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

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

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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.

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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

Sections 2 to 9 of this document shall be obtained from an assessment report prepared in accordance with Appendix A.

NOTE 1 The design parameters and product specifications required for use with this document may also be obtained from a current European Technical Assessment for the relevant fastener.

NOTE 2 This standard does not cover site testing of fasteners. Guidance on site testing is available in AEFAC Technical Note 05: Guidelines for Site Testing of anchors Vol.1 – Vol.4.

Concrete members shall be composed of normal-weight concrete without fibres and shall conform to the requirements of Clause 2.4.

Supplementary reinforcement and reinforcing steel inserts in chemical fasteners shall have a ductility class type N in accordance with AS/NZS 4671.

Chemical fasteners intended for applications involving sustained tensile loads shall be qualified for sustained loading applications in accordance with Appendix A.

1.2 Normative references

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

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

AS 1012.9, *Methods of testing concrete, Method 9: Compressive strength tests—Concrete, mortar and grout specimens*

AS 1170.4, *Structural design actions, Part 4: Earthquake actions in Australia*

AS 1379, *Specification and supply of concrete*

AS 3600, *Concrete structures*

AS 4100, *Steel structures*

AS/NZS 1170.0, *Structural design actions, Part 0: General principles*

AS/NZS 4671, *Steel reinforcing materials*

AEFAC Technical Note 10, *Prequalification and design requirements for fastenings under seismic actions*, Australian Engineered Fasteners and Anchors Council (AEFAC), www.aefac.org.au

EOTA TR049, *Post-installed fasteners in concrete under seismic action*

EAD 330008, *Anchor channels*

EAD 330087, *Systems for post-installed rebar connections with mortar*

EAD 330232, *Mechanical fasteners for use in concrete*

EAD 330499, *Bonded fasteners for use in concrete*

EAD 330747, *Fasteners for use in concrete for redundant non-structural systems*

1.3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

C1.3.16 *Concrete blow-out failure is usually experienced by fasteners that have a deep embedment and small side cover.*

C1.3.47 *Under-utilized reinforcement in the concrete member may be used for supplementary reinforcement.*

C1.3.48 *The lateral expansion occurs in a torque-controlled expansion fastener due to the application of torque to the fastener during installation. Follow-up expansion may occur due to the application of tensile load.*

1.3.1
action
set of concentrated or distributed forces acting on a structure (direct action), or deformation imposed on a structure or constrained within it (indirect action)

1.3.2
anchor
headed component of anchor channel

Note 1 to entry: In Australian practice, a fastener installed in concrete may be referred to as an "anchor", such as "mechanical anchor" and "chemical anchor". For clarity in this document the term "anchor" is reserved for the headed component of the anchor channel.

1.3.3
anchor channel
fastener made of profiled steel element with two or more rigidly connected anchors that are installed into position prior to the casting of concrete (see Figure 1.3(B))

1.3.4
base material
material in which the fastener is installed

1.3.5
bond failure
mode of failure for chemical fasteners characterized by pull-out of the fastener caused by either separation at the interface of the bonding compound and the embedded steel element or between the bonding compound and the base material

1.3.6
capacity reduction factor
factor used to multiply the nominal capacity to obtain the design capacity

1.3.7
cast-in fastener
fastener that is installed into position prior to the casting of concrete (see Figure 1.3(B))

1.3.8
channel bolt
screw or bolt positioned in the steel profile of the anchor channel that is used to connect an element to the anchor channel

1.3.9
characteristic edge distance
distance required between the free edge of a concrete member and the centre-line axis of the fastener in order to develop the characteristic strength of the fastener

1.3.10
characteristic spacing
specific distance required between two fasteners having the same characteristics in order for the characteristic strength of the fasteners to be achieved

1.3.11
characteristic strength
5 % fractile strength (value with a 95 % probability of being exceeded with a confidence of 90 %)

1.3.12
chemical fastener
post-installed fastener that includes a steel element (threaded rod or reinforcing bar) and a bonding compound that transmits loads from the embedded steel element into the base material

Note 1 to entry: Also known as bonded fastener.

1.3.13
chemical expansion fastener
chemical fastener with an embedded steel element with a profile specially designed such that the application of displacement on it results in follow-up expansion

Note 1 to entry: Also known as bonded expansion fastener.

1.3.14
chemical product
chemical placed between the wall of the drilled hole in the concrete and the embedded portion of the fastener (see Figure 1.3(A) (e) and (f))

Note 1 to entry: Also known as “bonding compound”, “adhesive” or “chemical”.

1.3.15
combined pull-out and concrete cone failure
possible mode of failure of chemical fasteners characterized by bond failure in the lower portion of the embedded fastener and concrete cone failure in the upper portion of the embedded fastener

1.3.16
concrete blow-out failure
mode of failure characterized by spalling of the side face of the concrete member that is confined to a region adjacent to the head of the fastener

Note 1 to entry: This failure mode does not involve concrete break-out at the top surface of the concrete member.

1.3.17
concrete cone failure
mode of failure characterized by the formation of a cone or wedge of concrete surrounding a fastener or group of fasteners that become separated from the base material

1.3.18
concrete pry-out failure
mode of failure characterized by the formation of a concrete spall on the opposing side of the fastener, relative to the direction of shear loading

1.3.19
concrete screw
post-installed fastener installed into a pre-drilled hole that contains threads to engage with the concrete via mechanical interlock

1.3.20
concrete splitting failure
mode of failure characterized by cracks in the concrete member which form in the plane of the axis of the fastener