N4

Building & Structural Construction

Lecturer Guide

Patrick Neal & Johan Neethling

Additional resource material for this title includes:

- PowerPoint presentation
- Past exam papers
- Electronic Lecturer Guide

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Lecturer guidance

1. General aims

To provide students with knowledge and skills that is used for structural design in the construction industry

2. Specific aims

2.1 The student should obtain thorough background knowledge of the theory and methodology as applied in Building and Structural Construction.
2.2 The teaching of this subject is aimed at introducing the student to the application of technological principles and practices in the building and structural construction industry

3. Prerequisites

The student must meet at least one of the following requirements.
3.1 N3 certificate with Building and Civil Technology and any N2 Trade subjects of Plumbing Theory, Carpentry or Bricklaying and Plastering theory.
3.2 Passed Grade 12 with Mathematics or Physical Science.
3.3 NCV Level 4 Certificate in Civil and Building Construction.
3.4 Technical Matric with Technical subjects.
3.5 Passed senior certificate for adult learners with NQF Level 4 (50% or D symbol) in Mathematics or Physical Science.

4. Duration

Full-time: 7.5 hours per week. This instructional offering may also be offered part-time.

5. Evaluation

5.1 Evaluation is conducted continuously by means of two formal tests at college level. Learner must obtain a minimum ICASS mark of at least 40% in order to qualify to write the final examination and a mark will be calculated together in a ratio of 40:60 to derive the promotion mark. The learner must obtain at least 40% on the final examination.
The promotion mark will be calculated as follows:
Promotion Mark = 40% of (ICASS mark) + 60% of (Exam mark)
5.2 The examination in Building and Structural Construction N4 (Engineering Studies – Report 191) will be conducted as follows:

Modules 1 to 10:
MARKS: 100
DURATION: 4 HOURS

CLOSED BOOK:
- No formulae sheet is required.
- A2 drawing paper
- BOE 8/2 (Hot rolled structural steel sections code of practice) Annexure A of the question paper

5.3 Weighting:

The following weights are consequently awarded to each category: Knowledge and Understanding	Applying	Analysing / Syntheses and Evaluating
05 – 10	10 – 80	05 – 20

6. Learning content

Theoretical background
It is essential that this subject should be illustrated and evaluated within the context of practical within the workshop environment.

Technical background
It is essential that this subject should be illustrated and evaluated within the context of technical skills and simulation of practical environment.

7. Mark allocation and weighed value of modules

MODULES	WEIGHTING (%)
1. Foundations	10
2. Damp proofing	10
3. Bonds in brickwork	10
4. Arches	10
5. Steel door frames and windows	10
6. Roofs	15
7. Roof coverings	5
8. Guttering	5
9. Ceilings	5
10. Structural steelwork	20
TOTAL	**100**

8. Work schedule

Week	Topic	Content	Hours
1	**Module 1** Foundations	1.1 Soil 1.2 Types of foundatios 1.3 Strength and mix proportions	10 hours
2	**Module 2** Damp proofing	2.1 Materials 2.2 Position of damp proof course 2.3 Thermal insulation 2.4 DPC on basement walls	10 hours
3	**Module 3** Bonds in brickwork	3.1 Types of brick bonding 3.2 Brickwork drawings	10 hours
4	**Module 4** Arches	4.1 Openings 4.2 Types of arches	10 hours
5	**Module 5** Steel door frames and windows	5.1 Doors and windows	10 hours

6–7	**Module 6** Roofs	6.1 Types of roofing 6.2 Timber and steel roof trusses 6.3 Roof trusses in riveted and bolted construction 6.4 Pitch and valley of steel roof trusses	15 hours
7	**Module 7** Roof coverings	7.1 Types of roofing covering 7.2 Sealants	5 hours
8	**Module 8** Guttering	8.1 Types of guttering	5 hours
8	**Module 9** Ceilings	9.1 Types of ceilings 9.2 Construction of ceilings	5 hours
9–10	**Module 10** Structural steelwork	10.1 Designing structures for steelwork	20 hours
	TOTAL		**100 hours**

9. Lesson plan template

CAMPUS	
LECTURER	
SUBJECT AND LEVEL	N4 Building and Structural Construction
PRESCRIBED TEXTBOOK: TITLE AND AUTHOR	*N4 Building and Structural Construction* by P Neal & J Neethling

LESSON	CONTENT/OUTCOMES TO BE COVERED THIS WEEK	LIST OF EXAMPLES TO BE DONE IN CLASS BY THE LECTURER TO EXPLAIN THE OUTCOME/CONCEPT	FACILITATION METHOD (PLEASE TICK)		TEACHING RESOURCES/AIDS (PLEASE TICK)		STUDENT ACTIVITY (EXERCISE IN TEXTBOOK/ADDITIONAL SUPPORTING TASK) TO BE DONE THIS WEEK
WEEK 1			Lecture		White board/ OHP		
			Group work		Models		
			Demonstration		Handouts		
			Simulation		Multimedia		
			INTRODUCTION TO LESSONS				
			RECAPPING/REINFORCEMENT				

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WEEK 2			Lecture		White board/ OHP		
			Group work		Models		
			Demonstration		Handouts		
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WEEK 3			Lecture		White board/ OHP		
			Group work		Models		
			Demonstration		Handouts		
			Simulation		Multimedia		
			INTRODUCTION TO LESSONS				
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WEEK 4			Lecture		White board/ OHP		
			Group work		Models		
			Demonstration		Handouts		
			Simulation		Multimedia		
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WEEK 5			Lecture		White board/ OHP		
			Group work		Models		
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			Simulation		Multimedia		
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WEEK 7			Lecture		White board/ OHP		
			Group work		Models		
			Demonstration		Handouts		
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			Group work		Models		
			Demonstration		Handouts		
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MODULE

1 Foundations

By the end of this module, students should be able to:

- analyse the following different soil samples from a given scenario in order to choose a suitable foundation:
  - clay soil
  - loam soil
  - loose or sandy soil;
- identify and draw the following types of foundations:
  - strip foundation
  - stepped foundation
  - raft foundation
  - pad foundation
  - pile foundation; and
- explain strengths, mixing proportions and curing requirements according to Standard Building Regulations for single- and double-storey buildings.

Soil compaction can be described in various ways, but the simplest manner is to describe the concept as the application of dynamic energy, via a mechanical roller or compactor, to soil in order to reorganise the solids and thereby reduce their void ratio. By achieving this, the density of the soil is increased, which is always the main objective of compaction.

Exercise 1.1 SB page 16

1.1

Volume of mortar= 1 m^3

Mix ratio –> 1:4

Dry volume of mortar = Wet volume × 1.33

Dry volume = 1,0 m^3 × 1,33 = 1,33 m^3

Quantity of cement:

Quantity of cement = (Dry volume of mortar × Cement ratio) / (Sum of the ratio)

∴ Quantity of cement = $\frac{1,33 \times 1}{1 + 4}$ = 0,266 m^3

Density of cement = 1 440 kg/m^3

∴ Weight of cement = 1 440 × 0,266 = 383,04 kg

1 bag of cement contains 50 kg of cement

∴ Number of bags = $\frac{1,33 \times 1}{1 + 4}$ = 7,661 bags

Quantity of sand:

Cement : sand : 1:4

Quantity of sand = Quantity of cement × 4

∴ Quantity of sand = 0,266 m^3 × 4 = 1,064 m^3

Density of sand = 1 420 kg/m^3

∴ Weight of the sand= 1,064 m^3 × 1 420 kg/m^3= 1 510,88 kg =>1,510 tonnes

Quantity of water:

Water cement ratio = weight of water /weight of cement

W/C–>0,50

weight of water = (weight of cement) × (w/c ratio)

∴ Weight of water = 383,04 kg × 0,5 = 191,52 kg (litre)

1.2

Case 1

No. of bricks = Volume of brickwork/ volume of 1 brick with mortar

Volume of 1 brick with mortar = 0,20×0,10×0,10=0,002 m^3

Volume of brickwork = Thickness of wall x Area of brickwork

Volume of brickwork = 0,19 m × 1 m^2 = 0,19 m^3

∴ No, of bricks = $\frac{0,19}{0,002}$ = 95 (without wastage)

Consider the wastage percentage as 10 %

Then,

No. of bricks with wastage = 95 + 9.5 =104.5

If, the thickness of wall = half brick thick wall (partition wall)

Then,

No. of bricks without wastage = 47,5

No, of bricks with wastage = 52,25

Case 2

No. of bricks = Volume of brickwork/ volume of 1 brick with mortar.

Volume of 1 brick with mortar = 0,240 × 0,120 × 0,080 = 0,002304 m^3,

Volume of brickwork = 1 m2 × 0,230 m =0,230 m^3

$\therefore$ No. of bricks in 1 m^2 = $\frac{0{,}230}{0{,}00204}$ = 99,826 ≊100 (without wastage)

Consider the wastage percentage as 10 %

Then,

No. of bricks with wastage = 99,826+9,982=109,808 ≊110

if, thickness of wall = half brick wall

Then,

No. of bricks without wastage = 49,913 (50) (without wastage)

No. of bricks with wastage = 54,904 (55) (with wastage)

eLinks

Students can visit these links to learn more about types of foundations:

- *futman.pub/Foundations1*
- *futman.pub/Foundations2*
- *futman.pub/FoundationAnimation*
- *futman.pub/FoundationModel*

Students can visit this link to learn more about different types of soil:
futman.pub/SoilTypes

Students can visit this link to learn more about the strength of cement mixes:
futman.pub/WaterCementRatio

Students can visit this link to learn more about concrete curing:
futman.pub/ConcreteCuring

MODULE

2 *Damp proofing*

By the end of this module, students should be able to:

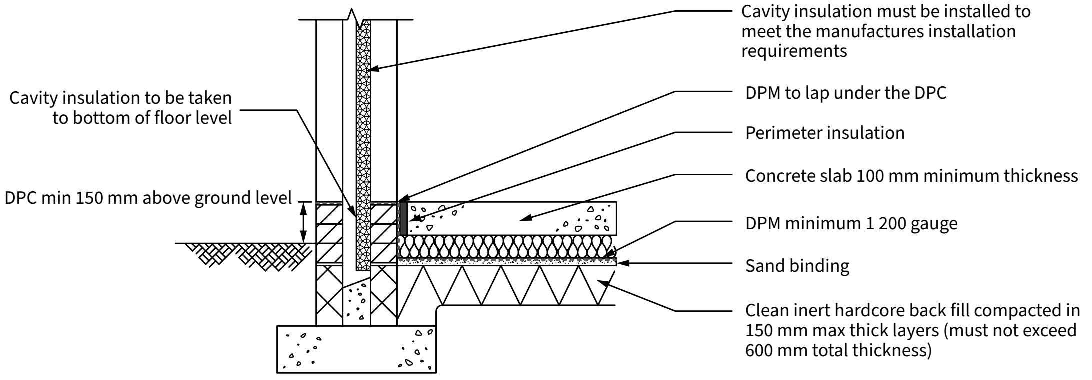
- describe the following damp-proofing materials and their application methods:
  – plastic DPC and DPM
  – bitumen sheeting
  – torch-on systems;
- draw neatly labelled vertical/horizontal section indicating the position of the DPC below window opening and cavity wall;
- draw to scale a neatly labelled vertical section through the eaves of a 30° pitch roof truss showing thermal insulation and ventilation;
- produce a neatly labelled drawing showing a method of damp proofing on the following structures:
  – basements walls; and
  – concrete tank (septic tanks, swimming pools).

In construction, damp proofing or a damp-proof is a type of moisture control applied to building walls and floors to prevent moisture from passing into the interior spaces. Dampness problems are among the most frequent problems encountered in residences. It causes unpleasant odours and can result in the formation of mould and fungus growth, which is harmful to humans. Typically, the damp proofing coating cured thickness is less than 10 mm thick. It is a basic, acceptable form of treatment in many situations. Damp proofing is not intended to keep all water and moisture out, but rather its goal is to retard moisture infiltration by blocking the capillaries of concrete or masonry work, which slows water penetration.

Exercise 2.1 SB page 28

1. A damp proof course (DPC) is the first layer of brick laid over a damp-proof membrane as a moisture barrier applied to foundations to prevent moisture from rising into brickwork.

2.



Drawing requirements:

- The inner leaf damp proof course must link with the upstand to the damp proof membrane, by a minimum of 50 mm and be sealed to it. This is to ensure a continuous barrier against damp, this includes where low level sills are present, i.e. doorways.
- Lay the DPC on a full even bed of fresh mortar in one continuous length, for the full width of the leaf.
- Provide at least a 100 mm overlap at any joint or corners.
- The DPC must not obstruct the cavity.
- Ensure the external edge of the DPC is visible and not bridged by mortar when completing pointing of the mortar joint.
- External render must not bridge the DPC.
- Ensure the lean mix cavity fill material is at least 225 mm below the lowest DPC.
- Ensure the DPC is a minimum 150mm above external ground level.

3. A whirlybird is a robust designed galvanised extractor that performs like a turbine. Its installed in the roof and is well insulated from water penetration. Very little wind and even a slight breeze will cause the turbine fins to spin and cause suction to occur from inside the roof.

Whirlybird details:

- Constructed of lightweight, rust-resistant aluminium or sturdy galvanised steel
- Uses sealed Teflon bearings for maintenance-free operation; these are superior to the bush-type bearings used in many other ventilators
- Has aerofoil vanes with rolled edges to prevent rain and dust from penetrating
- Roof ventilation is an effective and efficient way to help regulate the temperature of your property, but only when done right.

eLinks

Students can visit these links to learn more about laying damp proof courses:

- *futman.pub/DPC1*
- *futman.pub/DPC2*
- *futman.pub/DPC3*

MODULE

3 *Bonds in brickwork*

By the end of this module, students should be able to:

- draw and identify the following bonds in brickwork:
  - English bond
  - stretcher bond
  - Flemish bond;
- alternative plan courses and isometric view in right angle corner, T-junction and cross-junction one and one and half thick brick wall; and
- draw to scale the following in acute and obtuse angled brickwork:
  - English bond
  - stretcher bond
  - Flemish bond.

The art of bricklaying is many years old. Many brick buildings older than 2 000 years are still standing and are still in daily use. The bricklayer is an artisan and highly skilled. The art is not only in the ability to lay the bricks. The art is in the ability to 'see and feel' the mortar and to control the consistency of the mortar, the method of placing the bricks and the ability to use the correct configuration at the right place and the right time.

Using the correct mortar mix is essential when building. If the mortar is too strong for the brick, the moisture in the wall is retained in the brick rather than the joint, which means the brick is overworked during evaporation and freezing of the moisture. This will eventually result in the spalling of the face of the brick. Once spalling occurs, the erosion of the face is increased. Therefore, the mortar must never be stronger than the brick with which it is used.

Exercise 3.1 SB page 40

1. (Any two)
   1.1 Composed entirely of stretcher bricks, bricks are laid in courses; courses are offset by a half brick.
   1.2 Alternating courses of headers and stretchers; headers are laid centred over stretchers from the course below with each alternate row vertically

aligned; a queen closer is used at the start and end of the wall (after first row).

1.3 Alternating headers and stretchers are used; they are laid out in a single course.

Exercise 3.2 SB page 41

1. Sand and gravel deposits found on beaches or in rivers and streams, are mostly quartz (silicon dioxide, SiO2) grains. Weathering of rocks such as granite forms these quartz grains. In the process of weathering, the softer, weaker minerals in granite (such as feldspar) are weathered away. Aggregate refers to the different sizes of stone that are used in the building, construction and road-making industries while sand is the collective name given to finer grain size components. Ninety percent of sand will pass through a square sieve with an aperture size of 4,75 mm, whilst such a sieve will retain at least ninety percent of the coarse stone.

Area	Province	Sand type	Use
Klipheuvel/ Malmesbury	Western Cape	Quartzsitic course sand	General concrete works
Philippi	Western Cape	Fine silica sand	Plaster works
Rivers and streams with sandy embankments	All over SA	Fine to course quarzitic sand	Plaster and general works
Mine dumps	Gauteng/Free State	Fine tailings, silty in nature	Glass manufacture

In South Africa, heavy mineral sands deposits are found in the extensive beach placer deposits located along the eastern, southern and north-eastern coasts. Smaller deposits are found along the west coast, in the north of Cape Town.

2. In South Africa, various rock types are available for aggregates and concrete aggregate is usually found in abundance around most of the major centres of development. The three main groups of coarse aggregate are:
   - Igneous rocks – Andesite, basalt, dolerite, felsite, gabbro, granite, granodiorite, norite, rhyolite and syenite.
   - Metamorphic rocks – Granite-gneiss, granulite, hornfels, quartzite and slate.
   - Sedimentary rocks – Quartzite, sandstone, greywacke, shale and tillite.
3. Lime should be used if the sand lacks fine material or is single sized, as such sands tend to produce mortar with poor workability unless lime is included in the mix. Lime also helps the fresh mortar to retain water when it is placed against dry cement bricks or blocks and helps to prevent cracking of the hardened mortar. For Class I mortar, a maximum of 10 kg of lime is permitted per 50 kg of cement. For Class II mortar, a maximum of 25 kg of lime is permitted per 50 kg of cement. Do not use lime with masonry cement.

eLinks

Students can visit this link to learn more about stretcher bonds:
futman.pub/StretcherBond

Students can visit this link to learn more about English bonds:
futman.pub/EnglishBond

Students can visit this link to learn more about Flemish bonds:
futman.pub/FlemishBond

MODULE

4 Arches

By the end of this module, students should be able to:

- draw to scale the position of centring in arches for masonry, steel and timber; and
- draw the following different types of arches:
  - rough and axed arches
  - segmental arches
  - half-circular arches (two- and three-ringed)
  - flat gate arches (brick-on-edge or soldier brick).

The arch is an old form of bridging the gap between two points. The history of arches extends back for many ages and, over time, many forms of arches have been developed. As mentioned, arches are used to cross between two points with a structural element that can carry the load that it is designed for. The simplest type of arch is probably the modern-day lintel used above doors and windows. The most complex arches are arch bridges like the Storms River Bridge in the Eastern Cape, or the Bloukrans Bridge in the Western Cape. Arches can also be used for building dam walls, such as the Katze Dam up in the mountains of Lesotho which has both a vertical and a horizontal arch.

In this module we will investigate how arches are used in buildings to bridge the openings between two sections of wall to create window and door openings. Different methods are available to make this possible, but the main focus will be rough- and axed arches, segmental arches, semi-circular arches and flat-gate arches.

Exercise 4.1 SB page 52

1.–4. Guidelines for drawings:

- Drawings are neat
- Drawings are to scale (1:20)
- Correct brick type and course structure is followed
- Correct specifications followed
- Centre point has been calculated

Additional activities

The practical activities below are additional enrichment exercises which students can complete in class time or in their free time. Encourage students to do more research on the internet or by observations in their community and surroundings, and discuss their findings in class.

Practical activity 1 **SB page 52**

Students must open a web browser and search for in 'arches in architecture'. From this web search they can access a lot of interesting information and examples of arches and their history. Alternatively, the lecturer or tutor can do a search in class with the students and then discuss amongst the class.

Practical activity 2 **SB page 52**

For each type of arch mentioned in Module 4, students must find an example nearby and take a photo. Allow them to break away into groups or pairs and compare photos and discuss the construction of the arch.

eLinks

Students can visit these links to learn more about arches:

- *futman.pub/ArchTypes*
- *futman.pub/ArchTerms*
- *futman.pub/HowArchesWork*

MODULE

5 *Steel doorframes and windows*

By the end of this module, students should be able to:

- describe by means of a neatly labelled drawing the process of setting up a steel door and window frame in horizontal and vertical cross section for both one brick and cavity wall;
- draw the vertical and horizontal cross section to show the top and bottom part of domestic and industrial type of steel casement window frames; and
- list different types of glasses and describe their characteristics.

Steel doors and the accompanying frames are sturdy construction elements meant for long lasting durability and permanent feature in any facility. It can be found at a building's external entrance as well as internally. Primarily the function of this choice of material (aluminium included) is high-level security, but as steel can be finished in a high glossy appearance, the feature is also decorative. This type of door can withstand constant opening and closing and will resist deformation in its rest position. It will survive a lot of foot traffic and activity too. The choice of this type of door is meant to make a statement about the type of building you enter and what to expect inside. Some of these doors are fire-rated, meaning that it has been tested to withstand extreme heat for a minimum period of time before succumbing to the heat; usually one-and-a-half hours. This will allow occupants to escape in the event of a fire hazard.

Exercise 5.1 SB page 82

1. (Any two) Schools/places of learning, shopping centres, public transport hubs or large-scale communal public spaces.
2. (Any two of each)
   Advantages: Strong and durable; can withstand lots of traffic/frequent use; long lifespan (longevity); often galvanised; affordable.
   Disadvantages: Not as attractive as aluminium; requires more maintenance compared to aluminium such as painting which can affect cost
3. (Any two): Wood, aluminium, polyvinyl chloride (PVC) or concrete.

4.1 Safety glass – has insulated layer; breaks into smaller fragments instead of jagged-edged pieces
4.2 Can cover large areas effectively and quickly.
4.3 Laminated glass – toughened glass; of a high quality standard; energy efficient because it has insulated layer; offers UV protection
4.4 Annealed glass – treated glass with extra durability
4.5 Double glazed – good for insulation; suitable for cold climates

Exercise 5.2 — SB page 82

1. Guidelines for drawing:
   - Drawing is neat
   - Drawing is to scale (1:20)
   - Waterproofing and energy-flow taken into consideration and indicated in drawing

Additional activity

The practical activity below is an additional enrichment exercise which students can complete in class time or in their free time. Encourage students to do more research on the internet or by observations in their community and surroundings, and discuss their findings in class.

Practical activity — SB page 81

1. Get students to use their cell phones and walk through their neighbourhood/school surrounds and photos of the following structures:
   - Church
   - Mosque
   - A Victorian-style house
   - A Cape Dutch style house
   - A modern house with a flat roof.

   Students must:

   1.1 Try to sketch the front face of each of these structures on paper.
   1.2 Write down the differences that they see concerning the windows and the doors.
   1.3 Think about the fact that, irrespective of the intended use of the structure, it still contains the basic elements of doors, windows, and roof and wall structures.
   1.4 Write down remarks about the differences concerning the styles reflected in their photos.
   1.5 Give specific detail regarding doors and windows.

2. Get students to visit a local hardware store and ask for a window and door catalogue. It can be any catalogue, either for wooden windows or steel windows, PVC or aluminium. Students must compare the measurements of the different windows and doors in the catalogue. They must then make an annotated drawing of any window and any door of their choice, using a scale of 1:10 and according to the dimensions given in the catalogue. They must draw a front view and a cross-section through the middle of the window and the door of their choice. The must calculate the window (glass pane) areas.

MODULE

6 *Roofs*

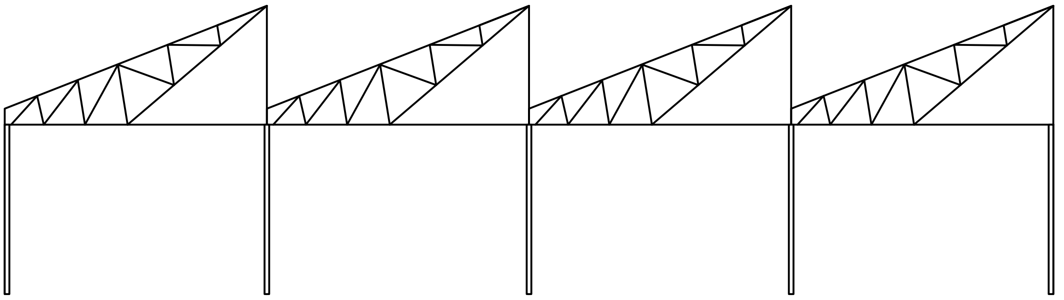
By the end of this module, students should be able to:

- list and draw the following types of roof trusses:
  - Howe
  - mono-pitched
  - Pratt pitched
  - Pratt bridge
  - camelback
  - saw-tooth
  - fan truss
  - lean-to roof (steel and timber parapet wall);
- draw to scale the following connection of timber and steel roof trusses construction:
  - bolted
  - nailed
  - gang nail;
- describe the following roof trusses of riveted and bolted construction:
  - fink
  - monitor
  - saw tooth; and
- draw the vertical section through pitch and valley of steel roof trusses.

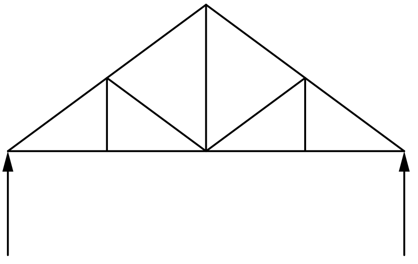
The roof of a structure has a number of important functions. The choice of roof and the structural system of a roof are related to the dimensions of the area to be covered and the type of weather that has to be dealt with. The roof makes up a large portion of the structure, and as a result the type of roof and the roof material used have a great influence on the aesthetics of the building. If the roof is incorrectly designed, it may result in its being damaged by wind or even lifted off the structure during a storm. To prevent a disaster of this nature, a number of safety precautions were designed and some detail will be given in this module.

Exercise 6.1 **SB page 119**

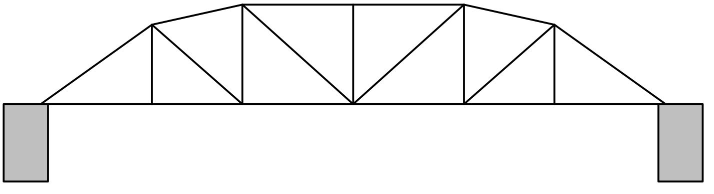
1.1 Saw-tooth truss:



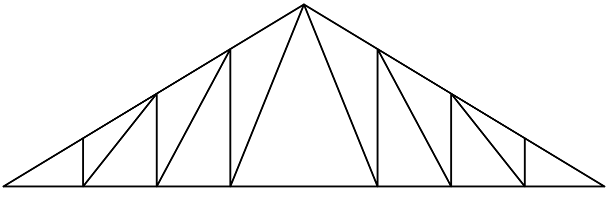
1.2 Howe truss:



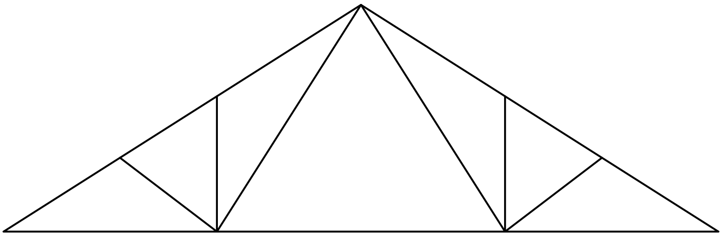
1.3 Camelback truss:



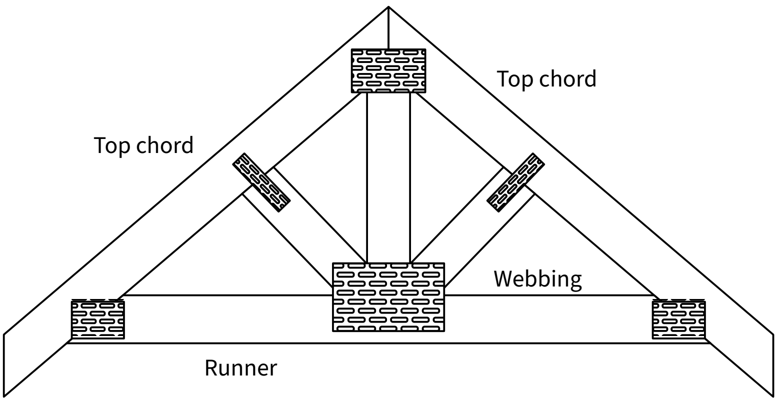
1.4 Pratt-pitched truss:



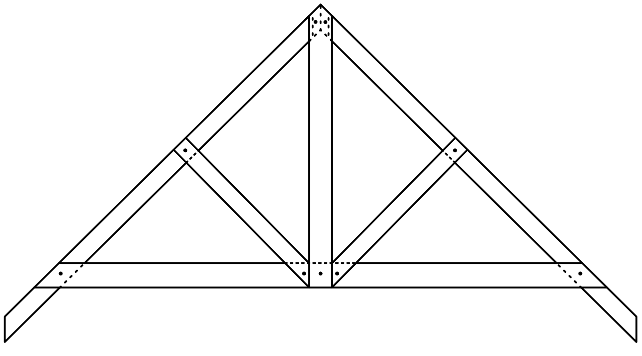
1.5 Fan truss:



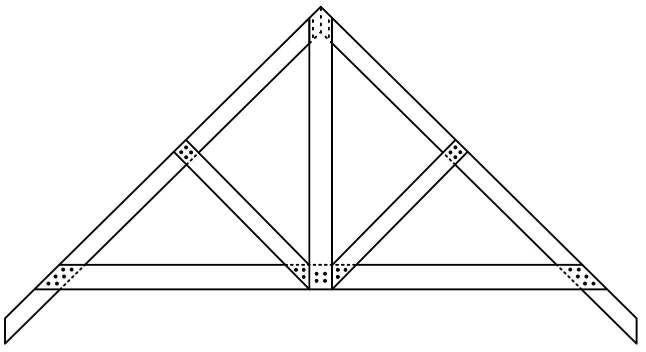
2.1 Gang-nailed truss:



2.2 Bolted truss:



2.3 Nailed truss:



3.1 C: Gang-nailed roof truss
3.2 A: Saw-tooth roof truss
3.3 E: Lean-to roof
3.4 D: Fink truss
3.5 B: Nailed truss

Exercise 6.2 SB page 120

Guidelines for exercise:

- Drawings are neat, to scale (1:20) and annotated
- Forces at an angle are changed to vertical and horizontal forces
- Reactions are calculated per figure
- Axial forces in members are calculated; statement of member in tension or compression
- Students have tested their results using equations

eLink

Students can visit this link to learn more about how trusses work: *futman.pub/HowTrussesWork*

MODULE

7 Roof coverings

By the end of this module, students should be able to:

- describe, by means of a neatly labelled drawing, the following different types of roof coverings and methods in fixing them on timber and steel roof trusses:
  - concrete/clay tiles
  - corrugated IBR roof sheeting
  - long span aluminium roofing sheet
  - step tiles; and
- discuss the application for water proofing and torch-on systems.

The roof and, therefore, the choice of roof covering is vital to protecting a structure. This module will familiarise you with the different types of roofing materials available for fixing to timber and steel roof trusses, as well as the types of sealants required to protect the roof and any underlying structures.

Exercise 7.1 SB page 140

1.
   - Hip roof (rectangular building): (C + L) × A÷2
   - Hip roof (square building): A × L ÷2 (all sides equal)
   - Gable roof: Area =2 × A × L
   - Lean-to roof: A × L
   - Mansard roof: (A × L) × C ÷ 2

Exercise 7.2 SB page 141

1. Roof sealants help protect a roof and structures below; as well maintain or repair the roof.
2. Solvent-based roof sealants: resilient and better for withstanding weather and the elements; more expensive and requires more effort (difficult) to apply. Water-based roof sealants: More affordable, but less resilient. Less odours with

application, but may require more maintenance because it's less resilient when facing the elements.
3. (Any two): Acrylic, polyurethane, silicone, rubber, sealant tapes
4. Surfaces must be very clean, primer must be applied before torch-on roll is applied and safety precautions must be followed.
5. Advantages (any two): Very durable (lasts 15–20 years), is a good long-term sealing solution; requires little maintenance once applied
Disadvantages (any two): Can be expensive in the beginning; upper surface can become brittle or crack; process is more complicated and expensive than alternative sealing methods

eLinks

Students can visit this link to learn more about concrete and clay tiles:
futman.pub/ConcreteClayTiles

Students can visit this link to learn more about corrugated IBR roof sheeting:
futman.pub/IBR_Roofing

Students can visit this link to learn more about long-span roof sheeting:
futman.pub/LongSpanRoof

Students can visit this link to learn more about step tile roofing:
futman.pub/StepTileRoof

Students can visit this link to learn more about waterproofing tiled roofs:
futman.pub/WaterproofingTile

Students can visit this link to learn more about waterproofing metal roofs:
futman.pub/WaterproofingMetal

Students can visit this link to learn more about waterproofing roofs:
futman.pub/WaterproofRoof

Students can visit these links to learn more about waterproofing and torch-on systems:

- *futman.pub/TorchOn1*
- *futman.pub/TorchOn2*
- *futman.pub/TorchOn3*

MODULE

8 *Guttering*

By the end of this module, students should be able to:

- draw and describe the following types of gutters with down pipes and galvanised sheeting, fibre-cement and plastic material:
  - half-round
  - square
  - box gutter.

A gutter can be defined as a narrow channel, or trough, forming a component of a roof system which collects and diverts a downpour from the roof edge. It is also known as an eaves trough, eaves channel guttering or simply as a gutter.

Gutters can be a big advantage in areas that receive high rainfall. It has the advantage that it can channel the downpour away from the entrance to your house, making it much more comfortable for the inhabitants to get in and out of the house while keeping the water from the roof away from the doors and windows. It is also of great help in drought-stricken areas to channel water to a reservoir where it can be reserved for use when needed. Gutters protect the walls of your structure and give the paint and brickwork (or wood if it is a wooden construction) a much longer life expectancy. It not only protects the walls of the house, but it will also prevent excessive water saturating the soil around and below the foundations of the structure, which will help to prevent differential settlement of the foundations. Although many other advantages can be mentioned, depending on where the structure is erected, it does add some finesse to the structure and gives it a beautiful rounded off appearance.

Exercise 8.1 **SB page 150**

1.1 and 1.2

Guidelines for drawings:

- Drawings are neat
- Drawings are to scale

- Drawings meet stipulated measurements and dimensions (same as Figure 8.6 in Student Book)
- Fixing details for gutter and downpipe supplied

2. Guideline for drawing(s):
   - Drawing is neat
   - Drawing is to scale (1:50 and 1:20 for detailed drawings)
   - Drawing is of a saw-tooth roof
   - Three portals used (of specified dimensions)
   - Thickness of gutter specified
   - Downpipes supplied (to specifications)
   - Box channel dimension are to specifications
   - Detailed profile of box provided
   - Fixing details and drip edge indicated (roofs)

MODULE

9 Ceilings

By the end of this module, students should be able to:

- list and draw the following different types of ceilings:
  - gypsum/rhino plaster board
  - fibre board
  - fibre cement
  - tongue and groove
  - acoustic ceiling materials
  - pressed steel suspended ceilings; and
- draw to scale ceiling construction detail for suspended ceilings (aluminium framing).

The ceiling of a room will make up the same square metres as the floor. Although the floor is usually more structural than the ceiling, ceilings are hanging from the roof and if not constructed correctly, may fall down onto people below and cause a great number of casualties and material damages. Not long ago a ceiling of a great shopping centre has fallen down causing great damage. The fixing of ceilings is an engineering problem and should be handled with extreme care.

Ceilings have a number of very important functions. Ceilings are important for the aesthetics of the inside of a structure. It is not only important for the finishing touches of the structure, but it also isolates the structure against external noises or noises from inside that may cause disturbances outside the structure, inflow and outflow of heat as well as a barrier against dust, insects and even rodents.

Over time the material used to manufacture ceilings has changed. The wooden ceilings like knotty pine, mahogany and other types of wood tongue and groove ceilings was a common type of ceiling for many years, but lately the cost of wood has risen dramatically to the extent that wooden ceilings became less affordable and designers make use of gypsum board, plastics, fibre boards and other lightweight materials like fibre glass, foam and metal. Many other local products are also available like reeds and in some areas people will use bamboo, simply because it is the only material available.

Ceilings are also a fire barrier, but can also be a fire hazard. For this reason, the SANS 10400, NHBRC as well as NBR have a section dedicated to the safety of ceiling, taking into account the fire hazard and the construction detail. The biggest practical problems concerning ceilings are the fire hazard and heat barrier. In this module we will only look at a few types of ceiling materials, the advantages and disadvantages of the materials and how to fix it to the roof or floor above.

Exercise 9.1 **SB page 164**

1. Guidelines for drawing:
   - Drawing is neat
   - Drawing/plan view is to scale (1:100)
   - Drawing meets stipulated measurements and dimensions
     - External walls and clay brick cavity walls are 280 mm
     - Fire wall is 230 mm
     - Internal walls (other) are 110 mm
     - Roof is clip-on metal sheet with 350-mm overhang (side walls)
     - Roof overhang for gables is 150 mm
   - Ceiling details provided
   - Sections included at A-A, B-B and C-C
   - Windows don't exceed 15% of floor area in each room

eLinks

Visit this link to learn more about tongue and groove ceilings:
futman.pub/TongueGroove

Visit this link to learn more about general specifications for suspended ceilings:
futman.pub/CeilingSpecs

MODULE

10 Structural steelwork

By the end of this module, students should be able to:

- draw the different types of:
  - rivets
  - welding symbols
  - hexagonal bolt and nut;
- differentiate by means of a neatly labelled drawing between steel beams and steel columns;
- draw a neatly labelled angle iron, gusset plate and holding down bolts;
- draw a neatly labelled steel column to beam connection beam to beam connection at right angles;
- draw a neatly labelled vertical side and top view of column beam connection;
- draw to scale a neatly labelled steel column and base plate connected to a concrete foundation; and
- draw a neatly labelled isometric view of a section showing the base plate, gusset plates, angle iron, steel stanchions and beam.

Tall buildings were made possible because of structural steel. Previously building structures were limited in height because of the instability of the structure when exceeding that limitation. With the help of structural steel, this problem has been eliminated. Currently the tallest building in the world is the Burj Khalifa, a skyscraper in Dubai. It measures 828 m in height and is considered super tall. This building's incredible height is possible because of the availability and use of structural steel.

Structural steel consists of a number of profiles. The profiles commonly used are H beams, I beams, U channels, angles (L), tubes and combinations of these steel profiles. It is quite interesting to see how these steel constructions took over the construction world.

In the world of engineering and design, the engineer will always aim for all points in the structure to be in a state of equilibrium.

Exercise 10.1 SB page 178

1. Guidelines for drawings:
   - Drawings are neat
   - Drawings are to scale
   - Drawings meet stipulated measurements and dimensions
   - Front view, side view and top view of joints have been drawn
   - Positions of bolts are visible
   - Sizes and spacing of bolts is provided

Glossary

A

abutment – the section at the beginning or end of the system on which the arch rest

adverse – bad or unfavourable

aesthetics – related to beauty and art

Alucushion – a brand of thermal roof insulation made of polyethylene and Aluminium

annealed – a heating and cooling treatment process applied to materials, commonly metals, to improve its strength

arch ring – a course of material having the same curvature as the arch

axial forces – a force directed along a body's longitudinal axis

B

bitumen – a sticky and thick, black petroleum-based substance suitable for waterproofing

body corporate – the name given to a group of owners of propert(ies) within a sectional title property scheme

brandering – metal or wooden strips used to secure boards to a ceiling

C

centre of gravity – the point in a body at which all external forces can be taken to act

chain reaction – a sequence of reactions which is self-sustaining as the result of one step initiates another

cladding – a covering of one material or structure on or over another

combustible – the ability to catch fire and burn easily

crown – the top of the arch or the highest point of the extrados of the arch

D

dagha – a term that is used on South African building sites; refers to building mortar cement that is used for laying bricks and for plastering walls and floors

deformation – the process or result of changing or damaging the regular shape of an object

donga – a dry watercourse caused by erosion of land by waterflow and usually has steep sides finesse – to display or do something with impressive skill and ability

drip edge – metal flashing at the edges of roofs which keeps water away from getting underneath or into parts of your roof

durability – the quality of being able to last for a long time without losing strength or regular properties or breaking

E

eccentric – away from the centre

equator – the imaginary line which runs through the earth (or any other body) at equal distances from the North and South poles

extrados – the outer or external surface of the arch

equilibrium – a state of balance in a system that is produced and maintained by a variety of forces which may increase or decrease, but they always cancel each other out, producing a steady state

F

fenestration – that which relates to the arrangement of windows in a building or structure and the flow of energy therein

fineness modulus – the cumulative percentage retained on a specified series of sieves divided by 100

finesse – to display or do something with impressive skill and ability

fire-rated – material tested to withstand extreme heat for a minimum period of time before succumbing to the heat

G

galvanise – to coat another metal (commonly iron and steel) with a protective zinc layer to prevent rust and corrosion

gypsum – a white mineral used to produce cements and plasters

H

habitable – a space or room intended for living

heat reservoir – a body that is able to supply or absorb heat energy without changing temperature; examples include bodies of water or air in the atmosphere

I

impenetrable – impossible to enter or pass through

impost – a projecting block which rests atop a column or embedded wall as the base for a springing stone or the lowest arch block

infrared – a type of radiation which is part of the electromagnetic spectrum; examples of infrared light include remote control devices and electric heaters

ingress – when water from the outside finds its way into and penetrates a building

intrados or soffit – the underside or inner surface of the arch

K

keystone – the highest central stone or brick of the arch

L

lintel – a reinforced, pre-tensioned concrete bar that is needed to support the soffits of door- and window openings during the building process

longevity – the lifespan of an object or person or how long something lasts

lug – a piece of metal or plastic which protrudes or sticks out from the main unit or structure in order for it to be fixed in position

lustrous – glossy or silky; to do with a material's properties, texture or ability to reflect light

M

magnitude – the amount or size of something

N

Nutec – a brand of ceiling and drywall boards

P

pestilence – a disease or infestation

pier – the section in between the abutments on which the arch rest

plasticity – the ability to be moulded within a certain range of moisture contents

plumb – perfectly horizontal

pre-tensioned – the reinforcement of concrete by putting tension into wires or cables before they're placed in the concrete to introduce internal stresses that will counteract the stresses of loads the concrete structure will need to withstand

Q

queen closer – a brick that is cut lengthwise into two halves and used in the corners in brick walls

R

radiation – heat transfer due to the the emission of energy in the form of electromagnetic waves

retarded – delayed or held back

RhinoGlide® – a brand of quick-setting drywall joint filler which can be used to skim or plaster gypsum boards, like crete stone

S

shrinkage coefficient – the degree or percentage by which a material or substance will shrink

skew back – the surface on the abutments or the piers on which the arch rest

skim – a method of plastering walls

solids – the dense inert matter that makes up soil, disregarding plant matter and other organic material (such as vegetative plants or decayed roots and branches)

spalling – breaking off into fragments

span – the clear distance between the beginning and the end point of the arch

springing line – the horizontal line between the abutment and the pier or next abutment

springing stone – the first block or wedge resting onto the springing point of the abutment or pier

T

tempo – the speed or rate of motion

tensile – related to tension or stretching or pulling forces

topography – the physical features of an area of land, such as rivers and lakes, hills and mountains or roads

V

voids – the spaces in-between the solids that are filled with either gases (air) or water

voussoirs – also known as arch blocks, these are the wedge stones or bricks used to build the arch