UNISON OPEN COLLEGE

BLOCK HCPM.101

CONSTRUCTION METHODS AND MATERIALS

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Preface

In this Block, we will cover the main methods and materials used in house construction.

We will begin by establishing the relevance to housing managers of a knowledge of construction methods and materials. We will then survey the history of domestic building construction since the 1890s, which saw the beginnings of public housing development, through the social, economic and technological changes of the twentieth century.

In the second section, we will examine the methods and materials used in the construction of traditionally built houses, and the systems of heating, lighting and sanitation. In the final section, we look briefly at some non-traditional methods of housing construction, including a discussion of their advantages and some problems.

Objectives

After studying this Block you should be able to:

- explain the relevance to your work of a knowledge of building methods and materials;
- identify the main periods of house construction of the 20th century, and outline the main characteristics of housing of those periods;
- explain the basic principles of construction for the main parts of a building;
- describe the function and purpose of primary and secondary elements;
- demonstrate a knowledge of some of the materials and products used in the fabric and finishing of buildings, and its internal systems;
- identify some common building problems which occur in dwellings;
- describe some approaches to remedying common defects;
- describe the main types of non-traditional building methods used for housing, and outline their advantages and problems.
- understand the timber frame method of housing.

Contents

A. Introduction

1. The Relevance of House Construction

As someone responsible for the satisfaction of customers, and the management of housing stock, the housing manager needs to know the basics of development and construction, maintenance and refurbishment. Managers must direct everyday maintenance and repairs, and may be called upon to mediate between technical experts and tenants. Housing organisations have themselves an important client role in the development of new buildings: an understanding of construction principles will enable the manager to take a balanced view, and to brief the experts on behalf of the organisation.

The maintenance and running costs of buildings, for the housing organisation and its customers, are clearly of the utmost importance. Informed choices and decisions at the design stage, and appropriate refurbishment, can help to avoid excessive costs.

> *When you have finished working your way through this Block you will not be an expert on building construction and materials, but you should have acquired a much better understanding of how a building is constructed and the type of defects that can arise as maintenance and repair problems.*

2. Evolution of Construction Methods and Materials

In this section we shall be looking at how we arrived at current construction techniques, and the materials used in contemporary buildings.

2.1 Principal influences

The enormous economic, social, and technological changes of the last hundred years have affected the ways in which buildings are constructed, and the methods used in their development. These are some of the main influences for change in building.

- Changing social and economic conditions, including the changes caused by wars.
- New materials and technologies.
- Authoritative advice, including successive Housing Design Manuals, especially the Parker Morris Standards.

- Legislation, including building bye-laws and regulations.
- Financial controls on costs in public housing.
- Introduction of metrication.
- The impending world energy crisis.

Let us look at some of these in a little more detail.

2.2 Legislative framework

The connection between poor housing and health led to a number of Acts of Parliament from the Victorian era onwards which established basic requirements for sound housing conditions. These requirements included:

- adequate sanitation,
- adequate water supply,
- freedom from damp,
- adequate natural light,
- adequate ventilation.

Some of these criteria are covered by the *Building Regulations* introduced in 1965 and since amended. The primary purpose of the Building Regulations is to establish minimum standards for the health and safety of occupants. They do not define quality or levels of workmanship.

Other legislation affecting the construction of houses includes:

- Public Health Acts,
- Housing Acts,
- Planning Acts,
- Water Bye-laws.

2.3 Authoritative advice

Besides the statutory obligations, a number of sources of authoritative advice seek to establish good building practice.

(a) Perhaps the most significant is the British Standards Institution (BSI) who regularly publish detailed guidance on a variety of technical matters. These include:

- *British Standards* which cover such areas as the quality and dimensions of materials;
- *Codes of Practice* which cover wider issues such as building design and construction method.

(b) Other authoritative advice is published by the *British Board of Agrement* which appraises new products and techniques, and by the *Building Research Establishment*, which provides a number of invaluable reports and digests on all aspects of construction.

(c) Trade bodies such as the *Timber Research and Development Association* (TRDA) and the manufacturers themselves also produce excellent guides on specific products. Finally, most volume house-builders are members of the *National House-Building Council* which sets out minimum standards of construction and produces regular bulletins relating to building defects.

3. House Construction Over the Last 100 Years

In this section we will be looking at the different ways in which houses have been constructed since the latter part of the last century.

Activity 1

Think about any large town you know and the types of housing which may be found there. How might estate agents describe the housing? Make a list using our example to assist you. Try to get at least 5 descriptions.

1 Large Victorian terraced house.

Time allocation 5 minutes

Carol is a development officer working for a medium sized housing association in Leeds. We asked her to show us her list;

Housing in Leeds

- Victorian terraced houses
- Edwardian Villas
- Back to back street houses
- Interwar semi-detached houses
- Unity (prefabricated) houses
- The Macmillan People's House
- Deck access flats
- High rise block
- Modern estate house
- Timber framed house

How does Carol's list compare with yours? You may have come up with a different way of classifying different house construction. But a quick look at Carol's list shows that over the last 100 years there have been some enormous changes in the way in which houses are constructed.

Compare a large Victorian semi-detached house with a deck access flat built in the 1960s. The house is much bigger, is constructed of solid brickwork, with a large garden. The deck access flat will be smaller, may be built of concrete panels and has no individual garden area. A timber framed house built on a new-build housing association scheme is significantly different in terms of construction to a "Unity" house, built after the last War, as a quick fix for the nation's housing shortage.

The following extract and illustrations are from *"House Construction: a basic guide"* written by Alan Woodhead for the Chartered Institute of Housing. In it the author attempts his own classification of house construction since 1900. Read the article and then look at the activity which follows.

House construction: A basic guide

Housing stock can generally be categorised and identified as Old Traditional, Prefabricated, Traditional, Rationalised Traditional, or Industrialised and it may be that if present experimental work is successful, new categories will be established in the future.

In the following notes, an attempt has been made to date the various categories, but these are approximate, as each category was slowly superseded by another, the acceptance of which, particularly Industrialised, was largely dependent upon the attitude of individual Local Authorities.

Old Traditional 1900-1930

These had solid external walls of locally produced bricks, on brick foundations, no damp courses, segmented or flat arches to door and window openings, with much use of brick string courses and cills and large areas of cement rendering etc. Roofs were pitched, of timber, many with no underfelt, and covered with slates or clay tiles, with mainly cast iron gutters and fall pipes. Ground floors were often solid to kitchen and storage areas, and of suspended timber construction to other rooms and upper floors. Kitchen and store walls were frequently unplastered, and ceilings were lath and plaster. Windows were generally timber, vertical-sliding sash, and external and internal doors either panelled or boarded. Kitchens had very few cupboards, if any, and the free-standing sink often had no drainer. The food storage consisted of a cold slab and shelving in a separate larder. Most rooms had open fireplaces and occasionally, an open cauldron-shaped water boiler with lid, in the kitchen. Internal plumbing was in lead. Some houses built in 1910 are illustrated in Plate 1.

Damp courses were gradually introduced in the 1920s and an example from 1925 is shown in Plate 2.

1930-1940

Cavity external walls (still of local bricks) were gradually introduced around the 1930s on concrete strip foundations and dampcourses were in common use. The external appearance was slightly less ornate and timber or steel casement windows were introduced. Roofs now had underfelt, but were still uninsulated, and cast iron or wooden gutters were provided. There was some improvement in the provision of kitchen fittings, and all walls were now plastered, but many bathrooms were still positioned on the ground floor, usually directly off the kitchen. Open fires were still provided to the main rooms, and lead internal plumbing was gradually replaced by iron or galvanised steel. An example is shown in Plate 3.

Prefabricated 1945-1950

After the second world war there was an urgent need to replace the thousands of houses destroyed, particularly in the cities, and many more were required to provide first homes for the vast numbers of service personnel returning to civilian life. Practical considerations controlled the rate of demobilisation and there was insufficient time to provide either the materials or suitable labour, to meet the requirements by traditional building methods. However, there were many factories which had been geared to the war effort, which were suitable for redirection towards the mass production of both new materials and those not previously in common use, e.g. fibre boards and aluminium and these were utilised.

As far as possible the resultant designs were prefabricated in the factories, using non-traditional materials, in order to reduce the time and skilled labour required on site. They were of frame construction, (generally with trussed roofs of very low pitch), and clad with a variety of materials, including asbestos, steel, aluminium, and concrete, although some were provided with an external skin of traditional brickwork. Metal casement windows of widely different design were in common use and internally maximum use was made of fibre and plasterboards, for wall, ceiling and partition linings. The provision of kitchen facilities was greatly improved with the introduction of mass-produced cupboard units (some of metal construction) and the inclusion of free-standing cookers and refrigerators. Heating was often provided by an open fire in the living room, and closed stove in the kitchen, with some attempt to provide background heat elsewhere. There was a greater provision of electric power points than previously and whilst subsequent improvements in standards evoked criticism of the performance of some of these dwellings, the better ones are still regarded with some affection by both past and present tenants. See Plate 4.

A minority of the prefab designs were only intended to have a short or restricted life span and yet gave many years satisfactory service. Of these designs, one in particular was so successful that many tenants were reluctant to transfer to more modern houses, even after being informed that demolition was essential, due to structural deterioration.

***Traditional** 1945-1960*

There had been some traditional building during the prefab era, and this was gradually increased as more skilled labour and materials became available.

Of necessity, most Authorities simply resumed building to the same designs as had been used just prior to the outbreak of war and whilst pitch roofs had always been predominant, some flat-roofed dwellings had been introduced and these also continued. Flat roofs were of timber or concrete, felt or asphalt-covered, with parapet walls to the edges, and an example is shown in Plate 5. Apart from the roof, the rest of the construction and fittings was identical to that of the pitched roof dwellings built in this period but many maintenance problems were to occur, simply because of the roof construction.

Initial improvements to the road network, greater availability and use of motor transport, permitted less reliance on the use of local materials and made available a wider selection of facing bricks of many colours and textures. Concrete roofing tiles of different colours and profiles were introduced. Coke breeze building blocks of various thicknesses were readily available for internal walls, partitions and inner leaves of cavity walls. Pitched roofs returned to a more traditional (steeper) pitch than the prefab type, with much use of asbestos gutters and pipes. Windows were wood or metal casements, doors flush. Some form of background heating was very occasionally included. Copper pipework and wastes were used and also either separate cookers or combined heating-cooking appliances. Solid floors were either thermoplastic-tiled or asphalt-covered.

Towards the end of the 1950s, plastic gutters and pipes were introduced, together with pivot windows, and more use was made of glass panelled external doors. Separate cookers and heating appliances had now superseded the combination range but provision of background heating was still limited and individual electric wall fires often used to supplement the main heat source. More variety was introduced into the external appearance by the use of small panels of cement rendering or timber boarding and reinforced concrete boot lintels (sometimes with projecting concrete window surrounds) were introduced. See Plate 6.

Rationalised Traditional

In the late '50s and early '60s, fresh efforts were made to improve efficiency and speed in the traditional building process, by the combination of modular-controlled, factory-produced components, and traditional practices on site, i.e. by rationalising the traditional approach. Probably the best known of these is the cross wall construction, involving brick or block gables and separating or 'party' walls, set out to receive infill panels to front and rear elevations. These panels *were produced off-site and often only required the addition of window glass and external door hanging after installation. Such panels were generally timber framed, covered with a variety of materials, e.g. boarded or plywood/asbestos panelled. See Plate 7.*

By the early '60s some Authorities were already introducing some form of central heating, if only to the ground floor rooms. However, by the late '60s all authorities were doing so following the introduction of mandatory heating and space standards, as recommended earlier in the Parker Morris Report.

Industrialised

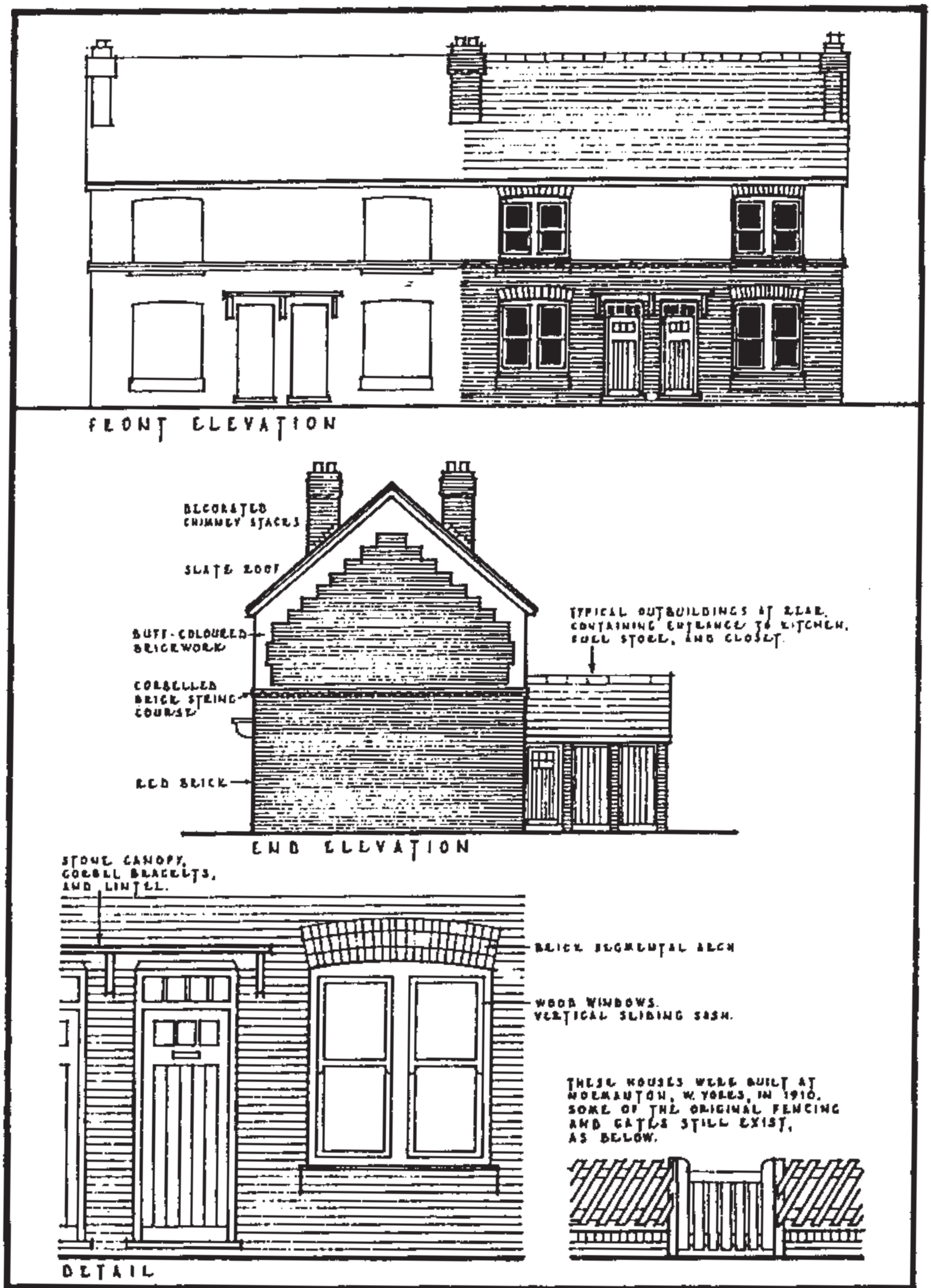
The rate of house building had not kept pace with housing needs. Accelerating slum clearance programmes and the anticipated post- war population boom, were creating a huge housing deficit and drastic measures were required. A vast number of modular building systems were developed using new techniques, materials and maximum use of factory produced and assembled components, which could be so arranged on site as to provide some variation in the external appearance of the dwellings, or internally, to permit the use of a standardised bathroom layout within houses of varying plan arrangements. They generally consisted of a structural frame of timber, steel or concrete, usually with infill panels, or sometimes with an outer skin of brickwork to create a more traditional appearance. In many cases, concrete was the basic material for both the structure and external shell of the dwelling with the emphasis on prefabrication off-site, or cast in-situ using the 'no fines' principle. Most building systems were also designed to allow greater flexibility in the choice of heating installation and waste disposal was by the single stack system. See Plate 8.

Such provisions should have improved the living conditions of the occupants. Unfortunately, some building systems relied too heavily on the use of joint sealants, whilst others may have been too enthusiastic in their acceptance of some continental building techniques, which were designed for different climatic conditions to those prevailing in this country. At least one system was designed to such critical structural limits, either through ignorance or economic pressure, that it became unstable in extreme weather conditions, and would have required a degree of quality control during fabrication and construction that was virtually impossible to achieve, given all the vagaries of our weather, and the building industry.

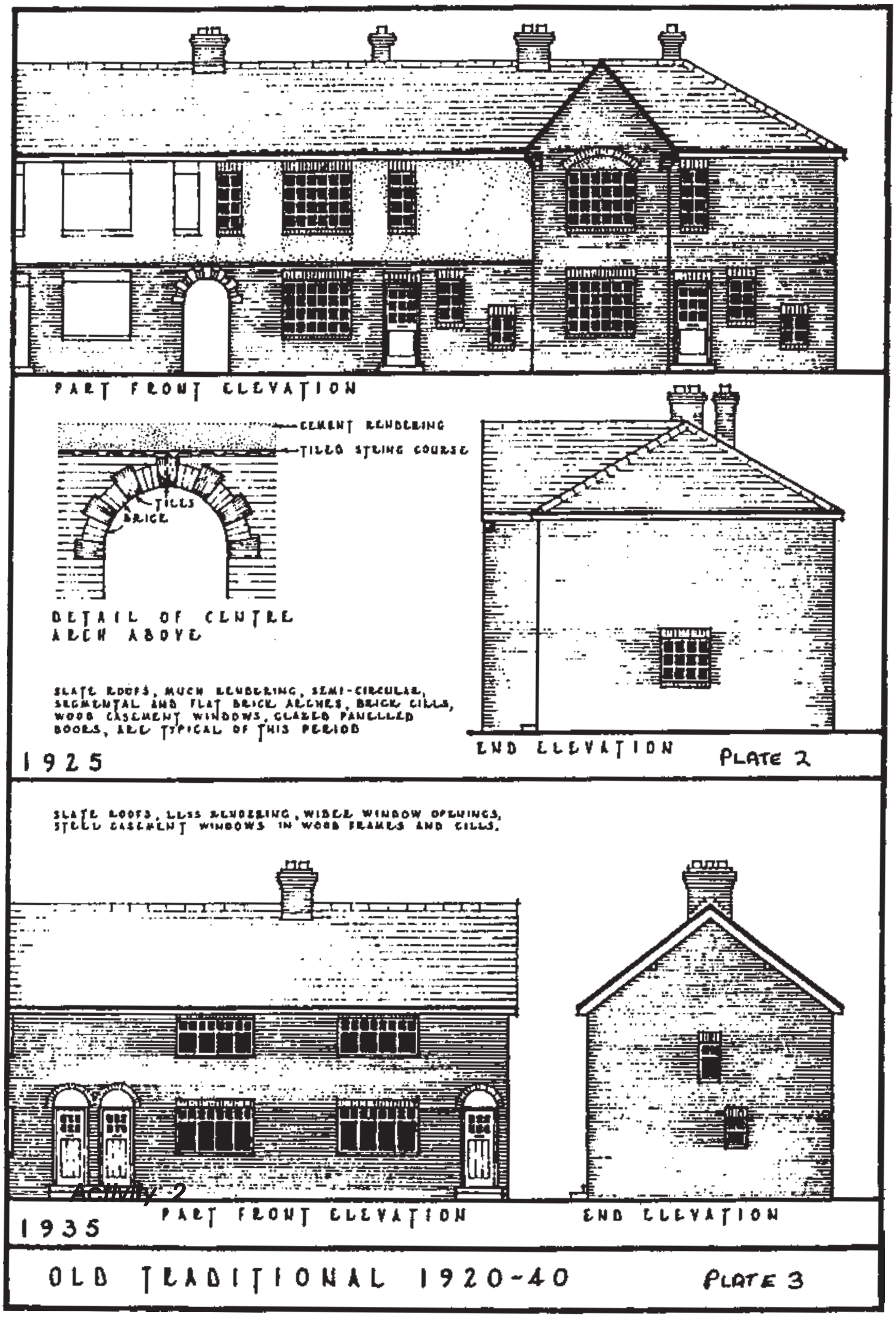
At the peak of the industrialised period there were over two hundred systems on offer, some of which were promoted by companies who had previously only supplied an individual building component, and simply attempted to provide a complete system around it, with insufficient experience or knowledge of the overall problems of housing design and construction. It was, therefore, obvious that many of the systems could not possibly survive the intense competition, and some Local Authorities took this into account, together with the implications for future maintenance, when making their selections. Furthermore, industrialised systems were seen as a threat by traditional building contractors, many of whom reacted by offering their own 'design and build package deals' as an alternative.

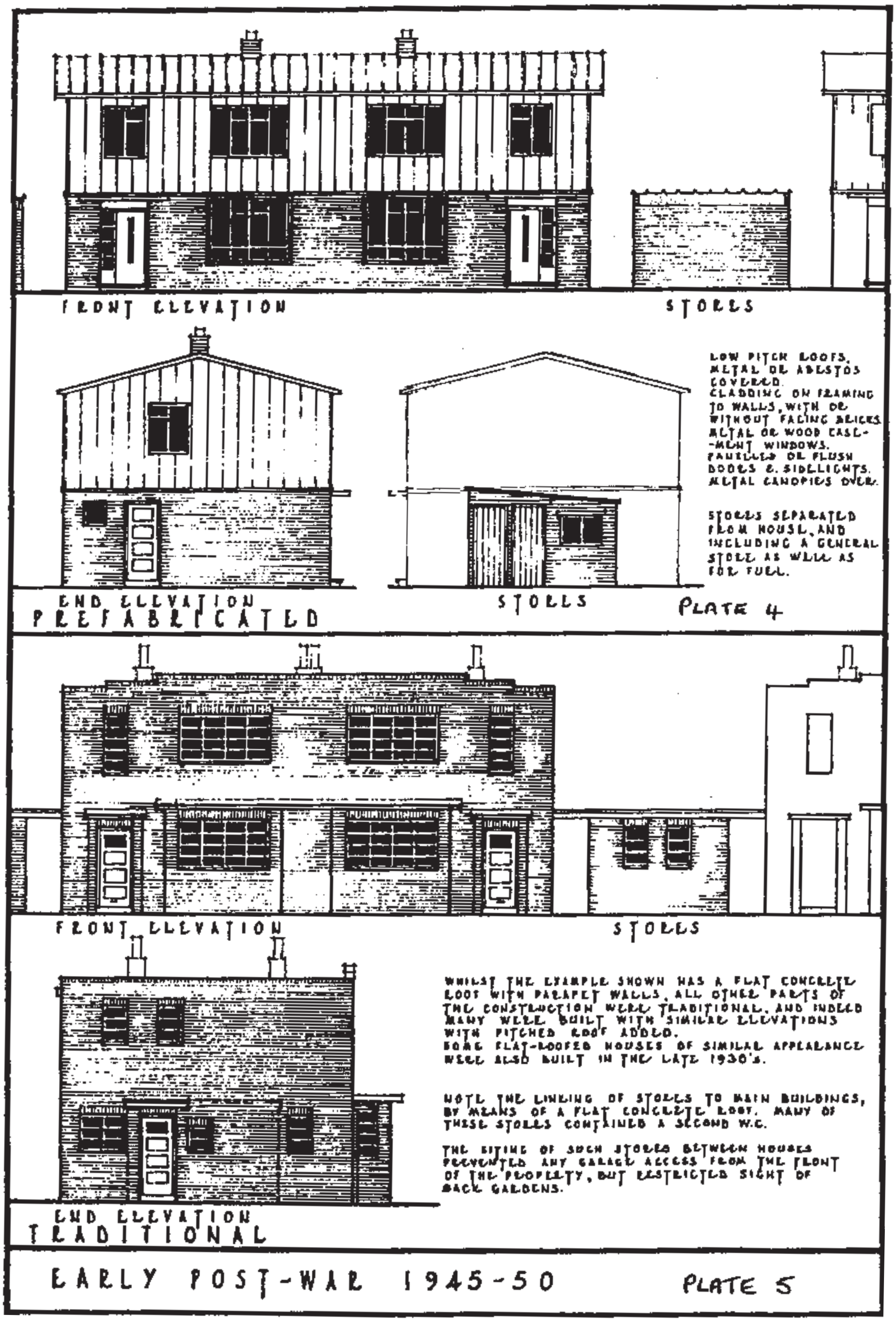
Of the failures during the Industrialised Period, some were predictable and should have been avoided. Others were not so obvious, and whilst, with hindsight, some criticism of the designers, builders and Local Authorities is warranted, they were subject to the policies, pressures and financial or design constraints of successive central governments and their agencies. The financial and social legacy of such policies has already compelled some Local Authorities to demolish various industrialised dwellings built within the last twenty years, which were intended to last for a minimum of sixty years, rather than attempt to maintain or improve them to a satisfactory habitable standard.

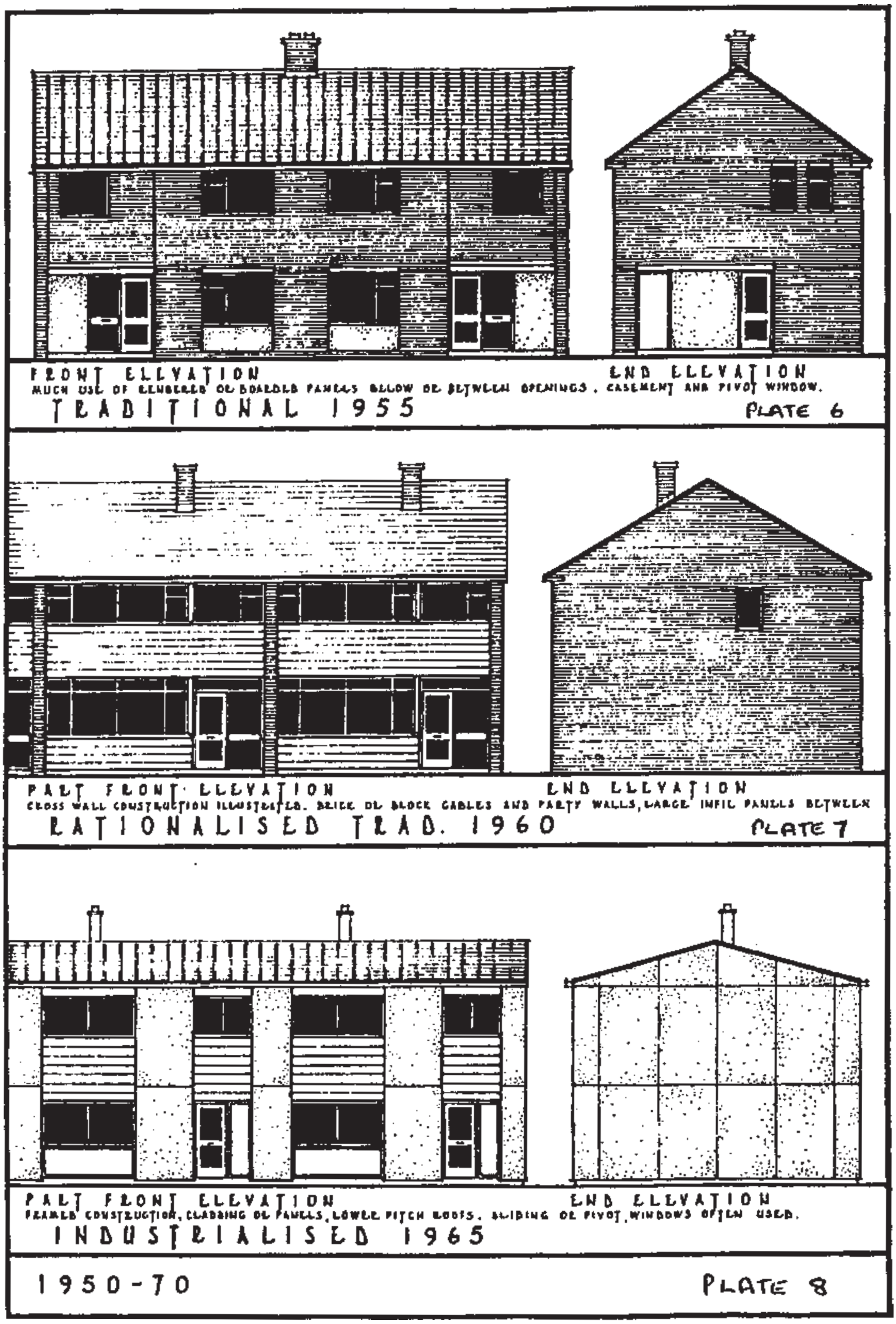
Whilst routine maintenance and repair of minor defects occurring in the successful systems is often similar to that required for more traditional housing, detailed knowledge of the particular building system is essential when more serious faults are being examined. This also applies to prefab housing and is beyond the scope of this manual.



OLD TRADITIONAL 1910 PLATE 1


PART FRONT ELEVATION
CEMENT RENDERING
TILED STRING COURSE
TILES
BRICK
DETAIL OF CENTRE ARCH ABOVE
SLATE ROOFS, MUCH RENDERING, SEMI-CIRCULAR, SEGMENTAL AND FLAT BRICK ARCHES, BRICK CILLS, WOOD CASEMENT WINDOWS, GLAZED PANELLED DOORS, ARE TYPICAL OF THIS PERIOD
1925
END ELEVATION
PLATE 2
SLATE ROOFS, LESS RENDERING, WIDER WINDOW OPENINGS, STEEL CASEMENT WINDOWS IN WOOD FRAMES AND CILLS.
Activity 2
1935
PART FRONT ELEVATION
END ELEVATION
OLD TRADITIONAL 1920-40
PLATE 3


FRONT ELEVATION
STORES
LOW PITCH ROOFS, METAL OR ABESTOS COVERED.
CLADDING ON FRAMING TO WALLS, WITH OR WITHOUT FACING BRICKS.
METAL OR WOOD CASE-MENT WINDOWS.
PANELLED OR FLUSH DOORS & SIDELIGHTS.
METAL CANOPIES OVER.
STORES SEPARATED FROM HOUSE, AND INCLUDING A GENERAL STORE AS WELL AS FOR FUEL.
END ELEVATION
PREFABRICATED
STORES
PLATE 4
FRONT ELEVATION
STORES
WHILST THE EXAMPLE SHOWN HAS A FLAT CONCRETE ROOF WITH PARAPET WALLS, ALL OTHER PARTS OF THE CONSTRUCTION WERE TRADITIONAL, AND INDEED MANY WERE BUILT WITH SIMILAR ELEVATIONS WITH PITCHED ROOF ADDED.
SOME FLAT-ROOFED HOUSES OF SIMILAR APPEARANCE WERE ALSO BUILT IN THE LATE 1930's.
NOTE THE LINKING OF STORES TO MAIN BUILDINGS, BY MEANS OF A FLAT CONCRETE ROOF. MANY OF THESE STORES CONTAINED A SECOND W.C.
THE SITING OF SUCH STORES BETWEEN HOUSES PREVENTED ANY GARAGE ACCESS FROM THE FRONT OF THE PROPERTY, BUT RESTRICTED SIGHT OF BACK GARDENS.
END ELEVATION
TRADITIONAL
EARLY POST-WAR 1945-50
PLATE 5


FRONT ELEVATION
END ELEVATION
MUCH USE OF RENDERED OR BOARDED PANELS BELOW OR BETWEEN OPENINGS, CASEMENT AND PIVOT WINDOW.
TRADITIONAL 1955
PLATE 6
PART FRONT ELEVATION
END ELEVATION
CROSS WALL CONSTRUCTION ILLUSTRATED. BRICK OR BLOCK GABLES AND PARTY WALLS, LARGE INFIL PANELS BETWEEN
RATIONALISED TRAD. 1960
PLATE 7
PART FRONT ELEVATION
END ELEVATION
FRAMED CONSTRUCTION, CLADDING OR PANELS, LOWER PITCH ROOFS, SLIDING OR PIVOT WINDOWS OFTEN USED.
INDUSTRIALISED 1965
1950-70
PLATE 8

PART END PART FRONT ELEVATION

CLEAN DESIGN. IMPROVED INSULATION. ATTENTION TO DETAILS TO REDUCE MAINTENANCE COSTS. HIGH PERFORMANCE WINDOWS.

RATIONALISED TRAD. 1975 PLATE 9

FRONT ELEVATION PART END

VERY HIGH INSULATION STANDARD TO ROOF, WALLS & FLOOR, & DOUBLE GLAZING, PERMITS VERY SMALL HEATING UNIT.

EXPERIMENTAL LOW ENERGY 1980 PLATE 10

NOTE.

SINCE THE BEGINNING OF THIS CENTURY, DIFFERENT BUILDING CONSTRUCTION TECHNIQUES HAVE BEEN INTRODUCED TO MEET CHANGING SITUATIONS, AND TO BENEFIT FROM NEW MATERIALS AND TECHNOLOGY.

ANY CHANGES MAY HAVE BEEN GRADUAL, OR SUDDEN, AND SUCCESSFUL, OR OTHERWISE.

IT IS NOT THEREFORE POSSIBLE TO DEFINE THE PRECISE PERIODS WHEN INDIVIDUAL METHODS/SYSTEMS WERE IN USE.

HOWEVER, THE EXAMPLES SHOWN ON PLATES 2. TO 6. ARE OF EXISTING BUILDINGS, AND THEIR INDIVIDUAL CONSTRUCTION DATES STATED.

1970 TO THE PRESENT.

As you can see, the author identifies five main categories of house construction;

- *Old traditional*
- *Prefabricated*
- *Traditional*
- *Rationalised traditional*
- *Industrialised*

Let us look again at the list of house types which Carol identified in Leeds and attempt to place each of them into one of these categories.

- *Victorian terraced houses*
- *Edwardian villas*
- *Back to back street houses*
- *Interwar semi-detached houses*
- *Unity (prefabricated) houses*
- *The Macmillan People's House*
- *Deck access flats*
- *High rise block*
- *Modern estate house*
- *Timber framed house*

Time allocation 10 minutes

We asked Carol to do this Activity and her response was as follows;

Old traditional

- Victorian terraced houses
- Edwardian villas
- Back to back street houses
- Interwar semi-detached houses

Prefabricated

- Unity (prefabricated) houses

Traditional

- The Macmillan People's House
- Modern estate house

Industrialised

- Deck access flats
- High rise block

Rationalised traditional

- Timber framed house

Whilst there might be some argument about some of our classifications, (for example is modern timber framed really a rationalised traditional form of construction?), this exercise is useful in that it requires you to think in more detail about the different ways in which houses have been built over the last century.

So far we have stopped at the end of the 1960s. What has been happening since? Read the final section of the extract from "*House construction: a basic guide*".

Housing Today

Since the end of the 60s, Authorities have turned away from the industrialised approach and yet there has been an increasing use of the types of timber-framed structures which were originally inspired by it. The standards achieved will vary, as they do with any other form of construction, including traditional. It is, therefore, perhaps unfortunate but inevitable, that even the better ones will be subject to the antipathy originally created by the industrialised approach.

Most Authorities have reverted to a more sophisticated rationalised, traditional approach, based upon the mandatory modular 300mm square plan grid, with mandatory heating and insulation standards for walls and roofs. To achieve these standards, much use is being made of thermal building blocks, high performance windows, some form of cavity insulation, and more efficient roof insulation. Externally, many designs are simple, clean in appearance, utilising high quality brickwork and roofing tiles (usually on trussed rafters) with plastic rainwater goods. Plate 9. Internal, single-stack drainage systems are in almost universal use, with ample provision of both kitchen units and internal storage areas, and wider selection of better quality flush doors. More attention is being paid to detailing, in order to reduce maintenance costs and to improve the internal living conditions of the occupants. There is also a greater emphasis on providing a much more humane and varied environment, which is certainly preferable to the soulless, drab monotony of much of the past.

Future Trends

Decreasing world fuel supplies are accelerating the study of dwellings, insulated to such a degree that the occupants' comfort will be maintained by the use of a very small heating appliance, using minute quantities of fuel. The nature of the construction may influence the external appearance of future housing and an example of one such experimental "low energy house" is shown in Plate 10.

Experiments are also being carried out to utilise radiated heat from the sun (solar heat), and whilst our climate is not as suitable as others, some success has been achieved here in the provision of hot water for domestic purposes. If it should become possible to provide all our house heating requirements by these means, then the solar panels required to do this will most certainly affect the external appearance and structure of houses in the future.

Estate Design

Whilst the foregoing notes should assist the reader to identify the main types of housing and approximate periods when they were built, they can often be dated by the type of estate layout used, the facilities or amenities provided and the social needs which influenced their design, e.g. car ownership, segregation of pedestrians and vehicles, access roads etc. Whilst such influences may have had some effect on the design of dwellings, they have had little or no effect upon housing maintenance. However, they have created problems in the maintenance of garages, landscaping, parking and play areas.

There seems to have been a return to some of the more traditional building techniques, and a reluctance, borne out of experience, to experiment with new forms of construction. The typical dwelling today will be a 2 storey semi detached or terraced house, with traditional cavity wall construction of brick and block, and high levels of insulation.

However, housing managers are not simply managing the newer stock built in the last 10 years. Often they are required to manage and maintain stock built in every decade this century and some landlords will have housing in all of the categories we have identified. It is essential therefore that housing managers have some understanding of the different ways in which their stock has been constructed and in the following sections of this block we will be looking at both traditional and non traditional forms of house construction.

Self Test 1

1. *What aspects of building performance are the Building Regulations concerned with?*

2. *What other legislation affects housing construction?*

3. *To what bodies and publications would you look for authoritative advice on good practice in building?*

4. *In which housing periods or categories would you expect to find the following features?*

   (a) Brick foundations.

   (b) Lath and plaster ceilings.

   (c) Iron or galvanised steel internal plumbing.

   (d) Low pitched trussed roofs.

(e) Asbestos gutters and pipes.

(f) A frame of timber, steel or concrete with infill panels.

5. *Which contemporary environmental concern is likely to affect the traditional appearance of buildings?*

6. *What type of external wall construction will typically be found on houses built 100 years ago?*

7. *Around what time were cavity walls becoming more common?*

8. *What was the reason for the development of prefabricated forms of dwelling after the last War?*

9. *What was the best known form of rationalised traditional construction?*

Now turn to the Answers at the end of the Block.

B. Traditional Construction

1. Introduction

This section examines the construction of houses in approximately the order in which a traditional dwelling is constructed. This is followed by a discussion on the various defects which may be associated with each particular aspect of construction.

Landlords and tenants have differing responsibilities for repairing and maintaining dwellings. However, it is landlords who have the greatest responsibilities. They are responsible for all major repair and maintenance items. It is, therefore, essential that landlords have a detailed knowledge of the construction of their dwellings and of organisational procedures relating to their repair and maintenance.

Activity 3

Before we begin the detailed study of this block think about the different elements that make up a typical house and make a list of any you can identify. To help you we've set out some of the elements below;

Foundations

Roof coverings

Doors and windows

Time allocation 5 minutes

We asked Lesley, a housing officer in a small rural authority in Wales, to tackle this activity and this is what she listed:

Primary building elements:

- Foundations
- Block work
- Floors
- Brick work

Secondary building elements:

- Roof timbers
- Roof coverings
- Windows and doors
- Electrical wiring
- Plumbing and heating
- Internal joinery
- Plaster
- Painting

How does your list compare with Lesley's? No doubt you have included many of the items in Lesley's list, and you will probably have included others.

Primary Building elements

As you can see, the primary building elements are all related to the basic structure of the building: the foundations, walls, floors, roofing timbers and the roof covering. When a house is being constructed these are usually the first elements to be constructed.

Secondary Building elements

The shell of the house consists of the primary building elements. The secondary elements relate to aspects such as wiring, plumbing, internal joinery (such as doors, architraves, windows), plaster and painting.

All dwellings consist of similar parts. However, the type and construction of each constituent part varies between, and even within the same, dwellings, depending on when a property was constructed, and/or converted or modernised. As you have already discovered, in this century alone, huge changes have been made in the particular construction techniques employed.

It is therefore essential that the landlord maintains records showing the differing construction of each dwelling and employs those specialist staff capable of diagnosing constructional problems as they occur, and who are capable of correcting those problems.

Larger landlords frequently employ architects, surveyors and building inspectors. Smaller landlords will probably have to consider contracting out diagnostic work to specialist companies.

Let us begin by looking at the purpose and nature of **foundations**, the first stage in any construction.

2. Foundations

Once a decision to construct a building has been made and all of the approvals have been obtained, the first task is to determine the "quality" of the ground on which it is to be built. This is done by drilling or excavating a number of small trial holes on the site to establish the solidity, or otherwise, of the ground below the immediate surface. This ensures that the appropriate foundations for the building can be correctly specified.

2.1 The purpose of foundations

Activity 4

All buildings have foundations on which the building rests. Why can't the building simply be built directly on to the soil?

Time allocation 5 minutes

Think about buildings or structures which do not have solid foundations. The next time you are in a church yard, look at some of the gravestones. You will probably find that a lot of the older graves have headstones at all sorts of angles. Most gravestones are simply laid directly on the earth without any real foundations and over time the ground will move. It may shrink as it dries out, or swell and heave as it gets waterlogged. All of this will affect its ability to carry a load. As a result any structure built on it will move. Think about the leaning Tower of Pisa, another example of a building with ineffective foundations.

You should also think about how the weight of a building is distributed. Most of the weight of a building is in the walls and roof and this is transmitted to the ground via the walls. Foundations can therefore help to spread the load of a building more evenly over the ground.

Foundations then exist to support the whole building by providing a firm base to prevent its movement and to spread the weight more evenly.

2.2 Types of foundations

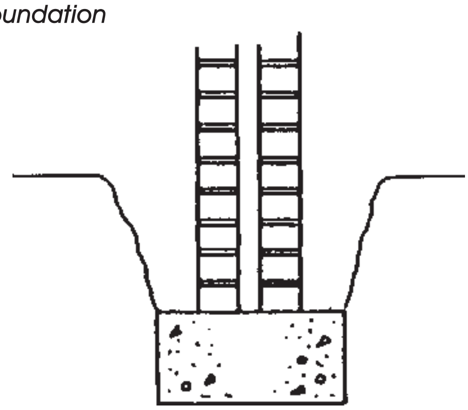
The type of foundation used will depend upon the nature of the ground on which building is to take place. Put simply, the "weaker" or more variable the sub-soil, the bigger the foundations required. A *site survey* may be necessary to establish the exact nature of the sub-soil.

Nowadays all foundations are made from concrete and can take one of three basic forms:

(a) Strip

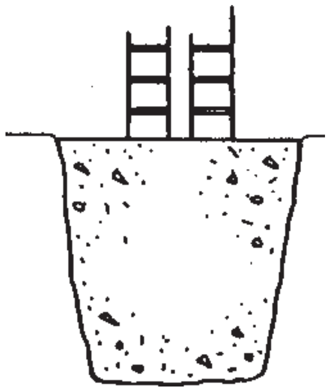
Probably the most common form of modern foundation, this is created by digging a trench to the pattern of the load-bearing walls of the building and then pouring concrete into the bottom of the trench. Frequently, the concrete is reinforced by laying steel bars or mesh into the wet concrete. Once the concrete has dried the walls are then constructed, using the foundation as a base.

Figure 1: A strip foundation



A variation of the strip foundation is the system known as "trench-fill" which is similar, but the concrete is poured much deeper and actually fills the trench up to ground level.

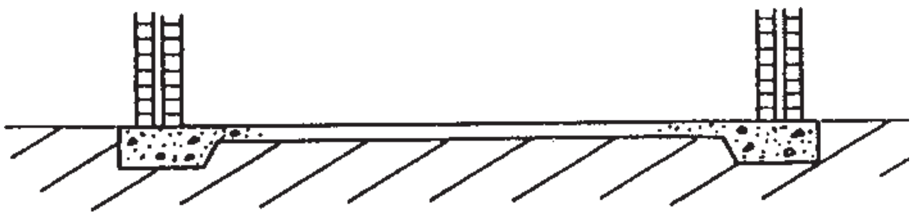
Figure 2: The "trench-fill" variation



(b) Raft foundations

Where the soil is "weak" or where subsidence may occur a raft foundation may be constructed. This lies near ground level under the entire building and, just like a raft, provides a single, solid, plate upon which the whole house rests.

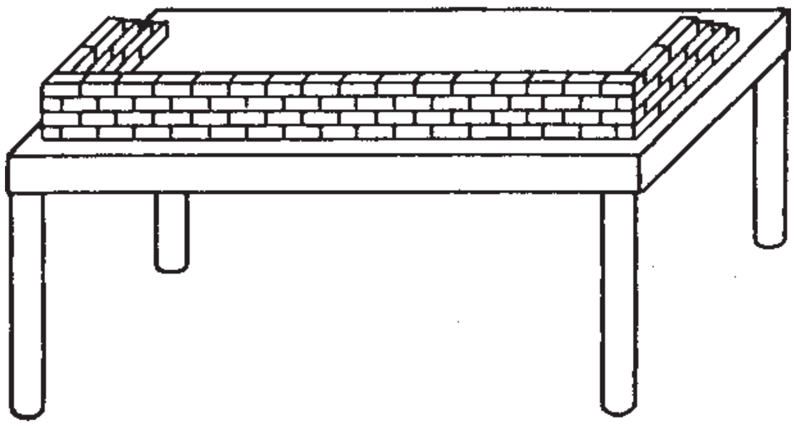
Figure 3: A raft foundation



(c) Piles

To support very heavy buildings, such as flats, or if the sub-soil is very poor, then a much deeper foundation is needed. In such cases deep holes are sunk at the corners of the building. These are filled with concrete to form deep "legs" upon which a reinforced strip foundation is then laid.

Figure 4: A pile foundation



In some dwellings built at the turn of the century, or even earlier, the foundations may consist entirely of bricks, but this practice, known as "Providing brick-footings", has subsequently been discontinued.

2.3 Problems with foundations

It is unlikely that a customer would come into a housing office and report defective foundations. They are more likely to report some other problem with their house, which could then be attributed to problems with the foundations.

The most likely complaint is that there are cracks in the walls. Wall cracking, as we will see later in this block, can have a number of causes but one of the causes can be defective foundations.

(a) Subsidence

Areas in Great Britain have suffered from exceptionally dry summers leading to the water content of the soil falling. This has caused the ground to dry out and shrink. One of the results has been that dwellings have subsided if the foundations have not been deep enough. As the ground shrinks then the building may move, causing the cracking which is often the first sign of any problem. Of course newer houses should not suffer from this problem because the building regulations now impose much more stringent requirements for foundation design.

(b) Heave

Another cause of cracking could be *heave*: where the ground is very porous, it can expand and contract depending on the amount of water in the soil. If the original foundations were not designed with this in mind then the ground may swell and “push” the building upwards. A common cause of heave is when trees growing near to buildings are removed. As they are no longer taking water from the earth, the water content causes the ground to swell and to affect the stability of the building.

In areas with porous soil, it may be necessary to consider a raft foundation. If there is movement the whole of the raft will move, but the walls will remain at right angles to the foundations.

(c) Tree roots

Tree roots may not only take up moisture and cause subsidence; they may also push away the foundations, damaging their structural integrity.

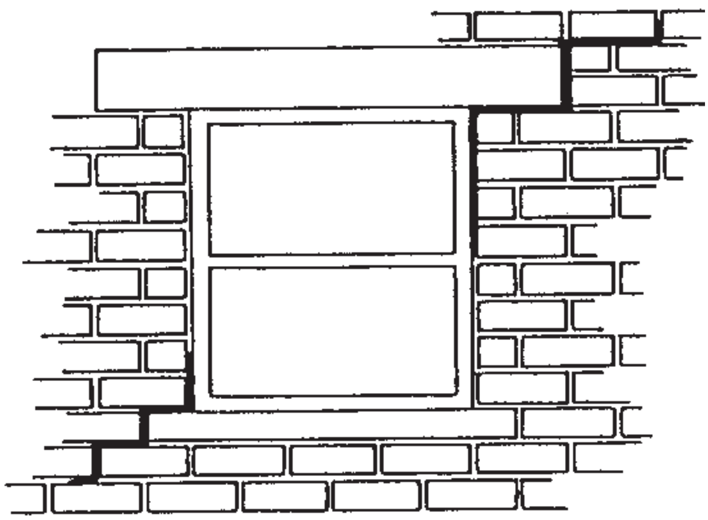
(d) Defective construction

If the foundations have been badly designed or constructed, then they may not be suitable for the ground conditions in the area. The result may be the structural cracking.

2.4 How to recognise foundation failure

The most obvious symptom of a foundation failure is a movement of the walls. Whilst the actual movement is not apparent to the eye, cracked brickwork or lines of failed mortar are usually an indication that part of the wall has moved. This movement is often most apparent around window and door openings. Unfortunately, it is not easy to see any failure in the actual foundation as this is below ground level and, to be checked, must be excavated.

Figure 5: Example of diagonal cracking across window opening



2.5 Remedial action

If walls have moved out of the perpendicular then they may be ***shored up*** or ***buttressed*** using external props. Alternatively, the unsound wall can be ***"tied"*** to a structurally sound wall or joist using metal rods.

More drastic remedies include ***demolition*** of either the whole building or of just the defective wall and rebuilding. If partial demolition is chosen, then the foundations must be excavated and repaired. This is normally achieved by ***underpinning*** - actually propping-up the foundation and wall from underneath.

3. Walls

3.1 Introduction

(a) Materials

Walls are normally constructed of brick but other materials may be used to either supplement or replace traditional brickwork. Stone, reconstructed stone, breeze blocks, cast concrete or even wood can be used. However, the choice of material for the walls will depend on a number of factors - appearance, strength, etc. - and different materials may be used for different parts of the dwelling. The external surface of the wall may also be rendered to provide a smooth finish. This is especially common in Scotland.

(b) The purpose of walls

Walls serve a number of purposes: they delineate boundaries; support roofs and floors; prevent water entering the dwelling; keep warmth in and cold out; prevent the spread of fire, etc. Some walls will be required to have all of these properties whilst others may only be required to fulfil some of these functions. Obviously a wall has failed if it can no longer fulfil all of the purposes for which it was constructed or if it becomes unsafe in its own right.

(c) Types of walls

Walls can be split into four basic types for the purpose of this Block:

- external;
- internal;
- load bearing;
- non-load bearing.

All walls fall into two of these basic types. Normally external walls are load bearing whilst only a few internal walls are load bearing - but it is not always immediately apparent which is which! However, the construction of internal walls is often a very accurate clue as to whether or not they are load-bearing.

3.2 External walls

(a) Solid walls

As you have already learned, external walls built in the 100 years or so before 1930 were always at least 9” thick: they were constructed using two thicknesses of brick. These are referred to as **solid walls**.

(b) Cavity walls

After 1930, the tendency has been to construct walls consisting of two “skins” of brick with a space or cavity between them, thus the wall is about 11” thick (2” x 4.5” wide bricks with a 2” space between the two). More recently builders have used breeze block to create the inner part of the **cavity wall** because blocks are bigger and cheaper than brick and, as they are not visible, their unattractive appearance is hidden from view. They may also have improved thermal properties.

(c) Examples

To determine whether a wall is a **solid** or **cavity wall** one may either measure its thickness - through a window or door opening, for example - or look at the outside. If the ends of the bricks are visible, this will normally indicate that the bricks are laid across two courses of brickwork and the wall is therefore solid.

Figure 6: Sections through solid and cavity walls

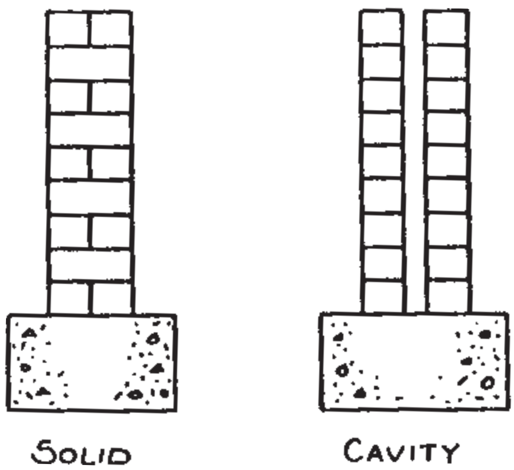
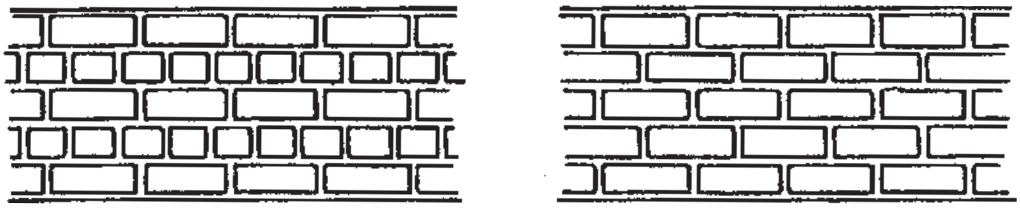


Figure 7: Examples of solid and cavity walls as viewed from outside

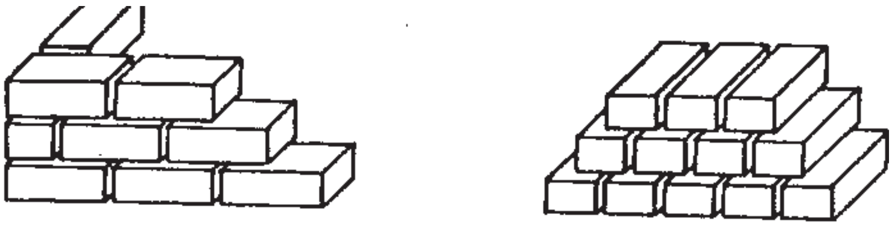


SOLID
(English bond)

CAVITY
Stretcher bond)

Bricks which are laid lengthways (looking at the wall) are known as **stretchers** whilst those laid "endways" are called **headers**.

Figure 8: Stretchers and headers



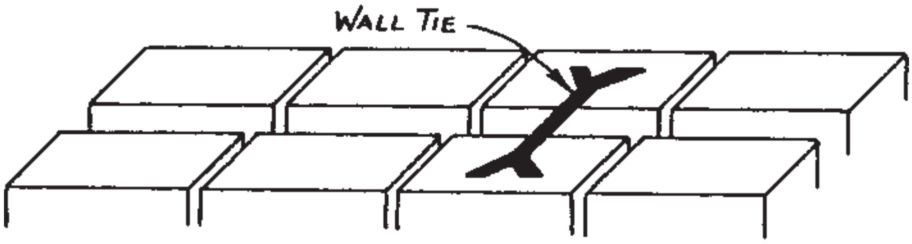
STRETCHERS

HEADERS

(d) Ties

When cavity walls are constructed, the inner and outer skins of brickwork are "tied" together using either metal or plastic **"wall ties"** which are laid across the cavity into the mortar between layers of bricks, approximately six layers of bricks apart vertically and 900mm horizontally.

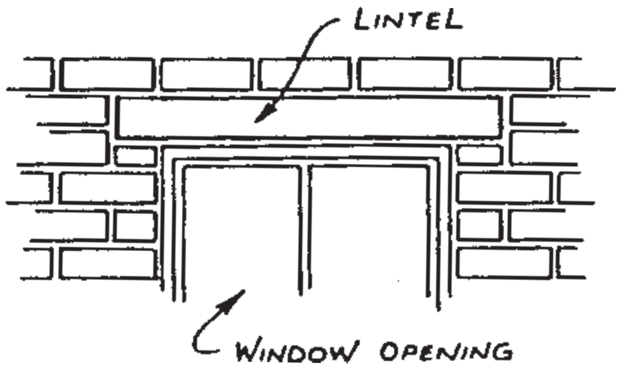
Figure 9: Wall ties



(e) Lintels

At various places within the walls it is necessary to leave spaces for windows and doors. Above these, to support the brickwork above, are laid **lintels** usually made of pre-cast and reinforced concrete or steel. In older properties, they will be made of wood.

Figure 10: Example of a lintel



This, then, is the structure of an external and load bearing wall, although some internal load bearing walls may dispense with two lines of brickwork and, instead, consist of only a 4.5" wall.

The external wall must, however, fulfil other functions than that of supporting loads such as floors and roofs. It must also prevent cold and moisture from entering the house.

The cavity in between the two skins of brickwork acts as an insulator, the air in between the bricks keeping both the moisture out and helping to lessen the effects of the extremes of outside temperature. Nowadays, many cavity walls are actually filled with some insulating material to retain the heat within the building, **but** the material must be carefully chosen and inserted to prevent it from acting as a moisture conductor, allowing water to get away from the outer layer of brickwork to the inner.

(f) Mortar

The material used to join bricks is called mortar. This is a mixture of sand, cement and/or lime, and water. Mortar should have the following properties.

The properties of a good mortar are:

(i) it should be easily workable;

(ii) it should stiffen quickly after laying to enable bricklaying to proceed without delay;

(iii) it should develop sufficient strength for the job on which it is used;

(iv) it should bond to the bricks to give a tight joint through which rain will not penetrate;

(v) it must be durable.

With age, mortar will loosen and gaps will appear between the bricks. The property will need replacement of the mortar, called "repointing".

(g) Damp penetration

A cavity wall fails to function properly if it allows in moisture, which may permeate into the dwelling by several means:

(i) By being carried across by dirt or other material (mortar stuck to a wall tie, extraneous material in the cavity wall insulation, etc.).

(ii) By following lintels, sills, etc., which are actually fixed across both "skins" of brick.

(iii) By getting into the bottom of the wall or foundation and working up through the brickwork - **rising damp**!

To prevent moisture rising up through the wall or penetrating across lintels, etc., a number of **damp proof courses** *(dpc) must be laid when the wall is constructed. Nowadays a strong plastic sheeting is used to form the dpc, but in old properties the dpc may be made of lead, slates, asphalt or copper. Normally a dpc will be laid on top of the second brick above ground level, below every sill, above every lintel and below the floor. Of course, if the dpc is torn when laid then it will fail to prevent the passage of moisture.*

3.3 Internal, non-load bearing, walls

(a) If an internal wall is constructed simply to form the wall of a room and is not required to carry any weight, then it will frequently, nowadays, be built of wood and plasterboard; the wood forming a frame onto which is nailed plasterboard or a similar proprietary board. These walls are known as **panel** or **stud-panelled partition walls**.

(b) Older houses will often have 4.5" thick brick walls even though they are not required to support weight. Breeze block is also used fairly frequently.

(c) Obviously, it is important to determine whether a wall is "load-bearing" before removing all or part of it. If the wall *does* support the floor above or a wall on upper floors, then the gap to be left must be supported by a steel girder or a concrete lintel.

(d) Covering the walls.

Occasionally people will leave the surface of an internal wall as bare brick for decorative purposes but this does require an inner skin of decorative brick. It is more usual for internal wall surfaces to be finished by either covering with plaster or plasterboard. Both finishes provide a smooth, even and resistant surface which can be subsequently decorated by the householder.

3.4 Problems with walls

Activity 5

What are the sorts of problems affecting walls, that are likely to be reported to a housing officer by a customer?

Time allocation 5 minutes

Chris works for a large housing association as a housing assistant. We asked him to keep a log over a number of weeks of the problems relating to walls that were reported to him. This was his list.

- Cracking to both internal and external walls.
- Damp patches appearing on internal walls.
- Black mould on the walls.
- Water penetration.
- Cracking at the joint between ceilings and walls.
- Mortar falling out of brickwork.
- Bricks disintegrating.
- Walls bulging.

How did this list compare with yours? Let's look at each of these in turn, putting together some of the related complaints;

(a) Cracking to both internal and external walls Cracking at the joint between ceilings and walls

We have already looked in the last section at the problem of foundation failure; cracking to walls could be an indicator that there are problems with the foundations. Some cracking however may simply be due to a new building drying out and cracks appearing as part of this process. These cracks can usually be filled with a proprietary filler and they will not recur.

(b) Damp patches appearing on internal walls Black mould on the walls Water penetration

These may have a number of causes. The most likely problem is *condensation* where the warm humid air inside a dwelling hits the relatively colder wall and causes moisture to form. If this is not wiped away, black mould can form. We will be looking at condensation in more detail later in this block. It is best solved by:

(i) increasing both the heating and the ventilation in the building, to reduce the amount of water vapour in the air;

(ii) avoiding activities which increase water vapour, such as drying clothes on radiators or cooking without having the kitchen well ventilated.

Moisture penetration could however occur, as we have seen, if the wall cavity is bridged, or in the case of a solid wall if water has worked its way through the brickwork. In the event of the cavity being bridged it will be necessary to clean up the cavity to avoid the problem and this can be a costly exercise.

A further cause could be *rising damp* where water rises up the wall from ground level. A damp proof membrane is normally in place to avoid this happening, but if there is no damp proof membrane, or it is faulty, rising damp may be the cause of the complaint. Another cause of rising damp is where the ground outside has been allowed to be raised above the damp proof course level, allowing moisture to travel unhindered up a wall.

(c) Mortar falling out of brickwork
Bricks disintegrating

These problems are often due to defective construction. If the mortar is falling out of the joints this means that moisture can penetrate the brickwork more easily. To remedy this situation it will be necessary to repoint the brickwork, by “raking” out the defective mortar and replacing it.

In certain circumstances mortar can fail and bricks begin to “spall” or disintegrate because of frost attack. If water gets into the joints or into the brick and then freezes it will expand and may crack the mortar or brick.

(d) Walls bulging

This may be due to the failure, or omission, of wall ties which hold the internal and external walls together. This type of structural defect will need to have expert attention to remedy it.

(e) Remedial work

The most frequent failing is of the damp proof course, which makes a total replacement necessary or the use of one of the proprietary electro-chemical systems. In some cases it may be necessary to take out parts of the wall to tackle the source of the problem. The problems of dampness and condensation are examined later in this section. In cases of severe structural failure it becomes necessary to rebuild the wall.

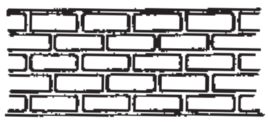
Plasterwork finishes which “fail” can usually be cured by removing the faulty or loose plaster or broken boarding and either replacing or plastering over.

Self Test 2

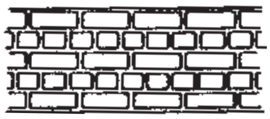
1. *Identify possible causes of foundation failure.*

2. *Which of these walls is likely to be a cavity wall.*

(a)



(b)



3. *What are walls made from plasterboard nailed to wooden frames called?*

4. *What is a damp proof membrane for?*

Now turn to the Answers at the end of the Block.

4. Floors

Although flats often have floors of pre-cast, or cast in-situ concrete, floors in traditional two or three storey dwellings are either:

- solid floors;
- suspended timber floors.

The ground floor may be of either construction whilst the upper floor will be suspended.

The construction of both is best explained by referring to the following two figures.

Figure 11: A solid concrete floor

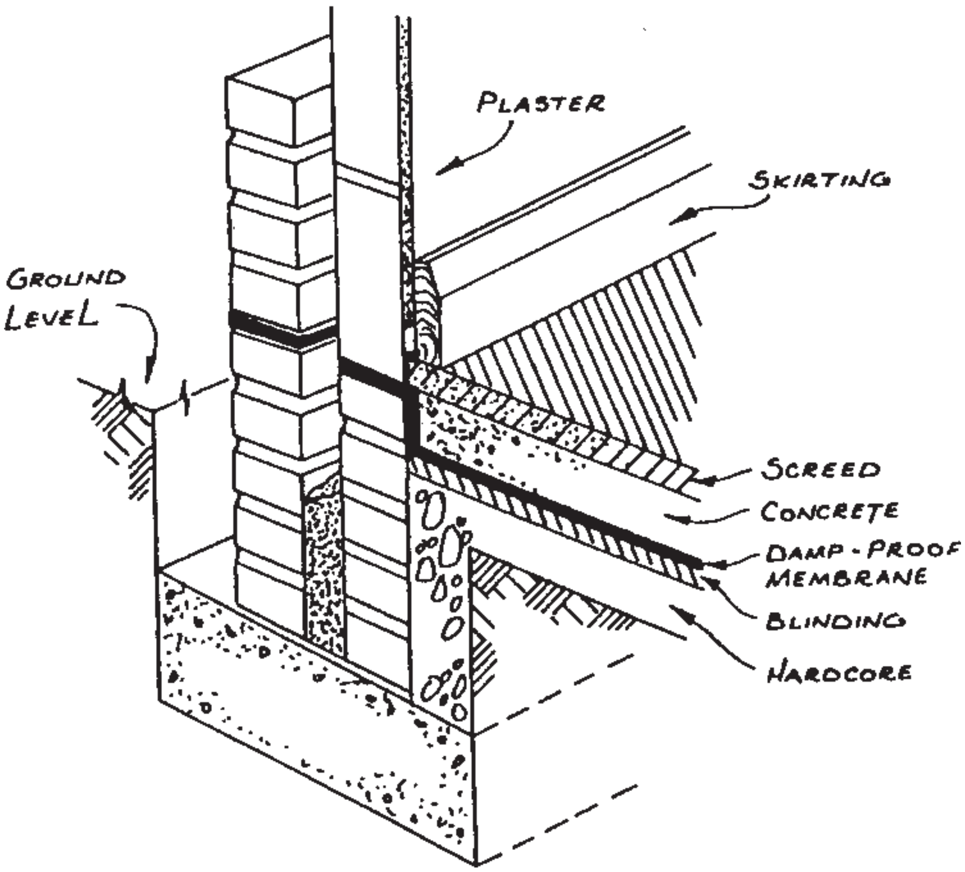
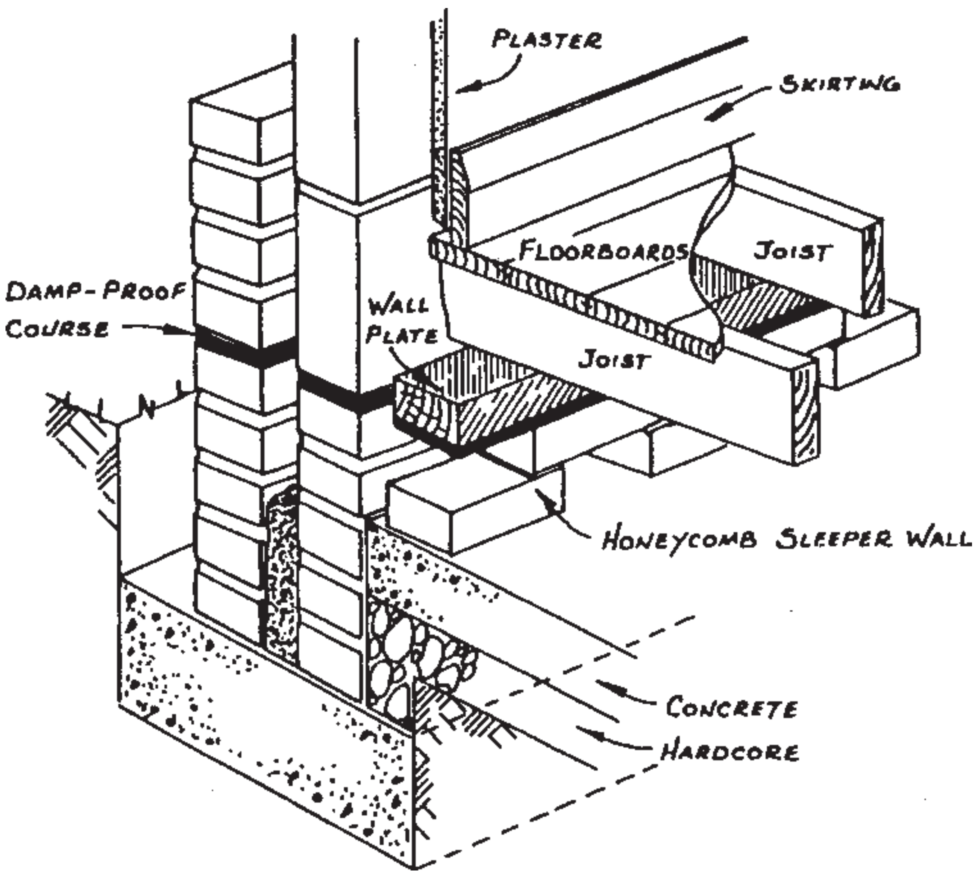
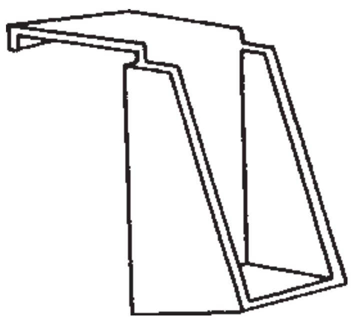


Figure 12: A suspended timber floor



Suspended timber floors may be supported in other ways than by using a "sleeper wall", as is shown in Figure 12. Obviously floors higher than the ground floor must be held up in other ways. The two alternative methods are: build the end of the joists into the wall itself; hang steel shoes or **hangers** onto the wall into which the joist will fit.

Figure 13: Joist hanger or shoe



Activity 6

From what you have just learned about both suspended and solid floors, what do you think are likely to be the main problems which will be encountered with such floors? Make a list in the space below.

Time allocation 5 minutes

4.1 Problems with solid floors

A major problem with solid floors is dampness coming up through the floor which will be caused by the dpc failing, of by the fact that the membrane below the concrete floor is not connected with the dpc running through the inner leaf of brick work.

Solid floors may also bulge or crack when laid on certain types of shale hard cores which, when water reacts with the sulphate in the shale, expands and forces up the floor itself.

In both cases the floor will probably have to be dug up to carry out the necessary repair, to replace the dpc or clear all the shale, before a new floor is relaid. This can be expensive and inevitably causes disruption to residents.

4.2 Problems with suspended floors

Most of the faults in suspended floors relate to the wetness or dryness of the area below. Lack of dpc or a faulty dpc will allow moisture into the joists which, unlike concrete, will slowly rot away. Many older houses will have no "oversite" concrete and under the floor one may find bare earth. In many cases this can also be a source of dampness. Older houses were frequently built with joists running right into the walls which also led to problems of wet and rotting wood.

It is also important to ensure that the space below the floor is ventilated as a lack of fresh air into this area will encourage the growth of the DRY ROT FUNGUS which, once established, will rapidly spread throughout the wood which forms the floor and joists.

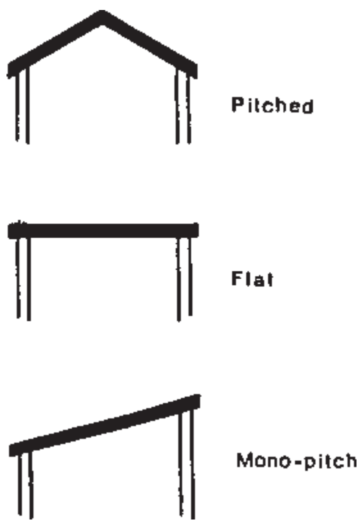
5. Roofs

Once a builder has constructed a roof to a dwelling then work on many of the services, fittings and wall finishes can be started. Therefore the builder tries to complete the walls and roof as quickly as possible, so that the weather cannot disrupt the completion of the dwelling.

The roof itself must be capable of providing protection against all forms of weather.

There are three main types of roof, as shown in Figure 14 below:

Figure 14: Three types of roof



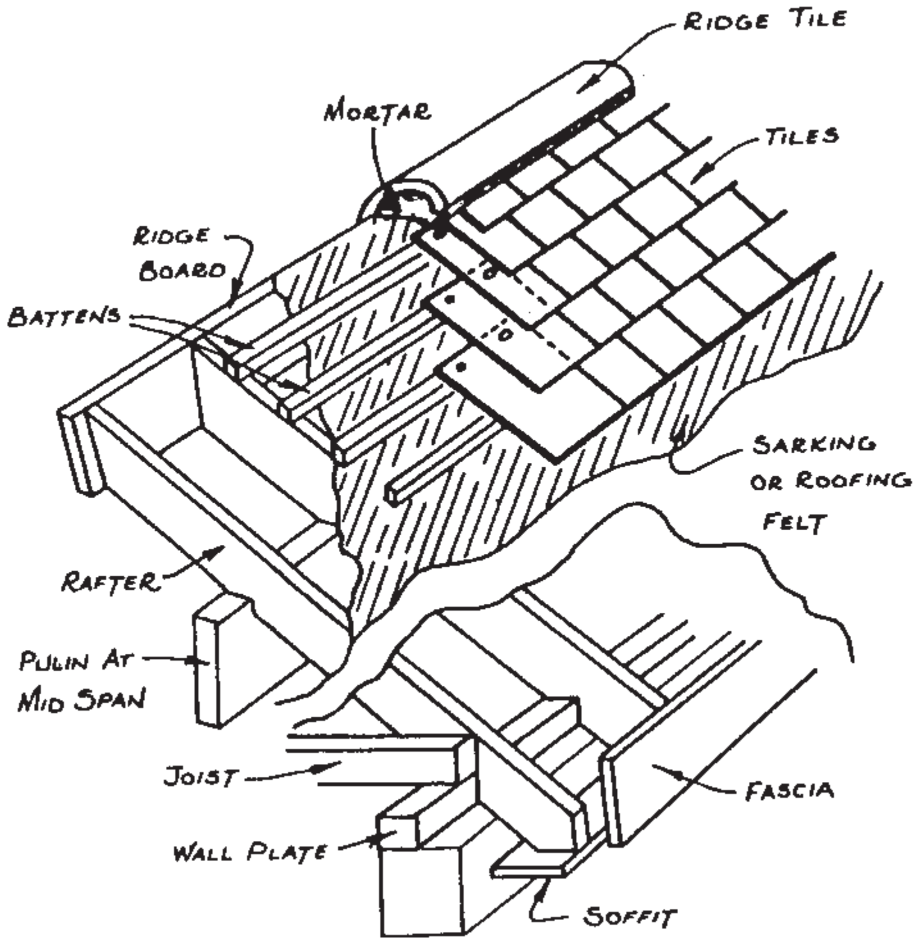
It is important to note that flat roofs are never completely flat and if the slope of the roof is less than 10 degrees then the roof is referred to as a “flat roof”.

5.1 Pitched or mono-pitched roofs

(a) Construction

Pitched roofs are normally covered by clay or cement tiles which overlap each other. Older houses may have slates. Both slates and tiles are nailed to wooden battens which are laid across the roof.

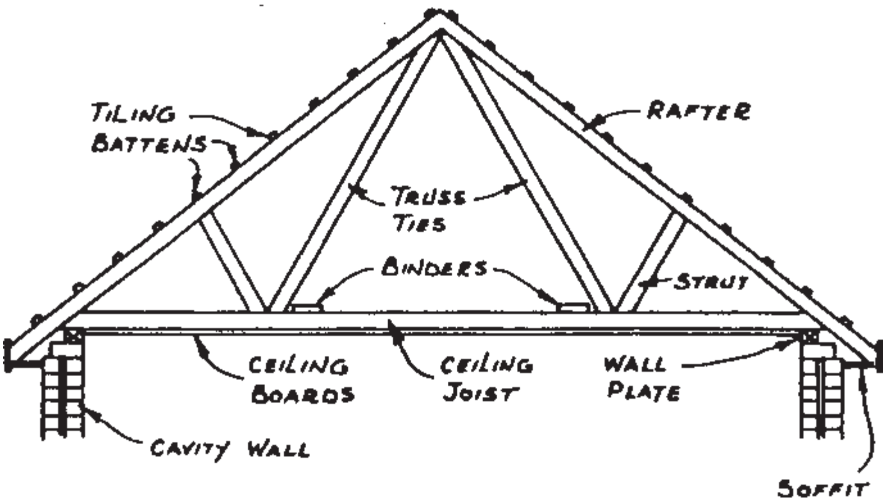
Figure 15: Pitched roof construction



The battens are nailed to the rafters which run up and down the roof. (See Figure 15).

The triangular frames of the pitched roof are constructed in the factory and arrive at the building site ready made. Older houses will have been built in-situ. Normally the pre-constructed triangular frame will be braced with a "W" shape of bracing timbers, as in Figure 16.

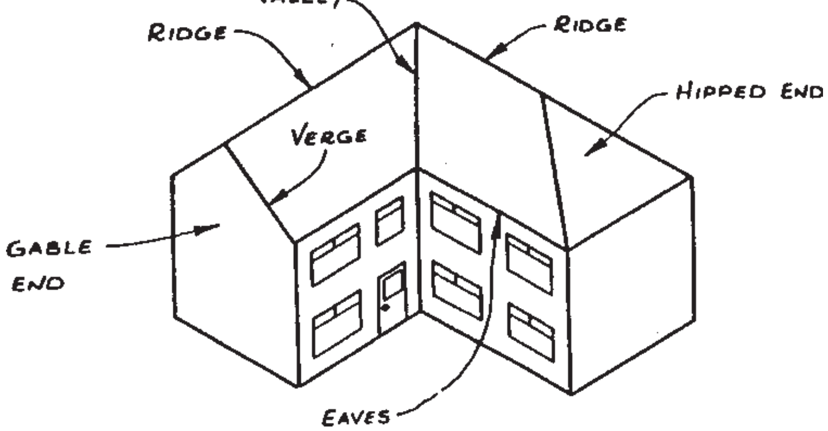
Figure 16: Example of a pre-constructed triangular frame



Each triangular frame, consisting of *rafters*, a *ceiling joist* and *truss ties*, will normally come pre-formed. A series of these are placed on top of the wall and are then "tied" to each other by fixing *binders* which run the length of the roof.

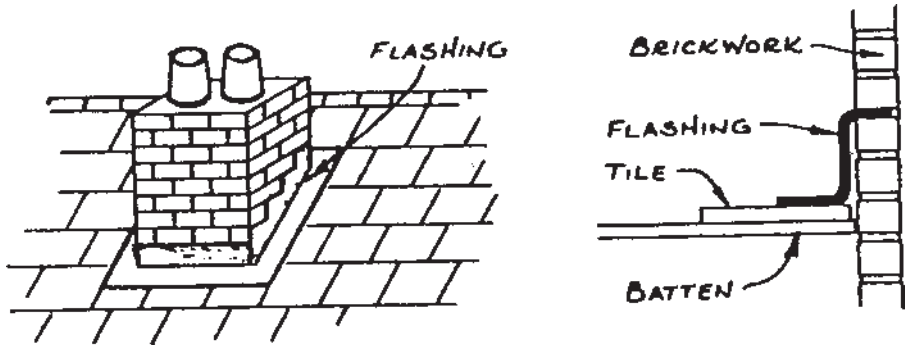
The edge of the roof is sealed by nailing a *sofit board* below the rafter so as to fill the gap between the overhang of the roof and the external face of the wall.

Figure 17: Illustration of common roofing terms



Special *ridge* and *hip tiles* are used to cover the joints at the roof's highest points. However, in the *valleys* which occur (as in Figure 17) where two roofs meet, or at the sides of chimneys or dormer windows which project through the roof, it is necessary to line the area with metal sheeting - often lead on older buildings. This is known as *flashing* which is inserted into the brickwork and overlaps the surrounding tiles or slates.

Figure 18: Roof flashing



Activity 7

What is the purpose of flashings? Make a note of your answer in the space below.

Time allocation 5 minutes

Flashings are necessary to prevent rainwater entering the roof space where there is a break in the roof. At chimneys the roof is broken as the chimney protrudes through the roof and flashings are placed at this junction to stop rainwater finding its way into the roof through the gap. Figure 18 demonstrates this principle very clearly.

(b) Problems with pitched roofs

(i) Structural problems

- The joints between rafters, joists and/or ties may fail, leaving the weight of the roof pushing downwards and forcing the triangle of the roof to **spread**.
- The wood itself may become wet and rot.

(ii) Roof covering

- The ridge tile which “seals” the peak of the roof comes loose or falls off, allowing water into the roof.
- Tiles or slates break and fall off.
- The roofing felt or "sarking" tears.
- The nails holding slates/tiles perish, allowing the roof covering to fall off.
- The flashing fails.
- The slates/tiles are not overlapped sufficiently, or the slope of the roof is too shallow, so wind and rain enters through the roof.
- Rain enters the top of the wall because no dpc exists and dampness works down through the wall.

5.2 Flat roofs

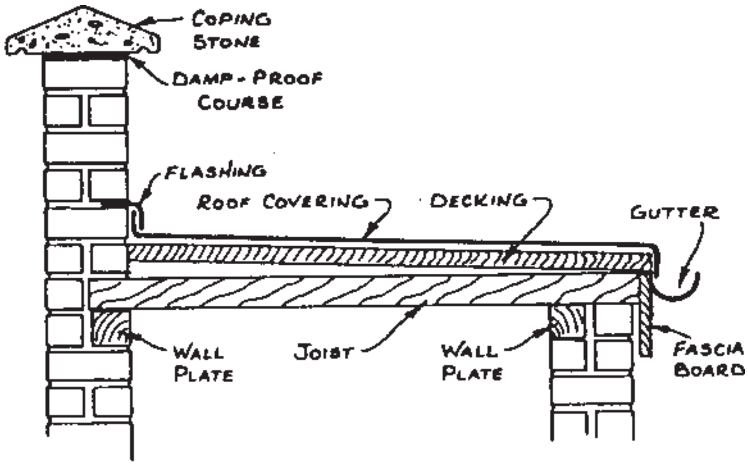
(a) Construction

Flat roofs are simpler to construct, but more liable to become defective. They are constructed like floors, normally from wood although some dwellings will have a pre-cast concrete slab roof.

Flat roofs should **not** be *totally* flat as this will not encourage water to drain off and will allow pools to form and stand on the surface. Normally a fall of between 1 in 40 and 1 in 80 is expected.

The surface laid on top of the concrete or wood is critical. Usually it consists of asphalt or multiple layers of roofing felt. Often stone chippings are used to coat the surface to prevent extremes of temperature affecting the roof surface.

Figure 19: Flat roof construction



(b) Problems with flat roofs

Many of the faults found in flat roofs are the same as those found in pitched roofs but, in addition, the roof covering may split or crack or the joints may become unsealed. Strong sunshine may melt a bitumen (tar-based) material causing blistering. If the blister bursts this will leave a hole in the roof covering.

Unfortunately, when leaks occur in flat roofs the fault often does not lie immediately above the damp patch seen on the ceiling. This is because moisture works its way through the gaps, joints and lines of least resistance, making it possible for water which enters a gap in the roof covering to exit through the ceiling at the other side of the dwelling. Tracing the problem is thus difficult and perhaps the only reliable remedy for a leaking flat roof is to totally replace or recover it.

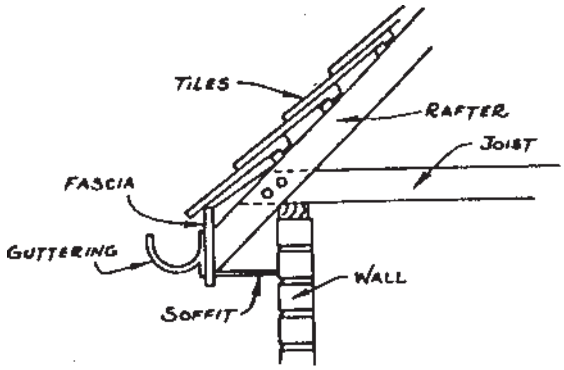
Having completed the roof the shell of the house is now finished and work can begin on all the internal fixtures, fittings and services. However, a number of external jobs still need performing.

6. Guttering

As we have seen in the last section, all roofs must have a fall to dispose of rainwater. Roofs normally project a little beyond the external walls so as to prevent water running down or into the brickwork. Obviously it is not very convenient to have water cascading down from the roof onto everyone who steps out of the house. Gutters are, therefore, provided to collect the water which runs off the roof and then channel it away.

(a) Construction

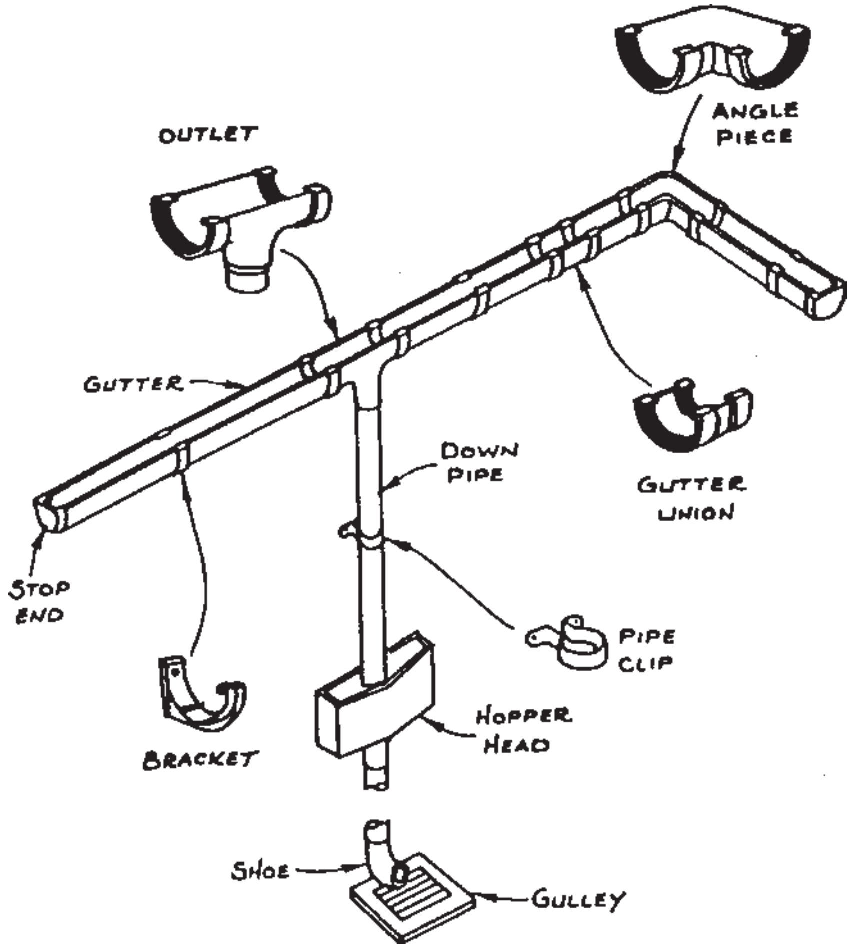
Figure 20: Example of guttering



In older houses the guttering will possibly be fixed directly to the joist ends, but on most buildings the **fascia board** will support the guttering. Older gutters may be of cast iron or wood; asbestos cement was used from about the 1940s. Plastic and aluminium are now the most common materials.

The gutter itself must be fixed at a slight angle to the horizontal to allow the water to flow down to its outlet pipe for eventual discharge.

Figure 21: Illustration of guttering parts



(b) Problems with guttering

Some guttering materials are more likely to be affected than others: iron may rust if not properly maintained, asbestos cement may crack and wood will rot! In addition, the actual fixing may fail because nails or screws have rusted away or the fascia board itself has rotted.

Other problems include:

(i) No "fall", or gutter slopes in the wrong direction. This can be caused by incorrect fixing, by screws loosening or by light plastic materials sagging. As a result, the water collects at one end or at the centre of the gutter and overflows instead or running down into the pipe.

(b) If, for similar reasons, the fall is too great then water may overshoot the discharge outlet and create a waterfall at the end of the gutter.

(c) Gutters often become blocked because of leaves, moss (even bird nests!) and other debris and need fairly regular clearing. This means that gutter clearing should be included as part of every housing organisation's planned maintenance programme.

Self Test 3

1. *In a traditional 2 storey building are the upper floors likely to be solid or suspended?*

2. *What is needed in the space below a suspended timber floor to prevent dry rot?*

3. *What are the three main types of roof?*

4. *What prevents rain water penetration to the roof space where a chimney breaks through the roof?*

5. *What part of the roof supports guttering on newer dwellings?*

6. *What are the main problems of pitched roofs likely to be reported to a housing office?*

Now turn to the Answers at the end of the Block.

7. Joinery Fittings

7.1 Doors and windows

Normally both are made of wood, although metal window frames were introduced during the 1930s, and nowadays aluminium and UPVC (plastic) are becoming more popular materials for window frames.

(a) Doors

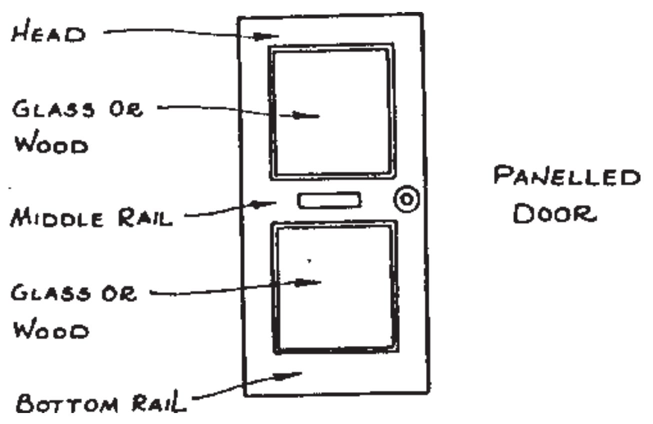
(i) Construction

Building Regulations require doors to withstand fire for specific periods of time, and more thought is being given to the security aspect of both doors and windows.

External doors will normally be heavier and more solid than internal doors because they have been constructed to fulfil different purposes.

The traditional exterior door will consist of a timber frame containing a number of glass or wooden panels.

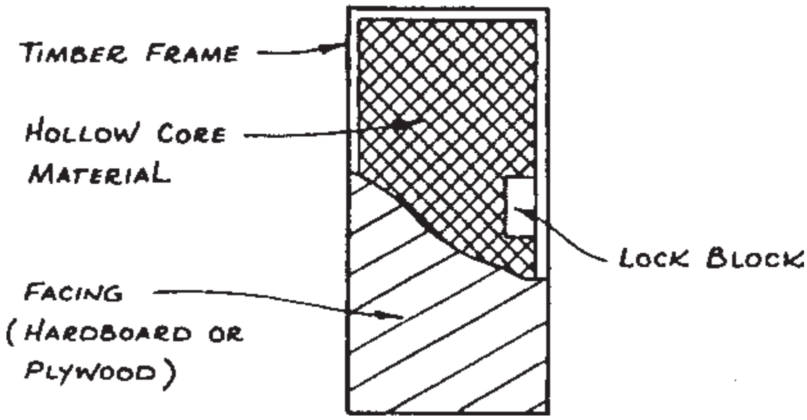
Figure 22: Example of a timber framed door



In many older houses panelled doors have also been used internally. In some cases these have been subsequently *"flushed"* by nailing onto the door a sheet of hardboard.

Flush doors are now commonly used internally. As they do not have to withstand the weather they can be made thinner and lighter and, consequently, cheaper.

Figure 23: Example of a flush door



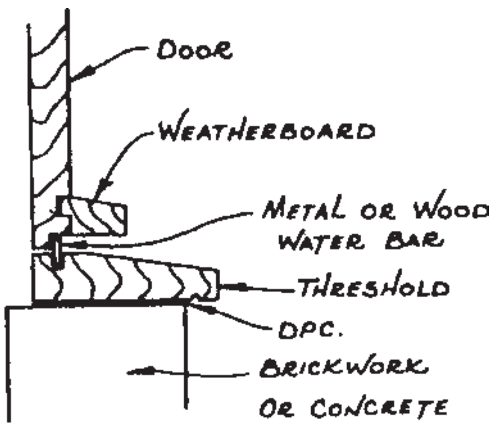
Most flush doors are built as in Figure 23; some will have a *middle rail* running across the door instead of the *lock block.* The core material will vary dependent upon the quality of the door; often the interior is filled with an *"egg b*ox" - like material which acts as an insulator.

All door frames are fixed by hinges onto one side and screwed into the door frame. The frame itself is nailed or screwed to the surrounding wall.

External doors are normally finished by attaching to the bottom, a strip of wood known as a *weatherboard* which is sloped to deflect water away from the gap at the bottom of the door. In addition the bottom of the door frame is finished with a *threshold* which also acts to prevent water running into the building.

You should note that the Housing Corporation requires all dwellings to be built to a mobility standard which means that the threshold must be flush with the footpath outside. This can cause problems in preventing water coming into the building and careful attention to detail is required.

Figure 24: Section through the bottom of a door



Note: Under both weatherboard and threshold is a small groove. This is called a DRIP or THROAT and is cut into the bottom of the overhang to prevent water trickling back into the house along the underside of the material.

(ii) Problems with doors

The most common faults are those relating to the "fit" of the door: if too loose it allows in rain and draughts; if too tight then it impossible to open or close. Unfortunately, doors made of wood naturally expand and contract unless they have been made of properly seasoned and treated wood and kept in good condition. A door which swells and jams in the winter and is subsequently "eased" by shaving off a little wood may, when it dries and contracts in the summer, allow rain in easily from any summer showers.

Unless well maintained all woodwork will perish, with joints and hinges the most likely to go first. In addition, any movement of the house or foundations may vary the "fit" of the door because of the movement of the frame.

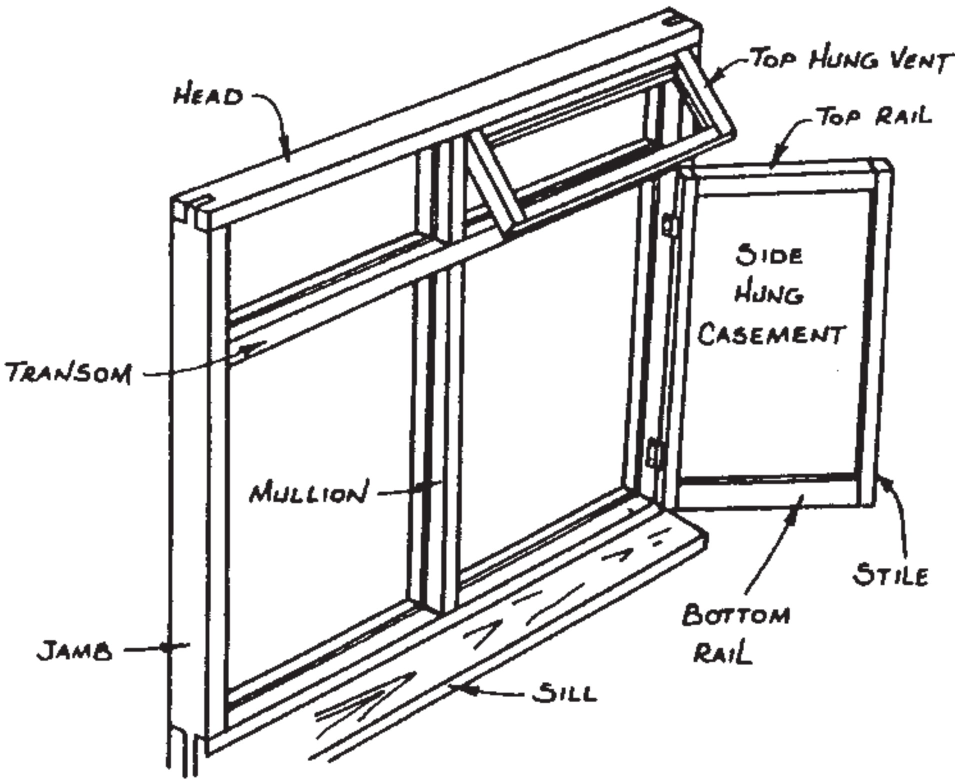
(b) Windows

(i) Construction

Windows frames are generally made of wood but other materials are fast becoming more commonplace. In particular, UPVC windows are popular because they avoid the need for regular repainting. Some windows open whilst others are fixed, and all are constructed of glass set into a frame of wood or other material. The frame is screwed or nailed into the surrounding wall.

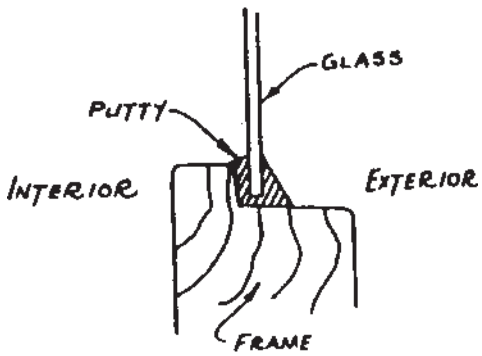
The various components of a window are shown in Figure 25.

Figure 25: Components of windows



The glass is held into the surrounding frame by a combination of putty and small nails or by putty, and a thin beading, nailed to the frame. Where the frame is not wood different systems may be made.

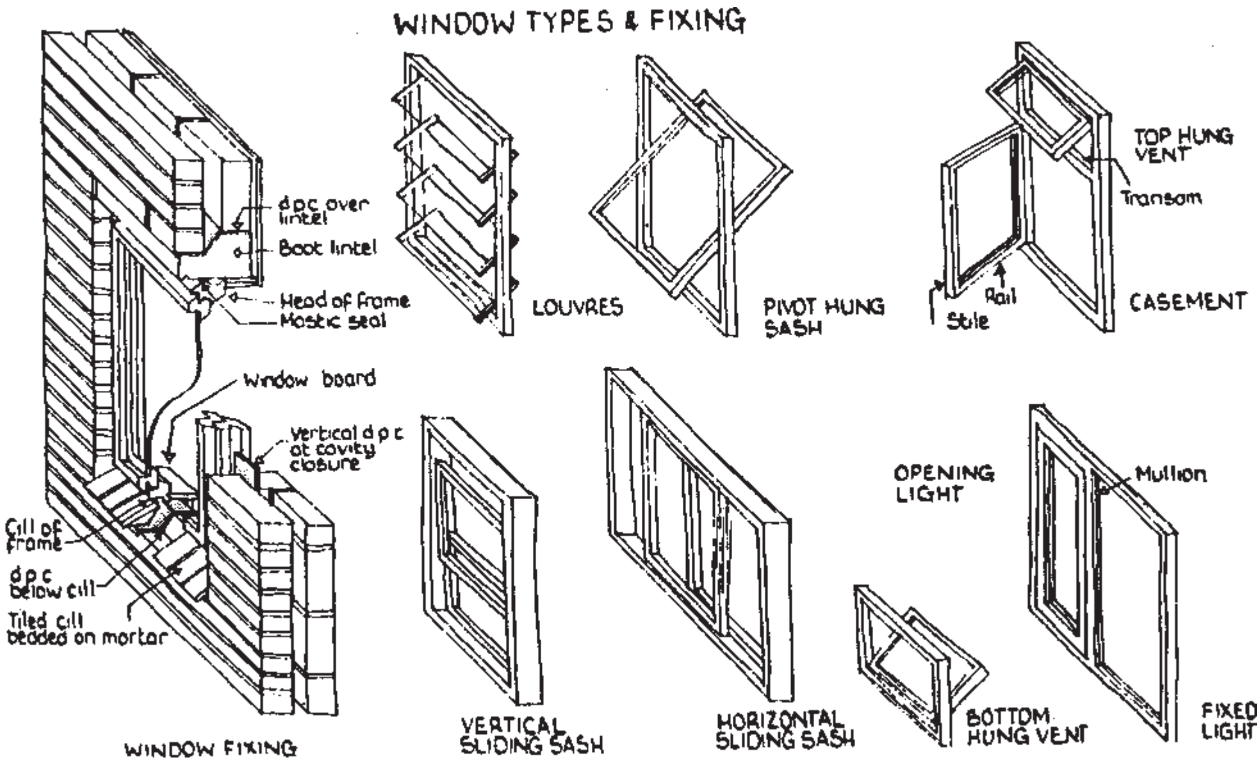
Figure 26: Section showing fixing of glass to wooden frame



Various types of windows and window opening systems exist, the commonest shown in Figure 27.

Below the window there is normally a sill which is constructed in similar fashion to the threshold.

Figure 27: Types of windows



(ii) Problems with windows

Wooden windows suffer the same problems as wooden doors, but windows also contain glass which is more liable to create condensation in the interior. Therefore, windows may be more likely to suffer problems of rot than doors. In addition, the putty used for retaining the glass may crack or drop out, and needs regular checking.

(c) Problems of all woodwork

Normally wood is given two coats of primer before being assembled as, once in place, only the exposed parts can be painted, which would mean that any water which seeps into the joints between the frame and the brickwork is likely to permeate both the wood and the wall. Paint, properly applied, forms a waterproof coating to the woodwork but does not last forever, so it is normal for all external woodwork to be repainted at regular intervals.

The result of untreated faults is that the entire door, frame or window has to be replaced. It is, therefore, important to act quickly upon any sign of deterioration.

Obvious signs of deterioration include:

- Staining at the joints.
- Depressions or soft patches in the woodwork.
- Crumbling, loose or missing putty.
- Flaking or peeling paintwork.

(i) Timber decay

Any wood exposed to damp will begin to disintegrate even though, in some cases, it may not be the *moisture* itself which causes the damage but the *fungi* it attracts.

(ii) Dry rot

This is a fungus which thrives on any wood containing more than 20% moisture. Once established it expands along the surface of the woodwork, quickly devouring the wood itself. Once it is really established it has a mushroomy smell and has a grey or white rubbery appearance.

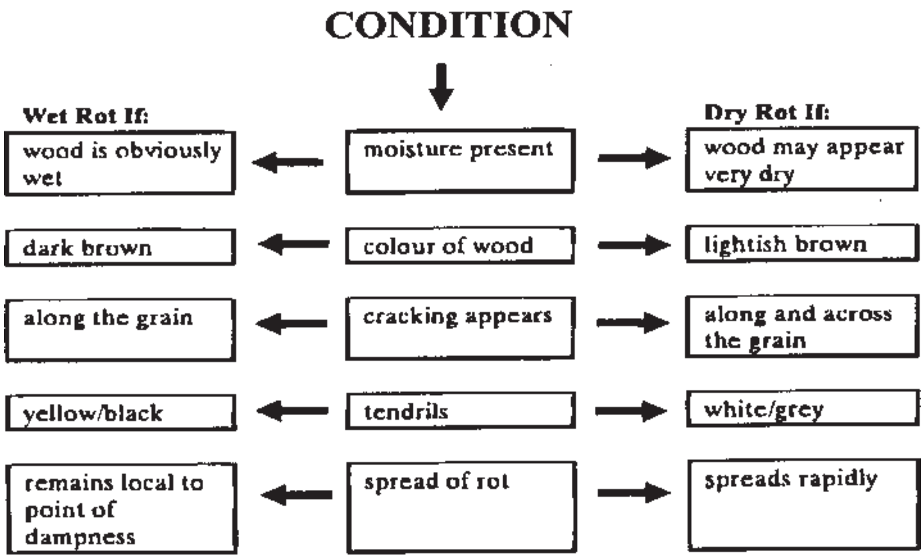
The effect of this fungal growth is to make the wood it is attached to crumbly and lacking in strength. It is, therefore, both dangerous and expensive. Once established it requires replacement of all affected - and nearby - wood, treatment of the remainder and the spraying of all surrounding brickwork with a special toxic chemical. As the fungus can penetrate brickwork and plaster it is also necessary to remove nearby plaster in order to treat the brickwork.

Preventing dry rot requires keeping woodwork both dry and well-ventilated, as the growth likes wet and still air. Therefore, the spaces below suspended floors and joists, etc., should be kept well-ventilated.

(iii) Wet rot

This is also a fungus but it is easier to eradicate as it does not spread. Sound, but affected, timber can be sprayed with an anti-fungicidal spray and still be retained. Badly affected wood does need cutting out and replacement, however.

(iv) Detecting whether the problem is wet or dry rot



(v) Insects

Wood can also be affected by insect attack, usually **woodworm**. The woodworm bores small holes into the wood and destroys its strength. If caught early and sprayed the wood can be retained - otherwise, the timber has to be removed and destroyed and new, treated, timber used.

Activity 8

What steps should a sensible housing organisation take to reduce maintenance problems with windows and doors? Make a list in the space below.

Time allocation 5 minutes

The most important step which housing organisations can take is to ensure that joinery is maintained to the highest possible standard. The main requirement is to ensure that external woodwork is regularly painted. This will normally be necessary on a 3-5 year cycle, depending on the location of the dwelling. For example dwellings in rural Shropshire are only likely to need repainting externally every 5 years, whilst on the west coast of Scotland the cycle is likely to be a three year one because of the harsher climatic conditions here.

Before woodwork is repainted it should be inspected and any necessary remedial repairs (such as cutting out rotten wood) carried out. A good specification should be drawn up for the repainting programme, and the work should be well supervised to ensure a high quality finish. In addition as we saw in *Customers and Services* many housing organisations now give their customers a choice of colours to be used when their houses are repainted.

7.2 Other joinery

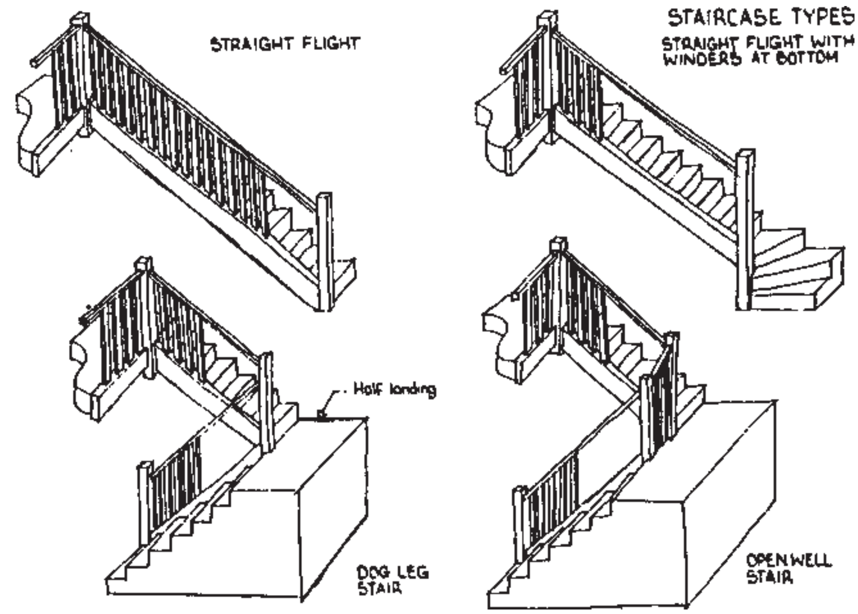
(a) Kitchen units

Fitted kitchen units were introduced only after the last war. They are usually mass-produced, as complete units or in pieces for assembly and fixing on site. All units are manufactured to a range of standard widths, heights and depths, so that they can be easily interconnected in almost any combination. Worktops are generally made of wood composition board ('chipboard') and faced with plastic laminate. Many housing organisations have now established planned maintenance programmes to replace kitchen units on a 15-20 year cycle.

(b) Staircases

Staircases are described by their general shape e.g. Straight Flush, Quarter Turn (where they turn through 90 degrees) or Half Turn (a 180 degree turn). Some common types are illustrated in Figure 28.

Figure 28: Staircase types



Each step (a tread and a riser) is fitted to the strings (side panels) and sometimes rests on a central carriage or bearer which runs from top to bottom.

Modern staircases are usually prefabricated and are made of timber. In flats the staircases may be concrete, in which case they are cast on site.

8. Plumbing

This Section is concerned with the supply and heating of water; the fittings for making use of hot or cold water; and the means of disposing of waste water.

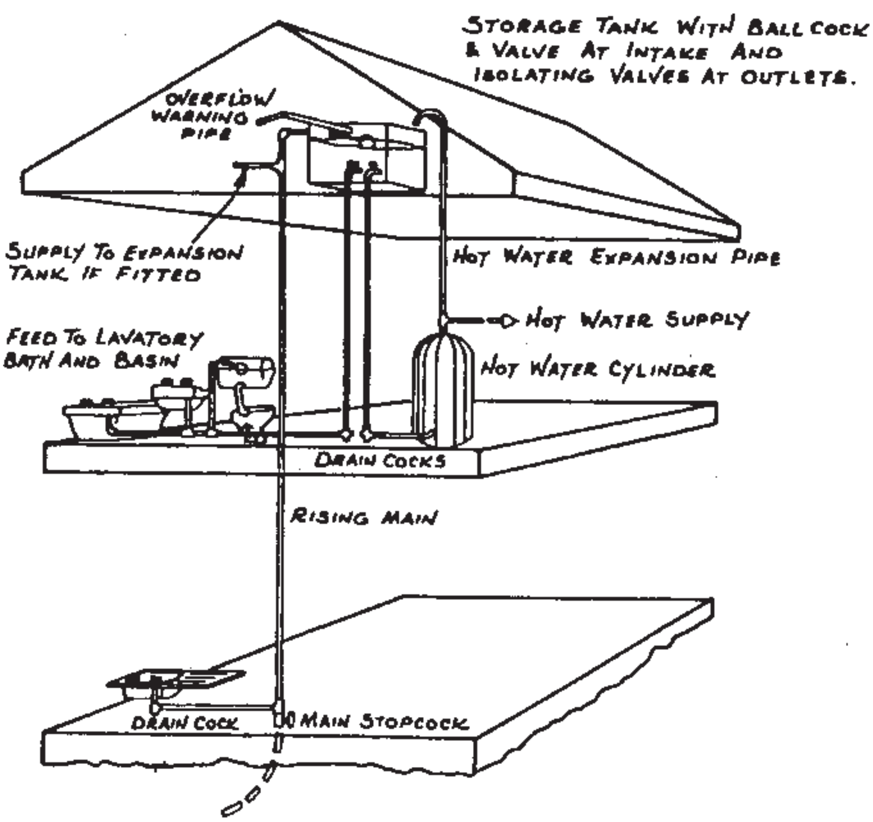
8.1 Cold water supply and distribution

Normally water is piped into every house from a public source. The incoming supply pipe is often found in the kitchen and is known as *the rising main*. At its lowest point, where the pipe enters the house, is usually found a valve which can shut off the supply to the whole house. This valve is known as the *stoptap* or *stopcock*. From this point the pipe will normally lead upwards with a spur leading off to the kitchen sink. Further spurs lead off to provide cold water to baths and basins and to the WC cistern before the pipe terminates at a *storage tank*, usually placed as high up in the building as is possible. All drinking water supplies will be provided direct from the rising main whilst the WC, shower, etc. may be fed from the storage tank.

Other stop taps may be inserted into the pipework to allow parts of the system to be shut down.

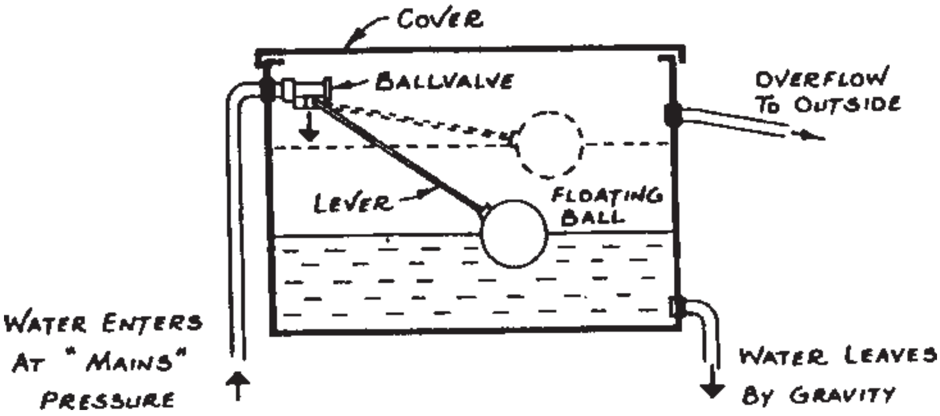
The pipework may be of iron or lead in older houses, although copper and plastic are common materials nowadays.

Figure 29: Cold water distribution



The rising main terminates in a ball valve which controls the flow of water into the storage tank. The tank itself will normally hold between 30 to 50 gallons of water and is usually situated in either the roof space or high on the first floor of the dwelling.

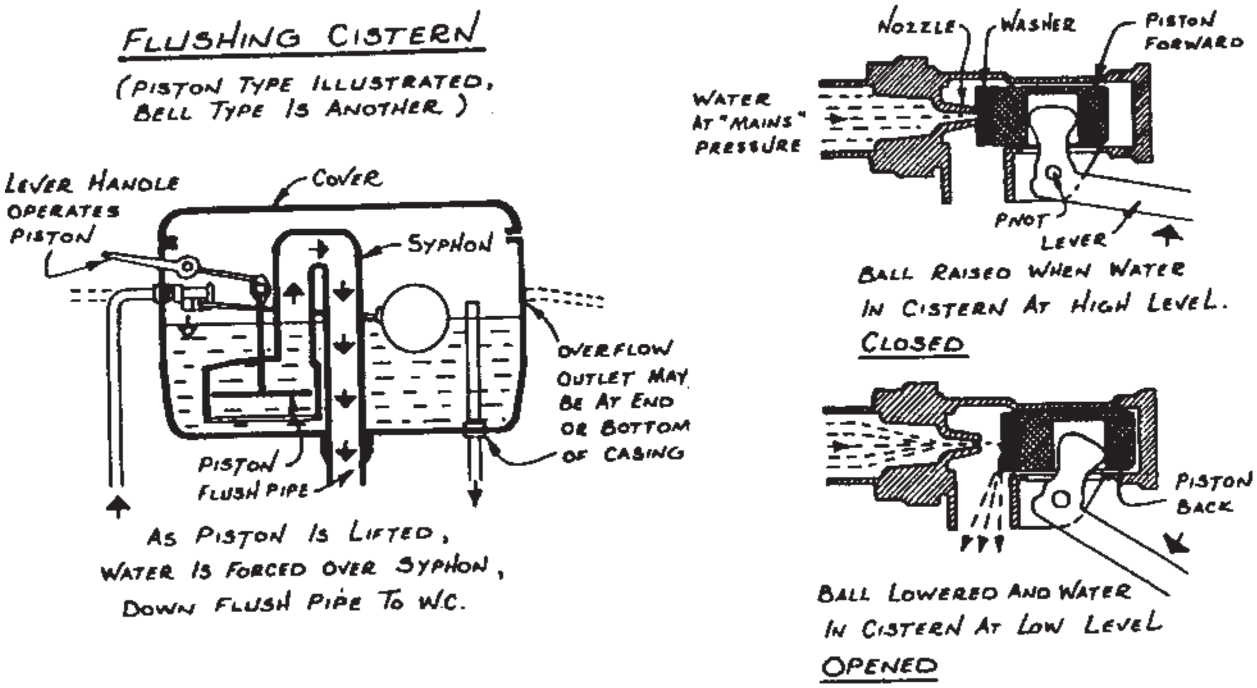
Figure 30: Storage feed cistern



The ball valve automatically allows water to flow into the tank from the rising main to compensate for water drawn off from the tank. The storage tank will always have an overflow pipe leading directly through the exterior wall. This is there to prevent the tank overflowing and flooding the house in the event of a ball valve jamming open.

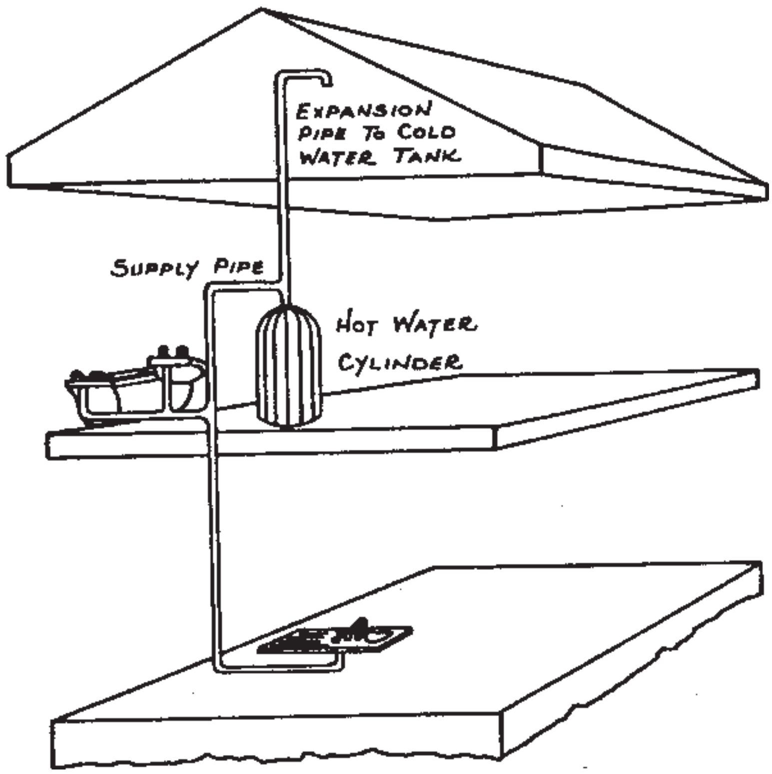
Water to be used for WC flushing will be controlled by a ball valve similar to that used to control the supply to the storage tank.

Figure 31: The flushing cistern



8.2 Hot water systems

Figure 32: Hot water system



Whilst there are a number of appliances, such as the Ascot water heaters, which heat water adjacent to a sink or bath, the commonest methods of heating water are those which involve the water being heated at one point and then being piped to all the fittings where hot water is required.

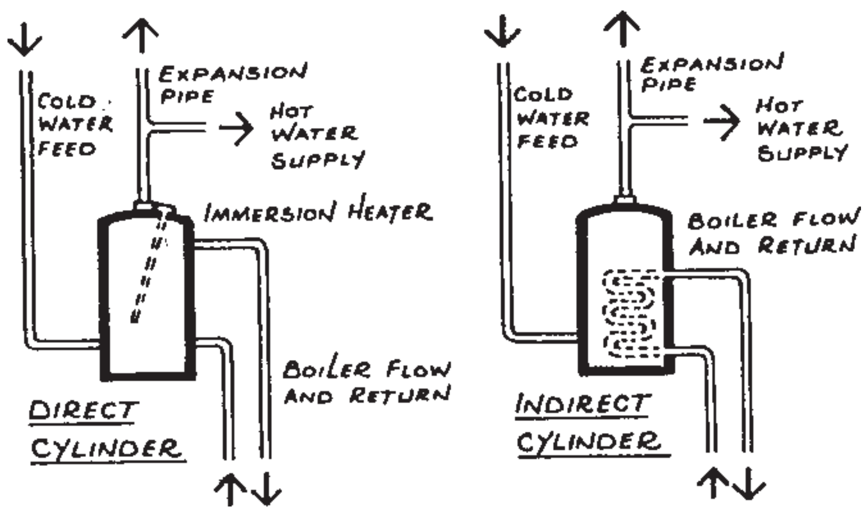
Heated water must be stored so that it is ready when required. Most dwellings will include a copper water cylinder which is usually sited in or near the bathroom, often within a cupboard which utilises the heat from the water contained in the cylinder to dry or air linen.

The two most common systems of water heating are:

(a) The *immersion heater:* an electrical element which is fitted into the cylinder to heat the water, in just the same way as an electric kettle works.

(b) *The boiler:* forms part of the house heating system, as a "back boiler" behind the fire, or an independent boiler which also provides a supply of hot water to central heating radiators. The water heated in this way may be used directly or may be piped, in a "coil" shape, through the copper cylinder to warm the water there.

Figure 33: Direct and indirect cylinders



The hot water taken from the cylinder is drawn off from the top and replaced by cold water which flows down, because of gravity, from the higher storage tank to fill up the space left in the hot water cylinder.

(c) In recent years *"Combination"* boilers have become more popular. These boilers provide both central heating to radiators and also provide hot water directly on demand. When a hot water tap is opened the boiler fires up heating water almost instantaneously.

The main benefit of a combination boiler is that it removes the need for a cold water tank in the roof space to supply a hot water cylinder, and the need for a hot water cylinder. This is because all hot water is supplied direct from the boiler when it is required and therefore there is no need to store hot water. The boiler is supplied with cold water directly from the main and there is no need for a cold water tank. All of this saves on plumbing and materials.

However there are some problems with combination boilers. The main one is that such boilers tend to be more expensive than conventional central heating boiler systems and this additional cost must be weighed against the savings on pipework and plumbing which we have already identified. The other main problem is that the hot water pressure tends to be lower than would normally be achieved in a conventional system, so, for example, it will take much longer for the bath to fill.

8.3 Disposal of waste and water

The appliances which use water - baths, showers, WCs, sinks and wash basins - are all connected to piping which will carry away the waste semi-automatically.

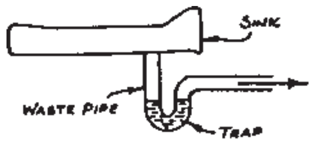
Sinks, baths and wash basins have a bottom which slopes slightly towards a waste outlet, which is fitted with a plug.

Appliances are also normally fitted with an additional outlet in the shape of an overflow, to prevent the receptacle from overflowing. The pipe from the overflow is itself connected into the waste pipe.

All these appliances rely on gravity to drain them; the WC suite or lavatory pan is emptied by extra water being flushed into the basin to push out the original contents.

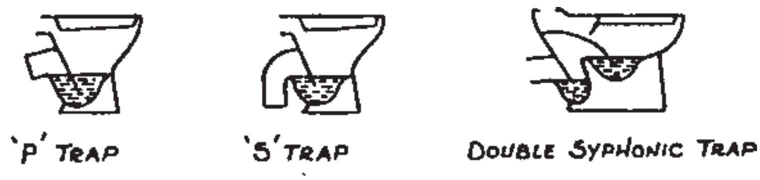
In every case the pipe carrying out the waste or water contains a bend immediately below the appliance. This bend exists to retain water which forms a seal in the pipe. This is referred to as the **trap**. Under sinks and basins this "bend" will be a U shape.

Figure 34: Example of a trap



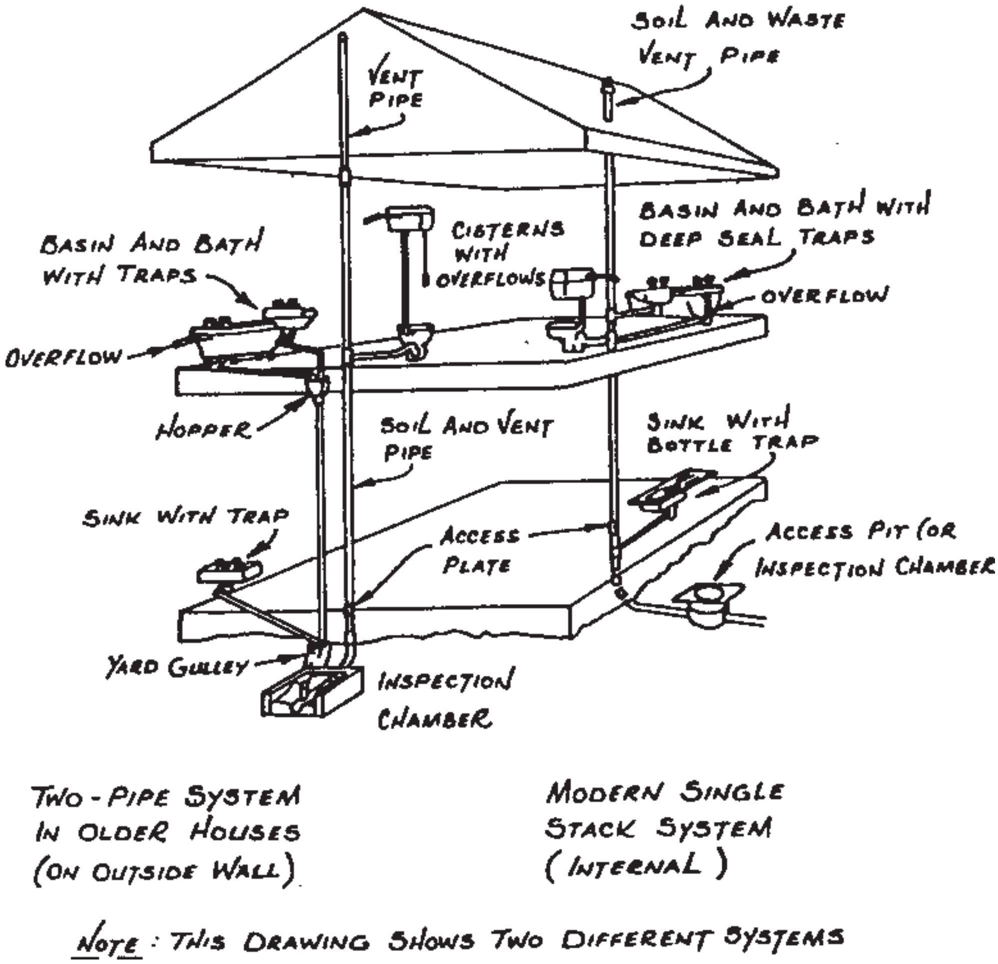
Under the WC suite the shape of the waste pipe (called *soil pipes* in the case of WCs) will be one of the following shown in Figure 35.

Figure 35: Soil pipes



The "trap" is there to prevent smells working back from the drains and into the building. Waste from the sink, basin and bath may discharge into an open gully outside the dwelling in a similar position to the downpipe on a guttering system. The WC will always discharge directly to the main drainage system. The overall waste disposal system is shown in Figure 36.

Figure 36: Waste and soil connections



8.4 Problems with plumbing

Activity 9

What are the most common problems concerning plumbing which are likely to be reported by customers to a housing office? Make a list in the space below.

Time allocation 5 minutes

We asked Denise, who is the maintenance administrator for a medium sized housing association in England to review repairs requests which she received. This is her list:

- leaks to radiators;
- no hot water;
- problems with boilers not working properly, especially failures of pilot lights;
- blockages in sinks and WCs;
- leaks from the soil pipe;
- occasional burst pipes;
- dripping taps and faulty washers;
- overflows running and problems with ball valves.

How does your list compare with Denise's list?

The most frequent recurring problems relate to leaks or bursts in the pipework or faults in taps or valves.

(a) Leaks to the water supply:

Caused by either the contents freezing, thus expanding and bursting the pipe; or faulty joints; or simply deteriorating materials. Occasionally pipes, particularly under floors, are punctured by nails when the occupier lays carpets.

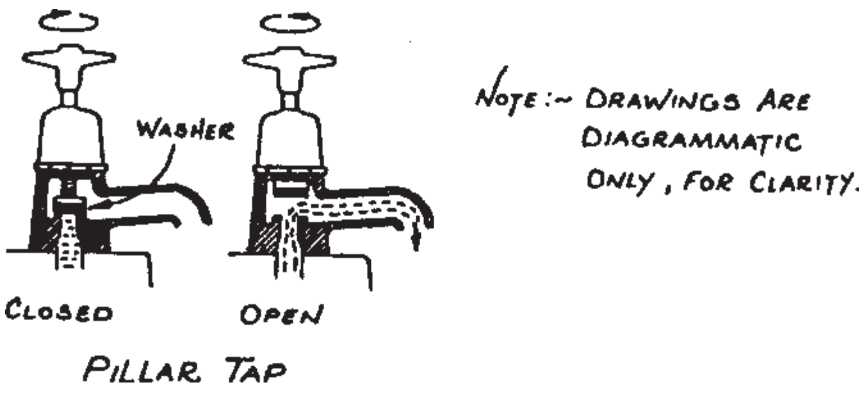
In each case the supply should be shut off using the stop tap, the pipes drained by turning on the taps to clear the water quickly, and the appropriate repair to the joint or pipe carried out.

If a leak is severe, or if it is near to a light or wiring, then the electricity supply should be switched off and checked.

(b) Leaks to taps or valves:

The washer which seals the tap will perish, and need periodic replacement, otherwise the tap will continually drip.

Figure 37: The flow of water in taps



(c) Faulty ball valves

Perhaps the commonest repair complaint received by many social housing landlords is related to a **ball valve** which is failing to perform properly. Faults may be:

(i) the valve fails to operate, allowing water to flow into the WC cistern or storage tank continuously. This will eventually fill and the water will then overflow;

(ii) the valve sticks, preventing water entering the cistern, etc., or allowing in only a small amount;

(iii) the inflow is noisy.

In some cases the valve and/or ball valve can be adjusted but often it will need re-washering.

(d) Other problems

Other problems which may occur include:

(i) "water hammer", caused by pipes vibrating because they are not adequately supported or fixed, or by an airlock in the system;

(ii) low water pressure, which may be a fault in the whole supply - a problem for the Water Company - or by the pipes "furring" up;

(iii) problems which may affect the heating of water are normally electrical. A fault in the immersion heater thermostat can result in the water being too hot or too cold. Alternatively, the element may "burn" out and need replacing.

Lagging the hot water cylinder will ensure that the heated water remains warm for much longer than if the cylinder is left uncovered.

9. Heating

The traditional form of heating was by logs or coal/coke being burnt on an open fire. Older houses will have one or more open fireplaces, but direct warmth from the fire is only available in the areas around the lit fire.

Houses built later than 1960 usually have a central heating system installed which provides heating throughout the dwelling. Older houses which have been modernised also normally contain a whole house heating system.

9.1 Main types of heating systems

(a) Radiation and convection

Dwellings can be heated by either **radiated** or **convected** heat, or by a combination of both. A radiant heater is one which heats by direct radiation, the rays of the sun being a good example. Radiant heat is normally given off from a heat source which is readily visible: for example, an open coal fire, the flames from a gas fire or by the elements or bars of an electric fire.

Whole house heating can be provided by the provision of radiant appliances in each room but, as each burns independently of the others, this can be both inefficient and expensive.

(b) Central heating

The normal systems of providing heating to the whole house is by the production of heat from a single central point, such as a boiler, which feeds outlets elsewhere. The following are the most common systems.

(i) Hot water radiators: the water being heated in a boiler which is itself heated by **coal**, **coke**, **electricity**, **gas** or **oil.**

(ii) Ducted warm air: air is "blown" around the dwelling through a series of ducts after being heated by **electricity**, **gas** or **oil**.

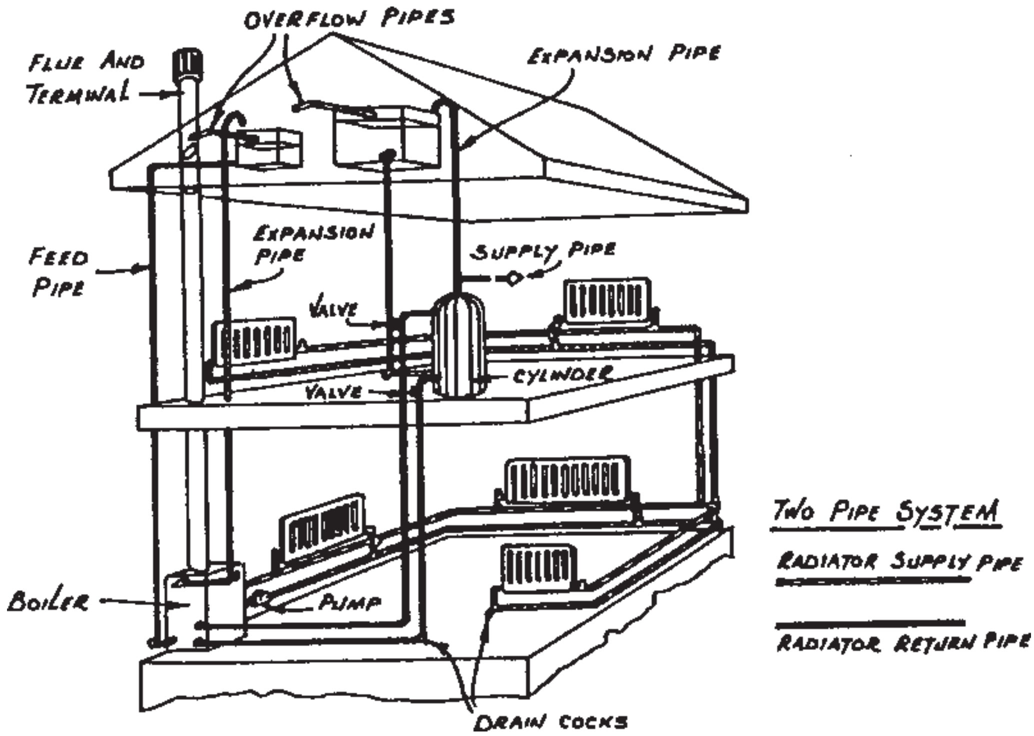
(iii) District heating: in which radiators in every dwelling on an estate are heated by hot water piped throughout the estate from a central boiler house serving the whole estate.

Probably the most popular and frequently used system is the **hot water radiator system** which can be installed in both new and existing houses relatively easily. The water is heated in either a fire back boiler (coal, coke or gas); a free-standing boiler (all fuels) or a wall-mounted unit (gas or electric). The system operates by water being pumped round the system of radiators before returning to the boiler for re-heating. Individual radiators can be switched off if not required, and many systems incorporate an adjustable thermostat at each radiator allowing automatic control to the temperature selected by the occupier.

Other control systems may include:

- A timer or programmer, which allows the occupier to pre-select the times that heat and/or hot water is wanted.
- A boiler thermostat, which can be adjusted so that the heating source is switched off when the water in the boiler reaches the selected temperature.
- Room thermostats, which control the heating system so that a fixed temperature is maintained.

Figure 38: Hot water radiator central heating system



A **ducted system** is normally installed at the time a dwelling is constructed. The system operates by fresh air being drawn into the system and drawn over a heating element by an electric fan. The warmed air is then passed along ducts and emitted through grills set at a low level in each room. Both timer/programmers and room thermostats may be used to control the system.

Many local authorities, and some housing associations, have provided **district heating schemes**. The commonest group of dwellings which utilise district heating systems are sheltered housing schemes, but many traditional or high-density estates have also been constructed or adapted to use heat from a central source provided and run by the landlord. The system operates in just the same way as the individual house hot water radiator system, but is much larger, perhaps serving upwards of four or five hundred separate dwellings.

Usually the pipework is laid underground but occasionally is overhead - which must be heavily insulated to prevent too much of the heat being lost outside the dwelling. Often such a scheme can be run fairly cheaply by taking advantage of bulk purchasing of cheap fuel to heat the central boiler. However, there are substantial heat losses from the supply pipes and, obviously, faults which occur are liable to affect more than one household.

Unlike the individual system which requires the householder to pay the electricity or gas companies for fuel, or to purchase solid fuel or oil, the resident pays the landlord for the heat provided by the district heating scheme. Charging for such schemes has created problems and much criticism from users: landlords may charge the tenant a fixed charge along with the rent of the dwelling or may meter the supply and, like the gas or electricity companies, bill the user for the appropriate amount; or may charge weekly, and meter the usage and then, annually, recharge or credit the consumer after calculating usage.

9.2 Problems with central heating systems

The commonest faults are those which can be attributed to the electrical parts, water pumps, heating elements and fans. Although gas appliances are unlikely, in themselves, to fail completely, they are liable to become inefficient and dangerous if not periodically checked and serviced.

Of course, any system utilising pipework is susceptible to leaks, although these are, in the case of central hearing, more likely to be faulty joints rather than bursts from frost damage.

Other faults may include faulty thermostats and/or timers or programmers which may prevent the system being used as it was intended.

Probably the commonest problem which effects the small bore system is the air lock which may either create “water hammer” or may prevent individual radiators from fully heating up. In most cases this can be solved by “bleeding” the radiator by using a simple key to open a small valve at the top of the radiator.

9.3 Other types of heating systems

(a) Open coal fires

Open coal fires are simple and easy to understand, but fuel has to be stored and is dirty. Coal storage is not always convenient and, of course, it is not possible to programme a traditional open fire to switch on and off!

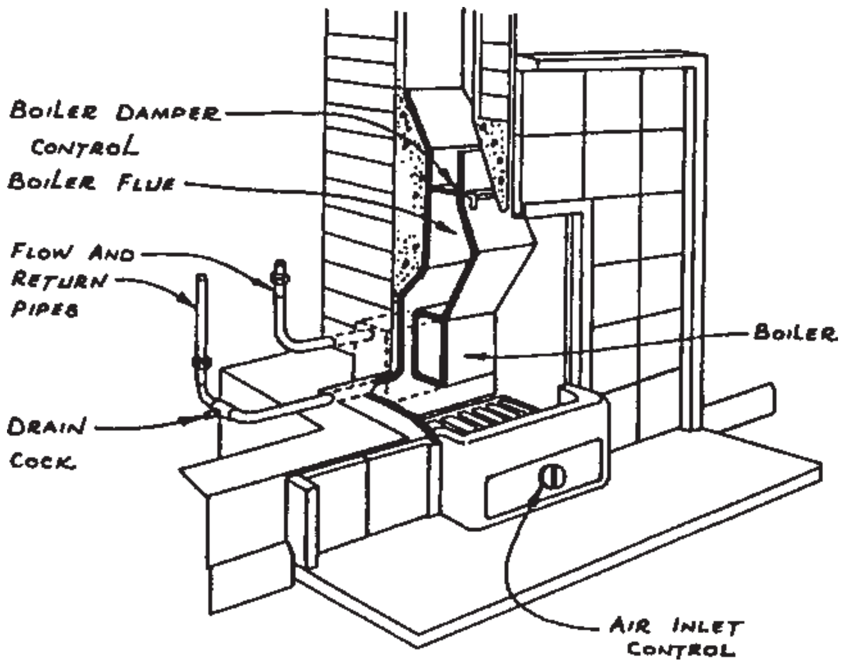
Common faults are:

(i) Burnt-out grates usually caused by a failure to clear the ash from below the grate.

(ii) Poor burning, perhaps caused by lack of ventilation either to the room or because the space below the grate is filled. Chimneys must be cleaned regularly to provide an effective flue to carry away smoke and also to “draw” the fire.

(iii) Smoking back, which may be caused by a poorly drawing chimney; by a fireplace opening being too high (in which case a cowl might help), or because the chimney is "shaded" by a higher building, in which case the chimney may need heightening or a special cowl might be used.

Figure 39: Open fire with back boiler



(b) Individual electric convector heating

These are usually night storage heaters utilising cheap tariff electricity. This is relatively simple, but not always fully understood by tenants and, if run incorrectly, can be extremely expensive.

The system works by taking electricity at night to store heat to be discharged the following day. A special tariff can be taken from the electricity company and a special meter is required. Electricity is purchased at a specially cheap rate at night BUT electricity taken during the day may be considerably more expensive! Faults are likely to be few, but the system may be inconvenient as the heaters must be "switched on" the day before heat is required and, once charged, the heat must be used.

(c) Electric underfloor heating

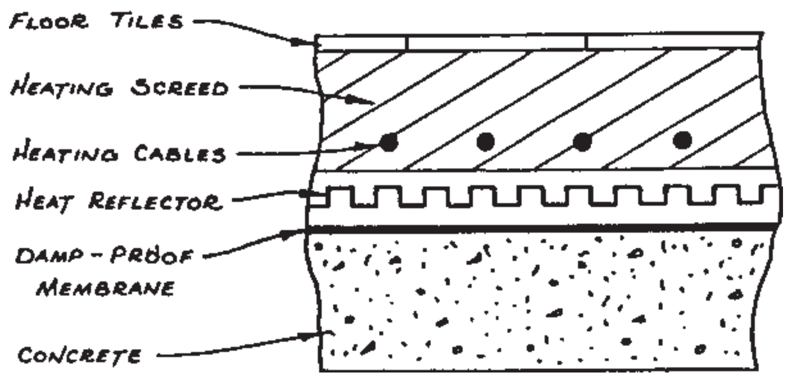
Heating cables are set into the floor when the dwelling is constructed. They operate on a similar "storage" system to (b) above. The biggest drawback of underfloor heating is repairing it! In many cases, faults can only be repaired by opening up the floor and many housing organisations now provide storage radiators to replace a broken underfloor system.

(d) Ceiling heat

This is similar to underfloor heating but cheaper to install and repair, using thinner, and easier to reach, heating elements. The system is rarely popular contradicting, as it does, the common requirement of "cool head, warm feet".

Figure 40: Underfloor heating

Section through a floor



10. Electricity Supply

10.1 Meters and fuses

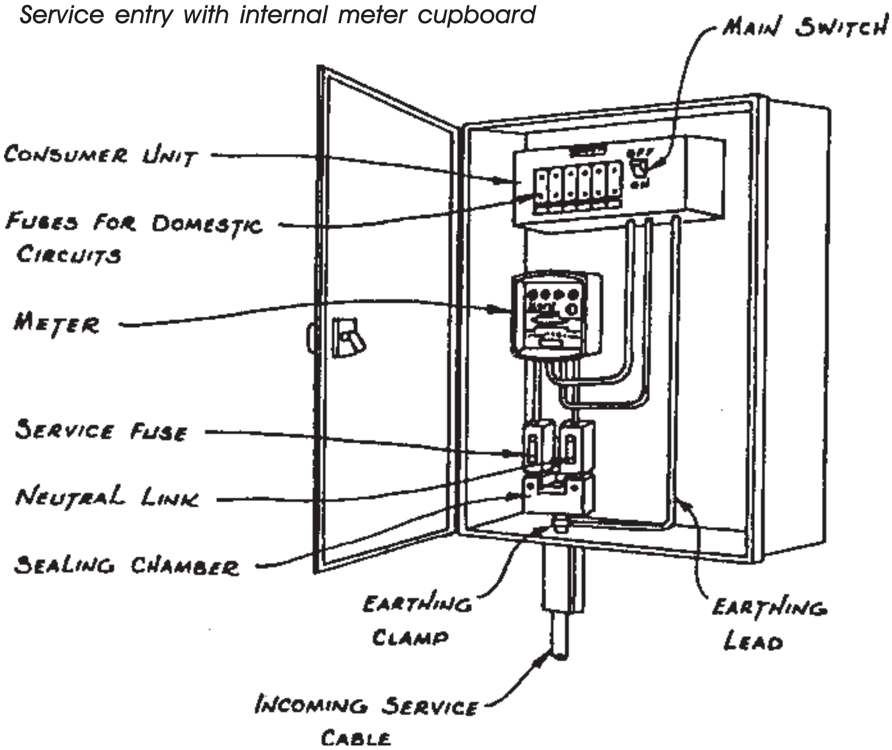
In older housing and in rural areas, many properties receive their supply of electricity by way of overhead cables but it is common in towns for the electricity to be supplied from the main under the street by an underground cable which rises through the ground floor.

At a convenient point close to the cable entering the house the electricity company fixes a meter. The meter, the cable and supply to it remains the property of the electricity company, while the wiring from the meter is the responsibility of the owner or occupier.

Nowadays it is common for the meter to be situated on an external wall so that it can be read by the electricity company's employees from outside. Older housing will have a meter inside, perhaps in the kitchen, hall, under the stairs, etc., where access is needed.

Figure 41: Electricity supply

Service entry with internal meter cupboard



The incoming service cable is fused before reaching the meter. This fuse is sealed and remains the electricity company's property. The purpose of the fuse is to cut off the supply to the circuit whenever an overload (or fault) occurs. The fuse must be the weakest link in the circuit. Thus it is essential that the correct size of fuse is used.

The incoming supply is then "metered" before passing though the *fuse box* or *consumer unit*. This box normally contains a *mains switch* which allows the occupier to shut down the whole supply of electricity, as well as individual fuses to protect the various circuits within the house.

Newer housing will now use *circuit breakers* instead of fuses.

A fuse burning out immediately cuts off the individual circuit's supply and is an indication of a fault somewhere within the system.

Fuses may be either wire or cartridge types, but it is important to use a fuse which is no stronger than is necessary. As this overrides the fuse's function, it could easily result in the fault occurring in a less obvious part of the circuit and a fire being the end result. The following is the normal rating for each circuit.

Lighting	5 amps
Immersion Heater	15 or 20 amps
Storage heaters	20 amps
Power sockets	30 amps
Cooker	30 amps

If an “off peak” supply is provided for heating purposes, then an additional meter will be fitted.

10.2 Internal supply

From the consumer unit (fuse box) electricity is distributed throughout the house by a number of separate circuits (lighting, power points, etc.).

Older installations provided 15 amp round-pin sockets and many of these may be unearthed, whilst newer circuits have 13 amp, square-pin sockets. However, newer sockets can easily be added to older wiring and, therefore, the existence of 13 amp square-pin sockets is no guarantee of the wiring being either modern or safe! A safe installation will consist of three wires - live, neutral **and** earth wires - and will have been recently checked by a qualified electrician.

The main fittings for outlets may be of a variety of types: sockets to receive plugs, spur units for fixed appliances, cooker control panels and light fittings, for example.

(a) Sockets

Newer houses will have a number of sockets or outlets throughout the dwelling allowing occupiers to plug in such appliances as a TV, kettle or washing machine where thy want them. In order to protect the individual appliance the plug itself should also be fitted with a fuse for the same reason as the fuse in the fuse box. The rating of the fuse in the plug should be as low as possible and will depend upon the appliance connected, as shown below:

Radios, TVs, table lamps (up to 750 watts)	- 3 amps
Fridges, cleaners, irons, hair dryers, toasters, mixers, electric drills (up to 1,000 watts)	- 5 or 10 mps
Electric heaters, washing machines, kettles, tumble dryers (up to 3,000 watts)	- 13 amps

(b) Light fittings

Lights may be controlled by a variety of methods - ordinary switches; two-way switches; pull switches, usually hung from the ceiling and usually used in bathrooms; and push-button time-delay switches which switch on lights for a set period of time.

Table lights may have an integral switch but are normally not connected into the lighting circuit, but fitted with a plug to allow them to be moved about, providing a fuse for safety.

The electricity circuit will always be the landlord's responsibility and the tenant should be discouraged from tampering with it, fitting additional sockets, wall lights, etc., without permission and without using a qualified electrician.

The occupier is responsible for movable appliances connected into the system and should be made aware of the correct method of wiring and fusing plugs and so forth.

10.3 Problems with the electricity supply and electrical fittings

Faults in the electrical circuit and/or the appliances connected to it can be fairly serious. Frequently the fuse in the consumer unit, plug or individual appliance will "blow" but, if the fuse does not blow and cut off the circuit/appliance, then a fire may occur. A large proportion of domestic fires are caused by electrical faults and many of these are attributable to a fault in the system (the landlord's) rather than in the individual appliance connected to the supply.

Problems may be caused through the wiring, or at least the wire's covering, perishing or connections becoming loose. Obviously a poorly installed electrical system will continue to give problems, but a competently installed system which is periodically checked should give few problems.

11. Gas supply

11.1 Supply

Gas is supplied through an underground pipe from the *main* in the road. The supply pipe is usually carried under the floor of the house and rises to the meter located in a convenient position such as a purpose-built cupboard or the space under the stairs.

The main gas cock to turn off the supply, is on the pipe next to the meter. Where houses are converted into separate flats there may be a second isolating valve in the street outside. Homes in rural areas may not be supplied with a mains gas supply. In such locations, gas is supplied in "bottles" e.g. propane gas or Calor gas, or from a large tank in the garden.

11.2 Distribution

Gas is distributed in the older house by iron pipes with threaded joints and fittings and, in modern houses, by copper pipes with compression joints. The pipes are carried under floorboards, clipped to joists and fitted with sleeves to protect them against damage when they pass through the walls.

All gas fittings such as boilers and fires have individual gas taps so they can be isolated from the supply for servicing, adjustment or repair. Some cooker connection points end in a bayonet-type fitting with tap. A flexible armoured hose is fitted to the cooker, and can be plugged into the bayonet fitting. This allows the cooker to be moved for cleaning.

> *Natural gas can cause death by suffocation and is explosive. It is therefore imperative to know the location of the main gas cock. It must be turned off at the first scent of a leak and the gas supply authority must be informed immediately.*

11.3 The requirements of gas installations

Gas installations must:

- ensure the supply of sufficient combustion and ventilation to appliances;
- ensure that the flue or chimney construction is gas tight, durable and adequate to remove combustion products;
- minimise the effects of a building fire;
- ensure that appliances can be used safely by tenants;
- maintain the whole installation in a safe condition.

For these reasons, gas appliances require regular servicing and maintenance.

Self Test 4

1. *What is dry rot?*

2. *What is the rising main on a water supply?*

3. *What are the two main types of hot water cylinder called?*

4. *Name the main types of central heating systems.*

Now turn to the Answers at the end of this Block.

12. Dampness and Condensation

One of the major problems which may occur in dwellings of all ages is that of dampness, which can create an unpleasant and unhealthy atmosphere within the house, and an equally unpleasant and unhealthy atmosphere in the relationship between landlord and tenant if no action is taken to remedy the defect.

The major causes of dampness are:

- rising damp;
- penetrating damp;
- leaks;
- condensation.

12.1 Rising damp

Figure 42: Transfer of ground water above DPC in solid wall

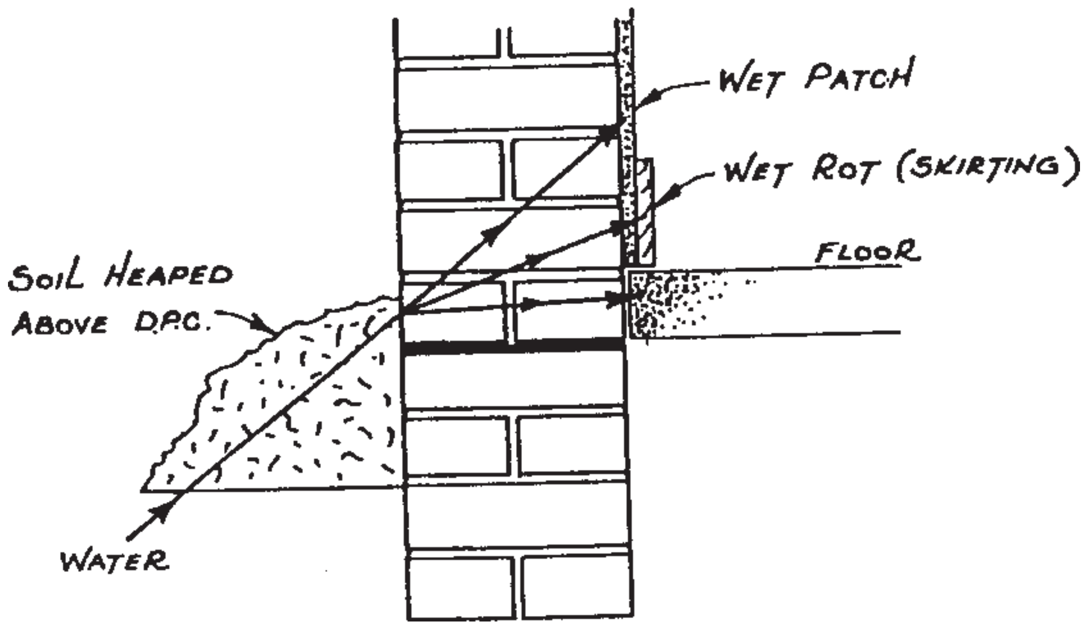
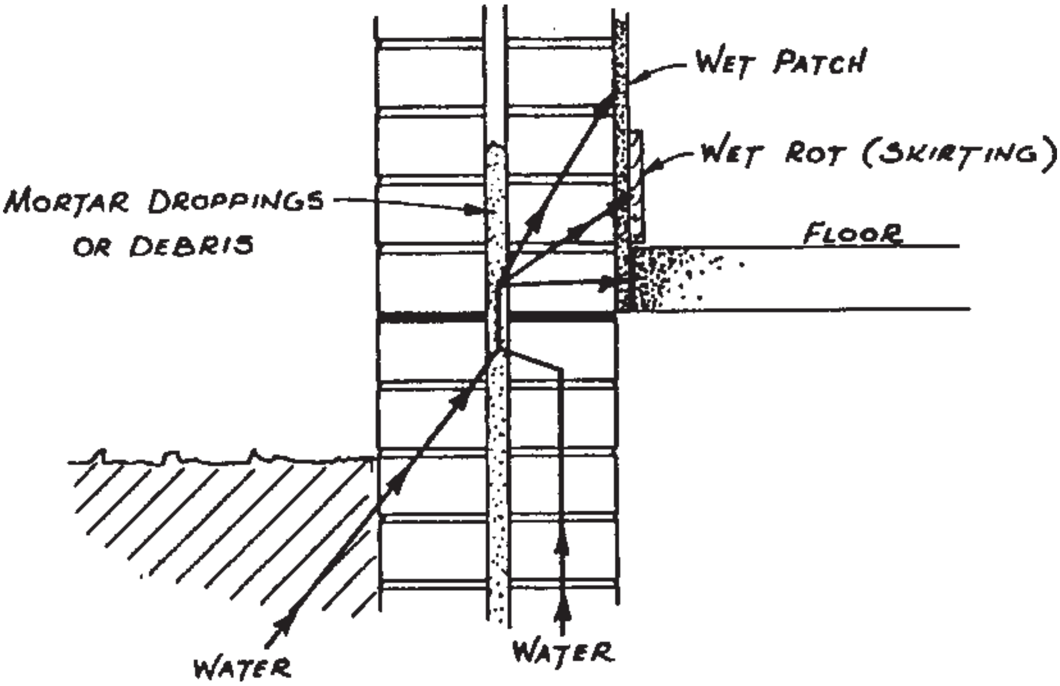


Figure 43: Transfer of ground water above DPC in cavity wall



As the name implies, rising damp may gain access at a low level and work its way up through the brickwork (the walls) as the problem continues.

Almost all building materials are porous and are capable of absorbing moisture. Earth is also very absorbent, and moisture in the ground can be transmitted into the structure of the dwelling if the damp proofing is inadequate.

Rising damp manifests itself in a damp patch reaching up the wall from ground level. In some cases it may be in a single patch, in others it may form a line almost horizontally across the wall.

At some point up the wall the amount of water in the brickwork (and plaster) will be low enough to evaporate and will leave a "tide mark" between an area of dry wall and, below it, a dark and damp area.

In order to prevent rising damp there needs to be a barrier in the wall to prevent it rising - this barrier is provided in the form of a damp proof course laid horizontally across the brickwork. If a solid floor is created at ground level, then this must “sit on” a continuous damp proof membrane which continues into the surrounding wall.

Activity 10

From the knowledge which you have acquired during your study of this block what do you think are the most likely causes of rising damp in a dwelling?

Time allocation 5 minutes

Should rising damp occur, the likeliest causes are:

(a) No damp proof course.

(b) If there is a solid floor there may be no damp proof membrane.

(c) Either the damp proof course (dpc) or damp proof membrane is faulty.

(d) Earth has been built up outside the house to a higher level than the dpc (this normally only occurs in solid walls). See Figure 42.

(e) The bottom of the cavity, in a cavity wall, is full of debris or mortar which extends above the dpc and allows a "bridge" to cross the cavity. See Figure 43.

The only cures are to replace a faulty dpc or dpm or, if the fault is of the dpc being “bridged”, to remove the offending material - which is relatively straightforward if it is simply a build-up of external material, but involves opening up the cavity if the fault is actually within the wall. It is also probable that the woodwork around the area will have rotted and need replacing, as will the internal plasterwork.

12.2 Penetrating damp

Penetrating damp occurs at any point where moisture passes from the outside face of the wall to the interior. In solid walls this can happen quite often, but can only affect a cavity wall if the cavity is "bridged" in some way.

In the case of a solid 9" wall, once the brick or mortar has absorbed water it will simply work through into the house, and probably the only remedy is to cover the interior of the wall with a damp proof membrane and fasten a thin partition onto the face of the wall. This does not rid the wall of dampness but, if the dpm is not breached, provides a barrier between the wall and the new, inner, surface. (This technique is often called "dry-lining".)

Cavity walls are, of course, constructed to prevent water from outside getting into the dwelling. Unfortunately, careless construction can provide a number of routes by which moisture can cross the cavity.

Activity 11

Again, from the knowledge which you have acquired during your study of this block, what do you think are the most likely ways by which moisture can cross a cavity?

Time allocation 5 minutes

These "routes" across a cavity wall include:

(a) Debris wedged in the cavity.

(b) A wall tie, which is designed not to allow moisture to cross it, being coated with mortar when the wall is built.

(c) Pipework which extends through the wall.

(d) Window, door frames and lintels which have been poorly fitted with damp proof courses.

Often the only solution is to open up the wall and repair the defect.

12.3 Leaks

In every house a number of pipes run through walls, under floors and through ceiling. Leaks usually are self-evident, with large amounts of water coming through ceilings, appearing under the floor, or wet patches on the wall or floor in the driest of weather.

Burst pipes are usually the easiest to find. Small leaks may not be as evident. As leaks and bursts are easier to correct than penetrating damp, the possibility of such a fault should be investigated before any other possibility is checked.

Should there be no obvious signs of a leaking pipe, then cutting off the incoming water at the stopcock and draining the hot water system (by turning all the taps on) will quickly empty the pipework and dripping water should cease. Leaks which are more difficult to trace are ones in storage tanks, cylinders and waste pipes, but are still relatively simple to correct.

Other leaks which may affect the house are faulty roofs and broken or badly fitted gutters, which may soak an external wall sufficiently to allow moisture to pass through a solid wall or find a possible "bridge" in a cavity wall.

12.4 Condensation

The problem of condensation has increased in recent years, due in part to such things as more steam producing domestic appliances, modern building materials and better draught sealing.

Preventing condensation is virtually impossible, but it is possible to reduce the level of condensation.

Condensation occurs because all air contains moisture in the form of water vapour. The amount it can hold depends on the temperature - the higher the temperature, the more vapour the air can hold.

The point at which the air is holding as much water as it can is the ***"dew point***". Condensation will normally occur when the dew point is reached, but this can occur very obviously on a window or wall or, less obviously, inside a brick or inside the cavity of a cavity wall.

(a) Surface condensation

This is caused when moist air hits a colder surface or when the air is suddenly cooled.

(b) Interstitial condensation

Caused by the air inside the house trying to escape (because air inside is warmer than outside, the air pressure is higher inside than out). The "departing" air will pass out through ventilators, gaps, holes, etc. and will also seep through the materials used to construct the dwelling.

If at any point the departing air reduces to dew point, then condensation will occur at that spot. As a wet material is less good at holding heat than a dry one, this is a vicious circle .... the material becomes wetter and cools causing more condensation which increases the wetness .... and so on.

Condensation creates a damp atmosphere, ruins furniture and decorations, increases heating costs and, like other forms of dampness, can lead to unpleasant mould growth and affect the health of the occupants of the dwelling.

Dampness which lies only on the surface of a wall is almost certainly condensation, but dampness which is deeper and recurs during cold or changeable weather rather than when the weather is wet, is also likely to be interstitial condensation.

Activity 12

Of all the maintenance problems reported to housing offices condensation is probably one of the most common. From your knowledge of the causes of condensation what would you advise a tenant suffering from condensation to do?

Time allocation 5 minutes

Suggesting solutions to the problem is simple, but they are often far more difficult to put into practice. If one can prevent dew point being reached, then one can prevent condensation occurring. This can be achieved by:

- reducing the amount of water vapour in the building; and
- increasing the temperature of the building.

Reducing the amount of water vapour can be undertaken by:

(i) Increasing ventilation to clear away the water vapour filled air. This can be partially achieved by fitting extractor fans in the wettest rooms and opening windows and door - **but** it must be recognised that the air that is being cleared away is the air which has already been warmed and the replacement air will be cool, so the occupant will have to pay for its re-warming.

(ii) Trying to reduce the causes of evaporation which fill the air with water vapour. Washing-up, washing and clothes drying all put a substantial amount of moisture into the atmosphere. Whilst all these are necessary parts of life, the problems of condensation may be reduced by confining these activities to well-ventilated rooms which are closed off from the rest of the house.

(iii) By not drying clothes indoors, in front of fires or hung on radiators, which produces a great deal of water vapour.

(iv) Avoid using paraffin or calor gas heaters which provide cheap heating but emit approximately one and a quarter pints of water into the atmosphere for every one pint of fuel used. The result could be a very warm and wet house!

To increase the temperature of the building:

(i) Turn up the heating system and/or burn more fuel, which may reduce the incidence of condensation but at considerable financial cost. It is not normally realistic to suggest this, although "background" heating in each room may prevent sudden temperature changes.

It is probably more realistic to look at ways of warming the actual structure or fabric of the building than the air inside it.

(ii) Insulation of one type or another may both retain heat within the house and provide a warmer surface to walls, floors and ceilings, thus reducing the occurrence of condensation.

Even so, certain cold spots may persist as some materials are less able to retain heat than others: for example the concrete lintel which supports the brickwork above windows and doors.

13. Insulation of Buildings

In the last section we looked at the problem of condensation, and noted that one of the possible remedies was to increase the insulation of the building.

Over recent years the insulation of buildings has become a much more important aspect of construction. Why do you think this is the case?

Activity 13

What are the main reasons why insulation has become more important in recent years, and what measures can be taken to improve it?

Time allocation 10 minutes

The main reason why insulation has become a more significant issue is because of the need to conserve energy. As the cost of energy has increased over the last 20 years greater efforts have been made by the construction industry to design energy-efficient buildings, and one important aspect of this has been to attempt to minimise the heat lost through a building. If heat can be retained, then less energy will be required to maintain a comfortable environment for the occupiers.

This has been particularly important for social housing landlords who have recognised that their customers are increasingly likely to be on low incomes, and that measures to reduce heating costs are even more necessary.

Activity 14

From your own knowledge, what are the main measures which can be taken to insulate a building to minimise heat loss?

Time allocation 5 minutes

Denise is a maintenance administrator for a housing association and she told us what she would do to minimise heat loss.

> *"There are a number of measures which can be taken to reduce heat loss in a building. Some are cheap to do, whilst others involve more significant amounts of expenditure. Obviously, if they are done at the time that the building is constructed then they can be done much more cheaply.*

- *Insulating hot water cylinders with a jacket.*
- *Draught proofing of doors and windows, including letter boxes.*
- *Increasing the insulation of the roof space.*
- *Installing cavity wall insulation to minimise heat loss through the walls.*
- *Considering the installation of secondary or double glazing."*

13.1 Insulation of roofs and walls

Traditional pitched roofs can be insulated by laying mineral or glass fibre quilting over or between the ceiling joists. (It is important to ensure that the area below the cold water tank is not insulated as there is a danger that the loft will become so cold that the cold water tank could freeze in very cold weather.)

Traditional cavity walls can be insulated by a variety of means:

- injection of urea formaldehyde foam into the cavity;

- injection of polystyrene pellets;

- injection of blown rockwool fibres into the cavity.

Over recent years the Building Regulations have required steadily higher standards of thermal insulation but existing buildings are not required to meet the higher standards applicable to newly constructed dwellings. Many social housing landlords when looking at capital expenditure projects have opted for works to improve thermal insulation standards in their existing stock, because they are relatively cheap, and generate immediate savings for customers, as well as increasing the comfort of homes.

13.2 Acoustic insulation

So far we have only considered thermal insulation of buildings, but it is also important to look briefly at acoustic insulation, which is to do with minimising noise coming into a building.

In many areas noise can be a severe problem. For example in cities, near major roads or airports excessive noise can be a significant issue for occupiers of houses.

This has been recognised in the Building Regulations which lay down minimum standards of acoustic insulation. Noise can be minimised by using high density building materials which absorb sound, double glazing of windows, suitable location of fences and screens as well as the provision of earth mounding or landscaping.

14. External Works

14. Fencing

Numerous types of fencing are used to define property boundaries. The most commonly used are identified here, and are illustrated in Figure 44.

(a) Chestnut

Chestnut paling is fixed by wire to posts driven into the ground. It has a poor appearance, and is usually confined to temporary fencing.

(b) Chain link

This type of fencing is much used, as it forms an effective boundary. It consists of chain-link mesh fixed to concrete posts. As an alternative, plastic-coated wire can be used, which lasts longer than galvanised wire.

(c) Strained wire

This is a cheap, open type of fencing consisting of five horizontal lines of wire secured to chestnut posts by galvanised staples. It does not provide a very effective boundary.

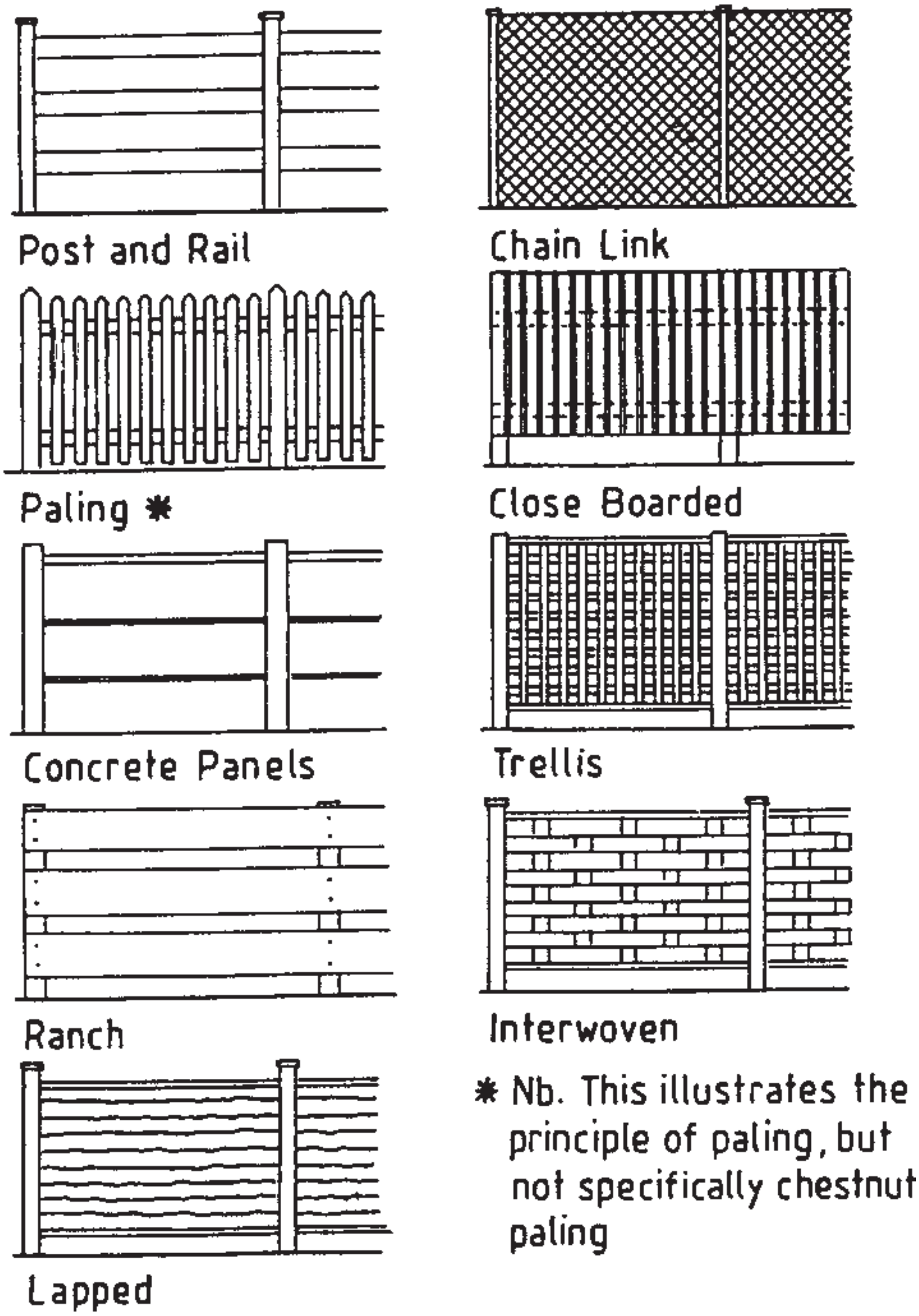
(d) Close-boarded

Close-boarded fencing is often of oak and although expensive does provide an attractive and effective boundary. Timber preservation treatment is essential.

(e) Interwoven or lapped fencing

This is a common form of fencing, quick to construct and with a pleasant appearance. Wooden posts are driven into the ground and the pre-made panels (wooden frame with overlapping layers of thin, rough timber fixed onto it) are fixed in between. It is simple, effective and relatively cheap. Timber preservation treatment is again essential.

Figure 44: Types of fencing



14.2 Retaining walls

Where the ground level on one side of a wall is higher than on the other side, this is known as a retaining wall. It must be strong enough to withstand the pressures exerted by the earth on the higher side. Weep holes are provided to allow accumulating water to escape from the high side. Walls are usually of brick and sometimes of concrete.

14.3 Paths and drives

The form of construction depends on:

- the desired appearance;
- cost limits;
- the availability of local material;
- subsoil conditions;
- sage.

(a) Materials

(i) Concrete

100mm thickness of concrete is usual for paths, and 150mm for drives. If heavy vehicles are to use it, steel mesh reinforcement should be included. Unless the subsoil is good, a layer of hardcore should be laid before concreting.

The maintenance is minimal and the cost moderate. However reinstatement is difficult, because the old concrete must be drilled out. The appearance can be improved by use of coloured cement, but this increases the cost and may reduce the wearing quality.

(ii) Bituminous or tarmacadam

This hard-wearing material is generally used for main roads through estates. The cost is moderate. Bitumen binds better to most stones than does tar and will, therefore, need less frequent maintenance dressings of hot bitumen and stone chips. The edges must be firmly supported with concrete or other suitable edging or they will break away; and any weeds must be treated regularly. The appearance is not particularly attractive, but reinstatement is not difficult.

(iii) Gravel

150mm thickness of gravel is laid. It is attractive in appearance but requires considerable maintenance, particularly if the gravel is not well graded or if it contains too high a content of clay. Again, the edges need support and weeds must be controlled. Gravel is unsuitable for steeply sloping or very wet sites.

(iv) Paving flags

These are usually laid on a weak mortar (cement) base. Hydraulically vibrated slabs are adequate for domestic use, and are available in a variety of sizes and colours. However, they can become quite dangerous with slight settlement, so need to be examined regularly for signs of unevenness.

(v) Cobbles, granite setts, natural stone flags or slate bricks

If such materials are available locally, their appearance can add much, especially to period buildings. The cost is likely to be higher, but if they are carefully laid, maintenance should not prove expensive.

(b) Layout

The layout of paths should, as far as possible, avoid steps or steep slopes. Paths should follow the natural line of pedestrians, otherwise short-cuts will be taken and tracks appear across the corner of grassed areas. Paths should have proper drainage falls and, if they cross depressions, gullies will be needed. Where against house walls, they should fall away from the building, and should be at least 150mm below damp-course levels, to avoid the problem of rising damp.

14.4 Garages, stores and sheds

(a) Materials

External garages, stores and sheds are normally built on concrete slabs (rafts) and may be brick, prefabricated concrete panels or asbestos panels on a steel frame, prefabricated timber panels, or purpose-built from timber based materials. All external timber should be treated with preservative.

(b) Roofs

Roofs may be pitched or flat, and covered with felt, corrugated asbestos cement, pvc or tiles in traditional manner. Roof drainage is normally by gutter and downpipe, which sometimes discharges into a rainwater butt or more usually to a soakaway.

(c) Walls

The walls of outbuildings are built to lower insulation standards than houses and are often single skin brickwork with strengthening piers.

(d) Doors and windows

Windows and doors are usually of standard pattern. Garage doors may be sliding, side-hinged or “up-and-over”.

14.5 Landscape work

The appearance of housing estates can be greatly improved by the provision of trees, shrubs and grassed areas. They provide a pleasant contrast to the harsh road and building surfaces. Flowering trees in grass verges or front gardens of houses add colour and beauty to the street picture, while shrubs can provide colour throughout the year.

For these reasons, it is suggested that in all designs:

(a) landscaping is treated as a priority item and not simply as a dispensable extra;

(b) the style should reflect the character of the local landscape, and take account of the local climate;

(c) landscaping should comprise a mixture of paved and grassed areas and planting, with a simple lay-out for easy maintenance;

(d) trees and shrubs should include a balance between coniferous and deciduous varieties, and reflect their eventual size. (But remember that the roots of trees can damage foundations.);

(e) trees should be properly tied, staked and caged to protect them from damage;

(f) small irregular unusable communal spaces should be avoided.

Self Test 5

1. *What are the four main causes of dampness?*

2. *What are the main routes by which moisture can cross a cavity wall?*

3. *What are the two main types of condensation?*

4. *Give some examples of types of fencing commonly used.*

Now turn to the Answers at the end of this Block.

C. Non Traditional Housing Construction

1. Introduction

In the last section, you examined the traditional approach to house construction in the UK. In this final section, we move on to look at some less common approaches to the construction of housing.

Well-tried, traditional techniques are by far the most common methods of construction in the UK. As you have already learned, their key characteristics include the use of brick (or stone/block), load-bearing walls, usually with pitched roofs covered in tiles or slates. All aspects of the construction are undertaken on site. This means that traditional techniques are expensive, because they are necessarily labour intensive.

1.1 What are non-traditional approaches?

Non-traditional approaches to house construction all essentially involve an attempt to shift some aspects of the construction process away from the site, to a factory. Hence, they are sometimes referred to as “industrialised” building techniques. Some elements of the construction are “pre-fabricated”, or they are complete “systems” which simply require *assembly* on site.

These industrialised methods considerably reduced the construction period, and reduced labour costs. However, because these were new approaches, a number of unforeseen problems have arisen. In this section, you will learn about some of these problems, and their implications both for tenants and for housing organisations.

1.2 What is the relevance for housing managers?

Activity 12

As we have already seen most housing in Britain has been constructed in the traditional manner, using brick and block walls with pitched roofs. So why do you think it is important for housing managers to have some understanding of non traditional building construction? Make a list of some of the reasons in the space on the next page.

Time allocation 5 minutes

As housing managers, it is important that you have some understanding of how these methods differ from the traditional approach. You may well find that you have to manage stock of non- traditional build. While non-traditional homes account for a relatively small proportion of dwellings in the UK, they are, nevertheless, *numerically* significant: it is estimated that almost one million such homes have been built since the Second World War. Most are to be found in urban areas.

As we have already indicated, non-traditional techniques have resulted in a wide range of specific problems. This has significant implications for the repair and maintenance of such stock.

We asked Michael, who is a neighbourhood housing manager with a Metropolitan District Council, to give us his response to Activity 12.

> *"I work in an inner city area and although most of the properties I come across are traditionally constructed it is important that I know something about other construction types. In my patch we have a number of high rise blocks and their form of construction gives rise to a number of maintenance problems which are often reported to my office, so it helps to know something about how the building is constructed.*
>
> *We also have a small estate of Airey houses which in the past was very popular. Again I have learned quite a bit over the years about how they were built and this helps when I have tenants in the office complaining that their properties are "unsafe". I am able to reassure them and give them some advice as to what needs to be done to keep the properties in a fit state of repair. It also helps to have some knowledge about these matters when talking to the technical people at headquarters. They don't try to fob me off these days with technical mumbo jumbo."*

2. Types of Non-traditional Construction

There are many different types of non-traditional construction methods. It is important that the particular type is identified, because each may have quite different implications for repairs and maintenance. However, from the outside, this is not always a simple matter!

Non-traditional homes may vary in two main ways:

- the design of the structure of the house;
- the methods and materials used in construction.

2.1 Structural design

Non-traditional construction techniques may adopt one of two main approaches to structural design:

(a) Skeleton structures

This involves the construction of a structural framework, which is then clad in a number of possible ways. The frame is the load-bearing element in the design. The walls themselves are not load-bearing.

The internal frames may be of concrete, steel, or timber. The frame may be clad in a variety of materials, such as brick, blockwork, or concrete. Some of these types may, therefore, appear to be of traditional construction.

(b) Exoskeleton structures

In this approach, the external walls are load-bearing, as well as forming the skin of the home. These types may be rather easier to identify, since some appear, obviously, to be pre-fabricated homes.

2.2 Construction methods and materials

Since non-traditional approaches are “factory based”, it is important to recognise that each manufacturer developed an individual system. This means that, although the different types may be similar, each different manufacturer produced a unique system with a different trade name.

It is impossible to identify all possible methods in this section since there are so many! We have, therefore, concentrated on **six** main types of non-traditional construction methods, each using one of the two approaches to structural design.

The charts below indicate some of the more common trade names associated with each of the six methods.

(a) Predominantly skeleton structural systems

TYPE	TRADE NAMES
Pre-cast concrete frame	Airey Kenhast Orlit Parkinson Unity Batterley
Steel frame	BISF Cussins Dennis Wild Dorlonco Doxford (British Housing) Howard Trusteel
Timber frame	Boro Developments Ltd. Scandinavian Timber Frame Spooner Swedish Timber

(b) Exoskeleton structural systems

TYPE	TRADE NAMES
In situ poured concrete	Duo-Slab Laing Easiform Wimpey No-Fines
Pre-cast concrete panel	Cornish Unit Dorran Myton Tarran Dorran Tarran Bungalow Tarran Newland Wates Woolaway
Large pre-cast concrete panel	Bison Larsen Neilson Shepherd Skarne

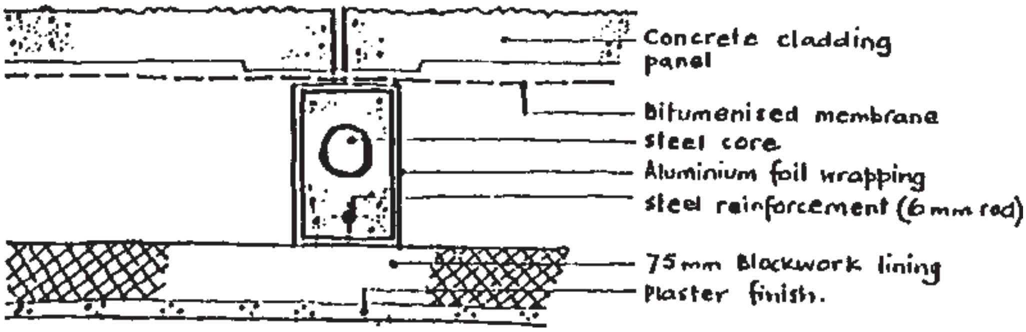
In the sections which follow, we shall be examining each of the six types of non-traditional construction methods. This will include some examples of particular systems, with specific trade names. We shall also identify some common problems of each type, and indicate how these might best be resolved.

3. Pre-cast Concrete Frame

This first group includes a very wide range of different house types. All have a structural system of pre-cast concrete frames, containing steel reinforcement to strengthen the concrete. This provides the load-bearing "skeleton", onto which a variety of different types of cladding was attached.

A plan view, through a concrete column, with an external concrete cladding panel, and internal blockwork lining, is shown below, in Figure 45.

Figure 45: Detail through pre-cast concrete frame



Look for the steel reinforcement in the concrete column. Corrosion of this steel results in these types of homes having some of the worst structural problems. This is due to three main problems with the concrete, known as the "three Cs".

3.1 The three Cs

(i) Carbonation

This is a natural process, in which the concrete reacts with carbon dioxide in the air. This reduces the alkalinity of the concrete, so it can no longer provide the chemical protection to the steel reinforcement inside. This permits the steel to corrode.

(ii) Chloride

Calcium Chloride was commonly added to the concrete to accelerate it's setting. However, it has since been discovered that too much chloride reduces the chemical protection which the concrete offers to the reinforcement. Hence, it may result in corrosion of the reinforcement.

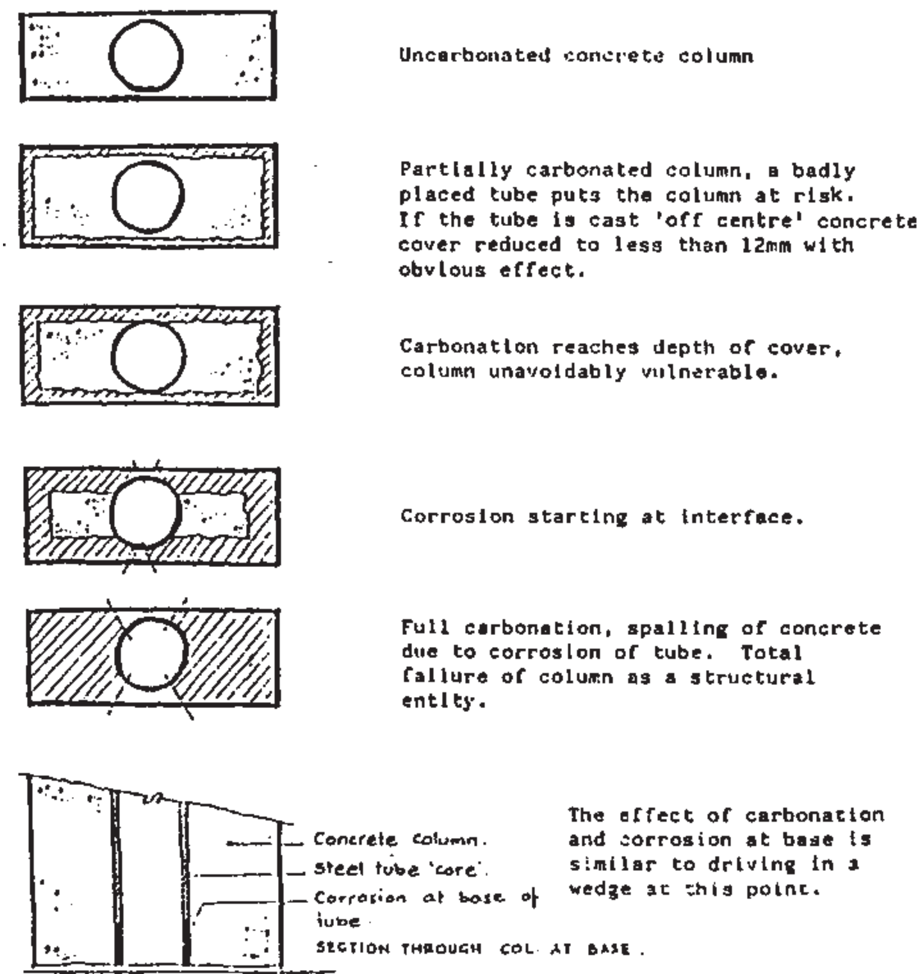
(iii) Cover

In some cases, the amount of concrete cover provided to the reinforcement was inadequate. The concrete was insufficiently thick. This results in insufficient protection to the steel reinforcement.

As a result of the three Cs, there may be very severe corrosion of the steel reinforcement. As it corrodes, it expands to crack the surrounding concrete. The entire structural frame may become unsafe.

This process is illustrated in the diagram which follows:

Figure 46: The effects of carbonation



3.2 The Housing Defects Act 1984

The problems identified above were first discovered during investigations, following a fire in 1980 in a pre-cast concrete Airey house, which led to a nationwide investigation of all pre-cast buildings. After the discovery of further defects, financial institutions (such as building societies) were reluctant to lend money for the purchase or resale of such properties. They effectively became unmortgageable.

The government, anxious not to see the 'Right to Buy' legislation undermined, responded with the *Housing Defects Act* of 1984. The aim of the Act was to re-establish the mortgageability of a property, and repair grants are available to homeowners who bought their houses from local authorities unaware of the potential defect. The Act enables the Secretary of State for the Environment to designate defective classes of dwellings.

The Act only applies to properties built before 1960, presumably to exclude high-rise dwellings, most of which were constructed after this date. In most cases, the repair involves replacing the external concrete wall with traditional load-bearing brick and blockwork. Homeowners of designated properties are eligible for grant aid even if their dwelling is not itself defective. The costs are roughly £20,000 per unit, at current prices.

The legislation has caused much controversy, because grants are only available to those who have opted to buy their houses under the Right to Buy legislation.

Under the Housing Defects Act a number of forms of non traditional dwellings are "designated defective" and are eligible for assistance. The designated defective dwellings include:

Characteristic appearance	**System**
Shiplap concrete planks	Airey
Concrete posts and panels	Cornish Unit Stonecrete Waller
Storey height narrow concrete panels	Dorran Dyke Myton Newland Stent Tarran Wessex

Storey height wide concrete panels	Reema Hollow Panel Wates
Blockwork (small panels)	Gregory Orlit Unity and Butterley
Brick clad	Schindler and Hawksley SGS
Rendered	Boot Dyke (variation) Orlit (variation) Parkinson Stent (variation) Underdown Unity (variation) Winget Woolaway
Mansard roof	Cornish Unit Gregory
Flat roof	Airey (variation) Orlit (variation)

3.3 Identifying designated defective dwellings

In 1984, the Department of the Environment and the Welsh Office issued a circular under the 1984 Housing Defects Act which set out the designated defective dwellings, and indicated their main characteristics. You should consult it to identify designated defective dwellings in your area. The circular is:

> *Housing Defects (Prefabricated Reinforced Concrete Dwellings) (England and Wales) Designations 1984:*
>
> DoE and Welsh Office 1984.

We shall now examine in more detail a pre-cast concrete frame system, the Airey House, one of those designated under the 1984 Act.

3.4 The Airey House

This was one of the first post-War system-built concrete houses. It was constructed as follows, and as illustrated in Figure 47.

(i) 4 inch and two and a quarter inch concrete columns are set at 18 inch centres, with one and a quarter inch diameter hollow mild steel locating tubes up the centre.

(ii) The external cladding is half inch exposed aggregate shiplapped concrete panels, tied to the columns by copper wire.

(iii) Internally, the cladding is plasterboard or fibre board with one inch insulation in the cavity.

(iv) Roofs are pitched and tiled.

(v) Gable ends are board finished, or hung with tiles.

Most Airey houses were semi-detached. The shiplapped boarding gives them a distinctive appearance (see Figure 48).

Problems with Airey houses

- Carbonation of the concrete columns allowing the mild steel tube to rust.

- Spalling of the concrete has occurred mainly at the foot of columns, although there has also been damage at mid-height and above.

- The very slender columns mean that the structural integrity is very easily impaired.

Of all the system-built concrete houses, Airey houses have been considered the most urgently in need of repair or upgrading. Many repair methods have been devised, including timber framing, replacing columns in steel or timber and masonry "enveloping" (brick and block system, Leeds). The Leeds system makes the existing columns redundant, and gives the house the appearance of traditional construction.

Figure 47: The construction of Airey Houses

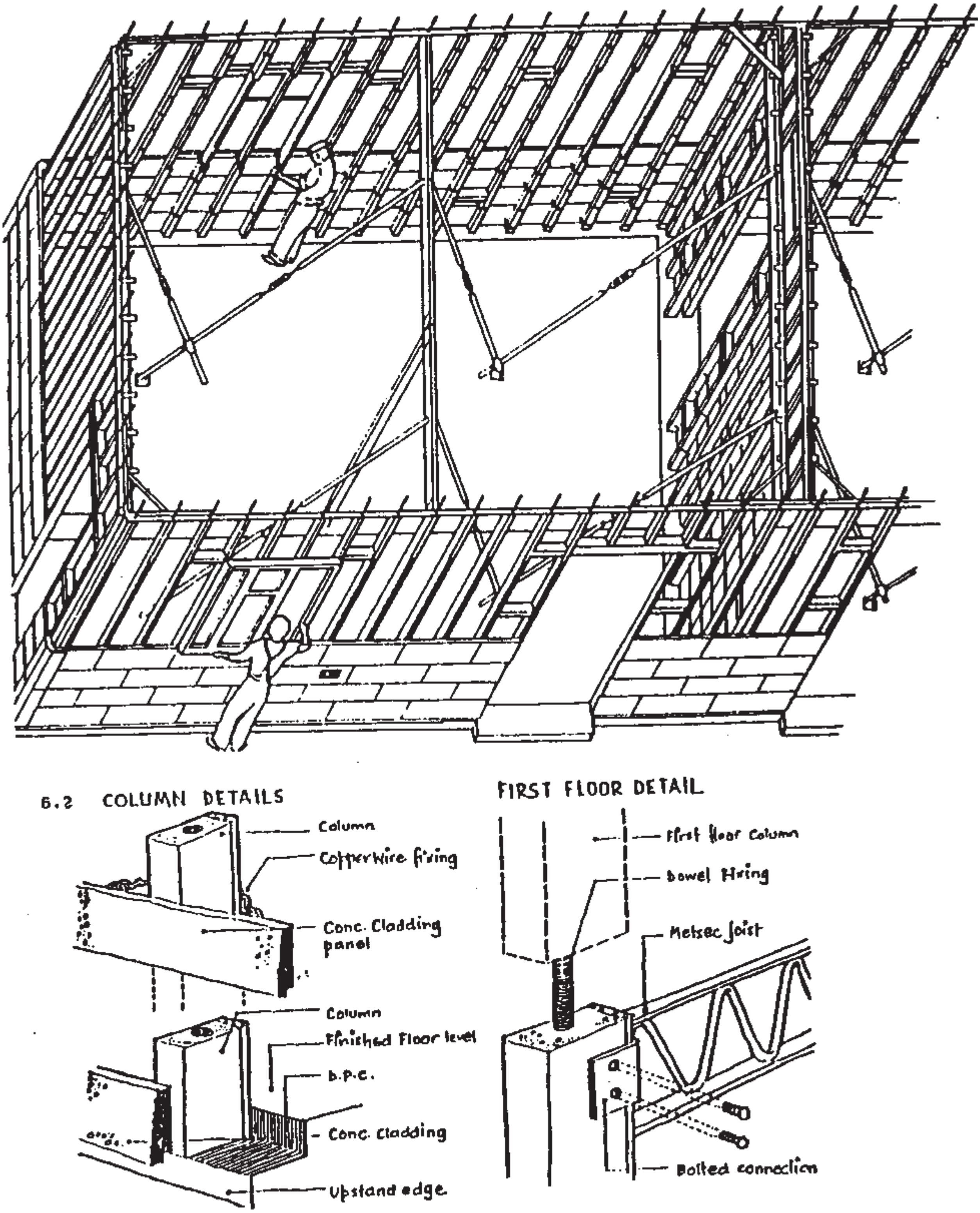


Figure 48: An Airey House

Source: Northern Consortium of Housing Authorities (1988)

4. Steel Frame Houses

This category forms the second largest range of house types. Skeleton steel frames are clad in various skins, ranging from steel sheets (BISF) to more traditional brick (Trusteel) and rendered finishes (Dorlonco), often making their true form of construction difficult to identify.

In general the steel sheeting skins and asbestos sheet roofs are now coming to the end of their useful life. For the BISF house type this has resulted in a range of different remedial enveloping solutions, which again can disguise the house type's true identity. This type of solution permits radical upgrading of wall insulation values.

We shall look, next, in more detail, at the BISF house.

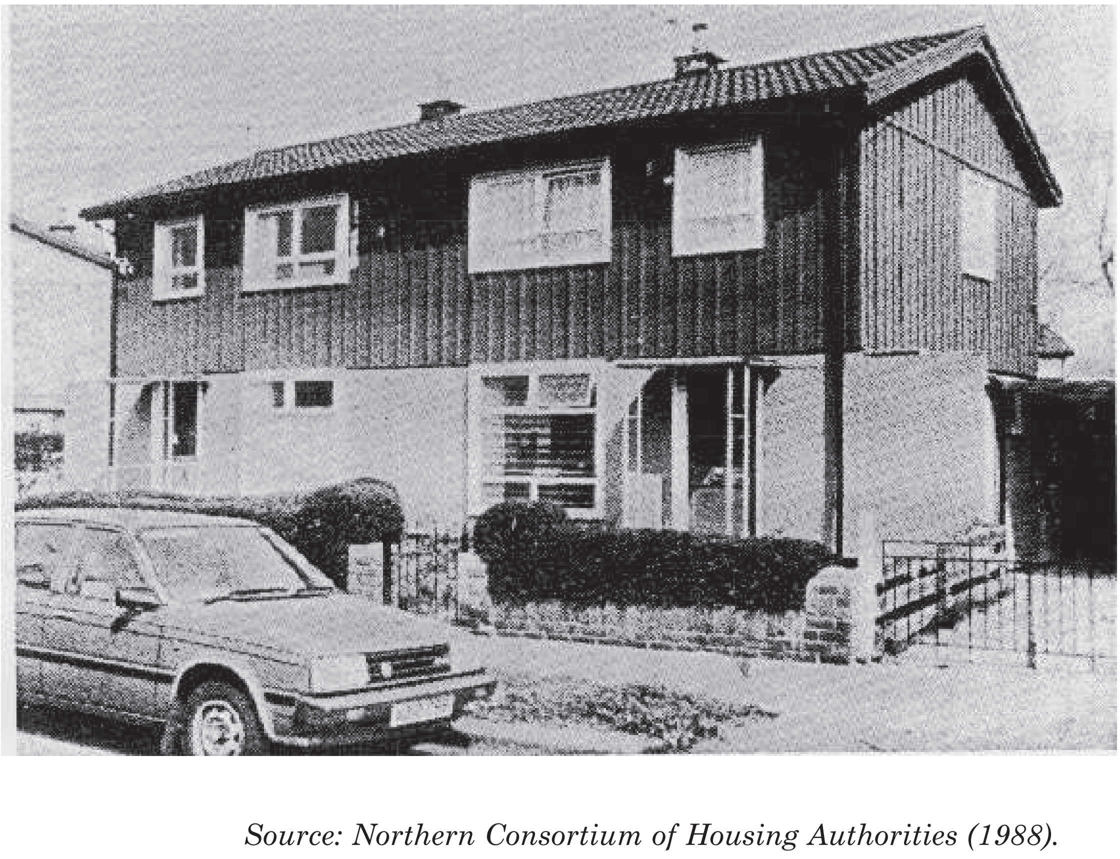
4.1 BISF houses

The most common non-traditional steel framed house is the BISF (British Iron and Steel Federation). Some 30,000 properties were completed after 1945, most of them semi-detached. They are not designated properties under the Housing Defects Act and, therefore no grant assistance is available to owners. A typical BISF house is shown in Figure 49.

The frame is made from steel stanchions or columns, with steel sheeting cladding the upper storey. The ground floor cladding consists of render on metal lath, which is tied to the steel columns. Internally, the frame is hidden by plasterboard fixed to timber battens, bolted across the columns. Steel trusses support the roof covering, which is asbestos cement sheeting. Construction details are shown in Figure 50.

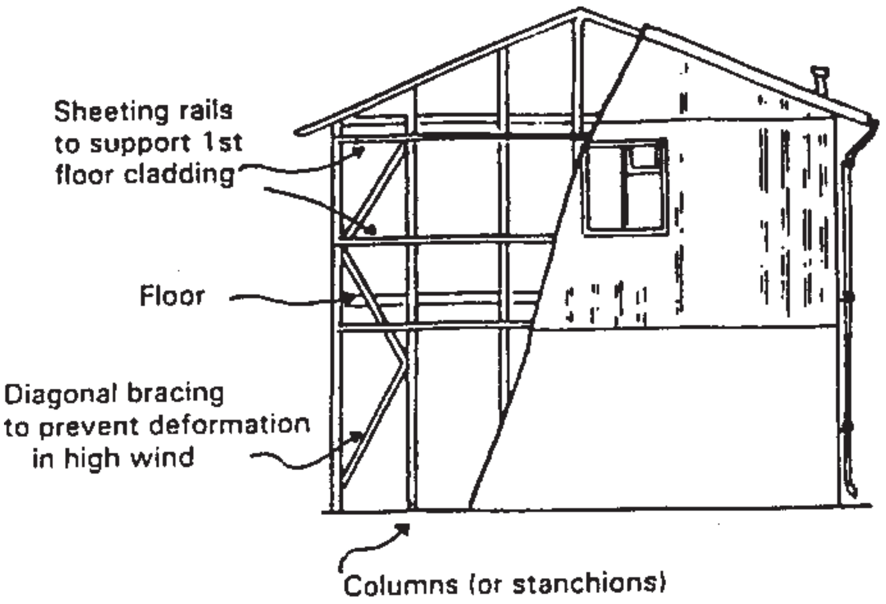
They are very popular with owner occupiers and tenants because, despite some of the defects, they offer very roomy accommodation.

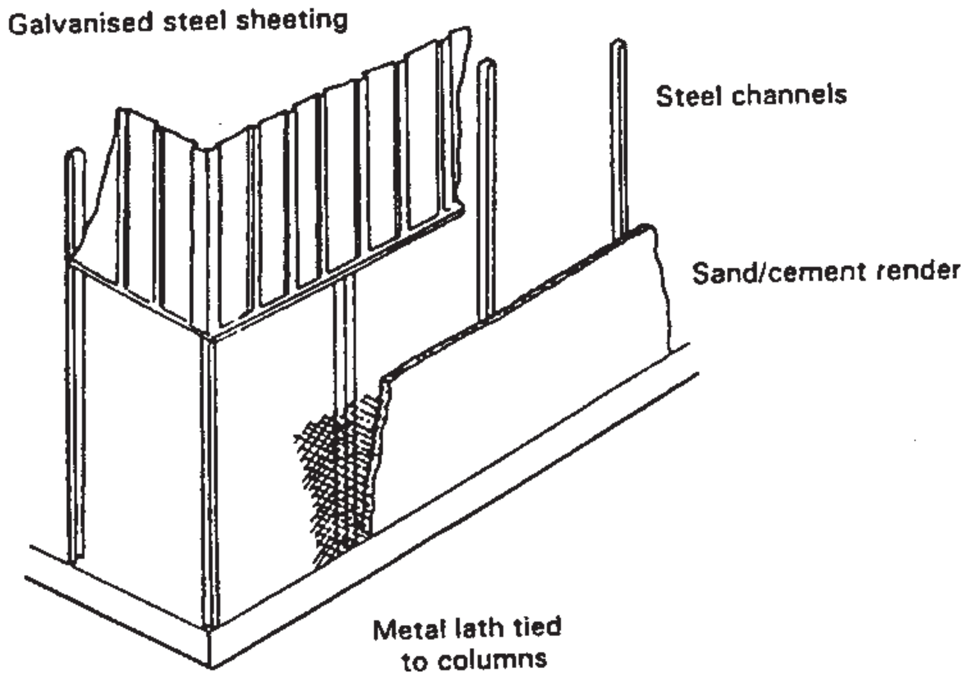
Figure 49: A typical BISF house



Source: Northern Consortium of Housing Authorities (1988).

Figure 50: Construction details, BISF house





4.2 The main problems with BISF houses

Activity 16

From what you have just learned about defects with Airey Houses can you attempt to predict what are likely to be the main problems affecting BISF houses? Make some notes in the space below.

Time allocation 5 minutes

The Building Research Establishment (The BISF Steel Framed House, 1986) has identified a number of defects, some of which have structural implications.

(i) Cracking of the render, which can be caused by impact damage. In addition, minor structural movement has occurred in some properties. This can result in rusting of the metal lathing, followed by total failure of the rendering.

(ii) Rusting of the steel cladding to the upper storey has also been a problem. It is caused by failure of the weather stripping on the gable ends, and by condensation. In severe cases, this has led to rusting of the sheeting rails which support the cladding.

(iii) The asbestos cement sheeting which forms the roof can deteriorate, and the material then becomes brittle and cracks. The only option in this situation is to re-cover the roof with a modern alternative such as aluminium.

(iv) Some corrosion has been found in the stanchions, particularly those at the corners of the building.

(v) There are other defects such as poor thermal insulation, discoloration of the steel sheeting and rusting of the chimney cowls. However, the majority of ISF houses are structurally sound, and those with deterioration of the structural framework can be relatively simply repaired by cutting out and replacing the affected members.

5. Timber Framed Housing

Norwegian timber frame systems were first imported during the 1920s, and these remain an attractive addition to the housing stock. Shortage of timber and labour during the immediate post Second World War period precluded the use of this type of construction, but during the 1960s and 1970s, it became popular again. It again lost favour following a "World in Action" television programme of 1983, which identified some of the problems of the system, which we shall examine shortly.

5.1 Construction

Generally, timber framed houses consist of load-bearing ply-faced timber panels, nailed together. The frames are factory made. In the UK, timber framed construction takes two forms, both illustrated in Figure 51.

(i) The platform frame, in which the panels are single storey height.

(ii) The balloon frame, when the panels are "house size" or two-storey", and the first floor incorporates a ring beam.

Internal walls are timber partitions. Externally, the frame may be clad in a range of materials, most commonly brick for a traditional appearance.

5.2 Problems

The problems associated with timber frame houses are due, for the most part, to poor erection procedures, and poor quality control on site. Examples include:

- missing, or misplaced fire-stopping;
- panels or units not properly fixed, or nailed;
- missing damp-proof courses and flashings;
- tears in the plastic sheeting vapour barriers;

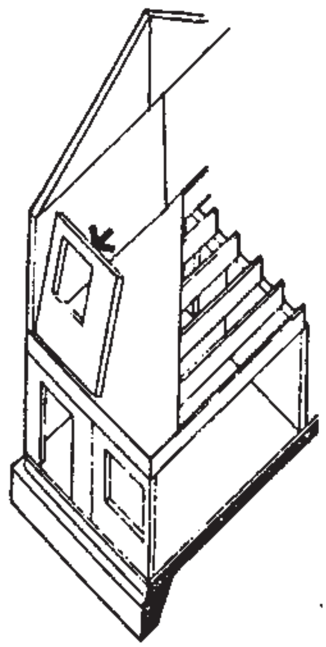
- missing or incomplete insulation;
- frame not properly fixed to floor slab;
- no allowance made for expansion and contraction;
- lack of ventilation in cavity between frame and cladding;

These have resulted in:

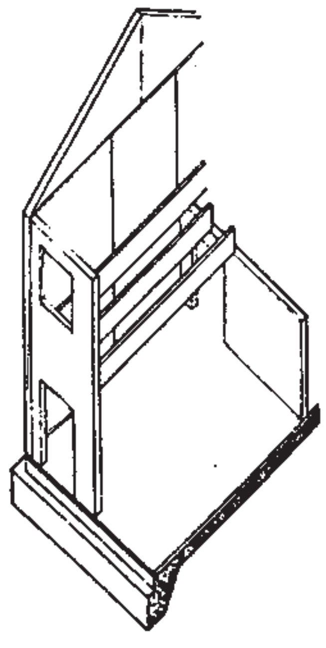
  - condensation on the timber frame and dampness in the cavity, both of which can lead to attack by dry or wet rot;
  - internal condensation;
  - internal cracking;
  - potential fire risk.

Timber frame construction is still fairly uncommon in the social housing sector. It was much more popular with speculative builders, so it is mainly owner occupiers who face these problems. In recent years, however, the construction industry has made a great effort to improve quality, with some increase in popularity of the method in both private and public sectors.

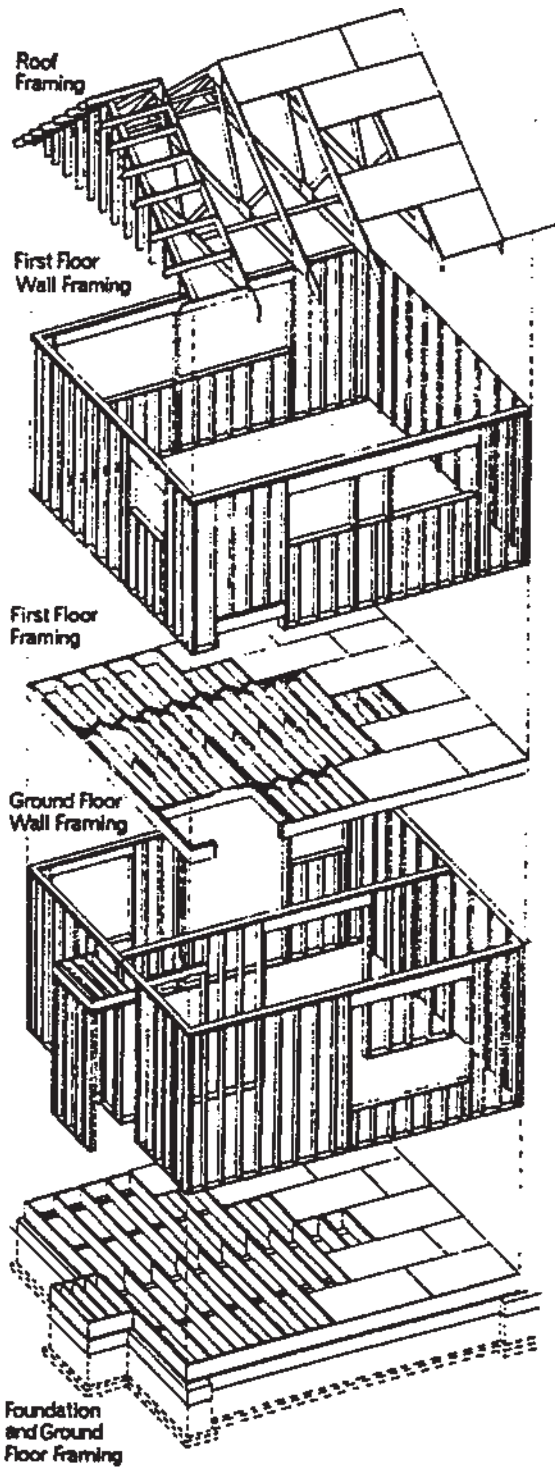
Figure 51: The construction of timber framed housing



Platform frame construction



Balloon frame construction



6. In Situ Poured Concrete

This category of non traditional houses is unique, in that unlike all of the other groups, it does not rely on the assembly of factory components (a kit of parts). Instead of being system-built, it involves innovatory approaches to wall construction, using in situ poured concrete.

The complete house was cast on site, using specially designed "house-sized" formwork. The example we shall examine is the Wimpey No-Fines house

6.1 Wimpey No-Fines

The walls of the house were cast on site, using large, re-useable, formwork moulds. 'No-Fines' refers to the type of concrete used - a mix of cement and coarse aggregate, without any sand (fines). The walls are load-bearing and the concrete is full of air holes - giving a slightly better insulation value.

The claim to prefabrication lies in the manufacture of large re-useable shuttering - the "moulds" into which the concrete is poured.

This type of construction enabled the house to be quickly erected using non-skilled labour. This made it particularly suitable to meet the demand for large scale social housing estates built during the 1950s and 1960s. Wimpey No-Fines was used to build multi-story flats as well as low-rise and houses. A typical semi-detached house is shown in Figure 52, and typical flats in Figure 53.

The rendered finish of these types of houses hides the fact that they are constructed from No-Fines concrete.

Figure 52: Wimpey No-Fines House

Source: Northern Consortium of Housing Authorities (1988)

Figure 53: Typical No-Fines flats

Source: Northern Consortium of Housing Authorities

A weakness of the design was the difficulty of compacting the concrete properly on-site, particularly below window openings.

It was also essential to render the outside of the structure to make it weathertight.

6.2 Problems

(i) Condensation due to fairly poor insulation values. Upgrading is usually by external insulation.

(ii) Cracking may appear around the doors and windows, leading to water penetration.

(iii) Cracking or spalling of the render can result in damp penetration.

Structural failure is not prevalent or intrinsic to this form of construction. Movement cracks do appear, however, at some window and door openings, permitting water penetration.

7. Pre-cast Concrete Panel

These houses are built with load-bearing pre-cast concrete panels. This means that the concrete storey height panels have to perform the dual role of structural support and external skin, and are completely exposed to the rigours of the elements.

One major area of confusion with this type of construction is the fact that identical house types are identified by different names by various local authorities.

> *All the houses in this group are designated defective under the 1984 Housing Defects Act.*

We shall now look at the example of Wates houses.

7.1 Wates houses

(i) The basic system comprises pre-cast load-bearing panels of one storey height. The panels have a tray profile - that is, with flanges around the edges.

(ii) The vertical edges of the panels are grooved. When butted together, and the groove filled with fine concrete and reinforcement, these form in situ columns supporting the panels. The tray hollows could be filled with lightweight concrete.

(iii) Horizontal joints are of mortar, with continuity reinforcement.

(iv) There is a reinforced concrete ring-beam string course at first floor level and eaves.

(v) Roofs are traditional pitched.

7.2 Wates houses: problems

(i) Cracking of joints between panels (mostly vertical joints) due to differential movement. This can lead to corrosion of the reinforcement.

(ii) Cracking and spalling of panels, due to thin panels - a design defect.

(iii) Rusting of the reinforcements, particularly over openings, due to exposure to the elements.

(iv) There may be ring-beam (string course) deterioration, particularly in the connections to panels. Corrosion of string course reinforcements may also occur.

As you saw, Wates houses are designated defective under the 1984 Act.

Figure 54: Examples of Wates houses

Source: Northern Consortium of Housing Authorities

8. Large Pre-cast Concrete Panel

This category of non-traditional housing was mostly used during the 1960s and 1970s, in medium and high-rise developments and in two storey semi-detached and terraced houses.

The factory-made large panels were delivered to the site ready for assembly. While quality of the pre-cast concrete components was certainly better than earlier systems, this housing still suffered to some degree from the three Cs: carbonation, high chloride levels, and lack of cover.

8.1 Construction

(i) Each wall panel would have door and window openings "cast in", and may even have been glazed and painted in the factory.

(ii) Floor finishes were also cast in.

(iii) Panels needed no internal plastering; they were ready to decorate.

(iv) Externally, the concrete might have different textures, so each block might look different.

8.2 Bison wall frame

Between 1964 and 1975, approximately 40,000 Bison wall frame units were constructed, of both high and low-rise buildings, ranging from two to twenty storeys. Examples are shown in Figures 55 and 56.

(i) This was a large panel system, with load-bearing pre-cast walls and pre-cast flooring, stairs and lift shafts.

(ii) The bathroom and toilet were cast as one unit incorporating walls, floor, ceiling, airing cupboard, ducts for plumbing and ventilation.

(iii) Each panel, weighing up to 7 tonnes, was lifted into place by a crane.

8.3 Common problems

(i) Rain penetration, through roof parapets, through vertical and horizontal panel joints, and around window openings, resulting in accelerated deterioration of the internal finishes, and of the structure itself.

(ii) Differential movement: this may occur between the cladding panels, and between the panels and the window frames. This can result in cracks appearing internally, at vertical junctions between panels, and also between ceiling and floor levels. There may also be leaks around windows, causing the frames to rot.

(iii) Condensation: a very common problem, especially in high rise blocks, due to wind exposure and lower temperatures at high levels. The system suffers from "cold bridging" at floor and ceiling levels, due to the poor thermal insulation properties of concrete.

(iv) Roof problems: these units were built with flat roofs. Many suffer from leaks and water penetration through the roof. Due to poor insulation, there may also be dampness due to condensation forming inside the roof. Further problems arise when felt roof-covering fails as a result of stress cracking, due to its inability to cope with differential movement.

(v) Sound insulation poor, due to gaps between panels and poor jointing. As a result, smells and smoke may also be transmitted between units.

(vi) Spalling concrete: causes bits of panels to break off. It may be due to lack of tolerance - that is, fit - between panels. A more common cause is the use of calcium chloride in the concrete mix at the factory. Spalling exposes the steel reinforcement, causing it to rust. This can lead to major structural problems.

(vii) Asbestos: commonly used as a lightweight insulating product, but as it deteriorates and fragments it becomes a major health hazard. It was used for fire-protection, fire stopping between units, and for some cladding panels.

The figure below shows the 21 individual panels which were assembled to produce a 2 bedroomed flat. The complete bathroom unit is panel number 4.

Figure 55: Assembly of a Bison Wall Frame unit

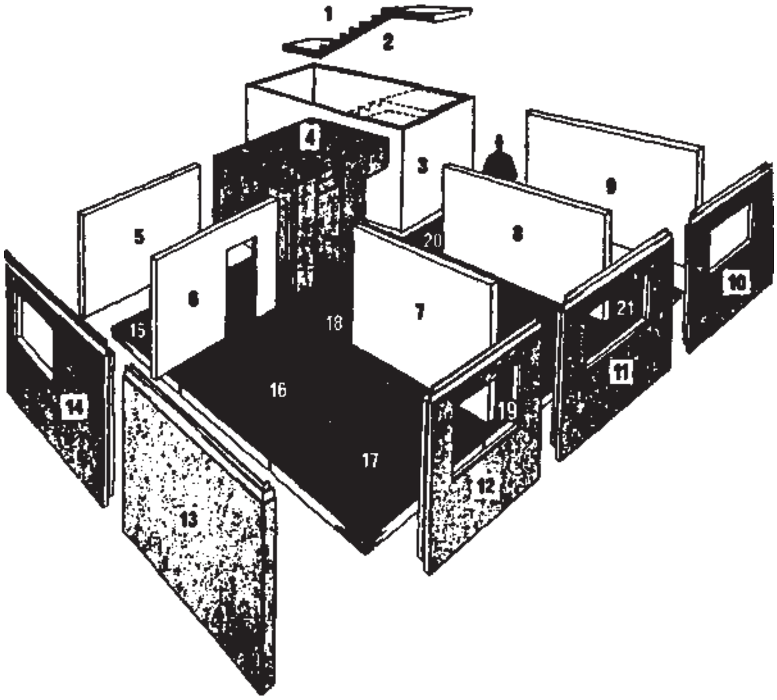


Figure 56: A Bison Wall Frame low rise block

Source: Northern Consortium of Housing Authorities 1988

Activity 17

You have now examined six main types of non-traditional construction, and have learned about a range of problems which may arise. However, these problems have many similarities. Review those identified, and try to ***generalise*** *about the* ***types*** *of problems which non-traditional properties may share.*

Time allocation 20 minutes

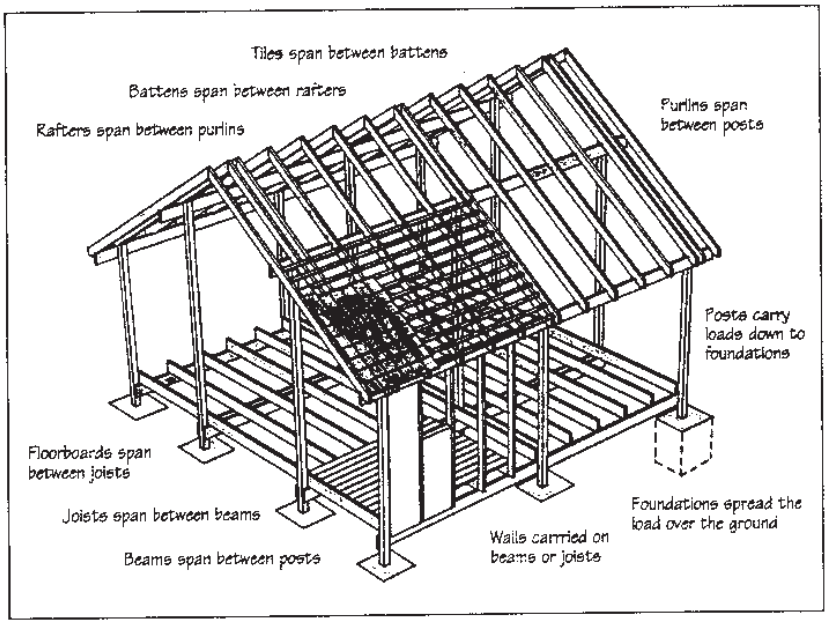
9. Self Build Housing

There are various methods applicable to self build; the example listed here is a timber frame method invented by an architect, Walter Segal. The method is summarised below using text from "Out of the Woods: Environmental Timber Frame Design for Self Build", published by The Centre for Alternative Technology, Machynlleth, Powys, Wales.

9.1 Post and beam frames

The structural principle of 'post and beam' framing is that loads are carried by small timbers - tiling, lath and studs - which in turn are carried by slightly larger pieces - rafters, floor joists, ceiling joists - to beams, which are supported at larger intervals by posts, which are carried by the foundations.

Figure 57: Post and beam frames



Advantages

- Planning freedom. As walls are not loadbearing, they can be placed to form the rooms you want;
- Windows and doors can be placed anywhere;
- Few foundations are necessary, as the posts carry all loads to only a few points;
- The roof can be constructed early to provide a sheltered building site;

- Good fire resistance is provided to structural elements;
- The structure can be decorative;
- It is easy to alter the building later;
- Damp is defeated. The building touches the ground in just a few places, where it is sealed.

Disadvantages

- Some high quality, large section, expensive timber is needed;
- The jointing of timber is critical and involves care;
- Infill walls are often strong enough to hold the building up, so posts may be redundant;
- Frames are often heavy to raise;
- Care is needed to keep the structural elements clean, if they are to be exposed to view and decorative.

9.2 Summary of the Segal Method construction stages

Foundations and site works

- Construct the access road, if necessary.
- Install temporary services and site hut.
- Set out and clear the site, strip the topsoil.
- Dig trenches for drains and services.
- Dig foundation pads and fill them with concrete.
- Install drains and services.

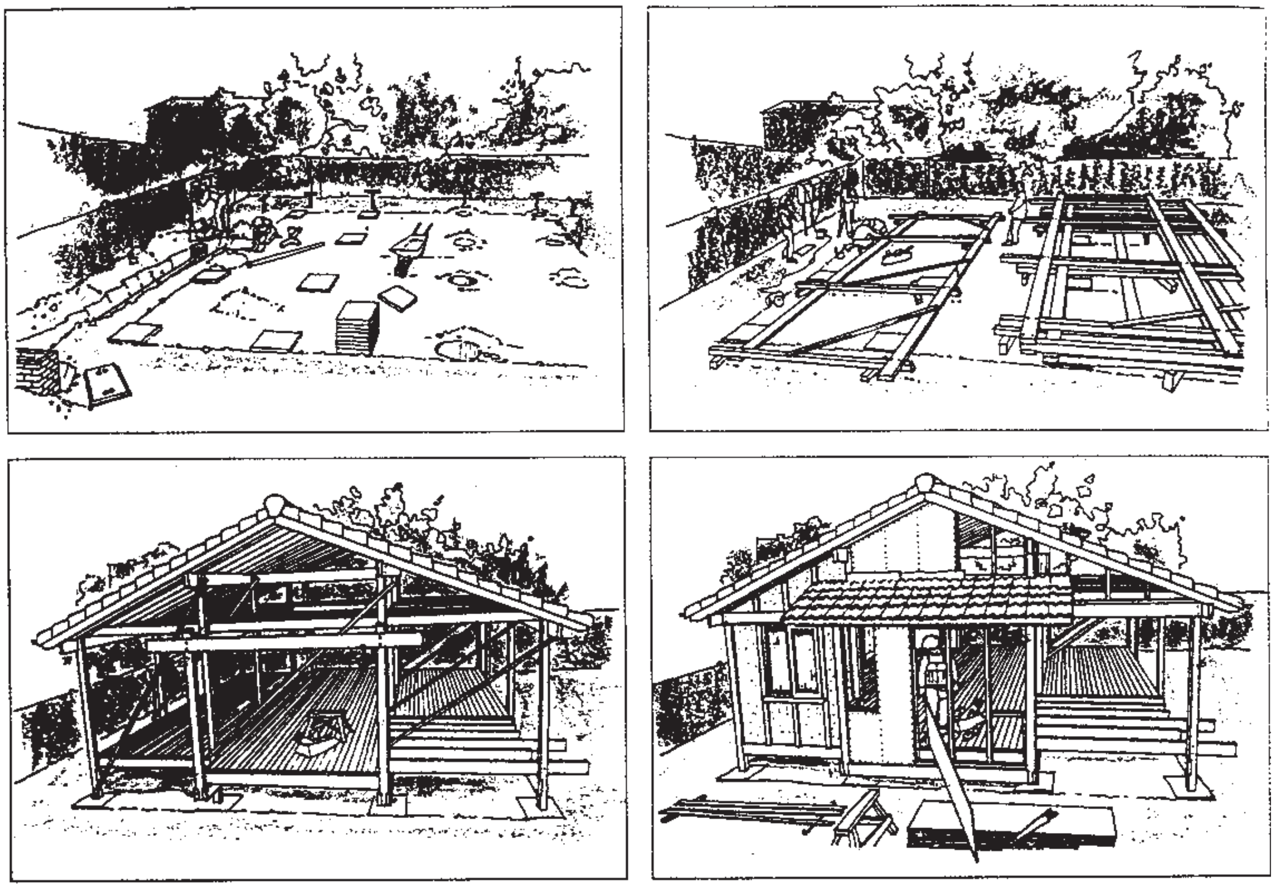
Structural frame

- Sort and stack the first timber delivery.
- Mark out, cut, drill and assemble the timber into frames.
- Stack the frames in reverse order of rising.
- Raise the first frame and brace it to the ground.
- Raise the subsequent frames, space them off from each other the correct distance and brace.
- 'Square-up' the frames and put a damp proof course under each post.
- You can now see the building's shape.

External skin: roof

- Install scaffolding around the roof perimeter.
- Cut and fit roof timbers (rafters, joists or purlins).
- Install roof covering (tiles or slates on battens, turf on a membrane on a membrane on a timber deck, conservatory glazing, or whatever.)
- Fix fascias, bargeboards and gutters, soil and vent pipes.
- Re-erect scaffolding to suit constructing the external walls.
- You now have some shelter from the weather.

Figure 58: Segal Method Construction Stages



9.3 Construction: stages and choices

External skin. Floor

- Cut and fit the floor joists and insulation supports.
- Fit a temporary floor (floorboards upside down to keep them clean).
- You now have a sheltered workshop.

  The floor will be completed later, after the building is completely weather-tight and services have been installed.

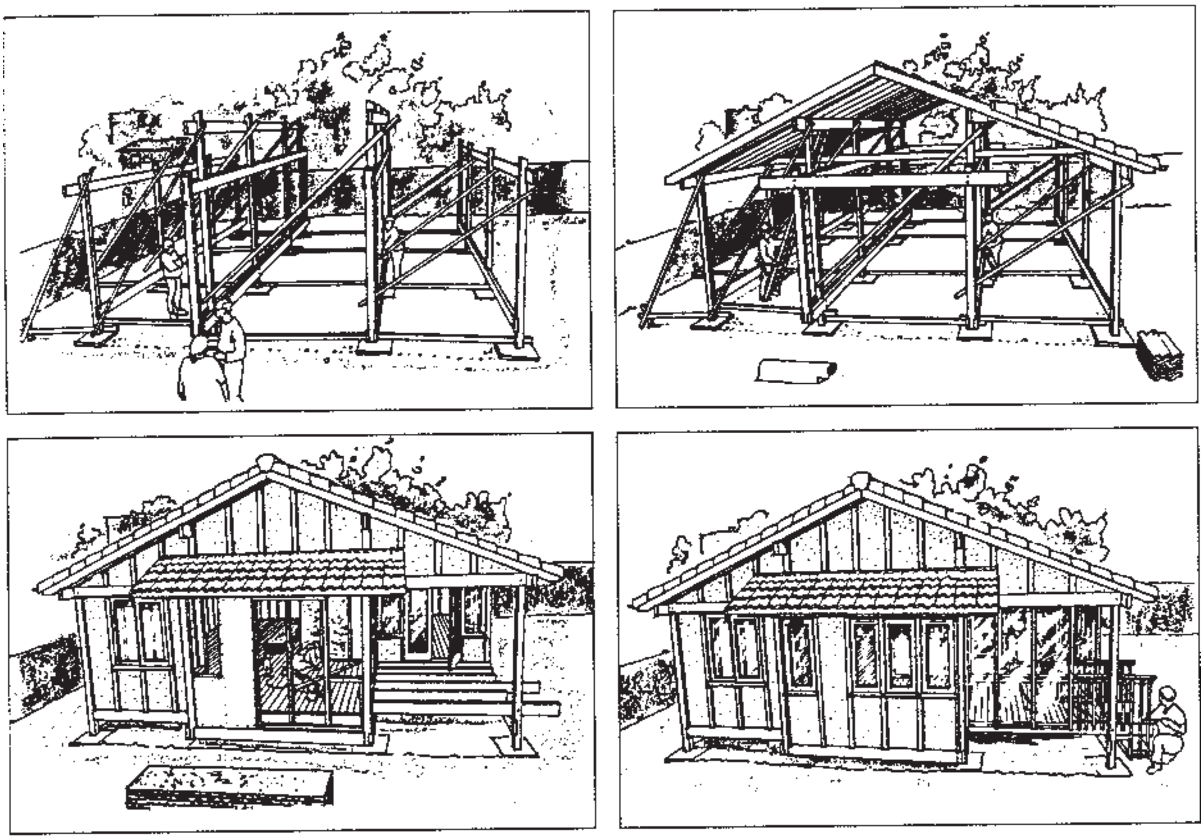
External skin: walls, windows and doors

- Decide on positions of the windows and doors
- Construct the timber studwork
- Fit external sheathing, windows and doors
- Fit external finish (timber weather- boarding, sheeting and coverstrips or render).
- Your building is now weathertight.

Internal walls, services, insulation and finishes

- Install 'first fix' wiring and plumbing.
- Insulate the roof, walls and floor
- Fix the flooring
- Construct the internal wall studwork and door frames
- Decorate and fix the internal wall and ceiling finish (usually plasterboard with timber coverstrips.)
- Build stairs, external steps and ramps.
- Finish conservatory, verandah (if any).
- Install 'second fix' electrics and plumbing fittings, heating radiators, bathroom and kitchen fittings.
- Fit internal doors.
- Commission heating, connect electrics to the mains.
- Finish floors
- Complete landscaping, roads, paths.
- You can now move in.

Figure 59: Construction - Stages and Choices



9.4 Foundations

The ground floor stands above the ground rather than being laid on it. Foundations are only required under the posts. This minimises messy ground works and reduces the amount of concrete used to about 20% of that needed for conventional strip foundations.

Sloping can easily be accommodated by cutting posts to suit, the foundation tops following the site contours. The posts rest on the foundation pads.... the building's own weight keeps it in position.... a damp proof course is slipped under each timber to prevent rising damp." The feet of the timber posts can be on top of brick or concrete piers so that debris cannot collect around the base of timber posts; this avoids the risk of rot occurring.

Concern is sometimes expressed that the feet of the timber posts are vulnerable to rot, as they are sitting at ground level. The foundation top can retain water and earth and leaves may collect around the post. To alleviate this, masonry piers (of brick, block, stone or cast concrete) can be inserted to keep the post base clear of the ground.

If these piers are built first, they are very vulnerable to being knocked over during frame-raising. To overcome this, it seems best to raise the frames as normal on the foundation; jack each post in turn, cut off the excess timber and slide in a pre-cast concrete pier on a bed of mortar.

Advantages

- Water can drain away from the post base easily;
- Leaves and other debris will not collect around the post base.

Disadvantages

- Setting-out has to be very accurate;
- Bricklaying skills may be required;
- Piers will be more costly than simple pads;
- It is an extra operation.

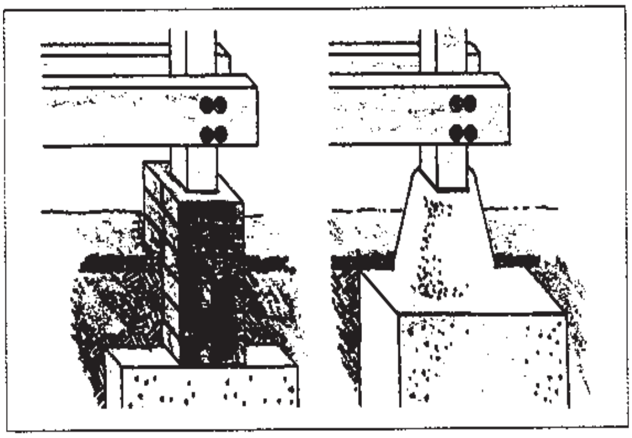


Figure 60: Above left: Brick or block Pier. Right: Concrete pier cast in a bucket

Figure 61: Post ends resting on concrete piers precast in a bucket, at the Centre for Alternative Technology, Mid-Wales.

9.5 Roof frame

Flat roofs are of course the simplest or alternatively a pitched roof can be built. The design will affect the internal space of the building.

Frames: flat roof frame

This option is the cheapest and easiest to build. The roof perimeter simply follows the plan shape, and posts are disposed along the frames to suit structural and planning requirements.

Advantages

- Provides infinite planning flexibility;
- Post and beam joints are all at right angles;
- A flat roof is easy to lay and safer to work on than a pitched roof;
- All the walls are of the same height.

Disadvantages

- There is a limited choice of finishes for the flat roof;
- Water is not ‘shed’ off the roof - and any leaks are hard to find.
- No loft space or place for water tanks.

Figure 62

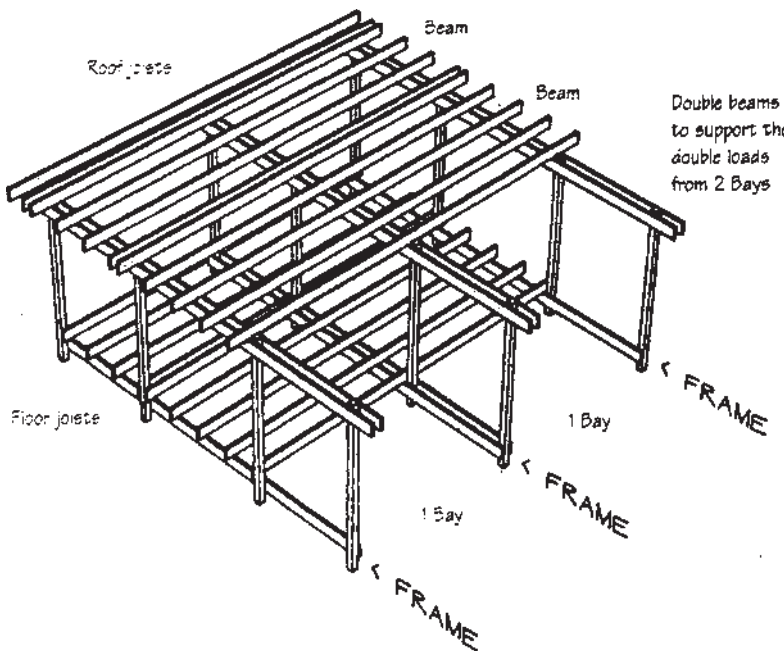


Figure 63: Flat roof frames on the Lewisham self build house (1980)

A purlin is the name given to a horizontal beam that supports sloping secondary members (rafters). Purlin frames run parallel to the roof ridge. To make the roof slope, frames are of different heights. Rafters are usually notched (called a birdsmouth) to fit over the purlins. Alternatively, purlins can have an angle planed on their top surface on which the rafters sit. Rafters are bolted to posts that they pass - to prevent the wind lifting the roof off.

Advantages

- Rafters can be formed into trusses to span large distances;
- Interesting internal spaces can be created;
- Rain will be 'shed' off a pitched roof;
- There is a wide choice of finishes.

Disadvantages

- Space planning options are often limited by the roof shape;
- Fitting of rafters is difficult;
- More material is used and it is more complex to build than a flat roof.

Figure 64: Frames: pitched roof purlin frame

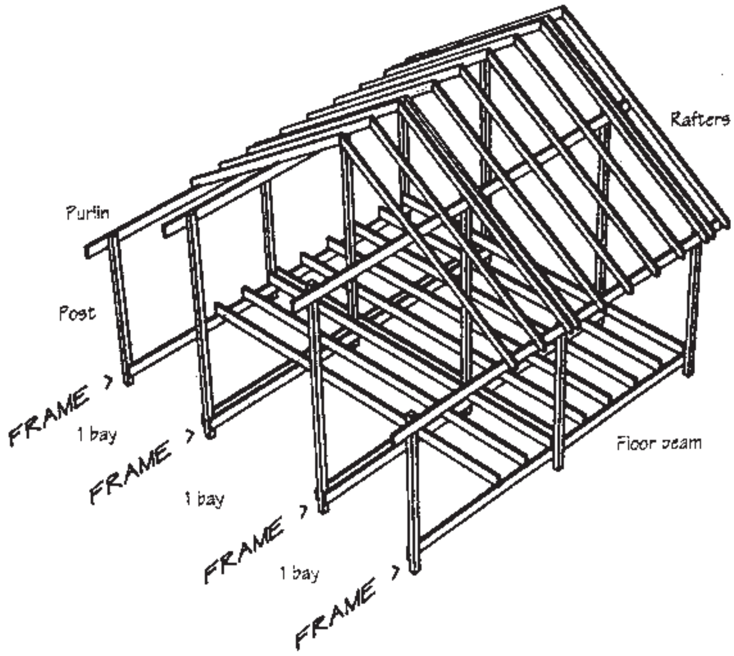
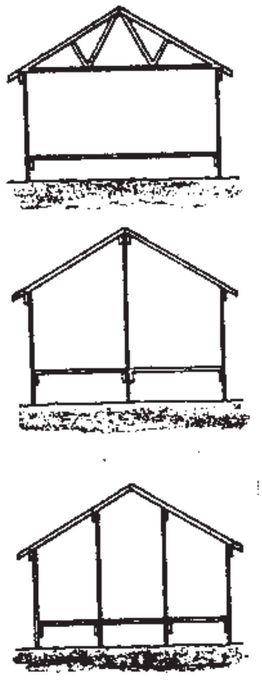


Figure 65: Purlin frames to form one-, two- and three-bay structures



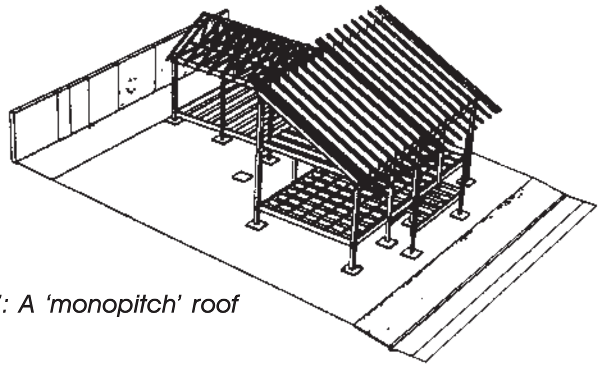


Figure 67: A 'monopitch' roof structure

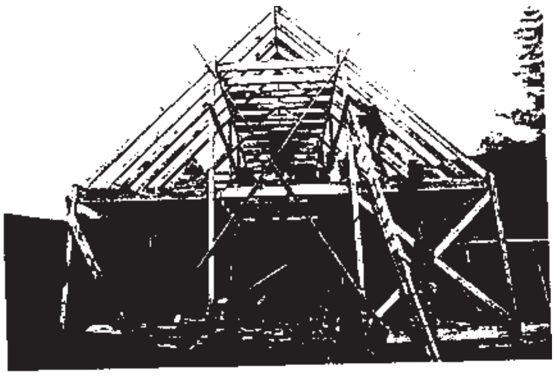


Figure 66: Three-bay purlin framed house at C.A.T.

9.6 Platform frame

At each level a platform floor is built, on which the next storey is raised…" up to 4 and 9 storey buildings have been completed in this way.

9.7 Structural frame

The primary structure consists of a series of frames of posts and beams jointed together, assembled flat on the site, raised to vertical and then braced together. Although frames can be raised piecemeal, post by post and beam by beam, raising whole frames is a delightful communal enterprise where, after just a few hours work, the form of the whole building is dramatically revealed.

It is an exhilarating, potentially hazardous business: the mechanics of the process needs careful consideration; the effort required (lifting moment) must be calculated; pushing poles of the correct length should be bolted to the posts; and sufficient, well-briefed people be involved.

The layout of posts and beams is derived from the mixture of planning, structural and aesthetic considerations. The most basic decision is that of roof shape and covering; Walter Segal's original flat roof design allows for the maximum flexibility in planning at the lowest cost, but many prefer the aesthetic and rain-shedding properties of a pitched roof.

Figure 68: Making frames: timber is sorted, marked out, cut to length and jointed together

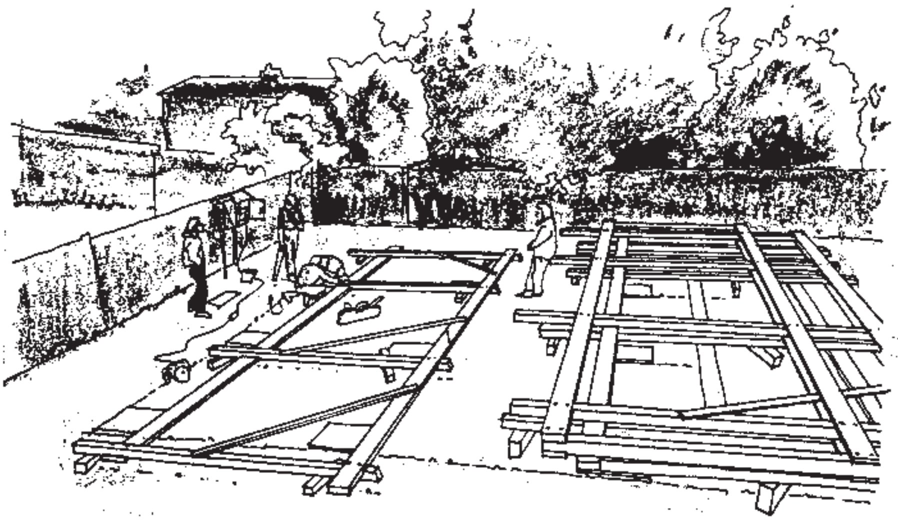
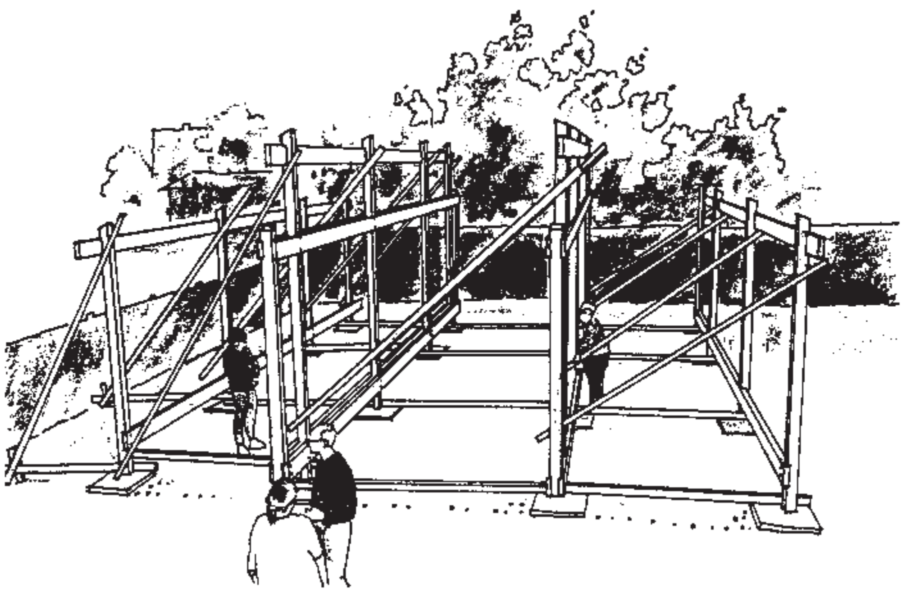
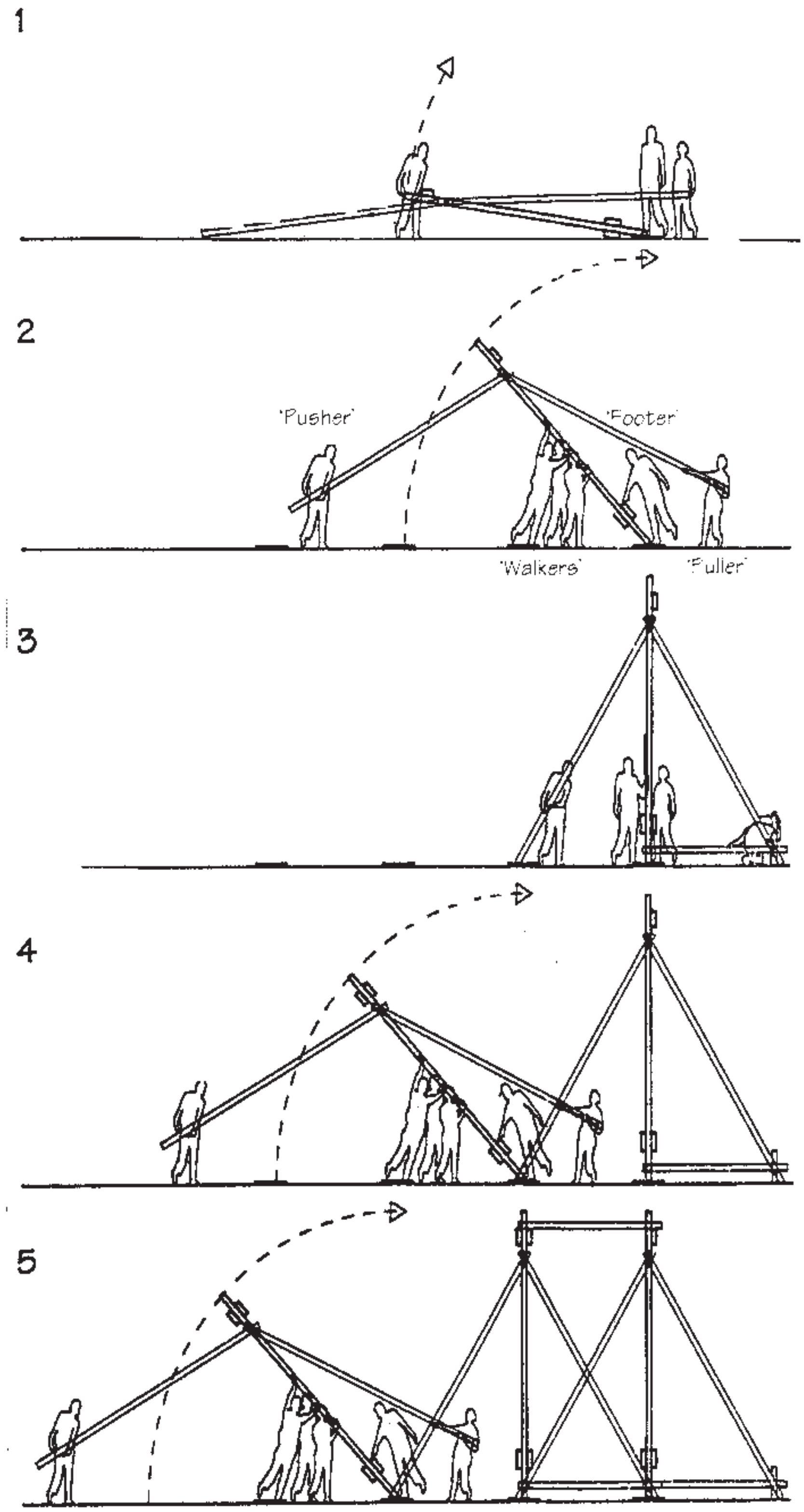


Figure 69: Frame raising: frames are raised and braced rigidly together



9.8 Frame-raising

Figure 70: The stages of frame-raising



10. Conclusions

The six main types of non-traditional construction may each have a number of specific problems. However, you should have found it possible to generalise about the sorts of problems found. Essential remedial work to non-traditional housing tends to be of two kinds:

(a) Repairs to the external cladding, incorporating external insulation to extend its useful life. This reduces condensation problems, and improves the appearance.

(b) Complete removal of the prefabricated elements, and replacement with traditional cavity walls. This is extremely expensive, and involves the temporary removal of tenants.

As a result of Right to Buy legislation, some tenants opted to purchase their non-traditional housing, some of which were later discovered to be defective. In order to help owners who had bought before the inherent problems were discovered, the government set up *PRC Homes Ltd.* Its function was to vet proposals from private builders for remedial work to those houses, and to provide grants to the owners to pay for the work. The proposals invariably involved the more radical and expensive solution of replacement of prefabricated elements with traditional construction.

However, no additional funds for remedial work have been made available to social housing providers. Local authorities have the majority of this housing stock. Their approach has been to identify problems and carry out remedial work from Housing Investment Programme (HIP) funds or Housing Strategic and Operational Plan (HSOP) funds. Since the work is expensive, and involves decanting tenants, the opportunity has often been taken to combine it with other major rehabilitation work, such as window replacement.

As you have seen, the external appearance of some non-traditional housing hides the form of construction. Concrete, steel or timber frames are hidden behind traditional brick or rendered skins. More recent rehabilitation schemes may have further camouflaged the original house type and form of construction.

> *Accurate identification of the house type is essential for accurate diagnosis of defects, and effective remedial proposals.*

However, most non-traditional stock is still in its original state, and under local authority ownership. In the limited number of cases where tenants have bought their homes, they have often made dramatic cosmetic changes to create a more traditional appearance.

Non-traditional housing is still an important resource. The houses often form the basis of settled communities, many with their original tenants. They should be seen as a form of housing which requires further research and additional resources for rehabilitation.

Self Test 6

1. *What are the two main approaches to structural design used in non traditional construction?*

2. *Give some examples of Steel Frame systems.*

3. *What are the three main problems affecting the concrete used in pre cast concrete frames?*

4. *Which Act of Parliament provides for repairs or repurchase of designated defective housing purchased under the Right to Buy?*

5. *What does the term "no fines" indicate?*

6. *What is the name of the large pre cast panel system used during the 1960s and 1970s which is described in this block?*

Now turn to the Answers at the end of this Block.

Summary

1. Social housing has been affected by the enormous social, economic, and technological changes of the last 100 years.

2. Building Regulations, Public Health Acts, Housing and Planning Acts and Water Bye-laws affect the construction of housing, and establish basic requirements for adequate sanitation, water supply, ventilation and natural light, and freedom from damp.

3. Standards are also established by BSI Standards and Codes of Practice; the British Board of Agrement; the Building Research Establishment; the Timber Research and Development Association; and the National House Building Council.

4. The main categories of housing stock are:
   - Old Traditional
   - Prefabricated
   - Traditional
   - Rationalised Traditional or Industrialised.

5. Most housing managers will have to manage housing from all of these categories, and will be responsible for repair and maintenance. So it is essential that they understand basic construction details, and the problems that can arise; and that they maintain records of the different kinds of stock under their care.

6. They also need to understand the internal service systems of dwellings - heating, plumbing, waste disposal, gas and electricity, as well as insulation for energy conservation, and soundproofing.

7. Almost one million homes of various non-traditional designs and building techniques have been built in the UK since the Second World War. Most are in urban areas, and most are in local authority ownership.

8. The main types of non-traditional construction methods are:
   - pre-cast concrete frame;
   - steel frame;
   - timber frame;
   - in situ poured concrete;
   - pre-cast concrete panel;
   - large pre-cast concrete panel.

9. Most have given rise to a wide range of repair and maintenance problems. Some have been found to have inherent structural problems, with significant implications for repair and maintenance, and in some cases calling for radical rehabilitation solutions.
10. However, the non-traditional dwellings are still a significant housing resource, some providing roomy accommodation, and popular with tenants.
11. Self build housing is usually based on timber frame methods; the example given is the method designed by Walter Segal which is light, requires few building skills, no foundations and can be completed by two or more people.

Answers

Self Test 1

1. The regulations are concerned with the health and safety of occupants, not standards of production.

2. Housing professionals need to know the Public Health Acts, Housing Acts, Planning Acts and Water Bye-laws.

3. You can find advice on good building practice in a variety of sources, including the BSI, with their regular publication of technical guidance, and Codes of Practice; the British Board of Agrement, which assesses new products and techniques; the Building Research Establishment, which publishes reports and digests.

   There are also the publications of trade bodies such as the TRDA and the National House Building Council.

4. These characteristics can generally be found in:

   (a) Old Traditional 1890-1930

   (b) The same

   (c) Old Traditional 1920-1940

   (d) Prefabricated 1945-50

   (e) Traditional 1945-60

   (f) Industrialised (Post War).

5. The need to conserve energy and control emissions, with experiments with developments like solar panels will be likely to change the appearance of domestic buildings in the future.

6. Solid walls.

7. Between 1930 and 1940.

8. To replace houses damaged in the war very quickly.

9. Cross wall construction.

Self Test 2

1. Drought, heave, subsidence, trees, frost, defective construction or design.

2. Wall A.

3. Panel or stud partitions.

4. To prevent moisture travel through brickwork into a building.

Self Test 3

1. Suspended.

2. Adequate ventilation.

3. Pitched, flat and mono pitched.

4. Flashings.

5. Fascia board.

6. The main problems are likely to be:

    - rainwater coming through the roof;
    - tiles/slates missing;
    - tiles/slates slipped;
    - ridge tiles missing or slipped.

Self Test 4

1. It is a fungus which attacks wood which is damp.

2. The rising main is the incoming cold water supply to a dwelling from the high pressure water main.

3. Indirect and direct cylinders.

4. Hot water radiators, ducted warm air, district heating, electric storage heating, electric underfloor or ceiling systems.

Self Test 5

1. Rising damp, penetrating damp, leaks and condensation.

2. Debris in the cavity, wall ties coated with mortar, pipework through the cavity, windows, door frames and lintels with poorly fitted DPCs.

3. Surface and interstitial condensation.

4. Post and rail, chin link, paling, close boarded, concrete panels, trellis, ranch, interwoven, lapped.

Self Test 6

1. Skeleton and Exoskeleton

2. BISF, Cussins, Dennis Wild, Dorlonco, Doxford, Howard, Trusteel.

3. Carbonation, chloride and cover.

4. The Housing Defects Act 1984.

5. That the concrete used does not contain any sand.

6. The Bison Wall Frame system.