4 - NO. 10
	MEDIUM	2.00 - 0.425	0.08 - 0.017	NO. 10 - NO.40
	FINE	0.425 - 0.075	0.017 - 0.003	NO. 40 - NO. 200
FINES	SILTS	0.075 - 0.005	0.003 – 0.0002	**HYDROMETER TEST (INCLUDED IN ASTM D422 – FULL GRADATION)**
	CLAYS	< 0.005	< 0.0002	

PARTICLE-SIZE ANALYSIS (FULL GRADATION) – ASTM D422

LABORATORY PROCEDURE USED: ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils (Includes Hydrometer Test)

RESULTS GIVEN:

1.) Percent of clay, silt, sand, gravel and cobble size;
2.) Particle-size distribution curve;
3.) Detailed table of the particle-size distribution curve plot data including sieve sizes, particle-sizes in millimetres and a percent finer column

*** Refer to Appendix II for a sample laboratory testing report.**

REQUIRED SAMPLE SIZE FOR TESTING:

Nominal Maximum Size	Minimum Test Sample Size, kg (lbs)
4.75 mm (No. 4) or smaller	0.5(1)
9.5 mm (3/8 in.)	1(2)
12.5 mm (1/2 in.)	2(4)
19.0 mm (3/4 in.)	5(11)
25.0 mm (1 in.)	10(22)
37.5 mm (1.5 in.)	15(33)

NOMINAL MAXIMUM SIZE: The largest sieve that retains some of the soil-aggregate particles but generally not more than 10 percent by weight.

GREATER THAN NO. 200 (0.075 mm) SIEVE ANALYSIS – ASTM C136

LABORATORY PROCEDURE USED: ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

RESULTS GIVEN:

1.) Percent of fines (less than No. 200 sieve), sand, gravel and cobble size;
2.) Particle-size distribution curve;
3.) Detailed table of the particle-size distribution curve plot data including sieve sizes, particle-sizes in millimetres and a percent finer column.

REQUIRED SAMPLE SIZE FOR TESTING:

Nominal Maximum Size	Minimum Test Sample Size, kg (lbs)
4.75 mm (No. 4) or smaller	0.5(1)
9.5 mm (3/8 in.)	1(2)
12.5 mm (1/2 in.)	2(4)
19.0 mm (3/4 in.)	5(11)
25.0 mm (1 in.)	10(22)
37.5 mm (1.5 in.)	15(33)

NOMINAL MAXIMUM SIZE: The largest sieve that retains some of the soil-aggregate particles but generally not more than 10 percent by weight.

MATERIALS FINER THAN NO. 200 (0.075 mm) SIEVE – ASTM C117

LABORATORY PROCEDURE USED: ASTM C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

RESULTS GIVEN: Percentage of material finer than the 0.075mm (No. 200) sieve.

REQUIRED SAMPLE SIZE FOR TESTING:

Nominal Maximum Size	Minimum Dry Mass, g
4.75 mm (No. 4) or smaller	300
9.5 mm (3/8 in.)	1000
19.0 mm (3/4 in.)	2500
37.5 mm (1.5 in.)	5000

NOMINAL MAXIMUM SIZE: The largest sieve that retains some of the soil-aggregate particles but generally not more than 10 percent by weight.

BACKGROUND INFO: Anything finer than the 0.075 mm (No. 200) sieve are considered to be fines (Fines: silt, clay, rockflour); therefore, the percentage that you are given is percentage of fines in the sample. Please see the Unified Soil Classification System on page 5 for more details.

STANDARD PROCTOR (COMPACTION CHARACTERISTICS OF SOIL) – ASTM D698

LABORATORY PROCEDURE USED: ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (600kN-m/m^3)

RESULTS GIVEN:

1.) Maximum Dry Density, kg/m^3;
2.) Optimum Water Content, %;
3.) Dry Density vs. Water Content Plot Curve;
4.) Oversize Particles Correction for both the Maximum Dry Density and Optimum Water Content per ASTM D4718. Please note, the oversize correction will only be given if the sample yields 5% or more of oversize particles.

*** Refer to Appendix II for a sample laboratory testing report.**

REQUIRED SAMPLE SIZE FOR TESTING: 20 kg (One-5 gallon pail)

NOTE: If client does not specify the procedure (A, B, or C), the choice will be based on the material gradation. Procedure A will be used if 20% or less by weight of the material is retained on the No. 4 (4.75 mm) sieve. Procedure B will be used if more than 20% by weight of the material is retained on the No. 4 (4.75 mm) sieve and 20% or less by weight of the material is retained on the 3/8 in. (9.5 mm) sieve. Procedure C will be used if more than 20% by weight of the material is retained on the 3/8 in. (9.5 mm) sieve and less than 30% by weight of the material is retained on the 3/4 in. (19.0 mm) sieve.

MODIFIED PROCTOR (COMPACTION CHARACTERISTICS OF SOIL) – ASTM D1557

LABORATORY PROCEDURE USED: ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (2,700kN-m/m^3)

RESULTS GIVEN:

1.) Maximum Dry Density, kg/m^3;
2.) Optimum Water Content, %;
3.) Dry Density vs. Water Content Plot Curve;
4.) Oversize Particles Correction for both the Maximum Dry Density and Optimum Water Content per ASTM D4718. Please note, the oversize correction will only be given if the sample yields 5% or more of oversize particles.

REQUIRED SAMPLE SIZE FOR TESTING: 20-30 kg (One full 5 gallon pail)

NOTE: If client does not specify the procedure (A, B, or C), the choice will be based on the material gradation. Procedure A will be used if 20% or less by weight of the material is retained on the No. 4 (4.75 mm) sieve. Procedure B will be used if more than 20% by weight of the material is retained on the No. 4 (4.75 mm) sieve and 20% or less by weight of the material is retained on the 3/8 in. (9.5 mm) sieve. Procedure C will be used if more than 20% by weight of the material is retained on the 3/8 in. (9.5 mm) sieve and less than 30% by weight of the material is retained on the 3/4 in. (19.0 mm) sieve.

HYDRAULIC CONDUCTIVITY (PERMEABILITY) OF FINE GRAINED SOILS (CONSTANT HEAD) – ASTM D5084

LABORATORY PROCEDURE USED: ASTM D5084 - Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

RESULTS GIVEN:

1.) Hydraulic Conductivity (Permeability) at 20 degrees Celsius, k_{20}, in cm/sec;
2.) Dry Density, kg/m^3;
3.) Hydraulic Gradient;
4.) Water (Moisture) Content.

*** Refer to Appendix II for a sample laboratory testing report.**

BACKGROUND INFO: Hydraulic Conductivity is also known as "Coefficient of Permeability". ASTM D5084 is the standard test method to determine the hydraulic conductivity (permeability) of fine-grained soils where precise measurements are required.

REQUIRED SAMPLE SIZE FOR TESTING:
If the permeablility of an undisturbed sample is required, use a 3 inch o.d. Shelby tube to collect the sample. Shelby tubes can be purchased from Solum or any drilling rig service provider. Solum also offers Shelby tube extractors for surface samples free of charge; shipping is extra.
Solum will remould disturbed soil samples to a density and moisture content as specified by the client. If the client has the remoulding specs (ie. standard proctor results of the soil) then 2000g of soil is sufficient. If soil has particles greater than 4.75 mm (No. 4) then 3000g is required. If there is no proctor data for the disturbed sample then the standard proctor test must be performed. See standard proctor – ASTM D698 for required sample size.

HYDRAULIC CONDUCTIVITY (PERMEABILITY) OF FINE GRAINED SOILS – FALLING HEAD METHOD

LABORATORY PROCEDURE USED: CORPS OF ENG. EM1110-2-1906, APPENDIX VII - Measurement of Hydraulic Conductivity (Permeability) of Fine Grained Soils – Falling Head

RESULTS GIVEN:

1.) Hydraulic Conductivity (Permeability) at 20 degrees Celsius, k_{20}, in cm/sec;
2.) Dry density (kg/m^3) or percent (%) of maximum dry density.

REQUIRED SAMPLE SIZE FOR TESTING:

If the permeablility of an undisturbed sample is required, use a 3 inch o.d. Shelby tube to collect the sample. Shelby tubes can be purchased from Solum or any drilling rig service provider. Solum also offers Shelby tube extractors for surface samples free of charge; shipping is extra.
Solum will remould disturbed soil samples to a density and moisture content as specified by the client. If the client has the remoulding specs (ie. standard proctor results of the soil) then 2000g of soil is sufficient. If soil has particles greater than 4.75 mm (No. 4) then 3000g is required. If there is no proctor data for the disturbed sample then the standard proctor test must be performed. See standard proctor – ASTM D698 for required sample size.

BACKGROUND INFO: Hydraulic Conductivity is also known as "Coefficient of Permeability". The falling head permeability test is good indicator of the permeability of the soil but please note, this test is not ASTM approved. If precise measurements are required the use of standard test method ASTM D5084 (Constant Head) is recommended.

HYDRAULIC CONDUCTIVITY (PERMEABILITY) OF GRANULAR SOILS – ASTM D2434

LABORATORY PROCEDURE USED: ASTM D2434 – Standard Test Method for Permeability of Granular Soils (Constant Head)

RESULTS GIVEN:

1.) Hydraulic Conductivity (Permeability) at 20 degrees Celsius, k_{20}, in cm/sec;
2.) Dry Unit Weight, kg/m^3;

NOTE: In order to limit consolidation influences during testing, this method is limited to disturbed granular soils containing not more than 10% soil passing the No. 200 (0.075 mm) sieve.

REQUIRED SAMPLE SIZE FOR TESTING: 20 kg (Three-quarter full 5 gallon pail)

BACKGROUND INFO: This constant head method is used to measure the hydraulic conductivity (permeability) of granular soils that may be used as embankments or when used as base courses under roads.

THERMAL CONDUCTIVITY /RESISTIVITY OF SOILS – ASTM D5334

LABORATORY PROCEDURES USED: ASTM D5334 - Standard Test Method for Determine the Thermal Conductivity / Resistivity of Soils (ASTM D5334)

RESULTS GIVEN: Thermal Resistivity, in K-cm/watt.

FACT: ASTM D5334 is the standard test method to determine the thermal conductivity/resistivity for disturbed or undisturbed soils.

REQUIRED SAMPLE SIZE FOR TESTING:
If the resistivity of an undisturbed sample is required, use a 3 inch O/D Shelby tube to collect the sample.
Solum will remould disturbed soil samples to a density and moisture contents as specified by the client. If the client has the remoulding specs (ie. standard proctor results of the soil) then 2000g/point of soil is sufficient. If soil has particles greater than 4.75 mm (No. 4) then 3000g is required. If there is no proctor data for the disturbed sample then the standard proctor test needs to be performed.

TOTAL POROSITY, AIR-FILLED POROSITY - CORPS OF ENG. EM1110-2-1906, APPENDIX II

LABORATORY PROCEDURE USED: CORPS OF ENG. EM1110-2-1906, APPENDIX II, Total Porosity and Air-Filled Porosity

RESULTS GIVEN:

1.) Total Porosity, %;
2.) Air-Filled Porosity, %;
3.) Water (Moisture) Content, %.

REQUIRED SAMPLE SIZE FOR TESTING:
Undisturbed samples are collected using thin walled Shelby tubes. Samples should be undisturbed but Solum can remould disturbed samples to densities and moisture contents as specified by client.

NOTE: This test method is not suitable for soils that contain significant amounts of particles coarser than the 4.75mm (No. 4) sieve, organic soils or soils of low plasticity which will not be readily retained in the cylinder.

BULK DENSITY (INSITU DENSITY) – ASTM D2937

LABORATORY PROCEDURE USED: ASTM D2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

RESULTS GIVEN:

1.) Dry Bulk Density, kg/m^3;
2.) Water (Moisture) Content, %.

REQUIRED SAMPLE SIZE FOR TESTING:
Undisturbed samples are collected using thin walled Shelby tubes.

REMARKS: This test method is not suitable for soils that contain significant amounts of particles coarser than the 4.75mm (No. 4) sieve. This test method is also not suitable for organic soils or soils of low plasticity which will not be readily retained in the cylinder.

SPECIFIC GRAVITY OF SOILS – ASTM D854

LABORATORY PROCEDURE USED: ASTM D854 - Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

RESULTS GIVEN: Specific Gravity

REQUIRED SAMPLE SIZE FOR TESTING: 750g of Soil

REMARKS: This test method is used to determine the specific gravity of soils that pass the 4.75 mm (No. 4) sieve.

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOIL – ASTM D2435

LABORATORY PROCEDURE USED: ASTM D2435 - Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

RESULTS GIVEN:

1.) Coefficient of Consolidation;
2.) Time-Deformation Curve

REQUIRED SAMPLE SIZE FOR TESTING:
Undisturbed samples (Shelby tubes) or disturbed samples may be remoulded to a density and moisture condition stipulated by the agency requesting the test. Sample size: 600-1000g

FALL CONE SHEAR TEST FOR DISTURBED FINE-GRAINED CLAYEY SOIL – ROCTEST® PROCEDURE

LABORATORY PROCEDURE USED: Fall Cone Manufacturer (ROCTEST ®) Procedure

RESULTS GIVEN:

1.) Shear Strength (t/m^2) versus Water (Moisture) Content Plot.

*** Refer to Appendix II for a sample laboratory testing report.**

REQUIRED SAMPLE SIZE FOR TESTING: 1000-1500g of disturbed fine-grained clayey soils.

BACKGROUND INFO: The fall cone test is a fast and inexpensive way to determine the shear strength of a soil when the water content is in the range of the plastic limit and the liquid limit.

LABORATORY MINIATURE VANE SHEAR TEST FOR SATURATED FINE-GRAINED CLAYEY SOIL – ASTM D4648

LABORATORY PROCEDURE USED: ASTM D4648 - Standard Test Method for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil

RESULTS GIVEN:

1.) Plot of undisturbed shear strength (kPa) and maximum torque (N-m).

2.) Plot of remoulded shear strength (kPa) and maximum torque (N-m).

3.) Rate of shear and time to failure

*** Refer to Appendix II for a sample laboratory testing report.**

REQUIRED SAMPLE SIZE FOR TESTING: (Fine-grained clayey soils only.)

1.) Undisturbed vane strength: Shelby tube sample;

2.) Machine remoulded vane strength: using above (1) failed undisturbed sample;

3.) Hand remoulded (compacted) vane strength: 2000-2500g of disturbed soil.

BACKGROUND INFO: Machine remoulded vane strength is obtained by rotating the vane rapidly through a minimum of five to ten revolutions on the failed undisturbed specimen, similar to remoulded field vane tests (ASTM D2573) and conducting a vane test 1 minute after the machine remoulding process. Please note, machine remoulded shear strength is typically higher than the hand remoulded shear strength.

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS – ASTM D3080

LABORATORY PROCEDURE USED: ASTM D3080 - Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

RESULTS GIVEN:

1.) Initial and final dry density; initial and final water content;
2.) Normal Stress, rate of deformation and shear displacement;
3.) Plot of log of time or square root of time versus deformation of those load increments where t_{50} (time to 50% consolidation) was determined;
4.) Plot of nominal shear stress versus percent relative lateral displacement.

NOTE: Three or more specimens are generally tested, each under a different normal load, to determine the effects upon shear resistance and strength properties. Normal loads should be selected which represent the field conditions being investigated.

REQUIRED SAMPLE SIZE FOR TESTING:

1.) Undisturbed samples are collected using thin walled Shelby tubes;
2.) Disturbed samples may be remoulded to a density and moisture condition stipulated by the agency requesting the test; approximately 2000 g of soil is needed for remoulding of the test specimen.

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS – ASTM D2850

LABORATORY PROCEDURE USED: ASTM D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.

RESULTS GIVEN:

1.) Specimen dry density, percent saturation, void ratio, and water content;
2.) Rate of axial strain, percent per minute; axial strain at failure, percent;
3.) Compressive strength and the values of the minor and major principal stresses at failure;
4.) Stress-strain curve;
5.) Failure sketch of specimen.

REQUIRED SAMPLE SIZE FOR TESTING:

1.) Undisturbed samples are collected using thin walled Shelby tubes;
2.) Disturbed samples may be remoulded to a density and moisture condition stipulated by the agency requesting the test; approximately 2000 g of soil is needed for remoulding of the test specimen.

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS – ASTM D4767

LABORATORY PROCEDURE USED: ASTM D4767 – Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

RESULTS GIVEN:

1.) Effective consolidation stress; time to 50% primary consolidation (t_{50});
2.) Specimen dry density, percent saturation after consolidation, void ratio, water content;
3.) The value of the principle stress difference (deviator stress) at failure and the values of the effective minor and major principal stresses at failure;
4.) Axial strain at failure, percent; rate of strain, percent per minute;
5.) Principal stress difference and induced pore-water pressure versus axial strain curves;
6.) Failure sketch of specimen.

REQUIRED SAMPLE SIZE FOR TESTING:

1.) Undisturbed samples are collected using thin walled Shelby tubes
2.) Disturbed samples may be remoulded to a density and moisture condition stipulated by the agency requesting the test; approximately 2000 g of soil is needed for remoulding of the test specimen

LABORATORY RESEARCH AND DEVELOPMENT STUDIES

Solum has assisted major environmental engineering companies and Oil & Gas producers in the following projects:

1.) Treatability Studies
2.) Remediation Engineering Studies
3.) Invertebrate Identification Studies
4.) Laboratory Sedimentation and Consolidation Tests on Tailing Ponds
5.) Geotechnical Engineering Characteristics of Tailing Ponds
6.) Solidification and Stabilization of Metal and Hydrocarbon Contaminated Soils
7.) Geotechnical Engineering Characteristics of Soil-Bentonite Mixtures due to Freeze-Thaw Cycles

For more information please call the laboratory manager at (403) 250-3035 or email solum@mymts.net

SOLUM™
CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL
TESTING LABORATORY

GEOTECHNICAL/ MATERIAL LABORATORY TESTING RATES (2012)

1.	WATER (MOISTURE) CONTENT – ASTM D2216		$6.75
2.	SOIL CLASSIFICATION (UNIFIED SOIL CLASSIFICATION SYSTEM) - ASTM D2487		FREE*
3.	ATTERBERG LIMITS – ASTM D4318		$95.00
4.	PARTICLE-SIZE ANALYSIS (FULL GRADATION) – ASTM D422		$135.00
5.	GREATER THAN NO. 200 (0.075 mm) SIEVE ANALYSIS - ASTM C136		$95.00
6.	MATERIALS FINER THAN NO. 200 (0.075 mm) SIEVE – ASTM C117		$65.00
7.	STANDARD PROCTOR – ASTM D698		
	A) METHOD A & B		$175.00
	B) METHOD C		$195.00
8.	MODIFIED PROCTOR – ASTM D1557; INCLUDES PARTICLE OVERSIZE CORRECTION (ROCK CORRECTION) FOR MAXIMUM DRY DENSITY AND OPTIMUM WATER CONTENT		
	A) METHOD A & B		$210.00
	B) METHOD C		$225.00
9.	HYDRAULIC CONDUCTIVITY OF FINE GRAINED SOILS –ASTM D5084		$295.00
10.	PNEUMATIC CONDUCTIVITY OF POROUS SOILS – ASTM D 6539	RIGID WALL	$390.00
		FLEXIBLE WALL	$475.00
11.	HYDRAULIC CONDUCTIVITY OF GRANULAR SOILS (CONSTANT HEAD) – ASTM D2434		$295.00
12.	HYDRAULIC CONDUCTIVITY (PERMEABILITY) OF FINE GRAINED SOILS (FALLING HEAD METHOD) – FOR UNDISTURBED SAMPLE OR DISTURBED SAMPLE IN CONJUNCTION WITH STANDARD PROCTOR – CORPS OF ENG. EM1110-2-1906, APPENDIX VII		$180.00
13.	REMOULDING OF TEST SPECIMEN – IN-HOUSE PROCEDURE		$35.00
14.	TOTAL POROSITY, AIR-FILLED POROSITY –CORPS OF ENG. EM1110-2-1906, APPENDIX II		$55.00
15.	BULK DENSITY (INSITU DENSITY) - ASTM D2937		$40.00
16.	SPECIFIC GRAVITY OF SOILS – ASTM D854		$95.00
17.	ONE-DIMENSIONAL CONSOLIDATION TEST		
	a) USING STANDARD INCREMENTAL LOADING (ASTM D2435) [LOADING UP TO 800KPA & UNLOADING TO 25KPA]		$395.00
	b) OTHER LOADING CYCLES		BY QUOTATIONS
18.	ONE-DIMENSIONAL SWELL TEST – ASTM D 4546		
	a) METHOD A & C		$395.00
	b) METHOD B		$235.00
19.	UNCONFINED COMPRESSIVE STRENGTH – ASTM D2166 (INCL. MC & BULK DENSITY)		$120.00
20.	FALL CONE SHEAR TEST FOR DISTURBED FINE-GRAINED CLAYEY SOIL – FALL CONE MANUFACTURER (ROCTEST ®) PROCEDURE		$175.00
21.	MINIATURE VANE SHEAR TEST - SATURATED FINE-GRAINED SOILS – ASTM D4648		$100.00
22.	DIRECT SHEAR TEST OF SOILS		
	1. CONSOLIDATED DRAINED CONDITIONS (CD) – ASTM3080		
	a) COARSE-GRAINED SOILS (e.g SAND) NORMAL LOADS <=800KPA		$190.00 / 1 SPECIMEN, $335.00 / 3 SPECIMENS

b) FINE-GRAINED SOILS (e.g CLAY & SILT) NORMAL LOADS <=800KPA
$250.00 / 1 SPECIMEN, $700.00 / 3 SPECIMENS

2. CONSOLIDATED UNDRAINED (CU)
   a) FINE-GRAINED SOILS (e.g CLAY & SILT) NORMAL LOADS <=800KPA
   $200.00 /1 SPECIMEN; $550.00 / 3 SPECIMENS
3. UNCONSOLIDATED UNDRAINED (UU)
   a) FINE-GRAINED SOILS (e.g CLAY & SILT) NORMAL LOADS <=800KPA
   $100.00 /1 SPECIMEN; $250.00 / 3 SPECIMENS
4. OTHER REQUIREMENTS BY QUOTATION

23. UNCONSOLIDATED UNDRAINED (UU) TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS – ASTM D2850
    a) ONE LOAD $225.00
    b) MULTI STAGES $450.00 / 3 PTS
24. CONSOLIDATED UNDRAINED (CU) TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS –ASTM D4767
    a) CONSOLIDATION PRESSURE <= 800 KPA $525.00 / 1 PT
    b) MULTI-STAGE W/ CONSOLIDATION PRESSURE <= 800 KPA $945.00 / 3 PTS
    c) MULTI-STAGE W/ CONSOLIDATION PRESSURE <= 1200 KPA $1275.00 / 3 PTS
    d) OTHER REQIREMENTS BY QUOTATION
25. CALIFORNIA BEARING RATIO, PER POINT (PERFORMED IN CONJUNCTION WITH STANDARD PROCTOR TEST),
    a) UNSOAKED $120.00 / POINT
    b) SOAKED $140.00 / POINT
26. CALIFORNIA BEARING RATIO, PER POINT (PERFORMED IN CONJUNCTION WITH MODIFIED PROCTOR TEST),
    a) UNSOAKED $150.00 / POINT
    b) SOAKED $170.00 / POINT
27. pH OF SOIL $10.00
28. SOIL ELECTRICAL CONDUCTIVITY / RESISTIVITY $35.00
29. SOIL THERMAL CONDUCTIVITY / RESISTIVITY-ASTM D5334 $165.00/PT FOR UNDISTURBED SOIL
30. ORGANIC CONTENT $55.00
31. WATER SOLUBLE SULPHATES $65.00
32. CHLORIDE $65.00
33. SAMPLE PREPARATION FOR DIRECT SHEAR TEST, CONSOLIDATION, SWELL,TRIAXIAL, UNCONFINED COMPRESSIVE STRENGTH, CONSTANT HEAD & THERMAL CONDUCTIVITY $35.00 / SPECIMEN
34. RUSH LABORATORY TESTING SERVICES 100% SURCHARGE
35. LABORATORY RESEARCH AND DEVELOPMENT STUDIES BY QUOTATION
36. TECHNICAL STAFF $95.00/Hr
37. STANDARD THIN WALLED TAPERED SHELBY TUBE (3 INCH O.D.) $24.50 **
38. SAMPLE STORAGE FEE (SHELBY TUBE / 5-GALLON PAIL / STANDARD COOLER)
    $2.00/ $7.25/ $ 9.25 PER MONTH FOR FIRST 3 MONTHS; $3.00/ $11.00/$13.00/MONTH AFTER
39. SAMPLE DISPOSAL FEE – NON-CONTAMINATED PER SHELBYTUBE/ PAIL/ COOLER $1.25/ $5.00/ $8.00
40. SAMPLE DISPOSAL FEE – CONTAMINATED SOIL (DISPOSAL CHARGES MAY VARY DEPENDING ON LEVEL OF CONTAMINATION; SAMPLE MAY ALSO BE RETURNED TO THE PROJECT MANAGER**) MIN $25.00/PAIL

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* Solum will classify the soil sample free of charge if the following tests are performed:
Atterberg Limits (ASTM D4318) and one of the following:
1.) Particle-Size Analysis of Soils (Full Gradation) – ASTM D422; or,
2.) Greater Than No. 200 (0.075 mm) Sieve Analysis – ASTM C136.

** Shipping charges will be applied.

Note: Solum will pay for local sample shipping for testing order more than $100.00 per pail, cooler or Shelby Tube. For out of town sample shipping, Solum will reimburse shipping costs up to 10% of the testing order, if requested.

SOLUM™
CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL
TESTING LABORATORY

STANDARD LABORATORY TERMS AND CONDITIONS

1.0 Description of Services to be Performed by Solum Consultants Ltd. (Solum)
Solum shall provide geotechnical and material laboratory testing services on samples in accordance with these terms and conditions and executed Laboratory Testing Request Forms. Solum shall perform its work in accordance with accepted laboratory standards and accepted standard operating procedures. Solum reserves the right to modify methods as necessary based upon experience and/or current scientific literature. If the Client requests a manner of analysis that varies from standard operating or recommended procedures, the Client shall not hold Solum responsible for the results. Such variations of analysis will be noted on the reports. Solum reserves the right to subcontract laboratory testing if a particular test cannot be performed by Solum.

2.0 Reports, Confidentiality and Third Parties
Laboratory reports provided by Solum will be composed of a cover page, summary table of results, and other tables and figures if applicable. Reports will be e-mailed in PDF format to the individual(s) specified on the Laboratory Testing Request Forms. Laboratory reports may also be faxed or mailed to the Client upon request. Except as required by law, Solum shall not disclose testing results or reports to any party other than the Client, unless the Client, in writing, requests information to be provided to a third party. Solum shall abide by any additional confidentiality requirements requested by the Client provided that such requirements are provided to Solum at or before execution of the testing.
Information provided by Solum is intended for Client use only. Any use by a third party, of reports or documents authored by Solum, or any reliance on or decisions made by a third party based on the findings described in said documents, are the sole responsibility of such third parities, and Solum accepts no responsibility of damages suffered by any third party as a result of decisions made or actions conducted.

3.0 Laboratory Testing Request Form (Chain of Custody)
The laboratory testing request form must be completed by the Client and be accompanied with the samples. Testing will not commence until the laboratory testing request form has been completed. If requested by the Client, Solum shall provide a copy of the laboratory testing request form with the report.
No persons other than the designated representatives for each Laboratory Testing Request Form are authorized to act regarding changes to the testing request form. Any changes or amendments of the laboratory testing request form must be in writing and be completed by the originator.

4.0 Acceptance, Contamination and Disposal of Samples
Loss or damages to samples remains the responsibility of the Client until Solum representatives' acceptance of samples by notation on the laboratory testing request form.
As to any samples that are suspected of containing hazardous substances, the Client will specify the suspected or known substance and level of contamination. This information is to be stated on the laboratory testing request form and be accompanied with the samples before testing can commence. Solum may refuse acceptance of samples if it determines they present a risk to health and safety.
Samples accepted by Solum shall remain the property and liability of the Client while in the custody of Solum. Solum will discard all non-contaminated samples after testing has been completed without a retention period at a fixed disposal charge, or if requested by the Client, samples may be returned to the Client at no cost to Solum. If requested by client, Solum will store samples provided the Client agrees to pay for the storage charge. Contaminated material may be returned/shipped to the Client at the Client's expense or Solum will discard samples with disposal rates varying for samples containing higher levels of contamination, refer to price list.
Soil samples requested to be stored will be stored inside the lab up to the expiration of storage period. Soil Samples will be discarded upon the expiration date of the storage period unless client requests either extending storage period or returning samples back to client at no cost to Solum.

5.0 Indemnification/Hold Harmless
Solum shall protect, indemnify and save harmless Client, and its directors, officers, employees, agents, representatives, invitees and subcontractors, and at Client's request, investigate and defend such entities form and against all claims, demands and causes of action, of every kind and character, without limitation, arising in favour of or made by third parties, on account of bodily injury, death or damage to or loss of their property resulting from any negligent act or wilful misconduct of Solum.
The Client shall protect, indemnify and save harmless Solum, and its directors, officers, employees, agents, representatives, invitees and subcontractors, and at Solum's request, investigate and defend such entities form and against all claims, demands and causes of action, of every kind and character, without limitation, arising in favour of or made by third parties, on account of bodily injury, death or damage to or loss of their property resulting from any negligent act or wilful misconduct of Client.

6.0 Limitation of Liability
The total liability of Solum or its staff whether based in contract or tort, will be limited to the lesser of the fees paid or actual damages incurred by the Client. Solum will not be responsible for any consequential or indirect damages even if caused by negligence of Solum. Solum will only be liable for damages resulting form negligence of Solum. All claims by the Client shall be deemed relinquished if not made within one year after the testing date. No warranty is either expressed or implied, or intended by any agreement or by furnishing oral or written reports or findings.

7.0 Termination of Testing Work Order
The Client may order work suspended or terminated upon seven days advance written notice. If work is suspended, Solum shall receive, upon resumption, an adjustment in the cost of services to compensate for additional costs incurred due to the interruption of services. Upon suspension or termination, Solum shall preserve samples provided that the Client agrees to pay the sample storage charge.

8.0 Pricing, Payments and Invoicing
Invoices will be based on current Solum laboratory testing rates; rates may change without notice. Solum invoices shall be paid within thirty (30) days of receipt of the invoice. Amounts not paid when due shall bear interest at the rate of 18% per annum from the date due until the date of payment.

APPENDIX I

LABORATORY TESTING REQUEST FORM

PLEASE MAKE COPIES OF THIS FORM, COMPLETE WITH SAMPLE INFORMATION AND FAX TO SOLUM OR INCLUDE WITH SAMPLE(S). THE LABORATORY TESTING REQUEST FORM MAY ALSO BE PRINTED FROM OUR WEBSITE:
http://www.solumconsultantsltd.com/pdf/testingrequestform.pdf

APPENDIX II

SAMPLE OF A GEOTECHNICAL LABORATORY TESTING REPORT

ALL SAMPLE INFORMATION, PROJECT NAMES, DATA, AND RESULTS INCLUDED IN THIS SAMPLE REPORT ARE FICTIONAL AND SHOULD BE USED FOR ILLUSTRATION PURPOSES ONLY.