CHAPTER 2: Materials

CONTENTS

FUNCTIONAL REQUIREMENTS

2.1 TIMBER

Workmanship

i. All workmanship must be within the tolerances defined in Chapter 1 of this Manual.
ii. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

i. All materials should be stored correctly in a manner that will not cause damage or deterioration of the product.
ii. All materials, products and building systems shall be appropriate and suitable for their intended purpose.
iii. External timber should be adequately treated or finished to resist insect attacks. Timber treatment should be in accordance with relevant British Standards and Codes of Practice.
iv. The structure shall, unless specifically agreed otherwise with the Warranty provider, have a life of not less than 60 years. Individual components and assemblies, not integral to the structure, may have a lesser durability, but not in any circumstances less than 15 years.
v. Timber used in the dwelling to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.

Design

i. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
ii. Structural elements outside the parameters of regional Approved Documents must be supported by structural calculations provided by a suitably qualified expert.
iii. The materials used for construction must meet the relevant Building Regulations, Eurocodes and other statutory requirements.
iv. Specialist works must be provided and supported by structural calculations completed by a suitably qualified Engineer where necessary.
v. Any engineered beams/posts manufactured off-site must have structural calculations endorsed by the manufacturer.

2.1.1 Storage

Timber should be stored correctly to ensure it does not deteriorate. It should be kept dry and covered in cold conditions to prevent surface freezing, and should be kept off the ground and spaced to allow air to move around freely. Timber should be kept flat to prevent warping or twisting.

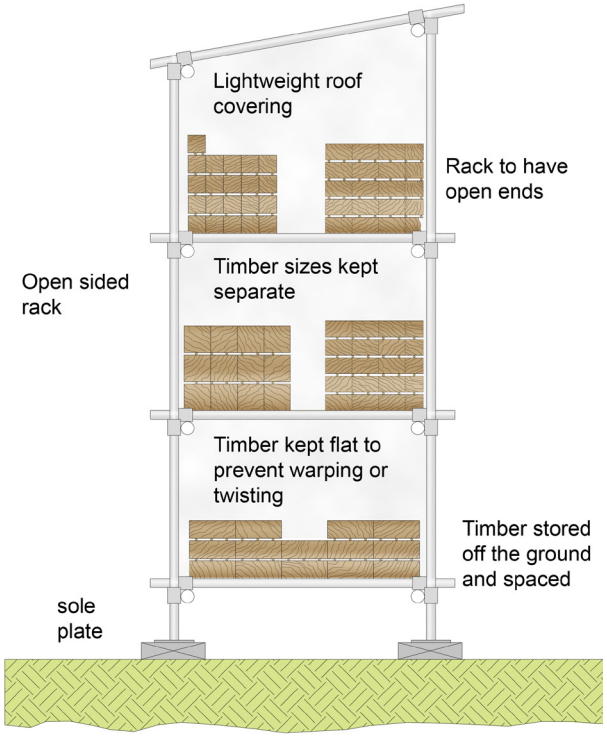

Figure 1: Storage of timber on-site

2.1.2 Timber durability

Timber should be appropriately treated to resist insect attacks. Some timber species have a natural ability to resist attack; Table 1 identifies various species of timber and whether treatment is required.

2.1.3 Timber grading

Timber should be of the appropriate strength classification in order to meet its design intention. For timber that is to be used for structural purposes, e.g. floor joists, rafters and ceiling joists, the strength classification should be assumed to be C16 unless it is appropriately stamped with its specific strength classification.

Durability class	Timber type	Species	Variety	Typical strength grade*
Very durable	Softwood	None		
	Hardwood	Opepe		D50
		Padauk-Andaman		N/A
		Afromosia		N/A
		Greenheart		D70
		Guarea		N/A
		Iroko		D40
		Jarrah		D40
		Okan		N/A
		Pyinkado		N/A
		Teak	Malaysian	D40
		Kapur	Sabah	D60
			Burma	D60
		Padauk	White	N/A
		Peroba		N/A
Durable	Softwood	Cedar	Western Red (non-UK)	C18
	Hardwood	Besralocus		N/A
		Ekki		D70
		Chestnut	Sweet	N/A
		Karri Kampas		D50
		Louro	Red	N/A
		Oak	American White	D50
			European	D30
		Mahogany	American	N/A
Moderately durable	Softwood	Pine	Caribbean Pitch	C24
			American Pitch	N/A
		Cedar	Western Red (UK)	C18
		Fir	Douglas (North America)	C16-C24
			Douglas (UK)	C18
			Dunkeld (UK)	N/A
		Larch	European	C16-C30
			Hybrid	C16-C30
			Japanese	C16-C30
			Tamarack	C16-C30
			Western	C16-C30
			Maritime	C16-C30
	Hardwood	Keruing	Sabah	D50
			Malaysian	D50
		Oak	Tasmanian	N/A
			Turkey	N/A
		Mahogany	African	N/A
Slightly durable	Softwood	Fir	Noble	C16-C24
			Silver	C16-C24
			Balsam	C16-C24
			Grand	C16-C24
		Pine	Canadian Red	C16
			Corsican	C16
			Jack	C16
			Parana	C16
			Ponderosa	C16
			Radiata	C16
			Scots	C16-C24
			Southern	C16-C30
			Western White	C16
			Yellow	N/A
			Lodgepole	N/A
		Redwood	European	C16-C24
		Hem-fir	USA and Canada	C16-C24
		Spruce	Eastern Canadian	C16
			Engelmann	C16
			European (whitewood)	C16
			Sitka	C16
			Western White	C16
		Spruce-pine-fir	Canada	C16-C24
	Hardwood	Elm	Dutch	N/A
			English	N/A
			White	N/A
			Rock	N/A
			Wych	N/A
		Oak	American Red	D40
		Beech	Silver	D35-D40
Not durable	Softwood	None		
	Hardwood	Alder		N/A
		Beech	European	D35-D40
		Birch	Silver	N/A
			European	N/A
			Paper	N/A
			Yellow	N/A
		Chestnut	European Horse	N/A
		Lime		N/A
		Sycamore		N/A

*** Denotes typical strength grade and is for guidance purposes only.**

Table 1: Characteristics of timber species

2.1.4 Timber treatment

Timber should ideally be preserved in a factory environment; it is accepted, however, that this is not always possible. Timber treatments should be approved according to the relevant Code of Practice or British Standard, or have third-party accreditation. Careful consideration should be given to Health and Safety when applying timber treatment products. It is important that any pre-treated timber be re-treated if it is cut to expose untreated end grain. The treatment should be coloured so it can be proven that the end grain has been treated.

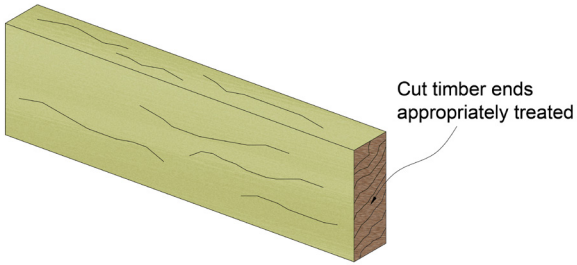

Figure 2: Pre-treated timber exposing untreated end grain

2.1.5 Metal fixings

Metal components should be galvanised where they are to be fixed or used adjacent to treated timber.

2.1.6 Standards referred to

- BS EN 1912: 2004+A4: 2010 Structural timber-strength classes – Assignment of visual grade and species
- BS EN 1995 1 1: 2004 & 2008 Eurocode Design of timber structures
- BS EN 5999-Part 1 – Durability of wood and wood-based products

FUNCTIONAL REQUIREMENTS

2.2 CONCRETE

Workmanship

i. All workmanship must be within the tolerances defined in Chapter 1 of this Manual.
ii. All work is to be carried out by a technically competent person in a workmanlike manner.
iii. Concreting shall not take place during cold weather periods or where ground conditions are frozen.

Materials

i. All materials should be stored correctly in a manner that will not cause damage or deterioration of the product.
ii. All materials, products and building systems shall be appropriate and suitable for their intended purpose.
iii. The structure shall, unless specifically agreed otherwise with the Warranty provider, have a life of not less than 60 years. Individual components and assemblies, not integral to the structure, may have a lesser durability, but not in any circumstances less than 15 years.

Design

i. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
ii. Structural elements outside the parameters of regional Approved Documents must be supported by structural calculations provided by a suitably qualified expert.
iii. The materials used for construction must meet the relevant Building Regulations, Eurocodes and other statutory requirements.
iv. Reinforced concrete elements must be supported by structural calculations and details produced by a suitably qualified Structural Engineer.
v. Precast structural elements must have structural calculations that prove their adequacy, as endorsed by the manufacturer.

2.2.1 Cold weather working

To meet the Functional Requirements of this Chapter, the minimum working temperature should not fall below 2°C. It is important that during cold weather periods, regular temperature readings should be taken. Thermometers should be placed away from direct sunlight, preferably in a shaded area. When assessing the temperature, it is also important to consider wind chill and weather exposure, and make the necessary allowances for sites that have a higher level of exposure.

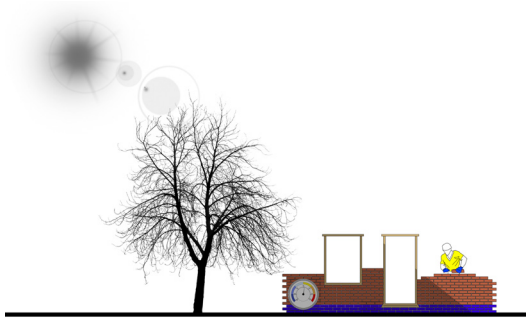

Figure 3: Cold weather working

2.2.2 Ready mixed concrete

It is a requirement of BS 8500 and BS EN 206-1 that the temperature of fresh concrete shall not be below 5°C at the time of delivery. Measures should also be put in place to ensure immature concrete is prevented from freezing before sufficient strength has been achieved.

2.2.3 Site mixed concrete

Site mixing is acceptable at low temperatures, provided:

- The minimum temperature is no less than 2°C.
- The concrete is appropriately protected during curing.
- Ground conditions are not frozen.

2.2.4 Concreting of foundations and oversite

Concrete should not be poured if the ground is frozen; frozen ground can change in stability and volume during thawing, and therefore may cause damage to the recently poured concrete.

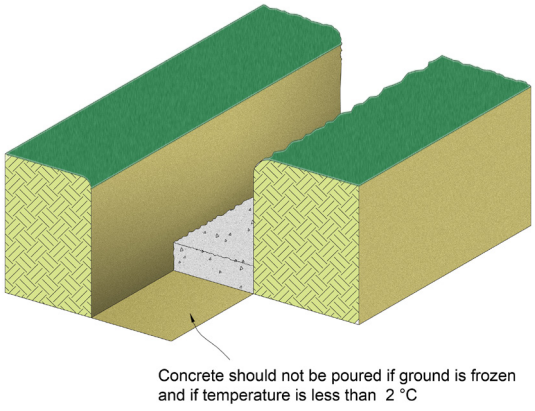

Figure 4: Concrete pouring in cold weather conditions

During cold weather, it may be appropriate to cover the ground to prevent freezing and, in some extreme cases, heating of the ground may be required.

Other concreting: Concrete reinforcing and formwork should not be frozen and be free from snow and ice.

2.2.5 Curing of concrete

Concrete may take longer to cure in cold conditions, and an additional six days may be required in extreme cases. Concrete may be covered with a rigid insulation to prevent freezing during curing periods. This is particularly useful for oversized slabs.

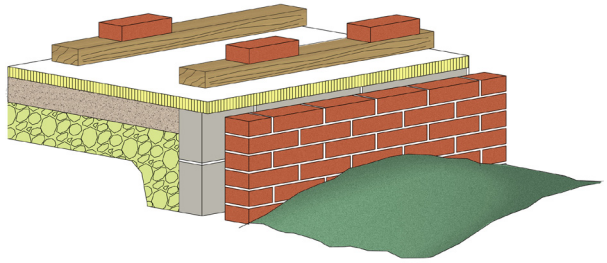

Figure 5: Concrete curing in cold weather conditions

2.2.6 Concrete suitability

Concrete of the appropriate durability and strength should be used in all circumstances. Table 2 gives details of the correct concrete for varying applications.

Application	Ready mixed concrete	Site mixed concrete	Consistence class
Substructure Blinding (unreinforced) Backfilling	GEN1	N/A	S3
Substructure (unreinforced) Structural blinding Strip, trench and mass filled foundations Concreting of cavity walls to ground level	GEN1	N/A	S3 / S4
Floor (dwellings unreinforced and unsuspended) With screed added or other floor finish Floor slab as finish (e.g. power float)	 GEN1 GEN2	 N/A N/A	 S2 S2
Garage floors (unreinforced and unsuspended)	GEN3	N/A	S2
Reinforced slabs (dwellings and garages suspended or unsuspended)	RC35	N/A	S2
Superstructure	As specified by a Structural Engineer	N/A	As specified by a Structural Engineer
External works Pathways Bedding for paving slabs	 PAV1 GEN1	 ST5 ST1	 S2 S1

Table 2: Concrete suitability

2.2.7 Concrete mixes

2.2.7.1 Ready mixed concrete

Concrete must be mixed using the correct proportions of cement, sand, aggregate and water. Ready mixed concrete should be delivered as close as possible to the site works and should be poured immediately to prevent settlement or separation of the mix. Ideally, ready mixed concrete should be poured within two hours of the initial mixing at the concrete plant.

Ready mixed concrete should only be sourced from a supplier who has a quality control system in place to ensure the correct standard of concrete is delivered. The quality control scheme should be either QSRMC (Quality Scheme for Ready Mixed Concrete) or a relevant British Standard Kite mark scheme.

It is important to pass all design specifications of the concrete to the ready mixed supplier to ensure that the delivered concrete meets the design intention.

Delivery notes should be kept and made available for inspection if required.

Additional water should not be added to the concrete on-site; nor should the ready mixed concrete be poured into water-filled trenches unless the concrete has been specifically designed for this purpose.

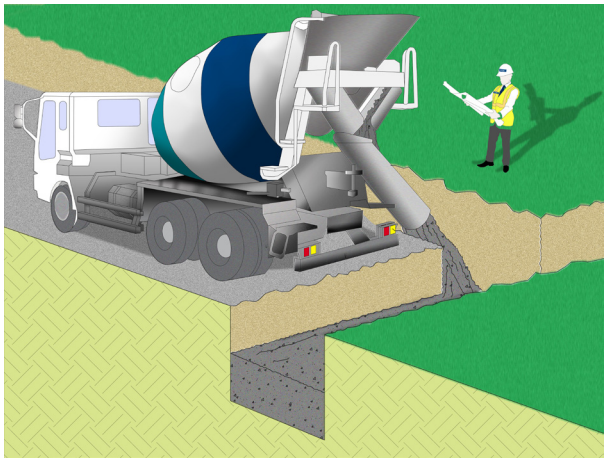

Figure 6: Ready mixed concrete

2.2.7.2 Site mixed concrete

Site mixed concrete should generally be avoided unless it is for non-structural applications, e.g. backfilling or bedding of paving slabs, etc. There may be exceptional circumstances where site mixing is unavoidable. Where this is the case, extra caution must be taken to ensure that the correct mix proportion is used; delivery notes should be provided if necessary, and a provision for testing may be required.

2.2.8 Reinforcing

Reinforcing bars and mesh should be clean and free from loose rust and any other contaminants that may cause deterioration of the reinforcing material or the durability of the concrete.

Reinforcing bars and mesh should be placed in accordance with structural drawings; bars that are to be bent should be done so using the correct tools for the job.

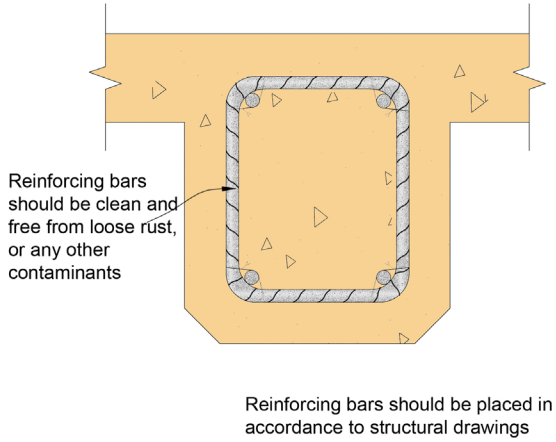

Figure 7: Reinforcing bars in concrete beam

Reinforcing bars should be correctly positioned, ensuring there is appropriate concrete cover, and reinforcing mesh placed in the right direction (main bars parallel to span).

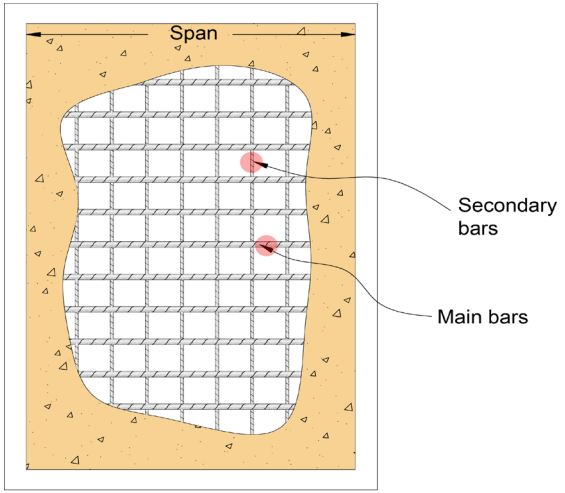

Figure 8: Position of bars on reinforced concrete slab

2.2.8.1 Reinforcing cover

An appropriate level of concrete cover should be provided to the reinforcing; the cover thickness will depend on the exposure of the concrete and its application. Concrete cover should be specified by a qualified Structural Engineer, or alternatively by using Table 3.

Application (concrete position)	Minimum cover (mm)
Concrete in direct contact with the ground	75
All external applications e.g. shuttered walling	50
Floor slabs and other applications where concrete is cast onto a membrane	40
Concrete over blinding concrete	40
Internal conditions	25

Table 3: Minimum concrete reinforcing cover

Reinforcing should be supported by proprietary chairs or spacers, and can be made of concrete, plastic or steel. The thickness and depth of a concrete spacer should not exceed 50mm x 50mm. Spacers should be placed at a maximum of 1m centres, and when supporting mesh should be staggered.

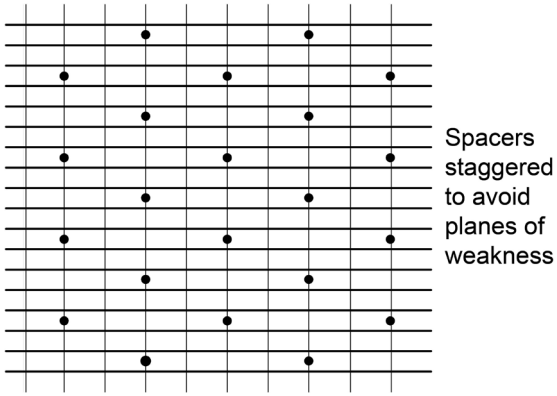

Figure 9: Position of spacers

2.2.9 Admixtures

Admixtures should only be used if stipulated as part of the original design specification. If an admixture is to be proposed where it was not intended as part of the design, a Structural Engineer must confirm that the admixture is appropriate and required.

It is important that the appropriate amount of admixture is applied to any mix. Any overdosing may cause concrete deterioration or poor workability.

Common admixtures

- **Plasticisers** – improve the workability of concrete, especially when pumped; they can also improve concrete adhesion, which is particularly enhanced when concrete is reinforced.
- **Air entraining agents** – increase the air void volume of concrete, which in turn produces a surface more resilient to cold weather, and is therefore ideally suited to outdoor conditions where cold weather exposure is high, such as pathways or roads.
- **Accelerators** – provide an improved curing time, but caution should be taken to allow for reasonable time to 'finish' the concrete.

Admixtures in cold weather

Admixtures may be used in cold weather, but usually will not assist in preventing concrete from freezing; therefore, they should not be relied upon to compensate for freezing conditions. The guidance for cold weather working should be followed in these circumstances.

Admixtures and reinforcing

Admixtures containing chloride will cause corrosion to occur, meaning they should not be used in concrete containing reinforcing.

2.2.10 Expansion/movement joints

Joints in concrete should be provided to prevent cracking caused by shrinkage; shrinkage will be less significant if the concrete is reinforced.

A larger number of expansion joints should be provided to concrete where weak spots may occur. This could include a narrowing width of floor slab for example.

2.2.11 Vibration and compaction of concrete

Reinforced concrete should be compacted using a vibrating poker, but care must be taken to ensure the concrete is not over-compacted and the concrete mix separated. Tamping of floors by hand is acceptable for floor slabs that do not exceed 150mm in thickness.

2.2.12 Curing of concrete

Concrete should be adequately cured before loads are applied. It is acceptable that masonry walls may be built up to Damp Proof Course (DPC) on a foundation that is not fully cured; however, care must be taken to prevent any damage to

the foundation. The concrete should be at least durable enough to carry the masonry.

The speed at which concrete mixes cure depends on the mix ratio and whether there are any additives within the concrete. Where curing time is critical, such as cast in-situ upper floors, curing times should be indicated as part of the design and formwork struck, as advised by a Structural Engineer.

To prevent concrete curing too rapidly after initial drying, exposed concrete should be covered with hessian, polythene or sand. This prevents the surface drying too quickly and protects the concrete. This level of protection is particularly critical in hot or adverse weather conditions.

2.2.13 Standards referred to:

- BS 8110 Structural use of concrete
- BS EN 1992 – 1-1 Design of concrete structures, general rules and rules for buildings (incorporating UK National Annex to Eurocode)
- BS 8500 Concrete – Complementary British Standard to BS EN 206-1
- BS EN 206-1 Concrete. Specification, performance, production and conformity
- BS EN 12620 Aggregates for concrete
- BS EN 197 Cement. Conformity evaluation

FUNCTIONAL REQUIREMENTS

2.3 OTHER COMPONENTS

Workmanship

i. All workmanship must be within the tolerances defined in Chapter 1 of this Manual.
ii. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

i. All materials should be stored correctly in a manner that will not cause damage or deterioration of the product.
ii. All materials, products and building systems shall be appropriate and suitable for their intended purpose.
iii. The structure shall, unless specifically agreed otherwise with the Warranty provider, have a life of not less than 60 years. Individual components and assemblies, not integral to the structure, may have a lesser durability, but not in any circumstances less than 15 years.

Design

i. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
ii. Structural elements outside the parameters of regional Approved Documents must be supported by structural calculations provided by a suitably qualified expert.
iii. The materials used for construction must meet the relevant Building Regulations, British Standards, Eurocodes and other statutory requirements.

2.3.1 Cold weather working

To meet the Functional Requirements of this Chapter, minimum working temperatures should not fall below 2°C when working with masonry. It is important that during cold weather periods, regular temperature readings should be taken.

Thermometers should be placed away from direct sunlight, preferably in a shaded area. When assessing the temperature, it is also important to consider wind chill and weather exposure and make necessary allowances for sites that have a higher level of exposure.

2.3.1.1 Protection of materials

Covers should be provided to protect materials from frost, snow and ice, particularly bricks, blocks, sand and cement. Frozen materials should never be used under any circumstances.

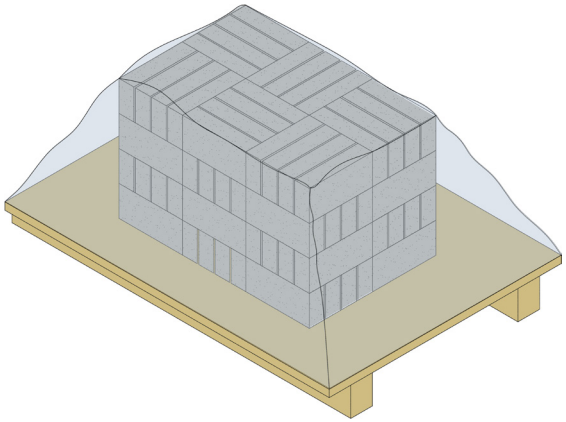

Figure 10: Protection of blockwork

2.3.1.2 Protection of masonry

Any new walls or other masonry construction will require protection against frost where temperatures are expected to drop below 2°C. Ideally, all masonry should be protected with polythene or hessian. If temperatures are expected to fall to an extremely low level, insulation boards may be required, and heating may even be considered.

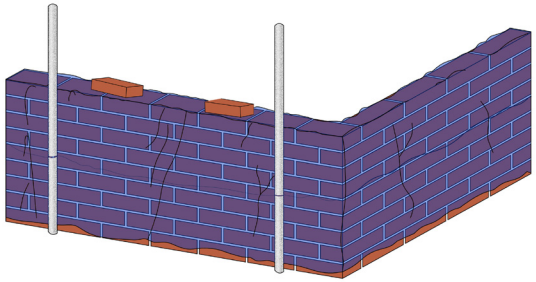

Figure 11: Protection of masonry walls

2.3.1.3 Finishes including rendering, plastering and screeds

Rendering should only be completed if the outside temperature is at least 2°C; there should be no frost within the construction that is to be rendered and, where possible, rendering should not take place where freezing weather conditions are anticipated prior to adequate curing.

No plastering or screeding should take place unless the building is free from frost. It is acceptable to use internal heating to warm the building effectively; however, it is important to ensure that heaters do not emit excessive vapour into the dwelling. Adequate ventilation should be provided to allow moist air to escape. The dwelling should be appropriately pre-heated before plastering, and continue to be heated whilst the plaster dries.

2.3.2 Masonry

2.3.2.1 Bricks

Bricks should be of an appropriate durability to meet the design intention. The type of brick to be used will affect the specification of the mortar. Bricks with greater durability should be used where there is a higher potential for saturation or severe exposure to wind-driven rain.

Durability (BS 3921)	Frost resistance	Soluble salts content
FL FN	Frost resistant durable in all uses	Limits of soluble salts are defined by tests
ML MN	Moderately frost resistant, durable except when saturated and subject to repeated freezing and thawing	Low (L) Normal (N)
OL ON	Not frost resistant. Bricks liable to be damaged by repeating freezing and thawing. For internal use only	
Note: calcium silicate and concrete bricks contain no soluble salts		

Table 4: Durability of brickwork

Use	Brick type			Notes on mortar
	Clay	Calcium Silicate	Concrete	
Foundation to DPC	FL,FN, ML, MN	Class 3	Strength >20N/mm²	
Foundation to DPC, (sulphates in soils)	FL,FN, ML, MN	Class 3	Strength > 20N/mm², all Class 1 sulphates and in some Class 2, consult manufacturers. Engineering quality concrete bricks up to Class 3 sulphates	Where sulphates are Class 3 or higher use sulphate resisting Portland cement
Un-rendered external walls (protected from saturation)	FL,FN, ML, MN	Class 3	Strength > 7N/mm²	
Un-rendered external walls (not protected from saturation)	FL,FN	Class 3	Strength > 15N/mm²	Use sulphate resisting cement in mortar with type N clay bricks
Rendered external walls	FL FN, ML,MN	Class 3	Strength > 7N/mm²	Use sulphate resisting cement in mortar and base coat of render with type N bricks
Copings, cappings and sills	FL,FN	Class 4	Strength > 30N/mm²	
Internal	FL,FN, ML,MN, OL,ON	Class 3	All	

Table 5: Suitability of brickwork in masonry

Use	Designation (BS EN 998-3)	Proportion by volume			Minimum compressive strength (N/mm²) [a]
		Portland cement: lime: sand	Air-entrained Portland cement: sand	Masonry cement: sand	
Mortar for internal and external use above DPC	(iii)	1:1:5-6	1:5-6	1:4-5	2.5
General purpose to BRE Digest 362		Air-entrained with plasticiser Portland cement: lime: sand 1:1:5.5 by volume			2.5
High durability mortar for A) Use below or near external ground level B) in parapets and chimneys C) External walls with high risk of saturation due to severe weather exposure	(ii) [b]	1:0.5:4-4.5 [c]	1:3-4 [c]	1:2.5-3.5 [c]	5.0
	If type N clay bricks are to be used, or for all chimneys use sulphate resisting cement				
Low permeability jointing mortar including copings, cappings and sills	(i) [d]	1:0.25:3 Use a Type S sand to BS 1200	N/A	N/A	10.0
Load-bearing masonry designed to BS 5628:1		Air entrained with plasticiser, Portland cement: lime: sand 1:1:5.5 by volume			As specified

Notes:
[a] Minimum compressive strength1 of site mixed mortars at 28 days (N/mm²)
[b] For concrete or calcium silicate brick use a designation (iii) mortar
[c] Where soil or ground-water sulphate levels are appreciable (Class 3 or higher) use sulphate resisting Portland cement.
[d] For concrete or calcium silicate bricks use designation (ii) mortar

Table 6: Suitability of mortar

2.3.3 Standards referred to

- BS 6399 Loadings for buildings
- BS 8103 Structural design of low rise buildings
- BS 187: 1978 Specification for calcium silicate (sand lime and flint lime) bricks
- BS 3921:1985
- BS 5628 Parts 1, 2 and 3 Code of Practice for use of masonry
- BS EN 771-1:2011
- BS EN 998 Specification for mortar for masonry

2.3.4 Developments within coastal locations

Developments in coastal environments will be subject to exposure from wind-blown salt spray, which could adversely affect the durability of components and claddings. This is in addition to the typical higher exposure environment encountered due to wind-driven rain (particularly on the Western seaboard; see Figure 2 in Chapter 7.1).

Where developments are within 3km of the coastal shoreline, structures and protective coatings/ claddings and detailing should be subject to scrutiny for a potentially enhanced risk of the effects of corrosion and reduced durability.

The design team should provide a detailed assessment of the protection and maintenance arrangements required for a project that falls within these locations, and identify suitably approved materials that are appropriate for use in the construction.

Shoreline/sea front developments will be designated as having a 'very severe' exposure risk, and the design team must provide specific proposals to demonstrate the durability, suitability and weather tightness of the construction, particularly for window and door openings, cladding and roof fixings, together with planned maintenance programmes to ensure the construction meets the requirements of this Manual.

2.3.4.1 Further reference

- BS 5628 – 3: 2005 Code of Practice for the use of masonry (superseded by BS EN 1996)
- BS 8104 Code of Practice for assessing exposure of walls to wind-driven rain
- BS 7543 Guide to durability of buildings and building elements, products and components
- BS 5493 Code of Practice for protective coating of iron and steel structures against corrosion
- BS 5427 Code of Practice for the use of profiled sheet for roof and wall cladding on buildings

2.3.5 Suitability of materials

It is important to ensure materials used in construction:

- Meet the requirements of British Standards or Codes of Practice or equivalent European Standards current at the time of application
- Are materials/products or systems covered by a current approval from an independent third-party technical approval body accepted by the Warranty Provider. This would either be a UKAS or European equivalent accredited organisation, such as ILAC (International Laboratory Accreditation Co-operation). Details of the testing body accreditation will need to be supplied, as well as the certification document

In addition:

- The independent third-party testing information must recognise UK Building Regulation requirements and additional Warranty standards. Details of the performance and the limitations of use of the material/product or system tested must be provided
- Where bearing a CE marking in accordance with the Construction Products Directive, this shall be supported by evidence of the testing carried out on the product

Construction products that do not meet the requirements of this Technical Manual may not be acceptable for Warranty approval. It is advised that the design team must approach the Warranty provider early in the design stage to discuss the viability of the use of such a material, and determine what further independent third-party testing may be required in advance of the final design proposal.