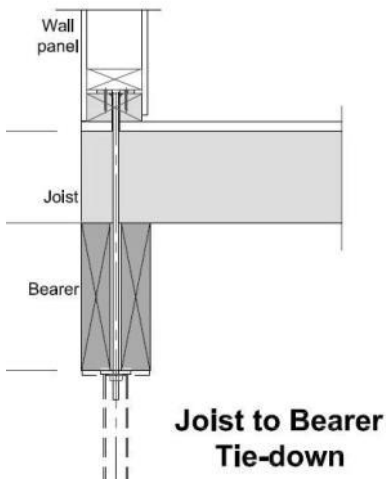


Guide for Designers



Information to assist designers in maximizing building efficiency using the Panelised Building System

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NOTES ON THIS DOCUMENT:

This design guide is intended to provide guidance information for designers wanting to create the most efficient PBS building. It contains tips and hints to simplify the fabrication and construction process. The information in this manual is not exhaustive and should only be taken as reference. All structures are required to comply with the Building Code of Australia (BCA) and associated standards. Clarification of any disputed items from this guide must be sought from the local consenting authorities before commencement of fabrication. Although all care has been taken in the production of this guide, Carter Holt Harvey does not take any responsibility for claims or losses arising out of implementation of the information contained within.






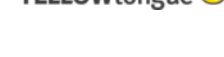
Panelised Building System (PBS)

1. History

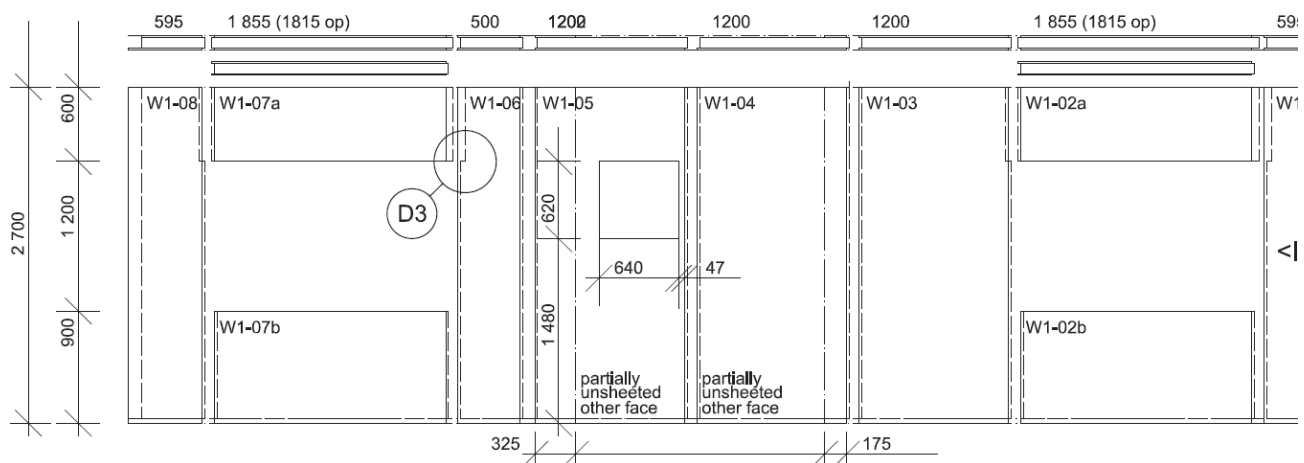
The lengthy time taken to construct homes throughout Australia is one of the most important challenges facing the housing market today. After all, time costs money. Delays associated with conventional on-site construction including stoppages due to weather, issues with co-ordination, purchase and delivery of materials, sourcing tradespeople at the relevant time and environmental considerations such as sediment control and waste disposal can all be impediments to improving housing affordability.

In response to this, Carter Holt Harvey, Australia's largest wood products supplier, has developed the Panelised Building System (PBS). The PBS solution consists of cost-competitive, lightweight and strong prefabricated building elements. This allows for faster, easier on-site construction as the panels are simply locked together in the required combination.

Panels utilise well known, trusted and durable Carter Holt Harvey products such as:

-  • 12mm BD ECOpoly structural plywood (internal wall/ceiling lining).
- 7mm DD ECOpoly structural plywood bracing.
-  • LASERframe structural framing.
-  • hySPAN structural LVL.
-  • hyJOIST engineered I-beams.
-  • 12mm SHADOWclad plywood cladding.
-  • 19mm STRUCTAflor Yellow Tongue particleboard flooring.

This building system is an important step in a journey to improve housing affordability.



Wall panel set-out example

2. System Overview

The PBS is a versatile prefabricated timber component system that provides efficient and economic solutions for a wide variety of building applications. It delivers individually designed and factory built solutions for single storey homes, but also has the capability of providing multistorey building solutions that satisfy the necessary fire and sound separation requirements of the Building Code of Australia (BCA) with established sheet systems. PBS can also utilise the Carter Holt Harvey Terminator Protection System and all elements can be individually treated to the level of durability required for the intended final location.

While modularised, the system is versatile and places few constraints on design expression. The system's components includes floor, wall, ceiling and roof panels, floor bearers and beams, posts, roof trusses and the additional elements necessary to meet design challenges. PBS panels and other elements are uniquely designed for each project and manufactured in the factory for quality and accuracy. Bundled with the fixings required on site, the PBS components provide a complete package solution for the building structure and major fabric elements.

The PBS package solutions can be optimised to match:

- The complexity of the design and site conditions.
- The availability of lifting and handling equipment (crane, etc).
- The skill level in the available workforce.
- Transport limitations (local or remote locations).

PBS provides all structural components and the major fabric elements of the building. It supports a wide range of external claddings and window and door systems. Internally, the wall and ceiling panels can be stopped and painted or lined with sheet material.

Accurate and engineered to withstand all wind categories in Australia, PBS provides its greatest benefits during construction. Assembly on site with PBS is fast and efficient. The components can be delivered almost anywhere and can be assembled with a mixed-skilled labour team. Buildings can reach lock-up stage in days rather than weeks.

This design guide aims to focus on delivery of single storey PBS homes. For solutions sets to suit multi-level buildings contact Carter Holt Harvey for advice.

2.1. Benefits of PBS

- Up to 40% faster construction time
- Cost effective building solutions when compared to conventional construction in remote and regional areas
- Suitable for slab on ground, raised subfloor and sloped site construction
- Flexibility in both internal and external final finishes
- Lower on-site waste associated with panelised structural components
- Wood based panels sized to suit the location
- Optional Terminator 25 year guarantee* - for your peace of mind
- Reduction in the need for skilled labour for site construction
- Panels sourced by builders through existing frame and truss supply channels
- Manufactured from sustainably managed plantation timber



2.2. PBS Applications

The Carter Holt Harvey Panelised Building System (PBS) provides efficient and economic solutions for a wide variety of building applications, including:

- Remote area housing delivery
- Eco-resort cabins
- Fishing lodges
- Beach houses
- Farm 'weekenders'
- Regional affordable housing
- Health/family care facilities
- Mining camp accommodation
- Metro studio/granny flats
- Government/educational/services buildings
- Mid-term transitional housing for disaster relief
- Metropolitan townhouse developments with space constrained sites
- Metro/regional sloping land development, reducing scaffolding



* The guarantee is provided by the chemical supplier for the benefit of the property owner. It is a limited and conditional guarantee covering the provision of replacement product in Australia. The full terms and conditions are available at www.chhwoodproducts.com.au/guarantees

2.3. Engineering Design

PBS solutions are engineered to comply with the site specific wind and loading conditions. Default wind design is calculated up to and including N3 wind classification. Where needed in the Northern regions of Australia the PBS can accommodate a C4 wind classification which equates to the maximum cyclonic rating used for design.

Through an integrated design, PBS provides an efficient structure. The loaded structural elements are not designed individually but as a complete system, increasing effectiveness and reducing the on-site construction time taken to 'lock' the panels together. Some examples of this are:

- Even for cyclonic wind classifications there are generally no steel 'tie-down rods' that typically connect the roof truss down to the foundations. PBS uses a load path transfer model with the plywood cladding and panel connections performing this function. In a closed panel scenario (lined on both sides with ECOply) this can equate to a 50% redundancy in connections (ie: the tie-down capacity of the panel connections in the system are twice what is required by Australian Standards).
- Closed panels are pre-fabricated in a controlled environment and lined on both sides, negating the need for noggins whilst leading to reduced panel weight and increased ease of service installation.



This design guide runs through preliminary sizing to allow project specification and initial design. To optimise the engineering for a specific project it is strongly recommended to call CHH on 1800 808 131 once you have concept plans. The experienced engineering team can then assess and discuss any further optimisation with you on a project by project basis.

2.4. Panel Manufacture and Supply

The PBS solution is based on the integrated design, factory manufacture and supply of prefabricated components made from a range of timber and wood products and suitable for quick and easy assembly. Accredited fabricators are used to manufacture PBS elements using CHH products. The tolerances required to ensure correct assembly, along with quality and material checks are part of this accreditation. Accredited fabricators can be found by contacting Carter Holt Harvey.

The panels and components can be delivered directly to the site from the factory or containerised for economic transport to remote locations around Australia or the world. Containerisation ensures components are available when they are needed, simplifying construction, reducing the potential for loss and damage and increasing security.

3. Building Considerations

3.1. Plan dimensional considerations

3.1.1. Panel Sizing

For PBS buildings, plan dimensions are not restricted to any specific module or numerical increment. While panels are modularised to maximum or preferred widths, panels of different widths and lengths can be combined to supply the dimensions and shapes required in most designs. Panels however have maximum optimal sizes based on standard sheet and timber sizes. These will vary depending on whether manual installation is required, or if larger panels can be utilised with installation through craneage or other lifting equipment.

Small Panels:

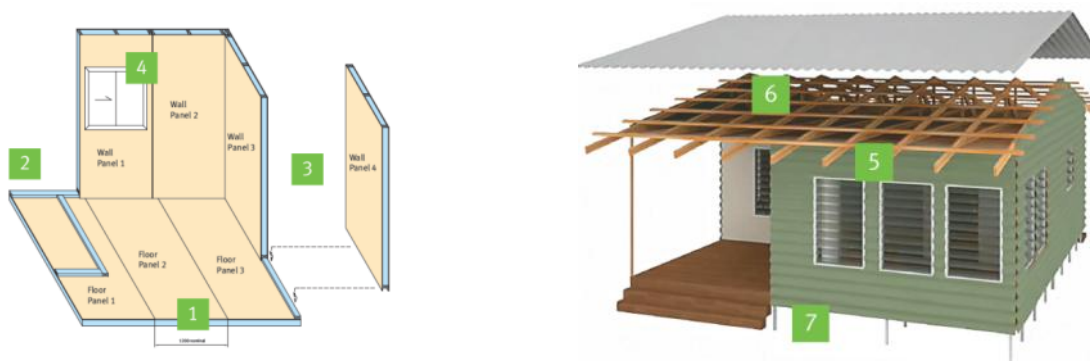
Used for manual installation with handling by 2-3 persons restricting the mass of the panels to around 80kg.

- Using plywood as a sheet covering, either as PLYfloor or ECOply wall cladding the standard sheet width of 1200mm governs standard panel size.
- Floor and roof panels are weight limited at approx. 1.2m wide x 3.6m long. This also optimises floor joist sizes.
- Wall panels are weight limited at approx. 1.2m wide x 2.7m high. At 2.7m, the ceiling height also allows sufficient head room for ceiling fan installation.
- Longer/higher panels can be reduced in width to give the same overall mass (eg. 4.5m high x 0.6m wide wall panels).
- Trusses and bearers are normally limited by the transportation option used for the project. Where containers are used, these are restricted to 5.8m (20') or 11.8m (40') in length.

Large Panels:

Where lifting equipment is available and transport is suitable, panel size becomes dependant on production restrictions at the fabrication plant, as well as general handling requirements.

- Large scale floor panels can be manufactured to a maximum of 2.7m wide x 12m long with STRUCTAflor as floor sheeting. When using PLYfloor the width is reduced to 2.4m.
- Large scale wall panels are typically a maximum dimension of 2.7m high x 6.0m long. When installing windows, sliding doors, etc into the panel the mass increases significantly, with the ability to flip the panel during fabrication being the limiting factor.



System Components: 1. Floor Panel, 2. Bottom Plate, 3. Wall Panel, 4. Window, 5. Ceiling Panel, 6. Trusses, 7. Final Finish

3.1.2. Panel Integration into a design – Methodology (Small Panels)

Although the plan dimensions are not restricted to specific modules as mentioned above, there are some simple design philosophies that can be used to maximise material usage and create the most cost effective design:

- On wall runs incorporate the maximum number of standard wall panels. 1200mm wide plywood sheets require a 2mm expansion gap between them, meaning the centre to centre dimension of standard full width panels is 1202mm.
- It is good practice to have at least a half panel (600mm wide) at external building corners (before an opening) to allow easy panel assembly and ensure sufficient bracing of the structure.
- When openings are not built into panels, header and sill panels are used, meaning wall panels must stop at sides of openings. This should be considered when locating openings.
- Maximise the use of sheet materials in panel design. Panel widths of 1100mm will only create a 100mm offcut, whilst panel width of 600mm can use a half sheet for the opposite side wall linings. Try not to have a considerable number of 800mm wide wall panels as this results in a 400mm waste offcut (33% waste in the plywood sheet).

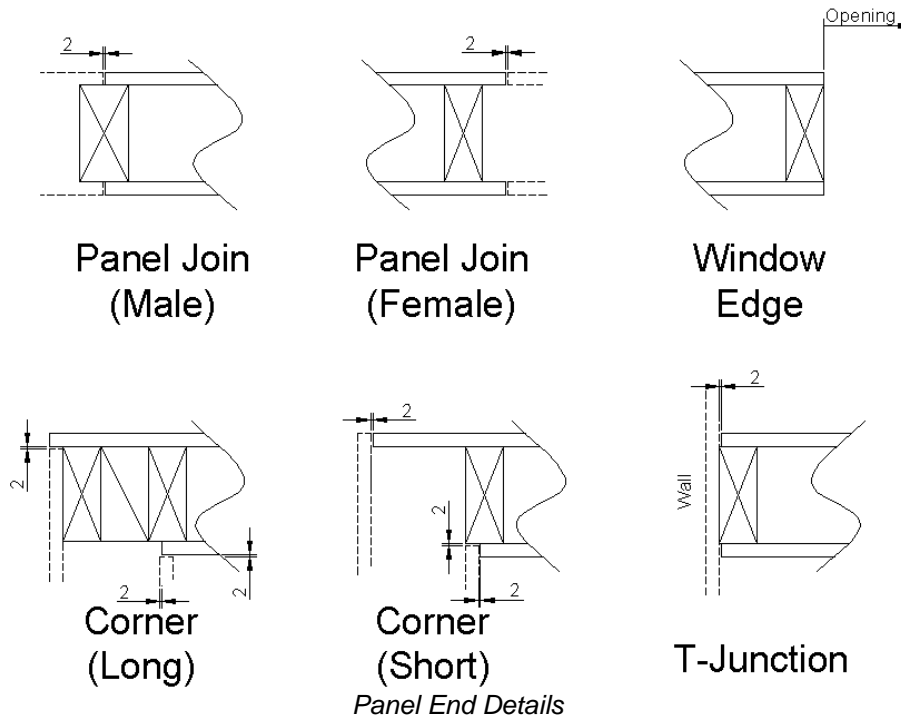
The easiest method of panel integration into a design is to forward the preliminary plans to Carter Holt Harvey or an authorised fabricator for review. Comment can then be given on modifications that may be implemented to increase the efficiency of the materials. When drawing a set of plans a sound initial design philosophy is to work to 600mm increments to the outside of the ply sheets as a datum line, noting external under-cladding plywood is 7mm thick, while SHADOWclad and internal linings are 12mm thick. If this is done then the building may grow/shrink only marginally ($\approx 20\text{mm}$) when the fabricator 'panelises' it.

There are a significant number of permutations in how the panel system works together and where it is referenced from. The following examples demonstrate this:

- Straight runs use 1200mm wide panels with a 2mm gap between them, hence a 1202mm panel increment. Here, the actual panel width for transport is 1224.5mm as the last 45mm wall stud protrudes out half to allow a fixing for the ply from the next panel (See panel end details).
- When you come up against a window the normal timber frame scenario is to use Aluminium frame width + 30mm each side to have timber stud wall opening. The 30mm allows for 20mm timber reveal + 10mm adjustment on either side. Using PBS, as the panels are preformed and rigid with a ply sheathing we can at least halve the 10mm either side, so the recommended window timber frame opening would be Aluminium frame size + 40mm reveals + 10mm adjustment. In these cases the ply sheathing stops flush with the edge of the timber stud. The sill and header panels then slot into pockets made on each full height side panel (See opening diagram).
- External corners have one ply sheet run past the timber frame by 7mm and stop at the outside of the return sheet. The other corner panel has the sheet protrude 88mm past the end of the timber frame to butt into this first sheet. This leaves a 2mm gap between the sheet end and edge on a 90mm timber frame (See panel end details).
- T-junctions have the ply on incoming panel stop 2mm short of the end of the timber stud to allow a sealant gap.

From the above examples, panel ends can consist of:

- Straight join both ends, or
- Straight join one end and window edge other end, or
- Long corner detail one end and straight join other end, or
- Short corner detail one end and straight join other end, or
- Long corner detail one end and window edge other end, or
- Etc, etc, etc



The end configurations above can be used to maximise sheet efficiency. One process to implement this is:

1. Drawing a preliminary plan layout with window and door locations.
2. Lock in a datum point and then start laying out ply sheets (600mm or 1200mm wide with 2mm gaps between them). These need to be referenced to the outside face of the plywood.
3. Internal walls are treated the same way working from T-junctions to the outside face of ply on corners. (Internal ply is 12mm thick, and outside ply is 7mm thick).
4. Corners will be different and should be adjusted to maximise sheet sizes (close to 600 or 1200, rather than say 850mm long).
5. To add further complexity, if a wall goes through a wet area and you only want it lined one side in the wet area the panel must be broken either side of the wet area.
6. Setting a datum point is probably the most critical item, as it is more about maximising the number of standard run walls and full sheet / half sheet panels. This is where a designer's skill becomes paramount.
7. If you got confused around item 4 above, then go back to the simple method of 600mm increments from outside of plywood and let the fabrication plant optimise the design for you.

3.2. Roof Types

PBS supports three primary roof structure arrangements: panel, truss, and rafter/purlin roofs. The recommended roof covering is either metal sheet roofing or waterproof membranes, but most roofing materials can be accommodated if required (such as roofing tiles). The roofing material will generally dictate the minimum pitch of the roof.

If a manual installation is required, the roof structure is best formed using trusses as simple gable or skillion roof assemblies consist of multiples of the same truss shape. A skillion roof will require additional external wall cladding at the high end to close out the roof cavity. Truss systems utilise either PBS ceiling panels for quick and easy installation, or a site-installed ceiling which generates a larger requirement for skilled workers on-site.

PBS roofing panels come as open or closed panel types. Closed panel systems have a plywood skin on each face and can be supplied complete with insulation. Easy to install with lifting equipment, they provide an immediate and flexible work platform for roofing and other tasks.

A rafter and purlin roof configuration is similar to a PBS roofing panel that is constructed on-site using the individual elements. This option may be used where the skill of the labour force has increased following training on previous PBS builds.

All PBS roof arrangements require the supply and installation of sarking and roofing material by other suppliers. Except for the closed roof panel system, other arrangements also require supply and installation of insulation by other suppliers. Roof battens are normally delivered as part of the PBS system.

3.3. Opening Size and Placement

PBS can accommodate openings:

- within individual panels,
- formed by groups of panels, or
- timber lintels spanning between panels or between posts and panels.

If openings are incorporated into individual panels the jamb studs are located to suit. This system can also include pre-installed components (windows/doors) and final external cladding where a sheet finish such as SHADOWclad is utilised, but is limited to openings less than 1.0m wide.

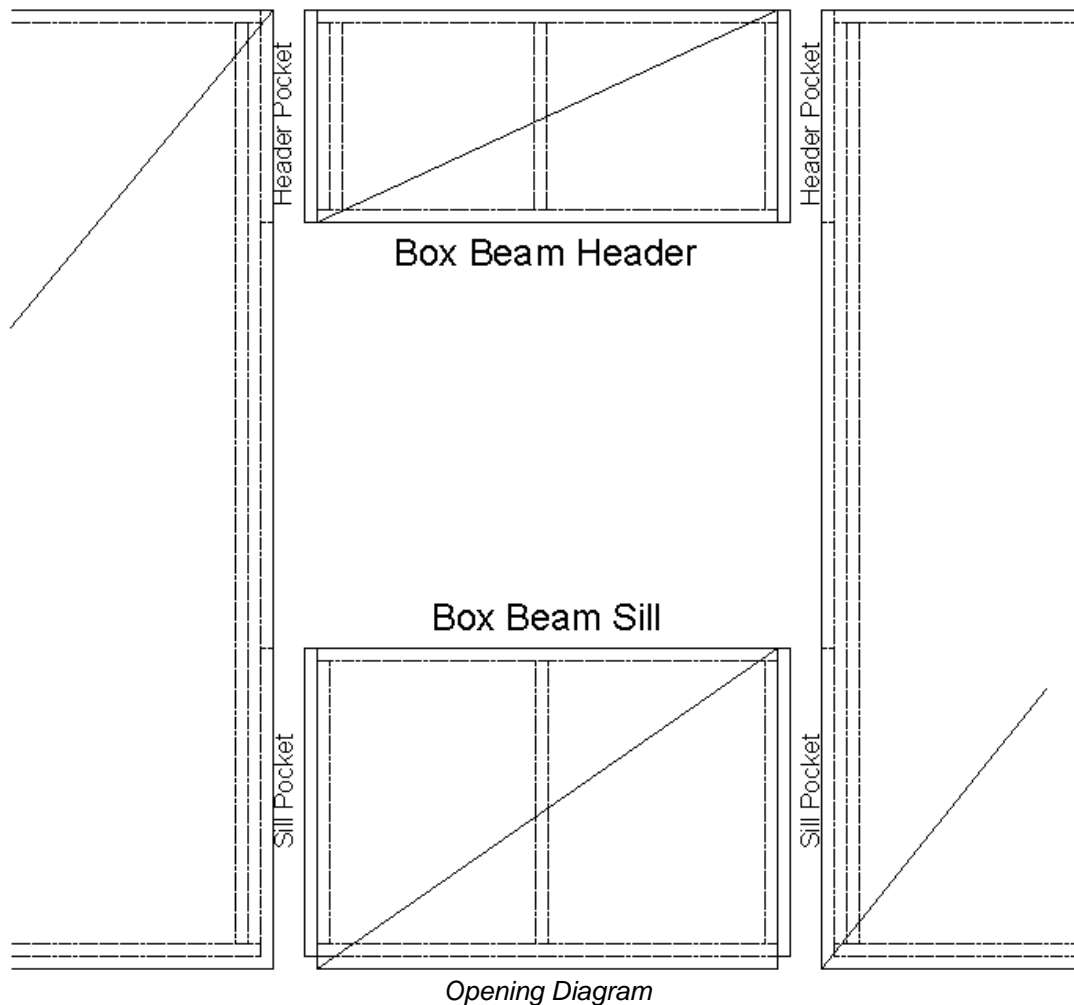
Where separate panels occur over openings, these are designed as load-bearing box-beams and remove the need for a solid timber lintel. Box beam panels are individually designed and their spanning capacity is dependent on their depth, the applicable load and the tie-down required at either end. Windows formed by separate panels incorporate both a header panel over the top of the window and a sill panel under the window, whilst doors use only a header panel.

hySPAN LVL or solid timber achieve the smallest lintel or beam size over an opening. Their sizes can be determined using the CHH designIT software. Design of these should take account of the wall width and fully fill the beam pocket made in the adjacent wall panels (eg. 2/45mm thick lintels for 90mm stud walls).

For both timber lintels and box beam configurations consideration must be given to the required tie-down and load transfer at each end of the opening, especially in cyclonic wind regions. Refer to preliminary design sizing for guidance.

When designing openings into a PBS building, standardisation of component dimensions will ensure both cost efficient manufacture and ease of assembly. This can be achieved by:

- Making the window height the same as any door heights to ensure the lintel panels are the same depth.
- Window and door widths should be optimised to be the same. As an example, if the standard window width is an 1860 frame opening, making the sliding door the same width means the header panel for the door is the same as the window.



3.4. Internal and External Finishing Options

PBS supports a wide range of external cladding and window and door systems. Fixings are readily available through the external plywood skin on the wall panels. Generally, the PBS does not include factory installed external cladding for small panel configurations. The exception to this is SHADOWclad, where the openings are located wholly within the panels. This is due to the difficulty in weatherproofing around openings and overlapping of vapour barriers. Claddings, windows and doors are predominantly supplied by others and individual manufacturers should be consulted with respect to any specific requirements that are needed to be included in the PBS elements.

Large panel PBS solutions can incorporate proprietary external claddings, and depending on the system there may be some finishing of corners or joins following panel installation. In most cases this is facilitated via a cherry picker, scissor lift, or similar. A complete scaffolding system is not generally required.

Internally, the wall and ceiling panels can be stopped and painted or lined with sheet material. The plywood panels are stopped with a proprietary mastic sealant (included in panel supply) and this is finished flush and painted using a high quality gap filling paint. Critical to the long term finish is the gap between panels that is filled with this sealant. A gap of 2-5mm has provided suitable performance through expansion/contraction cycles. Smaller or larger gaps will tend to show through bulging or recessing of the sealant when the building thermally reacts to climatic changes. This should be noted during the assembly phase.

If other internal finishes have been specified, the internal walls can be left open and once panels are installed they are then lined with plasterboard or other internal lining systems.

3.4.1. Internal Finishing Options – Wet Areas

Panels around wet areas can be provided in one of two common methods:

1. With an internal plywood skin. Where plumbing is required in the walls (such as showers) a removable access sheet is designed into the panel for this to occur. Walls that are lined in this manner and exposed to water must be finished with a coating that complies with the BCA wet area waterproofing requirements.
2. Without an internal plywood skin to accommodate plumbing and electrical services and lining on site with a water-resistant material such as a fibre cement sheet.



Finished interior – Kitchen



Finished interior – Lounge

3.5. Energy Efficiency

The PBS solution is no different to any similar lightweight construction in terms of energy efficiency. Solutions can be provided for all climate zones. Where energy assessment is achieved through software modelling, the insulation requirements can be altered to reflect the modelled configurations.

3.6. Service Installation

Service installation, both electrical and plumbing, is easy to install in PBS panels through the following items:

- Closed wall panels do not have noggins installed allowing for easy service feeds.
- Panels can be left open in areas such as bathrooms to facilitate plumbing installation. Following this walls can be lined with plywood or other wet area lining materials.
- Plumbing can be accessed upon request through specifically located removable access panels in closed panel configurations.

Where the design has been documented and complete electrical and plumbing line diagrams are available there is the opportunity to provide pre-installed wiring/piping in closed panels. This needs careful consideration and thorough discussion through the installation/certification chain to ensure all parties are agreed on lines of responsibility. This includes plumbers, electricians, certifiers and consultants. Carter Holt Harvey can be contacted to explore this possibility.



Roof insulation being installed



Electrical wiring in progress

4. System Components

4.1. Floor Panels

- Standard floor panels are 1200mm wide if fitted with a plywood floor or 900mm wide if fitted with a particleboard floor. The maximum panel length is limited by installation weights, container size, and other transport restrictions.
- An overlap of sheet material along one edge of the floor panel allows it to sit on and be fixed to the edge joist of the adjacent panel, ensuring continuity in the floor plane.
- The floor joists sizes in the panels vary to satisfy the requirement of span between bearers or walls and load support. See the preliminary design sizing below for a small panel span guide.
- Blocking is installed between the joists to add rigidity to the floor panels.
- Floor panels can be made open or closed. Closed panels include insulation although care is required in detailing to avoid issues with connections and installation of services.
- Floor finishes are easily applied over the sheet surface of the floor panels. Finishes can include vinyl, carpet and underlay, tiling, and pre-finished floating floors. Refer to individual floor system manufacturer’s information for suitability.



Floor Panel Span Guide:

hySPAN Size	Preliminary Design Span (at 400crs) *
90x45 hySPAN	1.7m
130x45 hySPAN	2.6m
150x45 hySPAN	3.1m
170x45 hySPAN	3.6m

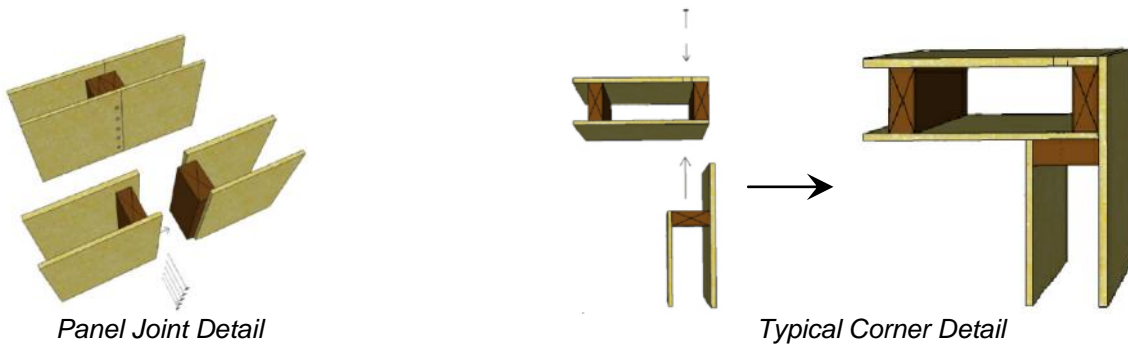
* Values relate to responsible design rather than maximum joist span. Designed for floor loading only conditions for houses.



Floor Panel Typical Elevation

4.2. Wall panels

- Standard external wall panels are nominally a 90mm LASERframe wall frame clad with a 12mm BD ECOply lining on the internal face and a 7mm ECOply bracing ply on the external face.
- Standard internal wall panels are nominally a 90mm LASERframe wall frame clad with 12mm BD ECOply lining on each face.
- Small panel configurations are a maximum of 1.2m wide with standard heights of 2.4m and 2.7m to match standard sheet sizes.
- Standard wall panels fit over a connecting floor plate and fit together with interlocking male and female edges (See load path description)



4.2.1. Header/Sill panels

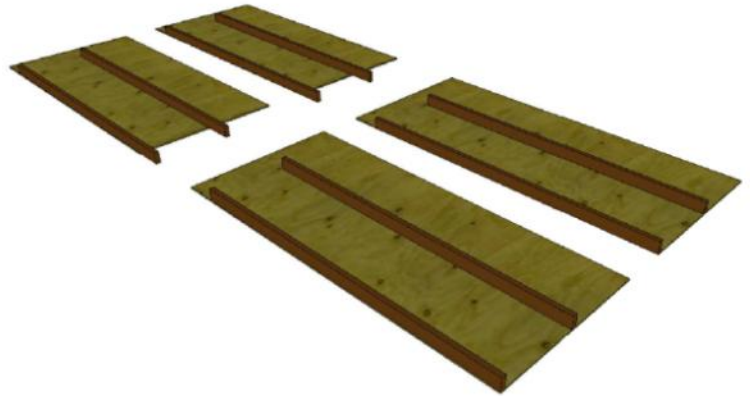
- Openings in walls wider than 1.0m are formed with a sill panel and either a header panel or a timber lintel.
- Sill panels are short panels the width of the opening and the height to the underside of the window.
- Header panels are designed as plywood box beams and fabricated to be supported by the panels on either side of the opening. They simply slide into pockets located in adjacent wall panels from above.
- Once fixed in place, the wall is ready for window/door installation and final over-cladding. Due to weatherproofing requirements, using SHADOWclad as a final cladding is only suitable when openings are pre-installed fully within fabricated panels.



Header Panel Configuration

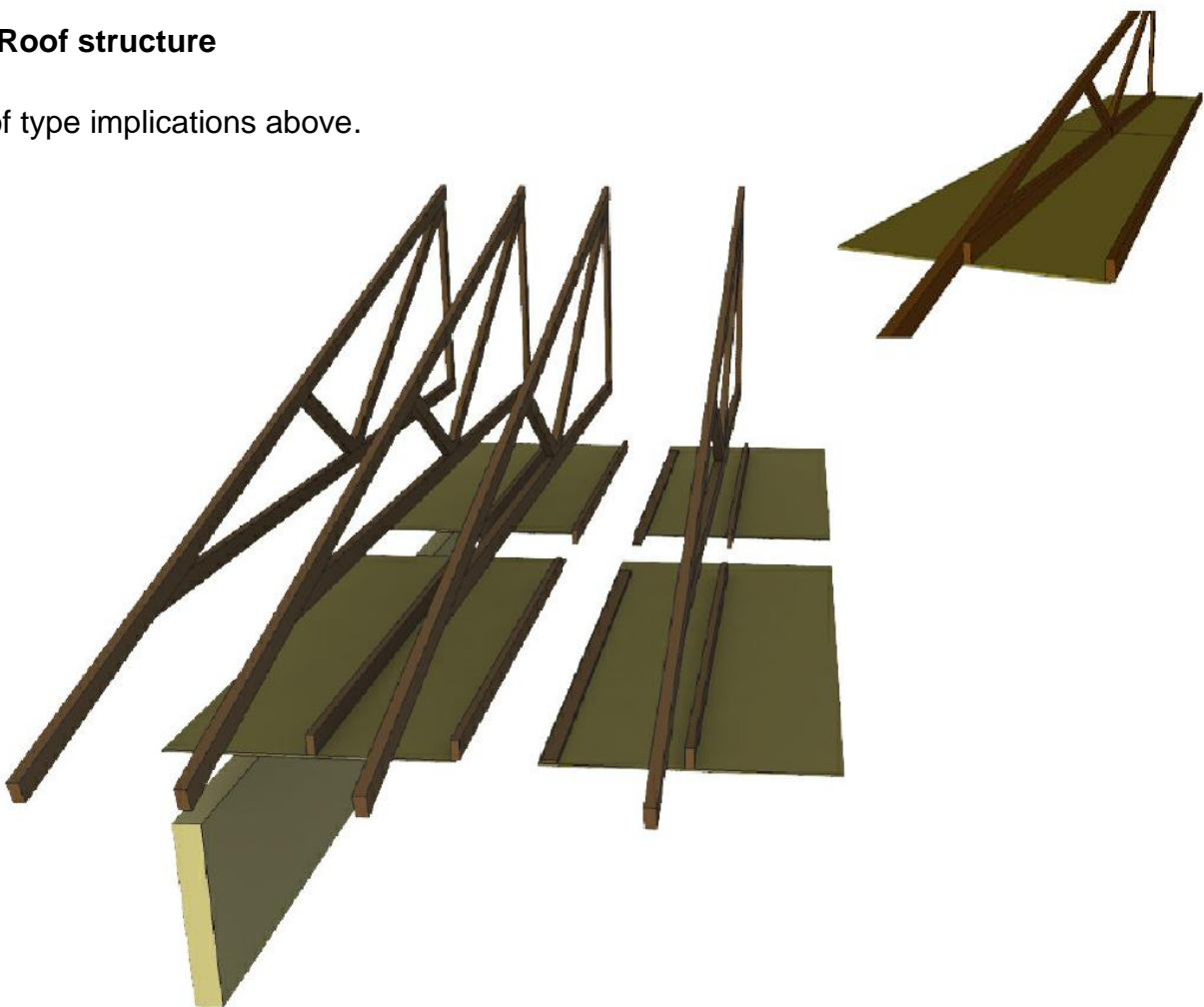
4.3. Ceiling panels

- Standard ceiling panels are 1200mm wide. They have a softwood ceiling joist with 12mm plywood lining on the internal face. Supported by truss or rafter systems above, they fit flush and can be stopped ready for painting.
- The function of the ceiling joist is to support ceiling ply for installation only and therefore is not structural. Minimum standard framing sizes are adequate to achieve this.



4.4. Roof structure

See roof type implications above.



Roof Truss / Ceiling Panel Arrangement

4.5. Footings and Foundations

The myriad of different systems available for foundations place this out of the scope of this document. The main substrate variations for the PBS to be installed upon are:

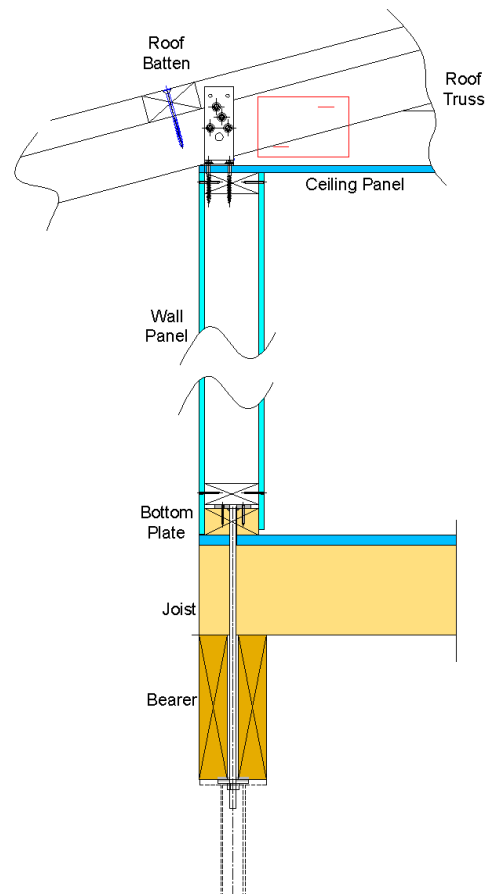
- Bearers and floor panels directly onto foundation systems. The foundations, or stumps, can be steel, masonry, or concrete or a combination of these. Uplift forces can be provided during preliminary design to allow the certifying engineer to ensure the foundation design is suitable. Minimum bearer height information above natural ground level is located in the BCA.
- Concrete slab-on-ground. With this variation the subfloor and floor panels are replaced with the concrete slab. The PBS elements therefore commence with securing the bottom plate to the slab.

Positioning of footings requires precision to ensure the accuracy of the panelised system is correct from the base up. There is some allowance for misalignment in the bearer to footing connection (up to approx 15mm off a central line), but the vertical alignment should be within 1-2mm to allow ease of construction. This is especially important if placing a PBS build on a concrete slab. In this instance, the bottom plate should be packed as required to achieve a correct base line for construction.

4.6. Load Path Transfer (Gravity and Uplift)

As the majority of PBS homes are envisaged to have lightweight roof structures (such as sheet metal), gravity loads are rarely critical in the design. Once component design has been achieved to accommodate uplift values, member sizes and construction methods will usually ensure gravity loads are catered for appropriately. The certifying engineer should verify this during initial design, focusing on high load gravity areas.

PBS solutions accommodate uplift with continual tie-down through a load transfer path of connections and structural components as shown in the figure opposite. For this reason there are often no full length tie-down rods required for high wind areas which provides flexible positioning of openings.



In preliminary design the tables below can be followed from top of roof battens down to foundations to provide initial confidence of PBS suitability and lock in design parameters. These tables use AS1684.2 -2010 and AS1684.3 – 2010 values as references, in addition to calculated capacities for proprietary connections. These tables should not be used for fabrication. Final design analysis is required through an authorised fabricator and CHH to ensure the solution is suitable for engineering certification.

Design Criteria for Preliminary Uplift Calculations:

- Lightweight Roof Material (Sheet Metal or similar)
- Timber used has JD4 joint group minimum

Roof Batten to Roof Truss Connection (roof edges):

- Battens at 900crs max with Trusses at 600crs max
- For up to N3/C3 use 1/100mm long #14 Type 17 screw (90mm long for 35mm batten)
 - Capacity from AS1684-2010 Table 9.25 (d).

Roof Truss to Wall Panel Connection:

	Max. Truss Span, m (Max. Area, m ²)		
	N3	C2	C3
1/Framing Anchor	6.9 (2.6)	NA	NA
1/Pryda CPAH Hold Down Bracket	>12 (7.5)	8.4 (3.0)	4.9 (2.0)
2/Pryda CPAH Hold Down Bracket	NA	>12 (6.1)	11.6 (4.0)

- Capacity from AS1684-2010 Table 9.21 (b) and Pryda calculations
- Truss span assumes 600crs and 900 O/hang

Common Wall Panel Tie-Down Capacity:

	Max. Truss Span, m (Max. Area, m ²)		
	N3	C2	C3
PBS Wall Plywood lined one side fixed at 150crs	>12 (7.8)	8.8 (3.2)	5.2 (2.1)
PBS Wall Plywood lined one side fixed at 50crs	NA	>12 (5.1)	9.4 (3.3)

- Capacity from AS1684-2010 Table 9.19 (g)
- Truss span assumes 600crs and 900 O/hang
- Double spans/areas if lined with plywood both sides
- Wall panel not carrying any concentrated loads from verandah beams, window headers or similar

Tie-Down of Wall Panels Supporting Concentrated Loads:

	Maximum Roof Area, m ²		
	N3	C2	C3
600mm long PBS Wall Plywood lined one side fixed at 150crs	4.3	1.8	1.2
600mm long PBS Wall Plywood lined one side fixed at 50crs	12.1	4.9	3.2

- Capacity derived from AS1720.1-2010
- Fixing to be using 8g x 45mm long screws
- Multiply by 0.45 for maximum area using 45x2.5Ø nails
- Double areas if lined with plywood both sides

600 Deep Box Beam (to suit 2.7m high ceilings with 2.1m window height):

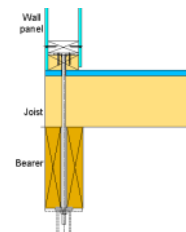
	N3	C2	C3
Beam to Panel Connection Capacity (m ²)	38.4	15.7	10.3
Max Box Beam Span (m)	3.6	2.7	2.7

- Capacity derived from AS1720.1-2010
- Box beam to be lined both sides with 12mm ECOply.
- Box Beam must comply with both conditions above (Maximum area and Maximum Span)
- Beam to Panel Area is calculated by multiplying total box beam span by RLW
- Fixing of box beam to wall panel to be using 8g x 45mm long screws at 50crs
- For other box beam depths, spans and loading configurations contact CHH

Bottom Plate to Bearer connection:

	Maximum Roof Area, m ²		
	N3	C2	C3
Standard Bottom Plate Connection	26.7	9.2	5.8

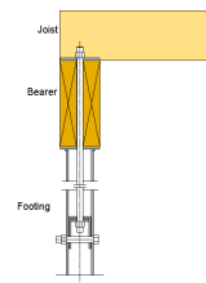
- Capacity derived from Pryda calculations
- Capacity over 13kN as required by AS1684-2010 Table 9.19(g)



Bearer to Footing connection:

	Maximum Roof Area, m ²		
	N3	C2	C3
Standard Bearer Connection	49.5	23.8	13.2

- Capacity derived from Pryda calculations



Bracing:

Bracing of PBS buildings can be calculated using standard assumptions from AS1684-2010 Section 8. Bracing capacity of the plywood lined walls is 3.4kN/m with fixings at 150crs and 6.0kN/m with fixings at 50crs. Note that if wall is lined with plywood on both sides the bracing capacity can be doubled as the joist to bearer connection above is suitable to accommodate this.

5. Construction

The erection of a PBS building involves many elements common to standard construction and should be approached in the same manner. The required tools to be used and an example methodology for the prototype building (see time lapse shots on side pane) can be referenced to show the ease and speed of construction the PBS solution offers. Individual projects will come complete with drawings and assembly sequence instructions, with elements clearly marked.

5.1. Required Tools (for PBS construction only)

- Screw Gun – cordless screwdriver, battery drill, collated screw gun, or similar.
- Hammer – to assist panels into position.
- Spanner Set – to tighten connections.

5.2. Typical Construction Process

The list below is not exhaustive and contains some non-PBS items (in italics) to put the build into context. Timing figures are based on prototype constructed in Darwin October 2010.

1. *Prepare site with earthworks and service delivery*
2. *Install foundations*
3. Fit PBS bearers to foundations and secure bearer to footing connections (0.5hr)
4. Fit PBS floor panels to bearers and screw panels together (1.5hr)
5. Mark out wall locations and fit bottom plate to floor panels (0.5hr)
6. Install joist to bearer connections as per supplied drawing (0.5hr)
7. Fit wall panels in required sequence, only tacking into position (4hrs)
8. Install ceiling panels and trusses together (4hrs)
9. Install verandah beams and posts with noted connection where noted (1hr)
10. Brace roof trusses and fit roof battens and gable end framing (3hrs)
11. Finish securing all wall and ceiling panel joins and connections (6hr)
12. *Install roof insulation, sarking, and roof sheeting (5hr)*
13. *Fit external windows and doors (3hr)*
14. *External; vapour permeable membrane and external wall cladding*
15. Stop internal screws holes and plywood joins (8hr)
16. *Plumbing and Electrical*
17. *Internal Doors*
18. *Bathroom Fitout and finishing*
19. *Painting*
20. *Internal and deck final floor finishing*
21. *Kitchen installation*
22. *Wardrobes*

5.3. Example Assembly Sequence



Table 1: PBS Systems boundaries

Element	PBS	Other
Roof structure up to roof battens	<input checked="" type="checkbox"/>	
Roofing or roofing system		<input checked="" type="checkbox"/>
Roof insulation	<input checked="" type="checkbox"/> (closed roof panels only)	<input checked="" type="checkbox"/> (other roof types)
Ceilings	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> (truss roofs)
Internal and external walls, columns and posts.	<input checked="" type="checkbox"/>	
External cladding	<input checked="" type="checkbox"/> (openings within panels)	<input checked="" type="checkbox"/>
Internal lining	<input checked="" type="checkbox"/> (plywood walls/ceilings)	<input checked="" type="checkbox"/> other systems
Windows, doors, etc.	<input checked="" type="checkbox"/> (installed into panels)	<input checked="" type="checkbox"/>
Wall insulation	<input checked="" type="checkbox"/> to R2.5	<input checked="" type="checkbox"/> above R2.5
Electrical services	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Plumbing services	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Ground floors	<input checked="" type="checkbox"/> suspended floors	<input checked="" type="checkbox"/> slabs
Deck structure and decking	<input checked="" type="checkbox"/>	
Bracing and tie-down between the bearer and roof battens	<input checked="" type="checkbox"/>	
Bearers	<input checked="" type="checkbox"/>	
Footing to underside of the bearer		<input checked="" type="checkbox"/>

Table 2: PBS activity boundaries

Services	PBS	Other
Site construction		<input checked="" type="checkbox"/>
Transport to site	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Solution engineering	<input checked="" type="checkbox"/>	
PBS system design and costing	<input checked="" type="checkbox"/>	
Architectural design		<input checked="" type="checkbox"/>

Panelised Building System:

- Small pre-finished panels
- Large pre-finished panels
- Large factory made floor panels

“One system with many solutions”



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