

AEFAC - TN02

PREQUALIFICATION OF POST-INSTALLED AND CAST-IN FASTENERS

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1. Scope

The purpose of this document is to explain prequalification of fasteners and outline the benefits of selecting independently qualified fastener products.

A prequalification provides the certainty that a product is fit for its intended use. It involves independently testing and assessing a product against state-of-the-art standards. AEFAC recognises prequalification as promoting best practice.

2. Terminology

The following terminologies and definitions are used in this Technical Note. Please refer to AEFAC Fastener Dictionary [1] for additional terminologies and definitions.

AVCP: Assessment and Verification of Constancy of Performance is a high-level quality control system that ensures the product continues to perform in accordance with its technical specification such as an ETA or harmonised European standard for the duration of its production. The system is in place for construction products in the Construction Products Regulation for Europe.

CE Marking: Conformité Européene (European Conformity) Marking which is a symbol denoting a manufacturer has conformed to the Essential Requirements of the Construction Products Regulation. The CE is only applicable to products that have an ETA and an AVCP system in place.

CEN: European Committee for Standardisation that is responsible for the planning, drafting and adoption of European Standards.

DoP: Declaration of Performance (DoP) is a document published by the manufacturer that includes the essential characteristics of a product. The DoP is generated when a product is covered by a harmonised European standard or an ETA. The manufacturer therefore assumes the legal responsibility of the product conforming to the declared performance.

EAD: European Assessment Document (EAD) is the replacement for an ETAG. An EAD provides the framework for testing and assessment of fasteners, except design methods have been removed and placed in European Standard EN 1992-4 [2].

EOTA: European Organisation for Technical Assessments (EOTA) (formerly European Organisation for Technical Approvals) comprises of Technical Assessment nominated to issue European Technical Assessments (ETAs) by EU Member States and European Free Trade Association States who have contracted to the European Economic Area Agreement. The EOTA monitors the drafting of ETAs and co-ordinates all activities relating to the issuance of ETAs.

ETA: European Technical Assessment (ETA) (formerly European Technical Approval) is prequalification for a construction product that represents a favourable technical assessment of its fitness for an intended use.

3. Introduction

In Australia, fasteners for construction do not currently require prequalification to be legally placed in the market. However, AS 5216 [3] requires the fasteners used in safety critical applications to have prequalification according to Appendix A of AS 5216. Prequalification is to ensure products meet minimum performance requirements for safety critical applications [4]. Prequalification provides independent verification that a product will perform as intended under environmental conditions and applied loads listed by the manufacturer. This document outlines the merits of using fasteners with prequalification reports, such as ETAs, for construction work.

4. Guidelines for prequalification

In Australia, in order for a fastener to be designed according to AS 5216, it must first have been tested and assessed (prequalified) in accordance with AS 5216 Appendix A. Alternatively, a product with a European Technical Assessment (ETA) demonstrating its fitness for purpose within the scope given in the ETA can be designed according to AS 5216.

In Europe, a product may carry the CE marking only if it has been issued with an ETA and the relevant conformity control measures are implemented by the manufacturer. In the past, ETAs were reviewed every five years. However, the period of validity of an ETA awarded after 1st of July 2013 is not limited provided the system for Assessment and Verification of Constancy of Performance (AVCP) is in place. An ETA is awarded to a single product only and is non-transferable to any other product, made either by the same or different manufacturer.

5. Prequalification of fasteners for use in concrete

AS 5216 requires testing and assessment of post-installed fasteners to be done in accordance with Appendix A of the standard. The requirements for testing and evaluation are similar to the ones in EAD 330232 [5] (for mechanical fasteners), EAD 330499 [6] (for chemical fasteners) and EAD 330008 [7] (for anchor channels).

5.1. Options

The Option number (refer to Table 1) determines the scope of the application for which the fastener performance has been independently verified. In total there are 12 possible combinations reflected in the Option number. The factors determining the Option number include the state of the concrete (cracked and non-cracked, or non-cracked only), concrete strength, direction of loading (single value covering all directions, or separate for tension and shear), effect of reduced edge and spacing distances, and design method. Options 1 (cracked and non-cracked concrete) and 7 (non-cracked concrete) are the most demanding test regimens, while Options 6 and 12 have the least demanding test regimes. The selection of a product for a given application must therefore ensure the Option covers the required criteria.

Table 1: Assessment Options for post-installed fasteners covered by AS 5216

Option No.	Concrete		Requirements for Specification				Reduced edge & spacing	Design Method as per Annex E
	Cracked & uncracked	Uncracked only	$f'_c = 20 \text{ MPa}$	$20 < f'_c \leq 50 \text{ MPa}$	One value for all directions	Different value for different direction		
1	✓			✓		✓	✓	A
2	✓		✓			✓	✓	A
3	✓			✓	✓		✓	B
4	✓		✓		✓		✓	B
5	✓			✓	✓			C
6	✓		✓		✓			C
7		✓		✓		✓	✓	A
8		✓	✓			✓	✓	A
9		✓		✓	✓		✓	B
10		✓	✓		✓		✓	B
11		✓		✓	✓			C
12		✓	✓		✓			C

5.2. Testing methods

A series of comprehensive tests are undertaken to measure the performance of the fastener against set criteria. The tests reflect factors that may be encountered during installation or during the expected service life of the fastener. However, it is important to note the scope of a prequalification document, such as an ETA, excludes gross installation errors. Correct installation is therefore critical.

5.2.1. Reference tests

Reference tests are performed as benchmarks of performance for later comparison during the assessment of performance. These tests are performed under 'ideal' conditions.

5.2.2. Suitability tests

The suitability tests are used to measure the performance of an fastener in adverse conditions. The required tests depend on the Option number and include a combination of the following:

- Installation safety tests
- Functioning in low or high strength concrete
- Functioning in crack movements
- Repeated loads
- Sustained loads
- Torque tests
- Functioning under freeze/thaw conditions
- Effect of installation direction

5.2.3. Tests for durability

Tests are conducted to ascertain durability performance involving either immersion in an alkaline solution or exposure to sulphurous atmospheres.

5.3. Assessment of tests

The assessment and judgement of a fastener's performance for its intended use includes an examination of load/displacement behaviour, as well as change in performance when certain factors are varied. If the requirements of the tests are met, the characteristic resistance of the product is determined. The published characteristic resistance is based upon the basic characteristic resistance determined from reference tests, modified according to environmental conditions and then reduced according to partial safety factors to account for uncertainty related to test results and installation.

5.4. Supplementary references for prequalification

A number of EADs / ETAGs relating to fastener prequalification, besides AS 5216, have been published and include:

- EAD 330196 “Plastic anchors made of virgin or non-virgin material for fixing of external thermal insulation composite systems with rendering” [8]
- EAD 330076 “Metal injection anchors for use in masonry” [9]
- EAD 330083 “Power-actuated fastener for multiple use in concrete for non-structural applications” [10]
- EAD 330087 “Systems for post-installed rebar connections with mortar” [11]
- EAD 330250 “Post-installed fasteners in concrete under fatigue cyclic loading” [12]
- EAD 330747 “Fasteners for use in concrete for redundant non-structural systems” [13]
- ETAG 020 “Guideline for European Technical Approval of Plastic anchors for multiple use in concrete or masonry for non-structural applications” [14]

Technical Reports (TR) published by the EOTA are developed as supporting reference documents to EADs / ETAGs. Technical Reports are evolving documents, expressing the common understanding of existing knowledge and experience of the EOTA bodies at a particular point in time. A number of Technical Reports have been published relating to fastener prequalification that include:

- TR048 “Details of tests for post-installed fasteners in concrete” [15]
- TR049 “Post-installed fasteners in concrete under seismic action” [16]
- TR051 “Recommendations for job-site tests of plastic anchors and screws” [17]
- TR053 “Recommendations for job-site tests of metal injection anchors for use in masonry” [18]
- TR054 “Design methods for anchorages with metal injection anchors for use in masonry” [19]

6. Design methodology for fasteners having prequalification

AS 5216 covers the design of fasteners for safety critical applications which covers both post-installed and cast-in anchor channel. The design theory is closely based on the design procedure given in EN 1992-4.

Supporting references such as the EOTA Technical Reports are also available for some fasteners which are not covered in AS 5216.

7. Selecting prequalified fasteners

One of the most important design considerations when selecting a fastener is the state of the concrete. Concrete may crack due to a variety of reasons. The state of the concrete must be checked in accordance with AS 5216.

Fasteners designed for cracked concrete automatically qualify for use in non-cracked concrete. Where cracked concrete is expected, fasteners with Options 1 – 6 in their prequalification report such as ETA should be selected, whereas fasteners qualified only in non-cracked concrete applications should be selected according to Options 7 – 12.

8. Installing prequalified fasteners

Structural capacity of fasteners is sensitive to installation. While the prequalification includes provision for a ‘reasonable’ variation from ideal installation practice, gross errors are beyond the scope of the prequalification. The installer should ensure that proper training has been received and that adequate supervision of fastener installation is undertaken for the fastener to be considered fit for its intended use. The installation procedure as recommended by the manufacturer must always be followed.

Correct installation is imperative to ensure the designer’s intent is met. In order to ensure correct installation, the following two steps are important:

1. Ensure an accurate and complete specification is provided. Recommendations are provided in the AEFAC publications [20-26]
2. AS 5216 Appendix B Clause B2 recommends the installer is competent and suitably qualified through the AEFAC Installer Certification Program and/or a specific training program from the product supplier. For further information on the AEFAC Installer Certification Program, please visit AEFAC website (www.aefac.org.au).

9. Benefits of prequalification

Fastener products having prequalification most likely require a modest upfront investment. However, prequalification provides the designer and builder with the necessary confidence that the selected products are fit for purpose and independently verified.

There are clear advantages to selecting fastener products with a prequalification, including:

- Fasteners with prequalification in accordance with Appendix A of AS 5216 can be designed using AS 5216
- Provides confidence for designers and builders that the fastener is fit for purpose since it has been prequalified under an assessment procedure.
- Confidence that the fastener will perform as intended for the duration of its design life.

- Prequalification reflects the required level of performance according to current state-of-the-art assessment techniques that have been independently verified.
- Ensures quality assurance and safety standards are achieved.
- Ensures a safety margin exists for 'reasonable' variations from the manufacturer's installation instructions during installation.
- Ensures the inclusion of comprehensive installation instructions supplied by the manufacturer with all required information for installation.

10. References

- [1] AEFAC, Technical Note: AEFAC Fastener Dictionary, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [2] EN 1992-4 Eurocode 2. Design of concrete structures. Design of fastenings for use in concrete, CEN, 2018
- [3] Standards Australia, AS 5216: Design of post-installed and cast-in fastenings in concrete, SAI Global, Sydney, 2018.
- [4] Construction Fixings Association, ETAs and design methods for Anchors used in Construction, Guidance note, www.fixingscfa.co.uk
- [5] EAD 330232, Mechanical fasteners for use in concrete, EOTA
- [6] EAD 330499, Bonded fasteners for use in concrete, EOTA
- [7] EAD 330008, Anchor channels, EOTA
- [8] EAD 330196, Plastic anchors made of virgin or non-virgin material for fixing of external thermal insulation composite systems with rendering, EOTA
- [9] EAD 330076, Metal injection anchors for use in masonry, EOTA
- [10] EAD 330083, Power-actuated fastener for multiple use in concrete for non-structural applications, EOTA
- [11] EAD 330087, Systems for post-installed rebar connections with mortar, EOTA
- [12] EAD 330250, Post-installed fasteners in concrete under fatigue cyclic loading, EOTA
- [13] EAD 330747, Fasteners for use in concrete for redundant non-structural systems, EOTA
- [14] ETAG 020 "Guideline for European Technical Approval of Plastic anchors for multiple use in concrete or masonry for non-structural applications", EOTA

TECHNICAL NOTE:

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- [15] TR 048, Details of tests for post-installed fasteners in concrete, EOTA
- [16] TR 49, Post-installed fasteners in concrete under seismic action, EOTA
- [17] TR 51, Recommendations for job-site tests of plastic anchors and screws, EOTA
- [18] TR 53, Recommendations for job-site tests of metal injection anchors for use in masonry, EOTA
- [19] TR 54, Design methods for anchorages with metal injection anchors for use in masonry, EOTA
- [20] AEFAC, Technical Note: Guideline for the specification of fastenings to concrete – engineering general notes, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [21] AEFAC, Sample Specification: Bonded anchors, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [22] AEFAC, Sample Specification: Torque-controlled expansion anchors, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [23] AEFAC, Sample Specification: Deformation-controlled expansion anchors, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [24] AEFAC, Sample Specification: Screw anchor, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [25] AEFAC, Sample Specification: Shield Anchor, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [26] AEFAC, Sample Specification: Anchor channel, Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.



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