N2

Bricklaying and Plastering Theory

Student's Book

Jowaheer Consulting and Technologies

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Bar chart planning

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Overview of Module 1

When you have completed this module, you will be able to:

- Explain the planning of building site operations.
- Define planning in the context of construction management.
- Describe the role of planning in the construction management process.
- Describe the benefits and limitations of planning.
- Name and describe the different stages of construction planning.
- Define the two major components of scheduling.
- Describe and create a work breakdown structure (WBS).
- Describe and create a critical path method (CPM).
- Define and create a Gantt chart.

Many different activities take place at the same time on a building site with tasks being carried out by different teams of contractors and subcontractors. Proper planning is essential for any construction project to be completed on time, within budget, and to acceptable quality standards. In this module, we look at how planning is done at the different stages of a project. We will also look at the tools that are used to plan, implement and monitor the daily activities involved in a construction project.

Figure 1.1: Planning is essential for the successful completion of a construction project

Starter activity

1. What do you understand by the term 'planning'?
2. Why do we need to plan before we start any new project?
3. What is the simplest form of planning that you know of?

Unit 1.1: Planning building site operations

1.1.1 What is planning?

Planning is the process of thinking about what needs to be done to achieve a particular goal. Two simple examples of planning are writing down a grocery list before going shopping or drawing up a study timetable. Planning is an essential management function in construction and project management. It is done by the management team, which may include the architect, project manager, client, engineers, site manager and other construction personnel.

In construction, planning involves identifying all the steps required to build a structure. Planning clearly defines tasks, orders these tasks logically, and determines what materials, labour and equipment will be needed to complete the project.

Figure 1.2: Planning answers six main questions

Generally, planning involves answering six main questions:

- **What** must be done?
- **Why** must it be done?
- **Who** does the work?
- **How** must the work be done?
- **When** must it be done?
- **Where** must it be done?

1.1.2 The role of planning in the construction management process

Planning is not something that is done at the beginning of the project and then stops. It is an ongoing process that is carried out at each stage of the project to ensure that the goals are achieved. Planning forms part of each of the following management processes:

- **Scheduling:** Breaking down the process into individual tasks and deciding when to start and complete each task.
- **Organising:** Identifying and obtaining the resources (people, materials and equipment) needed to perform each task.
- **Directing:** Ensuring that people complete tasks within the given ***time frames*** and to the required standards.
- **Monitoring:** Ensuring that the ***milestones*** are reached and carrying out regular inspection of the work.

time frame: *the number of days, weeks or months in which a project or task must be completed*

milestone: *a major phase or event in the course of a project that can influence the scheduling of other activities*

Activity 1.1

1. Define planning. (2)
2. State four benefits of planning. (4)
3. State four limitations of planning. (4)
4. List the stages of construction planning. (3)
5. What does detailed planning mean? (2)

TOTAL: [15]

Unit 1.2: Scheduling daily activities

1.2.1 The two components of scheduling

Planning daily site activities is a major task that requires knowledge of the project and the construction process. The project must be divided into smaller tasks that can be monitored. Scheduling is an important part of planning.

We saw earlier that scheduling involves breaking down a process into individual tasks and deciding when to start and complete each task. Scheduling has two major components:

- **Resource-oriented scheduling:** Focuses on when resources such as labour and building material must be available on site.
- **Time-oriented scheduling:** Focuses on when the project must start and end, and how long it should take to complete each task.

Time-oriented scheduling must consider potential delays such as public holidays, sick leave, late deliveries of material, bad weather, and labour unrest. It must also take ***dependencies*** into account – some tasks rely on others to be completed first. For example, plastering can only start once all the brickwork has been completed.

dependencies: *tasks that rely on other tasks to be completed first*

We will now look at three common tools that are used in construction planning.

1.2.2 Work breakdown structure (WBS)

A WBS breaks down major project activities into smaller and more manageable tasks (see Figure 1.4). For example, a major task such as laying foundations will be broken down into smaller tasks such as soil testing, setting out, excavation, and pouring the footings.

For tasks to be included in the WBS, they must:

- Have a logical sequence.
- Be measurable in terms of time.
- Be clearly defined with a definite start and end.
- Be independent of other tasks.

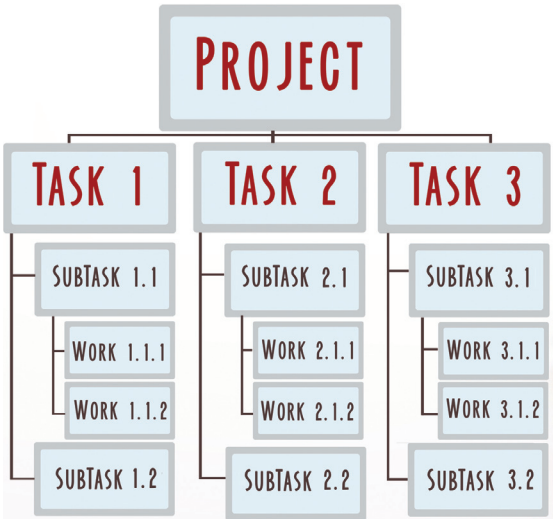

Figure 1.4: A work breakdown structure (WBS)

The following guidelines will assist in creating a WBS:

- The top level represents the main tasks that must be completed to finish the project. These tasks are also known as the ***deliverables*** of the project.
- The main tasks are divided into smaller subtasks. The subtasks are then broken down into work packages.
- Each work package will be assigned to a specific department or work team.
- The work package must state the work to be done, the duration, and the costs to meet the requirements of the subtask.
- Work packages should not exceed 10 days in duration.
- Work packages should be independent of other work packages in the WBS.
- Work packages are unique and should not be duplicated across the WBS.

deliverables: *tasks specified in a contract that must be completed (delivered) before the project can be successfully completed*

Figure 1.5 is an example of part of a WBS for a construction project.

TASK 1: Foundation	Subtask 1.1: Level the site	
	Subtask 1.2: Setting out	
	Subtask 1.3: Excavation	
	Subtask 1.4: Lay concrete footings	*Work package 1.4.1: Install formwork*
		Work package 1.4.2: Mix concrete
		Work package 1.4.3: Pour concrete
		Work package 1.4.4: Curing of concrete
		Work package 1.4.5: Remove formwork
	Subtask 1.5: Clean up	

Figure 1.5: Example of a work breakdown structure (WBS) for a construction project

Table 1.2 summarises the advantages and limitations of a WBS.

Table 1.2: Advantages and limitations of a work breakdown structure (WBS)

Advantages of a WBS	Limitations of a WBS
• Defines and organises the work that must done. • Responsibilities for each phase of the project are clear. • Simplifies project tasks. • Helps with drawing up schedules. • Helps with estimation of time, cost and risk. • Allows for better allocation of resources. • Avoids duplication of tasks.	• Does not show what resources are needed. • Does not show how long tasks will take. • Does not show tasks in the order that they will be completed. • Does not show dependencies between tasks. • Does not show which tasks are critical and which are not.

1.2.3 Critical path method (CPM)

The CPM is a scheduling tool that shows the sequence of interdependent tasks. The **critical path** is the series of activities that must be completed to finish the project on time. A delay in any one of these tasks will result in an overall project delay. The CPM can be used to calculate how early or late activities can start and end so that the project finishes on time.

Tasks that form part of the critical path are called **critical tasks**. If any of these tasks are delayed, the project deadline will not be met. **Non-critical tasks** can be delayed for a certain amount of time without affecting the project's completion date (see Figure 1.6).

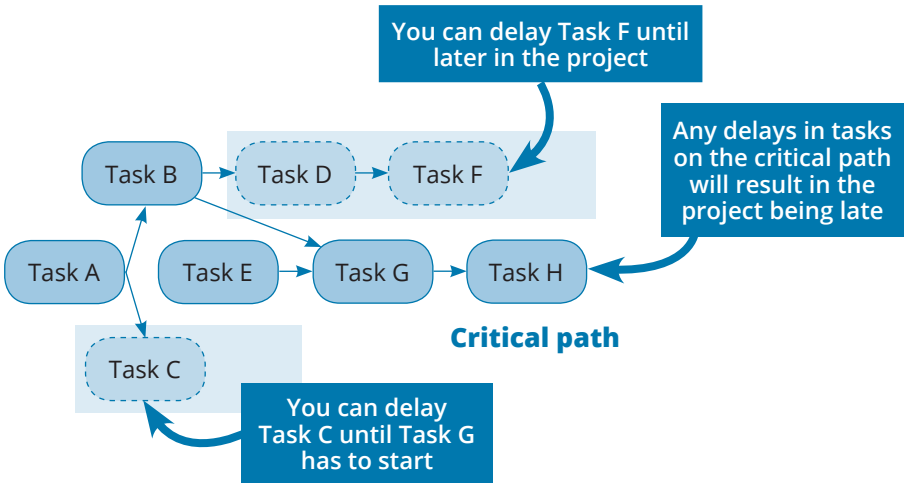

Figure 1.6: The critical path method (CPM)

Table 1.3 summarises the advantages and limitations of the CPM.

Table 1.3: Advantages and limitations of the critical path method (CPM)

Advantages of the CPM	Limitations of the CPM
• The CPM helps to identify the key tasks of the project. • It shows dependencies, which helps in the scheduling of individual activities. • It shows how long a task can be delayed before it affects the project deadline. • It helps to allocate resources to the right tasks, which reduces wastage and downtime. • It makes it easier to evaluate parallel activities and to deal with delays. • It provides an early warning if the project is in danger of being late.	• The CPM's reliability depends on the accuracy of estimated times. • Too many activities can make the diagram too complicated. • It is difficult to estimate the completion time for an activity. • In the case of large projects, the network is complex and the critical path is not always clear. • It cannot create and monitor the schedules of people involved in the project. • The allocation of resources cannot be properly monitored.

1.2.4 Gantt charts

a) What is a Gantt chart?

A Gantt chart is a type of bar chart used to illustrate a project schedule. It includes the start and finish dates of all activities.

- The vertical axis represents all the tasks related to the project, for example clearing of the site, and excavations.
- The horizontal axis represents the total time span of a period, such as days, weeks or months. The activities are represented by horizontal bars that show when each activity starts and when it ends. The length of each bar shows the time allocated to the activity.

A Gantt chart clearly shows the following:

- The start date of the project.
- What the project tasks and milestones are.
- Who is responsible for each task.
- When tasks start and finish.
- How long each task will take.
- Which tasks overlap or depend on each other.
- The finish date of the project (see Figure 1.7).

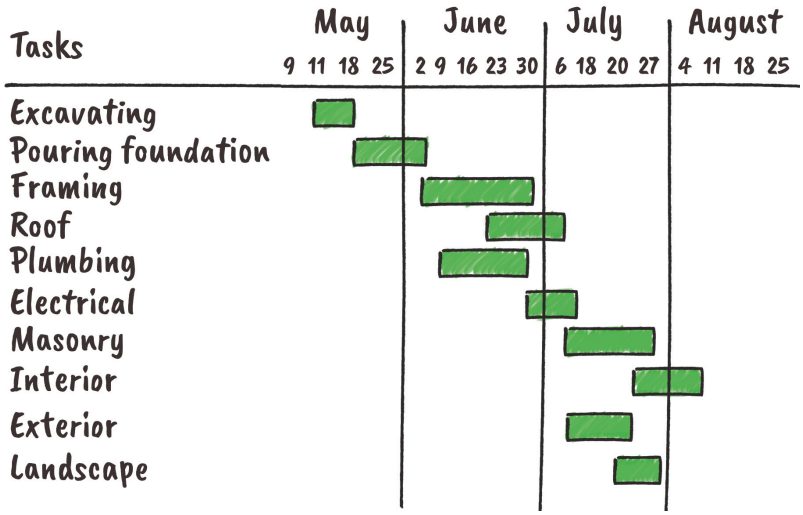

Figure 1.7: A Gantt chart drawn by hand

A Gantt chart can be drawn by hand or it can be done on a computer using software such as Excel (see Figure 1.8).

ACTIVITIES	TIME FRAME (in weeks)																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
TASK 1: EARTHWORKS																					
1.1 Excavation	■																				
1.2 Backfill and compaction														■	■						
TASK 2: STRUCTURAL WORK																					
2.1 Reinforced concrete work		■	■	■	■	■	■	■													
2.2 Steel frame									■	■	■										
TASK 3: FINISHING WORK																					
3.1 Masonry							■	■	■	■	■	■	■								
3.2 Plastering											■	■	■	■	■	■					
3.3 Painting																	■	■			
3.4 Floor covering																			■	■	
TASK 4: ELECTRICAL WORK																					
4.1 Conduit work												■	■	■							
4.2 Cable pulling																■	■				
TASK 5: MECHANICAL WORK																					
5.1 Plumbing															■	■					
5.2 Fittings																		■	■		
TASK 6: SITE CLEAN-UP																					
6.1 Clean-up																				■	■

Figure 1.8: A Gantt chart done on a computer

b) How to create a Gantt chart

The basic procedure for creating a Gantt chart is as follows:

Step 1	Use the WBS technique to break the project down into smaller tasks.
Step 2	Identify milestones within the project.
Step 3	Determine the expected time required to complete each task.
Step 4	Identify the sequence of tasks or order of precedence of tasks.
Step 5	Identify task dependencies and any overlap that will occur between tasks.

Step 6	Draw a horizontal time axis at the bottom of the page.
Step 7	Select a proper time scale to represent the duration of tasks, for example days or weeks.
Step 8	Draw the vertical axis on the left side of the page.
Step 9	In this column, write down the activities in the order in which they will occur.
Step 10	For milestones (activities that must occur at a specific time), you can use an open-diamond symbol under the time when the activity must be completed.
Step 11	Draw horizontal bars for activities that occur over a determined period of time. These bars must be **empty rectangles** starting on the day that the activity will begin and finishing on the day that the activity ends.
Step 12	Fill up the diamonds and rectangles as each activity is performed.

Figure 1.9 shows a Gantt chart created as described above. The first four bars have been filled in, meaning that these activities have been completed. The first diamond has been filled in, meaning that the first milestone has been reached.

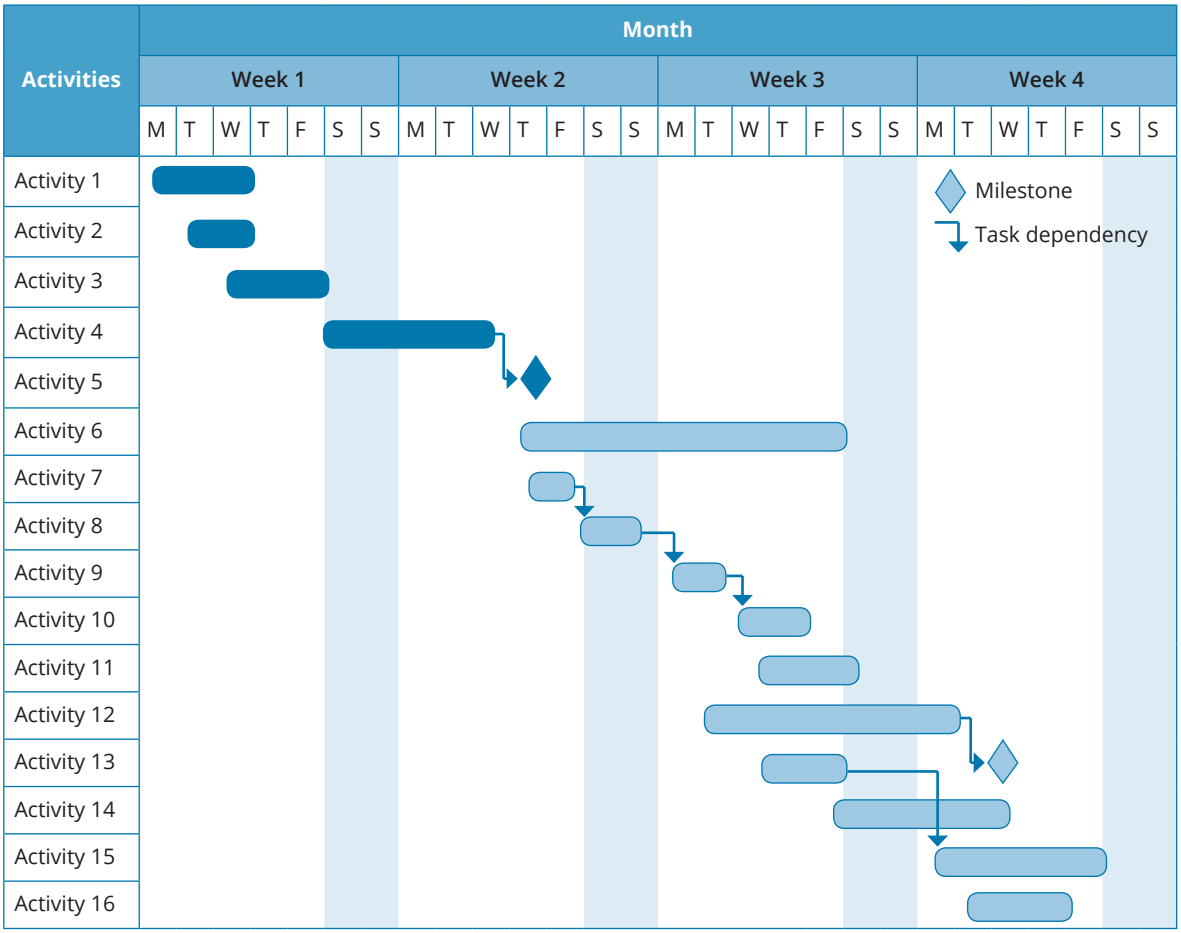

Figure 1.9: How to build and complete a Gantt chart

c) Advantages and disadvantages of a Gantt chart

Table 1.4 summarises the advantages and disadvantages of a Gantt chart.

Table 1.4: Advantages and disadvantages of a Gantt chart

Advantages of a Gantt chart	Disadvantages of a Gantt chart
• A Gantt chart shows tasks, subtasks and milestones visually on a graph. • Dates and time frames are easy to see. • It breaks down the construction programme into days, weeks and months. • It makes it easy to group all subtasks under a main task. • It makes it easy to check the project status and which tasks have been completed. • It distinguishes between tasks in progress and pending work. • It helps with scheduling and the coordination of work teams. • It is a useful visual tool to present at progress meetings.	• A Gantt chart is time-consuming to create. • It is difficult to update. • It does not consider costs and resources. • It must be constantly updated. • It is difficult to see on one sheet of paper. • Bars on the chart do not indicate how much work is required to complete a task. This makes it hard to know how many resources are needed to complete the task.

Activity 1.2

You have been contracted to build a single garage for your neighbour. The garage must have plastered and painted walls, a corrugated iron roof, one steel window, and an electric roll-up door. A washing machine and tumble dryer will be installed in one corner of the garage. The project must be completed in eight weeks.

1. Use the WBS technique to break the project down into smaller tasks. (10)
2. Draw a critical path diagram to show the order in which the tasks must be completed to meet the six-week deadline. (10)
3. Create a Gantt chart to show when each task will begin and when it will end. You can draw the chart by hand or you can do it on a computer if you have access to one. (15)

TOTAL: [35]

Summary of Module 1

Unit 1.1 Planning building-site operations

- In construction, **planning** involves:
  - Identifying all the steps required to build a structure.
  - Breaking them down into clearly defined tasks.
  - Ordering these tasks logically.
  - Determining what materials, labour and equipment will be needed to complete the project.
- Planning is an essential **management function** in construction and project management and is done by the management team.
- Planning involves answering **six main questions**, namely:
  - **What** must be done?
  - **Who** does the work?
  - **Where** must it be done?
  - **Why** must it be done?
  - **How** must the work be done?
  - **When** must it be done?
- Planning is an ongoing process and forms part of each of the following **management processes**:
  - Scheduling.
  - Directing.
  - Controlling.
  - Organising.
  - Monitoring.
- Although planning has a number of **benefits**, it does have its **limitations**.
- There are different **stages of construction planning**, namely:
  - Pre-tender planning.
  - Detailed or period planning.
  - Contract planning.

Unit 1.2 Scheduling daily activities

- **Scheduling** is an important part of planning and has **two major components**:
  - **Resource-oriented scheduling,** i.e. when resources such as labour and building material must be available on site.
  - **Time-oriented scheduling,** i.e. when the project must start and end, and how long it should take to complete.
- **Time-oriented scheduling** must also take into account **dependencies**, i.e. the fact that certain tasks cannot start until other tasks have first been completed.
- Three **common tools** that are used in **construction planning** are:
  - The **work breakdown structure (WBS)**.
  - The **critical path method (CPM)**.
  - The **Gantt chart**.
- A **WBS** breaks down major project activities into **smaller and more manageable tasks**.
- **Tasks included in the WBS** must:
  - Have a logical sequence.
  - Be measurable in terms of time.
  - Be clearly defined with a definite start and end.
  - Be independent of other tasks.

Summary of Module 1 (continued)

- A WBS comprises **main tasks**, **subtasks** and **work packages**.
- The **CPM** is a scheduling tool that shows the **sequence of interdependent tasks**.
  - The **critical path** is the series of activities that must be completed to finish the project on time. A delay in any one of these tasks will result in an overall project delay.
  - Tasks that form part of the critical path are called **critical tasks**.
  - If any of these tasks are delayed, the **project deadline will not be met**.
  - **Non-critical tasks** can be delayed for a certain amount of time without affecting the project's completion date.
- A **Gantt chart** is a type of bar chart used to **illustrate a project schedule**, including the start and finish dates of all activities.
  - The vertical axis represents all the tasks related to the project, e.g. clearing of the site and excavations.
  - The **horizontal axis** represents the total time span of a period, such as days, weeks or months. The activities are represented by horizontal bars that show **when each activity starts and when it ends**. The length of each bar shows the **time allocated to the activity**.
- A **Gantt chart clearly shows the following**:
  - The start date of the project.
  - Who is responsible for each task.
  - How long each task will take.
  - The finish date of the project.
  - What the project tasks and milestones are.
  - When tasks start and finish.
  - Which tasks overlap or depend on each other.
- The WBS, the CPM and the Gantt chart have a number of **benefits** when planning. However, they also have certain **limitations**.

Summative assessment for Module 1

1. Define the following terms:
   1.1 Resource-oriented scheduling.
   1.2 Time-oriented scheduling.
   1.3 Work breakdown structure.
   1.4 Critical path method.
   1.5 Gantt chart. (2 × 5 = 10)
2. State five advantages of the work breakdown structure. (5)
3. State five limitations of the critical path method. (5)
4. Create a Gantt chart using the following information. The project starts on 15 March. (15)

Brickwork	4 weeks
Concrete foundations	3 weeks
Excavation	1 week
Door and window frames	2 weeks
Painting	2 weeks
Plastering	2 weeks
Roof	3 weeks
Site clean-up and evacuation	1 week

TOTAL: [35]

Glossary

Words and terms

aggregate: *a material formed from a mass of fragments or particles compacted together 125*

alundum: *a hard material composed of fused alumina that is used as an abrasive 129*

arcade: *a covered passage with arches along one or both sides 170*

barge cap: *flashing that is used down the edges of the roof sheets to cover gaps or sharp edges and give a finished look to the roof 241*

base: *the layer of material into which the pavers are embedded; it can be sand or mortar (concrete) 255*

batten: *a strip of solid material such as wood 219*

Bessemer: *equipment formerly used for the mass production of steel 22*

bill of quantities: *a document that provides measured quantities for a specific project of all items of work identified from the drawings and tender document specifications 3*

bond beam: *a horizontal structural element, usually found as an embedded part of a masonry wall assembly; the bond serves to strengthen a wall horizontally 117*

bonding: *in brickwork, refers to how the individual bricks or masonry units overlap and interlock into a single structural unit 65*

brace: *a diagonal member that provides stability and resists lateral loads 52*

bridge: *material touching both walls that allows moisture to be transferred from the outer to the inner leaf 94*

burr: *a rough edge or ridge left on an object by the action of a tool or machine 223*

butt end: *the thicker end 243*

camber: *a slight curvature given to an arch or beam to eliminate the effect of sagging 180*

capillary action: *the tendency of a liquid in a pore to rise or fall as a result of surface tension 100*

caulk: *a flexible material used to seal gaps or joints between stationary building components and materials 60*

chamfer: *to cut away a right-angled edge (or corner) to make a symmetrical sloping edge 199*

clay: *a naturally occurring rock or soil substance found all over the world 138*

cleat: *(as used in scaffolding) a strip of wood or metal that is attached to one part of a scaffold plank to hold it in place and so prevent the plank from moving 31*

cleat: *(as used in shoring) a piece of timber that provides additional support for a needle and prevents a raker from slipping 52*

closer: *a cut brick that is used to complete a course or for spacing standard bricks in a course 67*

cobblestone: *a stone with a rounded upper surface used for paving streets 249*

combustion gases: *gases emitted as a result of the burning of fuel 152*

compacted: *compressed as a result of physical pressure, such as stamping with a compactor or other equipment; compressed and made denser by removing voids caused by air spaces 103*

competent person: *a person with the knowledge, training and experience specific to the work or task being performed 45*

composite: *a combination of two or more different materials that results in a superior, often stronger, product 125*

compressive force: *a force which presses inwards on an object causing it to become compacted; also called compression force 173*

compressive strength: *the ability of a material to resist loads which tend to compress it 16*

construction programme: *a document that sets out the sequence in which tasks must be carried out so that a project (or part of a project) can be completed on time 3*

construction supervisor: *a competent person responsible for supervising construction activities on a construction site 30*

contaminate: *make impure or unclean 99*

contractor: *a person or company that signs a contract to provide materials or labour to do a job 3*

cornice: *an ornamental moulding around the wall of a room just below the ceiling 216*

corrosion: *deterioration of metal as a result of chemical reactions between the metal and the surrounding environment 207*

course: *a continuous horizontal row of bricks or blocks that runs the length of the face of a wall 66*

creep: *the long-term deformation of concrete 17*

curing: *allowing a material to dry and harden so that it develops strength and durability 124*

damp-proof course (DPC): *a material used to prevent the penetration of damp 95*

datum line: *a line used as a reference for the measurement of heights and depths 146*

dead load: *in simple terms, the weight of a material 17*