

Australian/New Zealand Standard™

Characterization of structural timber

Part 2: Determination of characteristic values



AS/NZS 4063.2:2010

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Australian/New Zealand Standard™

Characterization of structural timber

Part 2: Determination of characteristic values

Originated as AS/NZS 4063:1992.
Revised, in part, and redesignated as AS/NZS 4063.2:2010.
Reissued incorporating Amendment No. 1 (April 2011).

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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee TM-001, Timber Structures, to supersede (in part) AS/NZS 4063:1992, *Timber—Structural—products—Strength and stiffness evaluation*.

This Standard incorporates Amendment No. 1 (April 2011). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide requirements for the sampling, statistical evaluation of test data and the determination of design characteristic values for structural timber for structural design in accordance with the relevant Australian or New Zealand timber engineering design standard. The test data used for the statistical evaluation is to be derived from testing in accordance with the test methods specified in AS/NZS 4063.1.

AS/NZS 4063:1992 provided an introduction to the philosophy of in-grade testing and evaluation. This revision includes knowledge gained from 16 years of experience in application of the Standard, and covers a period of transition from working stress design (WSD) to limit states design (LSD). During that period, the shortcomings in some test methodologies and the use of normalization to derive limit states design values become apparent and created the need for the significant reform apparent in the AS/NZS 4063 series. The AS/NZS 4063 series, *Characterization of structural timber*, comprises the following parts:

AS/NZS

4063 Characterization of structural timber

4063.1 Part 1: Test methods

4063.2 Part 2: Determination of characteristic values (this Standard)

In this revision, normalization—a device used in the conversion from WSD to LSD format to replace the effect of load factors and the material capacity factor in limit states design with the safety factor used for working stress design—has been discontinued. Henceforth, design characteristic strength values, determined in accordance with this Standard, are to closely approximate the material strength at the 5th percentile level. This change also ensures that this Standard is entirely material related. Matters relating to design and any effect of revisions to design Standards do not impinge on this Standard.

Other significant changes include the following:

- (a) Increased emphasis on the significance of definition of the reference population and the need for sampling to be representative.
- (b) The inclusion of a variety of statistical methods and, in an informative appendix, a suite of worked examples illustrating the application of each method.
- (c) Clear enunciation of guidelines for the determination of design characteristic values based on the characteristic values obtained from the sample testing and evaluation.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	4
1.2 APPLICATION	4
1.3 NORMATIVE REFERENCES	4
1.4 DEFINITIONS	5
1.5 NOTATION	6
SECTION 2 REFERENCE POPULATION, SAMPLING AND SELECTION OF TEST PIECES	
2.1 GENERAL	7
2.2 REFERENCE POPULATION	7
2.3 SAMPLING	7
2.4 SELECTION OF TEST PIECES	8
SECTION 3 EVALUATION OF CHARACTERISTIC VALUES FROM SAMPLE TEST DATA	
3.1 GENERAL	9
3.2 CHARACTERISTIC VALUES	9
3.3 STATISTICAL EVALUATION METHODS	9
3.4 NON-STANDARD TEST CONDITIONS AND CONFIGURATIONS	10
SECTION 4 DETERMINATION OF DESIGN CHARACTERISTIC VALUES OR STRESS GRADE FOR STRUCTURAL TIMBER	
4.1 GENERAL	11
4.2 DETERMINATION OF DESIGN CHARACTERISTIC VALUES	11
4.3 ASSIGNMENT OF STRESS GRADE	13
SECTION 5 REPORT	14
APPENDICES	
A RANDOM SELECTION OF TEST PIECE LOCATION	15
B STATISTICAL METHODS FOR EVALUATION	17
C WORKED EXAMPLES—STATISTICAL EVALUATION	25
D POOLING TEST DATA	44

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Australian/New Zealand Standard
Characterization of structural timber

Part 2: Determination of characteristic values

SECTION 1 SCOPE AND GENERAL**1.1 SCOPE**

This Standard sets out procedures and requirements for the evaluation of characteristic values of structural properties from test data, the determination of design characteristic values and the assignment of stress grade properties for stress-graded timber.

In addition to the requirements for stress graded timber, requirements for the determination of design characteristic values for round timber, glue-laminated timber, structural plywood and structural laminated veneer lumber, are also given in Section 4.

1.2 APPLICATION

The design characteristic values or stress grade, determined for structural timber in accordance with this Standard, are intended to be used for structural design in accordance with AS 1720.1.

1.3 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

AS

- | | |
|---------|--|
| 1720 | Timber structures |
| 1720.1 | Part 1: Design methods |
| 2082 | Timber—Hardwood—Visually stress-graded for structural purposes |
| 2858 | Timber—Softwood—Visually stress-graded for structural purposes |
| 3519 | Timber—Machine proof grading |
| 3818 | Timber—Heavy structural products—Visually graded |
| 3818.11 | Part 11: Utility poles |

AS/NZS

- | | |
|--------|--|
| 1328 | Glued laminated structural timber |
| 1328.1 | Part 1: Performance requirements and minimum production requirements |
| 1748 | Timber—Mechanically stress-graded for structural purposes |
| 2269 | Plywood—Structural (all Parts) |
| 4063 | Characterization of structural timber |
| 4063.1 | Part 1: Test methods |
| 4357 | Structural laminated veneer lumber (LVL) (all Parts) |
| NZS | |
| 3603 | Timber Structures Standard |

ASTM

- D2915 Standard Practice for Evaluating Allowable Properties for Grades of Structural Lumber
- D5457 Standard Specification for Computing Reference Resistance of Wood-Based Materials and Structural Connections for Load and Resistance Factor Design

1.4 DEFINITIONS

For the purposes of this document, the definitions below apply.

1.4.1 Characteristic value

A percentile value of a statistical distribution estimated with a specified level of confidence.

NOTE: Characteristic values generally apply to either a sample mean or fifth (5th) percentile values which are estimated with 75% confidence. Details are given in Section 3.

1.4.2 Design characteristic values

Design characteristic values are characteristic values determined suitable for structural design in accordance with AS 1720.1 or NZS 3603.

1.4.3 Percentile value

A numerical value in the statistical distribution of a structural property for which there is p -percent probability of a lower value.

1.4.4 Random sampling

The selection of sample pieces from a population so that each sample piece has the same probability of being chosen.

1.4.5 Reference population

The population of stress-graded timber for which the design characteristic values are to be determined.

1.4.6 Sample

A collection of sample pieces selected as representative of a population.

1.4.7 Sample size

The number of sample pieces in a sample.

1.4.8 Sample piece

A full length piece of timber from the reference population as manufactured.

1.4.9 Standardized stress grade

A stress grade included in AS 1720.1 and NZS 3603.

1.4.10 Stress grade (noun)

A classification assigned to structural timber, which indicates a suite of design characteristic values for strength and stiffness properties.

1.4.11 Stress grading system

The part of a manufacturing process that results in the assignment of a stress grade designation to structural timber.

1.4.12 Stress graded timber

Timber that has been graded for the purpose of assigning a stress grade.

1.4.13 Test piece

A segment cut from a sample piece for the purpose of testing to measure a specific structural property.

1.5 NOTATION

1.5.1 General

E = modulus of elasticity parallel to direction of grain, expressed in megapascals (MPa)

f = strength, expressed in megapascals (MPa)

G = modulus of rigidity, expressed in megapascals (MPa)

k_s = sampling factor

$k_{\text{size,norm}}$ = reference size normalizing factor for pooling data

n = sample size

p = percentile expressed as a decimal value

V = coefficient of variation

x_i = data value

ρ = density, expressed in kilograms per cubic metre (kg/m^3)

ρ_{12} = density at 12% by mass moisture content, expressed in kilograms per cubic metre (kg/m^3)

1.5.2 Subscripts

0.05 = 5th percentile value

[25] = 25% confidence level

[75] = 75% confidence level

k = characteristic value

b = bending

mean = mean value

ref = value for a reference size

std = standard

t = tension

tail = property related to the tail of a statistical distribution

u = upper limit of a characteristic value

v = shear

y = value for specific value of y on graph

SECTION 2 REFERENCE POPULATION, SAMPLING AND SELECTION OF TEST PIECES

2.1 GENERAL

This Section sets out requirements for the definition of a reference population, sampling and the selection of test pieces from the sample pieces.

2.2 REFERENCE POPULATION

The reference population, for which the design characteristic values or stress grade applies, shall be defined by specification of the limits of all variables likely to influence or correlate with the structural properties. Such variables shall include, but not be limited to, the following:

- (a) Species and log parameters (age, position in tree, diameter, geographic region, etc.)
- (b) Manufacturing processes including sawing, drying, conditioning, treatment, etc.
- (c) Grading method, grading parameters and grade docking practices.
- (d) Section size/s and the lengths of timber resulting from manufacture.
- (e) Limits of the range for moisture content.

NOTE: In defining the limits on variables for the reference population it may be necessary to consider the applicability of the evaluation for future production. Where it is intended the evaluation will apply for future production it can be difficult to obtain a sample that encompasses the fluctuations, or changes in resources and processes, that need to be accommodated within the limits on variables defined for the reference population. In this circumstance, this potential source of bias in the sample needs to be recognized and allowed for in the determination of characteristic values intended to apply for future production (see Clause 4.2.2(a)).

2.3 SAMPLING

2.3.1 General

The objective of sampling shall be to obtain a sample that is representative of the reference population. The method of sample selection, the size of the sample, and the degree to which the production population from which the sample is drawn is representative of the reference population, are all factors in determining achievement of this objective.

2.3.2 Sample selection

Sample pieces shall be selected from the reference population using random sampling or any method that minimizes bias in selection. The technique of random sampling shall be implemented in such a way that the opportunity for unintentional bias (such as operator bias) is minimized. The method of selection of sample pieces shall be recorded.

The sample pieces shall be selected after completion of all manufacturing processes defined for the reference population, including grading and grade docking processes.

2.3.3 Sample size

The sample size for each size and type of test shall be selected in consideration of the following:

- (a) The uncertainty in estimate of the characteristic value included in both the parametric and non-parametric methods of analysis contained in this Standard and for the parametric methods, expressed as the sampling factor (k_s). The sampling factor reflects the uncertainty of estimate where the sample is unbiased.

- (b) The larger the sample size the more likely the sample will be representative (unbiased).

NOTE: The risk of unintentional bias in the sample is inversely related to the size of the sample and directly related to the variability of the population.

This Standard provides evaluation methods where the sample size is not less than 30 or, for a tail-fit analysis, not less than 100.

2.4 SELECTION OF TEST PIECES

The following selection process shall apply for each type of test:

- (a) One test piece (for any particular test method) shall be cut from a sample piece.
- (b) Test pieces shall be cut to the length (and dimensions, if appropriate) specified for the test method.
- (c) Test pieces shall be cut from the sample pieces so as to minimize bias in selection. A method of satisfying this requirement is to cut test pieces from random locations within the length of the sample pieces. Alternatively, test pieces may be selected to be cut at a predefined location, such as the centre or at randomly chosen ends of the sample pieces, provided it can be demonstrated this minimizes bias.

NOTES:

- 1 The requirements do not preclude selection of test pieces for more than one test method from a sample piece.
- 2 The requirement for random position selection of a test piece from a sample piece, not necessarily incorporating the grade defining portion of the sample piece, has the following implications:
 - (a) Where the sample is sufficiently large the characteristic strengths so obtained will reflect the probability of grade defining (low strength) segments coinciding with zones of high stress when used in a structure.
 - (b) Any departure from the grade docking practices defined for the reference population will affect this probability and may result in changed characteristic values; that is, the use of random position test piece selection may result in characteristic values that are associated strongly with the limits on resource and process defined for the reference population rather than with the parameters defining the grade.
- 3 Guidance on procedures for docking test pieces from sample pieces at random locations is given in Appendix A.

SECTION 3 EVALUATION OF CHARACTERISTIC VALUES FROM SAMPLE TEST DATA

3.1 GENERAL

This Section sets out procedures for the statistical evaluation of characteristic values from test data derived from testing performed in accordance with AS/NZS 4063.1.

The values obtained from these procedures provide a basis for assignment of design characteristic values or stress grades to structural timber as detailed in Section 4.

3.2 CHARACTERISTIC VALUES

Characteristic values for strength and stiffness properties evaluated from sample test data shall be defined as follows.

- (a) The characteristic values for the following properties shall be the 5th percentile values estimated with 75% confidence:
 - (i) Bending strength, tension strength, and compression strength parallel to grain.
 - (ii) Beam shear strength.
 - (iii) Shear at joint details.
 - (iv) Tension strength perpendicular to grain.
 - (v) Bearing strength parallel to grain.
- (b) The characteristic value for modulus of elasticity shall be the mean or adjusted mean value, estimated with 75% confidence, as given in Paragraph B3.3, Appendix B.
- (c) The characteristic values for the following properties shall be mean values estimated with 75% confidence:
 - (i) Density.
 - (ii) Bearing strength perpendicular to grain.
 - (iii) Modulus of rigidity (in torsion or beam shear).
 - (iv) Modulus of elasticity perpendicular to grain.

3.3 STATISTICAL EVALUATION METHODS

3.3.1 Evaluation of characteristic values

The characteristic values, as defined in Clause 3.2, shall be calculated using any of the statistical evaluation methods given in Appendix B.

NOTE: Appendix C provides worked examples of the procedures for applying the statistical evaluation methods given in Appendix B.

3.3.2 Calculation of coefficient of variation

The coefficient of variation of the reference population used for modification of characteristic values in Clause 4.2.3 shall be taken as not less 0.1 (10%) or less than the coefficient of variation of the total distribution of the test data determined in accordance with Paragraph B2.2 or B2.4, Appendix B. Where a tail analysis is used, the coefficient of variation for the total distribution of the test data may be taken as $2V_{R,tail}$ where $2V_{R,tail}$ is determined in accordance with Paragraph B2.3, Appendix B.

3.3.3 Evaluation based on pooled data

The strength data of a specified structural property for timber of the same stress grade but across a range of section sizes and possibly from several production sources, may be pooled to increase the effective sample size for evaluation of characteristic values for each size.

NOTES:

- 1 A method that may be used for pooling strength data is given in Appendix D.
- 2 The efficacy of pooling is highly dependent upon the extent of similarity between resource and production variables for the individual sources of production from which the sample is drawn. The inclusion of information related to a method of pooling in the Standard should not be interpreted to imply that characteristic values derived using this method will be accurate for each of the production sources contributing to the sample.

3.4 NON-STANDARD TEST CONDITIONS AND CONFIGURATIONS

Where test conditions (for example, temperature and moisture content or test configuration, such as test span) are not as specified in this Standard series, adjustment factors shall be developed and applied to adjust the values obtained to those that would be obtained under the standard test conditions or configurations.

SECTION 4 DETERMINATION OF DESIGN CHARACTERISTIC VALUES OR STRESS GRADE FOR STRUCTURAL TIMBER

4.1 GENERAL

This Section specifies requirements and considerations to be met for the determination of design characteristic values for structural timber from a defined reference population. The requirements to be met in assignment of a standardized stress grade are also specified.

The design characteristic values are determined by modification of the characteristic values evaluated from the sample test data as described in Clause 4.2.

The requirements are also applicable for other structural timber products where characteristic values have been evaluated from test data derived from testing and evaluation procedures consistent with those specified in this Standard series.

NOTES:

- 1 The design characteristic values become, in effect, the minimum characteristic values for future production of the particular grade of timber (as defined for the reference population).
- 2 The design characteristic values or stress grade declared for a product, whether indicated by marking or otherwise, are a claim that the product is suitable for structural use when designed using the specified characteristic values.

4.2 DETERMINATION OF DESIGN CHARACTERISTIC VALUES

4.2.1 General

The design characteristic values for structural timber from a defined reference population (see Clause 2.2), shall be based on the characteristic values evaluated from the sample test data modified to take account of the factors specified in Clauses 4.2.2 and 4.2.3. The product of the modification factors shall be not greater than 1.0. That is, the characteristic values determined from evaluation of the sample data are the maximum (highest) values that may be determined as design characteristic values.

NOTE: The modification factors that relate to resource and process are not quantified. The determination of the numerical value for these factors is dependant upon the individual circumstance and risk assessment of manufacture.

4.2.2 Modification factor to provide a margin to allow for variations in manufacture and resource

The following shall be considered for the determination of an appropriate modification factor:

- (a) *Allowance for the representativeness of the sampled population* A margin shall be allowed according to an assessment of the possible effects of the differences that may exist between the sampled population (upon which the evaluated characteristic values are based) and the reference population (see Clause 2.2) for which the design characteristic values are to apply.

In particular, consideration shall be given to the possible effects of fluctuations or changes in resource or manufacturing process that may occur over time, which were not represented in the population during the sampling period.

NOTES:

- 1 The population from which the sample was taken may only be a sub-population of the reference population and, therefore, may not be fully representative of the reference population.

- 2 The differences between the sampled population and the reference population can be assessed by comparing the variables and their limits as defined for the reference population (see Clause 2.2), with those applicable for the sampled population.
- 3 Changes in process (as noted under Clause 2.2), in particular changes in grade docking or grade re-assignment practices, may have a significant effect on the achievement of design characteristic values.

- (b) *Allowance for levels of control of process and quality* A margin appropriate to the anticipated level of control of process and quality in manufacture and the rigour and extent of verification procedures shall be allowed for in the determination of design characteristic values.

NOTE: The more closely the design characteristic values correspond to those evaluated from the sample test data, the greater the rigor that needs to be attached to control of process and quality and procedures for demonstration of compliance.

4.2.3 Modification factor for variability

The following shall apply:

- (a) Where the coefficient of variation (V_R), calculated in accordance with Clause 3.3.2, for a particular strength property, is within the range specified for the material type given in Table 4.1, no modification is required ($a_v = 1.0$).
- (b) Where the coefficient of variation (V_R), calculated in accordance with Clause 3.3.2, for a particular strength property, is outside the range specified for the material type given in Table 4.1, the modification factor for adjustment of characteristic value for the strength property shall be determined as follows:

- (i) Where the coefficient of variation (V_R) is greater than the uppermost value of the range (V_{upper}) given for the material in Table 4.1, the modification factor (a_v) is given by—

$$a_v = 1 - (V_R - V_{upper}) \quad \dots 4.2(1)$$

- (ii) Where the coefficient of variation, (V_R) is less than the lowest value of the range (V_{lower}) given for the material in Table 4.1, the modification factor (a_v) may be taken 1.0 or as given by—

$$a_v = 1 - (V_R - V_{lower}) \quad \dots 4.2(2)$$

where

a_v = modification factor, which adjusts for variability of strength properties

V_R = coefficient of variation of strength property for reference population, determined in accordance with Clause 3.3.2

V_{upper} = uppermost value of coefficient of variation for the material from Table 4.1

V_{lower} = lowest value of coefficient of variation for the material from Table 4.1

NOTES:

- 1 The adjustment of characteristic values according to coefficient of variation is to maintain the safety and reliability basis used for derivation of design strength in AS 1720.1.
- 2 The coefficient of variation used for the reliability analysis for AS 1720.1 is that of the reference population.

TABLE 4.1
RANGE OF COEFFICIENTS OF VARIATION FOR STRENGTH PROPERTIES
FOR STRUCTURAL TIMBER

Type of structural timber	Range in coefficient of variation	
	V_{lower}	V_{upper}
(a) Sawn timber—AS 2082, AS 2858, AS/NZS 1748, AS 3519: —Stress grades: MGP15, A17, F17 and higher F-grades —All other sawn timber stress grades	0.20 0.35	0.30 0.45
(b) Round timber—AS 3818.11	0.35	0.45
(c) Glue-laminated timber—AS/NZS 1328.1	0.20	0.30
(d) Structural plywood—AS/NZS 2269 series	0.15	0.25
(e) Structural laminated veneer lumber—AS/NZS 4357 series	0.10*	0.15

* A coefficient of variation for a reference population less than 0.1 is not allowed for (refer Clause 3.3.2).

4.3 ASSIGNMENT OF STRESS GRADE

A standardized stress grade may be assigned where the characteristic values, determined in accordance with Clause 4.2, are equal or exceed the design characteristic values for the structural properties given for the stress grade in AS 1720.1 and NZS 3603.

NOTE: Those properties for which a test method is not specified in AS/NZS 4063.1 may be specified on the basis of the strength group of the species.

SECTION 5 REPORT

The following shall be reported:

- (a) Test report reference.
- (b) Reference population—defined limits on variables (see Clause 2.2)
- (c) Sampling period.
- (d) Procedure for sample selection.
- (e) Procedure for selection of test pieces from sample pieces.
- (f) Statistical evaluation procedure and analysis.
- (g) Characteristic values evaluated from sample test data.
- (h) The basis for any adjustments to characteristic values made to accommodate non-standard test conditions and/or configurations.
- (i) Report modification factors adopted for determination of design characteristic values from the evaluated characteristic values.
- (j) The design characteristic values.

NOTE: Reporting may involve a series of inter-linked reports by different parties.