CPCCBC5018A

Apply structural principles to the construction of medium rise buildings

Learner Resource

Contents

Introduction

Adult learners are internally motivated and self-directed.

Adult learners resist learning when they feel others are imposing information, ideas or actions on them (Fidishun, 2000).

This learning resource gives you an overview of all the areas of study. This learning resource also facilitates your learning by offering a series of additional resources for you to access. As you bring a wealth of knowledge and experience to your study it is up to you what areas you choose to explore further using the resource lists provided.

This learning resource covers CPCCBC5018A Apply structural principles to the construction of medium rise buildings.

Adult learners are practical and goal orientated.

"They experience a need to learn it in order to cope more satisfyingly with real-life tasks or problems" (Knowles,1980 p 44, as cited in Fidishun, 2000).

This learning resource includes opportunities for applying and embedding the knowledge gained through learning activities. The learning activities are included at the end of each chapter and can be completed either individually or in groups. Activities will focus on the key learning within the chapter and are designed to help consolidate and expand your knowledge of the subject.

Icons

The following icons are used throughout this resource to guide your learning:

This icon indicates there is a web link. They are highlighted to encourage further research. There are also multiple hyperlinks that can be found within the content.

This icon indicates a worked example is provided to support the application of learning.

This icon indicates that there is an activity to be completed.

This learner guide covers how to apply structural principles to the erection or demolition of medium rise buildings using conventional methods and in accordance with Australian Standards. Specifically considering the coordination and management of the construction process.

Chapter 1: Structural principles

The main structural principles that apply to the erection and demolition of structures are Loads; Forces; Properties; Structural members and Demolition. These are explored within this chapter using information amended from Build right.

1.1 Main structural principles

Loads

The structure of a building is responsible to maintain the shape of the building when subjected to forces and loads. The building must be designed to withstand the most severe combination of forces and loads that is likely to happen during its lifetime. Australian Standard AS/NZS 1170 is the loading code used during building design.

Loads can be separated into primary and secondary where primary loads **will** occur and secondary loads **may** occur

Primary Loads	Secondary Loads
Dead load – the weight of the building itself	**Snow load** – applicable in certain alpine regions at certain times of the year
Live load – unfixed items including furniture, people etc.	**Settlement load** – some parts of a building may settle at different rates causing stress.
Wind load – wind blowing against the building	**Thermal load** – buildings expand and contract with temperature change
	Shrinkage load – over time concrete will shrink
	Dynamic load – including impact from collisions
	Seismic load – caused by earthquakes

Forces

A force on a structure is the weight or pressure exerted on a structure and can be further defined to the type of force.

This may be in the form of gravity i.e. the weight of a building and its contents, the wind or weather e.g. snow or other phenomenon such as earthquakes or tremors. The balance for stability of the building is relied upon by a structure resisting these forces.

The forces include:

Compression = the force that causes the structural member to shorten and can result in failure due to crushing.

Tension = the force that causes elongation or lengthening of the member (tensile force).

Torsion = the force that results in a twisting action on a member.

Shear = the combination of two forces acting in opposition to each other resulting in a sliding or tearing tendency.

Elasticity = Stress/Strain

The forces that are notable are shear, tension, torsion and compression. Wind can place a serious load on a building from any direction with the resulting force that is pushing the building resisted by shear walls.

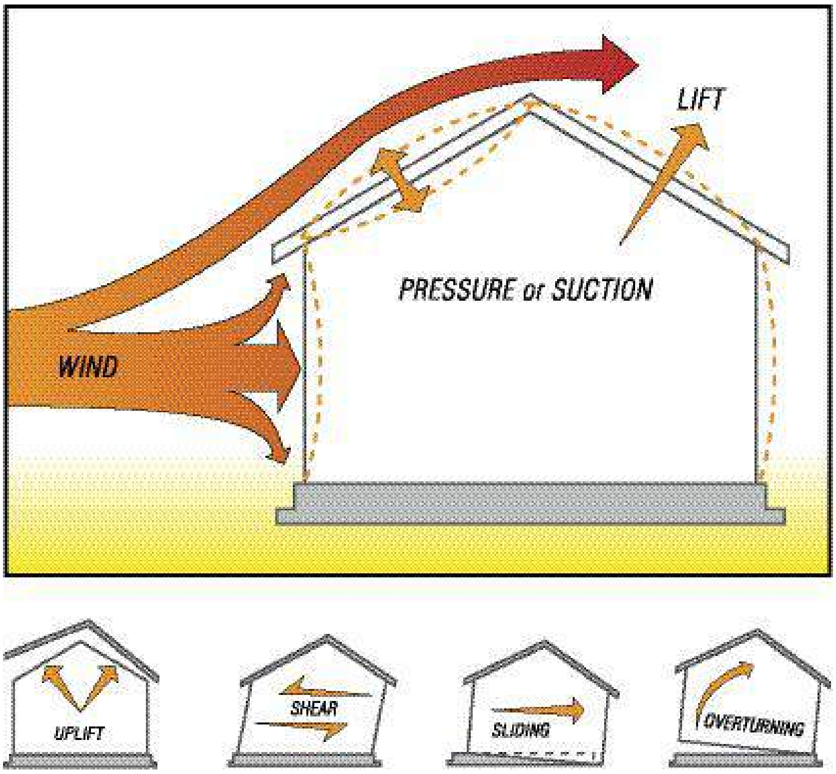

Image source

1.2 Material's performance characteristics

The type of material used and the shape of a structural member have a significant impact upon its structural effectiveness.

When considering the behaviour of common building materials under load, the suitability of material for any specific purpose is judged by its **mechanical properties**, some of which are listed below:

- **Strength** – resistance to fracture
- **Toughness** – resistance to fracture after twisting and bending
- **Elasticity** – if the material deforms with loading but then returns to its original shape when the loading is removed.
- **Plasticity** – the reverse of elasticity. The material does not return to its original state when the loading is removed.
- **Ductility** – materials that can be drawn out in the direction of its length [stretched] before it fails.
- **Malleability** – material that can be hammered (or otherwise) into different shapes.
- **Brittleness** – reverse of ductility, material breaks or snaps without any warning of approaching failure.
- **Hardness** – resistance to indentation, abrasion and scratching.

Activity

Match the following properties with the correct description.

Properties:

a. Strength
b. Hardness
c. Malleability
d. Elasticity
e. Plasticity
f. Brittleness
g. Toughness
h. Durability

Descriptions:

1. Resistance to the load that will just cause fracture
2. Ability to be drawn out in the direction of its length
3. Material deforms when loading and returns to original shape when loads are removed

4. Material retains its deformed shape when load is removed
5. Material can be worked into different shapes
6. Material will break without elongation
7. Resistance to fracture by repeated bending or twisting
8. Degree of resistance to indentation or abrasion

Section properties involve the mathematical properties of structural shapes. They are of great use in structural analysis and design. Note that these properties have nothing to do with the strength of the material, but are based solely on the **shape** of the section. It explains why some shapes are more efficient at supporting loads than others. These properties are referred to below:

Property	Characteristics
Centre of Area (or centroid)	The **centroid** of a section is important in structural design and is like the **centre of gravity** of the shape. Most structural shapes have their centroid tabulated by the manufacturer. Many other simple shapes are symmetrical about the x-x and y-y axes and the centroid can easily be seen.
Second moment of area (or moment of inertia)	The second moment of area is a measure of the 'efficiency' of a shape to resist bending caused by loading. A beam tends to change its shape when loaded. The second moment of area is a **measure of a shape's resistance to change**.
Section modulus	It is a direct measure of the **strength** of the beam. A beam that has a larger section modulus than another will be stronger and capable of supporting greater loads.
Radius of gyration	Can be considered to be an indication of the **stiffness** of a section based on the shape of the cross-section when used as a compression member (for example a column). The radius of gyration is used to compare how various structural shapes will behave under compression along an axis. It is used to predict buckling in a compression member or beam.

There are several structural members each with their own properties that need to be considered when planning the construction of a medium rise building. Some of the main ones are listed here with the considerations that need to be identified and analysed before applying them to the construction planning process.

Structural member	Considerations

Beams	**Bending:** When a beam bends under load, the horizontal fibres will change in length. The top fibres will become shorter and the bottom fibres will become longer. The bending moment is the amount of bending that occurs in a beam. It is a calculation used to identify where the greatest amount of bending takes place. For most beams with a uniformly distributed load (UDL), this bending occurs mid-span. The type of load and its location has a significant impact on the overall bending of a beam. **Shear:** Vertical shear forces are generated in a beam by the applied loads and by the support reaction. The reactions push up while the load pushes down. In most cases the maximum value of shear occurs close to the supports. Service holes through beams may be necessary for cabling or plumbing. The positioning of these holes must be carefully considered as they could seriously affect the structural integrity of the beam. Areas of high stress should be avoided close to the supports where the shear force is at a maximum and also at mid-span where the bending stress is at a maximum. **Deflection:** The factors that need to be considered when calculating deflections are span, load, beam shape, material properties, end fixity and camber. The longer the span and increased loads result in a greater deflection. The shape (refer to the second moment of area above) impacts on deflection particularly depending on which edge the beam is resting. The relative strength and elasticity of the material also impacts deflection – for example mild steel is stronger than aluminium and will bend less under load. The way the beam is attached to the supports affects the amount of deflection; if it is rigidly held in place it will deflect less than one that is free to slide or rotate. Some manufacturers deliberately incorporate camber to compensate for the amount the beam is expected to deflect.
Columns	Columns are vertical support members subjected to compressive loads. They are also referred to as pillars, posts, stanchions and struts. The most efficient shape for a column is the circular hollow section (CHS).The second most efficient shape is the square hollow section (SHS). When the load is central to the centre of gravity axis this is referred to as an 'axially loaded column' or a 'concentric column'. When the load is off centre the column is referred to as 'eccentric'. This results in bending and compression stress being applied to the column. Buckling is a major consideration in designing columns –deformation (deflection or bending) at right angles to the direction of the applied load. The longer and/or more slender the column the more likely it is to buckle under compression forces. Slenderness ratio involves the height of the column; the size and shape of its cross section and the manner in which the two ends of the columns are supported or fixed. The maximum load a column can be allowed to support is dependent on its slenderness ratio and the material from which the column is made.

Wind bracing	Most buildings are designed strongly enough to support the vertical loads created by dead loads and live loads. However, they also need to be able to resist lateral loads from wind loads. Numerous techniques can be used to overcome this problem. **Diagonal bracing**: Diagonal components of bracing interconnect and stiffen columns and beams. The main types of bracing are: knee bracing; K-brace and cross bracing. When using cable for cross bracing, it is necessary to use two cables to stabilise the structure against lateral forces from both directions. One cable will work effectively in tension while the other would just buckle. If rigid bracing is used, a single brace will stabilise the structure. Any of these methods may be used singly or in combination to stabilise a structure. **Rigid joints between beams and columns**: A rigid joint method can be developed for very tall buildings to form a rigid external 'tube'. Instead of having cross bracing, the external structure is stiffened by very deep beams and wide columns. **Shear wall:** In the shear wall method, the supporting structure consists of walls which resist lateral loads. The shear walls are preferred over columns and beams
Roof trusses	Roof trusses are load bearing frames constructed of connected triangular shapes. They take advantage of a triangle's natural attributes, its strength and its stability. The members forming the triangles have pinned joints. These types of joints have the property that all the bending moments within the truss are eliminated. The members making up the truss are either in compression or tension, unlike beams which experience tension and compression at the same time. This is the reason that trusses are more efficient at supporting loads over wider spans than simple beams. Trusses consist of: • Apex - the highest point of the truss • Top cord - the piece of timber which runs to the top of the truss • Web - is a short timber which runs from the bottom chord to the top chord • Panel point - is where the web meets the top chord. It is the strongest point for lifting the truss • Heel - is where the bottom chord meets the top chord • Bottom chord - is the large horizontal member (timber or steel) at the bottom of the truss • Truss span - is the length of the bottom beam that spans the wall frames

	• Pitch - is the angle the top chord makes with the bottom chord • Eave overhang - is the horizontal distance the top chord extends from the wall.
Concrete slabs	Concrete slabs are similar to beams in the way they span horizontally between supports and may be simply supported, continuously supported or cantilevered. Unlike beams, slabs are relatively thin structural members which are normally used as floors. Slabs are constructed of reinforced concrete poured into formwork on-site or into trenches excavated into the ground. Concrete slabs are usually 150 to 300 mm deep. Slabs transmit the applied floor or roof loads to their supports. Ground slabs are those slabs that are poured directly into excavated trenches in the ground. They rely entirely on the existing ground for support. The ground (more correctly known in the industry as the foundation**)** must be strong enough to support the concrete slab. It is important to understand the effects of foundation movement on the slab. The slab must be designed and constructed to make sure that it is strong and stiff enough to oppose stresses. It is necessary to have a method of regulating the moisture content of the foundation soils so that the overall stress is minimised. Some of the ways in which this can be done are: • Appropriate drainage • By sloping the ground away from the building • Paving • Careful tree planting • Minimal watering of garden beds The amount of water and its distribution throughout the soil have a direct influence on soil movement. Seasonal changes in the weather may cause overall expansion or shrinkage of the soil. Localised soil movement at a corner or along one side of a building may be caused by many factors. When there is foundation movement because of reactive soils, the slab will bend.

Activity

Consider your current or a previous work site and, taking one of the structural members above, determine which properties were considered when deciding which material to use. What alternatives would have been available?

1.3 Demolition

Any demolition work must be carried out in accordance with legislation, planning requirements and safe work practices.

The Australian Building Codes Board (ABCB) oversees a national framework for building legislation, including the Building Act 1993 which details the procedure for demolition. An application for a permit to demolish or remove a building must include the following information:

- A description of the building
- A site plan showing the building in relation to boundaries, other buildings on the site and adjacent sites, streets, footpaths and crossings
- Structural computations demonstrating the structural adequacy of the building if it is only to be partially demolished
- Details of protection, hoardings, barricades and protective awnings
- A written description of the demolition procedure
- Evidence that the demolisher has the necessary knowledge, experience, equipment and facilities to properly conduct the demolition operations

In planning a demolition the following items need to be considered, depending on the nature of the work to be completed:

- Details of the demolisher and appropriate licence
- Method of demolition - either manual or mechanised
- Extent of temporary fencing and hoardings
- Protection of adjoining properties, existing buildings and infrastructure
- Disconnection notices for the service authorities, electricity, water, gas and telecommunications
- The order in which the structural systems will be removed (the sequence of operations)
- Details of any hazardous materials and notification of these to relevant authorities
- On-site amenities such as toilet, first aid, fire services
- Control measures for dust, noise and vibration
- Vermin control for rats and mice
- Traffic control on and off the site
- Truck wash bays
- Environmental considerations such as recycling

All demolition operations are to be in accordance with Australian standards and codes of practices. These are:

- AS 2601: The demolition of structures
- code of practice - Demolition 1991
- code of practice for the safe removal of asbestos, second edition 2005

National legislation surrounding safe work practices includes:

The Act

- Work Health and Safety Act 2011
- Work Health and Safety (Transitional and Consequential Provisions) Act 2011

The Regulations

- Work Health and Safety Regulations 2011

Further information can be found on the Safe Work Australia website. http://www.safeworkaustralia.gov.au/sites/SWA

Activity

Research and note down the state legislation and local governments that cover your area of work. What changes have been made to them within the last 3 years? What prompted the change?

Chapter 2: Site and job assessment

Prior to any work on-site there are specific items that need to be assessed and need to be included in the planning and application process. Is the soil of the right type to allow the construction to be stable? What style and size of retaining walls will be required, if any? What temporary structures will be needed throughout the construction process and how will they be made safe and compliant with regulations?

2.1 Soil stability

Soils are measured for their allowable bearing pressure. The allowable bearing pressure is the soil's ability to carry the load of a building and its contents without excessive settlement. Few building failures are caused by insufficient soil bearing capacity even when footings are unevenly loaded. This is because the loads imposed on foundations soils by houses, even those with solid masonry walls, are small compared to the bearing potential of natural firm soil. Critically low soil bearing pressure is only found in alluvial soil (mud or silt), wet sand or poorly compacted fill. There are also rare cases of soils that have adequate bearing potential in dry weather, but which change to low bearing potential in wet weather.

Unsaturated soil consists of individual soil particles held together by water and air pockets between the particles. The air and water combination pulls the soil particles together by surface tension. This results in a force called 'soil suction'. Wetting the soil reduces this soil suction force. This causes the soil particles to separate and the soil volume to increase. Drying the soil revives the suction force which pulls particles together causing the soil volume to decrease.

Volume changes result in possible serious damage to the footings or to the building they support. The footing system must be selected to suit the anticipated volume change of the foundation soil. Footings laid on clay soil are liable to subside or lift as the clay's volume decreases with drying and increases with wetting. The pressure of a building on that soil can limit this volume change. However, small buildings of three or less storeys do not exert the necessary pressure to prevent expansion of the foundation material. Therefore, small buildings, like houses, are the most often damaged by soil volume changes.

Soil Type	Characteristics
Rock	Solid rock is the most stable but causes difficulties with excavation.
Sand	Considered the best as it is capable of supporting up to four storey buildings and easy to excavate.
Clay	Most common but subject to volume change according to the seasons.
Problem	Include soft clays, wet sand and previous dump sites (which are unpredictable). These sites often require engineers to design appropriate foundations.

Soils are classified according to their stability. Soil samples are taken on the site to determine soil class. A geotechnical engineer's report will clearly state the likely soil conditions and recommend a suitable footing system. The Soil Stability Test provides information about the integrity of soil aggregates, degree of soil structural development, and erosion resistance. It also reflects soil biotic integrity, because the organic matter that binds soil particles together must constantly be renewed by plant roots and soil organisms. This test measures the soil's stability when exposed to rapid wetting. Soil aggregate stability is affected by texture (soil particle size) and biotic and mineral constituents that may be present, so it is important to limit comparisons to similar soils that have similar amounts of sand, silt and clay.

2.2 Retaining walls

A retaining wall is a wall built to hold back soil. It is required to support soil where a sloping site requires excavation and either there is insufficient room or it is impractical to batter the soil. Retaining walls over one metre high must be designed by a qualified structural engineer. The engineer designs the retaining wall so that it is able to resist soil pressures and is a stable structure.

There are 3 main types of retaining wall:

Inclined: leans into the excavated soil and is constructed at an angle between 45 and 80 degrees. It may be constructed from brickwork or pre-cast interlocking concrete units.

Gravity: relies on its own weight to resist overturning forces from the soil. It is typically constructed of heavy materials such as stone, brickwork or concrete.

Cantilever: is the most complex and must be carefully designed by an engineer. It relies upon the correct placement of steel reinforcement and varying thickness of concrete.

All types of retaining walls require a system to minimise the build-up of water pressure exerted upon the retaining wall by the water contained within the soil. This pressure is called 'hydrostatic pressure'. Minimising hydrostatic pressure can be achieved by carefully controlling the backfill that is placed behind the retaining wall. It must be a coarse, well-draining material.

Activity

Draw a sketch of each of the main types of retaining wall highlighting their differences.

2.3 Temporary structural elements

Formwork and falsework are temporary structures that are built to support parts or the whole of a permanent structure until it is self-supporting. Individual components of formwork and falsework, such as scaffolding, are plant.

Formwork means the surface, support and framing used to define the shape of concrete until it is self-supporting.

- Formwork includes the forms on or within which the concrete is poured, the supports which carry the forms and the concrete, the bracing which may be added to ensure stability, as well as the foundations and footings.
- When complete, the formwork is sometimes referred to as the formwork assembly.
- The formwork supports, bracing, foundations and footings are sometimes known as falsework.

Falsework means any temporary structure that is used to support a permanent structure, material, plant, equipment and personnel until the construction of the permanent structure has advanced to the stage that it is self-supporting.

- A temporary structural support system referred to as falsework includes the foundations, footings and all structural members supporting the permanent structural elements.
- Falsework is commonly used to support spanning or arched structures, such as bridges, while they are being constructed.
- The temporary support structures for formwork used to mould concrete to form a desired shape and the scaffolding that might also give workers access to the structure being constructed is sometimes referred to as falsework.

Formwork and falsework activity should be carefully planned before work starts so it can be carried out safely. Planning involves identifying the hazards, assessing the risks and determining appropriate control measures in consultation with all relevant persons involved in the work, including the principal contractor, formwork/falsework contractor, designers and mobile plant operators.

Consultation should include discussions on the:

- Nature and/or condition of the ground and/or working environment
- Weather conditions
- Nature of the work and other activities that may affect health and safety
- Interaction with other trades
- Site access
- Management of mobile plant and surrounding vehicular traffic
- Type of equipment used for formwork and falsework
- Public safety
- Provision of adequate amenities
- Procedures to deal with emergencies

Activity

Research scaffolding and answer the following questions:

Can anyone erect scaffolding?

Are there height restrictions on its use?

What safety measures need to be incorporated?

What part of the building code relates to scaffolding?

Chapter 3: Footing systems

This chapter looks at setting-out a building (setting out involves working out the location and extent of the building on site) and footings: Footings are the construction that transfers the load from the building to the foundations; Both important elements at the start of the construction process.

3.1 Building set-out

Each site is different, so start by establishing the particular conditions. Use information from state authorities' records combined with an on-site inspection.

Understand the site

Where construction is being carried out, it's usually necessary to:

- Accurately locate boundary lines
- Determine ground conditions
- Verify the location of underground and overhead services
- Obtain site levels – it may appear flat or level, but appearances can be deceptive
- Accurately verify the position of existing structures, such as the house, garage, outbuildings and significant trees
- Use a contractor with the appropriate carpentry or foundations licence.

On site, the builder will:

- Erect profiles approximately 1.2 m (but not less than 0.9 m) outside the perimeter of the building (see figure 3)
- Brace all profiles to keep them from moving
- Level horizontal profiles, from the highest point of the site first using a builder's or laser level – the tops of the profiles are often set 20 mm above the top of the floor joist level (use a packer under the string line when levelling joists)
- Determine the longest building face, locating the structure corners on the longest line
- Set out lines at right angles to the longest line and locate all other lines
- Mark set-out lines on levelled profiles – check the set-out to ensure the building layout is square, to correct dimensions and at the correct level
- Mark the building lines permanently on the horizontal profile members
- Ensure lines setting floor levels will meet the minimum ground clearances

The finished floor level should be checked on site to ensure finished ground clearance can be achieved, gullies can be set at the correct heights and there will be sufficient fall for drain. Usually it is the builder's responsibility to place the building correctly on site, but it is important to check where responsibilities lie for individual contracts.

Generally, the owner must indicate the boundaries and ensure boundary pegs are properly positioned.

Most builders can undertake building set-outs that are clearly instructed and on easy contour sites. However, for more difficult sites or tight urban infill building where set-out is critical down to the finest measurement, employ a land surveyor to position the foundations. While on site, they can also set out other difficult-to-place features such as pile positions (tricky on steep sites), boundary walls and so on.

Activity

Go online and locate 3 contractors that offer set-out surveys as a distinct service. What would cause you to use their services?

3.2 Building code compliance - footings

There are five types of footings in regular use you should refer to AS 2870 specifies performance criteria and specific designs for footing systems for foundation conditions commonly found in Australia. It also provides guidance on the design of footing systems, abiding by engineering principles. The standard sets out the criteria for the classification of a site, and the design and construction of a footing system for a single dwelling, house, townhouse or similar structure.

Type of Footing	Characteristics
Stump pad	The stump is the simplest and most familiar footing used for the vertical support and the transfer of building loads to the foundation. Stumps are used to support timber-framed houses for which they are currently the most cost effective. The three types of materials most commonly used for stumps are timber, concrete and steel. Stumps must have a concrete or timber footing placed underneath the base of the stump. This is to spread the load transferred to the stump from the building.
Strip	Substantial footing supports of reinforced concrete are needed for buildings that have external or internal masonry walls - solid brick, cavity wall, brick veneer, or concrete blocks and earthwall or stonewall. Reinforced concrete footings are commonly called 'strip footings' and are usually continuous around the entire perimeter of the building. Strip footings are designed to engineer's specifications and installed to

	manufacturer's specifications.
Stepped	On flat building sites (or sites without slopes) a footing excavation can be made at a constant depth from the natural ground surface. Flat sites allow easy access and generally are simpler to excavate than sloping sites. The base of the excavation is always horizontal and parallel to the natural ground surface. Obtaining horizontal excavation bases on sloping sites presents problems. If the slope of the ground exceeds 1:10 fall (a 1 in 10 or 10% fall) it is unacceptable to excavate parallel to the natural ground surface. Sloping footings can slide down an allotment due to gravity. For this reason the base of strip footings should be excavated horizontally, where possible.
Concrete	Slab footings consist of concrete beams and floors across the entire floor plan. Slabs are also referred to as slab floors, slab on ground or raft slabs. The stiffened raft slab is the simplest and most common slab construction available although strip footings (see above) are also made of concrete.
Pier and beam	Pier and beam footings are only considered for low bearing (problem) soil sites and can either have concrete, steel or timber piers depending on the needs of the site, soil and structure.

3.3 Damp coursing and termite barriers

Damp Proof Coursing

Damp proofing is a protective measure in the form of a layer of impervious material applied to building foundation walls to prevent moisture from passing upwards or sideways through the walls into interior spaces. A damp-proof course (DPC) is a horizontal barrier in a wall designed to prevent moisture rising through the structure by capillary action - a phenomenon known as rising damp. A damp-proof membrane (DPM) performs a similar function for a solid floor.

Rising damp can arise for various reasons - the failure of an existing damp proof course, bridging due to the raising of external ground or internal floor levels, or in older buildings, the complete absence of a damp proof course.

Brick, stone and mortar are porous allowing damp from the ground to rise by capillary action, carrying with it ground salts including chlorides and nitrates. These salts from the ground can absorb moisture from the atmosphere leading to wall dampness in conditions of high relative humidity. Also they can ruin decorations and break down internal plaster.

Damp proofing is accomplished several ways including:

- A **damp-proof course** (DPC) is a barrier through the structure by capillary action such as through a phenomenon known as rising damp. The damp proof course may be horizontal or vertical. A DPC layer is usually laid below all masonry walls, regardless if the wall is a load bearing wall or a partition wall.

- A **damp-proof membrane** (DPM) is a membrane material applied to prevent moisture transmission. A common example is polyethylene sheeting laid under a concrete slab to prevent the concrete from gaining moisture through capillary action. A DPM may be used for the DPC.

- **Integral damp proofing** in concrete involves adding materials to the concrete mix to make the concrete itself impermeable.

- **Surface coating** with thin water proof materials for resistance to non-pressurized moisture such as rain water or a coating of cement sprayed on such as shotcrete which can resist water under pressure.

- **Cavity wall construction**, such as rainscreen construction, is where the interior walls are separated from the exterior walls by a cavity.

- **Pressure grouting** cracks and joints in masonry materials.

Materials

Materials widely used for damp proofing include:

- Flexible materials like butyl rubber, hot bitumen, plastic sheets, bituminous felts, sheets of lead, copper, etc.

- Semi-rigid materials like mastic asphalt

- Rigid materials like impervious bricks, stones, slates, cement mortar or cement concrete painted with bitumen, etc.

- Stones

- Mortar with waterproofing compounds

- Coarse sand layers under floors

- Continuous plastic sheets under floors

Activity

List the problems that might occur over time if a damp proof course is fitted incorrectly or subsequently fails.

Termite Barriers

Termites are also referred to as white ants and they eat timber. The Building Code of Australia contains instructions on how to construct a new building so as to minimise the risk of termite attack.

All new buildings must have their primary building elements (structural elements) built with termite resistant materials or be protected against termite attack. Termite resistant materials include:

- Steel, aluminium or other metals
- Concrete
- Masonry
- Fibre-reinforced cement
- Naturally termite resistant timbers
- Treated termite resistant timbers

Physical barriers or chemical barriers must be used where the building is a termite risk area or some or all of the primary building elements are not of a termite resistant material. These include concrete slabs (sometimes with graded stone, steel mesh or pesticides) and suspended timber floors.

Physical barriers are so-called because they rely on the physical resistance of the material to resist termite attack. Barriers can be placed under concrete slabs, foundations and within cavity walls. Hardware and building suppliers may be able to advise on products that are available for DIY.

Physical barriers are made from metal, crushed rock or other materials that termites cannot chew through, and in which any gaps are too small for termites to move through. Most of these products have to be installed by professionals that are licensed by the manufacturers.

Ant caps are installed at the top of underfloor piers or stumps to force termites into the open where they are easier to detect during regular inspections. Ant caps are not a barrier by themselves.

Chemical barriers are so-called because they rely on a chemical to resist termite attack. The chemicals are usually insecticides. These barriers can be placed under concrete slabs, foundations and around houses. There are two types of chemical barriers in-soil and in-plastics.

- **In-soil chemical** barriers are formed when the chemical is applied to the soil under or around the foundations of a building.
- **In-plastic chemical** barriers are plastic sheets containing a chemical - these are typically installed like physical barriers.

There are several different chemicals currently registered for use as chemical barriers. Registration is controlled by Australian Pesticides & Veterinary Medicines Authority. Approved methods of preventative termite control are covered by Australian Standard AS 3660.1 (2000). Remedial termite control is covered by AS 3660.2 (2000). More information is available from Australian Standards, and can be purchased from their website.

It is important to remember that house construction is variable. Consider:

- The type of construction (slab on ground, suspended floors, pole etc.)
- The materials used

- Soil types
- Slopes
- Size of house
- Size of block.

Australia is a big and varied country, from cooler temperate climates to wet tropical ones. Such variation is important to remember when considering termite control methods. Should one particular method work well for one house, it may not prove appropriate for a second.

Activity

What conditions (climate, soil, location etc.) influence the prevalence of termites on a site?

Capital Training Institute

Chapter 4: Structural elements

This chapter considers four common construction materials (concrete, steel, brick and wood) and their performance characteristics. It then looks at the relevant building standards and codes to ensure compliance and that provision has been made for services – electrical and plumbing.

4.1 Analysis of construction materials

Brick

A brick is a block or a single unit of a kneaded clay-bearing soil, sand and lime, or concrete material, fire hardened or air dried, used in masonry construction. Lightweight bricks (also called *lightweight blocks*) are made from expanded clay aggregate. Fired bricks are the most numerous type and are laid in *courses* and numerous patterns known as *bonds*, collectively known as *brickwork*, and may be laid in various kinds of *mortar* to hold the bricks together to make a durable structure. Brick are produced in numerous classes, types, materials, and sizes which vary with region and time period, and are produced in bulk quantities.

Bricks are made from clay by burning it at high temperatures. The action of heat gives rise to a sintering process that causes the clay particles to fuse and develops extremely strong ceramic bonds in the burnt clay bodies. Such bonds are highly stable. As a result, bricks can withstand the severe weathering actions and are inert to almost all normal chemical attacks.

Bricks are chosen for their durability, fire resistance, sound and thermal insulation, flexibility and strength.

Concrete

Concrete is a composite material composed mainly of water, aggregate, and cement. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily moulded into shape.

Characteristic	Details
Strength and Durability	Used in the majority of buildings, bridges, tunnels and dams for its strength Gains strength over time Not weakened by moisture, mould or pests Concrete structures can withstand natural disasters such as earthquakes and hurricanes
Versatility	Concrete is used in buildings, bridges, dams, tunnels, sewerage systems pavements, runways and even roads

Low maintenance	Concrete, being inert, compact and non-porous, does not attract mould or lose its key properties over time
Affordability	Compared to other comparable building materials, concrete is less costly to produce and remains extremely affordable
Fire-resistance	Being naturally fire-resistant concrete forms a highly effective barrier to fire spread
Thermal mass	Concrete walls and floors slow the passage of heat moving through, reducing temperature swings This reduces energy needs from heating or air-conditioning, offering year-round energy savings over the life-time of the building
Locally produced and used	The weight of the material limits concrete sales to within 300km of a plant site Very little cement and concrete is traded and transported internationally This saves significantly on transport emissions of CO_2 that would otherwise occur
Albedo effect	The high "albedo" (reflective qualities) of concrete used in pavements and building walls means more light is reflected and less heat is absorbed, resulting in cooler temperatures This reduces the "urban heat island" effect prevalent in cities today, and hence reduces energy use for e.g. air-conditioning
Low life-cycle CO_2 emissions	80% of a buildings CO_2 emissions are generated not by the production of the materials used in its construction, but in the electric utilities of the building over its life-cycle (e.g. lighting, heating, air-conditioning

(Structural) Steel

The structural steel properties heavily influence how it's used in different applications. The properties, such as tensile strength, elasticity and yield strength, are highly valued by engineers as structural steel is mainly used in construction. Alongside general properties, such as density, these properties help to determine steel's quality. Dependable and durable constructions can be achieved through the use of quality steel. In other words, these properties directly determine the performance of any structural steel material. Here are the major properties of structural steel.

Characteristic	Details
Tensility	Tensility of steel determines up to what limit steel can be stretched without fracturing. The breaking point is used to determine the tensility of steel. The breaking point refers to a point where steel breaks when subjected to stress. The structural steel has greater tensility as compared to other construction materials and hence is often preferred.
Yield strength	Yield strength refers to the capacity of structural steel to resist deformity. Yield strength is determined by measuring the minimum force which can cause deformation. Atomic and crystalline structure of steel will change due to deformation.
Elasticity	Deformation of steel often occurs when it is subjected to stress. The deformation point is where the elasticity of a given material is measured. This property is measured using the Young's modulus of elasticity.
Fire resistance	Steel usually loses strength when extremely heated. The critical temperature of any steel member refers to the temperature at which it is unable to support its load. According to structural engineering standards and building codes, critical temperatures are defined depending on the type, orientation, configuration and loading characteristics of the structural element. The critical temperature of structural steel is the temperature at which the yield stress of the steel has been minimized to 60 percent of the yield stress at room temperature.

Advantages of using structural steel for construction are that it's cost effective to manufacture, does not require a lot of maintenance and is much cheaper to insure as compared to other building methods. Provided steel is protected from rust, it will indefinitely maintain its strength.

Wood

Wood is a product of trees, and sometimes other fibrous plants, used for construction purposes when cut or pressed into lumber and timber, such as boards, planks and similar materials. It is a generic building material and is used in building just about any type of structure in most climates. Wood can be very flexible under loads, keeping strength while bending, and is incredibly strong when compressed vertically. There are many differing qualities to the different types of wood, even among same tree species. This means specific species are better suited for various uses than others. And growing conditions are important for deciding quality. Wood is an organic, hygroscopic and anisotropic material. Its thermal, acoustic, and electrical properties make it very suitable to use in construction.

Property	Details
Thermal properties:	Wood does not practically expand against heat. On the contrary, by the effect of heat, it dries out and gains strength. The only time wood expands a little is when the

	humidity level is below 0%, and this is only scientifically significant. In practice, the humidity level of wood does not drop under 5% even in the driest climate
Acoustic properties:	Sound isolation is based on the mass of the surface. Wood, as a light material, is ideal for sound absorption. Wood prevents echo and noise by absorbing sound.
Electrical properties:	Resistance to electrical current of completely dry wood makes it a very good electrical insulator.
Mechanical properties	Responsible for the high strength is the fantastic micro-structure of wood, which keeps the weight low and generates a surprisingly high load capacity. In terms of its weight, timber is able to carry 14 times more load than steel. Its compressive resistance is equivalent to reinforced concrete.

Activity

From your current site or your experience list two parts of a construction made from each of the four materials. Why were those specific materials chosen for that specific part? Could any other material have been used?

4.2 Plumbing and electrical conduits

Service pipes such as sewer and water are often required for plumbing fixtures that are not located directly adjacent to the external walls. These pipes must be run through or under the slab. Stormwater pipes may also need to pass through the slab.

Be aware that plumbing work is defective if it does not comply with relevant provisions of the Building Code of Australia, the Plumbing Code of Australia, plumbing regulations and the contract documents.

These service pipes may be installed using the following techniques:

Option	**Details**
Slab recesses	Recesses cast into the slabs allow for easier access for maintenance than trying to locate pipes under a slab.

Through beams	The technique of pipe penetrations through the edge beam should be avoided unless there is no alternative. Pipes must pass through the middle third of beams to ensure that the strength of the beam is maintained. Where pipes penetrate the beams, additional strengthening of the edge beam with steel reinforcement or depth of concrete can be used.
Below beams	Service pipes may run under stiffening beams. When pipes are laid and beams are excavated the finished depth of all beams must be considered to ensure sufficient clearance of services pipes.
Under slab	If pipes are laid under the slab they should be located wholly under the slab where possible. Extra bottom mesh should be placed over the pipe to avoid any weakening of the slab.
Through slab	It is best to avoid running plumbing pipes through the slab. However, this may occur when the pipe discharge level is critical and there is no other means to maintain sufficient height.

An **electrical conduit** is a tubing system used for protection and routing of electrical wiring. Electrical conduit may be made of metal, plastic, fibre, or fired clay. Flexible conduit is available for special purposes. Conduit is generally installed by electricians at the site of installation of electrical equipment. Electric heating cables may be embedded in the slab without any increase in thickness or reinforcement. The Australian Standards for Electrical Installations (AS: NZS 3000:2007) is known at the Wiring Rules.

4.3 Compliance of construction processes

The Building Code of Australia (BCA) is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and each state and territory government.

The BCA provides technical information for the design and construction of building structures throughout Australia. It defines the minimum standards of relevant health and safety including structural safety. The BCA allows for varying climate, geological and geographic conditions. It is published in two volumes:

- **Volume One** has information regarding Class 2 to Class 9 buildings
- **Volume Two** has information regarding Class 1 and Class 10 buildings which includes houses, sheds, garages and carports.

Further information can be located at the Australian Building Codes Board website.

Additionally, the building and construction industry uses a wide range of skilled workers who are employed in an equally wide range of working environments. There are many professionals involved in building design and a variety of tradespeople responsible for the numerous stages in the construction process.

Architects

Architects are tertiary qualified professionals who are registered with a professional organisation or institution. They must satisfy strict licensing requirements. They are mainly concerned with the design of buildings, but other skills are often required. Architects may be employed on a project to provide full or partial services and their tasks may include:

- Developing a client design brief
- Preparing concept sketches and working out what is possible
- Preparing site analysis reports including documentation of site constraints
- Preparing contract documentation, including the contract, specifications and working drawings
- Organising tendering
- Overseeing contract administration
- Organising design development and permit applications

Refer to the Australia Institute of architects as they offer advice on how to select an architect

Engineers

There are a number of categories of engineers who could be asked for specific construction advice. These include:

- **Geo-technical engineers** who provide recommendations on the foundation of a construction site. They take soil samples and analyse them to determine the best footing system for the type of soil
- **Services engineers** who are further categorised into more specialised areas which include:
  - Fire services, e.g. sprinkler systems, fire hose design.
  - Hydraulic engineers, e.g. design of water tanks on roofs.

  - Electrical engineers, e.g. design of lifts.
  - Mechanical engineers, e.g. air-conditioning plant.

- **Structural engineers** who design the structural components of a building such as the concrete slab or the footings. Additionally they may be used in:
  - Preparing reports on how to protect neighbouring properties
  - Designing the structure of retaining walls, columns, beams and loading walls in building projects
  - Preparing reports on the structural adequacy of existing buildings

There is a national register for engineers

Draftspeople

Draftspeople may be employed by a firm of architects to produce various types of drawings for buildings. They may also be employed by engineers to detail all the structural requirements of a building. Alternatively they may operate on their own, providing design and drafting services to the building industry. They may be involved with:

- Developing a design brief
- Preparing feasibility studies
- Inspecting sites
- Preparing site analysis reports
- Preparing measured drawings of existing buildings
- Plans for initial ideas
- Preparing concept plans for consultation with authorities
- Preparing permit documentation
- Preparing building permit documentation

Find local drafters in this directory.

Building Surveyors

A building surveyor checks that new buildings comply with the Building Code of Australia (BCA). A building surveyor also checks the maintenance, repair, alteration and renovation of existing buildings against the BCA. They employ building inspectors to be their eyes and ears on the site to ensure that the minimum requirements of the BCA are being met.

Building surveyors advise on and interpret laws and regulations controlling building construction and safety. They may also be involved in:

- Assessing building plans which have been submitted for approval to ensure they conform to building regulations and codes of practice
- Providing advice and assistance to builders and owners before finalisation and lodging plans so that potential problems can be avoided
- Making recommendations on providing amenities for the community
- Pre-purchase inspecting of all types of buildings
- Inspecting buildings during construction to ensure that proper methods and materials are used, paying particular attention to conformity with building regulations
- Keeping records and writing reports of building progress and instances where regulations have been breached and plans have been altered
- Giving evidence in court when prosecutions are necessary for breaches of building regulations
- Inspecting existing buildings to assess conditions
- Giving advice on building matters
- Issuing compliance certificates on completion

The Australian institute of building surveyors allows you to search by state for a building surveyor.

Land Surveyors

Land surveyors are licensed professionals who conduct on-site measurements of building sites and buildings. They measure distances, angles and levels. They may also be involved with:

- Taking levels on a site to produce detailed contour plans
- Determining location of existing buildings and other features on a site
- Setting out the building line, marking the location of columns or the external perimeter of a building
- Checking the vertical alignment of a building during construction
- Conducting boundary surveys and re-establishment of survey pegs
- Checking the positioning and overall height of a structure at completion to ensure compliance with the conditions of permits

Quantity Surveyors

Quantity surveyors are mostly employed on major construction projects as consultants to the client. As advisers, they estimate and monitor construction costs from the feasibility stage of a project through to the completion of the construction period.

Their name comes from the bill of quantities, a document which itemises the quantities of materials and labour required in a construction project. The bill of quantities is prepared using measurements from the contract drawings and is used by the contractors for tendering, progress payments and variations.

During construction the quantity surveyors are called on to determine fair progress payments at regular intervals. They will also cost the changes to the design or to quantities which may arise throughout the construction process by referring to appropriate bill of quantities rates. They may also be involved in:

- Initial cost advice during the pre-contract stage including preparing approximate estimates
- Costing planning information concerned with the development of a design
- Preparing the necessary tender documents, critically examining the tenders and priced bill of quantities when lodged for tender
- Valuing the work during the construction stage at required intervals
- Recommending the amounts to be paid to the main contractors including assessment of any variations
- Controlling costs during the construction stage
- Outlining the economics of alternative methods of construction

There is a professional body for quantity surveyors Australian institute of quantity surveyors (AIQS), which offer a list of their members.

Activity

Take one of the professionals above and locate three local providers using online research. Compare their services – which one would you choose for your next project and what influenced your choice?

CAPITAL TRAINING INSTITUTE

Glossary of terms

Term	Definition
Aggregate	A mixture of sand and stone and a major component of concrete.
Albedo	The ratio of reflected light on a surface compared to the total amount of light.
Architect	One who has completed a course of study in building and design, and is licensed by the state as an architect. One who draws up plans.
Batten	Narrow strips of wood timber used to cover joints or as decorative vertical members over plywood or wide boards.
Bay window	Any window space projecting outward from the walls of a building, either square or polygonal in plan.
Beam	A structural member transversely supporting a load. A structural member carrying building loads (weight) from one support to another. Sometimes called a "girder".
Bearing header	(a) A beam placed perpendicular to joists and to which joists are nailed in framing for a chimney, stairway, or other opening. (b) A wood lintel. (c) The horizontal structural member over an opening (for example over a door or window).
Bearing partition	A partition that supports any vertical load in addition to its own weight.
Bearing point	A point where a bearing or structural weight is concentrated and transferred to the foundation
Bearing wall	A wall that supports any vertical load in addition to its own weight.
Bedrock	A subsurface layer of earth that is suitable to support a structure.
Blocked (rafters	Short "2 by 4's" timber members used to keep rafters from twisting, and installed at the ends and at mid-span.

Blocking.	Small wood timber pieces to brace framing members or to provide a nailing base for gypsum board or panelling.
Bottom plate	The "2 by 4's or 6's"timber member that is fixed to lay on the subfloor upon which the vertical studs are installed. Also called the 'sole plate'.
Brace	An inclined piece of framing lumber applied to wall or floor to strengthen the structure. Often used on walls as temporary bracing until framing has been completed.
Brick lintel	The metal angle iron that brick rests on, especially above a window, door or other opening.
Brick tie	A small, corrugated metal strip @ 1" X 6"- 8" long nailed to wall sheeting or studs. They are inserted into the grout mortar joint of the veneer brick, and hold the veneer wall to the sheeted wall behind it.
Brick veneer	A vertical facing of brick laid against and fastened to sheathing of a framed wall or tile wall construction
Building codes	Community ordinances governing the manner in which a home may be constructed or modified.
Butt joint	The junction where the ends of two timbers meet, and also where sheets of drywall plaster board meet on the 4 foot edge. To place materials end-to-end or end-to-edge without overlapping.
Cantilever	A projecting beam supported at one end, or a large bracket for supporting a balcony or cornice. Two bracket like arms projecting toward each other from opposite piers or banks to form the span of a bridge making what is known as a cantilever bridge.
Column.	A vertical structural compression member which supports loads.
Concrete	The mixture of Portland cement, sand, gravel, and water. Used to make garage and basement floors, sidewalks, patios, foundation walls, etc. It is commonly reinforced with steel rods (rebar) or wire screening (mesh).
Concrete block	A hollow concrete 'brick' often 8" x 8" x 16" in size.

Conduit	A pipe, usually metal, in which wire is installed
Corner braces	Diagonal braces at the corners of the framed structure designed to stiffen and strengthen the wall.
Cross bridging	Diagonal bracing between adjacent floor joists, placed near the centre of the joist span to prevent joists from twisting.
Dampproofing	The black, tar like waterproofing material applied to the exterior of a foundation wall.
Demolition	The intentional destruction of all or part of a structure
Double hung window.	A window with two vertically sliding sashes, both of which can move up and down.
Earthquake Strap	A metal strap used to secure gas hot water heaters to the framing or foundation of a house. Intended to reduce the chances of having the water heater fall over in an earthquake and causing a gas leak.
Eaves	The horizontal exterior roof overhang.
Excavation	A hole made by removing earth
Expansive soils	Earth that swells and contracts depending on the amount of water that is present.
Falsework	The temporary structure erected to support work in the process of construction. Falsework consists of shoring or vertical posting formwork or beams and slabs, and lateral bracing.
Flashing	Sheet metal or other material used in roof and wall construction to protect a building from water seepage.
Footer, footing	Continuous 8" or 10" thick concrete pad installed before and supports the foundation wall or monopost.
Formwork	The total system of support for freshly placed concrete, including the mould or sheathing that contacts the concrete, as well as all supporting members, hardware, and necessary bracing.

Foundation	The supporting portion of a structure below the first floor construction, or below grade, including the footings.
Foundation ties	Metal wires that hold the foundation wall panels and rebar in place during the concrete pour.
Foundation waterproofing	High-quality below-grade moisture protection. Used for below-grade exterior concrete and masonry wall damp-proofing to seal out moisture and prevent corrosion. Normally looks like black tar.
Framer	The carpenter contractor that installs the lumber timber and erects the frame, flooring system, interior walls, backing, trusses, rafters, decking, installs all beams, stairs, soffits and all work related to the wood timber structure of the home. The framer builds the home according to the blueprints and must comply with local building codes and regulations.
Framing	Lumber Timber used for the structural members of a building, such as studs, joists, and rafters.
Gable	The end, upper, triangular area of a home, beneath the roof.
Girder	A large or principal beam of wood timber or steel used to support concentrated loads at isolated points along its length.
Grade	Ground level or the elevation at any given point. Also the work of levelling dirt. Also the designated quality of a manufactured piece of wood.
Grade beam	A foundation wall that is poured at level with or just below the grade of the earth. An example is the area where the 8' or 16' overhead garage door "block out" is located, or a lower (walk out basement) foundation wall is poured
Header	(a) A beam placed perpendicular to joists and to which joists are nailed in framing for a chimney, stairway, or other opening. (b) A wood timber lintel. (c) The horizontal structural member over an opening (for example over a door or window).
I-beam	A steel beam with a cross section resembling the letter **I**. It is used for long spans as basement beams or over wide wall openings, such as a double garage door, when wall and roof loads bear down on the opening.

I-joist	Manufactured structural building component resembling the letter "I". Used as floor joists and rafters. I-joists include two key parts: flanges and webs. The flange of the I joist may be made of laminated veneer lumber or dimensional lumber, usually formed into a 1 ½" width. The web or centre of the I-joist is commonly made of plywood or oriented strand board (OSB). Large holes can be cut in the web to accommodate duct work and plumbing waste lines. I-joists are available in lengths up to 60 feet long
Jamb	The side and head lining of a doorway, window, or other opening. Includes studs as well as the frame and trim.
Joint	The location between the touching surfaces of two members or components joined and held together by nails, glue, cement, mortar, or other means.
Joint cement or Joint compound	A powder that is usually mixed with water and used for joint treatment in gypsum-wallboard finish. Often called "spackle" or drywall plaster mud.
Joist	Wooden 2 X 8's, 10's, or 12's timber members that run parallel to one another and support a floor or ceiling and supported in turn by larger beams, girders, or bearing walls.
Joist hanger	A metal "U" shaped item used to support the end of a floor joist and attached with hardened nails to another bearing joist or beam.
Lintel	A horizontal structural member that supports the load over an opening such as a door or window.
Load bearing wall	Includes all exterior walls and any interior wall that is aligned above a support beam or girder. Normally, any wall that has a double horizontal top plate.
Manufactured wood Timber	A wood timber product such as a truss, beam, gluelam, microlam or joist that is manufactured out of smaller wood timber pieces and glued or mechanically fastened to form a larger piece. Often used to create a stronger member which member, which may use less timber. See also Oriented Strand Board.
Manufacturer's specifications	The written installation and/or maintenance instructions which are developed by the manufacturer of a product and which may have to be followed in order to maintain the product warrantee.

Masonry	Stone, brick, concrete, hollow-tile, concrete block, or other similar building units or materials. Normally bonded together with mortar to form a wall.
Moment of inertia	In a structural member, the product of each element of mass times the square of the distance from an axis
Monopost	Adjustable metal column used to support a beam or bearing point. Normally 11 gauge or Schedule 40 metal, and determined by the structural engineer
Mortar	A mixture of cement (or lime) with sand and water used in masonry work.
Non-bearing wall	A wall supporting no load other than its own weight.
Portland cement	Cement made by heating clay and crushed limestone into a brick and then grinding to a pulverized powder state.
Radius of gyration	An imaginary distance from an axis to a point such that, if an object's mass were concentrated at the point, the moment of inertia would not change
Rafter	Lumber Timber used to support the roof sheeting and roof loads. Generally, 2 X 10's and 2 X 12's are used. The rafters of a flat roof are sometimes called roof joists.
Rafter, hip.	A rafter that forms the intersection of an external roof angle.
Rafter, valley	A rafter that forms the intersection of an internal roof angle. The valley rafter is normally made of double 2-inch-thick members.
Ready mixed concrete	Concrete mixed at a plant or in trucks en route to a job and delivered ready for placement.
Rebar, reinforcing bar.	Ribbed steel bars installed in foundation concrete walls, footers footings, and poured in place concrete structures designed to strengthen concrete. Comes in various thicknesses and strength grade.
Retaining wall	A structure that holds back a slope and prevents erosion.

Roof jack	Sleeves that fit around the black plumbing waste vent pipes at, and are nailed to, the roof sheeting.
Roof joist	The rafters of a flat roof. Lumber Timber used to support the roof sheeting and roof loads. Generally, 2 X 10's and 2 X 12's are used.
Roof sheathing or sheeting.	The wood timber panels or sheet material fastened to the roof rafters or trusses on which the shingle or other roof covering is laid.
Roof valley	The "**V**" created where two sloping roofs meet.
Scaffolding	A temporary structure specifically erected to support access platforms or working platforms.
Section modulus	A term pertaining to the cross section of a flexural member. The section modulus with respect to either principal axis is the moment of inertia with respect to that axis divided by the distance from that axis to the most remote point of the tension or compression area of the section, as required. The section modulus is used to determine the flexural stress in a beam.
Set out	To mark out (as a design) : lay out the plan of
Soil stability	Soil stability depends on its shear strength, its compressibility and its tendency to absorb water
Stud	A vertical wood timber framing member, also referred to as a wall stud, attached to the horizontal sole plate below and the top plate above. Normally 2 X 4's or 2 X 6's, 8' long (sometimes 92 5/8"). One of a series of wood timber or metal vertical structural members placed as supporting elements in walls and partitions.
Stud framing	A building method that distributes structural loads to each of a series of relatively lightweight studs. Contrasts with post-and-beam.
Stud shoe.	A metal, structural bracket that reinforces a vertical stud. Used on an outside bearing wall where holes are drilled to accommodate a plumbing waste line.
Subfloor	The framing components of a floor to include the sill plate, floor joists, and deck sheeting over which a finish floor is to be laid.

Timber ceiling joist	One of a series of parallel framing members used to support ceiling loads and supported in turn by larger beams, girders or bearing walls. Also called roof joists.
Timber frame	A type of construction in which the structural components are timber or depend upon a timber frame for support.
Truss	An engineered and manufactured roof support member with "zigzag" framing members. Does the same job as a rafter but is designed to have a longer span than a rafter.
Wind brace	A structural member, either a tie or a strut, used to resist lateral wind loads

References

Fidishun, D. (2000) Andragogy and technology: Integrating adult learning theory as we teach with technology. [Conference Paper]: 5th Annual Instructional Technology Conference.

Websites accessed January 2015:

Build right

http://prointeriordesigner.com/construction/forces-on-buildings/

https://timberframehome.wordpress.com/tag/structural-engineering/

http://wiki.landscapetoolbox.org/doku.php/field_methods:soil_stability

www.safeworkaustralia.gov.au/.../Formwork_and_Falsework.docx

www.branz.co.nz

https://www.masterbuilders.asn.au/building-and-planning/australian-standards/important-australian-standards

http://www.abis.com.au/damp-proof-course

http://en.wikipedia.org/wiki/Damp_proofing

http://en.wikipedia.org/wiki/Brick

http://www.boral.com.au/Bricks/bricks-advantages.asp

http://www.wbcsdcement.org/index.php/key-issues/sustainability-with-concrete/properties-of-concrete

http://en.wikipedia.org/wiki/Concrete

http://www.steelforce.com.au/Article-Structural-Steel-pg27186.html

http://en.wikipedia.org/wiki/Building_material#Wood_and_timber

https://www.kultur.gov.tr/EN,35285/wood-as-a-building-material-its-benefits-and-disadvanta-.html

http://www.cannyliving.com/wood/wood_ingenious.htm

http://www.abcb.gov.au/en/about-the-national-construction-code/the-plumbing-code-of-australia.aspx