

Building Skills

Introductory Level Training – Workbook

This workbook has been prepared by Quasar Management Services Pty Limited, as a guide for use by not-for-profit NGOs in South Pacific village applications.



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Introduction

Purpose

The purpose is to provide introductory level building skills to trainees, enabling them to work as builders in the future and to undertake more advanced training.

Workbook

- This workbook is for basic building skills training for the construction of South Pacific village housing, community health buildings, school buildings and the like.
- The workbook employs photographs and diagrams where possible, with minimum use of text.
- More detailed training packages are available for higher level builder training.
- The trainee is encouraged to make notes in the space provided.

Trainer

The Trainer must be an experienced builder or building professional, who has received instruction in the use of this material.

Training Resource Material

This material is sourced from Power Point presentations, that can be used as:

- Teaching presentations
- Printed work books, to be given to the trainees as a permanent reference
- Printed and laminated posters, that are placed on site
- As a source of details, which can be copied and placed onto project drawings.

Cyclone



Let us pause and remember those killed in natural disasters, ordinary people like you and me in the wrong place at the wrong time.



Earthquake

Tsunami



Good Design Reduces Damage

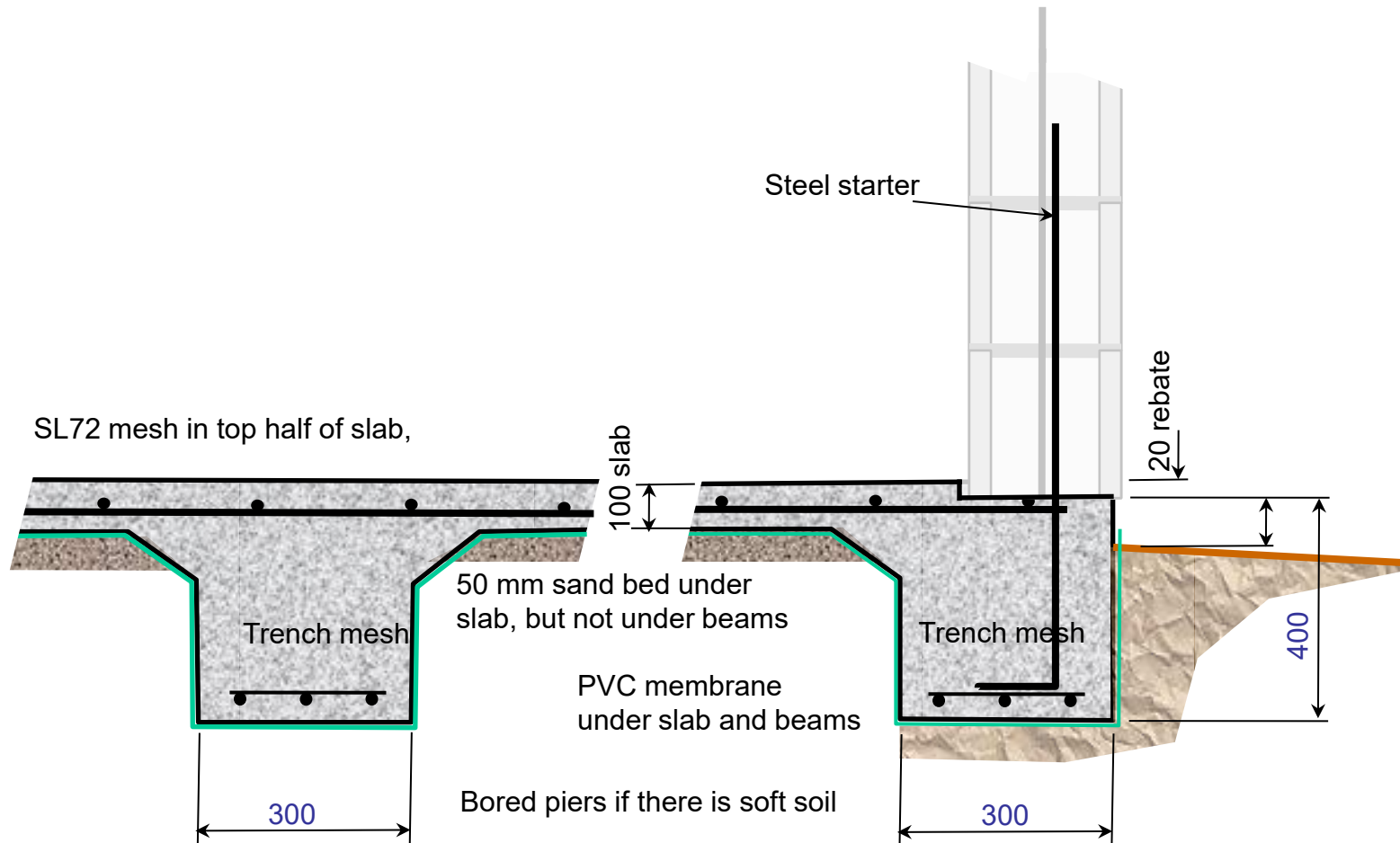
Two houses, side by side – same 2007 Solomon Islands earthquake and tsunami.

The green “timber and concrete house” includes bracing (strong lower storey room) and/or diagonal braces.

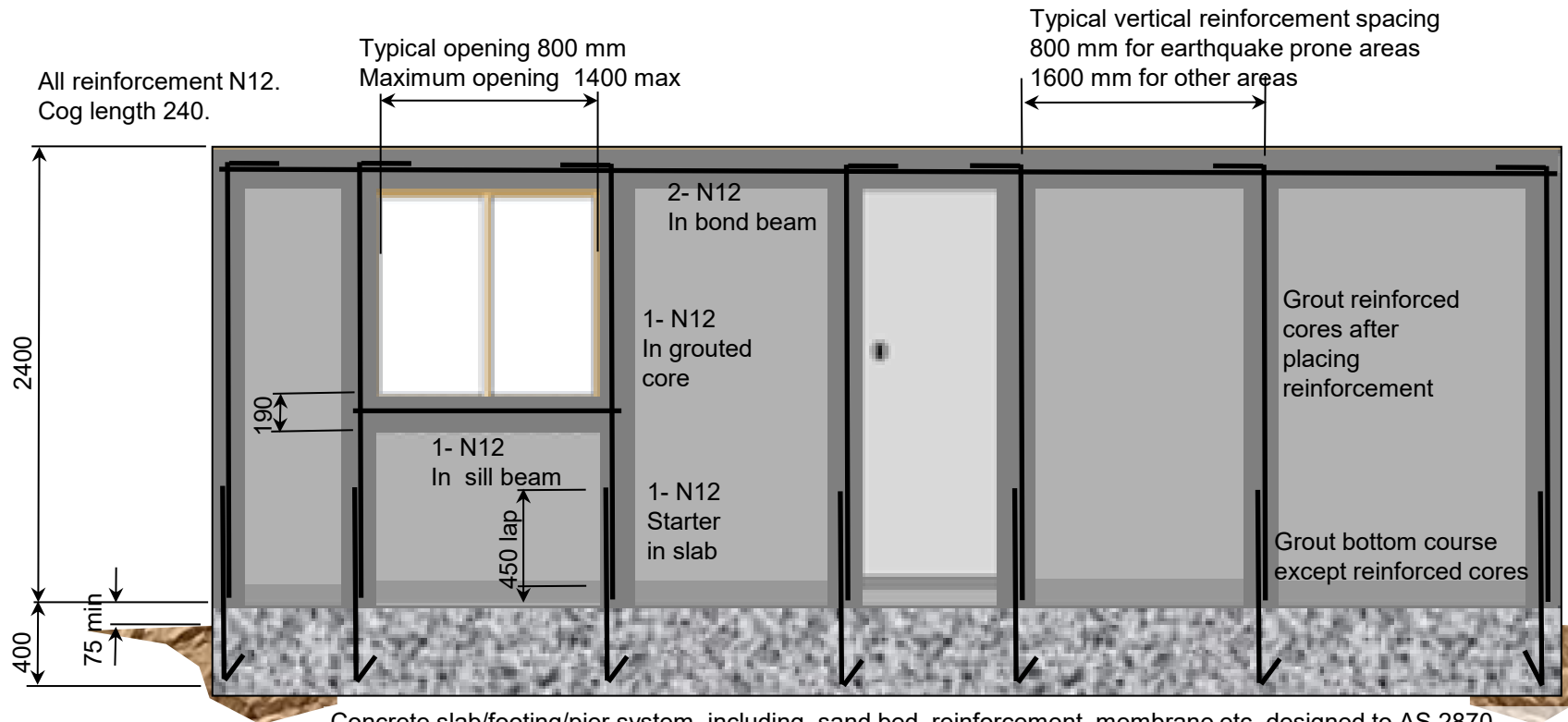
The brown “leaf house” (without any bracing) is near collapse.



Definitions – Concrete Slab-on-Ground



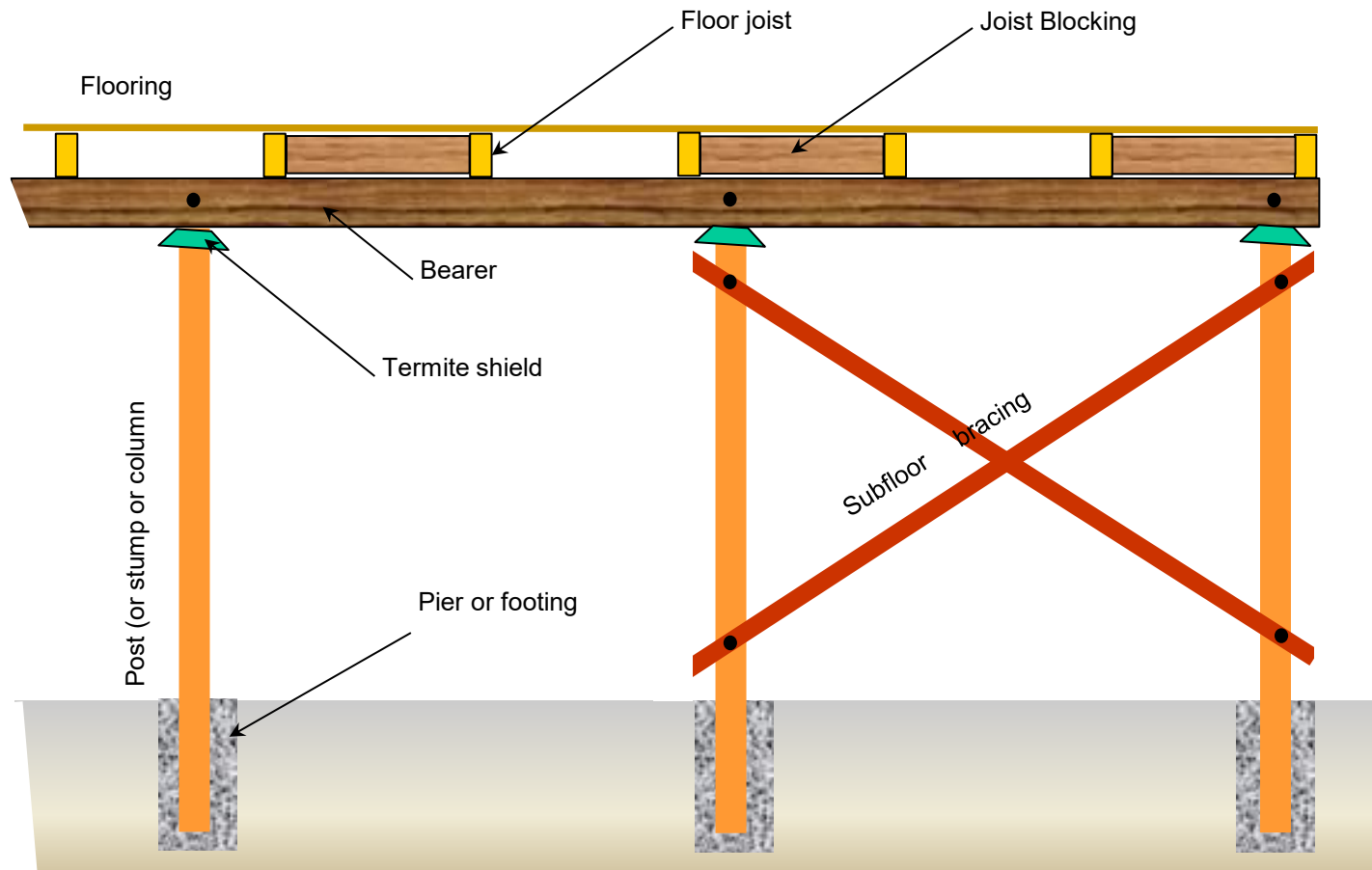
Definitions – Reinforced Concrete Masonry Wall System



Concrete slab/footing/pier system, including sand bed, reinforcement, membrane etc, designed to AS 2870.
Typically edge beams and cross beams, 300 x 300 mm, 3-11TM trench mesh. 100 mm concrete slab, SL72 mesh.

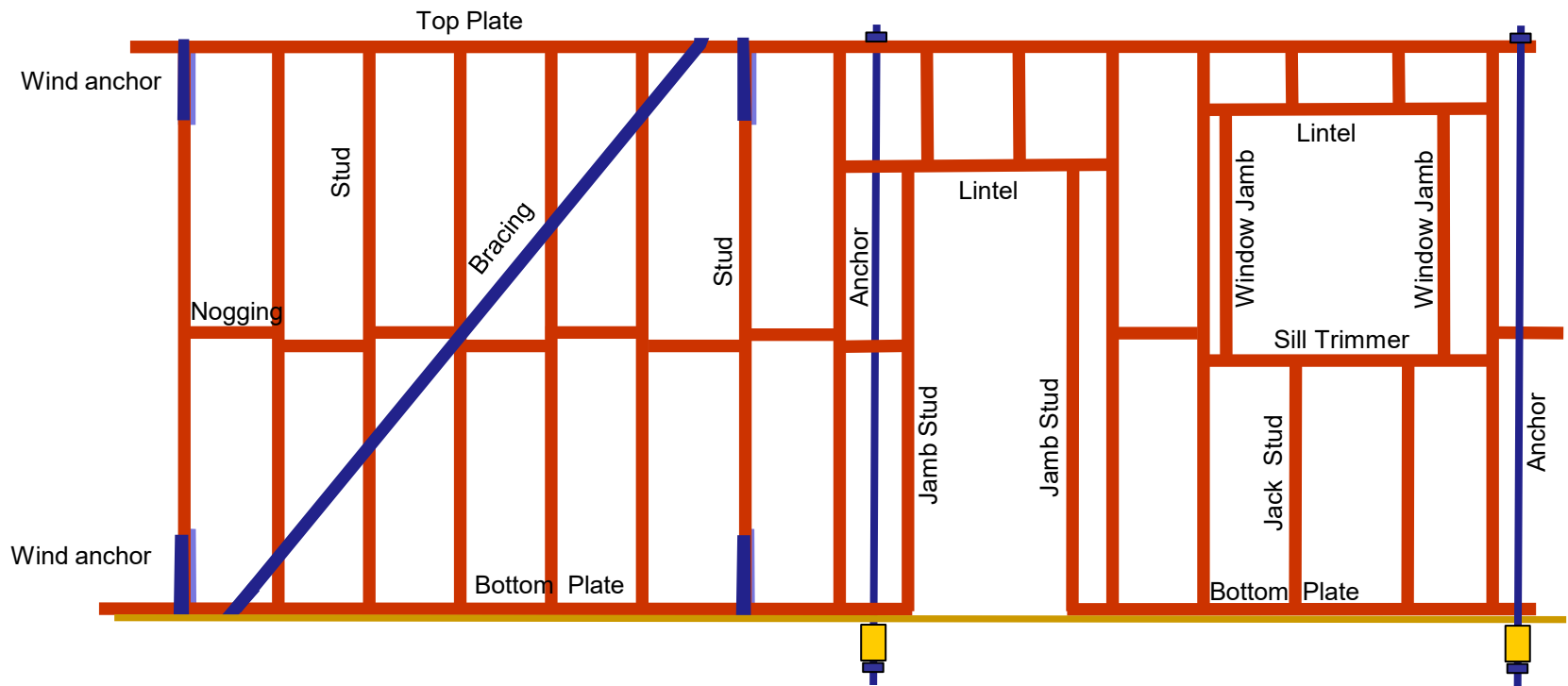
Typical Arrangement of Reinforcement

Definitions – Timber or Steel Subfloor



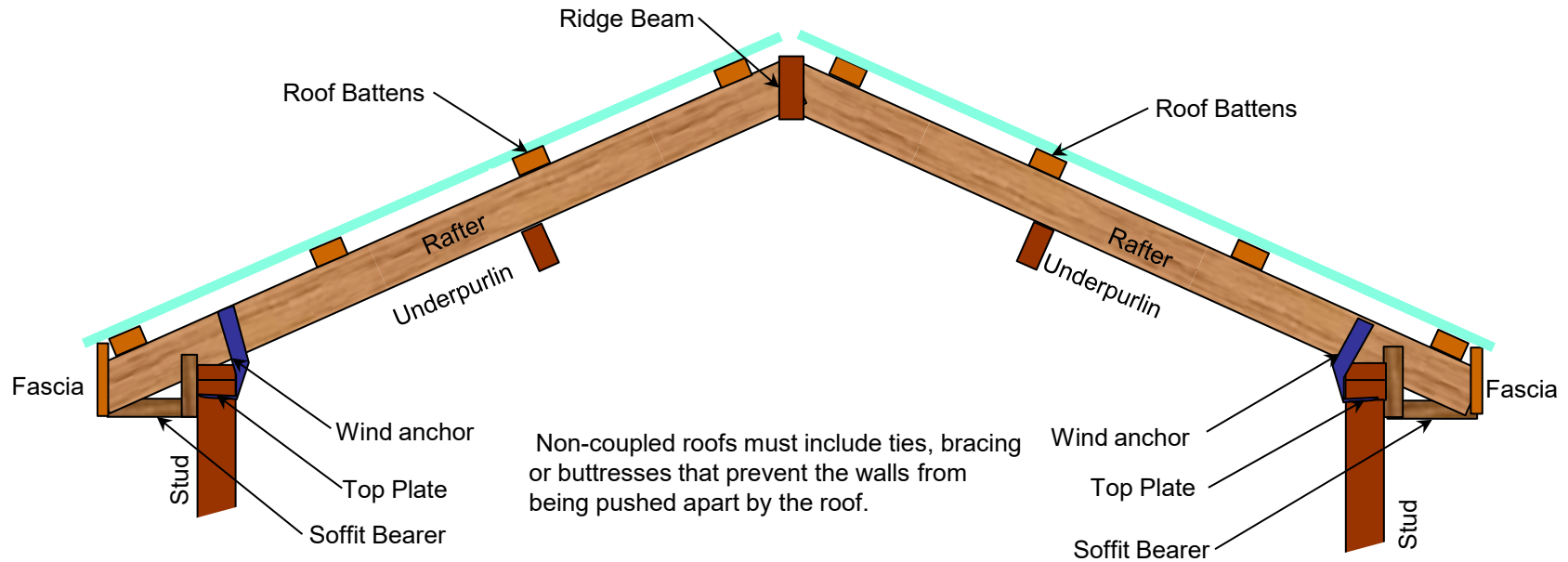
In this training package the term “pier” is used for the deep footing (not for the post)

Definitions – Timber or Steel Wall Framing



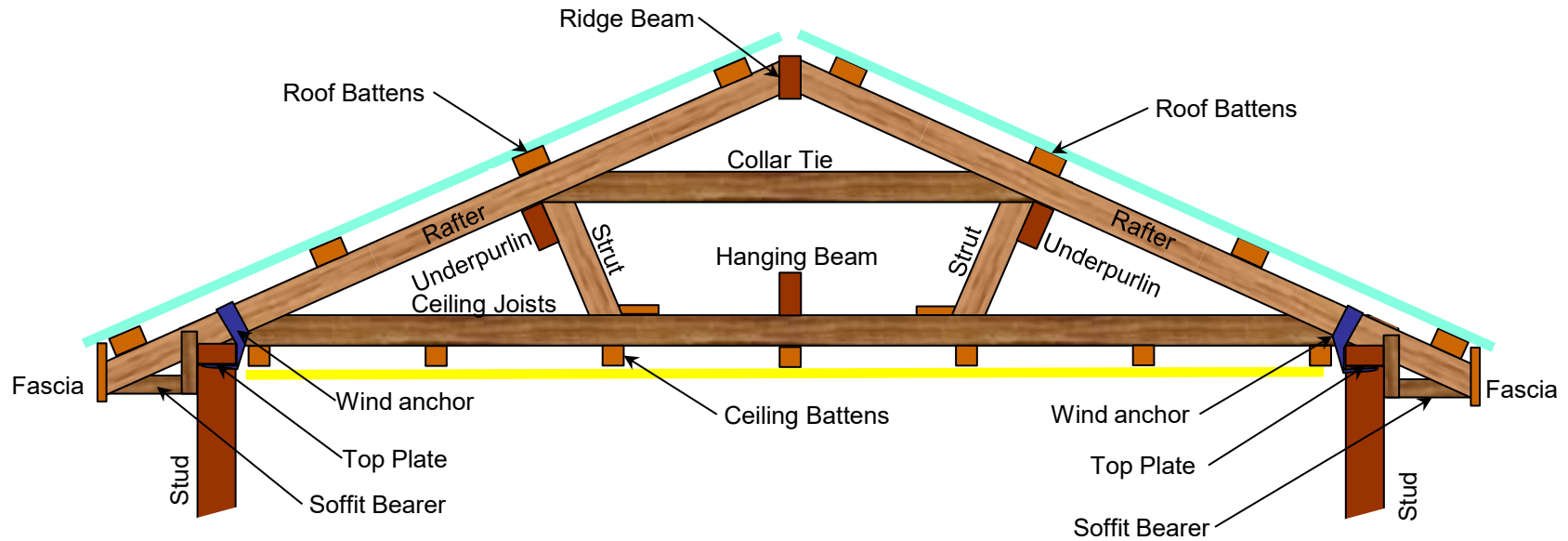
Definitions – Non-coupled Roof

Non-coupled roofs include cathedral roofs and the like, with or without a ceiling. They must include ties, bracing or buttresses that prevent the walls from being pushed apart by the roof.



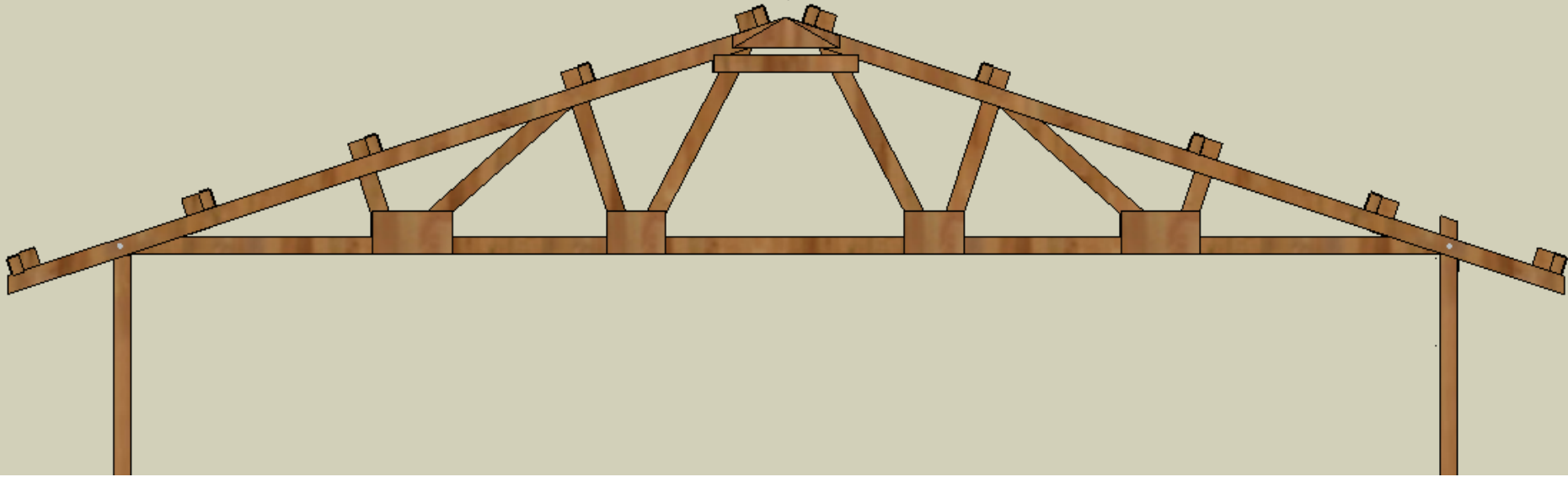
Definitions – Coupled Roof

Coupled roofs include collar ties and ceiling joists, which prevent the roof from pushing the walls apart.



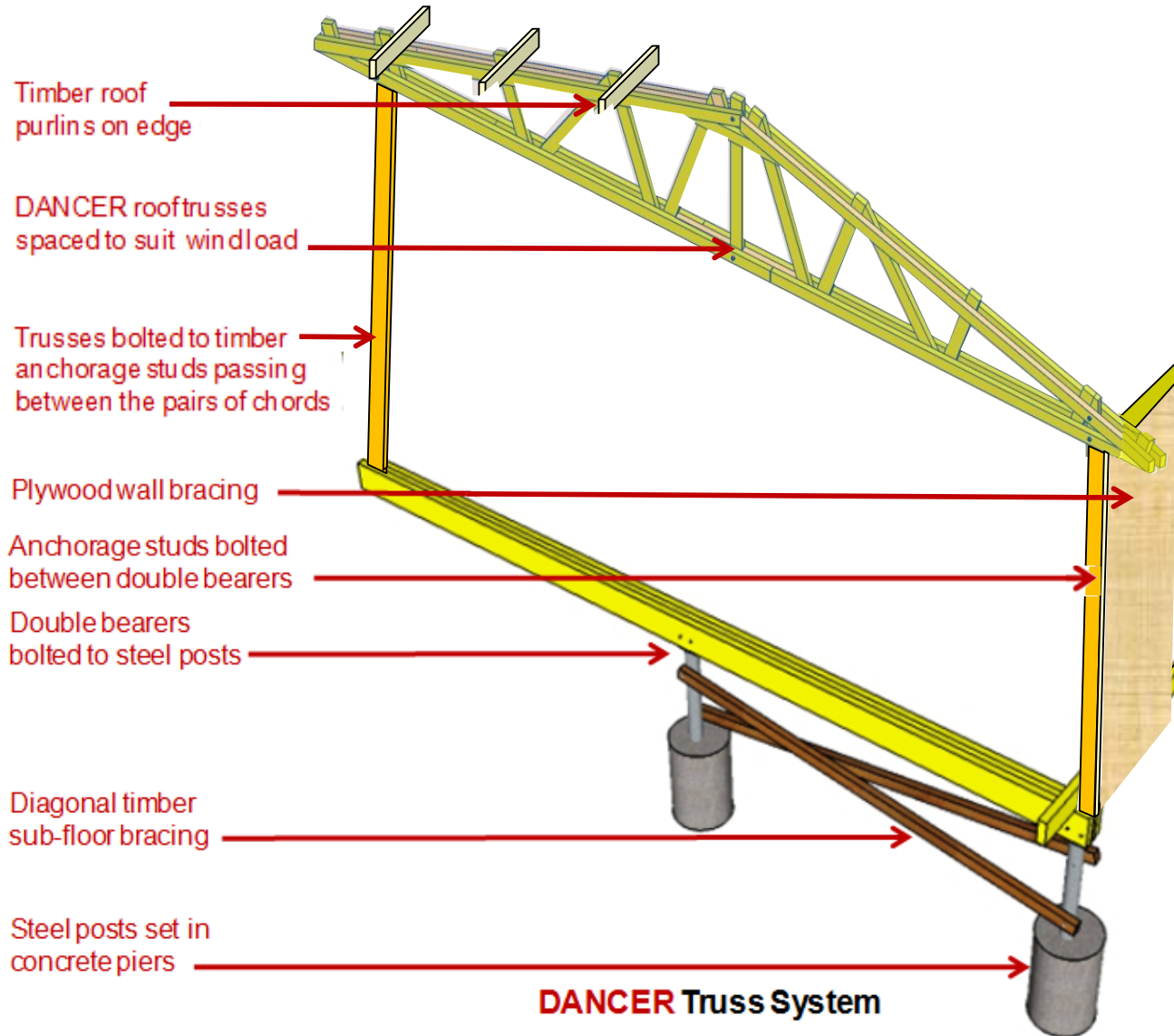
Definitions – Truss Roof

Truss roofs, which span large distances and prevent the roof from pushing the walls apart.



Definitions – **DANCER** Building System

Direct **A**nchorage **N**on-cyclonic, **C**yclonic & **E**arthquake **R**esistant Building System



DANCER Building Systems are also suitable for different truss types, slab-on-ground floors and reinforced concrete masonry walls.

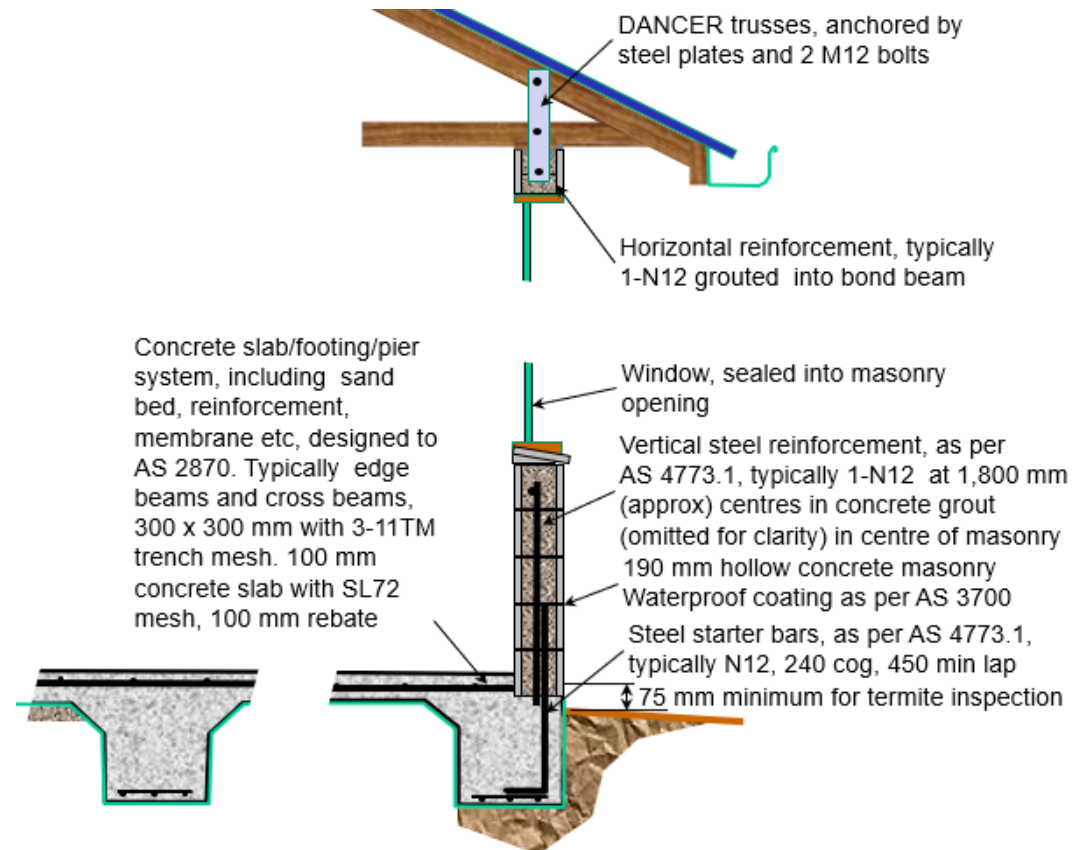
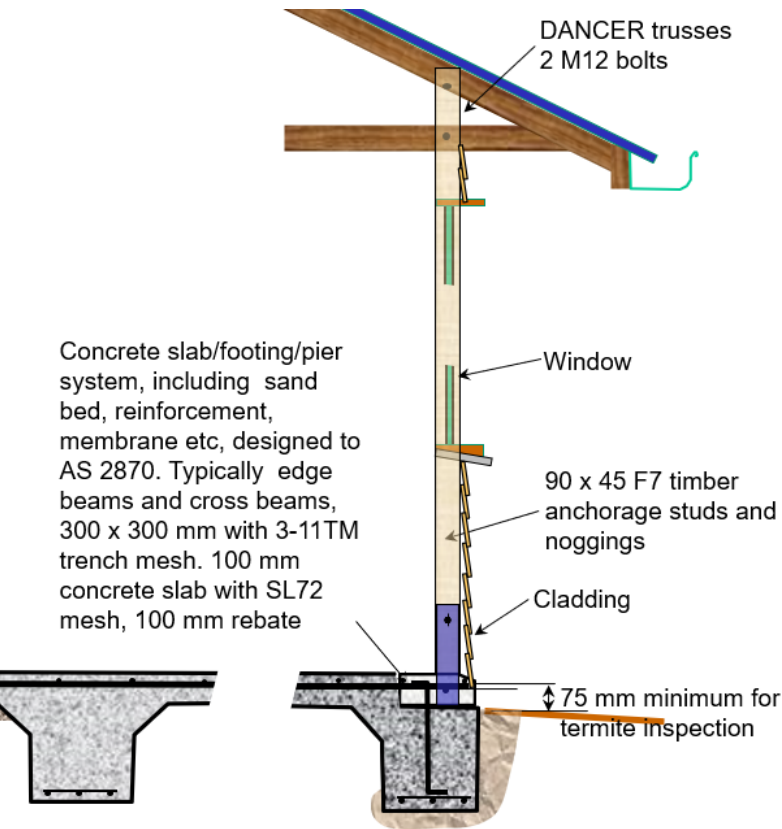
Alternatively, sub-floor diagonal braces may be fixed directly to the timber joists and bearers.

Definitions – **DANCER** Building System

Direct **A**nchorage **N**on-cyclonic, **C**yclonic & **E**arthquake **R**esistant Building System

DANCER Roof system +
DANCER Timber Walls +
 Concrete slab-on-ground floor

DANCER Roof system +
 Reinforced concrete masonry walls +
 Concrete slab-on-ground floor



Setting Out and Measuring Tools

| Tool | Use and Maintenance |
|-------------------------------|--|
| Tape | Used by all trades to measure lengths. Common useful lengths are 8 metres and 30 metres. Ensure the end stop is not damaged. Store in a clean dry place. |
| Stringline | Used by all trades to mark grid lines, levels and plan positions. Store in a clean dry place, and ensure that the string does not unravel. |
| Pegs | Timber pegs may be used to set out the corners of buildings, gridlines, and services. Store in a place where they will not be lost. |
| Hammer | Used to hammer in pegs and the like. Store in a clean dry place. |
| Electronic digital theodolite | Generally used by surveyors or major builders Store in a clean dry secure place. |



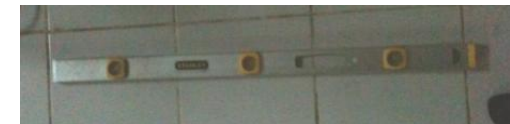
Leveling Instruments

| Tool | Use and Maintenance |
|------------------------------|--|
| Laser level | Generally used by surveyors or major builders. Store in a clean dry place. |
| Automatic level | Generally used by surveyors or major builders. Store in a clean dry place. |
| Dumpy level or tilting level | Less common on modern building sites. Store in a clean dry place. |
| Water level gauge | Only used in remote locations where surveyor's levels are not available. Store in a clean dry place. |
| Spirit level | Store in a clean dry place. |
| Staff | Used in conjunction with automatic levels and tilting levels. Store in a clean dry place. |
| Tripod | Used to support surveying instruments. Store in a clean dry place. |



Carpentry Tools (hand tools)

| Tool | Use and Maintenance |
|--------------------------------------|--|
| Hand saws e.g. rip saw, tenon saw | Cutting timber along or across the grain. Rub soap on the blade to prevent sticking in the cut. Store in a clean dry place. When not in use, rub oil on surface. |
| Brace and bit | Used for boring holes in timber for bolts or screws. Store in a clean dry place. |
| Hammer | Used for driving nails and removing nails. Store in a clean dry place. |
| Chisel | Used to remove slithers of timber. Ensure chisels are kept sharp and the blade protected. Store in a clean dry place. |
| Clamp | Used to hold pieces of timber together while they are cut, drilled, screwed, glued and/or nailed. Store in a clean dry place. |
| Spirit level | Used to determine ensure timber members are level during erection. Store in a clean dry place. |
| Squares | Used to ensure timber members are perpendicular. Other angles are possible. Store in a clean dry place. |



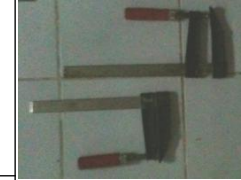
Plumbing Tools 1 of 2

| Tool | Use and Maintenance |
|----------------------|--|
| Hacksaw | Used to cut thick metal sections. Store in a clean dry place. |
| Tin snips | Used to cut thin metal sections . Store in a clean dry place. |
| Drill and drill bits | Used to drill holes for screw or rivets. Store in a clean dry place. |
| Rivet gun | Used to expand rivets in pre-drilled holes. Store in a clean dry place. |
| Silicon gun | Used to extrude silicone and other sealants from cartridges to seal joints in sheet metal. Store in a clean dry place. |
| Pliers | Used to pull and bed metal. Store in a clean dry place. |
| Screw driver | Used to drive and remove screws, flat, Philips-head, Allen key or other shapes. Store in a clean dry place |



Plumbing Tools 2 of 2

| Tool | Use and Maintenance |
|------------------|--|
| Clamp | Used to hold pieces of metal together while they are cut, drilled or screwed. Store in a clean dry place. |
| Squares | Used to determine ensure metal members are perpendicular to each other during erection. Other angles are possible. Store in a clean dry place. |
| Spirit level | Used to determine ensure metal members are level during erection. Store in a clean dry place. |
| Stilson wrench | Used to tighten or loosen threaded plumbing fittings. Store in a clean dry place. |
| Shifting spanner | Used to tighten or loosen nuts and bolts. Store in a clean dry place. |
| Multigrips | Used to tighten or loosen threaded plumbing fittings. Store in a clean dry place. |



Mechanical and Electrical Tools

| Tool | Use and Maintenance |
|------------------|---|
| Electric drill | May also include “hammer drill” for drilling concrete and masonry, using a masonry bit. Store in a secure, clean dry place. |
| Electric saw | Store in a clean dry place. |
| Cut-off saw | Store in a clean dry place. |
| Angle grinder | Store in a clean dry place. |
| Diesel generator | Used to generate electricity on sites where there is no power supply. Store in a clean dry place. |



Bricklaying and Blocklaying Tools

| Tool | Use and Maintenance |
|--------------|---|
| Trowel | Used to place mortar bed joints and perpendicular joints. Store in a clean dry place. |
| Shovel | Used to place cement, lime and sand in a mixer to mix mortar. Store in a clean dry place. |
| Mixer | Used to mix cement, lime and sand for mortar. Store in a clean dry place. |
| String line | Used to establish level bed joints. Store in a clean dry place. |
| Spirit level | Used to establish level bed joints. Store in a clean dry place. |



Concrete Tools

| Tool | Use and Maintenance |
|---------------|--|
| Bolt cutters | Cutting steel reinforcement up to 10 mm diameter. Store in a clean dry place. Rub with oil when stored for long periods. |
| Hacksaw | Cutting steel reinforcement 10 mm diameter and above. Store in a clean dry place. Rub with oil when stored for long periods |
| Screed | Levelling wet concrete after it has been moved to approximately the correct position and vibrated. Wash clean of any concrete. Store in a clean dry place. |
| Float | Used to smooth the surface of screeded concrete. May be steel float, wood float, sponge. Store in a clean dry place. |
| Broom | A stiff broom may be used over floated concrete to provide a “non-slip” finish. Store in a clean dry place. |
| Vibrator | Compacting wet concrete to maximise its density. Store in a clean dry place. |
| Spade, shovel | Used to move wet concrete. A spade is smaller and easier to use. Rub in oil and store in a clean dry place. |



Typical Inspection Schedule

“Date / Inspector / Comment” provides the inspector with the opportunity to record the results of the inspection. Further comments should be added to the bottom of the checklist.

“Hold / Witness” provides the specifier with the opportunity to signal whether the construction process must be halted (Hold) until the inspection is completed, or whether the construction may proceed, with the inspection taking place during the execution of the work (Witness).

“Accept Criteria” is a brief description of the acceptance/rejection criteria. These may refer to the specification, references to an Australian Standard clause, or a tolerance.

“Inspection Required” is a very brief description of the type of inspection to be carried out e.g. spot check dimensions, inspect delivery docket, count the number of items etc. If necessary, refer to the relevant Australian Standard.

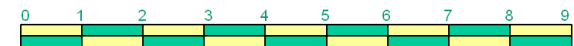
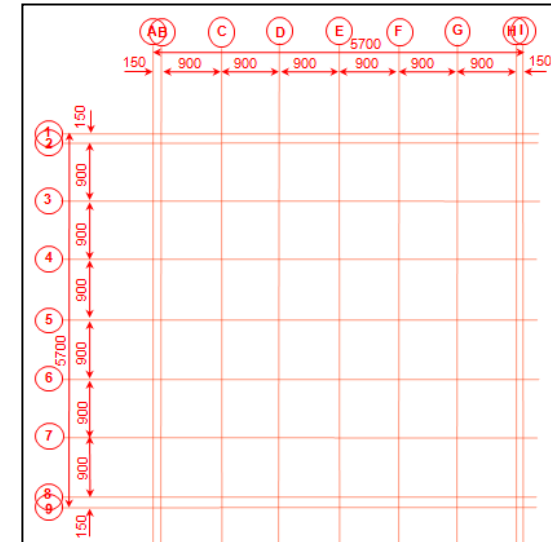
“Item or Product” is a list of the principal items to be inspected

| Item or Product | Inspection Required | Accept Criteria | Hold Witness | Date | Inspector | Comment |
|---|-------------------------------|--------------------------------------|--------------|------|-----------|---------|
| Drawings & Specifications | Inspect | In file | Hold | | | |
| Mains connection | View application | Copy in file | Hold | | | |
| Holes, chases, trenches | Visual | Correct position | Hold | | | |
| Pipes | Visual | Correct position | Hold | | | |
| Operation of all systems | Audible | No water hammer Unrestricted flow | Hold | | | |
| Testing - Cold water supply | AS/NZS 3500.1.2 Section 13 | AS/NZS 3500.1 criteria | Hold | | | |
| Testing - Sanitary plumbing & drainage, Soil, Vent, Waste, Water | AS/NZS 3500.2.2 Section 13 | AS/NZS 3500.2 criteria | Hold | | | |

Information Required on Drawings

Construction drawings must include the following:

- Title block stating the client, building and location.
- A notation indicating whether the drawing is “Preliminary” or “Approved for Construction” etc. and by whom.
- Issue or revision number and date
- Location on the site (orientation and distance from side boundaries. This is normally provided by a surveyor.
- Grid lines and grid dimensions. These should define the principal dimensions, orientation and position of the building on site, and enable the setting out of footings and sub-floor structure,
- Height datum and finished floor level.
- North point. While this is not sufficiently accurate for setting out, it enables the drawing to be quickly oriented to avoid confusion in labelling particular elevations.
- An approximate scale. Often drawings show a numerical value for the scale of each view (e.g. 1 : 100), but, as the drawing is copied and reduced or enlarged, this will become misleading. Use the dimensions stated on the drawing for construction purposes. Do not scale. A diagram showing the approximate scale may be provided to assist interpretation.



Use dimensions stated on the drawing for construction purposes. Do not scale. This approximate scale is provided to assist interpretation.

Grid Lines and Dimensions

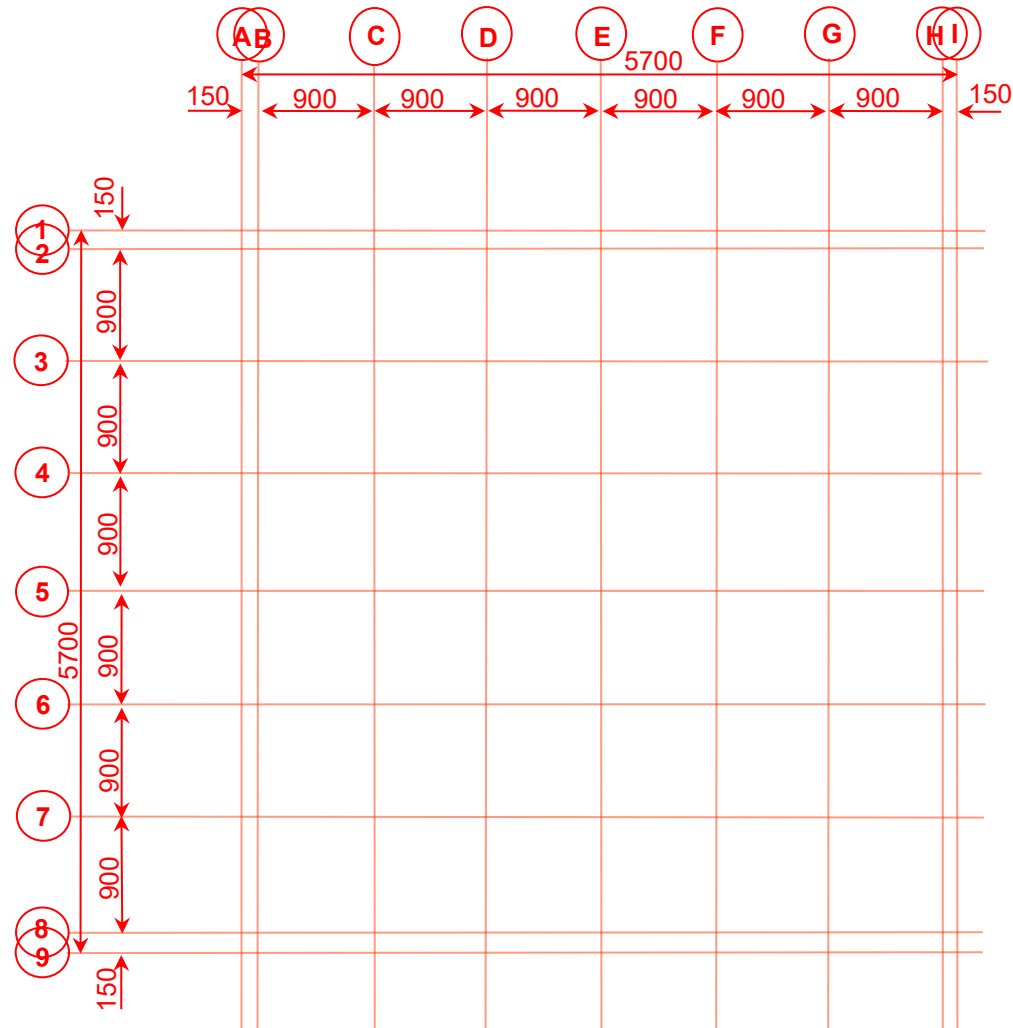
Grid lines should define the principal dimensions, orientation and position of the building on the site, and enable the setting out of footings and sub-floor structure.

When using CAD, the grid should be on a separate layer.

All dimension should be in millimetres.

Use 1, 2, 3, to define the horizontal gridlines

Use A, B, C, to define the vertical gridlines

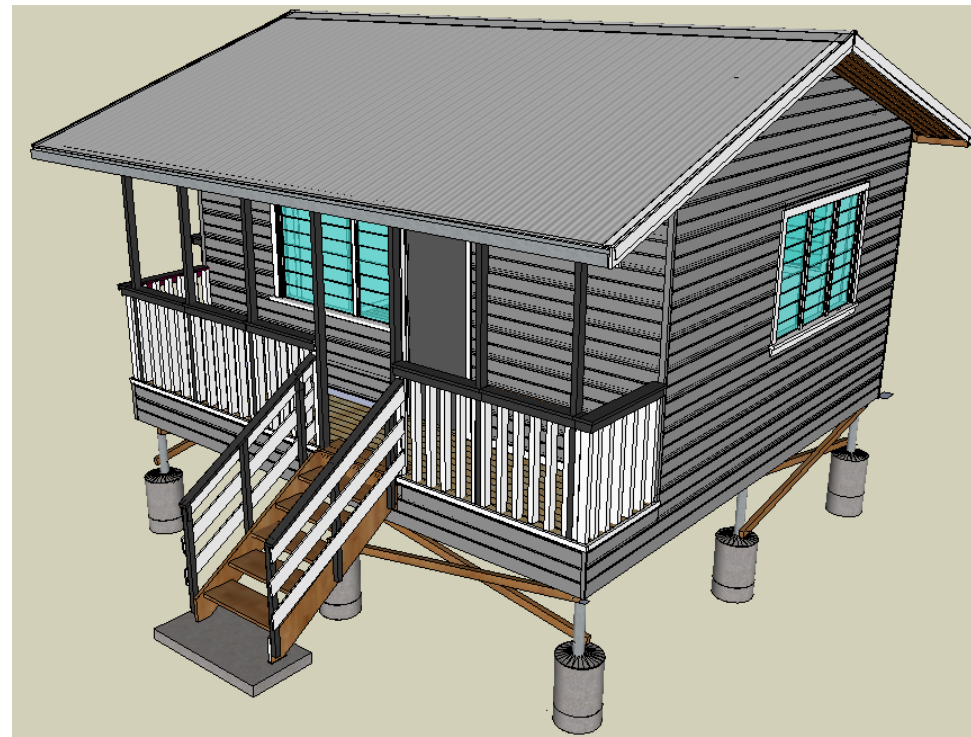


Design Drawings

Example

For an elevated timber framed 5.7 x 4.6 m house with an external balcony 1.1 m wide (suitable for non-cyclonic wind and significant earthquakes, on moderately reactive soils, but not subject to tsunami or flood) the following are the drawings required :

1. Architectural Drawings – Floor Plan, Elevations (four) and at Section (at least one)
2. Engineering Drawings and Details – Sub-floor Layout, Members, Details
3. Specifications – Sub-floor Posts, Footings and Bracing Details, Members, Cladding etc.



Typical Floor Plan

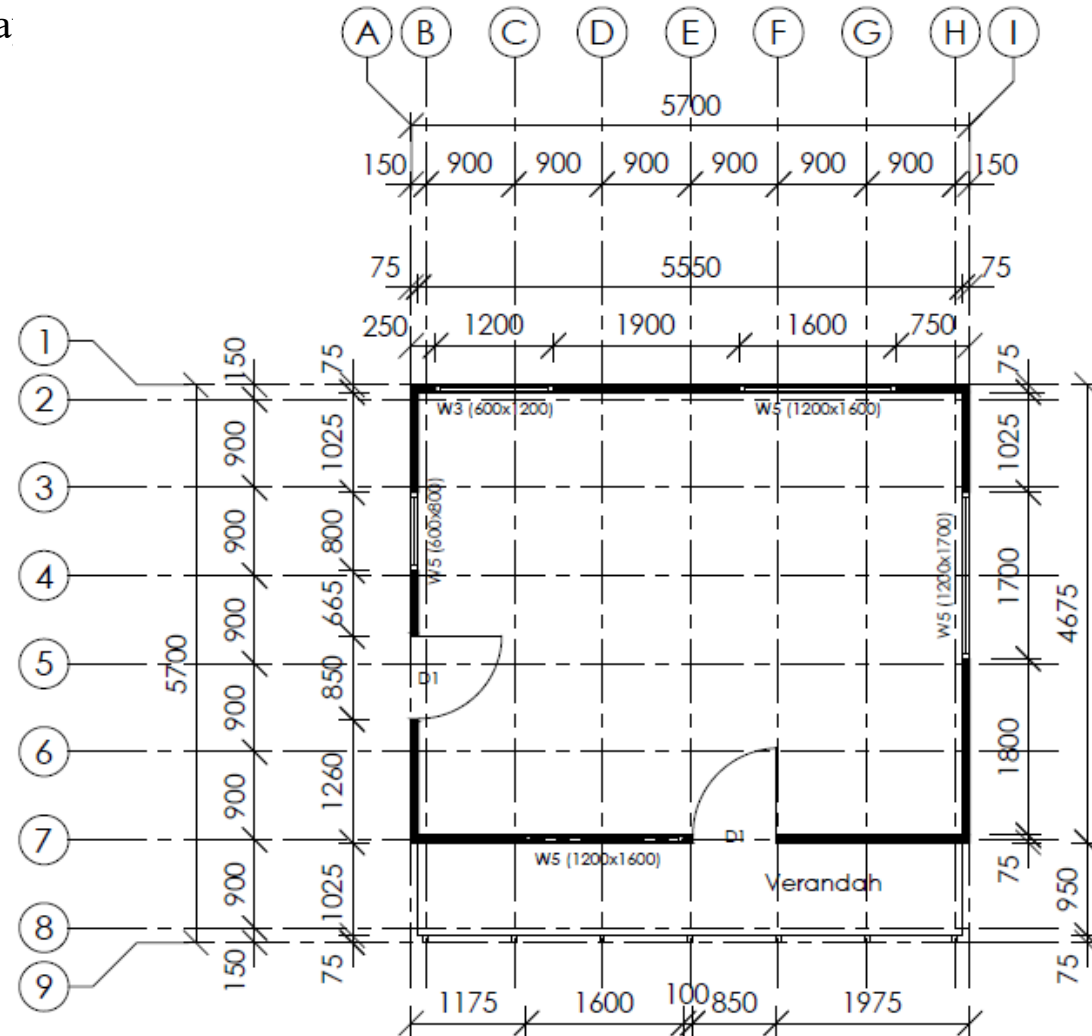
The floor plan is used for setting out all external walls, internal walls, doors and windows.

Dimensions of all components are related to the relevant grid lines.

Gridlines to which dimensions do not refer ma

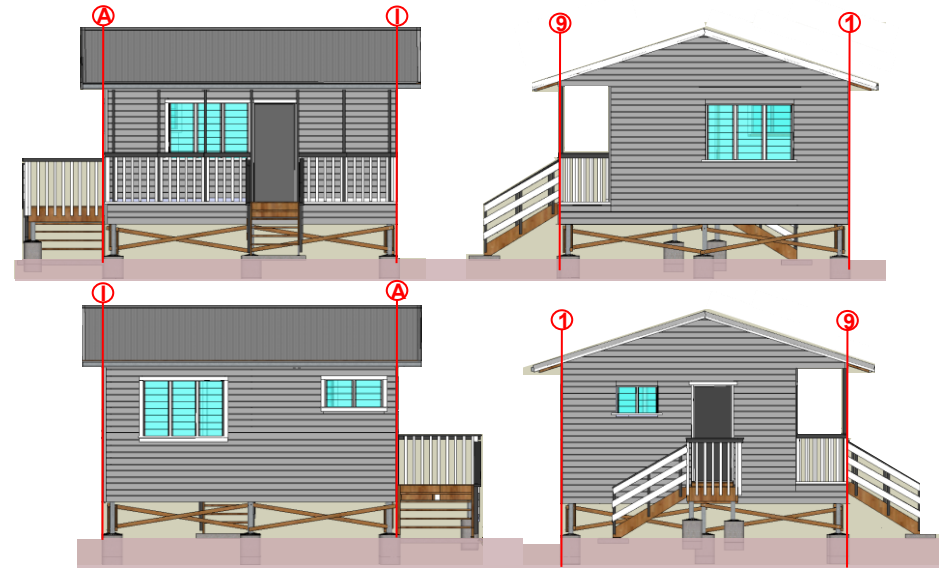
The floor plan should include:

- Dimensions to all rooms and walls
- Dimensions to windows and doors
Nomenclature of window and door schedules
- Details of the walls
- Details of external cladding and internal lining
- Details of the stairs
- Details of the deck
- Roof line above.



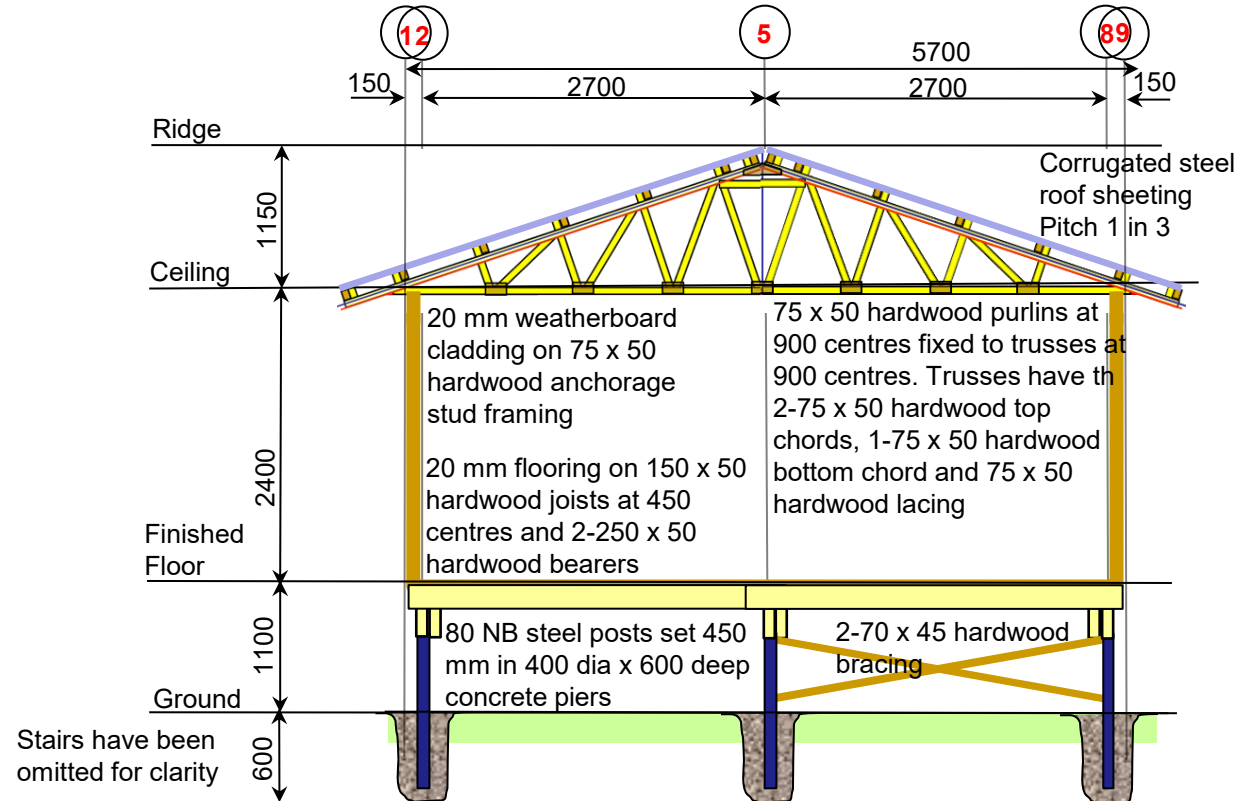
Typical Elevations

The elevations are used to define the features, cladding, roof shape, external doors and windows.



Section

The section is used to define the heights and levels, including ground level, floor level, ridge level, and the principle features of the house.



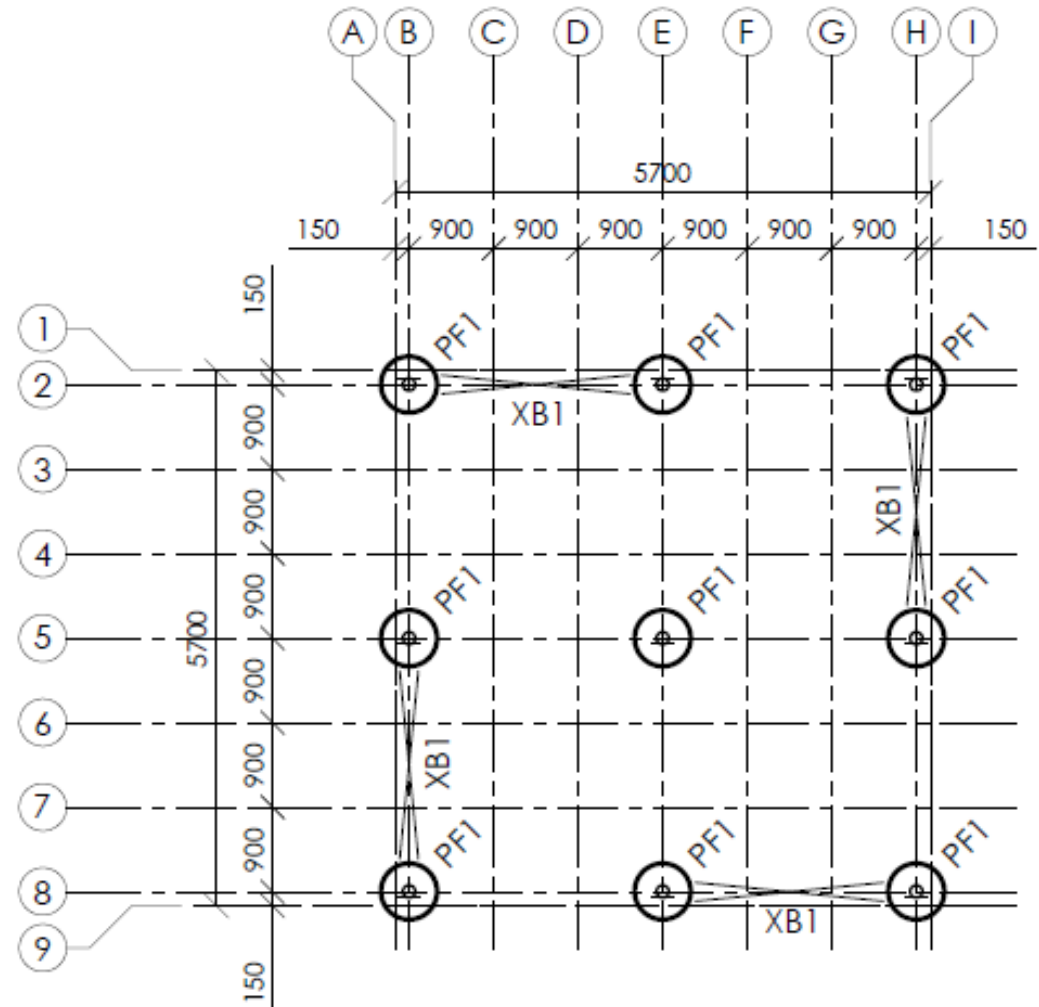
Typical Sub-floor Layout

The grid for setting out is 2.7 x 2.7 metres.

The overall length and the end distances vary with the stud depth, depending on the wind loading and timber availability.

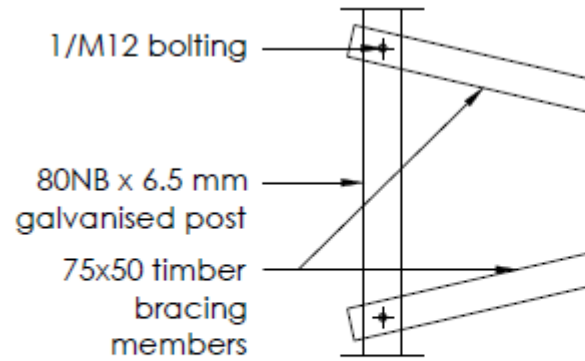
The overall dimensions are measured to the outside of the wall stud, not the outside of the cladding.

The following table gives the most common overall lengths and edge distance. The example assumes 75 x 50 rough hardwood studs for noncyclonic applications.



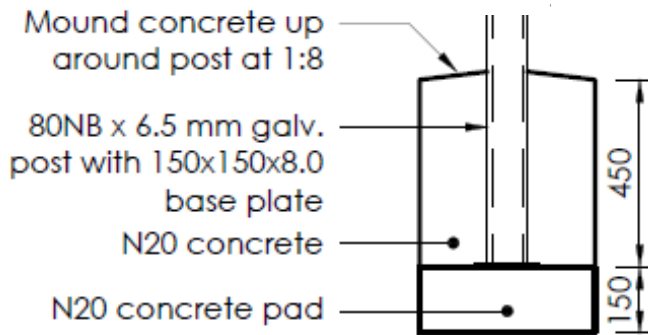
FOOTINGS & SUBFLOOR

Typical Sub-floor Posts, Footings and Bracing Details

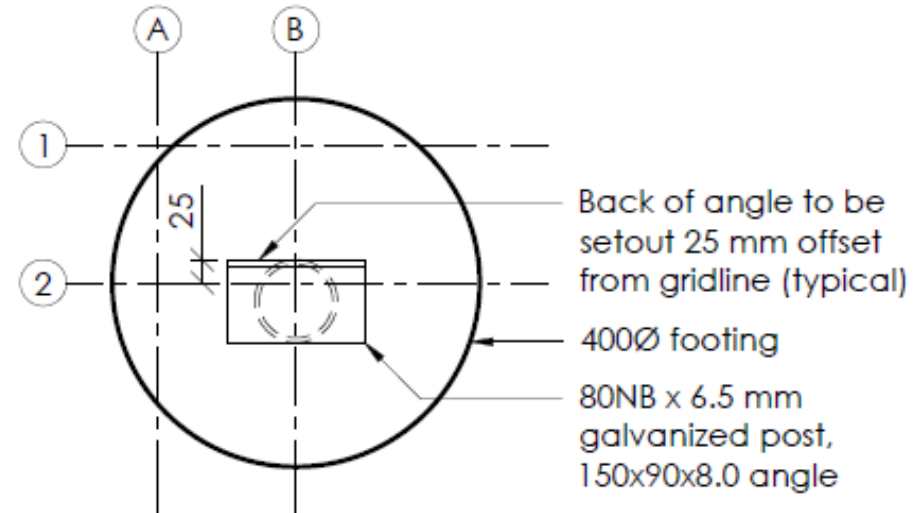


XB1 - SUBFLOOR BRACING DETAIL

SCALE 1:20



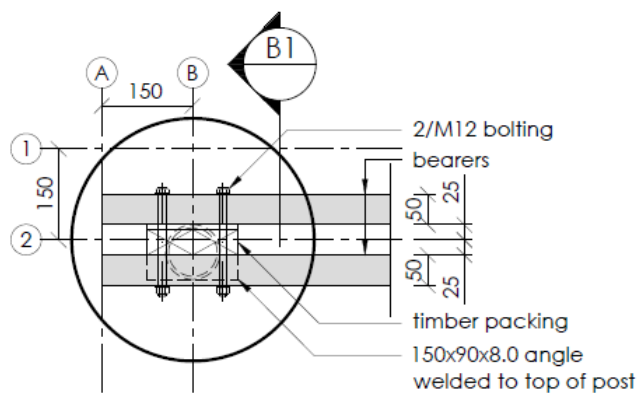
FOOTING DETAIL



STEEL POST SETOUT DETAIL

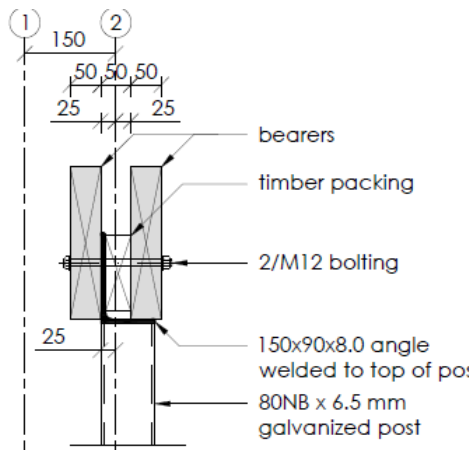
Typical Floor Bearer Layout and Details

FB1 - 2/250x50 F11 twin bearer
 FB2 - 2/250x50 F11 twin bearer



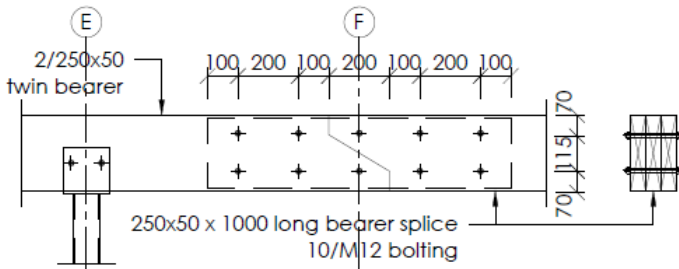
BEARER SETOUT DETAIL

SCALE 1:10



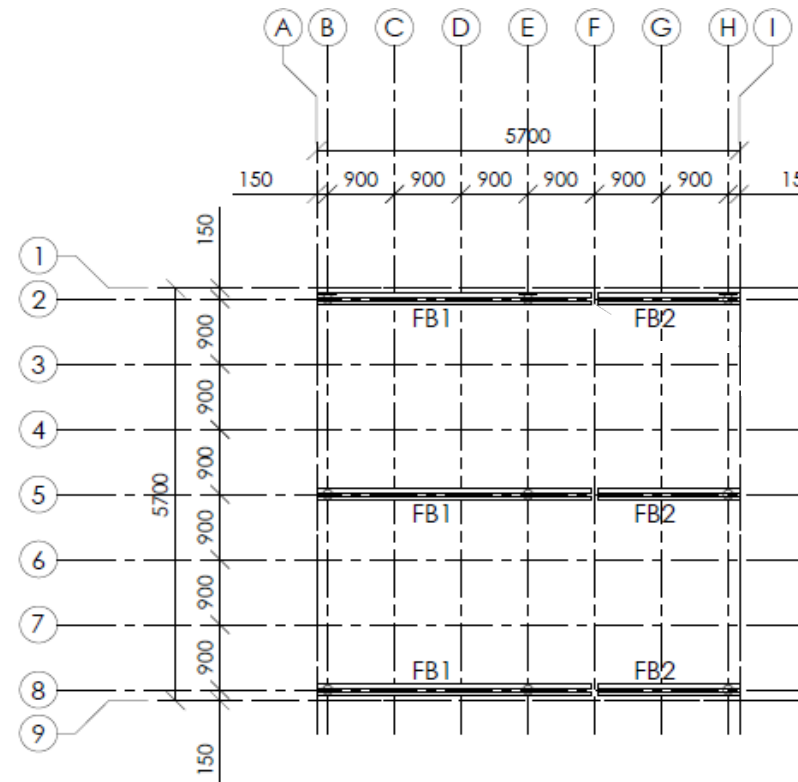
SECTION B1

SCALE 1:10



BEARER SPLICE DETAIL

SCALE 1:10



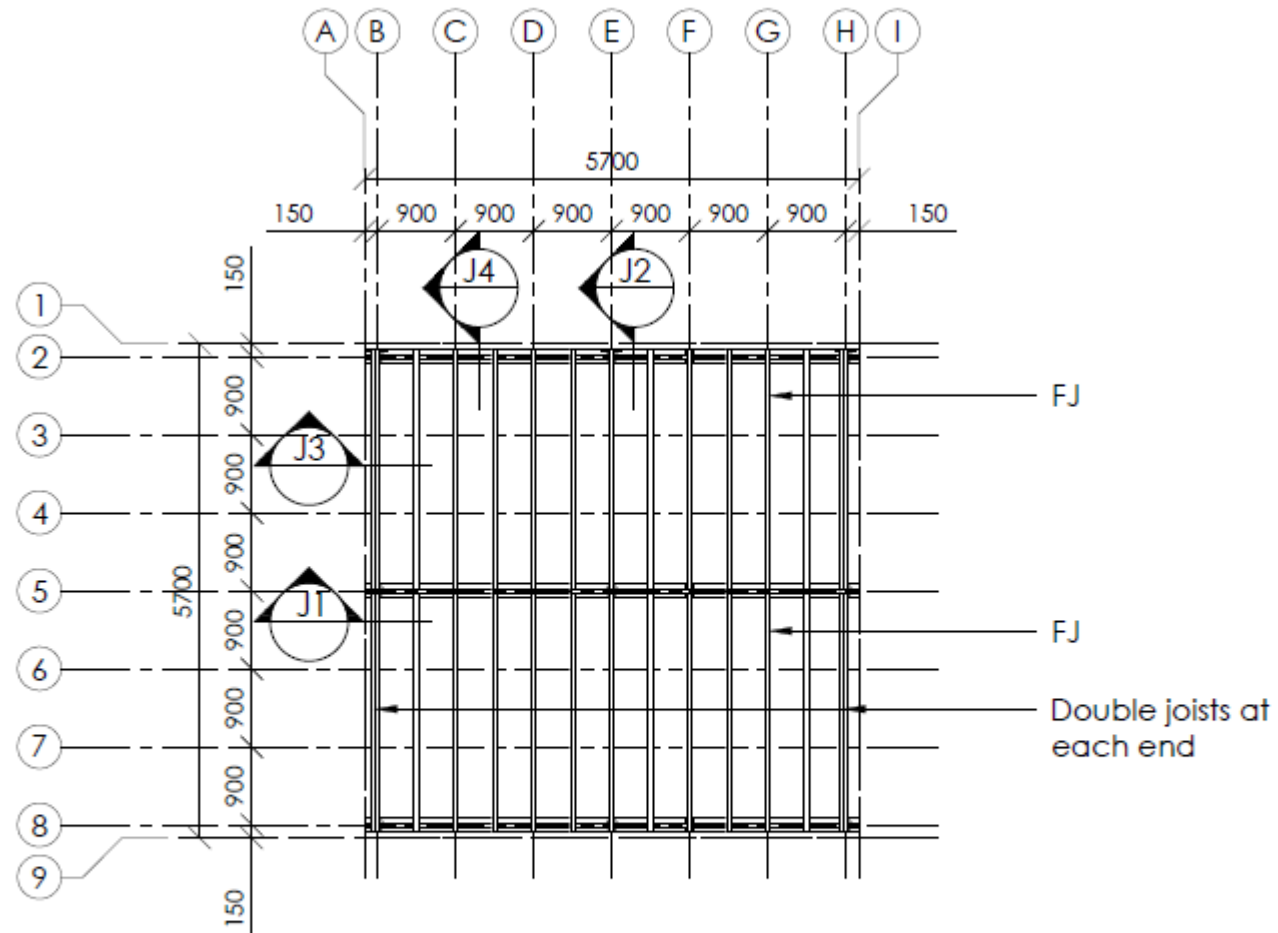
FLOOR BEARER LAYOUT

SCALE 1:100

FB1 - 2/250x50 F11 twin bearer

FB2 - 2/250x50 F11 twin bearer

Typical Bearer and Floor Joist Layout

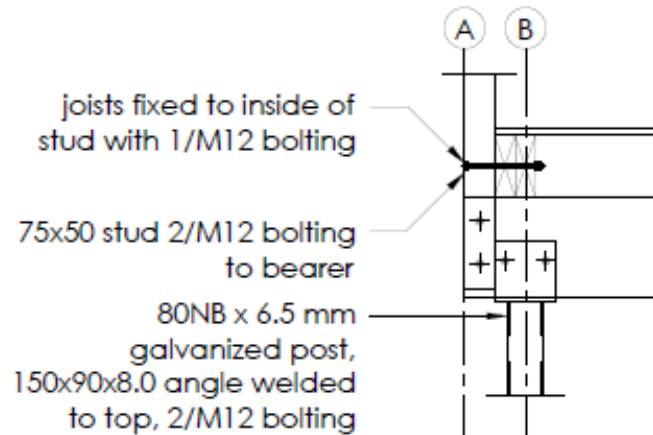


FLOOR JOIST LAYOUT

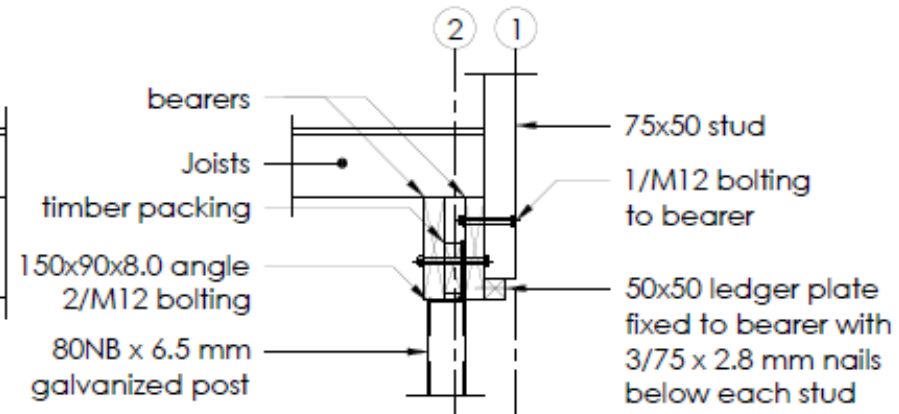
SCALE 1:100

FJ - 150x50 F11 joists @ 450 centres

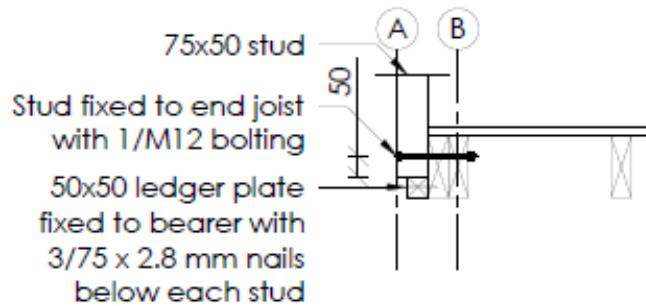
Typical Floor Joist Details



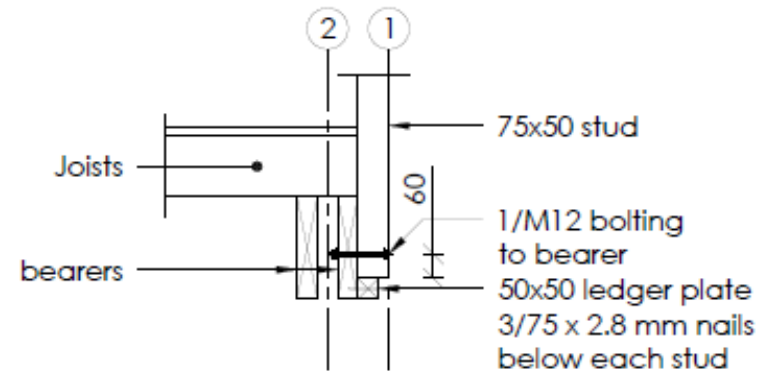
SECTION J1
SCALE 1:20



SECTION J2
SCALE 1:20

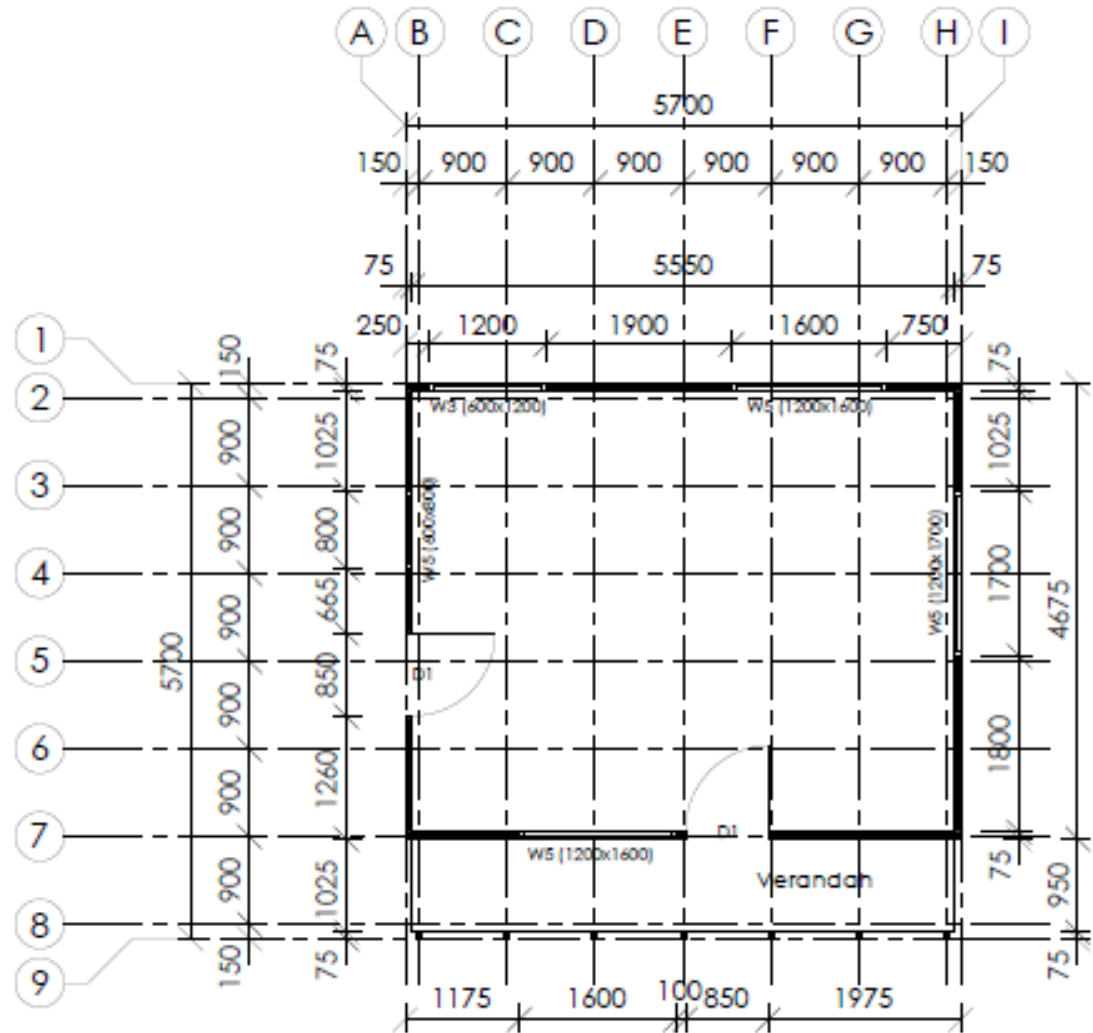


SECTION J3
SCALE 1:20



SECTION J4
SCALE 1:20

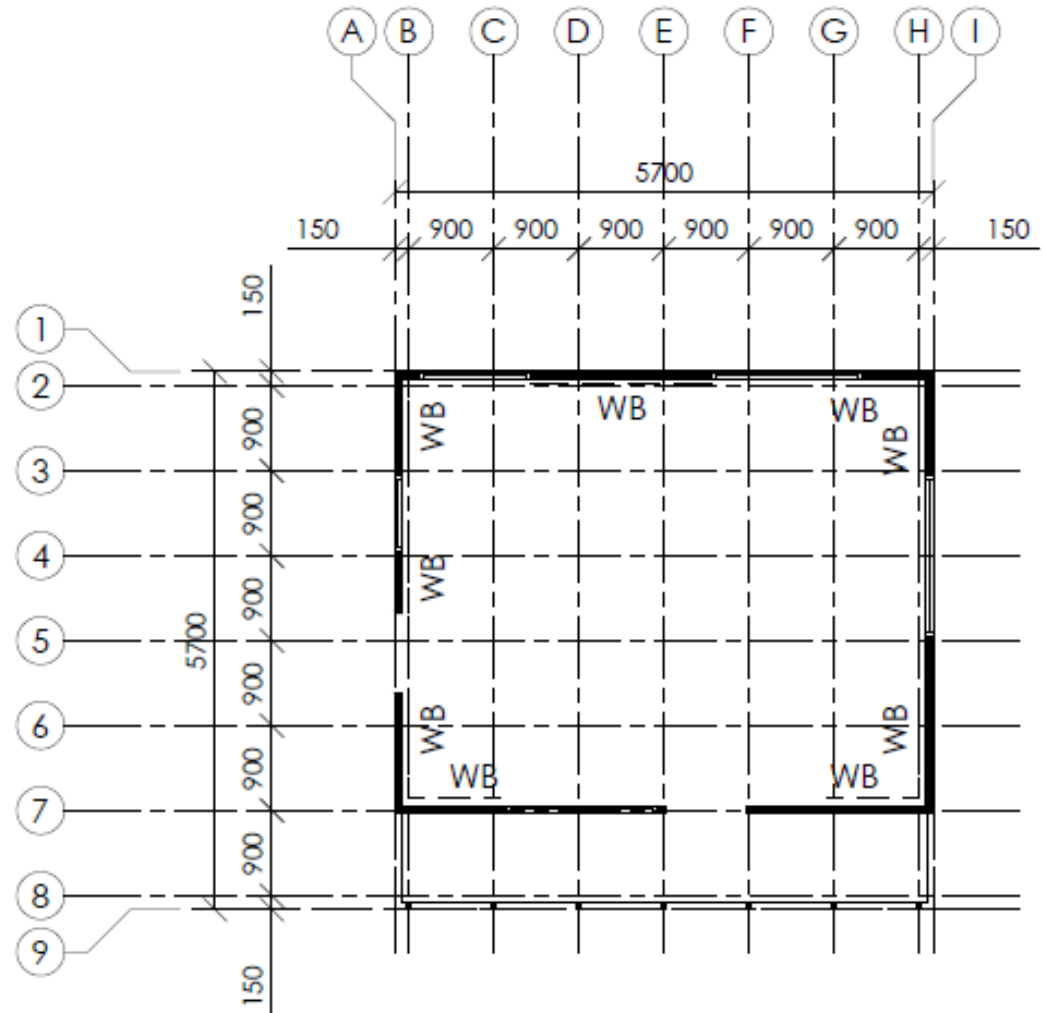
Typical Wall Layout



WALL LAYOUT

SCALE 1:100

Typical Wall Bracing Layout

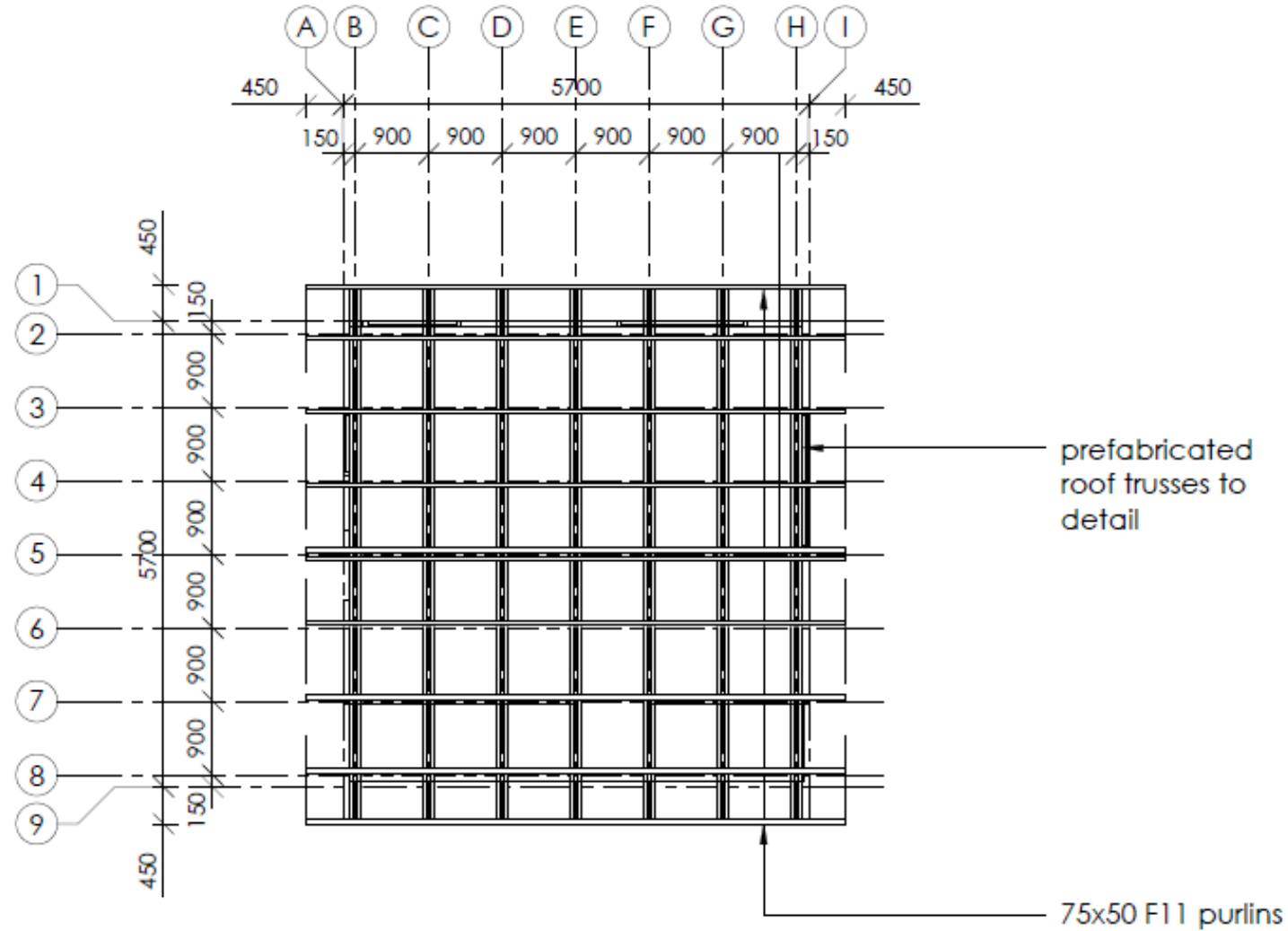


WALL BRACING LAYOUT

SCALE 1:100

WB - PLYWOOD WALL BRACING

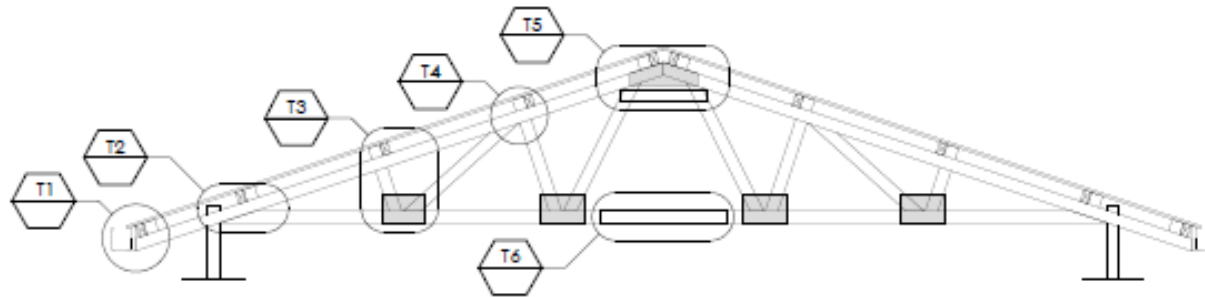
Typical Roof Frame Layout



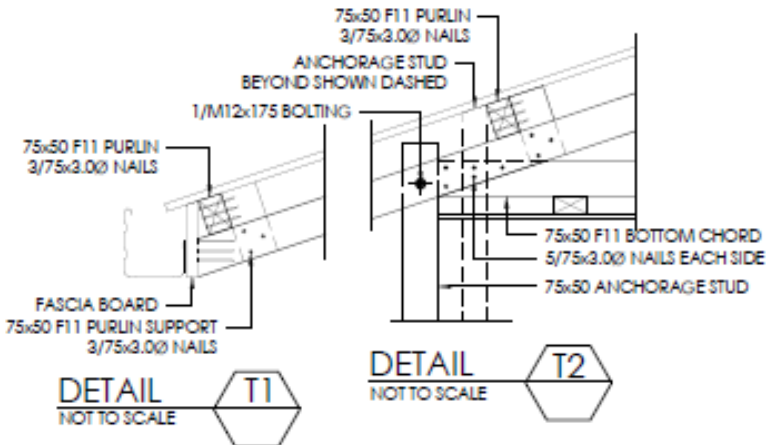
ROOF FRAME LAYOUT

SCALE 1:100

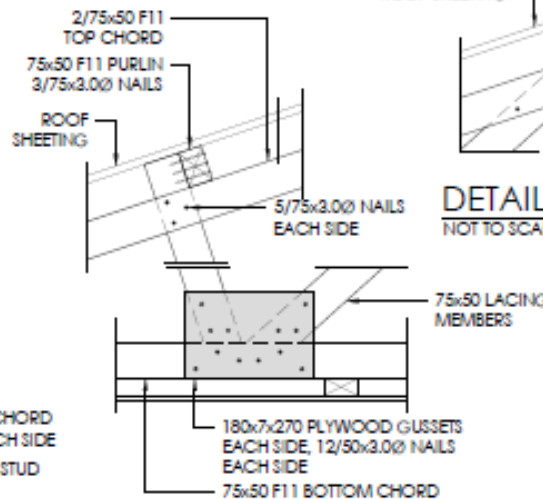
Typical Truss Details



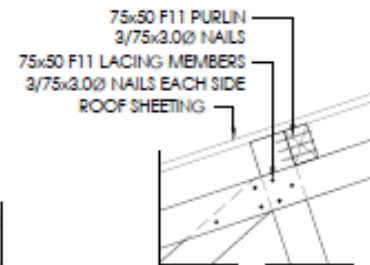
ROOF TRUSS DETAIL
NOT TO SCALE



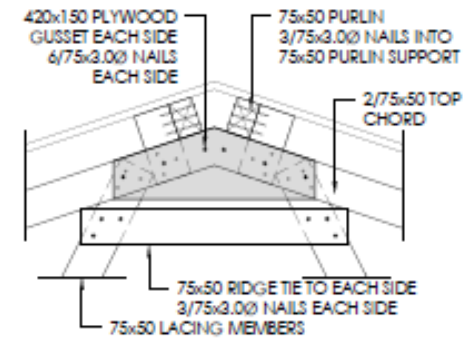
DETAIL T2
NOT TO SCALE



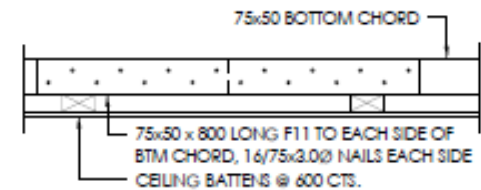
DETAIL T3
NOT TO SCALE



DETAIL T4
NOT TO SCALE

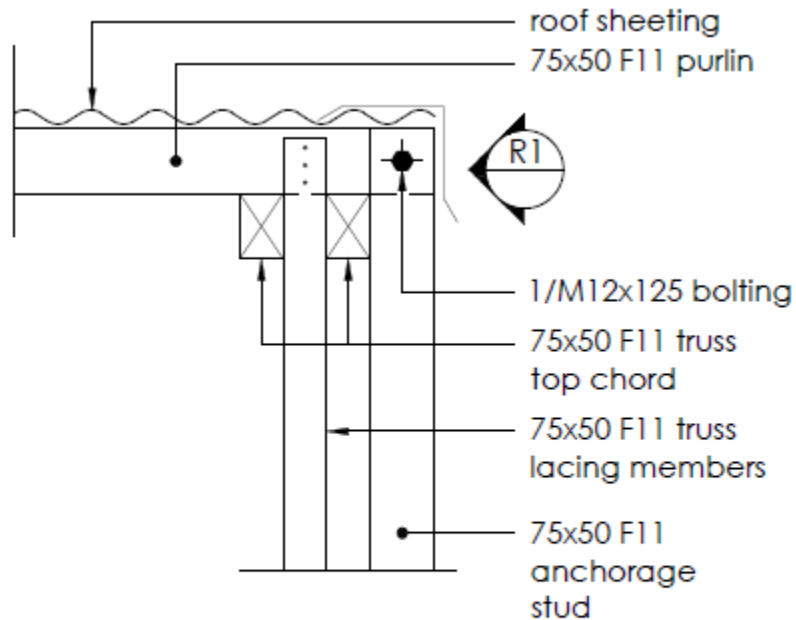


DETAIL T5
NOT TO SCALE

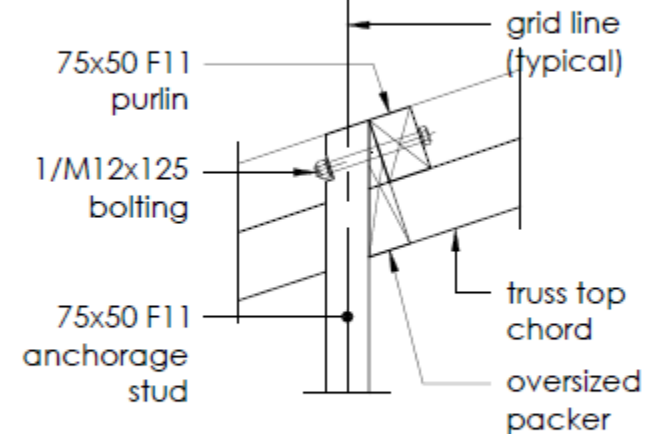


DETAIL T6
NOT TO SCALE

Typical Purlin Connection Details

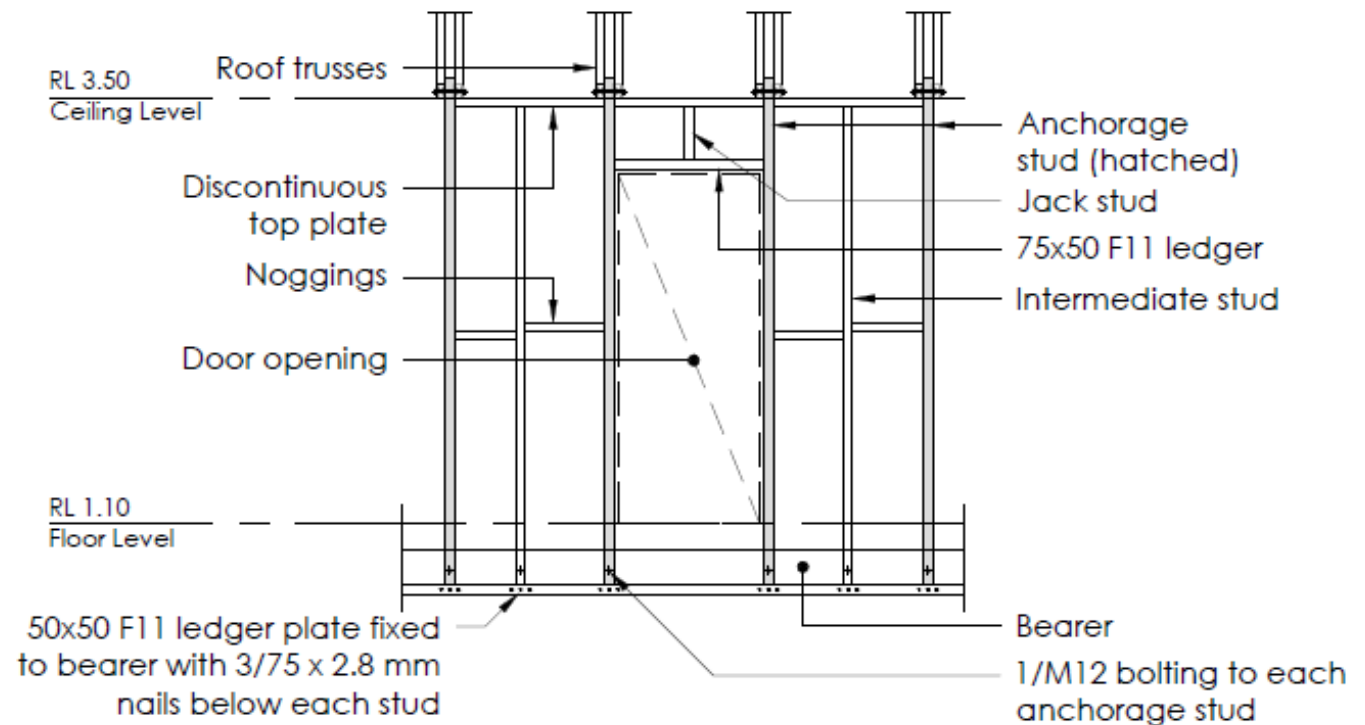


**ANCHORAGE STUD
TO PURLIN DETAIL**
SCALE 1:10



SECTION R1
SCALE 1:10

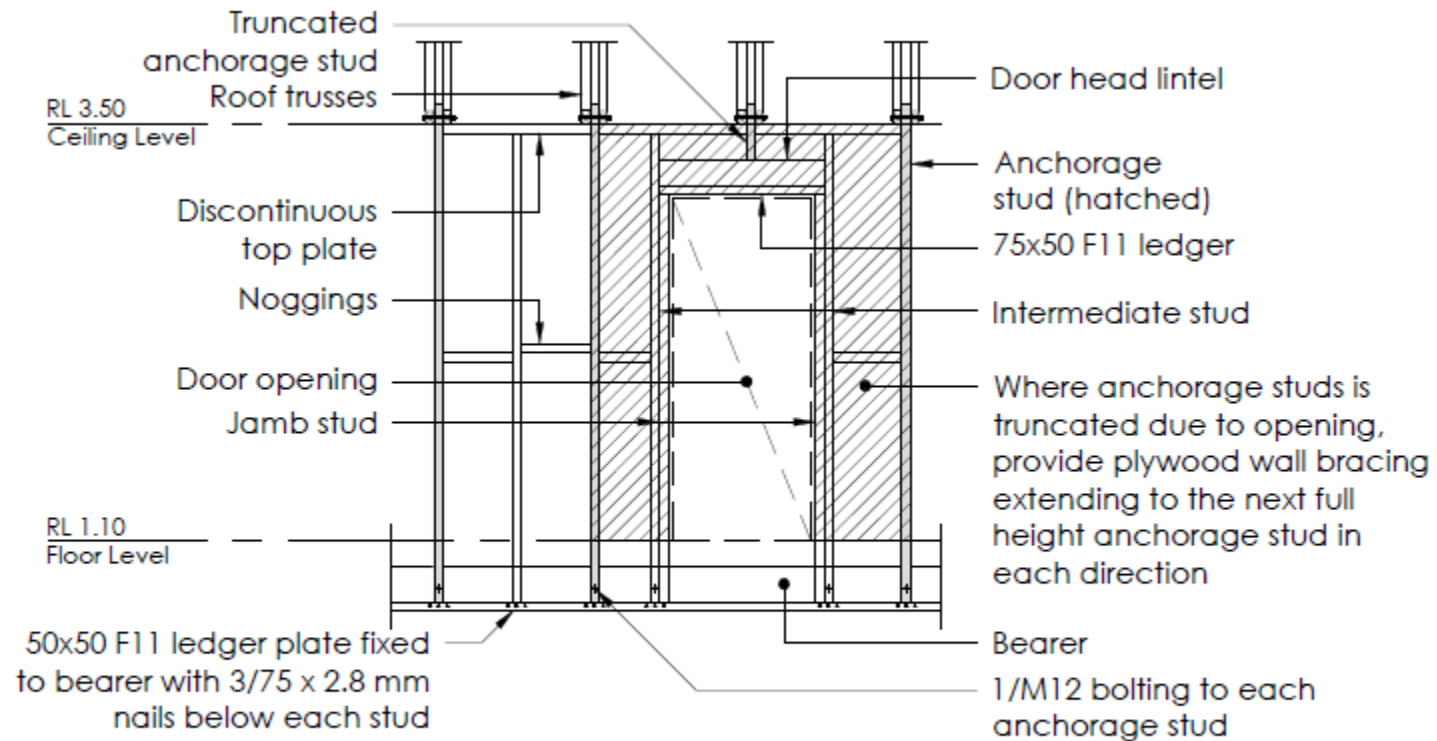
Typical Door Opening Details



DOOR OPENING WALL FRAMING DETAIL 1

SCALE 1:50

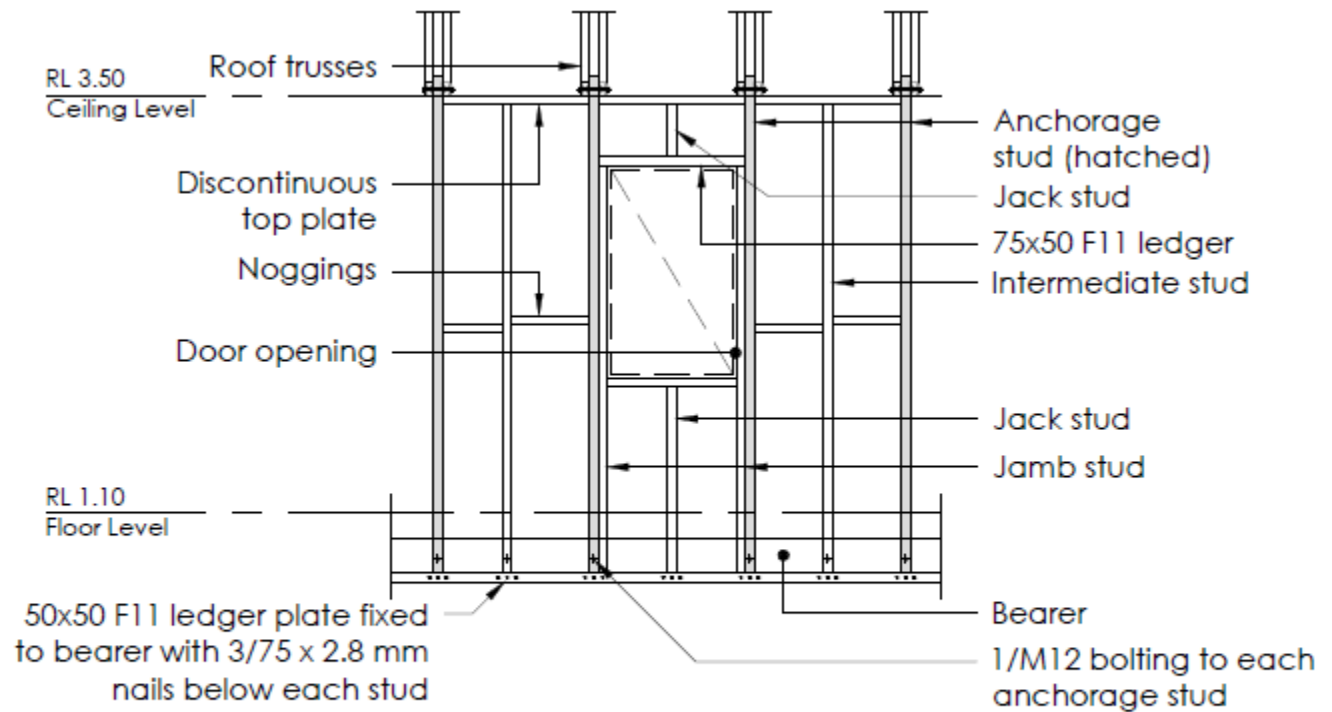
Typical Door Opening Details



DOOR OPENING WALL FRAMING DETAIL 2

SCALE 1:50

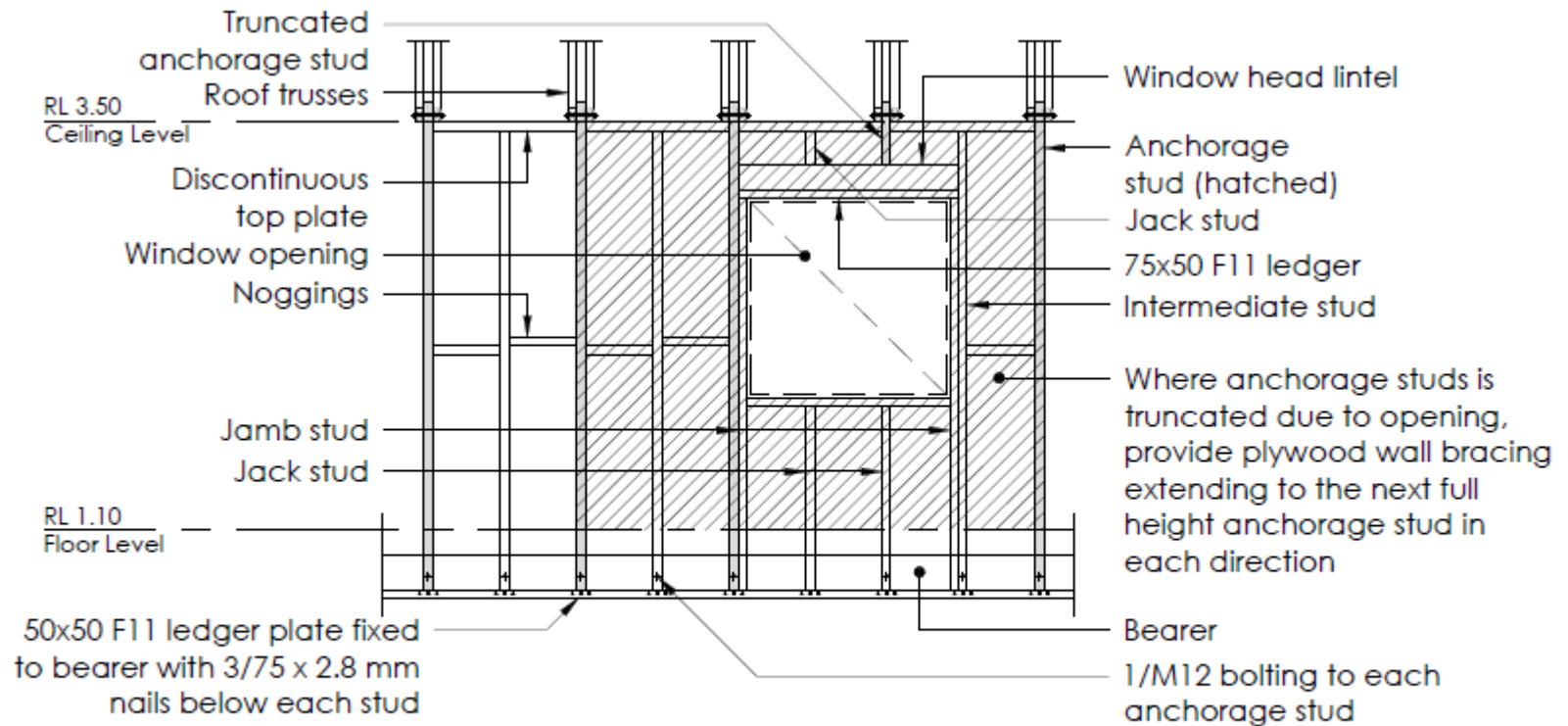
Typical Window Opening Details



WINDOW OPENING WALL FRAMING DETAIL 1

SCALE 1:50

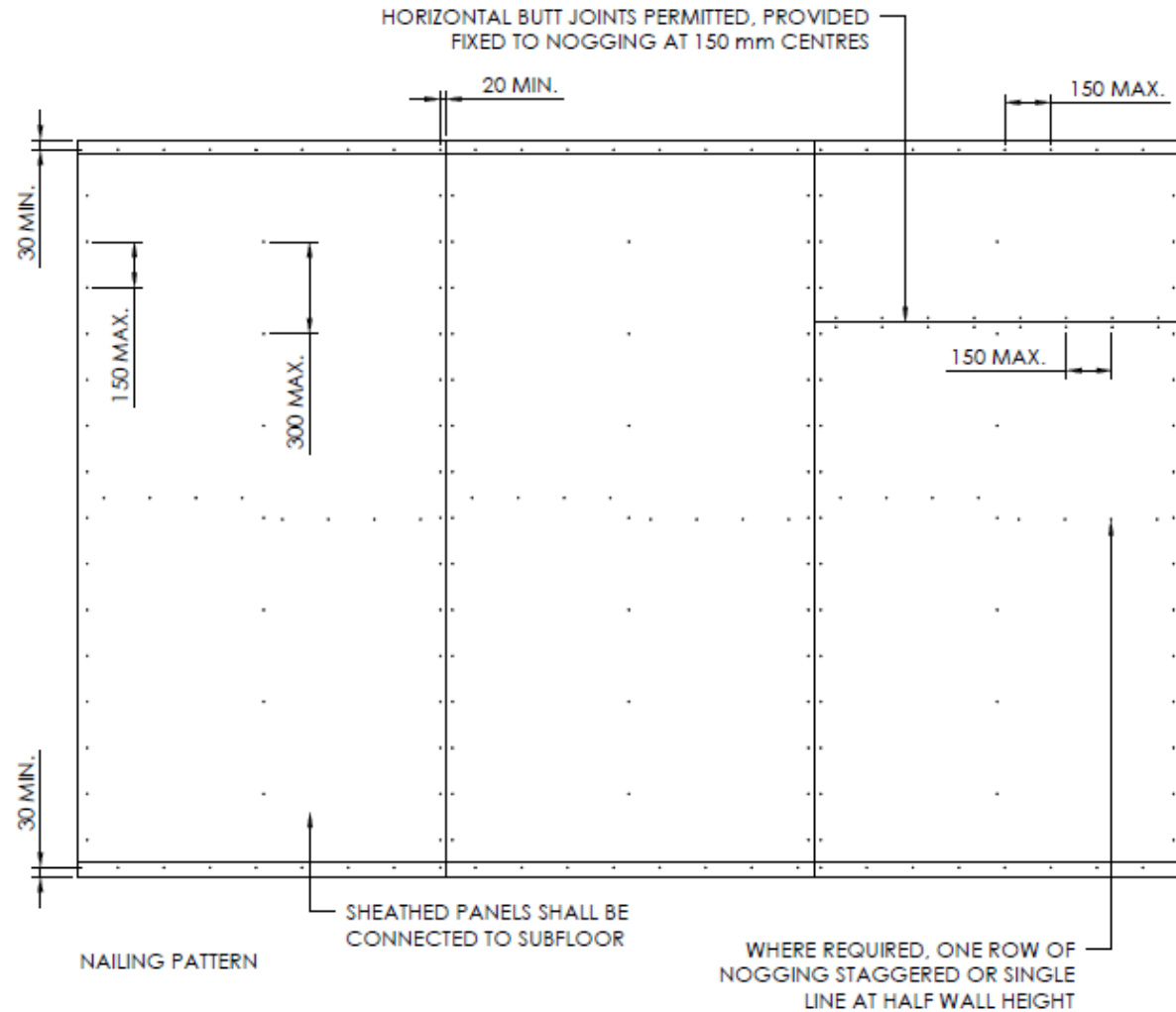
Typical Window Details



WINDOW OPENING WALL FRAMING DETAIL 2

SCALE 1:50

Typical Wall Bracing Details



WB - WALL BRACING DETAIL

SCALE 1:20

NOTE: PLYWOOD SHALL BE 7mm THICKNESS AND NAILED TO FRAME USING
30x2.8mm Ø GALVANISED FLAT HEAD NAILS OR EQUIVALENT.

Setting-out Elevated Houses

This training module provides guidance for the setting out of simple houses.



Surveyor to Mark Boundaries, Corners and Levels

Preliminary Clearing

On a site with trees and other heavy vegetation, it may be necessary to carry out some site clearance prior to the survey to provide suitable lines of site.

Checking Requirements

Whilst it is tempting to set out a building based on previously established corner pegs, there is considerable risk that they have not been correctly located during the original survey, or have been subsequently moved. Use a registered surveyor to establish and record the site corner pegs, the building corner pegs and the local level datum. Before commencing the setting out work, the Surveyor should check the approved plans to ensure that the boundary distances, heights and other critical dimensions meet the requirements of the site and relevant regulations. Check that there have been no drawing errors incorporated into the approved plans. Once construction has started it is difficult, if not impossible, to correct problems of set out. In particular, check all heights and reduced levels (RLs). Any errors or potential conflicts shall be brought to the attention of the Builder.

Detailed Survey Drawings

Local authorities may require a survey on completion of building works before issuing occupation certificate. On completion of the survey, the Surveyor shall provide to the Builder certified plans showing the boundaries, corner points of the building, gridlines, benchmark and temporary benchmark.



Levels, Dimensions, Square, Setting Out

Levels

It is critical that all floor framing is level. Before commencing the set out, check that slab or timber floor framing is level. It may be necessary to pack the frames in the low areas or to rectify the high areas.

Dimensions and Square

Check the position and square of the concrete slab or footings before commencing construction. Measure diagonals and pairs of opposite sides to check square.

Setting Out

When setting out the wall framing, a small error in position can lead to misalignment of the other components, such as the roof. Base the set out on the longest side of a building, since this will reduce the likelihood of errors in square.

Profiles and Recovery Pegs

Sometimes profiles and corner pegs can be disturbed.

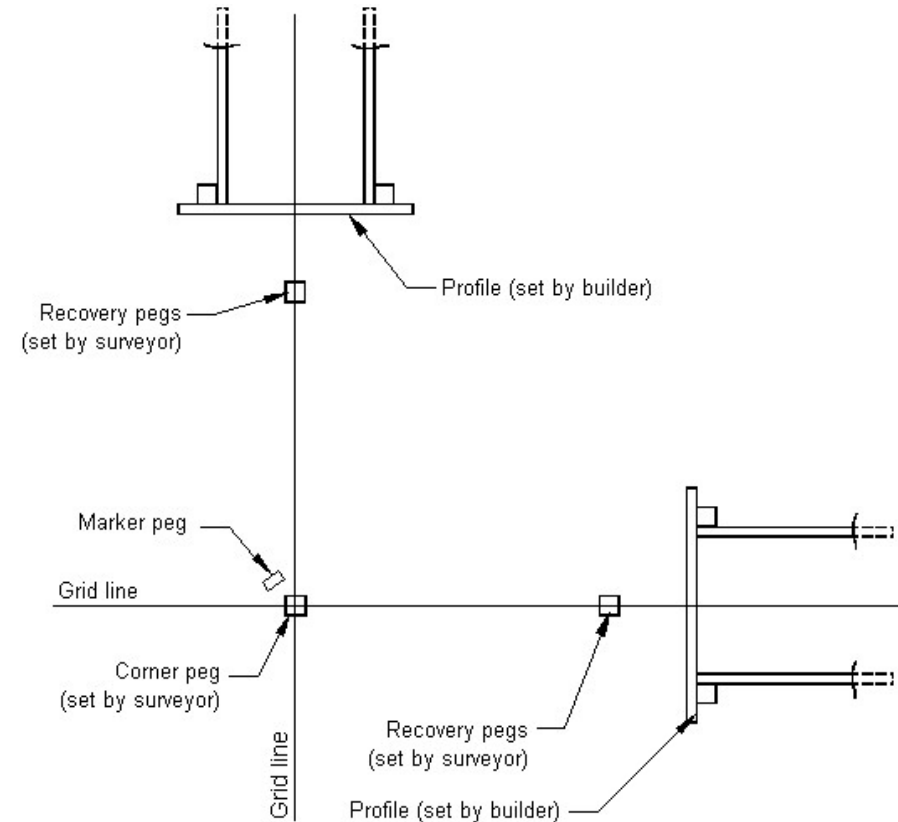
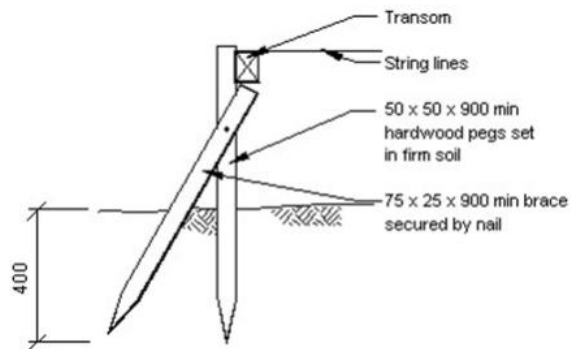
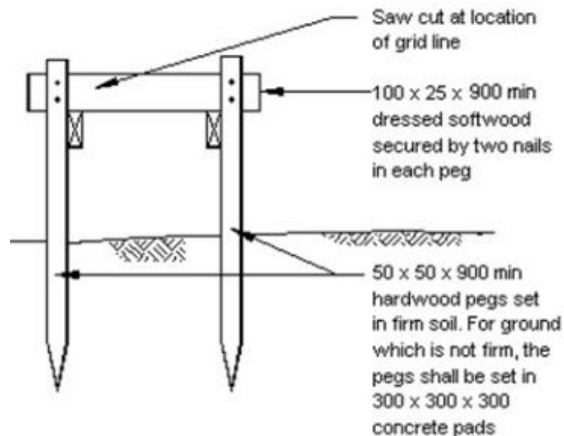
- To avoid disruption of profiles, ensure that they are placed an adequate distance from the earthworks.
- To recover lost profiles always measure from the principal grid line.

Marking Boundaries, Corners and Levels

The Surveyor shall mark by means of pegs, nails and paint the site boundaries, corner points of the building, gridlines shown on the drawings, benchmark and temporary benchmark. All pegs, nails and other marks shall be clearly identified by paint, coloured ribbon and/or star pickets and protected against damage.

Profiles and Recovery Pegs

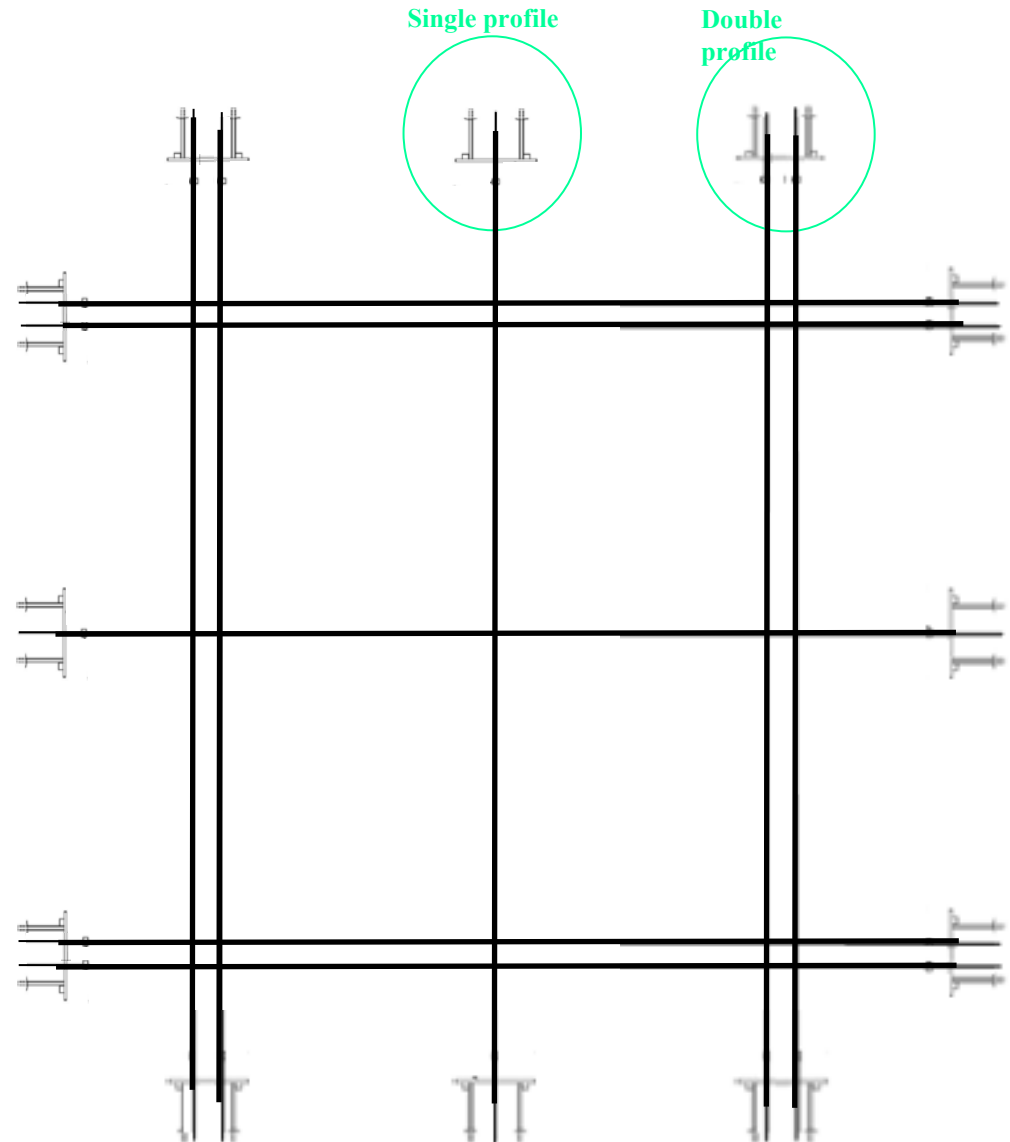
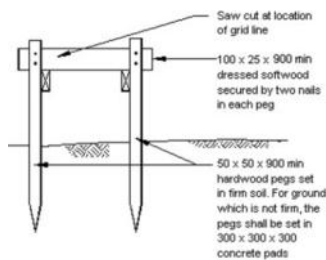
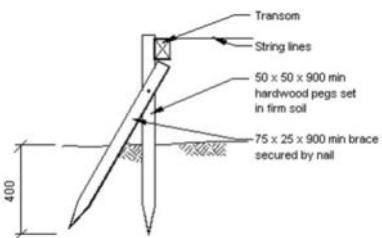
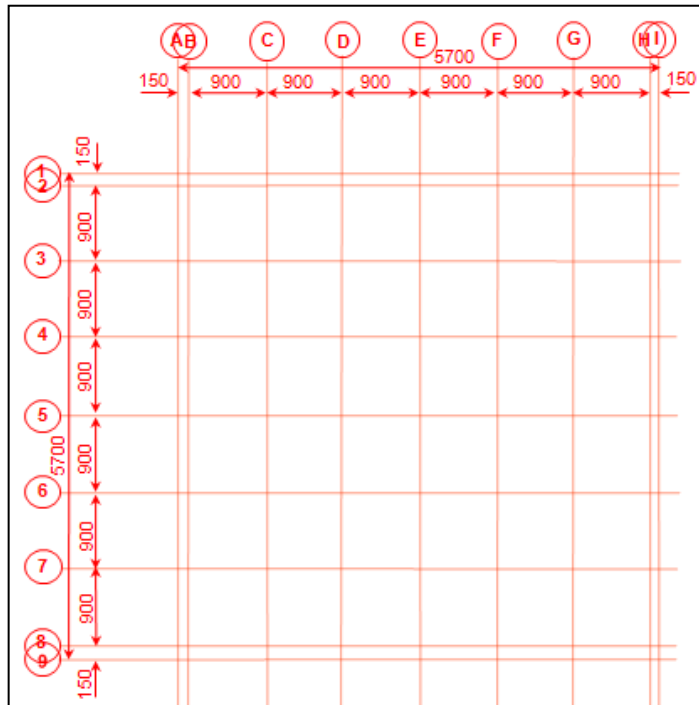
Where earthmoving machinery traverses the site, corner pegs will almost certainly be disrupted. Timber profiles (and perhaps offset pegs) are erected at some distance beyond the limits of any earthworks. Profiles establish the plan position of the main building grid lines. It is difficult (but not impossible) to simultaneously establish both plan position and level using the same profiles, although it is best to establish levels independently of the profiles. Pegs for marking gridlines and the like shall be 50 x 50 x 450 mm minimum hardwood with a sharpened point. Timber for profiles shall be dressed softwood.



Typical Layout of Profiles and Pegs

Profiles Setting Out Gridlines

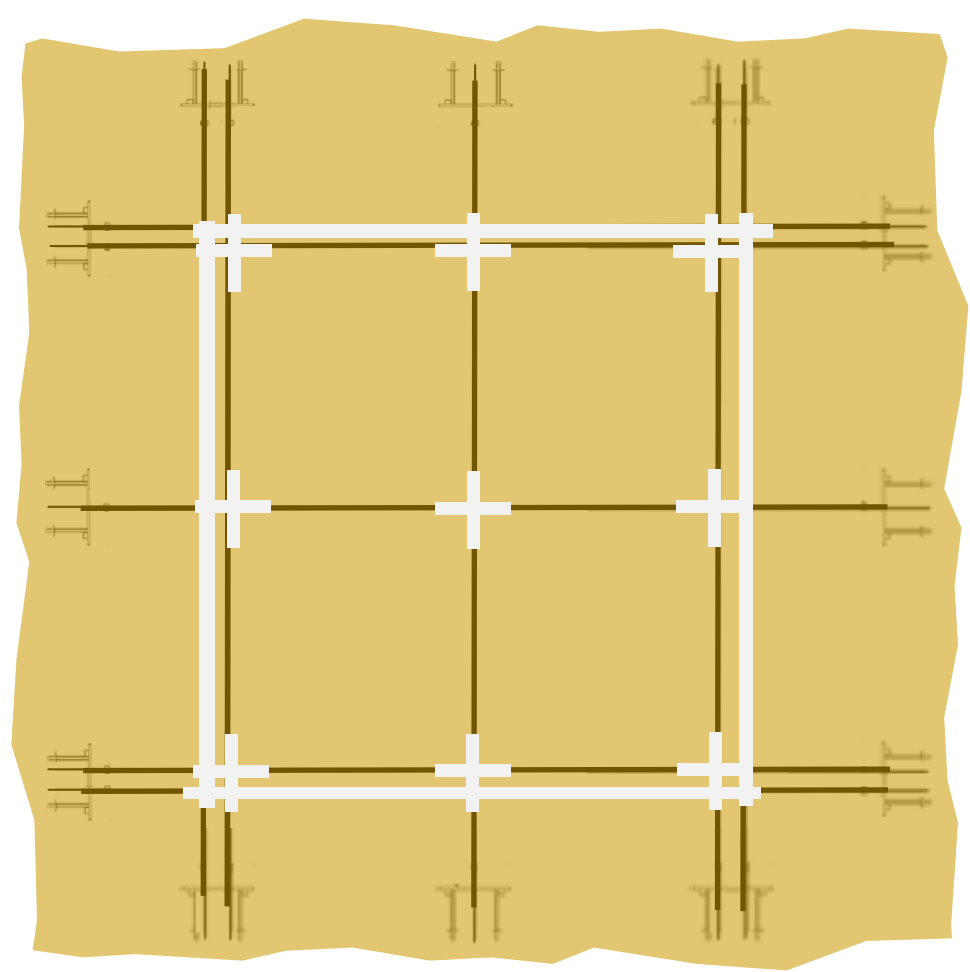
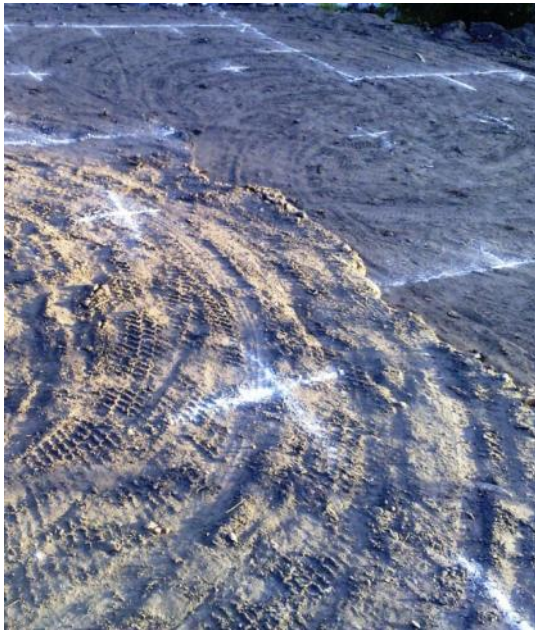
Set out grid lines as per the drawing.
Where to grid lines are close together, set out both on the same profile



Marking with Lime

After the gridlines are established and the string lines positioned, the outline of the building and footing positions should be marked on the ground using hydrated lime.

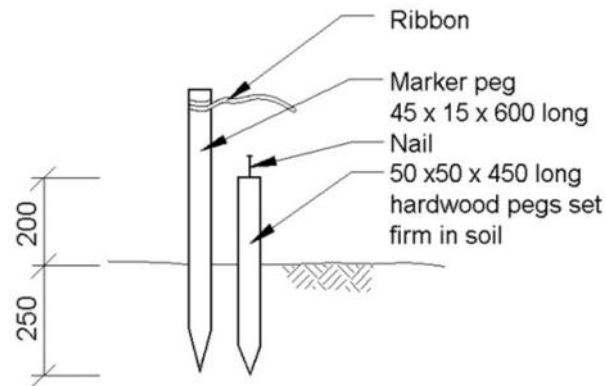
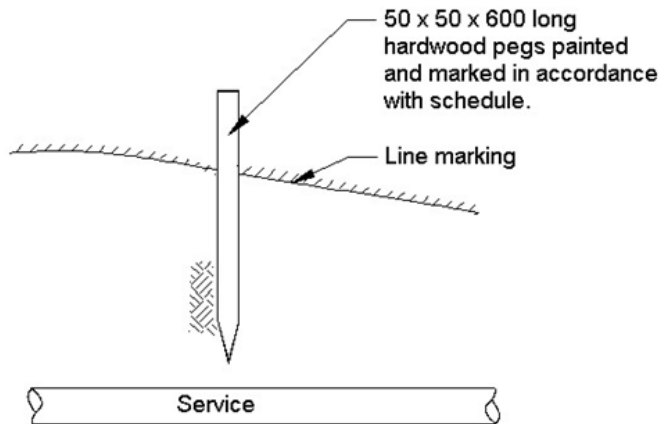
String lines are removed later to permit excavations to take place, and footings may be located using the lime outline.



Marking Services

A common problem in urban areas is the unearthing of services such as sewer pipes, water pipes, electrical conduits, telephone, gas and the like.

- Emergency telephone numbers of a plumber and electrician shall be prominently displayed in the site office.
- Obtain from the local authority or services authorities the location of all services.
- Mark these clearly on a site plan.
- Mark their location on the ground using pegs and lime. Marker pegs shall be 45 x 15 x 600 mm minimum hardwood with a sharpened point.



| SERVICE | COLOUR |
|-------------|--------|
| Electricity | |
| Water | |
| Drainage | |
| Telephone | |
| Gas | |
| Survey | |

Marking of Services

Corner or Offset Pegs with Marker Pegs

Dimensions, Square, Setting Out

Depending on the equipment available, setting out may be by one of the following methods:

- Electronic distance measuring equipment or electronic digital theodolite - generally used by surveyors or major builders.
- Manual theodolite - generally used by established builders.
- Tape and geometric calculation - generally used in remote locations where expert surveyors are not operating.



Acknowledgement: Universal
<http://www.universalinstruments.com.au/>

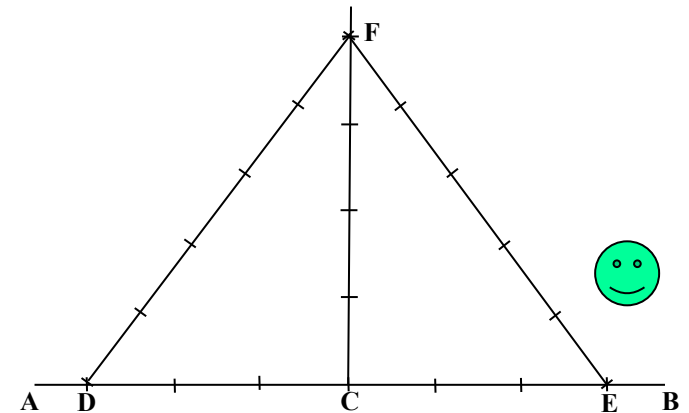
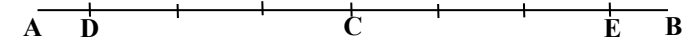
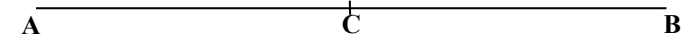
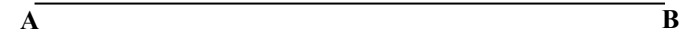


The following geometric calculations are useful:



Setting out a right angle (90°)

1. Establish a base line at least 8 metres long. Place pegs with nails in the top at each end of the base line “A”, and “B”, and draw a string line tight between the two nails.
2. Locate on the base line the point where the line at right angles must intersect. Place a peg with a nail in the top at this point “C”.
3. Using a tape, measure and place pegs with nails in the top at a fixed distance (say 3 metres) in both directions along the base line, “D” and “E”.
4. Using two tapes simultaneously, measure a distance of 5 metres from both points “D” and “E”. Where these points coincide, place a peg with a nail in the top “F”.
5. The line “F-C” is perpendicular to line “A-B”. That is, angles “ACF” and “BCF” are both right angles (90°).
6. To check the accuracy of this set out, measure the distance “F-C”. It should be 4.0 metres.



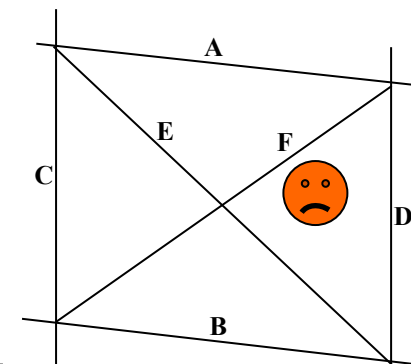
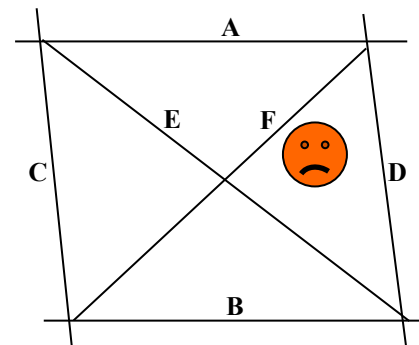
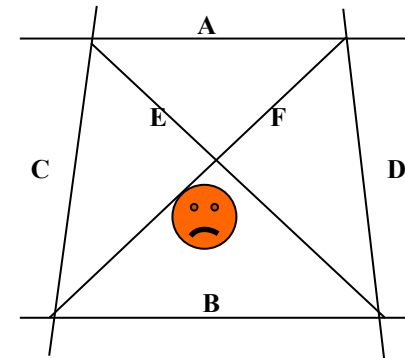
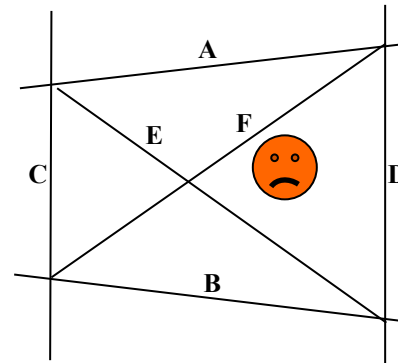
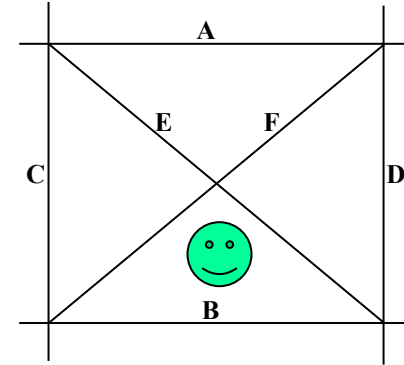
Checking for “square”

To check whether the grid lines are “perpendicular” to each other or are “skewed”, measure the diagonals across the rectangle formed by the grid lines and measure each pair of opposite sides of the shape.

- If the diagonals are equal and both sets of opposite sides are equal, the grid lines correctly form rectangles; that is the lines are perpendicular to each other, at right angles (90°) and the shape is a rectangle.

$$A = B, C = D, E = F$$

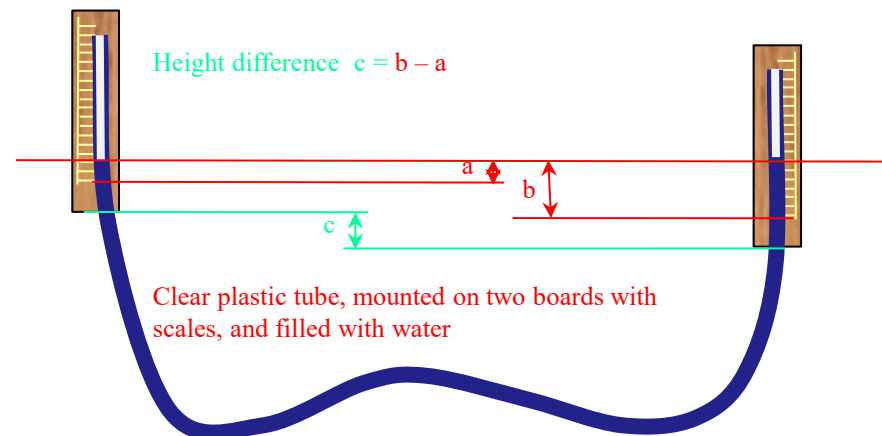
- If the diagonals are equal but the opposite sides are not equal, the grid lines are skewed and must be corrected.
 - Even though $A = B$ and $E = F$, the shape will not be a rectangle if $C \neq D$.
 - Even though $C = D$ and $E = F$, the shape will not be a rectangle if $A \neq B$.
- If the diagonals not are equal although the opposite sides are equal, the grid lines are skewed and must be corrected.
 - Even though $A = B$ and $C = D$, the shape will not be a rectangle if $E \neq F$.



Levels

Depending on the equipment available, the establishment of levels may be by one of the following methods:

- Laser levels – generally used by surveyors or major builders
- Automatic levels – generally used by surveyors or major builders
- Manual tilting levels – less common on modern building sites
- Water level gauge – generally used in remote locations where surveyor's levels are not available




Setting Out

| Design and Construction Checklist | | | | |
|---|------------------------------------|---|---------------------|---------------------------------|
| Site | | | | |
| Activity | | Setting Out | | |
| Item or Product | Inspection Required | Accept Criteria | Hold Witness | Date, Inspector, Comment |
| Drawing showing: boundary pegs, corner pegs, gridlines, benchmark, temporary benchmark | Inspect latest copy of the drawing | Latest issue of drawing with the relevant information in file | W | |
| Boundary pegs | Visual spot check | Pegs in place and protected | W | |
| Corner pegs | Visual spot check | Pegs in place and protected | W | |
| Gridline pegs | Visual spot check | Pegs in place and protected | W | |
| Benchmark and temporary benchmark | Visual spot check | Benchmarks in place and protected | W | |
| Profiles | Visual spot check | Profiles in place and protected | W | |


Structural Design

This module provides an example of the structural design of village houses in accordance with the Partner Housing policy document.



ABN: 88 722 057 429 • CFN: 15429

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Email: PartnerHousing@electronicblueprint.com.au Web: www.partnerhousing.org



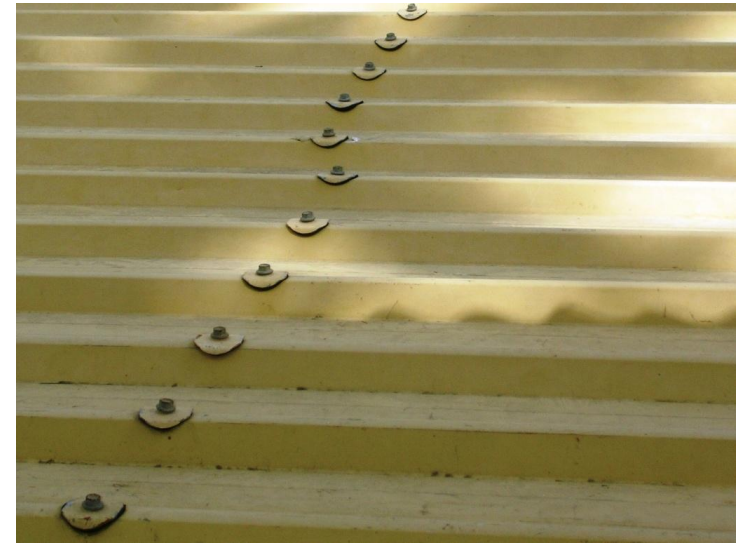
**Structural Resilience Policy and Details
for Designing Village Housing and Infrastructure
in the South-Pacific
for Wind, Earthquake and Tsunami**

Roof Fixings and Cyclone Washers

Cyclonic wind can suck roof sheeting (and wall sheeting) off the framing if there is an insufficient number of appropriate roofing screws, or if the screws have been installed without cyclone washers.

Roof sheets should be fixed through the high point of the ribs using long screws, not valley fixed. Roof sheets shall be laid in continuous lengths where practical, with the upper end turned up using the correct tool.

In very high wind areas, turn the sheets down into the eaves gutter at the lower end.



Suitable Spans and Fixing Arrangements of Corrugated Steel Sheeting (0.42 mm BMT)

| AS 4055 Wind Classification | N1 N2 N3 | N4 C1 | N5 C2 | N6 C3 | C4 |
|---|------------------|-----------|-----------|--------------|--------------|
| Maximum end span without cyclone washers | 950 | 900 | 750 | Not suitable | Not suitable |
| Maximum end span <u>with</u> cyclone washers | | 1,200 | 900 | Not suitable | Not suitable |
| Number of ribs to be fixed | Every second rib | Every rib | Every rib | Not suitable | Not suitable |
| Maximum internal span without cyclone washers | 1,200 | 900 | 750 | Not suitable | Not suitable |
| Maximum internal span <u>with</u> cyclone washers | | 1,200 | 900 | Not suitable | Not suitable |
| Number of ribs to be fixed | Every third rib | Every rib | Every rib | Not suitable | Not suitable |

Notes:

1. In some circumstances, engineering analysis of test results may give improved spans.
2. Refer to roofing manufacturer's technical manuals for specification of fixing screws, details and material compatibility.
3. References include: Lysaghts "Cyclonic Area Design Manual". <http://www.lysaght.com/roofing>

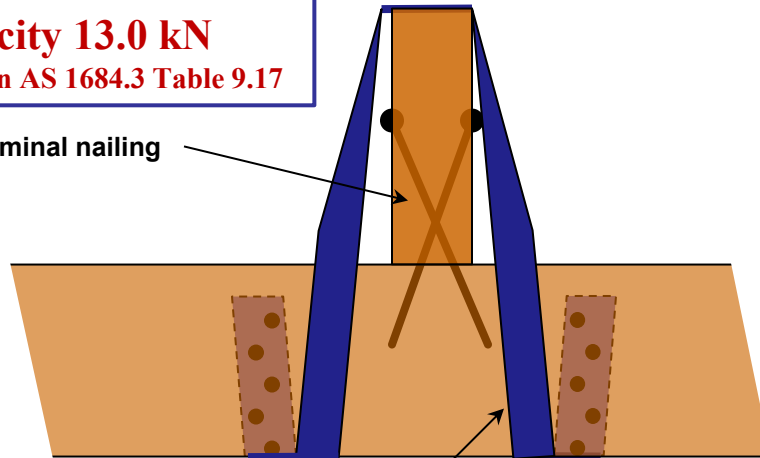
Roof Framing Fixings Must Resist Wind Uplift

Cyclonic wind can suck the roof framing off the timber wall framing if there is an insufficient number of appropriate ties, or if the ties are not correctly fixed to the wall framing.

Standard Detail Capacity 13.0 kN

Based on AS 1684.3 Table 9.17

Nominal nailing

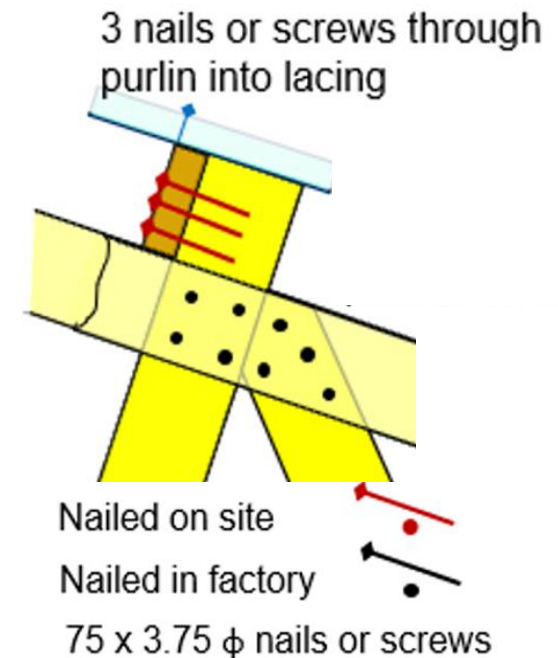


30 x 0.8 mm galvanised steel strap looped over the chord of the roof frame and under the top plate, and each end fixed by 5-30 x 2.8 mm ϕ galvanised flat-head nail.

DANCER Detail Capacity 3.14 kN

Based on AS 1684.3 Table 9.17

Suitable for wind uplift up to 2.6 kPa on purlins at 900 mm centres and trusses at 1,350 centres



Lateral Bracing

Failure to provide adequate cross bracing will make a building liable to collapse due to “racking” action caused by wind, earthquake or tsunami.

This may be prevented by installing:

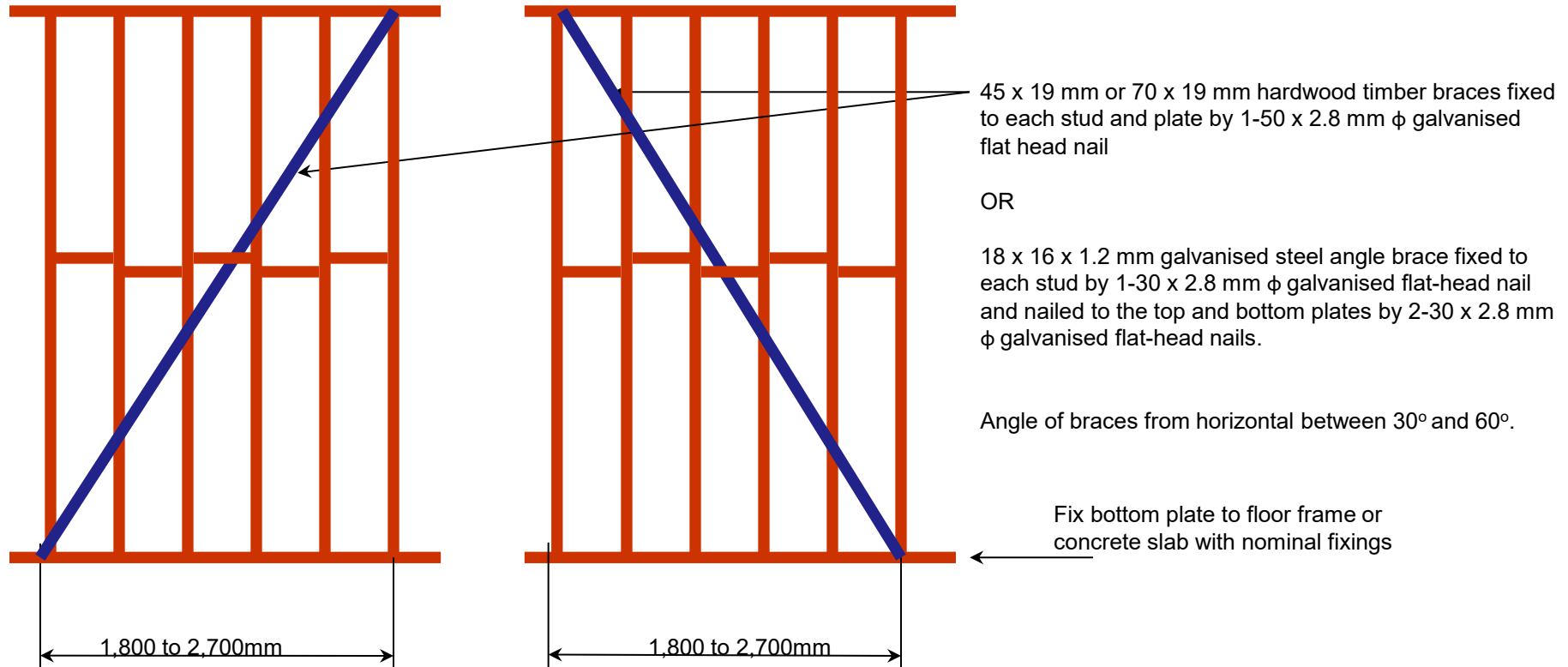
- Wall bracing, and
- Subfloor bracing (in elevated buildings).



Wall Bracing – Two Diagonally Opposed Timber or Metal Braces

Capacity 0.8 kN/m length

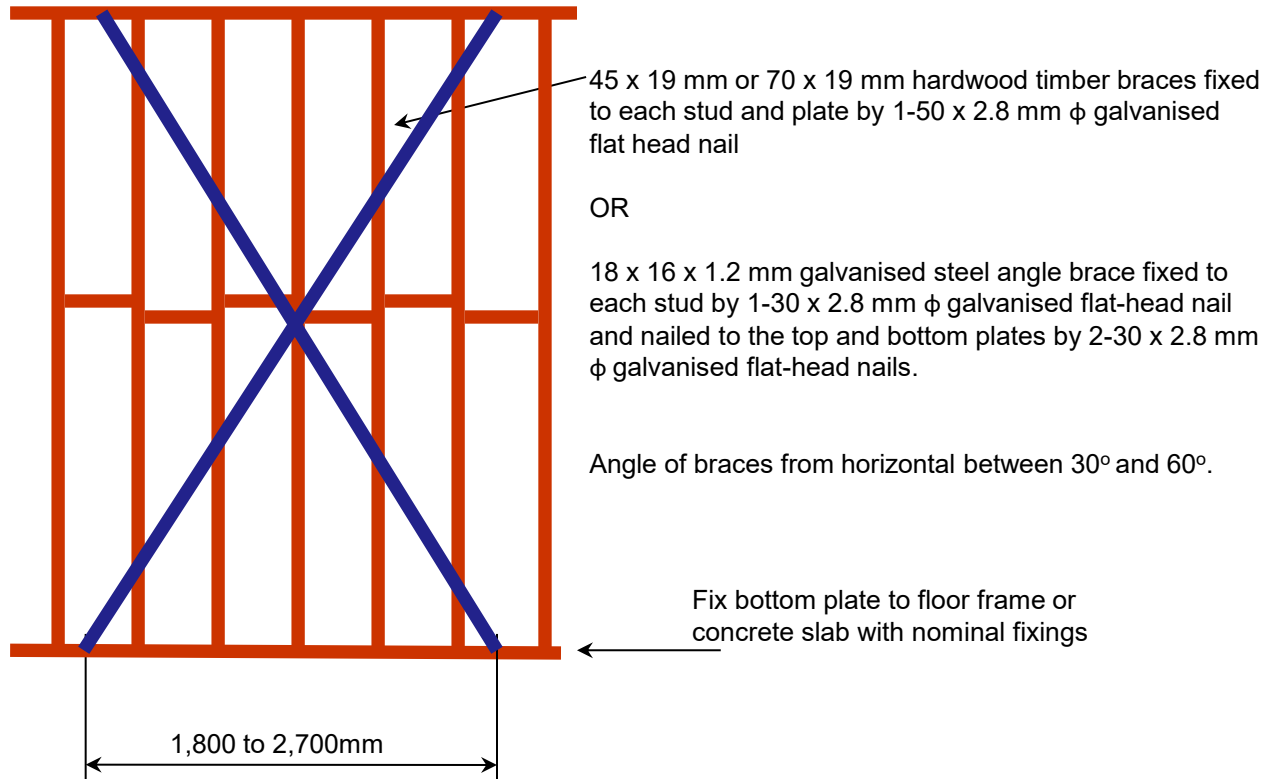
Based on AS 1684.3 Table 8.18 (a)



Wall Bracing – Pairs of Tensioned Metal Straps

Capacity 1.5 kN/m length

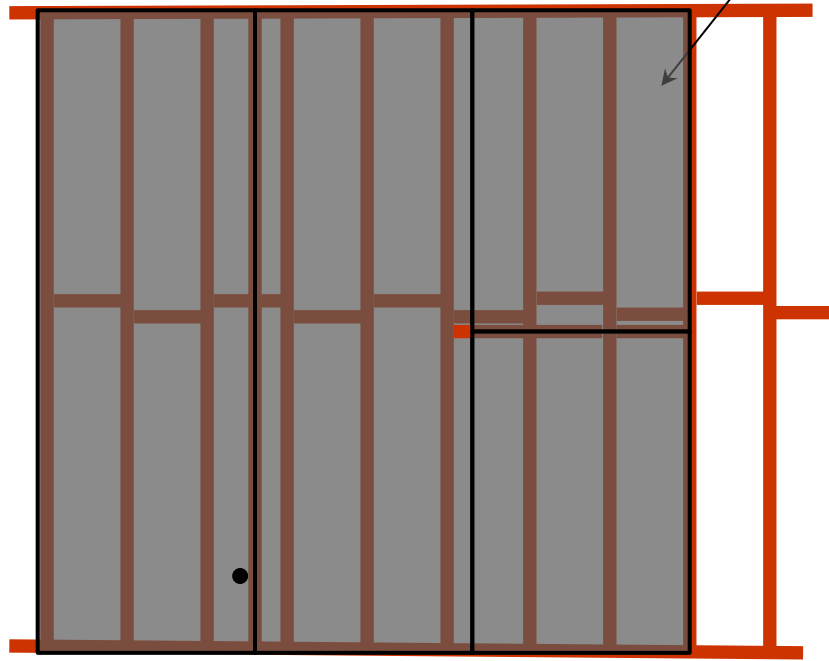
Based on AS 1684.3 Table 8.18 (b)



Wall Bracing – Plywood Sheeting Without Additional Connections

Capacity 3.4 kN/m length

Based on AS 1684.3 Table 8.18 (g)



Plywood sheets fixed:

- Around perimeter to top plate, bottom plate and end studs at 150 mm centres by 30 x 2.8 mm ϕ galvanised flat head nails; and
- To internal studs (and noggings where required) at 300 mm centres by 30 x 2.8 mm ϕ galvanised flat head nails.

Sheets may be butt jointed horizontally, provided they are fixed horizontally at the edges to noggings. Provide an additional row of nogging at half height of the wall, if required.

| Minimum Plywood Thickness | | | | |
|---------------------------|---|--------|--------------------|--------|
| Stud Spacing | 450 mm | 600 mm | 450 mm | 600 mm |
| Stress Grade | No nogging (except at horizontal butt joints) | | One row of nogging | |
| F8 | 7 mm | 9 mm | 7 mm | 7 mm |
| F11 | 4.5 mm | 7 mm | 4.5 mm | 4.5 mm |
| F14 | 4 mm | 6 mm | 4 mm | 4 mm |
| F27 | 3 mm | 4.5 mm | 3 mm | 3 mm |

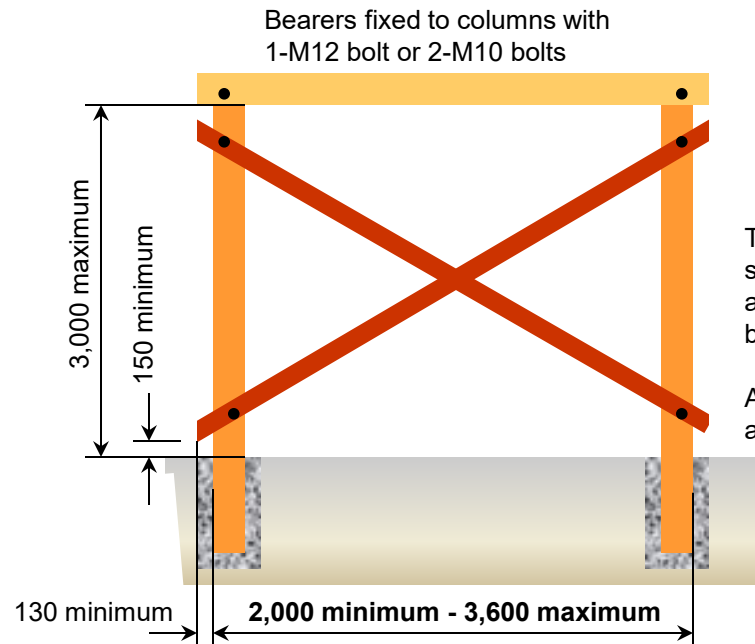
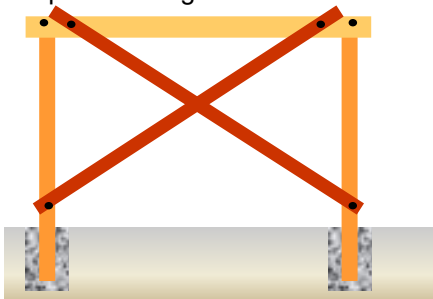
Sheathed panels shall be fixed to the sub-floor. Fix the bottom plate to floor frame or concrete slab with nominal fixings.

Sub-floor Tension Bracing

Capacity 15 kN

Based on AS 1684.3 Table 8.9

Alternative Detail:
Where practical, fix diagonal braces at the top directly to the bearers, to provide a more direct load path to the ground



Columns, of dimensions not less than:

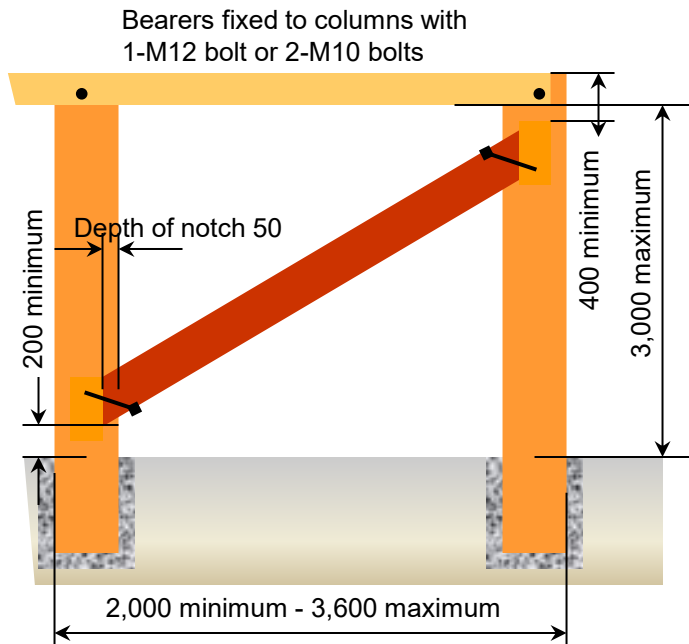
- 90 x 90 mm F11 (or stronger) hardwood
- 90 x 90 mm N20 (or stronger) concrete with 1 N12 reinforcing bar
- 190 x 190 mm 15 MPa reinforced concrete masonry with 1 N12 reinforcing bar
- 90 OD x 3 mm CHS galvanised steel hollow section

Two diagonal braces, 90 x 45 mm F11 (or stronger) hardwood, fixed to columns at the bottom and to the bearer (preferred) or column at the top by 1-M16 bolt (or stronger) .

Angle of braces from horizontal between 30° and 60°.

Sub-floor Compression Bracing

Capacity 15 kN (Nominal)



Columns, of dimensions not less than:

- 200 x 200 mm or 250 mm diameter F11 (or stronger) hardwood, or
- 150 x 150 mm or 200 mm diameter N20 (or stronger) concrete with 1 N12 reinforcing bar

Two diagonal braces in opposing directions in two bays on each side of building, at least 90 x 90 mm or 150 mm diameter F11 (or stronger) hardwood, notched into the columns to a depth of 50 mm and fixed at the top and bottom by at least 2 – 150 x 3.15 mm ϕ galvanised flat head nails (or stronger) .

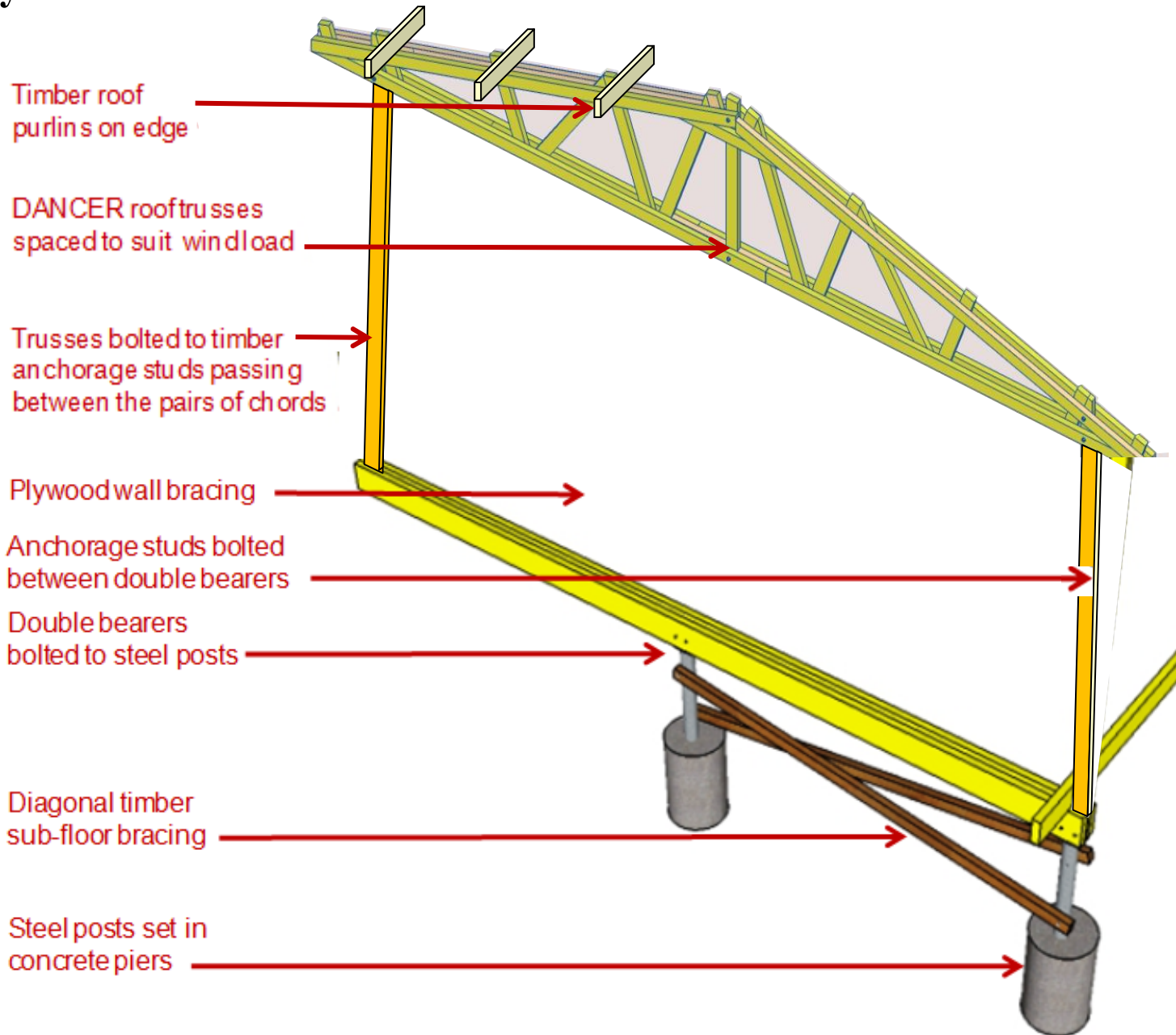
Angle of braces from horizontal between 30° and 60°.

DANCER - **D**irect **A**nchorage **N**oncyclonic, **C**yclone & **E**arthquake **R**esistant

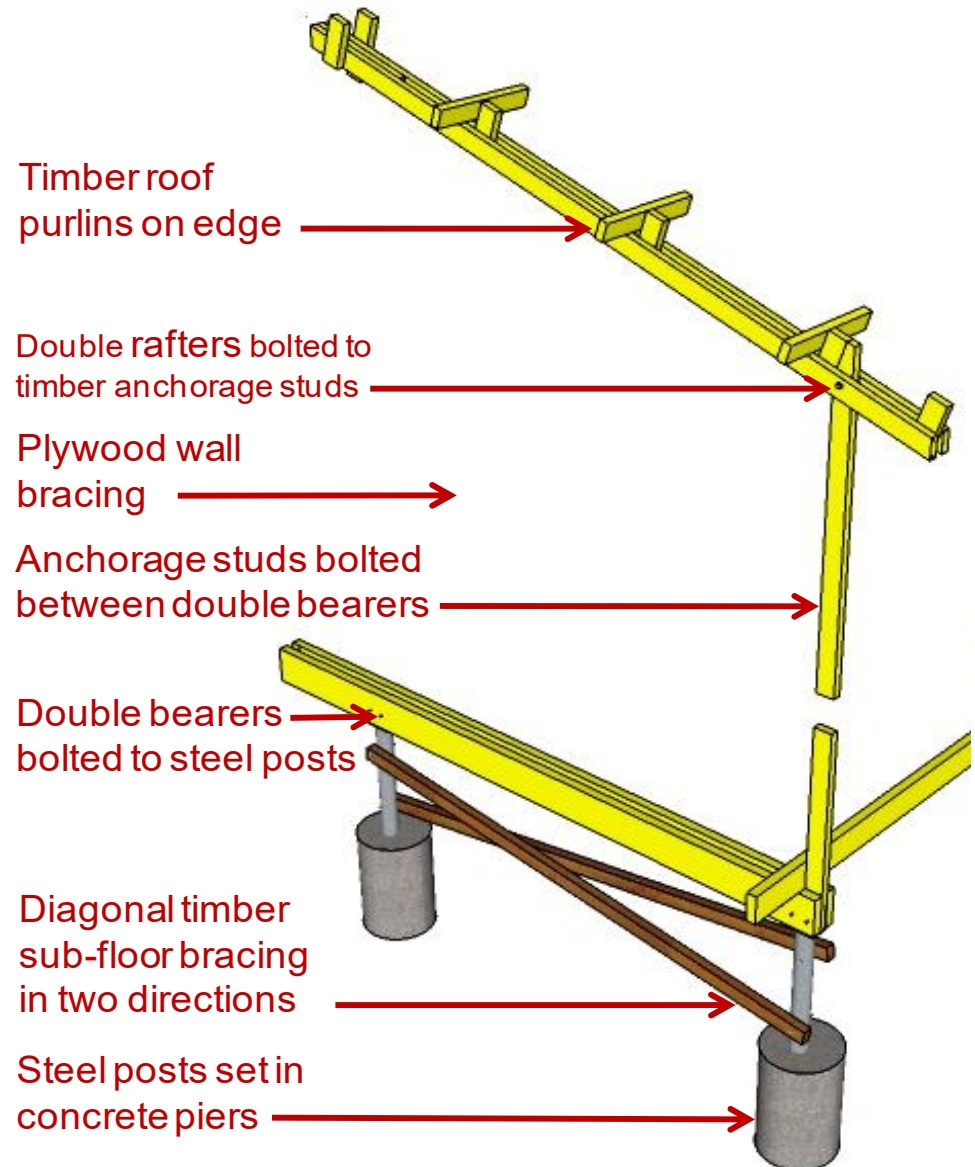
- Timber roof purlins, on edge (to maximize the span) are screwed horizontally to timber lacing members that are fixed between the double truss chords (or double rafters, as appropriate). They are fixed at 900 mm maximum centres to support corrugated steel roof sheeting.
- DANCER Trusses (or DANCER Rafters) consisting of double top chords and double bottom chords (enabling the lacing/purlin cleats to be screwed between from both sides and the anchorage studs bolted in double shear between).
- The DANCER Trusses (or DANCER Rafters) are bolted to timber Anchorage Studs between both pairs of chords.
- The timber Anchorage Studs are bolted in double shear between the Double Bearers, providing a direct load path from the roof system to the floor and subfloor
- Double Bearers are bolted to steel posts, which are set in concrete piers.
- Plywood wall bracing and diagonal timber sub-floor bracing provide racking resistance.



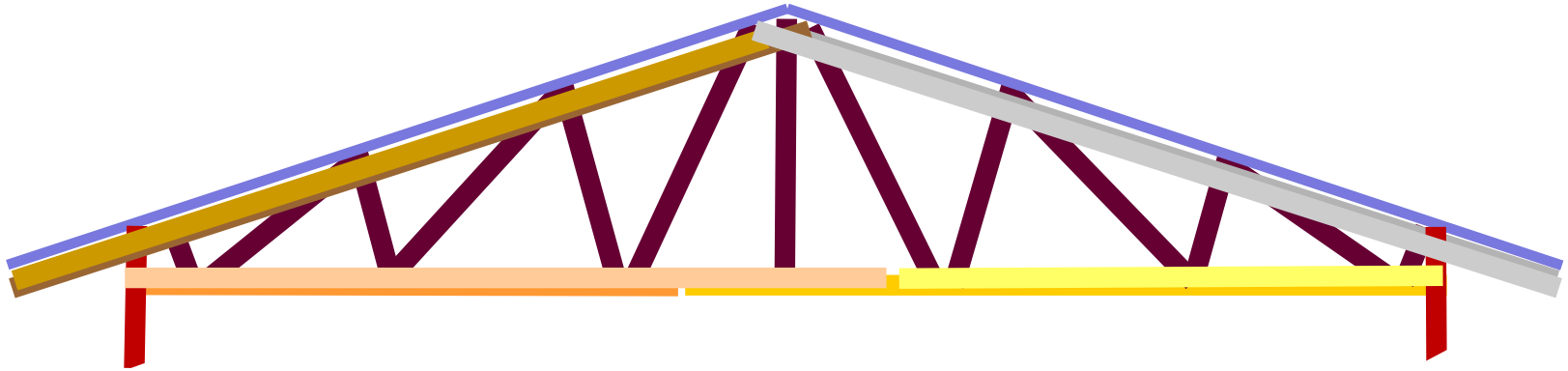
DANCER Truss System



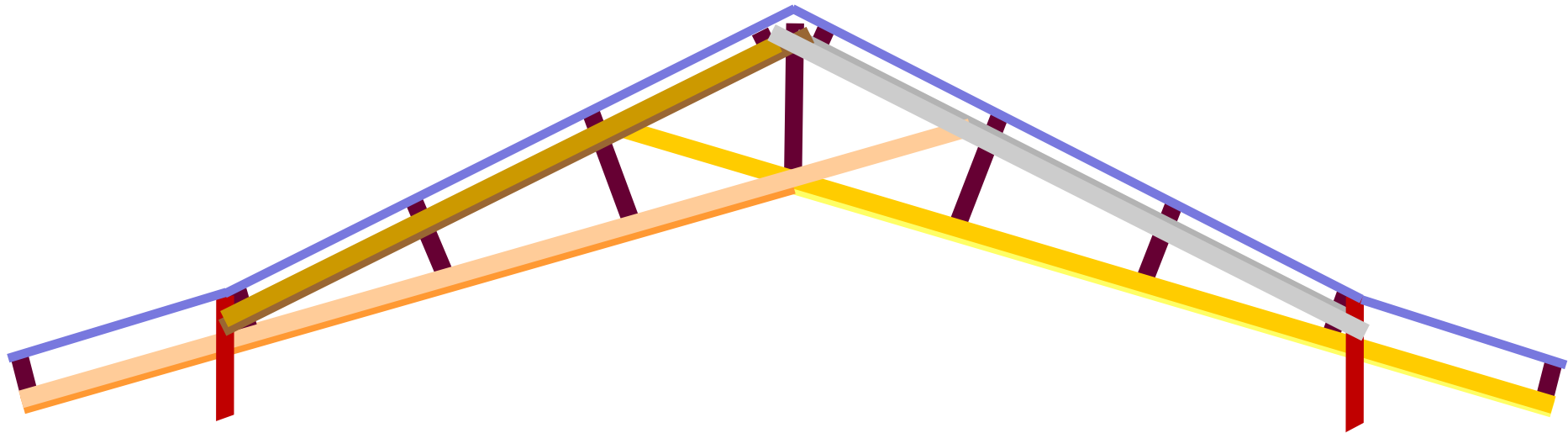
DANCER Rafter System



DANCER “Pratt” Truss

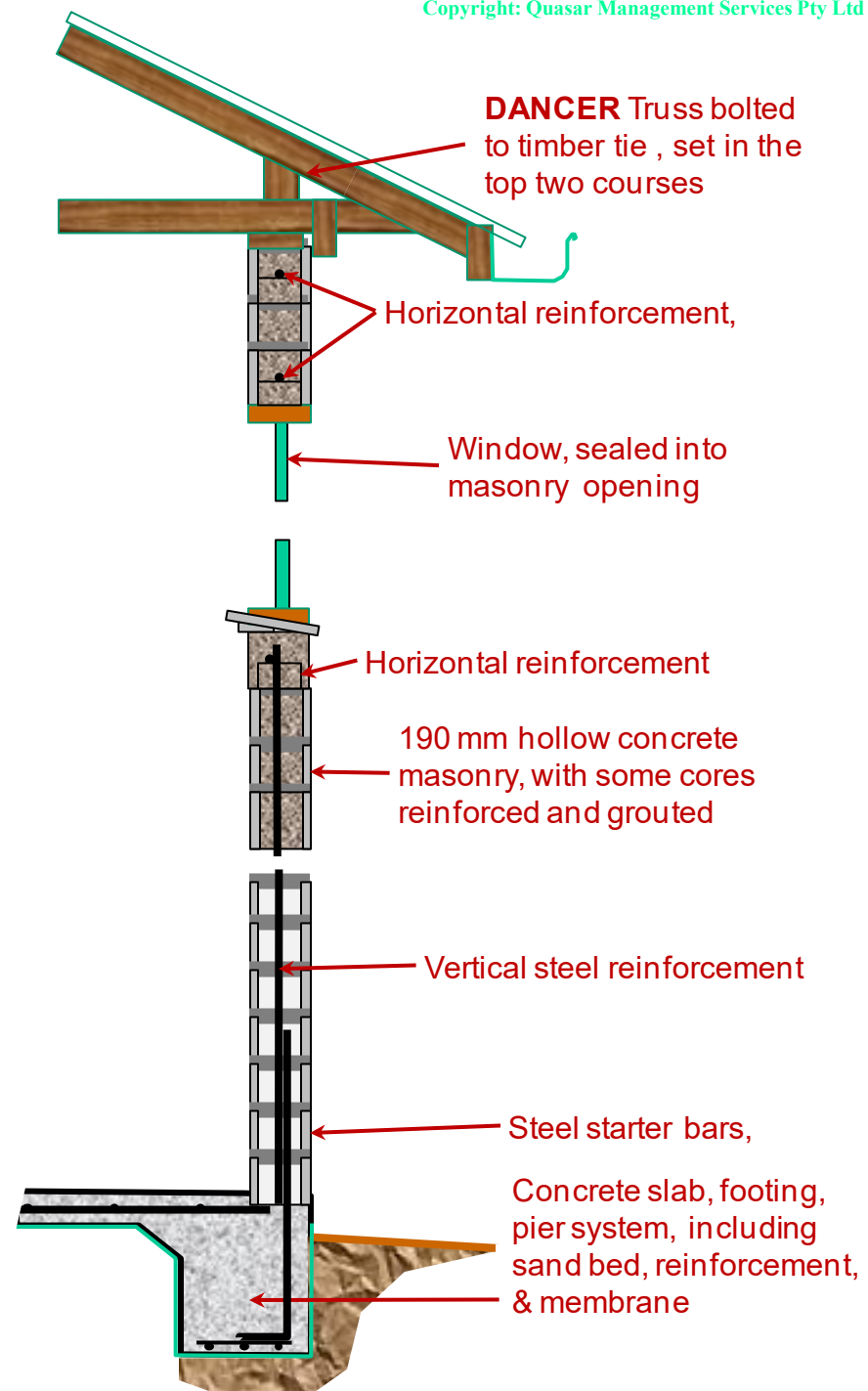


DANCER “Scissor” Truss

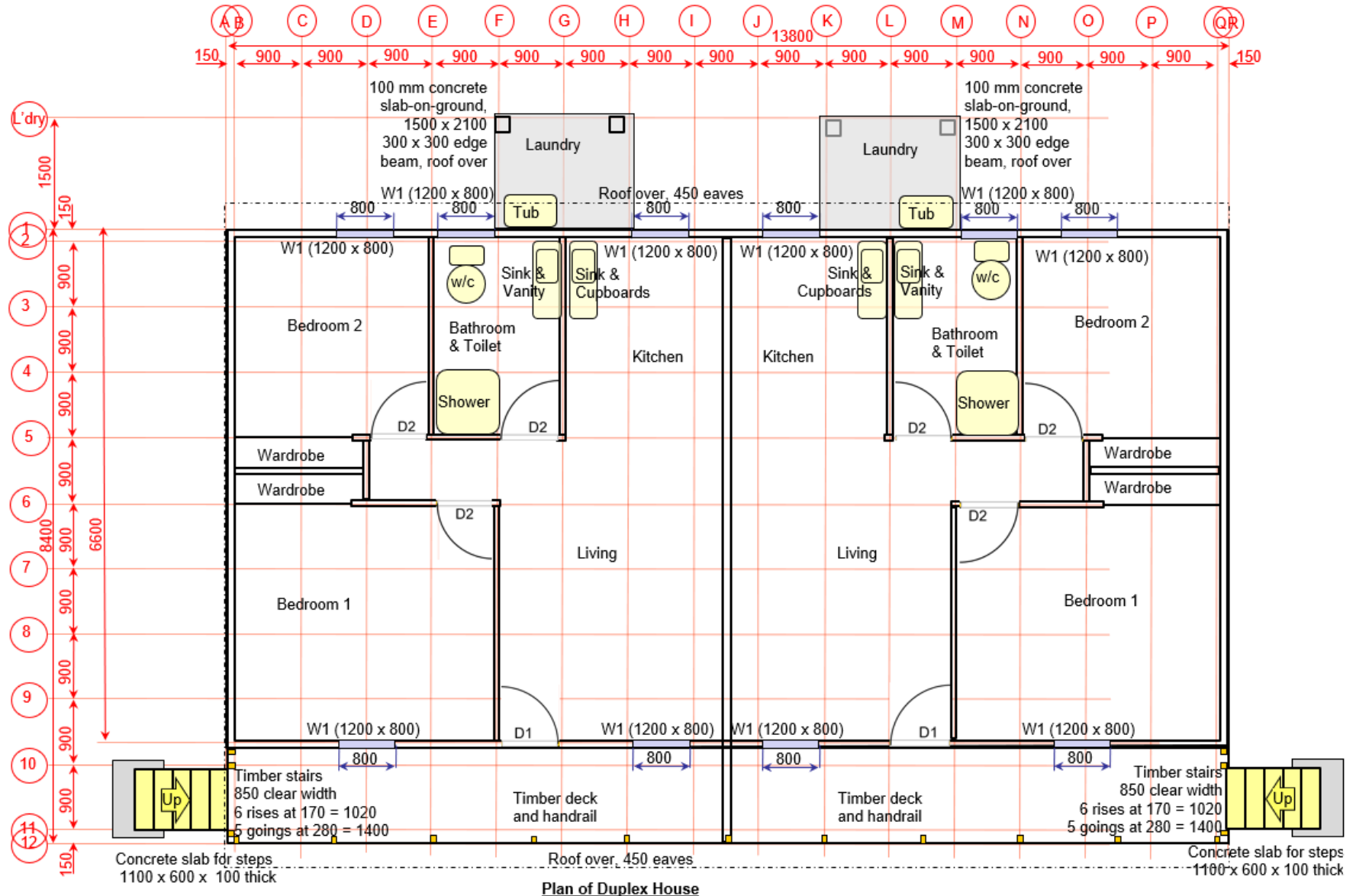


The **DANCER** Building System can be adapted suit any architectural style without compromising structural efficiency

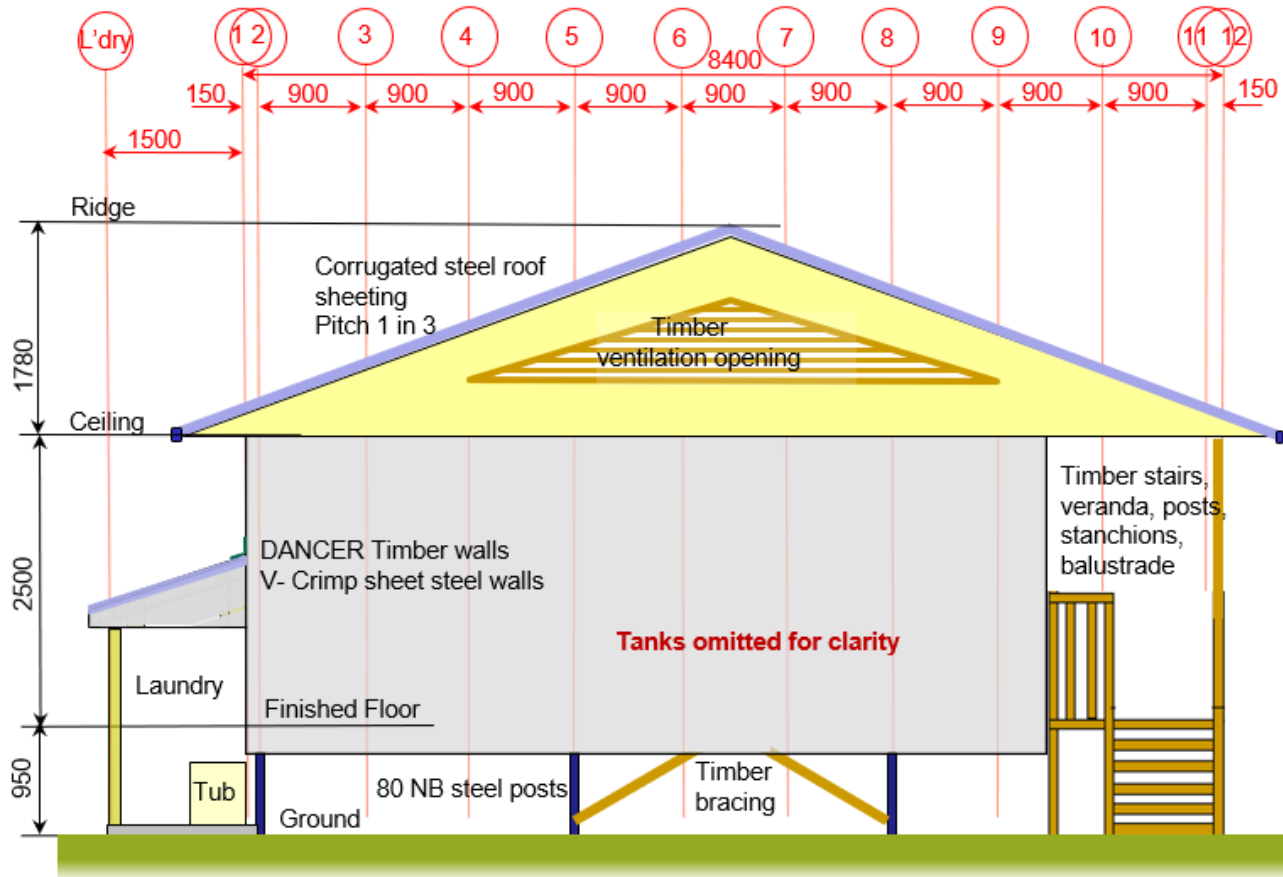
DANCER Reinforced Masonry System



DANCER – Floor Plan of a Duplex House

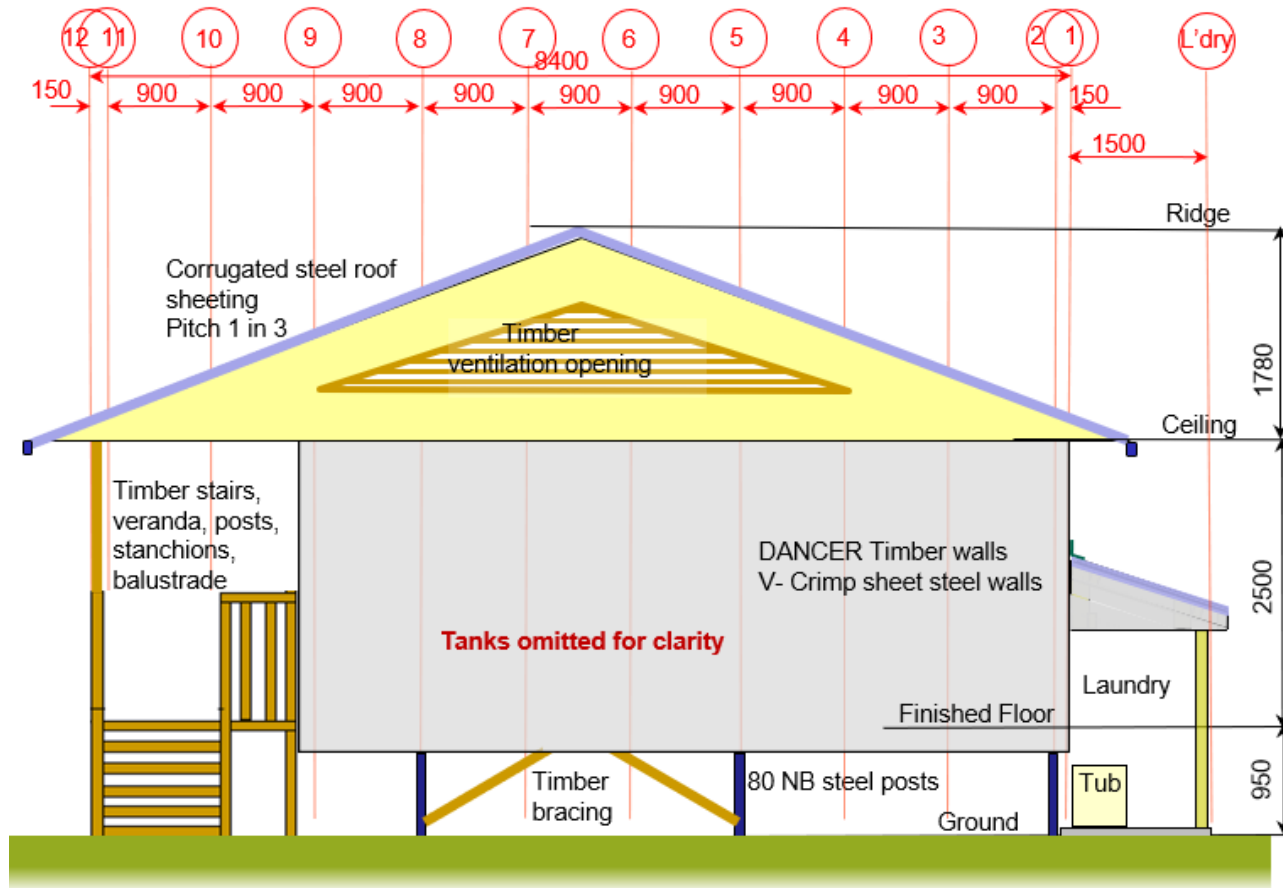


DANCER – End Elevation of a Duplex House



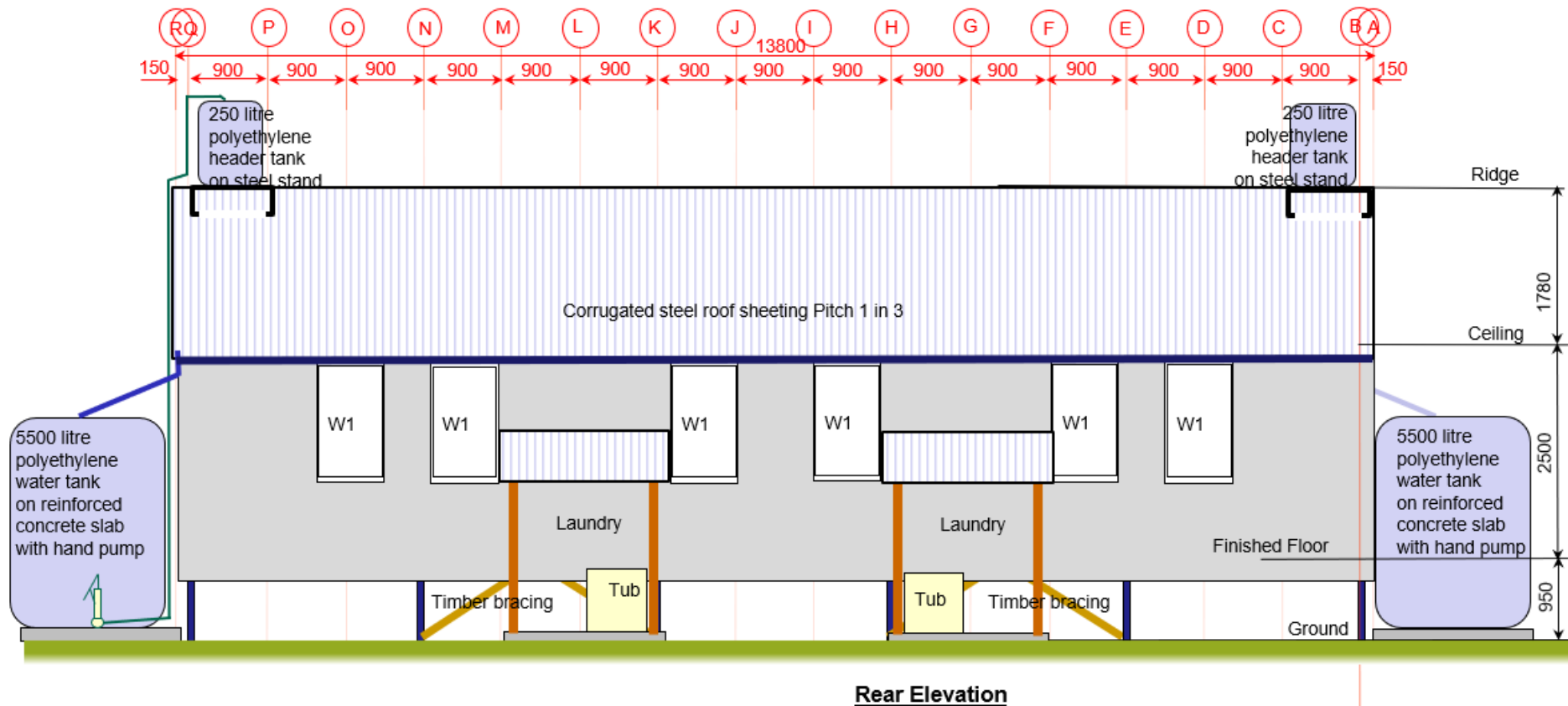
Left End Elevation

DANCER – End Elevation of a Duplex House

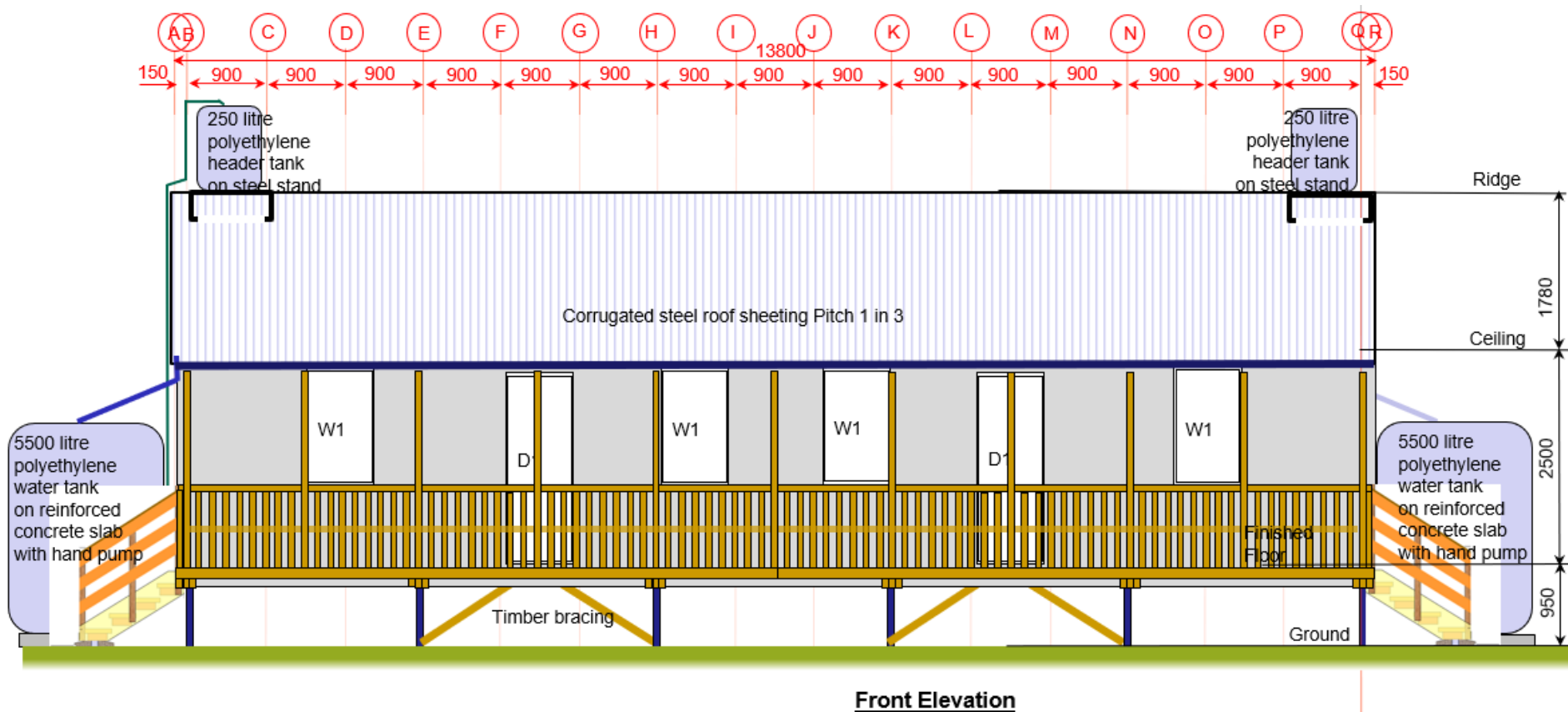


Right End Elevation

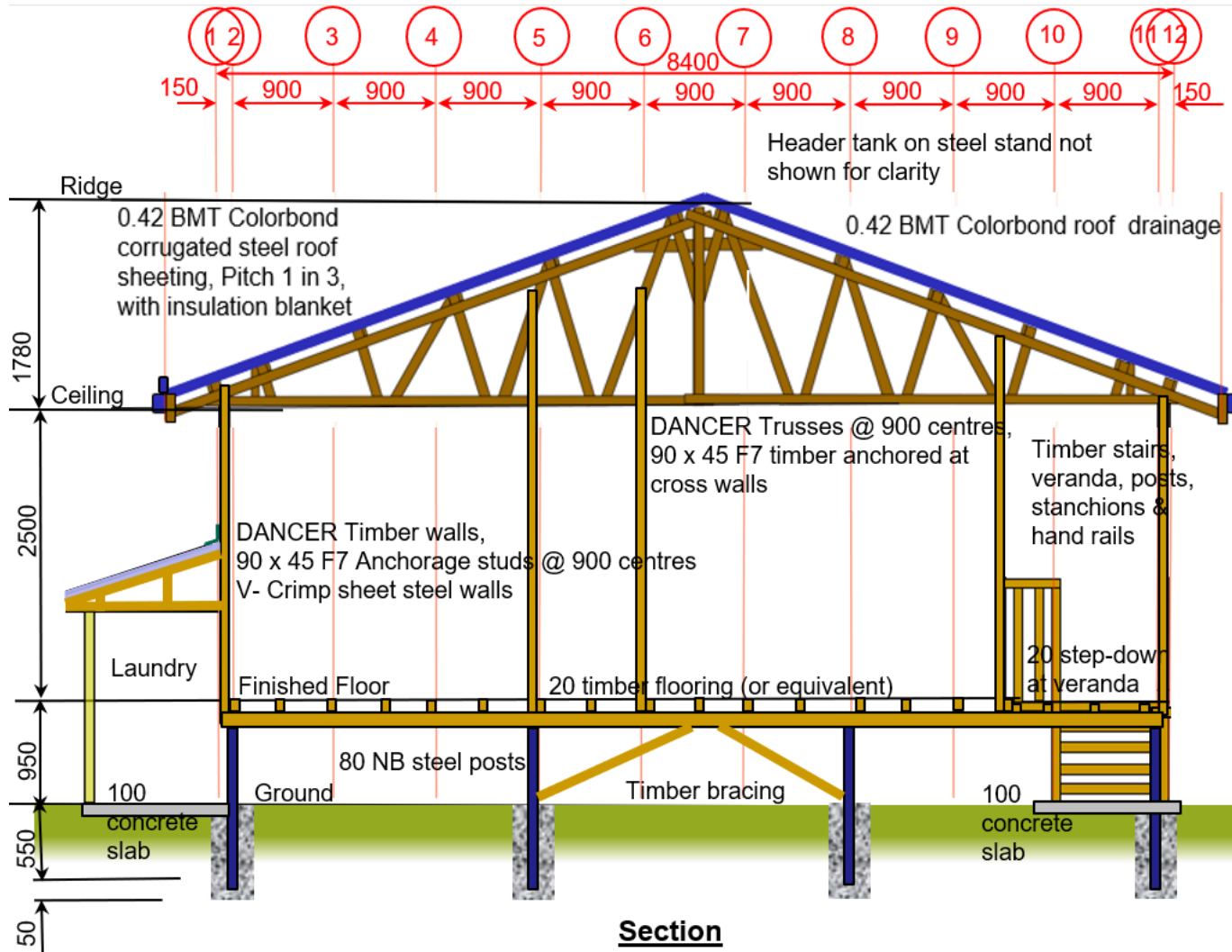
DANCER – Rear Elevation of a Duplex House



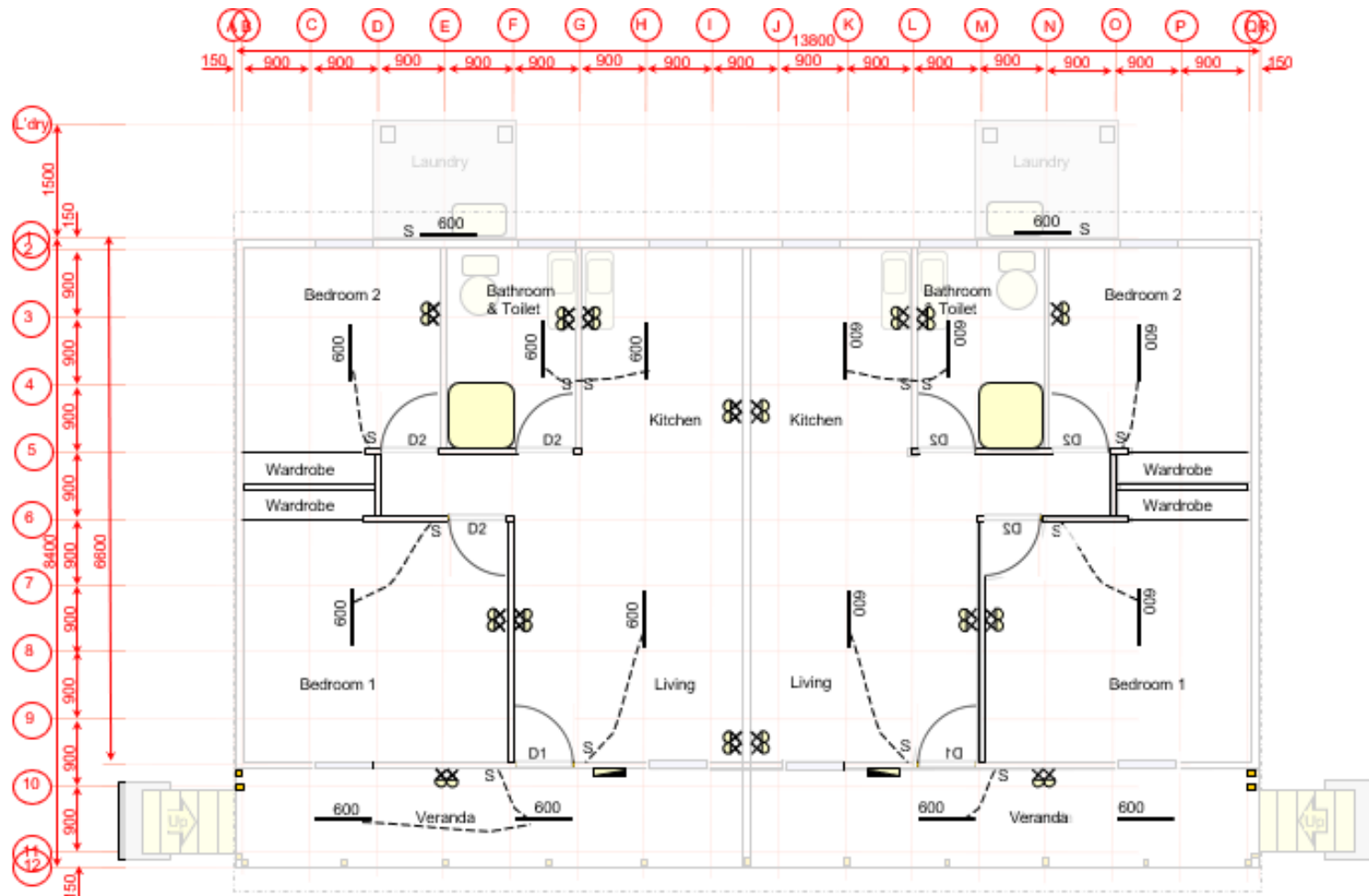
DANCER – Front Elevation of a Duplex House



DANCER – Section through a Duplex House



DANCER – Electrical Services for a Duplex House



Notes:

- All electrical installation shall comply with AS 3000 and the Specification, relevant to a 240 volt single-phase supply
- Mains supply and/or solar power supply to be designed separately.

S



Switch, 1200 above floor

Double GPO, 300 above floor

Switch board

Light, 1 x 18W, 613 x 26mm

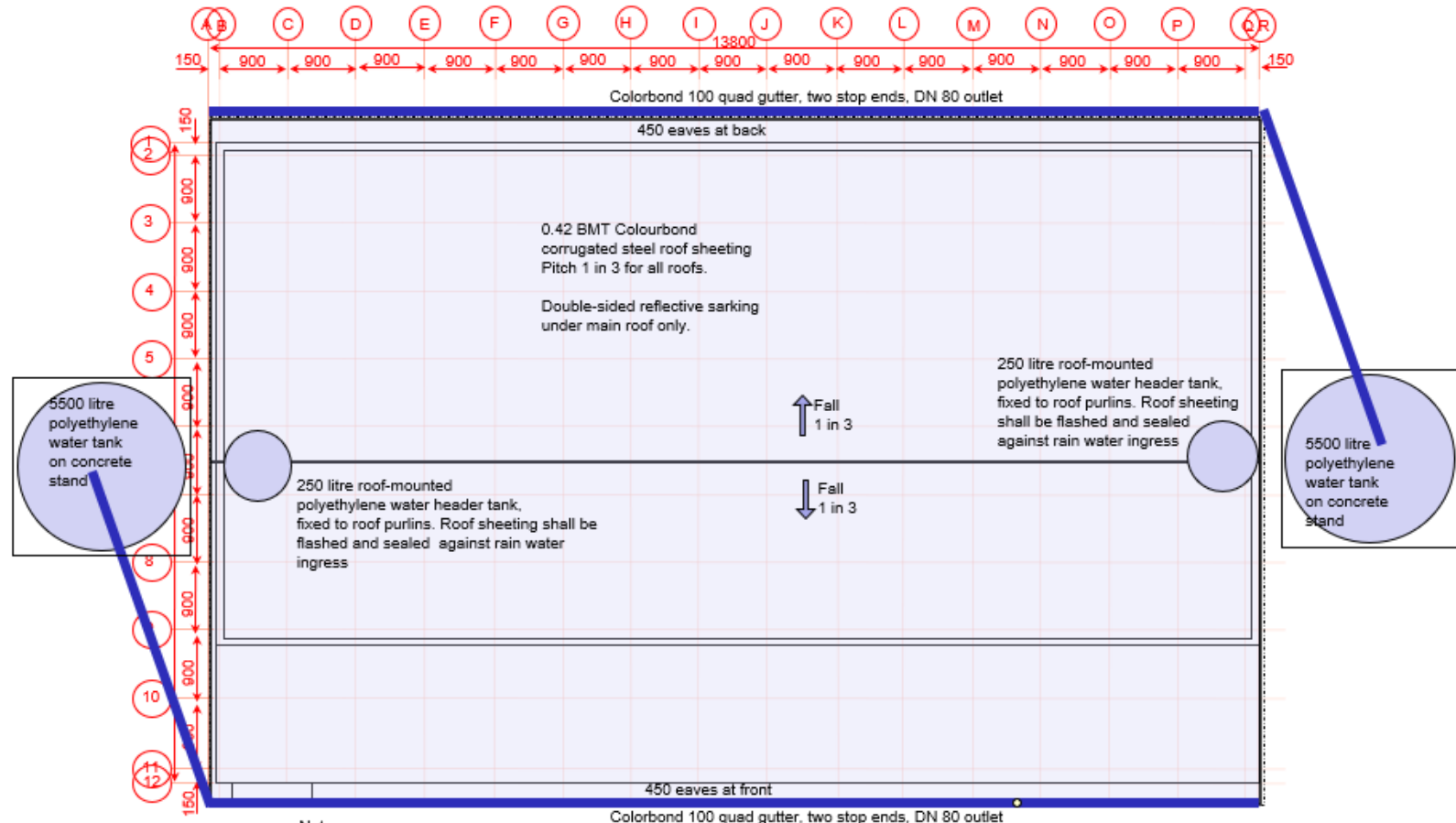
bare batten fluorescent tube

Light, 1 x 18W, 613 x 26mm

bare batten fluorescent tube

Electrical Services

DANCER – Roof Plumbing and Rainwater Tanks for a Duplex House

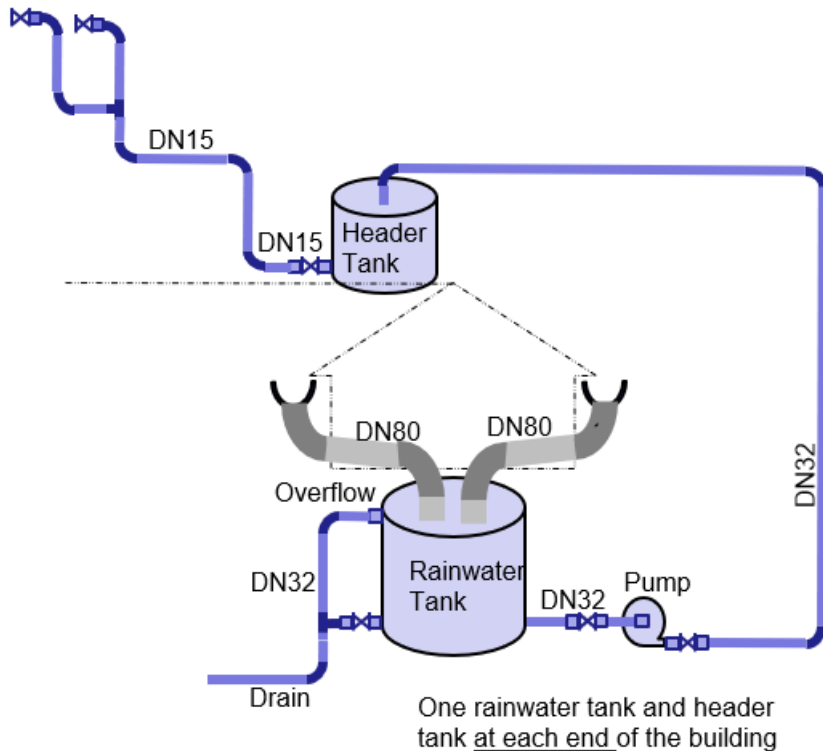


Notes:

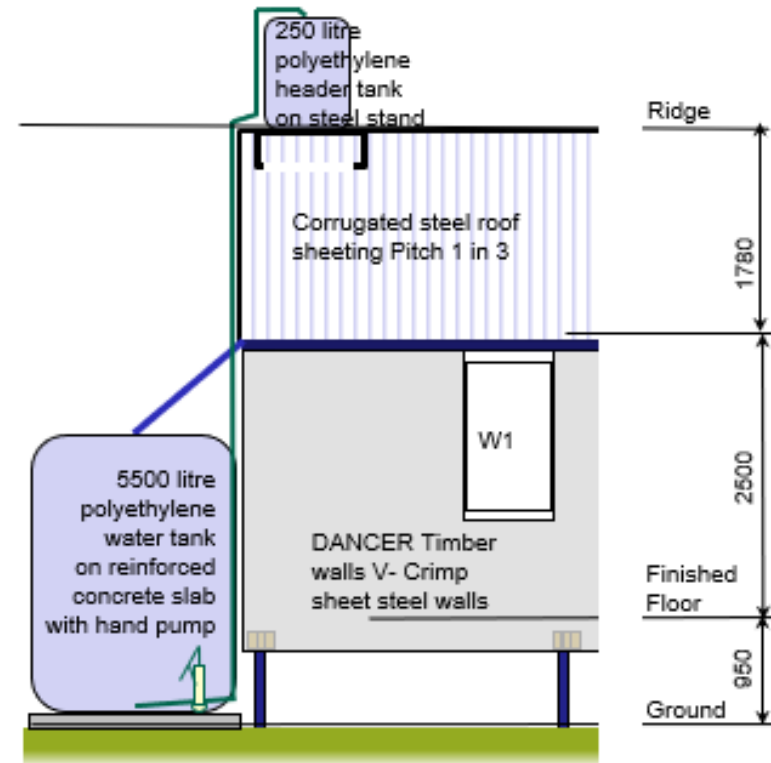
- All roofing – 0.42 BMT Colourbond corrugated steel roof sheeting (pitch 1 in 3), fixed with cyclone washers, 12-14x35 T17 HD/TG HH Class, top-lock hex galv roofing screws & plastic washers, screw spacing (main part of roof including 1.2 m from ends) – 80 mm (at every rib)
- Sarking (for main roof only) – Double sided reflective insulation placed between roof sheet and timber purlins
Roof Insulation (optional alternative to sarking for main roof only) - R1.8 reflective foil & glass fibre blanket
- Eaves gutter and rainwater collection - DN80 roof drainage (uPVC pipes, inlet & FF 88 elbows). Refer to plumbing schematic for further details.
- Colorbond 100 quad eaves gutter, Colorbond 100 quad stop ends, 12-14x35 T17 HD/TG HH Class 3 screws, Colorbond DN80 clip saddles
- Colorbond steel 200 x 0.6 mm thick ridge flashing, Colorbond steel 0.6 mm thick barge moulds, fixings galv roofing nails 65 x 3.75mm and jolt head nails 125 x 5.6mm fixings for flashing & barge moulds

DANCER – Roof Plumbing and Rainwater Tanks for a Duplex House

Standpipes and plumbing fixtures

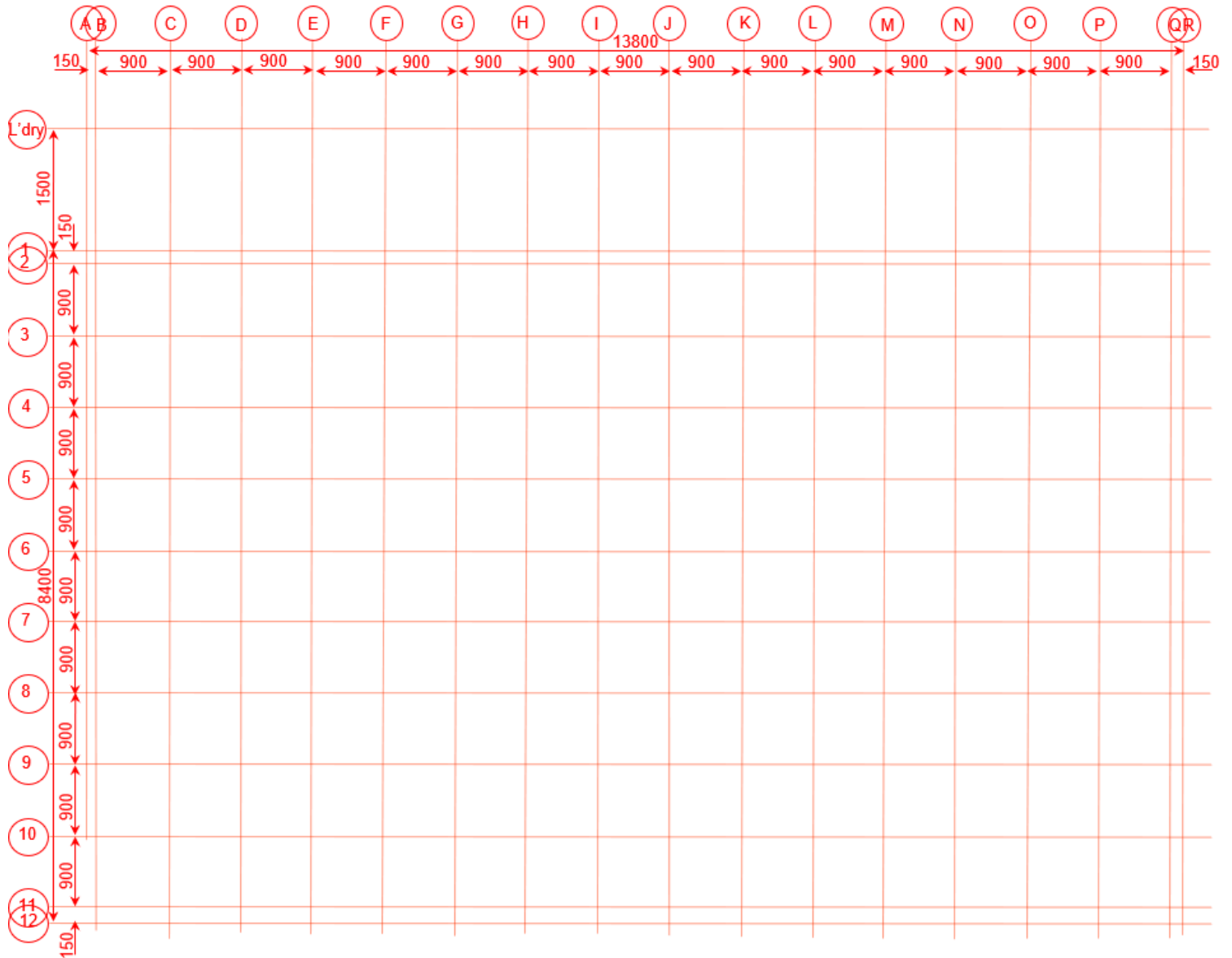


Rainwater Tanks and Header Tanks



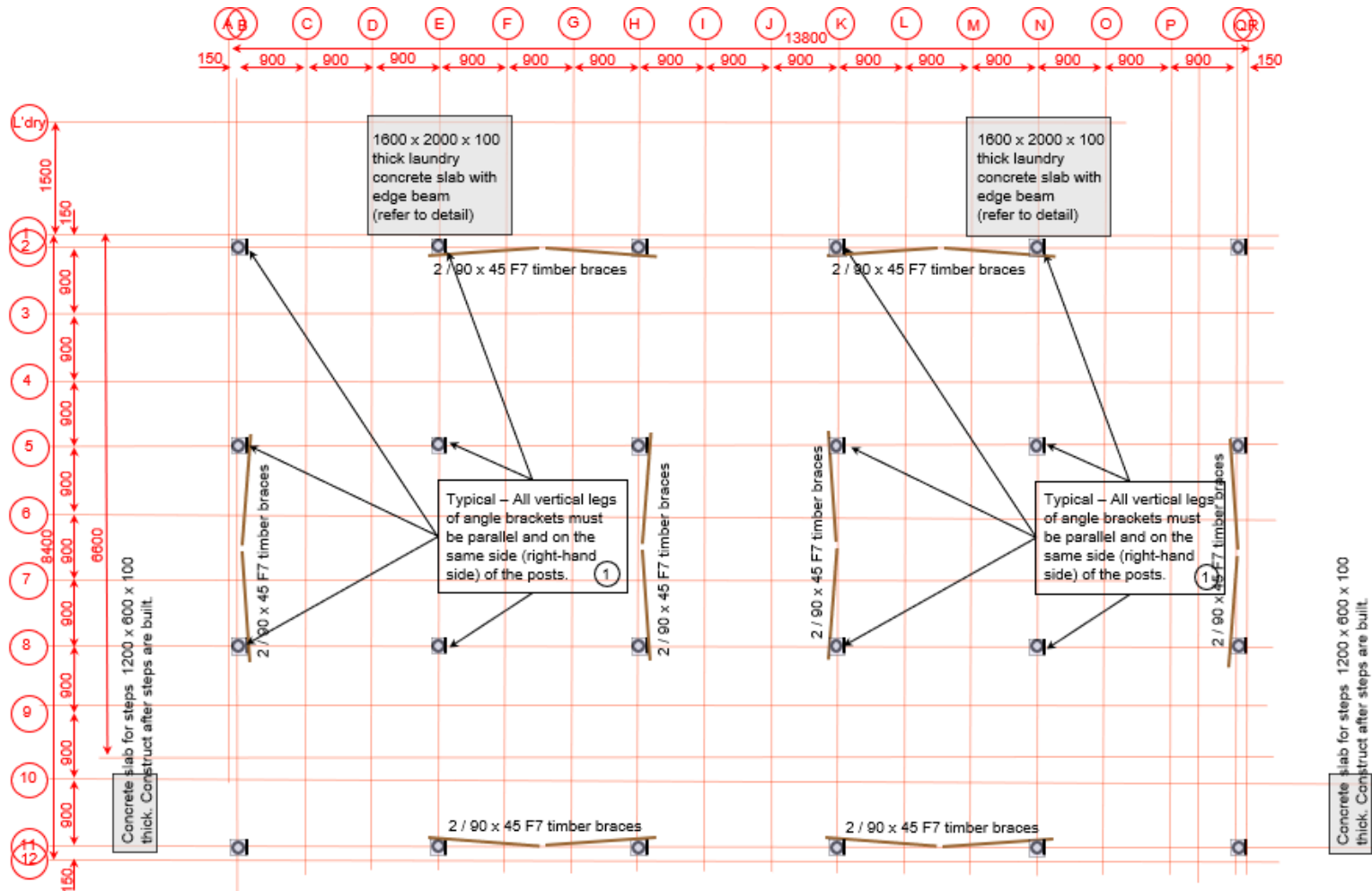
Tank Arrangement

DANCER – Gridlines for a Duplex House



Grid Lines for Duplex House

DANCER – Subfloor Pier, Post, Bracing Arrangement for a Duplex House



Concrete piers, 400 diameter x 600 deep. Steel Posts – 80 NB x 6.5 galvanized pipe x 1194 long, with 125 x 75 x 6 L x 150, drilled 2-14 mm holes, 6 cfw (continuous fillet weld) to top of pipe, and 2-10 dia x 150 bars 6 cfw (continuous fillet weld) to bottom of pipe.

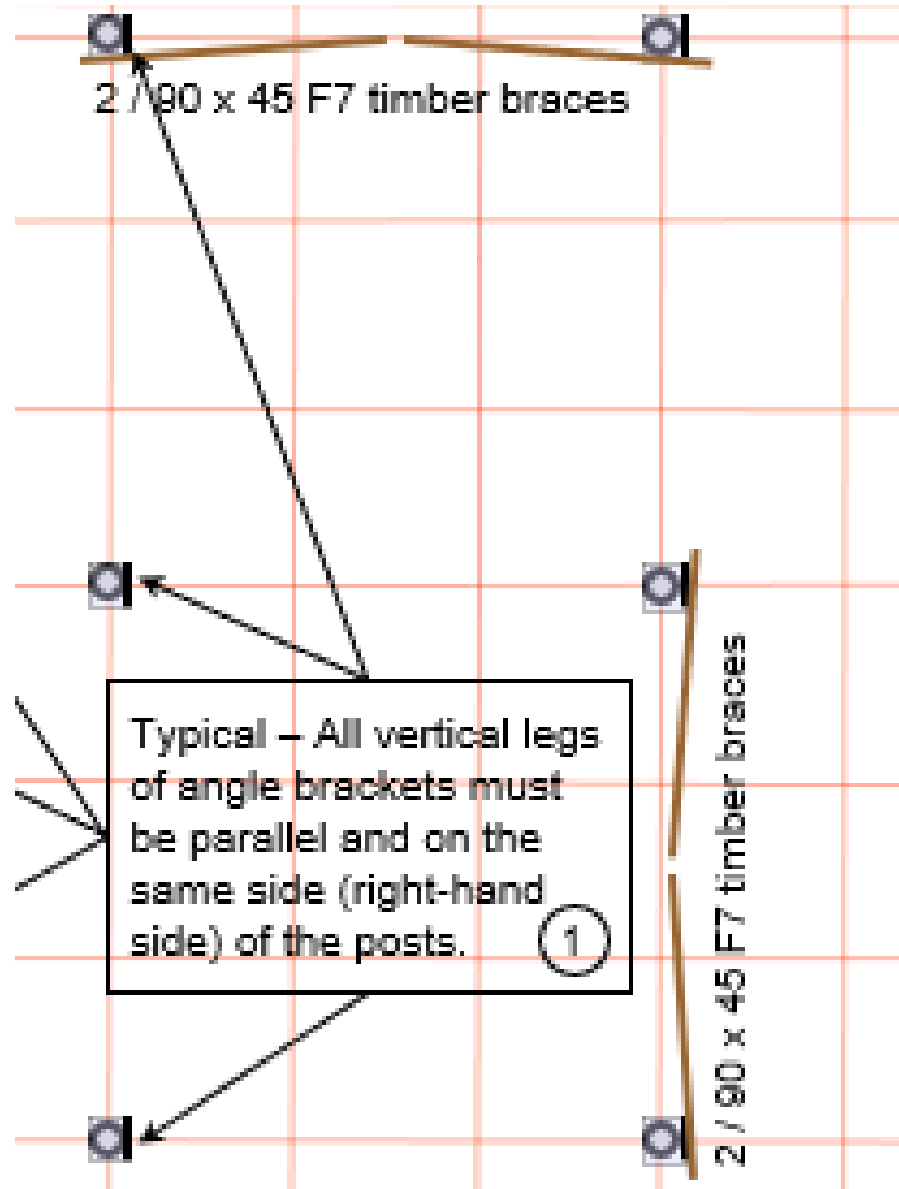
Concrete pad for steps – 1,200 x 600 x 100 mm thick. 5 / N10 x 550 reinforcing bars and 3 / N10 x 1150 reinforcing bars. Top surface of slab nominally 80 mm above ground level. If the slab surface is low, grout (up to a maximum thickness of 20 mm) under both stringers to make up required height. If the slab surface is high, trim the bottom surface of the stringers.

Concrete laundry slabs – 1800 x 2000 x 100 thick laundry concrete slab, reinforced with SL 72 fabric, with 300 wide x 400 deep edge beam with 3 N10 bars in the bottom. Refer to detail). Top surface of slab nominally 60 mm above ground level..

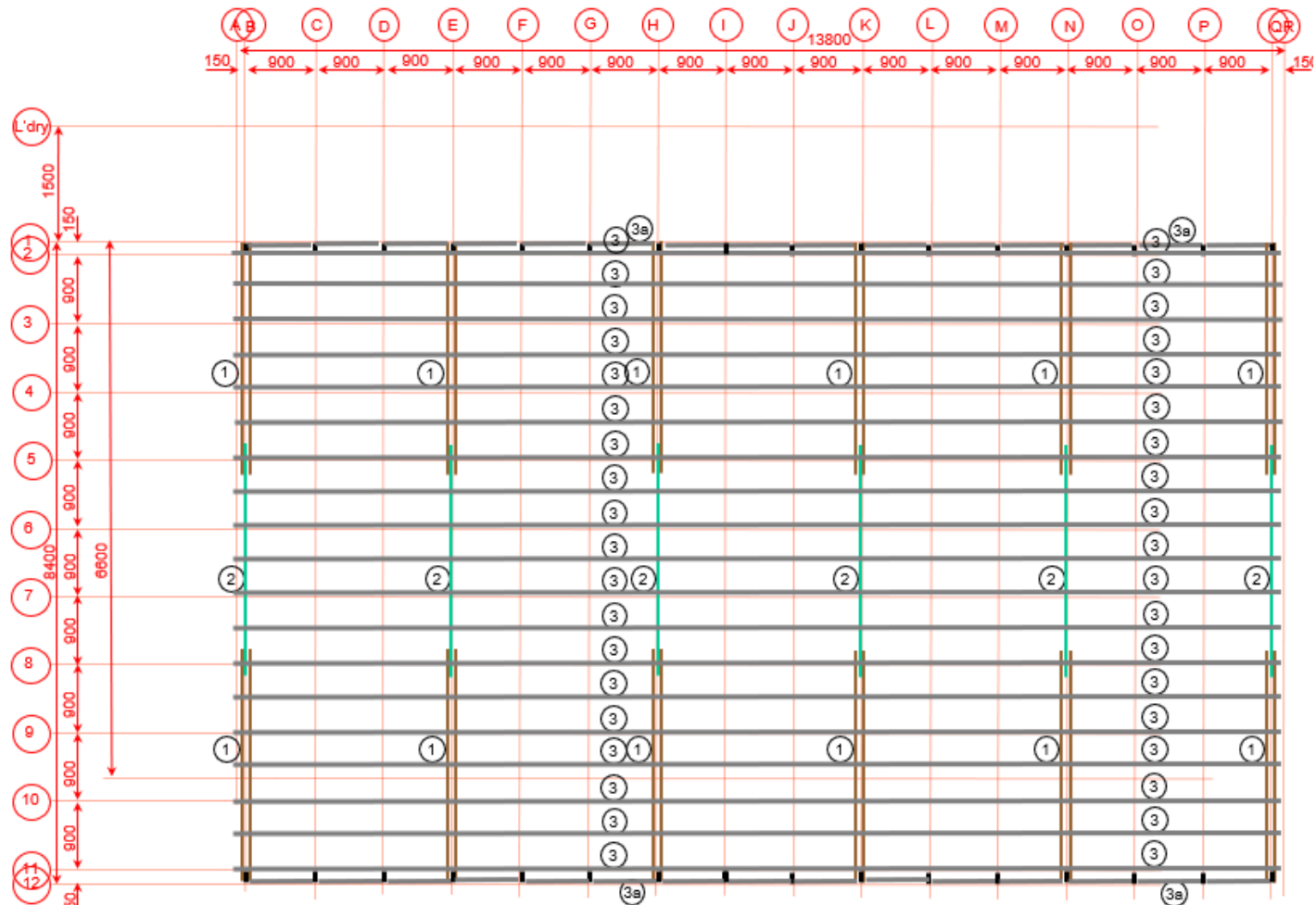
Notes:

1. N20 Concrete
2. For all other items, substitution of other sizes must be approved by the Engineer.
3. Refer to Engineer's Details for fixings, connections and associated members.

DANCER – Subfloor Post and Bracing Detail



DANCER – Bearer & Joist Arrangement for a Duplex House

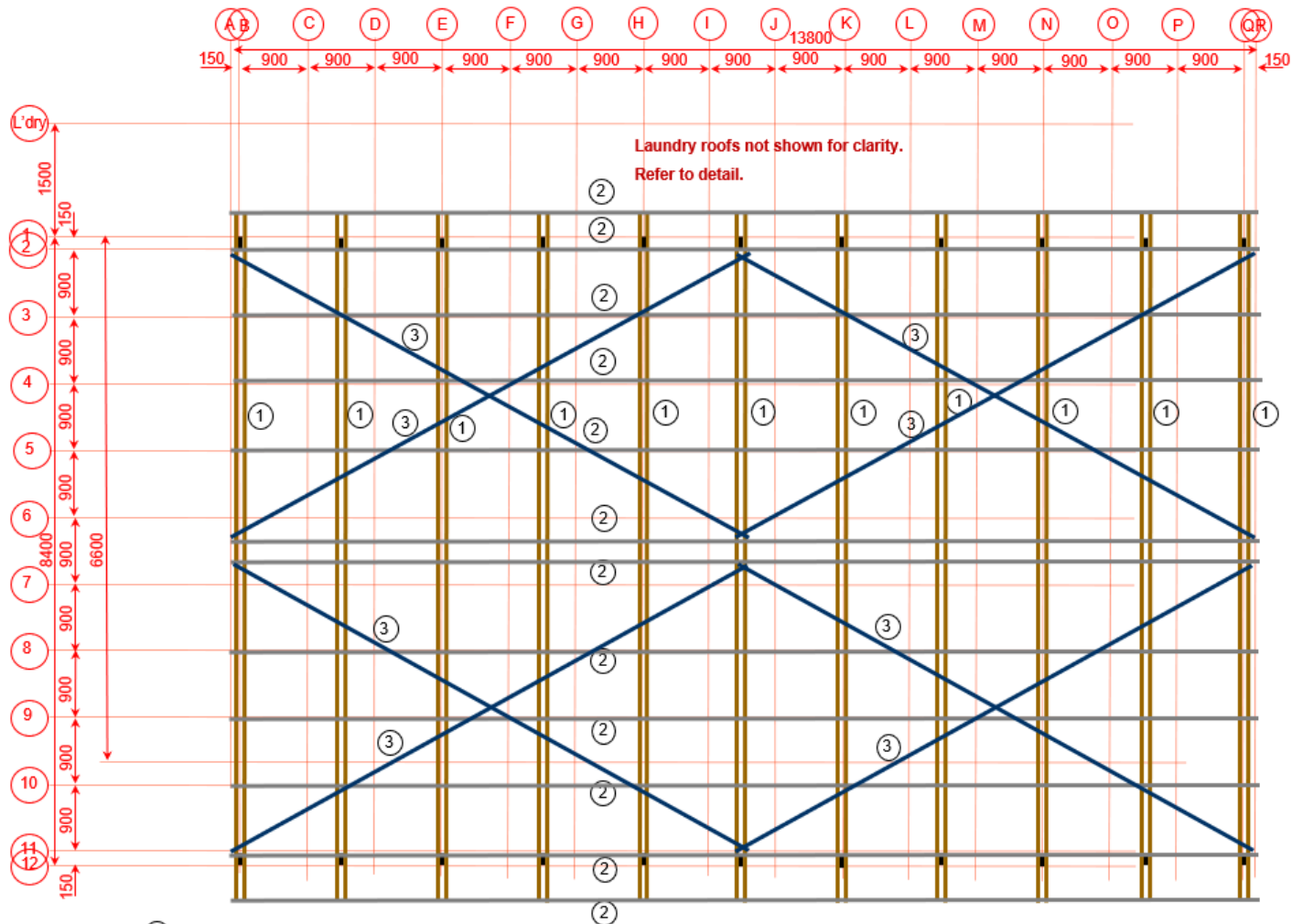


- ① Double Bearers (2 / 140 x 45 x 3000 long, lapped)
- ② Single Bearers (1 / 140 x 45 x 3000 long, lapped)
- ③ Joists (140 x 45 x 3000 long, lapped)

Notes:

1. All timber shall be graded F7, SD6, JD4 or stronger. Australian and New Zealand Seasoned Radiata Pine are deemed to meet this specification.
2. For all other items, substitution of other sizes must be approved by the Engineer.
3. Refer to Engineer's Details for fixings, connections and associated members.

DANCER – Roof Truss, Purlin & Bracing Arrangement for a Duplex House

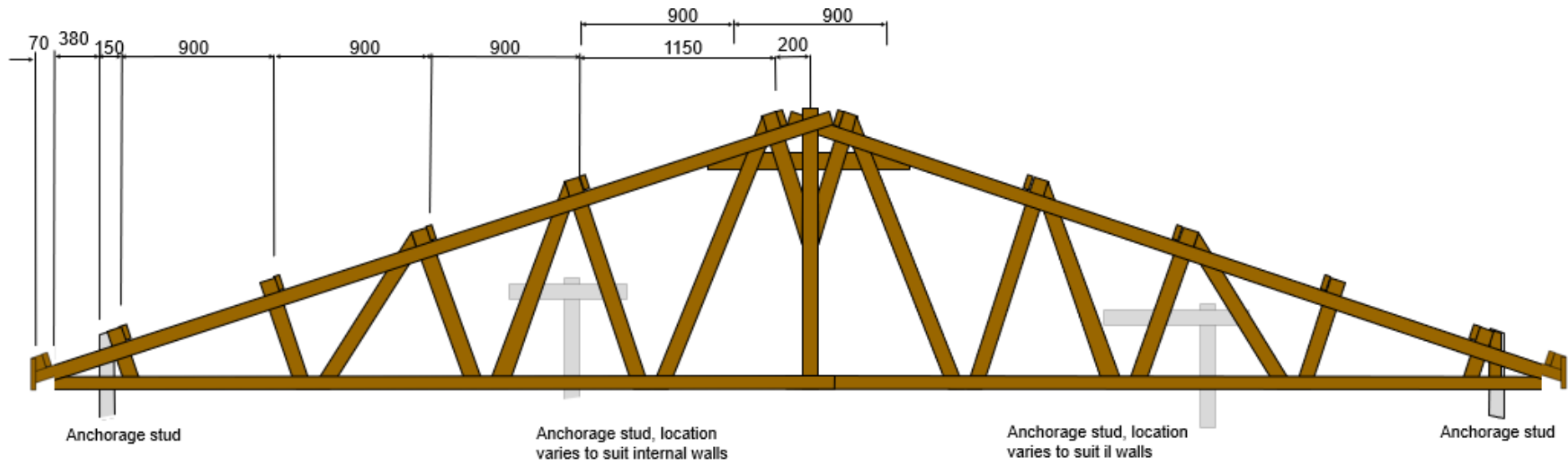


- ① DANCER truss (Chords double 90 x 45)
- ② Purlin P1 (90 x 45)
- ③ Steel strap (30 x 1)

Notes:

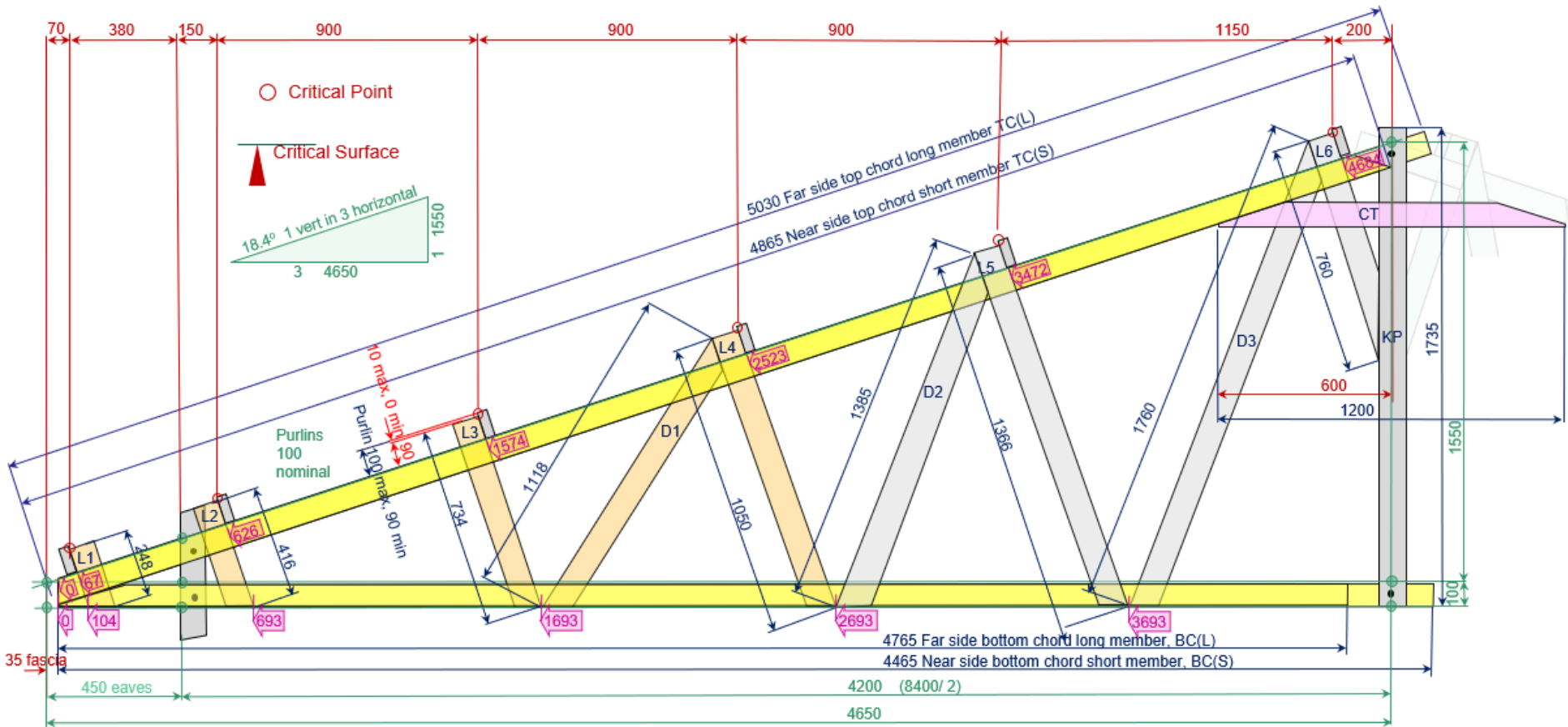
1. All timber shall be graded F7, SD6, JD4 or stronger. Australian and New Zealand Seasoned Radiata Pine are deemed to meet this specification.
2. For all other items, substitution of other sizes must be approved by the Engineer.
3. Refer to Engineer's Details for fixings, connections and associated members.

DANCER – DANCER Trusses



DANCER – DANCER Truss Details

| Roof Trusses | | | | | 8.400 |
|--------------|-----------------------|---------|------|----------|--------------|
| Item | Component | Section | | Material | Length mm |
| | | mm | x mm | | |
| TC(L) | Truss Top Chord (or R | 90 | x 45 | F7 | 5,030 |
| TC(S) | Truss Top Chord (or R | 90 | x 45 | F7 | 4,865 |
| BC(L) | Truss Bottom Chord (a | 90 | x 45 | F7 | 4,765 |
| BC(S) | Truss Bottom Chord (a | 90 | x 45 | F7 | 4,465 |
| CT | Collar Tie | 90 | x 45 | F7 | 1,200 |
| KP | King Post | 90 | x 45 | F7 | 1,735 |
| L1 | Lacing at eaves | 90 | x 45 | F7 | 248 |
| L2 | Lacing at anchorage s | 90 | x 45 | F7 | 416 |
| L3 | Lacing | 90 | x 45 | F7 | 734 |
| L4 | Lacing | 90 | x 45 | F7 | 1,050 |
| L5 | Lacing | 90 | x 45 | F7 | 1,366 |
| L6 | Lacing | 90 | x 45 | F7 | 760 |
| D1 | Diagonal | 90 | x 45 | F7 | 1,118 |
| D2 | Diagonal | 90 | x 45 | F7 | 1,385 |
| D3 | Diagonal | 90 | x 45 | F7 | 1,762 |



DANCER – Truss Bolted Apex Splice

Purlins
90 x 45

Double top chords
2 / 90 x 45

Truss diagonal lacing between
double chords
1 / 90 x 45

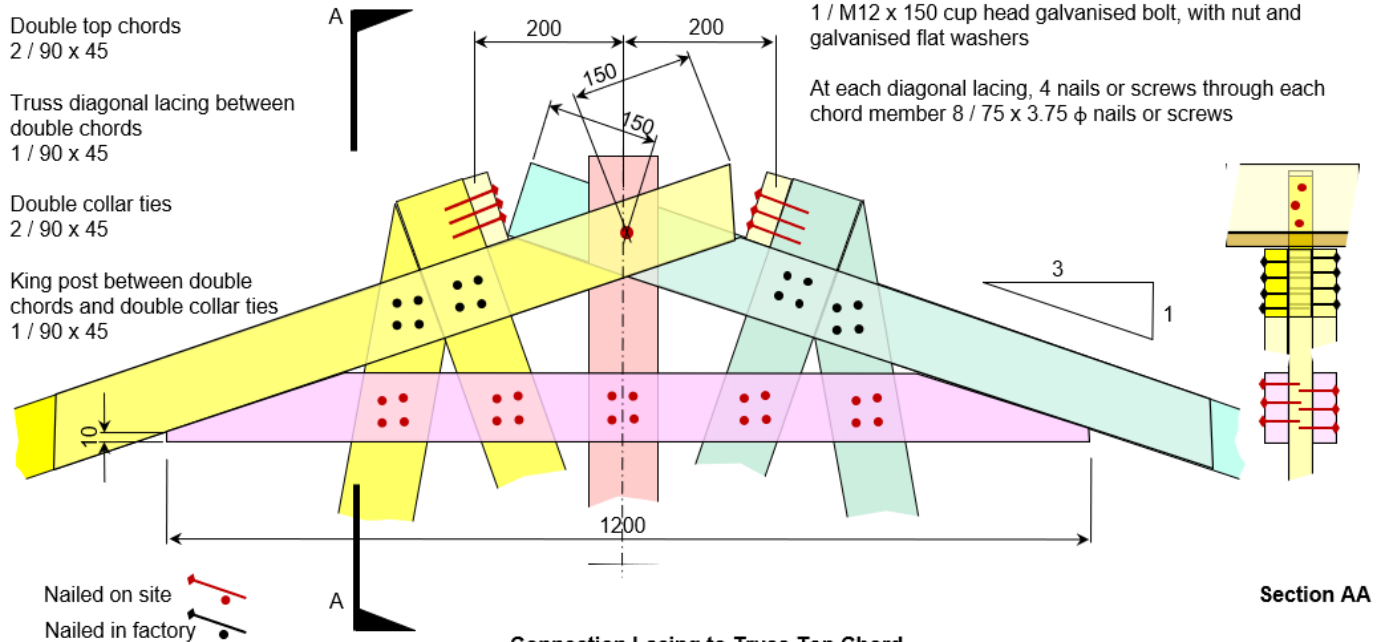
Double collar ties
2 / 90 x 45

King post between double
chords and double collar ties
1 / 90 x 45

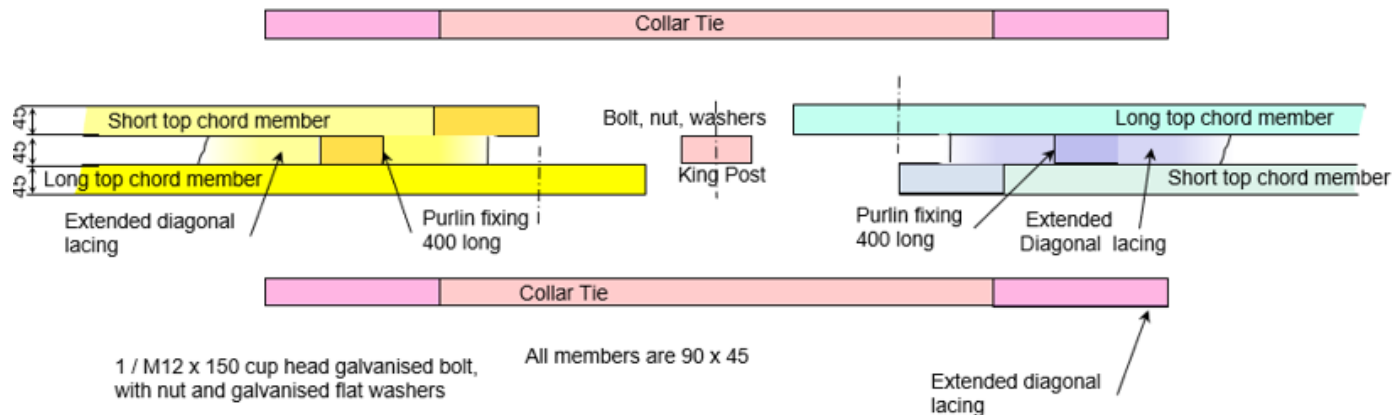
3 / 75 x 3.75 φ nails or screws through purlin into lacing

1 / M12 x 150 cup head galvanised bolt, with nut and galvanised flat washers

At each diagonal lacing, 4 nails or screws through each chord member 8 / 75 x 3.75 φ nails or screws

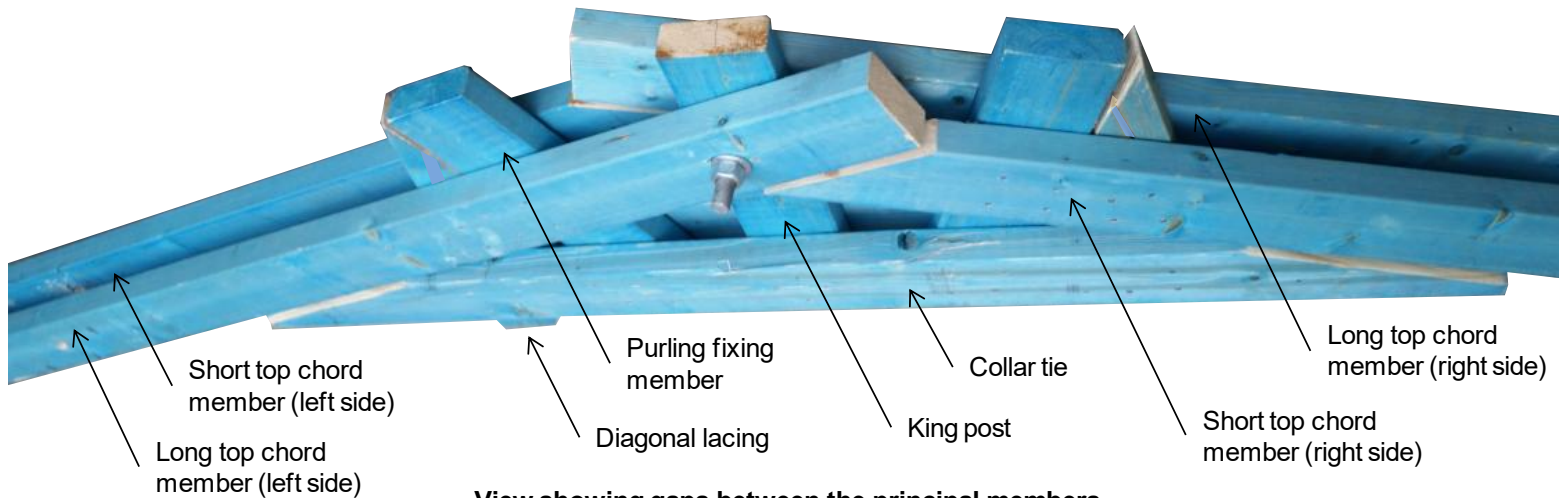
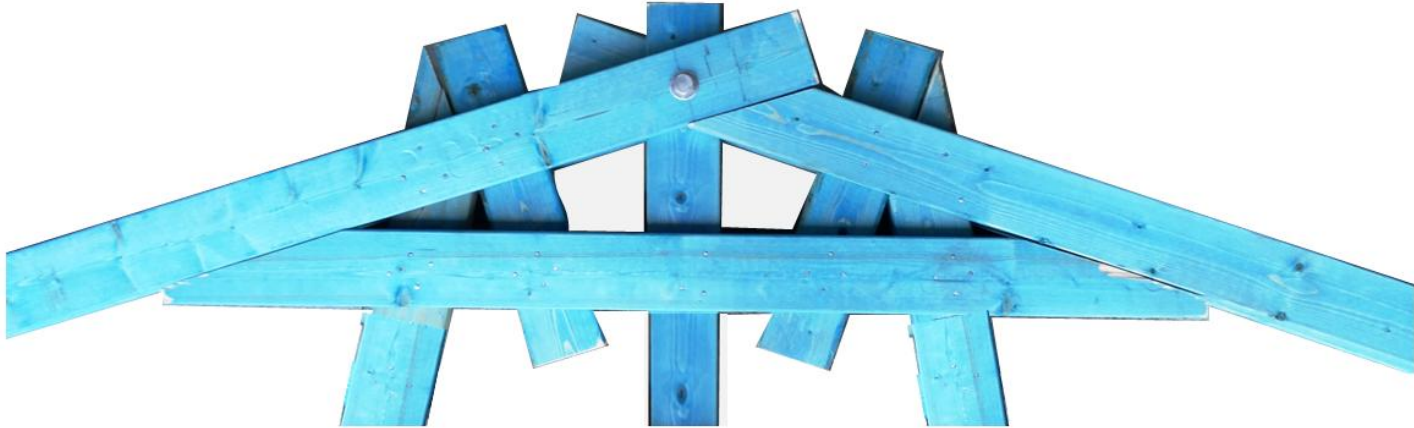


**Connection Lacing to Truss Top Chord
Connection Truss Top Chord Apex Splice**



Exploded Plan View (Purlins omitted for clarity)

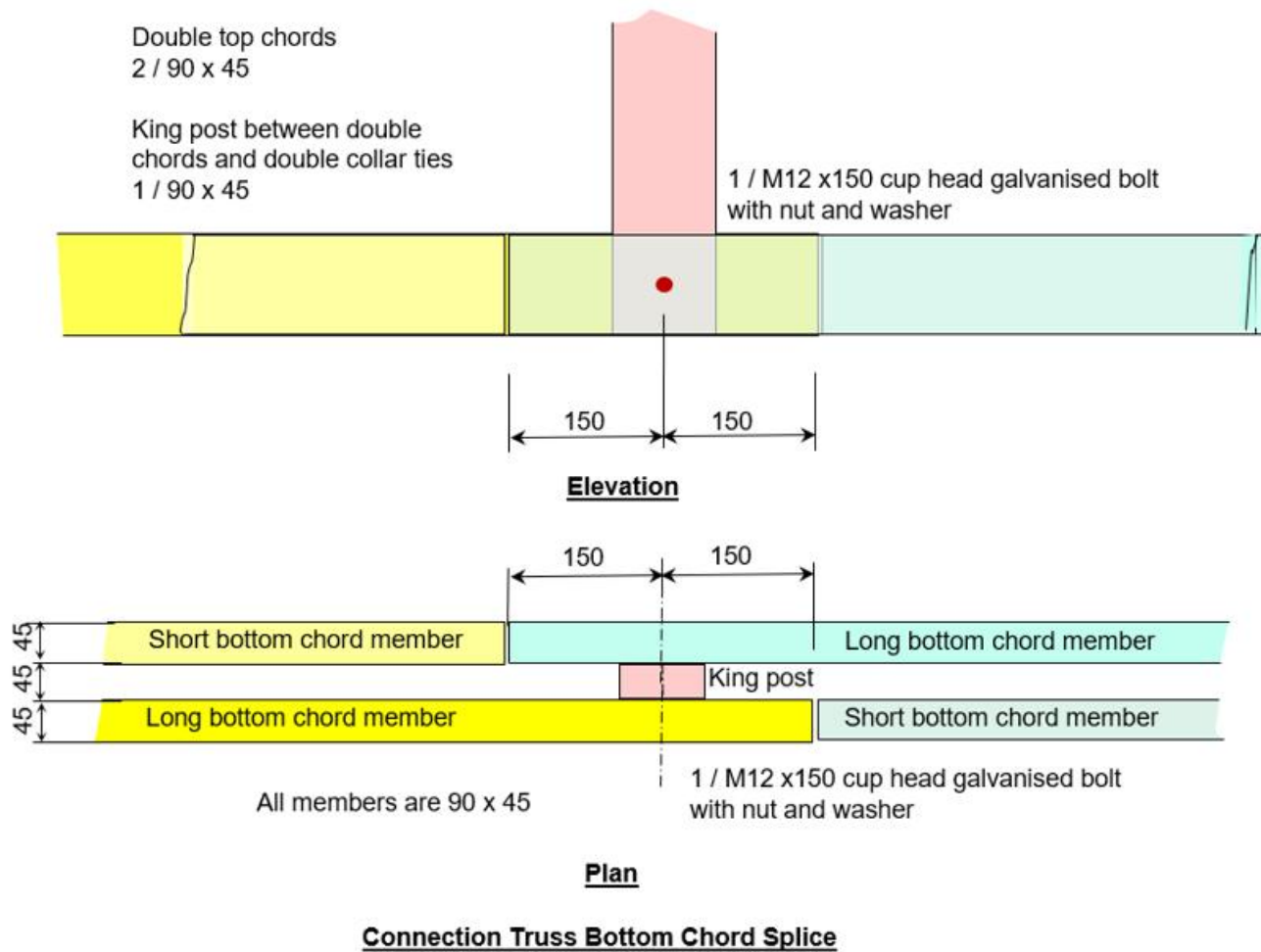
DANCER – Truss Bolted Apex Splice



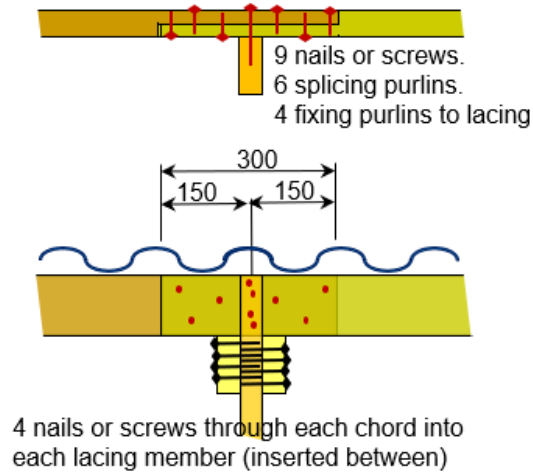
View showing gaps between the principal members

DANCER – Truss Bolted Bottom Chord Splice

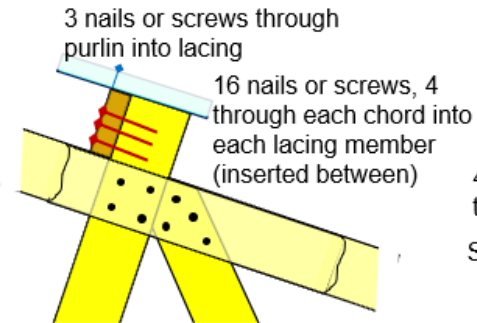
The Bottom Chords shall be spliced in a lapped double chord arrangement (similar to the top chord).



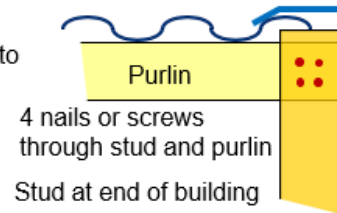
DANCER – Purlin, Diagonal Lacing and Double Top Chord Connections





Purlin Splice (Preferred Detail)



**Connection Purlin to Double Top Chord
Connection Lacing to Double Top Chord**

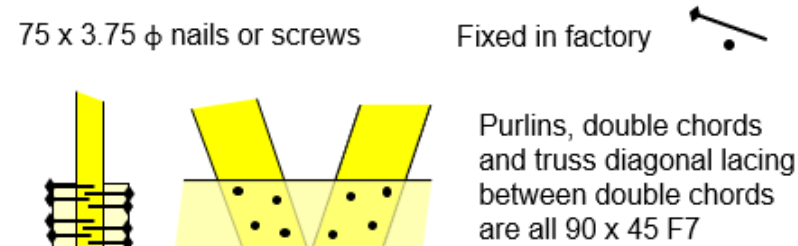


Connection Purlin to End Wall Stud

- Nailed on site 
- Nailed in factory 
- 75 x 3.75 ϕ nails or screws
- Purlins, double chords and truss diagonal lacing between double chords 90 x 45 F7 timber

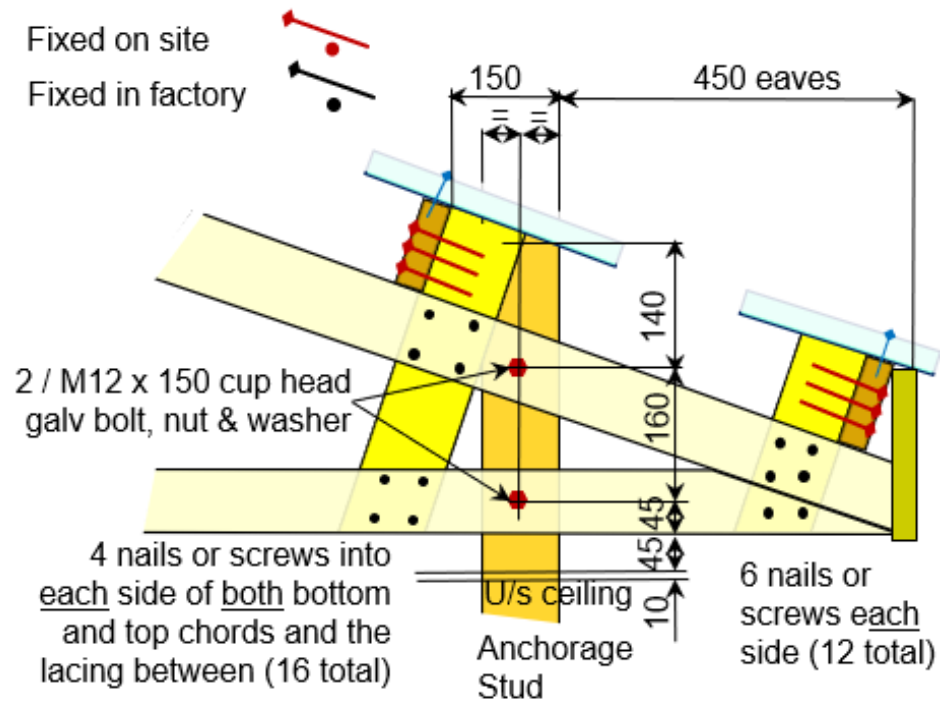
Top Chord, Lacing, Purlin Fixing and Purlin Splice

DANCER – Double Bottom Chord, Anchorage Stud and Eaves Connections



4 nails or screws through each side of both bottom chords into lacing at both lacing (16 total)

Connection of Lacing to Bottom Chords



Top Chord to Bottom Chord
Top Chord to Anchorage Stud

450 Eaves

DANCER – Roof Fixings and Cyclone Washers

Cyclonic wind can suck roof sheeting (and wall sheeting) off the framing if there is an insufficient number of appropriate roofing screws, or if the screws have been installed without cyclone washers.

Roof sheets should be fixed through the high point of the ribs using long screws, not valley fixed.

Roof sheets shall be laid in continuous lengths where practical, with the upper end turned up using the correct tool.

In very high wind areas, turn the sheets down into the eaves gutter at the lower end.

CUSTOM ORB®/CUSTOM BLUE ORB®

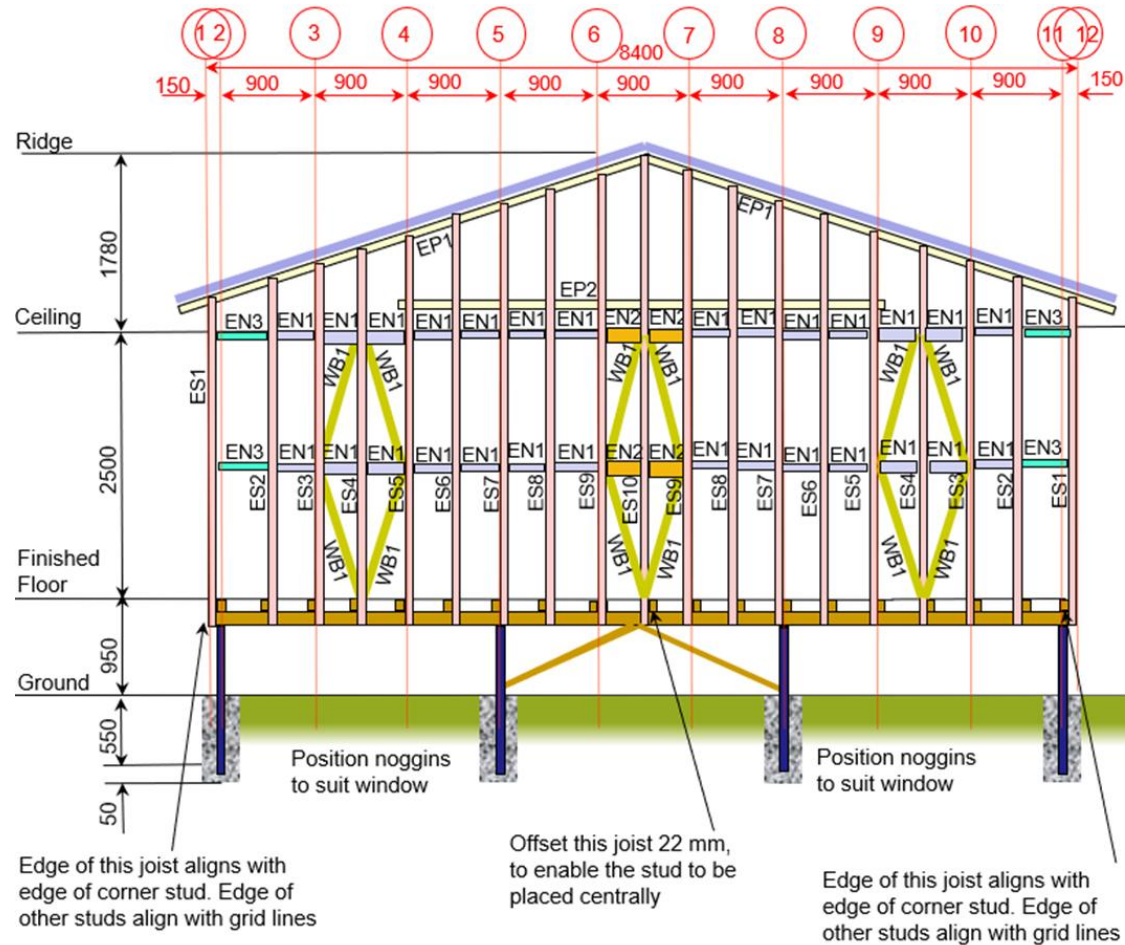


Table 4.2

CUSTOM ORB® 0.42mm BMT.

| Span (mm) | Roof | | | |
|-----------|-------------|-----------------------|---------|---------|
| | Crest fixed | With cyclonic washers | | |
| | 3.75kPa | 5.58kPa | 8.21kPa | 10.8kPa |
| 450 | OK | OK | OK | X |
| 600 | OK | OK | OK | X |
| 750 | OK | OK | OK | X |
| 900 | OK | OK | X | X |

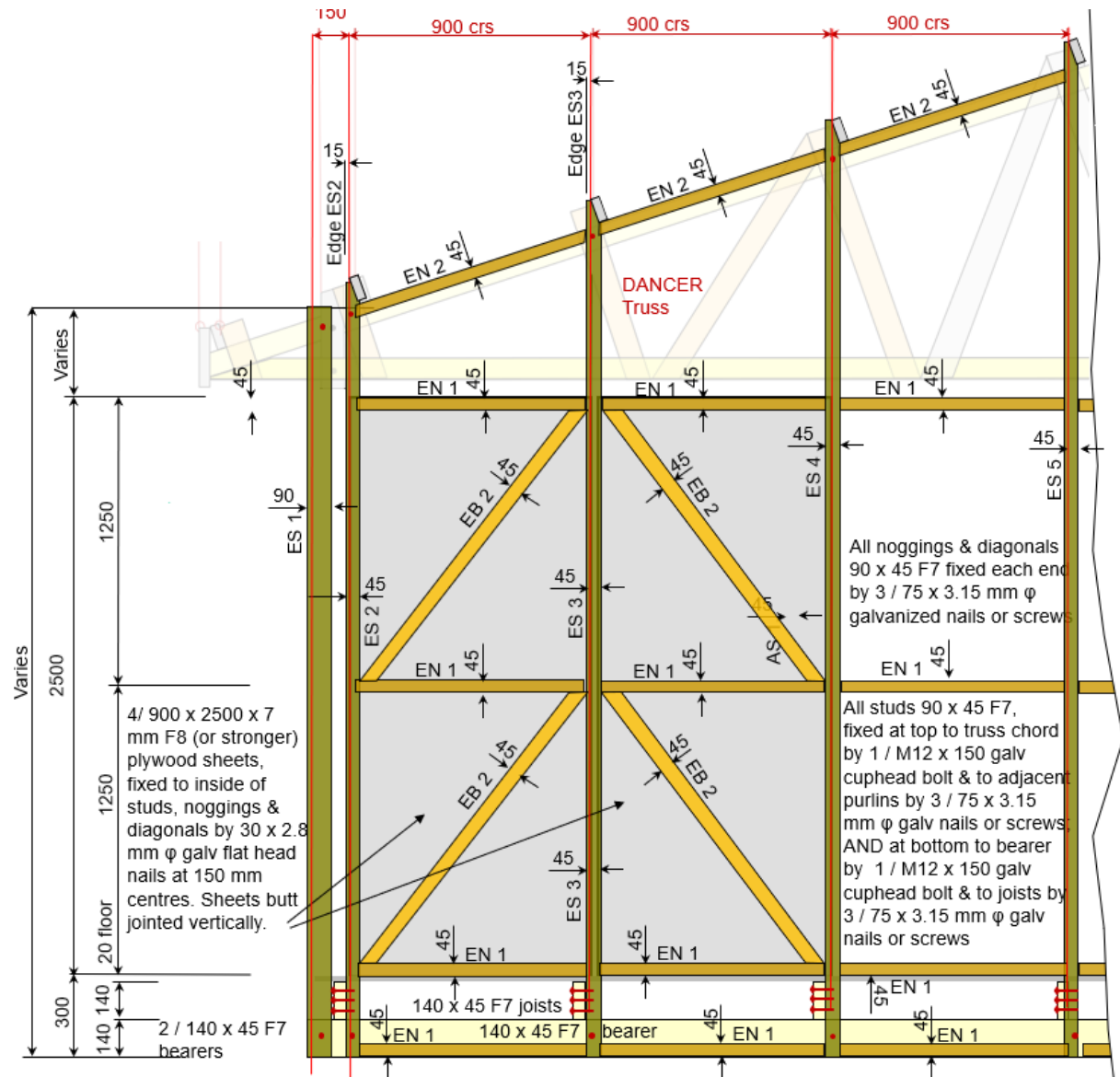
DANCER – End Wall Framing



Notch the studs (ES3, ES4, ES5; ES9, ES10, ES9; ES5, ES4, ES3) where the diagonal braces (WB1) cross these studs. Fix nogging (EN1 and EN2) with 90 dimension vertical where these braced are located.

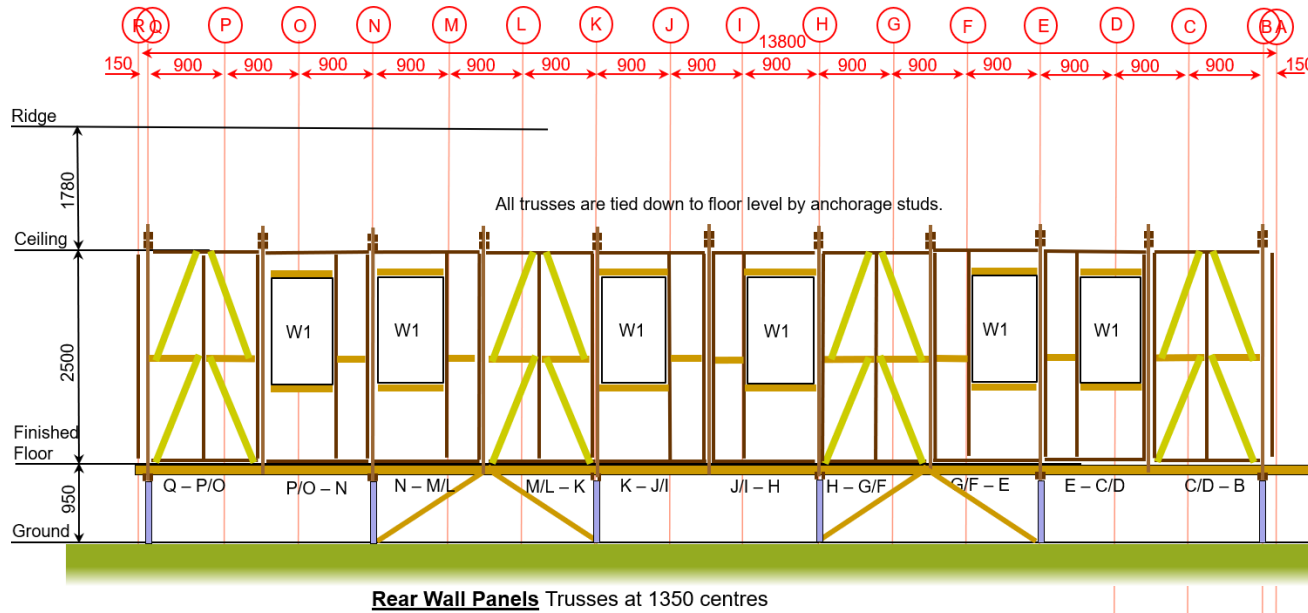
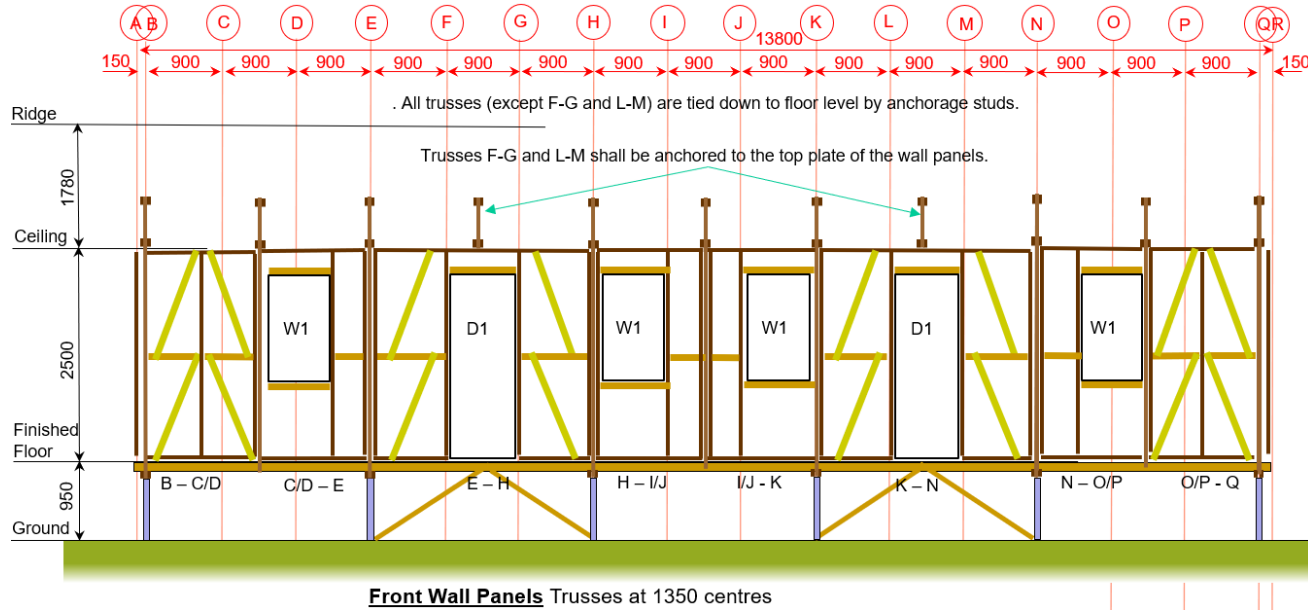
Section Through End Walls

DANCER – Typical End Wall Bracing

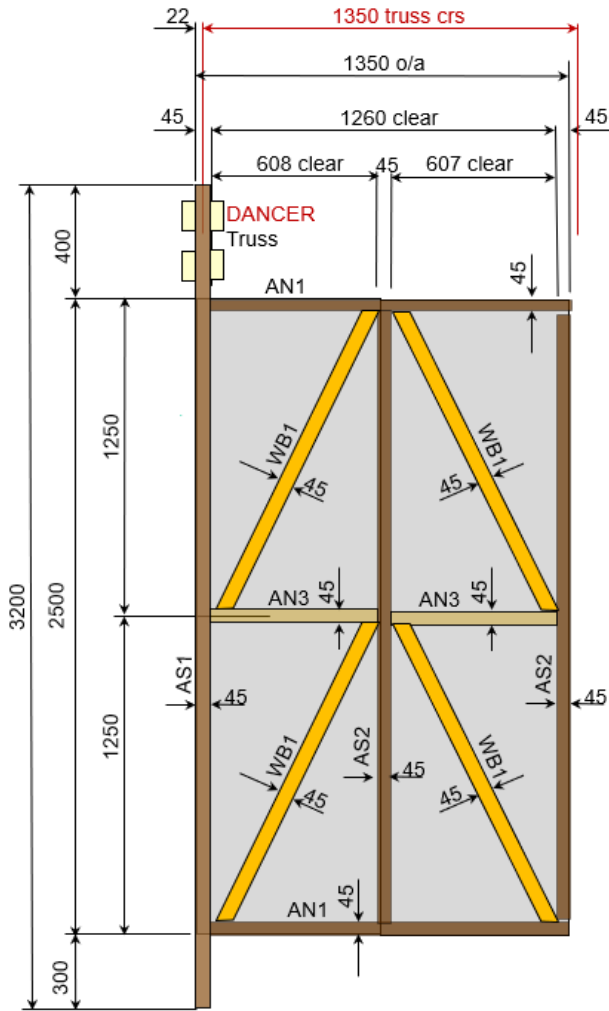


Typical End Wall Framing Viewed from outside building

DANCER – Side Wall Framing for a Duplex House



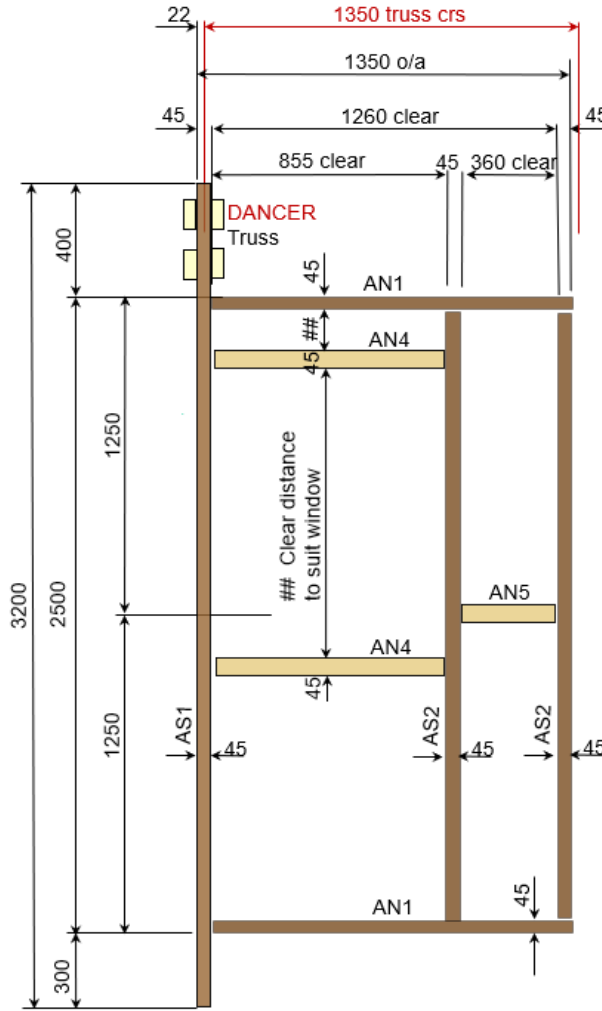
DANCER – External Wall Frame Details



2 / 620 x 2500 x 7 mm F8 (or stronger) plywood, fixed to inside of studs, noggings & diagonals by 30 x 2.8 mm ϕ galvanized flat head nails at 150 mm centres. Sheets butt jointed vertically.

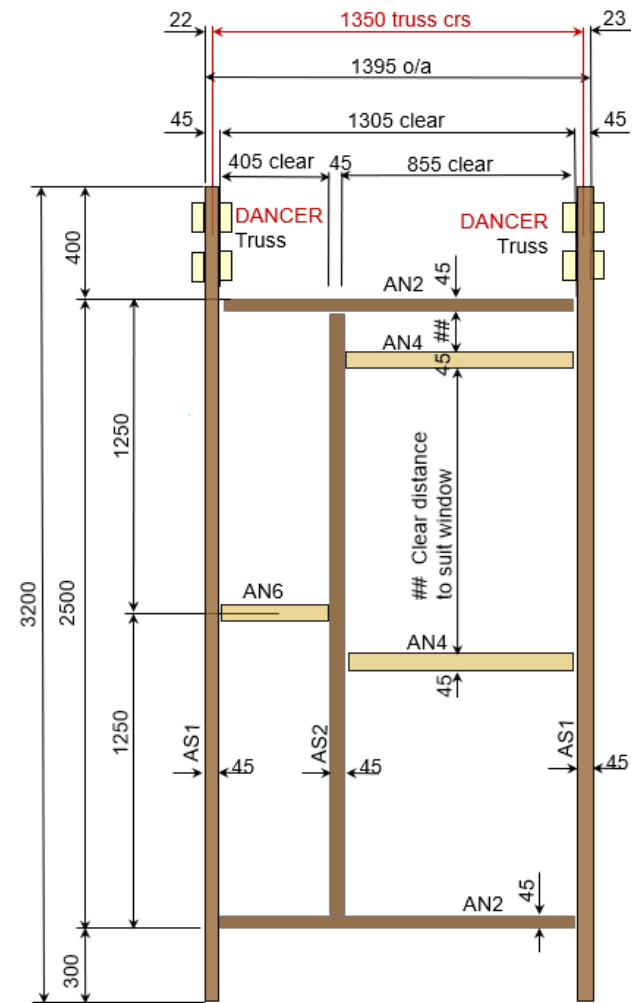
All members, 90 x 45 F7, fixed each end by 3 / 75 x 3.15 mm ϕ galvanized nails or screws

Typical Wall Framing 1350 long with Bracing



All members, 90 x 45 F7, fixed each end by 3 / 75 x 3.15 mm ϕ galvanized nails or screws

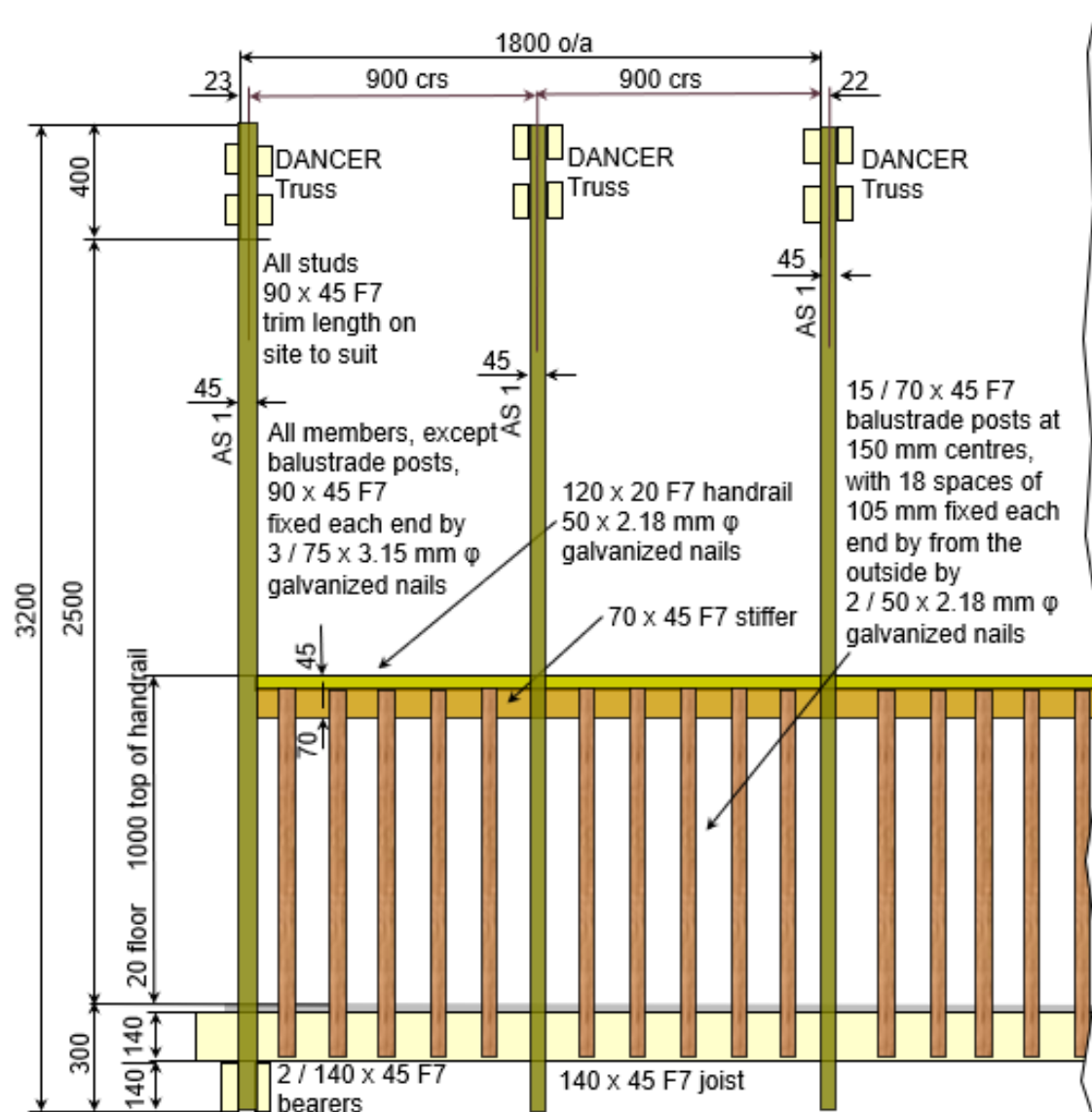
Typical Wall Framing 1350 long with Window



All members, 90 x 45 F7, fixed each end by 3 / 75 x 3.15 mm ϕ galvanized nails or screws

"Make-up" Wall Framing 1345 long (with Window)

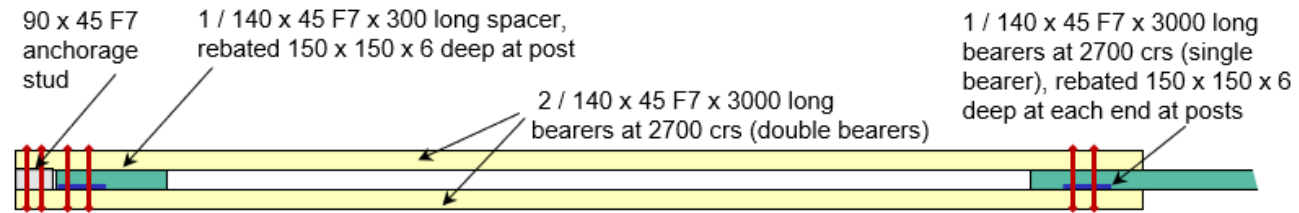
DANCER – Veranda Wall Framing for DANCER Trusses at 900 Centres



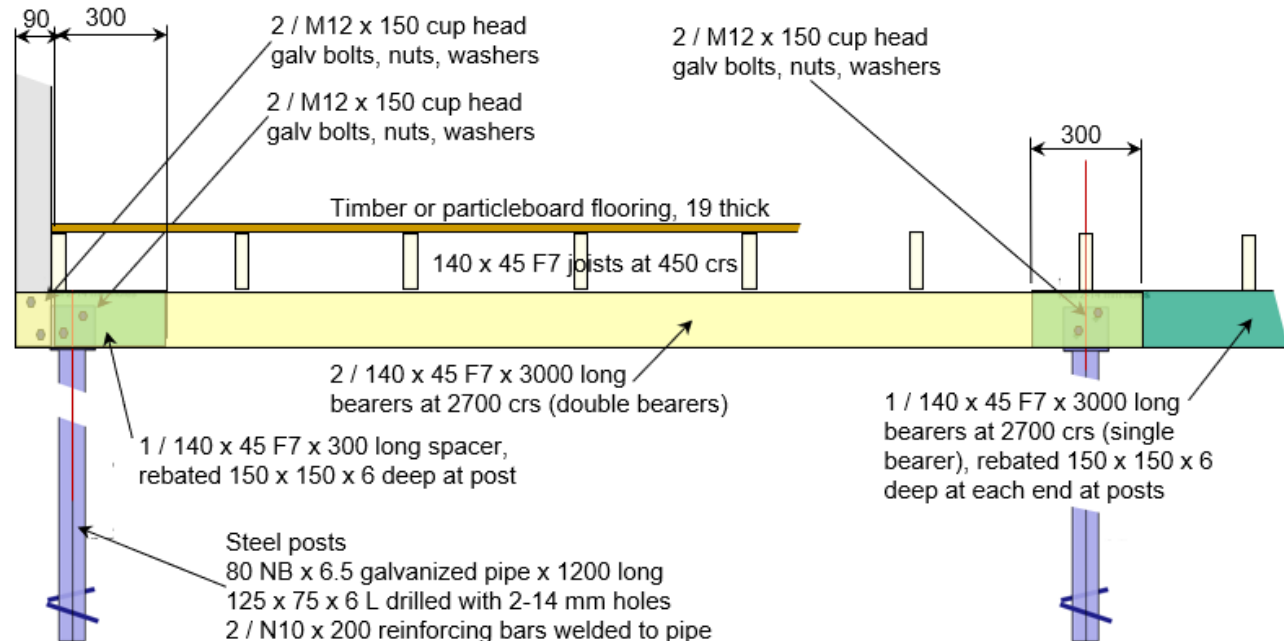
Veranda Wall Framing supporting DANCER Trusses at 900 centres

DANCER – Bearers, Joists, Floor, Posts and Stud Arrangement

For standards buildings on a 2.700 x 2.700 grid with 0.150 overhangs, the bearer timbers will all be 3,000 long.



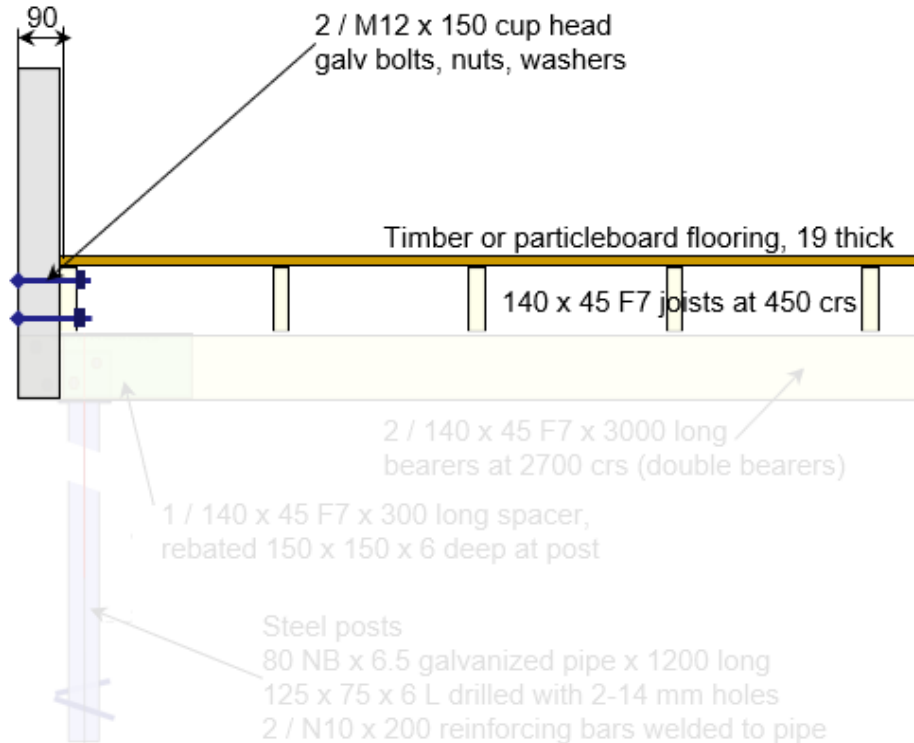
Plan Showing Anchorage Studs, Double & Single Bearers



Bearers in external bays are double bearers, bearers in internal bays are single bearers.
Except where specified otherwise in these drawings or specifications, all details shall comply with AS 1684.3

Section Showing Anchorage Studs, Joists, Double & Single Bearers and Posts

DANCER – Joists, Floor and Stud Arrangement (no bearers or posts)

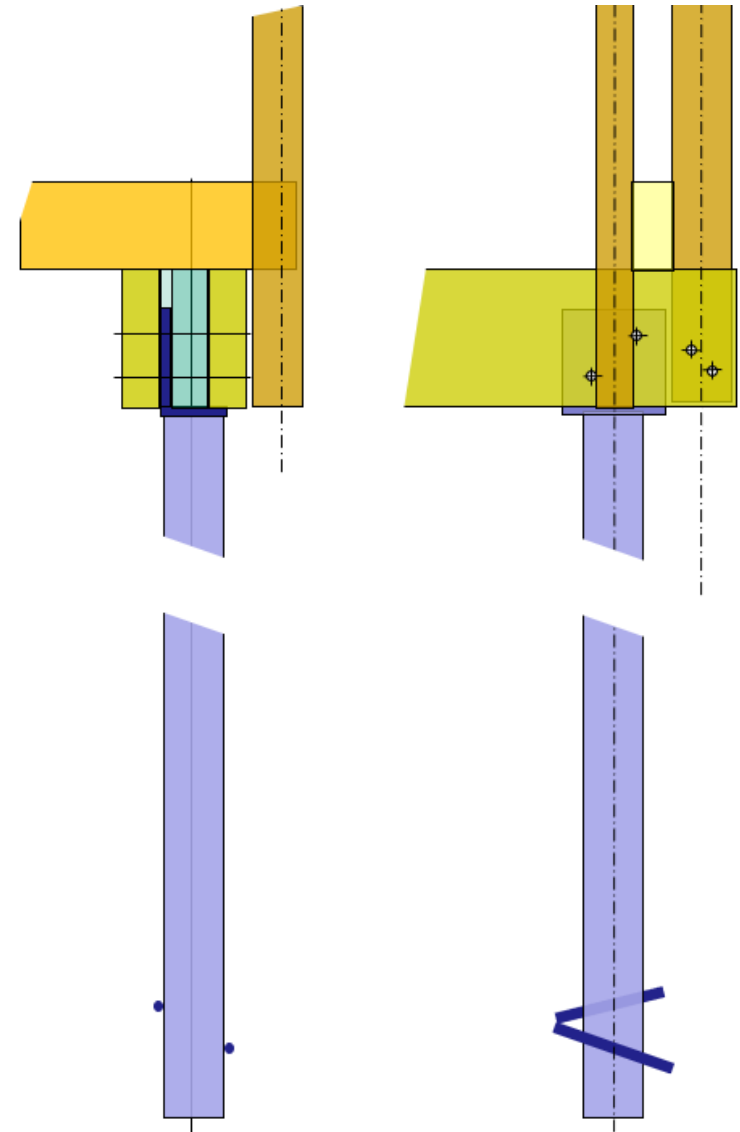
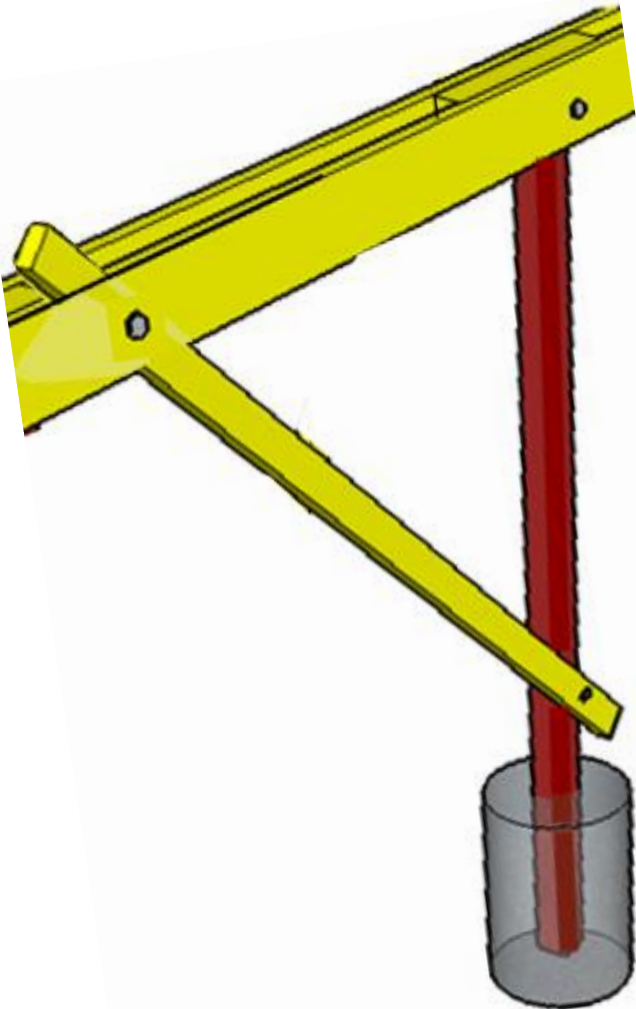


Bearers in external bays are double bearers, bearers in internal bays are single bearers.

Except where specified otherwise in these drawings or specifications, all details shall comply with AS 1684.3

Section Showing Anchorage Studs and Joists where there are no Bearers or Posts

DANCER – Diagonal Sub-floor Bracing and Steel Posts



Connections at floor of steel posts with additional cleats

DANCER – Other Steel Posts and Diagonal Sub-floor Bracing Options

Steel Posts

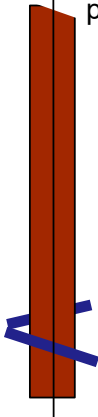
Direct Anchorage Detail

Fix diagonal braces at the top directly to the bearers or joists (as appropriate), to provide a direct load path to the ground

125 x 75 x 6 L drilled with 2-14 mm holes

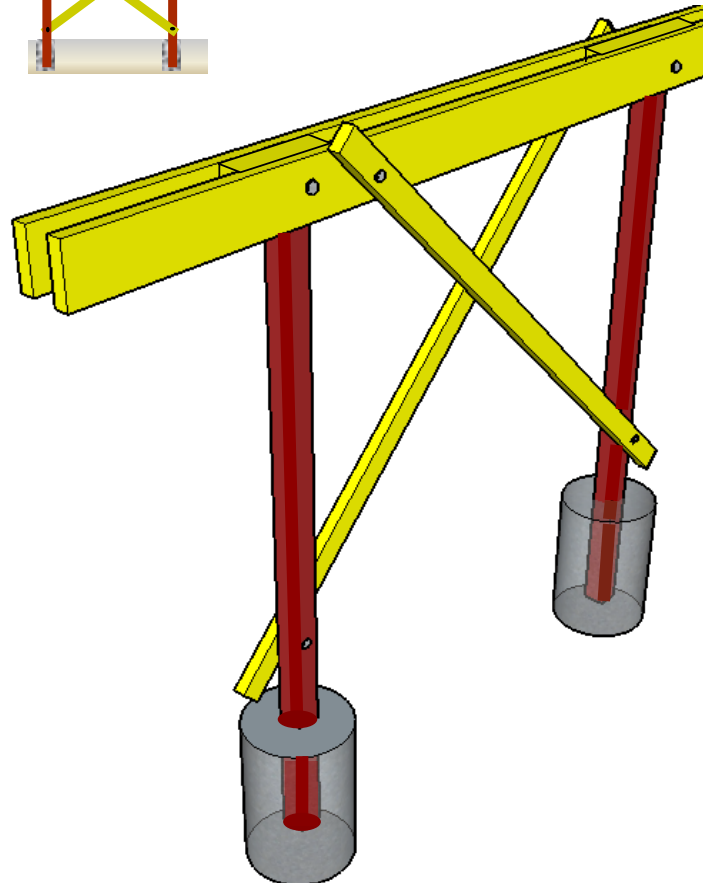
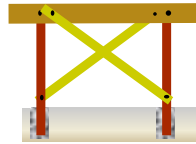


80 NB x 6.5 galvanized pipe x 1200 long

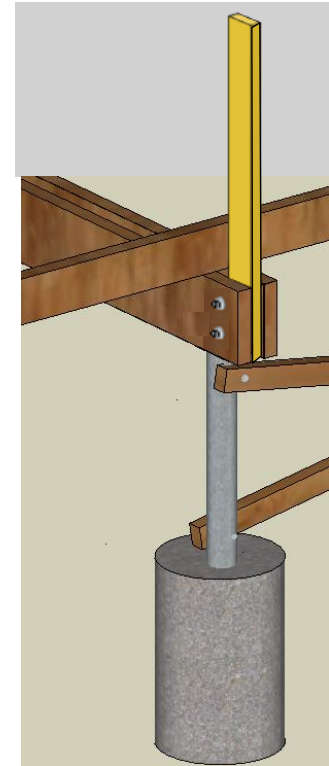


Steel Posts (ex stock)

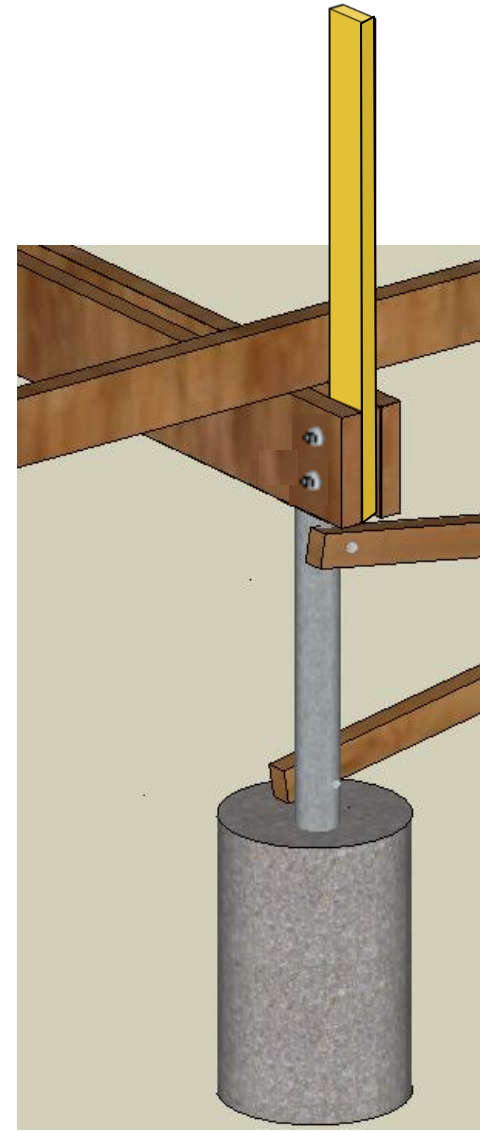
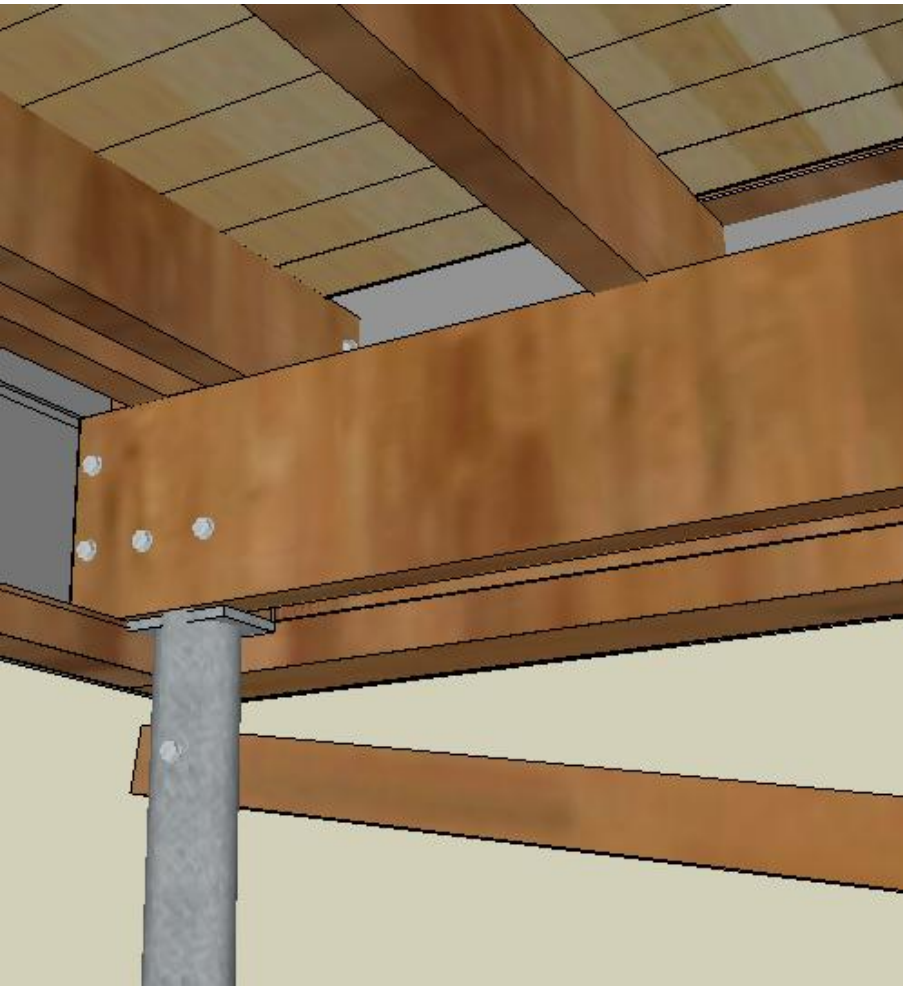
Option 1 – Brace fixed at the top to bearers



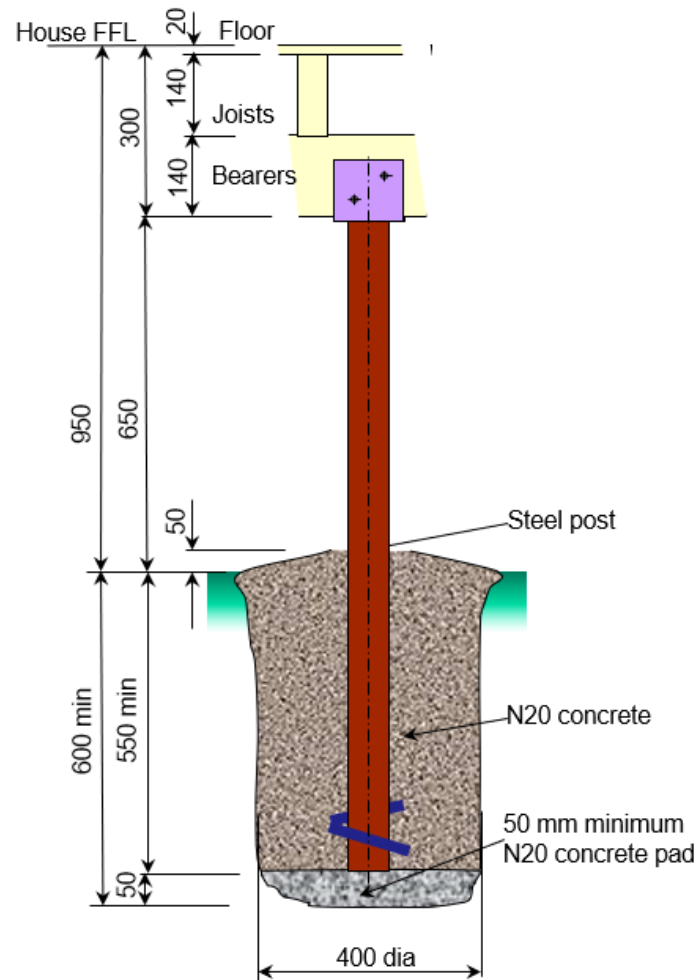
Option 2 – Brace fixed at the top to posts



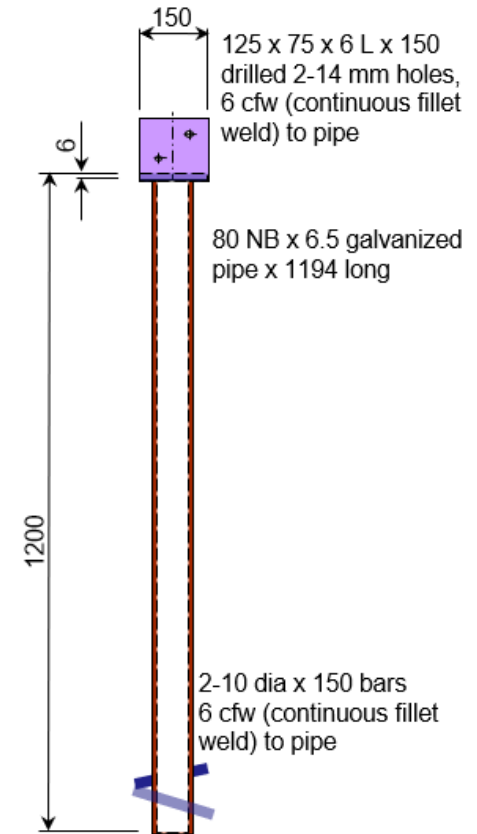
DANCER – Other Steel Posts and Diagonal Sub-floor Bracing Options



DANCER – Concrete Piers and Steel Posts



Concrete Pier, Steel Posts and Timber Floor

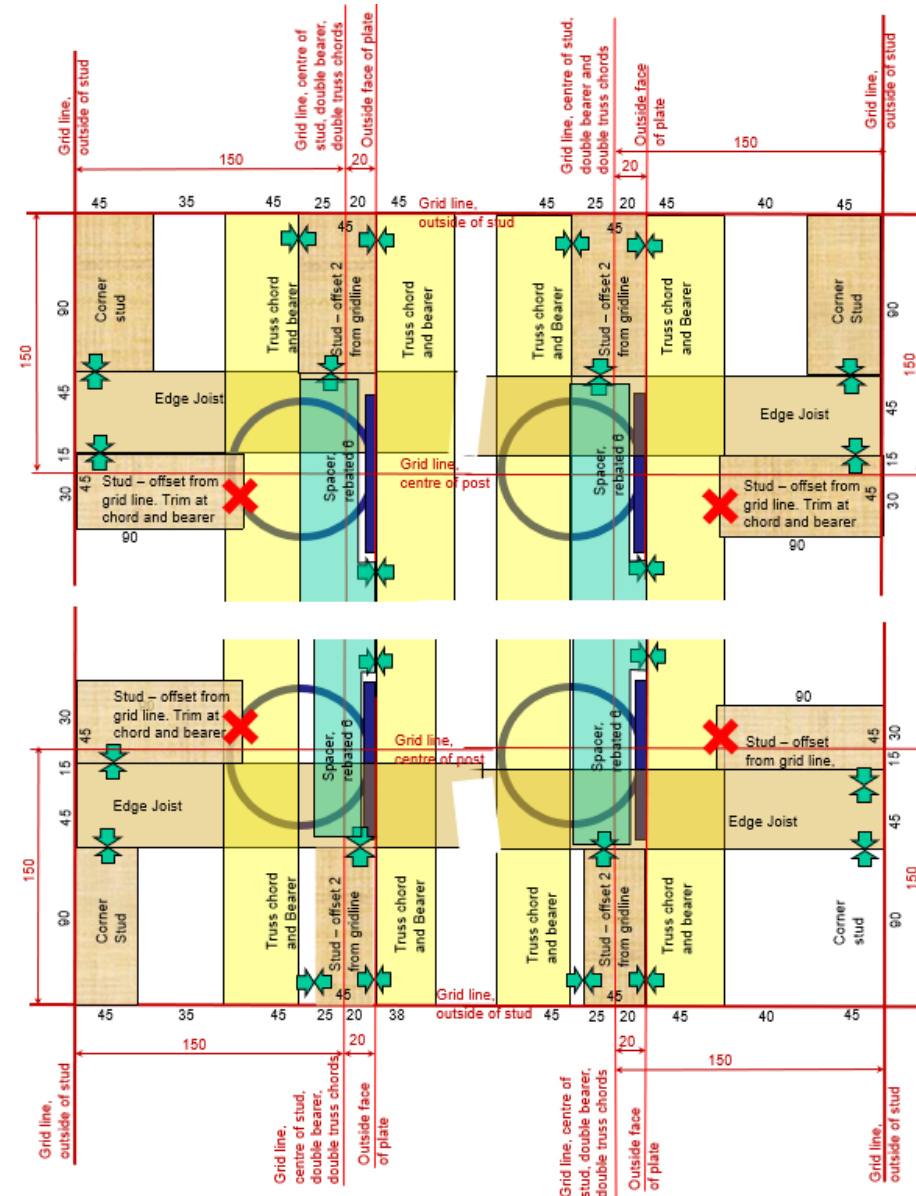


Fabricated posts meeting this specification (or similar) may be available from hardware retailers. If the length of the post is different, the height of the finished floor level and the details of the steps may need to be adjusted.

Steel Posts

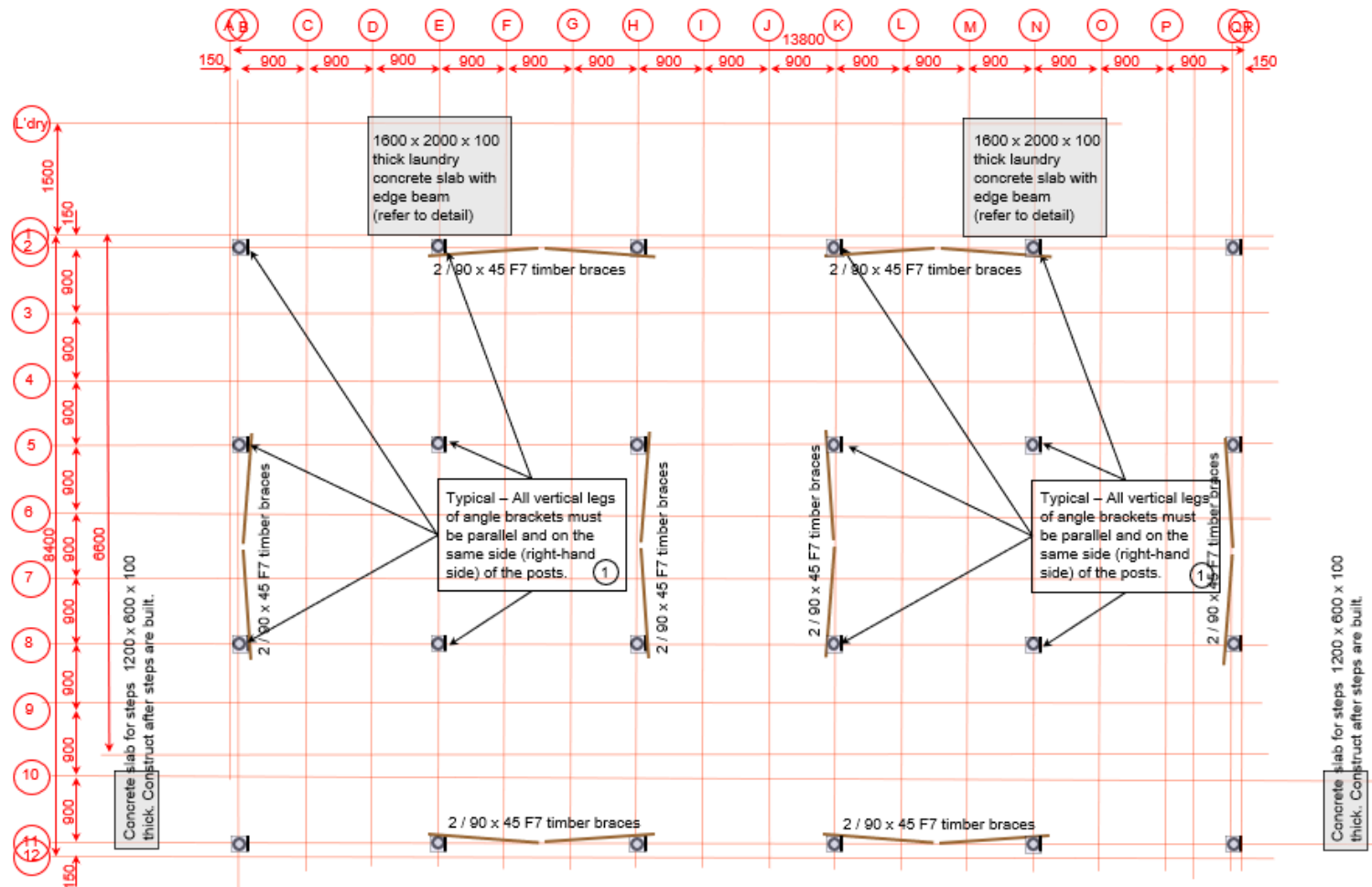
DANCER – Plan of Corner Showing Bearer, Joist, Post and Studs

The plan views show the relative positions of the double bearer (including the spacer), edge joist, steel post, anchorage stud and corner stud. The outside vertical face of the steel angle must be offset 20 mm from the gridline and must be on the same side for every post. If this is not done, prefabricated wall framing will not fit properly. The spacer timbers at the posts (shown in green) must be rebated 6 mm for a 150 mm length, to fit past the steel section. The plan (for 90 x 35 dressed timber) below is typical of the arrangement.



Arrangement at the Corner of Building for 90 x 45 studs and 140 x 45 bearers

DANCER – Post and Bracing Arrangement for a Duplex House



Concrete piers, 400 diameter x 600 deep. Steel Posts – 80 NB x 6.5 galvanized pipe x 1194 long, with 125 x 75 x 6 L x 150, drilled 2-14 mm holes, 6 cfw (continuous fillet weld) to top of pipe, and 2-10 dia x 150 bars 6 cfw (continuous fillet weld) to bottom of pipe.

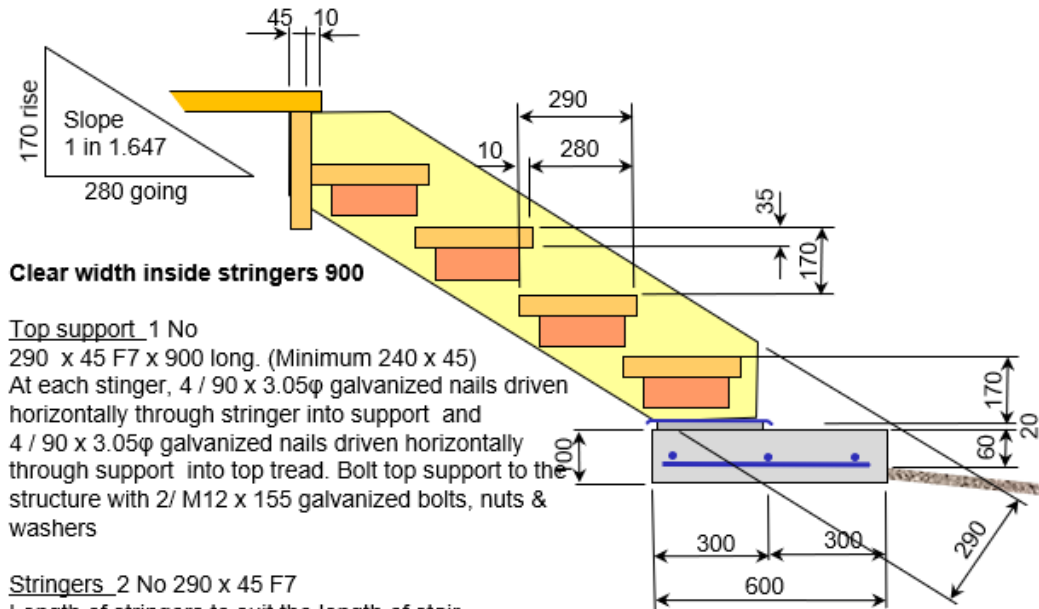
Concrete pad for steps – 1,200 x 600 x 100 mm thick. 5 / N10 x 550 reinforcing bars and 3 / N10 x 1150 reinforcing bars. Top surface of slab nominally 80 mm above ground level. If the slab surface is low, grout (up to a maximum thickness of 20 mm) under both stringers to make up required height. If the slab surface is high, trim the bottom surface of the stringers.

Concrete laundry slabs – 1600 x 2000 x 100 thick laundry concrete slab, reinforced with SL 72 fabric, with 300 wide x 400 deep edge beam with 3 N10 bars in the bottom. Refer to detail. Top surface of slab nominally 60 mm above ground level.

Notes:

1. N20 Concrete
2. For all other items, substitution of other sizes must be approved by the Engineer.
3. Refer to Engineer's Details for fixings, connections and associated members.

DANCER – Timber Stairs



Clear width inside stringers 900

Top support_1 No

290 x 45 F7 x 900 long. (Minimum 240 x 45)
At each stinger, 4 / 90 x 3.05φ galvanized nails driven horizontally through stinger into support and 4 / 90 x 3.05φ galvanized nails driven horizontally through support into top tread. Bolt top support to the structure with 2 / M12 x 155 galvanized bolts, nuts & washers

Stringers_2 No 290 x 45 F7

Length of stringers to suit the length of stair.

Treads – Number of treads to suit length of stair

290 x 45 F7 x 920 long. Slot the treads into rebates, 10 mm deep in the stringers to give 900 clear width.
At each stinger, 2 / 90 x 3.05φ galvanized nails driven horizontally through stinger into tread and 2 / 90 x 3.05φ galvanized nails driven vertically through stinger into support

Tread supports –

2 per tread. 90 x 45 F7 x 260 long
3 / 90 x 3.05φ galvanized nails driven horizontally through support into stinger

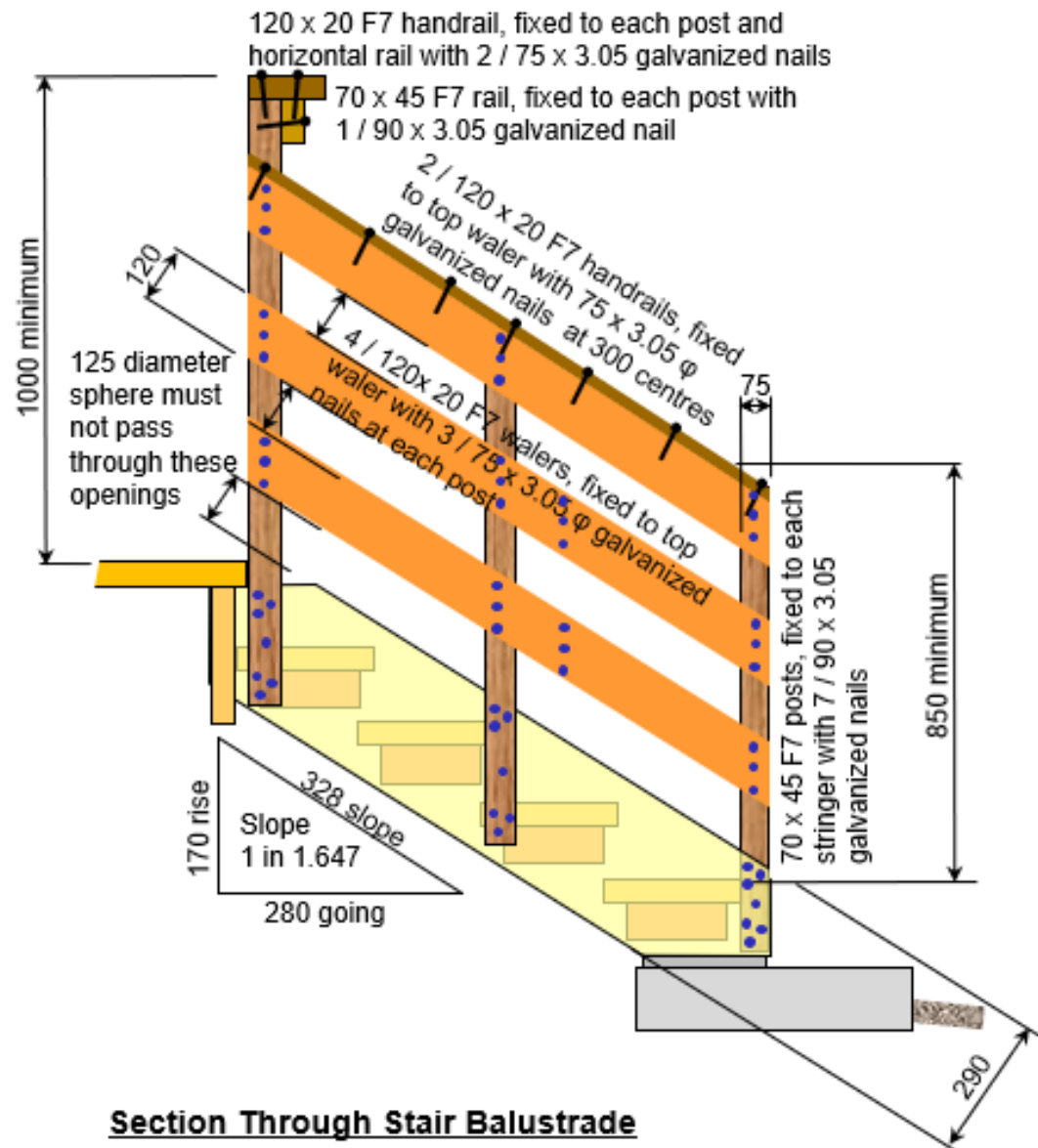
Termite shield – 2 / 100 x 3 x 350 galvanized steel strips, folded down 20 mm around edges, nailed to the underside of the stair stringer and kept clear of debris.

Concrete Pad – 1,200 x 600 x 100 mm thick
5 / N10 x 550 reinforcing bars and
3 / N10 x 1150 reinforcing bars
Top surface of slab nominally 60 mm above ground level. If the slab surface is low, grout (up to a maximum thickness of 20 mm) under both stringers to make up required height. If the slab surface is high, trim the bottom surface of the stringers.

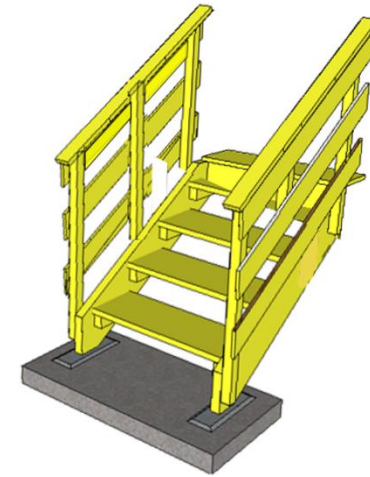
| Stair Dimensions | | | | |
|-----------------------------|--------------|------------|-------------|----------------|
| Stair going | 280 | mm | | |
| Stair rise | 170 | mm | | |
| Grout thickness | 0 | mm | | |
| Height of slab above ground | 80 | mm | | |
| No of Rises | No of Goings | Stair Rise | Stair Going | Veranda Height |
| 5 | 4 | 850 | 1120 | 930 |

Section Through Timber Stairs

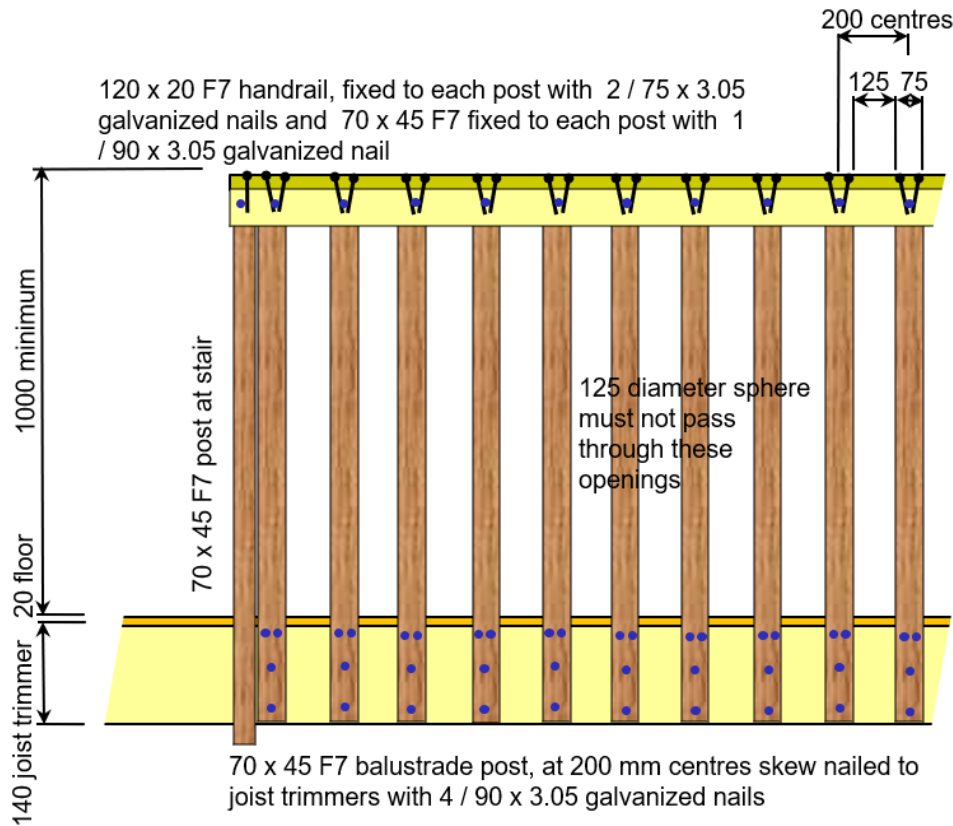
DANCER – Timber Stairs and Balustrades



DANCER – Timber Stairs and Balustrades

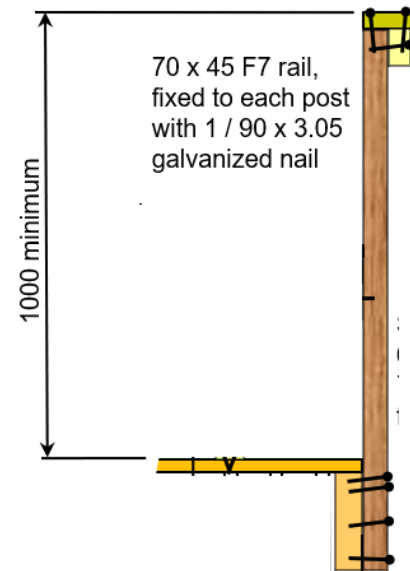


Timber Stairs – 5 Rises



Elevation of typical Veranda Balustrade

120 x 20 F7 handrail, fixed to each post and horizontal rail with 2 / 75 x 3.05 galvanized nails

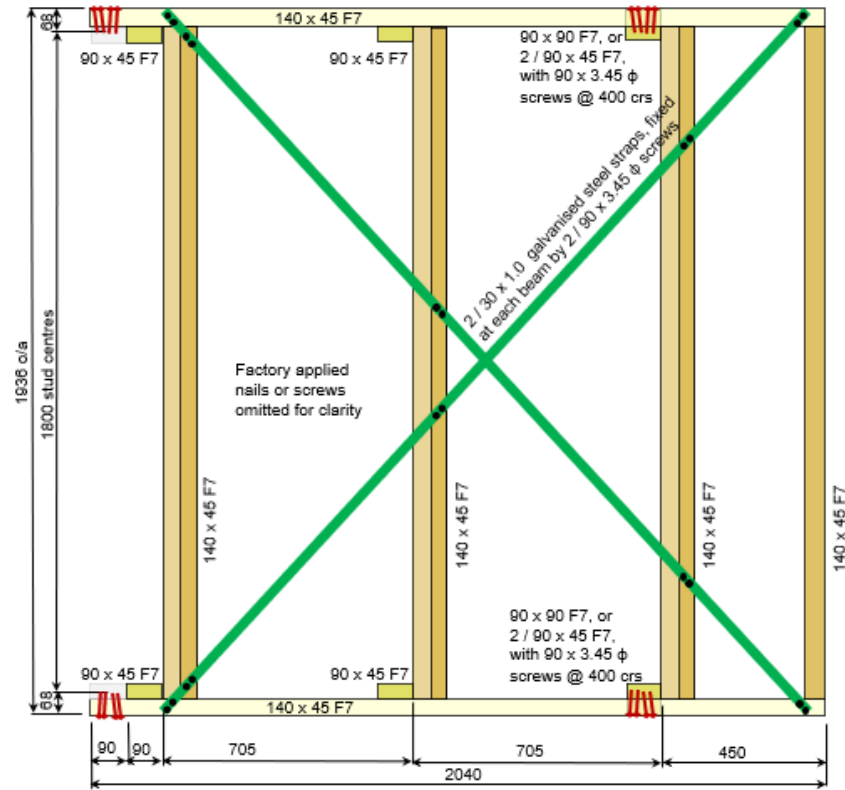


Section through Veranda Balustrade

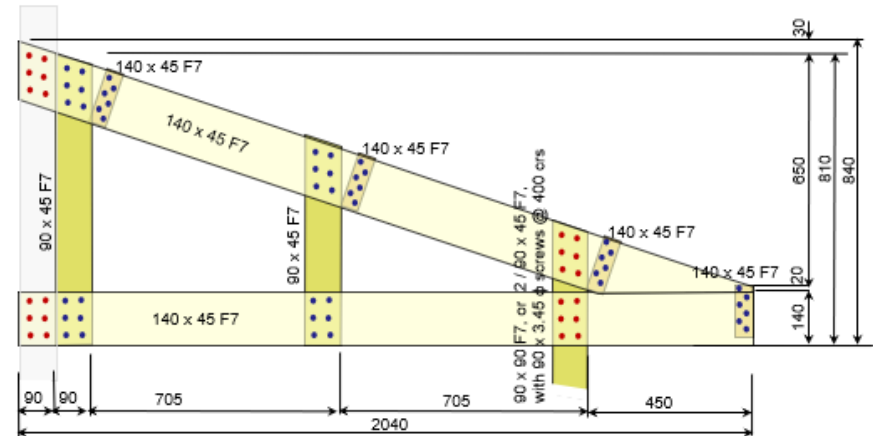
DANCER – Laundry Annex Roof

All timber members shall be fixed at each end by –
 6 / 90 x 3.45 φ screws. If screws cannot be used,
 substitute 6 / 90 x 3.75 φ nails

Nailed or screwed on site
 Nailed or screwed in factory

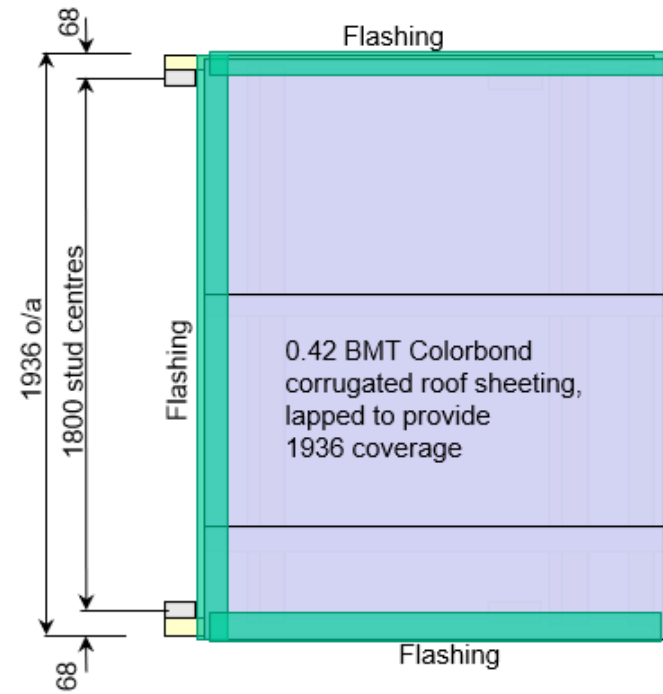
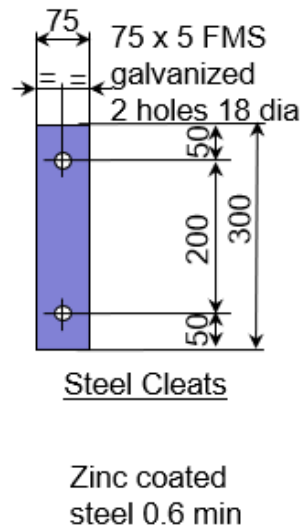
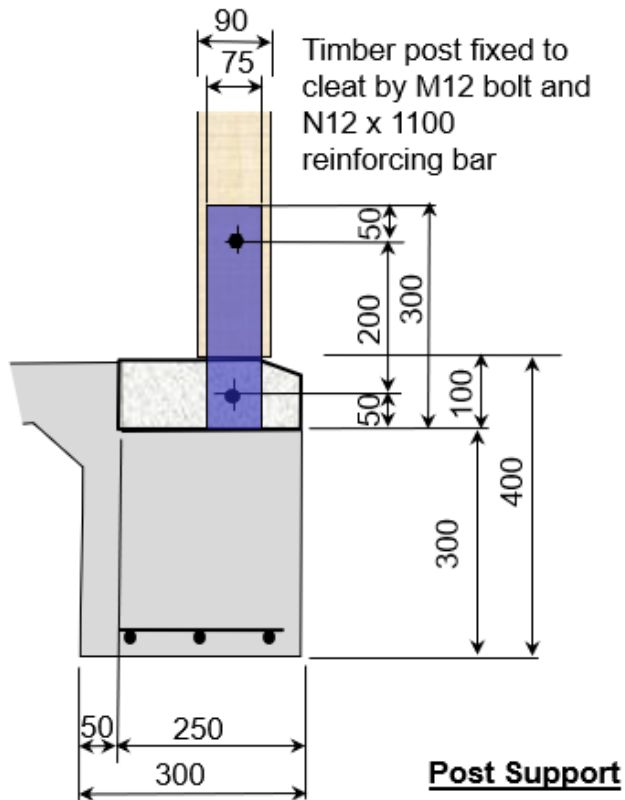


Plan of Awning Frame

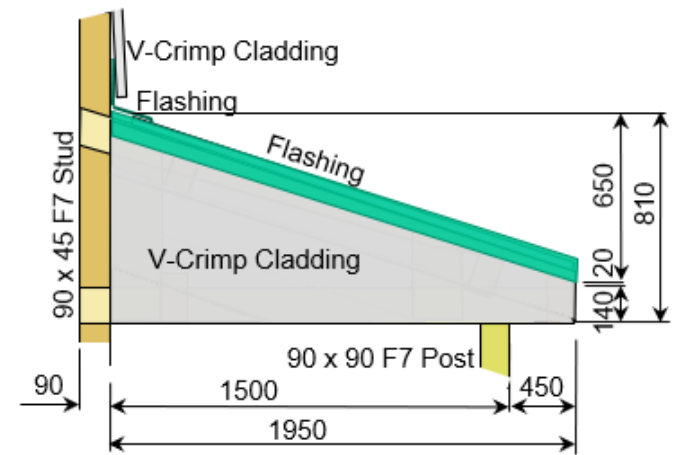


Elevation of Awning Frame

DANCER – Laundry Annex Roof & Posts



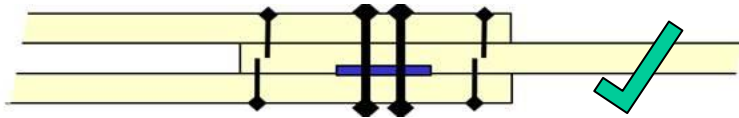
Plan of Awning



Elevation of Awning

DANCER – Details requiring special monitoring

A double/ single bearer splice should be used in lieu of a splayed splice.



Use a spacer rebate not more than 6 mm in thickness

The 90 x 45 mm spacer is required to be rebated 6 mm timber at the steel cleat, to achieve the correct spacing between the double bearers. However, if the rebate is too deep, the bearers will be too close together (as is the case in this photo) requiring the studs to be rebated. The depth of the spacer rebate must be limited to no more than 6 mm.



DANCER – Details requiring special monitoring

Fix the end wall studs into one of the double bearers by two M12 x 150 cuphead galvanized bolts through the stud. Also fix the stud to the joist by three screws.



Do not cut diagonal bracing.

Where an internal wall meets the external wall, it does not require an extra stud in the external wall. The end stud of the internal wall may be flush with the inside face of the external wall.

DANCER – Details requiring special monitoring

Support the ceiling battens from the bottom chord of the trusses.
This will reduce the number of separate ceiling supports required.

End eaves are not required

The standard DANCER design does not include end wall gables. This is intentional, because it reduces the area (and cost) of the roof sheeting. It also enables the standardisation of the roof purlins. If the building requires end wall gables, this will require a redesign and budget increase.



Concrete in Structures

Concrete is a mixture of portland cement, sand, stone (called aggregate) and water, which sets hard.

It may include components which provide colour, increase strength, accelerate hardening, retard hardening, improve fluidity, lighten the structure and many other functions.

- Concrete is **strong in compression, but weak in tension**.
i.e. It may crack when pulled apart, but not when squeezed together. Tensile strength is provided to concrete structures by the incorporation of steel reinforcement.
- Concrete **shrinks and cracks**. The inclusion of steel reinforcement (at close centres) will restrict the width of cracks that form in concrete as it shrinks.
- Steel **reinforcement rusts, expands and spalls** the concrete if it is placed too close to the concrete surface or if the concrete does not include sufficient cement to protect the steel.

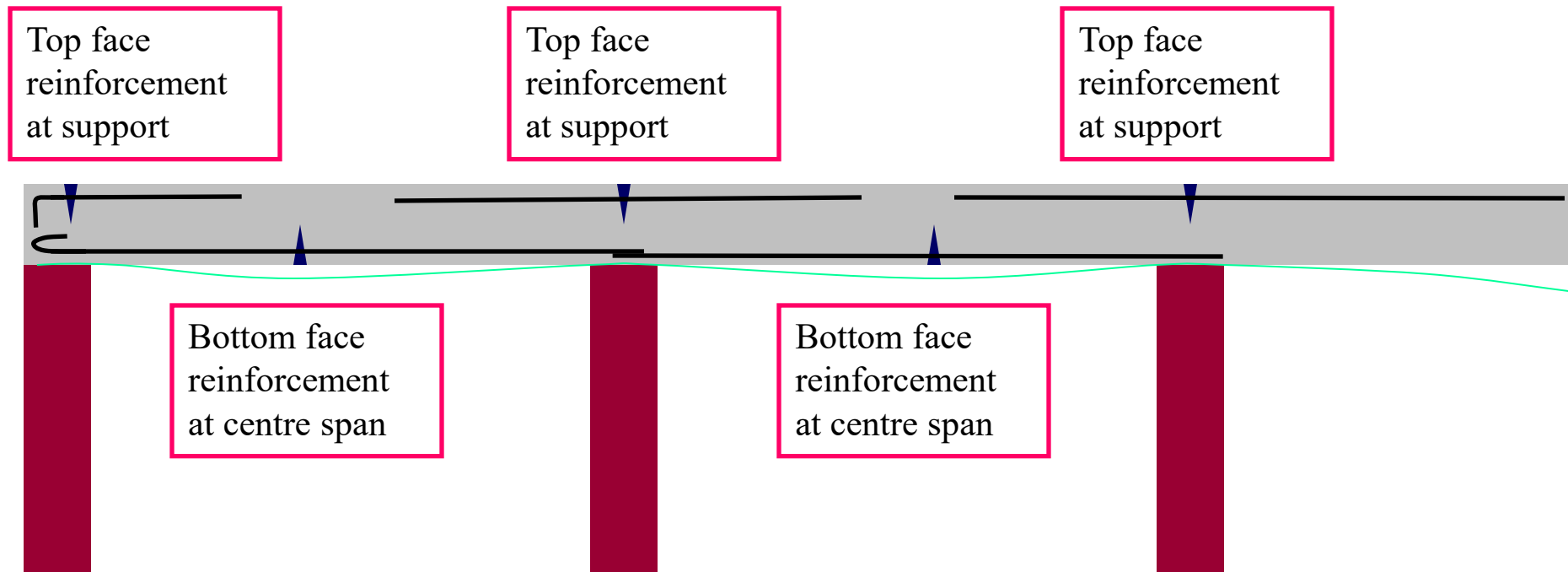


Deflection and Cracking of Concrete Structures

When a concrete slab is suspended, it will bend under the action of its self weight and any imposed gravity loads.

Cracks will form at the **top** of the slab **over supports** and at the **bottom** of the slab at the **centre** of the span. It is at these locations the main tensile reinforcement is placed.

Note: There is other reinforcement placed in concrete slabs and beams to control shrinkage cracking, support the main reinforcement and to control **diagonal shear cracking near supports**.



20 MPa Concrete Specification

For use in slab-on-ground or for footings

Approximate mix (by volume) 1 : 2 : 4

For 1 cubic metre of 20 MPa concrete, the mix should be:

- **8 bags (40 kg each) of GP or GB portland cement**

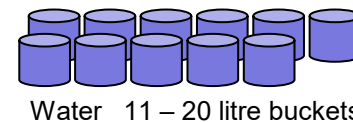
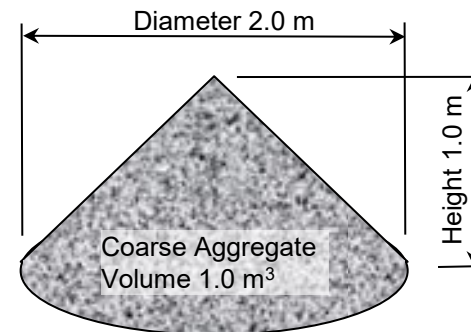
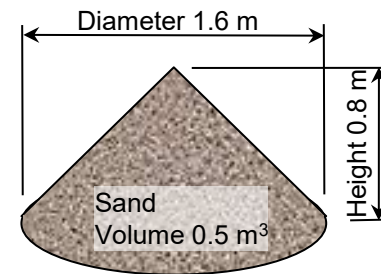
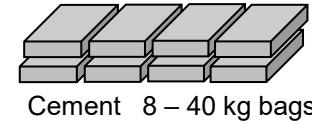
OR 16 bags (20 kg each)

- **0.5 m³ of sand** - Sand should be clean sharp sand, NOT brickies sand or plasters sand.
- **1.0 m³ of 20 mm coarse aggregate** - Aggregate should be clean 20 mm river gravel, crushed aggregate or similar.
- **200 – 220 litres of water** – Approximately 12 20 litre buckets (300 mm diameter x 290 mm deep). Less water should be used if sand or aggregate are damp.

Basis of calculation:

Density of cement, dry sand and dry aggregate 1,500 kg/m³

Includes 5% allowance for wastage.



25 MPa Concrete Specification

For columns, beams and suspended slabs

Must be designed and specified by structural engineer

Approximate mix (by volume) 1.1 : 2 : 4

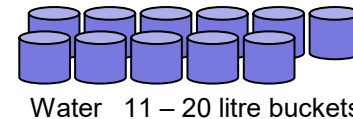
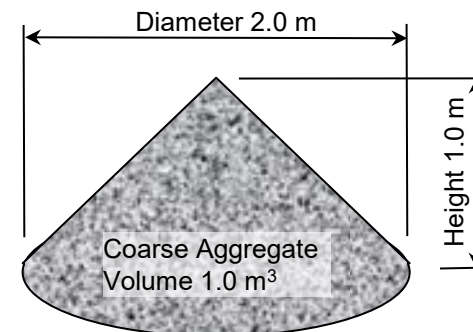
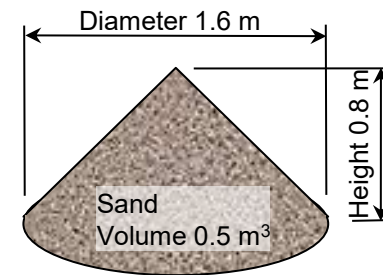
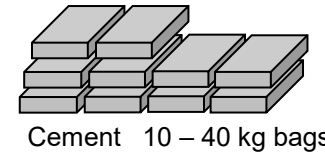
For 1 cubic metre of 20 MPa concrete, the mix should be:

- **10 bags (40 kg each) of GP or GB portland cement**
OR 20 bags (20 kg each)
- **0.5 m³ of sand** - Sand should be clean sharp sand, NOT brickies sand or plasters sand.
- **1.0 m³ of 20 mm coarse aggregate** - Aggregate should be clean 20 mm river gravel, crushed aggregate or similar.
- **200 – 220 litres of water** – Approximately 12 20 litre buckets (300 mm diameter x 290 mm deep). Less water should be used if sand or aggregate are damp.

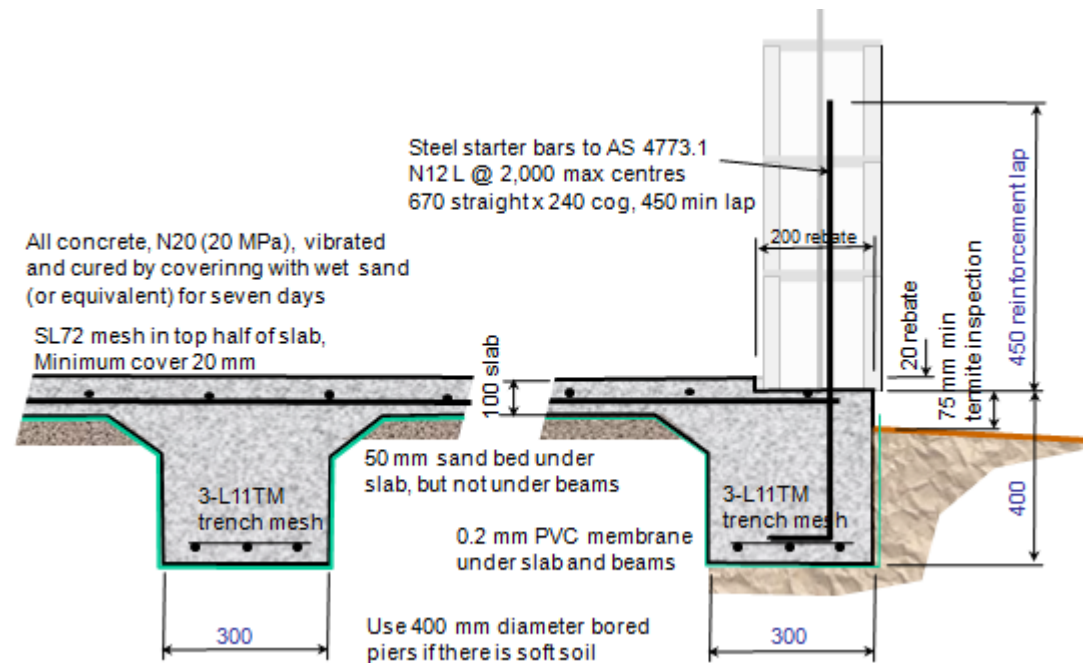
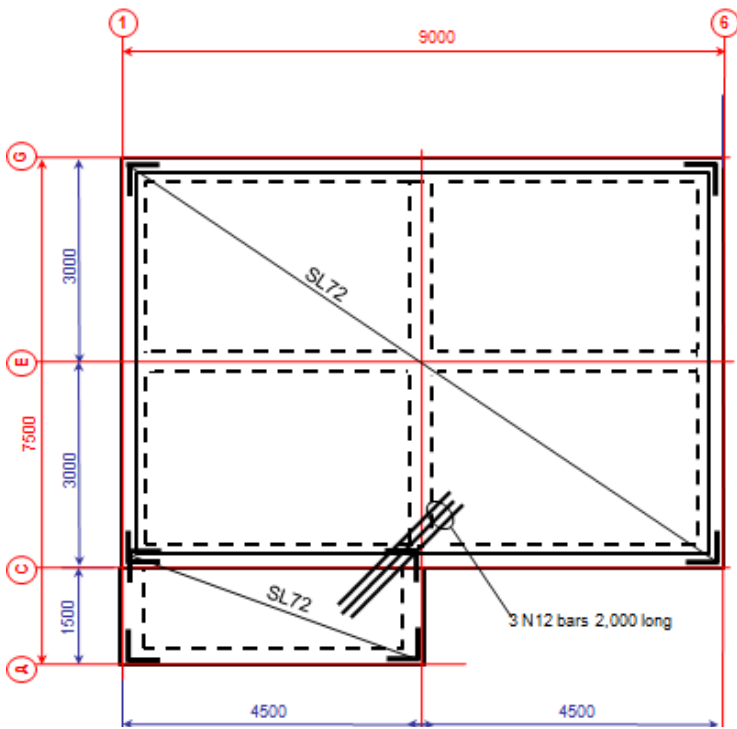
Basis of calculation:

Density of cement, dry sand and dry aggregate 1,500 kg/m³

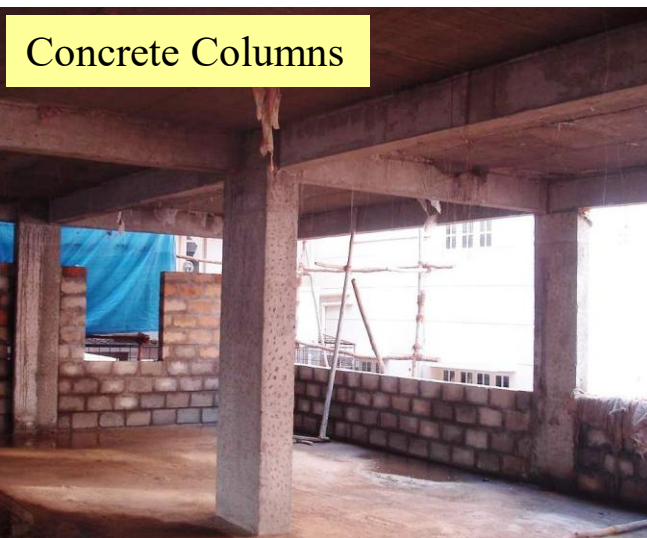
Includes approximately 5% allowance for wastage.



Concrete Slab-on-Ground

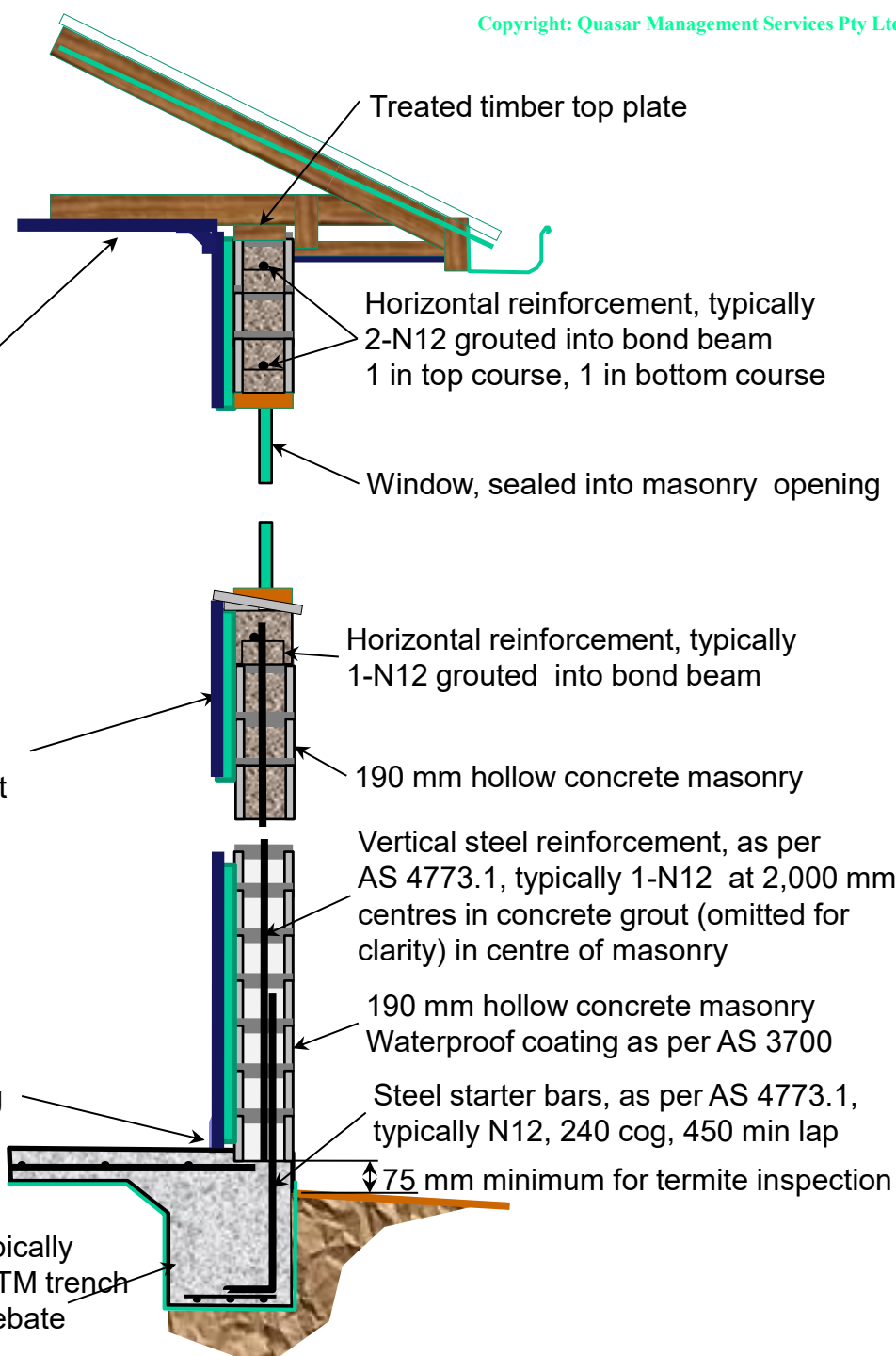


Concrete Superstructures



Partially Reinforced Concrete Masonry

Plasterboard ceiling and cornice



Treated timber top plate

Horizontal reinforcement, typically 2-N12 grouted into bond beam
1 in top course, 1 in bottom course

Window, sealed into masonry opening

Horizontal reinforcement, typically 1-N12 grouted into bond beam

190 mm hollow concrete masonry

Vertical steel reinforcement, as per AS 4773.1, typically 1-N12 at 2,000 mm centres in concrete grout (omitted for clarity) in centre of masonry

190 mm hollow concrete masonry
Waterproof coating as per AS 3700

Steel starter bars, as per AS 4773.1, typically N12, 240 cog, 450 min lap

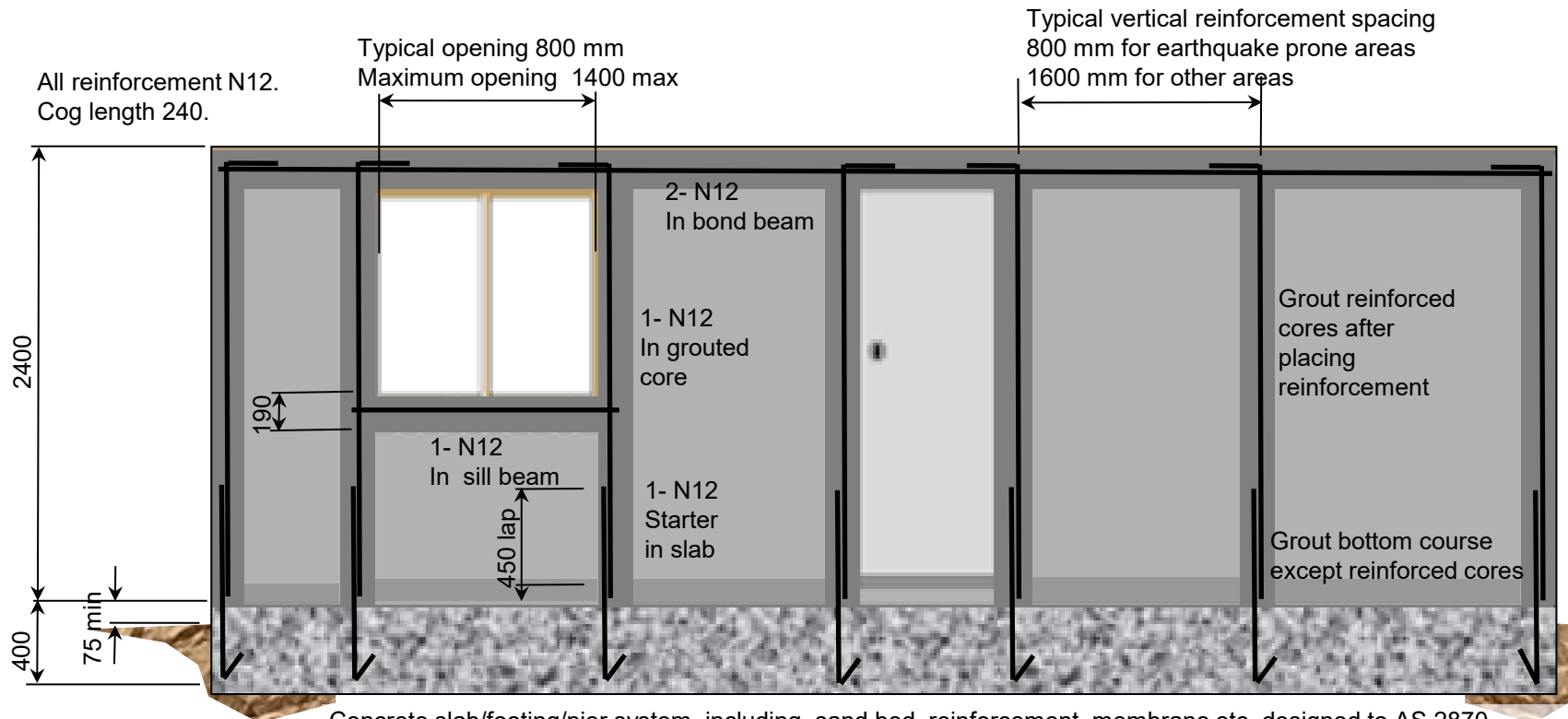
75 mm minimum for termite inspection

Skirting

Light gauge steel furring channels, fixed by steel clips with thermal break (omitted for clarity), insulation to requirements of building regulations and 10 mm plasterboard lining. This may be omitted if not required by the designer or by the regulations.

Concrete slab/footing/pier system, including sand bed, reinforcement, membrane etc, designed to AS 2870. Typically edge beams and cross beams, 300 x 300 mm with 3-11TM trench mesh. 100 mm concrete slab with SL72 mesh, 20 mm rebate

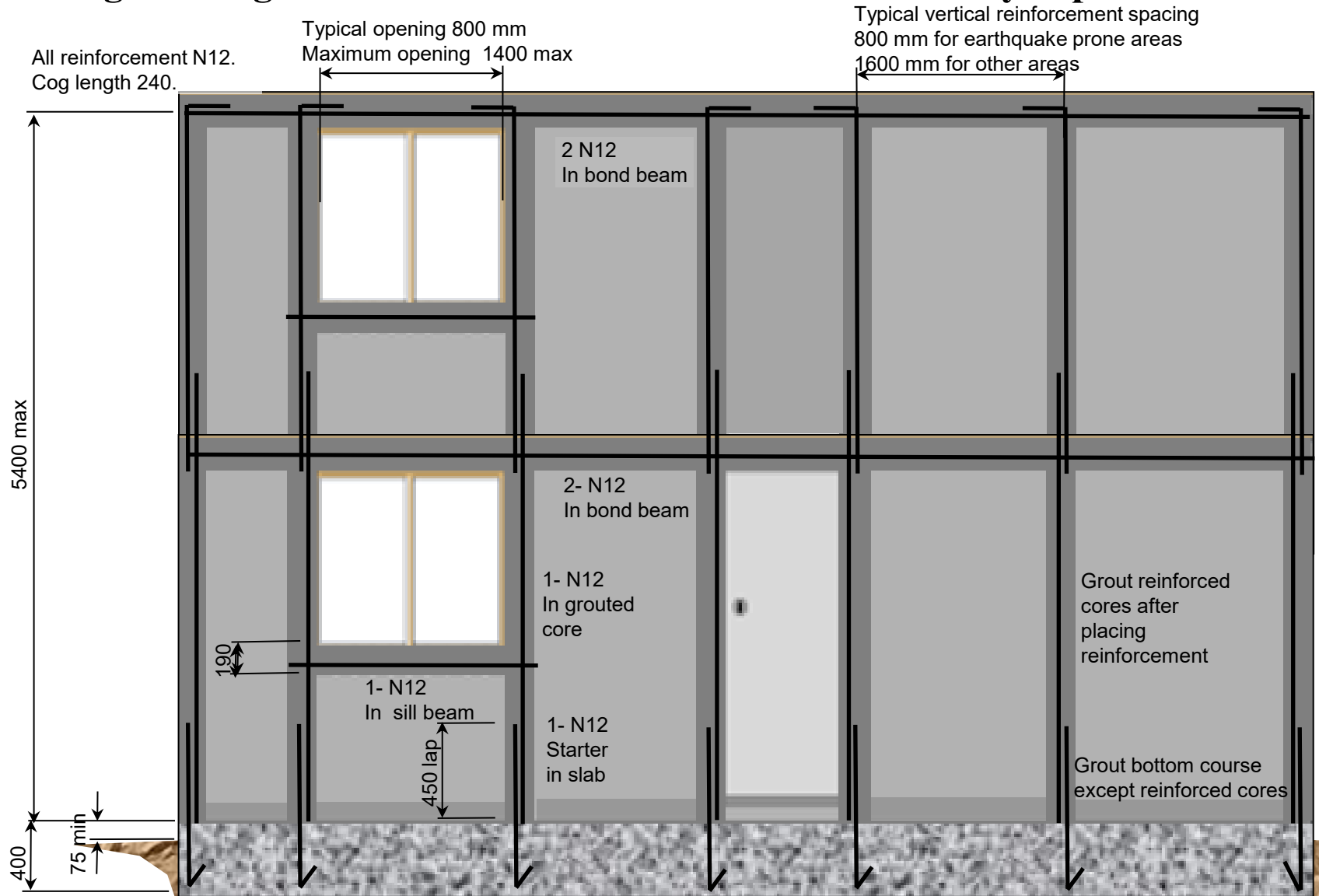
Typical design of single leaf reinforced hollow concrete masonry superstructures



Concrete slab/footing/pier system, including sand bed, reinforcement, membrane etc, designed to AS 2870. Typically edge beams and cross beams, 300 x 300 mm, 3-11TM trench mesh. 100 mm concrete slab, SL72 mesh.

Typical Arrangement of Reinforcement

Typical design of single leaf reinforced hollow concrete masonry superstructures



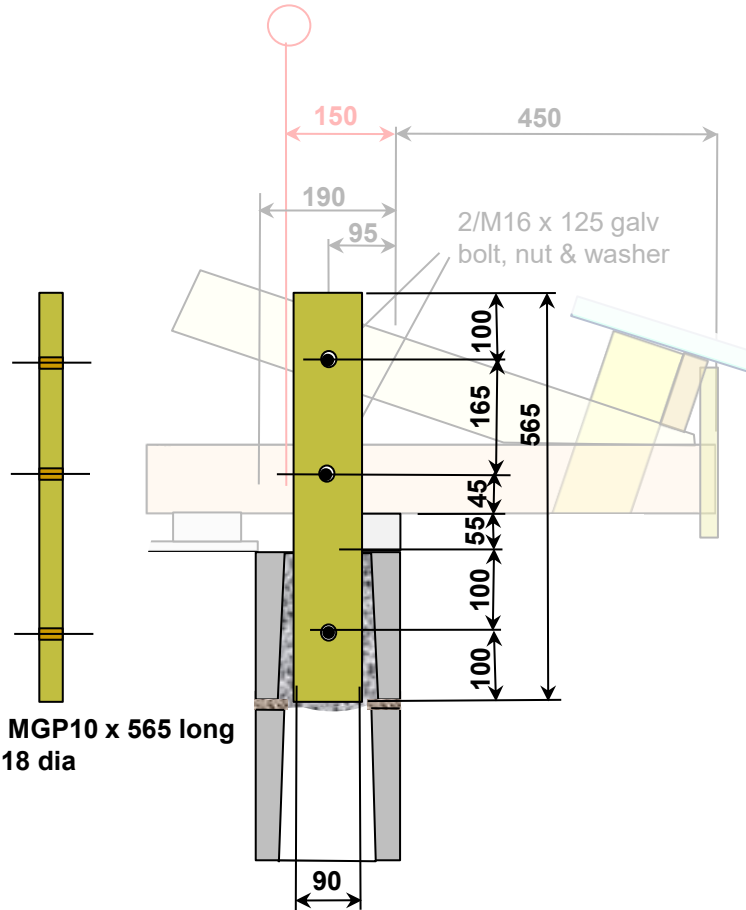
Concrete slab/footing/pier system, including sand bed, reinforcement, membrane etc, designed to AS 2870. Typically edge beams and cross beams, 400 x 300 mm, 3-11TM trench mesh. 100 mm concrete slab, SL72 mesh.

Typical Arrangement of Reinforcement

Timber Roof Anchors for Reinforced Concrete Masonry Bond Beams

Capacity

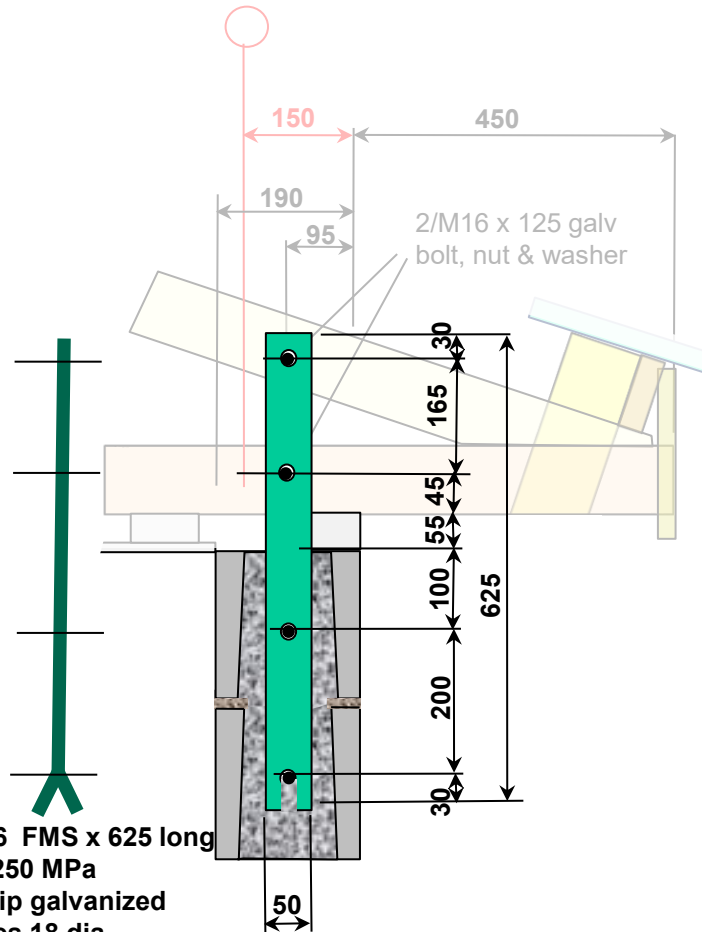
190 mm reinforced masonry 13.1 kN



Steel Roof Truss Anchors for Reinforced Concrete Masonry Bond Beams

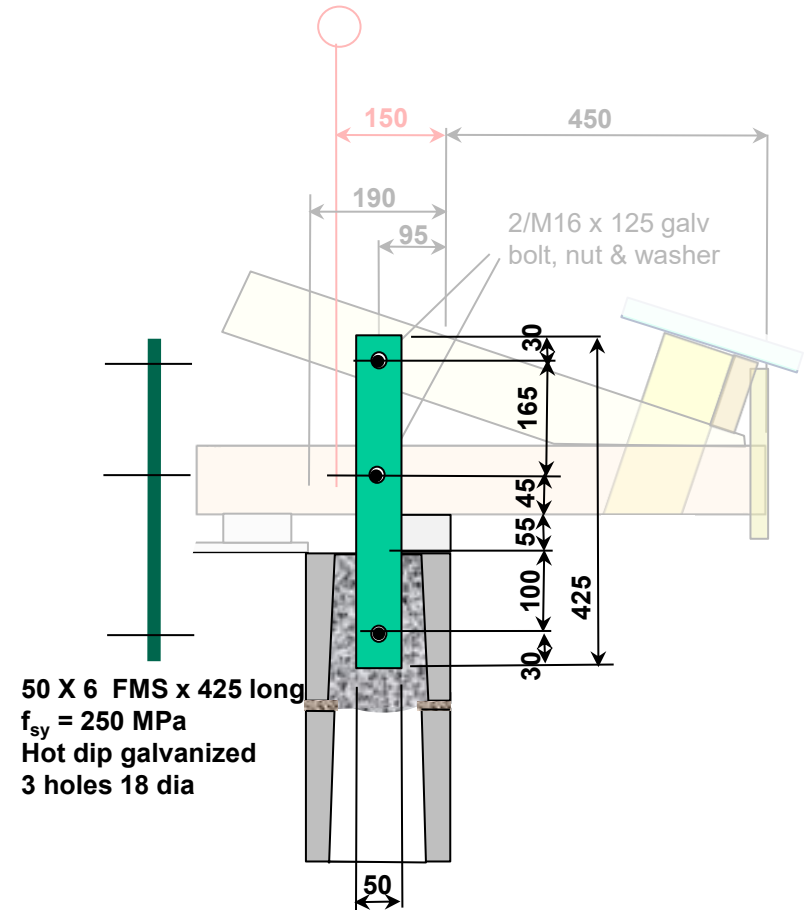
Capacity

190 mm reinforced masonry 30.7 kN



Capacity

190 mm reinforced masonry 13.1 kN



Foundations and Formwork

The construction sequence commences with the construction and compaction of an appropriate mound.

For shallow footings, the edge beam may be formed on the mound. For deeper footings, they must be excavated.

The membrane is placed and the reinforcement tied in position.



Concrete Slabs and Beams

Concrete slabs and ground beams are constructed incorporating starter bars. As a safety measure these should be capped. Alternatively, they may be hooked as shown below.

Because of the waterproof coating subsequently applied to the wall, it is not common to include a rebate in the slab.



Concrete Blockwork

The concrete blockwork superstructure is constructed with a small overhang over the concrete slab, to ensure that it can be subsequently weather-proofed.

A suitable termite-proofing details is also incorporated.



Wall Reinforcement

Vertical “wide spaced” reinforcement is placed in the walls in accordance with AS 4773.1 and AS 4773.2.



Reinforced Bond Beams and Lintels

The reinforcement in the bond beams and lintels must be detailed in accordance with AS 4773.1 and AS 4773.2 to ensure the following:

- The reinforcement must transfer loads via the wall reinforcement and starter bars to the footings.
- The reinforcement must be correctly positioned using hangers, spacers and the like to provide both strength (effective depth) and durability (cover).
- The inclusion of a horizontal bond beam at each suspended floor level provides additional integrity to partially reinforced blockwork, and also provides a sound substrate for the fixing of floor anchors.



Water-resistant Finish

No masonry systems are impermeable to water, and therefore single leaf reinforced concrete masonry houses must be coated with a water-resistant finish. There is a very wide range of suitable paints and renders commercially available.



Strong Enough ???



Concrete Block Manufacture

This part of the training package provides information on the manufacture of concrete blocks for houses common in South-East Asia and the South Pacific region. Concrete blocks are manufactured with varying degrees of sophistication and in a range of sizes and shapes.



Manual manufacture of concrete blocks

- Sand, portland cement and water are manually mixed, and then placed into steel moulds to cure.
- The moulds must be well oiled and have a false bottom to permit the blocks to be removed.
- When hardened, the concrete blocks are forced out of the moulds.



Manual manufacture (Trincomalee, Sri Lanka)

“Egg-layer” machine manufacture of concrete blocks

- Stiff concrete is extruded from the mobile “egg-layer” machine onto a concrete slab.
- The machine then moves forward to deposit the concrete for the next block.
- The blocks are allowed to air-cure on the slab.



“Egg-layer” Machine (PNG)



“Egg-layer” Machine (India)

Semi-automated machine manufacture of concrete blocks

- Portland cement is stored in a dry place.
- Sand and aggregate are stock-piled where they are free of contamination.
- The ingredients are mixed, and a little water added.
- The mix is then fed into a concrete block machine, which vibrates and then extrudes the “green” concrete onto timber or steel pallets.
- The pallets of “green” concrete are then removed and stored for curing.



Raw Materials Storage



Sometimes there are problems



Semi-automated machine manufacture
(Colombo & Batticaloa, Sri Lanka)



Semi-automated machine manufacture of soil-cement bricks and blocks

Inexpensive soil/cement blocks may be manufactured using simple block-making equipment.

- The principal materials are red sandy silt, with some cohesion, to which is added a little river sand, and a specified quantity of portland cement.
- This is thoroughly mixed, placed in the feed-hopper and compressed in the machine.
- Finished blocks are then removed from the machine and stacked to dry.



The suitability of the mix must be checked by measuring the penetration of a hand-held penetrometer.



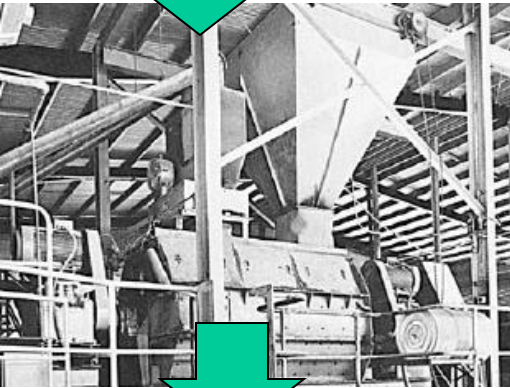
Semi-automated manufacture of soil-cement bricks and blocks (Kanyakumari & Pondicherry India)



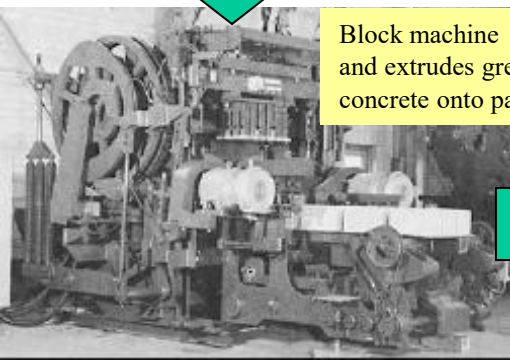
Automated machine manufacture



Raw materials
delivery, storage
& retrieval



Batching &
Mixing



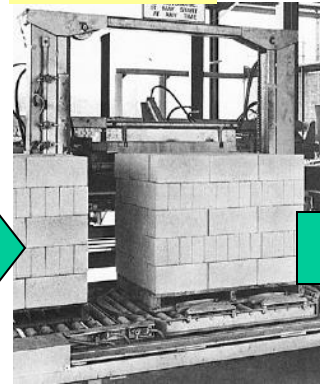
Block machine vibrates
and extrudes green
concrete onto pallets



Curing



Cubing onto
timber pallets

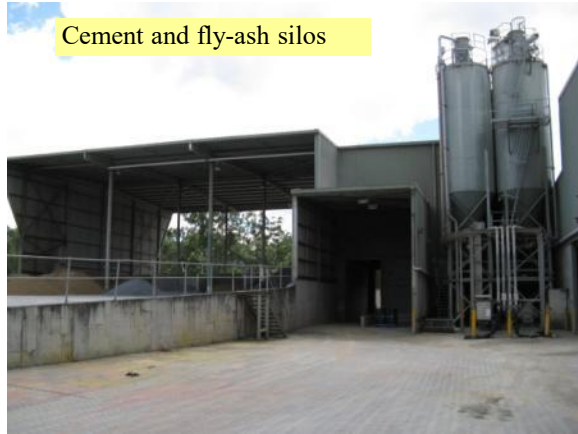


Storage & Delivery



Photos courtesy of Concrete Masonry
Association of Australia

Automated machine manufacture



Cement and fly-ash silos



Mixer



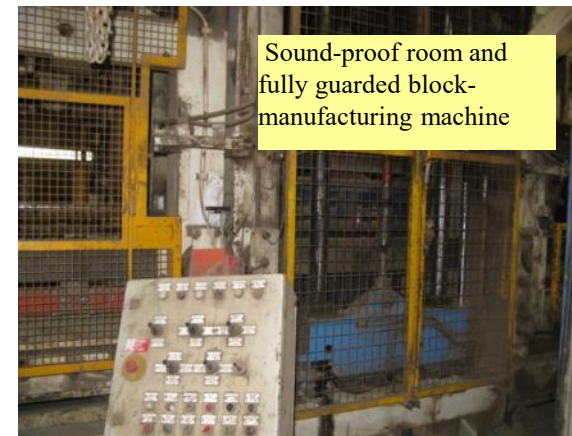
Placing "green" blocks in kilns



Protected sand stockpile



Mould racks



Sound-proof room and fully guarded block-manufacturing machine

Concrete Block Manufacture and Testing



Manufacture of Concrete Blocks – Process

Concrete blocks may be manufactured using simple block-making equipment.

The principal materials are clean sand, 5 to 7 mm aggregate (stone), to which is added approximately 10 % to 15% portland cement. This is thoroughly mixed with a little water, placed in the feed-hopper and compressed in the machine.

Finished blocks are removed on a pallet from the machine and stacked to dry.



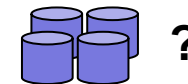
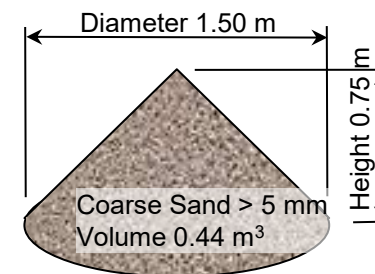
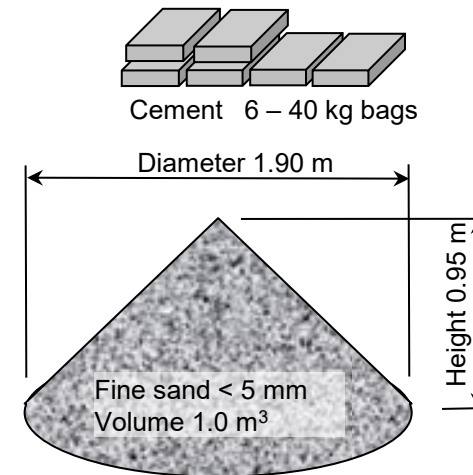
Typical Mix for 15 MPa Denseweight Hollow Concrete Blocks

For 1 cubic metre of concrete, the mix should be:

- **6 bags 40 kg each (240 kg) of GP portland cement**
Cement is also available in 20 kg bags, in which case 11 would be required.
- **0.88 m³ (1,400 kg) of fine sand**
Sand should be clean sharp sand under 1.5 mm nominal size
- **0.44 m³ (650 kg) of coarse sand and aggregate**
Coarse sand and aggregate should be clean river gravel, crushed aggregate or similar above 1.5 mm nominal size.
- **Minimum quantity of water** – Approximately 11 20 litre buckets (300 mm diameter x 290 mm deep). Less water should be used if sand or aggregate are damp.

Note:

Fine and coarse sand may be combined as a single aggregate when supplied to the block plant.



Water to suit conditions



Manufacturing Checklist

Builder:

Site:

Activity: Manufacture Concrete Blocks

| Item or Product | Inspection Required | Accept Criteria | Hold Witness | Date | Inspector | Comment |
|----------------------------|----------------------|-------------------|--------------|------|-----------|---------|
| Block making machine | Trial run | In running order | Hold | | | |
| Cement storage | Visual inspection | Clean and dry | Hold | | | |
| Materials storage | Visual inspection | Clean | Hold | | | |
| Block handling | Visual inspection | In running order | Hold | | | |
| Curing facility | Visual inspection | In running order | Hold | | | |
| Block storage | Visual inspection | Not crowded | Hold | | | |
| Mould shape and dimensions | Accurate measurement | +,- 0.5 mm | Hold | | | |
| Mix specification | Calculation check | Correct | Hold | | | |
| Cement | Visual | Clean, dry, fresh | Hold | | | |
| Sand | Sieve | To grading limits | Hold | | | |
| Coarse aggregate | Sieve | To grading limits | Hold | | | |
| Admixtures | Visual | Clean, fresh | Hold | | | |

Typical Mixes without Fly Ash for Various Concrete Masonry Units

The mixes below are appropriate to large manufacturing plants, using portland cement without the addition of fly ash.

| | | Typical Concrete Masonry Manufacture | | | | | |
|--|--------|--|--|-------------------------------------|--------------------------------|----------------------------------|--------------------|
| | | Concrete denseweight masonry units | Concrete lightweight masonry units | Concrete retaining wall units | Concrete domestic pavers | Concrete industrial pavers | Concrete bricks |
| Natural dense weight coarse aggregate (> 5 mm) and dust | tonnes | 0.30 | 0.25 | 0.23 | 0.22 | 0.20 | 0.25 |
| Natural denseweight fine aggregate (< 5mm) includes sand and ash | tonnes | 0.60 | 0.61 | 0.63 | 0.63 | 0.60 | 0.65 |
| Portland cement | tonnes | 0.10 | 0.14 | 0.14 | 0.15 | 0.20 | 0.10 |
| Oxides | tonnes | 0.0000 | 0.0000 | 0.0045 | 0.0048 | 0.0032 | 0.0000 |
| Admixtures | tonnes | 0.00015 | 0.00015 | 0.00015 | 0.00015 | 0.00015 | 0.00015 |
| Total | tonnes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Average Mix | | | | | | | |
| Total aggregates | | 90.0% | 86.0% | 85.5% | 84.5% | 79.7% | 90.0% |
| Total cementitious (including fly ash, blast furnace slag, admixtures) | | 10.0% | 14.0% | 14.5% | 15.5% | 20.3% | 10.0% |

Assignment

Please complete your name, email address and postal address; and answer the following questions using the notes in this workbook. Submit this page to the tutor, or email this page to RodJohnstonAUS@gmail.com. The tutor will assess it and reply with comments and will complete the Training Certificate.

Name: _____ Email: _____

Postal Address: _____

- To prevent building collapse due to wind or earthquake, what should be fitted between the posts?
 _____ x _____ MGP10 softwood fixed by M _____ bolts.
- In the Direct Anchorage system, with roof trusses spanning 8.4 m in a non-cyclonic region:
 What is the purlin size and fixing? _____ mm deep x _____ mm wide MGP10 softwood _____ / _____ x _____ screws
 What are the top and bottom chords? _____ / _____ x _____ MGP10 softwood
 What is the correct truss to stud fixing and stud to bearer fixing? _____ M _____ bolts x _____ mm long
- What is the correct mix for normal 20 MPa (megapascals) concrete?
 _____ 40 kg bags of portland cement _____ m³ sand _____ m³ gravel _____ litres water
- In the hollow concrete block walls of a single storey reinforced concrete masonry house?
 What is the common size of concrete blocks? _____ mm (length) x _____ mm (height) x _____ mm (width)
 What is the common size and spacing of reinforcement? N _____ mm (diameter) x _____ mm (spacing)

Training Certificate

I hereby certify that

has completed course material in

Building Skills Training – Introductory Level

prepared by Quasar Management Services Pty Limited.

Signed:

Name:

Date:



Quasar Management Services Pty Limited
ABN 21 003 954 210
Not-for-profit consulting structural and civil engineer
Subsidiary of Partner Housing Australasia (Building) Incorporated
69 Renwick Street, Redfern NSW 2016, Australia
Phone: +61 432 611 550
Email: RodJohnstonAUS@gmail.com

This certificate is valid only if signed and dated by an authorised officer of Quasar Management Services Pty Limited.

Disclaimer & Copyright

Disclaimer

This training package covers broad engineering principles and building practices, with particular emphasis on village infrastructure in the Asia-Pacific region. These broad principles and practices must be translated into specific requirements for particular projects by professional architects, engineers or builders with the requisite qualifications and experience. Associated sample specifications and drawings are available in electronic format, with the express intention that architects, engineers and builders will edit them to suit the particular requirements of specific projects. The design, construction and costing of structures must be carried out by qualified and experienced architects, engineers and builders, who must make themselves aware of any changes to the applicable standards, building regulations and other relevant regulations. The authors, publishers and distributors of these documents, specifications and associated drawings do not accept any responsibility for incorrect, inappropriate or incomplete use of this information.

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