

RAISING THE ROOF:

A GUIDE TO ROOF TRUSS SAFETY





Government of
South Australia

WE ACKNOWLEDGE THE SUPPORT FROM:



MASTER BUILDERS
SOUTH AUSTRALIA



SA Building
Consultants

Disclaimer

The information contained in *Raising the Roof* is intended as a guide only and is not a comprehensive account of the law or a substitute for professional advice. Although the information in this booklet has been researched and presented with due care, Consumer and Business Services accepts no responsibility for any errors or omissions which may have occurred within the publication.

Acknowledgements

The ***Raising the Roof*** education campaign has been a collaborative exercise between various South Australian government agencies, industry bodies and businesses.

A working party was formed during 2011 to develop resources for members of the building trade to alert them to roof truss safety issues. This booklet is one of those resources. There are also a DVD, some animations, factsheets and further information, available on the website, *RaisingTheRoof.com.au*.

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Preface

Prefabricated residential and light commercial timber and steel roof trusses are used extensively in the building industry.

A trussed roof contains a series of two dimensional, triangulated structural frames that support the roof load and transfer it to load bearing walls (generally, the inner leaf of the external walls).

Prefabricated roof trusses are light weight and cost effective. Like many other building materials, they may fail if not handled or installed correctly.

This booklet is designed as a guide to help promote industry best practice. The booklet is not an instruction manual on how to erect roof trusses, nor does it replace *Australian Standards*. Current building legislation and Standards should always be the primary reference sources for builders/supervisors and erecting contractors.

Overview

Roof trusses must be transported correctly, stored on site properly prior to installation and be protected from long term exposure to the weather.

The installation of prefabricated roof trusses must be carried out in strict accordance with manufacturers' instructions and care must be taken when installing lateral support such as roof bracing, battens and ties.

As prefabricated roof trusses are designed for a specific purpose, any special loads such as roof-mounted water heaters, water storage units, air conditioning, solar panels, carports, verandas and the like must be included in design considerations at the time of manufacture of the trusses. It cannot be assumed that roof trusses are capable of supporting additional loads after manufacture. No on-site modification of roof trusses, without written design approval from the manufacturer and approving authority, is permitted.

There could be catastrophic consequences as a result of mishandling of roof trusses. This could happen:

- during the time of delivery,
- during storage on site,
- during installation, or
- by overloading or modifying without approval.

Those responsible could be held liable for prosecution.

Background

In 2002 sections of the prefabricated timber roof truss frame at the Riverside Golf Club, in South Australia, collapsed. There were two fatalities as a result. The subsequent Coroner's report into the fatalities raised concerns about the whole process of design, transport, manufacture, installation and modification of roof trusses.

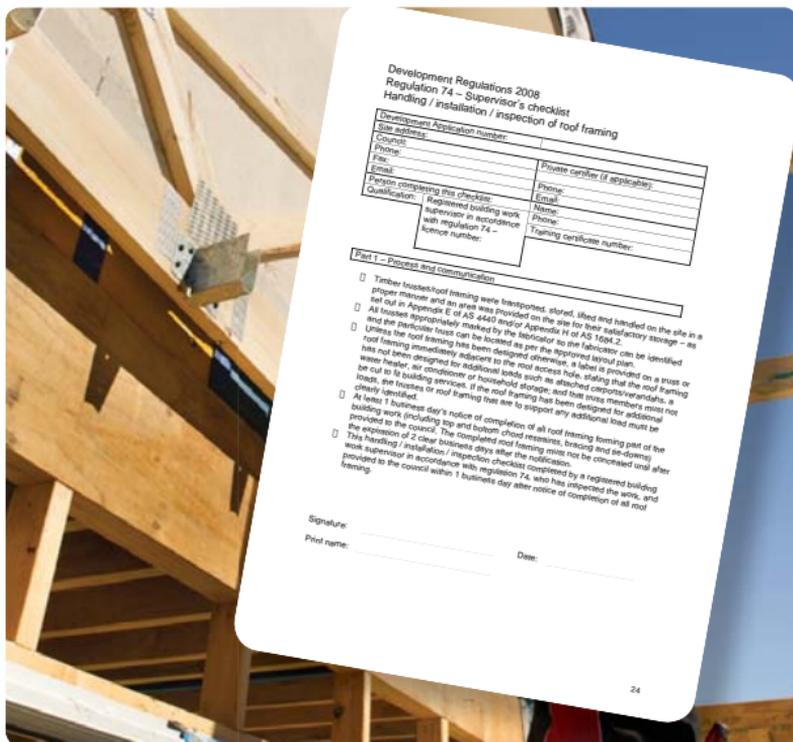
In 2006, the Minister for Urban Development and Planning established a Ministerial Taskforce to respond to the Coroner's report and to look at ways of preventing similar roof truss failures.

The final report of the Ministerial Taskforce on Roof Trusses was published October 2008 and sets out a range of proposed changes to the design and manufacture of roof trusses in South Australia.

In response to the report a number of initiatives have been implemented by the South Australian Government, including:

- Building Advisory Notices regarding the identification of faulty trusses have been issued.
- An online checklist that builders or property owners can use to determine the level of risk in their roof or structure is now available online at:
www.sa.gov.au

- The Development Regulations have been amended to introduce responsibilities for builders, supervisors and contractors in relation to the installation of roof trusses. Compulsory checklists, notifications and inspection policies have also been introduced. Only persons who have completed a course of training in relation to the installation of roof trusses are able to sign off a checklist. Further information is available on the website of the SA Government: www.sa.gov.au



Safety Considerations

Current building legislation should always be a builder's primary reference. Examples of construction standards that apply to roof trusses are:

Timber Framing

- AS 4440-2004
"Installation of nail plated timber roof trusses"
- AS 4440-Appendix E
"Transport, storage, lifting and handling of trusses"

Steel Framing

- NASH Standard
"Residential and low-rise steel framing - Part 1 Design Criteria"
- NASH Standard
"Section 6.2 Roof bracing"

Roofing

- AS 2050
"Installation of roof tiles"
- AS/NZS 1562.1
"Design and installation of sheet roofing metal"
- AS 1397
"Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium"

Common errors

Common errors when working with trusses include:

- incorrect storage & handling
- cutting into and through truss members
- connecting conventional sections of a roof frame to the sides or top of truss members when they are not designed to accept those loads
- overloading truss members with services
- failing to ensure adequate lateral support, including incorrect installation of tile battens, roof purlins and bracing
- cutting or over drilling of roof truss members for services etc
- poor bracing methods as well as incorrect fixing of bracing and incorrect type and amount of fixings to bracing
- trusses not being installed as per manufacturers' details/drawings
- incorrect tie down procedures
- installing additional loadings not allowed for during the manufacture of roof trusses
- not inspecting each truss prior to installation to ensure the markings on the trusses match with the installation layout drawing as well as the correct spacing and positioning of the trusses.

Mistakes occur during:

- installation of roof trusses
- installation of tile battens
- installation of roof-mounted air conditioning and ducting
- installation of roof-mounted water heaters and water storage units
- installation of solar panels
- installation of carports, verandas etc supported off the truss overhang
- installation of additions to the original building work.



Residential and Light Commercial – Timber Roof Trusses

Specifications:

Timber Framing

- AS 4440-2004
“Installation of nail plated timber roof trusses”
- AS 4440- Appendix E
“Transport, storage, lifting and handling of trusses”
- AS 2050
“Installation of roof tiles”
- AS/NZS 1562.1
“Design and installation of sheet roofing”
- AS 1684
“Residential timber-framed construction”

Key Safety Points

Everyone in the workplace is subject to the requirements of the Occupational Health, Safety and Welfare Act. This means that on the building site workers should have safe clothing, use tools and machinery safely, and protect the public appropriately in order to achieve a safe working environment.

If you make a practice of always using a checklist when installing roof trusses you can ensure that you comply with all the requirements applicable to the roof you are installing.

The following sections contain some common scenarios which have been organised into DOs and DON'Ts for installing timber framed roof trusses. *(The list is not intended to be exhaustive.)*

DOs

Pre-installation

1. Make sure you comply with the manufacturer's instructions. If it's not clear or you don't know, seek advice from the manufacturer first.



Details typical notice left on site with delivery of trusses - read the notice.

2. Provide a flat area to store roof trusses or, in the event of a sloping or undulating site, crane the truss packs directly on to the walls of the building. Regardless of the place of storing, ensure that storage of trusses is to a stable flat level area.

Where trusses are not stored correctly and are twisted and bent, inspect all the trusses and truss plates carefully. Any damage or concerns should be reported immediately to the truss company who should inspect the trusses and provide written approval to use the trusses prior to installation.



Trusses stored on a flat site

Tip

If it's not clear or you don't know, seek advice from the manufacturer.

3. Always use bearers to keep the trusses flat and level. Brace the wall frames appropriately before placing the trusses on the walls. The trusses may also be installed to solid brick walls which may also require temporary bracing.



Trusses stored on top of wall frames

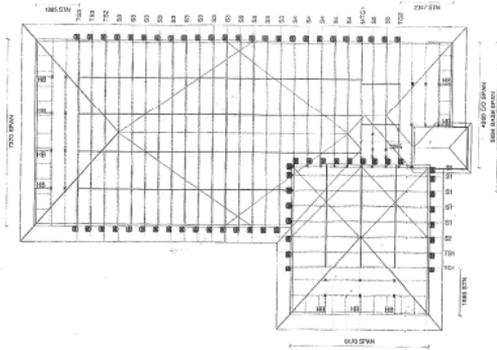
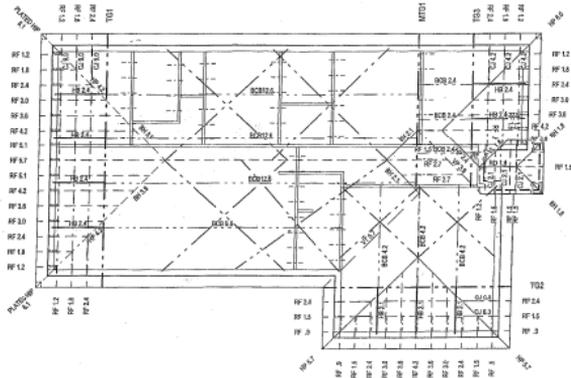
Installation

4. Always:

- Install trusses in the correct order and correct orientation.
- Check the provided layouts and the markings on the trusses.
- Ensure the layouts are approved by the approving authority; if not, question the authenticity of the documents in your possession – they may not be approved in which case they should not be used.
- A good indication of approval is the approving authority's stamp and approval date.



Typical placement identification marking to the underside of a bottom truss chord



Typical truss layout plans.

While it is acceptable for plans to be in black and white, like those above, some builders prefer colour coded plans; eg bracing in blue, brackets in red, hips and valleys in black.

5. Always install trusses with correct clearance to internal walls. Install fixings to brackets at top of slots and do not drive nails fully home.



Typical internal wall truss bracket fixed to the bottom chord of the truss and the top of the wall plate.

Tip

Trusses flex when various loads are applied. Internal wall brackets must be installed in a manner that allows vertical movements to occur.

6. Support trusses at load-bearing points only, as designed. Some trusses are designed to be supported along the span of the truss. These are marked to identify the support points.

Tip

Do not support the truss along the span unless the point is clearly marked.

Other than at the pitching points or at a cantilever web the bottom chords of trusses should be clearly marked to identify any other support position. Do not allow the truss bottom chord to be supported on a wall unless the bottom chord is clearly marked. You may have the truss or trusses oriented in the wrong direction.

7. Use only the type of girder truss brackets detailed on the approved documentation from the truss manufacturer. Examples of commonly used brackets are detailed below.



Commonly used brackets

8. Be aware of the maximum designed gust wind speed for the area in which the building is being constructed as these may affect the type and amount of tie downs required. The various wind speeds are designated as:

**N1 (28m/s), N2 (33m/s),
N3 (41m/s) and N4 (50m/s).**



Typical strap tie downs at the pitching point of a truss.

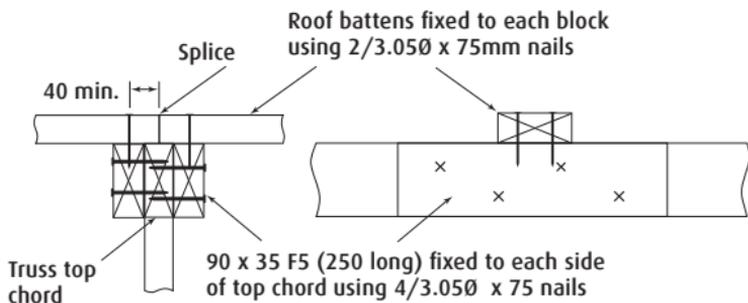


Use correct heel tie down methods and "bracing" nails only.

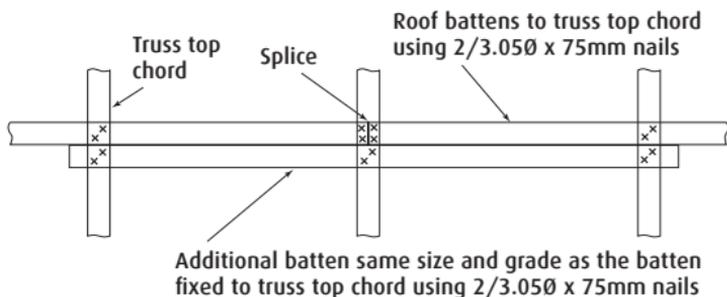
9. Alternate the batten splices (joins) over trusses where tile roofs are to be used.

There are a number of methods that can be used to splice a tile batten, including those detailed in the following diagrams:

OPTION 1



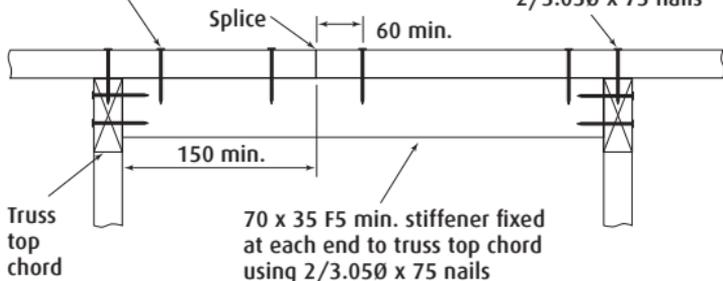
OPTION 2



OPTION 3

Fix batten to stiffener with minimum with minimum 2/3.050 x 75 nails each side of splice

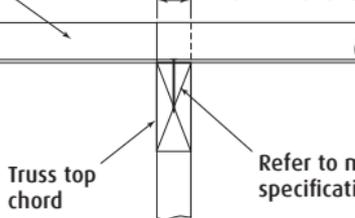
Roof battens fixed to each truss using 2/3.050 x 75 nails



OPTION 4

Metal Batten

40 min. overlap



10. Ensure all lateral bracing (lateral restraints) for bottom chords have been installed to manufacturer's layout. Always install the ceiling linings as the treatment of the ceiling and the type of attachment to the bottom chords may well affect the lateral bracing. The ceiling lining may be designed for further restraint.

11. Ensure all the top chord steel bracing is installed correctly and in its designed position.



Steel brace installed to top of roof trusses

Tip

Alternate tile batten splices over trusses and use one of the demonstrated methods for your splice.

12. Ensure cantilevered trusses are correctly installed with the cantilever directly over the loading point as designed.



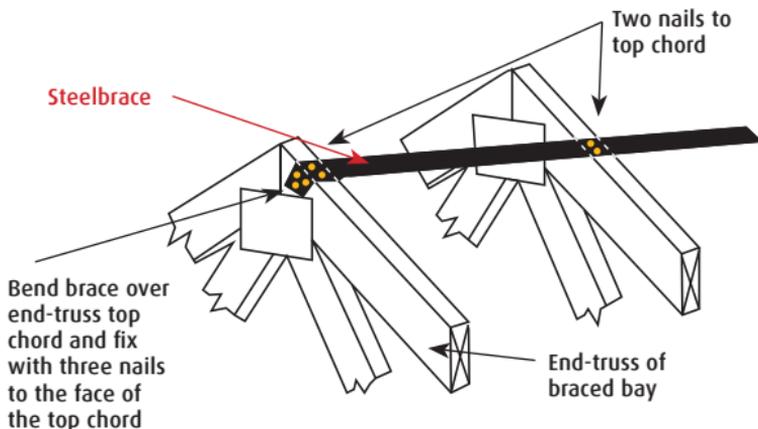
Cantilever correctly installed.

- 13.** Ensure all saddle trusses are correctly installed and supported.



A correct method of installing saddle trusses.

- 14.** Ensure all bracing is fixed with the correct amount and type of fixings.



End fixing details at apex

Post installation

15. Trusses are constructed in factory conditions with metal truss plates installed with specifically designed presses. Never remove and replace a truss plate on site for whatever reason as truss failure will almost certainly result. Truss plates removed and installed on site will delaminate, as detailed in the photographs, if not installed by a proper truss press by the manufacturer.



Look out for faulty nail plates!

16. When stacking tiles ensure the load is spread evenly across the roof.
17. Seek advice from the manufacturer first when applying any additional loads to the trusses, including the ends of the trusses (such as pergolas, verandas, carports, hot water services, air conditioning units and solar panels). Obtain prior written approval of the manufacturer as well as the approving authority.



Trusses indicating location of proposed air conditioning unit.

DON'Ts

Pre-installation

1. Don't unload (or allow the unloading of) trusses unless you have a clear flat level area to land the trusses or place the trusses on the ground.



Typical building site with trusses poorly stored. Severe damage can result to the trusses when stored in this manner.

- 2.a Don't use second hand trusses unless you have them approved for use on your job by a structural engineer.

- 2.b** Don't install trusses that are not approved for the site.
- 2.c** Don't use damaged trusses or trusses with damaged frame components.
- 2.d** Don't repair damaged trusses without written approval from the manufacturer and specification for repairs by a structural engineer. If in doubt return the damaged truss to the manufacturer for repairs.



A cracked strut member supporting a roof apex joint assembly



Over-tightening of strapping due to poor methods used in the truss factory



Trusses damaged on delivery

Tip

Don't use or repair damaged trusses without written approval from the manufacturer.

3. Don't leave trusses exposed to weather for long periods of time. Generally trusses left exposed for over three months (whether stored on the ground or installed and left uncovered) should be inspected by the truss company and accepted in writing as being fit for purpose prior to any loadings being applied.



Old trusses stored for reuse



Weathered trusses

Installation

4. Don't load or fix the bottom chords of trusses on wall frames or top plates of a wall unless they are designed to do so.



Bottom chords sitting on and nail fixed to the top plate. The underside of the top plate should be clear of the top of the wall plate

5. Don't place trusses on the wall frames unless the frames have been braced properly.



Braced wallframes

6. Don't distort trusses or allow them to sag between supports during installation. Prop the truss pack as required.
7. Don't modify, cut or drill holes through trusses without prior approval of the manufacturer.



Modified roof trusses

Tip

Don't distort trusses or allow them to sag between supports during installation.

8. Don't modify the truss layout without written approval of the manufacturer, engineer or relevant authority.
9. Don't leave ends of trusses loose, swinging in the breeze! Install all of the required bracing.



Unbraced trusses

10. Don't replace structural timber with steel fascia without approval of the manufacturer.
11. Don't attach safety barriers or lines to trusses without prior written approval of the manufacturer.

12. Don't install high-load trusses without adequate load transfer and top chord restraints.
13. Don't overnail heel connections.
14. Don't fix or brace bent, distorted or out of alignment trusses. Trusses should be installed plumb – an acceptable tolerance is that they must not lean more than the thickness of the truss timbers. Individual trusses should be installed in a straight line – an acceptable tolerance is that they must not be out of line more than the thickness of the truss timbers in any part of its length.



Distorted trusses

Tip

Don't fix or brace bent, distorted or out of alignment trusses.

15. Don't use incorrect tie downs.

Inappropriate tie downs

- 16.** Don't install internal wall brackets incorrectly. Don't drive the nails fully home. The bracket must allow for movement of the truss.



Nails punched through bracket which does not allow for any movement of the truss.



Nails driven fully home do not allow for any movement of the truss.

Tip

Make sure the bracket allows for movement.
Don't drive nails fully home.

17. Don't allow consecutive splicing of roof tile battens over any one truss as this can lead to bracing failure and in extreme cases the collapse of a roof truss frame.

The types of splices as detailed in photos below are not permitted as there is not enough holding power in the fixings. Appropriate action would be a parallel batten over adjoining two bays one, or both sides of the splice.



Tip

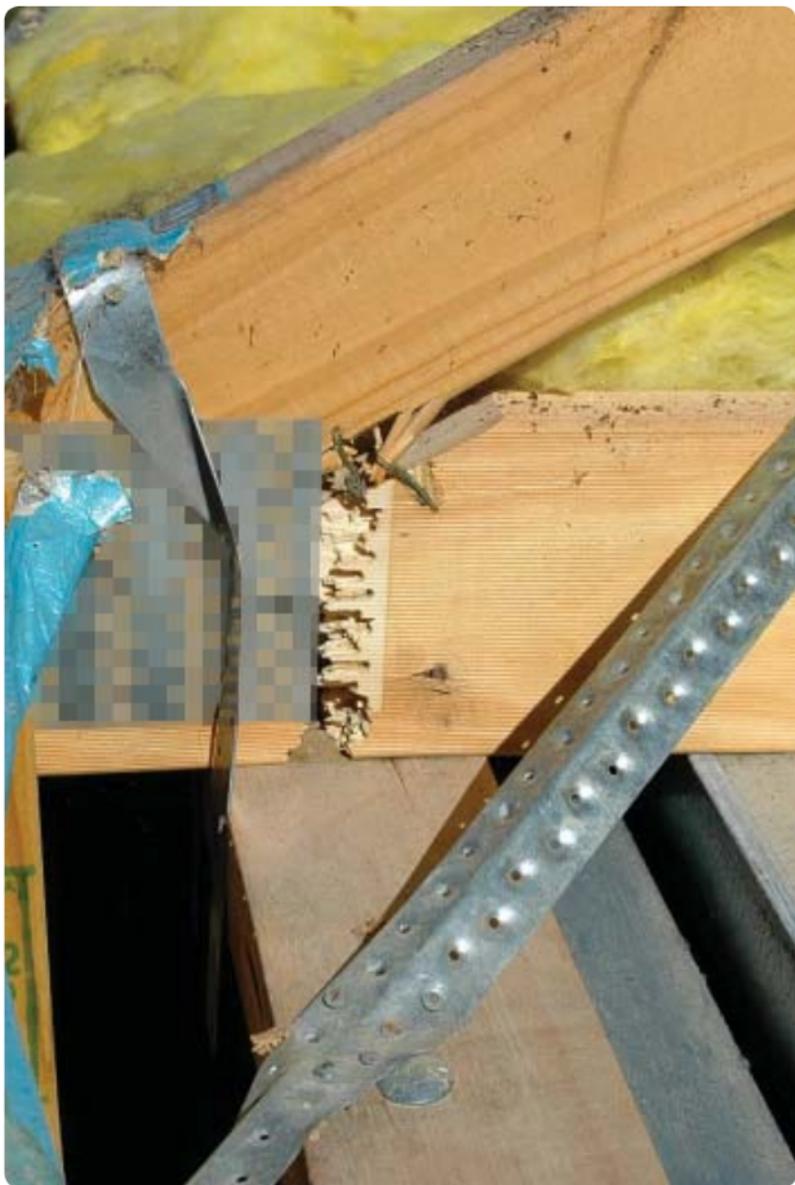
Tile batten splices must be staggered, so that at least every other batten is continuous over the top chord of the truss.

Post-installation

- 18.a** Don't turn a truss roof into an attic for storage purposes.
- 18.b** Don't install a platform on the top of the bottom chords.
- 18.c** Don't cut the speed brace or any other bracing to the trusses.







Tip

Don't overload trusses.

- 19.** Installing additional loads: don't add additional loads to the trusses without prior written approval of the manufacturer or a structural engineer, and your local council.

This applies to loads such as:

- Attached pergolas, verandahs and carports
- Hot water services
- Water storage units
- Air conditioning units and ducting
- Solar panels.



Residential and Light Commercial – Steel Roof Trusses

Specifications:

Steel Framing

- NASH Standard -
*“Residential and low-rise steel framing
- Part 1 Design Criteria”.*
- NASH Standard -
“Section 6.2 Roof bracing”
- AS 4100 Steel structures
- AS 2050 Installation of roof tiles
- AS/NZS 1562.1
“Design and installation of sheet roofing metal”
- AS 1397
*“Continuous hot-dip metallic coated steel
sheet and strip - Coatings of zinc and zinc
alloyed with aluminium and magnesium”*

Key Safety Points

Everyone in the workplace is subject to the requirements of the Occupational Health, Safety and Welfare Act. This means that on the building site workers should have safe clothing, use tools and machinery safely, and protect the public appropriately in order to achieve a safe working environment.

The frame must be permanently electrically earthed on completion of fixing.

A person should not set out to install a steel frame truss roof unless they are trained to install that particular manufacturer's roof truss system.

If you make a practice of always using a checklist when installing roof trusses you can ensure that you comply with all the requirements applicable to the roof you are installing.

The following sections contain some common scenarios which have been organised into DOs and DON'Ts for installing steel framed roof trusses.

(The list is not intended to be exhaustive.)

DOs

- 1.a** Make sure you get training in how to install the particular manufacturer's roof truss system. Manufacturers of steel roof trusses use different brackets, connecting plates, fixings, bolts, washers and tie down plates. Always comply with the particular manufacturer's instructions and only use their components.

- 1.b** Only use correct coating class screws and fixings. If it's not clear or you don't know, seek advice from the manufacturer first.



Typical tie down at the pitching point of a truss.



Typical fixing brackets and fixings

2. Be aware of the maximum designed gust wind speed for the area in which the building is being constructed as these may affect the type and amount of tie downs required. The various wind speeds are designated as:

**N1 (28m/s), N2 (33m/s),
N3 (41m/s) and N4 (50m/s)**

3. Sections of the SA Coast are defined as having breaking surf. Any corrosion protection needs to be of an adequate standard.

When ordering trusses or framing, including bracing and tie-down materials, specify the corrosion environment if applicable, and ensure that what is delivered is what was ordered.

Corrosion environment maps can be found on the sa.gov website. Enter “corrosion maps” in the search box of the www.sa.gov.au website.

4. When stacking tiles before installation ensure the load is spread evenly across the roof.
5. Provide a flat area to store roof trusses or, in the event of a sloping or undulating site, crane the truss packs directly on to the walls of the building.

6. Roof trusses must be inspected on arrival at the site and any damage or concerns should be reported to the truss manufacturer immediately. If there is damage the manufacturer will need to advise what action needs to be taken prior to installation.

Tip

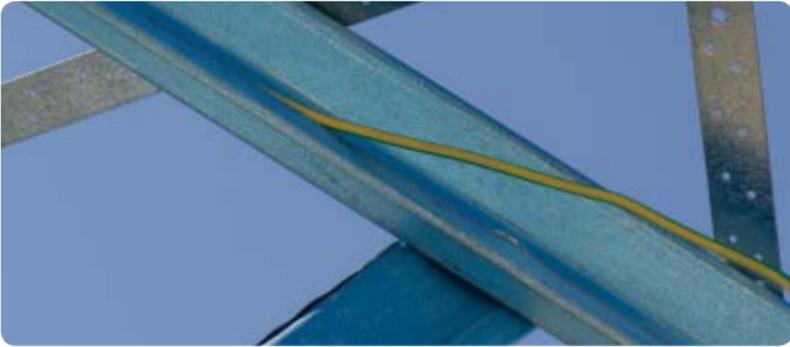
Look out for trusses that have not been stored correctly and are twisted and bent. Inspect all the trusses.

7. Keep the steel out of contact with dissimilar metals such as copper, lead, brass and stainless steel; this includes fasteners and brick ties.

Keep the steel components out of contact with treated timbers and other timber capable of retaining moisture.

8. Permanent earthing of a completed steel frame is essential in accordance with the regulations of the local electricity authority; it should be done as soon as is practicable once the steel frame is anchored.



**Tip**

Ensure the steel frame is earthed as soon as it is anchored.

9. Ensure cantilever trusses are correctly installed with the cantilever directly over the loading point as designed.
10. Ensure you have supporting engineering documentation before cutting into or removing any sections.
11. Ensure the manufacturer is aware of any additional load to the bottom chord.



Additional bracing for the support of a garage panel lift door.

DON'Ts

Pre-installation

- 1.** Don't install trusses that are not designed or approved for the site.
- 2.** Don't store roof trusses on uneven surfaces prior to assembly.
- 3.** Don't store trusses in sand or soil.
- 4.** Don't allow trusses to be exposed for prolonged periods of time.
- 5.** Don't distort or allow trusses to sag between supports during installation. Prop the truss pack as required.
- 6.** Don't modify the truss layout without written approval of the manufacturer, engineer or relevant authority
- 7.** Don't attach safety barriers or lines to trusses without prior written approval of the manufacturer.

Installation

7. Don't use second hand trusses unless you have them approved for use by a structural engineer.
8. Don't use or repair damaged trusses without the written manufacturer's approval or the written approval of a structural engineer.
9. Don't modify, cut or drill holes through trusses without prior approval of the manufacturer. If in doubt return the damaged truss to the manufacturer for repairs.
10. Don't use trusses with any damaged frame components, truss webs etc as this could reduce the structural integrity of the particular section or compromise the complete roof frame.



Damaged brace



Damaged bottom chord

- 11.** Don't distort or damage lip profiles in trusses.
- 12.** Don't use grinders on steel framing - use cold cut methods. If protective coatings are damaged replenish with a zinc rich paint. (Cold Galv).
- 13.** Don't place the trusses on the wall frames unless the frames have been braced properly.
- 14.** Don't commence installation of steel roof trusses until the steel wall frame is connected to an earth stake.

- 15.** Don't use different or substitute components such as brackets, connecting plates, fixings, bolts, washers and tie down plates from that as specified by the manufacturer of the trusses as this could reduce the structural integrity of a particular section or compromise the complete roof frame. Don't use incorrect tie downs or incorrect tie down methods.
- 16.** Don't install high-load trusses without adequate load transfer and top chord restraint.
- 17.** Don't fix or brace bent, distorted or out of alignment trusses. Trusses should be installed plumb – an acceptable tolerance is that they must not lean more than the thickness of the truss members.

Individual trusses should be installed in a straight line – an acceptable tolerance is that they must not be out of line more than the thickness of the truss members in any part of its length.

- 18.** Don't over tighten screws.
- 19.** Don't omit any screws as shown on the plan.

Post-installation

- 20.** Don't cut or remove any bracing.
- 21.** Don't turn a truss roof into an attic for storage purposes.
- 22.** Don't install a platform on the top of the bottom chords.
- 23.** Don't support loads such as air conditioners, hot water services in the roof unless the trusses are designed to do so.

Installing additional loads

- 24.** Don't add additional loads to the trusses without prior written approval of the manufacturer or a structural engineer, and your local council.

This applies to loads such as:

- Attached pergolas, verandahs and carports
- Hot water services
- Water storage units
- Air conditioning units and ducting
- Solar panels.

Frequently asked questions

Q: What is a roof truss?

A: A roof truss is a rigid, strong triangulated structural framework made up of timber or steel members, fastened and held together by metal connector plates, screws, bolts and such. This framework accounts for the shape of the roof and supports the roofing loads.

Q: Are timber or steel trussed roofs better than a conventional timber roof frame?

A: A timber or steel trussed roof may be seen as being better because timber and steel used by quality truss manufacturers conforms to strict, local, and national building design criteria. Timber and steel used for trusses is cut by machines that are mathematically calibrated and set to produce highly accurate cuts. This helps eliminate gaps when truss members are joined. Because trusses are manufactured with great precision in jigs, multiples of the same truss are identical in size, assuring uniformity throughout your roof system.

Q: Why should I check with an engineer before installing a load such as a water heater or solar panels on a roof?

A: All structural components of a building require design and approval. When you add additional loads to the structural members without having the design engineer and approving authority check the calculations the additional loads imposed may cause short or long term failure. This could lead to collapse of the roof and could cause injury or death. The roof must be able to support the extra loads imposed. You may be held liable if you impose extra loads without approval if something goes wrong.

Q: What should I do if I accidentally cut into a roof truss?

A: Contact the truss manufacturer for advice. The manufacturer may design an onsite repair method or require the truss to be returned to the factory for repairs. Alternatively the truss may need to be replaced.

Q: Why shouldn't I use second hand trusses?

A: Trusses are engineered to fit the exact purpose for a building and site. Second hand trusses are not designed for your job.

Q: How many tile batten splices can I have on the one truss?

A: Tile battens provide lateral support to the top of the truss. Tile batten splices must be staggered, so that at least every other batten is continuous over the top chord of the truss.

Q: There is no room on the site to store the trusses. What should I do?

A: A flat, level place must be available for delivery of the trusses. If storage is a problem, you will need to address it before you call for delivery. The trusses may be required to be craned and stored on top of the walls. Usually the delivery driver will contact you or return the trusses to the factory if the area for storing has not been prepared.

Q: What do I do if some roof trusses are damaged?

A: Contact the truss manufacturer for advice. The manufacturer may design an onsite repair method or require the truss to be returned to the factory for repairs. Alternatively the damaged truss/es may need to be replaced.

Q: How long will the roof truss system last?

A: With normal maintenance and repair, the roof system should maintain its structural integrity for the lifetime of the building barring fire or some other disaster.

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engineersaustralia.org.au

Housing Industry Association (HIA)

Cnr Port Rd & Station
Place, Hindmarsh SA 5007
P 8346 5091
www.hia.com.au

Local Government Association

First Floor, 16 Hutt Street,
Adelaide SA 5000
P 8224 2000
www.lga.sa.gov.au

Master Builders Association (MBA)

47 South Tce
Adelaide SA 5000
P 8211 7466
www.mbasa.com.au

Planning SA

Roma Mitchell House
136 North Terrace
Adelaide SA 5000
P 8303 0600
www.planning.sa.gov.au

Safe Work SA

Level 3, 1 Richmond Rd
Keswick SA 5035
P 1300 365 255
www.safework.sa.gov.au

Service SA

EDS Centre
108 North Tce
Adelaide SA 5000
P 13 23 24
www.service.sa.gov.au

TAFE SA

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Business infoline
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