

AS/NZS 2699.1:2000

Australian/New Zealand Standard™

Built-in components for masonry construction

Part 1: Wall ties



This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD/28, Masonry Wall Ties and Accessories. It was approved on behalf of the Council of Standards Australia on 22 December 1999 and on behalf of the Council of Standards New Zealand on 20 December 1999. It was published on 28 February 2000.

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Australian Institute of Steel Construction
Australian Paint Manufacturers Federation
Australian Stainless Steel Development Association
Autoclaved Aerated Manufacturers
Building Research Association of New Zealand
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Australian/New Zealand Standard™

Built-in components for masonry construction

Part 1: Wall ties

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD/28, Masonry Wall Ties and Accessories, to supersede AS 2699—1984, *Wall ties for masonry construction*, and, in part, NZS 4210:1989, *Code of practice for masonry construction: materials and workmanship*.

This Standard is the first of a three-part series on masonry wall ties, connectors and accessories, and lintels and shelf angles. The series comprises the following:

AS/NZS

2699 Built-in components for masonry construction

2699.1 Part 1: Wall ties

2699.2 Part 2: Connectors and accessories

2699.3 Part 3: Lintels and shelf angles (durability requirements)

The objective of this Standard is to provide manufacturers with requirements for the classification of wall ties into three duty ratings. Type A cavity wall ties and veneer wall ties are classified according to characteristic strength only. Type B seismic-resistant veneer ties are classified according to stiffness and characteristic strength which are functions of serviceability, ultimate strength and ductility or toughness. All ties are classified for their corrosion resistance. Provisions are also included for remedial (retrofitted) ties.

Test methods are given for determination of—

- (a) resistance to water transfer;
- (b) characteristic strength and stiffness; and
- (c) corrosion resistance.

The types and spacings of ties necessary to meet design requirements are specified in AS 3700, *Masonry structures*, and NZS 4210, *Code of practice for masonry construction materials and workmanship*.

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

Notes to clauses in this Standard are for information and guidance only and compliance with them is not a requirement of the Standard.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Built-in components for masonry construction****Part 1: Wall ties**

SECTION 1 GENERAL

1.1 SCOPE AND APPLICATION This Standard specifies the requirements for wall ties for use in tying together—

- (a) the leaves of cavity masonry walls;
- (b) masonry veneer walls and load-bearing frames; and
- (c) masonry veneer walls against a strong backing wall.

NOTES:

- 1 AS/NZS 2699.2 specifies the durability performance and test procedures for structural performance of connectors and accessories used in masonry construction.
- 2 AS/NZS 2699.3 specifies the requirements for durability of lintels and shelf angles.
- 3 This Standard gives categories of wall ties, and classifies wall ties by characteristic strength and durability and, where applicable, characteristic stiffness.
- 4 The durability classifications employed in this Standard are compatible with the environments specified in AS/NZS 2312, NZS 3604 and AS 3700.
- 5 Design and installation of wall ties are specified in AS 3700, NZS 4210 and NZS 4230.

This Standard applies to ties used in masonry described in AS 3700, NZS 4210 and NZS 4230, including those used in thin-jointed masonry (for example, autoclaved aerated concrete (AAC) blockwork).

1.2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

1199	Sampling procedures and tables for inspection by attributes
1397	Steel sheet and strip—Hot-dipped zinc-coated or aluminium/zinc-coated
1399	Guide to AS 1199—Sampling procedures and tables for inspection by attributes
1449	Wrought alloy steels—Stainless and heat-resisting steel plate, sheet and strip
1580	Paints and related materials—Methods of test
1580.481	Coatings
1580.481.1.9	Method 481.1.9: Exposed to weathering—Degree of blistering
1580.481.1.10	Method 481.1.10: Exposed to weathering—Degree of flaking and peeling
1580.481.3	Method 481.3: Exposed to weathering—Degree of corrosion of coated metal substrates
2193	Methods for calibration and grading of force-measuring systems of testing machines

AS	
2331	Methods of test for metallic and related coatings
2331.2.1	Method 2.1: Average thickness tests—Dissolution methods—Strip and weigh, and analytical
2331.3.1	Method 3.1: Corrosion and related property tests—Neutral salt spray test (NSS) test
3700	Masonry structures
3894	Site testing of protective coatings
3894.3	Method 3: Determination of dry film thickness
3942	Quality control—Variables chart—Guide
AS/NZS	
2312	Guide to the protection of iron and steel against exterior atmospheric corrosion
2699	Built-in components for masonry construction
2699.2	Part 2: Connectors and accessories
2699.3	Part 3: Lintels and shelf angles (Durability requirements)
4455	Masonry units and segmental pavers
4534	Zinc and zinc/aluminium-alloy coatings on steel wire
4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
ISO 9000	Quality management and quality assurance standards
ISO 9000.1	Part 1: Guidelines for selection and use
ISO 9004	Quality management and quality system elements
ISO 9004.1	Part 1: Guidelines
NZS	
3604	Timber framed buildings
4203	General structural design and design loadings for buildings
4210	Code of practice for masonry construction: materials and workmanship
4230	Code of practice for the design of masonry structures
4230.1	Part 1: Structures
4230.2	Part 2: Commentary
SAA/SANZ	
HB18	Guidelines for third-party certification and accreditation.
HB18.28	Guide 28: General rules for a model third-party certification scheme for products
ASTM	
G1	Standard practice for preparing, cleaning and evaluating corrosion test specimens

1.3 NEW TECHNOLOGIES This Standard shall not be interpreted as preventing the use of materials or methods of manufacture not specifically referred to herein, provided the specified performance criteria are met.

1.4 DEFINITIONS For the purpose of this Standard, the definitions below apply.

1.4.1 Cavity tie—a wall tie designed to connect two leaves of masonry that are separated by a clear cavity of any width.

1.4.2 Characteristic stiffness—the stiffness used to determine the classification under Clause 2.7, calculated in accordance with Appendix A for Type B ties.

1.4.3 Characteristic strength—the strength used to determine the classification under Clause 2.7, calculated in accordance with Appendix A for Type B ties and Appendix B for Type A ties.

1.4.4 Characteristic value—the value that is exceeded by at least 95% of the ties in the lot.

1.4.5 Duplex coating—a coating system that provides corrosion protection through the combination of an organic barrier coating applied to galvanized steel.

NOTE: A film of organic matter, such as paint or plastic, is not an automatic indication of a duplex coating. Such films may simply have been applied to identify the durability classification (see Clause 4.1).

1.4.6 Durability classification (R)—identifies the level of corrosion protection provided to a tie to meet the performance condition for the design life of a structure.

NOTE: The classifications R0 to R5 are individually defined by reference to exposure conditions given in AS 3700.

1.4.7 Face loads—the loads applied normal to the face of the wall, which impose compressive or tensile forces on the ties.

1.4.8 Galvanized coating—a protective zinc coating alloyed to the steel substrate and applied by hot-dip immersion in molten zinc of at least 98% purity.

1.4.9 In-plane loads—the loads applied in the plane of the wall, which impose bending and shear forces on the ties.

1.4.10 Lot—a group of wall ties of a single type with specific characteristics and dimensions, presented for sampling at the same time.

1.4.11 Masonry couplet—two stack-bonded masonry units joined by a bed of mortar, or adhesive, as appropriate.

1.4.12 Organic coating—a protective coating, based on one or more organic resins, in liquid or powder form, applied to the substrate.

1.4.13 Specimen—a specially prepared item for testing, consisting of masonry wall tie or ties embedded in a masonry couplet, possibly affixed to a length of timber or metal stud or embedded in another couplet, to simulate the various service conditions or, where more than one type of service condition applies to that tie, the most demanding.

1.4.14 Veneer tie—a wall tie designed to connect an outer masonry skin to an inner wall of timber, metal or other relevant material.

1.4.15 Wall ties

1.4.15.1 Type A tie—a tie not required to have specific seismic design characteristics. Type A ties are as follows:

- (a) *Type A cavity tie*—a tie, together with its fixings or anchorages, used to transfer face loads between skins (leaves) of a cavity wall while being capable of accommodating differential in-plane horizontal and vertical deflections between the attached elements.
- (b) *Type A veneer tie*—a tie, together with its fixings or anchorages, used to transfer face loads from a veneer to a structural backing while being capable of accommodating differential in-plane horizontal and vertical deflections between the attached elements.

- (c) *Type A remedial tie*—a tie manufactured for installation after a masonry leaf has been erected. Remedial ties may be either cavity ties or masonry veneer ties and are usually used to replace defective ties, or where ties have been omitted.

NOTE: The requirements for the use of Type A ties are given in AS 3700.

1.4.15.2 *Type B tie*—a tie required to have specific design characteristics under cyclic dynamic loading, such as occurs under seismic conditions. Type B ties are as follows:

- (a) *Type B non-flexible veneer tie*—a tie, including its fixings or anchorages, used to transfer face loads between a masonry veneer and a structural backing, while being capable of accommodating differential in-plane horizontal and vertical movements between the attached elements, during which time the cavity width may vary.

NOTES:

1 Type B non-flexible veneer ties may transmit shear forces across the cavity from the seismic-resisting structure to the veneer when it is subjected to in-plane earthquake effects with relative movements of up to ± 20 mm.

2 In New Zealand these ties are known as ‘standard ties’.

- (b) *Type B flexible veneer tie*—a tie that, together with its fixings and anchorages, is capable of transmitting face loads between a masonry veneer and its structural wall, while not transferring shear or bending loads across the cavity when accommodating differential in-plane horizontal and vertical deflections between the attached elements.
- (c) *Type B remedial tie*—a tie with specific seismic design characteristics manufactured for installation after a masonry leaf has been erected. Remedial ties are usually used to replace defective ties or where ties have been omitted.

NOTE: The requirements for the use of Type B ties are given in NZS 4210 and NZS 4230.

SECTION 2 PERFORMANCE CRITERIA

2.1 SCOPE OF SECTION This Section sets out specific requirements for the design and manufacture of wall ties.

Categories of wall ties are as follows:

- (a) *Type A ties*, which comprise the following:
 - (i) Cavity ties.
 - (ii) Veneer ties
 - (iii) Remedial ties.
- (b) *Type B ties*, which comprise the following:
 - (i) Non-flexible veneer ties.
 - (ii) Flexible veneer ties.
 - (iii) Remedial ties.

2.2 AIM The performance criteria set out in this Section are designed to ensure that—

- (a) wall ties are durable and serviceable, and have adequate strength, while satisfying other relevant criteria such as resistance to water transfer; and
- (b) there is no loss of function of ties or adverse effect on the masonry over a design life of not less than 50 years, except for those intended for durability classification R5, which requires the use of specifically designed ties.

2.3 SAFETY Ties shall be manufactured without sharp features, such as points or corners, that could injure site workers.

2.4 DURABILITY

2.4.1 General Materials for the manufacture of masonry wall ties shall be either inherently corrosion resistant or suitably coated to impart adequate corrosion resistance to achieve design life.

2.4.2 Damage Each wall tie shall be free from fracture or surface cracks. Where ties are fabricated from coated sheet, wire or bar, the manufacturing process shall not materially damage the corrosion-resistant coating except at cut edges or ends.

2.4.3 Classification of materials Ties manufactured from any material shall be identified as durability classifications R0 to R5, by application of the acceptance criteria in Clause 2.4.4.

2.4.4 Durability criteria for wall ties Ties shall suffer no loss in serviceability or performance over the design life of the structure (see Clause 2.2) when subjected to the following in-service conditions:

- (a) Elevated temperatures with a maximum of 55°C, where the tie is exposed on the external face of the masonry (for example, some remedial ties), or 40°C, where the tie is embedded within the mortar bed in accordance with Clause 2.6.
- (b) A cyclic temperature variation of 40°C over any 24 h period.
- (c) The mortar bed having an initial alkalinity with a pH of up to 10, but carbonating over time to a pH of not less than 7.
- (d) Being wet and remaining wet for a period of three months per year.

- (e) Exposure to UV radiation (global radiation of 20 MJ/m²) for a period of up to four weeks (the construction period).
- (f) Aerosol penetration, with the highest level of airborne salt deposited at the exterior of the masonry, as follows:
 - (i) R0 nil g/m²/day.
 - (ii) R1 10 g/m²/day.
 - (iii) R2 20 g/m²/day.
 - (iv) R3 60 g/m²/day.
 - (v) R4 300 g/m²/day.
 - (vi) R5 See Note 2.

NOTES:

- 1 The extent of aerosol penetration depends largely on the distance from the coast; however, in practice, microclimatic effects may distort otherwise normal climatic patterns by many kilometres and should always be taken into account. The salt deposition in the wall cavity would normally be half that experienced on the exterior face of the wall. The values used in Appendix C reflect this situation.
- 2 The R5 durability classification refers to specific corrosive environments outside the above criteria. Where industrial fall-out, bacteria, chemicals or other environmental conditions exist, it is necessary for the manufacturer to test all unique coatings and materials to confirm their resistance to the particular environment for the expected life of the structure. Because that environment cannot be specified in this document, suitable coating systems cannot be recommended.

2.4.5 Test methods Ties produced from materials not meeting the deemed-to-comply provisions (see Section 3) shall be tested and assessed for compliance in accordance with Appendix C or Appendix D, as appropriate.

For ties produced from other materials, such as polymers, no specific test methods are available and alternative means of compliance with the criteria set out in Clause 2.4.4 shall be demonstrated by the manufacturer.

2.4.6 Durability criteria for fasteners The veneer wall tie and its fasteners shall be galvanically and chemically compatible, and the combination shall have a corrosion resistance of at least that of the tie alone. (See Clause 2.6(g).)

2.5 RESISTANCE TO WATER TRANSFER Wall ties shall be manufactured such that, when tested in accordance with Appendix E, no tie from the sample permits water transfer across the cavity.

2.6 EMBEDMENT, MOVEMENT AND TOLERANCE Wall ties shall be manufactured such that the following criteria is met:

- (a) The anchorage section of a wall tie shall be capable of being bedded on, and completely surrounded by, mortar.
- (b) They shall be capable of being easily immobilized within the mortar bed, with a layer of mortar under and above the anchorage section of the tie.
- (c) They shall be capable of being mechanically keyed within the mortar bed.
- (d) They shall be designed in such a way that they are easily and practicably embedded in mortar as the construction proceeds.

- (e) The seating anchorage in the mortar shall be not less than the following within ± 5 mm:
 - (i) For solid or cored units up to 100 mm wide half the width of the unit.
 - (ii) For solid or cored units 100 mm or wider 50 mm.
 - (iii) For hollow units with face-shell bedding 50 mm.

NOTE: In a hollow-unit masonry construction, it may be necessary to obtain the required embedment by filling the appropriate cores with mortar.

- (f) The part of a wall tie that provides anchorage to the mortar bed joint in masonry shall have an overall height of the anchorage section, including any crimping or bending, not exceeding 70% of the design joint thickness. This limitation shall not apply to ties used with autoclaved aerated concrete blockwork constructed with thin-bed mortar, but provision shall be made to accommodate the thickness of the tie.
- (g) Wall ties that are intended to be fixed to non-rigid members shall be capable of being fixed by non-impact methods (for example, screwing), unless it can be shown that the method of fixing will not adversely affect the ability of the tie or the mortar to perform as required.

Tie and fasteners shall be supplied as an integral system.

NOTES:

1 Screw fixings do not suffer or produce the same problems as do impact fixings, such as nails.

2 Galvanic compatibility between tie and fastener is required by Clause 2.4.6.

- (h) The tolerance between any moving parts of veneer ties in the direction of the face loads shall be such as to allow no movement.
- (i) Type B wall ties shall be capable of tolerating both horizontal and vertical differential movements of the leaf and the loadbearing frame, so as to maintain compliance with the applicable requirements of Table 2, when subjected to the applicable displacements in Paragraph A8, Appendix A.
- (j) Type B wall ties shall be designed and made so that no component of a tie disengages in service, including during earthquakes.
- (k) Type B flexible veneer ties in their unstressed condition shall be constructed so as to not reduce or increase the cavity width by more than 2 mm when accommodating differential in-plane horizontal and vertical deflections between the attached elements as described in Paragraph A8, Appendix A.
- (l) Remedial ties shall be manufactured to satisfy the performance requirements for Type A or Type B wall ties. Those remedial ties intended for use in upgrading buildings in earthquake-prone areas shall be capable of satisfying the horizontal in-plane and out-of-plane loads and deflections as set out in Paragraph A8, Appendix A, for Type B veneer ties supported from flexible structures. Remedial ties used to upgrade cavity wall buildings shall comply with Clause 2.7.2 for Type A cavity ties.

2.7 STRUCTURAL PERFORMANCE—STRENGTH AND STIFFNESS

2.7.1 Strength Wall ties shall be tested in accordance with Appendix A or Appendix B. The characteristic stiffness values in tension and compression so obtained for Type B ties shall be not less than the appropriate values given in Table 2 for the particular duty classification.

2.7.2 Classification of Type A ties Cavity and veneer ties shall be classified in accordance with their characteristic strength as shown in Table 1. The classification is as follows:

- (a) Light duty.
- (b) Medium duty.
- (c) Heavy duty.

TABLE 1
MINIMUM CHARACTERISTIC STRENGTH OF TYPE A
VENEER TIES AND TYPE A CAVITY TIES

Classification	Minimum characteristic strength, kN	
	Tension	Compression
Light duty	0.20	0.24
Medium duty	0.40	0.48
Heavy duty	1.00	1.20

NOTE: A lower bound value on stiffness is imposed on ties by the test method. This places an upper limit of 1.5 mm on the tie deflection at ultimate load.

2.7.3 Classification of Type B ties Veneer ties for use in seismic areas shall be classified in accordance with their characteristic strength and stiffness as shown in Table 2. The classification is as follows:

- (a) Earthquake light duty (EL).
- (b) Earthquake medium duty (EM).
- (c) Earthquake heavy duty (EH).

TABLE 2
TYPE B VENEER TIES (FLEXIBLE OR NON-FLEXIBLE)
MINIMUM CHARACTERISTIC STRENGTH AND CHARACTERISTIC
STIFFNESS UNDER AXIAL LOADING

Classification for seismic veneer tie	Minimum characteristic axial stiffness kN/mm	Minimum characteristic axial strength (at the end of 4 th , 10 mm tension cycle) kN	Minimum characteristic residual strength (at end of 15 mm cycle) kN
Light duty (EL)	0.150	0.500	0.350
Medium duty (EM)	0.175	0.750	0.550
Heavy duty (EH)	0.200	1.500	1.100

NOTE: Type B non-flexible veneer ties are known as 'standard ties' in New Zealand.

SECTION 3 DEEMED - TO - COMPLY PROVISIONS FOR MATERIAL SELECTION

Wall ties complying with Table 3 (for sheet) or Table 4 (for wire) are deemed to meet the durability criteria of Clause 2.4.4.

NOTES:

- 1 Galvanized steel wire employed for the manufacture of masonry wall ties is normally supplied to a tensile strength specification of 550 MPa max.
- 2 Wall tie feedstock, already appropriately coloured for durability classification identification, may be available from materials suppliers.

TABLE 3
DURABILITY CLASSIFICATION FOR MASONRY WALL TIES
MANUFACTURED FROM STEEL SHEET

Durability classification	Material requirement
R0, R1, R2	(a) Masonry wall ties manufactured from galvanized steel sheet complying with AS 1397 with a galvanized coating of at least grade Z600 (b) Masonry wall ties galvanized after manufacture from bare steel sheet and complying with AS/NZS 4680 except that the coating mass shall be at least 300 g/m ² on each side
R3	Masonry wall ties galvanized after manufacture from bare steel sheet and complying with AS/NZS 4680 except that the coating mass shall be at least 470 g/m ² on each side
R4	Stainless steel grade AS 1449/316 or AS 1449/316L. (UNS S31600 or UNS S31603 respectively) (See Table 4, Note 1)

NOTE: For ties of durability classification R5, see Clause 2.4.4, Note 2.

TABLE 4
DURABILITY CLASSIFICATION FOR MASONRY WALL TIES
MANUFACTURED FROM STEEL WIRE (OR BAR)

Durability classification	Material requirement
R0, R1, R2, R3	(a) Masonry wall ties manufactured from galvanized steel wire (or bar) complying with AS/NZS 4534, except that the galvanized coating mass shall be at least 470 g/m ² . (b) Masonry wall ties galvanized after manufacture from bare steel wire (or bar) and complying with AS/NZS 4680 except that the coating mass shall be at least 470 g/m ²
R4	Stainless steel grade AS 1449/316 or AS 1449/316L (UNS S31600 or UNS S31603 respectively).

NOTES:

- 1 A chemical procedure is described in Appendix F for the identification of grade AS 1449/316 or AS 1449/316L stainless steel.
- 2 For ties of durability classification R5, see Clause 2.4.4, Note 2.

SECTION 4 IDENTIFICATION MARKS

4.1 TIE MARKING Each wall tie shall be colour coded or stamped with an identifiable mark to indicate its durability classification. This colour code or mark shall be such that it is readily visible in the cavity portion of the building construction.

Where colour coding is used for ties, the coding shall be as follows:

- (a) Wall ties for durability classifications R0 and R1 green.
- (b) Wall ties for durability classification R2 yellow.
- (c) Wall ties for durability classification R3 red.
- (d) Wall ties for durability classification R4 white or blue.

White shall be used only for colour-coded R4 uncoated (bare) materials, except that stainless steel ties may be supplied uncoloured.

NOTE: See Clause 3.1, Note 2.

Wall ties of durability classification R5, being dedicated items for critical applications, shall be labelled or otherwise identified, in a manner agreeable to both manufacturer and purchaser.

Where stamping is employed for strip metal ties, they shall be stamped 0, 1, 2, 3 or 4 to indicate R0, R1, R2, R3 or R4 respectively.

Where additional stamping is used, the markings on Type B ties shall be as follows:

- (i) Earthquake light duty EL.
- (ii) Earthquake medium duty EM.
- (iii) Earthquake heavy duty EH.

4.2 PACKAGE MARKING The following information shall be marked on each package of wall ties, or on a label securely attached thereto:

- (a) Reference to this Standard, that is, AS/NZS 2699.1.
- (b) Name or registered trade name or mark and address of manufacturer.
- (c) Duty classification.
- (d) Rated cavity width, in millimetres.
- (e) Durability classification.
- (f) If applicable, fastening requirements.
- (g) Any limitations on the use of the tie, including those not specifically identified in the Standard.

NOTES:

- 1 For an example of labelling see Appendix G.
- 2 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.