DEPARTMENT *of* INFRASTRUCTURE, ENERGY *and* RESOURCES, TASMANIA
GENERAL SPECIFICATION

G5 - DESCRIPTIVE TERMS IN GEOMECHANICS

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G5.1 SOIL AND ROCK

G5.1.1 General

These notes summarise the terminology used on boreholes and excavation logs for the description of soil and rock. Further details are given in M&R Lab Note N16 and AS1726.

G5.1.2 Soil Descriptions

Classifications of material are based on the Unified Classification System.

Moisture Condition: Based on the appearance of soil at the time of sampling.

(D) Dry — Looks and feels dry; cohesive soils usually hard, powdery or friable; granular soils run freely through hands.

(M) Moist — Soil feels cool, darkened in colour; granular soils tend to cohere, cohesive soils usually weakened by moisture presence. No free water on hands when remoulding.

(W) Wet — Soil feels cool, darkened in colour; granular soils tend to cohere, cohesive soils usually weakened. Free water forms on hands when handling.

Consistency: Relates to the strength of predominantly cohesive materials. It is based on the unconfined compressive strength usually estimated by hand manipulation. The terms used are outlined below.

DESCRIPTION	SYMBOL	UNCONFINED COMPRESSIVE STRENGTH (kPa)	FIELD TEST
Very Soft	VS	<25	Exudes in the fingers when squeezed in the fist
Soft	S	25 - 50	Easily penetrated several cm by the fist
Firm	F	50 - 100	Can be moulded in fingers by slight to moderate pressure
Stiff	St	100 - 200	Can be moulded in fingers by strong pressure
Very Stiff	VSt	200 - 400	Readily indented by thumb nail
Hard	H	>400	Indented with difficulty by thumb nail
Friable	Fb		Crumbles or powders when scraped by thumb nail

Density Index*: Relates to predominantly non-cohesive materials. The terms used are outlined below. Tests are not usually done, but an estimate is sometimes made based on the ease of penetration into the material of the digging/boring device. * Refer to AS1289.E5. 1 & E6.1

DESCRIPTION	SYMBOL	DENSITY INDEX (%)
Very Loose	VL	<15
Loose	L	15 - 35
Medium Dense	MD	35 - 65
Dense	D	65 - 85
Very Dense	VD	>85

Additional Notation

Standard laboratory tests are often carried out on samples taken from test excavations and boreholes. The commonly used abbreviations are listed below:

m/c	Moisture content, oven dried (%)	LL	Liquid Limit
DD	Dry density of in situ material (t/m^3)	PL	Plasticity Index
WD	Wet density of in situ material (t/m^3)	LS	Linear Shrinkage (%)
Std DD	Maximum dry density for Standard compaction test (t/m^3)	Std OMC	Optimum moisture content for Standard Compaction test (%)
Mod DD	Maximum dry density for Modified compaction test (t/m^3)	Mod OMC	Optimum moisture content for Modified compaction test (%)
DDR	Dry Density Ratio (%)	UCS	Unconfined compressive strength (kPa)
C_u	Undrained cohesive strength (kPa)		

G5.1.3 Rock Descriptions

Weathering: Based on a visual assessment of the rock, using the following terms:

TERM	SYMBOL	DEFINITION
Fresh	Fr	No weathering effects visible to the naked eye
Slightly Weathered	SW	Partial staining of the rock substance but no significant loss of strength
Moderately Weathered	MW	Staining extends throughout whole of rock substance with significant loss of strength.
Highly Weathered	HW	Considerable change in appearance and loss in strength. Some constituent minerals decomposed to clay
Extremely Weathered	EW	All mineral and interparticle bonds affected by weathering. Has soil properties.

Extremely weathered materials are usually classified in a re-moulded state as soils according to the Unified Classification.

Strength: Based on the Point Load Strength Index, Is (50), in (MPa). Tests on drilled core are diametral tests unless otherwise indicated. Test results are written on the borelog logs. Where no actual tests are done, the strengths are assessed by examination of the core and drilling records.

CLASS	SYMBOL	POINT LOAD STRENGTH INDEX Is (50), (MPa)
Extremely Low	EL	<0.03
Very Low	VL	0.03 - 0.1
Low	L	0.1 - 0.3
Medium	M	0.3 - 1.0
High	H	1 - 3
Very High	VH	3 - 10
Extremely High	EH	>10

Defect Spacing: Are measured on rock core. Individual defect spacings are not always measured but rather the core is categorised into segments with similar spacing of defects. Fractures induced across the rock fabric during or after removal from the core barrel are not considered defects.

Defect Descriptions: The inclination of defects with respect to the core axis, (or alternatively the dip), defect condition and any coatings are recorded.

G5.2 INTERPRETATION AND PRESENTATION OF SEISMIC INFORMATION

G5.2.1 Introduction

This note gives a brief summary of the testing methods and equipment used in carrying out seismic refraction surveys, the recording and interpretations given for geotechnical documentation, and the limitations of the method. The seismic interpretations given have been for the purposes of various stages of investigation and design, and the level of interpretation has been chosen to suit these ends.

G5.2.2 Equipment

The most frequently used seismograph is a Nimbus ES 1210F 12 channel signal enhancement device. A single channel Nimbus seismograph and a 12 channel RS4 has also been used infrequently. Shots usually comprise Emulite 110 g sticks (or previously AN 60 gelignite), placed in a hole made with a crowbar or hand auger, 0.4 to 1.0 m deep. Electrical firing triggers the shot and the seismograph. Hammer and plate seismic is done infrequently.

G5.2.3 Recording/Data

From the seismograph output charts an estimate is made of the time of arrival of the first shock wave at each geophone. These times are used to produce time distance plots. Where the breaks on the charts are not sudden or are indefinite, the fact is usually noted on Form MRF-55. This form gives details of the location/layout of the traverse and the time-distance plots. Copies of the raw data (seismograph chart outputs) are available on request. The results of straight forward interpretations by critical distance method are usually written on the graph, and a velocity analysis plot is sometimes included.

G5.2.4 Interpretation

There are two quite distinct levels of interpretation. The first involves the derivation of seismic properties (refractor depths, shapes, layer velocities). The second, which is essentially speculative makes inferences as to possible geological conditions from the calculated seismic properties. Both types of interpretation involve assumptions, and neither will provide a unique interpretation of the same set of data.

G5.2.4.1 Seismic Properties

One or both of the two following methods are used to derive the seismic properties.

(1) Critical Distance Analysis
(2) Reciprocal (Hawkins) Method

The reliability of both methods is governed by their inherent assumptions, the positioning of the geophones with respect to local geological boundaries, the clarity of the breakpoints in the field charts and the scatter of the points on the time distance plots. In using the methods it is usually assumed that:

- There are distinct boundaries on which the seismic waves refract
- Each layer is of sufficient thickness to be detectable at the surface
- The velocity of each layer is greater than that of all layers above it
- When using opposing shots, the seismic waves refract on the same surface
- The shot is at the surface ((ie. no correction is usually made for the depth of the shot)

G5.2.4.1.1 Apparent Velocities

These are usually calculated from lines drawn by eye on the time distance plots and are shown on these plots (metre/sec). The velocities are sometimes set from experience (eg. over water or where there is a shallow surface layer where the velocity could not be ascertained from the data). Such assumptions would normally be indicated on MRF-55.

G5.2.4.1.2 Critical Distance Method

The results are usually presented on the time distance plots. Calculations are usually made for individual shots. The calculations assume planar boundaries (including surface profile) and constant “true” refractor velocities. A slope term correction of unity is usually assumed for depth calculations. Differing apparent refractor velocities for opposing shot directions are interpreted as a sloping refractor. In this case the “calculated true” velocity would normally be indicated on the form.

G5.2.4.1.3 Reciprocal (Hawkins) Method

This method can be used to treat variable terrain and refractor slopes, variable layer depths and variable refractor velocities, although not all at once. It is based on the “time-depth” parameter. A minimum of two opposing shots are required, which overlap in the geophones’ responses to a given layer. Velocity analysis is sometimes used to determine the “true” refractor velocity. The assumptions and limitations of the Reciprocal method include:

(i) For each geophone analysed, the first arrivals for each shot must have been refracted from the same layer.
(ii) The calculations are for shallow investigations only, where the scale of variability of vertical profiles is small compared with the geophone spacing used.
(iii) Layer velocities are usually assumed to be uniform in order to calculate refractor depths. Alternative assumptions are sometimes made. The presentation of the results will usually indicate what alternative assumptions have been made.

G5.2.4.2 Geological Interpretations

Seismic information is used mainly to locate changes in geological properties. It may be possible to infer the geological nature and condition of strata from seismic information. The reliability of such inferences is dependent on the quality of local knowledge, the complexity of the ground conditions and the quality of the seismic data itself. Ideally seismic information should not be considered in isolation, but interpreted in conjunction with other geotechnical tests and with an appreciation of the local geology. The geological interpretations of seismic data included in geotechnical documents have often been made prior to more definitive subsurface testing (drilling, excavations, etc) and their reliability should be assessed in the light of this fact.

G5.3 TERMS AND TEST METHODS USED IN PAVEMENT INVESTIGATION

G5.3.1 General

These notes summarise the methods, terminology and abbreviations used for the collection and presentations of pavement data.

The data presented may include:

- Pavement Condition Map
- Deflection Beam Tests
- Pavement Report Forms

G5.3.2 Pavement Condition

The map is a representation of the approximate location, extent and nature of visible defects in the pavement surface. The categories of surface condition are outlined in the Section "Pavement Report Forms" below. No physical or precise measurements are made of the area or of the severity of defects. Location (chainage) is established either by vehicle odometer or by a hand wheel odometer.

G5.3.3 Deflection Measurements

Chainages are usually established by vehicle or hand wheel odometers. These chainages will not necessarily be coincident with the final design chainages. The data may include:

Deflections:	the recoverable maximum vertical deformation measured by a Benkelman Beam or deflectograph. A correction factor of 1.2 is applied to deflectograph readings to convert them to an equivalent Benkelman Beam deflection.
Curvature Function:	the arithmetic difference between the maximum measured deflection and the value measured 200 mm from the point of maximum deflection in the direction of travel measured by a Benkelman Beam in accordance with Test Method T109.

G5.3.4 Pavement Report Forms

The pavement report forms (Form 152) describe the results of field observations, deflection tests and laboratory test data of selected samples obtained at the sites of test pits. The following provides a description of the various terms and abbreviations used in the forms.

(a) <u>Site Notes</u>

The location of the test pit is defined by chainage and offset from the centreline (c). L (left) and R (right) are always determined when facing in the direction of increasing chainage. The chainages refer to those used for the deflection testing. IWP refers to Inner Wheel Path. OWP refers to Outer Wheel Path.

(b) <u>Situation</u>

Defines the approximate height of cut (C) and fill (F) to the left (L) and right (R) of the centreline.
Eg. 2 C L/5 F R - a 2m cut on the left and 5m fill on the right hand side.

(c) <u>Surface Condition</u>

Describes the deformation and integrity (including cracking) of bituminous (sprayed seals and asphalt) surfaces within a metre of the test pit site.

(i) Deformation

Graded by the gap below a 1.2 m straight edge positioned to produce the maximum gap

Gap (mm)	Name
Less than 5	None, ND
Greater than 5 to 10	Little, LD
Greater than 10 to 20	Moderate, MD
Greater than 20	Severe, SD

(ii) Surface Integrity

Five classes of surface integrity are recognised:

Intact	I,
Cracked	C,
Patched	P,
Seal Break	B, and
Pothole	H.

Where cracking occurs, postscripts are used to define the type and condition of the cracks.

Crack Type		Crack Spacing (mm)		Crack Width (mm)	
Alligator	a	close (<100)	cs	fine (<0.5)	f
Longitudinal	l	medium (100 to 500)	ms	narrow (0.5 to 2)	n
Transverse	t	wide (>500)	ws	gaping (>2)	g

(d) Benkelman Beam

Refers to the rebound deflection at the location of the test pit.

(e) Sampling

Significant layers are sampled (identified by a container number). Depths are measured from the surface. Visual assessments are made of the material type (crushed rock, gravel, etc) and the likely broad geological description of the aggregate.

(f) Laboratory Tests

Not all samples are subjected to laboratory testing. Where a sample was found by visual inspection to be similar to another that has been tested, a reference is provided to the sample number of the tested sample. The dust ratio is the percentage passing the 0.075 mm sieve divided by the percentage passing the 0.425 mm sieve. Unless otherwise stated the moisture content applies to the fraction passing the 19 mm sieve.

G5.3.5 Pavement Design

(a) Calculated CBR

A calculated CBR (California Bearing Ratio) is estimated from particle size and Atterberg limits in accordance with Lab Note N25 “Methods of Assessment of Design CBR”. The calculation is applicable only to fine grained subgrade materials (CBR not greater than 15). There is no established relationship between this value and insitu conditions.

(b) Insitu CBR

Estimates of insitu CBR’s are made on suitable subgrade materials by:

- Dynamic Cone Penetrometer
- Farnell Soil Assessment Cone Penetrometer

(c) Adopted CBR

A CBR value adopted for the particular layer based on consideration of the test results and usual Departmental standards.

(d) Estimated Cover

The estimated cover of granular material that should exist over the particle layer, based on the adopted CBR and design traffic, necessary to satisfy the pavement design method, AUSTROADS “A Guide to the Structural Design of Road Pavements”.

(e) Extra Cover

Any deficiency of the existing cover over a particular layer relative to the estimated cover.