Australian STANDARD

Timber structures

Part 1: Design methods

STANDARDS Australia

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- A3P
- Association of Consulting Engineers Australia
- Australian Building Codes Board
- Australian Timber Importers' Federation
- Australian Wood Panels Association
- BRANZ
- CSIRO Manufacturing and Materials Technology
- Curtin University of Technology
- Department of Primary Industries and Fisheries Queensland
- Engineers Australia
- Frame and Truss Manufacturers Association Australia
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- Master Builders Australia
- Monash University
- New Zealand Timber Industry Federation
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- Timber Queensland
- University of Auckland
- University of Technology, Sydney
- Wood Processors Association

Additional Interests:

- Mr Bruce Hutchings

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Australian Standard®

Timber structures

Part 1: Design methods

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TM-001, Timber Structures, to supersede AS 1720.1—1997.

This Standard incorporates Amendment No. 1 (December 2010), Amendment No. 2 (August 2011) and Amendment No. 3 (August 2015). The changes required by the Amendments are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The decision to prepare this Standard as an Australian Standard was by consensus agreement of the Joint Committee.

The objective of this Standard is to provide a code of practice for the design and acceptance of timber structures and elements. It includes design methods and design data appropriate for commonly encountered structural elements and materials and requirements to be met for specification of the design, installation and maintenance of timber structures.

Capacity factors for the timber materials represented in this Standard have been reviewed and, in some cases, modified to better reflect the safety levels appropriate for the wide range of applications for which timber structural elements may be used.

For housing, the increasing sizes of houses and increasingly larger areas that are in some cases supported by a single structural element has resulted in a need to limit application of category 1 capacity factors according to the area likely to be affected by failure of the individual element. For structures other than houses the definition of 'primary structural element' has been changed to recognise that even a partial structural collapse of some structures can have severe consequences.

Conceptually, the limit state design principles of this Standard do not differ from the 1997 version. Only essential changes and editorial improvements have been made, which reflect experience with the application of the Standard over the past decade; these changes relate to layout improvements and clarification of meaning.

Differences from the 1997 edition include the following:

(a) The notation and terminology for actions have been aligned with AS/NZS 1170 series.

(b) For easier referencing, the design properties for commonly available structural sawn timber (F-grades, MGP-grades and A17-grade) are now consolidated and presented together in an appendix.

(c) The presentation of requirements for selection of capacity factors for member and joint design has been simplified and clarified.

(d) For consistency with the AS/NZS 4063 series, characteristic properties are now uniformly defined as including the effect of size.

(e) Issues associated with evaluation methods, verification procedures, monitoring and quality control in production and manufacture are not relevant to design and are not therefore directly referred to in this revised Standard.

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.

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SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION

1.1.1 Scope

This Standard sets out limit state design methods for the structural use of timber, which are based on the principles of structural mechanics and on data established by research. It provides design data for sawn timber, laminated timber, timber in pole form, plywood, laminated veneer lumber and various types of fastenings. In addition, it provides methods of test for components or assemblies of unconventional design which may not be readily amenable to detailed analysis.

For ease of use, the simpler design situations are set in the main body of the text. Related appendices, which form an integral part of the Standard, give acceptable procedures for detailed design situations.

1.1.2 Application

This Standard is intended for use in the design or appraisal of structural elements or systems comprised of timber or wood products and of structures comprised substantially of timber.

1.2 NORMATIVE REFERENCES

The normative documents referenced in this Standard are listed in Appendix A.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

1.3 TIMBER

1.3.1 General

All timber used in accordance with this Standard shall comply with the requirements of the appropriate Australian Standards, as follows:

(a) *Visually graded sawn timber* Visually graded sawn timber shall conform to the requirements of AS 2082 or AS 2858.

(b) *Mechanically graded timber* Mechanically graded timber shall conform to the requirements of AS/NZS 1748.

(c) *Proof-graded timber* Proof-graded timber shall conform to the requirements of AS 3519.

(d) *Structural plywood* Structural plywood shall conform to the requirements of AS/NZS 2269.0.

(e) *Structural laminated veneer lumber* Structural laminated veneer lumber shall conform to the requirements of AS/NZS 4357.0.

(f) *Glued laminated timber* Glued laminated timber shall conform to the requirements of AS/NZS 1328.1

(g) *Round timber* Round timber shall conform to the requirements of AS 3818.3 or AS 3818.11, as appropriate.

(h) *Other timber products or grades* Timber products or grades not listed in this Standard may have properties established by testing and evaluation methods consistent with those described in the AS/NZS 4063 series. In addition, for other timber-based products, modification factors for duration of load effect for strength and stiffness shall be determined based on authoritative research. Consideration shall also be given to the determination of the structural durability of adhesives used for manufacture.

1.3.2 Identification

Structural timber used in conjunction with this Standard shall have its stress grade identified in accordance with the relevant Australian timber product Standard given in Clause 1.3.1.

For various purposes, it may also be necessary to specify a particular species. When a particular species is specified, the specification shall require that all pieces of timber be suitably identified as to species.

NOTES:

1 The design properties recommended in this Standard have been chosen on the assumption that structures of unseasoned timber that are allowed to dry will not receive their full design load until a period of air-drying of at least 2 weeks has taken place. Freshly sawn timber that is unseasoned, or has recently been treated with waterborne chemicals, tends to have a reduced resistance and stiffness to sustained loads during the initial drying period. Under normal circumstances, unseasoned timber will have had this drying period before being subjected to its full design load.

2 Usually, only a limited number of the timber species and stress grades listed in this Standard will be readily available at any particular place and time.

1.3.3 Change of grade

The strength properties of graded timber or timber products may alter as a consequence of subsequent processes such as longitudinal resawing, chemical treatments and redrying processes.

NOTE: It may be necessary to reassess strength properties to ensure that graded timber or timber products still satisfy design requirements after having been subjected to such processes.

1.3.4 Special provisions

Design loads for timber joints and design rules for notched beams given herein are based on the assumption that there are no loose knots, severe sloping grain, gum veins, gum or rot pockets, lyctid-susceptible sapwood, holes or splits in the vicinity of any fasteners or notch roots.

1.3.5 Treated timber

Timber, treated by impregnation with waterborne chemicals such as preservatives, is classified as unseasoned timber unless seasoning is specified.

NOTE: Where the material is dried after treatment, re-grading may be required.

1.4 GENERAL DESIGN CONSIDERATIONS

1.4.1 Loads

1.4.1.1 *General*

A structure and its structural elements shall be designed to resist the design action effects produced by—

(a) the combinations of actions for the strength, stability and serviceability limit states as specified in AS/NZS 1170.0; or

(b) such other design actions deemed to be acceptable for the limit state as appropriate to the intended end-use service conditions of a structure or its structural elements.

1.4.1.2 *Duration of load*

Duration of load effects need to be considered in the determination of the critical combination of actions.

NOTE: For definition of duration of loading, see Clause 1.7.2.12, and for further information, see Clause 2.4.1.

1.4.2 Design methods

1.4.2.1 *General*

A structure and its structural elements shall be designed to resist the design action effects resulting from the appropriate combinations of actions in order to satisfy the requirements for strength, stability and serviceability limit states.

1.4.2.2 *Strength limit state*

This limit state condition shall be deemed to be satisfied when the structural elements of a structure are proportioned so that their design capacities (R_d) equal or exceed the design action effects (S^*). For a given failure mode the strength limit state takes the general form—

$$R_d \geq S^*$$

where

R_d = design capacity of a structural element determined in accordance with the relevant Sections of this Standard.

NOTE: The general requirements are given in Section 2.

S^* = design action effect, such as bending moment, axial force or shear force resulting from the combinations of actions for the strength limit states

NOTE: The design capacity (R_d) of a structural element is also referred to as the factored resistance of the structural element for a given failure mode.

1.4.2.3 *Stability limit state*

The structure as a whole (or any part of it) shall be designed to prevent instability due to overturning, uplift or sliding as follows:

(a) The design action effect and the design resistance effect shall be determined in accordance with AS/NZS 1170.0.

(b) The whole or part of the structure shall be proportioned so that the design resistance effect is not less than the design action effect.

1.4.2.4 *Serviceability limit state*

The structure and its structural elements shall be designed to give satisfactory performance under the specified service conditions by controlling or limiting deflections, vibration and displacement of fasteners as follows:

(a) Unless otherwise agreed, the combinations of actions for serviceability limit states shall be in accordance with AS/NZS 1170.0.

(b) Deflections due to combinations of actions appropriate for the serviceability limit state shall be determined by elastic analysis methods.

NOTES:

1 The deflection limits for the serviceability limit state should be appropriate to the structure and its intended use, the nature of loading, the relationship between adjacent members and the effect on other elements supported.

2 Guidance on selection of deflection limits is given in Appendix B.

3 The determination of acceptable deflection limits is part of the design process performed by the design engineer.

4 The characteristic modulus of elasticity values given in this Standard are mean values only and, accordingly, deflection of individual members subjected to the design loads may vary both above and below the calculated estimate. Where the actual deflection is critical, it is suggested that lower fifth-percentile estimates of modulus of elasticity should be obtained and used. A procedure for estimating lower fifth-percentile values of modulus of elasticity is given in Appendix B.

(c) Where required, structures shall be designed to ensure that the vibration induced by machinery, or vehicular or pedestrian traffic does not adversely affect the serviceability of the structure.

NOTES:

1 Where there is likelihood of a structure being subjected to vibration effects, measures should be taken to minimize any dynamic behaviour so as to prevent possible discomfort or alarm, damage to the structure, or interference with its proper function.

2 The AS 2670 series gives guidance on the evaluation of human exposure to whole-body vibrations of the type likely to be transmitted by structures.

(d) Where required, the displacement associated with various types of fasteners shall be assessed in accordance with the methods given in Appendix C.

1.4.2.5 *Experimentally based design*

Where a structure or a structural element is demonstrated by the full-scale tests specified in Appendix D to satisfy requirements for strength, deformation, stability and serviceability, the corresponding design requirements of this Standard shall also be deemed to have been satisfied.

NOTE: Other design considerations will still be required to be met.

1.4.3 Timber dimensions for engineering calculations

All engineering calculations shall be based on the minimum cross-section after taking account of tolerances. Such calculations shall not be based on the nominal cross-section.

NOTE: Nominal cross-section is sometimes referred to as ‘called’ cross-section.

1.4.4 Other design considerations

1.4.4.1 *Buckling restraints*

Where there is some doubt as to the effectiveness of buckling restraints, appropriate computations, as given in Appendix E, shall be made to check the stiffness and strength of the restraints.

1.4.4.2 *Erection and other extraneous forces*

Adequate provision shall be made to resist the lateral and other forces that can occur during the transport of structural elements, and during the erection of a structure.

1.4.4.3 *Secondary stresses*

Careful consideration shall be given to the influence of secondary stresses. Where secondary stresses cannot be reduced to negligible proportions, suitable provisions in the design or some reduction in permissible primary stresses shall be made.