GROUND FLOOR CONSTRUCTION

This text introduces a variety of subject matter related to Building and Construction, at a trade level.
It should be read in conjunction with “Basic Building and Construction Skills”, produced by TAFE and Addison, Wesley, Longman Australia Pty Limited, as between them they address the following;

The text outlines suspended timber ground floor construction methods, both past and present, and upper floor construction methods for two storey work. Alternative floor construction methods are outlined as well, including special beams and joists.

Calculation methods relating to floor frame member quantities, strip and sheet flooring and costs are explained and examples provided.

A comprehensive ‘Glossary of Terms’ is included at the end of the text which provides a detailed description of trade terms, technical content and some trade jargon.
GROUND FLOOR CONSTRUCTION

This section deals with conventional suspended timber floor frames and some alternative types of floor framing systems. As Units 5 and 6 dealt with Slab-on-ground construction and Strip footings, this unit will deal with the structure above the top of the footings to the top of the flooring.

Note: The area between the underside of the flooring and the ground level is known as the ‘Sub-floor’.

Ground floor construction in domestic buildings can be broken up into three broad areas:

1. Ground floor supporting systems for floor frames;
2. The floor frame;
3. The flooring.

CONVENTIONAL SUPPORT SYSTEMS for FLOOR FRAMES

Isolated Support System

This system includes all isolated piers, stumps, posts and columns, which may be used for a timber frame dwelling. The floor frame may be supported using any of the following supporting methods;

Masonry Piers

This system consists of isolated brick, block or stone piers. Brick piers are generally 230mm square supported on concrete pad footings. This type of pier is seldom braced, as the maximum height for a 230mm square pier is regulated at 1.0m (1000mm) which, for standard metric bricks limits the height to 11 courses.

Piers, which are increased in height, must be increased in overall base dimensions to compensate for the lack of stability and should not exceed 3.0m in height, without certification from a Structural Engineer.

The tops of all piers should be level and in-line to prevent unnecessary packing of bearers.

Fig. 1 Brick piers for domestic construction
Steel Posts

Steel posts are normally connected to the footing by the use of steel bottom plates, which may be cast into the footing or bolted to the footing pad by the use of cast-in hold down bolts, or bolted using masonry anchors. These posts are generally designed for structures which are raised off the ground or on sloping sites. The steel posts are often quite long and slim which means that extensive, well-designed bracing is essential. All steel post construction and bracing must be designed or approved by a Structural Engineer and the bases of posts should be protected with a rust inhibiting coating before being cast into concrete pads.

Precast Concrete Columns

Today, most columns are constructed of precast 20 MPa vibrated reinforced concrete. The reinforced concrete stumps have a steel rod projecting on top, which is used to connect the timber floor bearer to the stump.

The footing for the column is normally a poured concrete pad in a hole bored or dug down to stable bearing. The columns are cast with holes through their faces so that bracing can be attached. It is normal to brace members that extend out of the ground more than 900mm.
Timber Stumps
Stumps are normally round and made of durable, i.e. Class 1, timbers or must be chemically treated to improve durability, i.e. pressure treated with CCA. Stumps are not normally used in NSW, apart from the longer versions used for pole frame homes. If used, they should comply with details in the NSW Timber Framing Manual for min. diameter and max. height above ground level.
Embedment into the foundation material should not be less than 30% of the stump height above ground level or at least 450mm, which ever is the greater. Where the height above ground level exceeds 15 times the width of the smaller face, or the least diameter of the stump, an engineer must design the cross-section dimension, system of bracing and depth of embedment.

Fig. 4 Timber stumps embedded into foundation

Continuous Support Systems
Common Support System for Residential Structures
Foundation or ‘Dwarf’ walls for timber frame, brick veneer and cavity brick construction are usually 110 mm thick and are strengthened by engaged or attached piers, 230 mm x 110 mm, bonded or tied to them at designated centres to suit the size and stress grade of bearers. Generally the internal area of the floor frame is supported on 230 x 230mm isolated brick piers.
Timber Framed Structures

This system may be constructed of external dwarf walls, engaged piers and isolated 230 x 230mm mid floor supports or simply have 230 x 230mm isolated piers around the perimeter and supporting the mid floor area.

![Diagram of Timber Framed Structures]

Fig. 6 Typical section through a timber framed structure
Brick Veneer Structures

This is the most common type of residential construction design with the external 110mm skin being built from the top of the footing to the underside of the eaves. The sub-floor area consists of the 110mm external skin with brick piers being attached to it, usually by building in brick ties or reinforcing wire (Bricktor), at centres to suit the size and stress grade of the bearers. The tops of the piers are capped with termite shields (half caps) and the external walls have continuous termite shields built-in for the full length between piers. A damp-proof course (DPC) is usually placed directly under the termite shields.

Note: The continuous termite shields should cover the full width of the external skin to prevent termites travelling up through the air voids in the brick joints, as per AS 3660.1
Cavity Brick Structures

This construction consists of two skins of 110mm brickwork separated by a cavity with a 50mm average width. The DPC, termite shields and attached piers are placed similar to brick veneer construction. The only difference being that the termite shield must be the full width of the cavity wall to prevent termites accessing the upper areas through the cavity.

Fig. 8 Typical section through a cavity brick external wall
**Alternative Adjustable Pier System**

This system, commonly known by its trade name of ‘UNIT-PIER’, consists of a hollow square steel tube which has an adjustable telescopic shaft with a base plate at one end and a fixing bracket at the other, complete with its own built-in ant cap. It has a hot-dipped galvanised steel shaft with an adjustable top section, which is bolted through for load bearing applications. The base plate is welded to the shaft and may be masonry bolted to a concrete pad or be cast into the concrete pad to act as an anchor. The top or head section has a bearer fixing bracket welded to the bearer plate/ant cap, which in turn is welded to the head section.

The head section has a self-drilling screw to allow fixing off to a level, straight height before the load-bearing bolt is drilled through and fixed. This system has many advantages over conventional pier systems as shown below:

- Faster and easier to install than other pier types;
- More cost effective over 1.0m high;
- Strong steel construction and lightweight;
- East to level due to adjustable shaft;
- Maintenance free hot-dipped galvanised finish;
- Strong hold down in high wind terrain;
- Provides a higher, more open crawl space for inspection and;
- Supplied with head assembly for attaching timber or steel bearers.

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**Fig. 9 Uni-pier telescopic post and head**
Positioning Isolated Piers

Isolated piers, also referred to as sleeper or island piers, are placed at spacings to suit the maximum bearer and/or joist span and the position of internal load bearing walls. This will ensure that the roof loads, for conventionally constructed roofs, are transferred to the footings via the bearers and piers.

**Note:** Trussed roof systems only have external load-bearing walls, therefore the spacing of piers is only critical for the bearer and/or joist maximum spans. The maximum offset of bearers up to 125mm deep from under load-bearing walls is to be 22% of allowable bearer span for sheet roofs and 16% of allowable bearer span for tiled roofs.
SUB-FLOOR VENTILATION and ACCESS

The purpose of a sub-floor space is to provide the following:

- Elevation of the building for a sloping site to avoid cutting and filling;
- Sufficient space for air circulation and removal of trapped moisture;
- Easy access for future inspection or to carry out rectification work.

Ventilation

To provide adequate airflow, ventilation should be provided around the building to prevent trapped pockets of air beneath the floor. This may be achieved by placing suitable vents at nominated spacings under the lowest timber members, i.e. the bearers.

The amount of ventilation required may vary in different areas, but as a minimum the Australian Standard, ‘AS 3660.1 Protection of buildings from subterranean Termites’, recommends 7300mm² net ventilation area per lineal metre on both external and internal walls.

Selection of Ventilators

AS 3660.1 states that simply leaving dry perpends around the building will not provide adequate ventilation as the maximum provided would be approx. 4600mm².

To make sure ventilators provide the 7300mm² minimum per metre of external wall the open area of each type or system should be calculated. A comparison of ventilation methods shows the following:

- Dry perpends on every brick / metre of wall length = 4600mm²
- Terra-cotta vent placed every 4th brick = 4335mm²
- Double brick closer spaces every 4th brick = 11520mm²
- Concrete vents with wire insert every 4th brick = 42000mm²

Note: These are approximate areas only.

![Various venting systems](image)

Fig. 12 Various venting systems
Access for Sub-floor Inspection

The *Building Code of Australia - Volume 2. Housing Provision* states that where a structural member in a building is subject to attack by subterranean termites, AS 3660.1 *Protection of Buildings from Subterranean Termites - New Buildings* shall apply. Even when the building is constructed entirely of non-susceptible structural members (e.g. naturally termite resistant or preservative treated timbers, steel frames, etc.) legal opinion indicates that no termite protection has been provided, therefore termites may still enter the building and damage the contents and fitments. In these cases the builder will be liable for not providing suitable barriers.

Reasonable Access

Roof spaces and sub-floor areas, created by suspended timber, steel or concrete floors, must be made accessible in all new buildings regardless of the materials used for the construction. Obviously these provisions do not apply if the roof is lined on-the-rake, the floor is of a slab-on-ground construction or the slab in on fill.

Access to the roof space is through an access panel, also referred to as a ‘manhole’, which is normally placed between ceiling joists in the hall, laundry, walk-in-robe or attached garage. Access to the sub-floor is through a foundation access door, in brick cottages, or between supporting piers, for timber framed cottages.

Many old residential buildings have roof spaces and sub-floors, but do not have adequate access and in some cases no access at all. Some old cavity brick cottages have access panels in the floor of the hall covered by carpet or linoleum sheeting.

Access for visual inspection shall include a minimum clearance of 400mm between finished ground level and any structural components or other obstructions e.g. bearers, joists or plumbing fixtures. On a sloping site, the clearance may be reduced to 150mm provided that the area is no more than 2m from a point with a 400mm sub-floor clearance.

The following table is based on reasonable access as stated in AS 4349.3 – 1998 – *Inspection of buildings*:

<table>
<thead>
<tr>
<th>AREA</th>
<th>ACCESS HOLE (mm)</th>
<th>CRAWL SPACE (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOF INTERIOR</td>
<td>450 X 400</td>
<td>600 X 600</td>
</tr>
<tr>
<td>SUB-FLOOR</td>
<td>500 X 400</td>
<td>Vertical Clearance Timber Floor – 400 Concrete Floor - 500</td>
</tr>
</tbody>
</table>

Termite Protection Options

Termite protection methods have been described previously in Unit 5 for slab-on-ground and these treatments and barriers are also applicable to suspended floors, with some additions and modifications. Further details may be obtained from AS 3660.1 - 1995 *Protection of Building from Subterranean Termites.- Part 1: New buildings*. Other important areas include the following:
GROUND FLOOR CONSTRUCTION

Drainage

The sub-floor area below a suspended floor shall be graded and drained to prevent the ponding of water under buildings. All paving and other ground surfaces abutting external walls shall grade away from the building as water running through the sub-floor may lead to structural problems, timber decay and also creates a suitable environment for timber pest activity.

Structural Materials in Contact with the Ground

All structural materials in contact with the ground or below the termite barrier must be termite resistant. This may be provided for by using the following materials:

- masonry-brick stone
- concrete
- steel
- naturally termite resistant timber or preservative treated timbers.

Protecting Piers, Stumps and Posts

All posts and stumps, which are not termite resistant, shall stand on a corrosion resistant metal support, similar to a post shoe bracket, with a minimum clearance of 75mm above the finished ground level. Alternatively, they may be protected by metal termite shields (ant caps), stainless steel mesh (similar to Termi-mesh), graded stone (similar to Granitgard) or by using chemical soil barriers.

Masonry piers and timber stumps are usually provided with physical barriers such as termite shields, also known as ant caps. These caps do not prevent termites from passing but serve as an obstacle or barrier, which they must by-pass in order to reach the timber members. This forces the termites to reveal themselves by building their characteristic mud tunnels, also known as mud galleries, on the outside of the piers to enable them to pass around the shield, which allows them to be more easily detected during a visual pest inspection.

![Figure 13: Physical barriers for piers and stumps](image-url)
Termite Shields

These should comply with AS 3660.1 by having no perforations, be made from a suitable material which will last for the life of the structure, which is designed to be a minimum of 50 years, and be jointed in an approved manner. Suitable materials should be a minimum of 0.5mm thick, unless otherwise specified, and be made from the following materials:

- Galvanised steel;
- Zincanneal steel;
- Sheet copper;
- Stainless steel;
- Aluminium alloy;
- Alloys of copper and zinc, or;
- Stainless steel mesh (provided it is formed and jointed as per AS 3660.1)

Jointing Termite Shields

Jointing should comply with methods stated in AS 3660.1, which include the following:

- **Machine pressed** – external and internal corners and ‘T’ shaped attached pier caps may be preformed by machine pressing. This forms a folded gusset at the internal corners, which means they don’t require soldering, and the external corners are soldered or welded only;
- **Mitre cuts** – the turn down portions must be fully soldered, brazed or welded;
- **End joints** – where caps are butted or lapped at joins in length, or attached to machine pressed sections, they must be lock-seamed, welded and soldered, riveted and soldered or butt jointed and welded;
- **Inside angles** – where the joint is not in full contact to allow direct soldering or welding, a preformed gusset of the same material may be placed over the joint and then soldered or welded to the capping.

Fig. 14 Jointing of termite shielding
Damp-proof courses

The damp-proof course (DPC) provides a physical waterproof layer to prevent moisture rising or falling in masonry walls. It is built into masonry walls at a height between 150mm and 850mm above finished ground level but below the floor framing. The DPC must be of a durable, approved non-corrosive material, such as the following types:

- *Embossed black polythene* - the textured surface allows the mortar to grip the DPC to prevent a weak point or slip zone;
- *Bituminous-coated non-ferrous metal* – this includes Aluminium, copper and zinc coated to prevent chemical attack or *galvanic action* occurring;
- *Lead or other approved material* – this material was very popular and effective, but if it is not coated it is susceptible to oxidisation and breaking down.

Vermin Proofing

Galvanised bird-wire (approx. 12mm openings) is used to prevent vermin access up the cavity in brick veneer construction. Animals classified as vermin are the house mouse, roof rat and Norwegian rat.

The vermin wire is built into the external skin of brickwork, folded across the cavity and nailed to the edge of the bottom wall plate or may be placed under it during wall frame erection. The vermin wire should be covered with rolled newspaper or similar while the brickwork is being laid to prevent mortar dags building up on top of it, which could lead to water travelling across the cavity to the timber frame.

The rolled newspaper is removed and the cavities cleaned prior to the wall linings being fixed.

![Fig. 15 Placement of vermin wire.](image-url)
THE FLOOR SYSTEM

Apart from the concrete slab-on-ground, the following ground floor systems are the most commonly used in the residential and commercial areas;

- Suspended timber floor;
- Suspended steel floor;
- Suspended concrete slab floor.

SUSPENDED TIMBER FLOOR SYSTEM

Bearers

These are the lowest load-bearing floor frame members placed horizontally on top of piers, stumps or posts. They must be of a durable timber such as Class 1, 2 or 3 hardwoods, or softwoods such as Cypress pine, and of a sufficient stress grade to span unsupported between piers. The relevant sizes and spacings are stated in AS 1684 – 1999 ‘National Timber Framing Code’ which provides tables of the allowable section sizes, stress grades and maximum spans for a variety of timbers and situations.

Placement

Bearers should be fitted accurately and not packed, but rather checked over any high supports to bring the tops to the same level. This is achieved by starting with the narrowest pieces on the outsides, stringing lines across between them and checking out the high intermediate bearers over supports. Bearers with excessive spring may be ‘crippled’ over supports to prevent them from lifting up.

16 Placing and crippling bearers
Jointing and Connection of Bearers

The details below show how bearers may be cut, jointed and connected over piers or supports;

1. **End Butt** – needs to be well nailed together so as to prevent separation;

2. **End Butt and Connector Plate** - This is a quick and effective joint with maximum bearing;

3. **45° Splayed Heading** – inadequate bearing for one member and the joint tends to separate. Not recommended for use.

4. **Halved Scarf** – Suitable where bolting down is required but care should be taken to ensure adequate bearing, shown by ‘x’.

5. **30° Splayed Heading** – Provides adequate bearing and easier nailing than an end butt;

6. **Half Lap** – Provides good bearing and effective nailing but is labour intensive to produce;

7. **Bevel/Butt** – Recommended for maximum bearing, ease of cutting and good nailing. Addition of a nail plate would increase strength;

8. **Lapped or Staggered** – Convenient but not suitable over narrow bearing support.

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Fig. 17 Jointing and fixing bearers
Joists

These are supported by the bearers and placed horizontally and at 90° to them. They must be of a durable timber such as Class 1, 2 or 3 hardwoods, or softwoods such as Cypress pine, and a sufficient stress grade to span unsupported between bearers. They are normally spaced at 450 or 600mm centres and the relevant sizes are stated in AS 1684 – 1999 ‘National Timber Framing Code’ which provide tables of the allowable section sizes, stress grades and maximum spans for a variety of timbers and situations.

Placement

Joists should be fitted accurately and not packed, but rather checked over any high supports to bring the tops to the same level. This is achieved by starting with the narrowest pieces on the outsides, stringing lines across between them and checking out the high intermediate joists over the bearers. Joists with excessive spring may be ‘crippled’ over bearers to prevent them from lifting up. There are always two joists running along the outsides to support the external load-bearing walls. If the flooring is platform sheeting then the two joists may be nailed up against one another, but if the flooring is strip tongue and groove there should be a space between them to allow the inside joist to protrude and provide support for the ends of the flooring. Only single joists are required under load-bearing walls when platform floors are used.

Framing for Openings

Where the joists require trimming to create an opening around a fireplace, sub-floor access, flight of stairs, etc. then the following details should be followed to trim the opening:
Jointing and Connection of Joists

The details below show how bearers may be cut, jointed and connected over bearers:

1. *End Butt* – needs to be well nailed together so as to prevent separation over the bearer;

2. *End Butt and Connector Plate* - This is a quick and effective joint and reduces the risk of end splitting;

3. *Bevel Butt* – Recommended for maximum bearing. It allows for easier nailing than the end butt;

4. *Lapped or Staggered* – Convenient but not suitable in some locations as it will also stagger the line of nails for polished floors, which detracts from the appearance;

5. *Halved Scarf* – Not recommended for joining joists as it reduces the effective depth of the joist causing a weakness;

6. This illustrates the reduction in effective width;

7. *45° Splayed Heading* – inadequate bearing for one member and the joint tends to separate. Not Recommended for use.

8. This illustrates the result of movement in the splayed heading joint showing why it is unsuitable for use.

Fig. 19 Jointing and fixing joists
Procedure for Laying Bearers and Joists

STEP 1 Prepare sub-floor – ensure footings to all piers and external walls have been properly back filled and compacted to prevent water ponding around them. Remove any timber offcuts, paper, bricks, rubbish etc. and grade the whole area to the lowest corner to allow any water, which may enter to drain away. In some cases an agricultural line may need to be placed to collect and remove sub-soil seepage;

STEP 2 Prepare piers - clean off the tops of all piers to remove mortar dags, which might perforate the DPC or raise the level;

STEP 3 Fit DPC - cut and fit DPC material to all isolated pier tops, attached pier tops and the top of the external brick wall. Ensure log lengths are lapped at joins by 150mm min. and by the full width at internal and external corners;

STEP 4 Fit termite shields - place all termite shields as per AS 3660.1 and joint accordingly;

STEP 5 Lay outside bearers - place bearers in position, unless otherwise specified run bearers the long way of the building or room, selecting the narrowest pieces to run down both outsides. Straighten and temporarily brace as required to prevent movement during the floor construction process;

STEP 6 Lay intermediate bearers - run string lines across both ends and at least one across the centre. Place the intermediate bearers in position by checking out to height and crippling as required by sighting along their length between the string line positions. Intermediate pier positions should be placed to allow for load-bearing walls. Attach to piers as required for high wind terrain categories, or as specified;

STEP 7 Lay outside double joists – select the narrowest joists for the outsides, place, cripple as required and fix off;

STEP 8 Lay double joists for internal walls – set out and place double joists for internal walls, which run parallel to joists, for strip tongue and groove flooring or place a single joist under load-bearing walls when sheet flooring is used.

Note: Double skew nail all joists to bearers and ensure all bearers and joist joints are securely fixed off.

* Clean out all timber offcuts ready to lay sheet flooring or stand wall frames.

Fig. 20 Spacing double joists and skew nailing
THE FLOORING

There are two types of flooring systems used for suspended timber frame floors as follows;

- Strip flooring; and
- Platform flooring

Strip Flooring

Strip flooring is milled from a variety of timbers in boards with a nominal width of 75, 100 and 150mm. The thickness of the boards depends on the spacing of the joists and the species of timber, e.g. softwoods used for Max. 450mm c/c joists shall be not less than 18mm thick and 15mm thick for hardwoods.

The usual method of jointing is to run a tongue along one edge and a groove on the other edge of every board to provide a locked flooring system with joint protection, even if the boards shrink.

![Fig. 21 Detail of a typical tongue and groove joint](image)

Most early Australian cottages, i.e. pre-1900, had polished strip floors constructed of hardwood timbers, up to 150mm wide, such as ironbark, turpentine, tallowwood and some other mixed hardwoods. These boards are very strong and durable and in many old cottages they are still in tact and serviceable.

White Baltic pine (150mm wide), imported from Northern Europe, was a popular softwood timber used for strip floors in cottages constructed around the turn of the Century (1900) and up to around the 1940’s. It polished up very well but it is highly susceptible to attack from Furniture beetle (*Anobium punctatum)*.

White Cypress pine was commonly used as a later alternative to Baltic pine and may be seen in many 1950’s, 60’s and 70’s cottages with a highly polished surface. The boards are normally 75 or 100mm wide and the timber has the characteristic of many small and medium sized knots on the surface.

Cypress pine is still being used today but polished hardwood floors have come back into favour. The preferred hardwoods used are Brush box, Jarrah, Beech, Mountain ash, Sydney blue gum, Spotted gum and mixed hardwood species.

*Note: Narrow boards are best suited for flooring as they minimise shrinkage and cupping.*
Fixing

Flooring should be fixed with two nails, across the width of the board, along each supporting floor joist. The nails should be driven on a slight angle to assist with holding and penetrate the joist by approximately 30mm for secure fixing. The heads should be punched at least 2mm below the surface, to allow enough depth for filling with putty prior to polishing.

Note: To prevent splitting at ends, the boards may be pre-drilled or the nail may be driven head first into the timber to create a small indent and to flatten the nail point, then turned right way up and driven. This allows the nail to punch through rather than spread the timber, which would result in splitting.

![Fig. 22 Methods of preparation and fixing](image)

Secret Nailing

Filled nail holes tend to spoil the surface appearance of flooring, especially hardwood flooring, therefore to eliminate this feature specially milled boards may be used which allows the nailing system to be concealed in the tongue and groove joint.

![Fig. 23 Secret nailing method](image)
End Jointing Boards

Boards should join on a joist with their ends slightly undercut to allow for a tight surface fit. Alternatively, end matched boards may be used to join between joists which reduces material waste and labour. Only quality hardwoods should be used for end matching as softwoods do not have the required strength.

![Undercut joint](image)

![End matching](image)

Fig. 24 End treatment to boards

Finishing against a Wall

Boards are not usually run under walls as they tend to shrink and cannot be successfully protected during construction, therefore they are laid after the building is locked up and the ends must be supported on joists. The following details show how the ends are fully supported and dressed:

![Double floor joists under external walls](image)

**Note:** Ends of boards should be pre-drilled or have the nail punched and the point blunted to prevent end splitting

![Double floor joists under internal walls](image)

Fig. 25 Supporting the ends on joists
Laying and Cramping flooring

**STEP 1** Select the longest run of flooring, as close as possible to the middle of the building, and string a line through this position making sure it is parallel to the outside walls. Lay a run of boards along this line to provide a starting position and to reduce the overall creep by cramping boards against both sides to finish against opposite walls. In small rooms it is acceptable to start from one wall and cramp towards the opposite wall.

![Fig. 26 Cramping boards against a wall in a narrow room](image)

**STEP 2** Cut in and lay 4 runs on each side of the central board to form a rigid panel to cramp against. Lay a long, straight piece of hardwood along the edge of the last board to allow for even cramping and to minimise the number of cramps used. **Note:** It is wise to place a long sacrificial board, with a groove on one edge, against the tongue of the last board before the hardwood cramping piece is placed to prevent damage to the tongue, otherwise it will be difficult to fit the next run of boards to a split or crushed tongue.

**STEP 3** Continue laying and cramping boards in sections of 6 to 8 (Max.) rows of boards at a time. The boards require only limited nailing at this point to hold them in position as it is quicker and easier to do the bulk of the nailing at the end. It is advisable to stand on the boards during cramping to prevent the boards springing up. Laying up to a maximum of 8 rows of boards will reduce the risk of the boards springing excessively. When joining the boards onto joists it is essential that the joints are staggered, as even two boards joined on the same joist in consecutive rows will spoil the appearance of the finished floor. It will be necessary to cut short boards through doorways to allow continuity into adjoining rooms. The boards should be checked on a regular basis during laying to ensure they are still parallel with the outside walls.
STEP 4  When boards finish parallel to a wall it is difficult to fit bulky floor cramps into the space left to cramp the last few boards, therefore an alternative method needs to be found. The best option is to use a length of timber as a lever against a bearer to cramp boards close to the wall or to use a heavy chisel driven into the edge of the joist and used as a lever.

![Fig. 27 Levering boards in a confined space](image1)

STEP 5  The last three to four boards should be loosely fitted with the very last board scribed to create a tight fit, thus allowing the remaining boards to be sprung into place and nailed off.

![Fig. 28 Method of fitting boards against a wall](image2)
Floor Finishing

Nailing and Punching

Once all the boards have been laid and partially nailed, it will be necessary to go back over the floor to completely nail and punch it off. This may be carried out in the following manner;

**STEP 1**  Lightly mark the line of nails with a straight edge and pencil, or chalk-line. This will provide a guide line to enable the nails to be kept in a straight line for an overall neat appearance. They may be nailed by hand or by using a nail gun.  
*Note:* If nailing by hand wear impact resistant safety glasses as nails can spring back into your face, if they are not hit square on, or small pieces of red hot metal may shear off and end up in your eyes. It is also good practice to clean the hammer face of all dirt or resin to prevent it slipping on impact with the nail head.

![Mark a light line with pencil](Fig. 29)

**STEP 2**  When nailing by hand, work along the guide lines in sections, either towards or away from yourself, until the full length of the nailed row is complete. Repeat the process for all rows of nails.

**STEP 3**  After nailing is complete, go back over the rows following the same sequence and punch the nail heads below the surface by at least 2mm. Use a large flooring punch with a small head as it becomes difficult to hold a small nail punch for prolonged periods.
STEP 4  Give the floor a general sweep to remove timber pieces, loose nails, excessive dirt and grit, etc., then rough sand the whole floor using a drum type floor sander with coarse abrasive paper. This is normally carried out by specialist floor sanding contractors and may be left in this state if the floor is to be carpeted. If the floor is to be polished and exposed, then an additional fine sanding operation will be required.

Platform Flooring

STEP 5  Once all sanding is complete, thoroughly vacuum the floor and then fill nail head holes, plus any cracks or splits, with a suitable putty filler, which may be coloured to match the boards. If floors are to be stained as well then filling should follow the staining process.

Clean off any dust or remaining debris and apply at least two coats of an estapol, polyurethane, two pack resin, etc., using a roller or wool pad applicator.
Sheet flooring is laid across the joists, over the whole floor area, running under internal and external walls to finish flush with the outside line of the joists.

Materials used for sheet floors are:

- Structural grade particleboard with tongue and grooved long edges, (most commonly used);
- Plywood with tongue and grooved long edges;
- Compressed fibre cement sheets with butt joint edges.

**Structural Grade Particleboard Flooring**

These sheets, such as the common brand known as ‘Structaflor’, are made from graded timber flakes of varying sizes placed in layers and bonded with a moisture resistant synthetic resin. The upper surface is also coated with additional resin and the edges are wax sealed to provide additional water resistance during construction, however the sheets are not designed to be used in permanently moist conditions. If the sheets are left exposed to sun and rain for extended periods of time they will start to break down and the edges will swell.

Special purpose sheets are available with an added ‘fungicide’ and/or ‘termicide’ in areas where there may be a high risk of attack.

*Note: The surface of swollen edges must be rough sanded along the joints prior to carpet being laid otherwise the ridges will show with future carpet wear.*

Sheets are available in a variety of sizes, thicknesses and applications, as follows:

- **3600mm long x 900mm wide x 19mm thick** - commonly known as ‘yellow tongue’, is suited for general use in residential construction on floor joists spaced at 450mm Max. centres

  *Note: The tongues are made of removable coloured PVC strip to identify the type;*

- **3600mm long x 900mm wide x 22mm thick** - commonly known as ‘red tongue’, has the same application as yellow tongue, but for joists spaced at 600mm Max. centres;

- **3600mm long x 600mm wide x 25mm thick** – commonly known as ‘blue tongue’, is designed for use in residential, commercial, industrial and institutional buildings where concentrated floor loads are great. They will span up to 600mm Max. joist centres;

- **3600mm long x 1800mm wide x 19 and 22mm thick** - these have a square edge and are designed for specialist applications.
Fig. 32 Details for Particleboard and Plywood sheet floors under walls

Note:
- All sheets are to be laid with end joints staggered to distribute the loads evenly throughout the floor and they should be fixed in accordance with manufacturers specifications and AS 1860 –1998 ‘Installation of particleboard flooring’.
- All wet area installation and materials must comply with the requirements set out in AS 3740 – 1994 ‘Waterproofing of wet areas within residential buildings’.
ALTERNATIVE FLOOR SYSTEMS AND MATERIALS

There are several variations on the standard brick pier, bearers and joists system available for ground floor and upper floor construction. There are patent types of pre-cast concrete member systems available, however the more conventional methods are still used the most.

Suspended Reinforced Concrete

Suspended reinforced concrete slabs used in ground floor construction are normally simple single span designs. This means the main reinforcement runs across the short way of the slab and the slab is supported mainly on the two long sides. Generally all four sides are supported, as is the case when slabs are used for verandahs, patios, decks, bathroom/laundry/toilet floors, etc. The slabs rest on piers or dwarf walls and in most cases will have permanent formwork such as corrugated iron sheets, metal deck sheets like ‘Condek’, ‘Bondek’, or similar products. This is due to the limited access for removal of formwork sheeting.

In most cases the reinforcement is of a square or rectangular weldmesh, placed 20mm from the bottom in protected areas, in a 100mm thick, 20MPa concrete slab. Main upper floor slabs usually require design by a Structural Engineer and have a more complex formwork system.

Fig. 33 Simple suspended reinforced concrete verandah slab
Steel Ground Floor Systems

There are several types of patent steel floor systems available such as:

- Adjustable pier and site assembled systems;
- Prefabricated ladder floor systems;
- Site assembled ladder floor systems, and;
- Other site assembled systems (long spans).

An example of these types is the ‘Quika-Floor’ system. This is a lightweight flooring system which has been designed as an economical alternative to a concrete slab-on-ground or a suspended concrete slab. It consists of lightweight BHP steel members supported by adjustable hot dipped galvanised steel piers and diagonal steel bracing, where required.

Fig. 34 Typical steel ‘Quika-Floor’ detail
Suspended Deep Joist Floor Frames

These systems are more commonly used for two storey construction or roof conversion activities, however on steeply sloping sites it may be necessary to combine standard ground floor construction with a form of upper floor construction, such as over a garage, store room, basement, etc. The following details may be applied to these situations;

**Solid Timber – Deep Joists**

This system consists of deep sectioned softwood (Radiata pine or Oregon) or hardwood (mixed species) joists which have a single or continuous span. These timbers should be seasoned to prevent excessive shrinkage and movement, which makes this a relatively expensive system.

The ends and/or mid spans may be supported on posts or piers, timber walls, brick single skin walls with engaged piers or on solid 230mm brick walls.

*Note:* Where they are supported on timber wall frames to top plate must be a minimum of 70mm thick and the studs must be a minimum of 90mm wide, unless otherwise specified.

Double joists are required under all external walls where the wall runs parallel with the joists and the length of the joists must be blocked, using solid timber blocks 25mm smaller than the joist depth, or timber herringbone strutting. These blocks or struts are placed at Max. 1800mm centres, where the joist length exceeds 3.0m, to prevent the joists from twisting or bowing and adds lateral strength and stability, when it is continuous between solid supports.

Solid end blocking is also required every 3rd bay or 1800mm centres to prevent the ends from twisting.
Alternative Deep joist Support

Deep joist systems may also have to tie in with standard bearers and joists when the site is sloping or there is a step down for a garage, store room, cellar, etc. A ‘ribbon bearer’ may be used as an alternative to a solid top plate or double top plates. This allows for deep joists to be supported by a wall frame at any height, which will allow a mezzanine floor to be attached to standard height frames without having to re-locate the wall plates.

Fig. 36 Deep joists adjoining a conventional floor system
Herringbone Strutting and Solid Blocking

Herringbone strutting consists of lighter sectioned timbers, i.e. 38 x 38 or 50 x 50mm, crossed over between joists. A practical method of obtaining the length and bevel of a herringbone strut on the job is to run two string lines, or snap two chalk lines, across the tops of the joists. The space between the two lines should be equal to the depth of the joists less the required clearance, as shown on the sketch below. Lay the timber struts across the joists between the lines and mark the bevel at both ends on the underside of the struts. Cut the struts to length and run a saw cut in the top edge to allow ease of nailing and prevention of splitting.

![Fig. 37 Detail of herringbone strut set out](image)

Solid Blocking

Solid blocking, also known as ‘solid bridging’, may be used as an alternative to herringbone strutting. It is solid timber which finishes the width of the joists less required clearance and placed in-line or staggered at Max. 1800mm centres, where the joist length exceeds 3.0m.

![Fig. 38 Section through joists and solid blocking](image)
Special Joist and Beam Systems

*LVL (Laminated Veneer Lumber)* beams, bearers and joists are a strong, stable alternative to solid timber for the construction of ground floor and upper floor frames. The members are made in continuous lengths using rotary peeled Radiata pine veneers, which are dried and laminated together under heat and pressure. They are bonded by a Type ‘A’ bond marine grade adhesive or resin. The resulting section is similar to plywood as the veneers run vertically through the members for the full length.

They are not durable enough to be placed in external situations but they may be pressure treated with a ‘Light Organic Solvent Preservative’ and then painted to give them the required durability rating for use on decks, pergolas, balconies, etc.

Since the members produced are stronger than most solid timbers, smaller section sizes may be used to equal the stress grades of much bigger section size solid timber. Also, the material is very stable, resulting in little or no shrinkage, and consistent section sizes make it an ideal frame for flooring.

![Section through LVL](image)

Fig. 39 Section through LVL

‘HYBeams’ are another type of LVL composition used as an alternative to solid timber deep floor joists. They have LVL top and bottom flanges separated by a sheet ply web. They are produced in continuous lengths to span up to 6.0m, which may be supported at ends only, they are very lightweight, very stable and have no shrinkage at all. Again, an ideal alternative to heavy solid timber floor joists for large spans.

![Section through a ‘HYBeam’](image)

Fig. 40 Section through a ‘HYBeam’
‘Glulam’ beams are made up of smaller sections of timber laminated together in a horizontal plane to form a long member with high strength. These manufactured beams are stronger than solid timber of a comparative size and there is no shrinkage due to the use of seasoned timber. They are available in softwood or hardwood and may be left rough sawn for encased structural situations, or be dressed, stained or clear coated when placed in an exposed position, such as a beam supporting upper floor joists.

![Fig. 41 Section through a typical laminated beam](image)

**Plywood Box-beams** are basically hollow sections made up of solid timber, or LVL, top and bottom flanges faced with sheets of ply, used to make beams, columns and rafters. They are lightweight for their size and strength and have become very popular with portal frame construction in many commercial/industrial structures. They provide a high strength member, which is lightweight and very versatile allowing for greater flexibility in the design of structures.

![Fig. 42 Typical section through a boxed-beam](image)
CALCULATION OF SUB-FLOOR MEMBERS

BRICKWORK QUANTITIES

When constructing sub-floor areas, it may be necessary to calculate and order the quantity of bricks for piers and/or dwarf walls. Bricks are available in two main forms, i.e. dry pressed and extruded, and the method used to calculate the quantities of both is as follows;

Bricks are rectangular in shape and manufactured from burnt shale, clay or sand and cement. Shale or clay bricks are made in two groups - one for face work known as ‘face bricks’ and the other known as ‘commons’, used for walls which are to be rendered or for piers. The usual method of buying bricks is per thousand.

The measurements of a standard metric brick are: 230mm long x 110mm wide x 76mm thick

Bricks are laid on their widest surface, thus allowing a 230mm x 76mm side to show on the face. The thickness of the bedding, known as ‘bed joints’, is 10mm (within ± 2mm) making courses equal to 600mm.

The perpendicular joints, known as ‘perps’, are also 10mm (within ± 2mm).

To calculate the number of bricks, the face area of the wall is measured in square metres and then multiplied by the number of bricks in one square metre. There is an average of 50 bricks per square metre for walls 110mm thick, using standard joint thickness.

Method of Calculating the Number of Bricks Required

**Step 1** Calculate the face area of the wall in square metres = L x H

**Step 2** Multiply the result of (L x H) x 50/m²

This answer gives the number of bricks required for ‘one skin’ of brickwork. If there are ‘two skins’ of brickwork, the answer will have to be multiplied by 2, therefore the number of bricks = [(L x H) x 50] x 2

![Fig. 43 Details of brick skins](image-url)
**Example 1:**
Calculate the number of bricks required to construct a wall 7.0m long x 1.0m high x 110mm thick;

Formula: \( [(L \times H) \times 50] \times \text{No. of skins} \)

\[ = [(7.0 \times 1.0) \times 50] \times 1 \]
\[ = (7.0 \times 50) \times 1 \]
\[ = 350 \times 1 \]

Total = 350 bricks

**Fig. 44 Single skin brick wall**

**Example 2:**
Calculate the number of bricks required to construct a cavity brick wall 8.0m long x 1.5m high;

Formula: \( [(L \times H) \times 50] \times \text{No. of skins} \)

\[ = [(8.0 \times 1.5) \times 50] \times 2 \]
\[ = (12.0 \times 50) \times 2 \]
\[ = 600 \times 2 \]

Total = 1200 bricks

**Fig. 45 Cavity brick wall**

**Example 3:**
Calculate the number of bricks required to construct 25/230 x 230mm isolated brick piers, 8 courses high;

Formula: Bricks per course x Number of courses high x Number of piers

\[ = (2 \times 8) \times 25 \]
\[ = 16 \times 25 \]

Total = 400 bricks

**Fig. 46 Isolated brick pier**
Example 4:
Calculate the number of bricks required to construct the 110mm dwarf walls, 110mm engaged piers and 230 x 230mm isolated piers for the cottage shown in the sketch. The cottage is set on a level block and the height of the walls and piers is 688mm from the footing to the underside of the bearer:

**Dwarf Wall:** length (working in-to-over)

Formula: \( L \times H \times 50 \times \text{No. of skins} \)

- a. \( 6.000 - 0.110 \rightarrow = 5.890 \)
- b. \( 1.500 \downarrow = 1.500 \)
- c. \( 2.700 \rightarrow = 2.700 \)
- d. \( 3.800 - 0.110 \downarrow = 3.690 \)
- e. \( 6.000 - 0.110 \leftarrow = 5.890 \)
- f. \( 1.200 \uparrow = 1.200 \)
- g. \( 2.700 \leftarrow = 2.700 \)
- h. \( 4.100 - 0.110 \uparrow = 3.990 \)

Total length = 27.560

\[
\therefore [(27.560 \times 0.688) \times 50] \times 1
\]

= (18.960 \times 50) \times 1

= 948 \times 1

= **948 bricks**

**Engaged piers:**

Formula: Height \( \div \) brick course and bed joint \( \times \) No. of piers

\[
= (688 \div 86) \times 22
\]

= 8 \times 22

= **176 bricks**

**Isolated piers:**

Formula: Height \( \div \) brick course and bed joint \( \times \) bricks per course \( \times \) No. of piers

\[
= [(688 \div 86) \times 2] \times 11
\]

= (8 \times 2) \times 11

= 16 \times 11

= **176 bricks**

\[
\therefore \text{Total Bricks} = 948 + 176 + 176 = 1300 \text{ bricks}
\]
BEARER AND JOIST QUANTITIES

Bearers

To calculate the number and length of bearers in a room or building, the following information is required:

- Length of the room/building;
- Width of the room/building;
- Spacing of members; and.
- Size of individual rooms, if bearers are separated.

Procedure

Divide the width of the building by the maximum spacing of the bearers, which may be up to 4.8m depending on the floor load, size and stress grade of bearers and specification for joists. However, the position and spacing of bearers may be specified and their position may also depend on whether there are internal load-bearing walls or not. Once the spacing is decided the width is divided by the spacing and an additional one (1) is added to the answer to compensate for the starting bearer.

Note: If the width of the room divided by the spacing does not give a whole number, then it must be rounded up to the next whole number.

Therefore, the formula for the calculation will be:

\[
\text{Number of Bearers} = \frac{\text{Width of room/building}}{\text{Spacing of bearers}} + 1
\]

Example 1:
Calculate the number and length of bearers for a 1 room timber framed hall when the bearers run the long way of the hall and are spaced at maximum centres of 1500mm.

\[
\begin{align*}
\text{Length of bearers} &= \text{length of building} \\
&= 4.800 \\
&= \frac{4.800}{1.500} + 1 \\
&= 3.2 + 1 \\
&= 4 + 1 \\
&= 5
\end{align*}
\]

Length of bearers = length of building (orderable length)= 6.6m

\[
\therefore \text{Order} = 5/6.6
\]

Fig. 48 Plan of 1 room hall
**Example 2:**
Calculate the number and length of bearers for an ‘L’ shaped brick veneer cottage when the bearers run the long way of the rooms and are spaced at maximum centres of 1800mm.

Area 1:
\[
\begin{align*}
5.850 & + 1 \\
1.8 & \\
3.25 & + 1 \\
4 & + 1 \\
5 & 
\end{align*}
\]

Area 2:
\[
\begin{align*}
3.630 & + 0 \\
1.8 & \\
2.02 & + 0 \\
3 & 
\end{align*}
\]

Note: There is no need to add an extra bearer for Area 2 as it has already been counted in Area 1

Length of bearers = length of building (orderable lengths) Area 1 = 6.9, 5.7

Area 2 = 5.7

**Note:** Joined lengths should be staggered over supports

∴ **Order** – 5/6.9, 8/5.7

---

**Cost of Bearers**
Find the total lineal length of material and multiply it by the rate per m, e.g:

**Example 3**:
Calculate the cost of 100 x 75 hardwood bearers, based on answer for example 2, when the cost of 100 x 75 Hwd. is $6.30/m

Total length = (5 x 6.9) + (8 x 5.7)

= 80.1 lin. m

∴ 80.1 x $6.30 = $504.63
Joists

To calculate the number and length of joists in a room or building, the following information is required:

- Length of the room/building;
- Width of the room/building;
- Spacing of members, and;
- Size of individual rooms.

Procedure

Divide the length of the building by the maximum spacing of the joists, which may be 450mm or 600mm depending on the floor load, flooring type and thickness, size and stress grade of the joists.

Double joists are placed under all external and internal walls running parallel with them, if strip flooring is used, and a single joist under all load-bearing walls if platform flooring is used.

Once the spacing is decided the length of the building, or each room, is divided by the spacing and an additional one is added to the answer to compensate for the starting bearer. Also, additional joists need to be added where double joists occur.

Note: If the length of the room divided by the spacing does not give a whole number, then it must be rounded up to the next whole number.

Therefore, the formula for the calculation will be:

\[
\text{Number of Joists} = \left( \frac{\text{Length of room/building}}{\text{Spacing of joists}} + 1 \right) + \text{Allowance for double joists}
\]

Example 1:
Calculate the number and length of joists for a 1 room timber framed hall, when the bearers run the long way of the hall, which are spaced at maximum centres of 450mm.

\[
\begin{align*}
\text{Length of joists} &= \text{width of building} = 4.8 \text{m} \\
\end{align*}
\]

\[
\begin{align*}
\text{Order} &= \frac{18}{4.8} \\
\end{align*}
\]

Fig. 50 Plan of 1 room hall
Example 2:
Calculate the number and length of joists for an ‘L’ shaped brick veneer cottage, when the bearers run the long way of the rooms, which are spaced at maximum centres of 600mm.

Area 1:
\[
\begin{align*}
&= 5.600 + 1 + 2 \\
&= 9.3 + 1 + 2 \\
&= 10 + 1 + 2 \\
&= 13
\end{align*}
\]

Area 2:
\[
\begin{align*}
&= 7.000 + 0 + 1 \\
&= 11.67 + 0 + 1 \\
&= 12 + 0 + 1 \\
&= 13
\end{align*}
\]

Note: There is no need to add an extra joist for Area 2 as it has already been counted in Area 1.

Length of joists = width of building
(orderable lengths) Area 1 = 6.0, 3.6
Area 2 = 6.0

Note: Joined lengths should be staggered over supports.

\[\therefore\text{Order} = 26/6.0, 13/3.6\]

Cost of Joists
Find the total lineal length of material and multiply it by the rate per m, e.g.;

Example 3:
Calculate the cost of 100 x 50 hardwood joists, based on answer for example 2, when the cost of 100 x 50 Hwd. is $3.50/m

Total length = \(26 \times 6.0\) + \(13 \times 3.6\)
\[= 202.8\text{ lin. m}\]
\[\therefore 202.8 \times 3.50 = 709.80\]
FLOORING QUANTITIES

Strip Flooring

To calculate the total lineal, random lengths of tongue and groove flooring in a room or building, the following information is required:

Formula – (Area of room/building x lineal metres per m²) x Allowance for waste

- Length of the room/building;
- Width of the room/building;
- Effective cover of each board
- Lineal metres in 1m²
- Allowance for waste.

Procedure

The first thing to find is the lineal metres of flooring in 1m² which is calculated as follows;

Lineal metres = 1m² ÷ effective cover

(see attached sheet)

Fig. 52 Effective cover of tongue and grooved flooring

\[
\begin{align*}
&= \frac{1.000 \times 1.000}{0.090} \\
&= 11.1 \times 1.000
\end{align*}
\]

Example 1: = 11.1 lineal metres per m²

Calculate the lineal metres of strip flooring for a 1 room timber framed hall when the boards have an effective cover of 90mm and an allowance of 10% waste

\[
\begin{align*}
&= (6.400 \times 4.600) \times 11.1 \\
&= 29.44 \times 11.1 \\
&= 326.784
\end{align*}
\]

(allow for waste)

\[
\begin{align*}
&= 326.784 \times 1.10 \\
&= 359.462 \text{ say 360 lin. m.}
\end{align*}
\]
Example 2:
Calculate the lineal metres of strip flooring for an ‘L’ shaped brick veneer cottage, when the boards have an effective cover of 70mm and an allowance for waste of 15%;

Lineal metres = 1m² ÷ effective cover
= \frac{1.000 \times 1.000}{0.070}
= 14.286 \times 1.000
= 14.286 lineal metres per m²

Area 1:
= (9.280 \times 5.400) \times 14.286
= 50.112 \times 14.286
= 715.900

Area 2:
= (6.900 \times 5.650) \times 14.286
= 38.985 \times 14.286
= 556.940

Allow for waste
= (715.900 + 556.940) \times 1.15
= 1272.840 \times 1.15
= 1463.766 \text{ say } 1464 \text{ lin. m.}

Cost of Strip Flooring
Multiply the total lineal length of material by the rate per m, e.g.;

Example 3:
Calculate the cost of 100 x 25 Cypress pine tongue and grooved flooring, based on answer for example 2, when the cost of seasoned 100 x 25 flooring is $1.15/m

Total length = 1464 lin. m

∴ 1464 \times $1.15 = $1683.60
Platform Flooring

To calculate the total number of structural particleboard and plywood sheets for the platform floor in a room or building, the following information is required:

- Length of the room/building;
- Width of the room/building;
- Effective cover of each sheet in m²
- Allowance for waste.

*Note: Platform flooring is designed to pass under all wall frames to the outside line of the external walls.*

**Formula** – \((\text{Area of room/building} ÷ \text{area of 1 sheet}) + \text{Allowance for waste}\)

**Procedure**

The first thing to find is the m² in 1 sheet, 3600 x 900mm, which is calculated as follows:

\[
\text{Square metres} = \text{length} \times \text{width} \\
= 3.600 \times 0.900 \\
= 3.240\text{m}^2
\]

**Example 1:**
Calculate the total number of structural particleboard flooring sheets for a 1 room timber framed hall when each sheet is 3600 x 900 x 18mm thick with an allowance of 5% waste;

\[
= (6.500 \times 4.800) ÷ 3.240 \\
= 31.200 ÷ 3.240 \\
= 9.629
\]

(allow for waste)

\[
= 9.629 \times 1.05 \\
= 10.110 \text{ say 11 sheets}
\]

*Note: Sheets run under the walls to the outside face.*

Fig. 55 Plan of 1 room hall
**Example 2:**
Calculate the total number of structural plywood sheets for an ‘L’ shaped brick veneer cottage, when the sheets are 2.400 x 1.200mm wide, with an allowance for waste of 5%:

\[
\text{Square metres} = \text{length} \times \text{width} = 2.400 \times 1.200 = 2.880 \text{m}^2 \text{ (area per sheet)}
\]

**Area 1:**
\[
\begin{align*}
&= (9.480 \times 5.600) \div 2.880 \text{ (area per sheet)} \\
&= 53.088 \text{ (m}^2) \div 2.880 \\
&= 18.433 \text{ (sheets)}
\end{align*}
\]

**Area 2:**
\[
\begin{align*}
&= (7.000 \times 5.850) \div 2.880 \\
&= 40.950 \text{ (m}^2) \div 2.880 \\
&= 14.219 \text{ (sheets)}
\end{align*}
\]

(allow for waste - 5%)
\[
\begin{align*}
&= (18.433 + 14.219) \times 1.05 \\
&= 32.652 \times 1.05 \\
&= 34.285 \text{ say 35 sheets.}
\end{align*}
\]

**Fig. 56 Plan of ‘L’ shaped cottage**

**Cost of Sheet Flooring**
Multiply the total number of sheets by the rate per sheet, e.g:

**Example 3:**
Calculate the cost of 3600 x 900 x 18mm flooring sheets, based on answer for example 2, when the cost of each sheet is $35.00

Total number of sheets = 35

\[
\therefore 35 \times \$35.00 = \$1225.00
\]
GLOSSARY OF TERMS

Architrave - This term refers to the timber moulding placed around the outside of doors or windows to finish the jamb lining to the wall.

Bird-wire - This is galvanised wire mesh with small hexagonally shaped openings of approx. 12mm diameter. It may be used on bird cages or as a physical barrier when placed in a brick veneer cavity to act as vermin proofing.

Bricktor - This is a tradename used to describe the reinforcing wire, similar to bird-wire, placed in brickwork to provide tensile strength on the bed joints.

Chlorophyll - This is the green coloured matter found in the leaves of plants which forms part of a biochemical process to transform sugar and starches into food for the plant.

Combined water - This is water trapped within the cell walls of timber which needs to be dried out slowly during the seasoning process, to approx. 12% moisture content to keep the timber ‘alive’, which prevents collapse.

Commons - These are dry-pressed or extruded bricks used for situations where appearance is not important, i.e. piers, rendered walls, roof fire walls, etc.

Conifer - This is a term applied to softwood trees, which bear cones to produce seeds. Most pines and firs are referred to as conifers.

Crippling timber - This is a process which involves the cutting, wedging or cleating of timber framing to make it straight, where a spring occurs.

Cupping - This is caused when the longer growth rings on the end of timber pieces, which have been back sawn, shrink more than the shorter ones. This results in the face of the timber becoming concaved or hollow.

Durability - This is the timbers natural resistance to decay and the effects of weather.

Dwarf wall - This is a low 110mm brick wall with attached piers, to support bearers, which is laid up to floor level on some timber frame cottages.

Efflorescence - This appears as a white salt mark on the face of masonry where a DPC is not present. The water draws the ground salts up through the wall and dries as a white powder.

End-matching - This is a process of jointing strip flooring on the ends, using a tongue and groove joint system, to reduce wastage by allowing joints between joists supports.

Extractives - These form a small percentage of compounds found in timber apart from cellulose and lignin. They may be oils, waxes, gums, resins or starches.

Face bricks - These are dry-pressed or extruded bricks which are used where the appearance of the bricks is critical, such as external walls, feature

Figure - This describes the ornamental markings seen on the dressed face of timber caused by growth rings, medullary rays or direction of the grain.
**Free water** - This is the excess water trapped within the cells of timber, before seasoning, which is removed during the seasoning process.

**Fungicide** - This is a chemical treatment which is applied to timber or built into timber products to kill fungi.

**Gluts** - These are generally scrap pieces of timber laid under timber stacks to raise them off the ground.

**Green timber** - This is a term applied to freshly cut timber or timber which has a high proportion of free water trapped in the cells.

**Lignin** - This is the material in timber which bonds the cellulose and other materials together, giving timber its strength and hardness.

**Lined on-the-rake** - This is a term used to describe the ceiling lining of a pitched roof which is fixed to the underside of the rafters. There is no access to the roof structure as there is no roof space formed.

**Mud galleries** - These are access tubes made of earth and termite faeces, which are used by termites to travel from the nest to a feeding site without exposing themselves to the atmosphere. The galleries also keep the humidity at a set rate to ensure the termites do not desiccate (dry out).

**Polyethylene** - A plastic material which is tough, flexible, waterproof, and resists chemicals well. They have poor durability qualities which may lead to them breaking down when exposed to the weather. Examples are: moisture barriers under slabs, Damp Proof Course, pipes and electrical insulation.

**Pergola** - This is an open roofed timber frame over a path, patio, paved area, etc., which is usually attached to a wall. It is constructed to provide a frame for climbing plants and vines, which provide shade in the summer. A similar free-standing structure is known as a pagoda.

**Perps** - This is the common abbreviation for a perpend joint in masonry work, which is the vertical or perpendicular joint between bricks or blocks.

**Photosynthesis** - This is the food making process which takes place in the leaves of plants using the sun, water, minerals and chlorophyll.

**Regenerate** - This the process of re-growth of plants after logging or after devastation of bushland due to fire.

**Solid bridging** - These are solid timber trimmers placed between deep joists to prevent bowing and twisting. Also referred to as solid strutting.

**Staggered** - This refers to the placement of solid bridging, noggings, trimmers, etc. by offsetting every piece from the previous one, when placed in a row.

**Termiticide** - This belongs to a range chemicals, organophosphates and pyrethroids, designed to treat termite activity. The term literally means to kill termites.

**Workability** - This refers to the ability of timber to be worked with hand or power tools. It may depend on the density, grain structure or defects contained in the timber.


**VIDEOS**

Construction and Transport Division, Sub-floor Construction (CTV20) available from Resource Distribution, Yagoona