

AEFAC - TN09

SELECTION AND INSTALLATION OF FASTENERS IN MASONRY

Ver. 1.0
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TECHNICAL NOTE:

INSTALLATION OF FASTENERS IN MASONRY

1. Scope

Design provision for fastenings in masonry is currently not covered in AS 5216 [1].

This Technical Note provides guidelines for selection and installation of chemical and mechanical fasteners in masonry. The masonry could be clay brick or cement blocks and may be solid or hollow.

This Technical Note is applicable for mechanical and chemical post-installed fasteners to be used in masonry under tension and shear actions and does not cover fasteners under seismic, impact and fatigue loads.

Fasteners for multiple use are not covered in this Technical Note.

The basis of this Technical Note is from CFA guidelines [2, 3] and British Standard BS 8539 [4].

2. Terminology

The following terminologies and definitions are used in this Technical Note. Please refer to AEFAC Anchor Dictionary [5] for additional terminologies and definitions.

Course: A course is a layer of the same masonry unit running horizontally in a masonry wall.

European Assessment Document (EAD): documentation of the methods and criteria for the assessment of the performance of a construction product in relation to its essential characteristics.

European Technical Assessment (ETA): a certification that is awarded by EOTA (European Organisation for Technical Assessment) for products that have been rigorously tested and independently assessed to satisfy the requirements of EADs and demonstrated to be fit for their intended purposes.

Fastener: a type of device that is post-installed into matured concrete or masonry, or cast into concrete. Also known as anchor.

Masonry: building element constructed from masonry units, such as bricks, blocks or stones.

Masonry unit: general term used for any individual brick, block or stone.

Specifier: person or organization responsible for the selection (including anchor design) and specification of an anchor. The specifier might or might not be the designer.

Void: holes formed in perforated bricks and hollow blocks.

3. Selection of suitable fasteners

3.1. Factors affecting the performance of fasteners in masonry

There are several factors that need to be considered when designing, selecting and installing fasteners in masonry. For example; the wide range of strength and quality of masonry unit and mortar, the possibility of voids in the masonry unit, and the position of fasteners (usually when the surface is rendered/plastered and the locations of joints and courses are hidden). Some of the factors which needs to be considered during design, selection and installation of fasteners are discussed below.

Masonry unit

In general, better behaviour of fastenings is achieved with a stronger masonry unit. However, there are other factors that need to be considered as well. The performance of the fastenings depends on the nature of the unit itself. The behaviour of fasteners may be different in masonry with hollow blocks compared to solid blocks, even if the blocks look the same from the outside. It is very important to know the nature of the unit before deciding a suitable fastener.

Size of masonry unit and thickness of masonry wall

The behaviour of the fastenings depends on the size of the masonry unit and the thickness of the masonry. In general, better behaviour is achieved if the multiple layers of the masonry units are engaged.

Mortar

Similar to the masonry unit, the mortar has influential effect on the behaviour of masonry fasteners, if the mortar is present in the masonry. The quality, strength and the amount of mortar are some of the important factors that need to be considered while designing, selecting and installing the fasteners in the mortar.

Size and position of the fixing

The behaviour and strength of fasteners is dependent on the location of fasteners within the unit and also within the wall. The general guidelines about the location of fasteners is given in section 6 of this technical note.

Surface Condition

It is very difficult to identify the type of masonry unit and to locate the joint if the surface of the masonry is rendered or plastered.

TECHNICAL NOTE:

INSTALLATION OF FASTENERS IN MASONRY

Type of fasteners

There is limited type of fasteners that are suitable for particular type of masonry. The fasteners that are suitable for solid brick masonry may not be appropriate for hollow block masonry or stone masonry. Care should be given while selecting the fasteners.

Durability requirement

Durability requirement of the connection is an important parameter to be considered while selecting the suitable fasteners. The exposure requirement and the local environmental conditions should be considered.

Other factors

The following parameters also need to be considered when selecting a suitable parameter:

- Fire resistance
- Size, configuration and number of fasteners

3.2. Selection of suitable fasteners in masonry

Fasteners in masonry can be divided into three generic types:








- Chemical (bonded) fasteners
- Expansion anchors and
- Undercut fasteners

Any of these fastener types may be used in concrete, however, care should be taken in selecting a suitable fastener for use in masonry. A fastener that is suitable for one type of masonry may not be suitable for another type of masonry. Masonry and its unit vary significantly from one application to another. The pre-qualification documents may not cover the type of the masonry on site. Whenever available, the suitability of a fastener for a particular masonry type should be selected based on ETAs or similar pre-qualification documents. A general guideline for selection of appropriate type of fasteners is presented in Table 1. Before deciding the suitable fasteners for masonry, the factors explained in Section 4.1 should also be considered.

TECHNICAL NOTE:

INSTALLATION OF FASTENERS IN MASONRY

Table 1: Base material Suitability (Modified from CFA Guidelines)

Fixing	Clay Brick		Concrete Block				Stone	Typical Example
	Solid	Perforated	Dense Agg - Solid	Light Agg - Solid	Light Agg - Hollow	Aerated		
Chemical fasteners	✓✓	✓✓*	✓✓	✓✓	✓✓*	✓✓	✓✓	
Steel screw	✓✓	✓	✓✓	✓✓		✓	✓✓	
Torque Controlled Expansion fasteners (Thin sleeve)	✓✓	✓	✓✓	✓			✓	
Torque Controlled Expansion fasteners (Thick sleeve) [†]	✓		✓				✓	
Undercut							✓	
Plastic Plug	✓✓		✓✓	✓✓	✓	✓	✓✓	
Self-threading / Hammer in plug (plastic)	✓✓		✓✓	✓✓		✓	✓	
✓✓ - Suitable ✓ - Limited suitability If in doubt, ask the manufacturer								

* Proper sized mesh or sleeves may be required, check prequalification/technical documentation for suitable products.

† Small sizes torque controlled expansion fasteners may only be used due to the risk of splitting of the masonry unit.

4. Prequalification and Design of fasteners

For chemical fasteners, EAD 330076 [6] may be used for the prequalification of fasteners for use in masonry. For the prequalified fasteners, EOTA TR 054 [7] may be used for the design of chemical fasteners in masonry.

Where the application falls outside the scope of EAD 330076 and TR 054, advice from manufacturer/supplier needs to be sought.

5. Installation of fasteners

The performance of fasteners in masonry is largely dependent on the workmanship. The installation of fasteners in masonry requires high level of skills and supervision.

The installation instruction from the manufacturer should be strictly followed as applicable. Similar to installation of fasteners in concrete substrate, the following is the general installation procedure for post-installed fasteners in masonry:

1. Drill hole
Drill hole at the required location as per engineering specification to the recommended diameter and depth
2. Clean hole
The drilled hole needs to be cleaned thoroughly as specified by the manufacturer/supplier
3. Install fasteners
Insert the fasteners as per manufacturer installation instruction and using specified setting tools and accessories like proper sized mesh, if applicable
4. Tighten fasteners
Tighten the fastener according to the manufacturer's installation torque given for the specific masonry after full curing for chemical fasteners.

Special care should be taken while drilling into masonry. Drilling using powerful hammer or percussion drilling machine could be dangerous as it could produce larger holes in soft masonry. This may also cause the break out of the back of the masonry unit if sufficient thickness of masonry is not present. Rotary drill could be the better option in such case. Advice from manufacturer/supplier should be sought if in doubt.

Application of correct torque is important for all type of fasteners in masonry. Over tightening of fasteners in soft masonry could result in failure of anchorage. Care should be given in such soft masonry. Please note that some manufacturers recommend a reduced installation torque depending on the strength of the masonry. If this information is not available, the torque required for the masonry may be obtained from reducing the torque required in concrete in proportion to the strength of concrete and masonry (always consult the manufacturer/supplier). The proximity

of the fasteners to the edge of the masonry should be considered while deciding the appropriate torque.

Use of suitable accessories is important while using chemical fasteners in masonry. For example, the correct size of sleeve with compatible mesh sizes for a given chemical when used in hollow masonry. The perforation in sleeves are dependent on the viscosity of the chemical and should not be mixed and matched with other chemicals. If the chemical is too viscous and perforations are small, there would be insufficient bleed of chemicals resulting in poor attachment to the unit. Similarly, if the chemical is less viscous and perforations in sleeve are large, chemical will dribble into the cavity of the hollow unit.

6. Positioning rules for fasteners in masonry

Individual manufacturer/supplier provides the guidelines about the position of the fasteners within the masonry. Those guidelines should be followed as applicable.

The guidelines provided here are generic in nature and considered as best practice.

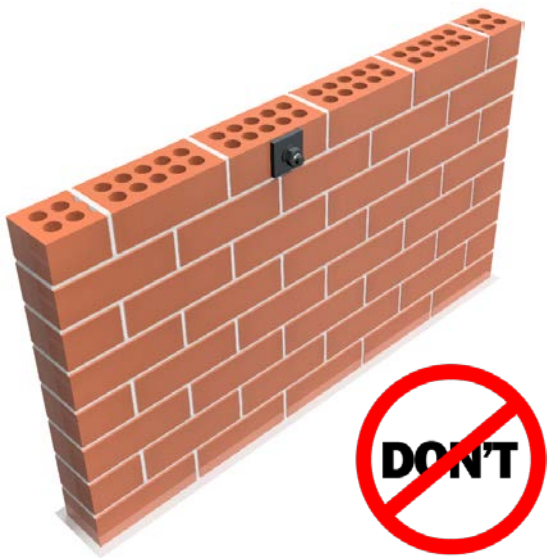
6.1. Position of the fasteners within the masonry unit

- Avoid installing multiple fasteners in an individual masonry unit. This is particularly important for expansion fasteners as they generate expansion forces during installation and may damage the unit.
- Locate the fasteners away from the edge of the masonry unit and position them close to the centre to the unit as possible.
- Leave enough space at the back of the unit (i.e., take note of the penetration depth of the fastener). This will prevent cracking or spalling of the masonry unit at the backside.

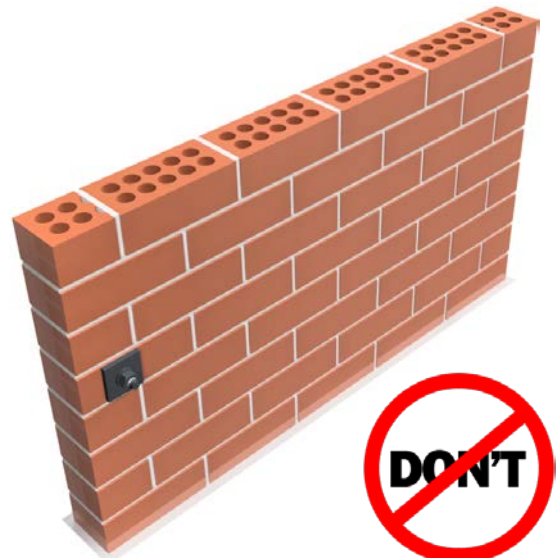
6.2. Position of the fasteners within the masonry wall

- The fasteners should be installed in such a way that it should be supported from surrounding structure. The fasteners should not be located at the top course or close to the edge of the wall. Allow at least 3 courses from the top of the wall and at least one complete unit from the edge of the wall as shown in Figure 1.
- Avoid installation of fasteners at the mortar joints, especially vertical joints. These vertical joints are often poorly filled and weakest part of the masonry.
- Try to engage back leaves, if there are more than one leaves, to take larger loads.
- Avoid setting embedment depth to coincide with joint between leaves.

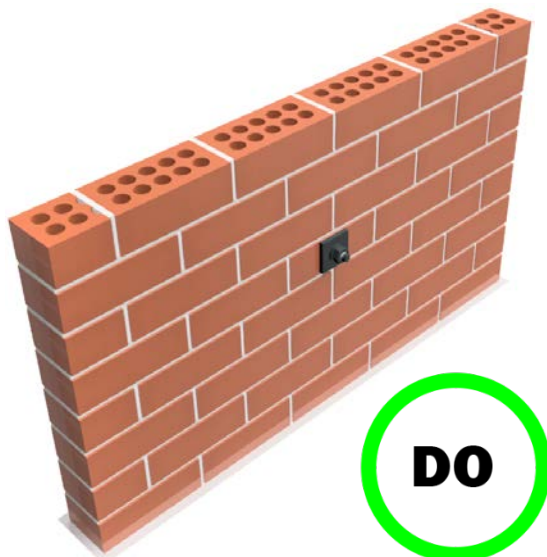
TECHNICAL NOTE: INSTALLATION OF FASTENERS IN MASONRY



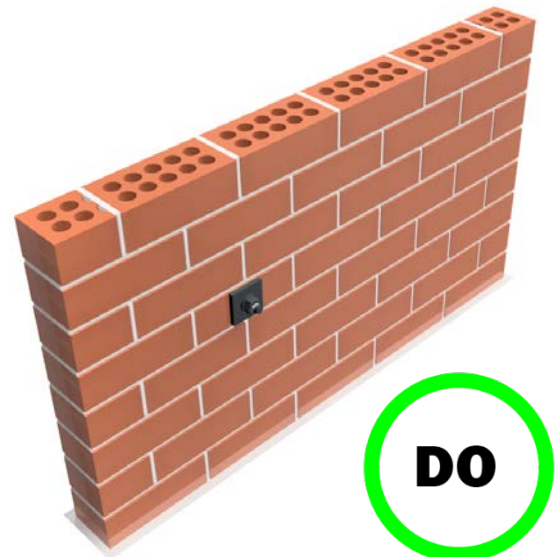
The fasteners should not be located at the top course. Allow at least 3 courses from the top of the wall.



The fasteners should not be located close to the edge of the wall. Allow at least one complete unit from the edge of the wall.

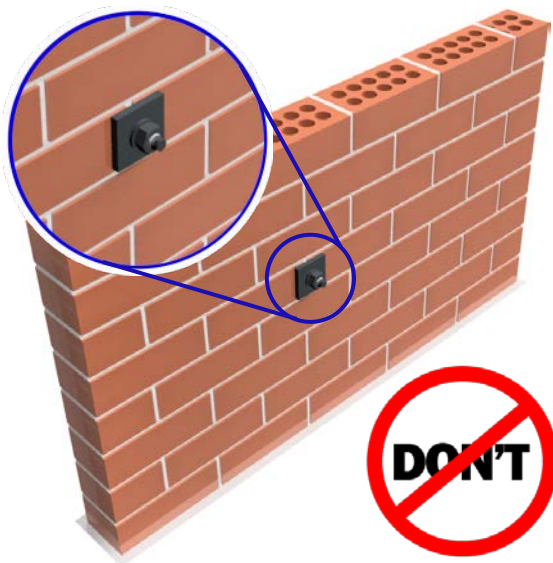


Avoid top three courses and fix centerline of the brick unit.

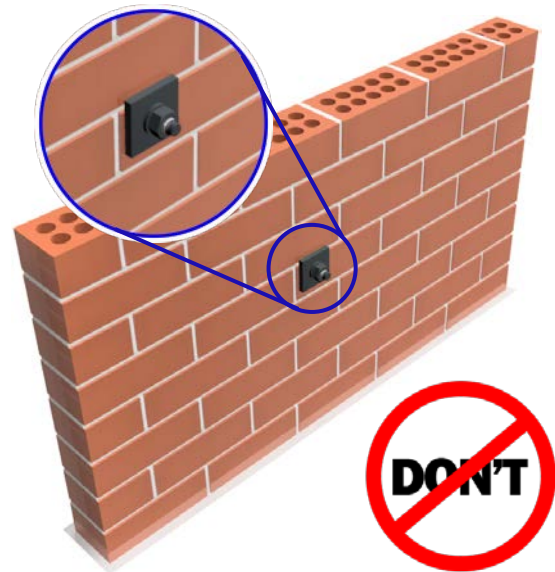


Leave at least one unit from the edge of the wall.

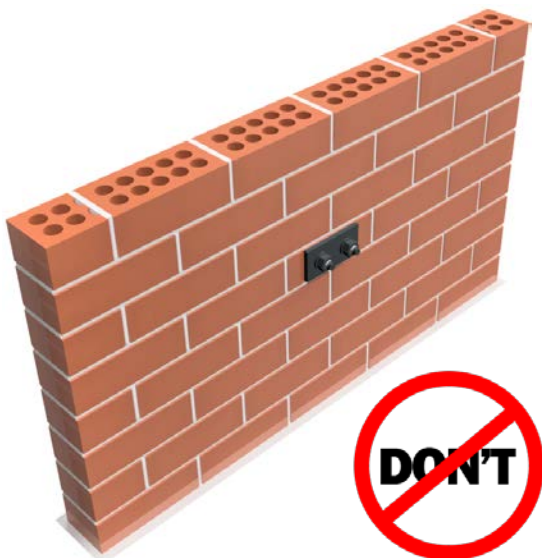
TECHNICAL NOTE: INSTALLATION OF FASTENERS IN MASONRY



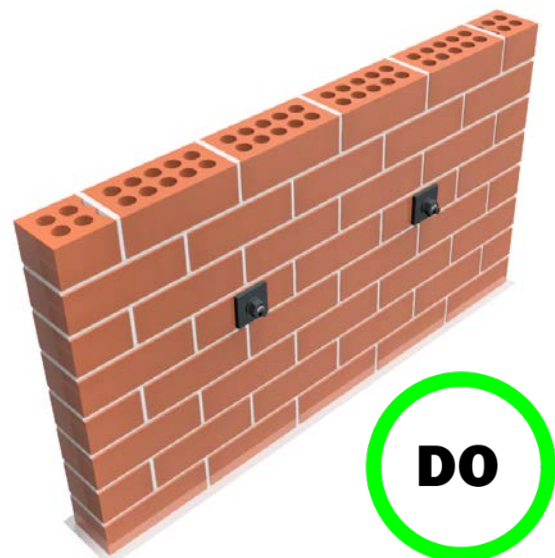
Avoid installation of fasteners at the mortar joints.



The fasteners should not be located close to the edge of the masonry unit. Position them close to the centre to the unit as possible.

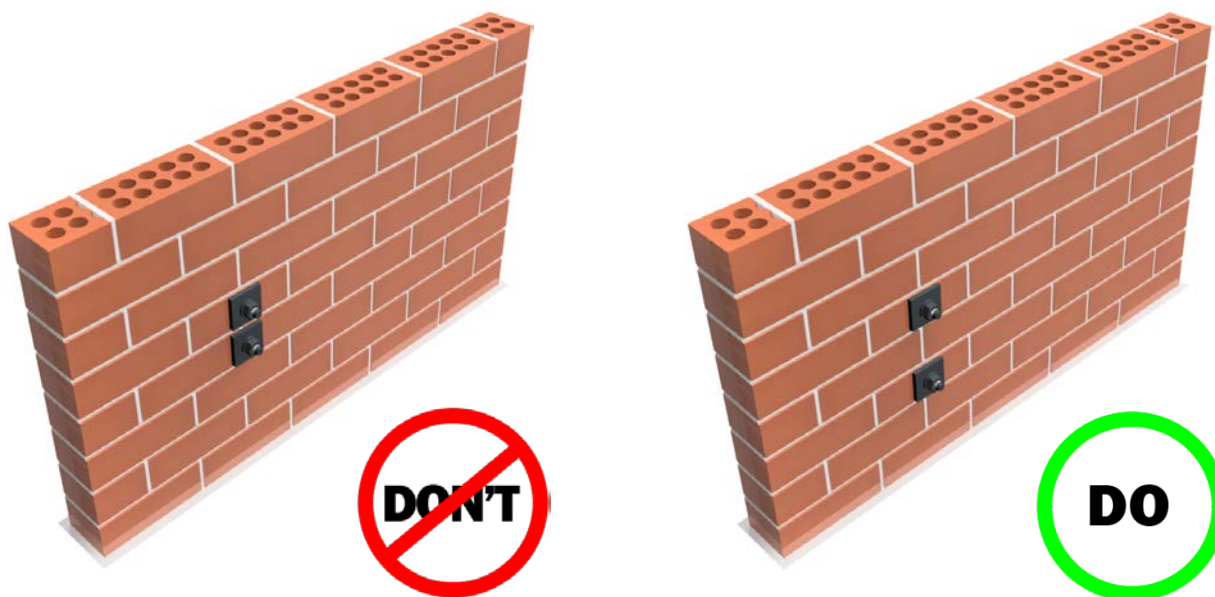


Avoid installing multiple fasteners in an individual masonry unit.



Anchors used to support significant loads should be located as further away as possible. They should not be located in adjacent units.

TECHNICAL NOTE: INSTALLATION OF FASTENERS IN MASONRY



Anchors used to support significant loads should not be located in adjacent units unless they are set at an embedment depth sufficient to locate the main bond in the remote leave.

Anchors used to support significant loads should be located as further away as possible. They should not be located in adjacent units.

Figure 1: Position of fixings

7. Site Testing

If the strength of the base material is not known, site testing should be performed to verify the suitability of the chosen fasteners and to estimate the resistance of the fasteners. Please refer to AEFAC Technical Note: “Guidelines for Site Testing of anchors - Volume 4: Testing in Masonry” [8].

8. Dos and Don'ts

8.1. Dos

- Anchors should only be set in structures strong enough to take the required loads
- Install anchor within the centre of the masonry unit
- Leave sufficient spacing from unsupported edge and from top of wall
- The fasteners should be supported from surrounding structure
- Engage back leaves for higher load

8.2. Don'ts

- No anchor should be located in a masonry unit at the edge of a wall
- No anchor should be placed closer to the top of an unrestrained wall
- No more than one anchor to be located in a single masonry unit
- Anchors used to support significant loads should not be located in adjacent units unless they are set at an embedment depth sufficient to locate the main bond in the remote leave
- Do not set embedment depth to coincide with joint between leaves
- No bonded anchors to be located in mortar joints
- Do not mix and match the sleeves and chemical
 - Too viscous/too small perforations – insufficient bleed
 - Too low viscosity/too large perforations – chemical will dribble into cavity
- Do not use powerful hammers or percussion drilling
- Do not hit/apply load anchor during curing time

9. References

- [1] Standards Australia, AS 5216: Design of post-installed and cast-in fastenings in concrete, SAI Global, Sydney, 2018.
- [2] CONSTRUCTION FIXINGS association - Fixings for Brickwork
- [3] CONSTRUCTION FIXINGS association – Guidance Note: Fixings for Brickwork and Blockwork
- [4] BS 8539: Code of practice for the selection and installation of post-installed anchors in concrete and masonry, British Standards Institution (BSI), 2012
- [5] AEFAC, Technical Note, “AEFAC Anchor Dictionary,” Australian Engineered Fasteners and Anchors Council. www.aefac.org.au.
- [6] EAD 330076, Metal Injection Anchors for use in Masonry, EOTA, 2014
- [7] EOTA TR 054, Design Method for Anchorages with Metal Injection Anchors for use in Masonry, 2016
- [8] AEFAC Guidelines for Site Testing of anchors - Volume 4: Testing in Masonry



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