

Australian Standard[®]

Geotechnical site investigations

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PREFACE

This Standard was prepared by the Standards Australia Committee on Geotechnical Site Investigations, to supersede AS 1726—1981, *Geotechnical site investigations*. This edition was prepared in a form that will allow it to be called up in legislation, and the provisions are supported in a number of non-mandatory Appendices.

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FOREWORD

This Standard presents statements concerning the geotechnical investigation of sites as a preliminary to civil engineering and building construction.

The principle adopted in the preparation of this Standard is to specify concisely those considerations affecting the design and construction of works which must be made in a geotechnical site investigation. Assessment of these factors, in the manner described in this Standard, will then permit the identification of the field and laboratory work which must be implemented to provide the geotechnical data required to facilitate the engineering design and construction of the works.

Some methods suitable for the collection of data and the testing of geotechnical materials, and a system of material classification, are set out in the Appendices.

STANDARDS AUSTRALIA

Australian Standard

Geotechnical site investigations

1 SCOPE This Standard sets out minimum requirements for a geotechnical site investigation, as a component in the engineering design, construction, commissioning and operation of civil engineering and building works.

2 APPLICATION The applications of this Standard include assessment of natural or filled ground, new construction, maintenance of existing facilities, the evaluation of post construction performance and the assessment of failure.

3 REFERENCED AND RELATED DOCUMENTS

3.1 Referenced documents The following documents are referred to in this Standard:

AS

1289 Methods of testing soils for engineering purposes

1289.0 Part 0: General requirements and list of methods

3.2 Related documents Attention is drawn to the following documents:

Australasian Institute of Mining and Metallurgy

Monograph Series No. 9—Field geologists' manual 3rd edition, Melbourne 1989

Institution of Engineers, Australia

Guidelines for the provision of geotechnical information in construction contracts. (National Headquarters, Canberra 1987)

International Society for Rock Mechanics

Commission on standardisation of laboratory and field tests, 1978. *Suggested methods for the quantitative description of discontinuities in rock masses*, (Int. J. Rock Mech. Min. Sci. Vol. 15, 319-68)

4 DEFINITIONS For the purpose of this Standard, the definitions given below apply.

4.1 Client—the individual or organisation commissioning the geotechnical site investigation.

4.2 Classification—a system of identification and description of a material which places it in a limited number of groups on the basis of a defined group or characteristic. For example, a soil classification may be based on grading and plasticity of disturbed samples.

NOTE: A system of classification of soils and rocks suitable for geotechnical reports is given in Appendix A.

4.3 Data—information collected and assembled during the geotechnical site investigation.

4.4 Data, factual—materials, statistics and properties that can be seen, measured or identified by means of accepted or standardized criteria, classifications and tests.

4.5 Data, interpretative—information derived from factual data using accepted and proven techniques, or from reasonable judgment exercised in the assessment of geological conditions or processes evident at the site.

4.6 Geotechnical—pertaining to the nature, condition and physical properties of the earth's crust (whether soil or rock and including water and gases therein) which affect its performance in civil engineering and building works.

4.7 Geotechnical site investigations—the process of evaluating the geotechnical character of a site in the context of existing or proposed works or land usage. It may include one or more of the following:

- (a) Evaluation of the geology and hydrogeology of the site.
- (b) Examination of existing geotechnical information pertaining to the site.
- (c) Excavating or boring in soil or rock.
- (d) In situ assessment of geotechnical properties of materials.
- (e) Recovery of samples of soil or rock for examination, identification, recording, testing or display.
- (f) Testing of soil or rock samples to quantify properties relevant to the purpose of the investigation.
- (g) Reporting of the results.

4.8 In situ—in its original place.

4.9 Investigator—the individual or organisation responsible for performing the geotechnical site investigation (including its reporting) or for that part of the geotechnical site investigation which is relevant in a particular context.

4.10 Monitoring—the activity of sensing, observing, measuring, and recording changes over a period of time.

4.11 Opinion—conclusions or recommendations derived by the investigator from consideration of factual and interpretative data, and from the exercise of judgment.

NOTE: A professional opinion is dependent on conclusions or recommendations derived from consideration of relevant available facts, interpretations and analysis and the exercise of judgment. Since the process involves interpretation and judgment, opinions of professionals may differ, although substantial agreement is expected. Examples where differences of opinion may occur are—

- (a) ease of excavation, types of suitable plant to use, rippability;
- (b) water inflow rates;
- (c) excavation stability;
- (d) settlements;
- (e) bearing capacity; and
- (f) pile types.

4.12 Serviceability—the ability of works to perform according to the design objectives.

4.13 Variability—the change in the properties or conditions of materials with time or location.

5 PLANNING AND DESIGN OF GEOTECHNICAL SITE INVESTIGATIONS

5.1 Nature and magnitude of proposed works The client shall provide the investigator with a written description of the proposed works in sufficient detail to permit definition of the objectives of the investigation.

5.2 Objectives of the investigation The investigator shall provide the client with a written statement of the objectives of the investigation. The statement of objectives shall define the level of detail required in the investigation.

5.3 Extent of investigation The investigation shall evaluate the material properties and the volume of ground which will significantly affect the performance of, or will be affected by, the proposed works.

6 METHODS OF INVESTIGATION

6.1 Investigations The site investigation methods used shall be chosen on the basis of a preliminary assessment of the relevant site conditions, and available geological information and history of the site.

6.2 Review of methods The methods used should be reviewed during the course of the site investigation and in the light of site conditions encountered.

6.3 Variability in nature of site conditions Account shall be taken of variations in material properties with time and location, in the area of the geotechnical site investigation.

NOTE: A selection of methods of investigation can be found in Appendices B and C, and a typical project brief is shown in Appendix D.

7 REPORTING

7.1 Data At the completion of a geotechnical site investigation, or at the completion of each phase of an extended investigation, a report shall be prepared by the investigator. As appropriate to the stated objectives and the phase of the investigation, this report shall contain—

- (a) a description of proposed works;
- (b) objectives of the investigation;
- (c) identification of site;
- (d) a description of methods of investigation and testing used;
- (e) location and reduced levels of all boreholes, test sites and observations to a defined, consistent and recoverable reference grid and datum for the site;
- (f) time observations made; and
- (g) data obtained.

7.2 Opinion As appropriate to the stated objectives and the phase of the investigation, the report shall contain the investigator's opinion independently of the data.

8 CONSTRUCTION REVIEW AND PERFORMANCE MONITORING

8.1 Construction review If the review is not carried out as recommended, the investigator and the relevant regulatory authority shall be informed and reasons given for the non-compliance.

8.2 Performance monitoring If the monitoring is not carried out as recommended, the investigator and the relevant regulatory authority shall be informed and reasons given for the non-compliance.

NOTE: Some guidelines on construction review and monitoring are given in Appendix E.

APPENDIX A

DESCRIPTION AND CLASSIFICATION OF SOILS AND ROCKS FOR GEOTECHNICAL PURPOSES

(Informative)

A1 SCOPE This Appendix describes the preferred systems of description and classification of soils and rocks for use with this Standard. However, it does not preclude an investigator from using an alternative system, provided that the report clearly states that an alternative system has been used, and that a comprehensive description of the system used is included in the report.

Alternative systems may be useful, for example, for certain soil types such as calcareous soils, pedocretes and laterites, where the preferred system may not adequately describe characteristics peculiar to such materials.

A2 SOILS

A2.1 Description Soil description is based on an assessment of disturbed samples, as recovered from boreholes and excavations, and from undisturbed materials as seen in excavations and exposures or in undisturbed samples. Soils may be described in terms of 'mass characteristics' as assessed in the field and in terms of 'material characteristics' assessed from disturbed samples. The geological formation, age and type of deposit may also be identified where known, but these may not be readily assessable without an additional geological study of the area.

A soil classification places a soil in a limited number of groups on the basis of grading and plasticity of a disturbed sample. These characteristics are independent of the particular condition in which a soil occurs, and disregard the influence of the structure, including fabric, of the soil mass, but they can give a good guide to how the disturbed soil will behave when used as a construction material, under various conditions of moisture content.

In a soil description, the terms used should be presented in a logical, consistent order, which—

- (a) distinguishes between *composition*, *condition* and *structure* of soil;
- (b) describes firstly, the *information* which may be obtained from a disturbed soil sample; and
- (c) secondly, describes the *additional condition and structure properties* which may only be observed in an undisturbed soil.

Table A1 is a guide to the naming and description of soils.

A2.2 Classification Any soil can be classified in one of a number of soil groups on the basis of the grading of the constituent particles, and the plasticity of the fraction of the material passing the 425 μm sieve. This may be done on the basis of estimation (field or rapid method) or from laboratory tests. The classification is carried out on material nominally finer than 63 mm. Coarse material, consisting of boulders and cobbles, is picked out and its proportion of the whole is estimated and recorded.

Group symbols for soil classifications are allocated as shown in Table A1.

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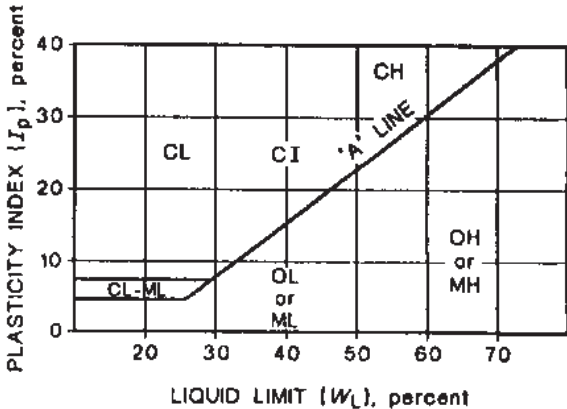
TABLE A1
GUIDE TO THE DESCRIPTION IDENTIFICATION AND CLASSIFICATION OF SOILS

Major divisions	Particle size, mm	Group symbol	Typical names	Field identification Sand and Gravels	Laboratory classification						
COARSE GRAINED SOILS (more than half of material less than 63 mm is larger than 0.075 mm)	BOULDERS 	200			Passing 63 mm for classification of fractions according to the criteria given in 'Major Divisions'	% (2) < 0.075 mm	PLASTICITY OF FINE FRACTION	$C_u = \frac{D_{60}}{D_{10}}$	$C_c = \frac{(D_{30})^2}{D_{10} D_{60}}$	NOTES	
	COBBLES 	63									
	GRAVELS (more than half of coarse fraction is larger than 2.36 mm)	coarse 	GW	Well-graded gravels, gravel-sand mixtures, little or no fines		Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	0-5	—	>4	between n 1 and 3	1. Identify lines by the method given for fine-grained soils. 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.075 mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels		Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	0-5	—	Fails to comply with above		
		medium 	GM	Silty gravels, gravel-sand-silt mixtures		'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	12-50	Below 'A' line or $I_p < 4$	—	—	
		fine 	GC	Clayey gravels, gravel-sand-clay mixtures		'Dirty' materials with excess of plastic fines, medium to high dry strength	12-50	Above 'A' line and $I_p > 7$	—	—	
		coarse 	SW	Well graded sands, gravelly sands, little or no fines		Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	0-5	—	>6	between n 1 and 3	
			SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands		Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	0-5	—	Fails to comply with above		
		medium 	SM	Silty sands, sand-silt mixtures		'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	12-50	Below 'A' line or $I_p < 4$	—	—	
		fine 	SC	Clayey sands, sand-clay mixtures		'Dirty' materials with excess of plastic fines, medium to high dry strength	12-50	Above 'A' line and $I_p > 7$	—	—	

Passing 63 mm for classification of fractions according to the criteria given in 'Major Divisions'

FINE GRAINED SOILS (more than half of material less than 63 mm is smaller than 0.075 mm)	SILTS & CLAYS (liquid limit <50%)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Dry* Strength	Dilatancy†	Toughness‡	Use the gradation curve of material
				None to low	Quick to slow	None	
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium	
		OL‡	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low	
	SILTS & CLAYS (liquid limit >50%)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Low to medium	Slow to none	Low to medium	
		CH	Inorganic clays of high plasticity, fat clays	High to very high	None	High	
		OH‡	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium	
	HIGHLY ORGANIC SOILS	Pt§	Peat and other highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture		§Effervesces with H ₂ O ₂	

More than 50% passing 0.06 mm	Below 'A' line
	Above 'A' line
	Below 'A' line
	Below 'A' line
	Above 'A' line
	Below 'A' line



Plasticity chart for classification of fine-grained soils

Field identification procedure for fine grained soils or fractions

These procedures are to be performed on the minus 0.2 mm size particles. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

* Dry strength (Crushing characteristics)

After removing particles larger than 0.2 mm 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.

† Dilatancy (Reaction to shaking)

After removing particles larger than 0.2 mm size, prepare a pat of moist soil with a volume of 10 cm³. 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 gloss disappear from the surface, 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, shows a moderately quick reaction.

‡ Toughness (Consistency near plastic limit)

After removing particles larger than 0.2 mm size, a specimen of soil about 10 cm³ 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. The specimen is then 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 rerolled 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 with 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 which occur below the A-line. Highly organic clays have a very weak and spongy feel at the plastic limit.