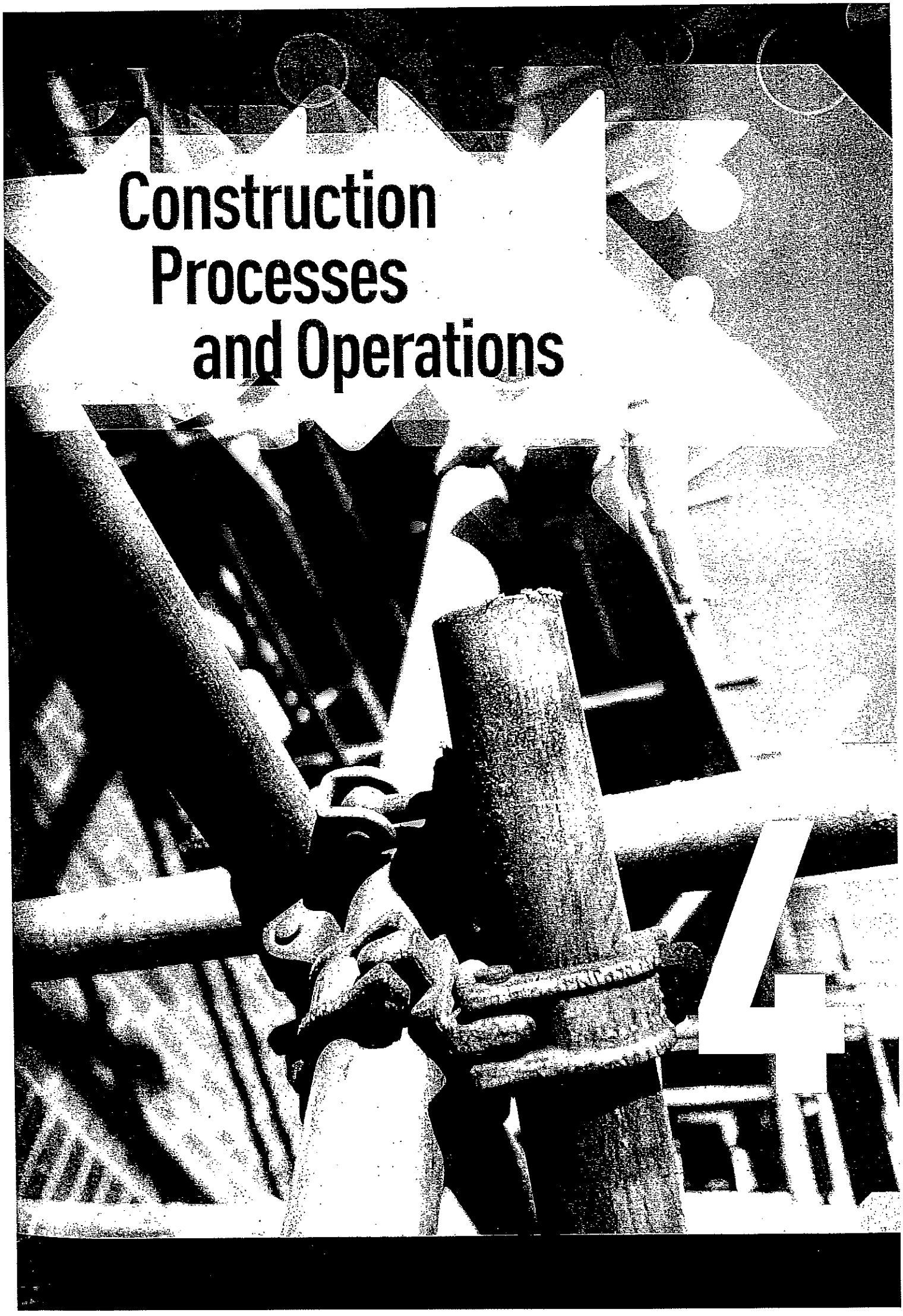


Construction Processes and Operations

4

Construction operations

Introduction

In this topic you will learn about the different stages of a construction project. Most construction operations, such as brickwork and blockwork or carpentry, usually happen at the same stage of construction, even on very different projects. After all, it would be very unusual to install a staircase before the walls had been constructed on any project! Understanding these stages and the sequence in which they occur is important when planning a project, estimating costs and carrying out the actual construction.

Stages of low-rise construction

Setting up a site

Remember

A low-rise building is a building that is less than 5.2 metres high.

First of all, a site has to be set up before construction can start. This involves making the site safe and creating welfare facilities for workers like kitchen and toilet facilities. A well-planned site means that work can progress smoothly and safely.

When you are planning, you should consider:

- accommodation – such as offices, welfare facilities and plant rooms
- storage of materials – in open areas or in sheds? How much material will you have on site at one time and does it need to be covered?
- car parking – how many people will be working on site every day? Could you get visitors like planning officers who will need to park?
- security of the site – what sort of lighting, CCTV, fencing and signs will you need?
- temporary services – such as water, electricity and communication links. Will you need a generator?
- disposal of waste – how much waste do you think you might have and how will you remove it?

Discussion

What sort of effect could poor planning have on the later stages of a construction project?

Activity 4.1

You are planning the construction of a new housing development in your town. As part of your setting up, you need to think about where you are going to store your materials, which will include:

- bricks and blocks
- steel I-beams
- cement
- wooden floorboards
- plastic guttering.

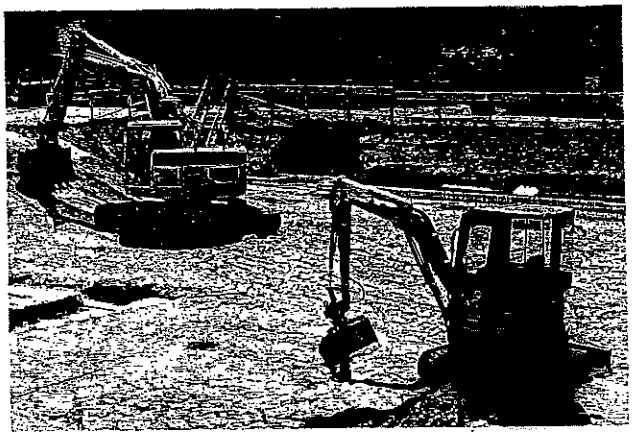
Now decide what you will need to store in sheds or under cover.

Groundwork

This involves clearing the site, removing topsoil and digging up the bushes and trees so that work can start, including demolishing existing buildings on the site. The topsoil is then removed so that construction work starts on firm, level ground.

Key term

Excavation – digging up the ground to reach the right level below ground to lay the foundations.



Site clearance in progress.

Sub-structure

The sub-structure is the underlying structure of a building. It includes all the works below floor level like foundations and drains. A very important operation at this stage of the project is the **excavation** and construction of the foundations.

Superstructure

The superstructure is all the parts of a building above ground level, including walls, floors and roof. Internal services such as gas, electricity, telecommunication, drainage and hot and cold water are added during this stage.

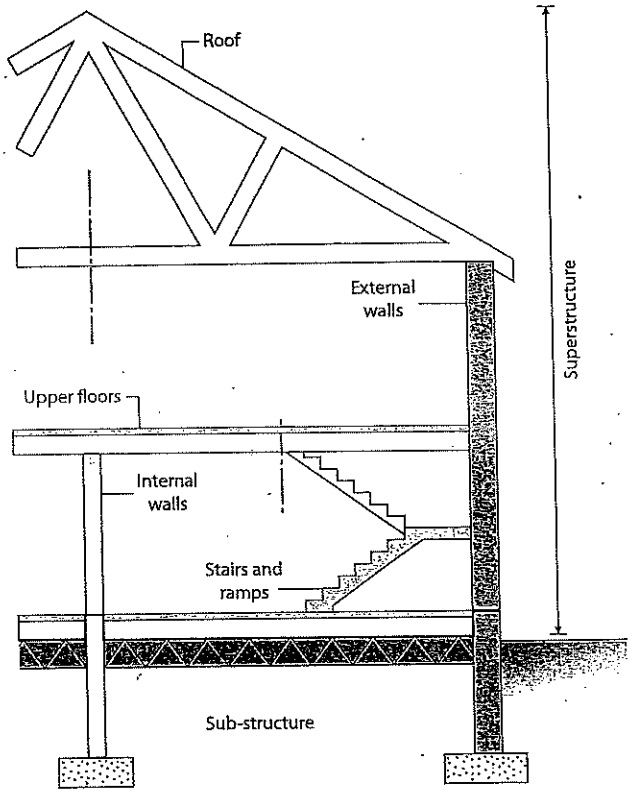


Figure 4.1 Sub-structure and superstructure.

External works

This is the additional work done around the building. It includes the construction of paved areas and driveways as well as garden landscaping. It also includes routing in utilities such as gas, electricity, drainage, telecommunications and water.

Link

For more about the sub-structure and the superstructure, see *Unit 1: Construction Technology.*

Finishes

These finishes are the final works that finish the building. This includes the installation of suspended ceilings and the flooring, as well as painting, decorating and tiling.

Activity 4.2

Look at Figure 4.1. Now cover the diagram and list three parts of the building that are included in the superstructure.

Link

To learn more about brickwork and blockwork, see *Unit 7: Exploring Brickwork and Blockwork Principles and Techniques.*

Construction operations

Before you can start planning a construction project, you also have to know about t operations that are part of each stage of construction. These involve different skills specialist trades people, so you will have to think about them when thinking about timing of project tasks.

The three key activities in most construction projects are:

- brickwork and blockwork
- carpentry and joinery
- roofing.

Brickwork and blockwork

Key terms

Mortar – a mixture of cement, sand, lime and water. It is used to join bricks and blocks together.

Bond – an arrangement of bricks and blocks. The term is also used to describe how various courses of brick or block work are joined together.

This involves the construction of walls. Traditionally, the external walls are constructed in two halves or skins. The outer half or skin is constructed in brickwork while the inner half or skin is constructed in blockwork. The two layers give good insulation.

'Laying to line' is a method of making sure your brickwork is straight. The line is the yellow string in this photograph.

Bricks and blocks are laid in layers called courses using cement sand **mortar** (this is how ratios are referred to in construction). The mortar gives an even surface for the courses and joins the bricks or blocks together.

Did you know?

- A brick is usually 215 mm long, 102.5 mm wide and 65 mm deep.
- A block is normally 440 mm long, 215 mm high and 100 mm wide.
- Mortar is normally laid 10 mm deep.

The **bond** is the pattern of bricks, which gives the wall its strength and stability. Bond commonly used in brickwork and blockwork include:

- the stretcher bond, which has only stretchers
- the English bond, which has alternate stretcher and header courses
- the Flemish bond, which has both headers and stretchers in the same course.

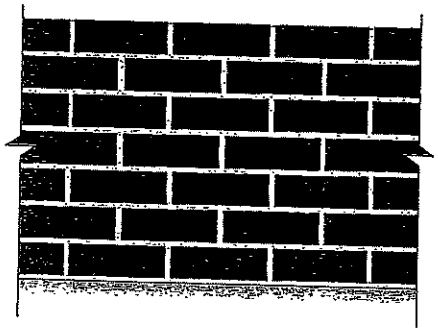


Figure 4.2 Stretcher bond.

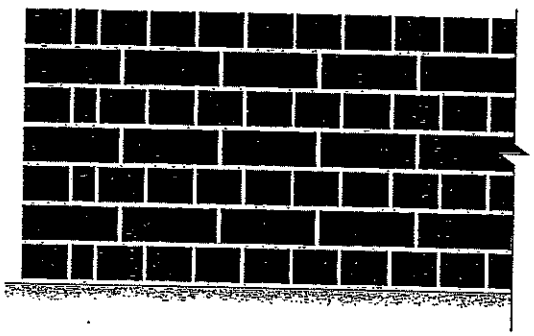


Figure 4.3 English bond.

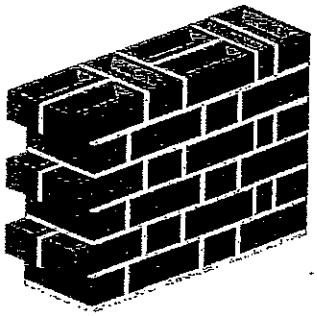


Figure 4.4 Flemish bond.

Carpentry and joinery

This is another very common operation and involves working with timber on tasks such as installing window and door frames and staircases, and fixing and assembling floors and roofs. It also includes wooden finishes such as laminate flooring. Usually, a joiner makes an item in the workshop and a carpenter installs it on site.

Link

To learn more about carpentry and joinery, look at *Unit 6: Exploring Carpentry and Joinery Principles and Techniques.*

Roofing

Roofers install **roofing battens**, attach the **roofing felt** and tile the roof. Roofing work starts quite early in the construction stage so that the building is weatherproof before work begins inside.

Roofs can be flat or sloping (pitched) depending upon the building's needs and local climate.

The roof is finished by fixing roof tiles to the wooden battens. There is a wide variety of tile types such as single and double lap. Finally, the roof space is insulated to keep the house warm.

Key terms

Roofing battens – strips of wood fixed to rafters, used to attach roof tiles to a roof.

Roofing felt – a protective layer between the actual roof structure and the building. It is made up of waterproof materials.

Aggregates – an aggregate is a mixture of pieces of crushed stone and gravel. They are used in making concrete as well as more generally in construction activities.

Painting and decorating

Living in an undecorated house would not be very nice. Paints are applied to interior and exterior surfaces including walls, doors, ceilings and skirtings. Painting surfaces, such as walls, makes them more attractive. It can also be done for special reasons, such as making surfaces resistant to water or mould. Painting involves applying wet paint to a surface with rollers or brushes, which then dries to form a perfect coating.

Decorating is the application of wall coverings using wallpapers. Wallpapers come in a range of finishes, including raised patterns, soft textures and washable coatings.

Painting and decorating.

Did you know?

Tiles are usually fixed to a roof in an overlapping pattern. This allows water to run off the roof without letting the water in through the joins between the tiles. This overlap can be single or double depending on the type of tiles. Natural slates are normally fixed as double lap tiles.

Link

If you want to know more about painting and decorating, see *Unit 8: Exploring Painting and Decorating Principles and Techniques.*

Concrete work

Concrete is a mixture of cement, sand, **aggregates** and water. These materials are mixed in varying proportions. The strength of concrete depends on the ratio used to make concrete.

Concrete can be used to construct foundations, beams and columns, as well as under the floors to give a firm base for their construction. It can be mixed on site or can be ordered ready-mixed.

Stonemasonry

Stonemasonry is a highly skilled craft. It involves working with stone in construction activities, such as creating stone walls and columns as well as interior features such as fireplaces. From construction of walls to producing various architectural features and patterns, stonemasons have to be very precise to produce a good-quality product.

Floor, wall and ceiling finishes

Like painting and decorating, this makes the interior of a building pleasing to look at and comfortable to live in. Floor finishes range from carpets to wooden and vinyl flooring. Walls and ceilings can be either painted or decorated in a range of finishes.

Plumbing and heating

This includes laying and installing pipes, fittings, fixtures and equipment to supply hot and cold water, drainage and heating in a building.

Electrical installation

This includes wiring buildings to give light and warmth, as well as connecting power appliances such as televisions and refrigerators.

Activity 4.3

1 Research the construction of a new house on a greenfield site.

2 Create a presentation to give to the rest of the group, covering various stages of construction as well as the operations carried out during each stage.

Just checking

1 **List three operations that are carried out during brickwork and blockwork.**

2 **Make a list of the ceiling, floor and wall finishes in your classroom.**

TOPIC A2

Sequencing and planning

Introduction

Good planning is essential for the success of any building project. Planning involves a systematic way of working through what needs to be done, how it would be done and when it should be completed. In this section, you will learn about the order in which construction activities are carried out and how these are planned.

What is a plan?

Most of us make plans all the time in our lives. You almost certainly planned to take this course. You want to work in the construction industry, so you planned to take this BTEC.

So what exactly is a plan in construction?

In construction, planning is vital. From simple tasks such as carrying materials from the factory to the site to complex operations like building the Olympic village, all construction activities need a plan. Without planning, success is almost impossible.

Activity A2

Make a list of all the plans you have made over the past five days and then answer the following questions:

1 Did you do everything that you planned to do?
2 Who else was involved in the planning?
3 Did you have to make any changes to your plans to allow for unforeseen circumstances?
4 How did you communicate your plans to other people involved?

How to plan

Project planning should start as soon as the client has the initial idea for the project. It continues until the final handover of the building, as well as during a set period of time after construction, where the builder is responsible for any defects. This is called the defects liability period.

To plan, the project is divided into small parts or tasks. Each task is planned first and then added to the overall plan.

Construction projects need tools to plan and control them, to ensure they run to time and budget. They also need methods for taking action if things do not work out.

Did you know?

Project planning is a specialist area of construction. Professionals called construction planners use computer software to make sure everybody knows their job and that their work is communicated to everyone involved.

Gantt charts

A Gantt chart shows the time allocated to each task or activity in the construction process (see Figure 4.5). The time can be given in hours, days or weeks.

Gantt charts give the order of activities so it is obvious which tasks need to be done before the next task can be started. Gantt charts also show which activities can be done at the same time. This means that they can be used as the schedule and the order of work.

Interpreting Gantt charts is an important skill for anyone working on a project. You need to know the sequence of activities as well as time allocated.

Figure 4.5 shows part of the Gantt chart for the construction of a bungalow. The time is given in weeks and the time taken to complete each activity is shown as a bar. The longer the bar is, the more time will be needed to complete the activity.

For instance, in Figure 4.5, the bar against site set-up is only one week long. In comparison, the construction of the concrete foundations starts in week 6 and the bar is five weeks long so the activity will be complete by the end of week 10.

Project: Factory extension

Contract Activity	Duration	Week Nr 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Site set-up	1																																				
Excavation	3																																				
Concrete fnds	5																																				
Hardcore fl slb	4																																				
Erect steel work	2																																				
Clad roof	2																																				
Concrete fl slab	2																																				
Clad walls	3																																				
Brickwork walls	8																																				
Doors and frame	1																																				
Drainage	4/5																																				
Painting	4																																				
Electrical instn	5																																				
Heating instn	2																																				
External landscaping	7																																				
Clean & handover	3																																				

Figure 4.5 What do you think are the benefits of Gantt charts? Can you see any drawbacks?

Sequencing activities

Discussion

Why is sequencing important? What problems could be avoided by sensible sequencing?

Sequencing is when you arrange activities in the most logical way. A Gantt chart sequences activities in the order that they are started, so each activity relates to the activities around them.

Some activities cannot start until the time the previous one is completed. In Figure 4.5, the cladding of the roof cannot start until the steelwork is in place.

Some activities can be done at the same time. For example, Figure 4.5 shows that although the brickwork walls will take five weeks to complete, wall cladding, drainage installation and other tasks can happen while the brickwork walls are being built. This means that the schedule is as efficient as possible.

ACTIVITY 4.5

Figure 4.5 shows part of a Gantt chart for the construction of a bungalow. Look at it and then answer the following questions:

1 When will painting start?
2 How long will electrical installation take to complete?
3 When will drainage be complete?
4 What other activities will happen at the same time as heating installation?
5 Why do you think drainage starts so early and happens in two phases?
6 How many weeks will it take before painting is complete?

Advantages and disadvantages

Gantt charts are very popular with construction professionals. This is because they:

- are easy to use
- give a visual understanding of the project activities
- show the sequence of activities
- are helpful when planning to arrange labour, plant and materials
- help monitor progress.

However, for larger projects, Gantt charts can be confusing as all the activities cannot fit on one page.

Key terms

Plant – machinery used in the construction process, such as bulldozers and excavators.

Industrial action – protest action taken by the employees of a company or organisation, such as striking.

Production problems and unforeseen events

You may have to deal with a number of problems during a project. These include problems such as bad weather, a shortage of materials or **industrial action** by lorry drivers or other construction workers. Things might go wrong with the construction, such as the collapse of foundation trenches or a plumbing leak. The site might also be flooded, robbed or vandalised.

Because there are many possible problems, careful planning helps you to:

- foresee these potential problems
- make these problems less likely to happen – for instance, by fitting good locks to the site gates
- make alternative plans in case these problems do happen – for example, finding several suppliers of a needed material.

This means that, even if something does go wrong, the project will probably still complete on time. Planning also helps you keep an eye on the progress of work so that action can be taken if things are held up. This will help to make sure the project does not finish late.

Just checking

1 Why is planning so important when preparing for a construction project?
2 How does a Gantt chart represent time against particular activities?
3 When do you think a Gantt chart would not be suitable?

Remember

'If you fail to plan, then you plan to fail.'

Assessment activity 4.1

You are a trainee planner with a local construction firm that is planning to construct a house. Your manager has listed a number of activities for the project. Now put them in the correct sequence.

Code	Activity	Days
A	2nd fix carpentry	3
B	Decorating	5
C	Install timber first floor	3
D	Excavate and lay foundations	5
E	Erect timber truss roof	3
F	Final clean	1
G	Fit uPVC fascia and soffit	3
H	Tile roof	4
J	Install external windows and doors	3
K	Construct sub-structure masonry	4
L	Construct metal studwork internal walls	3
M	Install staircase	1
N	2nd fix electrics	2
O	Conduct 2nd lift superstructure masonry	8
P	1st fix plumbing	2
Q	1st fix electrics	2
R	Construct suspended ground floor	6
S	2nd fix plumbing	2
T	Connect services	2
U	Install bathrooms	4
V	Construct 1st lift superstructure masonry	8
W	Install kitchen	3
X	Dry-lining	5

Now that the project is under way, there have been some problems on site. Read the problems listed below and answer the questions, before evaluating each problem's effect on sequencing and your schedule.

1 The plumbers started installing bathrooms last week but the services still have not been connected. Will this delay the completion of the project? What could you do to avoid any delay?

2 While installing roof tiles, a worker fell and was injured. There was no emergency plan and nobody on the site knew what to do, so there was a delay in taking the worker to hospital. This delay added an extra few days to his recovery. The lack of a plan also took up valuable time, as several members of staff had to work out what to do. The result is compensation payments and delay in work. What could you do to avoid this sort of thing happening again?

3 What is the earliest point that Activities E and H could happen? What will happen if you leave these activities until Activity X is complete?

4 Three weeks after the project started, the site was hit by heavy snow. This was followed by heavy rain, which caused flooding on site. How can you remedy this situation?

Tips

- Remember to explain why it is important to organise the project so that the activities are in the right order.
- Think about the importance of each activity in comparison to the importance of other activities.
- Think about what might go wrong in each activity. The best answers will keep in mind the impact of possible unforeseen events on their project's budget and schedule.

Key elements of low-rise buildings and their functions

Introduction

A building is made up of number of parts or elements. Each element has its own specific function. Some elements give support to the structure of the building, while others make the building comfortable to live or work in.

Key elements and their functions

Foundations

The foundations of a building are the lowest level of the building and are usually below the ground. They support the **load** of the building above by spreading the pressure over a large area. The soil on which a building is constructed can take some of this load. Spreading the load through the foundations uses the soil strength and means you do not have to spend extra money on more materials.

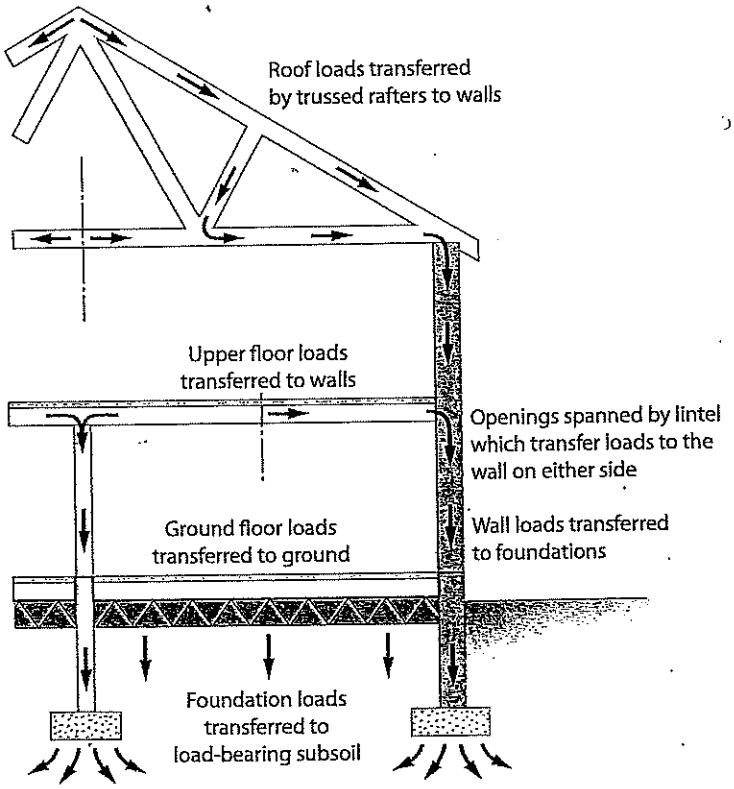


Figure 4.6 Loads from walls and floors are supported and spread out by the foundations.

Link

For more about these key elements of buildings and their functions, see *Unit 1: Construction Technology*.

Key term

Load – this is the weight that an element of a building has to bear.

Link

For more about loads, see *Unit 3: Scientific and Mathematical Applications for Construction*.

Activity 4.6

In pairs, look at Figure 4.6. Now describe to your partner how loads are transferred to the ground.

Link

To see what these foundations look like, see page 22 of *Unit 1: Construction Technology*.

There are four types of foundations:

- strip foundations – these are shaped like a strip. These are the most common types used in low-rise construction like the construction of a house. These are designed to support the loads of continuous walls and transmit it to the ground.
- pad foundations – these support loads from columns and piers and transmit these loads to the ground. This sort of foundation is like a concrete pad or slab supporting a column, normally in the middle of the pad.
- raft foundations – these take the load from the whole building and transfer it to the ground. These are more expensive than strip or pad foundations. These are used when soil conditions are poor or variable.
- pile foundations – these are constructed when soil is very weak to support the load. Through piles, load is transferred deeper into the ground to a stronger base.

Research

Using the Internet, find out what sort of buildings might use each of these four types of foundation.

Floors

Key term

Habitable – suitable to be lived in or occupied.

Link

Floors are discussed in more detail in *Unit 1: Construction Technology*.

Floors make a building functional, allowing people to move around inside it. They also make it **habitable**, supporting any interior features and furniture. They are usually level, horizontal surfaces designed to:

- support both live loads (moving pressures like people, furniture and movable equipment) and dead loads (unmoving pressures like the weight of the floor itself or the building)
- safely transfer these loads to either beams, columns or directly to the ground
- stop moisture from coming into the building from the ground
- fit in runs of mechanical and electrical lines
- give sound and thermal insulation
- be safe against fire.

A **solid floor** is a solid concrete slab resting directly on the ground.

Suspended floors do not rest directly on the ground, but are supported by beams or joists. These can be constructed using a variety of materials, including concrete and timber.

Activity 4.7

In groups, discuss the following questions.

1 Why do floors have to give sound insulation?

2 What kind of building would need this insulation most?

Walls

Walls enclose our living spaces to provide comfort and protect us from the weather. They also allow us to build structures with more than one floor or storey, by supporting the loads from the upper storeys. Walls can be:

- load-bearing walls – these are designed to take the load from other parts of the building. Usually, the external walls and some of the internal walls are load-bearing walls
- non-load-bearing walls – these are only designed to enclose a space and are not capable of taking any load from other parts of the building
- cavity walls – these are made up of two halves called leaves or skins, with a gap or cavity in between. External walls are generally constructed as cavity walls. The cavity stops moisture from travelling into the building and is usually filled with insulating materials to keep the building warm.

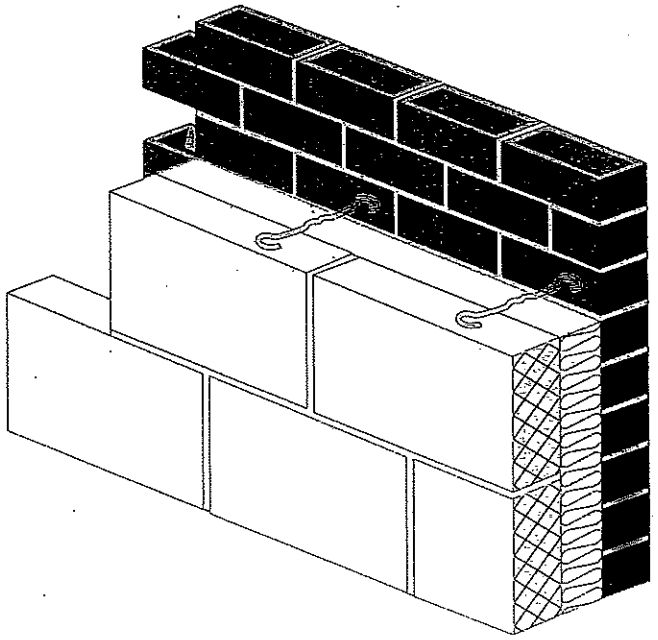


Figure 4.7 A cavity wall filled with insulation.

Roofs

Like walls, roofs make buildings comfortable and weatherproof. Roofs need a system of drains, gutters and downpipes to drain rainwater and melting snow. Roofs can either be constructed as flat or sloping (pitched).

Roofs are designed to:

- cover the internal space of a building, making it weatherproof
- look attractive
- resist the force of wind and other weather
- take both dead loads, such as its own weight, and live loads, such as people moving over it
- protect against heat and cold.

Links

Cavity walls are discussed in more detail in *Unit 1: Construction Technology* and *Unit 7: Exploring Brickwork and Blockwork Principles and Techniques.*

Flat and pitched roofs are covered in more detail in *Unit 1: Construction Technology.*

Doors

Doors give access to a building from the outside. They also allow movement between rooms in a building. A door gives privacy, weather resistance (for exterior doors), sound reduction and fire resistance. Doors can be made from a variety of materials such as timber and glass. They can be made to open, swing, slide or fold.

Discussion

Do you think that roofs should look attractive?

Windows

Windows allow natural light into a building and let fresh air circulate. Like doors, they can open in a variety of ways: swinging, hanging or sliding. Windows are installed in window frames, which are made from a variety of materials such as timber and plastic.

Stairs

Did you know?

Staircase design has to follow certain rules so that it is safe and comfortable for the users. One of the rules is:

Sum of going + twice rise = a minimum of 550 mm and a maximum of 700 mm.

A staircase gives safe access from one level of a building to another. Stairs can be constructed using a variety of materials, including timber and concrete. Each step is made up of a riser (the vertical part) and a going (the horizontal part). A staircase is designed so that all risers (the vertical part of a step) and goings (the horizontal part of a step) are the same size.

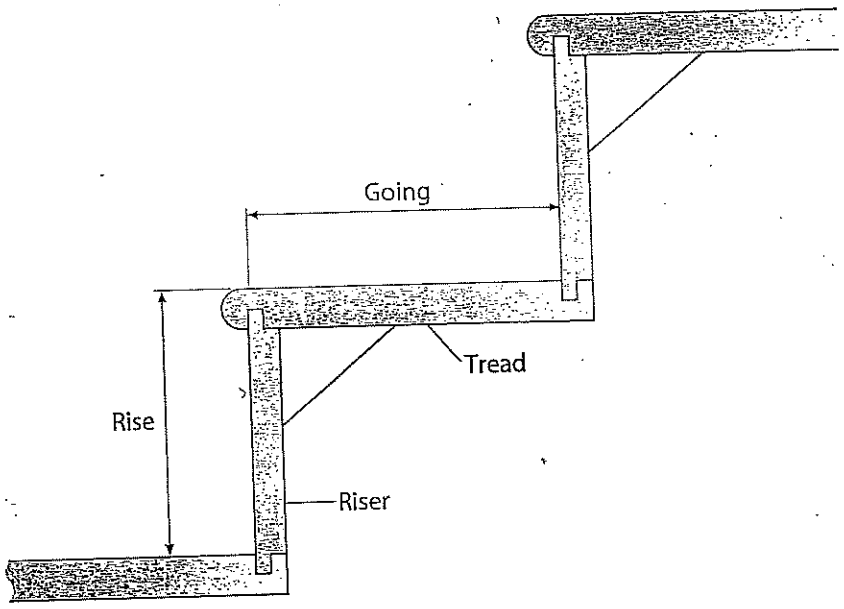


Figure 4.8 Parts of a straight flight of stairs.

Key terms

Foul water – the used water that comes from toilets, sinks and showers.

Surface water – water that runs off roads, roofs and gardens.

Services

Various services are provided in a building. These include:

- clean water for drinking, washing and cleaning purposes
- drainage for **foul water** and **surface water**
- electricity and gas.

Activity 4.8

Think about the key elements of your house, school or college. Identify and describe the functional requirements of two of these elements. Remember that the functional requirements are what an element needs before it can work properly.

Create a presentation using your findings.

OPIC B.2

Traditional construction of low-rise buildings

Introduction

In this topic, you will learn about the processes and activities that are part of traditional construction. In a traditional project, materials are brought to site and either mixed and put in place to create the building. Some components are made in a factory, such as windows and doors, and installed on site. This section discusses processes to construct traditional buildings.

Processes and operations

Setting up a site

In a project using traditional construction methods, setting up a site will include the following considerations:

- the size and position of the site will help in deciding the entrance and exit points – these should be kept to a minimum to keep control over what comes in and goes out
- try to avoid access points on roads that are narrow, fast or busy
- the size of the entrance is decided by the size of the largest item that will need to fit through it.

The size and layout of the site will usually decide the route of your roadway. Having a one-way system helps to control the site traffic. You will need to leave space for turning and unloading of site vehicles, as well as adequate parking space. If an entrance or exit will cross a public footpath, you must have permission from the local authority.

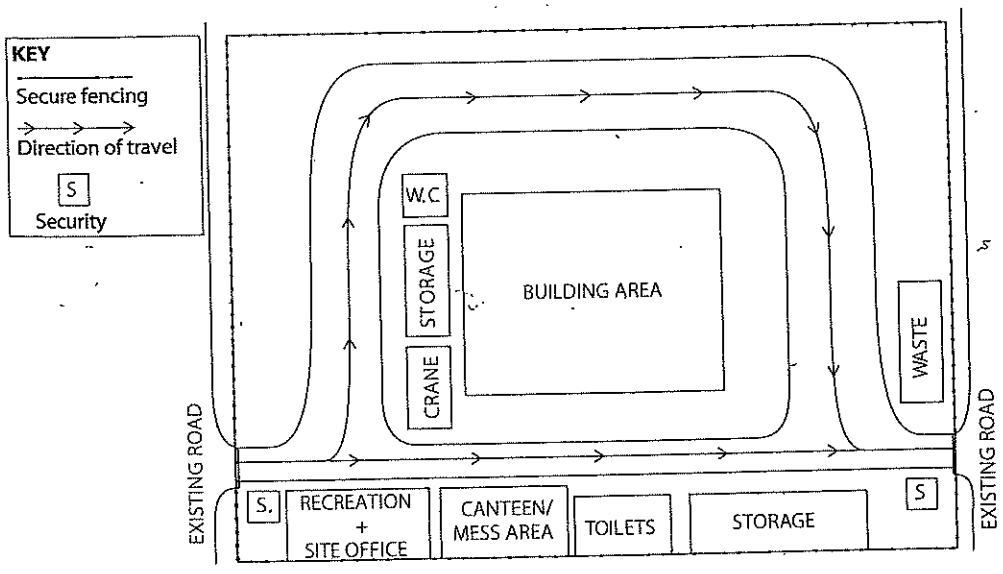


Figure 4.9 Creating a site plan can help you foresee any possible problems.

Activity 4.9

Look at Figure 4.9. This is a site plan for an apartment block. There is a primary school to the south-west of the site. There is also a busy road to the east of the site, running roughly north–south. In groups, discuss where you would put the site entrance and exit. Remember to explain why you made your choices.

Discussion

A site in a city centre and a site in a rural area may need different security measures. What differences can you think of?

The site should have a suitable security fence, plenty of lighting and CCTV cameras. Further security arrangements will depend on factors such as the type of project and the location of the site.

Safety notices should be visible to anyone working, visiting or passing the site. Clear signposting is also needed to make sure that people entering and leaving the site know exactly where they are going.

Figure 4.10 Why is it important that passers-by can see site safety notices?

Activity 4.10

Look again at Figure 4.9.

1 Suggest space to store materials.
2 Identify the security arrangements.
3 Suggest a location for welfare facilities.

Materials storage

How you store your materials on site depends on what kind of materials you are using and the quantity. This will also affect where you store the materials.

Setting out a building

Setting out is where you mark out the shape of a building on the ground. It transfers the sizes from the drawings to the site. Setting out is an essential process for any building.

First, a baseline is set out. From this line, the measurements can be taken. The main building lines are then marked out using stakes and twine. These should be checked using a steel tape.

On-site craft operations

Traditional buildings projects usually involve a lot of on-site craft operations. These on-site activities normally include:

- the use of in-situ concrete – either mixed on site or bought ready-mixed, to be used in foundations or under floors
- brickwork and blockwork – to construct the walls of the building
- roofing works – this includes tiling and insulating the roof
- carpentry and joinery – to produce elements such as the door frames
- finishes, such as painting, decorating and tiling
- service installations, including for gas, electricity and water.

Activity 4.11

You need to explain processes and operations in traditional construction. To help you do this, use the table below to list some of the activities carried out on buildings made using traditional methods. Fill in the craft operatives and materials used in columns 2 and 3. In the last column, list the sequence of the activities.

Activity	Craft operative	Materials needed	Sequence of work
Excavate and lay foundations			
Construct suspended ground floor			
Construct superstructure masonry			
Erect timber truss roof			
Install staircase			

Understanding the impact of traditional production

Traditional construction methods primarily rely on a large number of labourers attending site every day until the project is finished. Some components are made in a factory, brought to site and installed at a suitable stage. However, most of the work is done by the labour on site with the help of suitable plant and materials.

Activity 4.12

1 A housing estate with 50 houses is being built in your local area. The builder is using traditional methods of construction. What problems can you foresee for people living in the area?

2 You wish to reduce the waste and noise on this project. Which activities would you change to do this?

Traditional production needs lots of space for site accommodation and material storage facilities. As all operations are carried out on site, the work can be delayed due to a number of factors – for example, bad weather affecting productivity on site. Due to the longer time taken and the quantity of labour needed, on-site operations are more expensive. Quality control is another issue on such projects.

Modern construction of low-rise buildings

Introduction

Modern construction relies heavily on making the components of a building in advance and ordering these in good time. The aim is to improve quality while reducing the environmental impact and time spent on a project.

Did you know?

The person who sets out a building using modern equipment is called a site engineer.

Site set-up and setting out

Site set-up for modern construction projects is not as extensive as for traditional ones. All the site facilities mentioned in the previous section are provided, though material storage is kept to a minimum.

The key difference between traditional and modern construction is the degree of accuracy needed when setting out a building. As components in a modern build are made off-site, there is hardly any room for error: whatever you have ordered should fit in precisely. Computer programs and even satellite technology can be used to set out a building correctly.

Did you know?

If all new houses built in the UK since 1945 had been timber-framed houses, it is thought that more than 300 million tonnes of carbon dioxide would have been saved.

Frame construction

Frame construction is a method of building that relies on a frame as a basic means of structural support, and framed buildings are often referred to as lightweight construction. Frames can be made using timber, concrete or steel. Some of the features of frame construction are that they:

- are made with the highest level of accuracy and quality
- simplify on-site construction
- give greater control to the construction process
- improve construction health and safety
- have fewer defects and high customer satisfaction
- are easy to build.

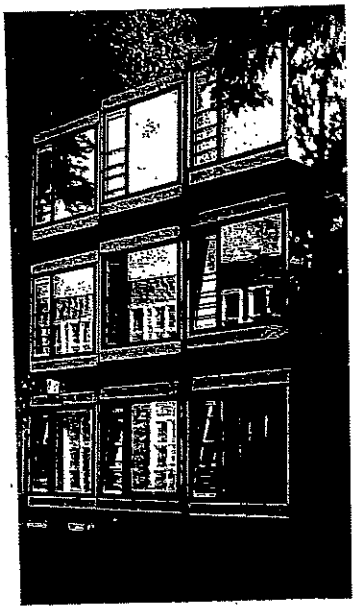
Key term

Fabrication – another word for manufacturing.

Off-site fabrication and modular construction

Think about dividing a building into a number of parts. These are made at various place and assembled on site. The parts are called modules (an example of a modular building is shown opposite).

These modules and other components are made off site. They are then brought to the site and are erected and fixed in place using lifting equipment. This means that far less time and labour is needed on site to finish a project.



A modular building. Can you see technique might be beneficial?

Some buildings may be constructed completely off site, with all the services installed, and just be assembled on site. In other cases, most elements such as structural frames are made off site. Even the roof can be constructed in parts or sections.

Non-load-bearing curtain walling

Curtain walls are made of glass and are designed to enclose the space and to give protection only. These walls do not take any load. As they are non-structural, they are lightweight. Curtain walls allow natural light into the building and are therefore pleasing to look at.

Cladding

Cladding is enclosing a building using prefabricated panels. The cladding panels can give the traditional look to a brick-faced building.

A modern building with wood cladding.

Lightweight demountable internal partitions

These are made of lightweight materials and can be taken down and moved to a new location. They usually have a permanent finish, which needs no decoration. These partitions divide the internal space quickly and can be fixed or sliding.

Integrated services

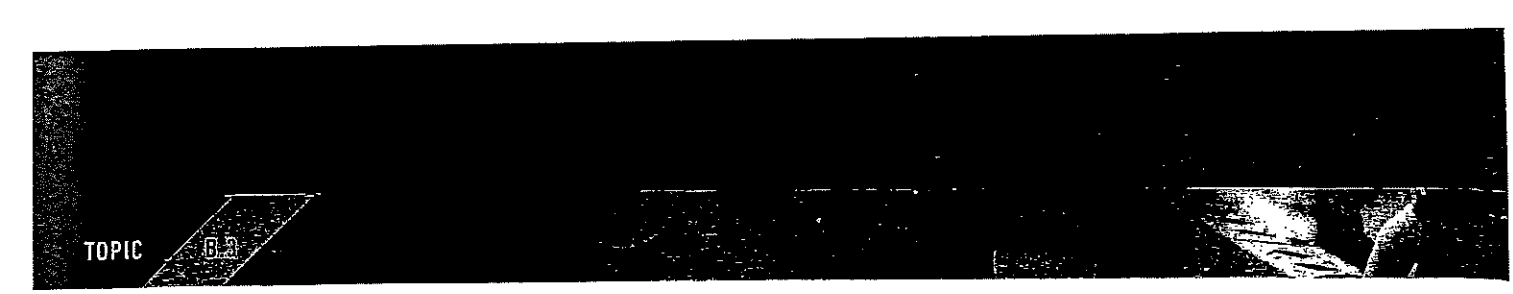
Modern buildings fit in a wide range of increasingly complex services in addition to water, gas, drainage and electricity, such as broadband and high-speed data cables. These services are **integrated** in to components such as raised access floors.

Key term

Integrated – to become a part of something.

Just-in-time delivery

If the project is well planned, a manufacturer can be asked to deliver the components on site on the day and even at the exact time when they are going to be installed. This is known as just-in-time delivery. This approach needs precise planning and coordination between the project staff and the manufacturer. When just-in-time delivery is managed well, it means that the site does not need to waste space or labour to store materials.



Key term

Evaluation – bringing together all the relevant information and using it to form a conclusion about something.

Benefits and downsides of off-site production

Before a decision is made whether a building is to be constructed using off-site construction, an **evaluation** needs to be carried out. This means that the benefits and downsides of this type of construction have to be looked at and considered.

Benefits of off-site production

- No storage is needed as components are brought to site just-in-time.
- Off-site manufacture reduces the need to work at height, making accidents on site less likely.
- Less time is needed to complete the project as components can be ordered to be made according to the timescale of the plan.
- Local environmental conditions are improved, as less site work means less noise and dust.
- Off-site manufacture is under factory conditions, where there will be minimum waste produced.
- Due to factory-controlled conditions, the quality of the finished product is much higher.
- Less skilled on-site labour is needed. On-site productivity is also improved because pre-made items are quicker to build.

Did you know?

Off-site construction could generate 90 per cent less waste than traditional construction.

Possible downsides of off-site construction

- It can take a long time to make and deliver the components.
- Excellent management skills are needed to coordinate the project activities.
- Reliability of the products is an issue in terms of how well they perform when used.
- The cost of the components can be very high.

Assessment activity 6

1 Make a list of activities carried out during construction of a building using modern methods. Explain each activity.

2 Using the table below, complete the following tasks.
- Identify which components of the building you can make off site.
- Which activities will not be needed as a result of this?
- How much time could you save on the project, with these changes?
- Would you have to face any challenges?
- Discuss in your group and present your findings.

Activity	Craft operative	Materials needed	Sequence of work
Excavate and lay foundations			
Construct suspended ground floor			
Construct superstructure masonry			
Erect timber truss roof			
Install staircase			

Learning aim C TOPIC C.1

Common construction materials

Introduction

The construction of buildings needs people to use and deal with a large variety of materials. These materials can be naturally occurring and can be used as they are, while other materials have to be made.

Natural materials

Natural materials can be used in their natural form. These include:

- timber – this is taken from trees and can be grouped into softwoods and hardwoods.
- stone – this is quarried from rock beds. There are various varieties of rock, including granite, sandstone and limestone.

Research

Lots of different insects damage timber. Carry out research about some of them and find out how this damage can be avoided.

Processed materials

Processed materials are made from natural materials and then processed to make them more suitable for their intended purpose.

Key term

Bitumen – a black sticky by-product from oil refining.

Table 4.1 Some common processed materials

Material	Characteristics
Aggregates	Aggregates are processed rock mixtures. Rock is taken out of the ground and can then be crushed to produce different sizes of crushed or uncrushed aggregate.
Concrete	Concrete is produced by mixing: • water – this must be free from contamination • fine aggregates – these are the sands and fine gravels that fill the small holes in concrete • coarse aggregates – these larger-sized aggregates give strength • cement dust – this binds all the materials together.
Bricks	Bricks are usually made from clay. The bricks are shaped out of clay and dried in air, then fired in a kiln to harden them up.
Metals and alloys	Metals such as iron and aluminium are made from ores that are extracted from the ground. A metal alloy, such as steel, is made by mixing two or more metals. Steel is a combination of iron and other elements such as carbon.
Timber products	These are products made from timber. Glued Laminated Timber or Glulam is made by bonding thin layers of timber under pressure. This makes a product that is stronger than the original timber. Other common timber products include plywood, mouldings and laminated timber.
Bituminous materials	Bituminous materials are made from **bitumen**. They are black or dark-coloured materials which have cementing properties. They are also often used in waterproofing materials.

Research

What are the stages in the production of cement? Use the internet and textbooks to find out.

Manufactured materials

Materials are also made through extensive manufacturing processes, for example plastics and paints. Table 4.2 lists some of the manufactured materieals used in construction.

Table 4.2 Manufactured materials

Material	Characteristics
Cement	Cement is a fine powder made by mixing limestone or chalk with clays and fine sands. It is used to make mortars and concrete because it acts as a binding agent.
Limes	Lime is an additive that is added to mortars and plasters to make them more workable and easier to spread.
Plastics	Plastics belong to a family of materials called polymers. Polymers are like chains of chemical materials. They are a by-product of refining oil and natural gas. Different combinations produce plastic resins. These are then moulded to make different plastic products. There are two kinds of plastic. • **Thermoplastics** can be heated and shaped several times. They become mouldable after reheating as they do not undergo lots of chemical changes when they are made. They are easily recycled. One example of a thermoplastic is polythene (PE). • **Thermosetting plastics** cannot be reheated to be reshaped once they have set. The molecules of these plastics are linked in three dimensions and this is why they cannot be reshaped or recycled. The bond between the molecules is very strong, which means that thermosetting plastics are very long-lasting and strong. Glass-reinforced polyester (GRP) is lightweight and used in cladding and roofing panels.
Paints	Paints are used to protect bare surfaces such as wood and make them more attractive. They are made up of: • thinner – the liquid part of the paint, which is either water or white spirit, which evaporates when paint dries • pigment – the solid colour of the paint which comes from organic, inorganic and synthetic sources • binder – combines pigment and other additives in the paint. It decides how well paint sticks to the surface being painted.

Take it further

Using the internet and this book or other textbooks, look up the following types of paint:

- glosses
- limewashes
- primers
- emulsions.

Name one suitable application for each type of paint. For each one, explain why this paint is suitable for this job.

Activity 4.13

Choose one of the materials listed in this topic. Use the internet or go to your local builders merchants and find out as much as you can about this material, then answer the following questions:

1 What are the possible uses for this material?

2 What is it about this material that makes it suitable for these uses?

TOPIC C2

Material uses and properties

Introduction

It is important to know about the properties of common construction materials, as these properties affect the finished structure.

Physical properties

If you look around, you will see that buildings are constructed using lots of different construction materials. This is because these materials all have different physical properties which make them good for certain purposes. Bricks might be used for strength in some cases instead of timber or metal, for example.

Table 4.3 lists the different properties that you need to think about when looking at construction materials.

Link

The properties of construction materials are covered in more detail in *Unit 3: Scientific and Mathematical Applications for Construction.*

Table 4.3 Physical properties

Property	Description	Examples
Density	A measure of how dense or compact a material is. Usually, the denser a material is, the stronger and heavier it is.	One example of a dense material is steel.
Tensile strength	A material has high tensile strength if it resists pulling or stretching forces. This means it does not stretch out of shape when put under pressure.	High tensile strength is useful in bridges and building. Materials with low tensile strength include natural stone and concrete. If these materials are put under tensile pressure, they will eventually break or crack.
Compressive strength	A material's ability to resist pushing or shortening forces. This means that the material does not get squashed or cracked under pressure.	Materials with high compressive strength include natural stone and concrete.
Elasticity	The ability of a material to return to its original shape once the load is removed.	Steel is an elastic material. This means that it can be used for structural purposes.
Ductility	Able to be deformed without losing its strength. Ductile materials often change shape or crack before failing. A 'warning' could be in the form of cracks or change of shape.	Steel is quite ductile and this means it can be used for structural purposes. Glass is not ductile. This means that it is brittle and breaks easily.
Porosity	A material's ability to allow moisture to pass through it. A porous material lets a lot of moisture through.	Foam insulation is porous and lets water through. Polythene is not porous, and so is good for damp-proof courses.

continued

Table 4.3 continued

Property	Description	Examples
Durability (or resistance to **degradation**)	A material's ability to resist wear and tear. A durable material is suitable for use on the outside of a building.	Concrete is durable because it does not get worn down by wind and rain. Steel, though durable, can degrade quickly if exposed to water and salts.
Workability	How easy a material is to work or handle – for instance, if it does not need a lot of energy to shape or cut. Modelling clay is very workable.	This term is often used to describe how easily concrete can be poured. The workability of a concrete mix depends upon the water : cement ratio.
Thermal conductivity	A material's ability to conduct heat through itself. Materials with high conductivity include copper and aluminium.	Expanded polystyrene and sheep's wool are examples of materials with low thermal conductivity. These are therefore used for thermal insulation.
Thermal resistance	A material's ability to stop heat passing through it. Materials with high thermal resistance are good insulators, because they do not allow heat to escape through them.	Sheep's wool has high thermal resistance, so it is an excellent insulating material. Glass has low thermal resistance, which is why single-glazed windows lose a lot of heat.

Key term

Degradation – when a material is exposed to sunlight, water and wind, it starts losing its strength, shape or appearance.

Did you know?

Just because a material has high tensile strength, it does not necessarily also have compressive strength. This is also true the other way around.

You can tell that this house is well insulated because the snow on its roof does not melt. This is because the insulation materials in the loft have high thermal resistance and don't let heat escape.

Just checking

1 What is compressive strength?
2 What are the elastic properties of timber?
3 Name two suitable applications for a material with high tensile strength.
4 Name three materials that are dense.
5 Why might ductility be an advantage?

Activity 4.14

1 Select part of your house, school or college that you can easily access. Make a list of the materials you can see around you and think of a reason why each of these materials has been used in this particular place. Record your findings in a table like the one below, adding more rows as needed. An example has been done for you.

Material	Location	Reasons
e.g. Bricks	e.g. External wall	e.g. To take the load from the structure above

2 Choose one natural, one processed and one manufactured construction material that could be used to fulfil the same function. For instance, you could choose timber, timber products and plastics as these could all be used to construct doors. Create a presentation about this subject, keeping in mind their resistance to degradation.

Common construction materials and their properties

Now you know about the different properties of construction materials, you can apply this knowledge to the most common construction materials.

Bricks

Bricks need to have good compressive strength to support structural loads. This means that bricks can be used for walls, columns and even larger structures such as bridges.

Concrete

Concrete has high compressive strength, but low tensile strength. The strength and workability of concrete depends on the quality of the materials in it, and the amount of water used. It has low ductility, porosity and elasticity, but it is dense.

Concrete is **non-combustible**, which means that it is fire-safe and able to withstand high temperatures. It is durable as it can resist wind, water and insects.

Timber

Timber has very good tensile and compressive strength. It is easily damaged by weather, **fungi**, insects and fire, and external timbers gradually lose their natural colours and turn grey. Timber is a natural material, so its properties vary according to its origin and **seasoning**.

Because of its properties, timber is used structurally in timber frames, joists, rafters and trusses. It is also used inside buildings, in staircases, doors and window frames.

Key terms

Non-combustible – does not burn.

Fungi – (singular: fungus), these are micro-organisms such as moulds.

Seasoning – treating natural timber so it is not affected by changes in moisture.

Did you know?

Cement has 'set' when it has become solid. Cement has only 'hardened' when it has developed strength.

Discussion

Cement shrinks as it dries and has low ductility once this has happened. What do you think might happen if cement was allowed to set too quickly?

Cement

Cement is used to bind the materials together. It is used in concrete to bind sand and aggregates. Cement requires water to start a chemical reaction resulting in a bond.

Metals

Different metals have different properties, but you are most likely to work with steel. Steel is the most common metal used in structural building work. It does not react well to extreme temperatures and also rusts easily if not protected, meaning that its durability is limited. Because of these properties, steel is used for reinforcing bars, wall ties, structural steel frames and lintels.

Bituminous materials

Bituminous materials like asphalt and tar are highly adhesive and are water resistant. They are also strong and durable, which makes them ideal for use in road surfaces.

Paints

Some paints are more durable than others. These paints are often used in areas that are used a lot, for example hallways and stairwells, or in areas with high humidity such as kitchens and bathrooms.

Assessment activity 4.3

You are working in an architectural practice, and have been asked for advice by a client. She is renovating her house and wants to know what her options are. For each of the following locations, produce a report specifying the materials that could be used. Remember to include more than one option for each location and give reasons for your choice:

- bathroom and kitchen
- external walls
- lounge and bedroom.

Tips

- The best answers justify their choice of materials. This means that you should give reasons or evidence for any decisions that you make. This demonstrates how you made your decision.
- For each location, try to choose a construction material from each of the three main categories: natural, processed and manufactured.