

Australian/New Zealand Standard™

Structural laminated veneer lumber

Part 0: Specifications



AS/NZS 4357.0:2005

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee TM-008, Plywood Timber Products. It was approved on behalf of the Council of Standards Australia on 26 April 2005 and on behalf of the Council of Standards New Zealand on 6 May 2005. This Standard was published on 8 August 2005.

The following are represented on Committee TM-008:

Australian Building Codes Board
CSIRO Forestry and Forest Products
Engineers Australia
Forests NSW
Housing Industry Association
New Zealand Forest Research Institute
New Zealand Plywood Manufacturers Association
Plywood Association of Australasia
Timber Development Association (NSW)

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Mr Kevin Lyngcoln

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

RECONFIRMATION
OF
AS/NZS 4357.0:2005
Structural laminated veneer lumber
Part 0: Specifications

RECONFIRMATION NOTICE

Technical Committee TM-011 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been amended since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 27 April 2016.

Approved for reconfirmation in New Zealand on behalf of the Standards Council of New Zealand on 18 May 2016.

The following are represented on Technical Committee TM-011:

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Wood Processors & Manufacturers Association of New Zealand

NOTES

Australian/New Zealand Standard™

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First published as AS/NZS 4357:1995.
Revised and redesignated as AS/NZS 4357.0:2005.

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Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TM-008, Plywood Timber Products, to supersede AS/NZS 4357:1995, *Structural Laminated Veneer Lumber*.

The objective of this Standard is to specify requirements for the manufacture, structural characterization, and structural verification of laminated veneer lumber (LVL) intended for structural applications.

The objective of this revision is to reflect the advances in the industry and developments in manufacturing and utilization technologies.

This revision includes requirements for the testing and labelling of structural LVL for formaldehyde emission. Three formaldehyde emission classes, E_0 , E_1 and E_2 have been specified.

LVL is an internationally used generic descriptor for an assembly of veneers laminated with adhesive, in which the grain direction of the outer veneers and most other veneers is in the longitudinal direction.

LVL is used for a wide variety of purposes, including structural and non-structural applications as follows:

- (a) Structural applications include continuous length LVL as beams and columns for houses, wide span buildings and bridges; formwork; truss chords; I-beam flanges; short length LVL jointed together with nail plates to form beams; scaffold planks and structural decking or soffits, usually incorporating two or more cross-band veneers for stability.
- (b) Non-structural applications include joinery, furniture and fitments where appearance or machining qualities, or both, are important but structural reliability and bond durability are relatively less important. LVL for these applications is sometimes curve-formed or covered with decorative overlays, or encased in other materials.

This Standard has been prepared to cover the manufacture and characterization of LVL intended for structural use only, and called structural LVL. It does not attempt to describe requirements for LVL intended for non-structural uses.

Appearance requirements for structural LVL are not specified. Only phenolic, Type A bonds are included on the basis that, currently, only that bond type has known long-term durability, suitable for structural applications.

This Standard is only concerned with the LVL component of assemblies such as trusses, nail plate jointed beams and I-beams, but not the assemblies themselves.

This Standard, written in performance terms, seeks to ensure reliability and predictability of performance in all aspects, by requiring the following:

- (i) Manufacture of structural LVL to a specification that identifies and sets limits upon all controlling process variables.
- (ii) Testing and evaluation of in-grade manufactured structural LVL in order to derive reliable engineering design properties.
- (iii) Continuous monitoring of the mechanical properties of structural LVL as it is produced, in order to verify and validate continued use of stated design properties.

This Standard is revised to form Part 0 of the AS/NZS 4357 series, *Structural laminated veneer lumber*, which comprises the following parts:

AS/NZS

4357 Structural laminated veneer lumber

4357.0 Part 0: Specifications (this Standard)

4357.1 Part 1: Method of test for measurement of dimensions and shape (to supersede AS/NZS 2098.10:1995, *Methods of test for veneer and plywood*, Method 10: *Measurement of dimensions and shape for structural Laminated Veneer Lumber*)

4357.4 Part 4: Determination of formaldehyde emission

This Committee is currently developing companion Standards in relation to testing and evaluation of structural LVL, as follows:

Part 2: Determination of structural properties—Test methods

Part 3: Determination of Structural Properties—Evaluation methods

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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Australian/New Zealand Standard
Structural laminated veneer lumber

Part 0: Specifications

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies manufacturing, in-grade structural characterization and structural verification requirements for structural laminated veneer lumber (LVL) as a continuously glued assembly of veneers and for which structural design is performed in accordance with [AS 1720.1](#) or [NZS 3603](#).

Design information specific to structural LVL is included in [AS 1720.1](#).

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|--------|--|
| 1199 | Sampling procedures and tables for inspection by attributes |
| 1199.0 | Part 0: Introduction to the ISO 2859 attribute sampling system |
| 1199.1 | Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection |
| 1604 | Specification for preservative treatment |
| 1604.1 | Part 1: Sawn and round timber |
| 1649 | Timber—Methods of test for mechanical fasteners and connectors—Basic working loads and characteristic strength |
| 1720 | Timber structures |
| 1720.1 | Part 1: Design methods |
| 2754 | Adhesives for timber and timber products |
| 2754.1 | Part 1: Adhesives for plywood manufacture |

AS/NZS

- | | |
|--------|---|
| 1604 | Specification for preservative treatment |
| 1604.4 | Part 4: Laminated veneer lumber (LVL) |
| 2098 | Methods of test for veneer and plywood |
| 2098.1 | Method 1: Moisture content of veneer and plywood |
| 2098.2 | Method 2: Bond quality of plywood (chisel test) |
| 2269 | Plywood—Structural |
| 4063 | Timber—Stress-graded—In-grade strength and stiffness evaluation |
| 4357 | Structural laminated veneer lumber |
| 4357.1 | Part 1: Method of test for measurement of dimensions and shape |
| 4357.4 | Part 4: Determination of formaldehyde emission |
| 4491 | Timber—Glossary of terms in timber-related Standards |

- AS/NZS
- HB 18 Guidelines for third-party certification and accreditation
- HB 18.28 Guide 28—General rules for a model third-party certification scheme for products

- NZS
- 3603 Timber structures Standard—Code of practice for timber design

1.3 DEFINITION

For the purpose of this Standard, the definitions given in AS/NZS 4491 and those below apply.

1.3.1 Face, edge, and end surfaces, length, width and thickness

Face, edge, and end surfaces, length, width and thickness are as shown in Figure 1.

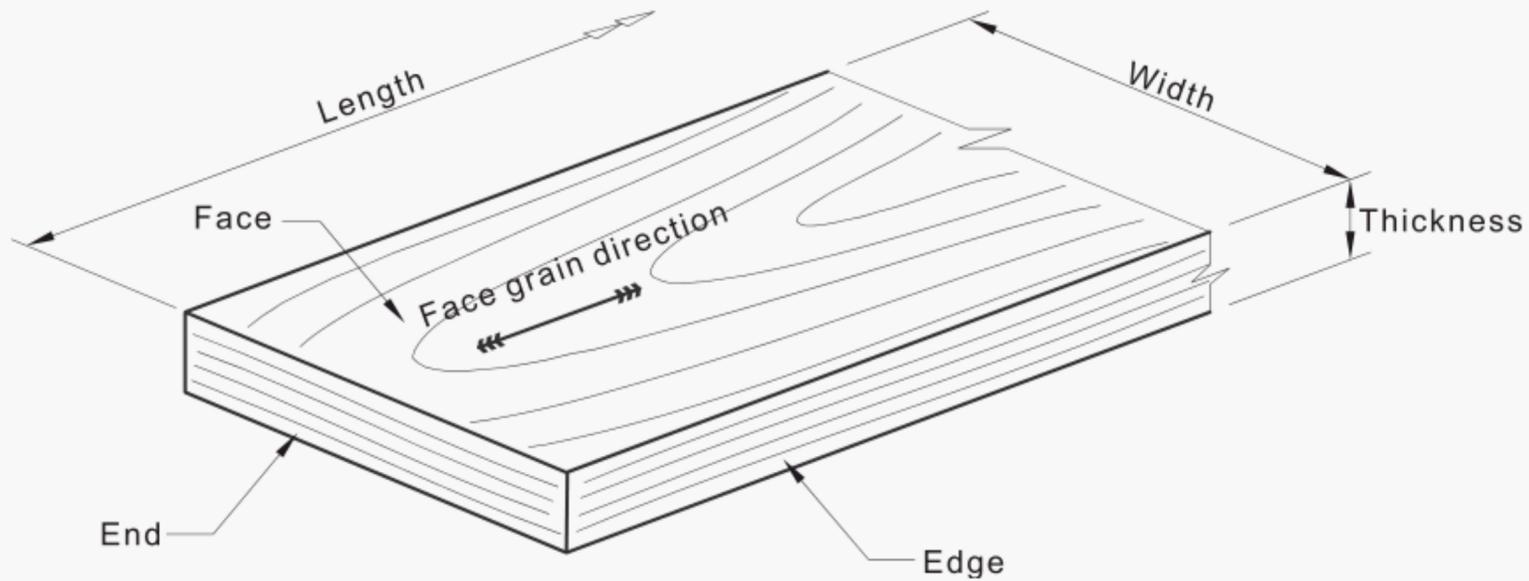


FIGURE 1 FACE, EDGE, AND END SURFACES, AND LENGTH, WIDTH AND THICKNESS OF LVL

1.3.2 Laminated Veneer Lumber (LVL)

An assembly of veneers laminated with adhesive, in which the grain direction of the outer veneers, and of most of the other veneers, is in the longitudinal direction.

1.3.3 Structural LVL

LVL manufactured in conformance with the requirements of this Standard and intended for structural application.

1.4 DIMENSIONS AND SHAPE

1.4.1 Dimensions

Unless stated otherwise by the manufacturer, the dimensions of structural LVL, measured in accordance with AS/NZS 4357.1, shall not differ from the manufacturer’s nominal dimensions by more than the following tolerances:

- (a) *Thickness* +4, –0 mm.
- (b) *Width, up to 400 mm* +2, –0 mm.

- (c) *Width, over 400 mm* +5, –0 mm.
 (d) *Length* –0 mm.

NOTES:

- 1 Actual dimensions are likely to exceed the minimum or called dimensions and this should be considered when detailing.
- 2 When LVL is ordered for recutting to length, it is good practice to include a cutting allowance in the supply length.
- 3 When length is critical, it may also be necessary to specify a positive tolerance.

1.4.2 Straightness

The straightness of the LVL piece shall be as follows:

- (a) *Spring* The spring of the LVL piece measured in accordance with [AS/NZS 4357.1](#) shall not exceed 1 mm in 1000 mm.
- (b) *Bow* The bow of an LVL piece measured in accordance with [AS/NZS 4357.1](#) shall not exceed 1 mm in 1000 mm.

NOTE: The measurement of bow in [AS/NZS 4357.1](#) involves application of a load.

1.4.3 Twist

The twist of an LVL piece measured in accordance with [AS/NZS 4357.1](#) shall not exceed the value calculated by the following equation:

$$\text{Twist} = \frac{\text{Length (mm)} \times \text{Width (mm)}}{3500 \times \text{Thickness (mm)}}$$

1.4.4 Squareness of section

When measured in accordance with [AS/NZS 4357.1](#), the sides of a nominally rectangular cross-section of LVL shall not deviate from square by more than 1 mm in 100 mm.

1.4.5 Cupping

No limit for cupping is specified in this Standard.

NOTE: Cupping is usually a result of a moisture gradient across the thickness and is more pronounced for thin, wide pieces. It is generally caused by exposure to changes in ambient conditions and, therefore, is usually not a manufacturing fault.

1.5 MOISTURE CONTENT

At the time of dispatch the moisture content of LVL, when determined in accordance with [AS/NZS 2098.1](#), shall be not less than 8%, nor more than 15%.

In the event of dispute, the moisture content shall be determined by the oven-drying method described in [AS/NZS 2098.1](#).

1.6 IMMUNIZATION, PRESERVATIVE AND CHEMICAL TREATMENTS

1.6.1 Immunization of lyctid-susceptible sapwood

Lyctid-susceptible sapwood veneer shall be immunized in accordance with [AS/NZS 1604.4](#).

NOTES:

- 1 The method for detection of lyctid-susceptible sapwood is given in [AS 1604.1](#).
- 2 Guidelines for the immunization of lyctid-susceptible sapwood for structural LVL are given in [AS/NZS 1604.4](#) and further information is available from state forestry departments, CSIRO Forestry and Forest Products, and Forest Research.
- 3 Attention is drawn to the provisions of the Queensland Timber Utilization and Marketing Act, 1987 and the New South Wales Timber Marketing Act, 1977, regarding the sale and use in those states of timber (including LVL) containing lyctid-susceptible sapwood.

1.6.2 Preservative treatment

Structural LVL exposed to insect or fungal attack shall be preservative treated in accordance with AS/NZS 1604.4.

NOTES:

- 1 In Queensland the Timber Utilization and Marketing Act, 1987, and in New South Wales the Timber Marketing Act, 1977, require prior approval of a treatment and registration of a brand before timber (including LVL) offered for sale in either of these states, can be described as preservative-treated. Detailed information about the requirements of such legislation may be obtained from the state forestry departments concerned.
- 2 Treatment processes involving harsh wetting and drying regimes may cause internal checking and consequent loss of structural integrity.
- 3 Some chemical treatments are known to adversely affect structural properties of Structural LVL.
- 4 Under conditions of long-term full-weather exposure, the exposed surface of the structural laminated veneer lumber should be adequately protected.

1.6.3 Chemical treatment

Where LVL is required to be chemically treated, then the possible effect of the chemicals or the treatment process upon the structural properties should be considered. Strength effects of the chemical treatment process and any subsequent drying shall be evaluated.

1.7 PUBLICATION OF CHARACTERISTIC PROPERTIES OR DATA

Data shall be provided in either or both of the following forms:

- (a) For the purpose of engineering design in accordance with [AS 1720.1](#) or [NZS 3603](#)—
 - (i) either the characteristic properties for the LVL appropriate to the intended end use shall be published; or
 - (ii) an F-grade classification shall be adopted in accordance with Clause 3.4, where each piece is identified as F-grade in accordance with Clause 1.8.
- (b) When design data are published in the form of application or load span tables, software output, or charts, the use of the LVL shall be restricted to those applications and the limiting conditions implied or specified by such data.

1.8 BRANDING

Each piece of structural LVL shall have the following information legibly affixed thereon, at least once, by the manufacturer at the point of manufacture:

- (a) Reference to this Standard, i.e., [AS/NZS 4357.0](#).
- (b) The manufacturer's name or registered mark.
- (c) The registered brand or marking that, in conjunction with published literature, clearly identifies the structural properties that apply to that product, or where a F-grade classification has been adopted, a F-grade brand shall be used.
- (d) Clearly stated limitations of end use, if relevant, as defined in Clauses 1.7 and 3.2.
- (e) If immunized or preservative-treated, branding in accordance with [AS/NZS 1604.4](#).
- (f) The bond type of the glue-line, i.e., A-BOND.
- (g) Formaldehyde emission class.

NOTE: Manufacturers making a statement of compliance with this Australian/New Zealand Standard on a product, packaging, or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

S E C T I O N 2 M A N U F A C T U R E

2.1 GENERAL

Structural LVL shall be manufactured in conformance with a manufacturing specification that defines and limits all variables likely to affect or correlate with structural performance of that specific LVL product.

2.2 MANUFACTURING SPECIFICATION

The manufacturing specification shall set the limits on all variables that affect or correlate with final product properties. Variables that influence the properties of LVL include—

- (a) species;
- (b) log diameter, log quality indices and geographical source,
- (c) veneer density or veneer characteristics (e.g., notional E);
- (d) veneer quality;
- (e) veneer joints (type and frequency);
- (f) veneer thickness;
- (g) veneer arrangement;
- (h) bond quality;
- (i) manufacturing process; and
- (j) secondary processes and treatment.

NOTE: The above list is not intended to be exhaustive.

2.3 VENEER

2.3.1 General

Structural LVL may be manufactured from veneer of any species, quality, density or characteristics, provided the manufacturing specification includes definition of the species, quality, density, and characteristics.

Where mixtures of species are used or where there are likely to be significant fluctuations in the characteristics or density of veneer, *any one* of the following shall apply:

- (a) Veneer shall be mixed in order to effectively randomize its inclusion throughout the assembly.
- (b) Veneer shall be separated according to its species, quality, density or characteristics, and assembled into the matrix in some specified pattern.
- (c) If neither procedure is used, then the minimum strength species, and veneer of the lowest quality, density or characteristics shall be used to manufacture material from which a sample is drawn for testing and evaluation of the structural properties.

2.3.2 Veneer quality

The minimum veneer quality shall be specified either as a standard veneer quality as defined in [AS/NZS 2269](#) or a non-standard veneer quality provided that the manufacturing specification includes the definition of the non-standard minimum veneer quality covering all characteristics defined in [AS/NZS 2269](#).

Veneer shall be free from decay and active insect attack.

2.3.3 Veneer thickness

Veneer of any thickness may be used. The thickness used shall be included in the specification. Where more than one thickness is used in a construction, then the location of each thickness in the assembly, shall be specified.

2.3.4 Veneer length

Veneer of any length may be used. However, the minimum and average lengths shall be specified.

2.4 ASSEMBLY

2.4.1 General

The assembly of structural LVL shall be defined in the manufacturing specification.

2.4.2 Construction

The construction of structural LVL containing cross-band veneers shall be balanced in regard to all properties affecting product stability.

Assemblies may contain layers other than wood veneer, such as plastics or metals, provided incorporation of such layers is taken into account in determination of structural properties and is compatible with the bond quality and durability requirements for the targeted application.

Sheets of veneer shall be free from any ferrous material such as clips and staples.

2.4.3 Veneer joints

The veneer joints shall be as follows:

- (a) The location, type and minimum spacing of veneer end joints shall be specified.
- (b) For lap joints, the minimum and maximum overlap shall be specified.
- (c) For scarf joints, the slope of scarf and alignment tolerances shall be specified.
- (d) For butt joints, the maximum gap, and limit on overlap (if any), shall be specified.
- (e) Bonding of scarf or lap end joints shall be achieved by an adhesive complying with type A bond requirements of [AS 2754.1](#).
- (f) Bond requirements for joints shall be the same as for the bonding between plies.

NOTES:

- 1 It is recommended that at least the two outer veneers be made continuous by jointing.
- 2 Cross-banded veneers should preferably only be introduced between continuous long-band veneers and be continuous across the full width of the LVL.
- 3 The process should be capable of successfully manufacturing the prescribed joint. This is particularly significant in overlapped (crushed) joints or in butt joints where overlap is permitted, which require extremely high specific pressures.

2.5 BONDING BETWEEN PLYS

The bonding between plies shall be a Type A bond and shall comply with the following requirements:

- (a) The adhesive used in the manufacture of structural LVL shall be of a phenolic type complying with [AS 2754.1](#).
- (b) The bond between the plies shall be continuous over the whole area other than where permitted imperfections occur.
- (c) When tested in accordance with [AS/NZS 2098.2](#) for Type A bond, the gluelines in a single test piece prepared from each sample shall have a bond quality in any single

glueline of not less than 2 and an average of not less than 5 when assessed in accordance with [AS/NZS 2098.2](#). If the initial test piece fails these requirements, a second test piece shall be taken from the same sample and tested in accordance with [AS/NZS 2098.2](#). The average bond quality for the initial and second test piece shall have a minimum in any single glueline of not less than 2 and an average of all gluelines not less than 5 when assessed in accordance with [AS/NZS 2098.2](#).

2.6 MANUFACTURING PROCESS

The type of manufacturing process and limits of the important aspects of the manufacturing process shall be specified.

NOTE: The type of process, e.g., continuous or stop-go, can affect the end-product properties.

2.7 FORMALDEHYDE

2.7.1 Test method

Testing of structural LVL for formaldehyde emission shall be carried out in accordance with [AS/NZS 4357.4](#).

2.7.2 Formaldehyde emission classes

The formaldehyde emission classes are specified in Table 1.

TABLE 1
FORMALDEHYDE EMISSION CLASSES

Emission class	Maximum formaldehyde emission
<i>E₀</i>	0.5 mg/L
<i>E₁</i>	1.0 mg/L
<i>E₂</i>	2.0 mg/L

2.8 STORAGE AND HANDLING

NOTE: Recommended practices for the storage and handling of structural LVL are described in Appendix A.

SECTION 3 STRUCTURAL PROPERTIES

3.1 GENERAL

This Section requires that LVL, manufactured in accordance with the manufacturing specification required in Section 2, shall have structural properties appropriate for its intended application, determined by testing and evaluation methods specified in this Section.

Structural properties of LVL shall be used in accordance with [AS 1720.1](#) and [NZS 3603](#).

3.2 PROPERTIES REQUIRED TO BE DETERMINED

For each LVL product, the structural properties shall be determined appropriate for the intended application. Table 2 defines properties to be determined for some specific applications.

TABLE 2
PROPERTIES TO BE DETERMINED DEPENDING UPON END USE

Intended application	Strength and stiffness								Joint strength					
	Bending, shear and bearing							Axial		Nails	Bolts	Self-drilling screws, e.g., Type 17	Nail plates	
	On flat				On edge				f'_t					f'_c
	E	f'_b	f'_s	f'_p	E	f'_b	f'_s	f'_p						
General beams used on edge only					✓	✓	✓	✓			✓	✓	✓	
Scaffold planks or other applications involving flat-wise bending only	✓	✓	✓	✓										
General structural use	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Nailplate jointed trusses (see Note 3)					✓	✓	✓	✓	✓	✓	✓	✓		✓

NOTES:

- 1 See AS 1720.1 for symbols/notations of E , f'_b , f'_s , f'_p , f'_t , and f'_c .
- 2 ✓ indicates property to be determined.
- 3 Assumes on-edge orientation. Where used on flat, corresponding on-flat properties will be required.

3.3 METHODS FOR DETERMINATION OF STRUCTURAL PROPERTIES**3.3.1 Strength and stiffness**

The strength and stiffness of a particular LVL required to be determined in accordance with Clause 3.2 shall be evaluated using the methods specified in [AS/NZS 4063](#).

NOTE: It should be recognized that structural properties evaluated for a particular cross-section size or sizes may not apply for markedly larger or smaller sizes.

Evaluations performed for LVL with 10 or more longitudinal veneers shall apply to other constructions with 10 or more longitudinal veneers. For each construction with fewer than 10 longitudinal veneers, sufficient additional testing shall be conducted to validate the structural performance.

3.3.2 Joint strength

Joint strength properties for a particular LVL product required to be determined in accordance with Clause 3.2 shall be evaluated using methods consistent with those used to derive joint strength properties for timber as included in [AS 1720.1](#) or [NZS 3603](#). Methods given in [AS 1649](#) meet this requirement.

In addition, the following shall be required:

- (a) *For nails or screws* The characteristic lateral and withdrawal loads shall be determined for nails or screws driven into the face and the edge of LVL, and loaded both parallel and perpendicular to the grain.
- (b) *For bolts* The characteristic bolt loads shall be determined for bolts inserted through both the face and the edge of the LVL.
- (c) *Nailplates* The characteristic tooth loads for nail plates shall be evaluated for plates fixed to both the face and/or the edge as appropriate to end use, with teeth orientated parallel and perpendicular to the grain, and loads applied both parallel and perpendicular to the grain. Tooth loads so evaluated shall only apply for the type of nailplate tested.
- (d) *Other connectors* For each connector type the characteristic strength shall be determined for connectors located in the face and/or edge as appropriate, and for load directions both parallel and perpendicular to the grain direction.

Joint strength properties for LVL containing cross-bands shall not be assumed to apply to LVL without cross-bands.

3.4 ADOPTION OF F-GRADE

Adoption of an F-grade and hence F-grade properties, as given for structural timber in [AS 1720.1](#) or [NZS 3603](#), shall be permitted, provided that none of the principal properties, the modulus of elasticity, and the characteristic strength properties in bending, tension and compression are less than the corresponding property given in [AS 1720.1](#) or [NZS 3603](#), for the adopted F-grade.

3.5 ADOPTION OF JOINT GROUP FOR NAILS, SCREWS AND BOLTS

A joint group, as given in [AS 1720.1](#) or [NZS 3603](#), shall be permitted on the basis of testing a single nail size and a single bolt size of the types and sizes included in [AS 1720.1](#) or [NZS 3603](#). The joint group adopted shall be such that the characteristic load determined in accordance with [AS 1649](#) for the nail in withdrawal or under lateral load, or for the laterally loaded bolt, for any orientation of the nail or bolt and for any load direction, shall be not lower than the corresponding value given for the joint group in [AS 1720.1](#) or [NZS 3603](#).

If a joint group is to be assigned for a fastener type and/or orientation of fastener, testing shall include consideration of the smallest fastener diameter.

NOTES:

- 1 The joint group for nails, screws and bolts determined in this Clause should not be used for other fastener types.
- 2 The joint group for a particular LVL construction may differ for different types of fasteners, e.g., JD3 for bolts and JD4 for nails.

3.6 STRUCTURAL DESIGN

3.6.1 General

The information given in Clauses 3.6.2, 3.6.3, and 3.6.4, shall be used for the purposes of structural design performed in accordance with [AS 1720.1](#) or [NZS 3603](#).

3.6.2 Section properties

3.6.2.1 *Non-cross-banded LVL*

Section properties for non-cross-banded LVL shall be calculated using full cross-sectional properties in accordance with [AS 1720.1](#) or [NZS 3603](#).

3.6.2.2 *Cross-banded LVL*

In assessing bending, tension and compressive strength and flexural rigidity of cross-banded LVL in the longitudinal direction, any cross-banded veneers shall not contribute to area, first moment of area and second moment of area.

In determining section properties, the thickness of an individual ply may be assumed to be in proportion to its nominal thickness, as the finished minimum LVL thickness is to the total of the nominal veneer thickness.

For a particular construction, where the cross-bands are the only variation to the manufacturing specifications, and there are at least 10 longitudinal veneers, then the same structural properties may be assumed to apply to that particular construction, but using the modified section properties which ignore the cross-bands.

3.6.3 Longitudinal sawing or machining to reduce thickness

Structural LVL shall not have its thickness reduced by longitudinal sawing or machining unless a structural evaluation has been performed to assess the structural effect.

NOTE: Sawing or machining to reduce thickness resulting in the removal of continuous outer veneers and a reduction in the number of parallel veneers may result in reduced strength properties.

3.6.4 Taper or curve cut LVL

Design properties derived for LVL with edges cut nominally parallel to the grain shall not be assumed to apply for taper or curve cut members.

SECTION 4 STRUCTURAL VERIFICATION

4.1 GENERAL

The system of verification of the structural properties dealt with in this Section requires that the initial evaluation of structural LVL, produced to the manufacturing specifications, has been performed in accordance with Section 3.

4.2 CONTINUOUS VALIDATION OF STRUCTURAL PROPERTIES

As a minimum, the F-grade or characteristic strength and stiffness properties assigned to structural LVL by the methods specified in Section 3 shall be continuously validated by ongoing testing from production of one stiffness and one strength property, usually bending modulus (E) and bending strength (R). The frequency of measurement of these structural properties shall be such as to validate that the LVL currently being produced continuously meets the stated properties derived from the testing and evaluation program.

NOTES:

- 1 Structural properties determined in accordance with Section 3 only remain valid while the controlling process variables remain within the limits defined in the manufacturing specification. It is strongly recommended therefore that manufacture be carried out under a third party audited, process based, quality control program (see Appendix B).
- 2 The method detailed in Appendix C is deemed to satisfy the requirements of this Clause. The method is based on AS/NZS 4063.

4.3 RE-EVALUATION OF STRUCTURAL PROPERTIES

In the following situations, the structural properties of LVL shall be re-evaluated:

- (a) Whenever the continuous validation of structural properties indicates a significant change in properties or a failure to comply with claimed or published structural properties, then either the process variable causing the change shall be identified and corrected, or revised design properties shall be determined by performing a major re-evaluation of all required design properties as detailed in Section 3.
- (b) Whenever a significant change in resource or process variables is initiated, then a major re-evaluation of all required design properties shall be performed for LVL manufactured to the revised manufacturing specification as detailed in Section 3.

APPENDIX A
STORAGE AND HANDLING OF STRUCTURAL LVL
(Informative)

Structural LVL requires care in storage and handling. The following suggestions will assist in ensuring satisfactory structural performance and ease of installation:

- (a) LVL should be kept dry during storage and transit.
- (b) LVL should be stacked on bearers well clear of the ground and arranged so that their supporting surfaces are in essentially the one plane.
- (c) Bearers should be spaced sufficiently close so that LVL spanning between them does not deflect excessively under its own weight. Recommended maximum spacing of supports for LVL stored on its flat over a minimum of three supports for different thicknesses are listed in Table A1.
- (d) Bearers or spacers within a stack should be located in near direct vertical alignment.
- (e) Care should be taken in lifting and handling LVL in order to avoid mechanical damage.
- (f) Wrapping should avoid entrapment of moisture.

TABLE A1
RECOMMENDED MAXIMUM SPACING OF SUPPORTS

Thickness of LVL (mm)	35	45	63	75	90
Maximum spacing of supports (m)	3.5	4.0	4.5	5.0	6.0

APPENDIX B

MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD

(Informative)

B1 SCOPE

This Appendix sets out the following different means by which compliance with this Standard can be demonstrated by the manufacturer or supplier:

- (a) Evaluation by means of statistical sampling.
- (b) The use of a product certification scheme.

B2 STATISTICAL SAMPLING

Statistical sampling is a procedure that enables decisions to be made about the quality of batches of items after inspecting or testing only a portion of those items. This procedure will only be valid if the sampling plan has been determined on a statistical basis and the following requirements are met:

- (a) The sample needs to be drawn randomly from a population of product of known history. The history needs to enable verification that the product was made from known materials at essentially the same time, by essentially the same processes and under essentially the same system of control.
- (b) For each different situation, a suitable sampling plan needs to be defined. A sampling plan for one manufacturer of given capability and product throughput may not be relevant to another manufacturer producing the same items.

In order for statistical sampling to be meaningful to the customer, the manufacturer or supplier needs to demonstrate how the above conditions have been satisfied. Sampling and the establishment of a sampling plan should be carried out in accordance with [AS 1199.1](#), guidance to which is given in [AS 1199.0](#).

B3 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the manufacturer that products comply with the stated Standard.

The certification scheme should meet the criteria described in [HB 18.28 \(SANZ HB18.28\)](#) in that, as well as full type testing from independently sampled production and subsequent verification of conformance, it requires the manufacturer to maintain effective quality planning to control production.

The certification scheme serves to indicate that the products consistently conform to the requirements of the Standard.

APPENDIX C

PROCEDURES FOR CONTINUOUS VERIFICATION OF STRUCTURAL
PROPERTIES FOR LVL BASED ON TESTING OF BENDING STIFFNESS
AND STRENGTH

(Informative)

C1 SCOPE

This Appendix provides the following procedures for the sampling and testing program conducted on LVL samples to be tested for bending strength and stiffness:

- (a) Sampling selection.
- (b) Testing.
- (c) Verification of end product bending strength and stiffness.
- (d) Corrective action procedures in case test results fail verification criteria.

C2 SAMPLE SELECTION**C2.1 Frequency**

Samples should be selected from a random billet at approximate two-hourly frequency with approximately 10 samples selected from a 24 h period. A minimum of 10 samples from each product run should be selected.

C2.2 Specimen size

An approximately 1800 mm long section should be cut across the full width of the billet.

The sample billet should be cut into four lengths 95 mm wide.

Two 95 mm wide specimens should be randomly selected for testing. The specimens should be allowed to cool prior to testing. The remaining specimens are held for retest if required.

C3 SAMPLE TESTING**C3.1 General**

The two specimens selected should be tested, one on the edge and the other on the flat for the following properties:

- (a) *Bending stiffness* modulus of elasticity (*E*).
- (b) *Bending strength* modulus of rupture (*R*).

C3.2 Testing machine configuration

The testing machine should be capable of four-point bending and be accurate to $\pm 1\%$ of applied load and deflection. The machine should apply the load equally and uniformly at both loading points.

The test span should be set at 18 times the nominal specimen depth as specified in Figure C1.

The loading points should be set at the 1/3 points of the test span as specified in Figure C1.

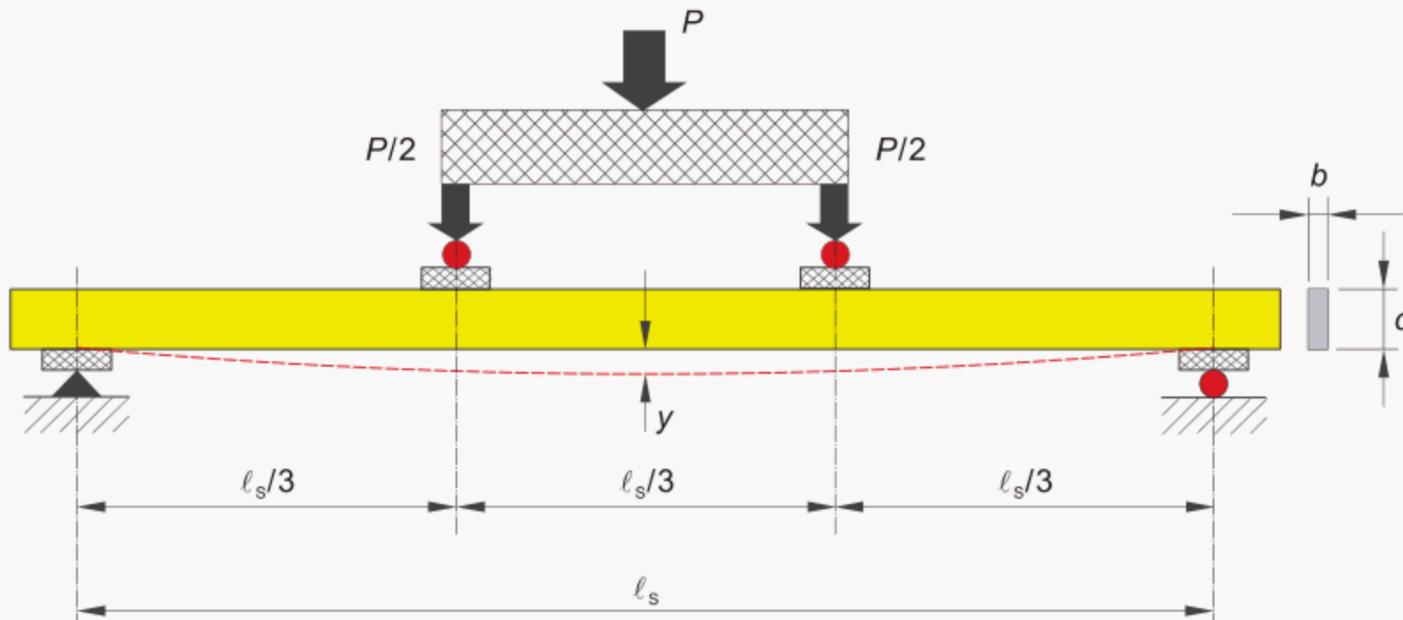


FIGURE C1 STANDARD TEST CONFIGURATION FOR MEASUREMENT OF BENDING STRENGTH AND MODULUS OF ELASTICITY

C3.3 Determination of modulus of elasticity (E)

C3.3.1 Testing on edge

The specimen should be placed in the test machine on edge. The span should be set at 18 times the nominal specimen depth, e.g., $18 \times 95 = 1710$ (mm).

The load should be applied and the load and deflection plotted.

The modulus of elasticity (E , in megapascals) should be calculated from the following equation:

$$E = \frac{23 \ell_s^3 \Delta P}{108 b d^3 \Delta y} \quad (\text{MPa}) \quad \dots \text{C1}$$

where

- ℓ_s = test span, in millimetres
- ΔP = change in load, in newtons
- b = actual specimen thickness, in millimetres
- d = measured specimen depth, in millimetres
- Δy = change in deflection, in millimetres

C3.3.2 Testing on flat

The specimen should be placed in the test machine on the flat. The span should be set at 18 times the nominal specimen thickness.

The specimen should be tested in accordance with Paragraph C3.3.1.

The bending stiffness should be calculated as per Equation C1 where—

- (a) d = measured specimen thickness, in millimetres; and
- (b) b = measured width of the specimen, in millimetres.

C3.4 Determination of bending strength (R)

C3.4.1 Testing on edge

The specimen should be placed in the test machine on edge and loaded until failure. The failure load shall be recorded.

Bending strength (R , in megapascals) should be calculated from the following equation:

$$R = \frac{P_{\max.} \ell_s}{b d^2} \text{ (MPa)} \quad \dots \text{ C2}$$

where

- $P_{\max.}$ = failure load, in millimetres
- ℓ_s = test span, in millimetres
- b = measured specimen thickness, in millimetres
- d = measured specimen depth, in millimetres

C3.4.2 Testing on flat

The specimen should be placed in the test machine on the flat with the span set at 18 times the nominal specimen thickness.

The specimen should be loaded until failure and the failure load recorded.

The bending strength should be calculated using Equation C2 where—

- (a) b = measured specimen width across the face veneer, in millimetres.
- (b) d = measured specimen thickness, in millimetres.

C4 END PRODUCT PROPERTIES VERIFICATION

C4.1 General

The results for bending strength and stiffness tested on the flat and edge, as determined in Paragraph C3, should be used to determine the characteristic stiffness ($E_{k,\text{mean}}$) and strength ($R_{k,\text{norm}}$).

$E_{k,\text{mean}}$ and $R_{k,\text{norm}}$ should be calculated after each test using a previous 30 specimen, moving total basis for each product.

The results should be compared with the published values for the relevant product. The requirements for acceptance of the product as specified in Paragraph C5 should be met. Where test results fail to meet acceptance criteria, corrective action should be carried out as specified in Paragraph C6.

C4.2 Determination of $E_{k,\text{mean}}$

$E_{k,\text{mean}}$ should be calculated on the moving previous 30 specimen total basis.

$E_{k,\text{mean}}$ should be determined from the following equation:

$$E_{k,\text{mean}} = \left[1 - \frac{0.7 V_e}{\sqrt{n}} \right] E_{\text{mean}} \quad \dots \text{ C3}$$

where

- $E_{k,\text{mean}}$ = characteristic stiffness based on the sample mean, in megapascals
- E_{mean} = average bending stiffness for the previous 30 specimens
- V_e = coefficient of variation for bending stiffness for the previous 30 specimens, calculated as follows:

$$V_e = \frac{\text{Standard deviation}}{\text{Mean}}$$

- n = total samples tested over the last 3 days

C4.3 Determination of $R_{k,norm}$

R_k should be calculated using the moving 30 specimens total basis.

$R_{k,norm}$ should be calculated from the following equations:

$$R_k = \left(1 - \frac{2.7 V_r}{\sqrt{n}}\right) R_{0.05} \quad \dots \text{C4(1)}$$

$$R_{k,norm} = \frac{1.69 \times R_k}{1.3 + 0.7 V_r} \quad \dots \text{C4(2)}$$

where

n = number of specimens tested (30)

R_k = characteristic strength, in megapascals

$R_{k,norm}$ = normalized characteristic strength, in megapascals

V_r = coefficient of variation obtained for bending strength for the previous 30 specimens, calculated as follows:

$$V_r = \frac{\text{Standard deviation}}{\text{Mean}}$$

$R_{0.05}$ = the fifth percentile value obtained for bending strength from all samples tested for the previous 30 specimens tested. The fifth percentile should be determined from the cumulative frequency calculated by the following equation or by assuming a log normal distribution:

$$F_r = (i - 0.5)/n \quad \text{when the data is first recorded} \quad \dots \text{C4(3)}$$

where

i = the ranking of the individual test results

F_r = the desired frequency, i.e., 0.05

C5 REQUIREMENTS FOR VERIFICATION

C5.1 General

If test results meet the verification criteria in Paragraph C5.2 or C5.3, production from which the sample was taken is deemed to meet structural property requirements for the product type.

If test results fail the verification criteria in Paragraph C5.2 or C5.3, corrective action in accordance with Paragraph C6 should be carried out.

C5.2 $E_{k,mean}$

The values for $E_{k,mean}$ obtained from the moving 30 specimens total should not fall below the published values for the product type.

Additionally the result for any one specimen should not be less than 0.85 the published value.

C5.3 $R_{k,norm}$

The values of $R_{k,norm}$ obtained from the moving 30 specimens total should not fall below the published value for the product type.

Additionally, the result for any one specimen should be not less than the value of R_k determined in the initial evaluation.

C6 CORRECTIVE ACTION PROCEDURES

C6.1 General

Corrective action procedures given in Paragraphs C6.2 and C6.4 should be carried out when test results fail the verification criteria specified in Paragraph C5.

C6.2 Individual (E) result lower than 0.85 of the published value of $E_{k,mean}$

Where an individual result for E is lower than 0.85 of the published value, the mill should immediately select two additional specimens from the same batch or production run manufactured as close as possible to the same time as the failed specimens and test.

The retest specimens (see Paragraph C2.2) should be subjected to the appropriate stiffness test as given in Paragraph C3.3.

If the retest specimens meet the verification criteria (min. 0.85 published E), production can continue.

If retests fail verification criteria, the corrective action given in Paragraph C6.4 should be carried out.

C6.3 Individual (R) result lower than R_k

Where an individual result for R is lower than the R_k value obtained in the initial evaluation and used to establish the published characteristic strength $R_{k,norm}$, the mill should immediately select two additional specimens from the same batch or production run manufactured as close as possible to the same time as the failed specimens and test.

The retest specimens (see Paragraph C2.2) should be subject to the appropriate strength test as given in Paragraph C3.4.

If the retest specimens meet the verification criteria (min. R_k), production can continue with no adjustments.

If retests fail verification criteria, the corrective action given in Paragraph C6.4 should be carried out.

C6.4 $E_{k,mean}$ or $R_{k,norm}$ falls below published values

Based on the moving 30 specimen sample, if $E_{k,mean}$ or $R_{k,norm}$ falls below published values, the possible causes should be formally investigated and the contributing factors determined and documented.

Once the contributing factors have been determined, corrective action should be taken immediately to rectify the cause and minimize recurrence. The corrective action should be formally documented.

Identify product from which the 30 specimen sample was taken, and take appropriate action to ensure structural property claims are satisfied in respect of that product.

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GPO Box 476 Sydney NSW 2001

Administration

Phone (02) 8206 6000

Fax (02) 8206 6001

Email mail@standards.com.au

Customer Service

Phone 1300 65 46 46

Fax 1300 65 49 49

Email sales@standards.com.au

Internet www.standards.org.au



Level 10 Radio New Zealand House

155 The Terrace Wellington 6001

(Private Bag 2439 Wellington 6020)

Phone (04) 498 5990

Fax (04) 498 5994

Customer Services (04) 498 5991

Information Service (04) 498 5992

Email snz@standards.co.nz

Internet www.standards.co.nz

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