



Built-in components for masonry construction

Part 2: Connectors and accessories



AS 2699.2:2020

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- Australian Industry Group
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- Australian Stainless Steel Development Association
- Australian Steel Institute
- Bureau of Steel Manufacturers of Australia
- Concrete Masonry Association of Australia
- Galvanizers Association of Australia
- Housing Industry Association
- Materials Australia
- Think Brick Australia
- University of Newcastle

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Preface

This Standard was prepared by the Standards Australia Committee, BD-028, Masonry Components and Accessories, to supersede AS/NZS 2699.2—2000.

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

AS 2699.1, *Built-in components for masonry construction, Part 1: Wall ties*

AS 2699.2, *Built-in components for masonry construction, Part 2: Connectors and accessories*

AS 2699.3, *Built-in components for masonry construction, Part 3: Lintels and shelf angles (durability requirements)*

The objective of this Standard is to provide manufacturers with specifications for corrosion resistance and tests for structural serviceability of connectors and accessories when built into masonry.

The types and spacings of connectors and accessories necessary to meet design requirements are specified in AS 3700, *Masonry structures*, and AS 4773.1, *Masonry in small buildings, Part 1: Design* and, AS 4773.2, *Masonry in small buildings, Part 2: Construction*.

The terms “normative” and “informative” are used in Standards 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 conformance with them is not a requirement of the Standard.

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by “C” preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

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NOTES

Australian Standard®

Built-in components for masonry construction

Part 2: Connectors and accessories

Section 1 Scope and general

1.1 Scope

This Standard specifies requirements for connectors and accessories built into masonry, including —

- (a) masonry anchors;
- (b) masonry connectors;
- (c) masonry components other than wall ties;
- (d) tie-downs in masonry;
- (e) bolts and fixings in masonry;
- (f) bed-joint mesh in masonry; and
- (g) all accessories for masonry construction other than —
 - (i) wall ties that are covered by AS 2699.1;
 - (ii) lintels and shelf angles that are covered by AS 2699.3;
 - (iii) damp proof courses and flashings that are covered by AS/NZS 2904 and AS 3700;
 - (iv) termite protection that is covered by AS/NZS 3660 series; and
 - (v) mullions are covered by AS 3700.

NOTE 1 Bed-joint mesh is fabric laid in masonry bed joints as a tying material. This item does not include structural reinforcement in the bed joints of reinforced masonry.

NOTE 2 The design and installation of connectors and accessories are specified in AS 3700, AS 4773.1 (design) and AS 4773.2 (construction).

The requirements for connectors and accessories specified in this Standard cover —

- (A) durability — materials specifications and test methods; and
- (B) structural — test methods only.

NOTE 3 The durability classifications employed in this Standard are compatible with the environments specified in AS 3700, AS 4773.1, AS 4773.2, ISO 9223 and AS 4312—2008.

Because of the wide variety of connectors and accessories and their diverse applications, this Standard does not provide specifications for structural performance parameters. Test methods for these parameters are given for the guidance of manufacturers, designers and purchasers.

NOTE 4 Specifications for structural performance of components may be nominated by manufacturers, or negotiated between manufacturers, suppliers, designers and purchasers.

This Standard applies to connectors and accessories used in masonry described in AS 3700, AS 4773.1 and AS 4773.2.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitute requirements of this document:

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

AS 1397, *Continuous hot-dip metallic coated steel sheet and strip—Coatings of zinc and zinc alloyed with aluminium and magnesium*

AS 2193, *Calibration and classification of force-measuring systems*

AS 2331.1.4, *Methods of test for metallic and related coatings, Method 1.4: Local thickness tests — Magnetic induction and eddy current methods*

AS 2699.1, *Built-in components for masonry construction, Part 1: Wall ties*

AS 2699.3, *Built-in components for masonry construction, Part 3: Lintels and shelf angles (durability requirements)*

AS 4040.3, *Methods of testing sheet roof and wall cladding, Part 3: Resistance to wind pressures for cyclone regions*

AS 3700, *Masonry structures*

AS 3894.3, *Site testing of protective coatings, Method 3: Determination of dry film thickness*

AS 4773.1, *Masonry in small buildings, Part 1: Design*

AS 4773.2, *Masonry in small buildings, Part 2: Construction*

AS/NZS 1170.2, *Minimum design loads on structures, Part 2: Wind loads*

AS/NZS 2904, *Damp-proof courses and flashings*

AS/NZS 3660, *Termite Management (all parts)*

AS/NZS 4455, *Masonry units and segmental pavers*

AS/NZS 4534, *Zinc and zinc/aluminium-alloy coatings on steel wire*

AS/NZS 4680, *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

ISO 19840, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces*

AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ASTM A240/A240M, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

1.3 Terms and definitions

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

1.3.1 batch

clearly identifiable collection of units, manufactured consecutively or continuously under the same conditions, using material or compound to the same specification

1.3.2**capacity design procedure**

design method in which elements of the primary lateral earthquake-force-resisting system are chosen, suitably designed and detailed for energy dissipation under severe deformations, to provide other structural elements with sufficient strength such that the chosen means of energy dissipation can be maintained

1.3.3**characteristic stiffness**

stiffness of a connector or accessory installed in substrate

Note 1 to entry: Methods of determining characteristic stiffness are specified in the various tests prescribed in [Appendix F](#).

1.3.4**characteristic strength**

strength of a connector or accessory installed in substrate

Note 1 to entry: The method of determining characteristic strength is specified in [Appendix F](#).

1.3.5**characteristic value**

value that is exceeded by at least 95 % of the components in the lot

1.3.6**connectors and accessories**

any components other than wall ties, lintels and shelf angles used in masonry construction to aid the structural integrity of the building or to provide support or stability to building finishes

Note 1 to entry: Connectors and accessories are frequently referred to as “components” in this Standard (see [Clause 1.1](#)).

1.3.7**corrosivity category****(C)**

standardized rating of corrosivity of atmosphere in relation to the one-year corrosion effect on steel and zinc

Note 1 to entry: The classifications C1 to C5 and CX are individually defined by reference to corrosivity of the atmosphere according to ISO 9223 and AS 4312—2008 (see [Appendix D](#)).

Note 2 to entry: A method for estimating corrosivity category is given in [Appendix D](#).

1.3.8**design life**

period for which the component is expected to fulfil its intended function

Note 1 to entry: See [Clause 1.3.6](#).

1.3.9**distributor**

any business entity that provides a point/source of supply of a component to the market

1.3.10**ductility**

ability of a structural element to sustain its load-carrying capacity when subjected to cyclic inelastic displacements during seismic activity

1.3.11
durability class
R

identifies the level of corrosion protection provided to a connector or accessory to meet the performance condition for the design life of a structure

Note 1 to entry: The classifications, R0 to R5, are individually defined by reference to exposure conditions given in AS 3700, AS 4773.1 and AS 4773.2.

1.3.12
factory production control
FPC

comprises operational techniques and all measures necessary to regulate and maintain the conformity of the product to the requirements of a Standard

1.3.13
galvanized coating

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

1.3.14
lot

group of connectors or accessories of a single type with specific characteristics and dimensions, presented for sampling at the same time

1.3.15
manufacturer

business entity providing the total, substantive or final production/assembly process of the connector or accessory

1.3.16
manufacturing lot
manufacturing batch

quantity of components of a single type with specific characteristics and dimensions, processed through the same or similar steps at the same time or over a continuous time period from a process with FPC

1.3.17
manufacturing lot number

unique alphanumeric code assigned by the component manufacturer to a manufacturing lot enabling its traceability throughout the entire production operation, including incoming materials control and all processes defined in the FPC

1.3.18
masonry couplet

two stack-bonded masonry units joined by a bed of mortar or adhesive, as appropriate

1.3.19
monotonic test

test procedure in which the applied load is gradually increased until failure occurs

1.3.20
overstrength factor
(R_o)

factor to be applied to the characteristic residual strength, to estimate the maximum probable strength of a connector or accessory installed in substrate where required for capacity design

1.3.21
purchaser

organization or person who buys components, but is not necessarily the user

1.3.22**residual load**

load resisted by a specimen after several cycles of displacement applied during the seismic loading test

Note 1 to entry: The seismic test is specified in [Appendix F](#).

1.3.23**sample**

one of more units of product drawn from a batch or lot, selected at random without regard to quality

Note 1 to entry: The number of units of product in the sample is the sample size.

1.3.24**shall**

indicates that a statement is mandatory

1.3.25**should**

indicates a recommendation

1.3.26**specimen**

specially prepared item for testing, consisting of single or multiple connectors or accessories embedded in a masonry unit or a masonry couplet, possibly affixed to a length of timber or metal stud, or embedded in another masonry unit or couplet, to simulate the various service condition or, where more than one type of service condition applies, the most demanding

1.3.27**statistical process control****SPC**

application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product

1.3.28**substrate**

1 masonry, timber or metal assembly of a building in or to which a connector or accessory is installed, embedded or affixed, as appropriate

2 basis metal to which a non-metallic coating, or component of a coating, is applied

1.3.29**supplier**

organization that provides components

Note 1 to entry: The supplier may be the manufacturer, an importer or a distributor.

1.3.30**trace lot number**

unique alphanumeric code assigned by a component manufacturer or distributor, which identifies the original manufacturing lot number in an unequivocal manner

1.3.31**type testing**

testing performed to prove that the component is capable of conforming to the requirements of this Standard

1.4 Product conformity evaluation

Product conformity to this Australian Standard shall be evaluated in accordance with [Appendix B](#).

If the evaluation of the product conformity is not completed, or the product does not fulfil the requirements stated in this Standard, claims shall not be made that products meet the requirements of this Standard.

1.5 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.

Section 2 Performance criteria

2.1 Scope of section

This Section sets out specific requirements for the design and manufacture of connectors and accessories.

2.2 Aim

The performance criteria set out in this Section are intended to ensure that —

- (a) connectors and accessories are durable and serviceable, and fulfil their intended function; and
- (b) there is no loss of function of the connectors or accessories, or adverse effect on the masonry, over a design life of not less than 50 years.

No specific test methods are available for durability class R5. An alternative means of conformance with the durability criteria set out in this Standard shall be demonstrated (see [Clauses 3.2](#)).

2.3 Durability

2.3.1 General

Materials for the manufacture of connectors and accessories shall be either inherently corrosion resistant or coated to impart adequate corrosion resistance to achieve design life.

2.3.2 Damage

Each connector or accessory shall be free from fracture or surface cracks. Where components are fabricated from coated sheet, wire or bar, the manufacturing process shall not materially damage the corrosion-resistant coating.

Cut exposed edges that are galvanically protected by the adjacent zinc for components fabricated from coated sheet and wire shall be deemed to be conforming. Exposed edges and damage to coatings on cut bar shall be repaired to restore the original corrosion protection.

***C2.3.2** The galvanic protection footprint of zinc on steel relies on current flow in surface films and generally does not extend beyond approximately 3 mm from the zinc.*

2.3.3 Classification of materials

Components shall be identified as durability classes R1 to R5, as defined in AS 3700, AS 4773.1, and AS 4773.2, by application of the acceptance criteria in [Clause 2.3.4](#).

2.3.4 Durability criteria for connectors and accessories

Connectors or accessories shall suffer no loss in serviceability over the design life of the structure (see [Clause 2.2](#)) when subjected to the following in-service conditions:

- (a) *R1 and R2* —
 - (i) all interior locations;
 - (ii) exterior locations more than 1 km from a non-surf coast and not classed as industrial;
 - (iii) exterior locations more than 10 km from a surf coast and not classed as industrial;

- (iv) protected exterior locations with a coating above the damp proof course (DPC) or a membrane below the DPC in any atmospheric environment; or
 - (v) locations not subject to wetting or soil exposure.
- (b) *R3* —
 - (i) exterior location 100 m to 1 km from a non-surf coast;
 - (ii) exterior locations 1 km to 10 km from a surf beach;
 - (iii) exterior locations subject to non-saline wetting and drying; or
 - (iv) below a DPC in contact with the ground and in non-aggressive soils.
- (c) *R4* —
 - (i) exterior locations less than 100 m from a non-surf coast;
 - (ii) exterior locations less than 1 km from a surf coast;
 - (iii) exterior locations subject to saline wetting and drying
 - (iv) below a DPC in contact with the ground and in aggressive soils.
- (d) *R5* — locations outside the above criteria which show severe corrosion

The design solutions for the durability criteria of this Clause shall be as specified in [Table 3.1](#).

NOTE 1 Examples of *R5* durability class are CX atmospheric environments, acid sulfate soils, enclosed swimming pools, fertilizer sheds, tanneries, chemical plants, piggeries, poultry sheds and similar environments, which may require special materials or coatings.

NOTE 2 [Appendix D](#) relates the durability classes *R1* to *R5* to the ISO 9223 corrosivity categories and locations described in AS 4312—2008.

2.3.5 Alternative materials

Where alternative material are used in the production of components, conformance to the durability criteria set out in this Standard shall be demonstrated as specified in [Clause 3.2](#).

2.3.6 Galvanic and chemical compatibility criteria for components and fasteners

In addition to meeting the requirements of [Clause 2.3.4](#), connectors and fasteners shall be galvanically and chemically compatible, and the combination shall have a corrosion resistance of at least that of the individual component alone.

2.4 Resistance to water transfer

Components shall be manufactured such that, when tested in accordance with [Appendix G](#), no connector or accessory permits water transfer across the cavity.

2.5 Embedment, movement and tolerance

Any part of a masonry connector or accessory that, in service, is built into a mortar bed in masonry shall be designed to have an overall height, including any crimping or bending, not exceeding 70 % of the design bed thickness. This limitation shall not apply to connectors and accessories used with autoclaved aerated concrete blocks; however, provision shall be made to accommodate the thickness of the connector or accessory.

2.6 Structural performance

The minimum characteristic property or properties of the connector or accessory shall be supplied with the product, including evidence of its structural performance, based on the test procedures specified in [Appendix F](#) and in accordance with the following criteria:

- (a) Tests on the connector or accessory shall simulate the most demanding in-service conditions for its intended use, including its fixings and substrates.
- (b) Tests shall evaluate the strength, stiffness and potential movement of the connector or accessory in the three orthogonal directions, with the loading regime chosen to simulate the intended use of the connector or accessory.

Section 3 Materials

3.1 Material selection

Materials for components shall be in accordance with [Table 3.1](#).

Determination of the coating thickness of galvanized components shall be in accordance with [Appendix A](#).

NOTE 1 The method set out in [Appendix A](#) for galvanized components may be used for site inspection of an individual article or for inspection of a batch lot, such as supplied to a distributor, or for house lots. It may also be used to demonstrate the galvanized coating thickness for alternative solutions.

NOTE 2 The methods set out in [Clause E.2](#) and [Clause E.3](#), for identifying 304 and 316 stainless steel components may be used for site inspection of an individual article or for inspection of a batch lot, such as supplied to a distributor, or for house lots. If there is any doubt, the stainless steel components should be assessed by examination of the supplier test report or a laboratory as described in [Appendix E](#).

C3.1 Experience from the 1989 Newcastle earthquake showed that corrosion was found to be worst in the mortar joints of the outer leaf of cavity construction. The salt deposition in the wall cavity and roof space would normally be approximately half that experienced on the exterior face of the wall.

[Appendix D](#) relates the durability classes R1 to R5 to the ISO 9223 corrosivity categories and locations described in AS 4312—2008. If the location of the structure has been defined according to AS 4312—2008, then the required durability class for components may be determined using [Appendix D](#), subject to the in-service conditions described in [Clause 2.3.4](#) being met.

The corrosion rate of components not directly exposed to the atmospheric environment (for example, embedded in mortar or within the cavity) may be correlated with the corrosion rates provided by AS 4312—2008 but the differences in time of wetness and chemical environment between the cavity and a rain-washed exterior mean there is not a constant factor. The corrosion mechanism within masonry is different from the atmosphere due to the accumulation of corrosives and extended time of wetness in the wall cavity whereas the external environment is sometimes rain washed and tends to dry more rapidly.

Galvanized (zinc) steel is resistant to mild alkaline conditions, such as exists in the mortar used in masonry construction. Uncured mortar does attack galvanized steel, although this attack slows once the mortar is cured, and experience has shown the durability is not significantly compromised. The coating types in AS 1397 include the “AZ” and “AM” coatings, which contain significant amounts of aluminium. These aluminium-rich products are susceptible to ongoing rapid corrosion in mortar due to their high aluminium content and are not suitable for use when components are embedded in fresh mortar.

Stainless steel grade 304 may exhibit rust spotting (tea staining) and crevice corrosion over time, specially in environments where the component is exposed to chlorides such as in marine locations and where it remains unwashed. If appearance is critical, the component may be coated, a smoother finish may be specified or grade 316/316L may be specified.