

AS 5216:2021



STANDARDS  
Australia



# Design of post-installed and cast-in fastenings in concrete

Currently in preview, click buy full version

AS 5216:2021

This Australian Standard ® was prepared by ME-029, Fasteners. It was approved on behalf of the Council of Standards Australia on 17 June 2021.

This Standard was published on 23 July 2021.

The following are represented on Committee ME-029:

- Association of Accredited Certification Bodies
- Australian Building Codes Board
- Australian Chamber of Commerce and Industry
- Australian Engineered Fasteners and Anchors Council
- Australian Industry Group
- Australian Steel Institute
- Austrroads
- Bureau of Steel Manufacturers of Australia
- Galvanizers Association of Australia
- Materials Australia
- National Association of Steel-Framed Housing
- National Association of Testing Authorities Australia
- National Precast Concrete Association Australia
- Society of Automotive Engineers — Australasia
- Swinburne University of Technology

This Standard was issued in draft form for comment as DR AS 5216:2020.

#### **Keeping Standards up-to-date**

Ensure you have the latest versions of our publications and keep up-to-date about Amendments, Rulings, Withdrawals, and new projects by visiting:

[www.standards.org.au](http://www.standards.org.au)

ISBN 978 1 76113 444 9

# Design of post-installed and cast-in fastenings in concrete

Originated as SA TS 101:2015.  
Previous edition AS 5216:2018.  
Second edition 2021.

© Standards Australia Limited 2021

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Cth).

## Preface

This Standard was prepared by the Standards Australia Committee ME-029, Fasteners, to supersede AS 5216:2018, *Design of post-installed and cast-in fastenings in concrete*.

The objective of this document is to provide minimum design requirements for fastenings used to transmit loads to concrete for safety-critical applications.

Standards Australia acknowledges and thanks the European Committee for Standardization—CEN, Rue de la Science 23, B-1040 Brussels, Belgium for permission to reproduce its content in the development of this document.

Standards Australia thanks the ICC Evaluation Service for permission to reproduce [Clause 4.3.3.2.1](#), equations in [Figure 4.3.3.2.1.2\(A\) and \(B\)](#) and equations in [Figure 4.3.3.2.2.2](#) from AC232:2019, *Anchor Channels in Concrete Elements*. These text and equations are copyright of ICC-ES. All rights reserved.

The major changes in this edition are as follows:

- (a) Design of fasteners for seismic actions.
- (b) Design of anchor channels.
- (c) Design of redundant non-structural systems.
- (d) Design of post-installed reinforcing bar connections.

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.

**This document 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 document.**

## Contents

Preface .....	ii
<b>Section 1 Scope and general .....</b>	<b>1</b>
1.1 Scope and application .....	1
1.1.1 Scope .....	1
1.1.2 Application .....	1
1.2 Normative references .....	2
1.3 Terms and definitions .....	3
1.4 Notation .....	11
1.5 Loading on fasteners .....	17
<b>Section 2 Materials and installation .....</b>	<b>18</b>
2.1 Types of fasteners and fastener groups .....	18
2.2 Dimensions of fasteners .....	19
2.3 Fastener materials .....	19
2.4 Concrete .....	19
2.5 Reinforcement .....	20
<b>Section 3 General design requirements .....</b>	<b>21</b>
3.1 General .....	21
3.2 Verifications for design .....	21
3.2.1 Strength limit state .....	21
3.2.2 Serviceability limit state .....	21
3.2.3 Load factors .....	22
3.2.4 Capacity reduction factors .....	22
3.3 Concrete condition .....	23
3.4 Verification of fastener strength .....	23
3.4.1 General .....	23
3.4.2 Tensile strength of fastener .....	24
3.4.3 Shear strength of fastener .....	28
3.4.4 Combined tension and shear strength of fastener .....	32
<b>Section 4 Determination of forces acting on fasteners .....</b>	<b>33</b>
4.1 General .....	33
4.2 Post-installed fasteners .....	33
4.2.1 Tension and compression loads .....	33
4.2.2 Shear loads .....	35
4.3 Anchor character .....	39
4.3.1 General .....	39
4.3.2 Tension loads .....	39
4.3.3 Shear loads .....	40
4.4 Supplementary reinforcement .....	43
4.4.1 General .....	43
4.4.2 Applied tension loads .....	44
4.4.3 Applied shear loads .....	44
<b>Section 5 Detailing of supplementary reinforcement .....</b>	<b>46</b>
<b>Section 6 Design for tensile loading .....</b>	<b>48</b>
6.1 General .....	48
6.2 Post-installed fasteners .....	48
6.2.1 General .....	48
6.2.2 Steel failure .....	48
6.2.3 Concrete cone failure .....	48
6.2.4 Pull-out failure .....	54
6.2.5 Combined pull-out and concrete cone failure for post-installed chemical fasteners .....	54
6.2.6 Concrete splitting failure .....	57

6.2.7	Concrete blow-out failure.....	59
6.2.8	Supplementary reinforcement.....	63
6.2.9	Redundant fastenings in non-structural applications.....	63
6.3	Cast-in anchor channel.....	63
6.3.1	General.....	63
6.3.2	Steel failure.....	63
6.3.3	Concrete cone failure.....	64
6.3.4	Pull-out failure.....	68
6.3.5	Concrete splitting failure.....	69
6.3.6	Concrete blow-out failure.....	70
6.3.7	Supplementary reinforcement failure.....	71
<b>Section 7</b>	<b>Design for shear loading.....</b>	<b>72</b>
7.1	General.....	72
7.2	Post-installed fasteners.....	72
7.2.1	General.....	72
7.2.2	Steel failure.....	72
7.2.3	Concrete edge failure.....	73
7.2.4	Concrete pry-out failure.....	80
7.2.5	Supplementary reinforcement.....	81
7.2.6	Redundant fastenings in non-structural applications.....	82
7.3	Cast-in anchor channel.....	82
7.3.1	Shear load acting perpendicular to longitudinal axis of the channel.....	82
7.3.2	Shear load acting along the longitudinal axis of the channel.....	88
<b>Section 8</b>	<b>Design for combined tension and shear loading.....</b>	<b>91</b>
8.1	Steel failure.....	91
8.1.1	Post-installed fasteners.....	91
8.1.2	Cast-in anchor channel.....	91
8.2	Failure modes other than steel.....	93
8.2.1	Post-installed fasteners.....	93
8.2.2	Cast-in anchor channel.....	94
8.3	Additional verification for fasteners with supplementary reinforcement.....	94
8.3.1	Post-installed fasteners.....	94
8.3.2	Cast-in anchor channel.....	95
<b>Section 9</b>	<b>Design for serviceability.....</b>	<b>96</b>
9.1	Verification of serviceability limit state — Displacement.....	96
9.2	Verification of serviceability limit state — Supplementary reinforcement.....	96
<b>Appendix A</b>	<b>(normative) Testing and assessment of fasteners.....</b>	<b>97</b>
<b>Appendix B</b>	<b>(informative) Means for demonstrating conformance to this standard.....</b>	<b>102</b>
<b>Appendix C</b>	<b>(normative) Verification of strength of concrete elements to loads applied by fasteners.....</b>	<b>104</b>
<b>Appendix D</b>	<b>(normative) Design of post-installed reinforcing bar connections.....</b>	<b>106</b>
<b>Appendix E</b>	<b>(normative) Design of redundant non-structural system.....</b>	<b>109</b>
<b>Appendix F</b>	<b>(normative) Design of fastenings under seismic actions.....</b>	<b>112</b>
<b>Appendix G</b>	<b>(informative) Assumptions for the design and installation of fasteners.....</b>	<b>115</b>
<b>Appendix H</b>	<b>(informative) Simplified methods of design for post-installed fasteners.....</b>	<b>117</b>
<b>Bibliography</b>	<b>.....</b>	<b>120</b>

# Australian Standard®

## Design of post-installed and cast-in fastenings in concrete

### Section 1 Scope and general

#### 1.1 Scope and application

##### 1.1.1 Scope

This document specifies minimum requirements for the design of fastenings used to transmit loads to concrete for safety-critical applications.

The fasteners covered in this document are as follows:

- (a) Post-installed fasteners:
  - (i) Mechanical fasteners (e.g. expansion fasteners, undercut fasteners and concrete screws).
  - (ii) Chemical fasteners (e.g. chemical fasteners, chemical expansion fasteners).
- (b) Cast-in anchor channel with rigid connection (e.g. forged or welded) between the channel profile and anchor.

This document also includes requirements for the testing and assessment of post-installed and cast-in fasteners to establish the necessary design parameters for use with this document.

The design provisions in this document are relevant to static, quasi-static and seismic loading that may include tension, shear, bending or torsion moments or a combination thereof.

The design provisions in this document do not apply to the following:

- (i) Design of fixtures.
- (ii) Design of fastenings for exposure to fire and durability.
- (iii) Design of anchor channel for seismic actions.
- (iv) Fasteners for lifting, transport and erection (e.g. brace inserts, lifting inserts, etc.), headed fasteners, ferrules, headed reinforcement and anchorage for prestressing strands.

NOTE For design actions, fastener products, substrates and applications not covered by the scope of this document, the design engineer should seek technical advice from the fastener supplier in relation to the suitability of the selected fastener for the intended application.

**C1.1.1** *The design theory for fastenings embodied in this document utilizes the tensile strength of concrete and is closely based on the design procedure published in EN 1992-4.*

*The design and installation provisions of this document have been developed on the assumption that materials used and their maintenance ensure that the installed fasteners will fulfil their intended function for the intended life of the structure.*

##### 1.1.2 Application

This document relies upon design parameters and product specifications that define a fastener's suitability for a given application. The testing and assessment of a fastener shall be performed in accordance with the requirements of [Appendix A](#). All necessary design parameters such as characteristic values and product specifications such as geometric and material properties required for