**Department of Sustainable Natural Resources**

# SOIL SURVEY STANDARD TEST METHOD

# UNIFIED SOIL CLASSIFICATION SYSTEM: FIELD METHOD

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| **ABBREVIATED NAME** | USCS |
| **TEST NUMBER** | P13 |
| **TEST METHOD TYPE** | B |
| **VERSION NUMBER** | 2 |

## SCOPE

This test method describes the engineering properties of a soil based on the size of the particles, the amounts of the various sizes and the characteristics of the very fine grains. It can be carried out by either field examination or laboratory testing.

## SPECIAL APPARATUS

Sieves, 75 mm, 4.75 mm (ASTM No 4), 2.0 mm (ASTM No 10), 0.425 mm aperture (ASTM No 40).

# PROCEDURE

### Field Classification Technique for Coarse-Grained Soils

1. Take a representative sample of soil (excluding particles >75 mm) (see Note 1) and classify the soil as coarse-grained or fine-grained by estimating whether 50% by weight, of the particles can be seen individually by the naked eye. Soils containing >50% of particles that can be seen are coarse-grained soils; soils containing <50% of particles smaller than the eye can see are fine-grained soils. If the soil is predominantly coarse-grained, identify as being a gravel or a sand by estimating whether 50% or more, by weight, of the coarse grains are larger or smaller than 4.75 mm (No 4 sieve size).

2. If the soil is a gravel, identify as being "clean" (containing little or no fines, <5%) or "dirty" (containing an appreciable amount of fines, >12%). For clean gravels final classification is made by estimating the gradation: the well-graded gravels belong to the GW groups and uniform and gap-graded gravels belong to the GP group. Dirty gravels are of two types: those with non-plastic (silty) fines (GM) and those with plastic (clayey) fines (GC). The determination of whether the fines are silty or clayey is made by the three manual tests for fine-graded soils.

3. If a soil is a sand, the same steps and criteria are used as for gravels in order to determine whether the soil is a well-graded clean sand (SW), poorly-graded clean sand (SP), sand with silty fines (SM) or sand with clayey fines (SC).

4. If a material is predominantly (>50% by weight) fine-grained, it is classified into one of six groups (ML, CL, OL, MH, CH, OH) by estimating its dilatancy (reaction to shaking), dry strength (crushing characteristics), and toughness (consistency near the plastic limit) and by identifying it as being organic or inorganic. (See Note 2.)

**Table 1. Summary of Field Identification Tests**

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| **COARSE-GRAINED SOILS**<br>**More than half the material (by weight) is individual grains visible to the naked eye** | GRAVELLY SOILS<br>More than half of coarse fraction is larger than 4.75 mm | CLEAN GRAVELS<br>Will not leave a stain on a wet palm | Substantial amounts of all grain particle sizes | GW |
| | | | Predominantly one size or range of sizes with some intermediate sizes missing | GP |
| | | DIRTY GRAVELS<br>Will leave a stain on a wet palm | Non-plastic fines (to identify, see ML below) | GM |
| | | | Plastic fines (to identify, see CL below) | GC |
| | SANDY SOILS<br>More than half of coarse fraction is smaller than 4.75 mm | CLEAN SANDS<br>Will not leave a stain on a wet palm | Wide range in grain size and substantial amounts of all grain particle sizes. | SW |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | SP |
| | | DIRTY SANDS<br>Will leave a stain on a wet palm | Non-plastic fines (to identify, see ML below) | SM |
| | | | Plastic fines (to identify, see CL below) | SC |

| **FINE-GRAINED SOILS**<br>**More than half the material (by weight) is individual grains not visible to the naked eye**<br>**(<0.074 mm)** | **Ribbon** | **Liquid Limit** | **Dry Crushing Strength** | **Dilatancy Reaction** | **Toughness** | **Stickiness** | |
|---|---|---|---|---|---|---|---|
| | None | <50 | None to Sight | Rapid | Low | None | ML |
| | Weak | <50 | Medium to High | None to Very Slow | Medium to High | Medium | CL |
| | Strong | >50 | Slight to Medium | Slow to None | Medium | Low | MH |
| | Very Strong | >50 | High to Very High | None | High | Very High | CH |
| **HIGHLY ORGANIC SOILS** | Readily identified by colour, odour, spongy feel and frequently by fibrous texture | | | | | | OL<br>OH<br>Pt |

**Dilatancy** (Reaction to Shaking)

After moving particles >0.4 mm (No 40 sieve size), prepare a pat of moist soil with a volume of about 10 $cm^3$. Add enough water, if necessary, to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and the gloss disappear from the surface, and the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

**Dry Strength** (Crushing characteristics)

After removing particles >0.4 mm (No 40 sieve size) mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

**Toughness** (Consistency near plastic limit)

After removing particles larger than the 0.4 mm (No 40 sieve size), a specimen of soil about 10 $cm^3$ in size is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 3 mm in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays.

Highly organic clays have a very weak and spongy feel at the plastic limit.

## REFERENCES

Charman, PEV & Murphy, BW (eds) 1991, *Soils: Their Properties and Management: A Soil Conservation Handbook for New South Wales.* Sydney University Press.

US Bureau of Reclamation 1960, *Design of Small Dams*. US Government Printing Office.

## NOTES

1. This value is not included in the USCS. It is necessary to know the amount of particles >75 mm if gravel content is required.

2. Many natural soils will have property characteristics of two groups because they are close to the borderline between the groups, either in percentages of the various sizes or in plasticity characteristics. For this substantial number of soils, boundary classifications are used i.e. the groups symbols most nearly describing the soil are connected by a hyphen, such as GW-GC.

   Proper boundary classification of a soil near the borderline between coarse-grained and fine-grained soils is accomplished by classifying it first as a coarse-grained soil and then as a fine-grained soil. Such classification as SM-ML and SC-CL are common.