TIMBER ROOF TRUSSES

This text introduces subject matter related to the manufacture and installation of timber roof trusses. It builds on knowledge and skills acquired during the first stage, which should be revised and practiced throughout the course.
Reference may be made to "Basic Building and Construction Skills", produced by TAFE and Addison, Wesley, Longman Australia Pty Limited, to re-examine and reinforce these basic skills.

The main areas covered are:
Truss types and connectors for gable and hip roofs and the erection procedure for both gable and hip roofs, including gambrel or Dutch-hip ends and flashings.

Also covered is the identification of truss types and quantities of each, based on truss layout plans.

***Note**: Only pre-fabricated trusses and their erection are dealt with. This text does not cover site manufacture or alteration.*

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.

INTRODUCTION

ROOF TRUSSES

A roof truss may be defined as being: '*an unyielding frame designed to span or transfer loads between supports.'*

Trusses have been used for building construction since the early Roman Empire days to create large open expanses of roof area. The simplest and most commonly used type for short spans is the *King post* truss, shown below:

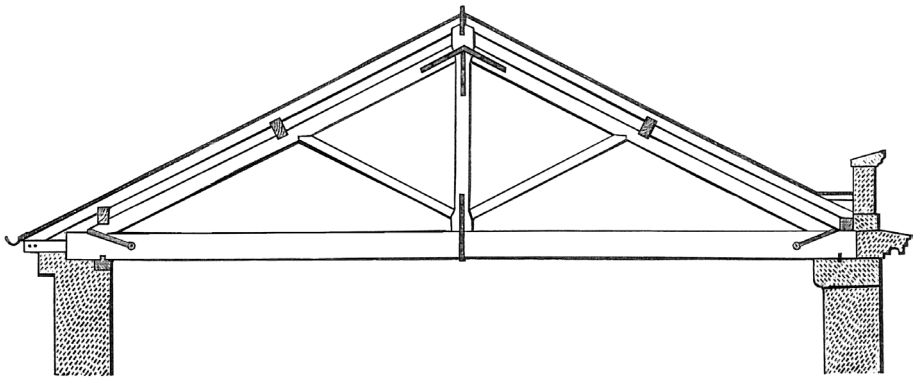


Fig. 1 King post truss

Larger spans saw the introduction of the *Queen post* truss, shown below:

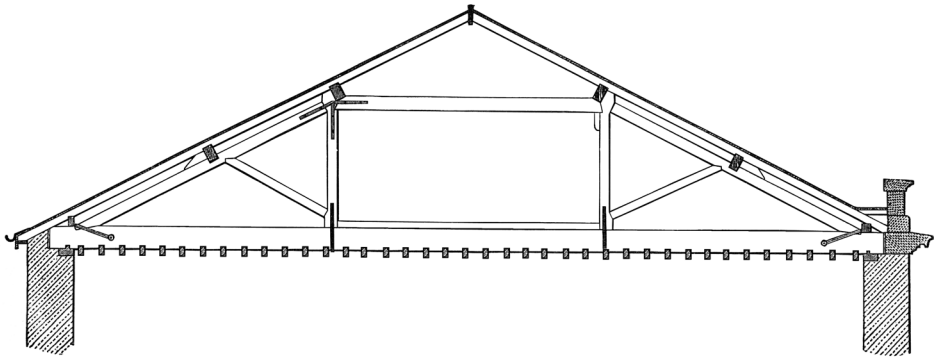


Fig. 2 Queen post truss

DECORATIVE TRUSS

Public buildings, such as churches, demanded a more ornate appearance than the simple King and Queen post trusses. This meant that trusses not only had to provide structural support, but they had to be aesthetically pleasing to the eye. Trusses with ornate built-up sections were constructed, such as the highly ornate *Hammer beam* truss, shown below:

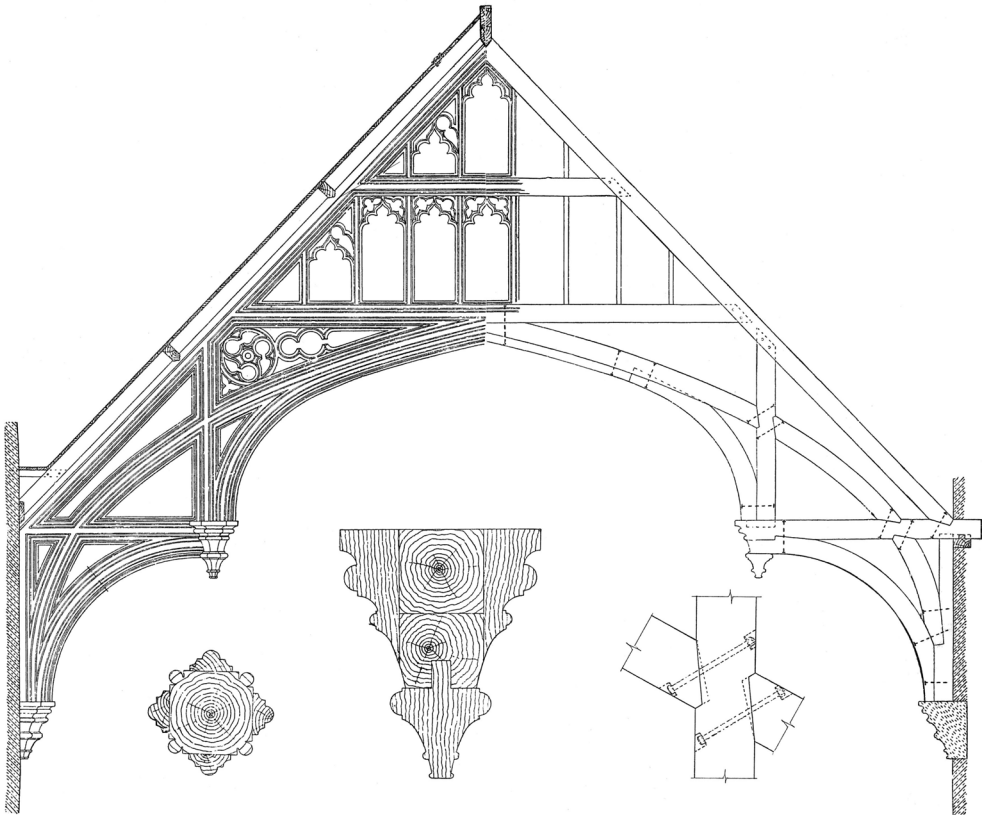


Fig. 3 Hammer beam truss and ornate sections

OTHER TRUSS TYPES

- Belgian truss
- Bell truss
- Bowstring truss
- Cambered Fink truss
- Cantilever truss
- Crescent truss
- Double Howe truss
- Double-W truss
- Fan truss
- Fink truss
- French truss
- Girder truss
- Half truss
- Hammer beam truss
- Hip truss
- Howe truss
- Inverted cantilever truss
- Jack truss
- King post truss
- Monopitch truss
- Parallel chord truss
- Pitched truss
- Pratt truss
- Queen post truss
- Sailover truss
- Sawtooth truss
- Scissored parallel truss
- Scissor truss
- Southlight truss
- Truncated truss
- Umbrella truss

CATEGORISING TRUSSES

These trusses fit into three basic categories, according to the shape of their upper chord:

1. Triangular roof trusses
2. Crescent roof trusses
3. Roof trusses other than these

1. ***Triangular Roof Trusses:***
These contain the most common types of trusses used for building. Triangular roof trusses may be identified by the web bracing used and the simple triangular geometric shape used throughout their design. The top chords are straight.

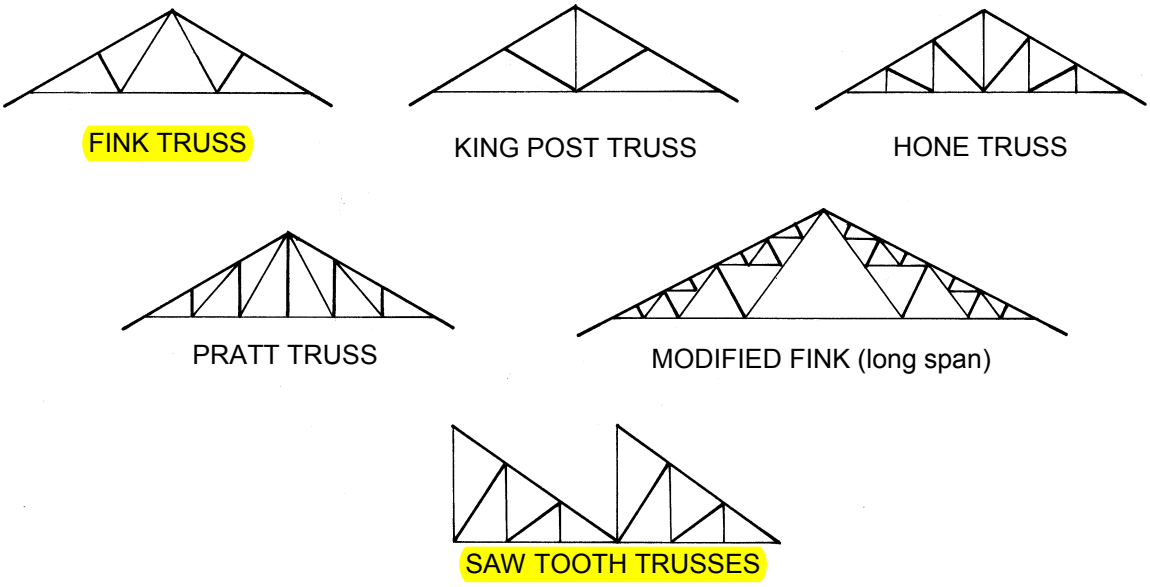


Fig. 13.4 Typical triangular roof trusses

2. ***Crescent roof trusses***
When the top chord of the truss becomes bent or curved the trusses are referred to as crescent trusses. The Sydney Harbour bridge is a large version of a *Bowstring* or crescent type truss.

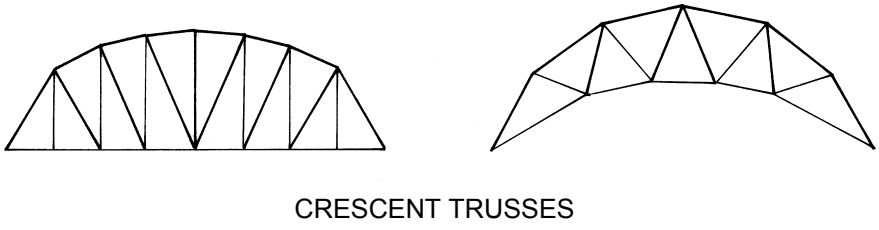


Fig. 5 Typical crescent roof trusses

3. ***Roof trusses other than these***

Trusses, which do not come under the title of triangular or crescent types, may be regarded in a class of their own. This class takes in trusses, which have top and bottom chords parallel, or almost parallel to one another, similar to those used for bridge building

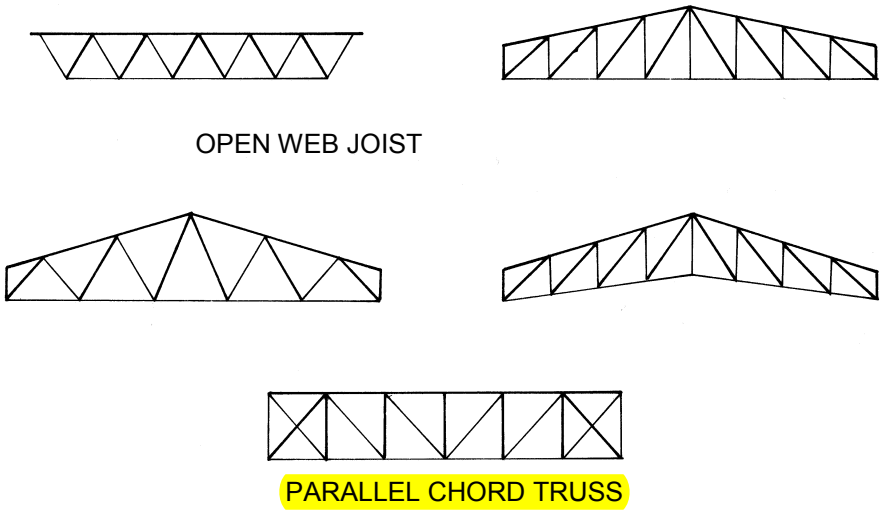


Fig. 13.6 Various trusses

Fig. 7 A well known trussed structure - Sydney Harbour Bridge

Terminology:

Abbreviations: BC - Bottom chord, HTC - Horizontal top chord, TC - Top chord, TG - Truncated girder (truss), TS - Truncated standard (truss).

Camber: This is an upward curvature built into the bottom chord to compensate for long-term deflection caused by dead loads, such as roof tiles.

Gable-end truss: This is the first truss at a gable end. It is also known as a *Raking truss*.

Girder Truss: This is a truss that supports other trusses or beams. It may have a standard truss shape or a truncated truss shape, depending on where it is situated in the roof.

Nailplates: These are patent-type metal connectors made from a light gauge galvanised steel with teeth formed from the plate, by punching them through from one side. The nailplates are normally pressed from both sides to form a spliced or gusseted connection.

Overhang: This is the section of the truss top chord found within the horizontal eaves width area. It runs from the pitching point to the end of the plumb cut at the fascia position.

Raking Truss: This is a gable-end truss, which has the top chord lowered, by the width of the top chord, to allow outriggers to be placed over the top to support the barge and eaves.

Reinforced-head nails: These are nails with either an enlarged shank beneath the nail head, or have a specially tapered head with enough thickness to eliminate the possibility of the head becoming brittle during driving or under load, and breaking off.

Station: This is the position of a truncated truss, a truncated girder truss, or a gambrel girder truss, as measured from the pitching point t the near face of the truss.

Structural fascia: This is fascia of the type capable of distributing overhang loads to adjacent trusses. Solid timber fascia would be a typical example of this.

Truss engineer: This is a professional engineer, as specified in the BCA, experienced in the design of nailplated timber truss systems.

Valley saddle trusses: These are trusses that are supported on top of other trusses and used to form the roof shape between roof segments.

Waling plate: This is a timber member normally fixed to the face of a truss to support intersecting rafters or trussers, as typically found on the front of a gambrel truss.

ROOF TRUSS MEMBERS AND STRESSERS

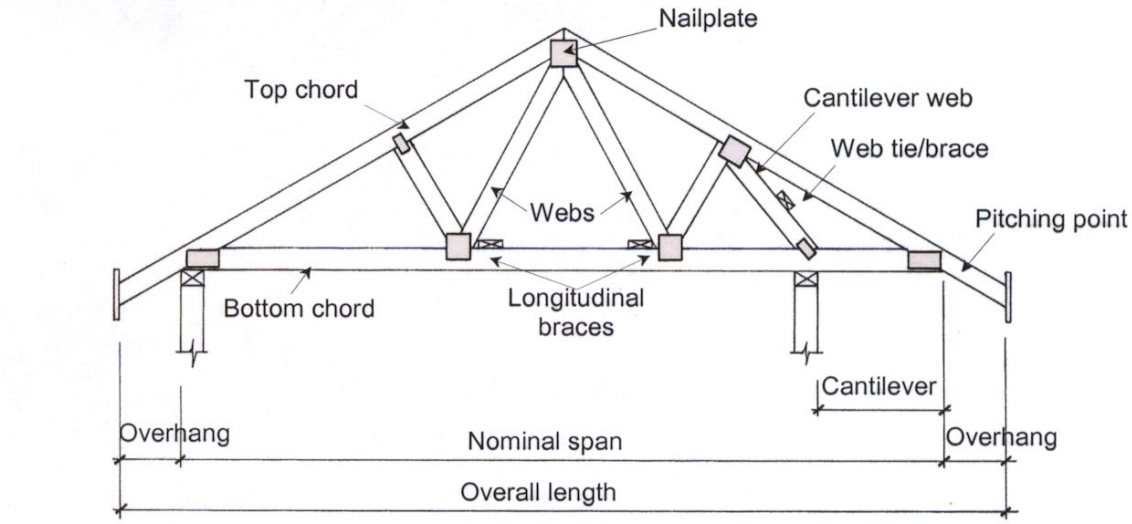


Fig. 8 Truss members

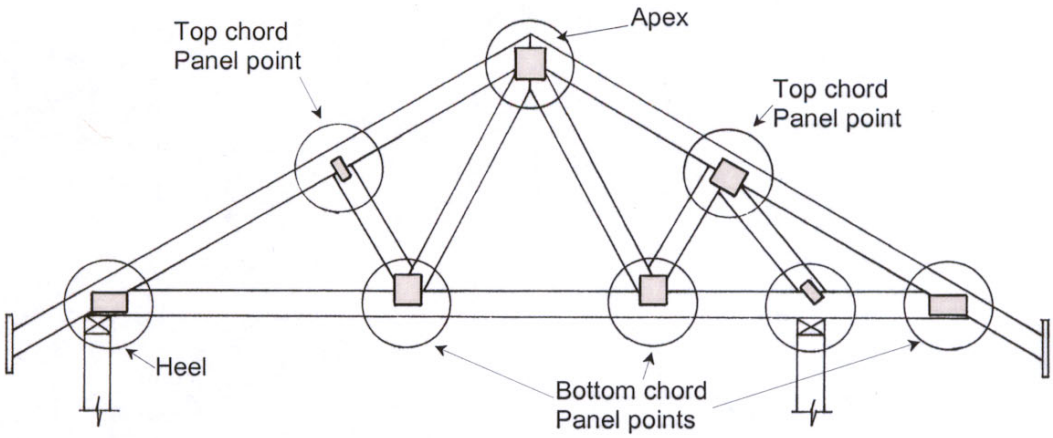


Fig. 9 Truss panel points

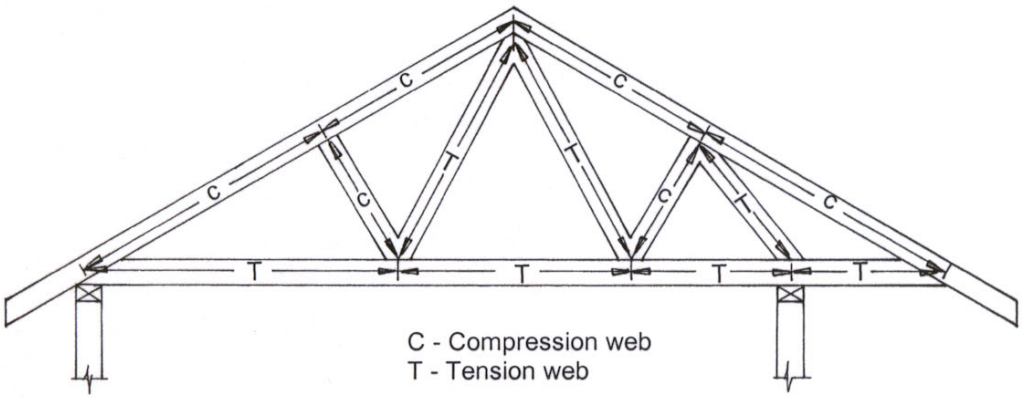


Fig. 10 Stresses in truss members

SPECIAL TRUSSES

Parallel Chord Trusses

These trusses are commonly used where large raking or level spans are to be bridged with no intermediate support. They provide strength and versatility using relatively small individual member section sizes. Parallel chord trusses are ideal for raking roofs and suspended floors as they allow services, like electrical, plumbing, air-conditioning, etc., to be built-in and concealed without having to modify the truss members.

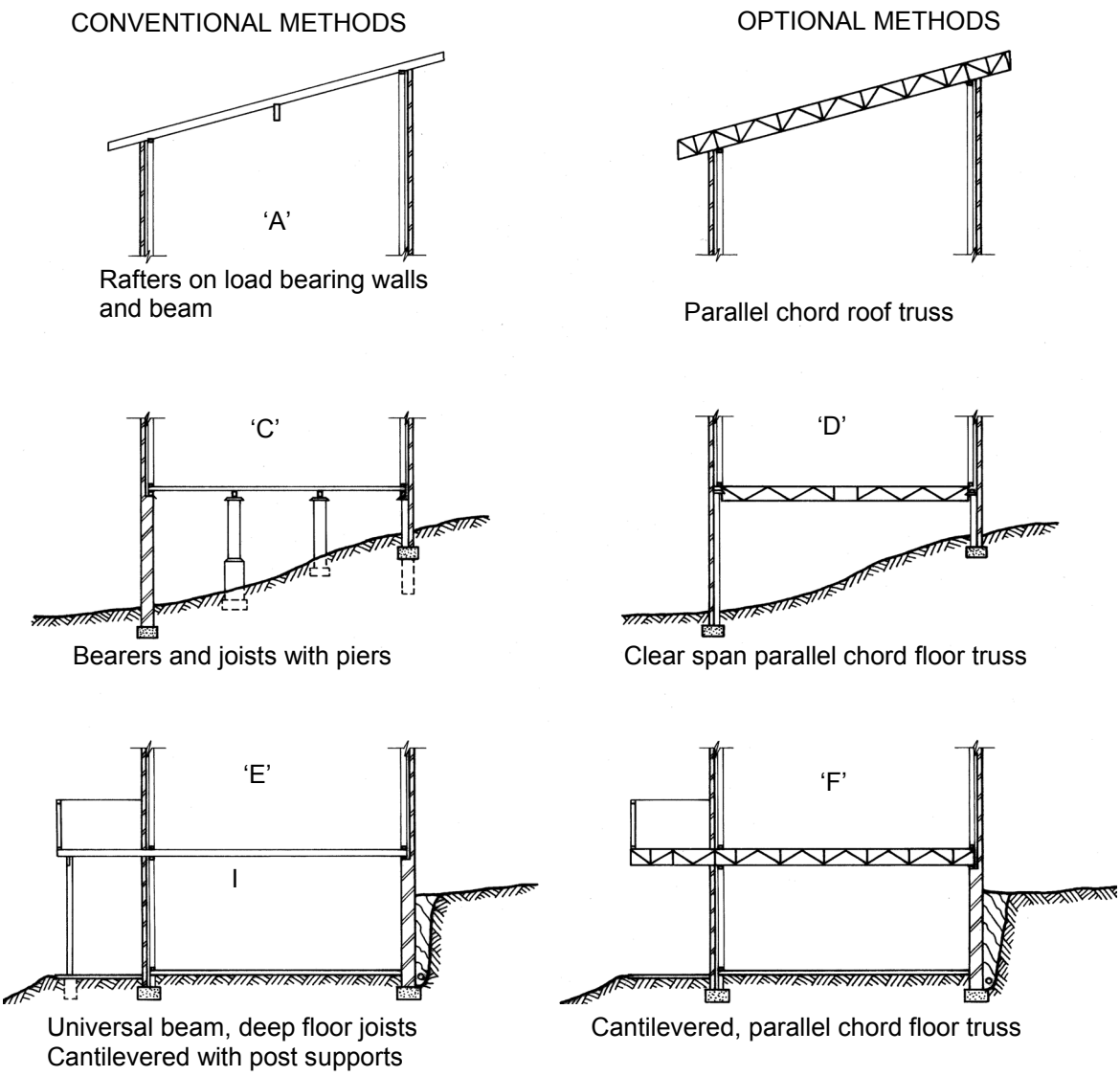


Fig. 11 Using parallel chord trusses

Parallel chord trusses may be used in a ground sub-floor or upper floor situation, provided suitable Class 1 or 2 timbers, or treated timbers, are used where the trusses are exposed to moist conditions.

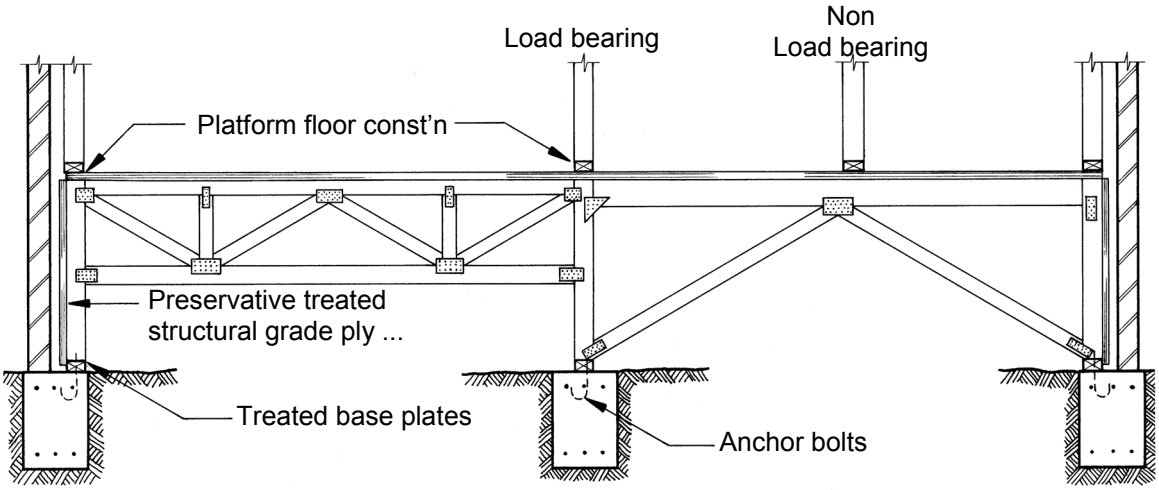


Fig. 12 Ground floor system

Cantilevers may also be built into the main length of the truss for balconies, however unless the timber is treated it may not be used in an externally exposed position. Block-outs may also be built into the design to cater for large sectioned services.

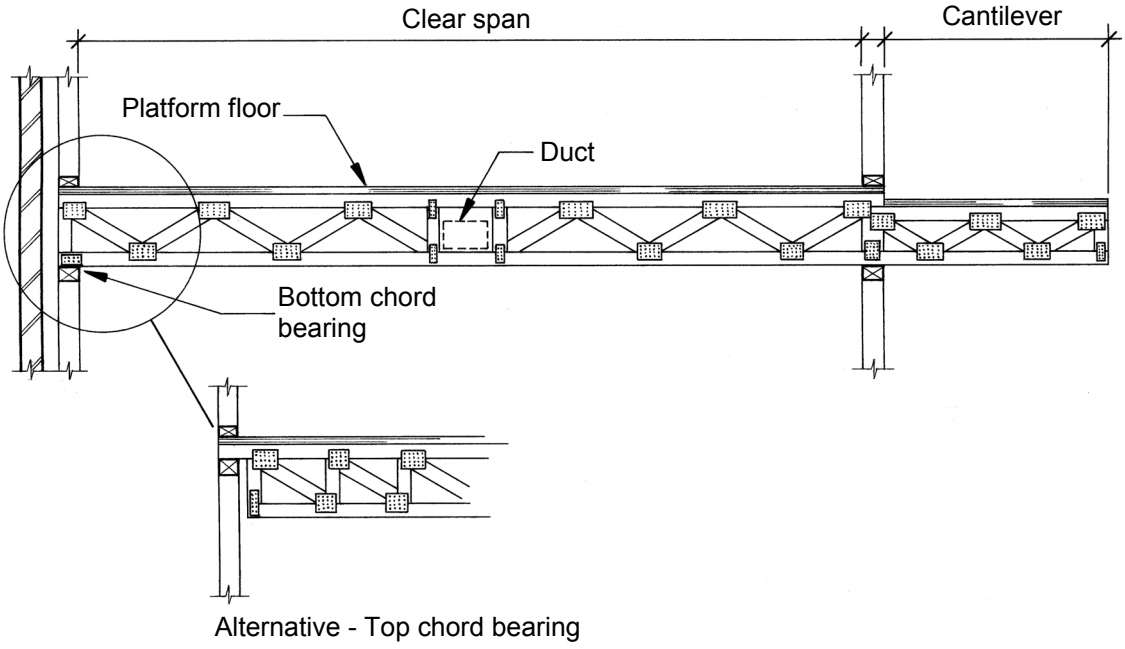
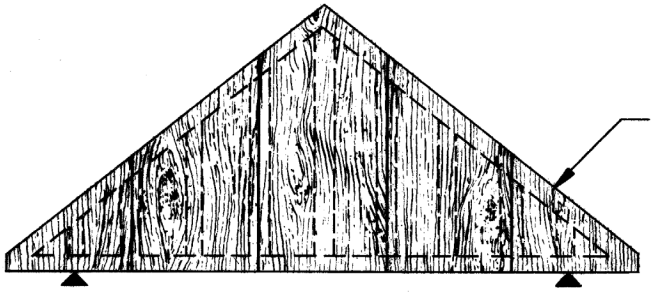


Fig. 13 Upper floor system with cantilever

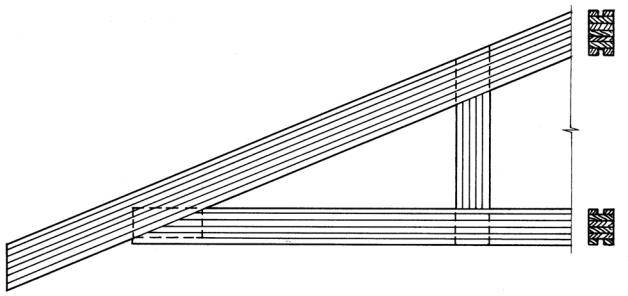
LAMINATED TIMBER TRUSS



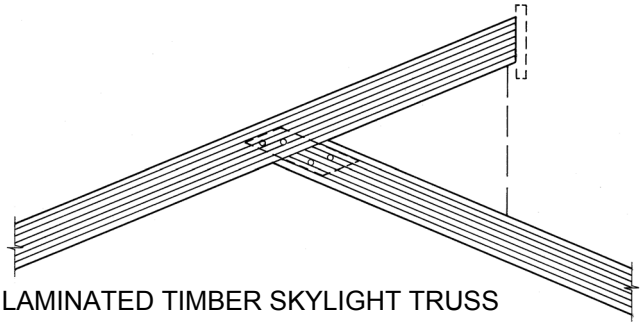
LAMINATED PLYWOOD TRUSS

Laminated timber trusses have great individual member strength, which reduces the number of members required to construct the trusses. They may be constructed from non-visual grade structural timbers and covered, or be constructed of visual grade structural timbers and covered, or be constructed of visual grade structural timbers and be exposed with a stained or clear finish. Laminated beams and portal frames are also available, such as the popular *'Glulam'* beam system.

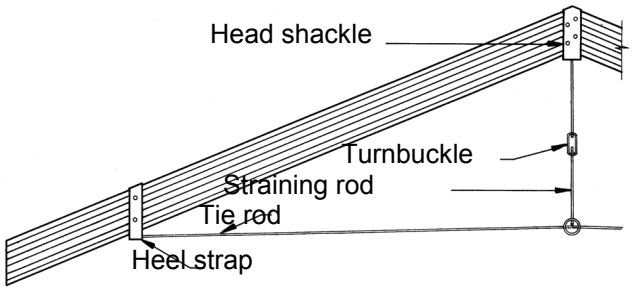
Vertically laminated plywood trusses are also available, although not widely used.



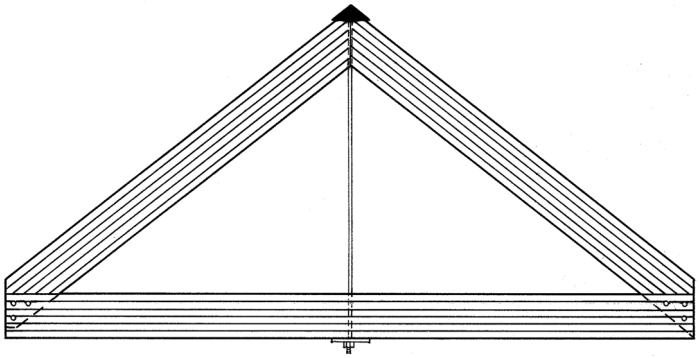
LAMINATED TIMBER ROOF TRUSS



LAMINATED TIMBER SKYLIGHT TRUSS



TIE ROD TRUSSED RAFTERS (LAMINATED TIMBER)



KING ROD TRUSS (LAMINATED TIMBER)

Fig. 14 Laminated truss types

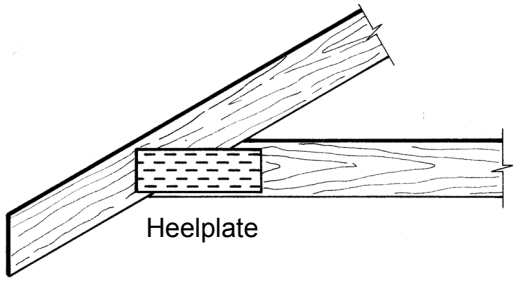
TRUSS MANUFACTURE

Assembly

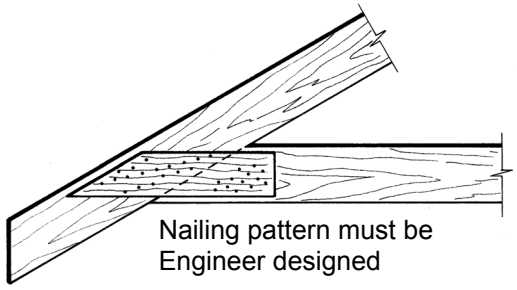
The member sizes, stresses and truss design are prepared by a professional truss engineer and must not be designed or manufactured by any other person, unless under the direct supervision of the engineer.

The trusses are manufactured in a controlled factory environment with members being calculated, cut and assembled using computerised machinery.

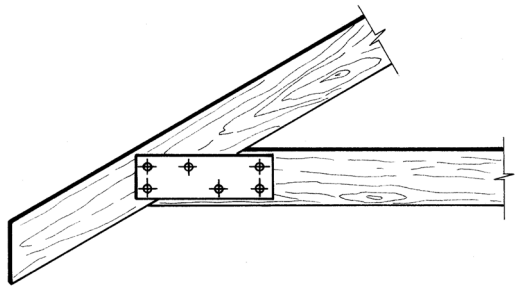
The members are set in position using a jig and joints are connected with patent type nailplates, on both sides of the connection, which, which are pressed into the timber using a static or mobile press.



GANGNAIL OR NAILPLATE TYPES



NAILED PLYWOOD OR TIMBER CLEAT



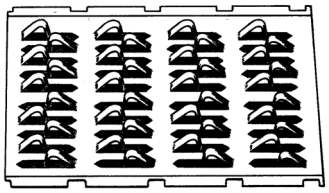
BOLTED STEEL FISHPLATE

Fig. 15 Methods of connecting members at panel points

Nailplates

The nail sections are punched out of a solid plate body to protrude from one side, allowing the plate to sit flat when pressed or hammered.

Claw-type plates are usually pressed, whereas Knuckle-type plates may be driven with a hammer.



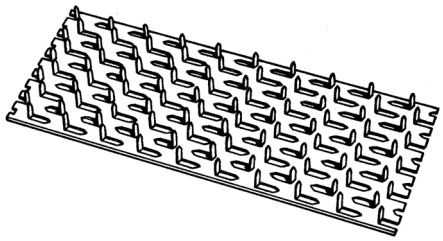
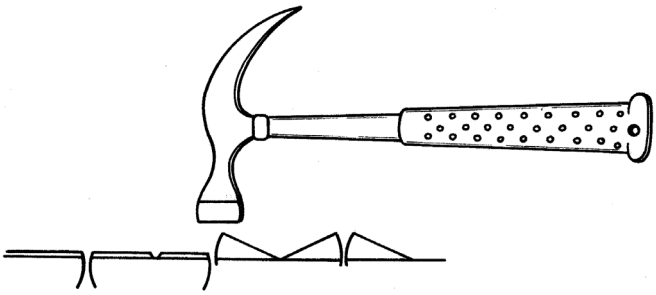


Fig. 16 Nailplate types

Driving Nailplates

Nailplates may be driven using a hammer, but this method would only be used where a press is unavailable such as an on-site truss repair or modification.

***Note**: Manually driven nailplates are not suited for general roof truss manufacture.*



Hammered or hydraulically pressed

Fig. 17 Hammer driven connector

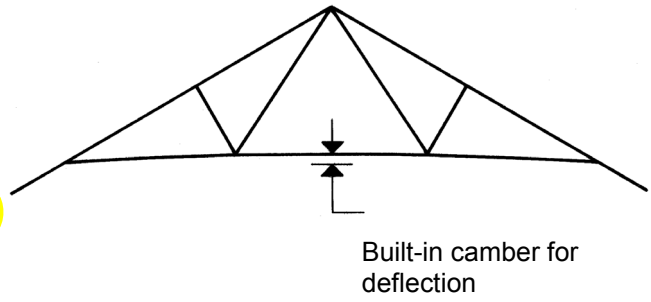
Camber

Trusses are fabricated with a slight camber in the bottom chord.

The camber is designed to provide a calculated maximum deflection, based on the span and load of the roof.

The camber is progressively taken up when deflection occurs due to roof loads being applied, such as roof tiles, ceiling linings, etc.

Under no circumstances should trusses be supported along their span, unless designed for, as applied loads may cause the truss to fail.



Built-in camber for deflection

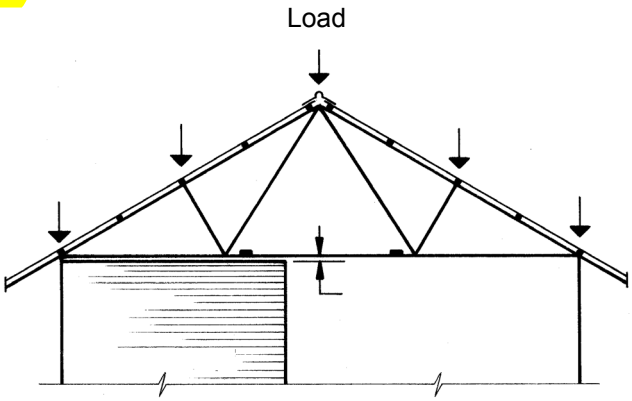


Fig. 18 Camber and settlement under load

SUPPORT PREPARATION FOR TRUSSES

The structure supporting the trusses must be level and square. Wall plates and beams must be load-bearing where the ends of trusses, or intermediate panel points for cantilevered trusses, are directly supported.

The minimum bearing width for trusses shall be not less than 70mm. If this cannot be provided the truss engineer should be consulted.

Load-bearing Walls

If standard thickness top wall plates are used, I.e. up to 45mm seasoned, 50mm unseasoned, then trusses must be placed directly over wall stud positions.

This allows direct transfer of loads from the roof through the walls to the footings, without causing deflection in the plates.

If the trusses are not located directly over studs, or within 1.5 times the thickness of the wall plate from the stud, it is considered to be *random loading*, which will require some reinforcement of the plates

This may be carried out by using a thicker top plate, i.e. 70mm minimum, or doubling the top plates, i.e. 2/35mm plates, or by fixing additional blocking between studs tight under the top plate.

Trusses with additional loads applied, such as a Girder truss, are best supported using a stud or studs directly under the ends. This will prevent possible cornice crushing in the future..

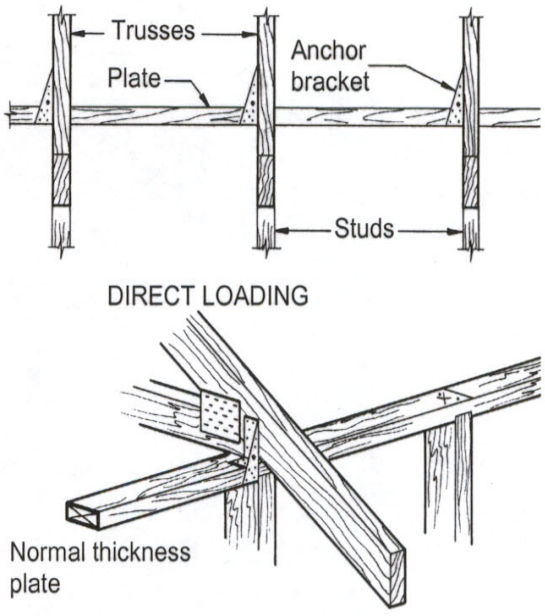


Fig. 19 Direct loading over studs

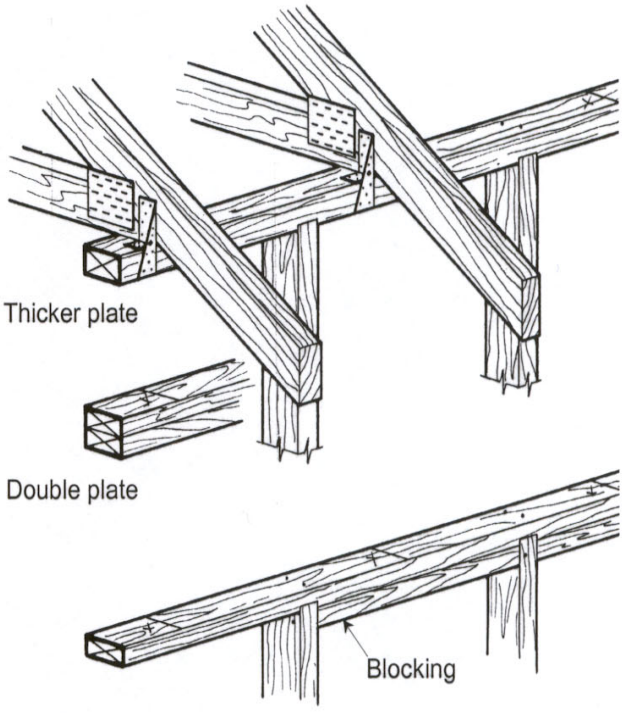


Fig. 20 Random loading requirements

Inadequate Support

When trusses do not align with studs, or plates are not thickened, doubled or blocked, the result will be deflection of the top plates, which inevitably causes cornice crushing and/or ceiling lining cracks.

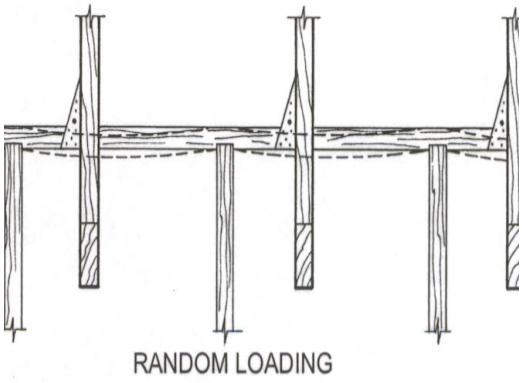


Fig. 21 Result of unsupported random loading

Lintels

Due to the roof loads being transferred to the external walls, it will be necessary to provide adequate support across openings.

A suitable timber, steel, or a combination of both, lintel will be required having a section size and stress grade as per AS 1684.2-1999 Part 2.

A common lightweight method of providing support is to use standard timber framing and a patent steel type ‘Z’ or’ ’C’ section cold formed lintel.

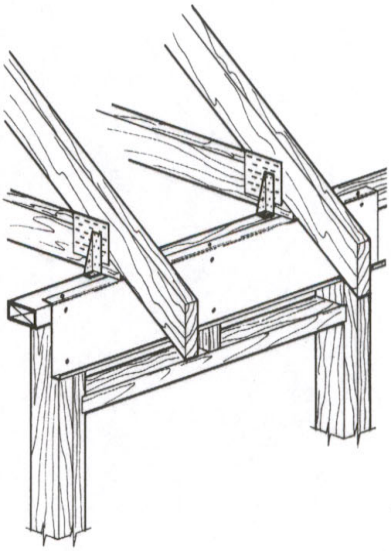


Fig. 22 Patent-type steel lintel system

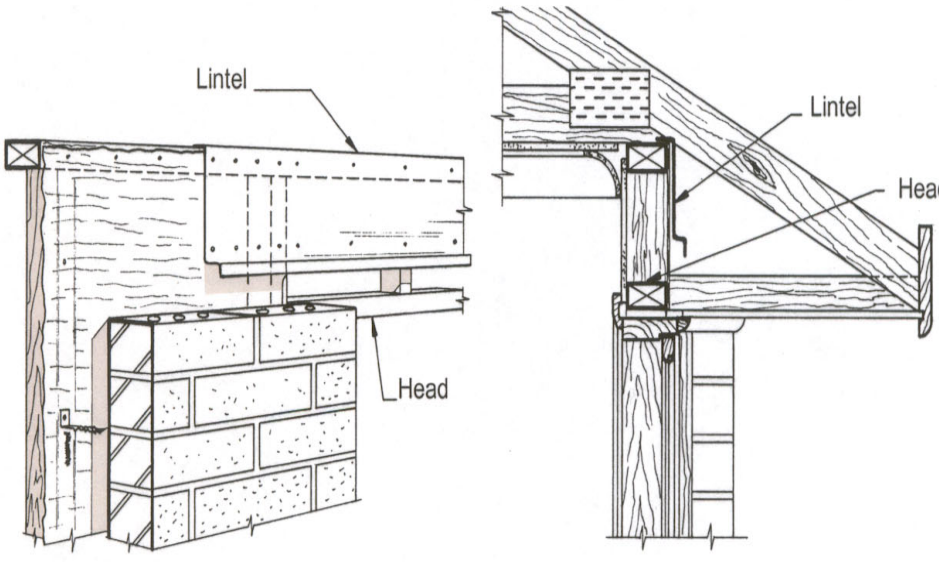


Fig. 23 Details of steel lintel placement

Lintel Details

Steel patent type lintels are available in a variety of sizes for 'Z' and 'C' sections. The sizes are to comply with requirements of AS 1684.2-1999 Part 2 for lintel loads and spans.

The following details provide a guide for design proportions.

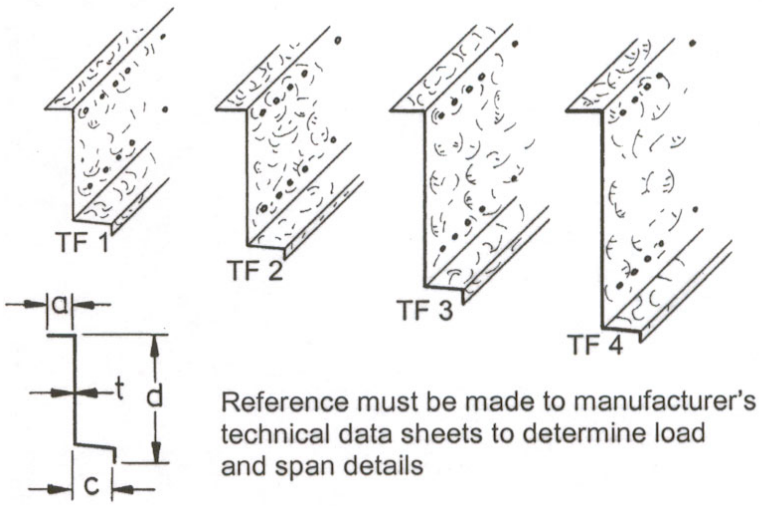


Fig. 24 Section details

Table 1
Steel Lintel Proportions

Type	Dimensions			
	a	d	c	t
TF 1	35	147	45	1.6
TF 2	35	147	45	2.0
TF 3	40	219	45	2.5
TF 4	45	264	45	3.0

Laminated Timber Lintels

Type A : Laminated veneer lumber (LVL) lintels and *bressumers* are vertically laminated veneers of timber, which give the appearance of being a very thick plywood member.

Type B: Glue laminated timber lintels and beams are constructed of engineered hardwood or softwood timbers horizontally laminated to form a stronger member than solid timber.

They may be plastic wrapped or wax coated for surface protection from exposure during construction.

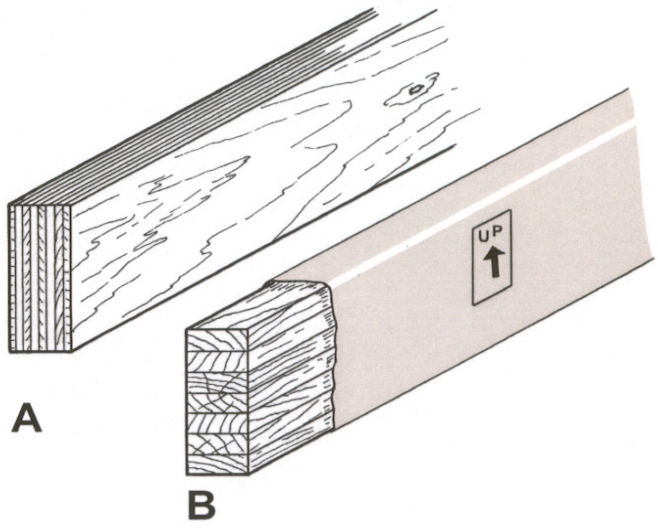


Fig. 25 Laminated lintels and beams

LIFTING and STORAGE of TRUSSES

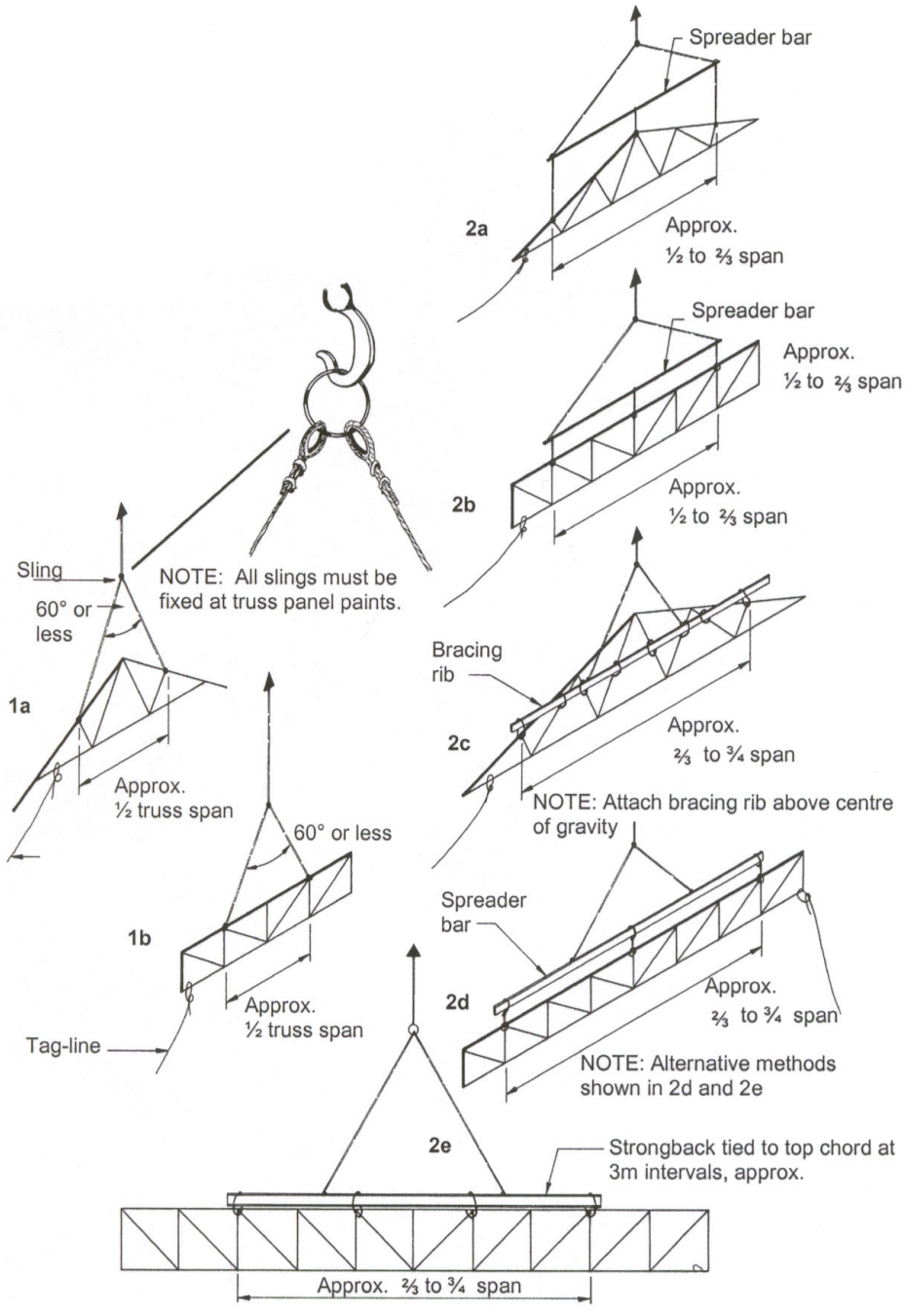
Lifting Trusses

When lifting, care must be taken to avoid damaging the timber and the joints or panel points.

Never lift a truss by its apex joint only as this may cause the truss joints to separate.

Always use a spreader bar to lift trusses to spread the load evenly and remove the pressure from joints.

The following details show how different types of up to 9.0m, types 2a to 2e are considered to have large spans of 9.0m to 18.0m.



Bundle Lifting

A number of trusses may be lifted into place at the one time, provided they are properly tied or banded together and lifted form the designated slinging points. This method of lifting same size trusses speeds up the lifting and placing process.

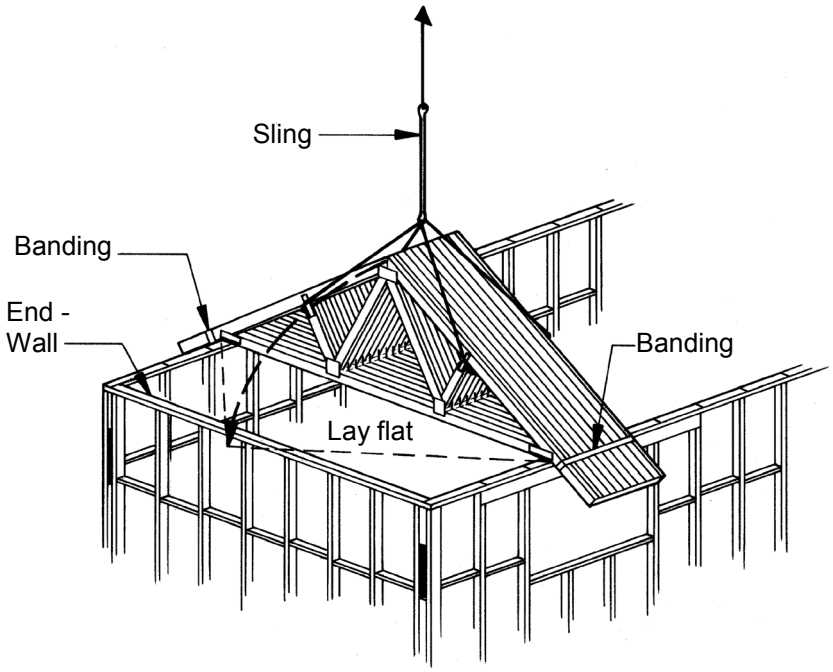


Fig. 27 Bundle lifting method

Storage of Trusses

Trusses should be inspected when they arrive on-site and any damage reported. They should not be site repaired without consultation with a truss engineer.

When stored on-site they should be placed on timber gluts, or *dunnage*, to keep them clear of the ground to allow flat storage and to avoid member distortion.

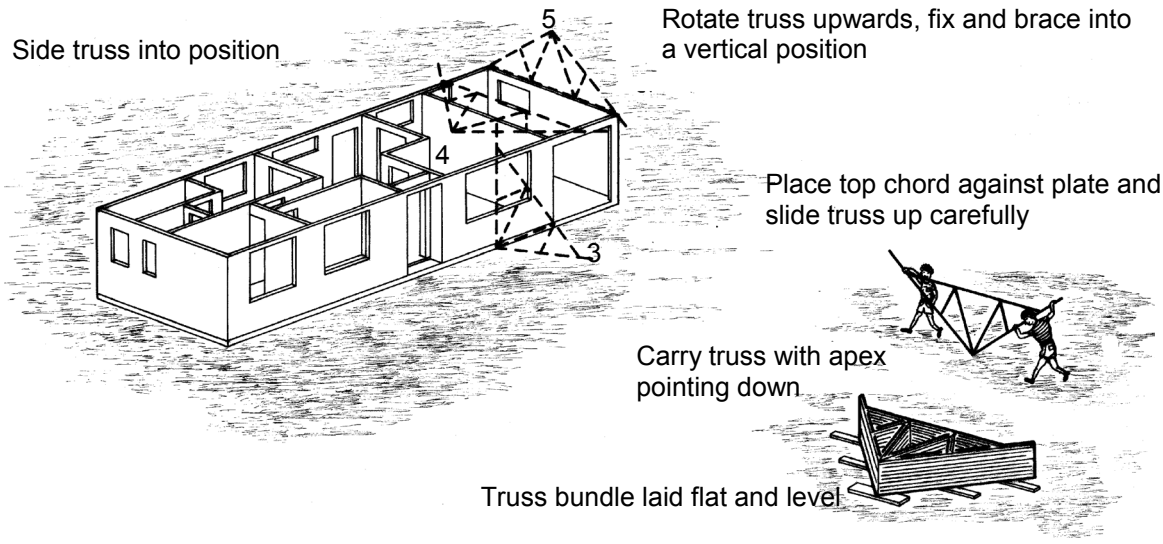


Fig. 28 Lifting trusses by hand

ERECTING AND FIXING TRUSSES

Gable Roof

The gable roof is the simplest style of roof to construct using trusses. All the trusses are exactly the same shape and size, except where raking trusses are used, making it a very quick and efficient system to use.

Note: *Installation of timber trusses comply with AS4440-1997 Installation of nailplated timber trusses.*

Method

Step 1 Truss positions may be marked out prior to erection, although with a straight forward gable roof this is not necessary.
The trusses are lifted onto the wall frames and stacked in positions where they are easily retrieved for erection. The stacks of trusses should be spaced far enough apart to allow progressive erection without having to move a stack out of the way . For example, if each stack has 5 or 6 trusses the first stack should be placed at least 5 or 6 spacings away from the position of the first truss to be erected from that stack.
This prevents the need for double handling and unnecessary moving of trusses.

Step 2 Start with a gable or raking truss at each end by aligning the heels of the trusses with the outside of the wall plates.
Erect and attach temporary braces to each end truss, holding them plumb, as all subsequent trusses are spaced from and attached to them.
Note: *External bracing is preferred to prevent the temporary braces form interfering with the next truss position.*
A string line is attached to the apex of the gable trusses and pulled taught to allow all subsequent truss apex points to be in-line, within ±2mm.

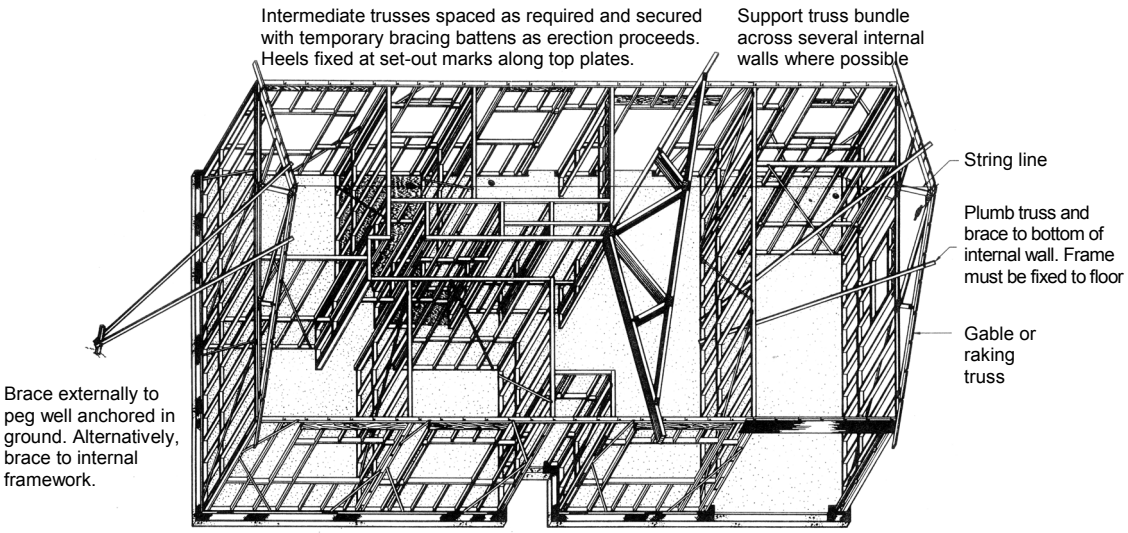


Fig. 29 Initial truss loading and preparation

Step 3 The spacing of trusses is best controlled by using a gauging rod. This is simply a length of batten at least 700mm long, for 600mm spacking, with two nails protruding at each end. The nails are set the thickness of the truss top chord apart and spaced equal to the truss centres.

One end of the gauging rod is placed over a fixed truss, with the next truss moved to allow the nails at the other end to hold it in the correct position while it is fixed off.

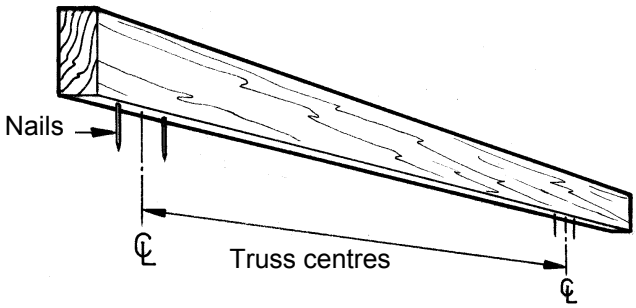


Fig. 13.30 Gauging rod for spacing trusses

Step 4 The remaining trusses are positioned using the gauging rod, skew nailed at the heel positions and held in place temporarily at the top using batten ties, which are tacked to the top chord.

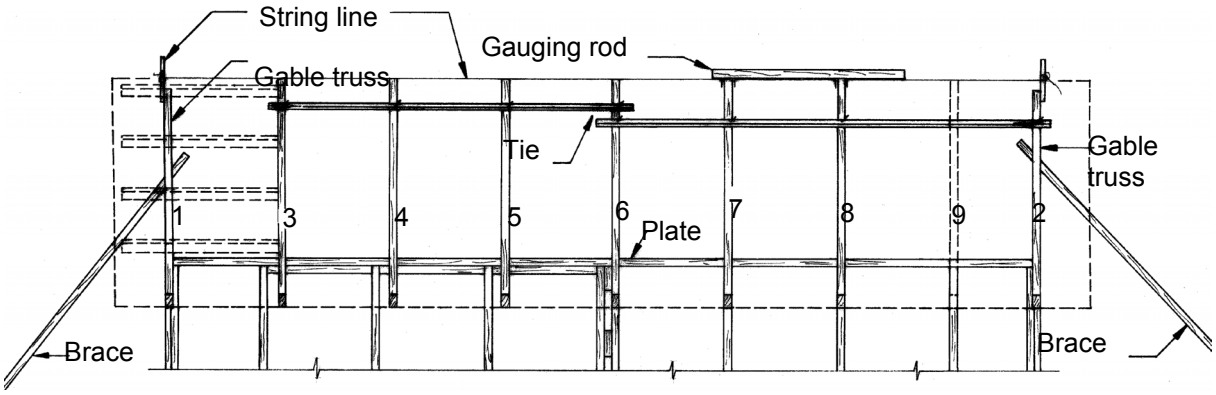


Fig. 13.31 Gable roof trusses set in position

Step 5 The ends, or heel positions, of each truss must be fixed securely to the top wall plates using one patent metal connector, similar to the Trip-L-grip.
These connectors provide 3-way fixing between the truss chord and wall plate using supplied flat-head nails.
There should be a minimum of 4 nails into the chord, 4 nails into the edge of the wall plate and 2 nails into the top of the plate.

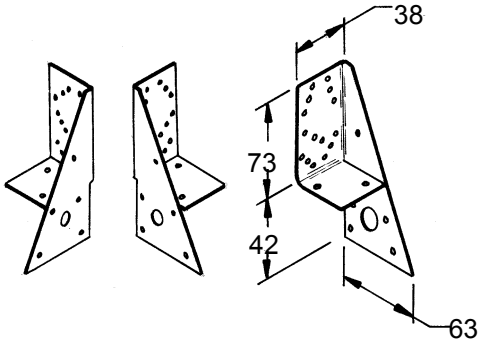
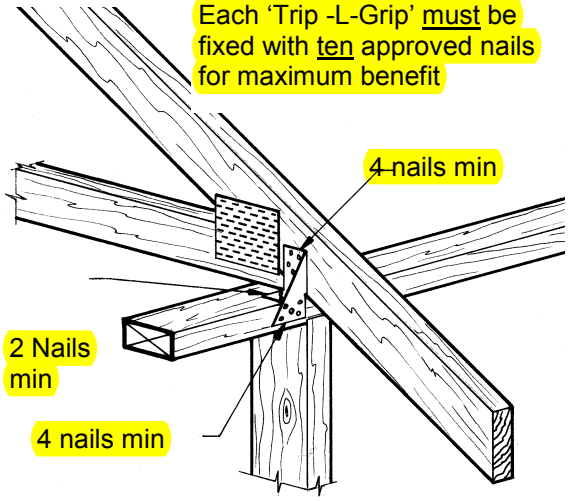


Fig. 13.32 Trip-L-Grip metal connectors

The following details outline the methods used to fix trusses to wall plates and provide alternative types of connectors for the same purpose.



ROOF TRUSS TO PLATE

Heel joints of trusses shall be fixed to top plates with one type AL or AR Trip-L-Grip. Use two Trip-L-Grips at each heel point in cyclonic areas or where sheet steel, aluminium, or fibrous cement is used.

Fig. 33 Conventional Trip-L-Grip connector

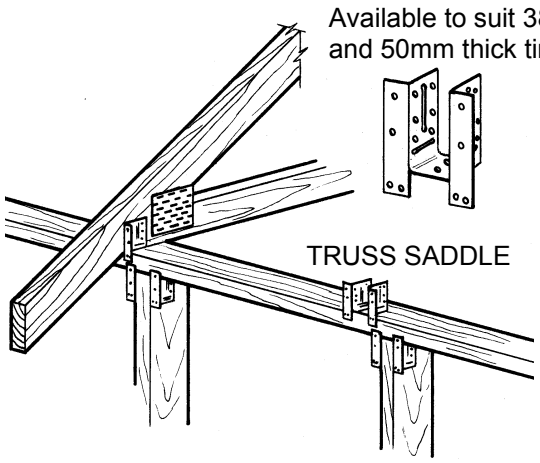


Fig. 34 Multi-grip anchor bracket

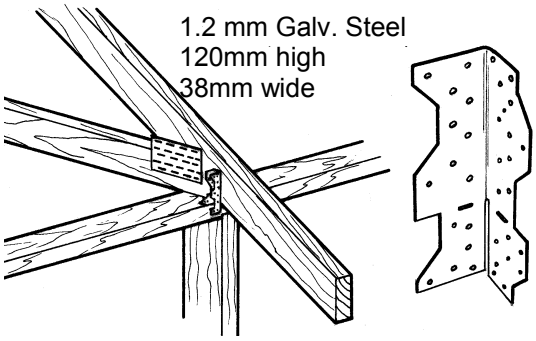


Fig. 35 Multi-grip all-purpose anchor bracket

Step 6

The gable end, or Raking Trusses, have their top chords set one chord width lower than the other trusses. This allows the outriggers, or verge trimmers, to run over the top of the raking truss to frame up the verge, which holds the barge and eaves lining.

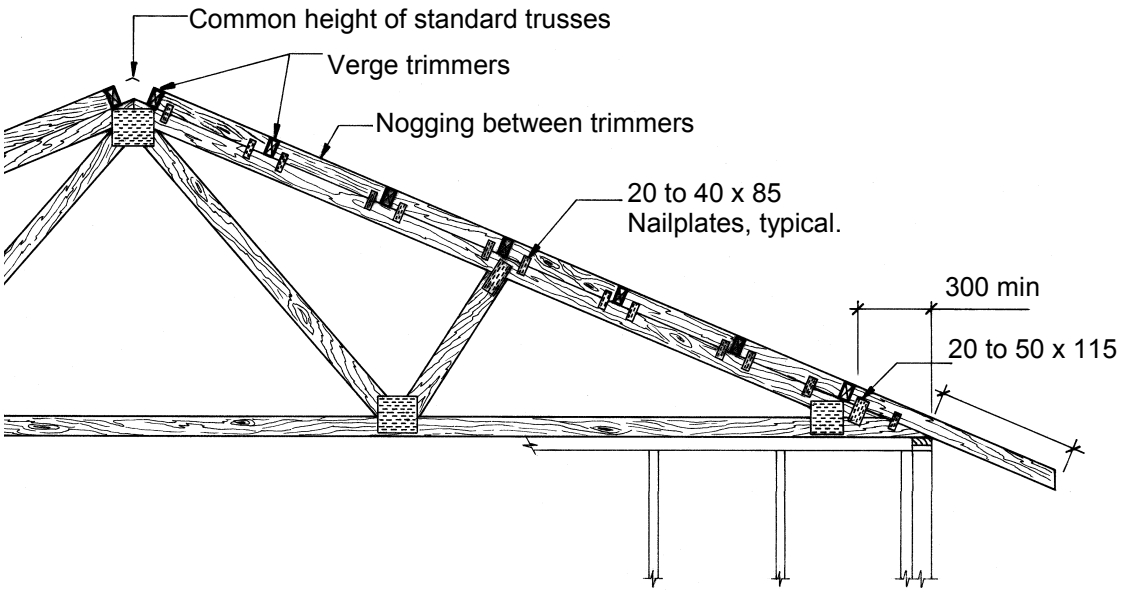


Fig. 36 Gable or Raking truss

VERGE FRAMING

Gable roof ends may have boxed or raking eaves.
The gable truss may be a *raking* truss, or it may also be a standard truss with short blocking for flush eaves. Specially designed 'Z' - sprockets, referred to as *Gunstocks* because of their shape, may also be used as an alternative.'

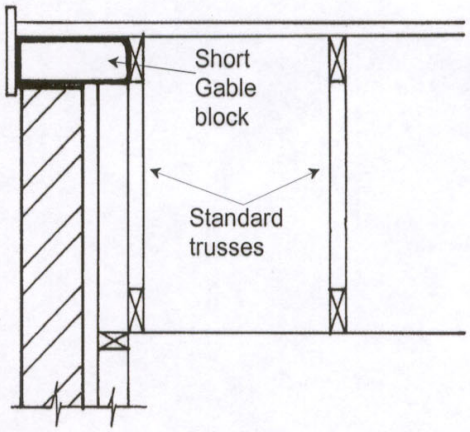


Fig. 39 Gable blocking

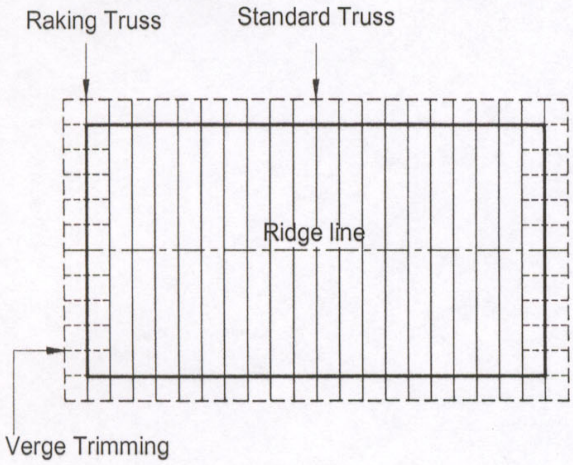


Fig. 37 Typical gable roof

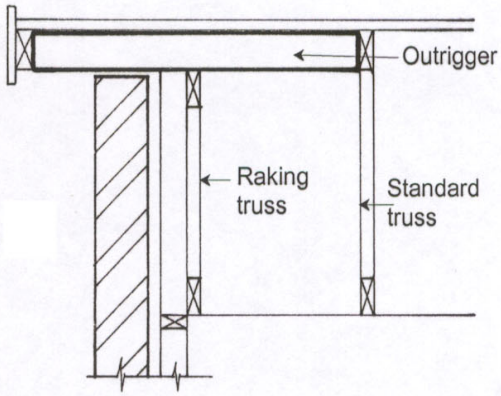


Fig. 40 Outriggers

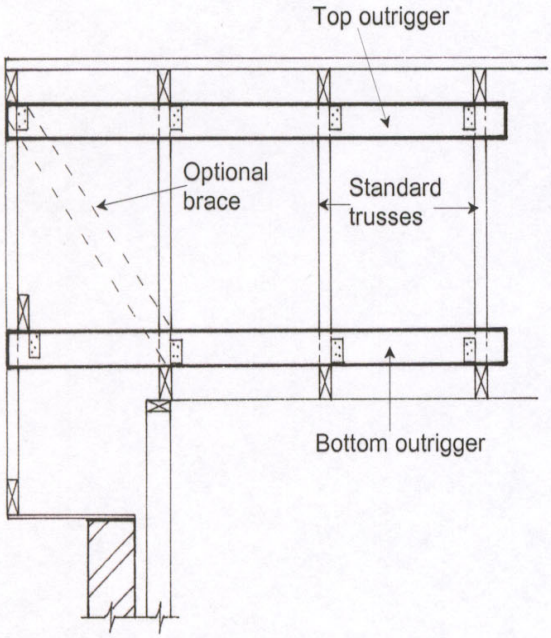


Fig. 38 Cantilevered outriggers

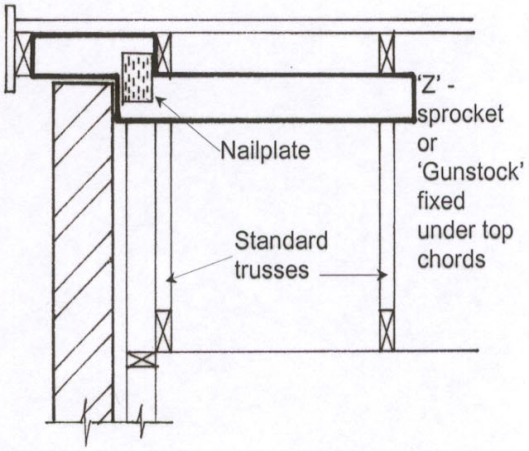


Fig. 41 'Z' - sprockets

Step 7

The bottom chords of the trusses need to be attached to internal walls without resting on them, unless they are cantilever trusses or they are otherwise designed to be supported internally.

Generally, trusses transfer the roof loads to external load-bearing walls only, leaving the internal non load-bearing walls free to be placed in any position.

Depending on the span of the trusses, there should be a minimum gap of 10mm between the bottom chord and the top wall plate of internal walls.

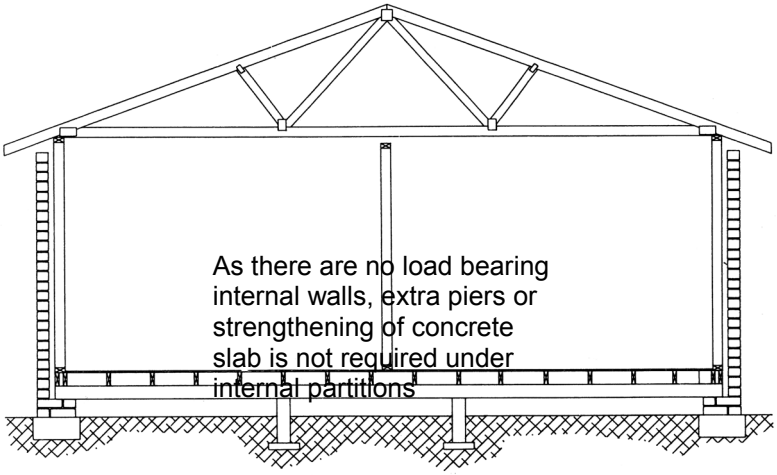


Fig. 13.42 Load transfer of roof trusses

Internal 'L' shaped wall brackets are used to connect trusses to internal walls, which prevents lateral movement of the trusses and the top of the wall. The wall brackets are fixed between the ceiling trimmers, and the top wall plates with a minimum of 3/30 x 2.8mm galvanised reinforced head nails to each bracket leg.

***Note**: The nails in the upright section of the bracket are fixed a the top of the slots to allow for bottom chord deflection movement.*

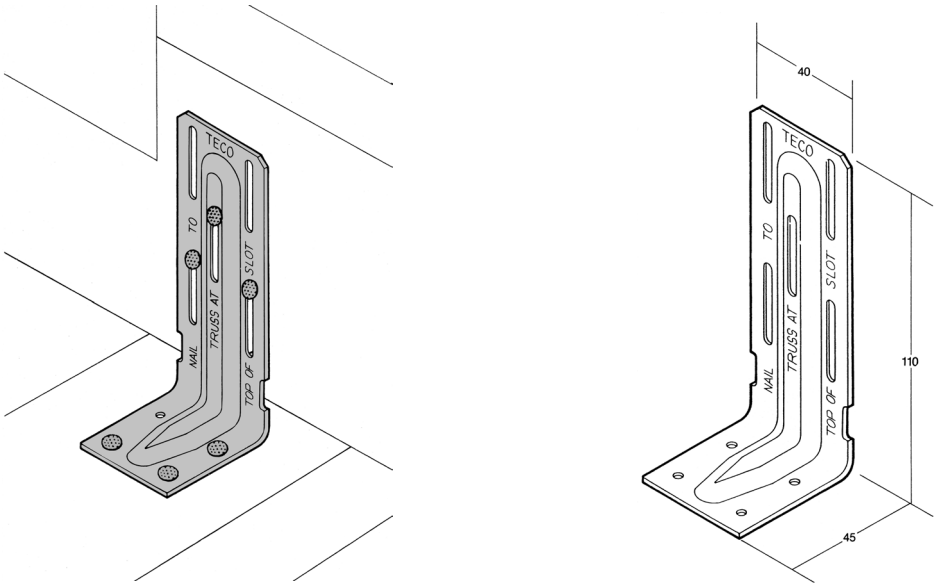


Fig. 13.43 Wall bracket details

Fixing to Non-bracing Walls

If internal or non-load bearing walls are not designed as bracing walls, the trusses are fixed to them using wall brackets.

The brackets are fixed at Max. 1800mm centres along support sections of the wall. Where trusses are parallel to the walls, ceiling trimmers are fixed between the truss bottom chords. Where non-load bearing walls are stable in their own right, no internal wall brackets are required.

***Note**: Ceiling trimmers are to be fixed at maximum spacings equal to the maximum spacing of trusses. The connection should also allow the truss to deflect vertically when loaded, ie, at least 10mm clearance between trimmer and top plate.*

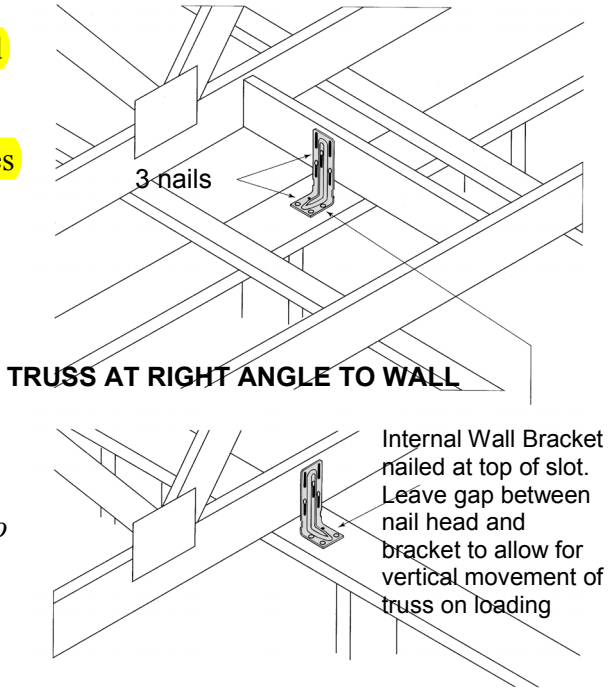


Fig. 44 Top plate fixing to non-bracing walls

Fixing to Bracing Walls

Where internal walls are non-load bearing but are designed as bracing walls, the trusses should be fixed to the top plates using structural connections of equivalent strength to the bracing strength of that particular wall.

This may be achieved by fixing blocking pieces to either side of the truss or ceiling trimmers.

***Note**: The connection should also allow the truss to deflect vertically when loaded, ie at least 10mm clearance between trimmer and top plate.*

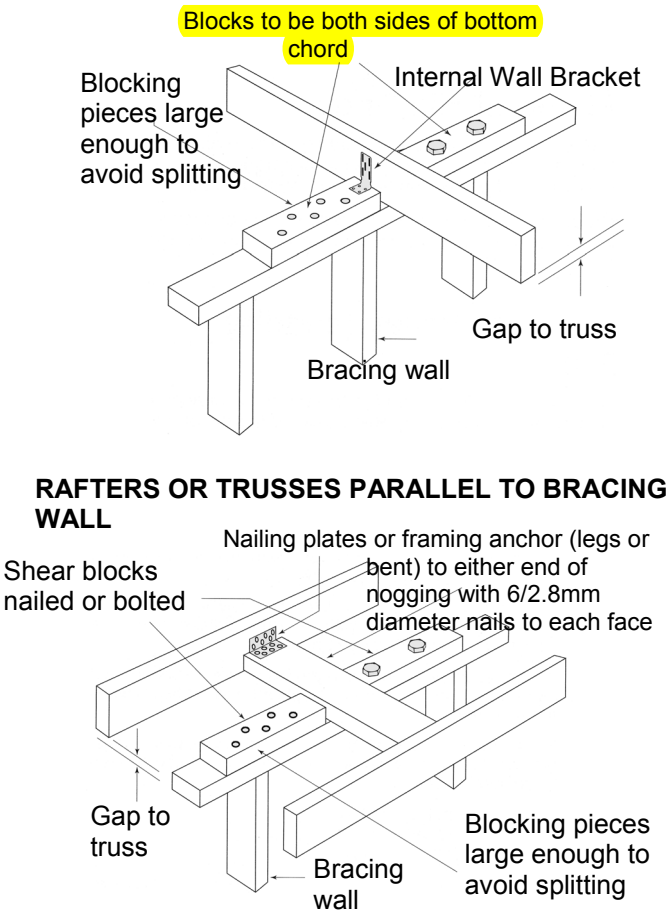


Fig. 45 Top plate fixing to bracing walls

Step 8

Fit permanent bracing over the top chords of the trusses onto the rigid walls to prevent the roof frame from racking, rotating or buckling under the load of the roof tiles, ceiling materials or from wind forces.

The most common type of roof bracing is perforated metal *Speedbrace.* This is a patent type of bracing system for trussed roofs for use in both low wind speed and cyclone areas.

Speedbrace is a tension bracing system that uses a pre-punched shallow 'V' shaped member that is easily handled and erected. It is applied in an 'X' or 'V' pattern to the top chords, which braces the trusses back to the frame.

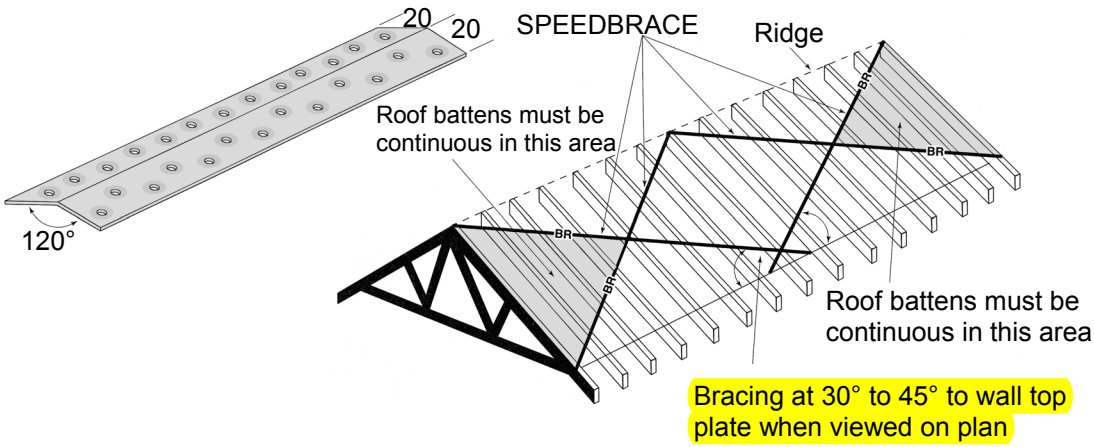
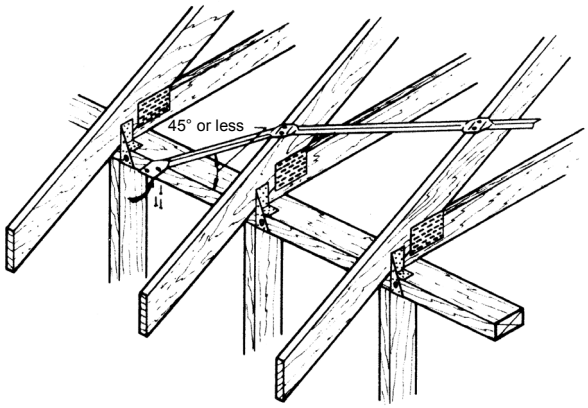


Fig. 46 The Speedbrace system

Fixing Methods

Ends should be wrapped around members as required and fixed off using 2/30 x 2.8mm galvanised reinforced head nails at each fixing position. ***Do Not*** use clouts.

Note*: See manufacturer's details for bracing designs of short to long roofs.*



Roofbrace secured to side of top-plate with two clouts and then bent around and fixed to bottom of plate with three nails

Fig. 47 Heel end fixing

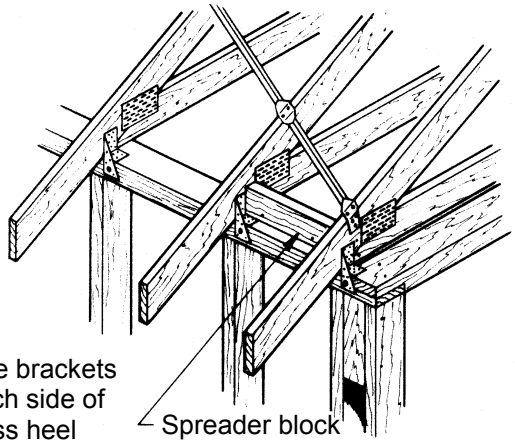


Fig. 48 Alternative heel end fixing

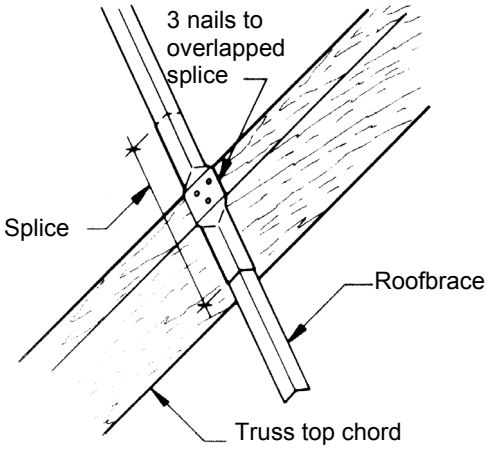


Fig. 49 Splice detail

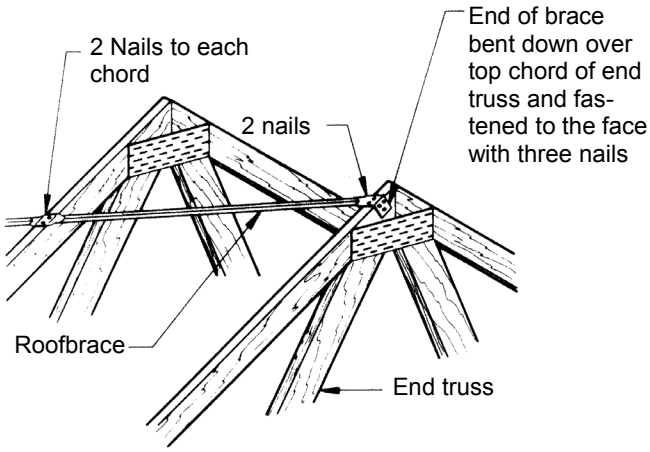


Fig. 50 Fixing to apex of end truss

Step 9

Permanent bottom chord braces, or Longitudinal braces, are required to hold the truss bottom chords straight under load.
For battened ceilings use batten sizes as specified by AS 1684.2 Part 2. Battern centres are not to exceed restrain centres specified on truss design drawings.

Bottom chord ties, and diagonal bracing may be required for suspended ceilings or where ceiling battens do not provide restraint to bottom chords, e.g. metal furring channels clipped to trusses.
Fit bottom chord ties for trusses at close centres with ceilings fixed directly to bottom chords with glue or nails. Bottom chord ties should be fixed and/or braced back to a rigid building element, such as an end or party wall.
The braces are normally fitted as close to the bottom panel points as possible to maintain lateral rigidity.

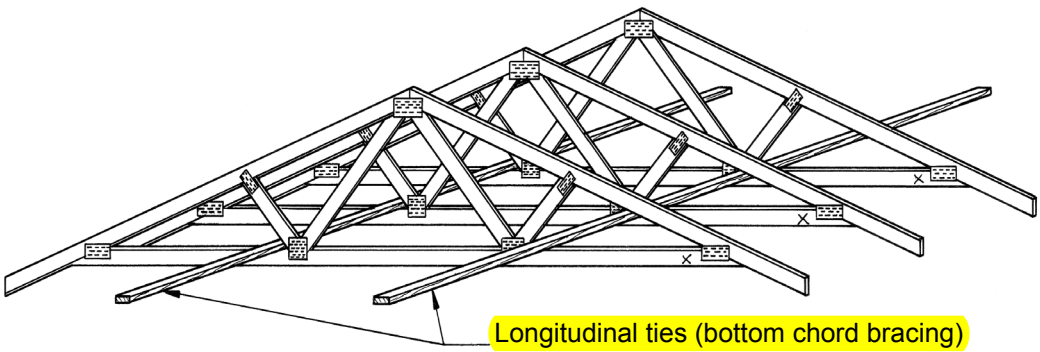


Fig. 13.51 Bottom chord or longitudinal bracing

SPECIAL NOTES ON TRUSS ERECTION

Temporary bracing

All trusses must be temporarily braced during the erection process to avoid the following:

- Collapse during erection; or
- Erection tolerance will be exceeded, causing overloading, buckling and possible permanent damage.

The first truss should be erected straight and plumb, within erection tolerances, and temporarily braced to a rigid element, such as a wall or to a peg in the ground.

Each successive truss should be spaced using a gauging rod, as shown previously on page 19, then fixed back to the first truss with temporary ties at each top chord panel point. Use minimum 50 x 25 battens for trusses paced up to 900 centres.

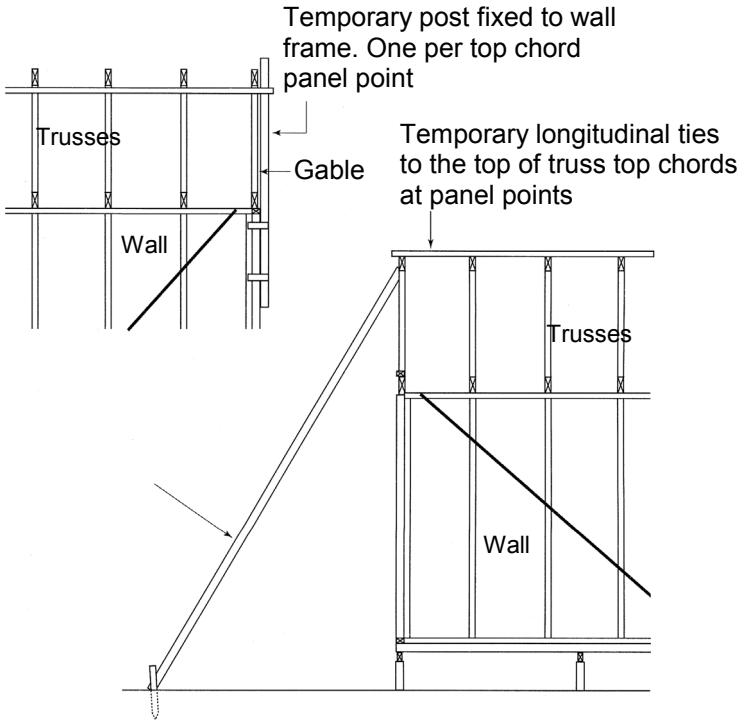


Fig. 52 Methods of temporary bracing first truss

***Notes**: The purpose of temporary bracing is to hold trusses straight and plumb prior to fixing permanent bracing. All permanent bracing, ties, hold down ties, etc. must be completely fixed off prior to loading the roof.*

Erection Tolerances

Working to acceptable tolerances is critical to maintain a good roof line and effective bracing. A stringline, plumb-bob and/or level and straight-edge should be used. The following tolerances are considered acceptable to AS 4440-1997 Installation of nailplated timber trusses:

1. Trusses to be erected with overall bow, or bow in any chord, not to exceed the lesser of L/200 or 50mm (when L is the length of the chord);
2. Erect trusses with the apex at not more than the lesser of span/200mm or 50mm from a vertical plane through the supports; and
3. At any section, the local out-of-plumb should not exceed the truss height/50 or a maximum of 50mm.

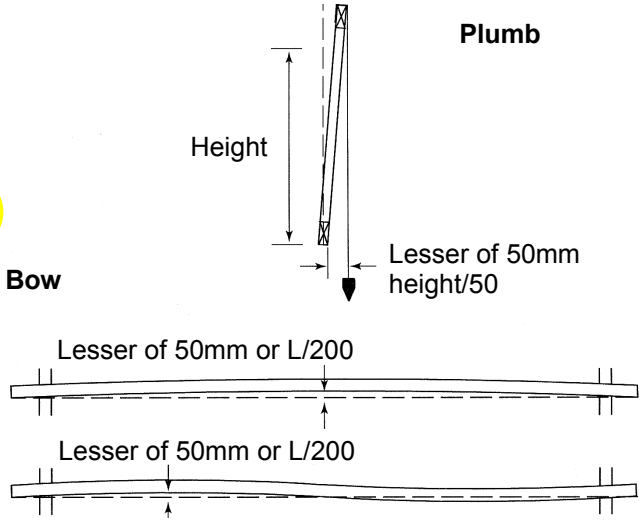


Fig. 53 Tolerances for bow and plumb

***Note**: Generally, if a bow or tilt is evident to the eye, the truss is outside the tolerances.*

ALTERNATIVE ROOF STYLES

There are many other commonly constructed truss roof styles, apart from the gable, which follow similar erection procedures and have similar shaped trusses. However, due to the change in at least part of the roof shape, new truss types are introduced. The new truss types are used to form the following common shapes:

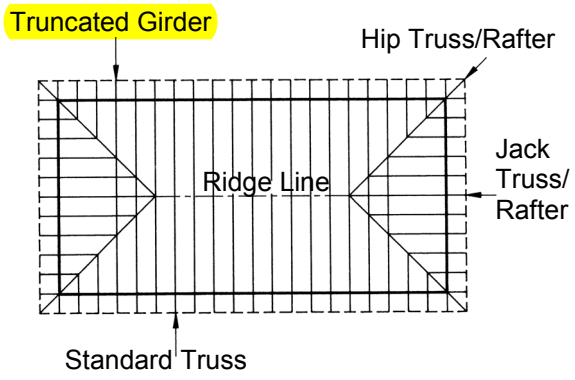


Fig. 54 Hip roof

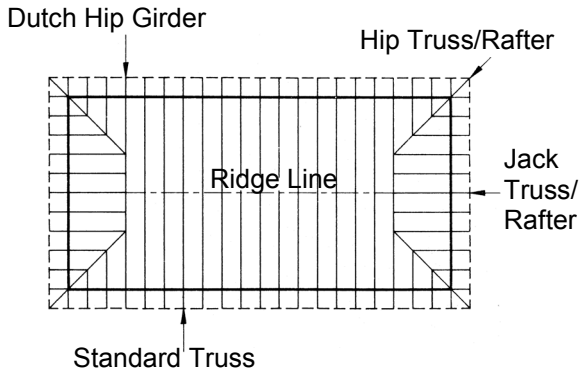


Fig. 55 Dutch hip or Gambrel roof

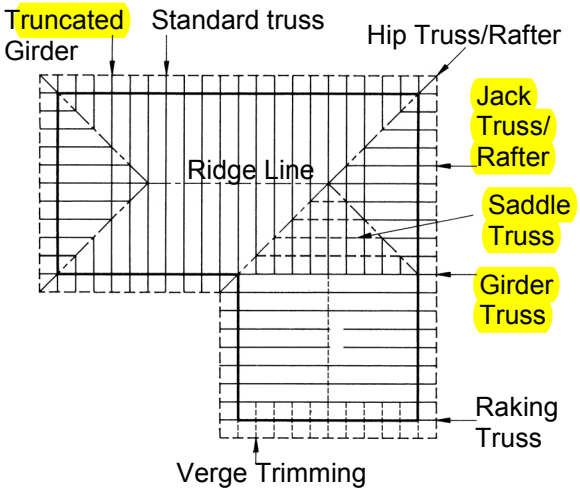


Fig. 56 'L'-shaped hip and valley roof

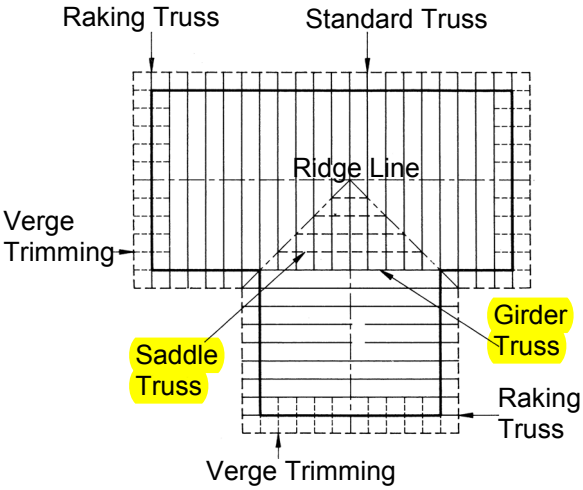


Fig. 57 'T'-shaped hip and valley roof

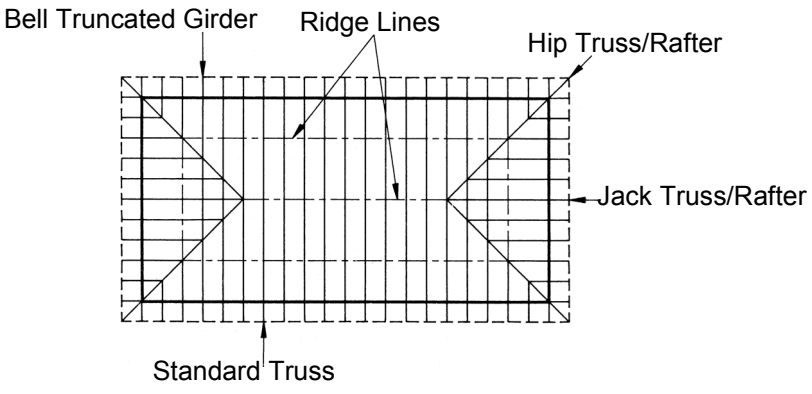


Fig. 58 Bell or Bellcast roof

HIP ROOF TRUSS TYPES

Apart from the basic triangular shape of the *Standard roof truss*, there are several special purpose trusses used to form hip roofs, and variations of the hip roof.

These truss types are shaped to form the finished roof surface and are placed in strategic positions. Hip and jack truss types may also be made up of single stick timber members for smaller roofs of where the distance to station positions is not excessive.

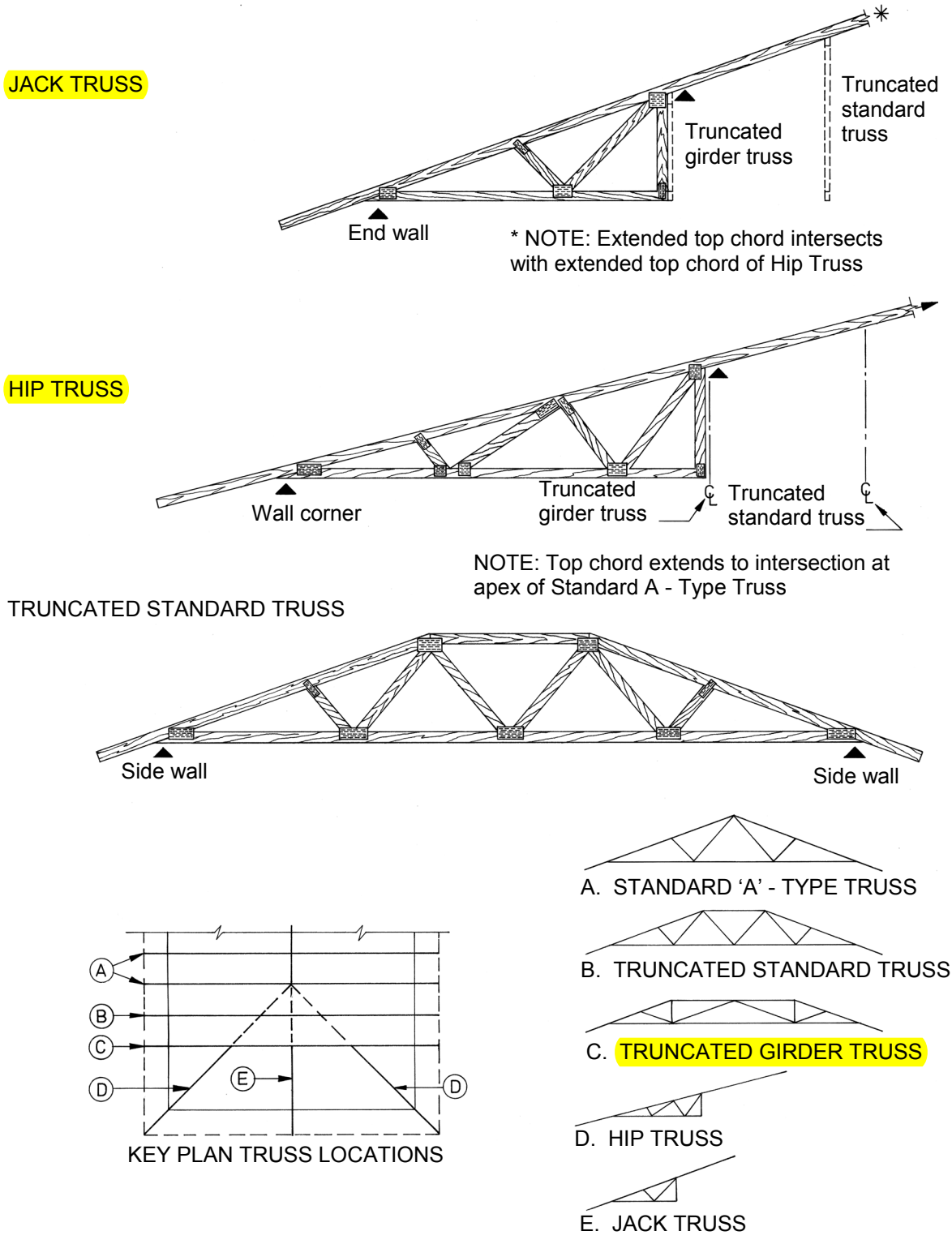


Fig. 59 Various truss types

TRUSS TYPE LOCATION

STANDARD GIRDER TRUSS

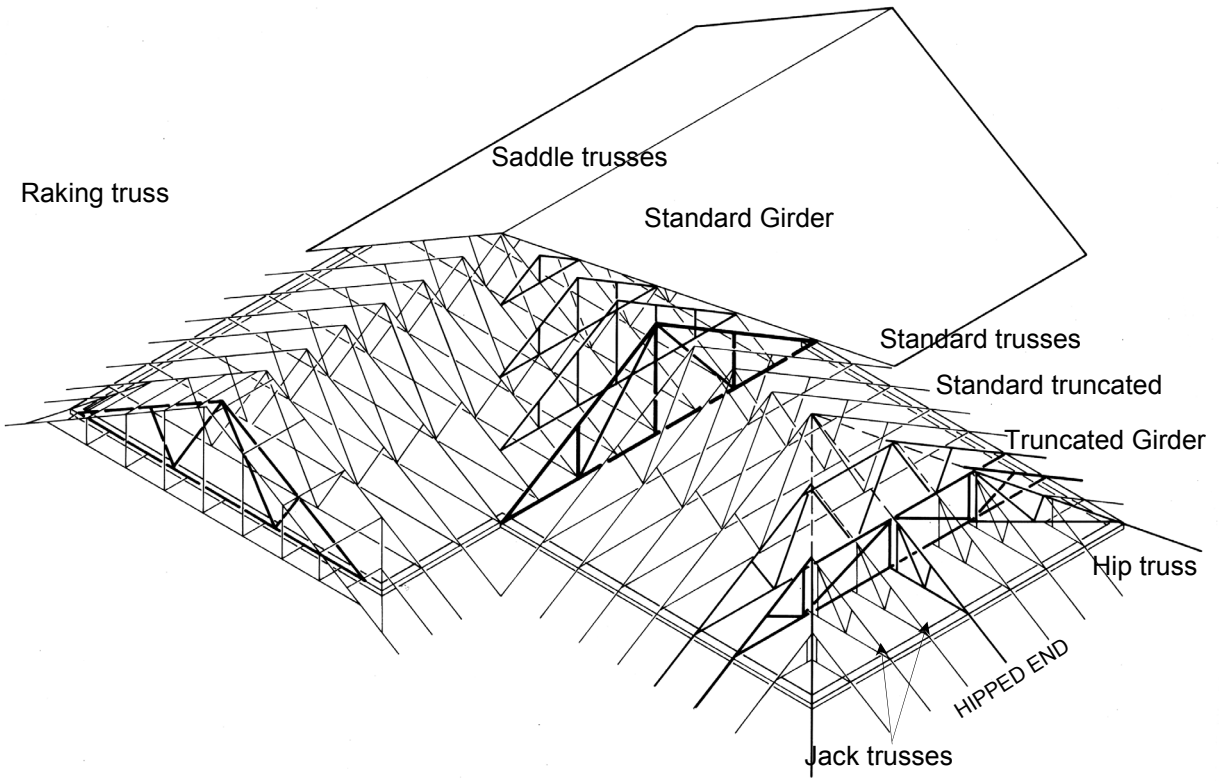


Fig. 60 Diagrammatic layout of roof trusses

Girder trusses are used to support other trusses. They may be made up of two trusses fitted back-to-back or have heavier sectioned members with a higher stress grade. For example, it is normal for standard trusses to have members with a stress grade of F8.

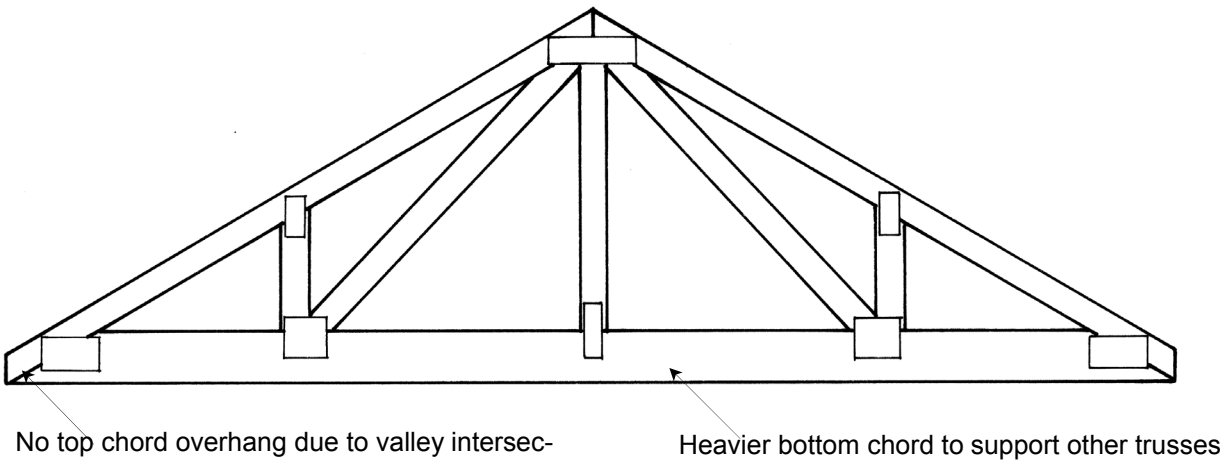


Fig. 61 Standard girder truss

SADDLE TRUSS

Saddle trusses, also called *Valley trusses,* are smaller standard type trusses, which are supported on top of other trusses at right angles. They are used to form the diminishing section of a minor roof connected to the major roof.
These saddles are spaced at the same centres as standard trusses and fixed with one 65mm skew nail through the bottom chord into supporting trusses. Their ends may form the line for the valleys on one or both sides, hence the name Valley truss. The structure is similar to a conventional scotch valley without the lay boards.
On roofs with a pitch greater than 15o, designed for wind loads up to 41m/s, a 50 x 38mm timber ledger or batten is fixed to the supporting trusses with one 65mm nail at truss intersections, to prevent the bottom chords from slipping. Alternatively, a framing anchor or *Trip-L-Grip* may be used at each intersection, without the need for a batten.
***Note**: Where saddle trusses are not supported on at least two other trusses, or the ends cantilever more than 450mm, 70 x 35mm block infill supports must be installed.*

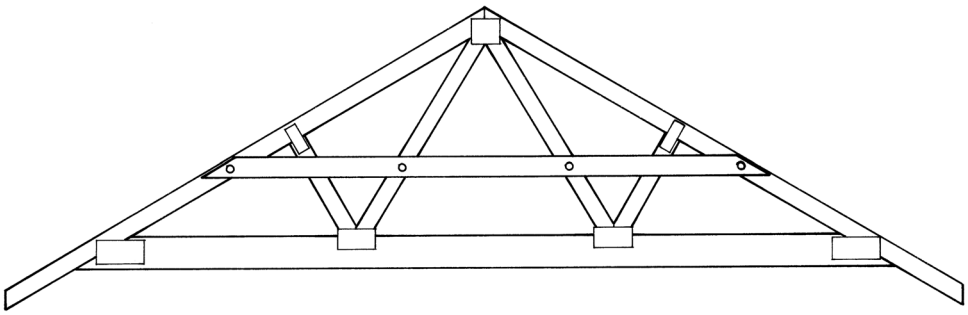


Fig. 62 Typical saddle or valley truss

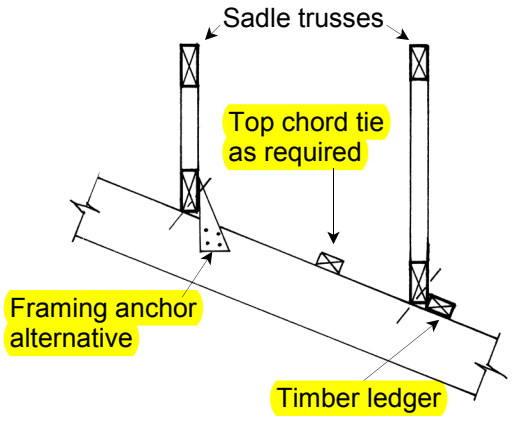


Fig. 63 Bottom chord connection

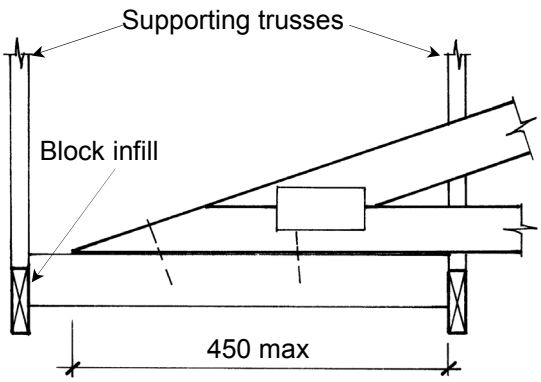


Fig. 64 End of truss support

***Note:** Intermediate top chord bracing may also be required where the spacing of valley trusses is greater than the restraint spacing, I.e. tile battens. Alternatively, the tile battens may be extended.*

TRUNCATED GIRDER TRUSS

The term *Truncated* means to have the top cut off or cut short, which is the shape of truncated trusses generally. They have a flat or level top section with the remainder of the truss being the same as a standard truss.

Truncated Girder trusses are used for hip ends to allow the pitch of the roof to be formed. These load-bearing trusses are placed at a station designed by a truss engineer to take the load of other members, such as hip and jack trusses, or stick timber ceiling joists and rafters over.

The bottom chords are generally larger than that of standard trusses and may be commonly constructed of timbers with an F27 stress grade.

STANDARD TRUNCATED TRUSS

These trusses are a similar shape to the girder, having the top or head removed, and are placed behind the girder at standard truss spacings, forming the pitch of the roof by increasing in size up to the apex of the hip end. As they are only standard trusses, they carry no additional load, apart from roof tiles and ceiling linings.

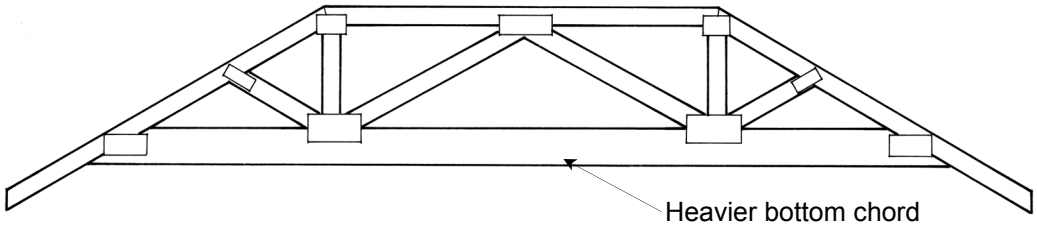


Fig. 65 Truncated girder truss

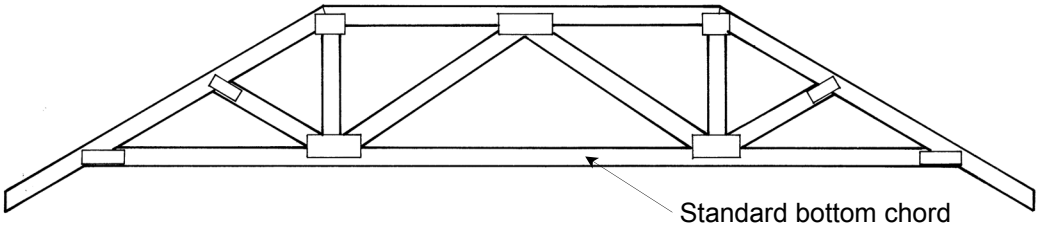


Fig. 66 Standard truncated truss

CANTILEVER TRUSS

These trusses are supported at a position set in from the standard pitching point and have an additional web built into the design to cater for this new support panel point.

***Note**: Cantilever trusses must be designed specifically for use, as a standard truss cannot be supported at any other position than the end pitching points.*

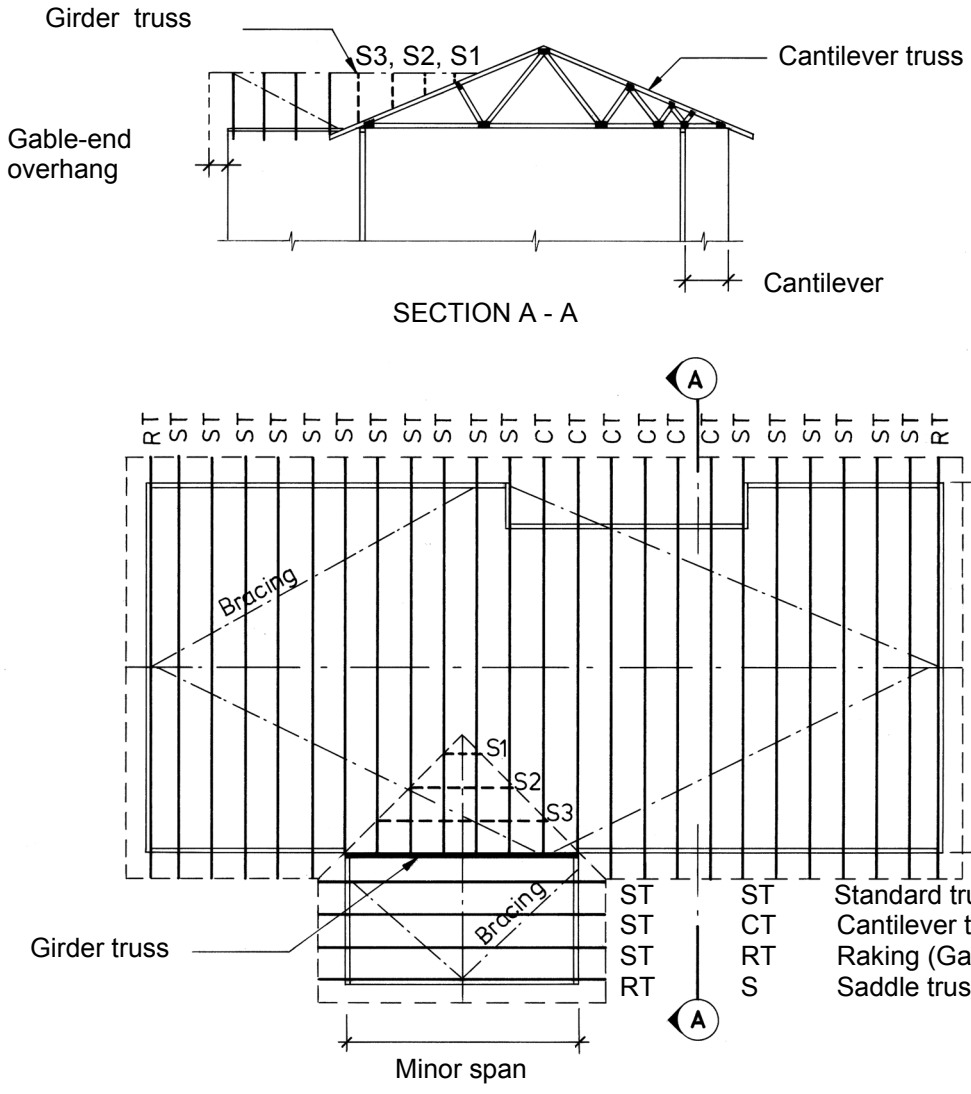


Fig. 67 Cantilever trusses

DUTCH-HIP or GAMBREL GIRDER TRUSS

These trusses are similar to a standard girder with the addition of waling plate nailed or bolted to the face. The truss forms the gambrel end by allowing the top chords of hip and jack trusses, or stick timber members, to be supported onto the waling plate with bottom chords, or stick timber ceiling joists, to be supported on the girder's bottom chord.

***Note**: Refer to the manufacturer's details for fixing methods of waling plates.*

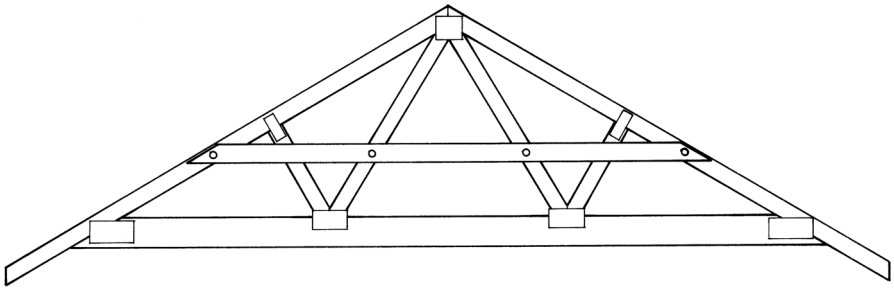


Fig. 68 Dutch-hip or Gambrel girder

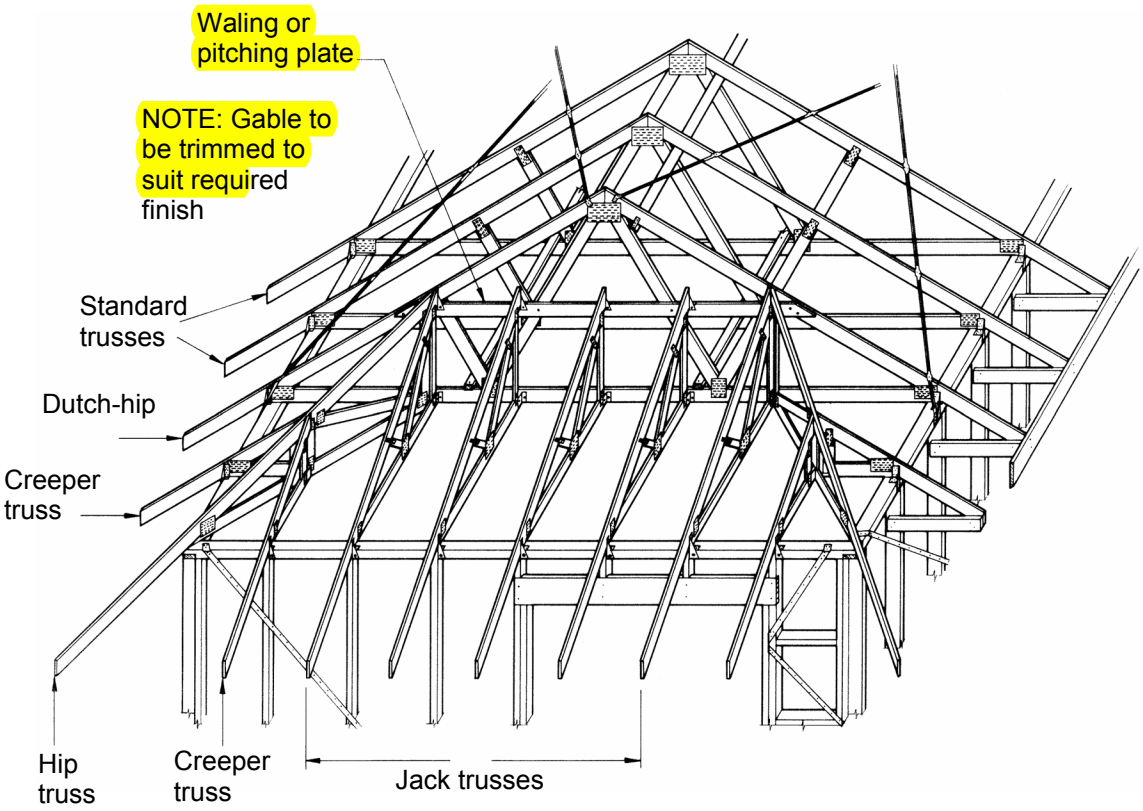


Fig. 69 Gambrel end truss layout

Girder Brackets (Truss boots)

Girder brackets, also known as Truss boots, are used to connect the ends of standard trusses to the bottom chord of girder trusses.

There are several types of brackets designed for specific purposes, as follows:

Framing Bracket (joist hanger)

The framing bracket, also known as a joist hanger, may be used to support the ends of standard trusses with a small span, such as half trusses, jack or creeper trusses. The bracket is fixed to both the supporting and the supported trusses and nailed off with 30 x 2.8mm galvanised reinforced-head nails to all bracket holes. A 12mm diameter bolt may be used for the prepared bolt hole in one of the bracket wings.

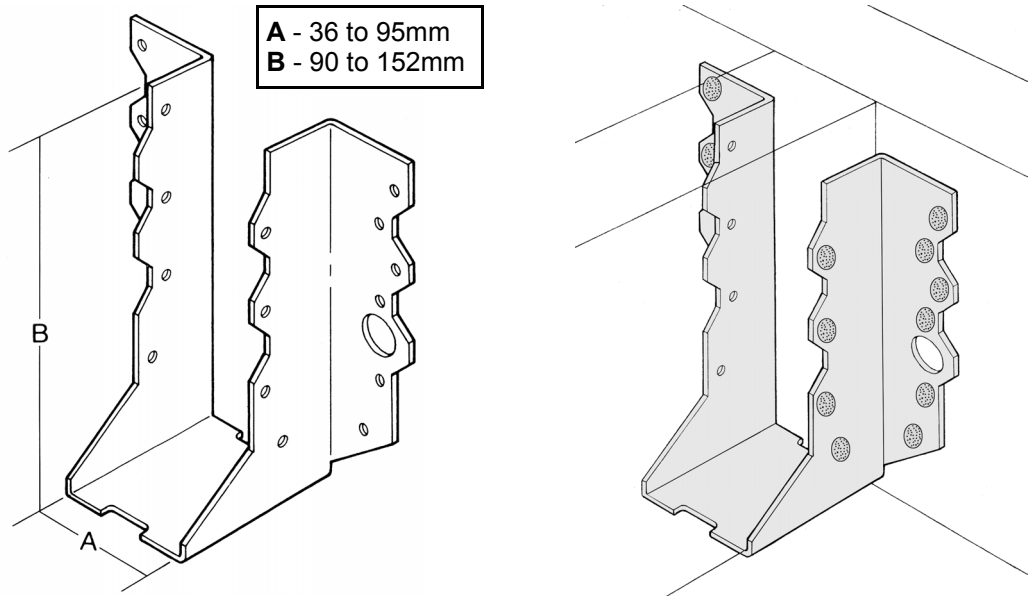


Fig. 70 Galvanised, 1.0mm thick Joist hanger

Girder Bracket (Press-on)

They were developed to fix trusses to the bottom chord of girder trusses or beams. They may also be used to connect beams to beams. They are applied during truss manufacture using a suitable pressing machine.

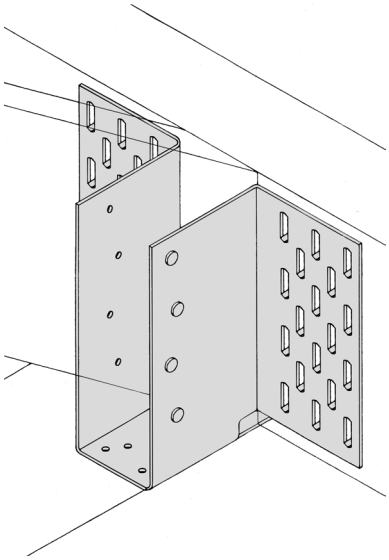


Fig. 71 Press-on bracket

STANDARD TRUSS BOOT

These brackets are designed to fix and support standard truss ends onto the bottom chord of girder trusses or beams. The bracket has an integral tongue, which prevents the rotation of the girder truss bottom chord, when the trusses are loaded.

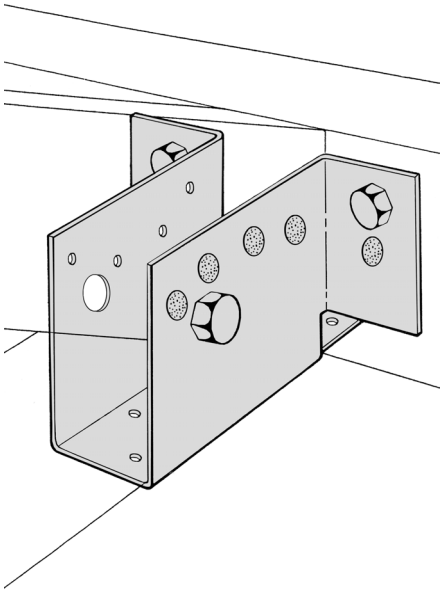


Fig. 72 Standard boot

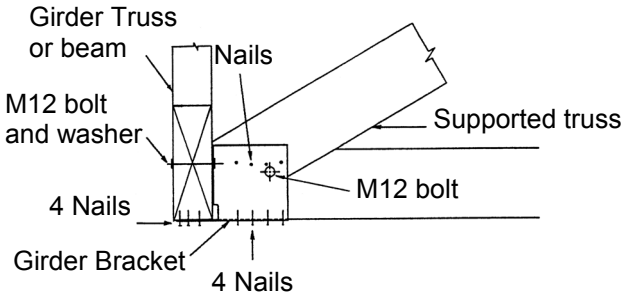


Fig. 73 Elevation of fixing

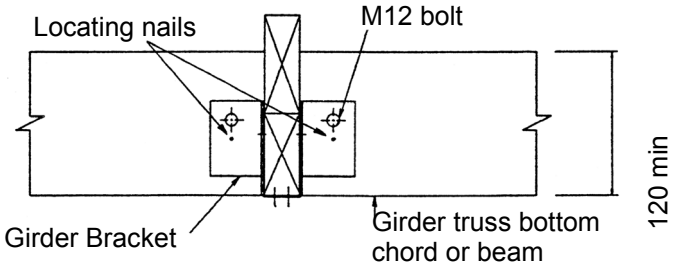


Fig. 74 End view of fixing

Girder Bracket (Bolt on)

These brackets are designed to fix and support trusses to the side of girder truss bottom chords, without the need for additional bracing to the girder truss bottom chord. They may also be used for the side connection of timber beams.

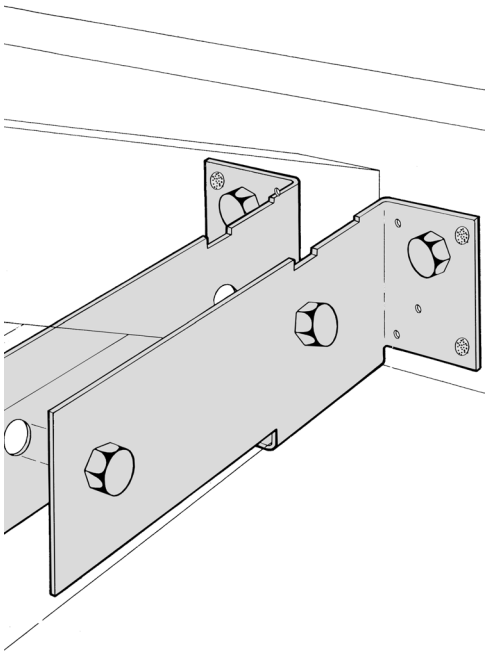


Fig. 75 Bolt-on bracket

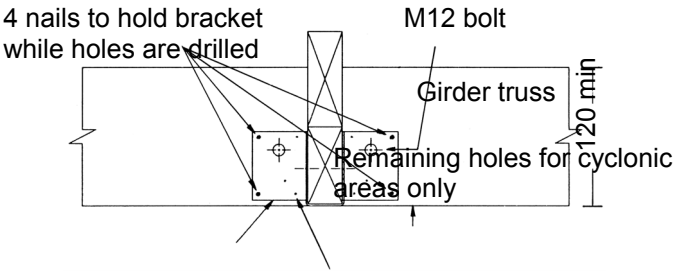


Fig. 76 Elevation of fixing

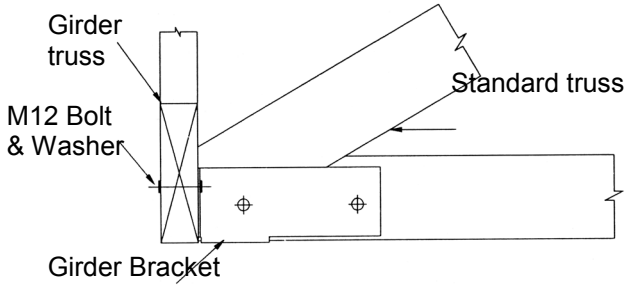


Fig. 77 End view of fixing

UNIVERSAL HI-LOAD BRACKET

These brackets are engineered for strength and ease of use to secure heavily loaded trusses, like truncated girder and secondary girder trusses, to primary girder trusses.

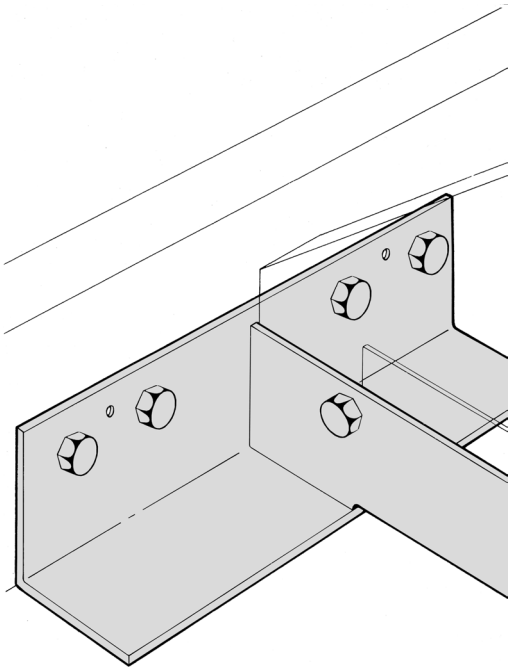


Fig. 78 Hi-load bracket

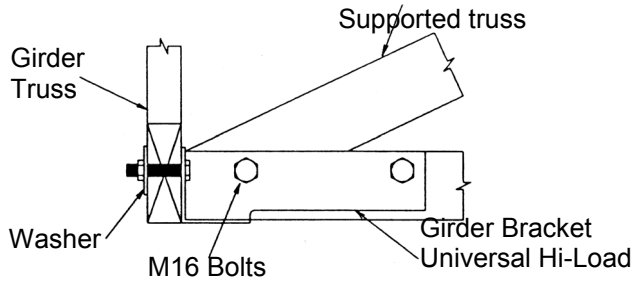


Fig. 79 Side view of fixing

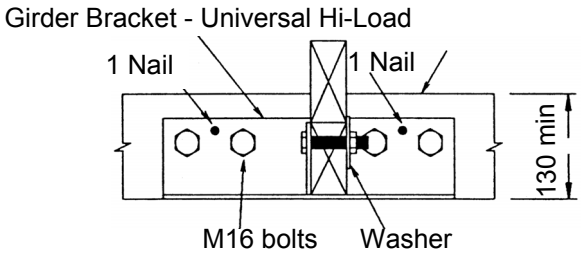


Fig. 80 Elevation of fixing

Boomerang Girder Bracket

These brackets are designed to fix and support trusses or beams where they are set at an angle to the girder truss bottom chord, which is ideal for supporting hip and/or creeper trusses. They are available in left or right hand angles ranging from 22.5 up to 45.

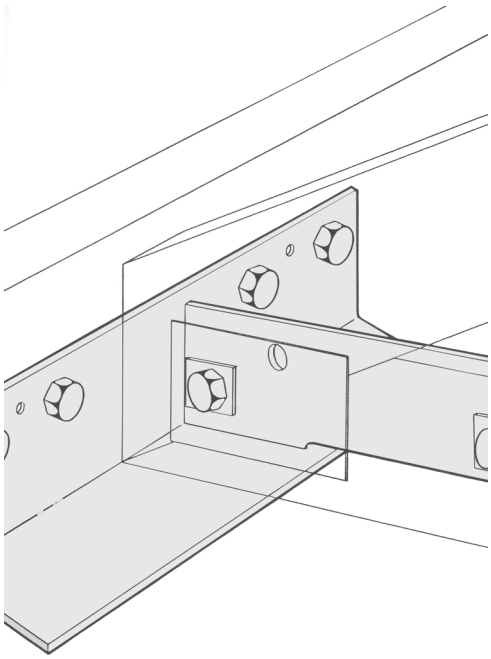


Fig. 81 Boomerang bracket

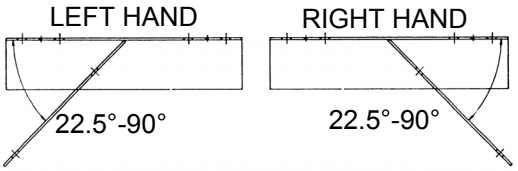


Fig. 82 Plan of angles

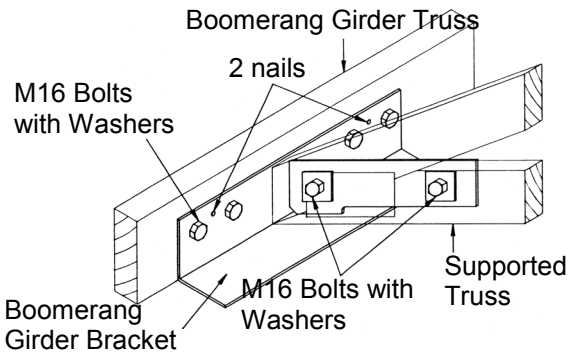


Fig. 83 View of fixing

Special Brackets

Girder Brackets for Cylonic areas

These brackets are used for side fixing and supporting heavily loaded truss and/or beam components in cyclonic situations.

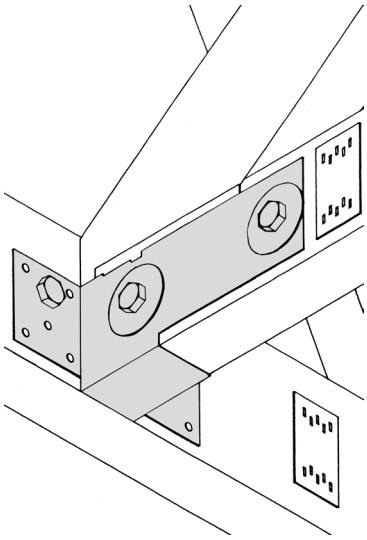


Fig. 84 Cyclone bracket

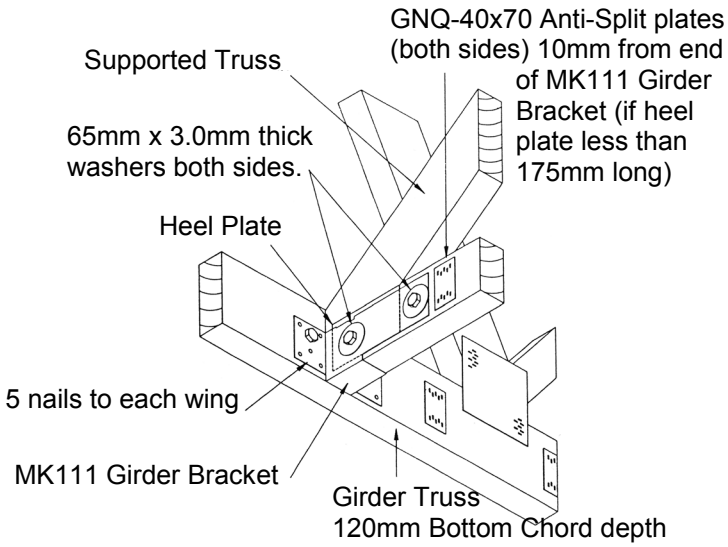


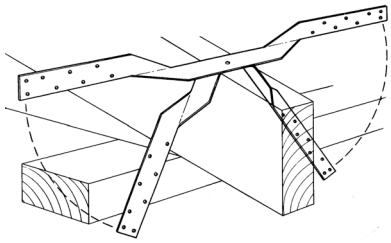
Fig. 85 Fixing details

Cyclonic Ties

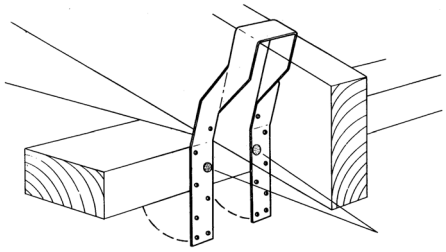
These ties are designed to provide roof security under extreme wind conditions. They may be used to secure purlins, rafters and trusses to top plates in areas subject to cyclonic and high wind loading.

INSTALLATION

STEP 1. Bend the tie over the truss top chord and fit legs tight against either side.



STEP 2. Nail each leg with a 30 x 2.8mm galvanised reinforced nails.



STEP 3. Bend each leg under the plate, nail with 3 nails in each and one nail into top.

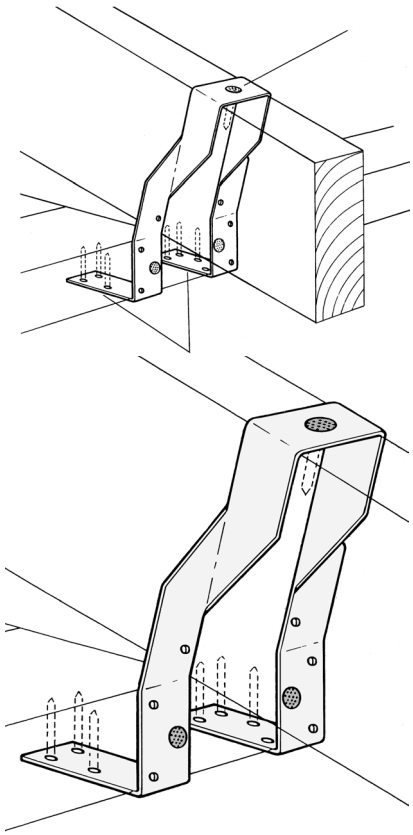


Fig. 86 Cyclone tie down bracket

ERECTING AND FIXING TRUSSES

HIP ROOF

Erection of the hip roof is similar to that of the gable, apart from the initial set up of the hip end. The remaining standard trusses are erected as for gable roofs.

***Note**: Installation of timber trusses must comply with AS 444—1997 Installation nailplated timber trusses.*

Method

Step 1 Use a truss layout plan to determine the station position for the truncated girder truss, at each end. Erect and brace in position and nail the heels at the pitching points.
Place a brace in the centre and ends of the truncated girder, to ensure it remains plumb and in wind.
***Note:** Trusses must be plumb within 50mm or plumb within the height of the truss ÷ 50, whichever is the lesser amount.*

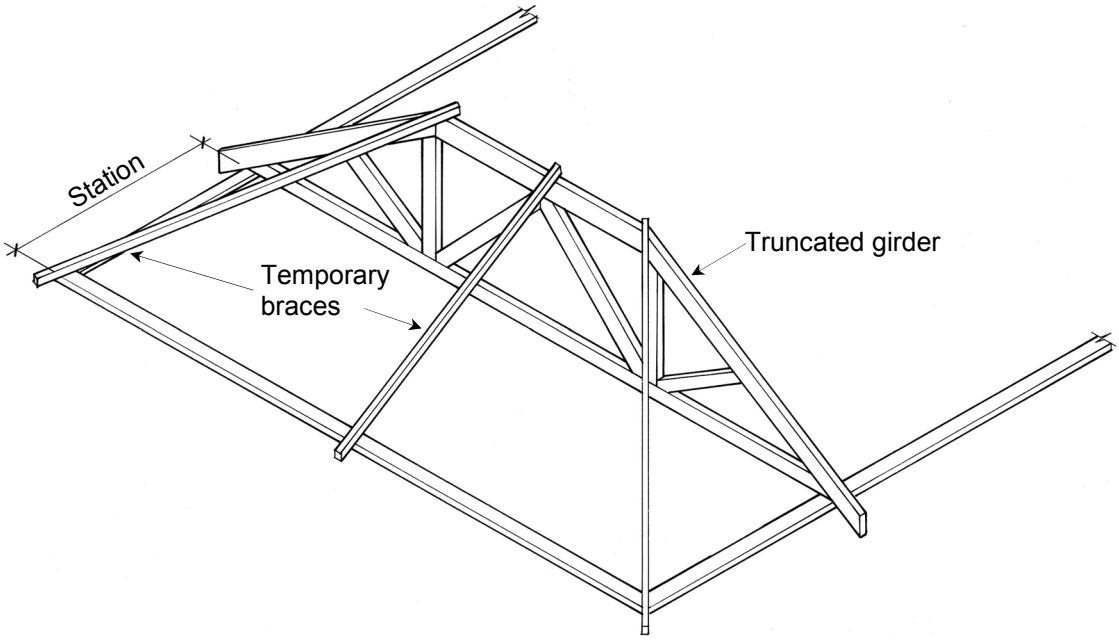


Fig. 87 Station position for truncated girder

Step 2 Erect the first standard truss, which should be placed at half the roof span, or at a standard spacing for the roof, e.g. 600mm centres. Tack the spacer battens to hold the top chord and the truss plumb then nail off the heels to the top plate.

***Note**: The hips do not have to meet the standard truss at the apex.*

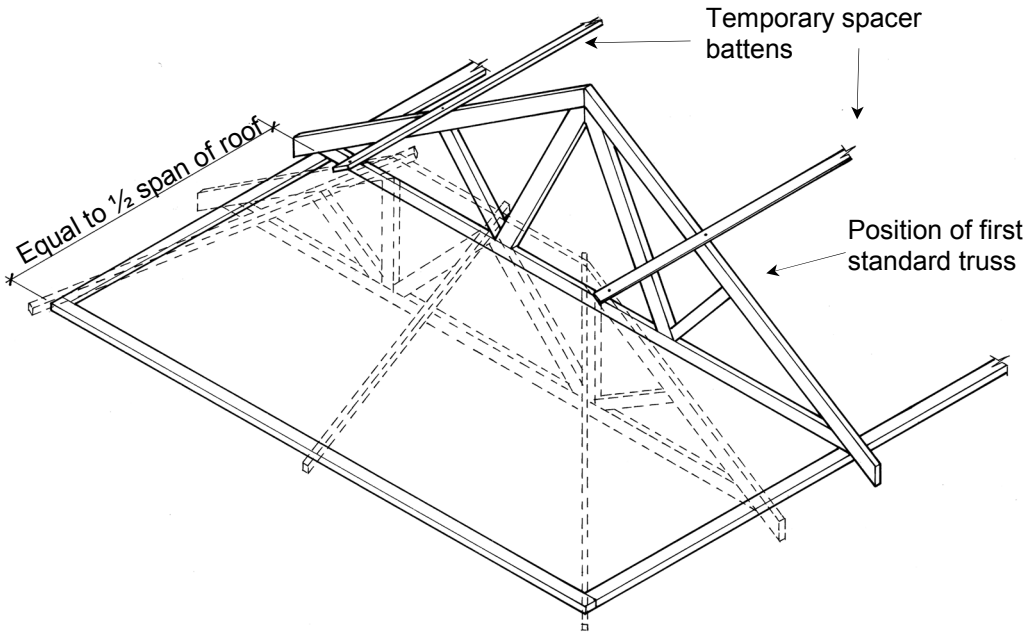


Fig. 88 Erect first standard truss

Step 3 Fit permanent bracing members to the hip ends, using jack and creeper trusses or stick timber. Erect the remaining standard trusses between the hip ends to a string line, using the spacer battens tacked to the top chords to hold them plumb and in position. Nail off the heels at the pitching points.

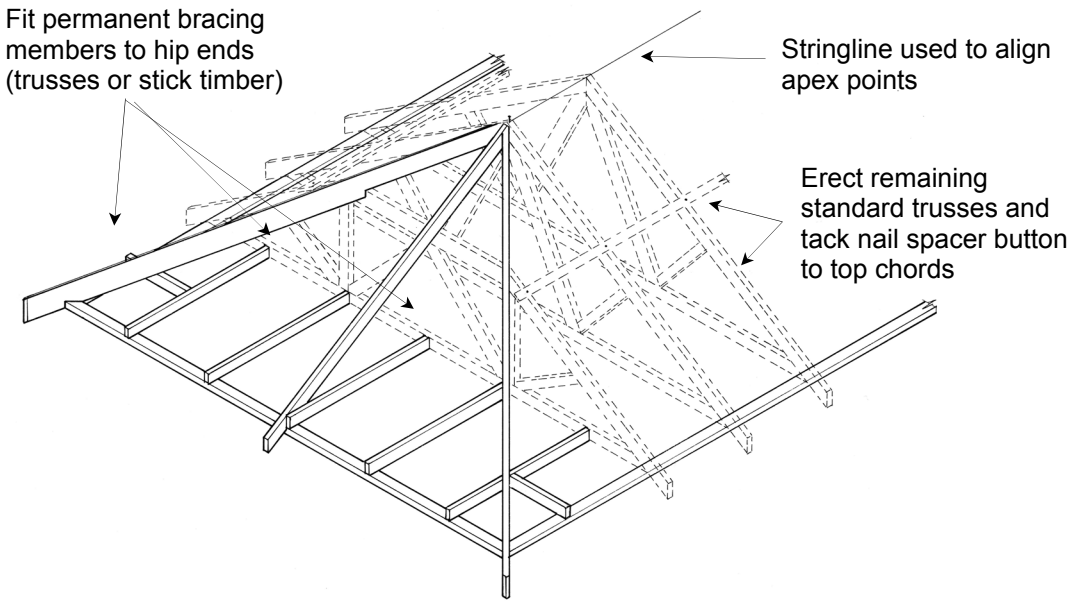
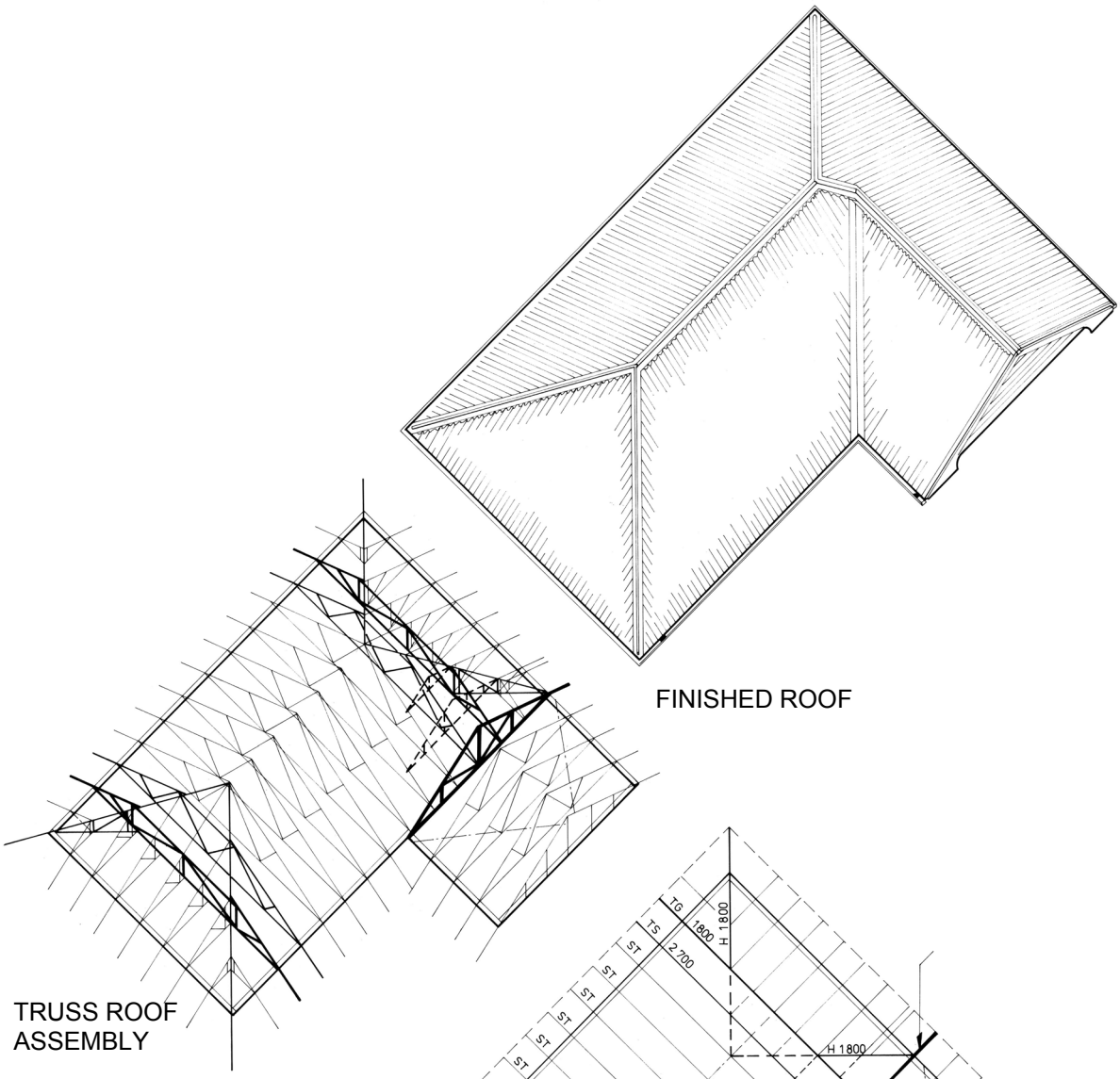


Fig. 89 Complete hip ends and erect the remaining standard trusses

STEP 4 Using the Truss Layout Plan show below, which is provided by the truss manufacturer, complete the full roof by installing all nominated trusses at the nominated positions and spacings.
Brace the roof and attach all patent metal connectors as previously described for a gable roof, in accordance with AS 4440-1997.
***Note**: The roof below is designed to take sheet roofing, therefore the trusses are spaced at 900mm centres instead of the normal 600mm centres.*



PLAN - TRUSS LAYOUT

LEGEND	
TG	Truncated Girder
TS	Truncated Standard
ST	Standard Truss
J	Jack truss
H	Hip truss
S	Saddle

Fig. 90 Completed broken hip and valley with one gable end

DETERMINING ROOF TRUSS TYPES FROM PLAN

To ensure the correct type and number of trusses have been delivered on-site, it is necessary to carry out a simple check, as follows:

Method

- the individual truss types are identified
- the numbers of each are counted
- the types and total numbers are checked against the supplied truss layout plan.

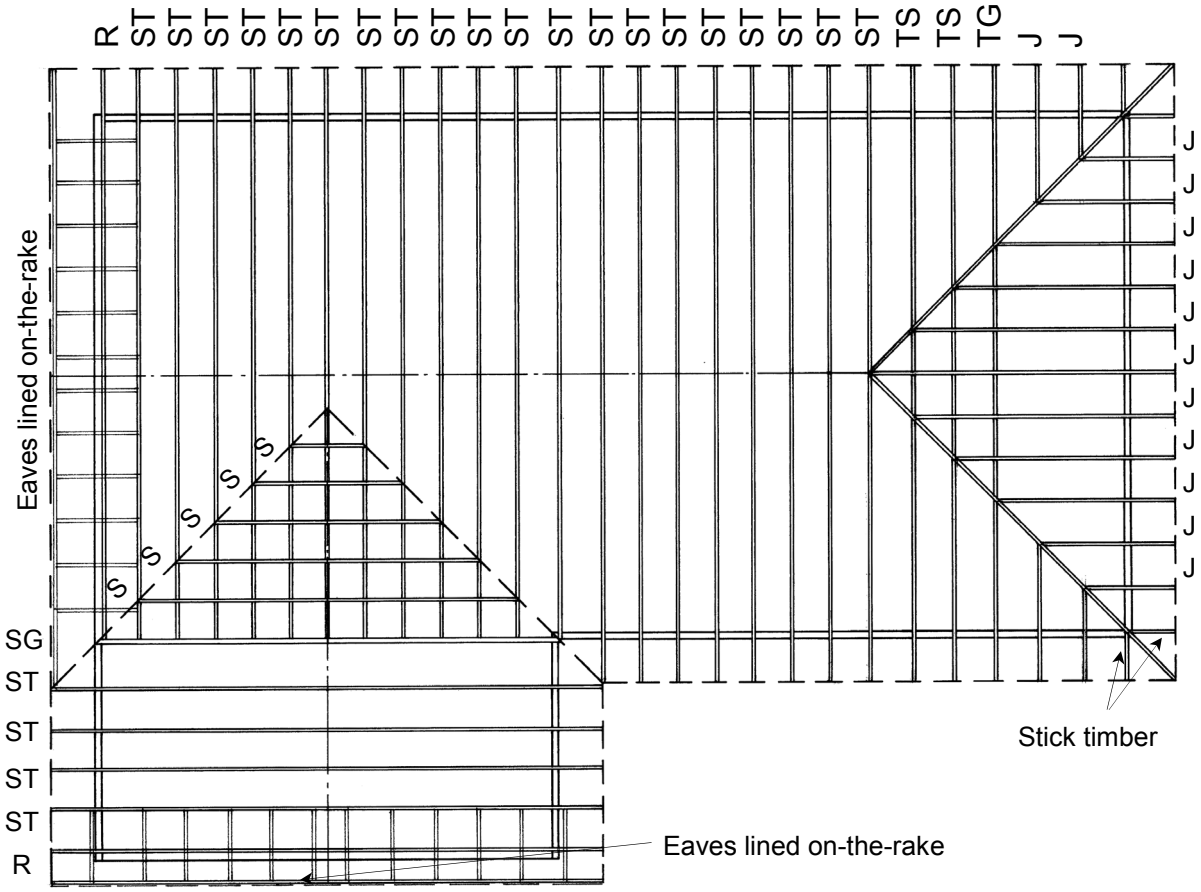


Fig. 91 Roof plan - Truss layout

TRUSS TYPE	QUANTITY
Standard	20
Raking or Gable truss	2
Truncated Standard	2
Truncated Girder	1
Standard Girder	1
Jack truss	15
Hip truss	2
Saddle truss	5

SPECIAL ROOF FLASHINGS

Gambrel ends, also called *Dutch gables* require a wide lead flashing run across the width of the gambrel end. It is turned up behind the cladding, minimum of 50mm, and beaten over the profile of roof tiles to form a waterproof seal.

The lead flashing, which must be a minimum of 1.8mm thickness or 20kg per m^2, is run the full width of the gambrel plus a minimum of 300mm, either side, past the centre of the hip. There must be an allowance for expansion of the lead, due to heat absorption, by joining and lapping the length at not more than 2.0m centres. The length of the lap should be at least 150mm to maintain a waterproof seal, provided the top layer at the joint is facing away from the direction of worst weather or driving wind.

The lead should be coated with point, plastic, rubber or bitumen to avoid galvanic action between dissimilar metals occurring, which is usually results in corrosion of the weaker metal.

***Note**: Roofing lead exposed to temperatures of 40°C, or above, for prolonged periods will cause the lead to grow up to 2mm in a 2.0m length, which inevitably ends up in stress splits in the width of the roll.*

The bottom of the lead flashing should be set a minimum of 90mm above the truss top chord to allow for tile battens and a course of roof tiles to fit under with ease.

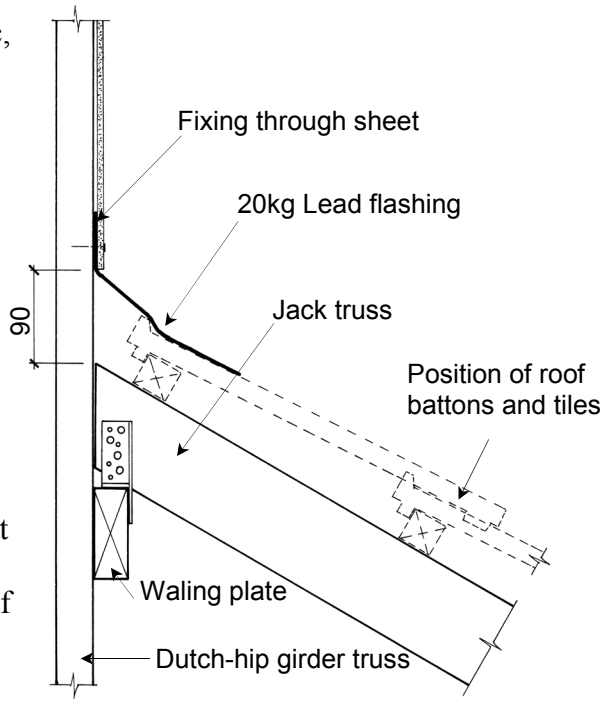


Fig. 92 Positioning the lead flashing

Fig. 93 Prepared trussed roof ready for tiles

TRUSSES - *Start to Finish*

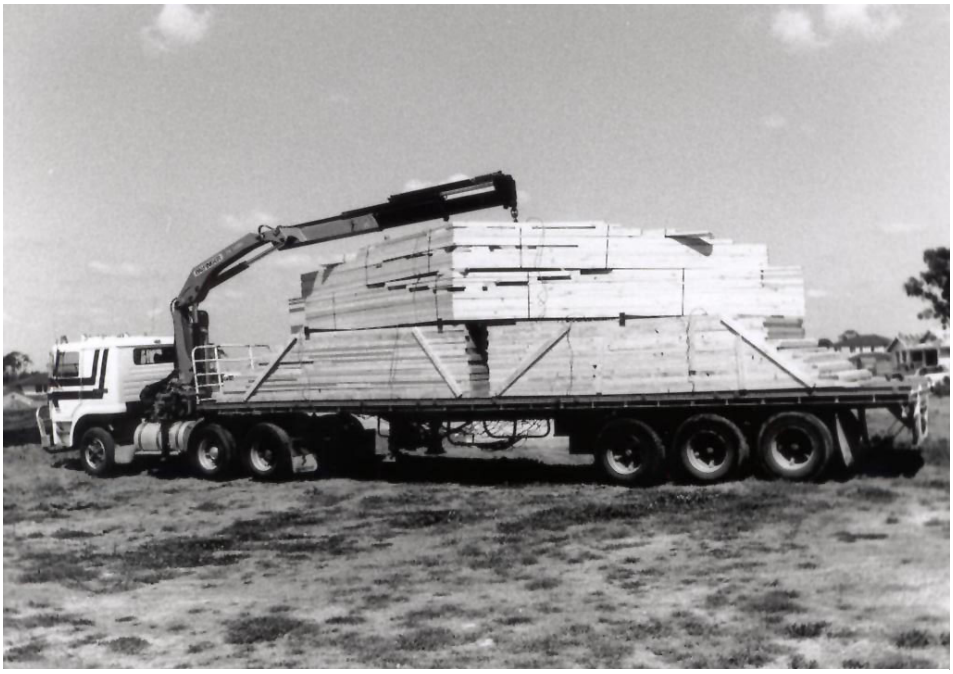


Fig. 94 Trusses delivered to site

Fig. 95 The completed roof frame

Glossary of Terms

Bressumers - This refers to a long heavy lintel or beam, usually of timber, which is designed to carry an upper wall or roof load.

Camber - This is a slight bow or bend up in members, built-in to allow for settling under load.

Cantilever - This is where part of a member is extended past the point of support, therefore requiring the extended section of the member to be self supporting.

Chord - This refers to the top or bottom of a framed member or truss, which may be straight or curved.

Dunnage - This refers to waste or scrap material, usually timber, which is used to pack up or temporarily raise members up during storage or transport.

Girder - This refers to a horizontal member within another member designed to take the main load, or load of other members.

Lintel - This is the top horizontal supporting member of wall frame opening to allow the roof load to be adequately supported.

Monopitch - This simply means that a roof surface has only one slope, such as a lean-to, awning or skillion roof.

Patent-type - A patent is a registered design, which allow an object to be reproduced exactly many times. Each object is recognised by a stamped or tagged trade name or symbol. These objects cannot be reproduced without the patent holders permission.

Station - This refers to the distance the first girder or truncated girder truss is placed in from the outside of the wall frames.

Stress - This is the result within a member when pressure is applied to it. The term is usually used to describe various types of stress within a member, such as shear stress, tensile stress, compressive stress, working stress or yield stress.

Truncated - To be cut short in height or to have the top section removed from an object.

Unyielding - This refers to a truss, which when loaded, will not give in or collapse under load. It is strong enough to withstand the forces applied to it.

Waling plate - This is a horizontal member fixed to the face of a wall or other member, usually of timber, which supports the load of other members, such as the top chord of jack trusses or stick timber on a gambrel end.

FURTHER READING

Australian Standards Committee, 1997, AS 4440 Installation of nailplated timber trusses, Standards Association of Australia Homebush, Sydney..

Simpson, Charles & Hodgson, Barry, 1995, Building a House- Framing practices, Macmillan Education, South Melbourne, Victoria.

Staines, Allan, Firth Edition, 1986, The Australian Owner Builders Manual, Pinedale press Caloundra, QLD.

Bloomfield, F.C. and E. Peterson, Revised by B.S. Brown and H.A. Slayter, First Edition 1958, Fifth edition 1985, The Australian Carpenter and Joiner - Volume 1, Standard publishing Co. Pty Ltd., Naremburn, NSW.

Manufacturer's or suppliers truss installation guides and brochures for connectors.