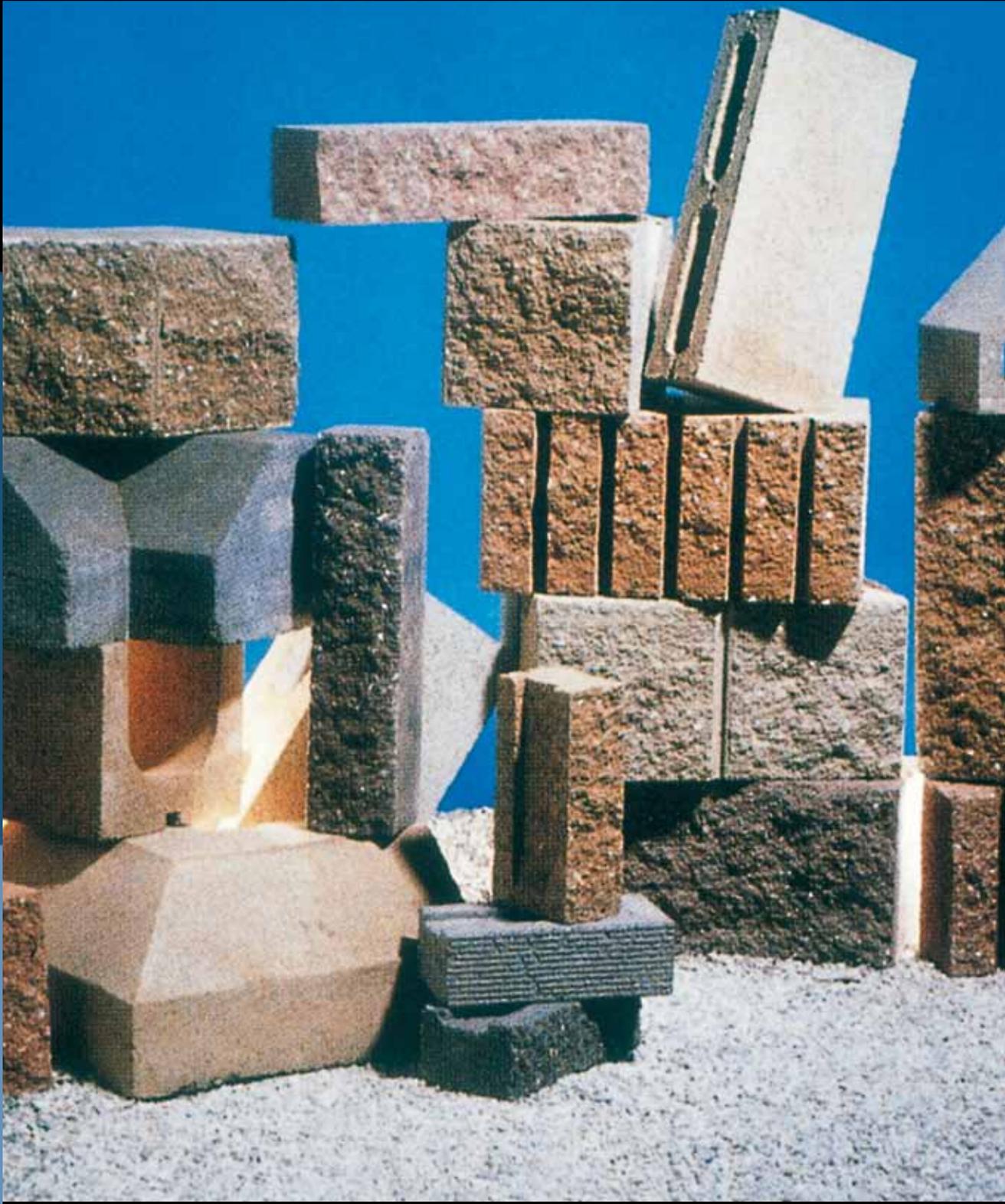


CONCRETE MASONRY MANUAL

Ninth Edition 2011



**Incorporating masonry requirements
in the application of the National
Building Regulations**



PREFACE

The National Building Regulations as promulgated in 1987 and revised 1990 remain unchanged. However SANS 10400 The application of the National Building Regulations has been updated to reflect new developments, the changes in Part B Structural design and Part K Walls being of particular importance for building in masonry.

A new series of standards SANS 2001 entitled "Construction Works" provides technical descriptions of the standards of materials and workmanship that will be used in the works that are executed or in the performance of the works when completed (or both).

As with all CMA publications the aim is — getting it right — not putting it right — when using concrete masonry units.

ACKNOWLEDGMENT

Excerpts from SANS 10400-K in shaded boxes.

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NINTH EDITION 2011

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1 PROPERTIES OF CONCRETE MASONRY UNITS

A concrete masonry unit is a preformed building unit of rectangular shape that is intended for use in the construction of bonded masonry walling. It is either solid or hollow and formed from a mixture of cement, aggregate and water.

The units are made in a range of sizes, shapes, colours, textures and profiles and are designed to meet various requirements such as strength, thermal and acoustic insulation and fire resistance.

When selecting units for any project, the appropriate unit should be used with a view to cost and desired properties.

STANDARD SPECIFICATION

The standard for concrete masonry units is SANS 1215. This standard covers the physical requirements and the sampling of units for testing.

Assurance of compliance with the quality requirements of this standard is by obtaining the SABS Certification Mark that the concrete masonry units manufactured comply with the requirements of SANS 1215. This certificate will indicate to purchasers that the concrete masonry units are produced under acceptable controlled conditions with appropriate materials. SABS accredited laboratories are permitted to perform the appropriate testing requirements on behalf of SABS in the awarding of the mark.

PHYSICAL CONDITIONS

1. Overall dimensions

Dimensions of concrete masonry units do not appear in SANS 1215, amendment No. 2 but in Appendix F Recommended nominal dimensions of concrete masonry units (see Table 1.1).

The use of modular size masonry units is essential if buildings are designed to the 100mm standard module — as stated in SANS 993 Modular co-ordination in building. Figure 1.1 shows the dimensions of the main types of masonry units of modular dimensions.

Modular planning is based on a nominal joint thickness of 10mm.

Modular wall thicknesses, as stated in SANS 10400, are 90, 140 and 190mm.

"A block is any masonry unit which has a length between 300 and 650mm or a width between 130 and

300mm or a height between 120 and 300mm. A brick is any masonry unit which is not a block".

Although the nominal dimensions of closure units (eg. half units, quarter units, etc.) used in a walling system are not given, such units may be used, provided that they comply with all the requirements of SANS 1215.

The permissible thickness of masonry walls in building is 90, 110, 140, 190 and 230mm and the modular dimensions are 90, 140 and 190mm.

In the marketplace there is a proliferation of different sizes of masonry units. Mainly these are based on the "imperial" brick size of 222 x 106 x 73 mm, or multiples of this size up to block size units of 448 x 224 x 224 mm. The width of these units exceeds the requirements of SANS 10400, namely 106 and 224 mm wall thickness as compared to the "deemed to satisfy" thicknesses of 90 and 190 mm. Thus for commercial reasons, units of reduced width are being made which are non-modular and non-imperial, such as 222 x 90 x 73 mm that satisfy the minimum requirements of SANS 10400.

Non-modular sizes of units are found in practice not to bond well without considerable cutting of the units. English or Flemish bond and construction of square brick piers is not possible as such units deviate from the basic principle of masonry bonding where the length of a unit should be twice its width plus the thickness of the bedding or perpend joint.

Generally, for easier, cost-effective and sound building practice, the unit size should be based on the principles of modular co-ordination. (See Figure 1.1 Dimensions of main types of masonry units of modular dimension)

Table 1.1 Nominal dimensions of masonry units (SANS 1215 - Table F-1)

WORK SIZES, mm		
Length	Width	Height
190	90	90
290	90	90
390	90	190
390	190	190

2. Strength

The compressive strength of a unit is based on its gross or overall area.

The class of masonry unit required is referred to as nominal compressive strength in SANS 1215 and in

SANS 10400-K and SANS 2001-CM1 as average compressive strength.

The nominal compressive strength can be equated to minimum individual strength (refer to SANS 2001-CM1).

Units are available in a wide range of strengths. Table 1.2 states compressive strengths of units specified in SANS 1215 whilst Table 5.1 states minimum compressive strengths of masonry units for single and double-storey construction, cladding and internal walls in concrete-framed housing units.

Masonry wall strengths are dependent on whether the masonry units are solid or hollow.

A solid wall contains cavities (also referred to as cores) not exceeding 25 % of the gross volume of the unit whilst a hollow unit contains cavities in excess of 25 % but not exceeding 60 %.

Table 1.2 Compressive strength of masonry units
(SANS 1215 -Table 2)

Nominal compressive strength, MPa	Compressive strength MPa, min	
	Average for 5* units	Individual units
3,5	4,0	3,0
7,0	8,0	5,5
10,5	11,5	8,5
14,0	15,5	11,0
21,0	23,5	17,0

*In the case of units having an overall length of 290mm or less, an average of 12 units is taken.

OTHER PROPERTIES

Tolerances (see Table 1.3), squareness, surface texture and appearance are specified in the relevant SANS standard.

The use of customised masonry is increasing and units of various colours, textures and profiles ranging from plain, close-textured faces to split-faced, exposed-aggregate and ribbed surfaces are being specified. These units do not usually require any surface finish or treatment (i.e paint or plaster).

Samples of the units should be requested by the client for quality and colour approval before orders are placed. (See section on typical masonry units, page 7).

Drying shrinkage should not exceed 0,06%.

Table 1.3 Tolerances on work sizes
(SANS 1215 - Table 1)

Work size	Tolerances, mm
Length	+ 2 - 4
Width	± 3*
Height	± 3

***Note:** In the case of FUA (face unit aesthetic) the tolerance on the overall width shall be ± 10mm.

Expansion on re-wetting should not exceed the value of drying shrinkage by more than 0,02%. When units are made from slag or clinker or burnt clay brick aggregates, the soundness of the unit should be checked to ensure that pop-outs do not exceed the specified amount.

Where units will be exposed to the weather, the design and detailing of the building are important factors in limiting efflorescence.

Water absorption of units is not specified in SANS 1215. This is not regarded as a significant characteristic of a concrete masonry unit where weather conditions in South Africa are mild, where freezing and thawing seldom occur. Water absorption is a measure of water absorbed in a unit for a particular laboratory test and does not measure or describe the porosity or permeability of a masonry unit.

Porosity is a measure of the total volume of voids in a unit and reflects the overall density of the unit. If pores are discontinuous then the unit is considered impermeable.

Permeability is a measure of the flow of a liquid or a gas through a unit under pressure. This is a significant factor determining resistance to rain penetration through a wall. However, weather proofing a building is primarily related to the wall design and workmanship. Permeability of masonry units subjected to a corrosive environment may be significant where reinforcement is incorporated in the core of a unit or in a cavity of a wall and where the infill concrete cover to the reinforcement is inadequate on the exposed face.

Initial rate of absorption (IRA) specified in SANS 10164 Part 1 is a measure of the amount of water absorbed into the bed face of a unit in one minute, i.e initial suction. This is generally not a significant property of concrete masonry units for use in walls. Masonry units made of materials other than concrete may be more sensitive to the IRA where it affects bonding of mortar to the masonry unit.

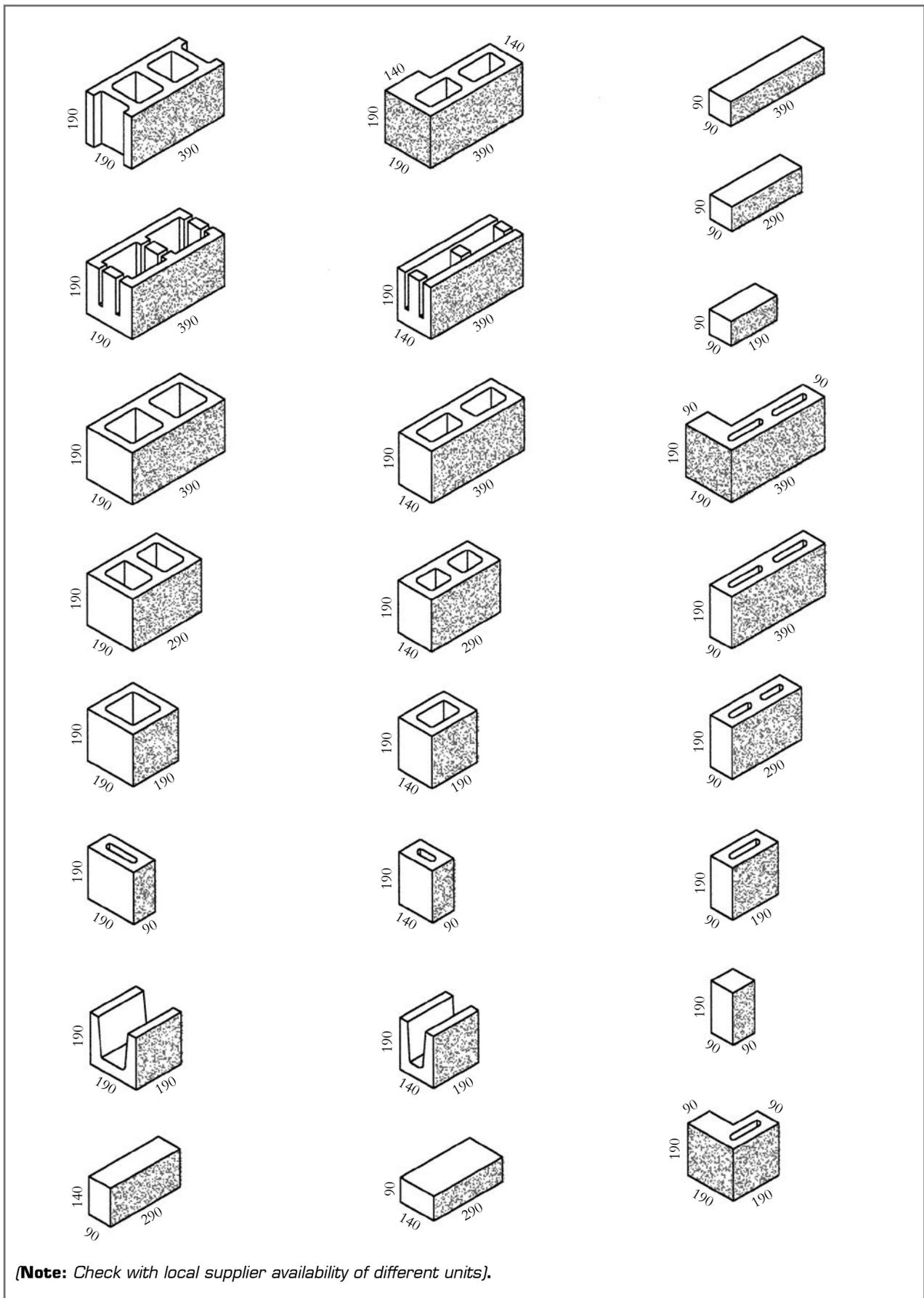


Figure 1.1: Dimensions of main types of masonry units of modular dimension

TYPICAL MASONRY UNITS

Concrete masonry offers the designer a rich variety of dimensions, aspect ratios, textures, colours and profiles as the basis of wall design. Innovations in the manufacturing process have added greatly to the palette of possible colours with the introduction of multiblend as distinct from monochromatic units.

The range of masonry units available will vary considerably from one manufacturer to another, depending on local needs and building practice. Details which follow cover typical face units displaying variations in textures and profile.

No attempt has been made to list colours from the almost limitless range of blended colours made possible with the most recent architectural facing units. Colour availability is a function of local aggregates and cements and will vary considerably from one locality to another. Colour requirements should always be checked with the supplier.

The density or mass of the unit manufactured will depend on the density of the aggregates used, whether natural aggregate or low density (light-weight) aggregates are used.

Textures

Plain face units are available in solids and hollows in "block sized" units, and in both "modular" and "standard" brick sizes. (See Figure 1.2).

Split face units are amongst the most popular facing units supplied.

They are produced as "double-sized" elements. After curing, the elements are split by shearing to defined profiles.

The standard splitter induces a vertical split, giving a block or brick with a tailored finish. The size and colour

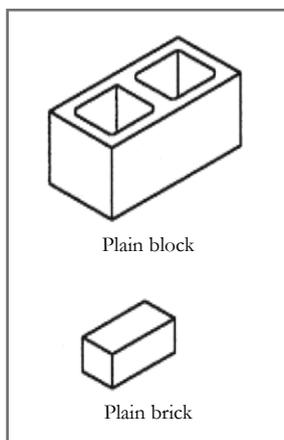


Figure 1.2:
Plain face units

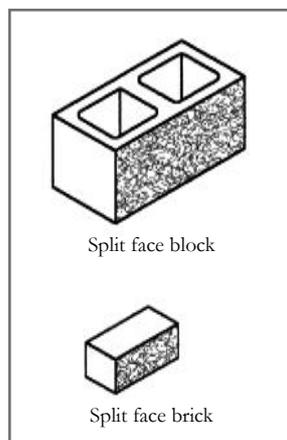


Figure 1.3:
Split face units

of the coarse aggregate particles in the concrete mix have a marked effect on the appearance of the finished face. Where the colour of the coarse aggregate contrasts with that of the matrix, the aggregate particles will "read" quite clearly in the finished face. Split face units come in the full range of sizes and in various colours. (See Figure 1.3).

Profiles

Concrete masonry is one of the few manufactured structural components in which a strongly profiled surface effect can be achieved.

Split-fluted block: This type of block is deservedly popular. It provides the most vigorous profile obtainable in concrete masonry. The forms of fluting which can be incorporated are almost limitless, from the provision of minor grooves in the face to the use of substantial protruding ribs.

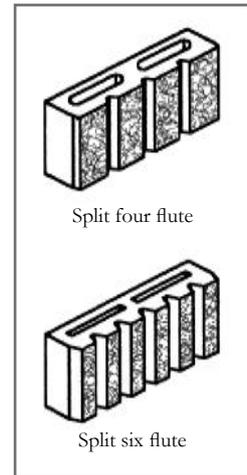


Figure 1.4:
Split-fluted blocks

A wide variety of profiles has been used, the main variations being the width of the split rib relative to the smooth-faced channel. (See Figure 1.4).

Colour

All masonry units can be produced in a rich variety of colours. The prime determinants of colour are:

- the colour of the cement
- the colour of the fine aggregates
- the curing system

These can be varied to produce a limited range of subdued colours.

A much bigger range, including strong colours, can be obtained by the introduction of metallic oxide pigments.

Colour control is more precise than with any other masonry walling material, but, because all colours are a function of variable raw materials, curing techniques and atmospheric conditions prior to curing, some minor colour variation is inevitable in concrete masonry manufacture.

Variations in colour will tend to occur between pallets. It is, therefore, good practice to select units at random from several pallets rather than to draw from a single batch. In this way any variation in colour

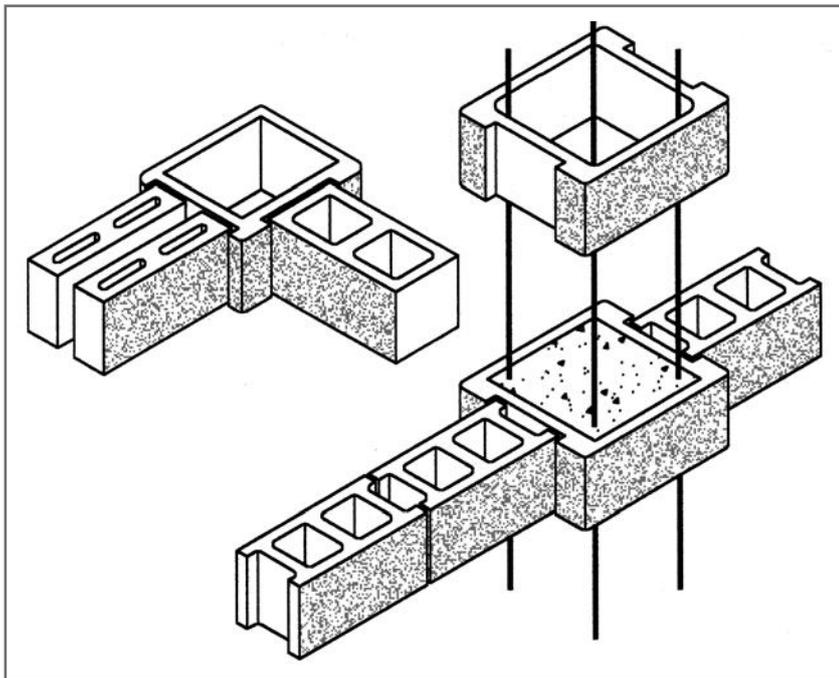


Figure 1.5: Pilaster blocks

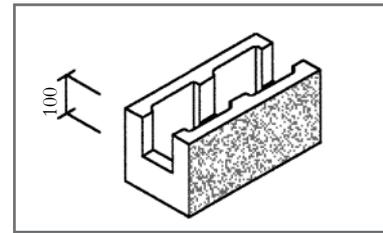


Figure 1.7 Bond-block

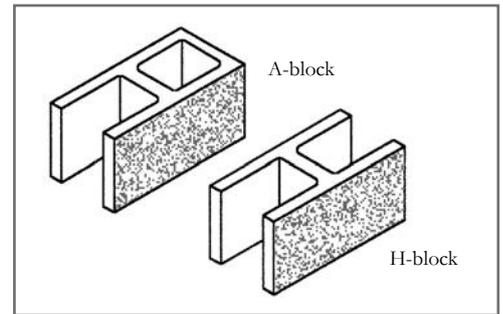


Figure 1.8 Single and double open end units

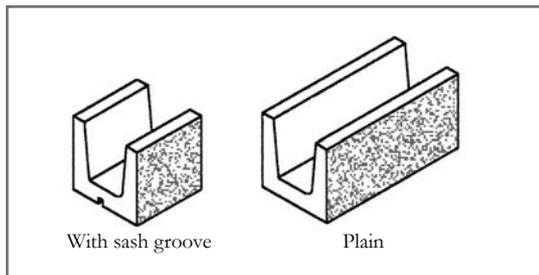


Figure 1.6: U-beam and lintel units

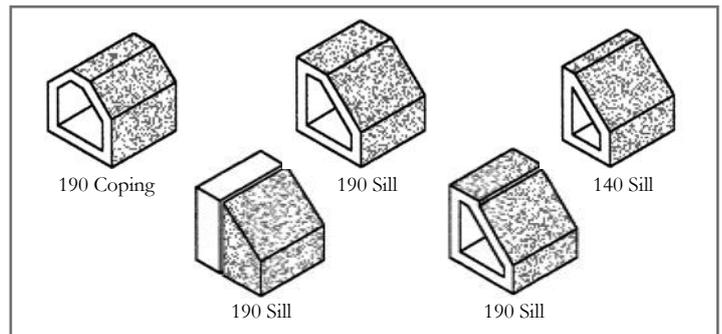


Figure 1.9 Concrete masonry sills and coping blocks

tends to be scattered randomly within the wall, and areas of localised contrast are avoided. The resulting wall tends to look a little less contrived than if a completely uniform colour prevails throughout and is more attractive.

SPECIFIC MASONRY UNITS FOR REINFORCED MASONRY

For ease of placing and fixing of reinforcement and housing the infill concrete or grout in hollow masonry units used in reinforced masonry specific units are manufactured such as U-beam, lintel units, bond-blocks, single and double open end units and pilaster blocks.

Pilaster blocks

Pilaster blocks are used to strengthen and stabilise walls, to create corners and piers, to locate control joints and to create certain architectural effects. The pilaster block may be used with or without reinforced concrete in the core (see Figure 1.5).

U-beam and lintel units

U-beam or lintel units are used over window or door openings to house the horizontal reinforcement required. Because of the way they are manufactured (extruded out of their mould such that the vertical face of the unit must be smooth or textured by being subsequently split), U-beam or lintel units cannot be made with a profile, such as fluted or ribbed. However, these units can be made with a sash groove to house the vertical leg of the transom of the steel window (see Figure 1.6). U-beam and lintel units can be laid on their side to form a vertical cavity to house vertical reinforcement.

Bond-blocks

Bond-blocks can be cut or manufactured. They can be made with the same colour, profile and texture as the standard units. Typical outer shell thicknesses are 32 mm for fair face units and 42 mm for rockface units. As the vertical cores are continuous through the hollow blocks, the bottom of these cores must

be in lintels and the cores filled with infill concrete or grout. This can be achieved by laying a fine mesh metal fabric in the bedding course below the cores. The soffit of the bond-block lintels may be rendered where exposed (see Figure 1.7).

Single and double open end units

The use of open end units eliminates having to thread units over existing vertical reinforcement in vertically reinforced masonry. The single open end units are termed A-blocks and the double end units H blocks. These blocks may be manufactured or cut to the right shape (see Figure 1.8).

Window sills and coping blocks

Concrete masonry sills and coping blocks can be manufactured of concrete similar to that of concrete masonry units, and on similar equipment to specified and dimensions (see Figure 1.9).

Decorative Block

Many decorative blocks are available. These units can be used in partition walls, fences, screen walls, etc., illustrated are but a few of the popular patterns (see Figure 1.10).

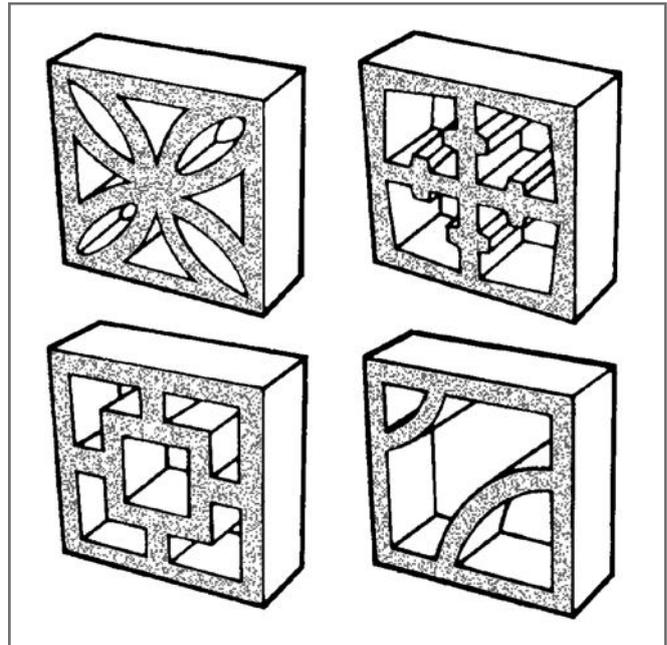


Figure 1.10: Typical decorative blocks

Range of masonry products

The following photograph illustrates the range of products available from some of the larger manufacturers of concrete masonry units. Colours of units available should be checked.

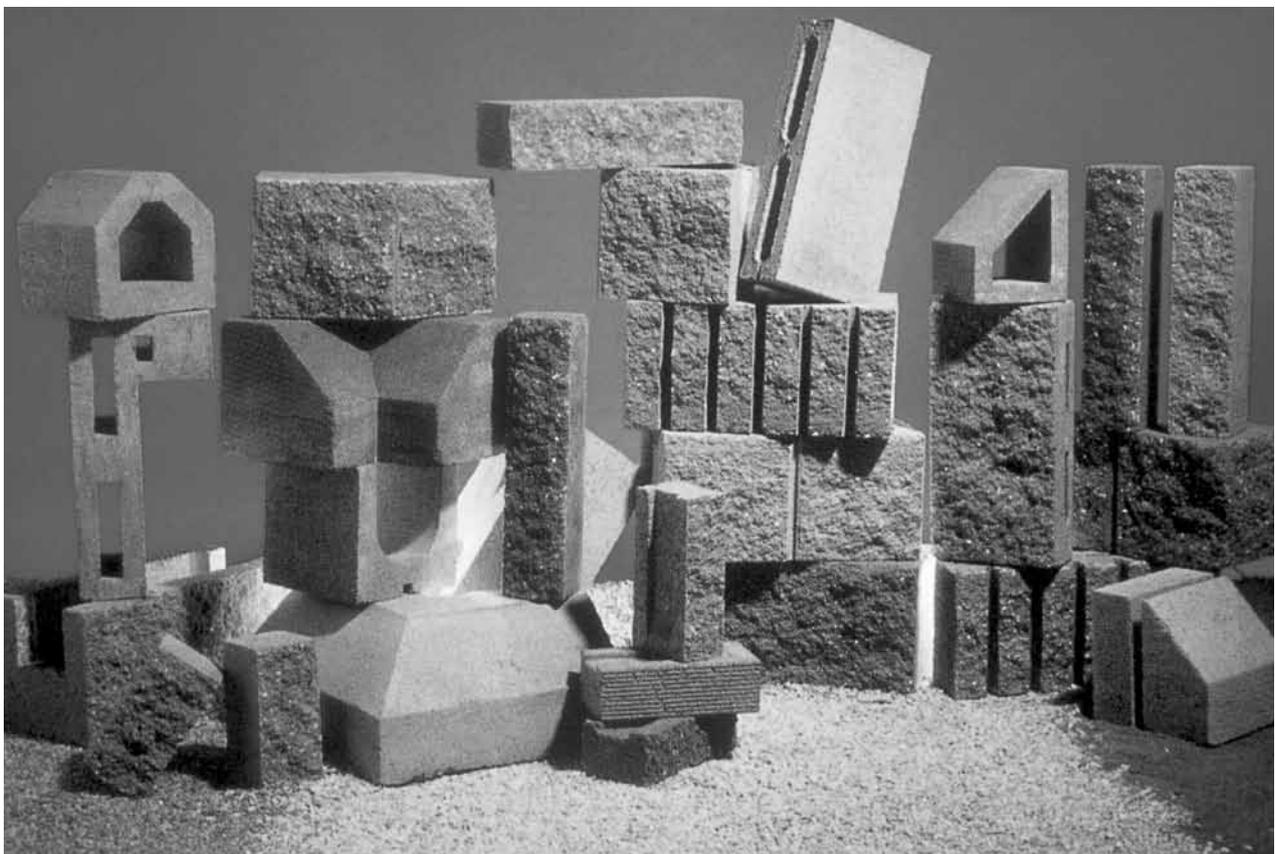


Figure 1.11: Range of masonry products

2 PERFORMANCE CRITERIA FOR WALLING

Any satisfactory walling system must meet certain minimum performance criteria. Special consideration may have to be given to any one or a combination of the following criteria:

- structural strength and stability
- durability
- accommodation of movement
- weatherproofness
- acoustic insulation
- thermal properties
- fire resistance.

Not only must the quality of the masonry units be satisfactory, but the design, detailing, specification and workmanship must be of an appropriate standard.

STRUCTURAL STRENGTH AND STABILITY

Concrete masonry structures will have adequate strength and stability for their purpose when designed and built under competent supervision according to the applicable standards and regulations. For normal buildings reference to tables of permitted dimensions for empirically designed walls is adequate, i.e. SANS 10400-K, NHBRC - HBM. Walls subjected to unusual loads should be designed according to SANS 10164-1.

DURABILITY

Experience has shown that with good detailing, specification, supervision and construction, masonry structures will remain durable for many years. Besides the use of masonry units of satisfactory quality, attention should be given to the type and quality of cement and sand used in the mortar mixes; the avoidance of admixtures that may cause corrosion of reinforcement; the cover to reinforcement and wall ties; and the positioning and sealing of control joints where used. Masonry units shall be sufficiently durable to resist local exposure conditions for the intended life of the building. Durability of concrete masonry units is generally related to compressive strength and Table 2.1 can be taken as a guide where there is no surface protection of the units.

Notes: Protected zone: Inland areas more than approximately 30 km from the coastline

Moderate zone: The coastal belt extending up to

approximately 30 km from the coastline, but excluding the sea spray zone.

Severe zone: This consists of the following areas:

- sea spray zone (eg. the eastern and northern seaward slopes of the Durban Bluff and other exposed headland areas)
- the coastal belt extending north-eastwards from Mtunzini to the Mozambique border and inland for a distance of approximately 15 km (this includes Richards Bay and St. Lucia)
- the coastal belt of Namibia

Very Severe zone: This consists of the following areas:

- areas where high moisture content derived from sea mists, high groundwater tables, high soluble salt content of the soil, together with large temperature fluctuations, combine to create severe exposure and weathering conditions (eg. Walvis Bay)
- industrial areas where high acid and alkaline discharges occur.

Table 2.1: Recommended nominal compressive strength for durability (SANS 10 249 -Table F. 1)

Exposure zone	Recommended nominal compressive strength, MPa	
	Solid units	Hollow units
Protected	7,0 — 10,5	3,5 — 7,0
Moderate	10,5 — 14,0	7,0 — 14,0
Severe	21,0	14,0
Very Severe	Manufacturer's guidance required	

ACCOMMODATION OF MOVEMENT

An understanding of movement in masonry requires a knowledge of the materials being used and their response to service loads and environmental factors.

All structures are subjected to varying degrees of dimensional change after construction. Determination of movement in response to the environment is a complex problem and not merely a summation or subtraction of extreme or individual values of thermal and moisture movement, but the response of the masonry to these movements must be considered.

Movement in response to each stimulus is controlled to some extent by the degree of restraint inherent in

the masonry and the supporting structure, namely the foundations, beams, slabs, etc.

Furthermore, walls move less horizontally under high vertical stress than walls subjected to lower vertical stress.

Not all movements are reversible. When the stimulus to movement is removed, for example when severe contractions cause cracks in perpendicular joints when the bond strength between a masonry unit and mortar is exceeded, the crack may not be able to close again due to mechanical interlocking, friction or insufficient force in the opposite direction.

With repeated expansion and shrinkage movement, cracks can become filled with debris, resulting in a ratchet effect which results in a continuous increase in length of the masonry.

In a building, it is often found that the orientation will induce different movements in various parts of the walls due to the incidence of radiation heat or prevailing rain.

An estimation of potential movement in a masonry element must rely to a great extent on engineering judgement. Many factors, such as temperature and moisture content of masonry units and mortar at the time of construction, the exposure to weather conditions and degree of restraint imposed on elements subject to movement are unpredictable.

In general, it is more simple to adopt empirical rules rather than try to estimate movement in a structure from first principles. Stresses in masonry that are sufficient to cause cracks may be controlled or reduced by the use of control joints and/or reinforcement.

Recommendations for the size and spacing of control joints to accommodate movement are given in SANS 10249 and joint spacing recommendations associated with quantities of reinforcement are given in SANS 10145. In concrete masonry, the recommended spacing of control joints varies from 6m to twice the height of the wall for unreinforced masonry and up to 18,5m for reinforced masonry. Further information on the spacing and position of control joints is given in Chapters 4 and 5.

WEATHERPROOFNESS

The resistance of a building to the ingress of rain depends not only upon the materials used, but on the quality of construction, skill of the designer and the work force, and on orientation, size and environmental exposure of the building.

Water generally enters a wall through fine capillary passages at the interface between masonry unit and mortar or through cracks in the masonry caused by movement

Prevention of rain penetration through walls begins with the design of the building, follows through with the selection of materials and the supervision of workmanship, and continues with maintenance of the structure after its completion.

The procedures to follow for exclusion of moisture from buildings are covered in detail in SANS 10249 and SANS 10021. Rain penetration of a wall can be determined by means of a rain penetration test described in SANS 10400-K.

It has been found in practice that there is no simple correlation between permeability and porosity of a masonry unit and the performance of test panels using the same units of construction and subjected to the standard rain penetration test.

Single-leaf walls are more vulnerable to moisture penetration than cavity walls, where the air space provides an excellent barrier against the passage of moisture. Cavity wall construction should be used in coastal areas. If exposure conditions are severe, all non-cavity exterior walls should be plastered or given some other effective water-proofing coating. Alternatively, non-porous units should be used. The quality of the mortar and the workmanship requires particular attention if the structure is to be weatherproof.

Specific recommendations on reducing rain penetration through walls is given in Chapter 5.

ACOUSTIC PROPERTIES

The acoustic performance of a building is related to the capacity of all the elements of the building (i.e. masonry units, windows, doors, floors and ceilings) to reflect, absorb and transmit sound.

Table 2.2 Approximate sound insulation values for various types of wall construction (as could be expected in practice); laboratory values would be higher

Wall thickness, mm	Approximate sound insulation values, I_a dB		
	90	140	190
Unplastered hollow block unit	40	43	45
Plastered hollow block unit	43	46	48
Unplastered solid block unit	42	45	47

Concrete masonry is a suitable material for attenuating noise as it is a dense material which reduces the transmission of airborne sound. Resistance to sound transmission increases with wall thickness (see Table 2.2). Surface texture, porosity of the concrete and density all affect the transmission and absorption of sound.

The sound insulation properties of a single-leaf masonry wall are largely related to the mass per unit area of wall, provided there are no direct air passages through the wall.

The sound insulation properties of a cavity wall are related to its mass per unit area, the width of the cavity and the rigidity and spacing of the wall ties.

Acoustic tests relate sound loss through a wall at various frequencies. The values obtained are used to compare sound insulation values.

To isolate noise requires more than simply providing barrier and sound absorbent walls. Doors and windows of lower acoustic performance than walls will reduce

effective sound attenuation as will fine cracks or badly fitting doors or windows. Noise leakage paths must be sealed by good design and good workmanship. Sound insulation is also affected by floors and ceilings and by the finishes applied to the concrete masonry.

At present there are no acoustic performance criteria in the National Building Regulations.

Minimum values of in situ airborne sound insulation between rooms in a dwelling unit, between adjoining dwelling units and between non-residential school buildings have been set by the Agrément Board of South Africa.

THERMAL PROPERTIES

The thermal performance of a building is related to the capacity of all the elements of the building (i.e. walls, roof, ceilings and floors) to reflect, store and transmit heat. Concrete masonry units made with dense aggregates are able to store heat while the cavities in hollow block improve the insulating value of the units. For estimates of the thermal behaviour

Table 2.3 Fire resistance ratings of loadbearing walls constructed of concrete masonry units
(SANS 10145 - Table 4)

Construction	Thickness (excluding plaster), mm, min., for fire resistance rating in minutes of				
	240	120	90	60	30
Solid concrete masonry units containing Class I aggregate*:					
a) Unplastered	190	150	90	90	90
b) Plastered † with VG ‡	150	90	90	90	90
Solid concrete masonry units containing Class II aggregate §:					
a) Unplastered	—	200	150	150	150
b) Plastered † with VG ‡	150	150	150	150	90
	Equivalent thickness // (excluding plaster), mm, min., for fire resistance rating in minutes of				
	240	120	90	60	30
Hollow concrete masonry units ¶					
a) Unplastered	Not recommended			90	73
b) Plastered †	Not recommended			73	73

* Class I aggregate = a coarse aggregate of foamed slag, pumice, blastfurnace slag, well burned clinker, crushed calcareous aggregate, and crushed brick or other burnt clay products (including expanded clay).

† Where plaster is to contribute to the fire resistance of a wall, it should be applied over a metal lath that is so fixed to the wall as to prevent the plaster from becoming detached from the wall in the event of a fire. The values in the table apply only to plaster of thickness at least 12 mm applied to that side of the wall in relation to which the wall is required to have a specified fire resistance rating.

‡ VG = a plaster of vermiculite and gypsum mixed in a V:G ratio that is in the range 1,5:1 to 2:1 (v/v).

§ Class II aggregate = a coarse aggregate of flint, gravel, or any crushed natural stones other than stones that would form a calcareous aggregate.

// Equivalent thickness = the solid wall thickness that would be obtained if the same amount of concrete contained in a hollow unit were recast without core holes.

¶ Applicable only to hollow units that form a wall having not more than one cell in any vertical plane through its thickness.

of a building reference should be made to the CSIR Division of Building Technology publication BRR 396, "The prediction of the thermal performance of buildings by the CR-Method".

FIRE RESISTANCE

The fire resistance rating of concrete masonry walls depends on whether the wall is loadbearing or not, whether solid or hollow units are used and on

the geological type of the aggregates used in the manufacture of the units. Plastering the wall improves the fire resistance rating.

The National Building Regulations requirements for walls are covered in SANS 10400-K. The fire resistance ratings of concrete masonry walls are given in SANS 10145 (refer Tables 2.3 and 2.4).

Note Definitions: see next page

Table 2.4 Fire resistance ratings of non-loadbearing walls constructed of concrete masonry units
(SANS 10145 - Table 5)

Construction	Thickness (excluding plaster), mm, min., for fire resistance rating in minutes of			
	240	120	90	60
Solid concrete masonry units containing Class I aggregate *†:				
a) Unplastered	150	90	73	73
b) Plastered ‡ with CS ‡	90	90	73	73
c) Plastered ‡ with GSS §	90	73	73	73
d) Plastered ‡ with VG ¶	90	73	73	73
Solid concrete masonry units containing Class II aggregate ¶:				
a) Unplastered	215	150	90	73
b) Plastered ‡ with CS ‡ or GSS §	150	108	90	73
c) Plastered with VG ¶	150	108	73	73
	Equivalent thickness (excluding plaster), mm, min., for fire resistance rating in minutes of			
	240	120	90	60
Hollow concrete masonry units ** containing Class I aggregate *†				
a) Unplastered	150	108	90	73
b) Plastered ‡ with CS ‡ or GSS §	108	90	73	73
c) Plastered with VG ¶	108	90	73	73
Hollow concrete masonry units, ¶ containing Class II aggregate ¶				
a) Unplastered	190	150	108	73
b) Plastered ‡ with CS ‡ or GSS §	150	108	90	73
c) Plastered with VG ¶	150	90	73	73
	Thickness of inner leaf (excluding plaster), mm, min., for fire resistance rating in minutes of			
	240	120	90	60
Cavity wall having both leaves of concrete masonry units, the outer leaf being at least 100 mm thick	90	73	73	73

* Class I aggregate = a coarse aggregate of foamed slag, pumice, blastfurnace slag, well burned clinker, crushed calcareous aggregate, and crushed brick or other burnt clay products (including expanded clay).

† See appropriate footnote to Table 2.3.

‡ CS = a cement-sand plaster.

§ GS = a gypsum-sand plaster

¶ VG = a plaster of vermiculite and gypsum mixed in a V:G ratio that is in the range of 1,5:1 to 2:1 (v/v).

¶ Class II aggregate = a coarse aggregate of flint, gravel, or any crushed natural stones other than stones that would form a calcareous aggregate.

** Applicable only to hollow units that form a wall having not more than one cell in any vertical plane through its thickness.

Note Definitions:

Hollow masonry units: A masonry unit that contains cavities that exceed 25% but do not exceed 60% of the gross volume of the unit.

Solid masonry unit: A masonry unit that either contains no cavities or contains cavities that do not exceed 25% of the gross volume of the unit.

Calculation of equivalent thickness for fire resistance ratings

For hollow masonry units fire resistance ratings are expressed in equivalent thickness of wall. Equivalent thickness is the solid thickness that would be obtained if the same amount of concrete contained in a hollow unit were recast without core holes. Percentage solid is based on the average net area or net volume of the unit.

The Table (see Table 2.5) that follows is based on the minimum shell thickness of hollow units viz 25mm or one-sixth the width of the unit whichever is the greater and an allowance of 2mm in the tapering of the mould to permit easy extrusion of the unit from the mould and a web thickness of 25mm. In practice shell and web thickness is often greater than the minimum and in these cases the net volume (gross volume - core volume) should be recalculated based on the formula.

$$\text{Equivalent thickness} = \frac{\text{Net volume of unit}}{\text{Length of unit} \times \text{height of unit}}$$

Table 2.5 Equivalent thickness of two core hollow masonry units for calculation of fire resistance ratings

Unit size, mm			Shell thickness minimum, mm	Solid content %	Equivalent thickness, mm
l	w	h			
390	90	190	25	68	61
390	140	190	25	52	73
390	190	190	32	53	101

Note: Solid units may contain up to 25% voids and this must be considered in determining equivalent thickness.

3 MODULAR CO-ORDINATION AND DESIGN

Modular co-ordination is a method of co-ordinating the dimensions of buildings and building components to reduce the range of sizes required and to enable components to be built in on site without modification. For modular co-ordination, the dimensions of components and the space to be filled by them must be related to a single denominator, the basic module.

The South African Bureau of Standards has accepted 100 mm as the basic module for horizontal and vertical dimensions.

Buildings should be dimensioned to incorporate controlling dimensions which provide for the necessary co-ordination of dimensions to accommodate all modular size components, assemblies and units. Setting out is simplified because most dimensions will be multiples of 100mm, though with concrete masonry a 200mm module is preferable. The use of modular graph drawing paper incorporating faint grid lines at intervals of 1 and 10mm (or multiples

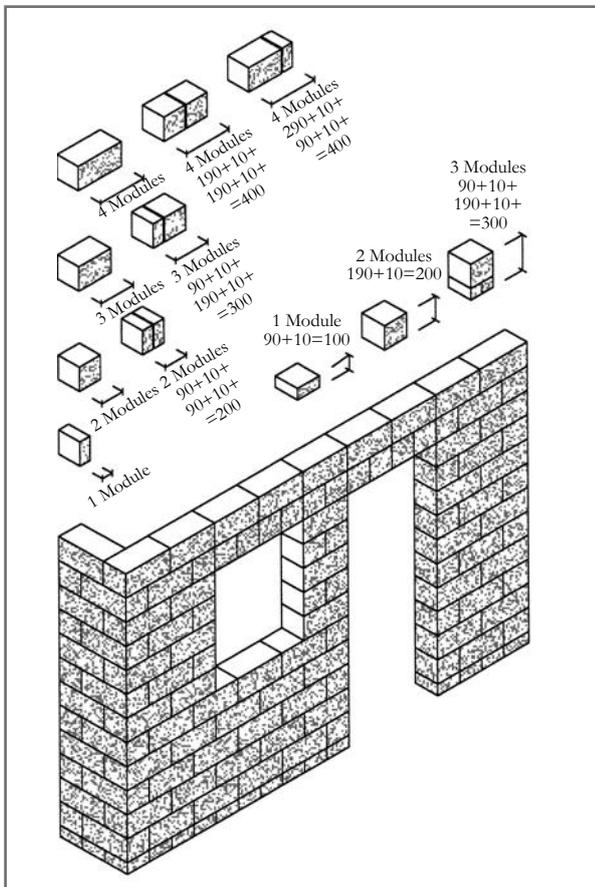


Figure 3.1 Modular co-ordination in a wall and planning modules

thereof) along both axes assists in planning and drawing to modular sizes. Figure 3.1 shows a section of wall where the vertical and horizontal planning is modular; modular size window and doorsets fit the space allowed. In Figure 3.2 portion of a house drawn on 10mm grid paper is shown, the plan on a scale of 1:100 and construction details on 1:20. Working drawings may also be drawn on 1:50 while other scales for details are 1:10, 1:5 and 1:1.

CO-ORDINATING SIZES

The co-ordinating sizes of building components, such as door and window frames and units such as blocks and bricks are the dimensions which permit them to fit into the space provided in a controlling reference system in a particular direction. Some vertical controlling dimensions and planning modules are shown in Figure 3.1. The co-ordinating dimension includes the work size of the component or unit, its manufacturing tolerances and the thickness of joint required to fit it in position. In some special cases allowance must be made for a positioning tolerance.

BLOCKS

The most popular co-ordinating block dimension is 400 mm (i.e. 4 modules) horizontal and 200 mm (2 modules) vertical. To make up the design lengths and heights it may be necessary to use, other than the basic size block, blocks having co-ordinating lengths of 100, 200 and 300mm and a co-ordinating height of 100mm. These sizes may be achieved by using specific blocks of suitable modular dimensions. If a unit is of modular dimensions, and is so described, it will fit into a modular space on the design grid.

Vertically, a co-ordinating height of 100mm may be achieved by the use of bricks or blocks of 90mm nominal height.

Details of standard and certain specific blocks for use in walls of 90, 140 and 190mm thickness are shown in Figure 1.1.

The standard and specific blocks shown are only some of the block sizes and shapes that may be made in your area. Manufacturers should be consulted prior to design and detailing to check the range of blocks available.

A modular dimensioned solid block manufactured with low-density aggregates such as clinker used in 140mm thick external walls is 290 x 140 x 90 and when used on its side in 90 mm thick internal walls is 290 x 90 x 140.

Internal and external walls are bonded with metal strips at 300mm vertical intervals, maximum.

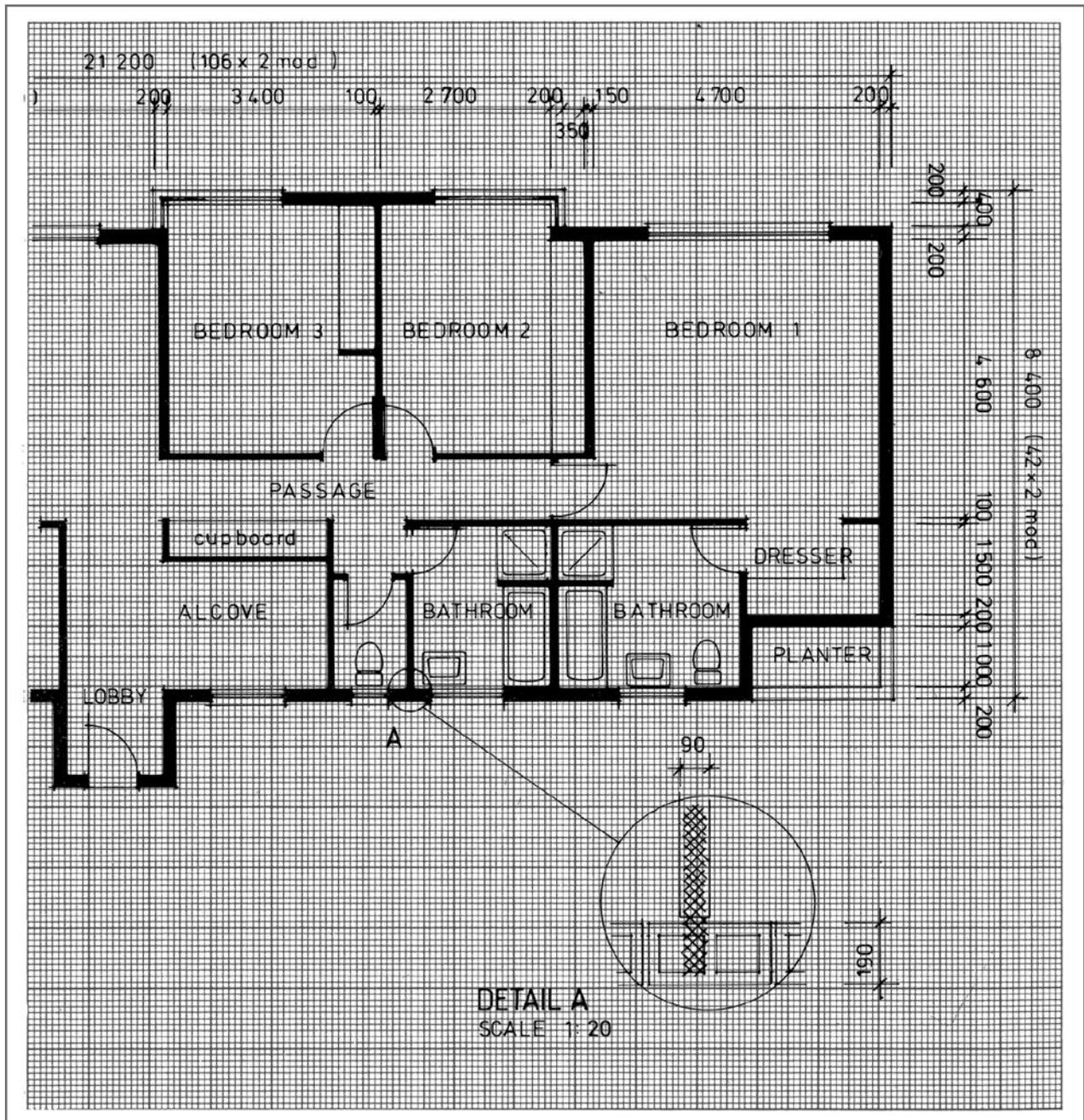


Figure 3.2 Use of modular grid

MODULAR DETAILING AND BUILDING

The purpose of good detailing is to assist in achieving sound construction and a buildable structure that will perform well in service. The three Concrete Manufacturers Association's publications on Detailing of Concrete Masonry cover the main types of masonry walls viz. single-leaf walls using solid units 140mm, single-leaf walls using hollow units 140 and 190mm and cavity walls 240 and 290 mm and should be referred to for modular detailing.

The abovementioned publications cover foundation walls, sills, lintels, window and door frames,

suspended floors, parapet walls, roof trusses, masonry bond patterns, joint profiles, wall intersections, control joints, reinforcing and provision for services.

The decision whether to build with large block size units or the smaller brick size units depends on a number of factors. Block size units are more cost-effective if the building is planned around blocks of modular size because of higher productivity of laying, sounder construction and less mortar being required. Bricks are easier to lay as they can be used without preplanning and can easily be cut and laid.

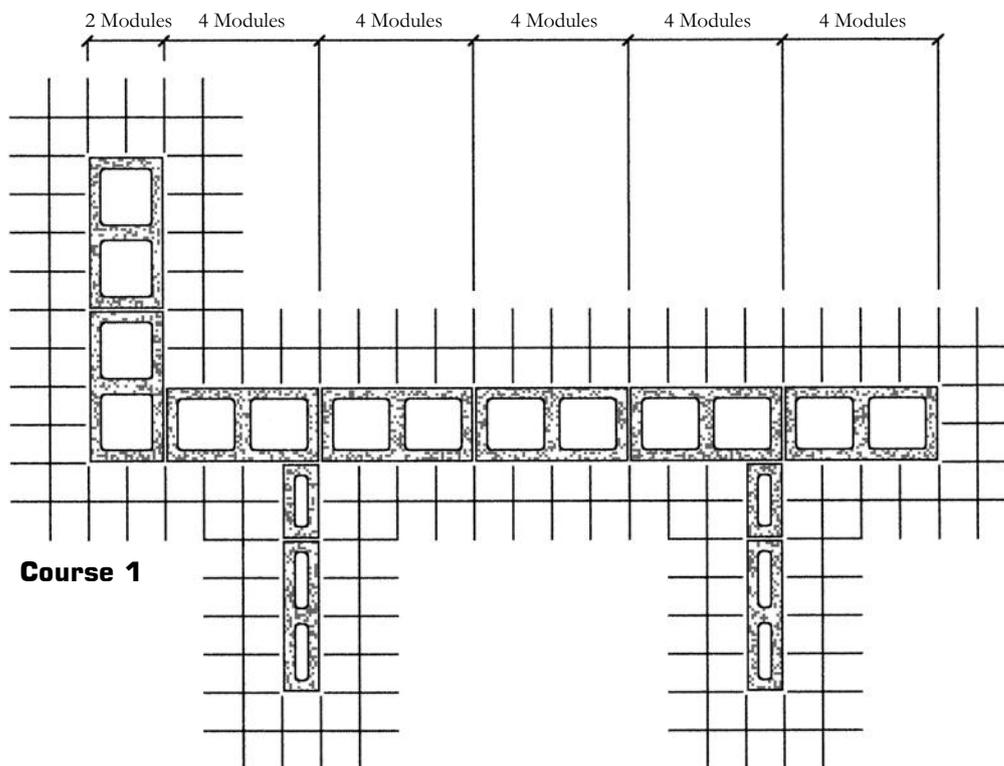
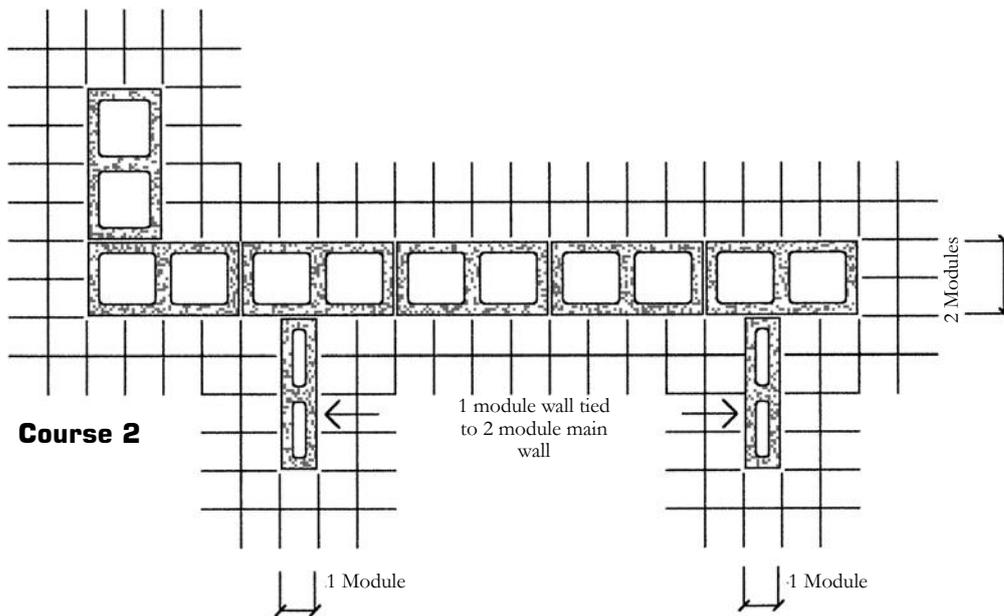


Figure 3.3 Bonding patterns of intersecting walls

4 BUILDING REGULATIONS

The National Building Regulations are statutory requirements that apply to the erection of all building in the country, unless otherwise exempted. SANS 10400 Application of the National Building Regulations is a non-statutory document which contains technical information needed for the practical application of the Regulations, namely satisfying the functional requirements of the NBR. The deemed-to-satisfy requirements in the standard take the form of "Rules" and are not mandatory. The Rules applying to walls are in Parts KK and have been completely revised.

Under the Housing Consumers Protection Measures Act, Act No. 95 of 1998, the Act provided for the establishment and functions of the National Home Builder's Registration Council to protect the public from poor building practices that leave new home owners with damaged buildings and no recourse except to the law.

The NHBRC has published their Home Building Manual (HBM) which sets out everything that is required for a house being built to be registered under their Standard Home Builder's Warranty Scheme.

The HBM states that "In the first instance, the design and construction shall ensure that all housing complies with the relevant requirements of the National Building Regulations and in the second instance, with those laid down by the NHBRC".

The structural performance requirements as detailed in SANS 10400-K : 2007 and the NHBRC HBM are the same.

Deemed-to-satisfy construction rules which ensure that design intent is met during construction are similar in the new SANS 2001 Construction Works standards and the NHBRC HBM.

NATIONAL BUILDING REGULATIONS. PART K: WALLS

K1 Structural strength and stability

Any wall shall be capable of safely sustaining any loads to which it is likely to be subjected and in the case of any structural wall such wall shall be capable of safely transferring such loads to the foundations supporting such wall.

K2 Water penetration

Any wall shall be so constructed that it will adequately resist the penetration of water into any part of the building where it would be detrimental to the health of occupants or to the durability of such building.

K3 Roof fixing

Where any roof truss, rafter or beam is supported by any wall provision shall be made to fix such truss, rafter or beam to such wall in a secure manner that will ensure that any forces to which the roof may normally be subjected will be transmitted to such wall.

K4 Behaviour in fire

Any wall shall have combustibility and fire resistance characteristics appropriate to the location and use of such wall.

K5 Deemed-to-satisfy requirements

The requirements of regulations K1, K2, K3 and K4 shall be deemed to be satisfied where the structural strength and stability of any wall, the prevention of water penetration into or through such wall, the fixing of any roof to such wall and the behaviour in a fire of such wall, as the case may be, comply with Part K of section 3 of SANS 10400-K.

SANS 10400 : APPLICATION OF THE NATIONAL BUILDING REGULATIONS. PART K : WALLS.

4. Requirements

4.1 General

The function regulations **K1** to **K4** contained in parts K of the national building regulations shall be satisfied where a masonry wall complies with the requirements of

- a) SANS 10400-B Structural design, SANS 10400-T Fire protection and fixing of roofs to concrete elements (SANS 10400-K clause 4.4)

or

- b) SANS 10400-K Clauses 4.2; 4.4; 4.5 and 4.6.

4.2 Masonry walls

4.2.1 General

4.2.1.1 The requirements of 4.2 apply only to masonry walls that are not exposed to severe wind loadings at crests of steep hills, ridges and escarpments and, in case of:

a) single-storey buildings or the upper-storey of double-storey buildings, where:

- 1) The foundations for masonry walls comply with the requirements of SANS 10400-H and the supporting members comply with the requirements of SANS 10400-B;
- 2) the span of roof trusses or rafters (or both) between supporting walls does not exceed:
 - i) 6,0 m in respect of 90 mm and 110 mm single-leaf walls;
 - ii) 8,0 m in respect of 140 mm (or greater) single-leaf walls and all cavity and collar-jointed walls;
- 3) the nominal height of masonry above the top of openings is not less than 0,4 m;
- 4) the average compressive strength of hollow and solid masonry units is not less than 3,0 MPa and 4,0 MPa, respectively;
- 5) the mortar is class II that complies with the requirements of SANS 2001-CM1;
- 6) the mass of the roof covering, in roofs other than concrete slabs, does not exceed 80 kg/m²;
- 7) the span of the concrete roof slabs between supporting walls does not exceed 6,0 m;
- 8) concrete roof slabs are not thicker than 255 mm if of solid construction, or the equivalent mass if of voided construction;
- 9) foundation walls are not thinner than the walls which they support; and
- 10) the height of foundation walls does not exceed 1,5 m;

b) the lower-storey in a double-storey building, where:

- 1) the imposed load does not exceed 3,0 kN/m²;
- 2) the foundations for masonry walls comply with the requirements of SANS 10400-H and the supporting members comply with the requirements of SANS 10400-B;
- 3) the height measured from the ground floor to the top of an external gable does not exceed 8,0 m;
- 4) the storey height measured from floor to wall plate

level or to the underside of the first floor does not exceed 3,0 m;

- 5) the span of concrete floor slabs between supporting walls does not exceed 6,0 m;
- 6) the floor slabs are not thicker than 255 mm if of solid construction, or the equivalent mass if of voided construction;
- 7) the average compressive strength of the hollow and solid masonry units is not less than 7,0 MPa;
- 8) the mortar is class II that complies with the requirements of SANS 2001-CM1;
- 9) the walls supporting floor elements are of cavity construction or have a nominal thickness of not less than 140 mm; and
- 10) the mass of the roof covering does not exceed 80 kg/m²;

c) infill panels in concrete and steel framed buildings of four storeys or less, where:

- 1) the average compressive strength of hollow and solid masonry units is not less than 3,0 MPa and 4,0 MPa, respectively;
- 2) the mortar is class II that complies with the requirements of SANS 2001-CM1;
- 3) the walls are either of a cavity construction or have a nominal thickness of not less than 140 mm; and
- 4) the nominal height of masonry above openings is not less than 0,4 m; and
- 5) the storey height measured from floor to soffit of the floor above does not exceed 3,3 m; and

d) free-standing, retaining, parapet and balustrade walls, where:

- 1) the average compressive strength of hollow and solid masonry units shall be not less than 3,0 MPa and 5,0 MPa, respectively; and
- 2) the mortar is class II that complies with the requirements of SANS 2001-CM1.

Note: In accordance with SANS 10400-B, the imposed load in the following occupancy classes and zones does not exceed 3,0 kN/m²:

- a) all rooms in a dwelling unit and a dwelling house including corridors, stairs and lobbies to a dwelling house;
- b) bedrooms, wards, dormitories, private bathrooms and toilets in educational buildings, hospitals, hotels and other institutional occupancies;
- c) classrooms, lecture theatres, X-ray rooms and operating theatres;
- d) offices for general use and offices with data-processing and similar equipment;
- e) cafes and restaurants;
- f) dining rooms, dining halls, lounges, kitchens, communal bathrooms and toilets in educational buildings, hotels and offices;
- g) entertainment, light industrial and institutional occupancies; and
- h) corridors, stairs and lobbies to all buildings.

The imposed load in the following area exceeds 3.0kN/m^2 :

- a) filing and storage areas to offices, institutional occupancies, and hotels;
- b) light laboratories;
- c) sales and display areas in retail shops and departmental stores;
- d) banking halls; and
- e) shelved areas to libraries.

4.2.1.2 The construction of the walls shall be in accordance with the requirements of SANS 2001-CM1. Rod reinforcement shall comprise hard-drawn wires that have a proof stress of 485 MPa.

4.2.1.3 Cavities in cavity walls shall not be less than 50 mm or more than 110 mm wide.

4.2.1.4 Metal wall ties used in areas

- a) between the coastline and an imaginary line 30 km inland,
- b) parallel with the coastline, or
- c) at the top of the escarpment or watershed of

the first mountain range inland, if these are less than 30 km from the coastline,

- d) shall have a minimum thickness of galvanizing of 750g/m^2 and in tidal splash zones shall be manufactured from stainless steel.

4.2.1.5 In areas within 1 km from the coastline or shoreline of large expanses of salt water and within 3 km of industries that discharge atmospheric pollutants which are corrosive,

- a) brickforce shall be manufactured from pre-galvanized wire, and the galvanizing shall be in accordance with SANS 935 for a grade 2 coating; and
- b) rod reinforcement shall be galvanized in accordance with the requirements of SANS 935 for a grade 2 coating or SANS 121, as appropriate.

4.2.1.6 In tidal and splash zones, brickforce and rod reinforcement shall be made of stainless steel wire.

4.2.1.7 Lintels shall be provided above all window and door openings in accordance with the requirements of 4.2.9.

4.2.1.8 Bed joint reinforcement shall be discontinuous across a control joint that is tied.

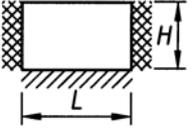
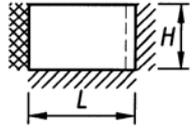
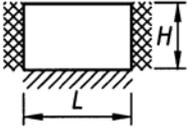
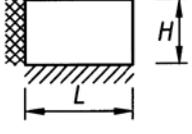
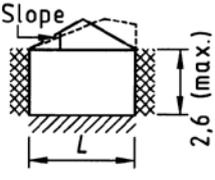
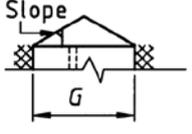
Wall Configuration	Table	Commentary
 <p>External wall panel</p>	<p>Table 1: Maximum dimensions for external unreinforced wall panels supported on both sides</p>	<p>Applicable to panels that do not incorporate gable ends. Wall panel sizes are sensitive to panel openings.</p> <p>Two categories of opening are provided for:</p> <ul style="list-style-type: none"> — less than 15 % wall area — greater than 15 % wall area
 <p>External wall panel</p>	<p>Table 2: Maximum dimensions for external unreinforced wall panels supported on both sides that incorporate a tied control/articulation joint</p>	<p>Applicable to panels that do not incorporate gable ends. Wall panel sizes are sensitive to panel openings.</p> <p>Two categories of opening are provided for:</p> <ul style="list-style-type: none"> — less than 15 % of wall area — greater than 15 % of wall area
 <p>Internal wall panel</p>	<p>Table 3: Maximum dimensions for internal unreinforced wall panels supported on both sides with or without openings</p>	<p>Wall panel size is not governed by openings</p>
 <p>Internal/external panel supported</p>	<p>Table 4: Maximum dimensions for internal and external unreinforced wall panels supported on one side only</p>	<p>Panels which incorporate full height doors are treated as walls supported on one side only with openings. Wall panel size is sensitive to openings (no size of opening is specified).</p>
 <p>Slope</p> <p>2,6 (max.)</p>	<p>Table 5: Maximum length of external unreinforced wall panel 2,6 m (max.) high supporting a free-standing (isosceles) gable triangle or portion thereof</p>	<p>Applicable to panels that incorporate gable ends (or a portion thereof) which have a panel height that does not exceed 2,6 m.</p> <p>Wall panel size is sensitive to panel openings.</p> <p>Triangular portion of gable above eaves level shall be in accordance with table 6.</p> <p>Internal walls with gables (fire walls) shall be designed in accordance with table 1 (no openings).</p>
 <p>Slope</p> <p>G</p>	<p>Table 6: Maximum base width (G) of external triangular unreinforced gable end</p>	<p>The base width (G) shall be reduced by the length of any openings within the gable.</p>
<p>LEGEND</p> <p> Horizontal support</p> <p> Vertical support (cross wall or return providing support)</p> <p> Vertical support (tied butt joint (see figure 7))</p> <p>L = Length of panel</p> <p>H = Height of panel</p> <p>G = Base width of gable end</p>		

Figure 4 Table selection chart for the determination of wall panel sizes in single-storey and double-storey buildings

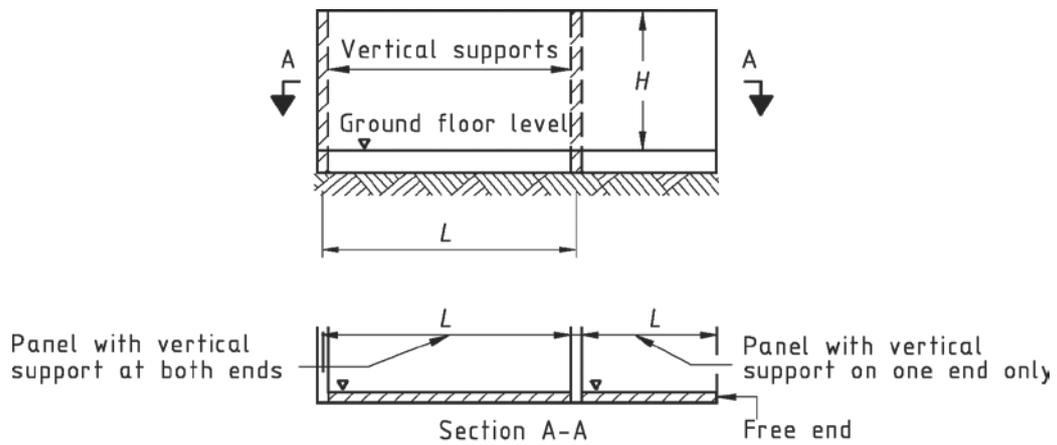
4.2.2 Masonry walling in single-storey and double-storey buildings

4.2.2.1 *Masonry wall panels in single-storey and double-storey buildings shall have dimensions not greater than those derived from figures 4 and 5 and tables 1 to 6, subject to the maximum lengths of openings and the minimum distances between the faces of supports and openings and between successive openings being in accordance with figure 6 and table 7.*

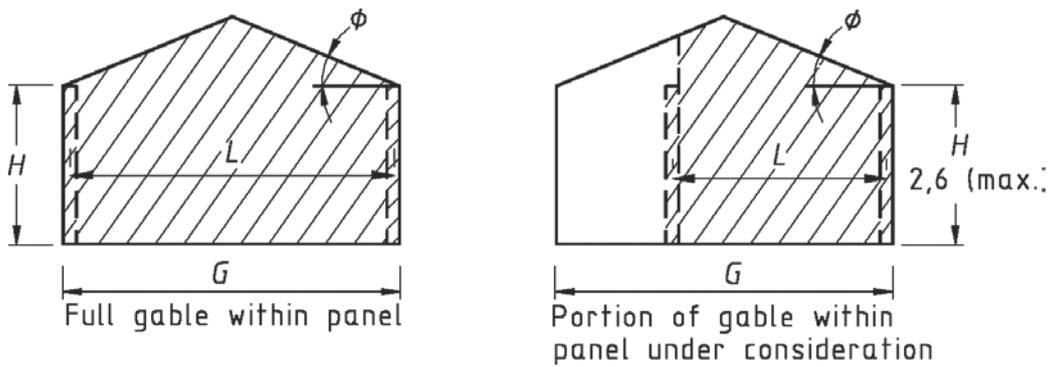
Note 1: *The dimensions for panels with openings in tables 1, 2, 4 and 5 are only valid if lintels in accordance with the requirements of 4.2.9 are provided above all windows and openings.*

Note 2: *Occasionally, during the lifetime of a building, the positions of openings in walls are changed. For this reason, it is recommended that reinforcement be provided in a continuous band in external walls, particularly in the case of walls less than 190 mm thick, to form a lintel or "ring" beam.*

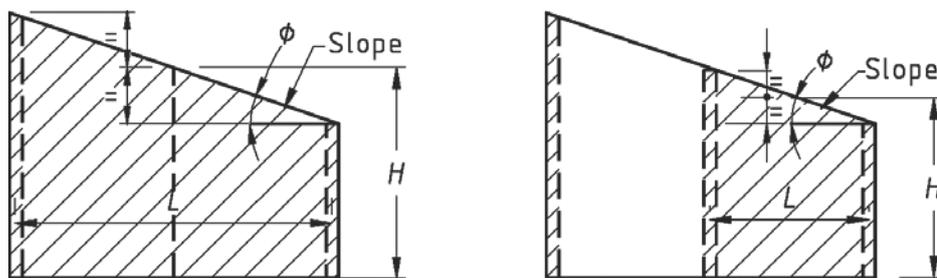
4.2.2.2 *The distance between an opening and a free edge shall not be less than dimensions "b" given in table 7. Where collar joints in collar-jointed walls are not fully mortared, such walls shall for the purposes of 4.2.1.1 be treated as being cavity walls. Panels incorporating full height doors or doors with fanlights shall be treated as panels supported on one side only and shall be sized in accordance with table 4 (wall with opening).*



a) Panel proportions



b) Gable end incorporating an isosceles triangle or portion thereof



c) Monoslope gable end

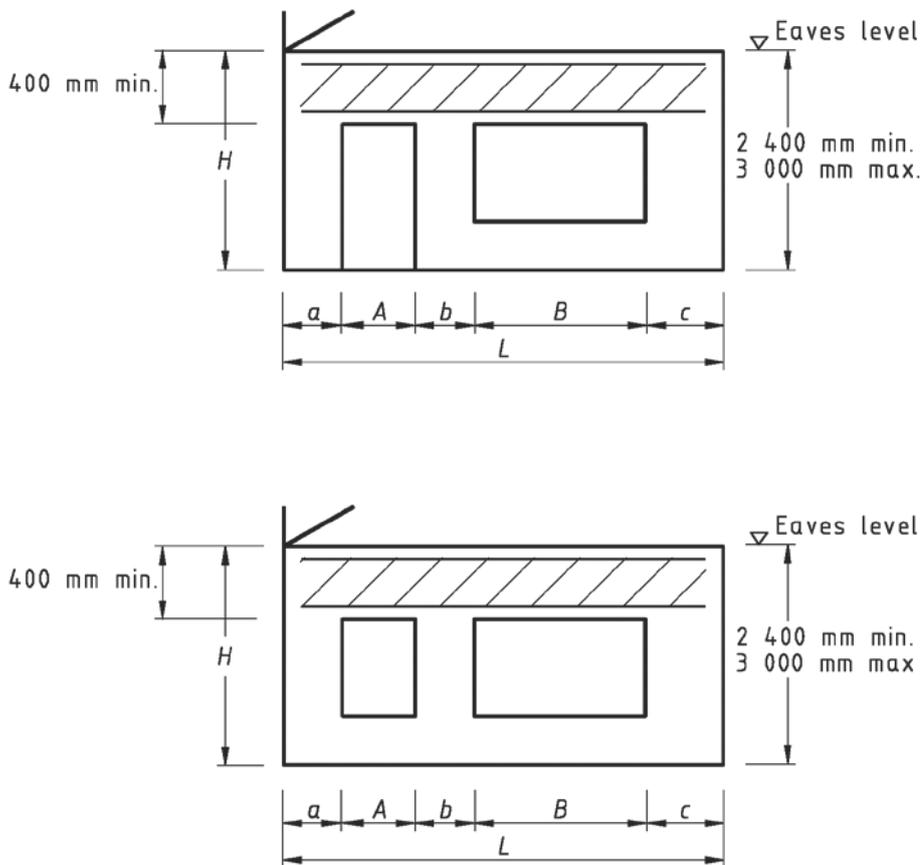
Legend

H = Height of panel

L = Horizontal distance between centres of vertical support

G = Base width of gable end

Figure 5 Wall panels in single-storey and double-storey buildings



Single-storey or upper-storey with sheeted or tiled roof

a and c not less than 150 mm (solid units) or 200 mm (hollow units)

b, A and B in accordance with table 7

Lower-storey of double-storey or single-storey or single or upper-storey with concrete roof

A or B not greater than 2 500 mm

a not less than $\frac{A}{x}$

c not less than $\frac{B}{x}$

b not less than $\frac{A + B}{x}$ or 300 mm (hollow unit filled with infill concrete)

or 300 mm (solid units)

400 mm (hollow units)

where

x = 6 for timber floor

4 for concrete floor (span not greater than 4,5 m)

3 for concrete floor (span not greater than 6,0 m)

Figure 6 Limitations of the size of openings

Table 1 Maximum dimensions for external masonry wall panels supported on both sides

Nominal wall thickness mm	Wall type	Panel A No openings m				Panel B Openings ≤15% wall area m				Panel C Openings >15% wall area m			
		L, max	H	L	H,max	L,max	H	L	H,max	L,max	H	L	H,max
Solid Units													
90	single-leaf	3,2	2,4	2,8	3,4	2,7	2,4	2,5	3,4	2,7	2,4	2,3	3,4
90 - 90	cavity	5,5	2,7	5,5	3,9	5,5	2,7	5,0	3,9	5,5	2,4	4,5	3,9
110	single-leaf	4,5	2,7	4,0	3,6	4,0	2,7	3,5	3,6	3,5	2,7	3,0	3,6
110 - 110	cavity	7,0	3,3	6,0	4,4	7,0	2,4	5,5	4,4	6,5	2,4	5,0	4,4
140	single-leaf	7,0	3,3	6,0	4,3	6,5	2,4	5,2	4,3	6,0	2,7	5,0	4,3
190	collar jointed	8,0	4,6	8,0	4,6	8,0	4,6	8,0	4,6	8,0	4,0	7,5	4,6
220	collar jointed	9,0	4,6	9,0	4,6	9,0	4,6	9,0	4,6	9,0	4,6	9,0	4,6
Hollow Units													
90	single-leaf	2,8	2,4	2,5	3,4	np	np	np	np	np	np	np	np
90 - 90	cavity	5,0	2,7	4,5	3,9	4,5	2,4	4,0	3,9	4,0	2,7	3,5	3,9
110	single-leaf	3,5	2,4	3,3	3,6	3,0	2,4	2,8	3,6	3,0	2,4	2,8	3,6
110 - 110	cavity	6,0	2,4	5,0	4,2	5,0	2,4	4,2	4,2	4,5	2,7	4,2	4,2
140	single-leaf	5,5	2,4	4,5	4,2	4,5	2,7	4,0	4,2	4,2	2,4	3,7	4,2
190	single-leaf	7,5	2,7	6,0	4,4	6,5	2,4	5,0	4,6	6,0	2,7	4,8	4,4

Note 1: Two alternative panel sizes (L x H) are provided in respect of each panel type. Linear interpolation is permitted between these two sets of panel dimensions but not between wall types.

Note 2: The values given in respect of solid units may be used for corresponding walls of hollow unit construction provided that the following reinforcement is provided:

a) truss-type brickforce (see figure 1) that has main wires of not less than 3,55 mm diameter built into courses at vertical centres that do not exceed 400 mm; and

b) either two 5,6 mm diameter rods in each leaf of walls in the bed joint immediately above window level, or a single Y8 bar in a bond-block in 140 mm and 190 mm single-leaf walls at this same level; such reinforcements extending across the entire length of the panel and into the supports.

Note 3: Refer Figure 5 for definitions of L and H.

np - Not permitted

Table 2 Maximum dimensions for external masonry wall panels supported on both sides incorporating a tied or articulation joint

Nominal wall thickness mm	Wall type	Panel A No openings m				Panel B Openings ≤15% wall area m				Panel C Openings >15% wall area m			
		L, max	H	L	H,max	L,max	H	L	H,max	L,max	H	L	H,max
Solid Units													
90	single-leaf	3,0	2,4	2,7	3,4	np	np	np	np	np	np	np	np
90 - 90	cavity	5,5	2,7	5,0	3,9	5,0	2,7	4,5	3,9	4,5	2,7	4,0	3,9
110	single-leaf	4,5	2,4	3,8	3,6	3,5	2,7	3,2	3,6	3,5	2,4	3,0	3,6
110 - 110	cavity	7,0	3,0	5,5	4,4	6,5	2,4	5,0	4,4	6,0	2,4	4,5	4,4
140	single-leaf	7,0	2,7	5,5	4,3	6,0	2,4	4,5	4,3	5,5	2,4	4,5	4,3
190	collar jointed	8,0	4,6	8,0	4,6	8,0	3,6	7,0	4,6	8,0	3,6	7,0	4,6
220	collar jointed	9,0	4,6	9,0	4,6	9,0	4,6	9,0	4,6	8,5	4,6	8,5	4,6
Hollow Units													
90	single-leaf	2,3	2,4	2,1	3,4	np	np	np	np	np	np	np	np
90 - 90	cavity	5,0	2,4	4,5	3,9	4,0	2,7	3,5	3,9	4,0	2,7	3,5	3,9
110	single-leaf	3,3	2,4	3,0	3,6	2,8	2,7	2,6	3,6	2,7	2,4	2,4	3,6
110 - 110	cavity	5,5	2,4	4,5	4,2	4,5	2,4	4,0	4,2	4,3	2,4	3,7	4,2
140	single-leaf	5,0	2,4	4,0	4,2	4,0	2,7	3,5	4,2	4,0	2,4	3,5	4,2
190	single-leaf	7,0	2,7	6,0	4,4	6,0	2,4	4,5	4,4	5,5	2,4	4,5	4,4

Note 1: Two alternative panel sizes (L x H) are provided in respect of each panel type. Linear interpolation is permitted between these two sets of panel dimensions but not between wall panel types.

Note 2: The values given in respect of solid units may be used for corresponding walls of hollow unit construction provided that the following reinforcement is provided:

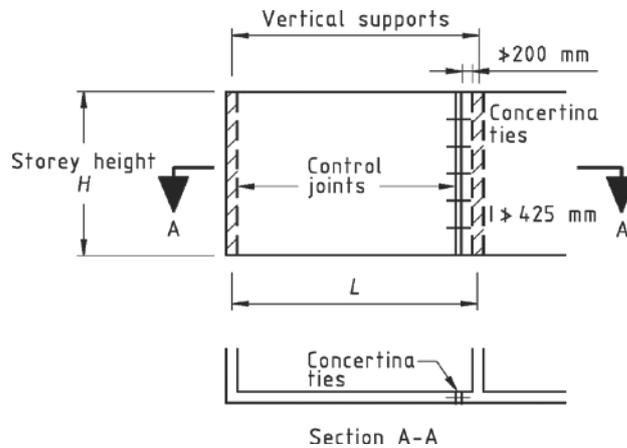
a) truss-type brickforce (see figure 1) that has main wires of not less than 3,55 mm diameter built into courses at vertical centres that do not exceed 400 mm; and

b) two 5,6 mm diameter rods in each leaf of walls in the bed joint immediately above the window level, or a single Y8 bar in a bond-block in 140 mm and 190 mm single-leaf walls at this same level; such reinforcement extending across the entire length of the panel and into the supports.

Note 3: See Figure 6 for definitions of L and H.

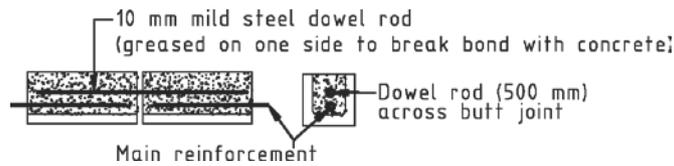
Note 4: See figure 7 for the location and details of the tied control joint.

np - Not permitted

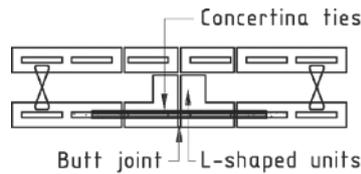


Concertina ties shall be placed in bed joints at centres that do not exceed 425 mm. Dowels shall be placed in hollow unit bond beams in lieu of concertina ties (see figure 7a).

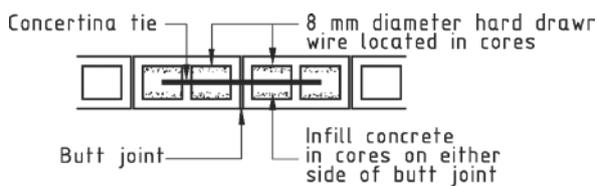
a) Section A-A



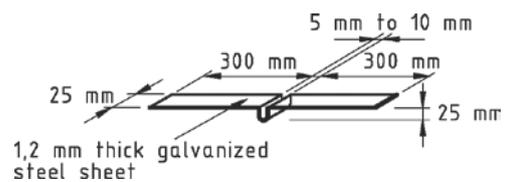
b) Section through hollow unit bond beam at tied control joint



c) Cavity wall detail at joint



d) Hollow single-leaf wall detail at joint



e) Concertina tie detail

Figure 7 Tied butt control joint details (lateral stability)

Table 3 Maximum dimensions for internal masonry wall panels supported on both sides with or without openings

Nominal wall thickness mm	Wall type	Internal wall panel with or without openings m	
		L	H
Solid Units			
90	single-leaf	4,5	3,4
90 — 90	cavity	6,0	3,9
110	single-leaf	5,5	3,6
110 — 110	cavity	7,0	4,4
140	single-leaf	7,0	4,3
190	collar jointed	8,5	4,6
220	collar jointed	9,0	4,6
Hollow Units			
90	single-leaf	4,5	3,4
90 — 90	cavity	5,5	3,9
110	single-leaf	6,0	3,6
110 — 100	cavity	7,0	4,4
140	single-leaf	8,0	4,6
190	single-leaf	8,5	4,6

Note 1: Internal panel lengths for gables (firewalls) that have slopes within the range presented, may be based on the maximum length given in respect of a wall without openings in accordance with column 3 (panel A) of table 1.

Note 2: See figure 6 for definitions of L and H.

Table 4 Maximum dimensions for internal and external unreinforced wall panels supported on one vertical side only

Nominal wall thickness mm	Wall type	Internal wall panel with or without openings m		External wall panels			
				Without openings m		With openings m	
		L	H	L	H	L	H
Solid Units							
90	single-leaf	1,4	3,4	1,4	3,4	1,2	3,0
90 - 90	cavity	2,1	3,9	2,1	3,9	1,8	3,6
110	single-leaf	2,0	3,6	2,0	3,6	1,6	3,6
110 - 110	cavity	2,6	4,4	2,6	4,4	2,1	3,6
140	single-leaf	2,5	4,3	2,5	4,3	2,0	3,6
190	collar jointed	3,4	4,6	3,4	4,6	2,7	3,6
220	collar jointed	4,0	4,6	4,0	4,6	3,1	3,6
Hollow Units							
90	single-leaf	1,4	3,4	1,4	3,4	1,2	3,0
90 - 90	cavity	2,1	3,9	2,1	3,9	1,8	3,6
110	single-leaf	2,0	3,6	2,0	3,6	1,8	3,3
110 - 110	cavity	2,6	4,4	2,6	4,4	2,0	3,3
140	single-leaf	2,5	4,3	2,5	3,6	1,8	3,0
190	single-leaf	3,4	4,6	3,4	3,6	2,4	3,3

Note 1: Where collar joints in collar-jointed walls are not fully mortared, such walls are structurally equivalent to cavity walls.

Note 2: See figure 6 for definitions of L and H.

Table 5 Maximum length (L) of external, masonry wall panel not exceeding 2,6 m in height supporting a free-standing (isosceles) gable triangle or portion thereof

Nominal wall thickness mm	Wall type	Without openings m					With openings m				
		Slope									
		≤11°	15°	17°	22°	26°	≤11°	15°	17°	22°	26°
Solid Units											
90	single-leaf	2,8	2,7	2,6	2,6	2,6	2,4	2,4	2,4	2,4	2,4
90 - 90	cavity	5,5	5,5	5,5	5,0	5,0	4,5	4,5	4,0	4,0	4,0
110	single-leaf	4,5	4,5	4,5	4,0	4,0	4,0	4,0	3,5	3,5	3,5
110 - 110	cavity	7,0	7,0	6,5	6,0	6,0	6,0	5,5	5,5	5,0	5,0
140	single-leaf	6,5	6,0	5,5	5,5	5,5	5,0	5,0	4,5	4,5	4,5
190	collar jointed	8,0	8,0	8,0	8,0	8,0	8,0	7,5	7,5	7,0	6,5
220	collar jointed	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
Hollow Units											
90	single-leaf	2,5	2,5	2,5	2,5	2,5	2,1	2,1	2,1	2,0	2,0
90 - 90	cavity	4,5	4,5	4,0	4,0	4,0	3,5	3,5	3,5	3,5	3,5
110	single-leaf	3,5	3,5	3,3	3,3	3,0	3,0	3,0	2,8	2,7	2,7
110 - 110	cavity	5,5	5,5	5,0	5,0	5,0	4,5	4,5	4,0	4,0	4,0
140	single-leaf	4,5	4,5	4,5	4,0	4,0	4,0	3,5	3,5	3,3	3,3
190	single-leaf	6,0	5,5	5,5	5,0	5,0	5,0	5,0	5,0	4,5	4,5

Note 1: The values given in respect of solid units may be used for corresponding walls of hollow unit construction provided that the following reinforcement is provided:

a) truss-type brickforce that has main wires of not less than 3,55 mm diameter at vertical centres that do not exceed 400 mm; and

b) two 5,6 mm diameter rods in each leaf of walls in the bed joint immediately above the window level, or a single Y8 bar in a bond-block in 140 mm and 190 mm single-leaf walls at this level;

such reinforcement extending across the entire length of the panel and into the supports.

Note 2: See figure 6 for the definition of L.

Table 6 Maximum base width (G) of external triangular masonry gable end

Nominal wall thickness mm	Wall type	Maximum base width (G) m				
		Slope				
		≤11°	15°	17°	22°	26°
Solid Units						
90	single-leaf	6,0	6,0	6,0	5,0	4,5
90 - 90	cavity	8,0	8,0	8,0	7,5	6,5
110	single-leaf	6,0	6,0	6,0	5,0	5,5
110 - 110	cavity	8,0	8,0	8,0	8,0	7,5
140	single-leaf	8,0	8,0	8,0	8,0	7,0
190	collar jointed	8,0	8,0	8,0	8,0	8,0
220	collar jointed	8,0	8,0	8,0	8,0	8,0
Hollow Units						
90	single-leaf	6,0	6,0	6,0	5,0	4,0
90 - 90	cavity	8,0	8,0	8,0	7,0	5,5
110	single-leaf	6,0	6,0	6,0	5,0	4,5
110 - 110	cavity	8,0	8,0	8,0	8,0	6,5
140	single-leaf	8,0	8,0	8,0	7,0	6,0
190	single-leaf	8,0	8,0	8,0	8,0	7,5

Note 1: Where openings are provided within the gable, reduce the permissible value of G by the width of such openings.

Note 2: The maximum base width of internal gables (firewalls), for the range of slopes presented, may be taken as that given in respect of a slope of 11°.

Note 3: See figure 6 for the definition of base width (G).

Table 7 Critical dimensions of openings and edge distances in respect of single-storey / upper-storey external masonry wall panels supporting sheeted or tiled roofs

Nominal wall thickness mm	Wall type	Minimum length of dimension b	Maximum length of dimension A or B	Maximum length of sum of dimensions A or B
		mm	m	m
Solid Units				
90	single-leaf	600	2,0	2,0
90 - 90	cavity	300	3,0	3,5
110	single-leaf	500	2,5	3,0
110 - 110	cavity	300	3,0	4,0
140	single-leaf	300	3,0	4,0
190	collar jointed	300	3,5	4,5
220	collar jointed	300	3,5	5,5
Hollow Units				
90	single-leaf	600	2,0	2,0
90 - 90	cavity	600	2,5	2,5
110	single-leaf	400	2,5	3,5
110 - 110	cavity	400	3,0	4,0
140	single-leaf	400	3,0	4,0
190	single-leaf	400	3,5	4,5

Note: See figure 6 for definitions of dimensions a, b, A and B.

Example

An owner wishes to build a single-storey building using 190 mm wide hollow masonry units.

The largest (and therefore critical) wall panel dimensions in the chosen layout are as follows:

- wall panel with no openings: 7,0 m x 2,6 m.
- wall panel with openings less than 15 %: 6,2 m x 2,6 m.
- wall panel with openings greater than 15 %: 6,5 m x 2,6 m.
- internal wall panels: 7,0 m x 2,6 m.
- gable end panel (11° double-pitched roof) without openings: 6,0 m x 2,6 m.

Wall panel with no opening: 7,0 m x 2,6 m panel is within the limits for panel A, (see column 3 of table 1), namely 7,5 m x 2,7 m.

Wall panel with openings less than 15%: The limiting dimensions for panel B of table 1 are 6,5 m x 2,4 m and 5,0 m x 4,6 m (see columns 7, 8, 9 and 10 of table 1).

Interpolating between tables, the maximum length of a 2,6 m high panel is:

$$6,5 \text{ m} - (2,6 \text{ m} - 2,4 \text{ m}) / (4,6 \text{ m} - 2,4 \text{ m}) \times (6,5 \text{ m} - 5,0 \text{ m}) = 6,36 \text{ m}.$$

Thus a 6,2 m x 2,6 m panel is adequate.

Wall panel with openings greater than 15%: The limiting dimensions for panel C of table 1 are 6,0 m x 2,7 m and 4,8 m x 4,4 m (see columns 11, 12, 13 and 14 of table 1).

A 6,5 m x 2,6 m panel does not satisfy the requirement of SANS 10400 as the dimension of its length exceeds the maximum permissible length of 6,0 m. It can be made to satisfy requirements by reducing the length to 6,0 m or by providing truss-type reinforcement and a reinforced bond-block in accordance with note 2 of table 1 as an 8,0 m x 4,0 m panel is permitted in respect of a 190 mm solid masonry units (see columns 11 and 12 of table 1).

Internal walls: The maximum internal wall panel dimensions (for hollow units) as given in table 3 are 8,5 m and 4,6 m. The 7,0 m x 2,6 m panel is well within these limits.

Gable end: The maximum wall panel length (for hollow units)(11° roof pitch) for walls without openings as given in table 5 is 6,0 m. A 6,0 m x 2,6 m panel satisfies requirements.

The maximum base width of the triangular portion of the wall above eaves height permitted in terms of table 6 is 8,0 m for a roof having a 11° roof pitch. The gable end dimensions are within this limit.

4.2.2.3 Vertical supports, where required, shall extend to the top of the wall, or in the case of gable ends, to eaves level, and shall comprise intersecting walls which shall, with respect to figures 6 and 8,

a) intersect the supported wall at an angle of between 60° and 120°;

b) have a thickness of not less than 90 mm; and

c) have a length projecting beyond the face of the unsupported wall of not less than the greater of:

1) for internal walls: 1/8th of the height of the wall and 1/10th of the wall length; and

2) for external walls: 0,5 m and one half the sum of adjacent panel lengths in the case of an intermediate support and one half the panel lengths for a corner support; as appropriate, divided by

i) for vertical supports of thickness ≤ 110 mm : 2,5

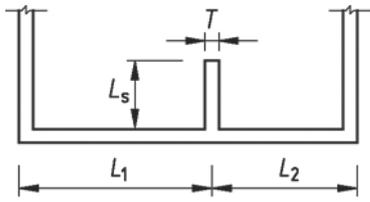
ii) for vertical supports of thickness ≥ 140 mm : 3,0.

4.2.2.4 Where such vertical supports incorporate an opening, the length derived in accordance with 4.2.2.3(c) shall be extended by the length of such opening. Supports should generally extend the full height of the panel. A support on one side of a panel may extend for only 90 % of the height of the panel provided that the support on the opposite end of the panel extends the full height (see figure 8).

4.2.2.5 Walls supporting either concrete floors or roofs shall have a thickness of not less than 90 mm in cavity wall construction and 140 mm in single-leaf and collar-jointed wall construction and contain no openings wider than 2,5 m.

4.2.2.6 The height of fill retained by foundation walls shall not exceed the values given in table 8.

4.2.2.7 Foundation walls shall be of a thickness not less than the wall it supports. The cores in hollow units and cavities in cavity walls shall be filled with grade 10 infill concrete.

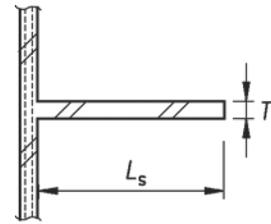


$$L_s = \text{greater of } \frac{L_1 + L_2}{2x} \text{ or } 500\text{mm}$$

where

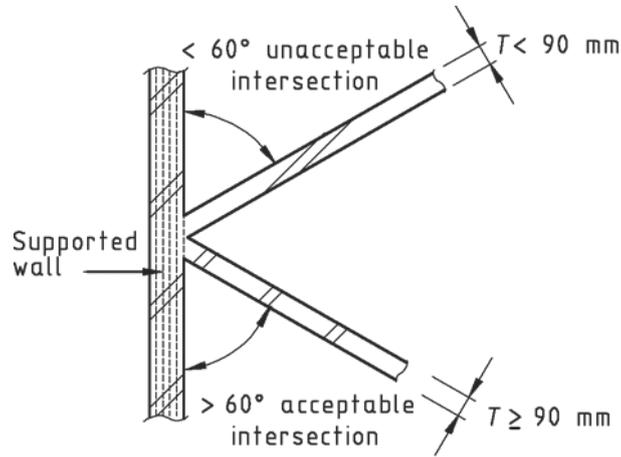
$$x = 2.5 \text{ for } T \leq 110\text{mm}$$

$$x = 3.0 \text{ for } T \geq 140\text{mm}$$

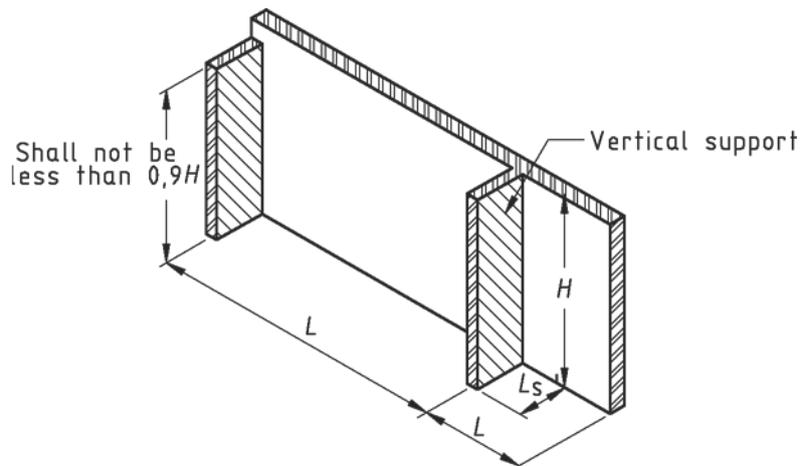


$$L_s = \text{greater of } H/8 \text{ and } L/10$$

a) Plan — External wall panels



Plan



b) Plan — Internal wall panels

Note: See figure 5 for the definitions of L and H.

Figure 8 Lateral support provided by intersecting walls

Table 8 Maximum height of masonry foundation walls where fill is retained behind wall

Nominal wall thickness mm	Wall type	Maximum difference in ground levels, h (see Fig 9) mm
90 & 110	single-leaf	200
140	single-leaf	400
190	single-leaf/collar jointed	600
220	collar jointed	700
90 - 90	cavity	700
110 - 110	cavity	1000
290	collar jointed	1000
330	collar jointed	1200

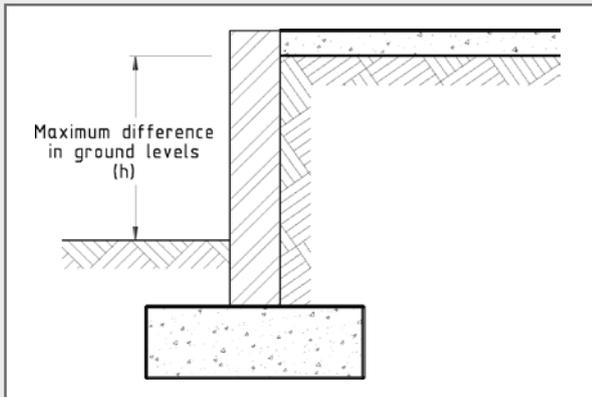


Figure 9 Foundation walls

4.2.3 Infill masonry panels in framed buildings

In SANS 10400—K there is a section on wall panels in framed buildings of four storeys and less with type of wall and thickness of wall related to panel sizes with no openings, 15 % and 25 % of wall area.

Note: Tables 9 to 15 and figures 10 to 16 which form part of clause 4.2.3 SANS 10400-K are not shown in the Concrete Masonry Manual.

4.2.4 Free-standing boundary, garden and retaining walls

4.2.4.1 Free-standing retaining walls shall be designed and constructed so that

a) the height of fill retained by free-standing retaining walls (see figure 17) does not exceed the values given in table 16, provided, however, that where x (see figure 17) exceeds 0,3 m, the height retained is reduced by the difference between x and 0,3 m,

b) piers, where required in terms of table 16, project on the opposite side of the wall to the fill that is being retained,

c) control joints are located at intervals that do not exceed 10 m,

d) no surcharge of fill is placed within a distance equal to the height of the amount of fill being retained, and

e) subsoil drainage is provided behind the wall by providing weepholes formed by building into the wall, 50 mm diameter plastic pipes, with the non-exposed end covered with geofabric, at a height that does not exceed 300 mm above the lower ground level, at centres that do not exceed 1,5 m.

Table 16 Retaining walls

Nominal wall thickness (T) mm	Wall type	Maximum height retained (h) m	Nominal pier dimension (overall depth (D) x width (W)) mm	Maximum centre to centre pier spacing (S) m
Solid Units				
140	single-leaf	1,3	600 x 300	1,8
190	collar jointed	1,3	600 x 300	2,5
190	collar jointed	1,6	600 x 400	2,6
220	collar jointed	1,7	660 x 330	3,0
220	collar jointed	1,8	880 x 440	3,1
290	collar jointed	1,0	-	-
300	collar jointed	1,2	-	-
Hollow Units				
140	single-leaf	1,1	600 x 300	1,8
190	single-leaf	1,1	600 x 300	2,5
190	single-leaf	1,4	800 x 400	2,6

Note: See figure 17 for plan and section of retaining walls

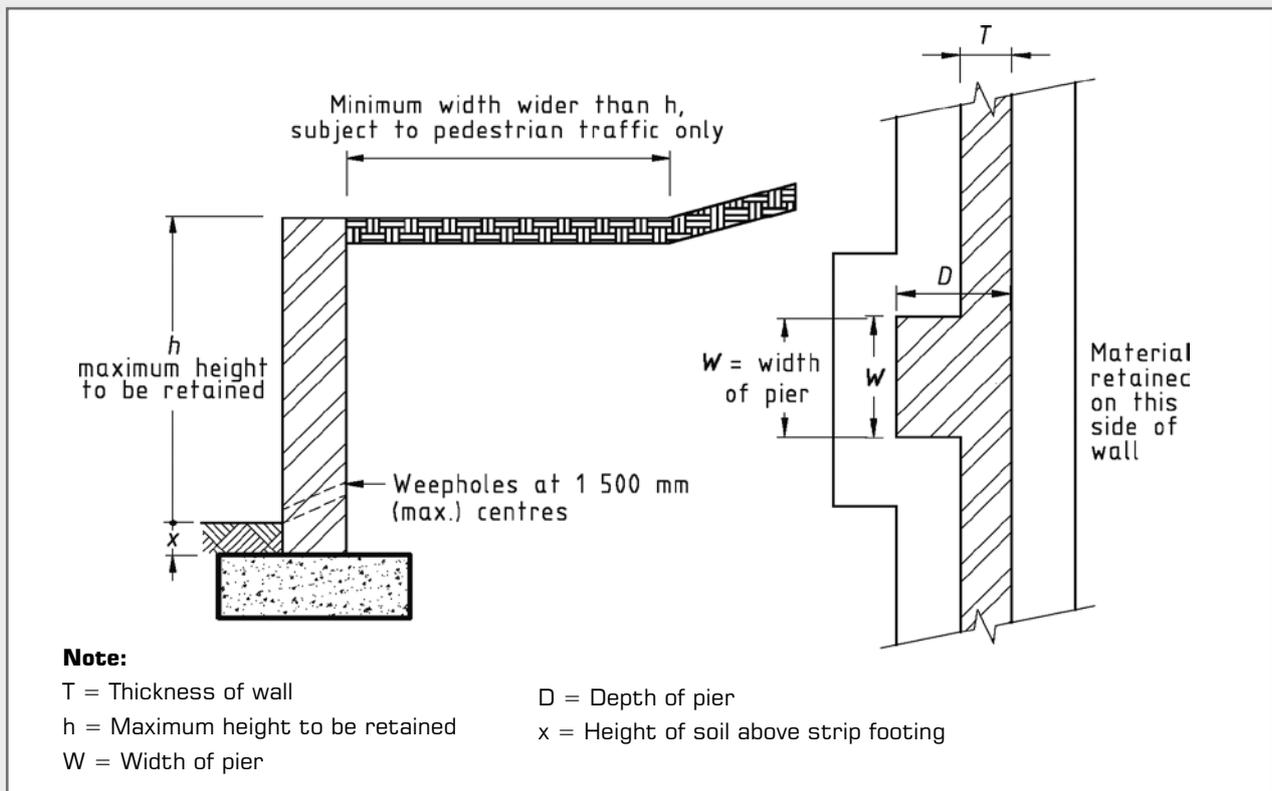


Figure 17 Retaining walls

4.2.4.2 Free-standing boundary and garden walls shall be designed and constructed so that

a) the height of the wall (see figure 18) does not exceed the values given in tables 17 and 18, provided however, that where x (see figure 18) exceeds 0,3 m, the height is reduced by the difference between x and 0,3 m,

b) no earth is retained,

c) piers extend to the top of the wall without any reduction in size,

d) walls terminate in a pier or a return, and

e) the cores of all piers are solidly filled with mortar or infill concrete where units are hollow.

4.2.4.3 No horizontal damp-proof course (DPC) shall be provided in free-standing walls.

Table 17 Free-standing walls (solid units)

Nominal wall thickness (T) mm	Maximum height (h) above ground m	Nominal pier dimension (overall depth (D) x width (W)) mm	Maximum centre to centre pier spacing (S) m
No Piers			
90	0,8	—	—
110	1,0	—	—
140	1,3	—	—
190	1,5	—	—
220	1,8	—	—
290	2,2	—	—
Z-shaped walls			
90	1,8	390 x 90	1,2
90	2,0	490 x 90	1,4
110	1,6	330 x 110	1,5
110	2,1	440 x 110	1,5
140	2,2	440 x 140	2,0
140	2,5	590 x 140	2,5
190	2,1	390 x 190	2,5
190	2,5	490 x 190	3,0
220	2,4	440 x 220	3,0
220	2,8	550 x 220	4,0
Piers projecting on one side			
90	1,4	290 x 290	1,4
90	1,5	390 x 290	1,6
90	1,7	490 x 290	1,6
110	1,5	330 x 330	1,8
110	1,5	440 x 330	1,8
110	1,9	550 x 330	2,0
140	1,7	440 x 440	2,2
140	1,8	590 x 390	2,5
190	2,0	590 x 390	2,8
220	2,3	660 x 440	3,2
Piers projecting on both sides			
90	1,5	490 x 290	1,4
110	1,6	550 x 330	1,8
140	1,6	440 x 440	2,2
190	1,8	590 x 390	2,8
220	2,1	660 x 440	3,2
Diaphragm walls			
90	2,1	290 x 190	1,4
90	2,7	390 x 190	1,4
110	2,6	330 x 220	1,6

Note: See figure 18 for plan and section of the different free-standing wall types

Table 18 Free-standing walls (hollow units)

Nominal wall thickness (T) mm	Maximum height above ground (h) m	Nominal pier dimension (overall depth (D) x width (W)) mm	Maximum centre to centre pier spacing (S) m
No Piers			
90	0,8	—	—
140	1,2	—	—
190	1,4	—	—
Z-shaped			
90	1,6	390 x 90	1,2
90	1,8	490 x 90	1,4
140	1,8	440 x 140	2,0
140	2,1	540 x 140	2,2
190	2,3	590 x 190	2,8
Piers projecting on one side			
90	1,2	390 x 390	1,4
90	1,7	490 x 390	1,7
140	1,4	440 x 290	2,1
140	1,5	540 x 390	2,3
190	1,6	590 x 390	2,8
Piers projecting on both sides			
90	1,0	490 x 290	1,4
140	1,4	440 x 440	2,2
220	1,7	660 x 440	2,9
Diaphragm walls			
90	1,8	290 x 190	1,4
90	2,3	390 x 190	1,4

Note: See figure 18 for plan and section of the different free-standing wall types

4.2.5 Balustrade and parapet walls

4.2.5.1 Balustrade and parapet walls shall not be less than 1,0 m in height unless unauthorized access of persons to the edge of a flat roof or similar structure is excluded by a physical barrier properly erected and monitored.

4.2.5.2 Free-standing balustrade and parapet walls shall have a thickness of not less than the height of the wall above the base divided by

a) Solid units:

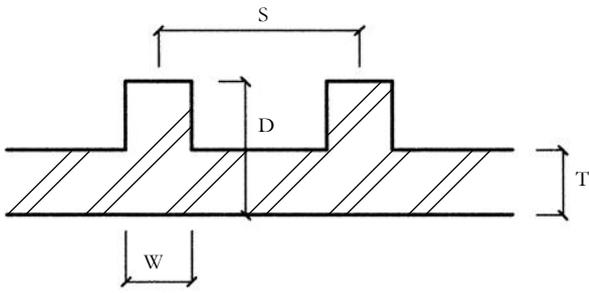
- 1) no DPC at base: 5,0
- 2) DPC at base: 4,5.

b) Hollow units that have cores filled with infill concrete:

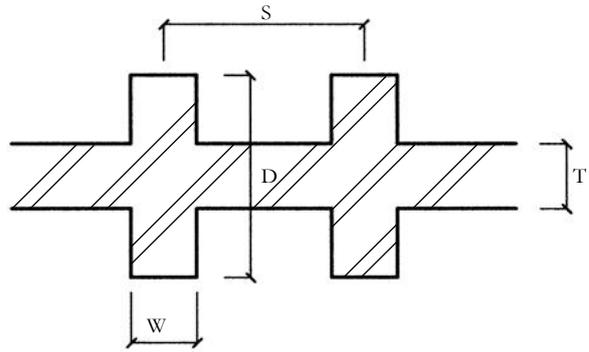
- 1) no DPC at base: 4,0
- 2) DPC at base: 4,0.

4.2.5.3 Balustrades and parapet walls that have returns which continue for a distance of at least 0,75 m from the external face of such walls or are fixed to columns at centres that do not exceed 3,5 m, shall have a thickness of not less than:

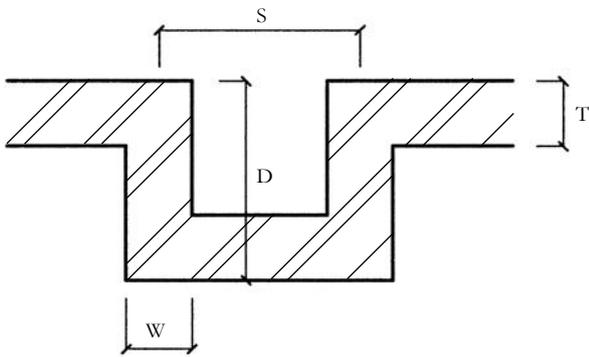
- a) solid units 110 mm
- b) hollow units 140 mm



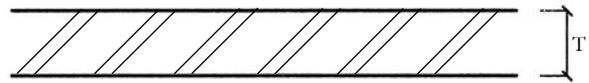
a) Piers projecting on one side only



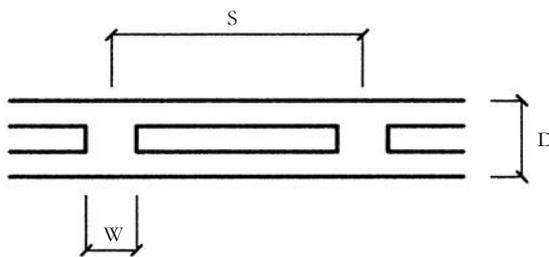
b) Piers projecting on both sides



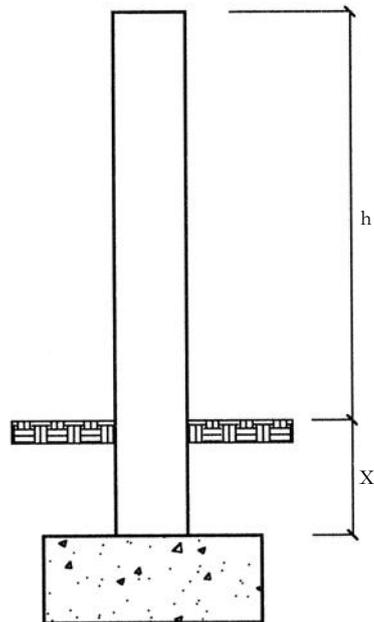
c) Z-shaped piers



d) No piers



e) Diaphragm



f) Typical section through wall

Note:

T = Thickness of wall

h = Maximum height of wall above ground level

W = Width of pier

D = Depth of pier

S = Spacing of piers

X = Height of soil above strip footing

Figure 18 Free-standing walls

4.2.6 Control joints

Butt joints are specified to form vertical control joints in the HBM where no lateral stability required. Reference should be made to the CMA detailing of Concrete Masonry publications where lateral stability is required and for other details on the positioning of control joints.

Control joint location for free-standing walls is shown in Figure 4.12.

4.2.6.1 The overall length of a wall between free ends or returns shall not exceed the limits derived from table 19, unless vertical control joints have been incorporated into such wall so that the distance between a free end

or a return and a vertical control joint, and the distance between vertical control joints is within such limits.

4.2.6.2 A vertical control joint shall be provided where there is a storey height change in the height of the external walling and where setbacks produce a return on plan of less than 800 mm (see figure 19).

Note: Control joints are not required to continue below ground floor level except at changes in level and in free-standing walls.

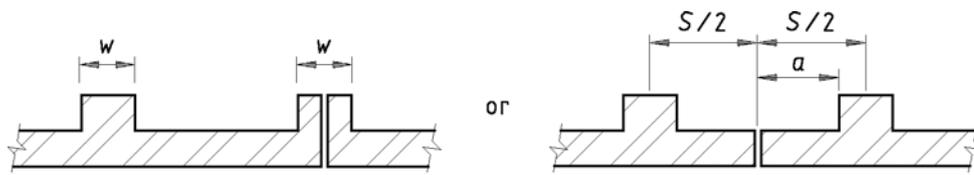
4.2.6.3 Vertical control joints in free-standing walls shall be provided at the locations shown in figure 20 and shall extend to the top of the foundation.

Table 19 Maximum spacing between vertical control joint in walls

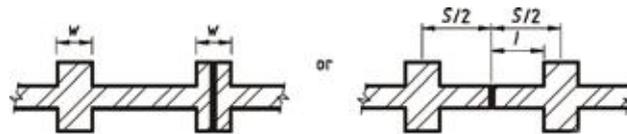
Unit type	Moisture expansion %	Maximum length of wall between vertical control joints	
		Free-standing wall m	Buildings m
Unreinforced masonry			
Burnt clay	< 0,05	16	18
	0,05 — 0,10	10	14
	0,10 — 0,20	6	10
Concrete	—	5,0 — 7,0	8
Masonry with bed joint reinforcement at vertical centres that do not exceed 450mm			
Burnt clay	< 0,05	16	18
	0,05 — 0,10	12	16
	0,10 — 0,20	8	12
Concrete	—	10	12

Note 1: SANS 227 contains a test procedure to establish the moisture expansion of burnt clay bricks

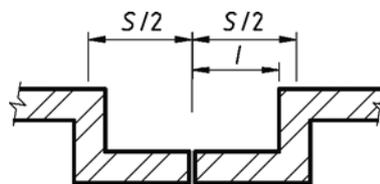
Note 2: In wall construction that comprises hollow masonry units, the placing of Y8 bar in bond beams at centres that do not exceed 1 200 mm (generally in the course below slabs, below sills, above windows and above doors and in the uppermost course) may be regarded as being equivalent to bed joint reinforcement.



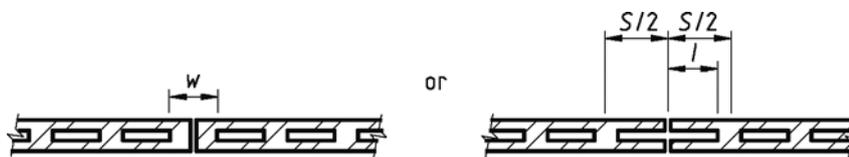
a) Piers projecting on one side only



b) Piers projecting on both sides



c) Z-shaped piers



d) Diaphragm

Note:

Dimension "l" shall not exceed L derived from table 4. (Panel supported on one side only).

Figure 19 Location of control joints in free-standing buildings (SANS 10400-K, Figure 20)

The primary object of control joints is to divide the wall into separate panels in such a way that stresses along its length produced by differential movement and changes in volume of building units are relieved.

The design and positioning of control joints should accommodate movements but should not impair the stability of the wall or any of its functions, i.e. impermeability, sound insulation and fire resistance.

Where necessary, dowels, angles or channels strong enough to provide lateral stability should be incorporated. The dowels, which are usually metal

rod or flat strips, should be anchored in the masonry in such a way that longitudinal movement is not restrained. Angles or channels fixed to one side of the control joint should project into grooves or recesses so as not to restrict longitudinal movement.

As a general rule, vertical joints to accommodate horizontal movement should be provided at intervals of 6m to 7m (see Figure 20) but since there are wide differences in the physical properties of concrete units and wall dimensions, and the loading to which the wall will be subjected, other joint spacings may

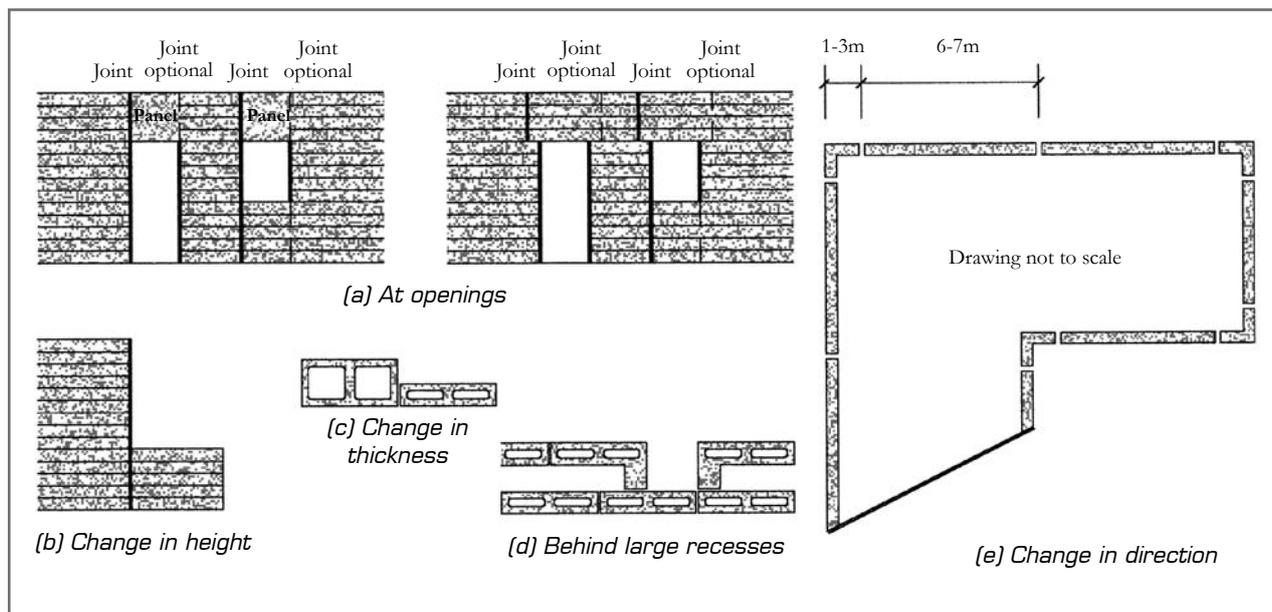


Figure 20 Control joint positions

be acceptable. Table 19 gives the maximum spacing between vertical control joints based on SANS 10400-K. Vertical control joints shall be but joints and the gap between adjacent surfaces shall not exceed 12 mm. SANS 10145 permits joint spacing up to 9m for unreinforced masonry ("subject to the length of wall between control joints not exceeding twice the height of the wall") and up to 18,5 m where vertical spacing of horizontal reinforcement is 200mm or less.

Control joints will not normally be required in interior walls of dwellings, and for other buildings control joint spacing of 7,5m to 10m is generally acceptable. As a general rule no particular account need be taken of thermal movement in interior masonry.

Vertical control joints in non-reinforced masonry should generally be positioned where concentration of or changes in stress may occur, such as at: openings; major changes in wall height; changes in wall thickness; control joints in foundations etc; one or both sides of wall openings, near wall intersections and near return angles in L, T and U-shaped structures (see Figure 20). Control joints can also be located between openings.

Control joints should be considered in foundations, floors, roofs, at wall openings and wherever changes in thickness and major changes in wall height occur.

Joints are not generally provided within the corners of exterior wall returns but are spaced 1 to 3m from them owing to the adverse effect of corner joints on stability of the structure (see Figure 20).

Control joints should be built into the wall during construction and should run the full height of the masonry. Sawn joints are generally more expensive, require great care in cutting and are not normally as effective as built-in joints.

It is not usual to continue the joints below the ground floor damp-proof course where changes in temperature and moisture content are minimal.

Where concrete masonry is used as a backing for other materials, control joints should extend through the facing if the bond is rigid (such as a masonry bond) but need not extend throughout the facing if the bond is flexible (eg. made of metal ties). Control joints should also extend through any plaster applied directly to concrete masonry.

A horizontal slip plate (of a suitable corrosion-resistant material) should be provided under at least one end of a lintel and, where the roof is supported on loadbearing masonry, at a control joint. If an effective horizontal slip plate cannot be built under the end of the lintel, then the position of the control joint should be placed not more than 3m away from the edge of the opening.

The position of the control joints, bond beams and joint reinforcement should be clearly shown on the plans.

With infilling panels in framed buildings, control joints allowing for vertical movement are required. The top of the panel has to be anchored to the structure to permit relative vertical movement while restraining the wall against lateral movement. Movement control gaps are required under any element that supports masonry cladding.

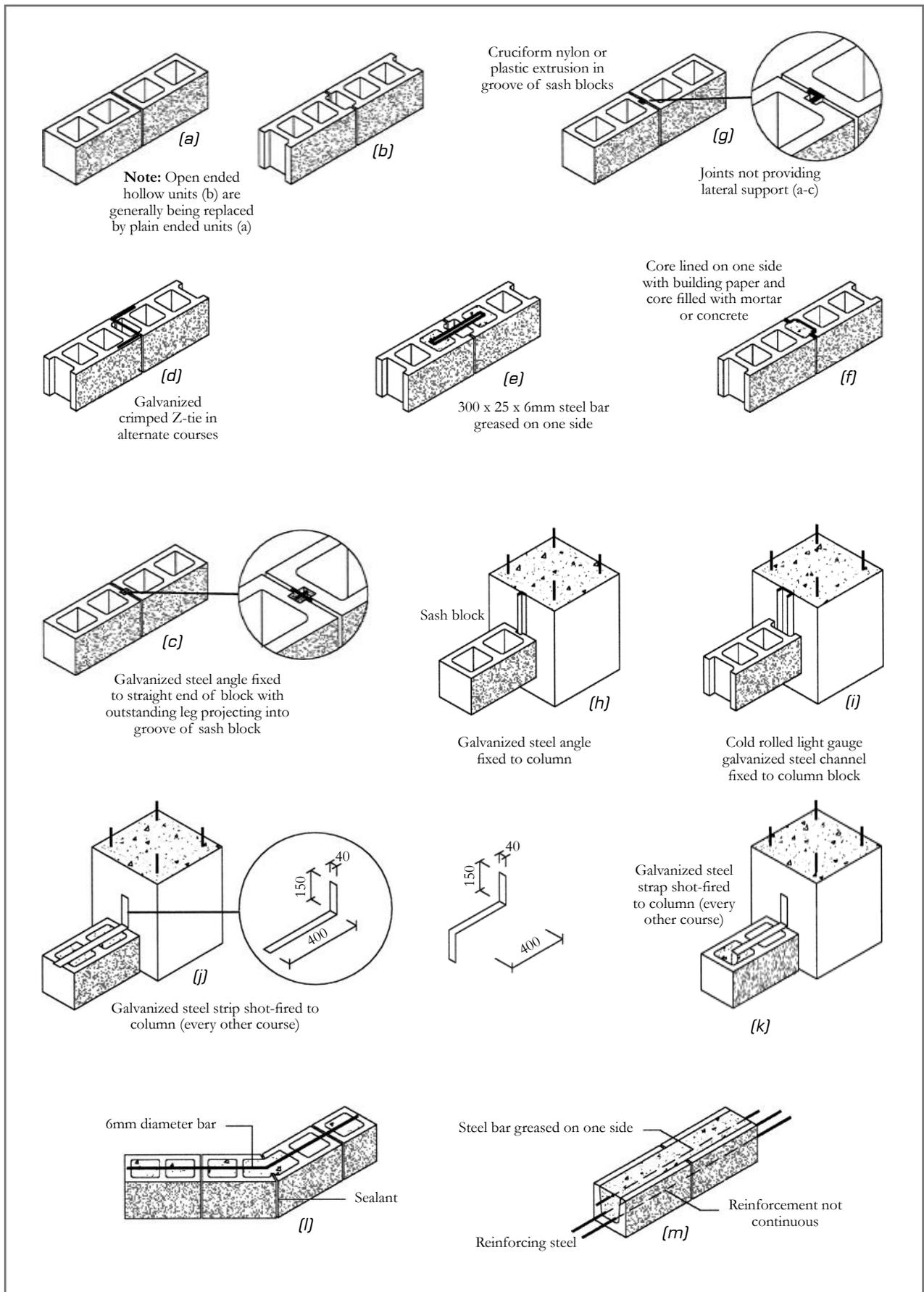


Figure 21 Details of some control joint configurations (Note: joint fillers and sealants not shown)

When calculating the thickness of the gap above infill masonry panels in reinforced concrete frame structures allow for 1,2 to 1,6mm/m shortening of columns due to stress, shrinkage and creep of concrete.

Where the cladding is separate to the reinforced concrete frame of the building, a horizontal control joint every third storey should be provided in the cladding to allow for frame shortening.

The American Concrete Institute, in its Commentary on building code requirements for concrete masonry structures, recommends a control joint for expansion at spacings of 45m to 60m.

The joint configuration depends on the purpose of the joint, primarily on the ability of the joint to transfer load across the gap.

In Figure 21, details are given of some control joint configurations. Joints (a), (b) and (c) are suitable for interior walls. Joints (d) to (m) are capable of providing mutual lateral support. Flat galvanised mild-steel strips 40mm wide x 1,6mm minimum thickness are also used for tying walls to concrete columns. The horizontal long leg of the strip, approximately 400 mm long, lies in the bedding course of the masonry while the vertical leg, approximately 150mm, is shot-bolted to the column in such a way as to give immediate lateral support to the wall, i.e. the vertical leg of the strip does not initially pull away appreciably from the column before providing support.

The horizontal leg of the tie should be parallel to the wall surfaces, otherwise cracks may be induced in the wall at the end of the tie. It is normal practice to fill the core of hollow units adjacent to the column with concrete or mortar. Calculations of lateral forces will determine the size, spacing and type of the control joint to be used.

4.2.7 Articulation joints

4.2.7.1 Articulation joints, where required, shall be capable of movement (expanding or contracting) to cater for the rigid body displacements of the walls as they rotate with the foundations. Joints shall be free of mortar droppings or other obstructions which might impede the function of the joints and, where required, shall be filled with a compressible filler and sealed with a sealant which is capable of withstanding the range of movements which are expected to take place.

4.2.7.2 Articulation joints at doors and openings shall be in accordance with the requirements of SANS 10400-K, Figures 23, 24 and 25. Articulation joints at doors shall extend through the walls to the

strip footings. Wall plates above articulation joints shall be cut and arrangements shall be made to transfer loads from trusses located above doors to adjacent trusses by means of timber bearers (relief beams). Cornices shall either be fixed to the ceiling or to the walls but not to both.

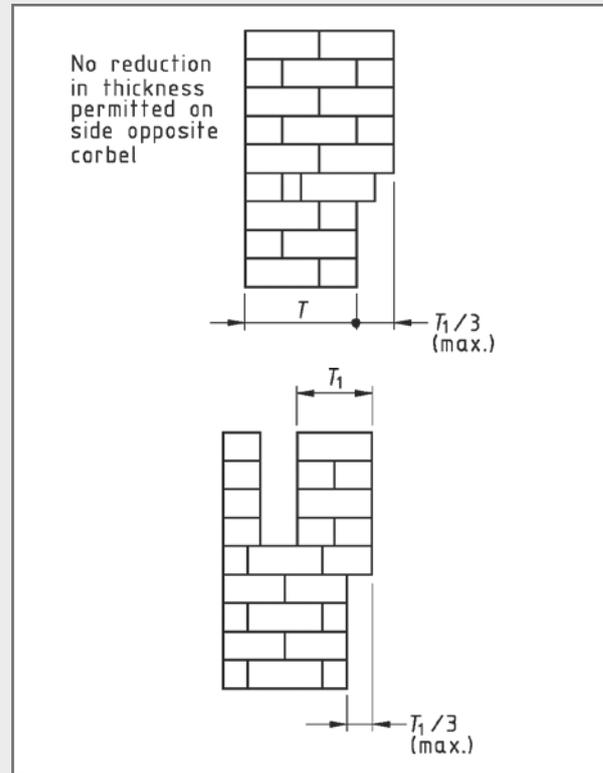


Figure 22 Size of corbels (SANS 10400-K, Figure 26)

4.2.8 Corbelling

Where courses are corbelled out one above the other, the extent of corbelling shall not exceed that shown in figure 26.

4.2.9 Lintels

Note 1: Annex B provides information on the design of lintels and the minimum depths of lintels and maximum size of openings that can be accommodated using the tabulation provided in 4.2.9.

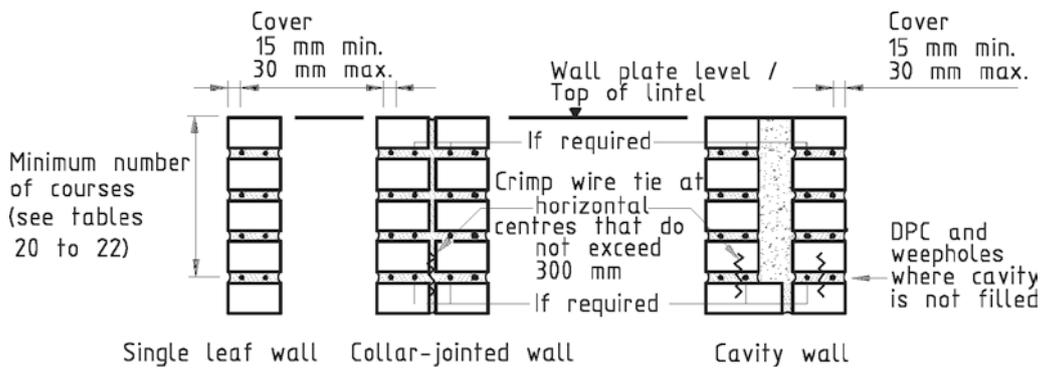
Note 2: In gable end construction, the minimum overall lintel depth or number of courses above the lintel soffit will be at the edge of the opening furthest from the apex.

4.2.9.1 Bed joint reinforced lintels

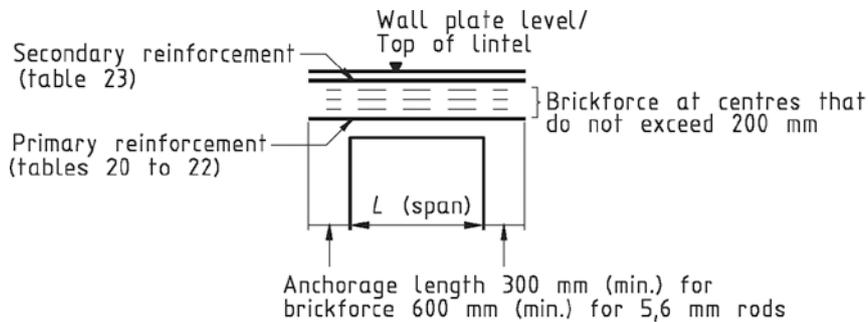
4.2.9.1.1 Bed joint reinforced lintels shall have primary reinforcement located in the lowermost bed joints in accordance with tables 20, 21 or 22 and secondary bed joint reinforcement in the uppermost bed joint in accordance with table 22 and in accordance with the details shown in figure 23.

Note: Tables 20, 21 and 22 provide reinforcing details for lintels supporting tiled and sheeted roofs. Lintels which support concrete floors and roofs and timber floors fall outside the scope of this part of SANS 10400 and as such should be designed in accordance with the provisions of SANS 10400-B. Guidance on

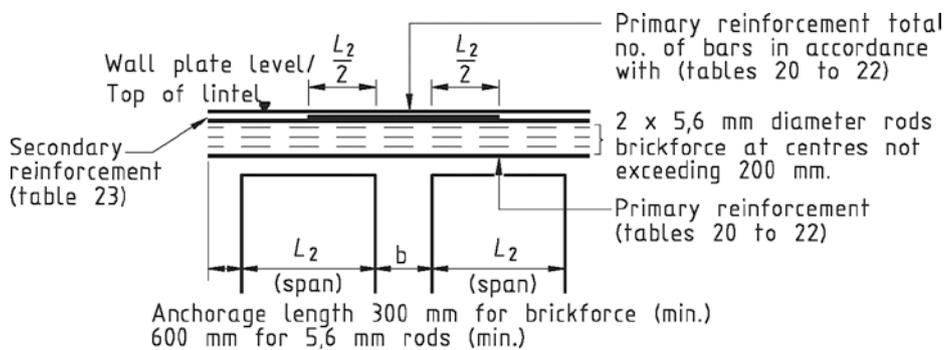
the design of lintels over openings is given in appendix G of the Joint Structural Division of the South African Institution of Civil Engineering and the Institution of Structural Engineers' Code of practice for foundations and superstructures for single-storey residential buildings of masonry construction.



a) Typical section through lintel



b) Single opening



c) Openings with narrow pier where $b < 750\text{mm}$

Figure 23 Bed joint reinforced lintel details (SANS 10400-K, Figure 27)

Table 20 Primary bed joint reinforcement for lintels that do not support roof or floors

Minimum number of courses			Maximum span m	Rod reinforcement (number x diameter) mm
Course height mm				
85	100	200		
90 mm single-leaf wall				
—	3	—	2,5	2 x 5,6
4	—	—	3,0	2 x 5,6
5	4	2	3,0	2 x 5,6
110 mm single-leaf wall				
4	—	—	3,0	2 x 5,6
140 mm single-leaf wall				
—	3	—	2,5	2 x 5,6
4	—	—	3,0	2 x 5,6
5	4	2	3,0	2 x 5,6
190 mm single-leaf/collar-jointed wall				
—	3	—	2,5	2 x 5,6
4	—	—	3,0	2 x 5,6
5	4	2	3,5	2 x 5,6
220 mm collar-jointed wall				
4	—	—	3,0	2 x 5,6
5	4	2	3,5	2 x 5,6
90mm - 90mm cavity wall (cavity solidly filled)				
—	3	—	2,5	2 x 5,6
4	—	—	3,0	2 x 5,6
5	4	2	3,0	2 x 5,6
110mm - 110mm cavity wall (cavity solidly filled)				
4	—	—	3,0	2 x 5,6

Note 1: If the cavity in cavity wall construction is not filled with infill concrete, the two leaves should be considered as independent leaves and be treated as single-leaf walls.

Note 2: Bed joint reinforced lintel details are shown in figure 23.

Table 21 Primary bed joint reinforcement for lintels that support light roofs

Minimum number of courses			Maximum roof span m					
Course height mm			4		6		8	
85	100	200	Maximum span m	Rod reinforcement (number x diameter) mm	Maximum span m	Rod reinforcement (number x diameter) mm	Maximum span m	Rod reinforcement (number x diameter) mm
90 mm single-leaf wall								
—	3	—	2,0	2 x 5,6	2,0	2 x 5,6	np	np
4	—	—	2,0	2 x 5,6	2,0	2 x 5,6	np	np
5	4	2	2,5	2 x 5,6	2,5	2 x 5,6	np	np
6	5	—	3,0	2 x 5,6	3,0	2 x 5,6	np	np
110 mm single-leaf wall								
4	—	—	2,0	2 x 5,6	2,0	2 x 5,6	np	np
5	—	—	2,5	2 x 5,6	2,5	2 x 5,6	np	np
6	—	—	3,0	2 x 5,6	3,0	2 x 5,6	np	np
140 mm single-leaf wall								
—	3	—	2,5	2 x 5,6	2,5	2 x 5,6	2,0	2 x 5,6
4	—	—	2,5	2 x 5,6	2,5	2 x 5,6	2,5	3 x 5,6
5	4	2	3,0	2 x 5,6	3,0	2 x 5,6	2,5	3 x 5,6
6	5	—	3,0	2 x 5,6	3,0	2 x 5,6	3,0	3 x 5,6
190 mm collar-jointed wall								
—	3	—	2,5	2 x 5,6	2,5	3 x 5,6	2,0	2 x 5,6
4	—	—	2,5	2 x 5,6	2,5	2 x 5,6	2,5	3 x 5,6
5	4	2	3,0	2 x 5,6	3,0	3 x 5,6	3,0	3 x 5,6
6	5	—	3,5	3 x 5,6	3,5	3 x 5,6	3,0	3 x 5,6
7	3	3	3,5	2 x 5,6	3,0	2 x 5,6	3,5	3 x 5,6
220 mm collar-jointed wall								
4	—	—	2,5	2 x 5,6	2,5	2 x 5,6	2,5	3 x 5,6
5	—	—	3,0	3 x 5,6	3,0	3 x 5,6	3,0	4 x 5,6
6	—	—	3,5	3 x 5,6	3,5	3 x 5,6	3,5	4 x 5,6
7	—	—	3,0	2 x 5,6	3,0	2 x 5,6	3,0	3 x 5,6
90mm - 90mm cavity wall (cavity solidly filled)								
—	3	—	2,5	2 x 5,6	2,5	3 x 5,6	2,5	3 x 5,6
4	—	—	3,0	3 x 5,6	3,0	4 x 5,6	3,0	4 x 5,6
5	4	2	3,0	3 x 5,6	3,0	3 x 5,6	3,0	4 x 5,6
110mm - 110mm cavity wall (cavity solidly filled)								
4	—	—	3,0	4 x 5,6	3,0	4 x 5,6	2,50	3 x 5,6
5	—	—	3,0	3 x 5,6	3,0	4 x 5,6	3,0	4 x 5,6

np = not permitted

Table 22 Primary bed joint reinforcement for lintels that support heavy roofs

Minimum number of courses			Maximum roof span m					
			4		6		8	
Course height mm			Maximum span m	Rod reinforcement (number x diameter) mm	Maximum span m	Rod reinforcement (number x diameter) mm	Maximum span m	Rod reinforcement (number x diameter) mm
85	100	200						
90 mm single-leaf wall								
—	3	—	1,5	2 x 5,6	1,5	2 x 5,6	np	np
4	—	—	2,0	2 x 5,6	1,5	2 x 5,6	np	np
5	4	2	2,5	2 x 5,6	2,0	2 x 5,6	np	np
6	5	—	2,5	2 x 5,6	2,0	2 x 5,6	np	np
7	6	3	2,5	2 x 5,6	2,5	2 x 5,6	np	np
8	7	—	2,5	2 x 5,6	2,5	2 x 5,6	np	np
9	—	—	3,0	2 x 5,6	2,5	2 x 5,6	np	np
—	8	4	3,0	2 x 5,6	2,5	2 x 5,6	np	np
10	—	—	3,0	2 x 5,6	3,0	2 x 5,6	np	np
110 mm single-leaf wall								
4	—	—	2,0	2 x 5,6	1,5	2 x 5,6	np	np
5	—	—	2,5	2 x 5,6	2,0	2 x 5,6	np	np
6	—	—	2,5	2 x 5,6	2,5	2 x 5,6	np	np
7	—	—	2,5	2 x 5,6	2,5	2 x 5,6	np	np
8	—	—	3,0	2 x 5,6	2,5	2 x 5,6	np	np
9	—	—	3,0	2 x 5,6	3,0	2 x 5,6	np	np
10	—	—	3,0	2 x 5,6	3,0	2 x 5,6	np	np
140 mm single-leaf wall								
—	3	—	2,0	2 x 5,6	1,5	2 x 5,6	1,5	2 x 5,6
4	—	—	2,0	2 x 5,6	2,0	2 x 5,6	1,5	2 x 5,6
5	4	2	2,5	2 x 5,6	2,5	3 x 5,6	2,0	3 x 5,6
6	5	—	3,0	2 x 5,6	3,0	3 x 5,6	2,5	3 x 5,6
7	6	3	3,0	2 x 5,6	3,0	3 x 5,6	2,5	2 x 5,6
8	7	—	3,0	2 x 5,6	3,0	3 x 5,6	3,0	3 x 5,6
190 mm collar-jointed wall								
—	3	—	2,5	3 x 5,6	2,0	3 x 5,6	2,0	3 x 5,6
4	—	—	2,5	3 x 5,6	2,5	4 x 5,6	2,0	3 x 5,6
5	4	2	3,0	3 x 5,6	2,5	3 x 5,6	2,5	3 x 5,6
6	5	—	2,5	2 x 5,6	3,0	3 x 5,6	3,0	4 x 5,6
7	6	3	3,5	4 x 5,6	3,5	4 x 5,6	2,5	2 x 5,6
8	7	—	3,0	2 x 5,6	2,5	2 x 5,6	3,0	3 x 5,6
9	—	—	3,5	3 x 5,6	3,5	3 x 5,6	3,5	4 x 5,6
—	8	4	3,5	3 x 5,6	3,0	2 x 5,6	3,5	4 x 5,6
10	—	—	3,5	3 x 5,6	3,5	3 x 5,6	3,5	3 x 5,6

np = not permitted

Table 22 concluded

Minimum number of courses			Maximum roof span m					
			4		6		8	
Course height mm			Maximum span m	Rod reinforcement (number x diameter) mm	Maximum span m	Rod reinforcement (number x diameter) mm	Maximum span m	Rod reinforcement (number x diameter) mm
85	100	200						
220 mm collar-jointed wall								
4	—	—	2,5	3 x 5,6	2,5	4 x 5,6	2,0	2 x 5,6
5	—	—	3,0	3 x 5,6	3,0	4 x 5,6	2,5	3 x 5,6
6	—	—	2,5	2 x 5,6	2,5	2 x 5,6	3,0	4 x 5,6
7	—	—	3,5	4 x 5,6	3,5	4 x 5,6	3,0	4 x 5,6
8	—	—	3,0	2 x 5,6	3,0	3 x 5,6	2,5	2 x 5,6
9	—	—	3,5	3 x 5,6	3,5	4 x 5,6	3,5	4 x 5,6
10	—	—	3,5	3 x 5,6	3,5	3 x 5,6	3,5	3 x 5,6
90mm - 90mm cavity wall (cavity solidly filled)								
—	3	—	2,5	3 x 5,6	2,5	4 x 5,6	2,0	3 x 5,6
4	—	—	2,5	3 x 5,6	2,0	3 x 5,6	2,0	3 x 5,6
5	4	2	3,0	4 x 5,6	2,5	3 x 5,6	2,5	4 x 5,6
6	5	—	2,5	2 x 5,6	3,0	4 x 5,6	2,5	3 x 5,6
7	6	3	3,5	4 x 5,6	2,5	2 x 5,6	3,0	4 x 5,6
8	7	—	3,0	3 x 5,6	3,0	4 x 5,6	3,0	4 x 5,6
110mm - 110mm cavity wall (cavity solidly filled)								
4	—	—	2,5	3 x 5,6	2,5	4 x 5,6	2,0	3 x 5,6
5	—	—	3,0	4 x 5,6	2,5	3 x 5,6	2,5	4 x 5,6
6	—	—	3,0	3 x 5,6	3,0	4 x 5,6	2,5	3 x 5,6
7	—	—	2,5	2 x 5,6	3,0	4 x 5,6	3,0	4 x 5,6

Note 1: If the cavity in cavity wall construction is not filled with infill concrete, the two leaves should be regarded as being independent leaves and be treated as single-leaf walls. Reinforcement for the leaf, that is supporting the roofs, is determined in accordance with this table; reinforcement for the leaf, that does not support any roof, is determined in accordance with table 20

Note 2: Heavy roofs are roofs with the following finishes:

- a) concrete roof tiles;
- b) clay roof tiles;
- c) slates; or
- d) thatch.

Note 3: Bed joint reinforced lintel details are shown in figure 23.

np = not permitted.

Table 23 Secondary bed joint reinforcement details for lintels

Span m	Load		
	No roof	Light roof (metal profile sheeting, metal roof tiles, fibre cement sheeting or fibre cement slates)	Heavy roof (concrete roof tiles, clay roof tiles, slates or thatch)
90 mm and 110 mm single-leaf wall			
1,5	Brickforce	Brickforce	Brickforce
2,0	Brickforce	2 x 5,6 mm diameter	Brickforce
2,5	2 x 5,6 mm diameter	2 x 5,6 mm diameter	2 x 5,6 mm diameter
3,0	2 x 5,6 mm diameter	2 x 5,6 mm diameter	2 x 5,6 mm diameter
140 mm single-leaf wall			
1,5	Brickforce	Brickforce	Brickforce
2,0	Brickforce	Brickforce	Brickforce
2,5	Brickforce	2 x 5,6 mm diameter	Brickforce
3,0	2 x 5,6 mm diameter	2 x 5,6 mm diameter	2 x 5,6 mm diameter
190 mm and 220 mm collar-jointed wall			
1,5	Brickforce	Brickforce	Brickforce
2,0	Brickforce	Brickforce	Brickforce
2,5	Brickforce	2 x 5,6 mm diameter	Brickforce
3,0	Brickforce	2 x 5,6 mm diameter	Brickforce
3,5	Brickforce	2 x 5,6 mm diameter	Brickforce
90 mm-90 mm and 110 mm-110 mm cavity wall (cavity solidly filled)			
1,5	Brickforce	Brickforce	Brickforce
2,0	Brickforce	Brickforce	Brickforce
2,5	Brickforce	2 x 5,6 mm diameter	Brickforce
3,0	Brickforce	2 x 5,6 mm diameter	Brickforce

Note 1: If the cavity in a cavity wall construction is not filled with infill concrete, the two leaves should be considered as independent leaves and be treated as single-leaf walls.

Note 2: Bed joint reinforced lintel details are shown in figure 23.

4.2.9.1.2 Masonry units in the lowermost course (course below the bed joint containing the reinforcement) shall either rest on the window or door frame below or, where practicable, be tied to the course above by means of crimp wire ties placed in cores or cavities or collar joints or perpend joints at centres that do not exceed 300 mm. Precast concrete lintels or lintel (U) blocks shall be used to form the bottom course in lintels where the soffit does not rest on a frame and the units cannot be tied to the course above by means of crimp wire ties.

4.2.9.1.3 Brickforce shall be provided at centres that do not exceed 200 mm between the primary and secondary reinforcement described in 4.2.9.2.1 and 4.2.9.2.2, respectively.

4.2.9.1.4 Primary reinforcement as described in 4.2.9.2.1 shall be located in the uppermost bed joint in accordance with the details shown in figure 24 where the pier between successive openings is less than 750 mm in width.

4.2.9.1.5 The cores and perpend joints in hollow units shall be solidly filled with mortar or grade 10 concrete, as appropriate.

4.2.9.1.6 Lapping of rod reinforcement shall not be permitted. The lap length in respect of brickforce shall not be less than 300 mm.

4.2.9.1.7 Lintels shall be adequately supported for a period of not less than 7 d after completion.

4.2.9.2 Bond-block lintels

4.2.9.2.1 Lintels constructed by means of bond and lintel (U) blocks shall have primary reinforcement located in the block in the bottom course in accordance with tables 24 to 26, as relevant, and in accordance with the details shown in figures 24 and 25.

Note: Tables 24 to 26 provide reinforcing details for lintels supporting tiled and sheeted roofs. Lintels which support concrete floors and roofs and timber floors fall outside of the scope of this part of SANS 10400 and should be in accordance with the requirements of SANS 10400-B.

4.2.9.2.2 Lintels shall have the following secondary reinforcement provided in the uppermost bed joint:

- a) spans up to 1,5 m: brickforce.
- b) spans greater than 1,5 m: truss-type reinforcement

having main wires not less than 3,55 mm in diameter.

Alternatively, a bond or lintel block reinforced with a single Y8 bar may be used in lieu of brickforce in the uppermost bed joint.

4.2.9.2.3 The cores of hollow units immediately adjacent to openings shall be reinforced with a single Y10 bar that extends from floor level to the top of the lintel (see figure 25) and shall be solidly filled with grade 25 infill concrete.

4.2.9.2.4 The cores and perpend joints of units shall be solidly filled with grade 25 infill concrete, as appropriate.

4.2.9.2.5 Lintels shall be adequately supported for a period of not less than 7 d after completion.

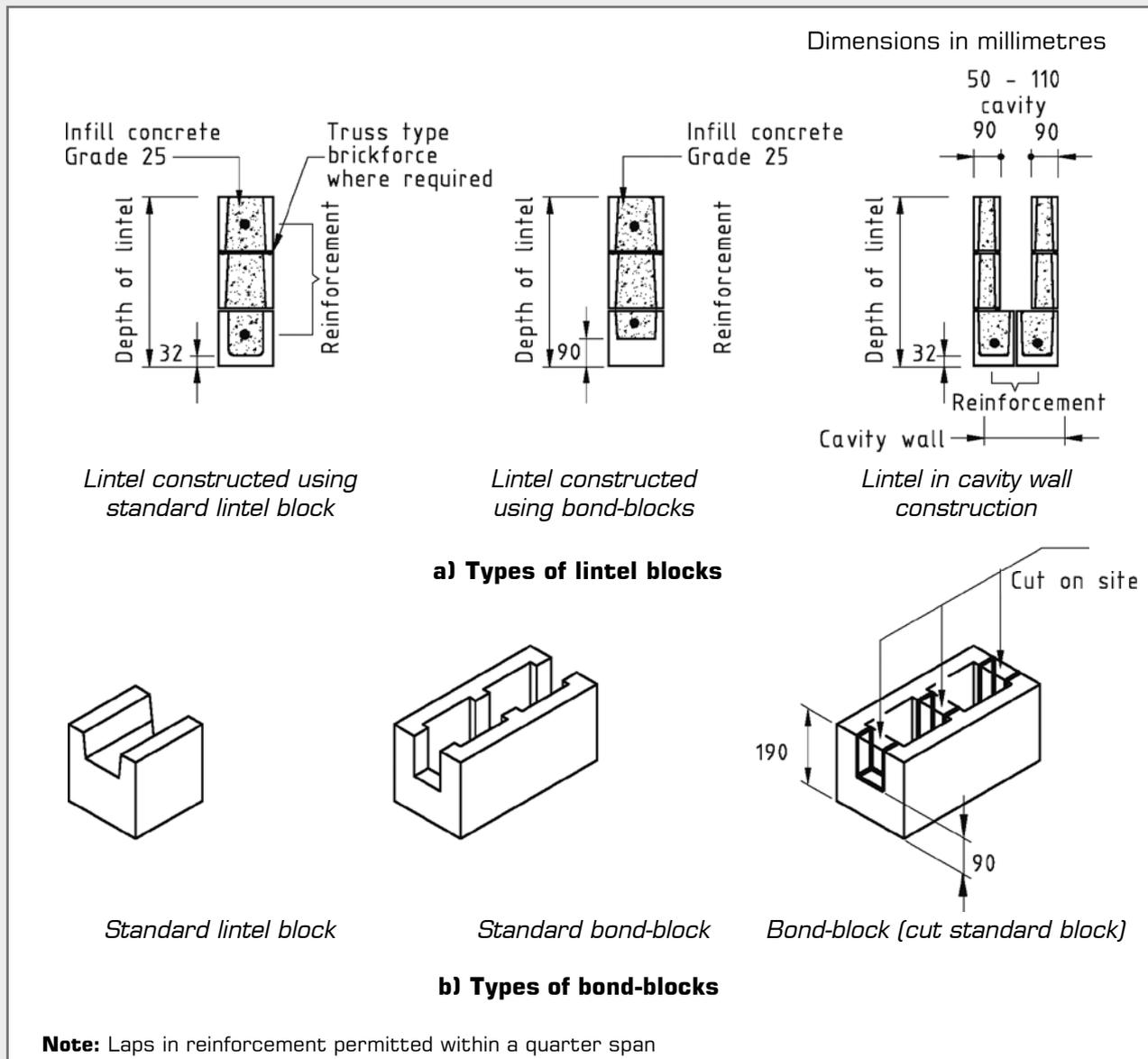
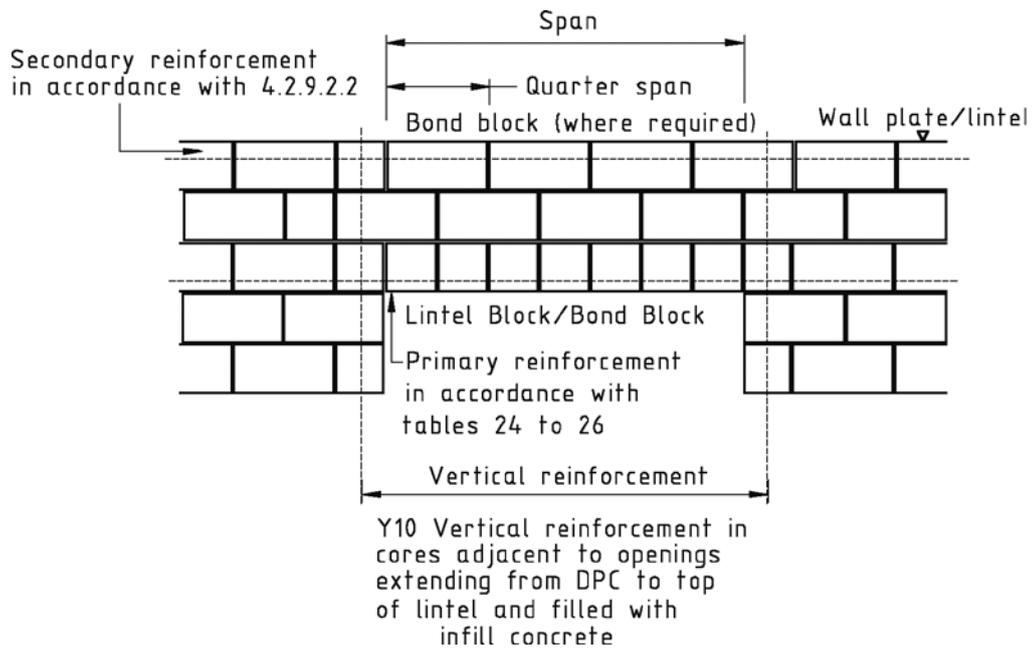
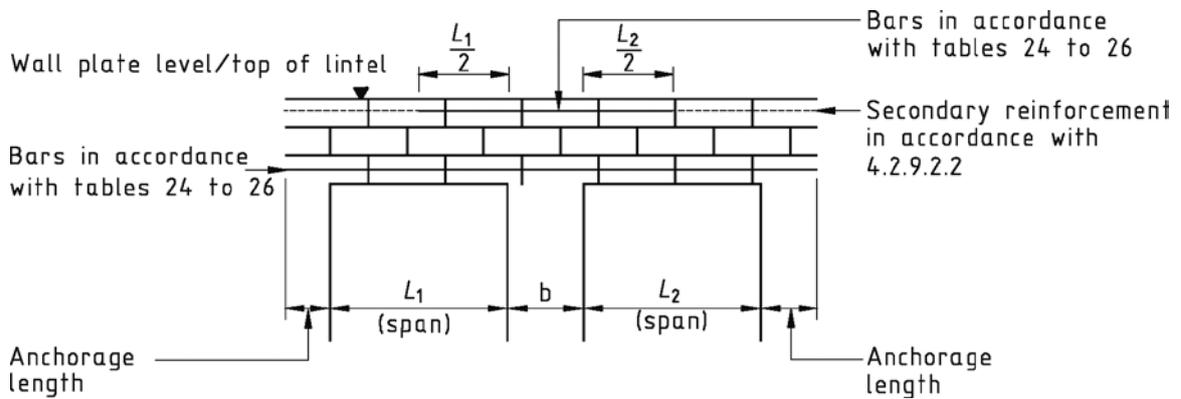


Figure 24 Lintel and bond-block details (SANS 10400-K, Figure 28)



a) Single opening



b) Openings with narrow piers where $b < 750\text{mm}$

Figure 25 Bond-block lintel details — Openings (SANS 10400-K, Figure 29)

Table 24 Bond-block lintels that do not support roofs or floors

Maximum width of opening m	Minimum overall lintel depth mm	Bond-block reinforcement number x bar details
140 mm single-leaf wall		
3,0	400	1 x Y8
3,0	600	1 x Y10
140 mm-140 mm bond beam in cavity wall construction		
3,0	400	1 x Y8
3,0	600	1 x Y8
3,0	800	1 x Y8
190 mm single-leaf wall		
3,0	400	1 x Y8
3,5	600	1 x Y8
3,5	800	1 x Y10

Table 25 Bond-block lintels that support light roofs

Maximum width of opening m	Minimum overall lintel depth mm	Maximum roof span m	Bond-block reinforcement number x bar details
140 mm single-leaf			
1,5	400	8	1 x Y8
2,5	400	6	1 x Y8
3,0	600	8	1 x Y10
140 mm-140 mm bond beam in cavity wall construction			
1,5	400	8	1 x Y8
2,5	600	8	1 x Y8
3,0	800	8	1 x Y8
190 mm single-leaf wall			
2,0	400	8	1 x Y8
3,0	600	8	1 x Y10
3,5	600	6	1 x Y10
3,5	800	8	1 x Y12

Note 1: The values given in respect of 140 mm single-leaf walls may be used where the cavity in the 140 mm-140 mm bond beam in cavity construction is solidly filled with infill concrete.

Note 2: Truss-type reinforcement that has main wires not less than 3,55 mm diameter shall be provided in the uppermost bed joint if a bond-block beam does not form the uppermost course where the span exceeds 1,5 m.

Note 3: Light roofs are roofs with the following finishes:

- a) metal profile sheeting;
- b) metal roof tiles;
- c) fibre cement sheeting; or
- d) fibre cement slates.

Table 26 Bond-block lintels that support heavy roofs

Maximum width of opening m	Minimum overall lintel depth mm	Maximum roof span m	Bond-block reinforcement number x bar details
140 mm single-leaf wall			
1,5	400	8	1 x Y8
2,0	400	6	1 x Y10
2,5	600	8	1 x Y10
3,0	600	6	1 x Y10
3,0	600	8	1 x Y12
140 mm-140 mm bond beam in cavity wall construction			
1,0	400	8	1 x Y8
1,5	400	6	1 x Y8
2,0	600	8	1 x Y8
2,5	600	6	1 x Y8
3,0	800	8	1 x Y8
190 mm single-leaf wall			
1,5	400	8	1 x Y8
2,0	400	6	1 x Y10
2,5	600	8	1 x Y10
3,0	600	8	1 x Y12
3,5	600	6	1 x Y10
3,5	800	8	1 x Y12

Note 1: The values given in respect of 140 mm single-leaf walls may be used where the cavity in the 140 mm - 140 mm bond beam in cavity construction is solidly filled with infill concrete.

Note 2: Truss-type reinforcement that has main wires not less than 3,55 mm in diameter shall be provided in the uppermost bed joint if a bond-block beam does not form the uppermost course where the span exceeds 2,5 m.

Note 3: Heavy roofs are roofs with the following finishes:

- a) concrete roof tiles;
- b) clay roof tiles;
- c) slates; or
- d) thatch.

4.2.9.2.6 Reinforcement may be lapped at the quarter spans; the length of such laps not being less than:

- a) Y10: 500 mm
- b) Y12: 660 mm
- c) Y16: 880 mm.

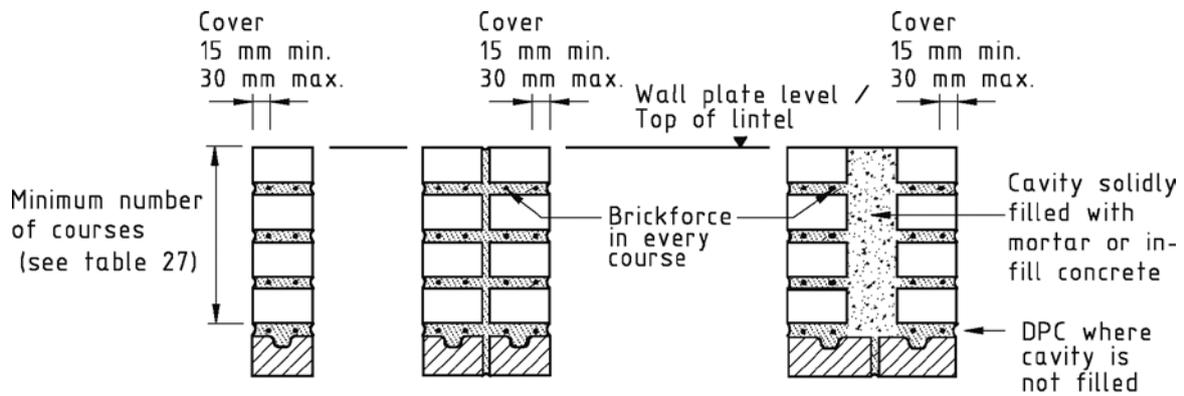
4.2.9.2.7 The side and top cover to reinforcement shall not be less than 30 mm.

4.2.9.2.8 Where the width of piers between adjacent openings is less than 750 mm, an additional bond beam shall be placed in the uppermost course that has the same reinforcement as would have been

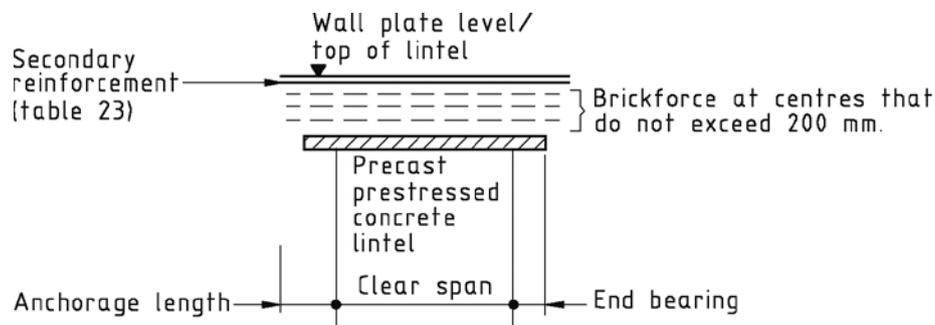
the case had it been a single opening. In such cases, the reinforcement in the bond beam immediately above the opening shall be not less than that given in tables 24 to 26, as appropriate. The upper bond-block beam shall be continuous across the pier and extend across at least one-half of the length of the openings on either side of the pier. (See figure 25.)

4.2.9.3 Precast prestressed concrete lintels

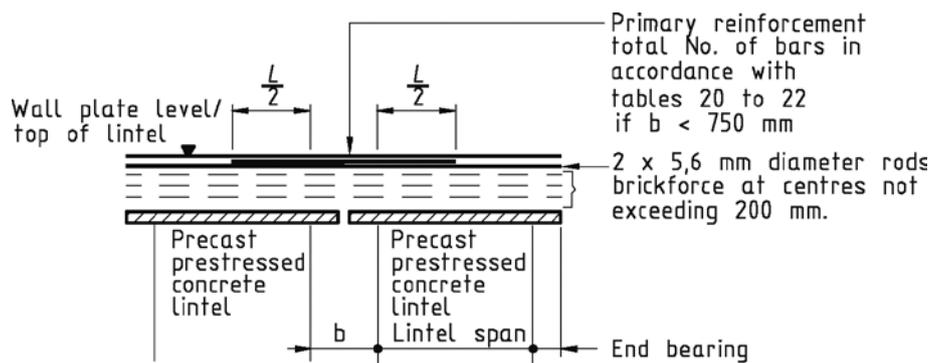
4.2.9.3.1 Precast prestressed concrete lintels, which comply with the relevant requirements of SANS 1504, may be built into walls compositely with masonry in accordance with table 27 and figure 26.



a) Section through lintels



b) Single opening



c) Multiple opening with narrow pier where $b < 750\text{mm}$

Figure 26 Precast prestressed concrete lintels (SANS 10400-K, Figure 30)

4.2.9.3.2 Prestressed concrete lintels that do not comply with the requirements of SANS 1504 may be used as soffits to bed-joint reinforced lintels and shall be reinforced in accordance with the provisions of 4.9.2.1.

Note: Prestressed concrete lintels that do not comply with the requirements of SANS 1504, may be used as "non-structural" lintels. Such lintels are regarded in terms of 4.2.9.3.2 as being a series of masonry units which merely replace the bottom course of masonry.

Table 27 Prestressed concrete lintels that comply with the requirements of SANS 1504

Minimum number of courses above the prestressed lintel	Maximum Span m		
	No roof	Light roof	Heavy roof
85mm course height: nominal width ≤ 140mm			
4	3,0	2,0	1,5
5	3,0	2,5	2,0
6	3,0	3,0	2,5
9	3,0	3,0	3,0
85mm course height: nominal width ≥ 190mm			
4	3,0	2,0	2,0
5	3,5	2,5	2,5
6	3,5	3,5	3,0
9	3,5	3,5	3,5
100mm course height: nominal width ≤ 140mm			
3	3,0	2,0	1,5
4	3,0	2,5	2,0
5	3,0	3,0	2,5
8	3,0	3,0	3,0
100mm course height: nominal width ≥ 190mm			
3	2,5	2,0	2,0
4	3,0	2,5	2,0
5	3,5	3,5	3,0
8	3,5	3,5	3,5

Note 1: Light roofs are roofs with the following finishes:

- a) metal profile sheeting;
- b) metal roof tiles;
- c) fibre cement sheeting; or
- d) fibre cement slates.

Note 2: Heavy roofs are roofs with the following finishes:

- a) concrete roof tiles;
- b) clay roof tiles;
- c) slates; or
- d) thatch.

4.2.9.3.3 Secondary reinforcement in accordance with table 23 shall be provided in the uppermost bed joint.

4.2.9.3.4 Where the width of piers between openings is less than 750 mm, primary reinforcement in accordance with tables 20 to 22, as relevant, shall be provided in the uppermost bed joint, in accordance with the requirements of figure 23.

4.2.9.3.5 Lintels shall be set in mortar and have a minimum bearing of

- a) lintel that supports masonry only: 150 mm
- b) lintel that supports roof trusses
 - 1) span less than or equal to 1,5 m: 150 mm
 - 2) span between 1,5 m and 2,5 m: 250 mm
 - 3) span greater than or equal to 2,5 m: 350 mm

4.2.9.4 Double garage openings

4.2.9.4.1 Lintels over double garage openings which do not exceed 5,0 m shall be reinforced in accordance with the provisions of figures 27 and 28 and table 27.

4.2.9.4.2 Cores and cavities shall be filled with grade 25 infill concrete.

4.2.9.4.3 Lintels shall be adequately supported for a period of not less than 7 d after completion.

4.2.9.4.4 Reinforcement may be lapped at the quarter spans; the length of such laps shall not be less than:

- a) Y10: 500 mm
- b) Y12: 660 mm
- c) Y16: 880 mm.

4.2.9.4.5 The side cover shall be not less than 30 mm.

4.2.9.4.6 The cores of any hollow units immediately adjacent to openings shall be reinforced with a single Y10 bar that extends from the floor level to the top of the lintel (see figure 25) and shall be solidly filled with grade 25 infill concrete.

4.2.9.4.7 Where the width of piers between adjacent openings is less than 750 mm, the primary reinforcement, as given in table 28 shall be provided at the top of the lintel and extend across at least half of the length of the openings on either side of the pier. (See figure 28.)

Table 28 Lintels over double garage openings that have a clear opening that does not exceed 5,0m

Lintel type	Minimum lintel depth mm	Primary reinforcement number x bar details	Application
190 hollow block	600	2 x Y10	No roof loads
	800	2 x Y12	Light roof loads up to 8,0 m
	800	2 x Y12	Heavy loads up to 6,0 m
	1000	2 x Y12	Heavy roof loads up to 8,0 m
2 x 140 hollow blocks combined with grouted cavity construction	600	2 x Y12	No roof loads
	800	2 x Y12	Light roof loads up to 8,0 m
	800	2 x Y12	Heavy roof loads up to 6,0 m
	1000	2 x Y16	Heavy roof loads up to 8,0 m
Grouted cavity construction	595/600	2 x Y12	No roof loads
	700	2 x Y12	Light roof loads up to 8,0 m
	765/800	2 x Y12	Heavy roof loads up to 6,0 m
	935/1000	2 x Y16	Heavy roof loads up to 8,0 m

Note 1: Light roofs are roofs with the following finishes:

- a) metal profile sheeting;
- b) metal roof tiles;
- c) fibre cement sheeting; or
- d) fibre cement slates.

Note 2: Heavy roofs are roofs with the following finishes:

- a) concrete roof tiles;
- b) clay roof tiles;
- c) slates; or
- d) thatch.

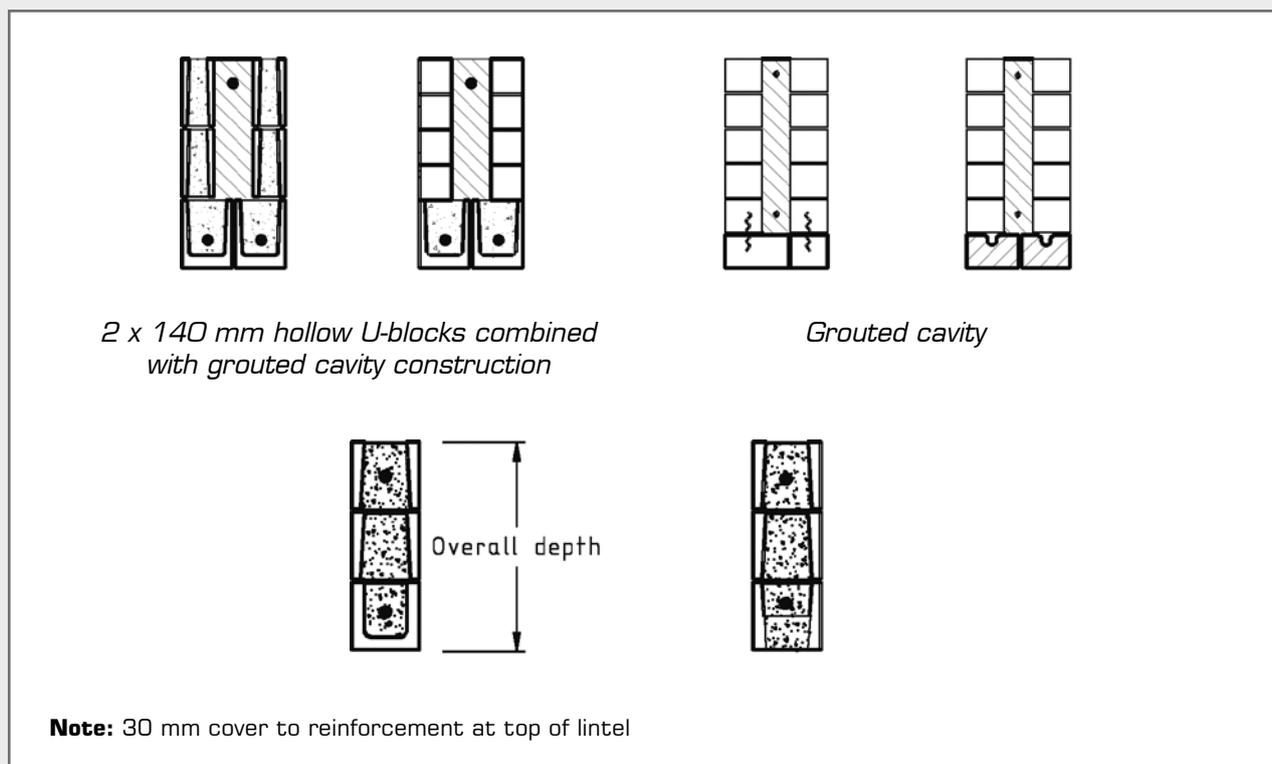
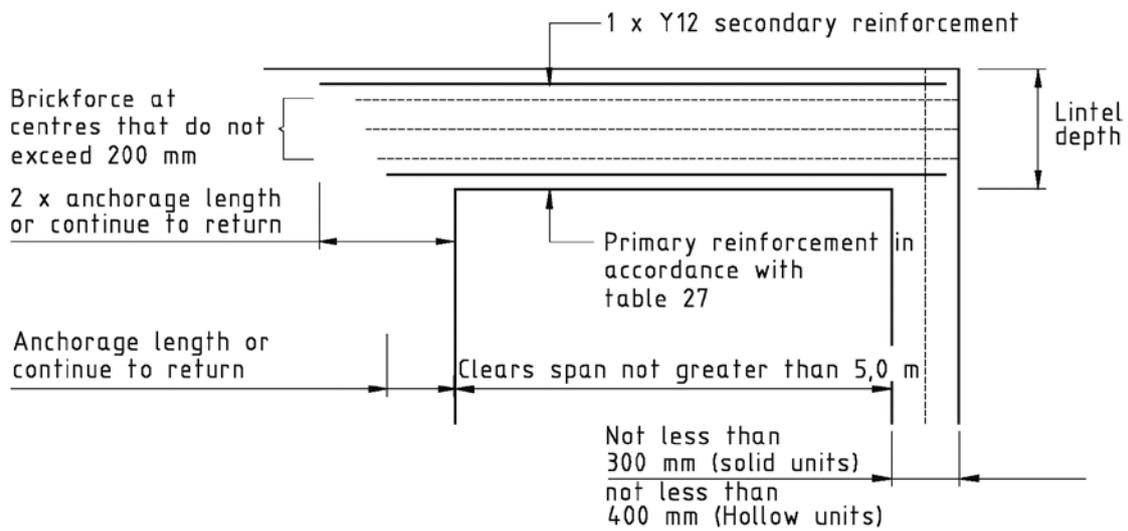
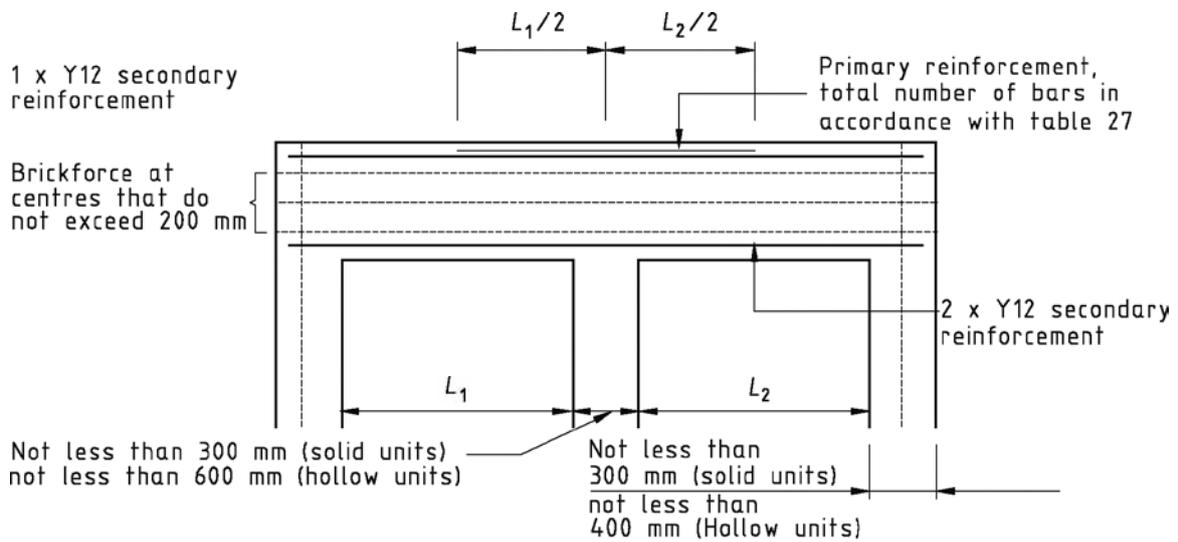


Figure 27 Lintels over double garage openings (SANS 10400-K, Figure 31)



a) Single opening



b) Multiple opening

Laps in reinforcement permitted within a quarter span

Anchor length:

- Y10 – 500 mm (min.)
- Y12 – 660 mm (min.)
- Y16 – 880 mm (min.)

Figure 28 Lintel details over double garage openings (SANS 10400-K, Figure 32)

4.2.10 Masonry arches

Circular masonry arches that have a span that does not exceed 2,5 m shall have an arch ring depth and proportions as shown in figure 29. Such arches shall be constructed as follows:

- a) The rise shall be between 0,3 and 0,5 times the span
- b) Masonry units shall be solid.
- c) The arch ring shall be constructed in either header or stretcher pattern.
- d) The arch ring depth shall be:
 - not less than 200 mm where the rise is between half and two-thirds of the radius,
 - not less than 300 mm where the rise is greater than two-thirds but less than or equal to the radius.

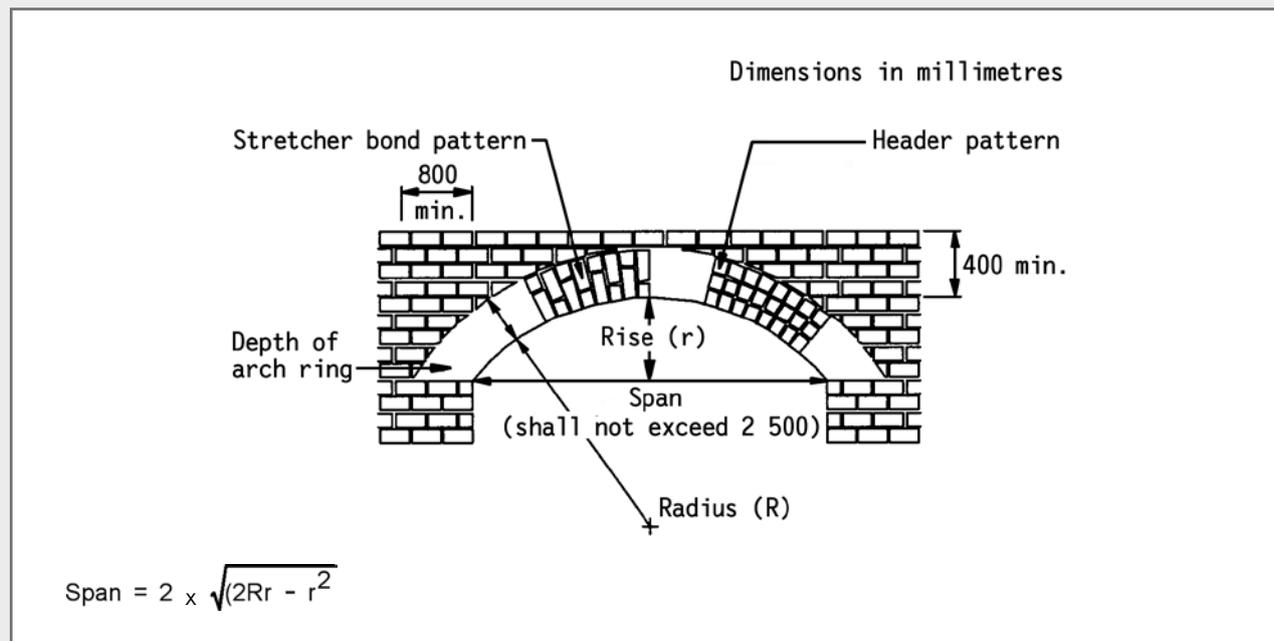


Figure 29 Masonry arches (SANS 10400-K, Figure 33)

4.2.11 Roof fixing

4.2.11.1 Timber roof trusses, rafters and similar structures shall be fixed to walls by means of the following anchor types, selected in accordance with table 29:

- a) Type A: two strands of 2,4 mm diameter galvanized steel wire
- b) Type B: 30 mm x 1,2 mm galvanized steel strap
- c) Type C: 30 mm x 1,6 mm galvanized steel strap

Table 29 Roof anchor selection

Roof slope degrees	Maximum roof truss/rafter spacing mm	Type of anchor required	
		Light roof	Heavy roof
<15	760 1 050 1 350	A, B or C B or C C	
15 to 30	760 1 050 1 350	A, B or C B or C C	A for all applications
>30	Any	A, B or C	

Wire shall not be permitted for lightweight roof coverings unless the truss/rafter spacing is 760 mm maximum. (This spacing would be very unusual.)

Note: Heavy roofs include those covered with concrete tiles, clay tiles or natural slates. Light roofs refer to metal or fibre cement, profiled sheet roofs, fibre cement slates or metal roof tiles.

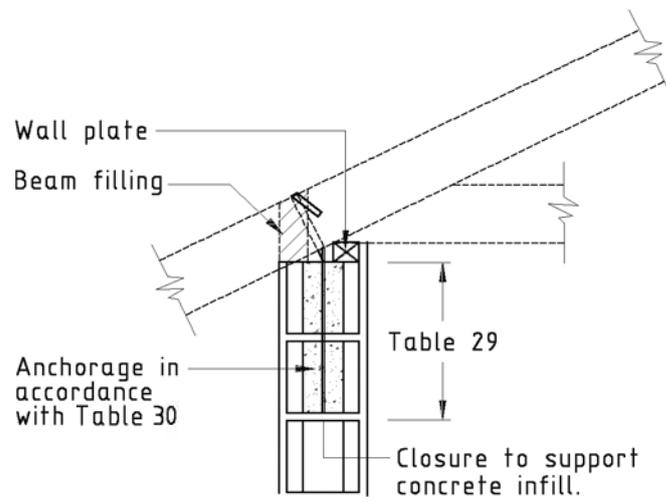
4.2.11.2 In the case of a wall of concrete or erected with masonry units, the galvanized steel strap or wires shall be embedded in the wall at positions suitable for

anchoring any timber roof truss, rafter or beam to such wall. Such anchors, where practicable, shall extend to a depth not less than that specified in table 30.

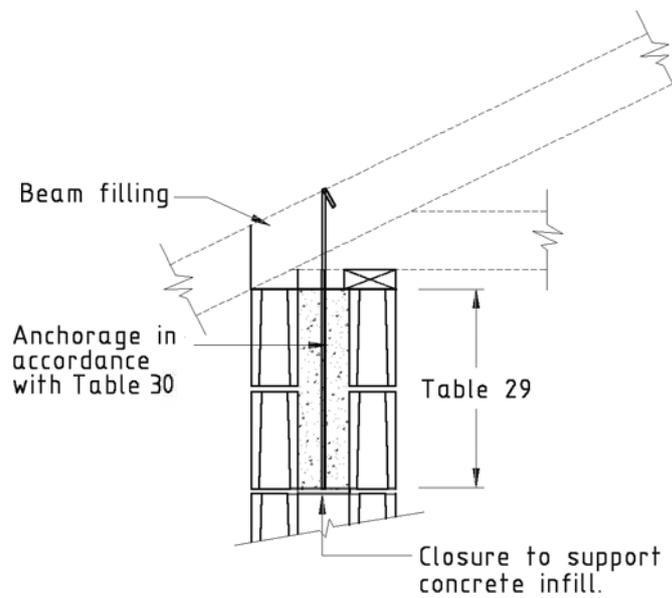
Table 30 Minimum depth of anchor embedment

Roof type	Description of wall	Minimum depth of anchor embedment mm
Solid units Heavy Light	All wall types	300
	All wall types	600
Hollow units Heavy Light	All wall types	400
	• 90 mm and 110 mm single-leaf walls:	
	• 90 mm-90 mm and 110 mm-110 mm cavity walls.	
	— cavity not filled above openings; span < 6,0 m	600
	— cavity filled above openings; span < 8,0 m.	600
• 140 mm and 190 mm single-leaf walls:		
— span < 6,0 m	800	
— span < 8,0 m	1 000	

4.2.11.3 Roof anchors shall be anchored in masonry in accordance with the details contained in figures 30 and 31. The depth of embedment in mortar of hoop-iron straps in bed joints shall be not less than 70 mm.

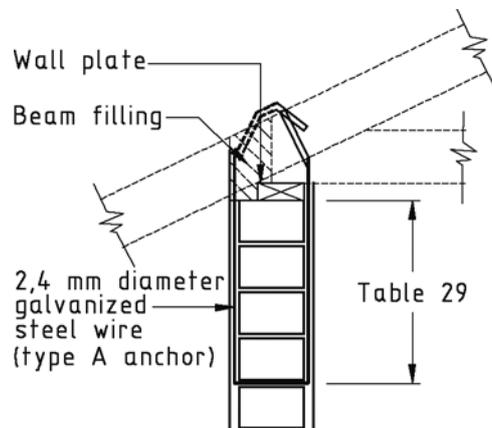


a) Single-leaf wall

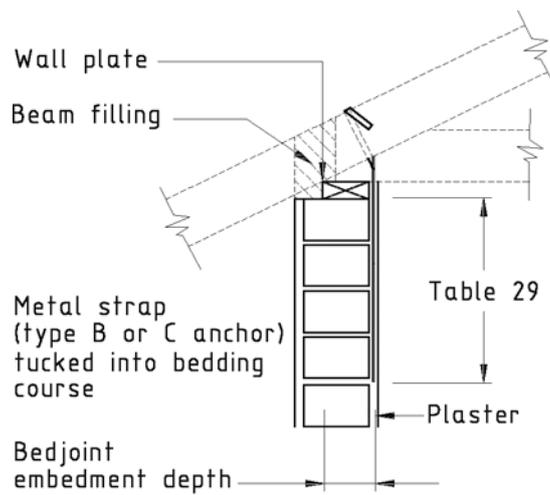


b) Filled cavity wall

Figure 30 Roof truss anchor details (hollow units) (SANS 10400-K, Figure 34)



a) Type A anchor



b) Type B or C anchor

Bed joint embedment depth:

- Type A (wire) – 100 mm
- Type B and C (metal strap) – 70 mm

Figure 31 Roof truss anchor details (solid units) (SANS 10400-K, Figure 35)

4.5.3 Rising damp

4.5.3.1 *Any wall or sleeper pier of a building shall be provided with damp-proofing and vapour barrier installations in such positions and to an extent that will reliably protect the wall against rising damp and the interior of the building against ingress of moisture from abutting ground.*

4.5.3.2 *Any material used as a damp-proof course shall comply with the relevant requirements contained in SANS 248, SANS 298 or SANS 952, or be the subject of an Agrément certificate.*

4.5.3.3 *In a masonry wall, a damp-proof course shall be installed*

a) at the level of the top of a concrete floor slab resting on the ground; or

b) where applicable, below any ground floor timber beam or joist.

4.5.3.4 *In the case of any masonry cavity wall*

a) each leaf of such wall shall be provided with its own damp-proof course which shall extend over the full thickness of such leaf, in which case the cavity shall extend 150 mm below the damp-proof course; or

b) each leaf of such wall shall be covered by a membrane which extends across the cavity provided that the position of the membrane at the inner leaf is higher than its position at the outer leaf; and

c) where necessary, weepholes to prevent build-up of water in the cavity shall be provided in the external leaf of every cavity wall, spaced not more than 1 m apart, in the masonry unit course immediately below the damp-proof course contemplated in (a) or in the masonry unit course immediately above the membrane contemplated in (b).

5 SPECIFICATION AND CONSTRUCTION DETAILS

The quality of masonry work depends on the care taken in laying the units accurately to line and level and on the neatness and uniformity of the joints. Good concrete masonry walls depend just as much on good construction as on a good unit, and many cracked and leaky walls are due to the method of construction rather than to the units themselves. Requirements for quality of masonry units and workmanship should be stated in the specification.

Suggested clauses for inclusion in the contract specification are given first and are distinguished by being in italics, followed by notes. "Unit" applies to both block and brick unless otherwise stated.

In SANS 10145, SANS 10249 and SANS 2001- CM I there are sections on precautions to be observed to prevent cracking of masonry and moisture penetration. Information is also given on site procedures and construction techniques. Reference should be made to these standards.

MATERIALS

1. Concrete masonry units

Concrete masonry units shall comply with the requirements of SANS 1215. Concrete masonry units of nominal compressive strength...MPa, shall be of the dimensions shown on the drawings, and be ...(solid, hollow); or

Concrete masonry units shall comply with the requirements of SANS 2001 - CM I and shall be of the thickness shown on the drawing.

In general concrete masonry units; should not exhibit any surface pop-outs, should units contain slag, clinker or burnt clay aggregate; have in the case of hollow units, face shells and webs not less than 25 mm thick, or one-sixth of the width of the unit, whichever is the greater; have a demonstrated drying shrinkage of not more than 0,06 % or not be built into walls within 21 days of manufacture.

The specifier must decide on the class of concrete masonry unit required for the contract. In the case of houses, the strength requirements based on the SANS 2001-CM I are given in Table 5. 1.

On important contracts, consideration should be given to building reference panel walls.

Note: The above clauses may include special requirements and special features such as profile, colour and surface texture of the masonry units. When face units are required to have coloured surfaces the colour shall be as agreed upon between the manufacturer and the purchaser and the manufacturer shall supply to the purchaser for his retention three units of the agreed colour to serve as an example of the possible range of such colour.

Table 5.1 Minimum compressive strength of masonry units (SANS 2001-CM I Table 1)

Description	Hollow units		Solid units	
	Average, MPa	Individual, MPa	Average, MPa	Individual, MPa
Single-storey construction				
• on-site manufacture	3,0	2,4	4,0	3,2
• off-site manufacture	3,0	2,4	5,0	4,0
Double-storey construction	7,0	5,6	10,0	8,0
Cladding and internal walls in concrete framed housing units	3,0	2,4	5,0	4,0

a) The average compressive strength is based on a minimum of five samples based on the gross surface area.

b) On-site manufacture is where units do not require to be transported more than 25 m to the place where they will be built into walls.

2. Sand

Sand shall either comply with all of the following requirements or, if required in terms of the specification data, the requirements of SANS 1090 for mortar sand (natural or manufactured):

a) sand shall contain no organic material (material produced by animal or plant activities);

b) sand shall not contain any particles which are retained on a sieve of nominal aperture size 5 mm;

c) when 2,5 kg of cement is mixed to 12,5 kg of air dry sand, the mixture shall not require more than 3,0 L of water to be added to reach a consistency suitable for laying of masonry units; and

d) when mixed with the cement in accordance with the mix proportions, the sand shall have workability suitable for laying of masonry units.

Table 5.2 Grading requirements of sand for mortar (SANS 1090 Aggregates from natural sources — fine aggregates for plaster and mortar)

Sieves of square apertures, μm	Grading (percentage passing by mass)	
	Fine aggregate for plaster	Fine aggregate for mortar
4750	100	100
2360	90 — 100	90 — 100
1180	70 — 100	70 — 100
600	40 — 90	40 — 100
300	5 — 65	5 — 85
150	5 — 20	0 — 35
75	0 — 7,5	0 — 12,5

Note 1: Sands which require the addition of more than 3,0 L of water in the above-mentioned test to reach a consistency suitable for the plastering, can in some instances be blended with coarse sand (for example, river sand with a particle size of less than 3,0 mm) to make them acceptable. The proportion of the blended sand can be determined by means of the above-mentioned test on a trial and error basis.

Note 2: Sand from beaches or dredged from the sea or from river estuaries or from cretaceous deposits may be used provided that the chloride ion content

of the mortar produced using such sands, when tested in accordance with SANS 202, does not have a mass fraction with respect to the cement that exceeds 0,3 %.

Note 3: Metal masonry accessories, metal wall ties, cramps, bed joint reinforcement and all other metallic objects which are embedded in mortar with high chloride ion contents will corrode.

3. Coarse aggregate

Coarse aggregate for infill concrete shall comply with SANS 1083 and be of nominal size... mm.

The nominal size of coarse aggregate should be chosen in relation to the size of void to be filled; normally this is 9,5 mm maximum.

4. Water

Water shall be fit for drinking.

5. Cement

Cement for mortar

Common cements shall comply with the requirements of SANS 50197-1.

Masonry cements shall comply with the requirements of SANS 50413-1.

Note: Bags should be clearly marked with a certification mark and the cement type, strength class and mix proportions conforming to table 5.5. Bulk cement delivery notes should confirm compliance with the relevant standard.

6. Lime

Lime for mortar shall comply with SANS 523 and shall be of the class A2P type.

The use of lime is optional but may be advisable with certain sands. Lime should not be used with masonry cement. Lime for mortar means hydrated lime, i.e. commercial bedding lime and not quicklime or agricultural lime. Research by the CSIR Division of Building Technology has shown that lime complying with class A2P of SANS 523 should be used in mortars. Lime gives best results when used with coarser sands lacking fines than with fine clayey sands.

7. Mortar admixtures

Mortar plasticizers and set-retarding admixtures, where permitted in terms of the specification data, shall comply with the requirements of BS EN 934-3.

The use of mortar plasticizers is optional. Their effectiveness varies with the quality of the sand. The manufacturer's recommendations should be followed.

8. Pigments

Mineral pigments shall comply with BS EN 12878.

Pigments may be used to colour mortar. The dosage of pigment to achieve the specific colour required depends on the type of pigment used. The recommended limit on mineral oxide content is 7% of common cement content.

9.1 Wall ties (metal)

Metal wall ties shall either comply with the requirements of SANS 28 or

- a) be of galvanized mild steel wire with a minimum thickness of galvanizing of not less than 450 g/m², or
- b) be of austenitic stainless steel and have the dimensions contained in figures 5.1 to 5.5 depending upon the tie type, and
- c) be manufactured from galvanized mild steel wire with a minimum thickness of galvanizing of not less than 450 g/m².

Where required in terms of the specification data, metal wall ties shall have a minimum thickness of galvanizing of 750 g/m² or be manufactured from austenitic stainless steel.

Alternatively, other wall ties, for which there is no SANS standard, may be used, provided the manufacturer or his agent is able to submit evidence to show that the material is suitable for the intended purpose.

Guidelines on the selection of ties are given in Table 5.4.

9.2 Wall ties (non-metallic)

Non-metallic ties shall, when the central 75 mm portion of the tie is clamped between two jaws of a testing machine capable of displacing the ends relative to each other, without twist, tilt or rotation, be capable of resisting a tensile force of 0,6 kN and a

Table 5.3 Selection of wall ties

		Type of tie	Cavity width, mm
Increasing strength	↑	Double triangle	75 or less
	↓	Butterfly	75 or less

compressive force of 0,7 kN when the tie ends have been displaced by an amount that does not exceed 1,5 mm, with a 95 % level of confidence.

Note 1: Wall ties should not lengthen or shorten significantly under load. The performance test described above ensures that wall ties will have adequate stiffness.

Note 2: A 95 % confidence level implies that there is only a 5 % probability that a tie will not be able to resist the prescribed force. As a result, the minimum force which a tie shall be capable of resisting, can be determined from the following formula:

$$X = X_c - 1.65 s$$

where

X is the minimum force which the tie shall be capable of resisting; in kN

X_c is the arithmetic mean of the test sample (minimum of 6 ties), in kN

s is the standard deviation of the test sample, in kN.

Polypropylene wall ties are permissible in the UK for double-storey buildings with a fire requirement of less than twenty minutes. However, these ties are likely to char under hot conditions and also to exhibit creep under normal working conditions.

10. Masonry anchors

Metal masonry anchors used to secure shelf anchors shall have an anchor diameter of not less than 10 mm and be galvanized, and have a minimum safe working load of not less than 10,0 kN. In areas within 1,0 km of the coastline such anchors shall be of stainless steel.

11. Reinforcement

Reinforcing steel including bed reinforcement shall comply with SANS 920 and SANS 1024.

Brickforce

Brickforce is a light welded steel fabric made of two hard-drawn wires of diameter not less than 2,8 mm and not greater than 3,55 mm held apart by either perpendicular (ladder type) or diagonal (truss type) cross wires.

Where required in terms of the specification data, brickforce shall be manufactured from pre-galvanized wire, galvanized in accordance with the requirements of SANS 935 for a grade 2 coating or be made of stainless steel wire.

Rod reinforcement

Rod reinforcement shall comprise hard-drawn wires that have a proof stress of 485 MPa and a diameter of not less than 4,0 mm and not greater than 6,0 mm. Rods shall be pre-straightened at the place of manufacture.

Note: Hard-drawn wire for welded steel fabric for the reinforcement of concrete manufactured in accordance with the requirements of SANS 1024 complies with the requirements of the above clause.

Where required in terms of the specification data, rod reinforcement shall be galvanized in accordance with the requirements of SANS 935 for a grade 2 coating or SANS 121, as appropriate or be made of stainless steel.

Note: When galvanized brickforce or rod reinforcement is used, 0,10 g/L of potassium dichromate or 0,14 g/L of potassium chromate should be added to the mixing water for the mortar to ensure adequate bond to the reinforcement.

Reinforcing bars

Reinforcing bars shall comply with the requirements of SANS 920 and be of the type indicated in the scope of work.

Prestressing steel

Prestressing steel (hot-rolled bars, high tensile steel wire and strand) shall be as stated in the specification data.

Metal lath strips for masonry

Metal lath strips shall either comply with the requirements of SANS 190-2 or all of the following requirements. They shall

- a) have a minimum standard metal thickness of not less than 0,8 mm;
- b) be of pre-galvanized mild steel;
- c) have openings with dimensions that do not exceed 30 mm in the longitudinal direction and 10 mm in the direction of their width; and
- d) exhibit no sign of cracking or fracture at the metal strands when bent through 90° in either direction over a mandril of radius 6 mm.

Types of wall ties (SANS 2001-CM I Table 2-5)

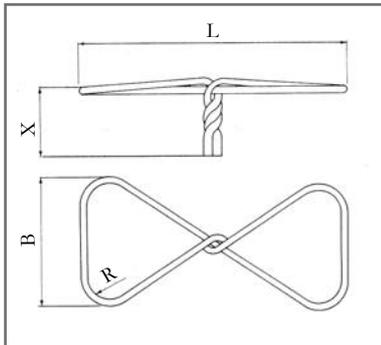


Figure 5.1 Butterfly wall tie

Wire Diameter mm	L mm	B mm	R (min.) mm	X mm
$3,15 \pm 0,1$	150 ± 5 or 200 ± 5	75 ± 5 or 100 ± 5	13	25 ± 5

Note:

- In general butterfly ties are preferred for use in concrete block walls.

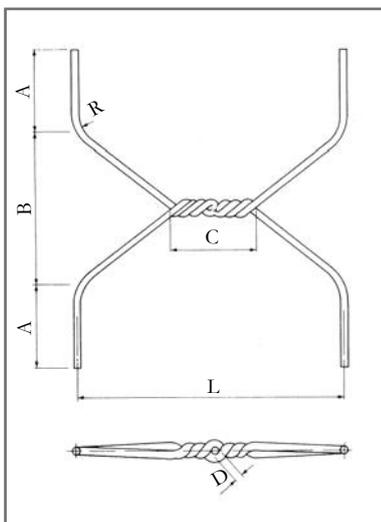


Figure 5.2 Modified PWD wall tie

Wire Diameter mm	L mm	A mm	B mm	C mm	D mm	R mm
$3,15 \pm 0,1$	150 ± 5 or 200 ± 5	50 ± 5	75 ± 5 or 100 ± 5	40 ± 5	8 ± 2	13

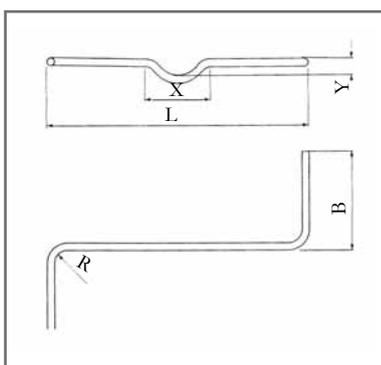


Figure 5.3 Single wire wall tie

Wire Diameter mm	L mm	B mm	R (min.) mm	X mm	Y (min.) mm
$4,5 \pm 0,1$	150 ± 5 or 200 ± 5	70 ± 5	8	22 ± 2	7 ± 2

Note:

- In the particular case of a non-cavity wall constructed in two stretcher bond leaves, with the vertical joint between the two leaves solidly filled with mortar, crimped wire ties may be used.

Types of wall ties cont...

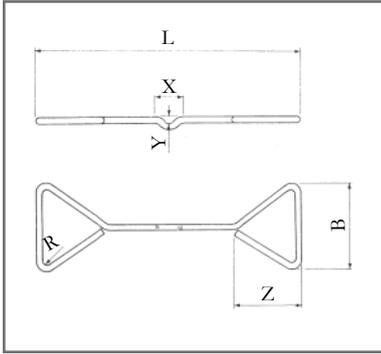


Figure 5.4 Double triangle wall tie

Wire Diameter mm	L mm	B mm	R (min.) mm	X mm	Y (min.) mm	Z mm
$4,3 \pm 0,1$	150 ± 5 or 200 ± 5	65 ± 5	8	22 ± 2	7 ± 2	50 ± 5

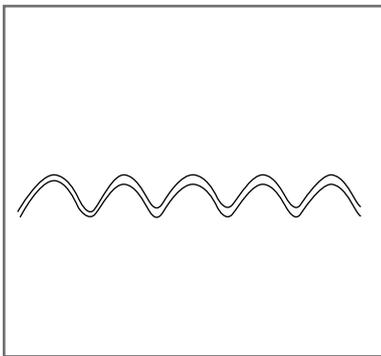


Figure 5.5 Crimp wire tie
(not for use in a cavity wall)

Wire Diameter mm
$3,15 \pm 0,1$

12. Expanded metal building products

Expanded metal building products shall comply with SANS 190 : Part 2.

13. Damp-proof courses

Horizontal and vertical damp-proof course materials shall either be the subject of an Agrément certificate or comply with one or more of the following standards:

- a) SANS 248;
- b) SANS 298;
- c) SANS 952.

14. Joint sealants

Sealing compounds shall comply with the relevant requirements of SANS 110, SANS 1077, SANS 1254 or SANS 1305 or the requirements of the scope of work.

STORAGE OF MATERIALS

1. Masonry units

Units shall be carefully unloaded and handled to prevent chipping and breakage. They shall be stacked on prepared level areas to ensure that the stack is stable. The top of each stack shall be kept covered during rainy weather, and the whole pack protected from staining or marking.

It is usually adequate to protect only the top of the stack from rain, as there is little penetration at the sides of stacks, except where driving rain is experienced. Where facework is being built, it is important to protect exposed faces from becoming stained as a result of other building activities. Face units must be offloaded and stacked with care to protect the faces and arrises; plaster bricks may be tipped.

Ensure that the supply of units is of a consistent, even colour range, from batch to batch and within batches. Distribute face units of varying colour evenly throughout the work so that no patches appear in the wall. Mix different packs and deliveries which may vary in colour to avoid horizontal stripes and raking back marks in the finished wall.

2. Cement

Cement stored on site shall be adequately protected against moisture and other factors that may cause it to deteriorate.

When the cement is supplied in paper bags, the bags shall be closely and neatly stacked to a height not exceeding 12 bags and arranged so that they can be used in the order in which they were delivered to the site.

Storage of cement in silos or similar containers shall be permitted provided that the cement drawn for use is measured by mass and not by volume.

Cement shall not be kept in storage for longer than 6 weeks without the specifier's permission.

3. Sands

Sands from different sources shall be stored separately. Contamination by foreign matter shall be avoided.

4. Coarse aggregate

Coarse aggregates from different sources shall be stored separately. Contamination by foreign matter shall be avoided.

5. Deteriorated material

Material that has deteriorated, or has been contaminated or does not comply with the specification shall not be used.

6. Reinforcement, metal ties and anchors

Reinforcement, metal ties and anchors shall be protected from contact with soil and before placing shall be free from loose mill scale and other coatings that will adversely affect bond.

NOTES ON THE PROPERTIES OF MORTAR FOR MASONRY

Important properties of mortar that impact on the quality of masonry work are workability, water retention, compressive strength, bond strength, ability to accommodate movement and rate of strength development. Workability is a property which describes how easily mortar can be spread over the masonry unit and affects the performance and the productivity of the artisan. Water retention is a measure of the resistance of mortar to loss of water from suction of a porous masonry unit. Good water retention properties are important to ensure that:

- water is prevented from bleeding out of the mortar;
- the mortar bed is prevented from stiffening too quickly and becoming unworkable before the unit can be placed in position; and
- sufficient water is retained in the mortar to ensure proper hydration of the cement.

Mortars with good water retention remain workable for a long time after been spread on bed joints. This assists with proper bedding of the units and later compaction of the joint by tooling.

Except for highly stressed structural masonry, the compressive strength of mortar is not a particularly important property. It has comparatively little influence on compressive strength of the wall (Compressive strength of mortar is measured by testing 100mm cubes of mortar. In practice the mortar bedding thickness is between 8 and 12mm. With mortar in this situation the triaxial shear regime results in a strength of 2 to 3 times that of an equivalent cube, i.e. a class II mortar cube of 5 MPa compressive strength has a 10 to 15 MPa bedding mortar strength). Since the compressive strength of cubes is easier to measure than a thin slice of mortar which resembles the bed joint, it tends to be used as the control for mortar strength. Bond strength between mortar and masonry units is a more representative property of both the tensile and flexural strength of walls.

Bond strength is important in relation to the permeability of masonry. Rain water usually penetrates a wall through fine cracks between the masonry units and the mortar, and only rarely through either the masonry units or the mortar. The greater the strength of the bond between mortar and masonry, the greater is the resistance to leakage.

Bond depends largely on the balance between initial rate of absorption (suction) of the unit and the water retention properties of the mortar.

Mortars shrink on drying and the magnitude of drying shrinkage is directly related to the water requirement of the mortar sand.

However, in a masonry wall shrinkage movement occurring in mortar is restricted by the masonry units and the compressive load on the units.

Concrete masonry units tend to expand with a gain in moisture and contract with loss of moisture. On the other hand some burnt clay bricks expand slowly after leaving the kiln when they come in contact with humidity in the air.

This expansion is not reversible even by drying the clay bricks and the movement, termed moisture expansion, continues for a number of years.

Cracks in masonry work is not only attributable to directly applied loads, but generally is caused by differential movement between various parts of a building as a result of thermal or moisture movement (i.e. environment) or foundation movement.

The objective in designing a mortar mix is to determine an economical and practical combination of readily available materials to produce mortar that will

satisfy the performance requirements for particular conditions of use.

Performance requirements are:

- In plastic state: adequate plasticity (cohesiveness), workability, water retention (in relation to initial rate of absorption of masonry units being used) and setting time
- In hardened state: adequate bond and compressive strength, low drying shrinkage and durability.

MORTAR QUALITY

General

Unless otherwise stated in the specification data or in the drawings, mortar shall comply with the requirements for a class II prescribed mix mortar.

Unless otherwise stated in the specification data, no mortar plasticizers and set-retarding admixtures shall be added to the mixes to improve workability or improve the properties of the mortar.

The types of sands and cement in a strength mortar shall not be altered during the construction of the works unless tests indicate that such changes allow the required strength to be achieved.

The method used for measuring materials for mortar shall be such that the proportions of the constituent materials can be controlled and adequately maintained.

Prescribed mix mortar

Mortars shall have the mix proportions as stated in table 5.6.

Strength Mortar

Strength mortar shall comply with the strength requirements of table 5.7 for the required class of mortar.

Note: The workability of the mortar can be assessed and improved in the following manner:

- a) Place a small quantity of the mix (at plastering consistency) on a non-absorbent surface and form a flattened heap about 100 mm high and 200 mm in diameter. Place a plasterer's trowel on top of the heap and push the trowel downwards. A mix with adequate workability is one which permits the mix to squeeze out from under the trowel, and allows the trowel to be pushed to within a few millimetres of the underlying surface. An unworkable mix will "lock up" once the trowel has moved a few millimetres and prevents further downward movement of the trowel.

Table 5.6 Prescribed mix proportions for mortar (SANS 2001-CM I Table 7)

Cement type	Cement	kg Lime ^a kg	Loose sand	
			L max.	Number of standard ^b wheelbarrows
Class I mortar				
<i>Common cements</i>	50	0 - 10	130	2
<i>Masonry cement MC 22,5 X, MC 12,5</i>	50	not permitted	80	1
Class II mortar				
<i>Common cements</i>	50	0 - 25	200	3
<i>Masonry cement MC 22,5 X, MC 12,5</i>	50	not permitted	130	2

Note: Cement should not be measured by volume. A bag of common cement, depending on the quantity of extenders, has a mass of 50 kg and a volume of approximately 33 L when packed under air pressure at the factory. Cement, however, fluffs up (bulks) when poured into a container, with the result that 50 kg of cement cannot readily be contained in a box of 33 L. The volume of a bag of loose (bulked) cement, depending upon its compaction, can be up to 20 % more than when in the bag. For this reason it is always preferable to use whole bags of cement when volume batching.

^a The addition of lime to common cements is optional, subject to the maximum amount given in table 7. Lime shall not be used to replace a portion of the cement in the mix.

^b A standard wheelbarrow for concrete that complies with SANS 795 (type 2) has a capacity of between 60 L and 70 L.

Table 5.7 Compressive strength requirements for mortar (SANS 2001-CM I: Table 8)

Mortar class	Minimum compressive strength, at 28 d MPa	
	Preliminary (laboratory) tests	Work tests
I	14,5	10
II	7	5

Trial mixes shall be conducted before commencing with the laying of masonry to establish the required mix for each class of mortar which is to be used. Permitted admixtures and pigments required in terms of the specification data, if any, shall be included in such trial mixes.

Methods and procedures

Mortar shall be mixed, on a surface free of contaminants, by a method and for a period of time that ensures that all ingredients are evenly distributed throughout the mixture.

Mortar in which initial set has occurred (i.e. thumbprint hard) shall not be used. Mortar made with common cements may be retempered before initial set, to restore the workability lost through the evaporation of the mix water, by adding water and thoroughly remixing to ensure that there is no segregation of materials. Mortar made with masonry cements or air entraining agents shall not be retempered.

Mortar shall be used within 2 h of mixing, unless the air temperature equals or exceeds 32°C, in which case it shall be used within 1 h.

Note: The batching of smaller mixes may be necessary to comply with this requirement.

Mortar shall be transported and discharged into mortar trays that serve the masons to prevent segregation, loss of ingredients and contamination.

Ready-mixed mortar shall be mixed and delivered to the site with adequate workability and without segregation. Ready-mixed mortar shall be protected from evaporation before use and shall not be used beyond the period of time established by the manufacturer.

Infill concrete quality

Infill concrete shall comply with the requirements of SANS 2001-CC2 and have a maximum size of 13 mm nominal aggregate and be of the following grades:

- a) unreinforced cavities, cores, pockets or spaces : Grade 10 or higher
- b) reinforced cavities, cores, pockets or spaces : Grade 25 or higher

Note: The words "infill concrete" and "grout" are referred to in SANS standards. In USA the terminology is "coarse" and "fine" grouts. Local interpretation is that "grout" contains no coarse aggregate and "infill concrete" is a mixture of cement, fine and coarse aggregate.

LAYING PRACTICE

For detailing of concrete masonry for single-leaf and cavity walls for various thicknesses of wall covering foundations, building in of window and door frames, sills, lintels, reinforcement, services, construction of corners, supporting of suspended floors and roofs, intersection of walls etc., reference should be made to the three CMA publications on "Detailing of concrete masonry".

1. Setting out

All specified dimensions and angles shall be laid down or set out to an order of accuracy appropriate to the type of building and its importance.

Reference should be made to SANS 2001:CM 1 (Table 13) for permissible accuracy in building. Although this clause covers the accuracy of setting out it should be borne in mind that setting out should be such as to reduce the cutting of masonry units to a minimum.

The first course should be laid with great care because inaccuracies in level, plumbness and alignment will be magnified in successive courses.

The line of the walls and the position of corners and openings should be accurately established. The wall should be set out by first laying units without mortar as shown in Figure 5.6. Layout dimensions should be multiples of the basic module dimension of 100 mm. This will ensure units being laid in their final positions with ease.

Tolerances of surfaces of foundations, beams or slabs supporting masonry are shown in Figure 5.7.

Note: The requirements that the maximum bed joint thickness of the first bed joint be not less than 5 mm or more than 35 mm has the following implications: (SANS 2001:CM1)

- a) masonry units may not be laid on edge as a means for the lower courses of foundation masonry to be built up to level; and
- b) grade 10 infill concrete may have to be used to raise the surface of the supporting member to enable a bed joint of acceptable thickness to be achieved.

Where reinforced structural masonry is specified then the following clause should be obligatory:

The position of vertical reinforcement starter bars and the setting out of inspection and clean out openings and service conduits/pipes/ducts shall be selected prior to laying the first course of masonry in order to fit in with the specified bond pattern.

2. Wetting of masonry units

Units **shall not** be wetted prior to laying in a wall. Whenever work stops the top of the wall shall be covered to prevent moisture entering the unfinished wall.

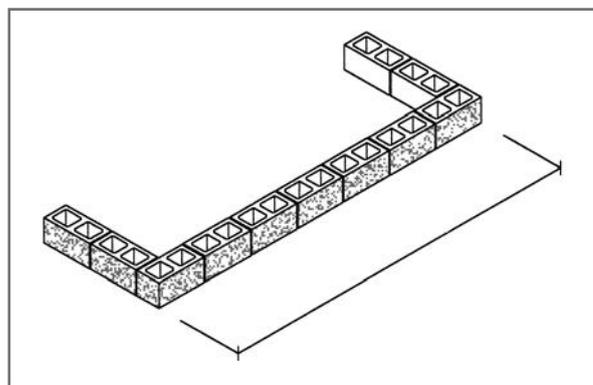


Figure 5.6 Units laid dry to check modular spacing

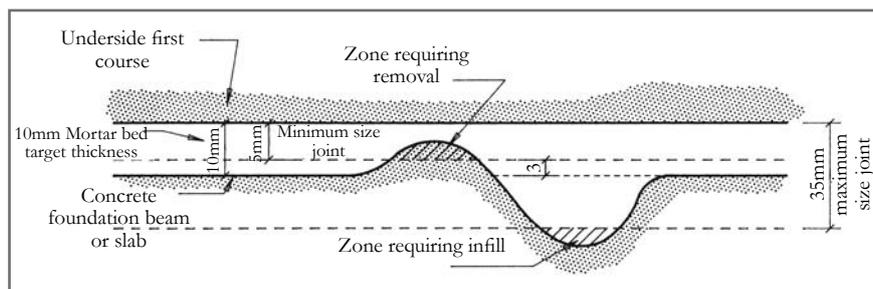


Figure 5.7 Tolerances of surfaces of foundations, beams or slabs supporting structural masonry

The consistency of the mortar should be adjusted to suit the degree of suction of the units instead of the units being wetted to suit the mortar.

When wet concrete masonry units dry out in a wall they shrink and may cause the mortar in the joints to crack.

Work should stop during heavy rain unless the work is adequately protected.

3. Laying of masonry units

a) Bedding of masonry

Units shall be laid on a bed of mortar of proportions as specified in "mortar quality" and as detailed on the drawings, using either shell bedding (applicable to hollow units only) or full bedding (as directed by the specifier). All joints are to be nominally 10mm thick.

In shell bedding only the inner and outer shells of hollow units shall be covered with mortar. In full bedding, the entire bedding area shall be covered.

Full bedding shall always be used with solid units with all perpend joints solidly filled with mortar as the work proceeds. Bed joints shall not be deeply furrowed before the laying of the units and perpend joints shall not be filled by slushing with mortar.

Hollow units shall be laid with the thicker shell-face uppermost and shall be shell bedded horizontally and vertically. The face shells of the bed joints shall be fully mortared. Perpend joints shall be mortared for a distance from each face at least equal to the face shell thickness of the unit. The webs shall be fully butlered in all courses of piers and columns, in the first course above a supporting element and on either side of cores which are reinforced.

All protrusions of mortar extending more than 15 mm into cores or cavities which are to be filled with infill concrete shall be removed.

Solid units having frogs shall be laid with the frog or the larger frog uppermost and frogs should be filled with mortar as the work proceeds.

A collar jointed wall shall have a vertical longitudinal joint not greater than 20 mm between leaves of masonry, filled with mortar or infill concrete as shown in figure 5.8.

Masonry shall not be laid when the ambient temperature is less than 5°C. Wet or frozen units shall not be laid. In hot (ambient temperature above 32°C) and/or windy and dry weather conditions, the length of mortar runs ahead of units, which are to be laid, shall be adjusted to ensure that the mortar

remains plastic when the units are laid.

Each unit shall be laid and adjusted to its final position while the mortar is still plastic.

Where hollow units are used in exterior walls, shell bedding reduces the penetration of rain to the inner surface. However, shell bedding results in a reduction in the strength of the wall.

Each unit should be adjusted to its final position in the wall while the mortar is still plastic and any unit which is disturbed after the mortar has stiffened should be removed and relaid with fresh mortar. Mortar should not be spread so far ahead of actual laying that it stiffens and loses its plasticity, as this results in poor bond.

Immediately after the unit is laid, excess mortar should be struck off the external face of the work and off the internal faces of leaves of cavity walls. Care should be taken to ensure that mortar is not scraped into the exposed face of the unit. Any accidental smears should be lightly brushed off the face after initial setting of the mortar has taken place.

All perpend and bed joints shall have a nominal thickness of 10 mm. The bed joint thickness shall not be less than 5 mm or more than 15 mm; perpend joint thickness shall not be less than 5 mm or greater than 20 mm. The thickness of the first bed joint above a supporting element shall not be less than 5 mm or more than 30 mm.

The rate of new construction shall be limited so as to eliminate any possibility of joint deformation slumping or instability which might reduce the bond strength

b) Bonding

Unless otherwise stated, units shall be laid in stretcher bond. The horizontal distance between vertical joints in adjacent courses shall be at least one quarter of the length of the units. Where the thickness of a solid wall consists of more than one unit, and in cavity wall

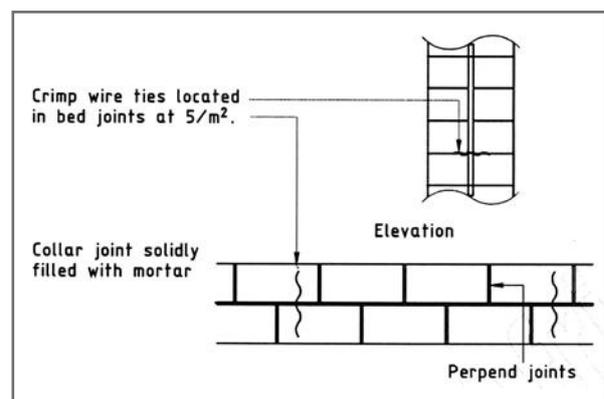


Figure 5.8 Wall with collar joint

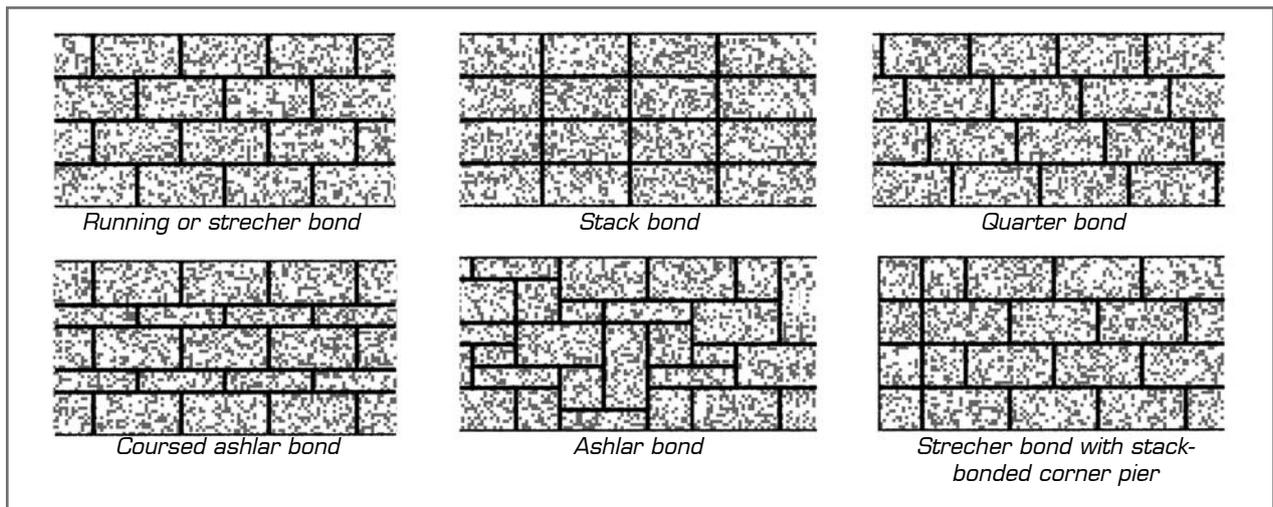


Figure 5.9 Types of bonding patterns with block and/or brick

construction, wall ties shall be placed in the horizontal joints at intervals of not more than 600 mm in the horizontal direction and not more than 450mm in the vertical direction, except that within 150mm of the sides of any opening, this distance shall be decreased to not more than 300mm. Ties shall be staggered in alternate courses and be laid falling to the outer leaf.

All multileaf walls shall be constructed as collar-jointed walls unless the specification data requires such walls to be constructed in English garden wall bond. Unless otherwise stated in the specification data or on the drawings, multileaf walls shall be constructed as collar-jointed walls.

Masonry units of dissimilar materials shall not be built into the same wall unless separated by a horizontal damp-proof course or a vertical control joint.

Blocks should normally be laid to stretcher bond, i.e. with staggered vertical joints. Stretcher or running bond, with blocks in each course overlapping those in the course below by half a block length, yield the best results in terms of wall strength.

Various bonding patterns are shown in Figure 5.9. For all normal construction the stretcher bond pattern should be used. For decorative and non-loadbearing blockwork the other bonding patterns may be used but note that the horizontal joints should be reinforced.

The cutting of units shall be kept to a minimum and wherever possible, standard closures and specific units shall be used to maintain bond.

Brick walls should generally be bonded in the traditional manner. When building a cavity wall, it is essential that the cavity should not be bridged by any material which could transmit water from the external to the internal leaf.

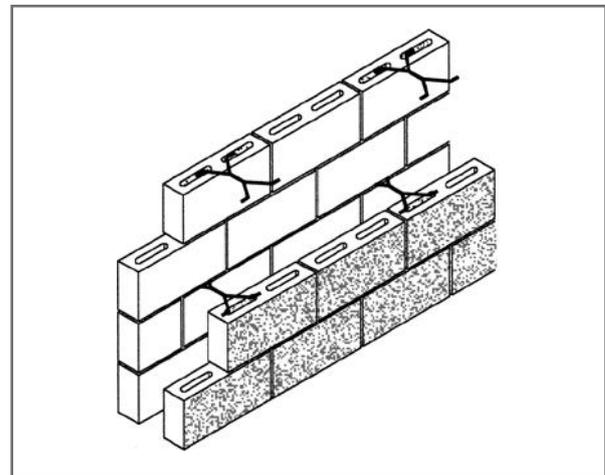


Figure 5.10 The positioning of wire ties in a cavity

Accumulations of mortar droppings in the cavity should be prevented by using laths, drawholes, fine sand and/or thick rope. Any mortar which does fall on wall ties or cavity trays should be removed and the bottom of the cavity should be cleared daily through temporary openings.

Both leaves of a cavity wall should be raised at the same time. The difference between the heights of the two leaves should be:

- i approximately the same as the vertical spacing of consecutive rows of ties, for vertical twist and flat twisted ties;
- ii not greater than five block courses, for double triangle and butterfly ties.

The wall ties should be placed in the bed joint of the appropriate course in the higher leaf as it is built and not pushed in after the units are bedded. Wall ties should be bedded to a minimum depth of 50 mm in

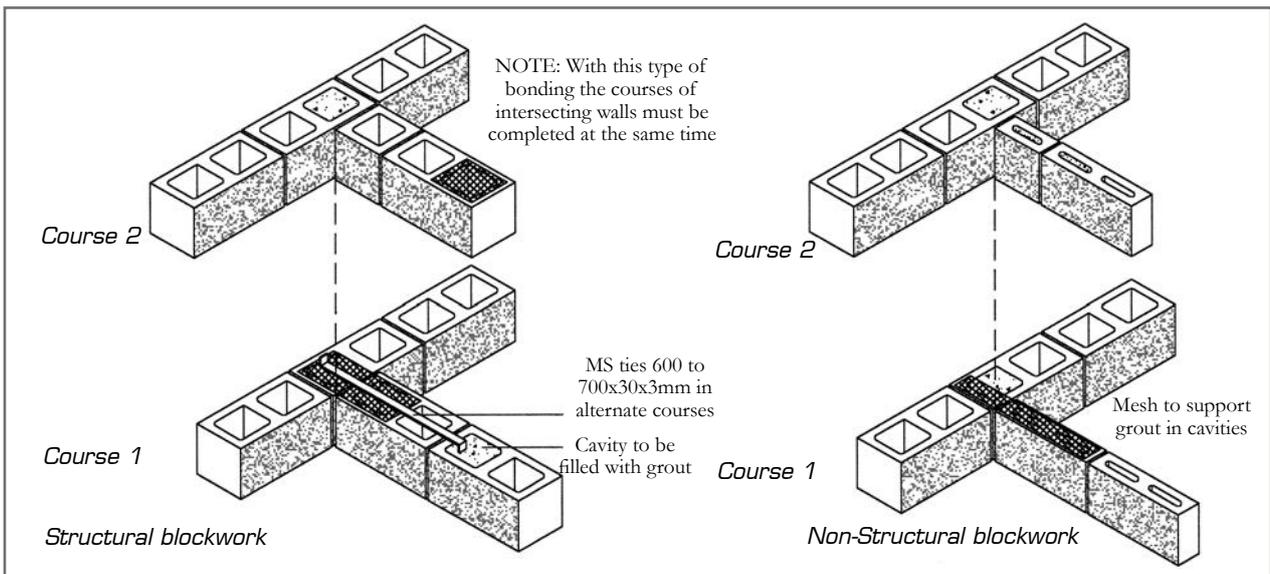


Figure 5.11 Bonding of intersecting walls

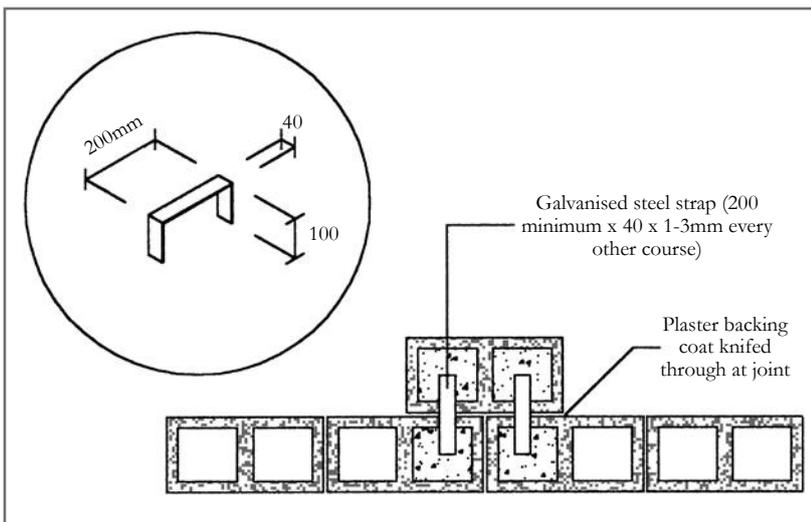


Figure 5.12 Bonding a pier

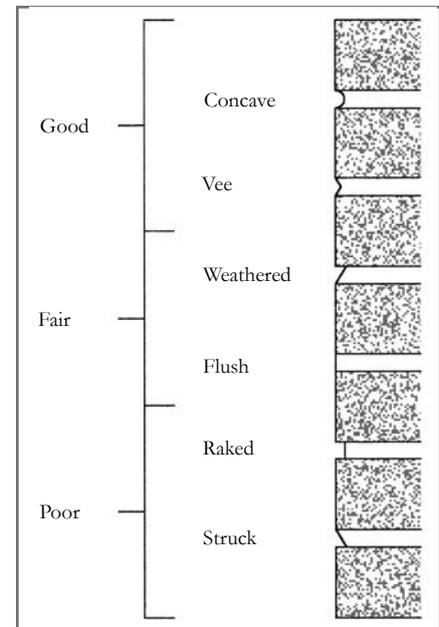


Figure 5.13 Joint profiles

each leaf and have a slight fall to the outer leaf.

See Figure 5.10 for positioning of wire ties in a cavity wall.

Masonry above the wall plate level shall, wherever possible, be bedded in mortar, cut in between roofing timbers and carried hard up to the underside of the roof covering and flushed up with mortar.

c) Bonding with a cross wall

Cross walls shall be masonry bonded or be built up flush against the existing wall with a control joint where they meet. If the cross wall is a structural wall of hollow block, the two walls shall be tied together with metal anchors or wire, starting at the first course above the damp-proof course and spaced at a vertical distance not exceeding

900mm. The anchors shall be at least 3mm thick, at least 30mm wide and approximately 700mm long, with a 50mm right angle bend at each end, and these bends shall be embedded in mortar or concrete placed in the cores. If the cross wall is not structural, the two walls shall be tied together with strips of mesh (metal lath strips) having a minimum thickness of 0,8mm placed in every second horizontal joint and stretching across the vertical joint between the walls. The strips shall be at least 450mm long and of sufficient width to permit a mortar cover of at least 20mm over the edges of the strips.

Details of bonding wall intersections and piers are shown in Figures 5.11 and 5.12.

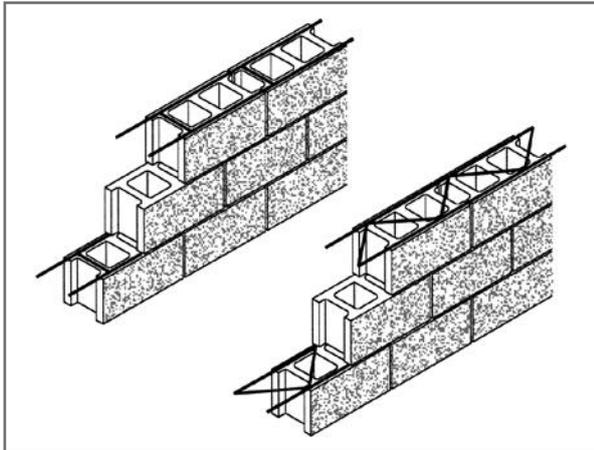


Figure 5.14 Joint reinforcement comes in many shapes for various purposes

d) Alignment and perpend

All masonry shall be built true and plumb. The courses shall be aligned and care taken to keep the perpend in line.

e) Raking back of masonry

Corners and other advanced work shall be raked back and not raised above the general level of the remaining blockwork by more than one metre at one lift.

The rate of new construction shall be limited so as to eliminate any possibility of joint deformation, slumping or instability which may reduce bond strength. Tooling of masonry shall not be permitted.

f) Corners

All corners shall be accurately constructed and the height of courses shall be checked by a gauge rod as the work rises. The bonding of corners shall preserve the symmetry in the appearance of the work.

g) Reveals

The depth of reveals and rebates shall conform as far as practicable to the unit size, in order to maintain masonry strength and to avoid cutting units.

h) Jointing and pointing

As the work proceeds, mortar joints on the face of the wall shall be compacted to give a... joint (specifier to specify shape of joint). Tooling shall be delayed until the mortar has stiffened slightly.

Figure 5.15 shows some of the types of joint finish commonly used in masonry. The type of finish selected depends on the use of the wall and on the appearance desired. A flush joint is made by cutting off the excess mortar with a trowel after the unit is laid. A raked

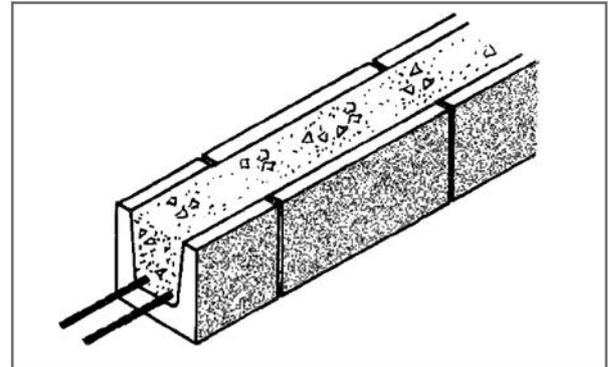


Figure 5.15 Typical concrete masonry bond beam or lintel

joint is made by raking out the mortar to a uniform depth after the unit has been laid. Both these joints have an inherent disadvantage in that the mortar is not compacted or pressed into place; this facilitates moisture penetration. Raked joints also reduce strength and tend to form water traps which may cause water penetration and efflorescence.

For these reasons, the concave (semi round) or V joint is preferred for exterior work. Such joints are formed by tooling with a convex or a V-shaped jointer or with the point of a trowel.

Joints should be tooled when the mortar has become thumbprint hard. The jointing tool should be slightly larger than the thickness of the mortar joint so that complete contact can be made along the edges of the units. Delayed tooling of the joints improves the impermeability of the mortar.

Joints in masonry of solid unit construction, which is to be cement plastered, may be raked to a depth of not more than 5 mm to form a mechanical key for the plaster.

Where pointing is required in terms of the specification data, joints shall be raked out to a depth of not less than 12 mm or not more than 20 mm and shall be filled with mortar mixed in the same proportions as the original bedding mortar and finished to the specified profile.

i) Reinforcement

Reinforcement for... (location) shall be...(type, size) complying with SANS 920.

Bed joint reinforcement for...(location) shall be...(type, size) complying with...

For type indicate type of steel (i.e. high yield, mild); for size indicate length and diameter (reference to drawings/schedules is often required).

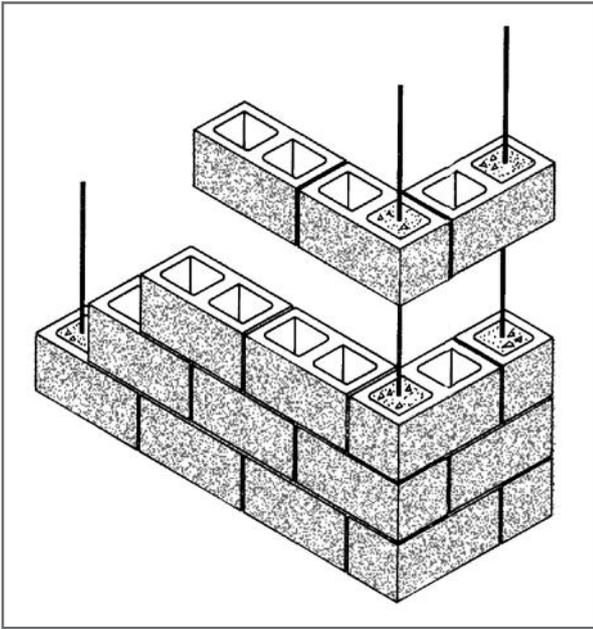


Figure 5.16 Reinforced corner construction

In the case of proprietary reinforcement, it may be necessary to indicate width, manufacturer's reference number, manufacturer and so on. (See Figure 5.14 and 5.15).

Reinforcement in a bed joint should not exceed 6mm in diameter and should be hard drawn (preferably) pre-straightened deformed steel wire or rod. Mild steel has the disadvantage of being difficult to maintain in a straight position and because of its lower yield stress (250 MPa) it is required in larger quantities.

At splices in the reinforcement the lap length of 280, 370, 460, 560 and 740 mm are required for bar diameters of 6, 8, 10, 12, and 16 mm respectively.

Brickforce can provide tension reinforcement in masonry work to control cracking. Because of the small wire diameter however its usefulness in reinforced masonry work is limited.

While bed joint reinforcement has been the traditional way of reinforcing walls, recent developments include the reinforcing of hollow blocks, both horizontally and vertically, or the filling with concrete of the cavities in cavity walls as a means to resist movement, to control cracking and to strengthen masonry.

In reinforced hollow blockwork, the cores of the blocks are filled with infill concrete (sand, stone, cement and water) or grout (sand, cement and water). (See Figures 5.16 and 5.20.)

Grouted cavity construction consists essentially of two parallel leaves of units built as a cavity at least 50 mm

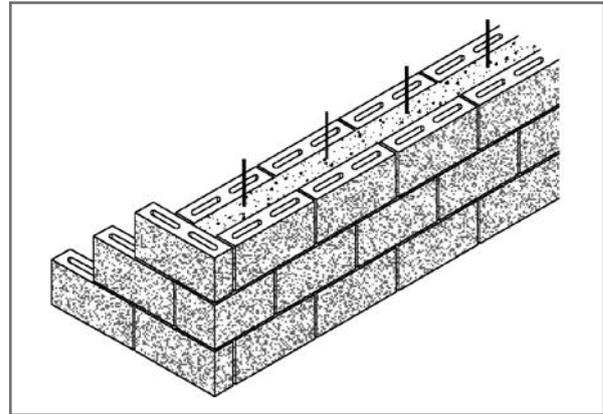


Figure 5.17 Grouted cavity construction

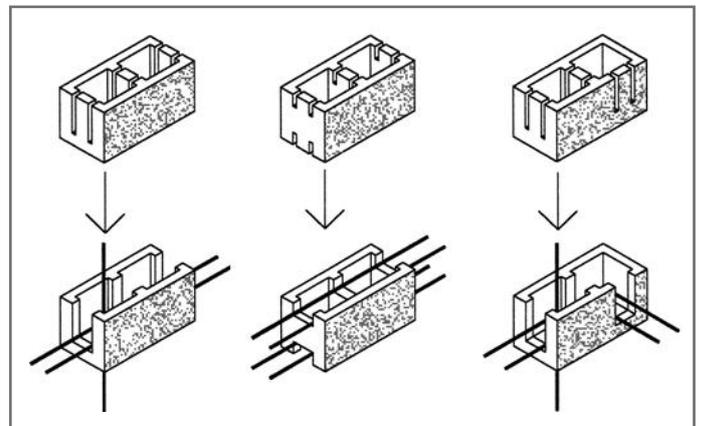


Figure 5.18 Cut blocks to suit reinforcing

wide, the two leaves tied together with wall ties, with reinforcement placed in the cavity which is filled with high slump infill concrete or grout (see Figure 5.17).

If special shaped blocks are not available standard hollow blocks may be cut to suit requirements for the placement of the reinforcement (See Figure 5.18).

Horizontal courses that support roofs or floors and/or as detailed on the drawings, shall be reinforced. For bed-joint reinforcement strips of expanded metal lath or two longitudinal wires of at least 4mm diameter, with cross wires at regular intervals, may be used as reinforcement. The width of the strips shall be such that there is a finished cover of at least 20mm of mortar over the steel.

Care should be taken to use sufficient mortar in the horizontal joints in which reinforcement is bedded to ensure that the whole surface of the steel is in contact with mortar so that there will be adequate bond and protection against corrosion. When horizontal reinforcement is placed in the joint, the mortar should first be spread, the reinforcement placed on the mortar and then tapped into position with a trowel, until it is fully covered.

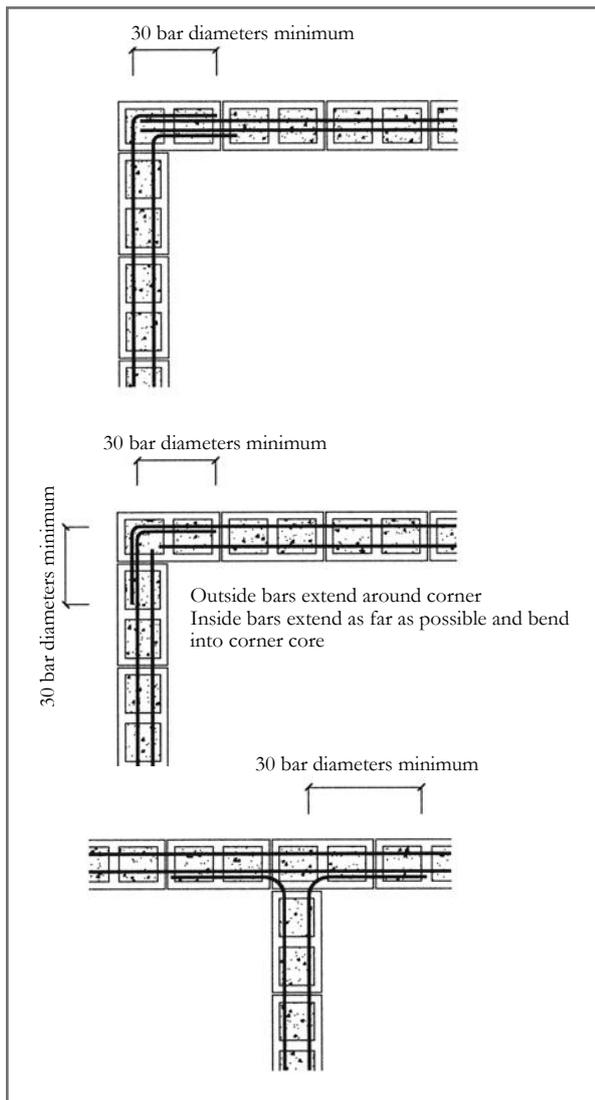


Figure 5.19 Typical detail of reinforcing steel for bond beams at corners of intersection walls

Vertical and horizontal bar reinforcement in concrete masonry cores, columns, beams and walls shall be properly positioned and secured against displacement. The cavities or cores containing such reinforcement shall be completely and solidly filled with concrete of mix proportions.....

Splices shall be made only at such points and in such a manner that the structural strength is not impaired. Minimum clear distance between vertical bars and masonry units shall be 12mm. Where the pour height exceeds 1000mm, clean-out openings shall be provided at the base of the vertical cores to be filled, and mortar droppings on the base shall be removed through these openings prior to fixing the reinforcement.

To reduce cracking in walls of hollow blocks, vertical reinforcement may be placed in the core of the block

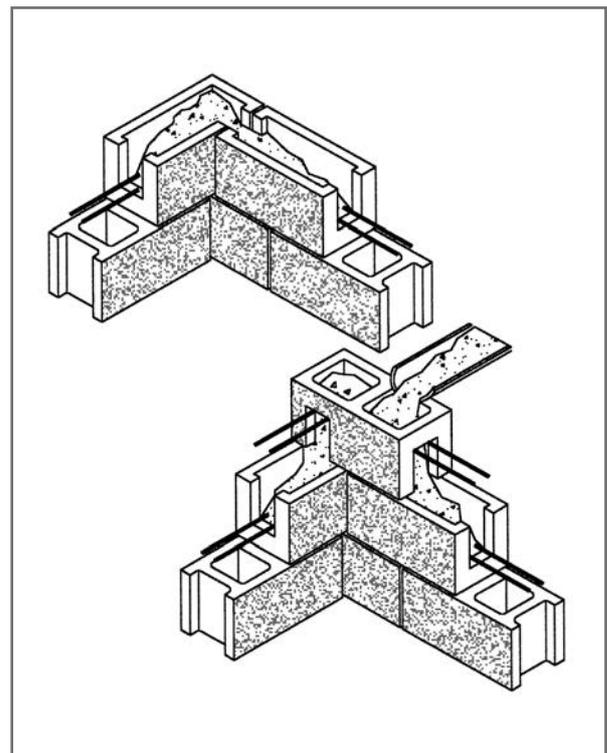


Figure 5.20 Typical details of intersection of bond beams

which adjoins a door or window or other opening. The reinforcement is usually a single steel bar of 6mm diameter or larger and should be embedded in mortar or concrete in the block core. Either a mortar or concrete mix may be used.

j) Reinforced hollow blockwork

- i) *Low lift construction.* In low lift reinforced hollow blockwork construction, the concrete infill in cores shall be placed as part of the process of laying the blocks, at maximum vertical intervals of 1000mm. Each layer of infill concrete shall be placed using receptacles with spouts to avoid splashing and staining of face work. The concrete infill shall be compacted immediately after pouring. Wall integrity shall not be disrupted during pouring.
- ii) *High lift construction.* In high lift reinforced hollow blockwork construction, the walls shall be built to a maximum height of 3m. Clean-out holes having a minimum size of 100 x 100mm shall be provided at the bottom of every core to be filled. Cores shall be free of debris before concreting. Cores shall be fully filled and compacted in lifts not exceeding 500mm in height. After initial settlement but before initial set in each layer occurs concrete shall be recompacted. In the filling of cores care should be taken to ensure that the pressure exerted by the infilling concrete does not disrupt the wall.

k) Grouted cavity construction

i) Low lift construction

In low lift construction, the concrete infill shall be placed as part of the process of laying the units at maximum vertical intervals of 500mm. Each layer of concrete or mortar shall be placed to within 50mm of the top level of the last course laid and shall be placed using receptacles with guards to avoid splashing and staining face work. The concrete infill shall be compacted immediately after pouring. Care shall be taken to avoid disruption resulting from raising the walls too rapidly. Any wall disrupted in this way shall be taken down and rebuilt.

ii) High lift construction

In high lift construction, the walls shall be built to a maximum height of 3m. Clean-out holes 150 x 200 mm in size spaced at approximately 500mm between centres, shall be provided at the base of the wall. After cleaning of the cavity these holes shall be blocked off and the concrete infill placed not earlier than three days after building of the wall. The infill concrete shall be placed and compacted in...(one, two, etc.) lifts. After initial settlement of the infill concrete and before initial set occurs, the concrete in each layer shall be re-compacted.

The number of lifts required will be dependent upon the overall height of the wall; in the case of walls up to 3m high, two lifts will generally be sufficient.

iii) Before grouting, the cavities to be filled shall be checked for cleanliness and projecting mortar shelves which shall be removed.

Some reinforcing details shown in figures 5.19 and 5.20.

l) Cleaning down

Acid may be used to clean down concrete masonry walls provided the treatment is tried on a small panel and found to be satisfactory.

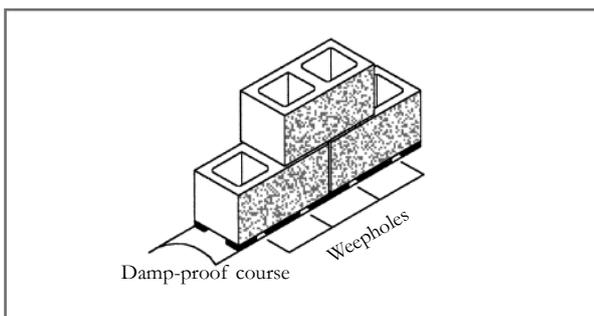


Figure 5.21 Position of weepholes above dpc for hollow blockwork

In the laying of units, any mortar which exudes from the joint should be cut away and on no account should mortar be scraped on to the exposed face of the unit. Any smears on the face of the masonry from mortar droppings should be allowed to dry a little and then be lightly brushed off and washed.

To minimise cleaning of new masonry consider:

- protect the base of the wall from rain-splashed mud or mortar droppings;
- turn scaffold boards on edge at the end of each workday to prevent possible rain from splashing mortar or dirt onto the wall;
- cover the tops of unfinished walls to keep water from entering and causing efflorescence.

For cleaning concrete masonry let large mortar droppings harden slightly, then remove with trowel or putty knife or chisel.

Concrete surfaces may be rubbed with another piece of concrete masonry, then with a stiff fibre-bristle brush.

The National Concrete Masonry Association, USA, does not recommend any other cleaning methods. Because the mortar and masonry unit usually are close in colour, this dry, abrasive rubbing usually is sufficient to remove stains.

m) Removal of mortar droppings

Mortar droppings which fall on wall ties in a cavity wall shall be removed and temporary openings shall be provided to permit their removal from the bottom of the cavity.

4. Weepholes

Where it is required to drain away moisture in cavity walls or where detailed on the drawings, weepholes shall be located in the first course above any damp-proof course membrane in positions specified. In cavity construction weepholes shall be approximately 50mm high and formed in perpend joints. In hollow masonry walls the weepholes shall be of the same thickness as the bedding course thickness, approximately 30mm wide and located in the bedding course beneath the hollow masonry unit cores.

For hollow block-work the weepholes should be located in the mortar bedding (see Figure 5.21).

5. Damp-proof courses

Damp-proof courses shall be provided at positions shown on the drawings.

The course on which a damp-proof course is to be laid shall be flushed up with mortar to form an even bed free from projections liable to puncture or damage the damp-proof course.

Damp-proof courses shall be positioned to fully cover the leaf thickness. All horizontal damp-proof courses shall protrude 10 mm from the exterior face of the wall and be turned downwards if possible.

Horizontal damp-proof courses shall be laid with mortar above and below and lapped 150 mm at all joints in the running length.

Where a damp-proof membrane is over the full thickness of a hollow block wall not less than 140mm thick, the membrane may be pierced at regular intervals over the centre of each cavity in the blocks forming the wall. The membrane shall be depressed towards the centre. In cavity walls the vertical damp-proof courses shall be of adequate width and be fixed to slope down from the inner to the outer leaf of the wall.

SANS 10021 should be referred to for more detailed information on damp-proof courses.

The choice of a damp-proof course should reflect the functional needs of a given situation. To ensure water tightness, all junctions, steps and stop-ends should be carefully detailed, preferably by isometric sketches. Complicated junctions should be prefabricated.

Under window sills exposed to the weather, the damp-proof course in two-leaf walls shall be tucked under the window frame and stepped down one course to project 10mm beyond the outer masonry leaf.

Changes in direction of dpc's whether horizontal or vertical and the junction between horizontal and vertical dpc's may, if not properly designed or considered, direct water into the building.

6. Anchoring of roofs

The roof truss, rafter or beam shall be anchored to the wall with a galvanised steel strap or wire to extend into the wall to a depth of at least 300mm in the case of a heavy roof (concrete or clay tiles or slate), or at least 600mm in the case of a sheeted roof, except that where the depth of the masonry is less than 300mm or 600mm, respectively, such strap or wire shall extend as far as possible into the wall.

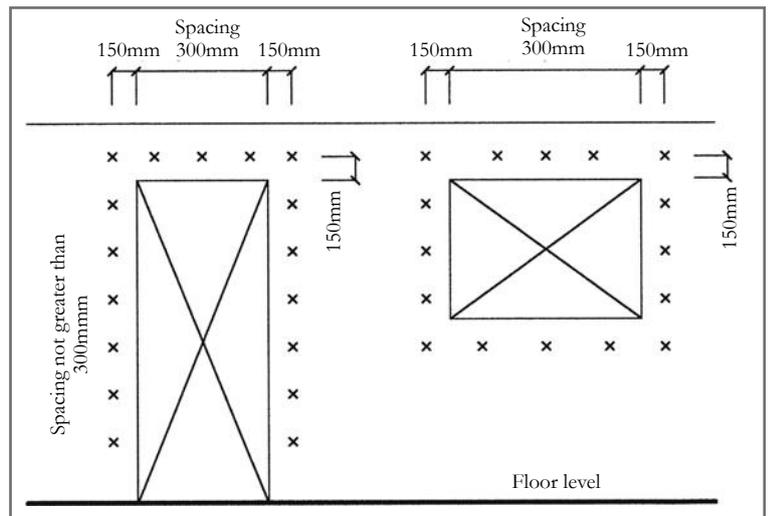


Figure 5.22 Positioning of wall ties around openings in cavity and collar jointed walls

The type of anchors to be used for light or heavy roofs, various roof slopes and roof truss/beam spacing are given in Chapter 4.

7. Flashing

Flashing material shall be used over openings or to cover an intersection or joint where water would otherwise penetrate to the interior of the building. Flashing or capping shall be provided to the tops of all parapets.

The material to be used should be sufficiently malleable to permit dressing into shape, but sufficiently stiff to maintain its shape and to resist lifting by the wind. Flashing should preferably be built in as work proceeds to avoid any damage to dpc's. It should adequately cover the joint it is intended to protect.

8. Masonry over and around openings

All masonry built over openings shall be adequately supported for not less than 7 days.

Where hollow blocks are used, the cores adjacent to the openings shall be filled with concrete (50 kg common cement to 150 l sand to 140 l stone) or mortar (class II).

Lintels over openings shall bear on the full thickness of the wall with a bearing length, at each end, of at least 190mm. Lintels may be of precast reinforced or prestressed concrete, or may be formed in situ with special lintel blocks filled with concrete and reinforced near the base with high tensile or mild steel rods.

Masonry in cavity walls and collar jointed walls around openings shall be reinforced with wall ties positioned

not more than 150 mm from the opening and at a spacing not exceeding 300mm.

Figure 5.22 shows position of wall ties around openings.

Except over single doorways in non-loadbearing partition walls, a suitably designed lintel must be provided over all door, window and other openings. For the design of reinforced masonry lintels reference should be made to SANS 10400-K and CMA publications Lintels design guide and Lintels technical note.

The core in a hollow block adjacent to an opening shall be filled with concrete grade 10 or mortar and reinforced with a single Y10 mm bar extending 400 mm past the opening.

9. Bearing plates on blocks

Bearing plates on blocks shall be bedded in mortar similar to that used for the masonry and shall be set level.

Where a concentrated load occurs in a wall, eg. at a lintel or beam bearing, local bearing stresses should be checked out, and where necessary suitable bearing plates, spreader beams or pad-stones should be provided.

10. Chasing for services

The positions and size of horizontal or vertical chasings to accommodate services or conduits for electrical and other services shall be as indicated on the drawings and shall be carried out neatly.

Well-considered earlier decisions on the location of services and wall finishes will be rewarded when electrical and plumbing services are to be installed. Horizontal chasing should be avoided where possible.

Ensure that chases, holes and recesses are so made as not to impair the strength or stability of the wall or reduce the fire resistance properties of the walling below the minimum permitted.

Small circular holes that can be made by drilling or coring may be formed after the construction of the masonry wall, but larger holes should preferably be square, of dimensions to suit the masonry unit size and coursing, and formed at the time of the construction of the wall. Holes and chases formed after the construction should not be made by impact methods as these can encourage local cracking that may propagate under loads and movements.

Vertical chases in solid units should not exceed one third of the wall/leaf thickness and horizontal chases should not exceed one sixth of the wall/leaf thickness.

Walls constructed of hollow units should not be chased at all and services should be located in the unit cores. Where chasing in these blocks is unavoidable, it should be no deeper than 15mm.

Chases in hollow concrete block wall shall be filled with Class I or II mortar once the conduits or pipes have been placed in their final position in the chase.

11. Joint infilling and sealing

Joints around door and window frames, control joints, abutting joints at external columns and other points where sealing is indicated or required shall be brush painted with... (type or name) primer and filled with (type or name) sealant of a colour specified by the specifier, the whole of which shall be carried out in accordance with the manufacturer's recommendations.

Many sealant materials effectively seal joints but frequently fail because of insufficient capacity to absorb total movement. Joints around door and window frames, unless properly designed, are not control joints and are not expected to accommodate movement.

Joints may be filled with various types of materials. Sealants are used to exclude water and solid material from the joints; joint fillers, which are of compressible material, are used to fill a joint to prevent the infiltration of debris and to provide support for sealants, if used.

Suitable sealants for masonry joints are field-moulded, chemically-curing materials such as polysulphides, polyurethanes and silicones.

These may be one- or two-component systems. Two-component systems require a catalyst while one-component systems, with the exception of silicones, cure by taking up moisture from the air.

In less critical applications acrylics, bitumen and polyisobutylene materials may be used. Allowable extension and compression of these materials is generally $\pm 20\%$, i.e. on a 10mm wide joint the sealant will be effective between joint widths from 8mm to 12mm. The closer the installation temperature is to the mean annual temperature, the less will be the strain in the joint-filling material.

The joint depth-to-width ratio is an important consideration with seals. To ensure adequate bond to the masonry, the depth of seal should be at least 5mm. Certain single-part moisture-cured sealants are best used in joints of small cross-section due to excessive curing time required in thick sections.

Optimum performance in butt joints is obtained when the width-to-depth ratio of the sealant bed lies within the range 2:1 to 1:1.

Check with sealant supplier as to the best joint shape factor for the particular sealant.

The sealant should be applied against a firm backing so that it is forced against the sides of the joint under sufficient pressure to ensure good adhesion. The filler or back-up material should not adhere to or react with the sealant.

Preformed materials used as fillers and back-up are generally bitumen-impregnated fibreboard (softboard), closed-cell expanded polyethylene, polyurethane and polystyrene rigid foams, natural-rubber sponges and neoprene or butyl sponge tubes or rods. When there is a likelihood of the filler material reacting with the masonry, the use of a bond breaker should be considered. In some instances, particularly on interior walls, a dry butt joint filled with mortar can be used provided hairline cracking is acceptable. Metal cover strips to joints can also be used.

12. Protection against damage

Finished masonry shall be protected where necessary to avoid damage during building operations.

Care should be taken to anticipate and prevent any possible damage or disfigurement to finished work due to subsequent building and other operations.

The arrises around openings should be protected from damage by barrows, etc.

Masonry walls subject to uniform floor or roof loads shall not be subjected to loading for at least 12 hours after completion. Concentrated loads shall not be applied for 3 days after completion.

13. Protection of new work

To ensure that hardening and strength development of the masonry will not be adversely affected all new work shall be suitably protected against both rain and rapid drying.

During construction, partially completed walls which are not enclosed or sheltered shall be kept dry by covering at the end of each day, and when work is not in progress, with strong, weather-resistant material extending to a minimum of 600mm down each side, and held securely in place.

When any working platform is not in use the inner board should be turned up on edge away from the wall to prevent splashing of the wall face.

14. Bracing during construction

Back-filling shall not be placed against foundation walls until they have been braced or have adequate strength to withstand the horizontal pressure.

15. Cleaning of finished work

Completed masonry shall be free of stains, efflorescence, mortar, infill concrete droppings and debris.

Cleaning down shall be carried out as the work proceeds and again at completion. In the first instance masonry shall be cleaned with water and a fibre brush. Thereafter, chemical cleaning agents may, if necessary, be used strictly in accordance with the manufacturer's instructions, provided, however, that the work is not damaged.

THE USE OF CONCRETE AND CLAY MASONRY UNITS IN THE SAME WALL

Introduction

Concrete and burnt clay masonry units respond differently to temperature, moisture and stress. Consequently when used in the same wall distress may occur.

Masonry units: Clay

After manufacture, some clay bricks expand slowly in contact with water or humid air; this expansion is not reversible by drying at atmospheric temperatures; the movement is termed moisture expansion and continues for a number of years.

In an unrestrained wall, a temperature change of 20 °C results in movements of approximately 0,1mm per m horizontally and 0,2mm per m vertically.

Creep — deformation in time under stress — is generally less for clay than for concrete units but, except in highly stressed loadbearing structures, this is not a significant factor in design.

Masonry units: Concrete

For a short period after manufacture, concrete masonry units shrink due to loss of moisture and carbonation.

Initial drying shrinkage should be substantially complete before units are built into the wall.

Concrete masonry units expand with a gain in moisture and contract with loss of moisture.

In an unrestrained wall, a temperature change of 20 °C results in horizontal and vertical movements of approximately 0,2mm per m.

Overall Considerations

a) General considerations

In a building the temperature range to which exterior and interior wall surfaces are exposed varies significantly. For example, the orientation of walls to the sun is a factor — south walls have little sun while west walls become hottest. Over-hanging roofs shade part of the wall.

Moisture changes in masonry units depend on whether they form an interior or an exterior wall, whether protected by plaster and/or paint or by an overhanging roof, and by the orientation of the walls towards the direction of the prevailing rain.

The stresses to which walls as a whole and various parts of the same wall are subjected, due to changing climatic conditions, vary throughout the day and night, and from point to point in a wall.

b) Design considerations

The designer of a wall should therefore consider the many factors affecting its performance in service to ensure a maintenance-free wall.

He should identify and assess the numerous stress factors referred to above to which various parts of the wall will be subjected and take into account the quality of masonry units and mortar to be used, the quality of workmanship and supervision, the provision of control and/or movement joints, wall type (single-leaf, double leaf, solid, cavity), wall ties, the use of bedding reinforcement, the position of service conduits, etc.

Recommendations

The notes that follow are based on conditions of exposure, quality of units, materials, workmanship and supervision on a well-organised and controlled building site.

a) Masonry units

Strength requirements for masonry units and mortar use in various positions in the construction of walling should be as specified.

b) Mortar sands and mix proportions

Sands used for mortar should not contain excessive amounts of fine or clayey material which frequently leads to excessive shrinkage and cracking of the bedding and perpend joints. Sands for mortar should comply with SANS 1090. Sand which does not comply with SANS 1090 should only be used with the written consent of the specifier. For mortar mix proportions refer to SANS 10145 and SANS 2001-CM1.

c) Wall ties

Wall ties in cavity walls should be able to accommodate the movement between inner and outer leaves. Butterfly and double triangular wire ties are more flexible and thus are preferred to flat or vertical twisted ties.

d) Type of wall

i) Separate leaves of concrete and clay masonry units in solid or cavity walls (see sketch No. 1 Figure 5.23).

This type of construction is satisfactory provided that: leaves are kept separate, i.e. no mortar between concrete and clay masonry units; separate leaves are joined together by wall ties; attention is paid to detailing at corners and openings.

ii) Concrete and clay masonry units in the same wall leaf. This may occur in four ways:

1. Adjacent areas of full wall height in concrete and clay masonry units (see sketch No. 2, Figure 5.23).

Areas of concrete and clay masonry units should be separated by a straight vertical control joint (see sketch No. 3, Figure 5.23).

Where lateral pressures are expected consider pillars behind control joints or the use of lubricated dowel bars in the bedding course.

2. Alternate horizontal courses of concrete and clay masonry units (see sketch No. 4, Figure 5.23).

This type of construction of units is unsatisfactory and should not be used.

3. Random distribution of units made from different materials yields unsatisfactory results as each type of unit will exhibit differing characteristic movement patterns. At point of contact between these areas cracking is likely to occur (see sketches No. 5 and 6, Figure 5.23).

4. Lower courses of a wall, eg. foundation walls, may consist of units of one material while those of a different material may be used for the superstructure. This type of construction is satisfactory, particularly if a horizontal slip joint, i.e. a dpc, is placed in the bedding course at the junction of the different masonry units (see sketch No. 7, Figure 5.23).

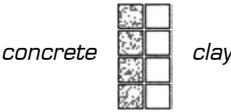
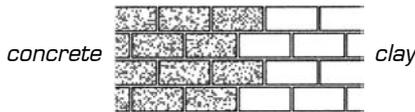
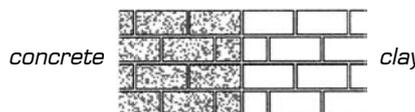
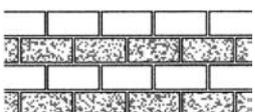
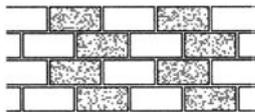
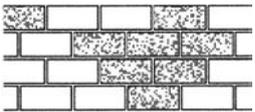
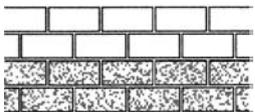
	Situation	Comment
Sketch 1	<i>separate leaves of concrete & clay masonry units</i>  <i>section</i>	<i>satisfactory if leaves kept separate but detailing problems at openings</i>
Sketch 2	 <i>elevation</i>	<i>unsatisfactory</i>
Sketch 3	<i>control joint</i>  <i>elevation</i>	<i>satisfactory</i>
Sketch 4	 <i>elevation</i>	<i>unsatisfactory</i>
Sketch 5	<i>concrete</i>  <i>elevation</i>	<i>unsatisfactory</i>
Sketch 6	<i>clay concrete</i>  <i>elevation</i>	<i>unsatisfactory</i>
Sketch 7	<i>clay (or concrete)</i>  <i>foundation elevation</i>	<i>satisfactory if joint, e.g. dpc, at junction of different masonry units</i>

Figure 5.23 Concrete and clay masonry units in the same wall

RAIN PENETRATION THROUGH MASONRY WALLS

Introduction

Masonry walls that leak when subjected to rain are of concern to designers, builders and occupiers.

Water generally enters the wall through fine capillary passages at the masonry unit/mortar interface, and through cracks caused by building movement.

The prevention of rain leakage through walls begins with the design of the building, follows through with the selection of materials and supervision of workmanship, and continues with maintenance of the structure after its completion.

Good practice involves the following:

1. Design

Best results are obtained with:

- Cavity walls — cavities must be properly drained and ventilated.
- Provision of dpc's and weepholes located where necessary.
- Non-continuous mortar bed across wall composed of hollow units, i.e. shell bedding.
- Correct profiles of joints; best — concave and vee joints, poorest — flush, struck and raked joints
- Correct detailing and reinforcing around windows and other openings to avoid cracks.
- Covering of top of walls — flashings, coping and roof overhang.
- Discharging of rain water from roof run-off away from wall. Large roof overhangs best.
- Surface finish — rendering, plastering, painting of non-face units and mortar.
- Provision of control joints, vertical and/or horizontal, of correct profile, spacing and sealing.

2. Materials

a) Masonry units

Research and experience regarding the ability of concrete masonry units to resist rain penetration have shown that:

- Strength, density and capacity for water absorption are not significant properties.
- Open textured, porous units soak up rain and generally dry out in wall under favourable climatic

conditions. Water-permeable units should be designed for through correct detailing.

- Dense face units give rise to a considerable run-off down the face of the wall with possible moisture penetration through cracks at the unit/mortar interface.
- There is no significant difference between hollow and solid units.

b) Mortar

Cement — Common and masonry cements are best

Sand — Avoid sands with high shrinkage characteristics, i.e. high clay content or requiring high water content for workability — preferably use sands complying with SANS 1090

Admixtures — Performance depends on properties of sand and mix proportions; mortar plasticizers are generally suitable

Lime — Use in common cement mortar mixes with coarse sand improves water retention and plasticity.

c) Wall ties

Use with moisture drip in cavity.

d) Bed reinforcement

Check longitudinal wire spacing and cover to suit particular dimensions.

e) General note

Protect all materials from contamination.

3. Workmanship

Specify quality requirements.

Use qualified and trained layers.

Supervise construction.

Lay concrete units dry.

a) Mortar and joints:

- Use correct mortar proportions — allow for sand bulking — check accuracy of batching.
- Batch cement by bag or mass.
- Fill, compact and retool joints after 30minutes to 2hours. Use correct tools for tooling joints.
- Avoid excessive joint thicknesses — 13mm maximum.
- Use correct joint profile.
- Provide adequate cover to bed reinforcement.
- Bed wall ties properly — slope to outside leaf.

- Prevent mortar dropping into cavity.
- Provide weepholes above dpc's, beams and lintels — except where dpc's pierced or cavity drained.
- Slope concrete infilling at top of bond beams and lintels to outer surface.
- Prevent excessive retempering of mortar — use within 1 hour of mixing (hot weather) 2 hours (cold weather).
- Protect work from rain and rapid drying.

b) Dampproofing:

- Sandwich damp-proof membrane between wet mortar.
- Position dpc to fully cover leaf thickness.
- Extend dpc 10mm beyond bedding mortar and turn end downwards.
- Place membrane over hollow units, pierce over the centre of each core and depress membrane towards centre.
- Lap dpc at least 150mm and seal where dpc not continuous.
- Provide dpc at openings.
- Provide dpc at reveals of openings in cavity walls, and over lintels that are not protected by eaves overhang.

c) Control joints:

- Ensure complete break in walls — no reinforcement over gap — consider greased dowel bars or other slip-joints where lateral loading is a factor.
- Seal joints.
- Protect work from rain and rapid drying.

4. Maintenance

Inspect walling at regular intervals and identify possible problem areas.

Maintain walling:

- repair cracks;
- consider tuck pointing of defective mortar joints;
- replace or top up control joint sealants in joints;
- consider painting.

5. Tests for moisture penetration and statutory requirements

Weather resistance of masonry structures depends on the interaction of design, materials, workmanship

and maintenance. Thus, any meaningful test for moisture penetration must encompass a test of the whole wall. A standard water spray test is detailed in SANS 10400 - K.

The spraying requirements in rain penetration tests for walls is that in a category 1 building the resistance period to be 4 hours, unless protected by a roof overhang, and in walls in a building other than a category 1 building the test or resistance period is related to mean annual rainfall and hourly mean wind speed.

The rain penetration acceptance criteria are given in SANS 10400-K Table 32.

Building Category	Acceptance criteria
Category 1	Moisture which penetrates the walls is of insufficient intensity to run down the wall and onto the floor of the house.
Other than Category 1	No damp patches are visible on the inside of the wall.

A category 1 building is a building which:

- a) is designated as being a class A3 (places of instruction); A4 (worship); F2 (small shop); G1 (offices); H2 (dormitory); H3 (domestic residence); and H4 (dwelling house);
- b) has no basements;
- c) has a maximum length between intersecting walls or members providing lateral support of 6,0 metres; and
- d) has a floor area not exceeding 80 m².

The resistance of external walls to rain penetration shall either be in accordance with spraying test requirements, as stated above, or in accordance with the requirements of one of the following:

- a) buildings other than category 1 buildings
 - 1) single-leaf, hollow unit, shell bedded masonry walls that have a thickness of 140 mm or greater;
 - 2) single-leaf, solidly bed-jointed masonry walls that have a thickness of 140 mm or greater plastered in accordance with the requirements of SANS 2001-EM1;
 - 3) collar-jointed, solid unit, solidly bed jointed masonry walls that have a thickness of 190 mm.

- 4) a masonry walls of cavity construction;
 - 5) a wall coated with a coating which is the subject of an Agrément certificate.
- b) category 1 buildings which have no overhangs or an overhang that does not comply with the requirements of figure 5.24.
- 1) masonry walls of thickness 140 mm or greater;
 - 2) walls of thickness 90 mm or greater plastered in accordance with the requirements of SANS 2001-EM1;
 - 3) a wall coated with a coating which is the subject of an Agrément certificate.
- c) category 1 buildings which have overhangs in accordance with figure 5.24.
- 1) masonry walls of thickness 90 mm or greater; or
 - 2) a wall coated with a coating which is the subject of an Agrément certificate.

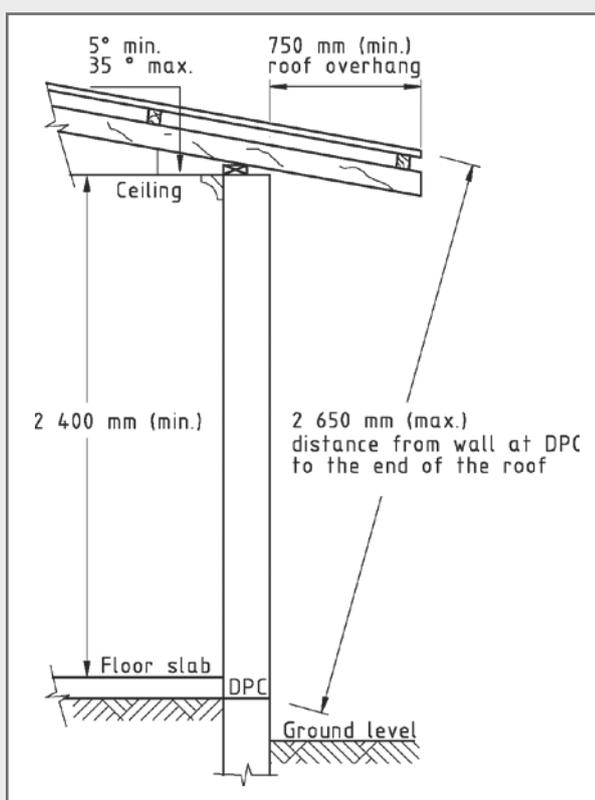


Figure 5.24 Roof overhangs which protect walls from rain (SANS 10400-K, Figure C1)

Note 1: The roof slope to be between 5° and 35°.

Note 2: The horizontal overhang from the outside face of the wall to the end of the roofing material is not less than 750 mm.

Note 3: The straight line distance between the end of

the roofing material to the edge of the damp-proof course shall not exceed 2 650 mm.

6. Conclusion

Solid walls are more vulnerable to moisture penetration than cavity walls. Cavity wall construction should be used in coastal areas. Where exposure conditions are severe, all non-cavity exterior walls should be plastered or given some other effective waterproofing coating.

The quality of the mortar and the workmanship require particular attention if the structure is to be weatherproof.

The assessment of condensation risk is an important consideration in the design of external walls.

Prediction of condensation risk is a complex subject involving a number of variables. The most important of these (the way a heating system is used, and the production of water vapour and its control by ventilation) are usually beyond the control of the building designer.

EFFLORESCENCE ON CONCRETE MASONRY

Introduction

Efflorescence on concrete masonry units normally takes one of three forms: lime bloom, lime weeping, crystallisation of soluble salts.

Lime bloom

The most common form of efflorescence is lime bloom and it is particularly noticeable on coloured units.

It is a white deposit which is apparent either as white patches or as an overall lightening in colour. The latter effect is sometimes mistakenly interpreted as the colour fading or being washed out.

The cause of lime bloom lies in the chemical composition of cement. When water is added to cement, a series of chemical reactions take place which result in setting and hardening. One product of these reactions is "lime" in the form of calcium hydroxide. Calcium hydroxide is slightly soluble in water and, under certain conditions, can migrate through damp concrete or mortar to the surface and there react with carbon dioxide from the atmosphere to produce a surface deposit of calcium carbonate crystals. This surface deposit is similar to a very thin coat of white-wash and gives rise to the white patches or lightening of colour mentioned previously. The surface deposit is normally extremely thin and this thinness is demonstrated by the fact that, when the concrete or mortar is wetted, the film of water on the

surface usually makes the deposit transparent and the efflorescence seemingly disappears.

The occurrence of lime bloom tends to be spasmodic and unpredictable. Nonetheless, an important factor is the weather. Lime bloom forms most readily when concrete or mortar becomes wet and remains damp for several days, and this is reflected in the fact that it occurs most frequently during the winter months. Extended periods of rain and cold weather in particular are conditions most likely to precipitate a severe manifestation.

Although drying winds are often suggested as a likely cause, they are probably not a major factor.

Lime bloom is not visible on damp surfaces and so only becomes apparent with the onset of dry weather. Thus dry weather does not necessarily produce lime bloom; it may only make visible a deposit which had already formed but could not be seen because the concrete or mortar was damp.

Concrete masonry units are normally only prone to lime bloom in the early stages of their service life. In general, concrete which has been in service for a year without being affected can be considered immune.

Lime bloom is a temporary effect and, given time, usually disappears of its own accord. It is purely superficial and does not affect the durability or strength of the concrete masonry units.

Lime weeping

Lime weeping is a rare phenomenon in concrete masonry. It is an encrustation or build-up of white material on the surface of concrete masonry.

It usually occurs at joints or cracks, or at dpc level where water emerges from the interior of a wall onto the surface.

Lime weeping is closely related to lime bloom. Water moving across or through concrete, deposits this lime as calcium carbonate. However, unlike lime bloom, the calcium carbonate is not deposited as a thin surface layer, but builds up to form thick encrustation in localised areas. Lime weeping is a process very similar to that which produces stalactites and stalagmites in caves in limestone rocks.

The presence of lime weeping does not normally give rise to concern about the durability of a structure.

It is, however, an indication that water is flowing through the concrete masonry and this may be undesirable.

Crystallisation of soluble salts

This type of efflorescence, which corresponds to that normally observed on burnt clay brickwork, is relatively rare on concrete masonry. It usually takes the form of a fluffy deposit.

Unlike lime bloom and lime weeping, the deposit is not calcium carbonate, but consists of soluble salts not normally present in concrete. These salts can originate from contaminants present in the original concrete mix, eg. sodium chloride, introduced by using sea-water as mixing water. Alternatively they may have migrated into the concrete from external sources, eg. groundwater in contact with walls or foundations. They are drawn to the surface and deposited where water evaporates from the concrete.

Removing of lime bloom

Lime bloom is usually a transient phenomenon and can be expected to disappear with time. The major factor influencing its duration is the environment to which the concrete is exposed. Where the concrete is fully exposed to the weather, rain-water (which is slightly acidic) dissolves the deposit and the lime bloom typically disappears in about a year. In more sheltered locations, removal by natural means may take considerably longer.

If immediate removal is required, this can be achieved by washing with dilute acid. This is a relatively simple operation, but care should be taken on two counts. Firstly, acids can be hazardous and appropriate safety precautions must be taken. Secondly, acid attacks concrete and over-application to a concrete surface can result in acid-etching, which will alter the texture and appearance.

Generally a 5% solution of hydrochloric acid or a proprietary acid-based concrete cleaner is used. The acid concentration can be adjusted to suit individual circumstances; a less concentrated solution will require more applications to remove lime bloom, but will be less likely to result in an acid-etched appearance.

Before the acid is applied, the surface should be dampened with water to kill the initial suction. This prevents the acid from being sucked into the concrete before it has a chance to react with the surface deposit. The acid is applied by brush or spray and a typical application rate is 1 litre of acid to 5 -10 square metres. Following application of acid, the surface of the concrete is allowed to dry out and is then inspected. Often one wash with acid is sufficient, but in more stubborn cases the treatment is repeated as

necessary until the lime bloom disappears. Finally, it is normal practice to give the concrete a final wash with water.

When carrying out acid washing, always test the effect on an inconspicuous area. Operatives should wear protective clothing, at the very least rubber gloves and goggles. Precautions should be taken to prevent acid from coming into contact with metals and other materials which may be adversely affected.

Acid is neutralised within seconds of coming into contact with concrete; consequently, when acid washing is used on concrete products, there is no risk of acid burns to users of such products. The attack on concrete by acid, even in the case of severe over-application, is limited to a thin surface layer and there need be no cause for concern that acid washing will affect properties of the concrete other than surface appearance. Whilst there can be no guarantee, experience suggests that lime bloom is unlikely to recur following its removal with acid.

Control and removal of lime weeping

Lime weeping is a white deposit produced at points where water merges from the surface of concrete. Its prevention involves design and workmanship which eliminate the leakage of water.

Where lime weeping is present on existing structure, it can be removed by mechanical hacking, using a hammer and chisel. Provided this is done carefully, the brittle encrustation can usually be knocked off without damaging the underlying concrete. Unless measures are taken to prevent further migration of water through the concrete, lime weeping will usually recur.

Control and removal of deposits of soluble salts

Salts crystallising on the surface of concrete may originate either from impurities present in the concrete mix or from ground-water in contact with the concrete.

Efflorescence resulting from contaminants present in the concrete mix is often a result of using sea-water as mixing water. The use of sea-water or of unwashed marine aggregates should be avoided in situations where efflorescence would be objectionable.

Ground-water does not migrate very easily through good quality concrete and soluble salts from ground-water do not often crystallise on concrete surfaces. In situations where precautions are considered

necessary, a bitumen (or similar) damp-proof membrane should be used to separate the concrete from the ground-water.

These deposits are often soft and fluffy and in many cases can be removed by using a dry bristle brush. Should this fail, a combination of brushing and washing with water may be tried. Should this also fail to remove the deposit, the surface should be washed with acid as described previously. In all cases, trials on an inconspicuous area should be carried out to determine the most effective treatment.

Test for efflorescence

There are no requirements in SANS 1215 pertaining to the amount of efflorescence permissible, but a test for efflorescence is described which states: "Place each of six masonry units on end in separate trays that are situated in a well-ventilated room and each of which contains 300ml of distilled water and has dimensions such that the depth of immersion of the unit is between 25 and 40 mm.

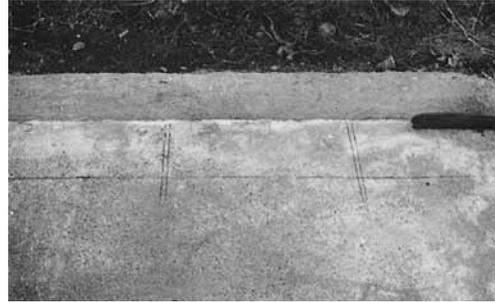
"Allow the water in the trays to evaporate. When the units appear to be dry and feel dry, place a further 300ml of distilled water in each tray. When the water has evaporated and the units have dried out, determine by visual examination the degree of efflorescence of each unit."

The permissible degree of efflorescence should be agreed upon by the supplier and the purchaser. Reference: HIGGINS, D.D. Efflorescence on concrete. Cement and Concrete Association 1982.

GOOD LAYING PRACTICE ILLUSTRATED



Setting out to block modules



Block module spacing



Positioning first corner block



Tapping the block into position



Remove excess mortar



Buttering end of block



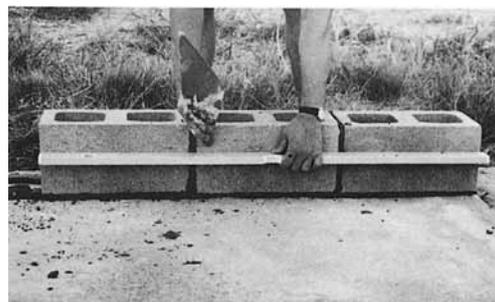
Place block against previous unit



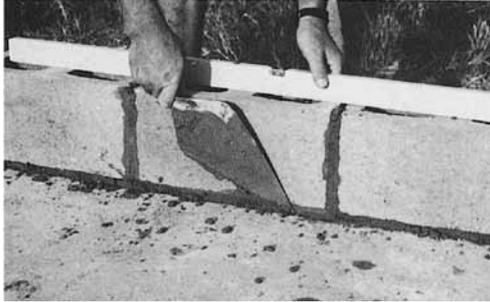
Tap into position



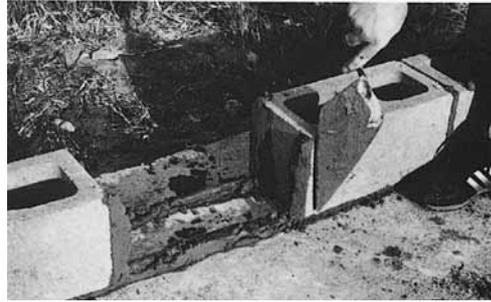
Check corner for plumb



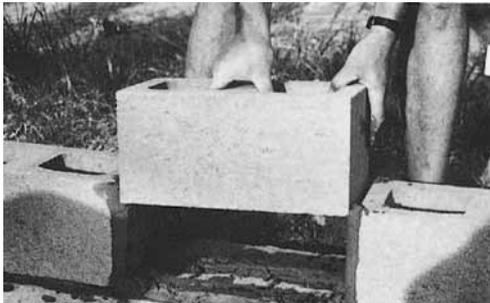
Check alignment with straightedge



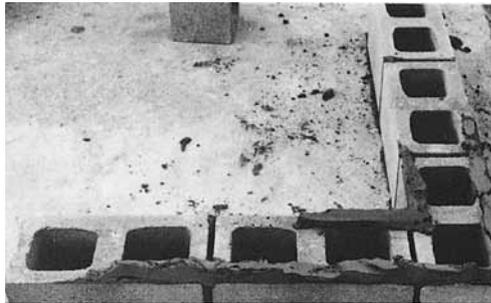
Check level



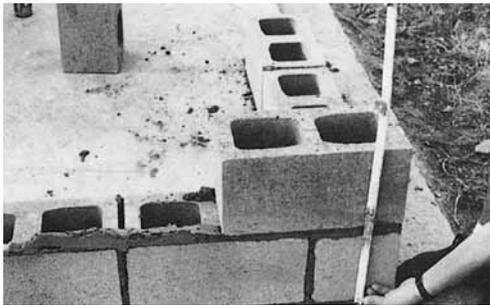
Mortar for closing block



Lay closing block



Face shall mortar bedding



Check course height



Check level



Lay blocks to mason's line



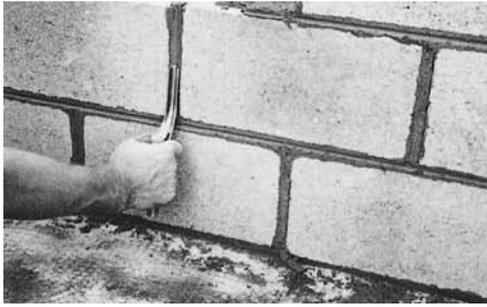
Check corner alignment



Re-fill mortar joints



Tool horizontal joints



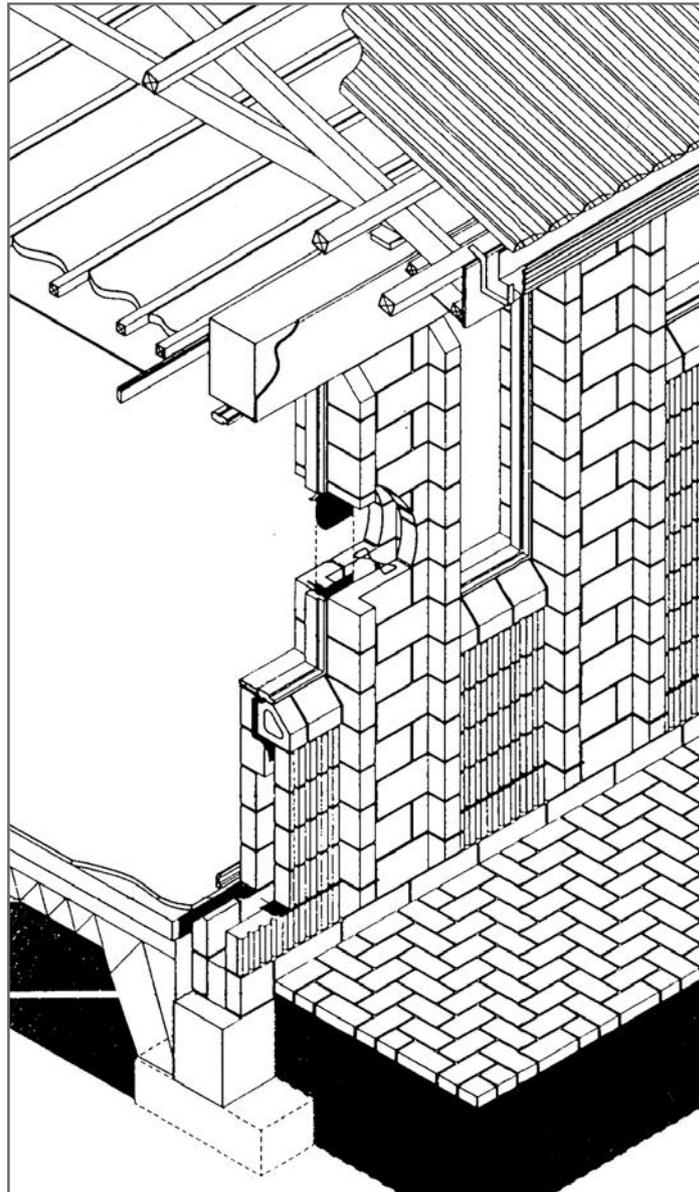
Tool vertical joints



Remove excess mortar burrs

GOOD DETAILING PRACTICE ILLUSTRATED

Drawing published with permission of Chief Architect: Chief Directorate Works, Provincial Administration of the Cape of Good Hope, Cape Town



6 SCHEDULE OF SITE CHECKS

SCHEDULE OF SITE CHECKS FOR CONCRETE MASONRY CONSTRUCTION

The check list is comprehensive in that it covers all aspects of concrete masonry construction. The extent of site checking will depend on the importance and consequences of failure of any aspect of construction.

1. MATERIAL

Item	Property to be checked	Test	Frequency * (applicable to non-SANS)	Notes
a) Concrete masonry unit	Compressive strength (minimum nominal compressive strength)	According to SANS 1215 Section 5.5 Compressive strength test	At pre-tender stage — (according to SANS consignment testing or sworn statement stating units comply with SANS 1215). During construction 10 units per 500m ² walling	Where specification requires SANS quality units contractor to provide proof at tender stage of quality of units to be used
	Drying shrinkage	According to SANS 1215 Section 5.6 Drying shrinkage test	At pre-tender stage — (according to SANS consignment testing or sworn statement stating units comply with SANS 1215) During construction 3 units per 1000m ² walling or when aggregates used are changed	SANS values: Normal 0,06% max. High shrinkage units 0,08% max. NHBRC HBM 0,06% max.
	Dimensions (tolerances)	According to SANS 1215 Section 5.3 Test for dimensions	At pre-tender stage — (according to SANS consignment testing or sworn statement stating units comply with SANS 1215) Weekly or when excessive deviation of dimensions suspected	SANS 1215 values of tolerances: Length +2-4mm Width +3-3mm Height +3-3mm
	Face, appearance and colour	Visual. Refer subsections 3.1.1; 3.1.2; 3.1.3 of SANS 1215	When significant changes noted	Important for face units. Retain three units of agreed colour and texture to serve as an example of the possible range of unit colour and texture

*Concrete masonry units which do not bear the SABS mark certifying compliance with SANS 1215 should be checked at frequency shown.

Most Concrete Manufacturers Association members manufacturing masonry units hold the SABS mark according to SANS 1215 Concrete masonry units.

Item	Property to be checked	Test	Frequency * (applicable to non-SANS)	Notes
<i>b) Common cement</i>	<i>General quality</i>	<i>See notes</i>	<i>See notes</i>	<i>Common cement sold in SA must bear SABS mark according to SANS 50197-1. Independent testing not necessary</i>
	<i>Contamination by moisture</i>	<i>Visual examination for lumps in cement</i>	<i>When contamination suspected</i>	<i>Cement contamination by water — during transport or storage on site. Refer cement manufacturer on possible testing</i>
	<i>Age of common cement at time of use</i>	<i>Check site records</i>	<i>Weekly</i>	<i>Cement to be used within 3 months of manufacture/delivery</i>
<i>c) Masonry cement</i>	<i>General quality</i>	<i>See notes</i>	<i>See notes</i>	<i>Masonry cements sold in SA must bear SABS mark for masonry cement SANS 50413-1</i>
	<i>Contamination by moisture</i>	<i>Visual examination for lumps in cement</i>	<i>When contamination suspected</i>	<i>Cement contamination by water — during transport or storage on site. Refer cement manufacturer on possible testing</i>
	<i>Age at time of use</i>	<i>Check site records</i>	<i>Weekly</i>	<i>Cement to be used within 3 months of manufacture/delivery</i>
<i>d) Lime</i>	<i>General quality</i>	<i>Tests as specified in SANS 523</i>		<i>Lime should comply with SANS 523 class A2P</i>
<i>e) Mortar sand</i>	<i>Grading</i>	<i>Sieve analysis</i>	<i>At commencement of contract and when changes are noted or once every 100m³</i>	<i>As per SANS 1090</i>
	<i>Contamination</i>	<i>Visual check on type and cleanliness</i>	<i>Daily</i>	
<i>f) Water</i>	<i>Purity as it affects setting and strength gain of cement</i>	<i>Test method SANS 10100-2</i>	<i>At beginning of contract and when contamination suspected</i>	<i>Municipal water need not be tested. Check borehole, farm dam and similar water</i>
<i>g) Admixtures (mortar plasticizers etc.)</i>	<i>General quality (check storage and shelf life of product not exceeded)</i>	<i>Obtain test certificate or quality statement on admixture by manufacturer</i>	<i>At beginning of contract</i>	<i>As per BS 4887 Check dosage rates as recommended by manufacturer</i>
<i>h) Reinforcement and wall ties (metal)</i>	<i>General quality</i>	<i>Obtain manufacturer's test certificate</i>	<i>At commencement of contract</i>	<i>Refer SANS 190, 920 and 1024; and 28</i>
	<i>Contamination (free from loose millscale and other coatings that will adversely affect bond, kinks and bends)</i>	<i>Visual check</i>	<i>Daily or at frequent intervals when being used</i>	
<i>i) Wall ties (non-metallic)</i>	<i>General quality</i>	<i>Obtain manufacturer's test certificate</i>	<i>At commencement of contract</i>	<i>Test for non-metallic ties specified in SANS 2001-CM1</i>

2. CONSTRUCTION

Item	Property to be checked	Test	Frequency * (applicable to non-SANS)	Notes
a) Setting out	Accuracy of setting out	Re-measurement	Before masonry laying commences	Refer SANS 2001-CM1. Preferable lay units to modular co-ordinating dimensions
b) Accuracy of building	Accuracy of building (plumb, line, level)	Measurement	At regular intervals or when inaccuracies in plumb, line and level noted	Refer SANS 2001-CM1. Three degrees of accuracy are given: Degree I is suitable for special work, Grade II and III is suitable for most other work.
c) Mortar	Materials used and mix proportions	Visual check on all ingredients. If sand quality uncertain a grading analysis is required. Check batching quantities.	Daily	Refer SANS 1090 for grading limits for mortar sands
	Mixing time and conditions of mixing equipment	Visual examination to check uniform distribution of ingredients in mix	Daily	Time of mixing depends on how ingredients mixed
	Consistency	Visual check	Daily	Consistency appropriate for suction of masonry units, rate of laying and vertical progress
	Retempering	Measurement of time interval between addition of water and use of mortar with masonry units (loss of workability)	When excessive retempering suspected	Mortar mixes to be used within 2 hours of mixing — in hot weather reduce to 1 hour. Retempering may change colour of pigmented mortars
	Compressive strength (only for structural masonry)	Cube tests (SANS test method 749)	3 cubes/150 m ² of masonry (structural masonry requirement)	Required for highly stressed masonry. Refer SANS 10164-1, Sections 6.1 and 6.2 and SANS 2001-CM1
	Colour	Visual examination	Daily	Important when colour of joints and uniformity of colour significant
d) Concrete masonry units	Moisture conditions at time of laying	Visual examination or test according to SANS 10145	Daily	Refer SANS 10145. Moisture content of units at time of laying (except in consistently high humidity area) should be dry, i.e. not wetted
	Quality/type of unit	Visual and refer to consignment delivery sheets	Daily	Check units are of right compressive strengths, size, profile, colour and texture
e) Laying	Mortar bedding: full or shell	Visual check	Daily	Hollow units should be laid with thicker shell uppermost, with shell bedding perpend joints filled to same depth as horizontal joints

Item	Property to be checked	Test	Frequency * (applicable to non-SANS)	Notes
e) Laying (cont)	Mortar stiffening	Thumb test to ensure mortar has not set before unit laid or when unit disturbed and relaid	When stiffening suspected	Bond between mortar and unit essential for strength and resistance to moisture penetration
	Joint profile	Visual check	Daily	Concave and weather struck best. Flush, raked and extruded, poorest in external walls. Retooling concave joints when mortar thumb-hard improves weather resistance
	Bond pattern (stretcher, stack or as specified)	Visual check	Daily	
	Bonding with a cross wall	Visual	Daily	Cross walls may be bonded with mesh or metal ties
	Permissible deviations in joint width	Measurement	Daily	Face work: bedding joints 10 mm ± 3mm; perpend joints 10mm — 5 + 10 for units complying with dimensional accuracy as per SANS 2001-CM1
	Mortar falling into cores and cavities	Visual	Daily	Mortar to be removed
	Visual appearance of face work. Smearing of face units with mortar	Visual	Daily	Mortar squeezed out joints should be lifted away from wall and not smeared into face of units
f) Reinforcement	Type, size and position, not contaminated in storage	Measurement	When used	Check against drawings and/or specification. Check cover to reinforcement
	Position in bedding joint	Measurement	When used	Brickforce to be placed in middle of joint thickness, reinforcement surrounded by mortar with adequate cover
	Position — vertical and/or horizontal in grouted or concrete filled cores	Measurement	When used	Refer drawings. Check vertical starter bars in foundation. Horizontal bars at least 25mm above or below mortar joint and fully embedded in grout/concrete and positively held in position
g) Cavity walls	Wall tie placing — horizontal and vertical	Measurement	Daily	Requirements Spacing: horizontal 600 mm, vertical 450 mm Type: butterfly or modified PWD. Cavity width: 50 -110 mm

Item	Property to be checked	Test	Frequency * (applicable to non-SANS)	Notes
g) Cavity walls (cont)	Wall tie in bedding joint	Measurement	Daily	Ensure wall tie bedded in mortar, slopes to exterior leaf and "drip" points downwards. Wall ties placed at right angles to the plane of the masonry
	Mortar droppings	Visual	Daily	Remove mortar droppings on wall ties and from cavity
h) Collar-jointed walls	Width of collar-joint and presence of crimp wall ties	Measurement and visual	Daily	Joint width 20 mm, - 5 + 10 mm. 5 crimp wire ties per m ²
i) Single-leaf — hollow units	Mortar droppings (note: shell bedding of mortar)	Visual (use mirror to assist)	Daily	Remove mortar from cores preferably through special cleanout blocks
j) Damp-proof courses	Position and shape in wall, sills and copings	Visual	When used	Refer drawing and/or specification
	Position in bedding joint	Visual	When used	dpc in middle of bedding mortar. To project 10mm from external face of wall and turned down
	Jointing of dpc's	Measurement	When used	Check lap required
	Hollow unit masonry	Visual	When used	dpcs over cores to be pierced and dpc depressed downwards
Weepholes	Position and size in bedding and perpend joint	Visual	When used	Refer drawing and/or specification
k) Lintels — masonry	Length of lintel (opening plus bearing lengths)	Measurement	When used	Refer drawings and/or specification. Lintel to be propped during construction and after
	Reinforcement, type size, position in lintel	Measurement	When used	Refer drawings and/or specifications
	Infill concrete	Mix proportions or concrete cube tests	When used	Refer drawings and/or specification
l) Lintels — precast prestressed concrete	Length of lintel (opening and bearing lengths)	Measurement	When used	Refer drawings and/or specification
	Orientation	Visual	When used	Reinforcement at bottom of lintel when placed
m) Control joints	Position and spacing	Measurement	When used	Refer drawings and/or specification
	Type	Visual and measurement	When used	Refer drawings and/or specification
	Width	Measurement	When used	Refer drawings and/or specification

Item	Property to be checked	Test	Frequency * (applicable to non-SANS)	Notes
<i>m) Control joints (cont)</i>	<i>Joint sealing</i>	<i>Check sealant and application on a backing</i>	<i>When used</i>	<i>Refer drawings and/or specification or manufacturer's instructions. Check if a primer must be used</i>
<i>n) Chasing for services</i>	<i>Position and size of chasing</i>	<i>Visual and measurement — check depth and width not excessive</i>	<i>When used</i>	<i>As indicated on drawings. Chasing tool to be used unless other methods permitted</i>
	<i>Chases in hollow units</i>	<i>Visual check on infill concrete — check width and depth not excessive</i>	<i>When used</i>	<i>Refer specification</i>
<i>o) Cleaning</i>	<i>Visual defects</i>	<i>Visual</i>	<i>When wall completed</i>	<i>Mortar smears on finished work removed by brushing. Clean first with water and fibre brush. Temporary holes in mortar joints filled</i>
<i>p) Protection against damage — completed work</i>	<i>Damage to wall after construction</i>	<i>Visual</i>	<i>Daily</i>	<i>Damage or disfigurement due to subsequent building operations</i>
<i>q) Protection against damage — new work</i>	<i>Damage to wall during construction</i>	<i>Visual</i>	<i>Daily</i>	<i>Tops of constructed walls protected from rain and in addition fair-faced work protected against staining from construction activities. Walls to be braced against wind and earth back-fill forces where necessary</i>
<i>r) Painting/ plastering</i>	<i>Condition of surface to be painted/ plastered</i>	<i>Visual</i>	<i>Before painting/ plastering commences</i>	<i>Surfaces of walls dry and cleaned down to remove all, dust and dirt and mortar dabs. Efflorescence removed with stiff brush or cloth</i>
<i>s) Anchoring of roofs</i>	<i>Heavy or light roof</i>	<i>Check length of anchorage</i>	<i>When used</i>	<i>Heavy roofs 300mm, light roofs 600mm</i>

ACCURACY IN BUILDING

1. Compliance with the requirements (SANS 2001-CM1)

1.1. Permissible deviations

1.1.1. Degree of accuracy

The permissible deviations in masonry shall be in accordance with table 6.1 for a degree of accuracy II, unless otherwise specified in the specification data.

1.1.2. Methods of measurement of deviations

1.1.2.1 Any deviation from flatness of a plane surface or any abrupt change in a continuous surface shall be measured as the maximum deviation of the surface from any straight line of length 3m joining two points on the surface, determined by means of a straight edge, the ends of which are supported on identical blocks of suitable thickness placed over each of the points.

1.1.2.2 Out of squareness of a corner or of an opening or of an element shall be measured by taking the longer of two adjacent sides of the base line, and determining any departure from the perpendicular of the side at either end of the base line.

Table 6.1 Permissible deviations in masonry work

Description	Permissible deviation (pd) mm		
	Degree of accuracy		
	III	II	I
1. Surfaces of supporting elements	-30, +15	-20, +10	-10, +5
2. Position on plan of any edge or surface measured from the nearest grid line or agreed centre line	30	20	10
3. Level (deviation from designed level with reference to the nearest transferred datum of the average top surface on an element)	-20, +10	-15, +5	-10, 0
4. Linear dimensions:			
a) Bed joint thickness (nominal)	±5	±5	±3
b) Perpend joint thickness	-5, +10	-5, +10	-5, +10
c) Collar joint thickness	-5, +10	-5, +10	-5, +10
d) Cavity Width	20	20	15
e) Cross section of an unrendered wall of column or beam	-10, +20	-10, +20	-5, +15
f) Infill concrete spaces	-10, +15	-10, +15	-5, +10
g) Length:			
• ≤ 5m	25	15	10
• > 5m; but ≤ 10m	30	20	15
• > 10m	50	30	20
h) Height:			
• ≤ 3m	15	10	5
• > 3m; but ≤ 6m	20	15	15
• > 6m	25	20	20

Description	Permissible deviation (pd) mm		
	Degree of accuracy		
	III	II	I
5. Variations from plane: a) Bed joints; • in any 3m length • maximum b) Top surface of load-bearing walls: • in any 3 length • maximum	5 15	5 15	5 10
6. Relative displacement between walls which carry vertical loads in addition to their own self-weight in adjacent storeys intended to be in vertical alignment	15	15	15
7. Deviation from straight line a) In any direction: • In any 5m length • Maximum over length of element/structure b) From the vertical: • In any 1m length • In any 3m length • Maximum over length of element/structure c) Centre line of perpend joints: • Face masonry • Non-facing masonry	15 25	10 20	10 15
8. Out of squareness of a corner or an opening or an element, such as a column for short side length: • $\leq 0,5m$ • $>0,5m$; but $\leq 2m$ • $>2m$; but $\leq 4m$	10 20 25	5 15 20	3 10 15
9. Placement of reinforcement: a) Distance from the centre line of reinforcement to the opposite face of masonry: • $<200mm$ • $>200mm$ but $<600mm$ • $>600mm$ b) Longitudinal spacing of vertical bars in walls	12 25 32 50	12 25 32 50	12 25 32 50
	Permissible deviation %		
10. Constituents in mortar mix (quantities from trial or prescribed mix)	5	5	5

7 QUANTITIES

The tables that follow are designed to assist in calculating the quantities of materials required to construct concrete masonry walls.

QUANTITIES OF MASONRY UNITS AND MORTAR

Table 7.1 Quantities of masonry units and mortar

Masonry unit size, mm			Masonry units per m ²	Mortar, m ³ per	
Length, l	Width, w	Height, h		1000 units	100m ² walling
190	90	90	50	0,27	1,35
190	190	90	50	0,57	2,85
222	90	73	52	0,29	1,48
222	106	73	52	0,34	1,74
290	90	90	33,4	0,36	1,20
290	90	140	22,3	0,41	0,90
290	140	90	33,4	0,56	1,87
290	140	140	22,3	0,63	1,40
390	90	90	25	0,45	1,13
390	90	190	12,5	0,54	0,68
390	140	90	25	0,70	1,75
390	140	140	16,7	0,77	1,29
390	140	190	12,5	0,84	1,05
390	190	90	25	0,95	2,38
390	190	190	12,5	1,14	1,43
440	90	190	11,2	0,59	0,65
440	140	190	11,2	0,91	1,02
440	190	190	11,2	1,24	1,38
440	110	220	9,7	0,75	0,73
440	220	220	9,7	1,50	1,45

The dimensions of units given in Table 7.1 are those of the commonly manufactured sizes.

Note 1: The table is based on exact sizes of solid masonry units, with 10 mm thick bedding and vertical joints, and no wastage.

Note 2: No allowance is made for:

- undersized units
- hollow units
- units with perforations or holes
- units with one or two frogs
- bedding and vertical joints thicker than 10 mm
- wastage
- site-mixed against ready-mixed mortar.

Note 3: Adjustment of mortar quantities given in Table 7.1 to allow for the above factors:

- For all mixes multiply mortar quantities by 2 for excellent control on site by 3 for average control on site

(Above factors based on many observations of quantities used).

- For hollow units where units laid in shell bedding, reduce mortar quantities by:

width of units, mm	% reduction
90 - 110	20
140	30
190 - 220	40

- For units with perforations or holes increase mortar quantities by 15%

- For units with frogs; frog laid face up (as required for structural walls), increase mortar quantities by 15%
- Once the above adjustments have been made: for mortar ready-mixed and delivered into watertight containers on site, reduce quantities by 20% as against site-mixed mortar.

Note 4: Adjustment of masonry unit quantities for size variation

- For under- or oversized units: Measure dimensions of 10 units and use the average for calculating the number of units per m².

Note 5: Quantities to be reduced by areas of wall occupied by openings such as doors, windows, airconditioning units etc. Refer to Form A for calculation of masonry units required. (page 105)

Basis for Table 7.1 Quantities of masonry units and mortar

$$\text{No. of units/m}^2 = \frac{1}{(l + 0,01)(h + 0,01)} = x \text{ (No.)}$$

$$\text{Mortar/1000 units} = 1000[l + 0,01 + h + 0,01] w.t = y \text{ (m}^3\text{)}$$

$$\text{Mortar/100m}^2 = \frac{xy(\text{m}^3)}{10}$$

where l, w, h are the work sizes of length, width and height of the masonry units and t the thickness of the mortar joints all measured in metres.

MORTAR MIX QUANTITIES OF MATERIALS

Table 7.2 Quantities of materials for mortar (not including wastage)

Mortar Class	Per 50 kg bag				Per cubic metre			
	Sand (damp & loose)		Cement	Lime	Sand (damp & loose)		Cement	Lime
	kg ⁺	l [*]	kg	l	kg ⁺	m ³ *	kg	l
Class I								
common cement only	160	130	50	0	1330	1,08	420	0
with lime added	160	130	50	10	1260	1,02	390	80
masonry cement	120	100	50	0	1150	0,96	480	0
Class II								
common cement only	250	200	50	0	1440	1,15	290	0
with lime added	250	200	50	40	1290	1,03	260	210
masonry cement	210	170	50	0	1310	1,06	310	0

* Sand measured loose and damp

+ Mass increased by 5% to allow for moisture in the sand

Table 7.2 provided by the Cement & Concrete Institute is based on the following data:

Relative densities:

Common cement	3,1
Lime	2,35
Masonry cement (MC 12,5)	3,08
Sand	2,60

Loose bulk densities, kg/m³:

Lime	700
Sand (dry)	1400
Sand (damp) 5% moisture (20% bulking)	1230

Water content, kg/m³ (total, sand dry):

Common cement + sand	350
Common cement + lime + sand	360
Masonry cement (MC12,5 only) + sand	330

Air content, %:

Common cement + sand	4
Common cement + lime + sand	4
Masonry cement (MC12,5) + sand	10

EXAMPLES OF CALCULATIONS FOR MASONRY UNITS AND MORTAR IN A WALL

Example 1

A 190 mm boundary wall, 80m long x 2m high using 390 x 190 x 190 2-core hollow blocks, with class II mortar, common cement and lime is to be built by an experienced builder.

Calculation of quantities

Area of wall $80 \times 2 = 160\text{m}^2$
 Number of blocks/ $\text{m}^2 = 12,5$
 Total number of blocks $= 12,5 \times 160 = 2000$
 No allowance for breakage in transporting and handling — normally between 2,5 and 5%
 Allow 5% breakages
 Order blocks $= 2000 \times 1,05 = 2100$
 From Table 7.1 $1,43\text{m}^3$ mortar required for 100m^2 walling without any adjustment for on-site factor, i.e.
 $\frac{160}{100} \times 1,43 = 2,29 \text{m}^3$

Material	Mortar required for 160m^2 walling			Order
	Nett quantities from Table 7.2	Quantities experienced builder x 2	Quantities adjusted for hollow units 40% reduction	
Common cement, kg	$2,29 \times 250 = 572,50$	1145	687	14 bags of 50kg
Lime, l	$2,29 \times 200 = 458,00$	916	549,6	22 bags of 25kg
Sand, m^3	$2,29 \times 1,01 = 2,32$	4,64	2,79	3m^3

Note: Lime packaged in 25 kg bags has a volume of approximately 40l when measured loose.

Example 2

A 230 wall collar jointed using $222 \times 106 \times 73$ solid bricks with frog one side only using class II ready-mixed mortar with common cement (no lime - ready mix supplier will use a retarder and maybe some mortar plasticizers which may affect quantities) using an experienced builder. Calculation of quantities per 100m^2 walling required for estimating only. Ready-mixed mortar to be pumped into containers on scaffolding ready for use by layers

Calculation of quantities

Bricks/ m^2 (x2) $= 52 \times 2 = 104$ (No)
 Mortar 100m^2 (x2) $= 1,74 \times 2 = 3,54\text{m}^3$
 Mortar for 10mm collar joint, $100\text{m}^2 = 100 \times 0,01 = 1,00\text{m}^3$
 Total mortar required, $100\text{m}^2 = 4,54\text{m}^3$
 From Table 7.2 material quantities are given.

Material	Mortar required for 100m^2 walling				Estimating quantities
	Nett quantities	Adjustment experienced builder x 2	Adjustment for frog x 1.15	Adjustment for ready mixed mortar -20%	
Common cement, kg	$4,54 \times 290 = 1317$	2 634	3 029	2 423	49 bags of 50 kg*
Sand, kg	$4,54 \times 1440 = 6538$	13 076	15 037	12 030	12,1t

* Bulk cement prices may be used for estimating costs, then use 2423 kg

Example 3

190 double leaf collar jointed wall using 190 x 90 x 90 solid bricks (no frog) using a class II mortar with masonry cement with an inexperienced builder. Quantities for 20 000 bricks required.

Bricks = 20 000
 Mortar/1000 bricks = 0,27m³
 Mortar for 10mm collar joint
 Area covered by 1000 bricks -one leaf only = $\frac{1000}{50} = 20\text{m}^2$
 Mortar for collar joint wall/ 1000 bricks = $20 \times 0.01 = 0,2\text{m}^3$
 Mortar for 20 000 bricks i.e 10 000 bricks in each leaf
 = $(0,27 \times 2 + 0,2) \frac{10\ 000}{1\ 000} = (0,54 + 0,2) 10 = 7,4\text{m}^3$
 From Table 7.2 material quantities are given.

Material	Mortar required for 20 000 bricks		
	Nett quantities	Adjustment for inexperienced builder x 3	Order
Masonry cement, kg	7,4 x 310 = 2300	6900	173 bags of 40 kg
Sand, m ³	7,4 x 1,06 = 7.9	24	24 m ³

A measurement of 10 bricks showed average size to be 187 x 87 x 87 (lower limit of acceptable sizes)
 Allow 5% for breakages on site (units not delivered on pallets)

Brick order = $20\ 000 \times \frac{190 \times 90}{187 \times 87} \times 1,05 = 22\ 072$ say 22 000 bricks.

Table 7.3 Calculated mass per m² face area: hollow (2 core) and solid concrete masonry walls including mortar
 (masonry density 2 200 kg/m³)

Manufacturing dimensions		Manufactured width of wall units, mm		
Length, mm	Height, mm	190	140	90
		Mass of wall per m2 face area, kg/m ²		
390	190 solid	390	285	185
390	190 hollow	200	160	130

As core volume and the properties of materials may vary, figures should be checked against the masonry units, mortar and core filling grout (if any) actually used.

Note:

Density of materials:
 concrete masonry: 2200kg/m³
 mortar: 2100kg/m³

Table 7.4 Percentage of solid material in hollow units:

Manufacturing thickness (mm)	Percentage solid	
190	51	The values shown are based on the minimum practical shell and web thicknesses used in manufacture
140	50	
90	66	

FORM A

Calculation of number of units required

Gross area of wall	m ²
Openings (deduct)	m ²
Net area of wall	m ²
Corners (deduct) $\frac{(No)^* \times (ht)^* \times (t)^*}{1000}$	m ²
Net area of masonry	m ²
Face dimensions of unit	mm
No. of units per 100m ² (Table 7.1)	

Total No. of Units

* No = Number of corners. *ht = Wall height in m. *t = Wall thickness in mm.

Deductions (special units)

Unit	Number of Units	
	Full	Half
Corner		
Lintel		
Sash/Jamb		
Control joint		
Other		
Total		

Total deduction in stretcher units

Net number of stretcher units

Calculation of quantity of mortar required

Net area of masonry	m ²
Manufacturing dimensions of unit (l x w x h)	mm
Quantity of mortar per 100 m ² (from Table 7.1)	m ³
Total quantity of mortar	m³

APPENDIX

STANDARDS, CODES OF PRACTICE AND REFERENCES ON THE MANUFACTURE AND USE OF CONCRETE MASONRY

MANUFACTURE OF CONCRETE MASONRY UNITS

SANS 1215 - 1984 (2004) Concrete masonry units
Lane J. W. The manufacture of concrete masonry units

MATERIALS OF MANUFACTURE

Cement

SANS 50197-1: 2000 Part 1. Cement. Part 1. Composition, specification and conformity criteria for common cements

SANS 50413-1: 2004 Masonry cements. Part 1. Specification

Aggregates

SANS 794 - 2002 Aggregates of low density

SANS 1083 - 2002 Aggregates from natural sources - Aggregates for concrete

Cement and Concrete Institute Commentary on SANS 1083 - 1994. Aggregates from natural sources. Aggregates for concrete

SANS 1090 - 1996 Aggregates from natural sources - Fine aggregates for plaster and mortar

USE OF MASONRY UNITS

Planning design and specification

SANS 993 - 1972 (2002) Modular co-ordination in building

SANS 10021 - 2002 Waterproofing of buildings

SANS 10155 - 2000 Accuracy in buildings

SANS 10249 - 2000 Masonry walling

NBRI R/Bou 602 Fire resistance ratings - walls constructed of concrete blocks

Building regulations

National Building Regulations and Building Standards Act 1987 revised 1990

SANS 10400 - 1990 (2007) Application of the National Building Regulations

SANS 10401 - 1989 The construction of dwelling house in accordance with the National Building Regulations

National Home Builders Registration Council's Home Building Manual, 1999

The Joint Structural Division of The South African Institution of Civil Engineering and The Institution of Structural Engineers. Code of practice. Foundations and superstructures for single-storey residential buildings of masonry construction. 1995

STRUCTURAL DESIGN

SANS 10100: Part 1 - 2002 The structural use of concrete Part 1 : Design

SANS 10100 - 1992 The structural use of concrete Part 2: Materials and execution of work

SANS 10160 - 1989 The general procedures and loadings to be adopted for the design of buildings

SANS 10161 - 1980 The design of foundations for buildings

SANS 10164: Part 1 - 2000 The structural use of masonry Part 1 - unreinforced masonry walling

SANS 10164: Part 2 - 2003 Part 2 - reinforced and prestressed masonry

SANS 1504 - 1990 Prestressed concrete lintels

The Joint Structural Division of The South African Institution of Civil Engineers and The Institution of Structural Engineers. Checklist for structural design.

Crofts F.S; Lane J.W. Structural concrete masonry. A design guide, 2000

CONCRETE MASONRY CONSTRUCTION

SANS 10145 - 2000 Concrete masonry construction

SANS 10249 - 1993 Masonry walling

CONSTRUCTION WORKS

<i>SANS 2001-CM1</i>	<i>Masonry walling</i>
<i>SANS 2001-CM2</i>	<i>Strip footings, pad footings and slab-on-the-ground foundations for masonry walling</i>
<i>SANS 2001-CG2</i>	<i>Concrete works (minor works)</i>
<i>SANS 2001-EM1</i>	<i>Cement plaster</i>

MATERIALS OF CONSTRUCTION

<i>Cement</i>	<i>As above</i>
Lime	
<i>SANS 523 - 2002</i>	<i>Limes for use in building</i>
Sand	
<i>SANS 1090 - 2002</i>	<i>Aggregates from natural sources - Fine aggregate for plaster and mortar</i>
Wall ties	
<i>SANS 28 - 1986</i>	<i>Metal ties for cavity walls</i>
Damp-proof courses	
<i>SANS 248 - 1973 (2002)</i>	<i>Bituminous damp-proof course</i>
<i>SANS 298 - 1975 (1999)</i>	<i>Mastic asphalt for damp-proofing courses and tanking</i>
<i>SANS 952 - 1985 (2000)</i>	<i>Polyolefin film for damp-proofing and waterproofing in buildings</i>
Lintels	
<i>SANS 1504 - 1990 (2002)</i>	<i>Prestressed concrete lintels</i>

REINFORCEMENT

<i>SANS 190 - Part 2: 1984 (2001)</i>	<i>Expanded metal. Part 2: Building products</i>
<i>SANS 920 - 1985 (2002)</i>	<i>Steel bars for concrete reinforcement</i>
<i>SANS 1024 - 1991</i>	<i>Welded steel fabric for reinforcement of concrete</i>

SEALANTS

<i>SANS 110 - 1973 (2001)</i>	<i>Sealing compounds for the building industry, two component, polysulphide base</i>
<i>SANS 1077 - 1984 (2001)</i>	<i>Sealing compound for the building and construction industry, two-component, polyurethane base</i>
<i>SANS 1305 - 1980 (2001)</i>	<i>Sealing compounds for the building industry, one component, silicone - rubber base</i>

USEFUL BRITISH STANDARDS

<i>BS EN 12878 -1999</i>	<i>Pigments for portland cement and portland cement products</i>
<i>BS 4551-1 - 1998</i>	<i>Methods of testing mortars, screeds and plasters</i>
<i>BS 4551-2 -1998</i>	<i>Methods of testing mortars screeds and plaster. Chemical analysis and aggregate grading</i>
<i>BS EN 934-3 - 2003</i>	<i>Admixtures for concrete, mortar and grout. Admixtures for masonry mortar. Definitions, requirements, conformity, marking and labelling.</i>

CONCRETE MANUFACTURERS ASSOCIATION PUBLICATIONS

<i>DETAILING OF CONCRETE MASONRY:</i>	<i>Volume 1 Solid Units - 140</i>
	<i>Volume 2 Hollow Units - 140/190</i>
	<i>Volume 3 Cavity Wall - 240/290</i>
<i>FREE-STANDING WALLS</i>	<i>Design guide</i>
	<i>Technical Note: Unreinforced/Reinforced</i>
<i>LINTELS</i>	<i>Design guide</i>
	<i>Technical note</i>
<i>BUILDING YOUR HOUSE - STEP BY STEP - WITH BUILDING PLANS</i>	

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MASONRY PRODUCER MEMBERS (MAY 2011)

<i>A Fick Cement Works</i>	<i>022 913 1921</i>
<i>Bafokeng Technicrete</i>	<i>014 538 0818</i>
<i>Boland Concrete</i>	<i>021 875 5365</i>
<i>Brick & Concrete Industries (Namibia)</i>	<i>00264 61 321 3000</i>
<i>Brickcast Industries cc</i>	<i>031 5075525</i>
<i>Cape Brick cc</i>	<i>021 511 2006</i>
<i>Columbia DBL</i>	<i>021 905 1665</i>
<i>Deranco Blocks</i>	<i>041 463 3338</i>
<i>Inca Concrete Products</i>	<i>021 904 1620</i>
<i>Inca Masonry Products</i>	<i>043 745 1215</i>
<i>Lategan's Cement Works</i>	<i>021 873 1154</i>
<i>Neat Contech</i>	<i>046 624 3377</i>
<i>Panda, Botswana</i>	<i>00267 244 2106</i>
<i>Stanger Brick & Tile</i>	<i>032 457 0237</i>
<i>Technicrete</i>	<i>011 674 6900</i>
<i>Watston Concrete</i>	<i>011 740 0910</i>
<i>West End Cement Bricks</i>	<i>011 851 1098</i>
<i>Western Granite</i>	<i>021 904 1620</i>

Members list above correct at the time of going to print.

DETAILING OF CONCRETE MASONRY

Volume 1 - Solid Units 140mm



Concrete masonry:
Strong, durable and attractive



DETAILING OF CONCRETE MASONRY

Volume 2 - Hollow Units 140/190



Concrete masonry:
Strong, durable and attractive



DETAILING OF CONCRETE MASONRY

Volume 3 - Cavity Walls 240 to 290



Concrete masonry: Strong,
durable and attractive



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