# BUILDER USER GUIDE

## FOR CONSTRUCTION OF TIMBER-FRAMED HOUSING IN WA

PREPARED BY THE TIMBER FRAMED HOUSING DEVELOPMENT PROJECT
FOR THE WA HOME BUILDING INDUSTRY

2017

## ACKNOWLEDGING THE FUNDING SUPPORT AND TECHNICAL ASSISTANCE:

Forest & Wood Products Australia

TIMBER LINK AUSTRALIA | NEW ZEALAND

James Hardie

WESPINE

pryda

GYPROCK Everything else is just plasterboard

CSR



**PREPARED BY THE TIMBER FRAMED HOUSING DEVELOPMENT PROJECT FOR THE WA HOME BUILDING INDUSTRY BY TIMBER INSIGHT PTY LTD.**

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# INTRODUCTION

The Western Australian Government, in its research report 'The Impact of New Techniques and Technologies in the Residential Housing Sector of the Construction Industry (2015)' predicts that over the next 10–20 years the size of the market for alternative home building systems could grow to 20% (6,000 homes) per annum. It quotes 'That gradual growth will occur as home buyers accept new practices and overcome the perceived stigma associated with alternative construction materials and methods'. It is predicted that the main drivers for the acceptance of change will be housing affordability underpinned by significant reduction in build cost and build time.

This Builders User Guide has been prepared to assist home builders with the specification, design, scheduling and construction of light-weight framed homes using timber frame building systems. The home building industry in Western Australia is in transition with an increasing focus on alternative building systems from traditionally double-brick masonry construction.

With the majority of homes in Australia built using timber frame wall systems, either with masonry or frame clad exteriors, builders in WA are now focusing on introducing light-weight timber frame houses. Of particular benefit to builders is reduced construction time, cost savings when building two-storey houses, and solutions for building on small and narrow lots, and non-standard reactive soil sites.

This User Guide provides guidance for home builder sales and marketing staff, schedulers and detailers, building supervisors and on-site construction staff. It focuses on providing technical marketing support under the following headings – Sales and Marketing; Design (and Scheduling); and Construction. Included is guidance to information and resources provided by manufacturers and suppliers of products directly aligned with light-weight construction systems.

The User Guide emphasises the benefits of using factory fabricated timber framing systems – for walls, floors and trussed roofs. A list of all truss and frame fabricators is included in the appendices.

## 1.1 MARKET ACCEPTANCE

Up until recently timber-framed construction systems used in home building – standard in home building on the east coast – form only a small percentage of home sales in the Perth metropolitan area. However, various market forces are currently bringing about rapid change to home building methods used around Perth and major regional centres, which are addressed in this Builder User Guide.

This first section on sales and marketing is prepared to assist builders' sales teams to market the benefits of the light-weight timber-framed home.

### I LIKE WHAT I SEE!

Various studies have been completed on the market acceptance of light-weight construction, including by Landcorp, various industry bodies and suppliers. (See references attached). Some of the key outcomes from these studies have been outlined below.

Each of the studies highlight that the look of framed construction is widely acceptable to consumers, and in many circumstances preferred. The look of many available cladding materials is seen as modern, innovative, exciting and separates their home from the rest.

A recent study completed by James Hardie in early 2016 found that 71% of the survey group would build a clad frame home based on its street scape elevation. The sales team can be confident that a well-designed frame home will be attractive to prospective clients.

## REASSURE ME

Framed construction is not Western Australia's primary home construction method. Therefore the client will look to their sales representative to re-assure them of some of the key purchasing criteria outlined below, as it is not yet common knowledge and quite often the market is ill informed. It has shown that giving basic information to re-assure the client, without going into a lot of detail is the best solution for re-assurance. Too much detail can be confusing and create doubt in the buyer.

Key selection criteria for a prospective home owner should be covered:

- The thermal performance exceeds that of a double brick home;
- The framing is engineered, strong and long lasting, with its popularity reflecting in the fact at least 85% of all homes built in Australia are framed;
- All framing timbers are termite treated to Australian Standards, and include a minimum 25 year guarantee;
- Acoustic performance of timber framed homes meets or exceeds National Construction Code requirements;
- Many cladding products have a minimum 25 year warranty;
- Many painted coating products have minimum 15 year warranties.

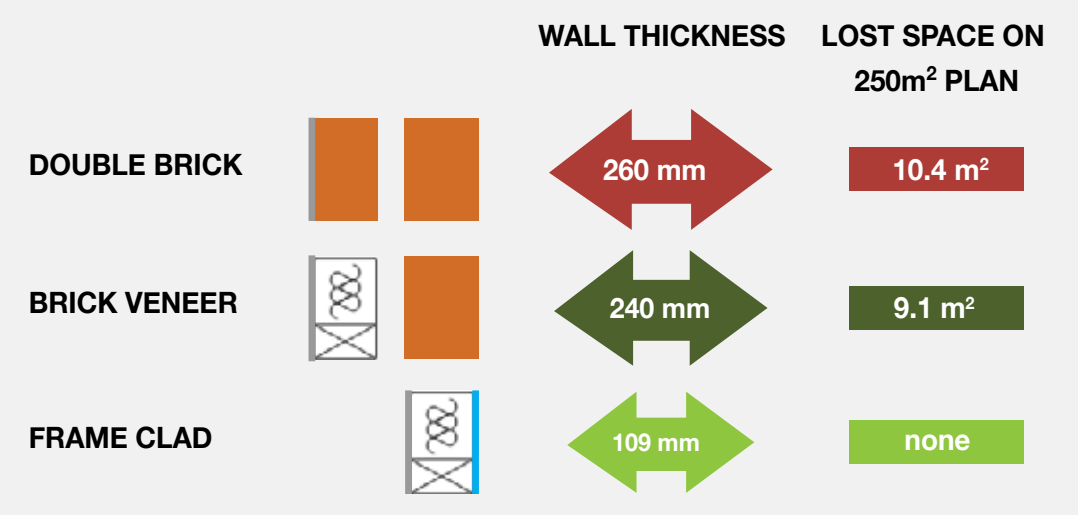
## THE TARGET MARKET

The research has also highlighted that buyers under the age of 35 are much more open to new and modern ways of building. The key benefits timber frame provides fits very well with consumers preferences for affordable, energy efficient, modern designed homes able to be constructed faster and on schedule. Where prospective clients have completed a build or renovation previously, if that experience has been good, they are more likely to repeat the same built form.

## 1.2 INCREASED SPACE

The greater Perth metropolitan area has seen a gradual and sustained reduction in typical housing lot size over the past 15 years. This is driven by affordability, limits to urban growth and the increasing supply of infill lots where zonings are typically R40 or higher. The want and need for space has become of increasing importance to the consumer as a result. Timber framed housing has the ability to increase the size of a prospective client's home, without increasing the overall foot print of the home itself. By reducing the overall external wall thickness as much as an additional 9 -10m² of living space on a 250m² footprint can be gained.

When put into simplified terms this equates to an additional bedroom ensuite, store room, or a large walk-in robe. These items are typically the first to be removed when the site is tight, however can be included with a light weight home.




Space maximisation benefits using frame solutions.

## 1.3 COST EFFECTIVE

### Foundations and Earthworks

The Perth metro area has been fortunate in that the vast majority of construction sites delivered have been 'A' class lots with negligible surface movement. This has been acceptable for traditional heavy double brick construction, with minimal settlement resulting in smaller footings required. More recently it has become evident that the percentage of housing lots delivered as 'A' class is reducing significantly year on year, and new housing sub-divisions are being developed to 'C' class, reflecting the less stable nature of the soil conditions and increasingly high cost of fill and site development.

This is driven by a number of factors, the key elements being that a majority of our urban growth will occur above clay soils (the Guildford formation), and the escalating price of fill sand is driving the cost of delivering an 'A' class lot up year by year. As such, the ability to deliver 'A' class lots while remaining affordable, for developers is becoming a financial challenge.

Builders are now starting to see housing estates delivering 'S' class, and in some circumstances more reactive 'M' class lots to market. ***So what does this mean for the sales team?*** Greater consideration must be given to using the most suitable built form for non-standard reactive soil sites.

A key challenge for the sales team is having a cost effective solution for building on 'S' and 'M' classified sites. Breaking the news to the home buyer of a substantial additional earthworks and footing upgrade costing tens of thousands of dollars can be a deal breaker. This is a significant example of where light-weight timber-framed construction can offer a cost effective solution for the client. As shown in the below table, utilising light weight construction on 'S' and 'M' classified lots does not greatly impact on the volumes of concrete or re-enforcement in the slab and footings. Therefore the construction cost of building on an 'A' classified lot, verses a 20mm 'S' classified lot are not dissimilar.

Utilising this methodology we can also reduce earth works. As we can cost effectively deliver a framed home on a high surface movement lot, we can remediate the site with lower amounts of fill to simply deliver a clad frame home on an 'M' classified lot with very little requirement for improvements at all.

CHART 1
SINGLE STOREY BUILDING'S FOUNDATIONS CONCRETE VOLUME COMPARISON CHART

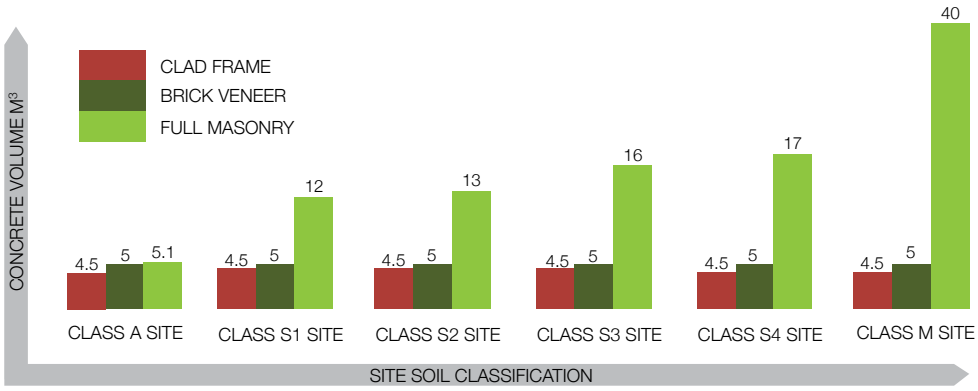
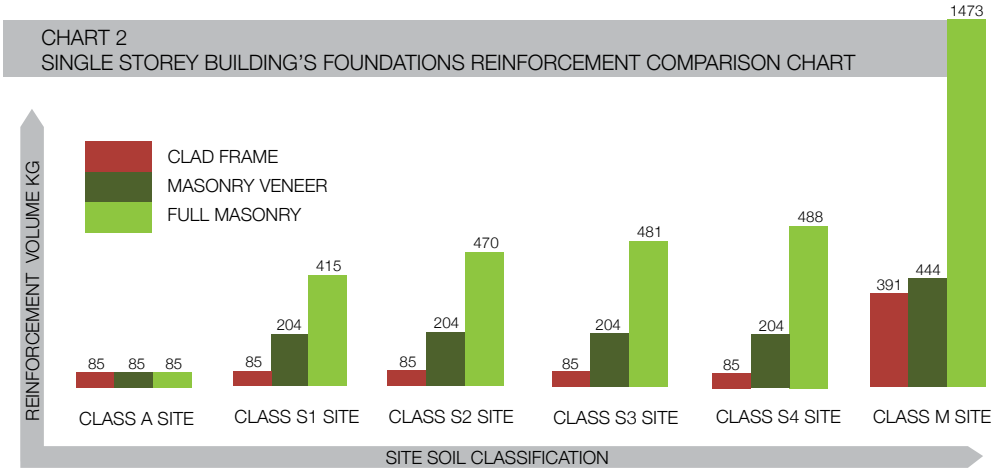



CHART 2
SINGLE STOREY BUILDING'S FOUNDATIONS REINFORCEMENT COMPARISON CHART




SOURCE: Engenuity Engineers

### Two-Storey Homes

Timber framed upper floors have been common in Perth for many years however the movement towards ground and upper floor frame has seen some great savings achieved. These savings are predominantly in replacing the suspended slab with a timber or composite floor system, the reduction in labour cost for a shorter build time, and the reduction of heavy structural steel. Most builders are achieving at least a 5% reduction in build costs, with the potential of greater savings as more efficiencies are achieved in engineering and design.

### Future Proofing Homes

Timber framed homes can be designed and built to suit short to medium term family needs, yet have the design and structural flexibility to change to suit future family needs. A timber frame home can be upgraded and added to cost-effectively. Timber framed upper storeys on a masonry ground floor have been common in Perth for many years.

However the trend towards single and two storey timber frame has seen some significant savings achieved. Rooms can be modified and enlarged by moving or removing non-loadbearing internal walls to suit changes in living circumstances as the family situation changes.

## 1.4 SUSTAINABLE

### Thermal Performance

Timber framed construction has an excellent thermal performance as a wall system, providing comfortable living conditions during the heat of summer and cool of winter. The result for the consumer is reduced energy bills. A light-weight timber frame wall system is made up of wall cladding/brick work, breathable membrane, timber frame, insulation and internal lining.

Timber frame offers a thermal performance exceeding that of double brick. As an example an R2.0 insulated wall provides a 60% greater insulating benefit over insulated double brick (source: ICANZ). Timber frame is also the most flexible system available to customise your thermal performance.

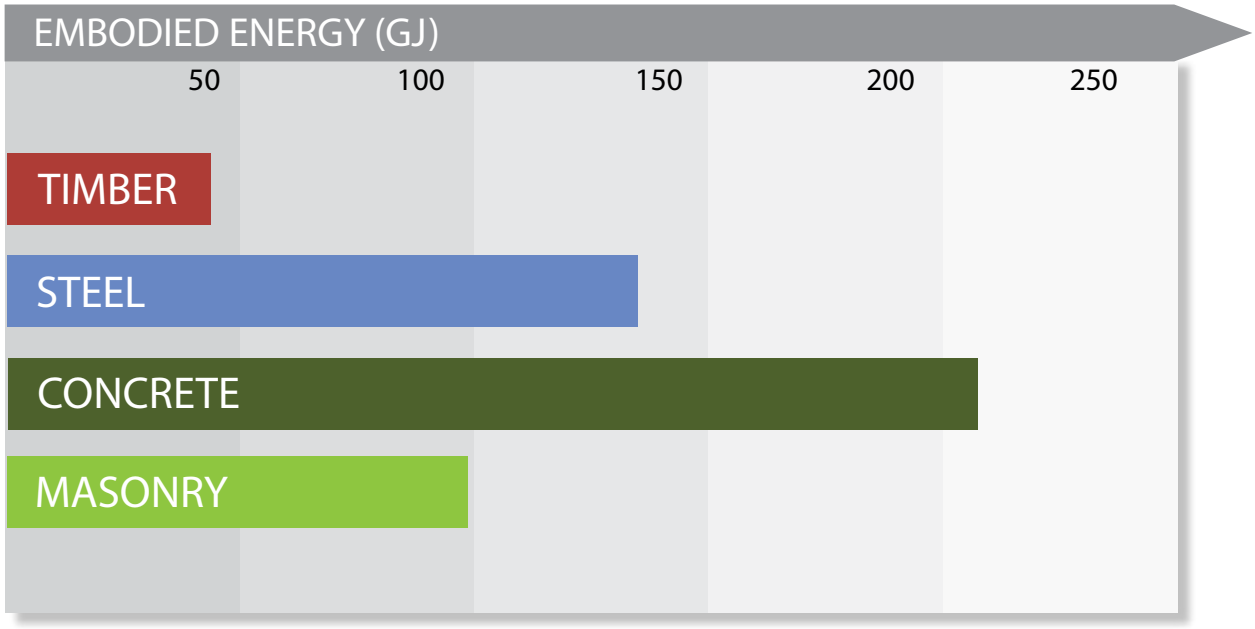
Wall rating can be increased by simply increasing the wall thickness slightly, or including a higher rated wall batt. This can offer great flexibility to the design team when considering building orientation and walls that may benefit from a higher thermal performance.

### Environmentally Friendly

Timber is the only environmentally friendly, sustainably supplied, renewable building material available in the market. Not only does timber remove carbon from the atmosphere during its growing life, using timber in buildings ensures that carbon is locked up into the structure for the life of the building. One cubic metre of timber products effectively stores 250kg of carbon, while one third of the volume in steel releases 1,750kg of carbon into the atmosphere.

In addition, timber products use less energy in manufacture than any other primary building material. The table below illustrates the comparison of embodied energy required in the manufacture of brick, steel, concrete, and timber.

To compliment the excellent rating of the timber frame, many of the claddings and linings associated with a wall system also utilise recycled and sustainably sourced materials. By using less concrete and steel, light-weight timber-framed homes are regarded environmentally as 'touching the earth softly' acknowledging the limited environmental impact associated with timber frame construction.




SOURCE: CSIRO

## 1.5 SPEED OF CONSTRUCTION

By building a timber framed home consumers are able to access their new home sooner. In utilising prefabricated framing systems the home can be locked up in just days, instead of weeks. Builders are now advertising guaranteed construction time reductions (in comparison to double brick) of between 25% and 30% on single and two storey construction.

## 2.1 FRAME DESIGN

Construction of light-weight timber framed houses – both brick veneer and frame clad - is the most common form of residential house construction in Australia. Over 90% of fully and semi-detached homes are finished externally with face or rendered brick, fibre cement, sheet metal, plywood or timber weatherboards. Frequently a combination of the above is used in a composite form of construction. Most common though is the use of timber framing to provide structural form to the building. Home building in Western Australia, in particular Perth and major regionally populated centres have evolved down a path of double brick wall building.

In WA timber framing has become more popular in second storey construction, for both new homes and additions to existing dwellings. A frame solution of upper floors has proved economical, structurally practical and time efficient.

A significant shift to light-weight timber frame construction is underway, with many of the major and mid-range home builders introducing single and two-storey timber framed homes into their range of designs.

Frame-clad walls either on some or all walls around the house is gaining in popularity, supported by the diverse range of cladding materials available today. With the average building lot size reducing year by year, and the greater advent of narrow lots (as little as 4.5 to 6.0 metres wide), two storey houses are gaining greater popularity with builders to maximise use of the ground area available.

Timber framed wall construction lends itself better to smaller lots, particularly with limited room for building materials and trade workspace around the home. Factory fabricated walls, floor frame and trussed roofs simplify the erection of the primary building shell. In particular, trade congestion is reduced, wet trades are eliminated from the site, and the construction schedule is accelerated.

## 2.2 FRAME SPECIFICATION

The primary timber frame specification for typical residential housing is determined by the size of loads onto the frames (ie: upper storey), wall heights, wind loads, and possibly internal lining or exterior cladding type specified. The configuration of the components, their size and spacing, will be determined by the roof loads applied and whether the frames are for single storey (or upper of two storey), or the ground floor of a two or multi-storey building. Integral to the design and performance of wall framing are metal connectors installed at design centres to interconnect the frame components to resist lateral and uplift wind forces.

Australian Standard AS1684 Residential Timber Framed Construction Code specifies that walls shall be framed with studs, plates, noggins, bracing, and lintels, as typically shown in the following diagram.

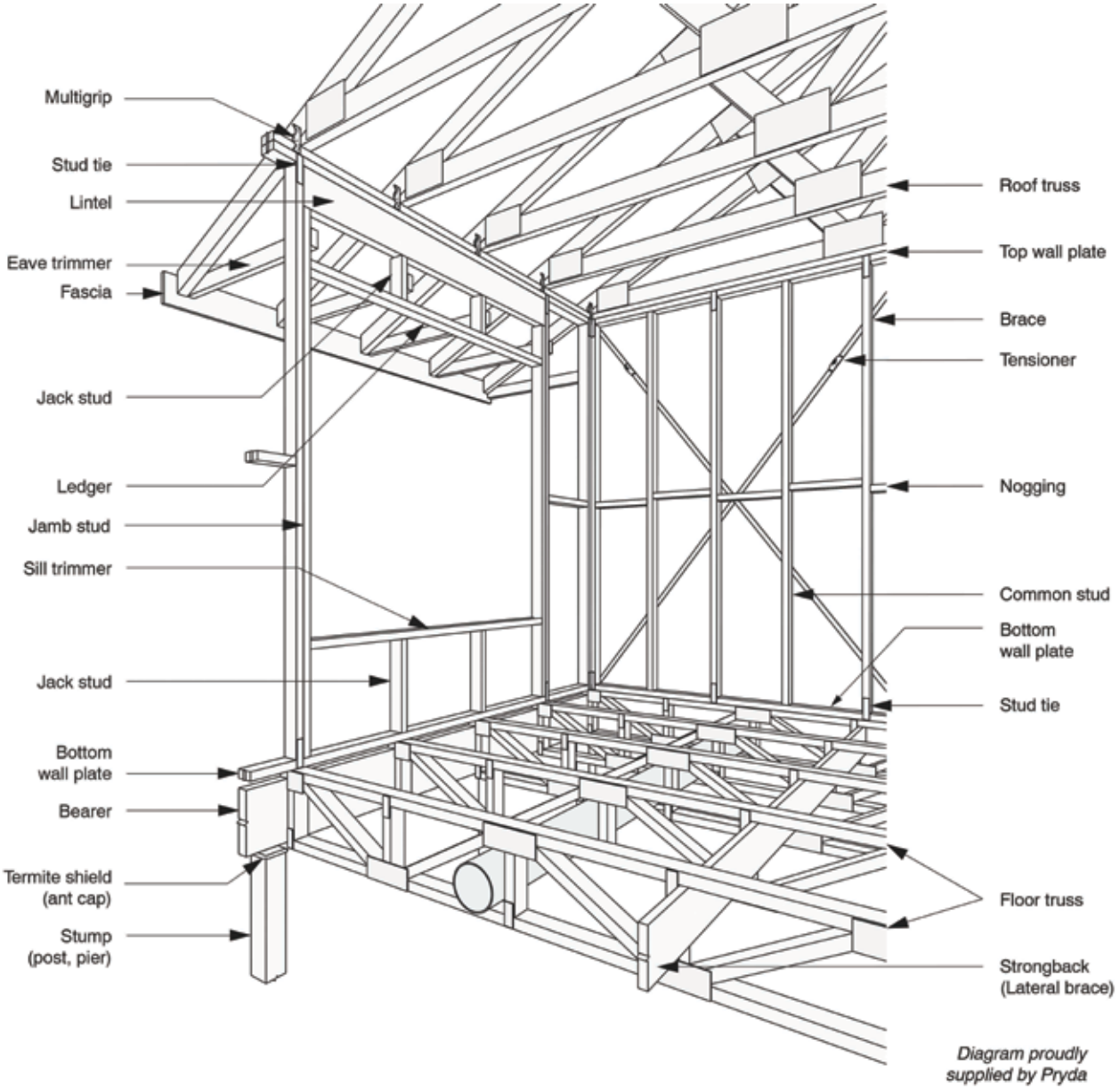



*Diagram proudly supplied by Pryda*

## 2.3 CODE REQUIREMENTS

Both factory-fabricated and on-site constructed wall frames are required to meet the design and construction requirements of Australian Standard AS1684 Residential Timber Framed Construction Code. This User Guide references AS1684 to highlight code conformance and best practice when building timber framed homes.

Where elements of the building design are incompatible with conformance to AS1684, an alternative solution can be designed and certified by a structural engineer. This alternative solution must be clearly documented and detailed to ensure onsite construction practice is completed correctly and associated trades affected by the solution can complete their supply and installation correctly.

## 2.4 TIMBER SELECTION

Timber used in frame construction is almost exclusively structural pine. Structural pine is manufactured to comply with Australian standards in such a way that every piece is machine graded and tested to determine its individual strength and stiffness. The graded pine is then branded with the grade manufacturing location and Standards number. The most common grade produced is MGP10.

Span tables for MGP and other grades are provided with AS1684. These span tables are specific to the timber type, structural grade and wind classification. Wall framing stud and plate sizes can default to minimum required sizes to suit load and installation requirements, or can be specified by the builder to suit individual preferences, ie: 90x45mm studs at 450mm centres, verses 90x35mm studs at 600 centres suited to most plasterboard and board claddings on single storey loadbearing walls and most non-loadbearing walls.

Around Australia, including in Western Australia, the primary structural timber used in residential construction is plantation grown softwoods, primarily Radiata pine in Western Australia. Other softwoods of similar characteristics are imported into WA to supplement demand of locally manufactured product.

Most importantly, any increase in demand for structural timber framing will be reliably met by the timber industry's capacity to increase manufacturing output and imported demand.

Advances in manufacturing technology and preservative treatment of structural pine has seen the cost of treated pine reduce to similar cost of untreated timber. Most producers and suppliers are now making H2F treated pine the standard offer (refer next section for explanation of treatment levels). In WA, with the occurrence of termite and European House Borer around the Perth metro area, treated pine is the preferred option to provide client peace of mind. All pine sizes from 70x35 to 240x45 MGP10 are readily available either in H2 or H3 treated.



## 2.5 PRESERVATIVE TREATED STRUCTURAL PINE

Structural pine manufacturers and distributors have for decades been producing preservative treated pine products which resist infestation of termites and European House Borer. These products are produced to Australian Standards and have proved so reliable as to now become the standard structural pine used in the home building industry Australia wide.

Standard structural pine is preservative treated to hazard protection class H2F and H3 in conformance with Australian Standard AS1604 Timber – Preservative Treated - Sawn and Round. When specifying treated pine, request H2 for internal applications, and H3 for exterior above ground applications.

The following Table identifies the various hazard protection levels applicable to the degree of exposure timber products are subjected too.

Applicable preservative treatment are specified to provide the required protection for that hazard level.

Timber suppliers guarantee protection against termite and EHB attack for 25 years. The timber grading and treatment mark verifies the structural grade and preservative treatment used in the manufacture of the timber product.

Visit the manufacturer's website for further detail of the supplier's guarantee. For further information on selection of preservative treatment of timber products applicable for various environmental hazards refer to Australian Standards:

- AS1604 Timber-Preservative Treated– Sawn and Round.
- AS1684 Residential Timber Framed Construction Code.

HAZARD CLASS SELECTION GUIDE

| HAZARD CLASS | EXPOSURE | SPECIFIC SERVICE CONDITIONS | BIOLOGICAL HAZARD | TYPICAL USES |
|---|---|---|---|---|
| H1 | Inside, above ground | Completely protected from the weather and well ventilated, and protected from termites | Lyctid borers | Susceptible framing, flooring, furniture, interior joinery |
| H2 | Inside, above ground | Protected from wetting. Nil leaching | Borers and termites | Framing, flooring, and similar,used in dry situations |
| H3 | Outside, above ground | Subject to periodic moderate wetting and leaching | Moderate decay, borers and termites | Weatherboard, fascia, pergolas (above ground), window joinery, framing and decking |
| H4 | Outside, in-ground | Subject to severe wetting and leaching | Severe decay, borers and termites | Fence posts, garden wall less than 1m high, greenhouses, pergolas (in ground) and land-scaping timbers |

## 2.6 DESIGN FOR EFFICIENCY

When building framed houses the roof frame is generally supported by the internal leaf of the perimeter walls. These are the loadbearing walls supporting the roof loads and resisting the wind uplift forces. For brick veneer construction the external brick wall is not loadbearing so becomes an external protective layer, just as a fibre cement cladding is on a frame clad wall.

Timber framed dwellings can be very innovative in design. However, it is important to balance design innovation and aesthetics with efficient use of materials to keep cost down and to minimise waste. Some important considerations for maximising design efficiency when building brick veneer and frame clad dwellings are listed below:

### Stud Framing

Ensure stud spacings are appropriate for the type of cladding and lining specified. Maximum stud spacing should not exceed 600mm. Ensure that all studs and framing members are plumb and flush at joints to allow accurate and even installation of external cladding and internal plasterboard linings.

### Wall Dimensioning

In the house design consider available timber and cladding lengths when choosing wall heights and dimensioning. Choosing a wall height of 2.8 metres when the style of cladding chosen is available in 2.7m panels can create unnecessary waste and installation costs. Fibre cement products are typically 4.2 metres long, so a wall designed slightly longer will result in an additional joint and associated waste and labour costs. Obviously, this cannot always be avoided, but is worth keeping in mind. Be aware that structural pine framing timber and most cladding products are dimensioned in 300mm increments (ie: studs in 2.4, 2.7, 3.0m lengths, and framing timbers in 3.6, 4.2, 4.8, 5.4, 6.0m lengths, cladding 2.4, 2.7, 3.0, 4.2 lengths).

### Brick Coursing

Ensure that brick coursing matches the dimensioning of windows and doors. Specifically note on the plans the height of openings to match brick coursing schedules, including for increased opening size for fitting frames, and allowance for window reveals and sills (if included).

## 2.7 DESIGN FLEXIBILITY

Framed construction is the most flexible building system to customise a home to the client's needs. There are literally hundreds of external finishes available for the client to choose from including Fibre Cement, Composite Timbers, Natural Timber, Brickwork, Aluminium, Colourbond and Plywoods. When selecting cladding for the home it is important to select based on the below considerations:

### Budget

Many claddings can have varying costs for supply and installation. Selection of cost effective claddings in specific areas such as the dead side of the house can assist with keeping budget down, or free budget up for premium linings on key elevations.

### Design Intent

Depending on the client's preferences for a modern, contemporary, heritage, traditional, Hamptons etc. style of home choosing the appropriate claddings can be simple.

Most cladding suppliers such as James Hardie and CSR can assist with the selection of claddings to best match the design intent, whilst also considering project budget.

### Maintenance and Warranties

Clients may want a low maintenance home, large areas of natural timbers may not be a suitable option. Considering cladding products that have long paint and product warranties.

### Use Reputable Products and Suppliers

Ensure products manufactured by reputable companies are specified. It is important to ensure all manufacturers' products are compliant with Australian Standards and have long lasting reputation for delivering consistent high quality claddings.

Many of the key Australian cladding suppliers have independently tested and Code Mark certified wall systems that allow the builder and home owner to be confident that products exceed the required performance criteria.

## 2.8 WALL CLADDING SYSTEMS

Claddings are defined as a semi-structural covering attached to the outside of the building to protect the building from the effects of weather. The external profile and finish is a key element in the final appearance of the dwelling and can significantly influence the attractiveness and value of the finished home. Not only does the cladding selected protect the home from the penetration of water and wind, it provides sound and thermal insulation, fire resistance, and security. Choice of cladding should take into account these considerations as well as installation practice and finished coatings (not just the latter).

Choosing a cladding can be considered specifically for separate elevations and aspects of the dwelling, achieving optimum physical performance and aesthetic appeal. West and north facing walls are subject to greater exposure.

Walls that are primarily concealed or out of sight can clad with a more cost-effective product keeping overall cost down, or allowing the home buyer a choice of more expensive options.

Composite construction options can integrate a variety of architectural styles with weather board, rendered sheet or expressed shadow lines or cover strips.

## 2.9 THERMAL PERFORMANCE

WA homeowners spend many thousands of dollars each year on home insulation and air-conditioning. This points to the fact that they want a home that is easy to cool in summer, and to warm in winter. Brick veneer and frame clad homes with insulated walls are easier to thermally control than double brick homes.

Modern timber frame construction provides a very efficient method to minimise heat gain and loss from the dwelling. In winter 40% of a home's warmth is lost through the ceilings, and 24% through the walls. In summer the heat flow is reversed with heat flowing in through the ceiling and walls.

Adequate levels of insulation will maintain interior surfaces at a temperature closer to that of the air within the house, and the difference between the inside and outside of the house will be greater.

By increasing the thermal resistance of the ceiling and walls, up to 70% of heat flowing in through bricks or exterior wall cladding is reduced. This can translate into a well-insulated home, being up to 7° C cooler in summer, and 10° C warmer in winter.

The Insulation Council of Australia & New Zealand (ICANZ) Insulation Handbook Part 1: Thermal Performance provides a comparison of the thermal performance of double-brick walls, brick veneer, and frame clad wall systems, showing the difference between insulated and uninsulated wall for each. Go to Part 4 in this guide for ICANZ web address.

# 2.10 ELEMENTS OF FRAME CONSTRUCTION

## Floor Framing

Both above ground and upper floors - have traditionally been constructed using structural pine, and suited to the wall or supporting beam spans designed into the structure. AS1684 provides design and span/spacing requirements to determine timber sizes for joists, bearers, stumps. In addition, AS1684 includes design and installation requirements for engineered timber I-Beams. Refer to AS1684 Part 2 Non-cyclonic for design and conformance requirements, and member span tables.

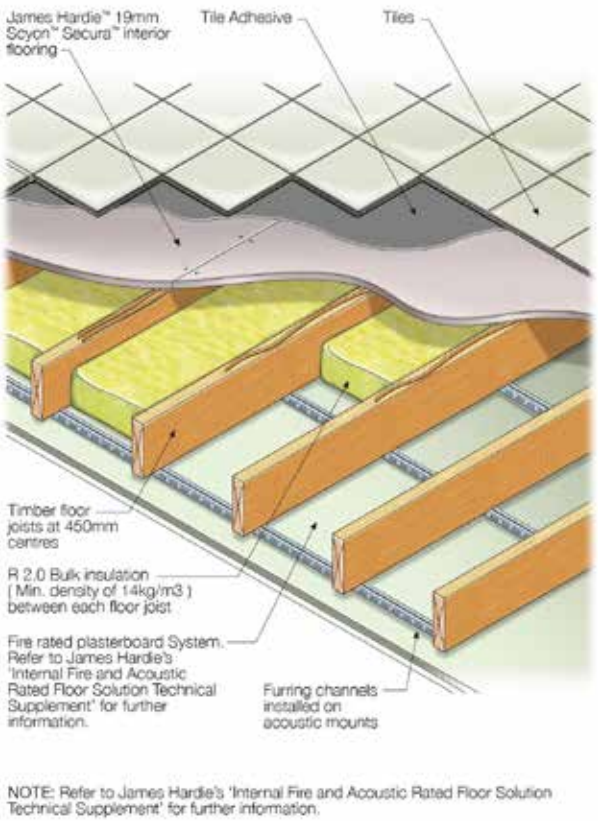
With more open design plan layouts in dwelling design today, and consideration given to installation of services through the floor (plumbing, electrical, smart wiring etc), fabricated timber floor trusses are commonly used and are custom-designed to suit loads, wet area step-downs and air-conditioning services through the floor.

Floor cassettes provide a complete structural system for timber floors, made up of flooring material, floor truss joists, cross-bracing and connections. The timber profile for these trusses is on the flat, which provides a wide 70-90mm surface on which to fix down flooring and install ceilings.

Floor trusses are made to order by licensed fabricators. The trusses are custom designed to exact spans to suit the building, and ends are detailed to suit the type of supporting point (ie: bearing onto a wall, or against a beam).

Floor trusses are an engineered product with the load sharing performance of the trusses and flooring designed to ensure effective dynamic performance.

As upper floor construction in Western Australia has typically been concrete, it is important to consider the characteristics of a floor system to achieve good acoustic performance and 'feel solid' under foot. This can be achieved through selection of structural flooring elements, and by considering the whole floor structure, including flooring, insulation and ceiling lining as a system. Manufacturers such as James Hardie Building Products provide flooring system solutions to achieve excellent acoustic performance and rapid cost-effective installation.




Hardies Scyon Secura Sound Floor System

## Wall Framing

When considering the use of timber framed walls focus should be placed on the wall system (ie: insulation, cladding, lining, etc) required, not just the timber wall framing. The wall is going to be clad on the outside, insulated and lined on the inside. What products will achieve the performance required and achieve the desired appearance and finish that the home buyer desires. Selection of these products will contribute to the structural, thermal and acoustic performance of the wall system, while at the same time meet the regulatory requirements and design considerations.

Companies like James Hardie Building Products and CSR are well recognised for the diversity of fibre cement wall claddings and linings, and design solutions for various structural challenges in building construction, ie: construction techniques for boundary walls, water proof systems for wet areas, and products that meet the requirements for building in bush fire prone areas.

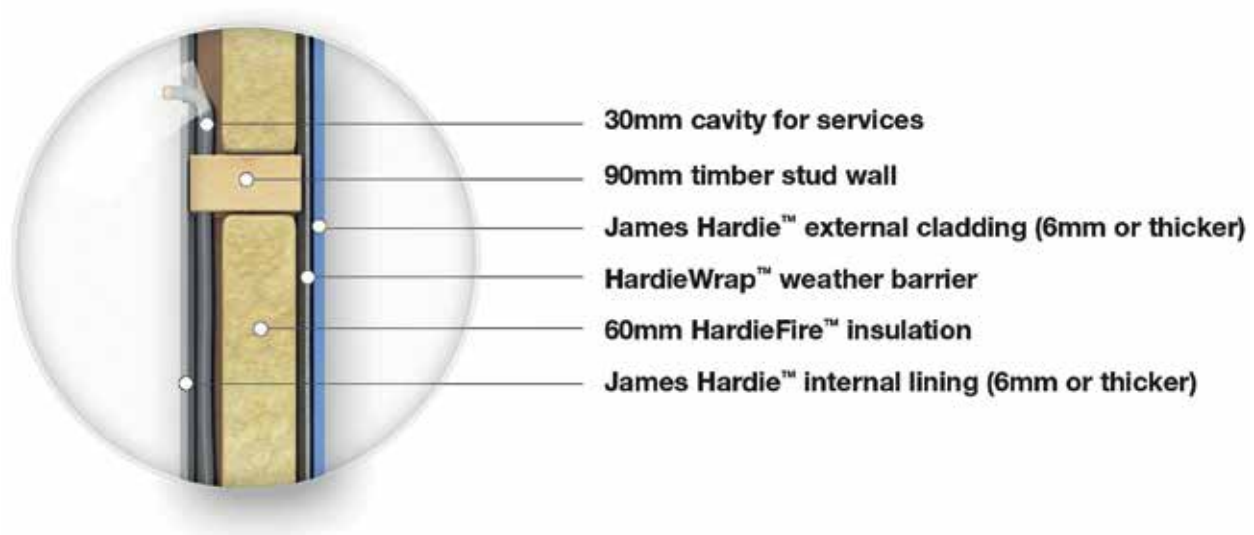
## Boundary Walls

With the decreasing size of housing lots across Western Australia, and a preference to fully optimise the building site, builders are constructing up to the boundary. Boundary walls that are required to achieve fire and acoustic performance in accordance with the National Construction Code (NCC) are becoming a standard solution.

Typically boundary walls are required to achieve a fire rating of 60/60/60, which requires the wall to perform when under fire attack for 60 minutes before being breached. Boundary walls are also required to achieve an acoustic performance of RW Ctr 47 to ensure that impact and ambient noise is minimised from impacting the neighbouring property.

There are many manufacturers that have developed tested and certified wall systems that achieve the required fire and acoustic characteristics determined by the NCC. It is important to consider the implications of the various certified wall systems for construction and occupancy. Some wall systems rely solely

## HardieSmart™ Boundary Wall System





on a single sided system and others require both the internal and external linings to work together to achieve the required performance. Considering also the proximity of the neighbouring property and access to construct, stand and clad the wall which may influence the selection of the wall system. Some systems such as the HardieSmart™ System (refer to previous page) and the CSR boundary wall system are now able to be fabricated off site, and delivered as partially or fully finished panels to simplify and speed up construction particularly where access to the external side of the fire wall is impeded by a neighbouring property.

### Roof Framing

Timber lends itself effectively to the construction of stick or engineered trussed roofs. Both methods are required to conform to specific Australian Standards. The complexity of roof shapes in houses, including stepped and coved ceilings has influenced a preference to build stick roofs in WA in contrast to the preference for trussed roofs in all other states.

AS1684 Residential Timber Construction Code specifies the most efficient member for the purpose intended. However, the home building industry settled on standardised member sizes for typical residential house roofs decades ago. Generally, hips and valleys, rafters, underpurlins and struts, and ceiling joists are the same size from roof to roof. Primarily strutting beams and hangers vary to suit loads and spans. This commonality has helped to maintain an efficiency in supply and scheduling roof frames for home building.

Part of the reason why timber trussed roofs have not experienced high demand in metropolitan Perth is the inherent complexity of roofs in house designs and floor footprints. However, as house shapes simplify in line with smaller lots the benefits of trussed roofs become evident.

A trussed roof is generally faster to build than a stick roof, and because it is designed to transfer roof loads out to perimeter walls the performance of the roof will be better than a stick roof. Truss manufacturers will provide detailed layouts, joint details, onsite installation guide, plus all connectors required for constructing and tying the roof down.

### Wet Areas

The aim with waterproofing wet areas such as shower recesses is to protect the structure of the building and to maintain the amenity of the occupants. Water must be prevented from penetrating behind fittings, linings and into concealed spaces of sanitary fixtures, bathrooms, laundries, etc.

Showers are considered as having the highest risk potential for leaking within internal wet areas, so it makes good sense to keep the water runoff within the designated shower area. The treatment of walls and floors in wet areas is further outlined in the Construction section of the User Guide.

In Part 3 Construction, an illustration on page 39 identifies the critical areas behind the wall tiles or lining in and around shower recesses, baths and basins that must be sealed using waterproofed linings and products.

## 2.11 BUILDING IN BUSH FIRE PRONE AREAS

The severity of bushfires appears to be increasing as climate change influences weather conditions in Australia. Minimising the risk of ember attack, radiant heat and direct flame on buildings requires effective design and specification, and understanding of the performance of building materials. Determining where and how the building is being regulated in order to minimise occupant safety and improve building performance. Building safely means building bushfires out, and it does not mean rejecting timber because it is combustible.

The Bushfire Attack Levels (BAL's) are determined by taking into account the predominant vegetation types, the distance between the vegetation and the building site, and the average lot of land between the building site and the vegetation. Most metropolitan and suburban blocks are classified as BAL-LOW, with no specific requirements due to the very low risk of bushfire attack. However, where suburban blocks are located in close proximity to bushland the bushfire risk requires assessment to determine risk.

Go to the Office of Bushfire Risk Management website www.obrm.wa.gov.au and search 'Map of Bushfire Risk Areas' to determine if a block to be built on is in a bushfire risk area or adjacent buffer zone, and to identify approved BAL assessors to conduct site assessments.

Australian Standard AS3959 Construction of Buildings in Bushfire-Prone Areas provides an extensive guide to building homes while minimising risk against different levels of bushfire risk. This Standard details the construction requirements for the protection of building elements such as flooring systems, external walls, openings and roofs.

The intent of AS3959 is to:

- Improve the ability of a building to withstand attack by bushfire;
- Provide the building with a level of protection while the fire front passes;
- Give occupants a level of protection while a fire front passes.

A description of Bushfire Attack Level's (BAL's) can be found in AS3959. For further information on building with timber in bushfire prone areas download Design Guide #4: Building with Timber in Bushfire-Prone Areas from website www.woodsolutions.com.au

When building houses in bushfire prone areas using traditional building methods allows for the use of timber in the following applications:



### Using Timber Products Internally

In bushfire prone areas there is no limit on the use of timber used internally, whether structural or decorative. Whether you are building using timber framing, timber wall panelling, flooring, stairs, or door and window trims, all can be timber used internally with no limits.

### Using Timber Products Externally

Externally a range of treated timber products, and many high density hardwoods, have inherent natural bushfire resistance and are suited to use for higher BAL's. Seven hardwoods are classified in AS3959 as bushfire resistant. Some of these timbers are available in WA (ie: Eastern States Blackbutt, Spotted Gum, and imported Merbau/Kwila). For these timbers negligible limits apply in the low BAL's, but limits increase as BAL's increase. Of note, Jarrah and Karri have independent certification for use as decking timbers in BAL 19 and 29 zones. Certification was achieved following compliance testing by fire performance authority Exova Warrington (refer to www.fifwa.asn.au). HardieDeck™ is also available particulary suited to all bushfire areas including BAL FZ.

### Using Other External Claddings

Many of the available claddings from key market leaders such as James Hardie and CSR have excellent guides to utilising their products in bush fire prone areas. Many of the claddings can be installed in areas rated up to BAL 29 without the need of additional wall linings or protection.

## 2.12 ENGINEERING

### Early Collaboration with Fabricator

The truss and frame fabricator uses very sophisticated design software when designing the framing requirements for a building. It is recommended that with the intention to have frames and trusses factory fabricated, for the project be discussed with a licensed fabricator early in the proceedings. This will ensure all design engineering and installation issues are addressed and allow the project to progress smoothly.

### Steel Minimisation

Some engineers and designers think structures will be stronger when steel beams and columns are designed into the structure. Steel is costly and often complicated to install. Quite frequently though, the structure can be designed with little or no steel beams or columns required.

### Wall and Roof Frame Bracing

Bracing has been developed to be structurally sound, easy to install, and cost effective. It is used for the bracing of roofs, walls, floors, and other parts of timber frame buildings to resist lateral and uplift wind forces. AS1684 timber framing code specifies bracing design and installation. Structural engineers usually determine the bracing requirements for the building. Truss and frame fabricators can design and certify bracing requirements for the building.

### Design for Efficiency

Designing to maximise direct load paths will minimise the need for structural steel beams and in-frame columns, and simplify frame design and engineer certification.

## 2.13 SOUND CONTROL

### Floor Frames and Internal Walls

Consider acoustics (TVs hung on bedroom walls, bedrooms having common walls with living areas) The National Construction Code (NCC) requires sound transmission controls to be implemented in residential construction.

Various proprietary systems and products available have been designed to provide increased acoustic performance, resisting sound transfer through walls and ceilings. For example, the CSR Gyprock produces a SoundChekTM composed of a high density gypsum plasterboard.

## 2.14 INTERNAL DETAILING

### Plasterboard Linings

Plasterboard is the most commonly used internal lining material for walls and ceilings as it provides a smooth, strong, durable surface in homes. Plasterboard contractors will all be familiar with installing plasterboard to walls and ceilings but there are a few decisions for the builder to make before asking your contractor for a supply and fix quote.

1. 10mm Plasterboard is typically used on walls and ceilings in homes, but a client may wish to upgrade certain areas with specialty products such as acoustic grade boards or impact resisting boards. The builder should clearly mark on plans where the specialty boards are to be used to allow the contractor to prepare a quote.

2. Do you plan to use skirting boards? If there are to be no skirting boards the plasterboard contractor will need to allow for the use of RE/SE plasterboard (one long edge recessed, one long edge square) with the square edge neatly fitted at floor level. The contractor will also need to allow for the stopping of screw heads in the bottom edge of the sheet. If skirting boards are not to be used the plasterboard contractor must be made aware before a quote is prepared as there may be some additional costs.

3. In wet areas a moisture resisting grade of plasterboard such as Gyprock Aquachek™ is required to comply with AS 3740 and the NCC. There is advice given in this guide on where moisture resistant boards must be used in order to comply. Again, mark clearly on the plan where moisture resisting board is to be used.

4. What detail do you plan to use around windows and external doors? You have a choice of timber reveals with timber architraves (less work/cost for the plasterboard contractor but more work/cost for the fixing carpenters), or flushed plasterboard reveals (more work/cost for the plasterboard contractor and less work/cost for the fixing carpenter). There will be an overall cost difference and not all homeowners will like the timber reveal/architrave method. The plasterboard contractor will need to know which method you are using in order to prepare a quote.

5. Will the house be handed over with fully painted walls? Plasterboard manufacturers strongly recommend against handing over a home with bare plasterboard walls as the yellowing of the paper surface when exposed to UV light can cause painting issues when the surface is finally painted.

   Preferably, the finished plasterboard surface should have as a minimum one coat of the recommended sealer/undercoat applied as soon after installation as is practicable. This also helps protect the finished plasterboard surface while other trades complete their work.

All the relevant details for the installation of plasterboard into timber framed homes can be found in the CSR publication 'CSR Gyprock Residential Installation Guide'. A copy can be downloaded from CSR's website (refer to page 42 resources.)

### Oversize Allowance for Door and Window Openings

The type of door and window frames specified will affect the size of opening required for installation of the door frame or window frame.

### Door Frames

Are the door frames solid timber – which will sit inside the wall frame opening, or knock-down steel – which will wrap around the jamb stud. Each will require a different wall frame opening size. Allow an extra 5mm each side and top for fitting the frames. Where door frames are located in passage ways it is recommended to allow a minimum 70mm stud return each side of the opening to ensure effective fitting of the door frame and architrave.

### Window Frames

How are the window frames being fitted. What type of reveal is to be used, i.e.: timber or plasterboard. Is the reveal fitted to the window frame? Allow an extra 3-5mm all round for fitting the window frame.

# 3.1 SCHEDULING AND PROCUREMENT

## Supply Chain

While timber frame and truss fabrication businesses in Perth and regional areas are not large businesses, they enter into formal licenced agreements with nail-plate and connector suppliers who, in addition to supplying machinery, nail-plates and hardware, also provide business and design software along with training, technical support and marketing support. In WA the two major nail-plate suppliers are Pryda and Mitek who actively service their fabricators to ensure good outcomes for the fabricators and their customers. In addition, truss and frame manufacturers, with the support of their nail-plate suppliers work closely with timber suppliers, treaters and distributors.

It is strongly recommended that early communication and collaboration with structural framing suppliers occurs to ensure the builders' supply needs are met, and the products specified are readily available.

## Scheduling Supply

The most important recommendation regarding supply and scheduling of factory fabricated timber framing is to make contact with the fabricator early in the design stage. Fabricator input into specification and design of the framing, discussion on supply options, quote review, approval of frame design variations, and enough time for fabrication and delivery to site will minimise problems later on.

Depending on how large and complex the job is, and how busy a truss and frame plant is at any particular time, the lead time for delivery to site can be from a few days, up to a number of weeks depending on demand at the time. Because there is not the need to fully cure the concrete floor slab, as is required for double brick house construction, timber wall frames can be scheduled for delivery to site one or two days after the slab is poured, and the frames can be stood up and pinned into position, then later bolted down prior to completion.

The Site Manager/ Supervisor should be calling up the wall frames within the required leadtime for manufacture as communicated by the fabricator. If building a two storey house then include delivery of floor trusses and flooring with the ground floor wall frames.

Window frames can be delivered to site around the same time as the wall frames. The roof trusses or stick frame timbers should be ordered at the same time, even though delivery will be a number of days apart. If frame clad then wall wrap and cladding should be delivered to site about halfway through the roof frame construction.

Appendix 3 provides an example of a construction schedule for an approximate 220-240m$^2$ single storey frame clad house, and compares the scheduling time line with that for a double brick house (note that this schedule and comparison is indicative only.)

### Choosing Factory Fabrication or Onsite Construction of Frames

The construction of wall, floor and roof framing can be carried out on site, or fabricated off site using licensed fabricators. On site construction may save some material and labour cost in the short term, but will incur additional construction time, and risk theft of materials on site for a prolonged time. Disposal of timber offcuts is a consideration as well.

Close supervision is required with onsite construction of the framing for the building. Trade skills can be quite variable, with the risk of sub-standard and non-compliant carpentry practices a real issue amongst trades unfamiliar with floor and wall frame manufacture and installation.

### Metro and Regional Truss & Frame Fabrications

In the Perth metropolitan area there are currently ten timber roof truss and frame fabricators in operation. In addition, there are currently eight fabricators in regional centres around the state, located from Albany to Broome.

These fabricators are licensed under agreements through nail-plate suppliers such as Pryda who provide highly sophisticated design software capable of accurate design and determination of all structural requirements customised for each project.

In addition, they supply manufacturing equipment, connector plates and associated hardware for the manufacture of wall framing, roof and floor trusses, and onsite erection.

Computer generated layouts and illustrated design details, plus installation instructions conforming to Australian Standard AS4440 Installation of Timber Roof Trusses and AS1684, guide the carpenter during onsite installation. Early communication with the truss plant design staff to discuss design requirements is highly recommended.

Refer to APPENDIX 1 for a comprehensive list of timber truss and frame fabricators located around Perth and regional areas.

## 3.2 SPECIFYING WALL FRAMES, FLOOR AND ROOF TRUSSES

Timber wall frames, roof and floor trusses are designed and manufactured to a high standard to ensure onsite installation is completed efficiently to exacting standards. Each project, whether large or small, is custom designed using 3D imagery which visualises the built structure. All components are manufactured under strict quality control practices. Bracing is designed for the project, and installed in the factory, ready for efficient installation on site.

### Fabricator Requirements for Quoting & Manufacture

It is the builders' responsibility to provide all required information for the design of frames and trusses. It is recommended that the frame and truss manufacturer confirms with the builder all details prior to manufacture. Invariably house design and specification can have last minute changes, but there must be a cut-off time when final working drawings go to manufacture. The fabricator requires the following information necessary to design and manufacture the frames and trusses:

- A full set of fully dimensioned building plans issued for construction;
- Structural engineering drawings and specifications, including:
  - Site wind classification (ie:N1 or N2);
  - Beam (if stick roof) and bracing layouts;
  - Timber treatment requirements (ie: H2S);

The following information is also required:

**For Wall Frames**

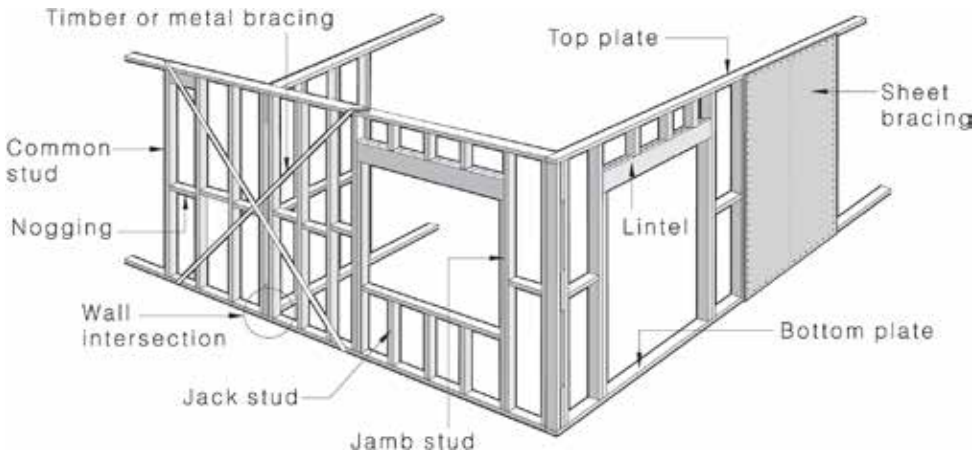
- Preferred stud size;
- Preferred stud spacing;
- Window and door frame specification or opening clearances;

**For Roof Trusses**

- Preference for truss spacing;
- Air-conditioning and hot water system loads and locations;

**For Floor Trusses**

- Type of flooring specified;
- Requirement and location for ducted air-conditioning;
- Requirement for wet area set-down.




Source AS1684 Section 6 Wall Framing.

## Wall Frame Layout & Manufacture

Wall frames are designed to carry roof loads (both single and multiple storey), resist uplift and lateral wind forces, plus configured to have external cladding and internal wall linings attached. Wall sections are broken up into manageable panels for easier onsite handling and erection.

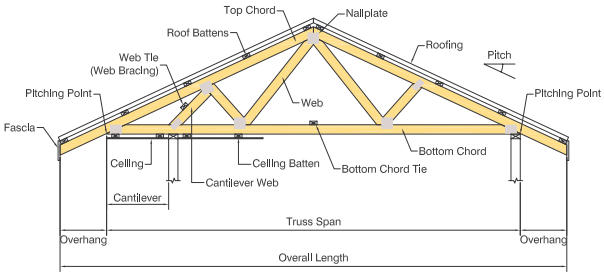
Lintels over openings are designed to carry concentrated loads over openings. Wall panels are numbered to correspond with the wall frame layout. The carpenter receives the layout at the time of delivery, used as a guide for the erection of the walls. Care must be taken to ensure wall panels are installed in the right order and orientation.

## Trussed Roof Layout & Manufacture

Timber roof trusses are designed in accordance with residential structures (NCC Building Classes 1, 2, 3 and 9.) Included with the supply of the roof trusses and associated materials the fabricator will provide a rooftruss layout illustrating location of the individual fabricated components.

Each roof truss is identified with a component number or label that corresponds with a location on the layout. The truss layouts (usually in multiple sheets) will include key installation dimensions, connector types and locations, and, if included in the supply, ceiling and roof batten layouts.

The diagram below illustrates the typical components in a truss roof structure.




Pryda WA Builders Guide 2010

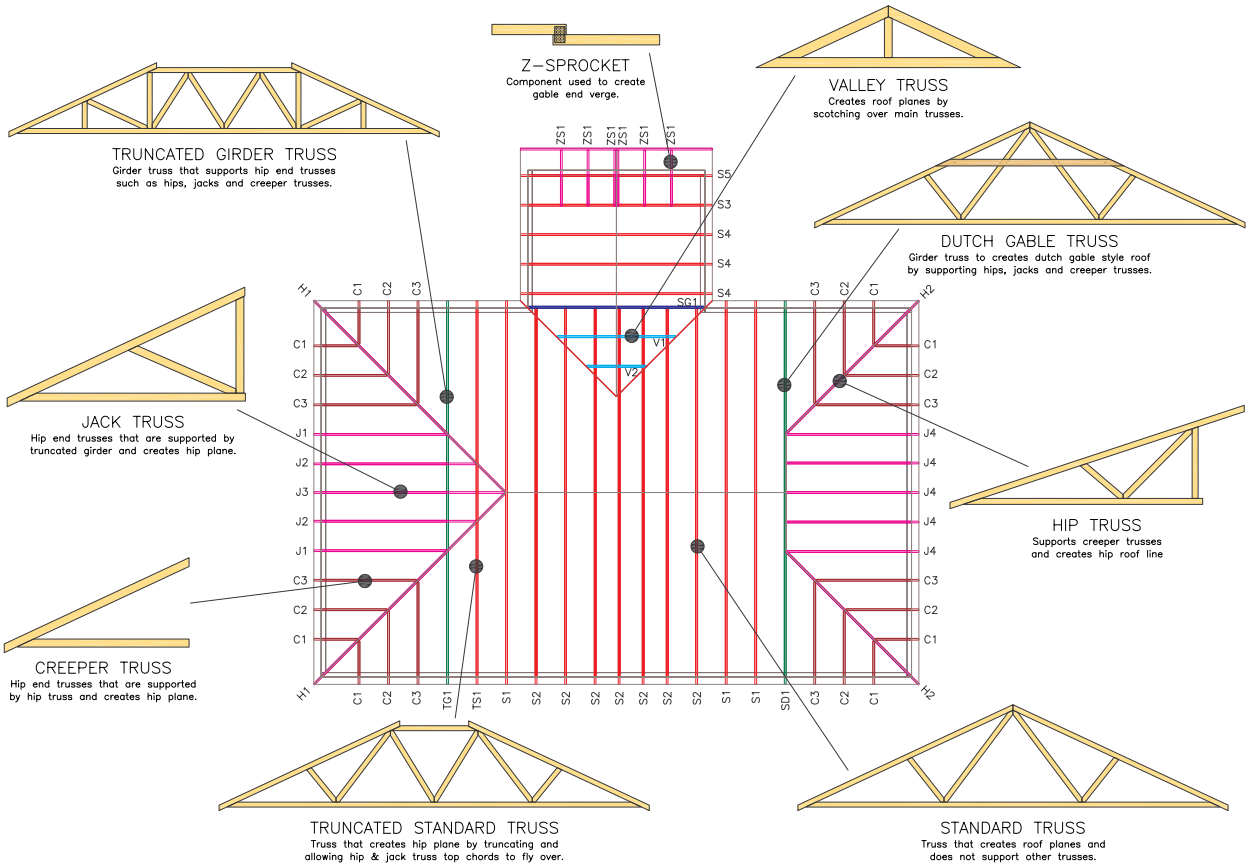
The top diagram on page 29 identifies various truss types common to trussed roofs. An installation guide for trussed roofs is included with the layouts. These specifications and layouts will guide the carpenter during the installation.

## Floor System Selection & Installation

### Conventional Stick Framed Floors

Various configurations of beams, bearers and joists can be used to support flooring at either ground level or upper storeys. Stick-built ground and upper floor framing is designed and constructed to AS1684, Sections 3 & 4, with flooring selected and laid in accordance with Section 5. Specifying seasoned and uniformly dressed pine joists ensures a level floor.

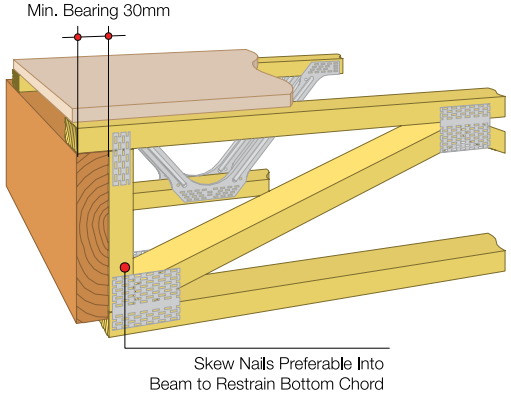
The code specifies blocking between deep joists, used to stiffen the joists, spread floor loads to adjoining floor joists, and share live loads to minimise floor vibration. The type of flooring used will determine the spacing of floor joists – generally 450mm to 600mm apart. Where joists are to be supported by bearers or beams, the joists can be installed between the beams using joist hanger brackets, keeping the floor depth to a minimum.




## Floor Truss Systems

Timber trussed floors provide a complete structural system capable of large spans at shallow depths and are made up of flooring materials, floor truss joists, lateral stiffeners, connectors and bracing.Most truss and frame fabricators include floor trusses in their product range. Floor trusses are custom-designed to suit each specific project, optimising the design efficiency of the floor system, and keeping cost down.

The manufacturer will supply a floor truss layout that clearly illustrates the correct locations of all trusses. The floor truss joists are individually marked with a reference number shown on the floor truss layout. It is important to ensure that designated floor trusses are located in the correct position corresponding to the layout, and are oriented end to end correctly and the right way up. Lateral stiffeners (Strongbacks) are fitted across multiple trusses to connect the floor laterally. Spacing of floor trusses is determined to suit the loads applied and type and thickness of flooring used. Truss spacing should be limited to no greater than 600mm. Floor truss ends can be designed to suit many support options. The floor trusses can be designed to fit between supporting beams, keeping the floor frame depth to a minimum.




Example of floor truss end support detail (pryda.com.au)

## Concrete Floors for Frame Construction

Concrete floor slabs laid for brick walls can have as much as 20mm variation across the slab. The bricklayer absorbs some of this inaccuracy when laying internal bricks to even up wall height. Even then accuracy is not very good. For installing framed walls a level, flat concrete floor slab is required. If the slab is not level the carpenter has to pack the bottom plates to even up and square off the wall frames. Concreters are required to lay a floor slab to much tighter tolerances than for an internal brick wall.

## Floor Construction Loads

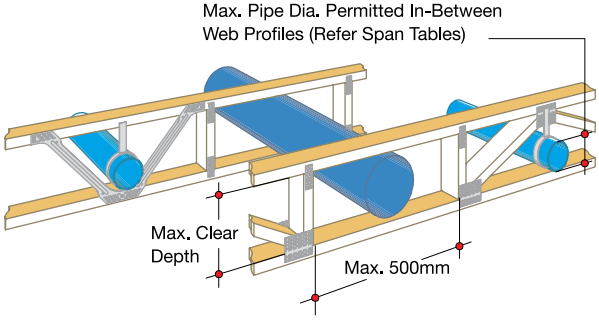
During construction, it is most important to avoid overloading the floor systems beyond what it is designed to carry, ie: with large packs of flooring or plasterboard. Such overloading can damage floor joists and trusses, risking excessive deformation or collapse of part of the floor system.

## Installing Mechanical Services

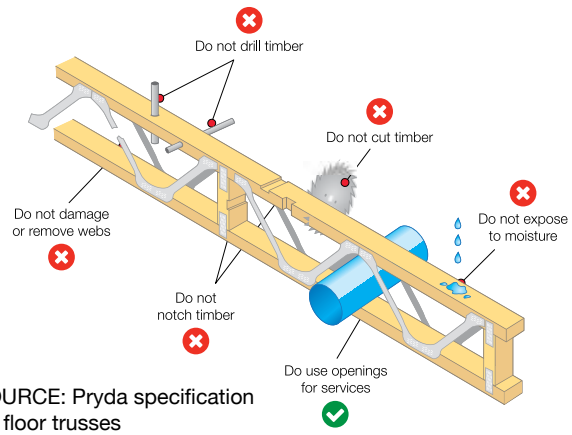
The open web configuration of floor trusses permits plumbing pipes, air-conditioning ductwork and mechanical services to pass through the depth of the truss. Again, it is most important for the builder to discuss the need for such services with the truss designer to ensure during service installation that no engineered components are adversely affected, i.e: provision of a ducting plan so that trusses are designed to accomodate the ducts and pipes. It is important to not over cut joists, components that are not pre-determined to be cut and top plates of floor trusses.

## Onsite Variations:
## Cutting & Notching Floor Joists

Being part of an engineered and custom-made floor system, floor trusses cannot be modified on site. They must not be altered, cut, notched or drilled. If any alterations are required on site it is the builders responsibility to communicate with the floor truss manufacturer and request an certified alteration design.




Making provision for mechanical services
SOURCE: Pryda specification for floor trusses




SOURCE: Pryda specification
for floor trusses

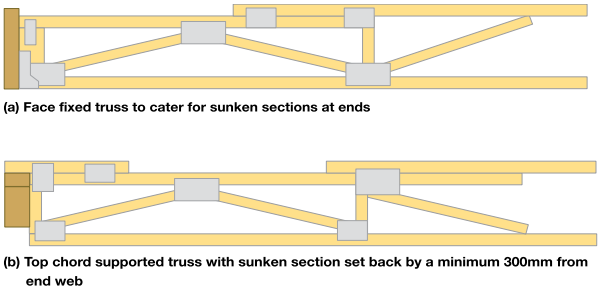
## Wet Area Set Downs

The ability to design and manufacture set down sections into the floor trusses provides significant labour savings in the following situations: In cantilever and balcony areas where the provision of adequate flashing and accommodation of different floor covering material thicknesses is critical. Bathrooms, toilets and other wet areas may also require the floor surface to be set-down.

This will provide significant labour savings when other trades start installing bathroom fixtures, fittings and tiling.

## Floor Cassettes

Floor cassettes provide a fast, cost effective way to install a complete structural flooring system for both ground floor and upper storey applications in a matter of hours not days. The cassettes are precision designed, engineered and fabricated to stringent dynamic performance criteria to eliminate bounce. Onsite waste is all but eliminated. The floor panels can span up to 10 metres, and are only limited in width by transport. Timber panel and fibre-cement flooring materials can be fitted to the cassette in the factory.




Set-down and recess sections
SOURCE: Pryda Installation Guideline 2015

A number of truss and frame fabricators manufacture floor cassettes. The cassettes use timber floor trusses to form a structural system using flooring material, insulation (optional), strong-backs, connections and bracing. Fabricated floor cassettes reduce onsite installation significantly, using lifting connectors fitted in the factory. Working at height risk can be reduced with much of the upper storey able to be installed from below.

## Erecting Temporary Bracing

Temporary bracing is necessary to support wind and construction loads on the building during construction. For single storey buildings temporary bracing should be installed in both directions evenly distributed prior to framing up the roof. Temporary bracing shall be the equivalent of 60% of permanent bracing required.

Floor cassette installation

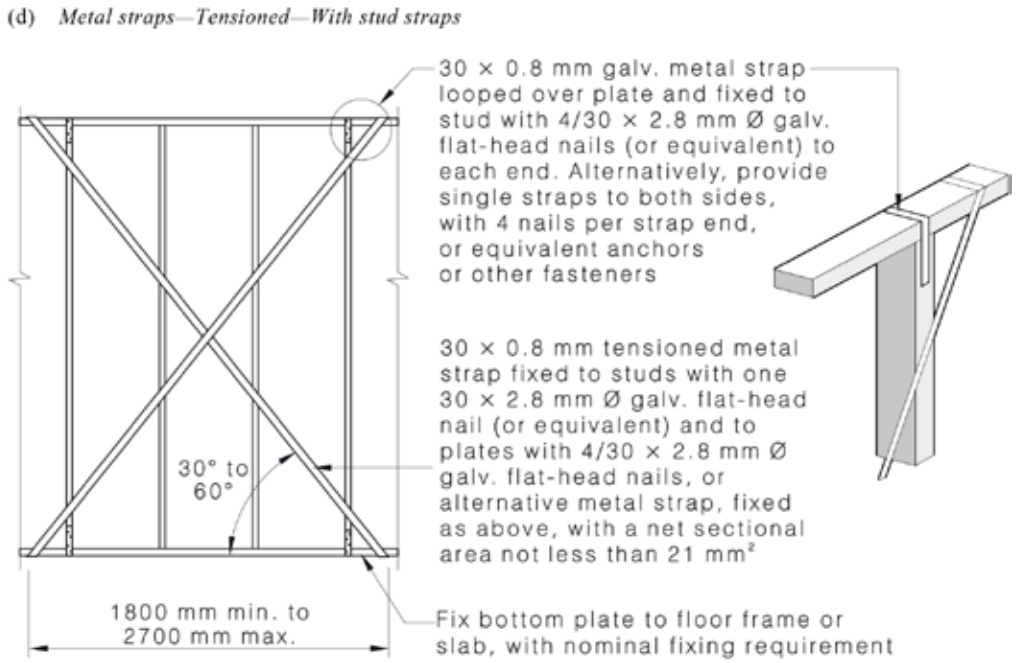



Diagram 1: Diagonal tensioned strap cross-bracing.
SOURCE: AS1684 section 8. Racking and sheet forces.

## Bracing Framed Walls

Wind produces horizontal loads on buildings that must be transmitted through the structure to the foundation. Permanent bracing shall be provided to enable the roof and wall framework to resist horizontal wind forces applied to the structure. It is important to note that wind forces on unclad frames can be greater than onto completed clad frames. It is imperative that bracing is determined, specified and installed correctly to ensure effective resistance to lateral and uplift wind forces.

AS1684 details the steps required to determine the bracing requirements of wall frames. The most common bracing types used are tensioned strap cross-brace and plywood/OSB board bracing. The buildings' bracing requirements can be determined by the structural engineer.

However, the benefit of factory fabrication is the suppliers' capacity to design and install the bracing requirements during the manufacturing process. Refer to AS1684.2 Section 8 Racking & Shear Forces, for determination and selection of bracing.

Plywood Bracing - requires onsite installation

## Panel Bracing

Panel bracing, ie: plywood or fibre cement bracing is often used for wall bracing because it achieves very high racking resistance over short frame lengths. The thicker the panel used the higher the strength rating. However, it is required to be installed on site after the frame has been stood up and squared off. AS1684 Section 8 on Bracing specifies the design rating per metre and the installation requirements.

Nailing compliance is very important to the bracing performance of panel bracing. One disadvantage of using panel bracing on frame clad walls is the thickness of the panel which can cause alignment problems with installation of internal linings or external claddings. This is more an issue with thicker plywood (7mm plus). Recessing it into the frame is time consuming and costly.

## Alternative Bracing Solutions

To minimise onsite installation of ply bracing there are a number of engineered certified alternative wind bracing systems developed by the fabricator suppliers for narrow wall panels. These are built into the frames in the factory, and replace the onsite material and labour cost.

Examples are dual (over/under) short cross-braces using strap or speedbrace, and vertical truss braces. The design and specification of these systems can provide very high lateral strength ratings (kN) without affecting the wall openings design or installation of claddings and linings.

Narrow wall strap bracing unit.

Vertical trussed narrow wall brace.

## 3.3 FRAME CONSTRUCTION PRACTICE

### Wall Frames: Supporting Stick Roofs

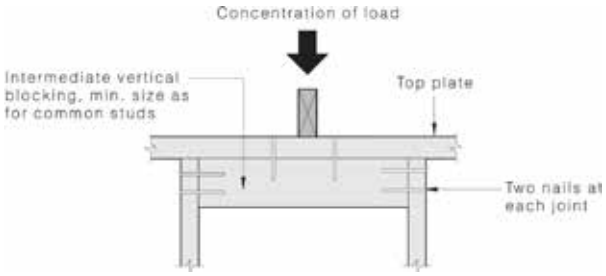
Stick roofs, pitched off the internal leaf of the perimeter walls, are designed to transfer roof loads onto internal walls via roof beams, underpurlins and struts. When building a stick roof on top of timber wall frames, all wall frames are determined as loadbearing. The top plate will generally require 45mm thickness. Internal wall frames are not set down as required for a truss roof. AS1684.2 Residential Timber Frame Construction Code specifies roof and wall frame design and materials requirements. Truss and frame fabricators can design and fabricate the wall frames to suit.

### Wall Frames: Supporting Trussed Roofs

Wall frames that support timber trussed roofs are designed as (1) Loadbearing frames designed to carry roof loads, and (2) Non-Loadbearing wall that do not support the roof trusses. The Loadbearing wall frames are typically the perimeter walls, but can include some internal walls where larger spans warrant use of an internal support for greater design and performance efficiency. The top plate of these walls is usually doubled up with a ribbon plate installed on site. Non-Loadbearing walls are designed to be slightly lower than loadbearing walls, with the roof truss bottom cord clearing the top of the frame by three to four centimetres, allowing the ceiling batten (if used) to extend over the wall frame without loading onto it.

### Concentrations of Load

Roof struts should be located over studs, and if large roof areas and tile roof loads are to be supported, additional studs are installed to carry point loads. Refer AS1684.2 Section 6.3.2 for determination of studs to carry concentrations of the load. Concentrated loads from strutting beams should be located over double studs, or where not suitable, then a thickener block is installed immediately under the top plate (refer AS1684.2 Section 6.2.2.3).




Top Plate stiffening
SOURCE: AS1684.2 SECTION 6

## Roof and Wall Tie Down

It is essential with any building structure that the resistance to vertical and lateral wind forces and component loads are stabilised with connections that will achieve effective resistance to such forces. AS1684 specifies connector types applicable to the design loads applied. These connectors are readily available, and when specified with wall and roof framing are supplied by the fabricator or hardware supplier.

A major benefit of timber frame construction is the continuity of tie-down between the roof frame and walls provided by using easy to install metal connectors and straps. AS1684 specifies numerous deemed to comply connections and tie-down systems to effectively strengthen the structure against loads applied.

Should roof or wall framing be designed in-house by the builder, and constructed onsite, care must be taken to ensure the engineered building design includes a complete tie-down specification to be used by the carpenter onsite. It is imperative that the site supervisor is knowledgeable on the connection and specific nailing requirements. Too often nailing is below spec for the installation required, putting the structural integrity of the dwelling at risk. Refer to Part 4 of this Builder User Guide for where to find specification on connector types and associated installation requirements.

## Installing Exterior Cladding

Aside from the importance of the structural integrity of the dwelling framework, it is the installation of exterior cladding, trims and highlights enhanced further by painting and final product finishing that provides a quality exterior which stands out from the usual brick walled houses. Reliable trades with a focus on quality installation and finishing makes or breaks the appearance of the completed exterior.

When it comes to installation of external cladding, to ensure a quality and efficient installation process, a clear understanding is required of the installation sequence and tolerances recommended by the manufacturer. Most cladding products will have a performance guarantee for their products which is voided if the product is not installed and finished correctly. Many of the cladding product manufacturers can provide technical support and off-site or onsite training to ensure installation is carried out with the correct prior knowledge.

Has the installing team been trained for the installation of the cladding product specified? Have the correct quantities been supplied to site, including ancillary items (starter strip, batten nails, corner trims, etc). Has sufficient waste factor been allowed for the cladding product specified? James Hardie provide a number of online calculators to assist with these questions. Go to www.accel.com.au.

Early collaboration and communication between builder and supplier, and installing trades is required to ensure all parties are completely familiar with the supply and installation process. Refer to the Resource page at the back of this User Guide for some supplier websites and contact details.

Linea cladding (James Hardie)

## Boundary Walls

Building to the boundary of residential (often narrow) lots requires walls to be installed and finished from the building lot side only. When there is no access from the adjoining lot all preparation and erection must be carried out from within the building site.

Therefore all construction and finishing to the wall exterior must be carried out prior to standing up the boundary wall panel. The boundary wall will need to be constructed in section panels, requiring a method of joining which will effectively self-seal on the outside. Structural integrity, reliable water proofing, acoustic and thermal performance are important features to ensure the effective performance for the life of the building.

Both James Hardie and CSR have developed boundary wall solutions used in home building. For more information refer to HardieSmart™ Wall Systems and CSR's The Red Book.

Erecting Boundary Walls

Narrow Lot Housing

### Moisture Control: Breathable Membrane

A breathable membrane is a water-resistant wrap which will allow water vapour to pass through when there is a difference in humidity on opposite sides of it. Breathable membranes are installed on the outside of framed walls under the exterior cladding material.

The breathable membrane is an integral part of the wall frame system, with three primary functions:

- To shed moisture and restrict any rainwater which penetrates past the exterior cladding;
- To act as a breather material allowing any moisture within the wall cavity to escape by diffusing through the membrane to the exterior;
- To act as a wind barrier to restrict wind movement through the wall at window and door frames;
- To provide some weather protection during construction.

The membrane should be installed to the manufacturers instructions using corrosion resistant fixings. Refer to the cladding manufacturers installation guide.

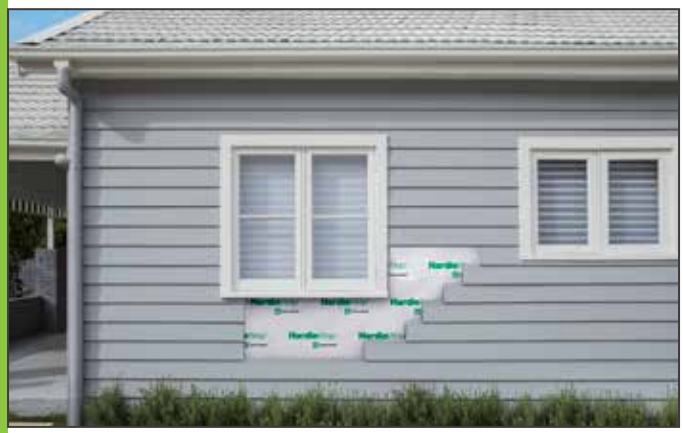
### Installing Plasterboard Linings

For a complete description of the installation procedure for interior plasterboard wall linings refer to the CSR Gyprock Residential Installation Guide, accessible from the CSR Gyprock website (Refer to the Resources and Website listing at the back of this guide).

The wall frames must be designed for the applied load with studs at the required spacing applicable for the wall lining to be installed. All framing members are to be straight (within AS1684 tolerances) and suitable for the application plasterboard sheets. The manufacturing and quality control practices associated with factory fabricated wall frames ensures any miss-match at frame joints and junctions are minimised, requiring limited planing of the frame prior to installing the plasterboard.

### Size to Suit Wall Height

Ensure sheet size delivered to site corresponds with the wall height. Ideally, in keeping material and labour costs down, consideration of wall height at the design stage should account for optimum plasterboard sheet width.



Cut-away of External Cladding to Reveal Membranane Under

Greater flexibility when plastering framed walls.

**Installing Windows and Internal Reveals**

With the dominance of double brick wall construction over many decades, window frames manufactured in WA have been designed for double brick walls, fitting onto the cavity on the inside of the external leaf. Internal walls are rendered and plastered including the window openings to finish flush with the window frame.

Framed walls currently require the wall lining installer to line the reveal of the window openings.

This is a very time consuming process, sometimes requiring a three stage install and finishing process by the contractor which incurs the greatest single cost when lining framed walls.

Aluminium Window frames manufactured in WA are currently not designed for framed internal walls. In contrast in the eastern states window manufacturers include timber reveals around the frames, fitted into the window opening and flushed off by the contractor when installing the wall linings.

**Floor Gap**

When fitting plasterboard sheets to the walls it is recommended to allow a small (10mm) gap between the bottom edge of the sheet and floor. This prevents pressure on the sheet causing any sheet deformation or buckling.
The following details illustrate two options for finishing reveals around window openings.

FIG 1: WINDOW WITH PLASTERBOARD REVEAL

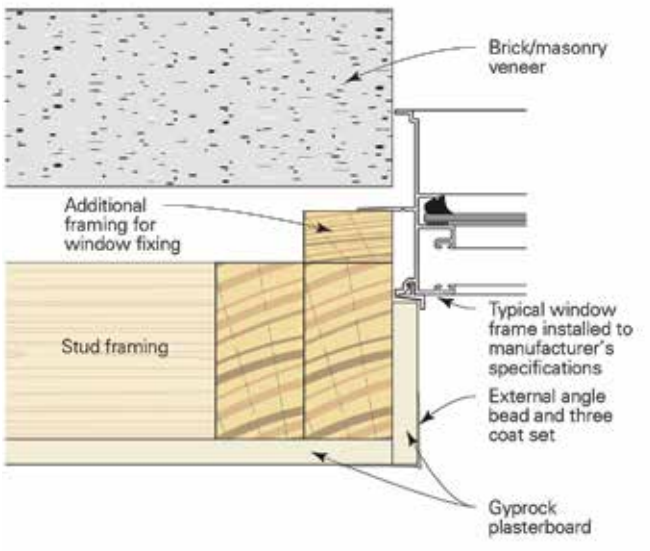
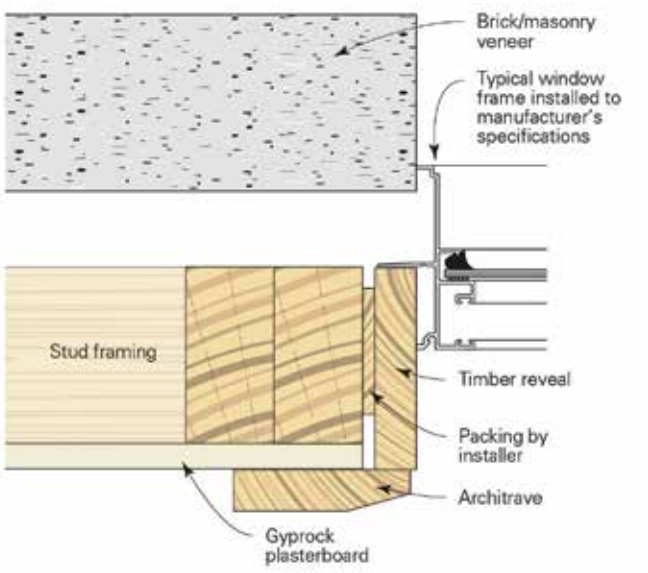



FIG 2: WINDOW FRAME WITH TIMBER REVEAL




Illustrations courtesy of CSR Gyprock®

### Waterproofing Wet Areas

The most common maintenance issue that arises in houses, irrespective of wall type, is water penetration and leakage in shower recesses and bathrooms. To minimise the risk of water damage to walls and floors, thorough preparation is required. The following is provided as a guide.

### Shower Recesses and Enclosed Showers

Waterproofing (membrane) needs to be applied on the floor and up the wall a minimum 150mm, or 25mm above maximum water level. Vertical joints need to be waterproofed to minimum 1800mm height. The wall lining needs to be water resistant, not waterproof. Hardie Villaboard is water resistant so only the joints need to be waterproofed, not the whole wall area. Both Villaboard and WR plasterboard are both water resistant, but plasterboard manufacturers don't warrant their boards without the full membrane installed.

### Wet Area Floors and Outside the Shower

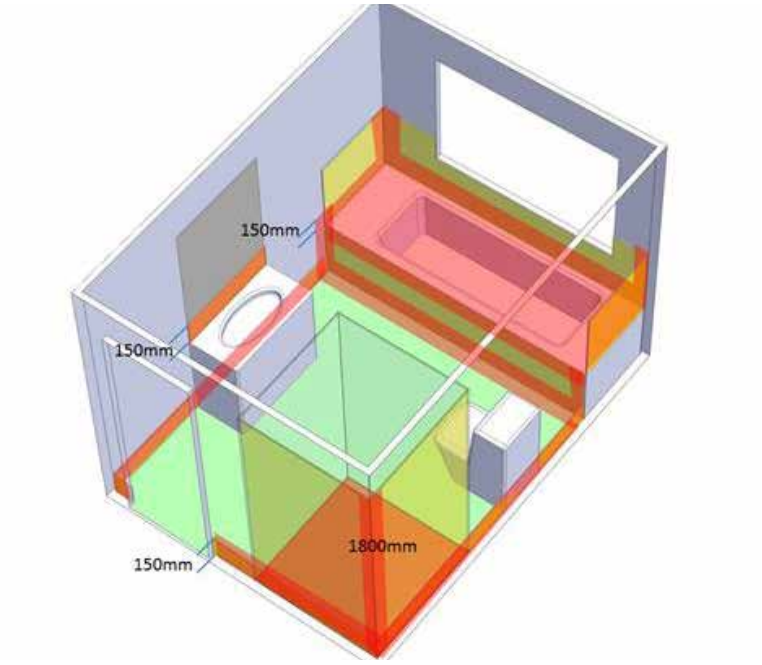
If particleboard is used, it must be fully waterproofed (tanked with membrane), with waterproofing applied to the floor to wall junction. If fibre cement is used, only the floor to wall junction needs to be waterproofed. The FC sheet joints don't need to be waterproofed.

### Around Baths

The platform and all junctions need to be waterproofed. The following illustration summarises where waterproofing is required, highlighted in Red.

### Behind Sinks and Basins

Waterproofing applied 150mm up-stand, and around the taps.



# 3.4 FOLLOWING TRADES

## Installation Services

To the experienced plumber and electrician installation of plumbing and electrical services into timber framed walls is simpler than into masonry walls. It is recommended that a site meeting be held with the plumber, electrical and communications contractors to clarify do's and dont's when services are installed.

## Plumbing, Electrical and Communications rough-in

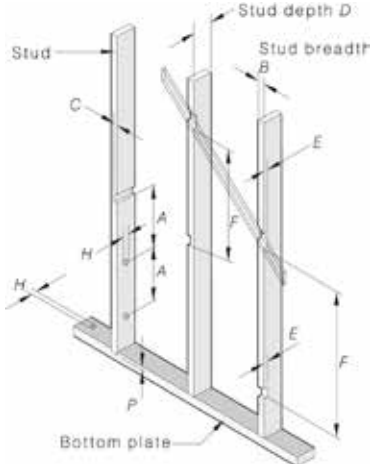
With timber-framed houses, the plumber and electrician will need to drill and notch the wall studs and plates to run pipes through where they need to be. AS1684 describes limits on size and location of notches and holes in studs and plates (refer diagram and table below.) If the holes that are cut in the frame are deemed to be 'excessive', these structural members will need to be appropriately reinforced or replaced to retain structural integrity.

Wall strap bracing must never be cut or removed. Plywood sheet bracing can be penetrated but holes must be kept to a minimum. Additional support blocks can be installed but must remain flush with wall frame. It is important that these service trades know exactly where everything's supposed to go, and the exact specifications for whatever's being installed so that there's less room for error or confusion. The precise locations of the electrical fittings should be marked on the floor so that they can be easily located and cut out when the plasterboard goes up for your home's interior walls.

## Notching, trenching and holes in studs and plates

Ensure when nailing fittings to the framing that the fittings and nail and screw heads are finished as flush as possible with the framing surface. This will minimise problems with installation of plasterboard.

The maximum size of holes, notches, trenches and cuts in framing components is described in AS1684, with limits applied as illustrated below (AS1684 Cl. 6.2.1.4, and Notches and Holes table). Holes in studs and plates are required to be located within the middle half of the depth and breadth of the component respectively.




| HOLES AND NOTCHES IN STUDS AND PLATES | | | |
|---|---|---|---|
| SYMBOL | DESCRIPTION | LIMITS NOTCHED | LIMITS NOTCHED |
| A | Distance between holes and/or notches in stud breath | Min 3D | Min 3D |
| H | Hole diameter (studs and plates) | Max 25mm (wide face only) | Max 25mm (wide face only) |
| C | Notch into stud breath | Max 10mm | Max 10mm |
| E | Notch into stud depth | Max 20mm (for diagonal cut in bracing only) See Notes 1 and 2 | Not permitted (See Note 1) |
| F | Distance between notches in stud depth | Min 12B | N/A |
| P | Trenches in plates | 3mm max | |

NOTES
1 A horizontal line of notches up to 25mm may be provided for the installation of bars.
2. Except as permitted for diagonal cut in bearing, notches up to 20mm may occur in every fifth individual stud.
3. For additional jamb stud requirements, see figures 6.5 and 6.9
4. Top and bottom plates in internal non-loadbearing and non-bracing walls may be discontinuous up to 60mm (cut or drilled) to permit installation of services provided that, at the disconuity, the plates are trimmed or otherwise reinforced to maintain lateral and longitudinal integrity of the wall.

## 3.4 TRADE SKILLS

With just 2-3% of homes in the Perth metrpolitan area prior to 2015 being fully framed construction, carpentry trades have historically had little experience in roof construction practice. However, with an anticipated growth in alternative building systems (estimated by the State Government to be at least 20% of the market in the next 10-20 years), carpenters are well placed to evolve their skills in response to an increasing demand for timber framed houses.

Whether framing up the home on site or standing prefabricated frames and trusses delivered to the site, carpentry trades underpin the savings in time and cost of building timber framed homes. With efficient onsite coordination and materials availability onsite, the carpenters can have a house to lock-up within two to three weeks. Carpentry trades are also very adaptive to associated skills such as installing exterior cladding, interior linings, and timber panelling.

In recognising the greater focus on timber framed construction and alternative building systems the trade training and apprenticeship programs in WA are being modified to incorporate development of skills required to transition to timber framing technologies, materials and construction methods. In addition industry-based skills devlopment training is available.

Industry Associations (HIA and MBA) are conducting upskilling training course for builders and carpenters. Contact your local Association representative for training course information.



This section of the Builder User Guide for timber frame construction provides references and resources readily available to assist builders with specification, selection and installation of systems and materials applicable to building using timber framing.

## REFERENCES AND RESOURCES


- Australian Government, Your Home: Australia's guide to environmentally sustainable homes
- CSR Gyprock, Residential Installation Guide (Ed. Oct 2015);
- CSR Gyprock, The Red Book (Ed. Feb 2017);
- CSR Bradford Insulation, Building Design Guide (2015);
- James Hardie Building Products,
- James Hardie Building Products, Technical Supplement: Construction of Buildings in bushfire prone areas to AS3959;
- James Hardie Building Products, HardieSmart Systems (2014);
- MiTek Australia, MiTek Guide (Edition 2);
- Pryda Australia, Pryda's Guide for Western Australian Builders on Prefabricated Timber Truss & Frame (Nov 2010);
- Pryda Australia, Installation Guide for Timber Truss Systems (June 2016);
- Pryda Australia, Specification Guide for Floor and Rafter Truss Systems (April 2012);


## WEBSITES FOR TECHNICAL INFORMATION AND RESOURCES

| | |
|---|---|
| • CSR BUILDING SOLUTIONS | www.csr.com.au |
| • CSR BRADFORD | www.csr.com.au/bradford |
| • PRYDA | www.pryda.com.au |
| • JAMES HARDIE BUILDING PRODUCTS | www.jameshardie.com.au |
| | www.accel.com.au |
| | www.looksmarthomes.com.au |
| • MITEK AUSTRALIA | www.mitek.com.au |
| • SCYON WALLS AND FLOORS | www.scyon.com.au |
| • SCYON DESIGN IDEAS | www.scyon.com.au/designideas |
| • TIMBERLINK AUSTRALIA | www.timberlink.com.au |
| • WESPINE INDUSTRIES | www.wespine.com.au |
| • WOOD SOLUTIONS | www.woodsolutions.com.au |
| • INSULATION COUNCIL OF AUSTRALIA & NEW ZEALAND | www.icanz.org.au/insulationhandbook |

## ACKNOWLEDGEMENTS


CSR Gyprock

Pryda

James Hardie Building Products

Timberlink Australia

Wespine Industries

Forest & Wood Products Australia

woodsolutions.com.au

# 5.1 LIST OF FRAME AND TRUSS MANUFACTURERS

## PERTH METROPOLITAN AREA

| PRYDA MANUFACTURERS | | |
|---|---|---|
| **COMPANY/LOCATION** | **ADDRESS** | **EMAIL/WEBSITE** |
| **BIBRA LAKE**<br>Worldwide Timber Traders | 179 Barrington Road, Bibra Lake<br>Ph: 08 9418 3222 | serge@wwtt.com.au<br>www.wwtt.com.au |
| **BULLSBROOK**<br>Engineered Timber Products | Lot 4 Morrissey Road, Bullsbrook<br>Ph: 08 9571 1770 | jenny@engineeredtimber.com.au |
| **HENDERSON**<br>Peak Trusses | 5 Egmont Road, Henderson<br>Ph: 0438 402 923 | manager@peaktrusses.com.au<br>www.peaktrusses.com.au |
| **MIDLAND**<br>Midland Timber Co. | 30 Clayton Street,Midland<br>Ph: 08 9274 8077 | sales@midlandtimber.com.au<br>www.midlandtimber.com.au |
| **ROCKINGHAM**<br>WA Spantruss | 4 Lodge Road, East Rockingham<br>Ph: 08 9439 6788 | waspantruss@waspantruss.net.au<br>www.waspantruss.net.au |
| **WANGARA**<br>WA Timber Sales | 57 Triumph Avenue, Wangara<br>Ph: 08 9302 2311 | sales@watimbersales.com.au<br>www.watimbersales.com.au |

| MITEK MANUFACTURERS | | |
|---|---|---|
| **COMPANY/LOCATION** | **ADDRESS** | **EMAIL/WEBSITE** |
| **ARMADALE**<br>AG Trusses | 10 Keates Road, Armadale<br>Ph: 08 9399 8336 | perthsales@agtrusses.com.au<br>www.agtrusses.com.au |
| **MUNDIJONG**<br>Colli Timber & Hardware | Lot 10, South West Highway, Mundijong<br>Ph: 08 9525 1144 | cesarecolli@colli.com.au<br>www.colli.com.au |
| **NEERABUP**<br>The Truss Factory | Unit4/9 Warman Street, Neerabup<br>Ph: 08 9404 6111 | wayne@thetrussfactory.com.au<br>www.thetrussfactory.com |
| **PICKERING BROOK**<br>Trade Price Frames & Trusses | 34 Carinyah Road, Pickering Brook<br>Ph: 1300 016 899 | quotes@tpft.com.au<br>www.tpft.com.au |
| **ROCKINGHAM**<br>Independent Timber Supplies | 109 Dixon Road, Rockingham<br>Ph: 08 9592 3737 | sales@indtim.com.au<br>www.indtim.com.au |

## REGIONAL AREAS

| PRYDA MANUFACTURERS | | |
|---|---|---|
| **COMPANY/LOCATION** | **ADDRESS** | **EMAIL/WEBSITE** |
| **BROOME**<br>Kimberley Roof Design | 5 McDaniel Road, Broome<br>Ph: 08 9192 5515 | luke@krdesign.com.au<br>www.krdesign.com.au |
| **DUNSBOROUGH**<br>Cape Timber Trusses | Ph: 08 9755 8143 | capetruss@bigpond.com |
| **ESPERANCE**<br>Roofline Trusses | 86 Norseman Road, Esperance<br>Ph: 08 9071 1058 | concreteworld@aapt.net.au |
| **GERALDTON**<br>Geraldton Roof Trusses | 7 Bateman Street, Geraldton<br>Ph: 08 9938 2230 | gtruss@iinet.net.au |

| MITEK MANUFACTURERS | | |
|---|---|---|
| **COMPANY/LOCATION** | **ADDRESS** | **EMAIL/WEBSITE** |
| **ALBANY**<br>Rainbow Frame & Truss | 17-21 Cockburn Road, Albany<br>Ph: 08 9842 1533 | richard@rainbowft.com.au<br>www.rainbowft.com.au |
| **BUSSELTON**<br>Pro-Truss | Lot 183 Cook Street, Busselton<br>Ph: 08 9754 1977 | sales@protruss.com.au<br>www.harmantimberprotruss.com.au |
| **DONGARA**<br>Dongara Truss & Frames | 11 Mason Crescent, Dongara<br>M: 0427 059 783 Ph: 08 9927 2708 | jphaug@hotmail.com |

## 5.2 TYPICAL CONSTRUCTION SCHEDULE FOR A 225M2 SINGLE STOREY HOUSE

(INCLUDES ESTIMATED PROGRESS PAYMENT SCHEDULE)

FRAME CLAD DOUBLE BRICK

| ACTIVITY - WEEK | DAYS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Progress payments | | | | Pp1 | | Pp2 | | Pp3 | | | Pp2 | | | Pp3 | | | Final pp | | | | | | Final pp |
| EARTHWORKS | 2 | | | | | | | | | | | | | | | | | | | | | | |
| CONCRETOR: FOOTINGS | 1 | | | | | | | | | | | | | | | | | | | | | | |
| PLUMBER: WASTES | 1 | | | | | | | | | | | | | | | | | | | | | | |
| CONCRETOR: SLAB | 2 | | | | | | | | | | | | | | | | | | | | | | |
| SLAB CURE | 7 | | | | | | | | | | | | | | | | | | | | | | |
| WALL FRAMES/WRAP | 4 | | | | | | | | | | | | | | | | | | | | | | |
| LOAD SLAB | 1 | | | | | | | | | | | | | | | | | | | | | | |
| BRICKLAYER | 15 | | | | | | | | | | | | | | | | | | | | | | |
| ROOF CARPENTER | 9 | | | | | | | | | | | | | | | | | | | | | | |
| CHASE WALLS | 1 | | | | | | | | | | | | | | | | | | | | | | |
| TUBE OUT: PLBR / ELEC | 5 | | | | | | | | | | | | | | | | | | | | | | |
| GUTTERS | 2 | | | | | | | | | | | | | | | | | | | | | | |
| ROOF COVER | 5 | | | | | | | | | | | | | | | | | | | | | | |
| EXTERNAL CLADDING | 7 | | | | | | | | | | | | | | | | | | | | | | |
| GYPROC WALLS/CEILINGS | 10 | | | | | | | | | | | | | | | | | | | | | | |
| PLASTERER: FLOAT n SET | 12 | | | | | | | | | | | | | | | | | | | | | | |
| CEILINGS | 5 | | | | | | | | | | | | | | | | | | | | | | |
| 2nd FIX/CABINETS | 5 | | | | | | | | | | | | | | | | | | | | | | |
| PLUMBER: SANIWARE | 2 | | | | | | | | | | | | | | | | | | | | | | |
| CERAMIC TILER | 10 | | | | | | | | | | | | | | | | | | | | | | |
| PAINTER | 10 | | | | | | | | | | | | | | | | | | | | | | |
| PAINTER (EXTERIOR) | 6 | | | | | | | | | | | | | | | | | | | | | | |
| PAINTER (INTERIOR) | 4 | | | | | | | | | | | | | | | | | | | | | | |
| PLBR / ELEC: FITOUT | 2 | | | | | | | | | | | | | | | | | | | | | | |
| SCREENS/MIRRORS | 2 | | | | | | | | | | | | | | | | | | | | | | |
| GRANO | 4 | | | | | | | | | | | | | | | | | | | | | | |
| GARAGE DOOR | 1 | | | | | | | | | | | | | | | | | | | | | | |
| BRICK PAVER | 4 | | | | | | | | | | | | | | | | | | | | | | |
| HOUSE CLEAN | 2 | | | | | | | | | | | | | | | | | | | | | | |
| SITE CLEAN | 1 | | | | | | | | | | | | | | | | | | | | | | |
| CARPETS / BLINDS | 1 | | | | | | | | | | | | | | | | | | | | | | |
| RETIC / LANDSCAPING | 4 | | | | | | | | | | | | | | | | | | | | | | |
| DETAIL CLEAN | 2 | | | | | | | | | | | | | | | | | | | | | | |
| FINAL INSPECT | 1 | | | | | | | | | | | | | | | | | | | | | | |

PP1/2/3 - Progress Payments

## 5.3 COMPLETION CHECKLIST - TIMBER WALL FRAME

| | | |
|---|---|---|
| OWNER: | | |
| BUILDER: | | |
| PROJECT: | | |
| PROJECT ADDRESS: | | |
| SUPERVISOR: | PHONE NO: | |
| DATE: | JOB NO: | |
| **COMPONENT** | **✓/ ✗** | **ACTION/COMMENT** |
| **WALL FRAME** | | |
| Check plans and any contract documents for any variations. | | |
| Room set-out and wall locations consistent with approved plans. | | |
| Wall frames plumb and straight to receive wall finishes. | | |
| Stud to plate tie-down fixings installed to manufacturers specification. | | |
| Bottom Plate connection to floor slab at correct spacing and minimum 50mm from edge. | | |
| All wall bracing in position as per approved plans and correctly nailed off to manufacturers requirements. | | |
| Non-load bearing walls set down minimum ceiling batten depth plus 10mm below height of loadbearing walls. | | |
| Internal door opening sizes consistent with plans. | | |
| Bottom plate removed from all internal doorways. | | |
| Lintel sizes installed as per approved plan. | | |
| Cuts and notches into frame components by Electrician and Plumber do not exceed code limits. | | |
| Bath fully framed up and supported with appropriate clearance for wall sheeting and tiles. | | |
| Noggins installed for WC Cistern and roll holder | | |
| Noggins installed for bathroom towel rails. | | |
| Noggins installed for wall mounted dryer. | | |
| Noggins installed for garage panel lift door. | | |
| Other required noggins installed. | | |
| Temporary bracing removed. | | |
| Wall bracing and connections finished flush with framing. | | |
| | | |



## 5.3 COMPLETION CHECKLIST - TIMBER TRUSSED ROOF

| | |
|---|---|
| OWNER: | |
| BUILDER: | |
| PROJECT: | |
| PROJECT ADDRESS: | |
| SUPERVISOR: | PHONE NO: |
| DATE: | JOB NO: |

| COMPONENT | ✓/ ✗ | ACTION/COMMENT |
|---|---|---|
| **TRUSSED ROOF** | | |
| Check plans and any contract documents for any variations. | | |
| Wall frames Plumb and straight. | | |
| Truss layout consistent with truss layout plan and fixed at correct centres. | | |
| Trusses Plumb (within max 50mm, or height/50 tolerance) and not bowed (max 50mm or bowed section within section/200). | | |
| Valley trusses correctly fixed to supporting truss top cord. | | |
| Roof tie downs and truss connections installed in accordance with approved plans and truss manufacturers requirements. | | |
| Strengthening for installation of hot water storage systems installed. | | |
| Steel bracing installed correctly in accordance with truss plan. | | |
| Bracing fixed to wall frames or plates is nailed flat to avoid interference with wall lining and cornices. | | |
| Truss bottom cord ties installed. | | |
| Transfer noggins installed to connect braced walls to trussed roof frame. | | |
| Non-load bearing walls connected to trusses using slotted wall brackets where required. Nails left proud to allow vertical movement. | | |
| Entry bulkheads straight and level. | | |
| Internal bulkheads installed plumb and straight. | | |
| Plumbing duct and vent pipe framing plumb and straight. | | |
| Trimmers and battens installed to Eaves for correct installation of specified eave lining. | | |
| Manhole correctly positioned and framed. | | |
| Outriggers to gables installed to truss plan. | | |
| Barge boards fixed and aligned correctly. | | |
| Fascia fixed and aligned correctly. | | |
| Where no eaves overhang Fascia is correctly aligned for cladding or brickwork. | | |
| Trussed roof inspection passed. | | |

## ADDITIONAL NOTES

timberinsight

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**M** 0498 121 262
**E** admin@timberinsight.com.au

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