SA Water

Engineering

Technical Guideline TG0634

General Technical Information for Geotechnical Design - Soil Testing

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Only the current revision of this Guideline should be used which is available for download from the SA Water website.

Significant/Major Changes Incorporated in This Edition

This is the first issue of this Technical Guideline under the new numbering format. The original version of the document was last published in 2007 with the name of General Technical Information for Geotechnical Design Part L – Soil Testing (TG 10l). A full version history of this document is given in Document Controls. The major changes in this revision include the following items:

- Addition of Section 3 to describe the general requirements of soil testing
- Major revision of Section 4 (formerly Section 2 in TG 10l)
- Major revision of Section 5 (formerly Section 3 in TG 10l)

Document Controls

Revision History

Revision	Date	Author	Comments
0	2004	Ed Collingham	First Issue of TG 10l
1	10/1/2007		Nil
2	16/9/2019	Moji Kan	Major Revision, Reformatting to TG 0634

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1 Introduction

SA Water is responsible for operation and maintenance of an extensive amount of engineering infrastructure.

This guideline has been developed to assist in the design, maintenance, construction, and management of this infrastructure.

1.1 Purpose

The purpose of this guideline is to detail minimum requirements to ensure that assets covered by the scope of this guideline are constructed and maintained to consistent standards and attain the required asset life.

1.2 Glossary

The following glossary items are used in this document:

Term	Description
CPT	Cone Penetration Test
SA Water	South Australian Water Corporation
SPT	Standard Penetration Test
TG	SA Water Technical Guideline
TS	SA Water Technical Standard
UCS (or q_u)	Unconfined Compressive Strength

1.3 References

1.3.1 Australian and International

The following table identifies Australian and International standards and other similar documents referenced in this document:

Number	Title
AS 1289.0	Method of testing soils for engineering purposes, Part 0: General requirements and list of methods

1.3.2 SA Water Documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Number	Title
NA	

1.4 Definitions

The following definitions are applicable to this document:

Term	Description
SA Water's Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): • Superintendent's Representative (e.g. AS 4300 & AS 2124 etc.) • SA Water Project Manager • SA Water nominated contact person
Responsible Discipline Lead	The engineering discipline expert responsible for TG 0634 defined on page 3 (via SA Water's Representative)

2 Scope

The scope of this document is to provide guidelines on soil testing for design and construction of SA Water infrastructure.

3 General Requirements

The soil testing may become prudent during investigation, design and operation of SA Water assets. The type and number of required tests, the test method, location, reporting style, required parameters, and the method of interpretation shall be specified by a qualified geotechnical engineer in liaison with the civil or structural engineer who is in charge of the design works. The test methods and its requirements shall comply with Australian Standards for soil testing. A list of general requirements and test methods for soil testing is provided in AS 1289.0 and those requirements shall be complied with in all SA Water projects, unless required dispensation is sought from SA Water Engineering.

4 Hand Test for the Estimation of the Consistency of Clays and the Density of Sands

A hand test method is described in this section to assist the designers to come up with rough estimations of the in-situ conditions of the soil in terms of the consistency of cohesive soils (clays) and the density of cohesionless soils (sands), as well as suggested correlations to the unconfined compressive strength (UCS) and standard penetration test (SPT) values. The hand test is based on using a fist, thumb, or thumbnail by an engineer or technical officer competent in such work to penetrate the exposed face of the soil of interest in a freshly exposed hand-trimmed area, to identify the existing condition of the soil. Table 1 can be used to interpret the results of the hand test.

The interpretations resulted from this hand test method shall be verified by a qualified geotechnical engineer. Note that these are high level rough estimates and cannot be used in place of more accurate in-situ or laboratory tests according to Australian Standards.

Table 1: Description of Hand Test for the estimation of consistency of clay and the density of sand with correlation to UCS and SPT.

Material		Hand Test (See Note 1)	Unconfined Compressive Strength (q_u) (See Note 2)	SPT (blows per 300 mm)
CLAYS	Very Soft Clay	Easily penetrated 40 mm with fist	< 25 kPa	< 2
	Soft Clay	Easily penetrated 40 mm with thumb	25 – 50 kPa	2 – 4
	Firm Clay	Moderate effort needed to penetrate 30 mm with thumb	50 – 100 kPa	4 – 8
	Stiff Clay	Readily indented with thumb but penetrated only with great effort	100 – 200 kPa	8 – 15
	Very Stiff Clay	Readily indented by thumbnail	200 – 400 kPa	15 – 30
	Hard Clay	Indented with difficulty by thumbnail	> 400 kPa	> 30
SANDS	Loose Clean Sand	Takes footprint (~25 kPa) more than 10 mm deep	n/a	< 10
	Medium-Dense Clean Sand	Takes footprint (~25 kPa) 3 mm to 10 mm deep	n/a	10 – 30
	Dense Clean Sand or Gravel	Takes footprint (~25 kPa) less than 3 mm deep	n/a	30 – 50

1. All field identification tests should be done on a freshly exposed hand-trimmed area by an engineer / technical officer competent in such work. Care must be taken to ensure that the soil in the test area was not compacted or loosened during the excavation. The moisture condition of the material at the time of testing must be recorded.

   If a clay soil is dry, and it is likely that it will become wetter during the life of any structure proposed for the location, then the test area should be saturated, and the water given time to be absorbed before repeating the trimming and the testing.
2. The unconfined compressive strength (q_u) of a clay is equal to:
   a. The penetrometer reading.
   b. Twice the undrained shear strength (2 C_u).
   c. The "safe bearing capacity" for a typical shallow, vertically loaded, strip footing if the allowable settlement is about 25 mm (FS = 2 on shear failure).

5 In-Situ Tests for Shear Strength Parameters

Any in-situ test for estimating the shear strength parameters, as an alternative to the triaxial testing of undisturbed samples, would need to have the following attributes:

1. Avoid the difficulties of and disturbance due to recovering samples;
2. Be continuous down the profile to give enough data to pick up the variability and allow averages to be estimated;
3. Be robust to cope with the inevitable rock and stone randomly distributed through the fill;
4. Be a good indicator of "consistency" irrespective of soil type – it is assumed likely that (for example) medium dense sands and stiff clays will be found together in a dam;
5. (In association with the previous attribute) test a reasonable volume of the in-situ material to provide a "mechanical" averaging; and
6. Provide samples for detailed logging.

One of the most suitable tests that appears to meet all these criteria is the Standard Penetration Test. The SPT, apart from being simple and cheap:

a) Is in-situ;

b) Is continuous;

c) Is certainly robust;

d) Has a blow count for loose sands (< 10) similar to that for firm clay (4 to 8), and the blow count for medium dense sands (10 to 30) is similar to that for stiff (8 to 15) to very stiff (15 to 30) clays;

e) Does effectively test a reasonable volume of material because the blow count depends not only on the consistency of the material picked up in the tube but also on the soil surrounding and ahead of the tube;

f) Recovers a reasonable sample for detailed visual/tactile logging and hand penetrometer testing.

Note that other possible in-situ tests (such as vane shear tests, pressure meter or cone penetrometer) are mainly developed for soft clays and would be confused by sands or the rapid changes or anisotropy in material type. The testing equipment in these tests might be stopped or damaged by stone and they do not recover a sample for logging.

The use of cone penetration test (CPT) is more suitable for clayey deposits or clayey fills. The use of CPTu test with measurement of pore water pressure would be warranted if the ground condition is wet or sub-strata is saturated. The outputs of the CPT test should be interpreted using appropriate tools which are mainly based on Robertson charts and publications. The required parameters for the design should be identified based on these interpretations, the parameters of interest might be the in-situ density, moisture content, void ratio, shear strength, bearing capacity, etc.