Brickwork Level 3

Second Edition

MALCOLM THORPE

For Construction Diploma, Technical Diploma and Apprenticeships

ROUTLEDGE

Brickwork Level 3

Brickwork Level 3 has been adapted from John Hodge's classic *Brickwork for Apprentices* – the established textbook on brickwork for bricklayers. Designed to meet new requirements of the City and Guilds bricklaying programmes this book has been written to match the latest industry-based requirements and technical developments in the field, including recent changes to the Building Regulations. Each chapter follows the syllabus and contains a section of multiple-choice questions to provide trainees with vital practice for the job knowledge and multiple-choice tests.

Highly illustrated throughout and now in full colour, this is the essential reference for qualified bricklayers and other professionals working in the construction industry, as well as students wishing to embark on a career in bricklaying.

There is also the facility to access the Support Material on the Routledge website, which includes:

- PowerPoint slides for each chapter
- Lesson plans and schemes of work
- Multiple-choice questions and answers
- Job knowledge questions and answers
- Practical drawings and mark sheets

Malcolm Thorpe is a Life Member of the Guild of Bricklayers and former Head of Construction at West Nottinghamshire College, UK. He has acted as a CITB adviser and was involved in the drafting of bricklaying programmes. He was a verifier for CITB and spent several years producing examination material for examining bodies. He also spent over thirty years designing and organising Guild of Bricklayers local and national bricklaying competitions.

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Malcolm Thorpe

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Preface

Changes in construction training have led to the need to update this series of books which incorporate the new Occupational Standards.

The content of each book follows the On-Programme Training Specification.

The On-Programme specification is divided into Knowledge Requirements (K) and Skill Requirements (S).

After the initial chapter, which gives the apprentice an insight into the construction industry they are entering, each chapter follows very closely the Training Specification for Apprenticeship and Diploma units.

The aim of each book is to provide an informative resource and workbook for all building craft apprentices. It can be used to provide teaching and assessment material, or used simply to reinforce college lectures.

Each chapter has a set of multiple-choice questions designed to test your level of knowledge before you move on to the next chapter.

There is also the facility to access the Support Material on the Routledge website, which includes lesson plans, schemes of work, completed units tracking sheets, mapping sheeting, PowerPoint displays, activity packs, job knowledge questions and answers, multiple-choice questions and answers, practical training units and practical competency units with marking sheets.

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Malcolm Thorpe

CHAPTER 1

The Construction Industry (Industrial)

This chapter will cover the following City and Guilds units:

• Apprenticeship	Level 2	Module 1	K2.1, K2.2
• Technical Diploma	Level 3	Unit 301	1.2, 2.1, 2.2, 2.3
• Diploma	Level 3	Unit 301/701	11.1, 11.2, 11.3, 11.4, 11.5

This chapter is about:

- The process of the construction industry
- Types of industrial buildings

The following skills and knowledge criteria will be covered:

- Understand environmental and sustainable considerations

The following Technical Diploma learning outcomes will be covered:

- Understand how to work in the construction industry
- Know building substructure and superstructure

The following Diploma learning outcomes will be covered:

- Understand energy efficiency and sustainable materials for construction

Introduction

The construction industry is one of the most important industries in the UK.

Construction means creating, not only the houses we need to live in but many other buildings such as schools, hospitals and shopping centres.

The majority of buildings and structures are designed and constructed for a specific purpose. The use of the building will determine the size, shape, style and ultimately the cost.

There are also several different types of construction work attached to the building industry.

Types of building

Many different types of construction are required to fulfil the needs of today's ever- demanding society.

Industrial buildings

For the purpose of Level 3, only buildings for industrial purposes will be discussed.

These buildings are constructed as a place of work. Examples are shown in Figure 1.1. Buildings in this category vary a great deal in their design. Their physical size and type of construction depend on the type of business being conducted and the size of the form.

The production of most consumer items is best achieved under cover of a building. The design of the building depends on the consumer item being produced. For example, car manufacture requires large production-type factory units with open floor area, whereas small electrical items could be produced in small individual factory units.

Buildings are also constructed simply to store materials, for example warehouses.

Other types of buildings constructed for work are offices, shops, banking establishments, etc. These buildings need other aspects not required in physical

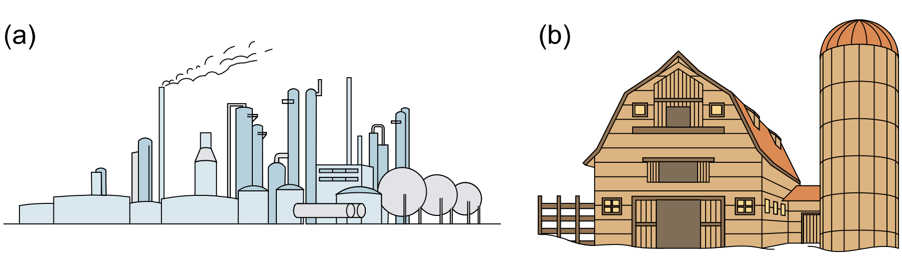

FIGURE 1.1
Types of industrial building: (a) factory; (b) agricultural

work areas. Offices have light, ventilation and comfort as their main criteria, which are normally found in small units.

There are many buildings in this category that could be considered for other categories, such as shops. These could be classified as either industrial or community: are they a place of work for the shopkeepers, or a place for the community to relax while browsing through the shops?

Types of industrial building

These buildings are required for people to work in the manufacture of goods. A surplus of these goods can then be exchanged for other goods produced by other groups of workers. These goods are sold in shops, stores and markets.

The organization of the workforce and exchange of goods is carried out in offices.

Storage

All living, communal and working accommodation has storage areas designed into it, but some buildings are designed solely for the storage of manufactured goods. These are classed as warehouses. Examples are shown in Figure 1.2.

Most storage accommodation requires large unobstructed areas, to facilitate modern mechanical handling of goods. Other storage accommodation includes reservoirs, water towers and oil tanks.

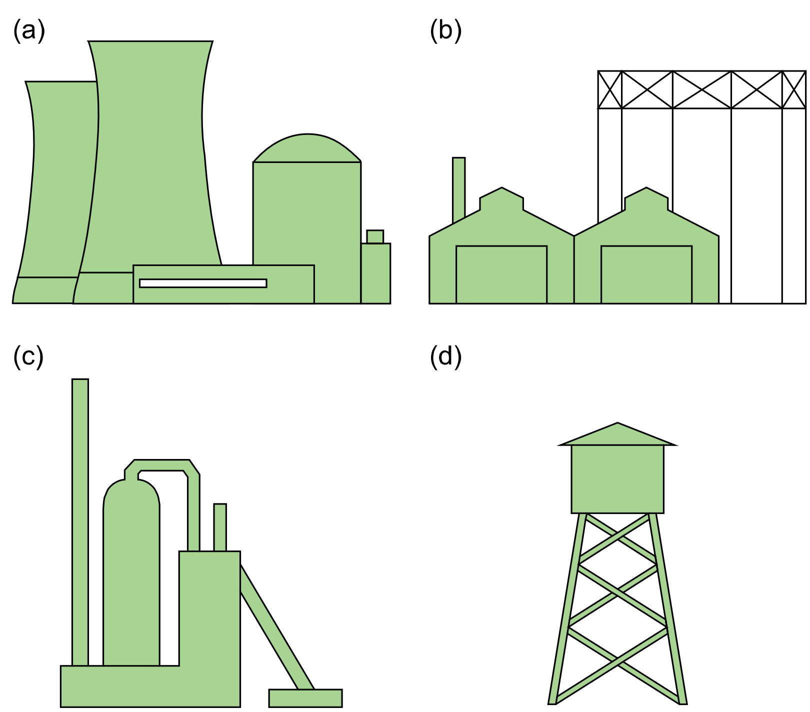

FIGURE 1.2
Types of storage building: (a) nuclear power station; (b) warehouse; (c) chemical storage; (d) water tower

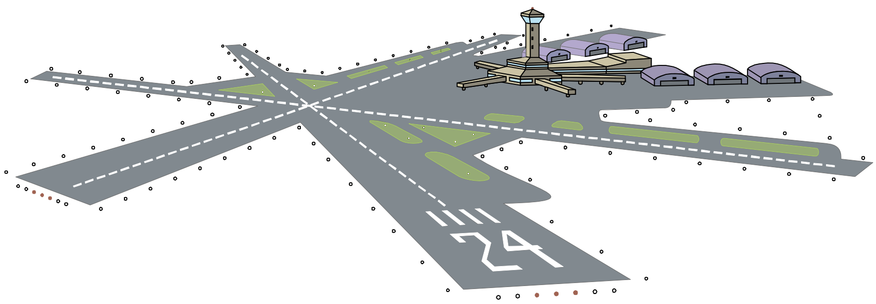

FIGURE 1.3
Type of transport buildings: airport

Each construction must be specially designed to accommodate the material to be stored.

Transport

In our modern society there is a need for many facilities for transport. To facilitate this there are national networks of roads, rail, rivers, etc.

These facilities, in turn, require ancillary buildings such as terminals, stations, waiting rooms and storage space. An example is shown in Figure 1.3.

The construction industry

The construction industry is the term given for the two main operations within the industry: building and civil engineering. Figures 1.4 and 1.5 show examples of each.

- Building – This is the term applied to work that relates to accommodation.
- Civil engineering – This is the term applied to work that relates to features and/or services around the accommodation.

FIGURE 1.4
Building

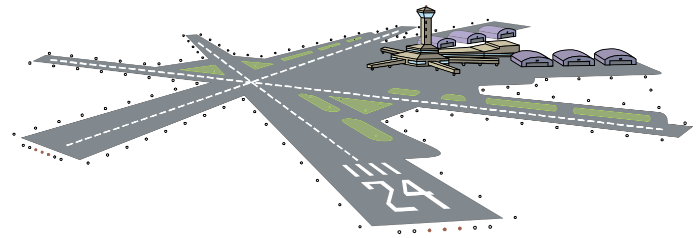

FIGURE 1.5
Engineering

New technology and methods used in construction

As the industry advances with new technology the design of buildings changes accordingly.

The majority of buildings are constructed for a specific purpose. This will determine their shape, size and style, and will also affect the quality and the eventual cost of the building.

The actual structure of the building is termed the external envelope, and protects the internal environment from all outside elements.

A structure can be defined as an organized combination of connected elements, which are constructed to perform some function, e.g. office block, factory unit or domestic building. Each building will be constructed with different structures to ensure that the correct facilities have been included and used to their full potential.

Structural forms

There are many structural forms in present-day use, each being modified from time to time to gain the best possible benefits from new materials and new techniques.

There are two basic forms of structure used in the construction of buildings:

- solid structure
- framed structure.

Solid structure

The walls of this type of construction support the loads, protect the internal environment and enclose space. The walls are therefore load-bearing, transferring the loads from the building down to the foundations.

The characteristic of this particular form is the thickness of the wall, owing to the materials and the manner in which they are used. Solid construction in the form of brick, stone and concrete is an easily erected structure. It is gradually built up from small units, block by block. When concrete is used some form of mould has to be provided to support the wet concrete until it has hardened.

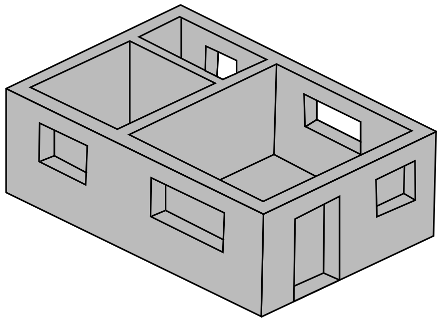

FIGURE 1.6
Cellular structure

There are two main types of sold wall construction: cellular and cross-wall construction.

In cellular construction (Figure 1.6), the structure consists of walls, connected together to form the rooms of the building. The result is a very rigid, load-bearing structure. The external walls form the external envelope and the internal walls divide and build up the rooms.

Cross-wall construction (Figure 1.7) consists of a series of walls parallel to each other and at right angles to the front of the building. These walls take the main structural loads and transmit them to the foundations.

Both methods can be built in cavity wall construction. It is very rare for either domestic or commercial buildings to be built with solid walls. Cavity walls are used in modern construction and provide better insulation to the property. They can be filled with various insulation materials to prevent heat loss.

Framed structures

A framed structure is a network of beams and columns connected together to form the skeletal frame of the building (Figure 1.8).

The interconnecting members also have a supporting function and they transfer the loads to the foundations. Protection is provided by either cladding fixed over the framework or infill panels fixed between the members.

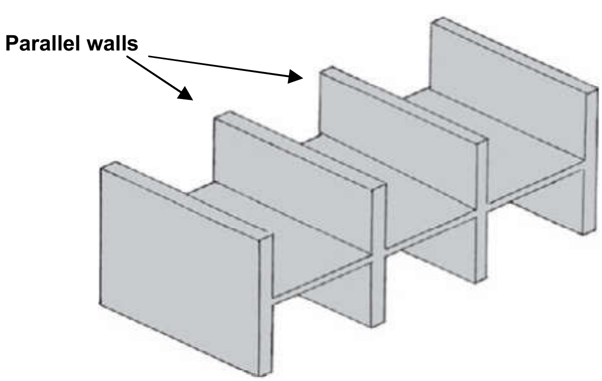

FIGURE 1.7
Cross-wall structure

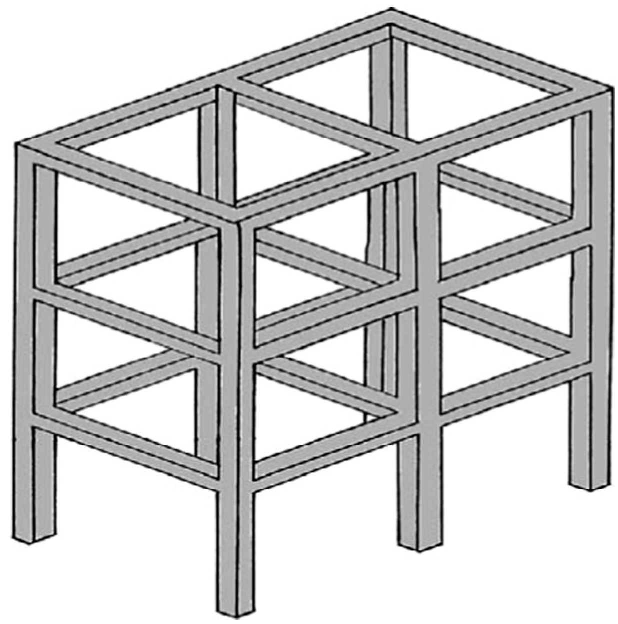

FIGURE 1.8
Framed structure

Framed construction is suitable for a very wide range of buildings from low rise to high rise, and is easily erected from prefabricated members. The members are simply connected together in a certain sequence to form the structural framework.

Concrete and steel are the two main materials used, with a few low-rise buildings having a timber-framed structure.

The rectangular framed structure is the most common type. This consists of a series of upright and horizontal members. The resulting frame provides the bearing for the floors, walls and roof.

The structure can be cladded with brick when the building has been made watertight. The whole frame is insulated before the brick cladding is added, to prevent heat loss from the building.

Design aspects

The appearance of the building should be pleasing to the eye. It should also be pleasing to the eventual owner and the public, and blend in with the surrounding buildings or area.

Technological aspects take into account the choice of the most suitable material for a specific purpose and the use of sustainable materials.

Good buildings are naturally those that are constructed with suitable materials and appropriate methods. In the past, buildings were constructed of materials that were local to the area to save on transportation costs, but nowadays materials can be used from anywhere in the world. The designer must be aware of the capabilities of all materials and the constructional methods to be adopted.

Buildability

It is impossible to design buildings to be used indefinitely, even if that were thought desirable. All building materials deteriorate eventually, and the cost of maintenance becomes prohibitive. Most buildings are designed to have a life-span of 70 years, or even less in some instances. The aim, though, is a building that will require as little maintenance as possible during its planned life.

The materials selected must be ones which, subject to conscientious maintenance by the occupiers of the building, will not show serious deterioration during the building's life.

Sometimes architects let their fantasies take over, resulting in a building that seems impossible to build.

Structural stability

Given determination, even the most apparently unstable structures can be satisfactorily built. Clearly, every building must be stable, whether it looks it or not.

Durability

Most architects will need to know the required life of the building. Most clients would not have any idea, but this aspect is crucial to the design team. It could determine the structural form and type, the selection of materials and the eventual building cost.

The architect will explain these reasons to the client, and between them they will decide on the life expectancy of the building.

Energy efficiency

A great deal of energy is used in the construction of a building.

Many years ago the whole of the construction process was carried out by hand. All the materials were produced and formed manually, the excavation was dug by hand, materials were mixed and transported by hand. A great deal of manual energy was expended.

Things have changed over the years and machines are used constantly on building sites to save on manpower and produce a more cost-effective building.

Construction process

When commencing building on a new site it is important to clear the site of all debris, old buildings and any other items.

The next operation is to remove the vegetable soil. Clearance of vegetable soil or top soil from the construction site area is mandatory, unless the work consists of alterations or amendments to existing buildings.

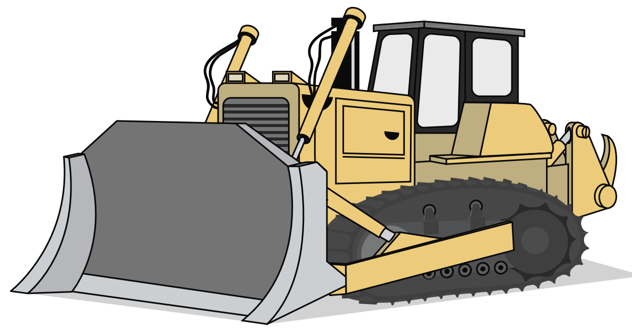

FIGURE 1.9
Bulldozer

Vegetable soil is soft, easily compressed and contains plant life, properties excluding its use as a basis for construction. It is found in variable depths, of approximately 150– 300 mm, and has been built up by nature over many years.

This layer is excavated separately from the other excavation work and the material is usually stockpiled on a part of the site where it will not be in the way of any other building work until it is required for landscaping. If it is not required it can be sold. The bulldozer is ideal for stripping the top soil and stockpiling it ready for later use (Figure 1.9).

Setting out

Once the area is clear the proposed building can be set out. It is important that this procedure is carried out accurately, as it is very expensive to correct later.

When contractors take possession of a building site they will receive a full set of contract drawings, including a site plan of the proposed building.

The production drawings produced by the architect will show the position of the building on the site, and it is important to ensure that the building is constructed as shown, as this has been approved by the local authority.

The front of the building will be a certain distance back from the road, which will have been prescribed by the Highway Authority, and the distance from the other site boundaries will be controlled by the planning authority.

Before the foundations can be constructed it is necessary to establish the exact position of the building in relation to the site boundaries. This is done by a process known as 'setting out'. Setting-out procedures are dealt with in Chapter 5.

Excavations

On small sites, hand-held tools such as picks, shovels and wheelbarrows are used. However, if the depth of excavation exceeds 1.2 m some method of removing spoil from the excavation will have to be used.

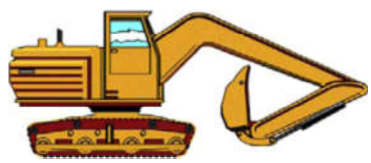

FIGURE 1.10
Backactor

On all sites mechanical methods could be used, depending on factors that are different on each site. These include the volume of soil involved, the nature of the site and any cost constraints.

The most common machine for digging site trenches is the backactor (Figure 1.10).

Foundations

The foundation of a building is that part which is in direct contact with the ground.

The current Building Regulations require that the foundations of a building shall safely sustain and transmit to the ground the combined dead and superimposed loads in such a way as not to impair the stability or cause damage to any part of the building.

The ground or subsoil on which a building rests is called the natural foundation or subfoundation, and has a definite load-bearing capacity, according to the nature of the soil (Figure 1.11).

Subsoils are of many varieties and may generally be classified as rock, compact gravel or sand, firm clay and firm sandy clay, silty sand and loose clayey sand (Table 1.1).

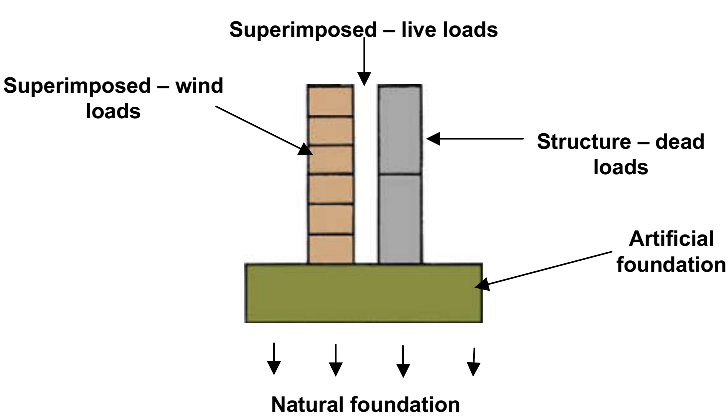

FIGURE 1.11
Loads

Table 1.1 Types of subsoil

Type of subsoil		Condition of subsoil
Class 1	Rock	Sandstone, limestone or firm chalk: requires pneumatic pick or similar appliance to excavate
Class 2	Compact gravel or sand subsoil	Requires a pick for excavation; a 50 mm wood peg; hard to drive more than about 75 mm
Class 3	Clay and sandy clay	Stiff, cannot be moulded in the fingers and requires a pick or pneumatic spade for removal
Class 4	Clay or sandy clay	Firm, can be moulded with the hand but can be excavated with a spade
Class 5	Sand, silty sand and clayey sand	Loose, can be excavated with a spade
Class 6	Silt, clay, sandy clay and silty clay	Soft, can be moulded with the hand and easily excavated
Class 7	Silt, clay, sandy clay and silty clay	Very soft and squeezes through fingers when squashed

Based on information found in Approved Document A in the current Building Regulations

It is possible to erect a wall on rock with little or no preparation, but on all soils it is necessary to place a continuous layer of in situ concrete in the trench, called the building foundation. (The term 'in situ' means cast in place in its permanent position; unlike 'precast' which is made elsewhere, lifted and transported later to the place where it is required for use.) This cast, in situ concrete is made from Portland cement with coarse aggregate, plus sharp sand or ballast, graded from 40 mm to fine sand, and mixed in the proportion of 1:6.

The design of a foundation is an important subject for the architect's consideration, particularly where the building structure is heavy, with possible concentrated loading, and the ground on which the building rests is of poor load-bearing capacity or is affected by other conditions such as seasonal change.

Even buildings of the small domestic and industrial type may require careful site exploration so that a suitable foundation is constructed and the future stability of the building assured.

Where buildings are extremely heavy it may be necessary to construct foundations of a special type, such as piles, where the site consists of deep beds of soft soil overlaying a hard soil, but it is the intention here to deal only with buildings of the smaller domestic and industrial range.

Foundation types

This chapter will deal with the four main types of foundations:

- strip foundations – narrow strip and wide strip foundations
- pad foundations
- raft foundations
- piled foundations.

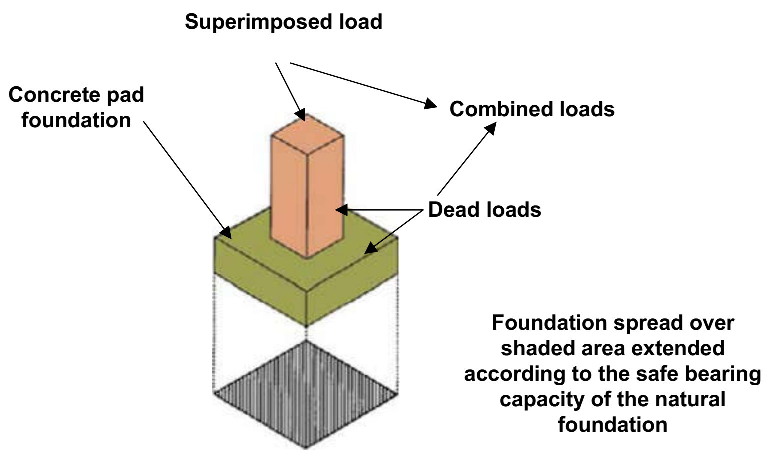

FIGURE 1.12
Transfer of building load onto subsoil under pad foundation

Foundation design

When a load is placed on soil it is necessary to spread or extend the foundation base to ensure stability. This extended or spread foundation is referred to as a strip foundation in the case of a continuous wall structure, or a pad foundation in the case of an isolated pier.

The important loads to be resisted by a foundation are the dead loads, or the weight of the building structure, and the superimposed loads, or the weight that may be placed on the building structure. The area or spread of the foundation base should be sufficient to resist the downward thrust or bearing pressure of these combined loads (Figure 1.12).

The spread of a pad foundation required for a pillar or isolated pier can be determined by dividing the combined loads by the safe bearing capacity of the soil, i.e.

$$\frac{\text{Combined load of pier}}{\text{Safe bearing capacity of soil per square metre}}$$

or

$$\frac{\text{Total load of pier}}{\text{Safe load on soil}}$$

These calculations are published in the current Building Regulations for the more common strip foundations on subsoils up to a maximum load of 70 k/N (Table 1.2). Any calculations outside this table should be carried out professionally.

The foundation required for a continuous wall structure (Figure 1.13) is obtained by similar methods; in this case a 1 m length of wall is taken for the purpose of calculation.

Having determined the spread of the foundation base it is now necessary to consider the depth. The base, in spreading the load, is subjected to stresses known as tension and punching shear, and must be of sufficient depth to resist them.

Table 1.2 Minimum width of strip foundations

			Total load of load-bearing walling not more than: (kN/m)					
	Type of subsoil	Condition of subsoil	20	30	40	50	60	70
Class 1	Rock	Sandstone, limestone or firm chalk	In each case equal to the width of the wall					
Class 2	Gravel Sand	Compact Compact	250	300	400	500	600	650
Class 3	Clay Sandy clay	Stiff Stiff	250	300	400	500	600	650
Class 4	Clay Sandy clay	Firm Firm	300	350	450	600	750	850
Class 5	Sand Silty clay Clayey sand	Loose Loose Loose	400	600	Note: If the total load exceeds 30 N/m then this table does not apply to types 5, 6 and 7			
Class 6	Silt Clay Sandy clay Silty clay	Soft Soft Soft Soft	450	650				
Class 7	Silt Clay Sandy clay Silty clay	Very soft Very soft Very soft Very soft	600	850				

Based on information found in Approved Document A in the current Building Regulations

Tension is due to the bending tendency and punching shear to the tendency of the wall or pier structure to punch a hole through the foundation base (Figure 1.14).

The thickness of the concrete foundation should not be less than the projection of the strip either side of the wall, but in no case less than

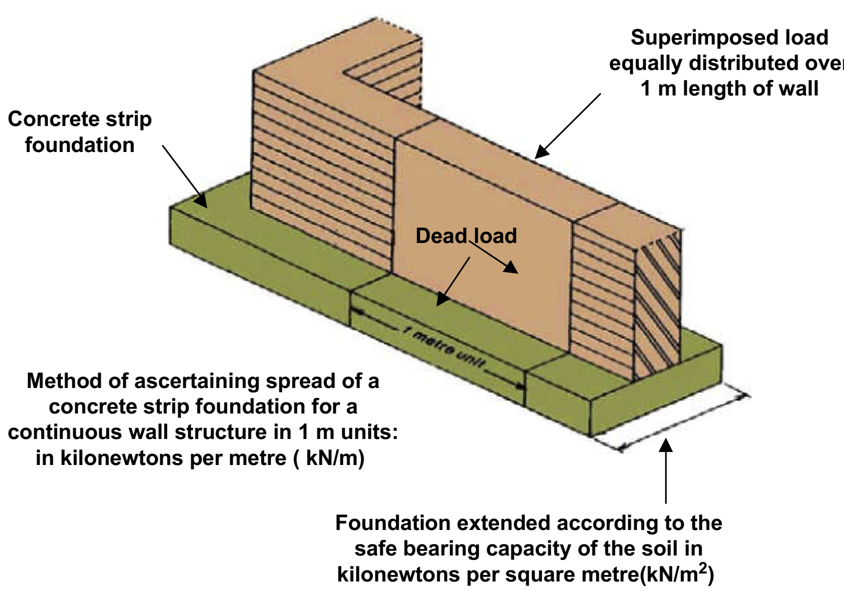

FIGURE 1.13
Loading under strip foundation

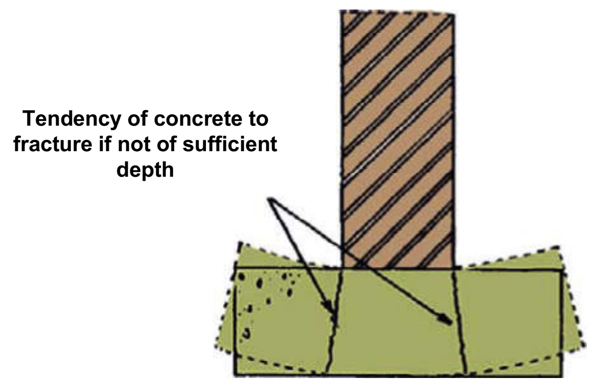

FIGURE 1.14
Potential failure of a strip foundation due to punching shear

150 mm. One method of ascertaining the depth of concrete is shown in Figure 1.15.

Design of simple strip foundations

Using the information given, it is now possible to calculate the spread and depth of simple concrete foundations.

You need to know the following:

- the total load per metre run of wall
- the type of subsoil
- the width of the wall.

Example 1

Design a strip foundation to carry a 275 mm wide cavity wall, if the total load is 60 kN per metre run of wall and the ground is stiff sandy clay (Figure 1.16).

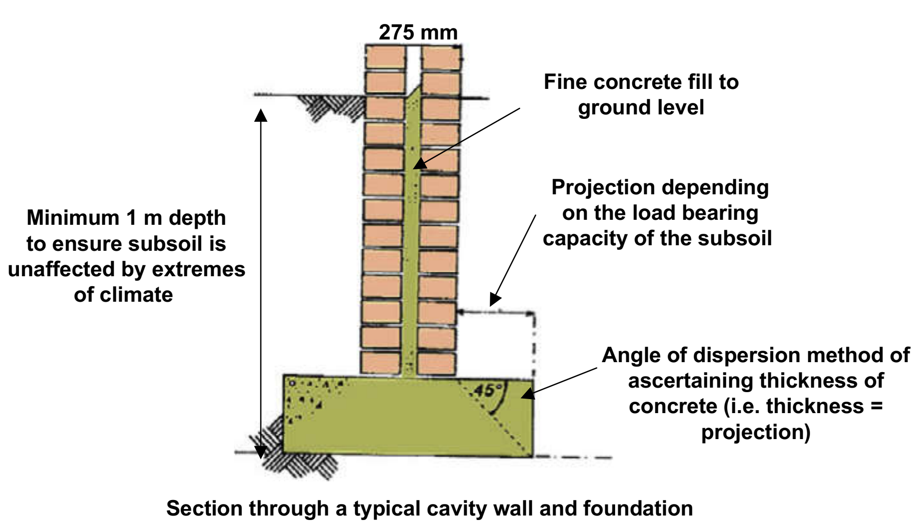

FIGURE 1.15
Establishing thickness of strip foundation concrete

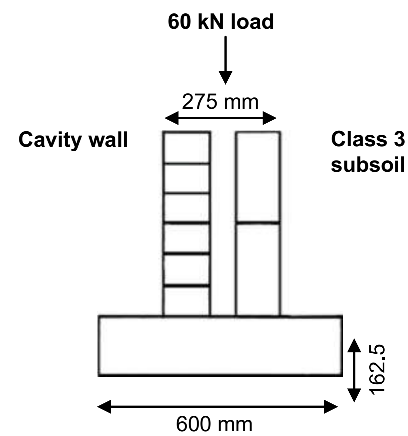

FIGURE 1.16
Designing a strip foundation

Remember: the wall should sit in the middle of the strip foundation. The first thing to check out is Table 1.2.

Find the column with the correct loading of 60 kN and trace down the column until you reach the correct class of subsoil – class 3. The two join at 600 mm.

This gives the minimum width of the strip foundation.

The next calculation is to find the projection of the concrete.

The wall is 275 mm wide and the total width of the foundation is 600 mm.

If we deduct 275 from 600 and divide by 2, it will give the projection:

$$\frac{600 - 275}{2} = 162{:}\ 5\ mm\ \text{projection}$$

According to the rules for the projections the depth must be at least equal to the projection but in no case less than 150 mm. Therefore the depth of the foundation concrete should be 162.5 mm.

This is the mathematical method of finding the depth; the angle of dispersion method is shown in Figure 1.15.

Example 2

Design a strip foundation to carry a 275 mm wide cavity wall, if the total load is 30 kN per metre run of wall and the ground is sandy gravel (Figure 1.17).

Again the first thing to check out is Table 1.2.

Find the column with the correct loading of 30 kN and trace down the column until you reach the correct class of subsoil – class 2. The two join at 300 mm.

This gives the minimum width of the strip foundation.

The next calculation is to find the projection of the concrete.

The wall is 275 mm wide and the total width of the foundation is 300 mm.

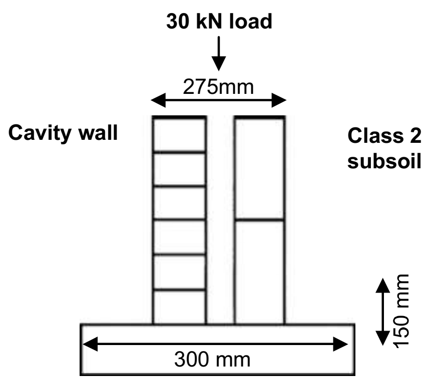

FIGURE 1.17
Designing a strip foundation

If we deduct 275 from 300 and divide by 2, it will give the projection.

$$\frac{300 - 275}{2} = 12.5 \text{ mm projection}$$

According to the rules for the projections the depth must be at least equal to the projection but in no case less than 150 mm. Therefore the depth of the foundation concrete in this example should be 150 mm.

These narrow foundations, although acceptable by the local authority, are practically impossible to build. They are usually extended in width to 150 mm to allow the bricklayer to stand in the trench when foundation walling is being built.

Atmospheric depth

This is the depth below ground level to which foundations should be taken.

It depends on the type of soil and is the depth at which the subfoundation ceases to be affected by the weather. This is between 600 and 1500 mm, decreasing as the proportion of gravel increases (Figure 1.15).

In buildings of the smaller domestic and industrial type, or where the loads are not excessive, standard methods and rules are applied to the design of the foundations. In general, the resultant construction complies with the Building Regulations, but in all cases the decision as to adequacy rests with the local authority building control office.

Other foundation types

Narrow strip

As in the last example, the working space required to build on top of the concrete strip foundation would make the strip wider than it needs to be to carry the load. In these circumstances, an economical alternative is the narrow strip, or trench fill as it is sometimes known (Figure 1.18).

A high standard of accuracy is required in constructing such a foundation.

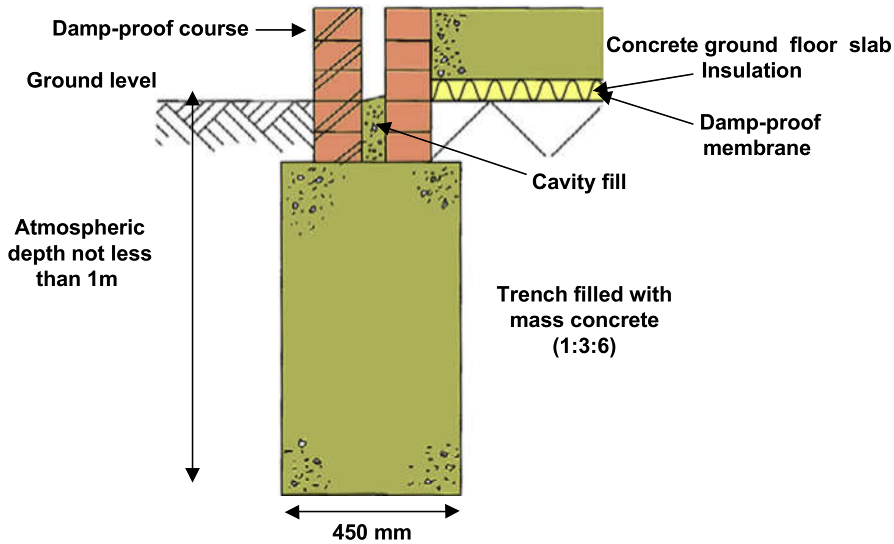

FIGURE 1.18
Narrow strip foundation

A narrow strip is excavated by the mechanical excavator and backfilled with mass concrete up to a level just below the finished ground level. It is cheaper and quicker to fill the trenches with mass concrete than to excavate a wider trench. There is less excavated material to be removed and backfilling is eliminated. A wider trench for a strip foundation requires timbering for safety purposes, foundation concrete to be laid, foundation brickwork constructed and the cavity filled with weak concrete up to ground level. This work could be reduced by using foundation blocks, but would still be more expensive than trench fill.

Wide strip foundations

Where the structural loads are very heavy or the safe bearing capacity of the soil is low, the spread of the foundation base increases. This is normally referred to as a wide strip foundation. It follows that the required depth of the concrete foundation base may be considered excessive; it can be reduced by the introduction of steel reinforcement, but the foundation must always be of sufficient depth to ensure that, in combination with the steel, it will resist the stresses of tension and shear. Figure 1.19 shows a simple example of a reinforced concrete strip foundation.

Pad foundations

Loads are not always evenly distributed along the wall, but may at times be concentrated at various points.

Figure 1.20 shows part of a wall with an attached pier, which may, for instance, bear a roof truss or beam. To obtain even pressure over the soil the foundation would be extended as shown.

For single loads that are transmitted down a column, the most common foundation is a square or rectangular block of concrete of uniform thickness known as a pad foundation (Figure 1.21).

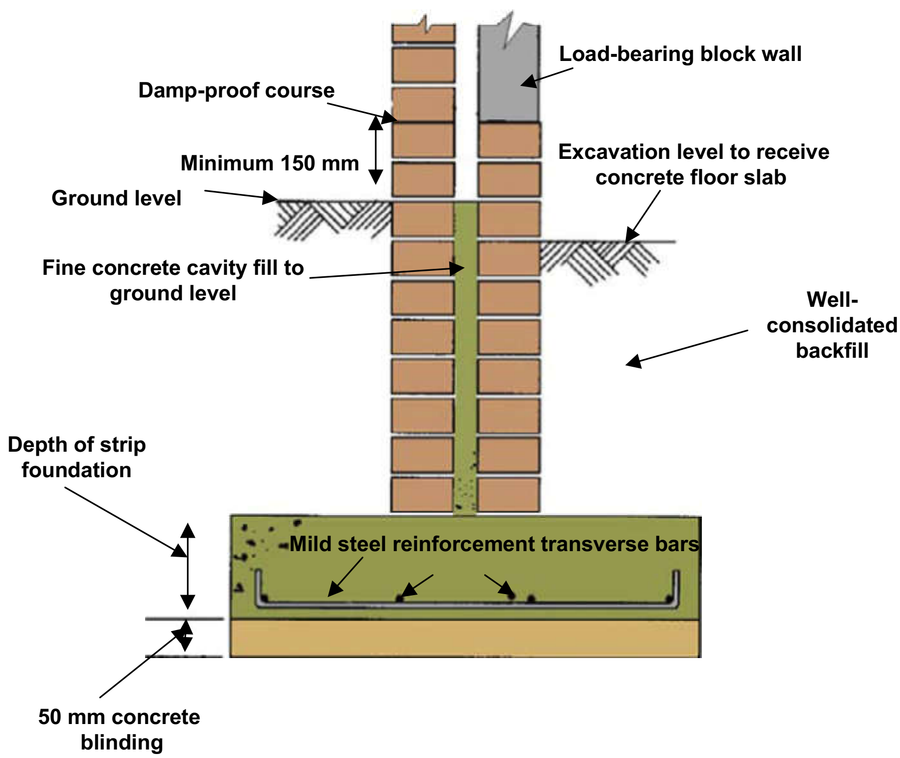

FIGURE 1.19
Reinforced wide strip foundation

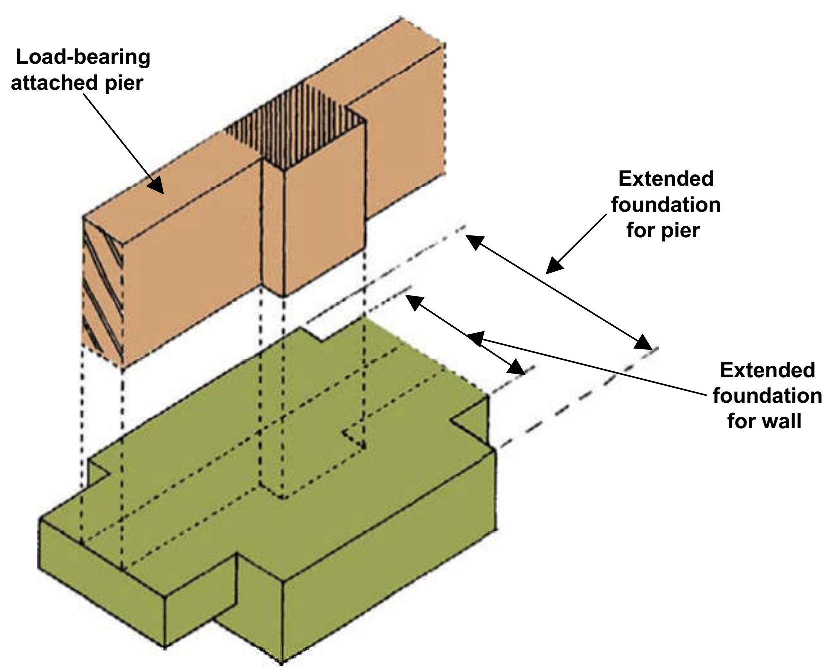

FIGURE 1.20
Extension of strip concrete foundation around attached pier

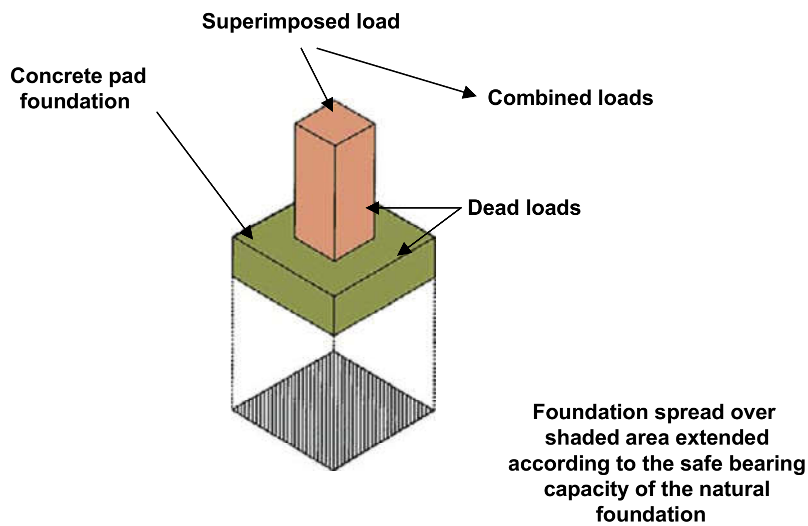

FIGURE 1.21
Pad foundation

It is sometimes more economical to construct a foundation of isolated pads with pillars of brick or concrete, which in turn support concrete ground beams and concrete floor slabs, which then support the walls of the building.

This method of construction avoids total trench excavation, timbering to the trenches and foundation brickwork all the way around the perimeter of the building.

To spread the load over a greater area it is necessary either to make the pad thicker or to use reinforced concrete.

Raft foundations

These foundations consist of a raft of reinforced concrete under the whole of the building.

Raft foundations are often used on poor subsoils for lightly loaded buildings and are considered capable of accommodating small settlements of the subsoil.

The simplest and cheapest form of raft is the thick reinforced concrete raft (Figure 1.22). Its rigidity enables it to minimize the effects of differential settlement.

Short bored piled foundations

If, instead of spreading the load from the wall over a wide area, it is decided to transfer it to a greater depth, an economical solution is the use of a short bored pile foundation.

Short bored piles are formed by boring circular holes 300 mm in diameter to a depth of about 3 m by means of an auger. This depth is governed by the level of suitable bearing capacity ground. The holes are filled as soon as possible with mass concrete.

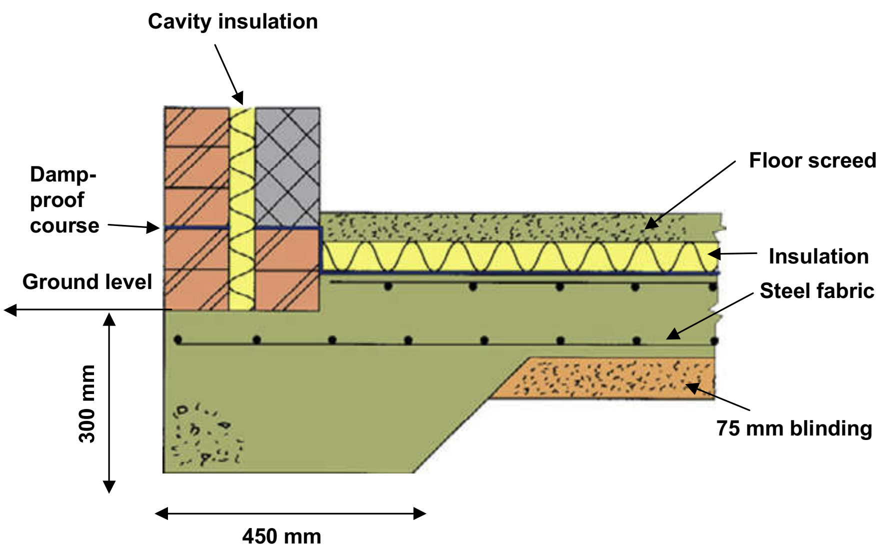

FIGURE 1.22
Raft foundation

The piles are placed at the corners of the building and at intermediate positions along the walls. They support reinforced concrete beams which are cast in place in the ground (Figure 1.23).

Brick footings

Many authorities consider brick footings to be obsolete, mainly because of the quality of concrete used in modern construction. However, the apprentice

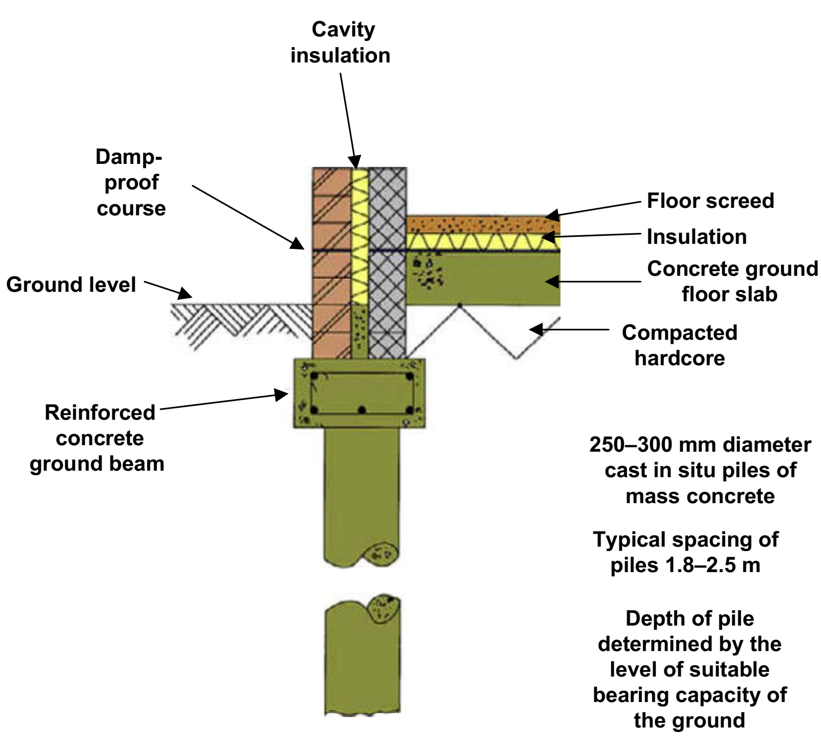

FIGURE 1.23
Piled foundation

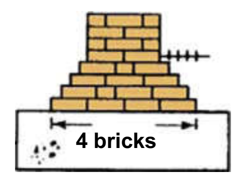

FIGURE 1.24
Cross-section of footing courses to a two-brick wall

should be aware of the principles involved when this form of construction is adopted and of the necessary bonding arrangements.

The stresses of tension and shear in a foundation base may be eased by the addition of a construction known as a footing. Where brick is used this is achieved by regular offsets at the base of the wall or pier structure. The footings spread the weight of the wall or pier and superimposed loads over the concrete, which in turn distributes the combined loads over the soil.

Thus, the first course of footings is always double the wall width, and the second and each subsequent course of footings is offset 56 mm each side. Every course of footings should be header bond and sectional, following rule 7 of bonding (Figure 1.24).

Strip foundations in Victorian or Edwardian buildings may not be concrete but rammed 'hoggin' instead (that is, 'as dug' gravel, before clay has been washed out).

Stepped foundations

These are constructed on sloping sites to ensure a horizontal bearing on the natural foundations (Figure 1.25). Note the overlap of concrete at the change of levels. The height of the steps must be maintained at not more than 450 mm; where this dimension is exceeded, special precautions may be necessary.

Walls

The standard form of construction for the external walls of domestic and communal brick buildings is called cavity walling. This means that the bricklayer builds the two separate leaves or 'skins' of brick masonry (a general term indicating brickwork and/or blockwork), with a 50–75 mm wide space between them.

The outer skin is usually 102.5 mm thick face brickwork, but may be constructed from facing quality blocks.

The inner skin is usually 100 mm thick common blocks that are later plastered to receive internal decoration.

Both skins of brick masonry are joined together with a regular pattern of corrosion- resistant ties, so that they behave as a single wall.

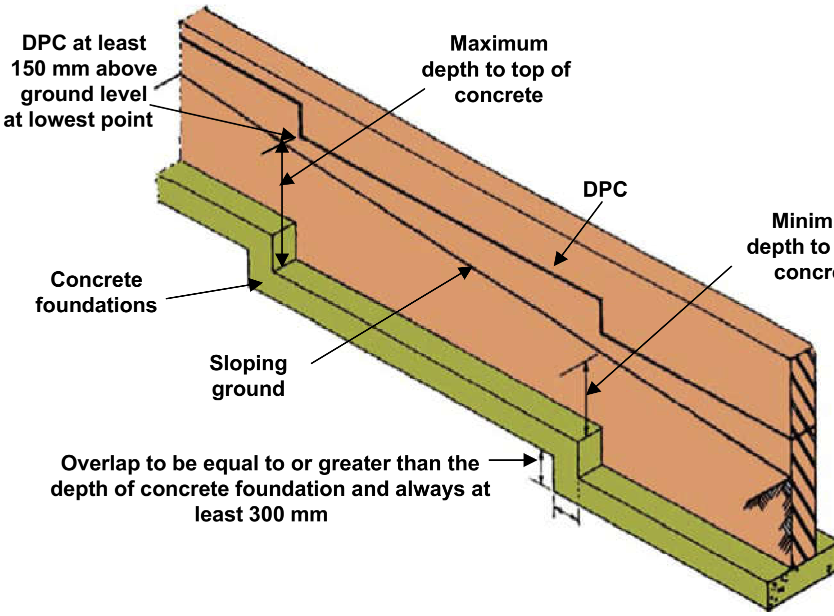

FIGURE 1.25
Stepped foundations on sloping sites

The main objectives of cavity walls are to prevent rain penetration and provide a greater degree of thermal insulation than solid wall construction.

New developments in the design of cavity walls have allowed for greater insulation values to prevent heat loss through the walls.

The external walls of domestic and communal buildings can also be designed in a framed construction. Frames can be timber, steel or concrete.

One of the great advantages of framed buildings is that the main construction can be almost finished and watertight before the external skin of brickwork is added. This is often considered as a faster method of building and allows other trades to continue while the external cladding is being fixed.

When designing to meet the current Building Regulations for heat loss through walls, it is important to consider which method of construction will be used, as the cost can vary according to which method is used.

The current Building Regulations require that external walls have a maximum U value of 0.18 W/m^2 K. The U value denotes the thermal transmittance, which is the rate of heat transfer through a wall from air to air.

The most common method of insulating cavity walls, whether they are brick and block or framed, is by inserting slabs of polyurethane foam, expanded polystyrene or bonded glass fibre into the cavity space.

Figures 1.26 and 1.27 show insulation placed in the cavity of a brick and block wall and insulation to timber-framed construction, respectively.

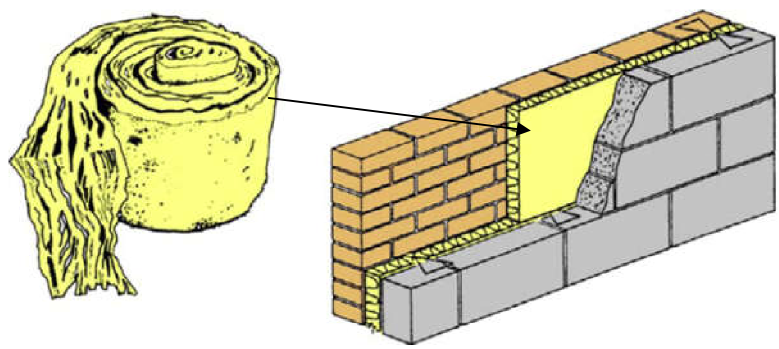

FIGURE 1.26
Insulation to cavity wall

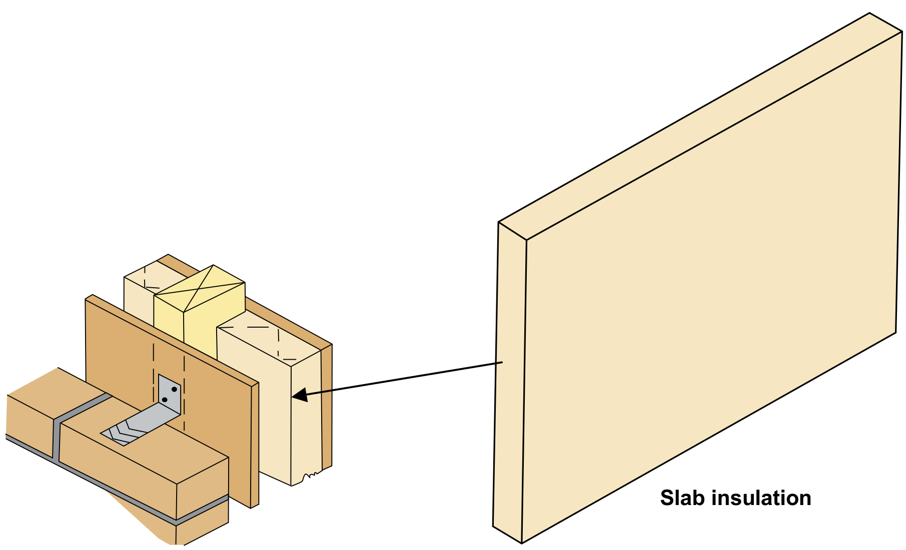

FIGURE 1.27
Insulation to timber frame cladding

Floors

Ground floors

There are two types of ground floor construction found in both domestic and communal buildings:

- solid
- hollow.

The functions of ground floors are to provide a level surface with sufficient strength to support all the loads, and to prevent dampness entering the building and heat loss from the building.

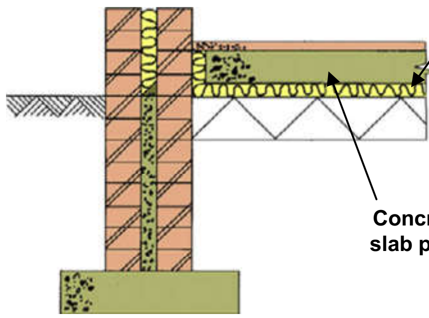

FIGURE 1.28
Damp-proofing a solid ground floor slab with the DPM under the concrete floor slab

Solid ground floors

Solid ground floors consist of a compacted hardcore with sand blinding on top. This protects the damp-proof membrane (DPM). Insulation is laid on the membrane on which a slab of concrete is laid.

Details are shown in Figure 1.28.

The horizontal damp-proof course (DPC) level must never be above the floor level.

Brick rubble or hardcore laid directly beneath the concrete floor will not only prevent settlement, but, being of a porous nature, also help to prevent dampness. Its thickness should be approximately that of the concrete floor.

Solid ground floors have to be insulated, according to the current Building Regulations, to provide resistance to unacceptable heat loss through the floor. This can be achieved in various ways but the most common is to place the insulation on top of the DPM, which is placed on a blinding layer on top of the hardcore.

This method of construction protects the concrete floor slab from any moisture or harmful salts. The only problem with this method is the risk of damage to the DPM and insulation when laying the concrete floor slab.

An alternative method is shown in Figure 1.29. This method is easier but the concrete floor slab is not protected against the ingress of moisture or harmful salts.

Materials suitable for floor insulation are dense resin bonded mineral or glass fibre slabs, and polystyrene and cork slabs. These should be placed above the DPM and turned up at the edges of the floor slab to prevent heat loss through the external wall.

Remember

The DPM *must* be continuous with the horizontal DPC in the external and internal walls.

Hollow ground floors

Suspended timber floors need to have a well-ventilated space beneath the floor construction to prevent the moisture content of the timber rising above an

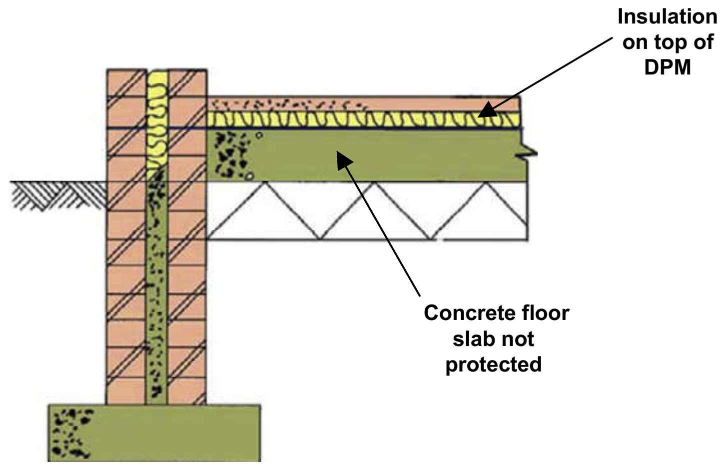

FIGURE 1.29
An alternative method with the DPM on top of the concrete floor slab

unacceptable level, i.e. above 20 per cent, which would create the conditions for possible fungal attack.

Hardcore and oversite concrete are still required for these floors, but in this case the concrete does not require a waterproof membrane.

Hollow sleeper walls are constructed on the oversite concrete to receive the wall plate, which in turns supports the floor joists (Figure 1.30). A horizontal DPC is inserted under the wall plate to resist rising damp.

Underfloor ventilation against dry rot

Having placed the oversite, the floor must be supported, so as to allow free passage of air to prevent the floor timbers from rotting. This is achieved by building honeycomb sleeper walls on the oversite concrete and air bricks built into the external wall.

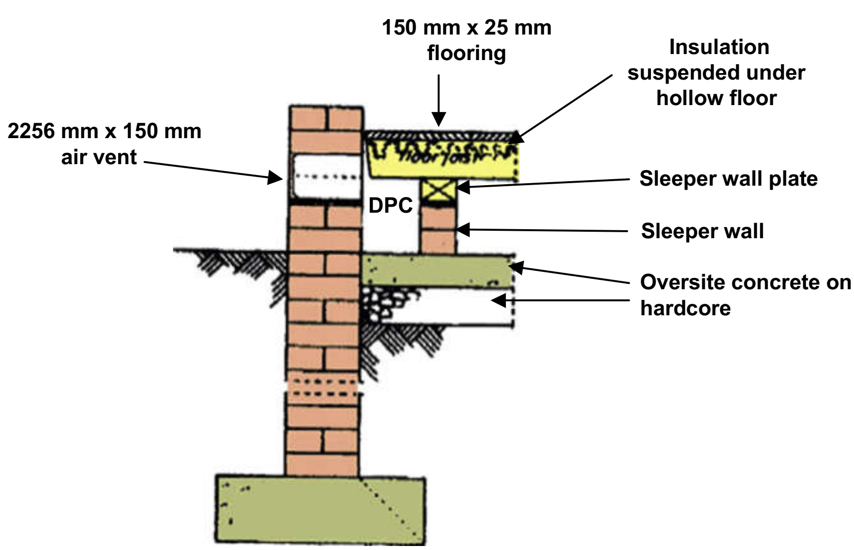

FIGURE 1.30
Solid wall: location of sleeper wall

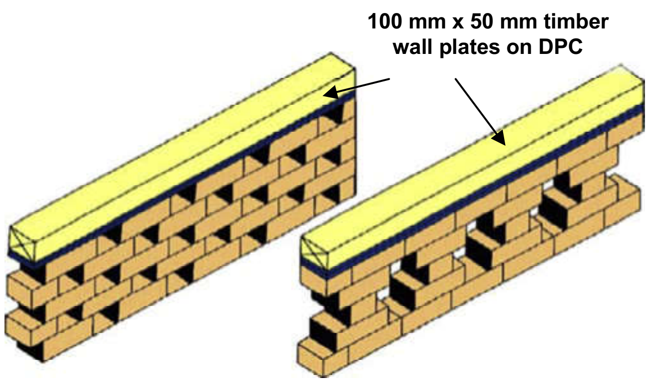

FIGURE 1.31
Types of sleeper wall construction

Two types are illustrated in Figure 1.31.

The sleeper walls nearest to the main wall are positioned as in Figure 1.30; this provides freedom of movement when the bricklayer is building the wall and reduces the possibility of mortar droppings collecting between the main wall and the sleeper wall.

Figure 1.32 shows a construction that will provide efficient support and very important ventilation to the floor timbers.

Damp, stagnant air provides ideal growing conditions for a fungus commonly called dry rot to take root in constructional timbers. Although needing moisture to grow, the fungus roots destroy the timber, leaving it split, broken and 'dry', thereby explaining the name.

Hollow floors have to be insulated to prevent cold air rising into the building (Figures 1.30 and 1.32).

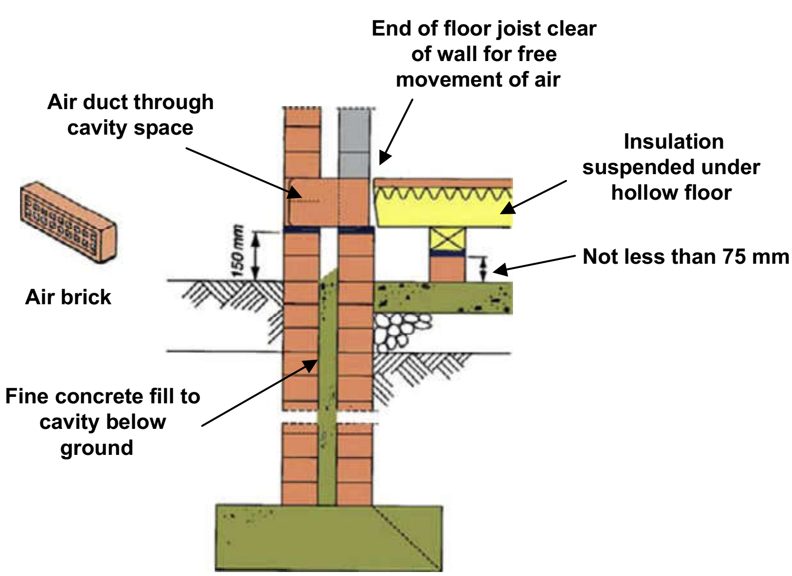

FIGURE 1.32
Cavity wall, showing underfloor ventilation

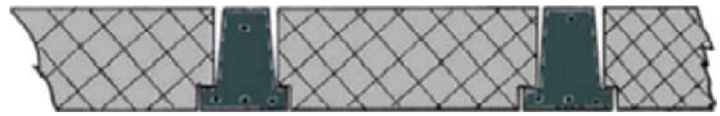

FIGURE 1.33
Precast concrete ground floors: concrete blocks resting on prestressed precast concrete beams

Precast beam and pots

Prestressed precast concrete beams were first used in commercial ground floor construction and are now common in domestic construction. They have been designed as an alternative to suspended timber floors. The same preparation is required as for suspended timber floors (Figure 1.33).

When precast floors have been constructed they provide a safer work area than suspended timber floors at both ground and first floor level.

Suspended timber floors require boarding out before work can proceed, whereas the complete floor area of precast floors is ready to work on and can take full loads.

Suspended upper floors

Timber floors are the most common type in domestic buildings and precast concrete floors are more common in commercial buildings.

A suspended timber floor consists of a number of joists either built into the walls (Figure 1.34) or resting on joist hangers (Figure 1.35).

Suspended floors that belong to the same dwelling unit are not required to be insulated, but when they are between two properties then insulation for sound, fire and heat loss is required.

Galvanized steel restraint straps (Figure 1.35) are used to restrict movement. Herring- bone strutting is fixed between the joists to prevent movement and twisting (Figure 1.36).

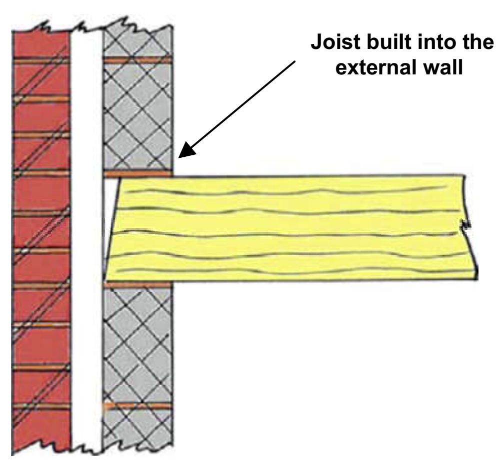

FIGURE 1.34
Suspended timber upper floors

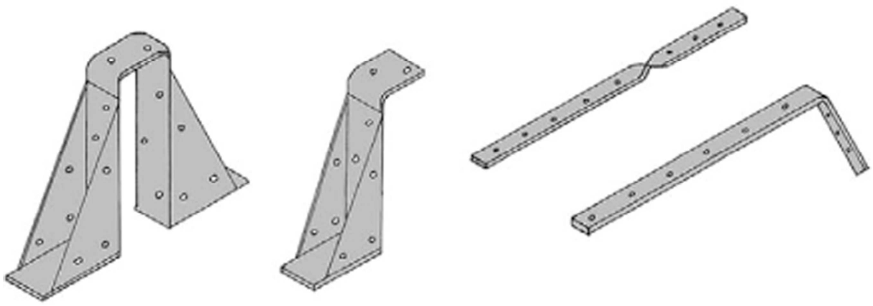

FIGURE 1.35
Double and single joist hangers and restraint straps

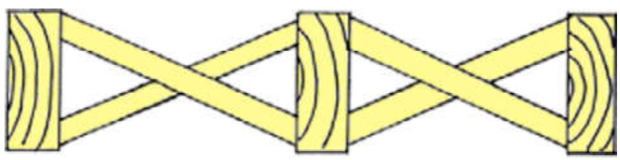

FIGURE 1.36
Herringbone strutting

Concrete suspended floors

Concrete beam and block floors are the most common in domestic buildings, but there are many other designs for commercial buildings where greater loading is required.

Concrete suspended floors fall into two categories: those that require formwork and those that do not.

Precast beams with concrete blocks or clay pots do not require formwork and can be used immediately the floor is completed. A typical design is shown in Figure 1.37.

Cast in situ concrete floors require temporary formwork while the concrete sets (Figure 1.38).

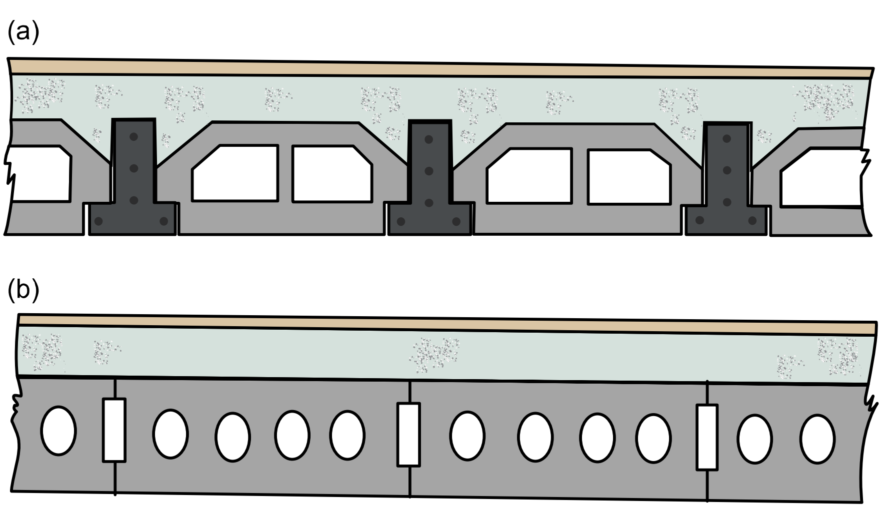

FIGURE 1.37
Precast first floors: (a) precast concrete beam and pot composite floor; (b) precast concrete cored slabs

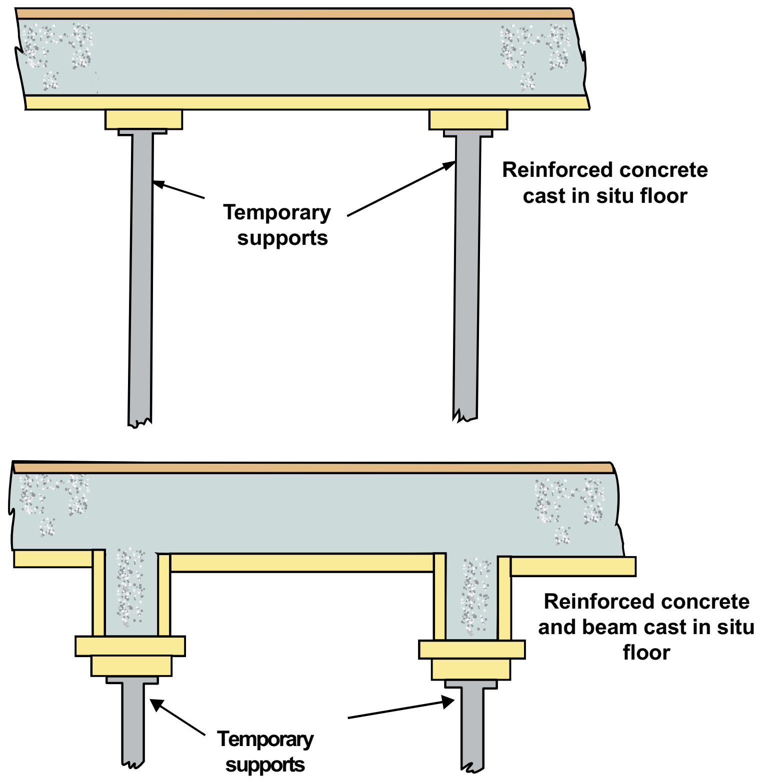

FIGURE 1.38
Cast in situ concrete floors

There are many methods available but all consist of a slab of reinforced concrete up to a spans of 5 m. When larger spans are required, beams are incorporated into the design.

There are several disadvantages of cast in situ floors over precast floors, the main one being the time involved. With precast floors, there is no waiting for the concrete to cure and the working area is available immediately.

Floor finishes

There are numerous floor finishes available, some of which form an integral part of the construction, such as floor boarding and screeds.

Screeds

These are used to give the concrete floor, at either ground floor or upper floor level, a durable finish to receive the final floor finish, such as tiles.

Cement and fine aggregate screed are laid up to a thickness of 75 mm directly on top of the concrete floor (Figure 1.39).

Floor boarding

Timber suspended floors can be covered with either floor boarding or sheets (Figure 1.40).

Tongue-and-groove boarding is laid at right angles to the floor joists and should be fastened using floor brads.

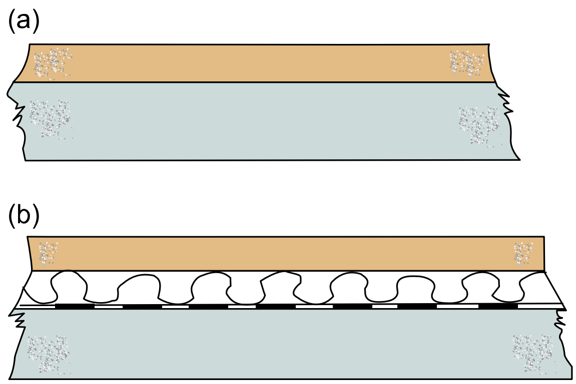

FIGURE 1.39
Screeds to concrete floors: (a) sand and cement screed laid on concrete slab; (b) sand and cement screed laid on insulation, DPM and concrete slab

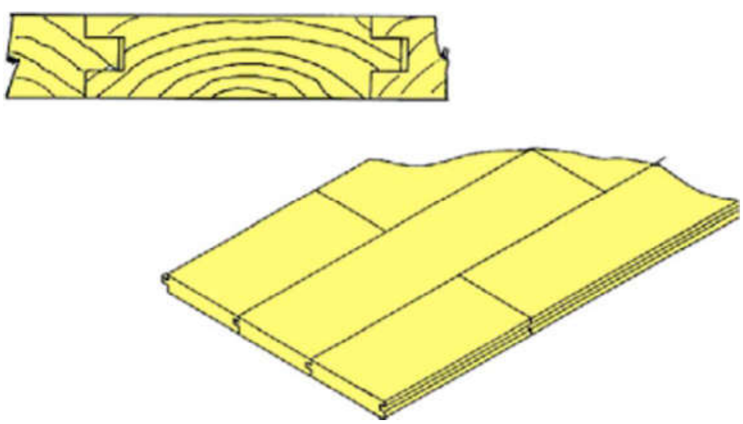

FIGURE 1.40
Covering to timber joists: tongue-and-groove floor boarding

Sheeting is available in 600 mm × 19 mm sheets and is laid at right angles to the floor joists in a chequerboard design. Sheeting should be screwed into position to prevent movement.

Floating floors

When quiet floors are required, such as for a library, floating floors can be constructed (Figure 1.41). They require the final floor to be separated from the floor structure to prevent the passage of sound up through the structure and into the room above.

Windows

The primary function of a window is to provide a means for admission of natural daylight to the interior of the building. A window can also serve as a means of providing the necessary ventilation of dwellings.

Window frames can be made from a variety of materials, such as timber, plastic or metal, e.g. aluminium.