



Australian Government

Department of Education, Employment and Workplace Relations

MSL974012A Perform tests to determine the properties of construction materials

Revision Number: 1

MSL974012A Perform tests to determine the properties of construction materials

Modification History

Not applicable.

Unit Descriptor

Unit descriptor	This unit of competency covers the ability to conduct multi-stage tests to determine the properties of raw and/or manufactured construction materials. These test results are typically used by clients to prove raw material deposits, tender for supply of construction materials, classify soils, determine the suitability of construction materials for specialised uses and inform the design of civil engineering works. The unit includes data processing and interpretation of results to identify obvious errors or unexpected results and take corrective action. However, personnel are not required to analyse data, optimise test methods or enterprise procedures for specific samples or troubleshoot equipment problems where the solution is not apparent.
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Application of the Unit

Application of the unit	This unit of competency is applicable to laboratory personnel working in the geotechnical and construction material testing industry sectors who conduct tests in consulting laboratories or laboratories at extractive, manufacturing or construction sites using established test methods. These tests (such as load bearing ability, creep, shrinkage, durability, plasticity, permeability, chloride diffusion and reactivity) are used to determine the properties of aggregates, concrete, soils, road pavement or other specialised construction materials and products. Industry representatives have provided case studies to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting. These are found at the end of this unit of competency under the section 'This competency in practice'.
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Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Prerequisite units		
	<i>MSL973001A</i>	<i>Perform basic tests</i>
	OR	
	<i>MSL973010A</i>	<i>Conduct laboratory-based acceptance tests for construction materials</i>

Employability Skills Information

Employability skills	This unit contains employability skills.
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Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.
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Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1. Interpret and schedule test requirements	1.1. Access relevant job instructions from laboratory information management system (LIMS) 1.2. Interpret test request to confirm samples to be tested, the test method and equipment involved 1.3. Identify hazards and enterprise controls associated with the sample, preparation methods, reagents and/or equipment 1.4. Assemble all required equipment and materials 1.5. Plan work sequences for optimum efficiency and/or throughput of multiple samples
2. Prepare samples or test pieces	2.1. Retrieve samples and/or test pieces from storage and record their general appearance 2.2. Check the accuracy and completeness of accompanying labels and documentation to ensure traceability 2.3. Check that the storage/curing conditions of samples and/or test pieces were appropriate 2.4. Compare samples and/or test pieces with test specifications, record observations and report discrepancies 2.5. Prepare samples and/or test pieces in accordance with appropriate test method 2.6. Conduct preliminary measurements to establish initial dimensions and test conditions as necessary
3. Check test equipment before use	3.1. Set up test equipment/instruments in accordance with test method 3.2. Perform pre-use and safety checks in accordance with enterprise procedures 3.3. Identify faulty or unsafe equipment/instruments and report to appropriate personnel 3.4. Check calibration status of instruments and report any out of calibration items to appropriate personnel
4. Conduct test to determine sample properties	4.1. Perform each treatment/measurement stage of the test method precisely and in the correct sequence 4.2. Record all data, observations and any factors that may impact on the quality of results 4.3. Recognise obvious errors or atypical data and take appropriate corrective actions 4.4. Seek advice to deal with any situation beyond own technical competence 4.5. Shut down test equipment/instruments in accordance with enterprise procedures
5. Process and interpret	5.1. Check data for accuracy and completeness

ELEMENT	PERFORMANCE CRITERIA
data	5.2. Perform required calculations and ensure results are consistent with expected values for the sample type 5.3. Record and report results with the appropriate accuracy, precision and units 5.4. Interpret trends in data and/or results and report out of specification or unexpected results promptly to appropriate personnel 5.5. Determine if obvious procedure or equipment problems have led to unexpected data or results
6. Maintain laboratory records	6.1. Enter approved data and test results into LIMS 6.2. Maintain confidentiality and security of enterprise information and test results 6.3. Maintain technical/administrative records and test reports in accordance with enterprise procedures
7. Maintain a safe work environment	7.1. Use safe work procedures and protective equipment to ensure personal safety and that of others 7.2. Minimise generation of wastes and environmental impacts of testing 7.3. Collect and/or dispose of all waste in accordance with environmental/quarantine requirements and enterprise procedures 7.4. Care for and store equipment, used test pieces and back-up samples in accordance with enterprise procedures

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit.

Required skills

Required skills include:

- interpreting client's test requests, test methods and procedures accurately
- planning work sequences involving multiple/parallel tasks
- interpreting safety information, such as material safety data sheets (MSDS), and working safely
- checking and using test equipment in accordance with enterprise procedures
- maintaining concentration and applying multi-stage test methods accurately
- estimating/calculating scientific quantities (e.g. stress, strain and stiffness)
- interpreting gross features of data and graphs (e.g. Mohr circles) and making logical conclusions
- identifying atypical data, errors and unexpected results and tracing any obvious causes
- recording and presenting results accurately and legibly
- maintaining security, integrity and traceability of all samples/testpieces, data/results and technical records
- cleaning and maintaining equipment
- seeking advice from a supervisor
- communicating with clients or outside service technician
- demonstrating a professional approach and positive company/organisation image

Required knowledge

Required knowledge includes:

- relationship between properties and uses of construction materials
- construction materials test methods routinely used in job role including:
 - purpose and principles of test
 - relationship between the properties and uses of construction materials
 - sample preparation procedures
 - key treatment/measurement stages
 - calculation steps to give results in appropriate units and precision
 - expected values for sample type
 - sources of uncertainty and methods for their control
- principles and concepts underpinning the test method such as:
 - mass, weight, forces, pressure, energy, density, friction and slip resistance
 - elasticity, hardness, strength of materials, plasticity, permeability and dispersion

REQUIRED SKILLS AND KNOWLEDGE

- electrical safety concepts including voltage, current, resistance, conductors/insulators and AC/DC
- chemical ions, pH and solubility
- principles and concepts related to equipment/instrument operation and testing including the function of key components of the equipment/instrument and effects on test of modifying equipment/instrument variables
- pre-use checks and operating procedures for test equipment/instruments routinely used in job role
- basic equipment/method troubleshooting procedures
- procedures for ensuring traceability of samples, test pieces, test data and results
- procedures for recording and reporting test results, calculations, test observations and unexpected or atypical results and equipment problems
- health, site safety and environmental management requirements relevant to job role
- confidentiality requirements relevant to job role

Evidence Guide

EVIDENCE GUIDE

The Evidence Guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.

Overview of assessment

Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors should ensure that candidates can:

- plan efficient work sequences
- prepare a range of laboratory samples or test pieces and conduct tests to determine their properties safely and accurately and within required timeframe
- interpret trends in data and results to identify obvious errors or unexpected results and take corrective action.

Context of and specific resources for assessment

This unit of competency is to be assessed in the workplace or simulated workplace environment. This unit of competency may be assessed with other relevant units of competency such as:

- *MSL924001A Process and interpret data*
- *MSL943002A Participate in laboratory/field workplace safety*
- *MSL953001A Receive and prepare samples for testing.*

Resources may include:

- data sets and records
- test methods and description of test setup
- computer and relevant software or laboratory information system
- relevant enterprise procedures.

Method of assessment

The following assessment methods are suggested:

- review of test data, results and records generated by the candidate
- feedback from supervisors and clients regarding the candidate's ability to conduct a range of multi-stage tests to determine the properties of samples reliably, safely and efficiently
- questions to assess understanding of enterprise procedures and multi-stage test methods relevant to their job role (including key treatment and

EVIDENCE GUIDE	
	measurement steps, expected values, sources of uncertainty and corrective actions). In all cases, practical assessment should be supported by questions to assess underpinning knowledge and those aspects of competency which are difficult to assess directly. Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability. Access must be provided to appropriate learning and/or assessment support when required. The language, literacy and numeracy demands of assessment should not be greater than those required to undertake the unit of competency in a work like environment.
This competency in practice	Industry representatives have provided the case studies below to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting. Construction materials testing A materials technician employed at a consulting laboratory reviews the ten job sheets assigned to him/her at the start of the day. The first client is a road construction company and requires a soaked California Bearing Ratio (CBR) test on a sandy gravel sample (@98% density ratio using modified compactive effort and 105%OMC). The technician locates and reads through the appropriate test methods (AS 1289.6.1.1 and AS1289.5.2.1) and assembles the necessary equipment. He/she uses a 19mm sieve to obtain suitable material for the test and prepares representative sub-samples to determine the dry density and optimum moisture content and CBR. To determine the CBR, he/she adds the required amount of water to the test portion to achieve the required laboratory density ratio and sets it aside to cure for the recommended time. Using the modified compactive effort procedure, he/she fills the mould in five layers taking care that each layer thickness meets specification. He/she then positions the required surcharges on top of the specimen and places it in a water bath to soak for four days. After retrieving the specimen, the technician checks the swell and performs the penetration test before the specimen dries out. After

EVIDENCE GUIDE

positioning the specimen, zeroing the measuring instruments, he/she applies the load with a constant penetration of 1+/- 0.2mm/min and records the load (kN) at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5mm. Afterwards, the technician removes the sample carefully and determines the moisture content for both the top 30mm layer and the rest of the specimen. He/she plots the load vs penetration data and applies corrections at 2.5mm and 5.0mm to compensate for its initial upward concave shape. He/she reads off force values of 9.2kN (at 2.5 mm) and 13.9kN (at 5.0mm) respectively and calculates CBR values of 69.7% and 70.2%. After checking all measurements, data plots and calculated values the technician decides that the results are consistent with expected values. He/she reports each of the required results to the precision specified in the test method (e.g. CBR=70% @ 2.5 and 5.0mm penetration) and other test details such as the surcharges used and the period of soaking. After completing the test report, he/she forwards it to the laboratory manager for review prior to its release to the client.

Construction materials testing

A laboratory receives a job request from a building developer to determine the shrink/swell index for soil samples collected from a proposed housing estate. A technician logs the job and locates the appropriate test method (AS 1289.7.1.1). Given the commercial importance of establishing whether or not there are any significant cut/fill variations across the development site, he/she reviews the method carefully. The technician notes that they need to be careful when removing the sample from the U50 tube to preserve its undisturbed state and to also check for stones and inert materials. He/she works through the steps required for separately conditioning and measuring the two specimens required for determining the index and notes that if the shrink specimen cracks while drying to constant length, the results will be invalid. After assembling and checking the required equipment, he/she performs the test successfully.

Range Statement

RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

Codes of practice

Where reference is made to industry codes of practice, and/or Australian/international standards, it is expected the latest version will be used

Standards, codes, procedures and/or enterprise requirements

Standards, codes, procedures and/or enterprise requirements may include:

- Australian and international standards such as:
 - AS ISO 17025-2005 General requirements for the competence of testing and calibration laboratories
 - AS 1012 Methods of testing concrete
 - AS 1289 Methods for testing soils for engineering purposes
 - AS 2981 Methods of sampling and testing asphalt
 - AS 1141 Series - Methods for sampling and testing aggregates
- AustRoads test methods
- conservation requirements
- enterprise quality manual, customer quality plan
- equipment manuals and warranties, supplier catalogues and handbooks
- MSDS
- National Association of Testing Authorities (NATA) documents regarding construction materials testing
- sampling and test methods, enterprise or standard operating procedures (SOPs)
- site safety plans
- State/Territory Road Authority test methods

RANGE STATEMENT	
Hazards	Hazards may include: • electric shock • light, dust, noise and heat • biohazards, such as microbiological organisms and agents associated with soil • chemicals such as acids, alkalis and hydrocarbons • flammable liquids and gases • burns from hot bitumen, hot plates, hot moulds or ovens • inhalation or burns from sulphur during preparation of concrete samples • fluids under pressure • hand tools • occupational overuse syndrome, slips, trips and falls • manual/handling of heavy equipment or materials • crushing, entanglement and cuts associated with moving machinery
Enterprise safe work procedures	Enterprise safe work procedures may include: • use of MSDS • barriers recognising and observing hazard warnings and safety signs/barriers • labelling of samples, reagents and hazardous materials • cleaning and decontaminating equipment and work areas regularly using recommended procedures • handling and storing hazardous material and equipment in accordance with labels, manufacturer's instructions, enterprise procedures and regulations • following established manual handling procedures for tasks involving manual handling • use of personal protective equipment, such as hard hats, hearing protection, gloves, goggles, safety glasses, coveralls, respirators and safety boots
Tests	Tests may include:

RANGE STATEMENT

- testing of concrete:
 - drying shrinkage
 - chlorides and sulphates
 - chloride ion penetration
 - stiffness
- testing of cement:
 - air permeability
 - setting times
 - normal consistency
- testing of soils:
 - moisture-density relationships
 - California Bearing Ratio (CBR) (1 point)
 - unconfined compressive strength
 - quick tri-axial stress (total stress parameters)
 - permeability (e.g. drainage material)
 - hydrometer analysis
 - shrink/swell tests (site classification)
- testing of asphalt:
 - Marshall stability/flow
 - skid tests
- testing of bitumen seals:
 - viscosity
 - penetration
 - softening point
 - flash point
- testing of aggregates:
 - 10% fines, wet-dry strength variation
 - <2 micron test
 - sodium sulphate soundness
 - Los Angeles Abrasion
 - Washington degradation
 - polished aggregate friction value

RANGE STATEMENT	
Samples and test pieces	Samples and test pieces may include: • samples of aggregates, soil, rock, concrete, road pavement and binders • disturbed and undisturbed samples
Test and sample preparation equipment/materials	Test and sample preparation equipment/materials may include: • crushers, mulchers, grinders, mills, riffles and sieves • moulds, bags and containers • ovens, microwaves and water baths • mass balances • microscopes • dimension apparatus (e.g. calipers and micrometer) • rammers, compression rigs and load cells • chemical reagents and volumetric glassware • temperature measuring devices, such as thermometers and thermocouples • pH and conductivity meters • analogue and digital meters, charts/recorders, data loggers and computers
Appropriate corrective actions	Appropriate corrective actions may include: • accuracy check of data entry and transcription • logical check of equipment setup • check of calibration, zero error and drift for basic instruments • careful re-reading of procedures • repeat test measurements • seek advice
Technical/administrative records	Technical/administrative records may include: • test and calibration results • equipment use, maintenance and servicing history • faulty, unsafe or quarantined equipment
Minimising environmental impacts	Minimising environmental impacts may include: • collection of surplus or spent samples and test pieces for disposal • recycling of non-hazardous waste, such as

RANGE STATEMENT	
	chemicals, batteries, plastic, metals and glass • appropriate disposal of all waste • correct storage and handling of hazardous chemicals and samples
Occupational health and safety (OHS) and environmental management requirements	OHS and environmental management requirements: • all operations must comply with enterprise OHS and environmental management requirements, which may be imposed through state/territory or federal legislation - these requirements must not be compromised at any time • all operations assume the potentially hazardous nature of samples and require standard precautions to be applied • where relevant, users should access and apply current industry understanding of infection control issued by the National Health and Medical Research Council (NHMRC) and State and Territory Departments of Health

Unit Sector(s)

Unit sector	Testing
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Competency field

Competency field	
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Co-requisite units

Co-requisite units		

