



Australian Government

AHCARB804 Analyse tree structure and biomechanics

Release: 1

AHCARB804 Analyse tree structure and biomechanics

Modification History

Release	Comments
Release 1	This version released with AHC Agriculture, Horticulture and Conservation and Land Management Training Package Version 5.0.

Application

This unit of competency describes the skills and knowledge required to identify and analyse aspects of tree biomechanics that affect the physical load and strength of trees, branches and anchorage in the ground. It requires the assessment of tree strength and the loads that occur, and the ability to assess factors that can weaken trees that increase the chance of failure.

The unit applies to individuals with highly specialised advanced theoretical and technical knowledge for professional work and research in arboriculture. They exercise advanced cognitive, technical and communication skills and demonstrate complete autonomy, judgement and adaptability in research and analysis for complex problems.

No licensing, legislative or certification requirements apply to this unit at the time of publication.

Pre-requisite Unit

Nil

Unit Sector

Arboriculture (ARB)

Elements and Performance Criteria

Elements	Performance Criteria
<i>Elements describe the essential outcomes.</i>	<i>Performance criteria describe the performance needed to demonstrate achievement of the element.</i>
1. Determine existing physical loads and strengths of trees, branches and anchorage	1.1 Determine existing physical loads affecting trees 1.2 Identify source and factors causing stress on trees 1.3 Assess root plate environment and history for damage 1.4 Assess history of pruning operations to above and below ground

Elements	Performance Criteria
<i>Elements describe the essential outcomes.</i>	<i>Performance criteria describe the performance needed to demonstrate achievement of the element.</i>
	components 1.5 Determine presence and extent of defects on trunk and root system 1.6 Assess strength and material properties of tree structural components
2. Determine wind load	2.1 Determine wind environment of tree 2.2 Determine surface area of structure exposed to wind 2.3 Determine crown surface area exposed to wind 2.4 Assess aerodynamic drag factor of tree crown 2.5 Estimate primary loads occurring in seasonal climatic events 2.6 Determine wind-load of prevailing stormy weather 2.7 Determine load and drag associated with saturated foliage
3. Determine structural integrity by static load testing	3.1 Determine static load on trees for structural integrity testing and estimate wind-equivalent load 3.2 Calibrate static load testing instruments according to manufacturer instructions 3.3 Conduct static tests according to instrument instructions and analysis procedures 3.4 Monitor loads and forces on trees to ensure safe limits to prevent damage 3.5 Record data from static tests according to workplace procedures 3.6 Compare data with benchmarks obtained from stable tree populations 3.7 Prepare a report on structural integrity testing of tree from the static load tests
4. Determine tree dynamic response	4.1 Investigate tree biomechanics using dynamic methods of analysis 4.2 Review complex models of tree dynamics analyses 4.3 Calculate mass of branches of tree to determine degree of open-grown 4.4 Calculate vector of force on tree 4.5 Determine tree dynamic response under defined wind loads 4.6 Prepare a report on structural integrity testing of tree from dynamic load analysis

Elements	Performance Criteria
<i>Elements describe the essential outcomes.</i>	<i>Performance criteria describe the performance needed to demonstrate achievement of the element.</i>
5. Investigate and consolidate structural integrity data and create a structural integrity report	5.1 Investigate level of contribution of material properties in tree dynamics 5.2 Investigate dynamic effect of branches on natural oscillation frequency and damping effect 5.3 Determine level of contribution of form and morphology in tree dynamics 5.4 Review suitability of invasive and non-invasive methods of testing 5.5 Evaluate and determine likelihood of structural failure 5.6 Confirm level of anchoring potential of root system and stability of tree 5.7 Prepare a structural integrity report and provide to client

Foundation Skills

This section describes those language, literacy, numeracy and employment skills that are essential for performance in this unit of competency but are not explicit in the performance criteria.

Skill	Description
Writing	Create logical, succinct and accurate reports that use appropriate industry terminology and mathematical language and symbols
Numeracy	Analyse and synthesise highly complex mathematical information for tree mechanics, and perform calculations to determine structural integrity of trees

Unit Mapping Information

Code and title current version	Code and title previous version	Comments	Equivalence status
AHCARB804 Analyse tree structure and biomechanics	AHCARB701 Analyse tree biomechanics	Code changed to reflect AQF alignment Title changed Elements and performance	Equivalent

		criteria clarified Foundation skills added Assessment requirements updated	
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Links

Companion Volumes, including Implementation Guides, are available at VETNet: -
<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=c6399549-9c62-4a5e-bf1a-524b2322cf72>

Assessment Requirements for AHCARB804 Analyse tree structure and biomechanics

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Performance Evidence

An individual demonstrating competency must satisfy all of the elements and performance criteria in this unit.

There must be evidence that the individual has analysed the structure and biodynamics of a minimum of five different trees, including performed the following:

- five static load tests, and
- five dynamic load analyses.

There must also be evidence that the individual has:

- determined existing physical loads affecting trees
- identified areas of high stress on trees and the factors that affect these areas of high stress
- assessed root plate environment for damage
- assessed history and effect of tree pruning operations on tree roots and stems
- determined presence and extent of tree defects
- assessed strength and material properties of tree structural components
- determined wind environment of tree
- determined surface area of structure exposed to wind
- determined crown surface area exposed to wind
- assessed aerodynamic drag factor of tree crown
- estimated primary loads occurring in seasonal climatic events
- determined wind-load of prevailing storms
- determined load associated with saturated foliage
- determined static load on trees for structural integrity testing as an estimate of a wind equivalent load
- calibrated static load testing instruments
- conducted static tests that must include:
 - loads to the tree
 - measures the trunk strength
 - assesses root plate anchorage

- monitored loads and forces using electronic equipment
- monitored trees to ensure loads are kept within safe limits to prevent damage
- maintained records of all data from static tests
- compared data against benchmarks from stable tree populations and prepared a report on structural integrity testing
- investigated tree biomechanics using dynamic methods of analysis
- reviewed complex models of tree dynamics analysis
- calculated mass of branches to determine degree of open-grown form of tree
- calculated vector of force on the tree
- determined tree dynamic response under defined wind loads
- investigated level of contribution of material properties in tree dynamics
- investigated the dynamic effect of branches on frequency and damping
- determined the level of contribution of form and morphology in tree dynamics
- reviewed suitability of invasive and non-invasive methods of testing
- evaluated and determined likelihood of structural failure
- confirmed level of anchoring potential of root system and stability of tree
- prepared a structural integrity report and provided to client.

Knowledge Evidence

An individual must be able to demonstrate the knowledge required to perform the tasks outlined in the elements and performance criteria of this unit. This includes knowledge of:

- tree dynamics and impact of tree form and morphology
- tree stability and physical loads affecting trees, particularly in high stress environments
- root plate environment, including:
 - depth and consistency of soil
 - spatial limitations
 - site excavations and potential damage
- arboricultural activity and impact on tree structure and stability, including:
 - pruning operations to branches and roots
- presence and impact of defects on tree structure, including:
 - extent of decay and damage of trunk and root system
 - assessment of strength and material properties of structural wood
- biomechanical impact of wind on tree structure, including:
 - seasonal wind patterns, and tree exposure
 - surface area and tree structure
 - aerodynamic drag factor of tree crown in relation to trunk diameter and extent of hollowness
 - estimation of primary loads occurring in seasonal climatic events
 - severe wind-load due to storms and extreme weather conditions
 - load associated with rain and snow saturated foliage

- additional drag associated with saturated foliage
- open-grown form of tree
- testing principles for static load, including:
 - use and purpose of a static load on trees during structural integrity testing as an estimate of a wind equivalent load
 - calibrating static load testing instruments
 - limits of structural safety during a static testing
 - measurement of trunk strength
 - invasive and non-invasive methods of testing trees
- assessment of root plate anchorage in the ground
- methods and reasons for monitoring loads and forces on trees, including:
 - electronic monitoring
 - monitoring of tree to ensure loads are kept within safe limits
- value and purpose of benchmarks obtained from stable tree populations
- tree biomechanics studies using dynamic methods of analysis, including:
 - simple models of tree dynamics
 - complex models and finite element analyses
 - multimodal approaches representing dynamics of branches on trees
- calculations required for structural and biomechanical assessments of trees, including:
 - mass of branches
 - vector of force on trees
 - tree dynamic response
 - wind velocity and direction
 - statistical analysis and interpretation of test results
- dynamic effect of branch movement on tree stability and failure rate, including:
 - oscillation frequency
 - energy dissipation and damping effect of canopy structure
 - likelihood of structural failure
 - level of anchoring potential of root system
 - stability of tree
- records and reporting procedures for analysis of structural integrity testing.

Assessment Conditions

Assessment of the skills in this unit of competency must take place under the following conditions:

- physical conditions:
 - an arboriculture work site that has the trees stipulated in the performance evidence
- resources, equipment and materials:
 - computer with word processing software

- wind environment statistics
- static load test equipment
- models of tree dynamics
- specifications:
 - test equipment manuals, standard procedures and quality standards for performing load tests
 - sample reports for the diagnostic test methods listed in the performance criteria.

Assessors of this unit must satisfy the requirements for assessors in applicable vocational education and training legislation, frameworks and/or standards. In particular, assessors must have:

- arboriculture vocational competencies at least to the level being assessed
- current arboriculture industry skills directly relevant to the unit of competency being assessed.

Links

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