

# PART B

## Chapter 8

### Durability

This chapter provides the design requirements for movement joints in masonry to control cracking due to shrinkage of the wall, concrete slab shrinkage, foundation movement and thermal expansion or contraction.

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# 8.1

## BASIS OF DESIGN

The durability of masonry and its components must be such that the required function can be performed throughout the entire design life of the structure. While some marginal deterioration of the units or mortar may be acceptable over a long period, any substantial deterioration of the masonry units, mortar, ties, connectors, lintels or reinforcement would be unacceptable.

Prevention of corrosion is of primary importance. Ties, connectors and lintels should be galvanised to the required thicknesses or, in extremely aggressive environments, be manufactured from non-corrosive materials such as stainless steel.

Concrete grout which protects reinforcement must have sufficient cement content to create an alkaline environment which lasts for the duration of the design life.



**8.2.1 GENERAL**

AS 3700 Section 5 sets out the durability requirements for masonry units, mortar, built-in components and reinforcement or tendons throughout the design life of the structure.

AS 3700 Table 5.1 defines the required classifications for masonry units, mortar, built-in components and cover for reinforcement or tendons for the particular environments and positions within the structure.

The associated Clauses and Standards cited in Table 5.1 are:

- AS/NZS 4456.10 provides a test and means of classifying the durability of masonry units. (See **Glossary** for Grades).
- AS 3700 Table 11.1 provides suitable mortar mixes for particular classifications.
- AS/NZS 2699 series provides performance requirements for built-in components and deemed-to-comply corrosion resistance of galvanising and other treatments.
- AS 3700 Clause 5.8 provides the requirements for grout to achieve the covers specified in Table 5.1.

**8.2.2 REQUIREMENTS FOR SPECIFIC ITEMS****Exposure Environments**

AS 3700 Clause 5.3 defines the exposure environments for which the masonry and its components must be designed.

**Concrete Masonry Units**

Salt resistance needs to be provided for masonry units that may be subject to salt attack. AS/NZS 4456.10 provides a test for resistance to salt attack.

**Mortar**

The durability of the mortar is covered by the deemed-to-satisfy compositions in AS 3700 Table 11.1. Type M1 and Type M2 mortars are not recommended for concrete masonry and therefore the mortar choice is between Type M3 and Type M4.

**Built-In Components**

Building accessories are commonly manufactured from galvanised steel and durability will be satisfied by the prescriptive galvanising covered in AS 2699.1, AS 2699.2 or AS 2699.3.

The testing criteria for components in categories R0 to R4 are quite severe:

- Maximum temperature of 55°C (or 40°C if the component is embedded).
- Daily temperature cycles from ambient (say 18°C) to 40°C.
- The medium surrounding the accessory being initially alkaline pH up to 10 but reducing over time to become not less than 10 (ie close to neutral).
- Remaining wet for a 3 month period.
- Aerosol penetration to an extent depending on distance from the coast:
  - R0 – Nil
  - R1 – 10 g/m<sup>2</sup>/day
  - R2 – 20 g/m<sup>2</sup>/day
  - R3 – 60 g/m<sup>2</sup>/day
  - R4 – 300 g/m<sup>2</sup>/day
- Exposure to UV radiation of 20 MJ/m<sup>2</sup> for a period of up to 4 weeks corresponding to the period of construction.

**Grout**

The specified 300 kg/m<sup>3</sup> cement content is to ensure that an alkaline environment surrounds embedded steel reinforcement and other items.

**Reinforcement and Tendons**

Where horizontal reinforcement is to be used, hollow concrete blocks should be of a type which allows the grout to surround the reinforcement throughout its length. 'H' blocks and 'Double-U' blocks are suitable types.

If flush-ended masonry units are used (which require the reinforcement to pass through the perpendicular joints) the reinforcement must be supported off the webs in such a way that the cover requirements can be achieved over the whole length of the reinforcement. This is difficult to achieve and would be unsuitable unless another form of corrosion protection is provided.

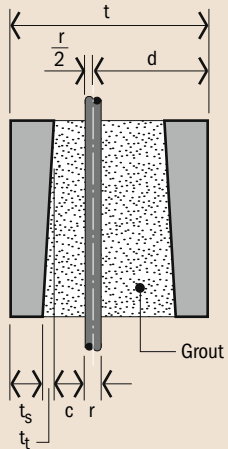
# 8.3

## STANDARD DESIGNS

This section sets out the required cover and resulting maximum effective depth of reinforcement for design purposes. For the specification of masonry units, mortars, built-in items and grout, refer to **Part C: Chapter 2**.

### REINFORCED MASONRY – Cover (c) and Effective Depths (d)

#### 140-mm leaf



Block thickness,  $t$  (mm) = 140

Core taper\*,  $t_t$  (mm) = 5

Face-shell thickness\*,  $t_s$  (mm) = 25

#### EXPOSURE CONDITIONS

##### Very severe

Severe marine environments. Saline or contaminated water and in tidal or splash zones. Within 1 km of industry producing chemical pollutants

##### Severe

Interior environments subject to saline wetting and drying. Masonry below the damp-proof course or in contact with aggressive soils. Masonry in fresh water

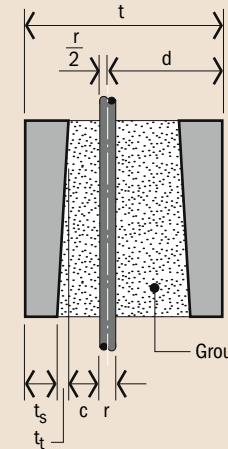
##### Other applications

(Note: 15 mm is considered to be the practical minimum for cover, giving consideration to the normal nominal size of aggregates)

Required grout cover, $c$ (mm)	30	20	15
Maximum possible effective depth, $d$ (mm) for following reinforcement diameter, $r$ (mm):			
12	74	84	89
16	72	82	87
20	70	80	85

\* Note: Manufacturers may adopt variations from these values for core taper and face-shell thickness. If so, this will alter the effective depth,  $d$ , given in the Table above

#### 190-mm leaf



Block thickness,  $t$  (mm) = 190

Core taper\*,  $t_t$  (mm) = 5

Face-shell thickness\*,  $t_s$  (mm) = 30

#### EXPOSURE CONDITIONS

##### Very severe

Severe marine environments. Saline or contaminated water and in tidal or splash zones. Within 1 km of industry producing chemical pollutants

##### Severe

Interior environments subject to saline wetting and drying. Masonry below the damp-proof course or in contact with aggressive soils. Masonry in fresh water

##### Other applications

(Note: 15 mm is considered to be the practical minimum for cover, giving consideration to the normal nominal size of aggregates)

Required grout cover, $c$ (mm)	30	20	15
Maximum possible effective depth, $d$ (mm) for following reinforcement diameter, $r$ (mm):			
12	119	129	134
16	117	127	132
20	115	125	130

\* Note: Manufacturers may adopt variations from these values for core taper and face-shell thickness. If so, this will alter the effective depth,  $d$ , given in the Table above

# 8.4

## WORKED EXAMPLE

### Purpose of the worked example

The purpose of the following worked example is to demonstrate the steps to be followed when performing manual calculations or when preparing computer software for the analysis and design of masonry. The worked example also serves the purpose of demonstrating the origin of the Standard Designs which are based on similar masonry capacity considerations. Although comprehensive in its treatment of AS 3700, the worked example is not intended to analyze or design all parts of the particular structure. It deals only with enough to demonstrate the design method.

### Design and detailing

All design and detailing shall comply with the requirements of AS 3700.

It is the designer's responsibility to allow for the effects of control joints, chases, openings, strength and stiffness of ties and connectors, and strength and stiffness of supports, in addition to normal considerations of loads and masonry properties.

### Masonry properties

The worked examples in this chapter are based on masonry properties complying with the General Specification set out in **Part C:Chapter 2**, modified as noted below.

### Hollow concrete blocks

Width 90 mm, 110 mm, 140 mm and 190 mm

Height 190 mm

Length 390 mm

Face-shell bedded

Minimum face-shell thickness,  
 $t_s = 25$  mm for 90 mm, 110 mm and 140 mm units  
 $t_s = 30$  mm for 190 mm units

Minimum characteristic compressive strength,  
 $f'_{uc} = 15$  MPa

Minimum characteristic lateral modulus of rupture,  
 $f'_{ut} = 0.8$  MPa

### Solid or cored concrete bricks

Width 110 mm

Height 76 mm

Length 230 mm

Fully bedded

Minimum characteristic compressive strength,  
 $f'_{uc} = 10$  MPa

Minimum characteristic lateral modulus of rupture,  
 $f'_{ut} = 0.8$  MPa

### Mortar joints

Mortar type M3 (or M4)

Joint thickness 10 mm

### Concrete grout

Minimum characteristic compressive strength,  
 $f'_c = 20$  MPa

Minimum cement content 300 kg/m<sup>3</sup>

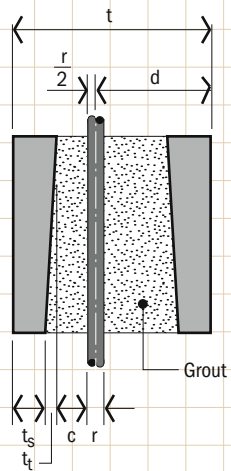
### Steel reinforcement

N12, N16 or N20 as noted.

GO TO WORKED EXAMPLE →

**DESIGN BRIEF**

For a 190-mm reinforced concrete masonry wall below the damp-proof course in contact with an aggressive soil, select the correct masonry units, mortar and components for durability. Calculate the effective depth of reinforcement, allowing for the required cover.



All references are to AS 3700 unless noted otherwise

**Masonry Unit**

Exposure grade.

Table 5.1

Seek advice on availability from the manufacturer

**Mortar**

Type M4

Table 5.1

1 part Type GP cement,  
4 parts sand plus  
methyl cellulose water thickener

Table 11.1

**Built-in Components**

R4 durability classification

Table 5.1

Unless an alternative is proven by test result, wall ties and connectors shall be stainless steel 316

AS/NZS 2699.1  
Table 3

Unless an alternative is proven by test result, lintels and shelf angles shall be galvanised or coated in accordance with AS 2699.3

Alternatives for lintels and shelf angles include stainless steel 316, or abrasive blast cleaned and coated in accordance with AS/NZS 2699.3

**Grout**

Grout shall be of a pourable consistency and have a minimum portland cement content of 300 kg/m<sup>3</sup> and a minimum characteristic compressive strength at 28 days ( $f'_c$ ) of 20 MPa.

$f'_c = 20$  MPa

10.7.3

> 12 MPa OK

ie The specified 20-MPa grout is stronger than the minimum strength permitted

Design characteristic compressive strength of grout (used in structural design),  $f'_{cg}$

$$\begin{aligned} f'_{cg} &= 1.3 f'_{uc} \\ &= 1.3 \times 15 \\ &= 19.5 \text{ MPa} \end{aligned}$$

Clause 3.5

<  $f'_c = 20$  MPa

ie By specifying grout  $f'_c = 20$  MPa, a design characteristic compressive strength of grout ( $f'_{cg}$ ) of 19.5 MPa may be used in structural design. This is the maximum value which is compatible with a concrete block of strength  $f'_{uc} = 15$  MPa.

**Reinforcement**

$t$  = total width of masonry unit  
= 190 mm

$t_s$  = work size face shell thickness at its thinnest point  
= 30 mm

$t_t$  = taper in core of hollow units from thinnest part of face shell to the thickest part  
= 5 mm (Check with the manufacturer)

$c$  = cover  
= 20 mm

required cover = 20 mm

Table 5.1

maximum size of aggregate = 20 mm

11.7.2.5

$r$  = diameter of reinforcement  
= 20 mm

$d$  = effective depth  
 $= t - t_s - t_t - c - r/2$   
 $= 190 - 30 - 5 - 20 - 20/2$   
 $= 125$  mm