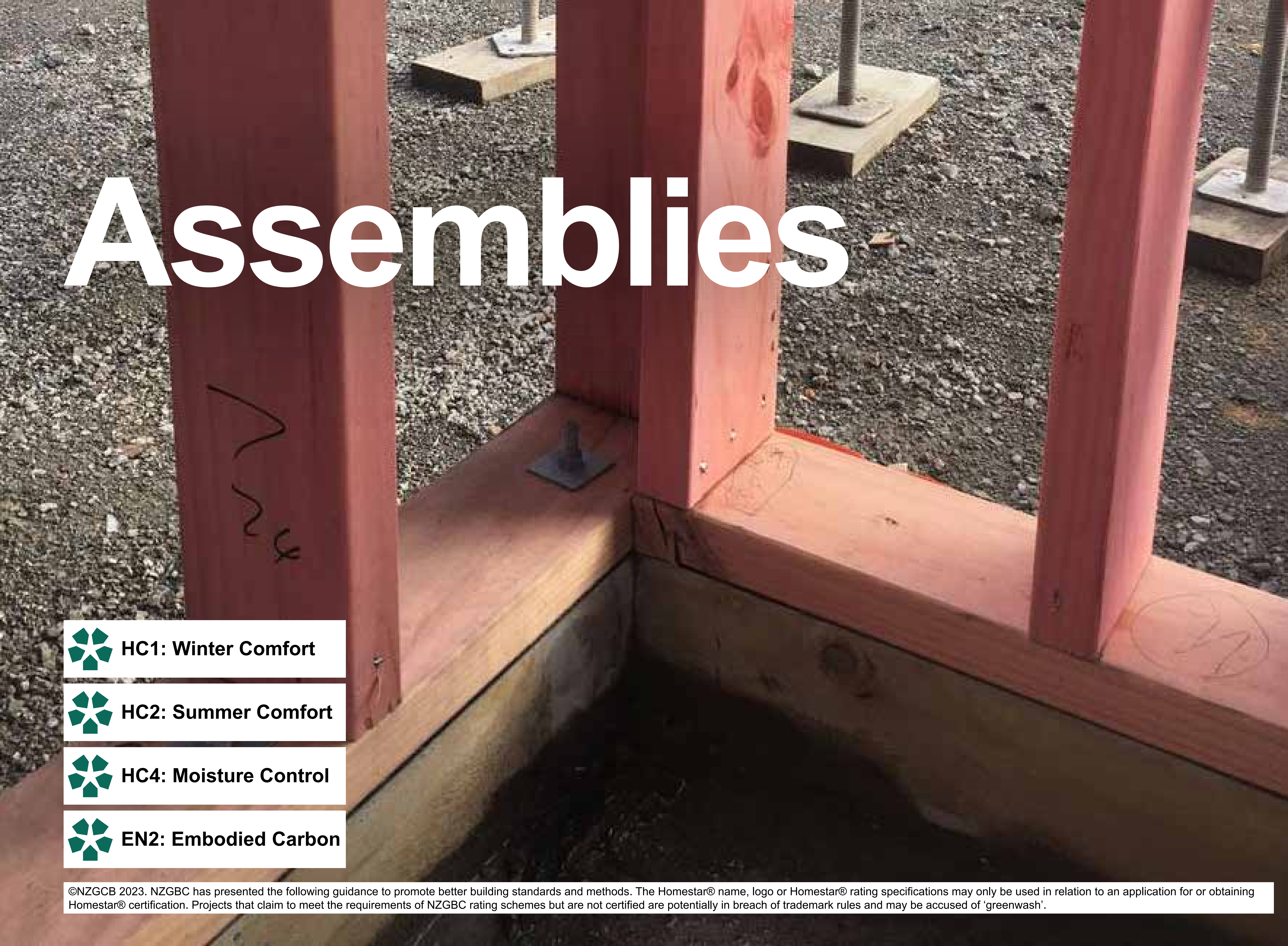


Assemblies

- HC1: Winter Comfort
- HC2: Summer Comfort
- HC4: Moisture Control
- EN2: Embodied Carbon

Assemblies

Why?

Different construction assemblies (or build-ups) perform in diverse ways based on the location, temperature, humidity, etc. We also need to balance the costs and client requirements.

There are a range of construction typologies available, each with their positives and negatives.
In this chapter we will introduce a range of build-ups for walls, floors, roofs, and joinery installations, and set out some properties of each. This list is not exhaustive but includes a range of standard and best practice build-ups.

Depending on the climate, site conditions and building design it may be possible to use a range of build-ups to achieve the required HomestarTM and performance level. However, thermally modelling the project will be the primary way to assess which is most suitable.

Each assembly is part of the three control layers, all of which must be continuous.

- Weathertightness
- Thermal envelope
- Airtightness

Any break in these, or junction between them has the potential for water ingress, thermal bridging or air leaks. These are covered in further detail in the Moisture Control chapter.

NB: Provided R-values are for information only - R-values of build-ups should be calculated for each build-up in each project using ECCHO.

For insulation the thermal conductivity of the product has been noted in W/mK along with the assumed timber content, to demonstrate where the R-values have been derived from.

In the case of details containing steel framing, you aren’t able to use ISO 6946 utilised by ECCHO due to the magnitude of difference in thermal conductivity of materials which invalidates the result, so other softwares are necessary.

Included assemblies:

Walls

- 90mm timber framing
- 140mm timber framing
- Concrete/ blockwork
- Insulated concrete formwork (ICF)
- External insulation – timber stud
- External insulation – steel stud
- Structural insulated panels (SIPs)

Floors

- Suspended timber
- Structural insulated panels (SIPs)
- Concrete flat slab – insulation under
- Concrete flat slab – insulation over
- Concrete waffle pod – insulation under
- Concrete waffle pod – insulation over

Roof/ ceiling

- Timber trusses with insulation between
- Timber rafter skillion
- Structural insulated panels (SIPs)
- External insulation – timber structure
- External insulation – steel structure
- External insulation – concrete structure

Joinery installation

- Thermally broken aluminium windows – non-recessed
- Thermally broken aluminium windows – recessed
- UPVC windows – recessed
- Timber and aluminium windows - recessed

A note on framing ratios

Historically it has been deemed acceptable to consider 15% timber content in wall framing when judging R-values. However, a BRANZ study showed that in reality this was much higher - an average of 36%.

This means that a standard 90mm wall with R2.8 insulation will, in reality, not meet the H1 minimum levels of insulation, and will result in far more heat loss and thermal bridging than assumed.

To this end 30% timber content is the default value to be used in Homestar, unless it can be shown that steps have been taken to reduce the timber content through reducing nogs/ dwangs, utilising 2 stud corners, and generally interrogating the wall and roof framing design.

Many framing suppliers are in the process of working through this requirement, and will provide shop drawings if requested.

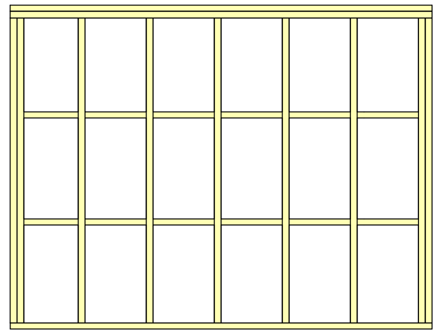
Things to look out for

When aiming to reduce the timber required in walls there are several key things you can consider:

- **Corners** - traditional corners have a lot of timber in them. This can easily be reduced to a ‘2 stud’ corner with a single piece of timber at the end of each wall for cladding fixing, and metal channels or ‘stud savers’ internally for linings fixing.
- **Nogs/ dwangs** - If you have a rigid wall underlay you don’t need nogs for bracing under NZS3604, so they can be removed. You may need timber for cladding fixings, in which case you can use 45x45 nogs installed on site, or 90x45 installed vertically to enable insulation to run over them, or use structural cavity battens to remove the need for them together
- **Stud spacings** - sometimes framers will automatically show studs at 400 or 450 centres, when 600 centres will suffice. Always check the shop drawings!

The easiest way to avoid timber content issues, is to put the insulation on the outside of the frames - see the external insulation details within this chapter.

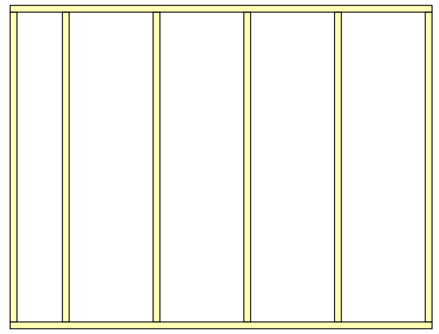
Received from framers



Wall Area: 6.00 m^2
Framing Area: 1.36 m^2

% timber content: 22.66%
R value 140mm framing: 2.956m^2K/W
R value 90mm framing: 2.029m^2K/W

Removed nogs, increased stud spacing, single top plate, exterior RAB

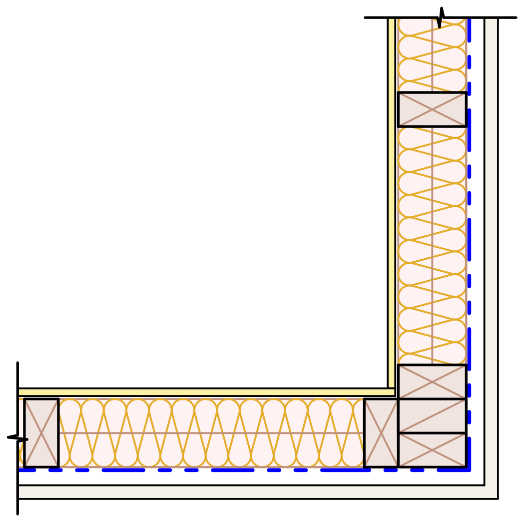


Wall Area: 6.00 m^2
Framing area: 0.81 m^2

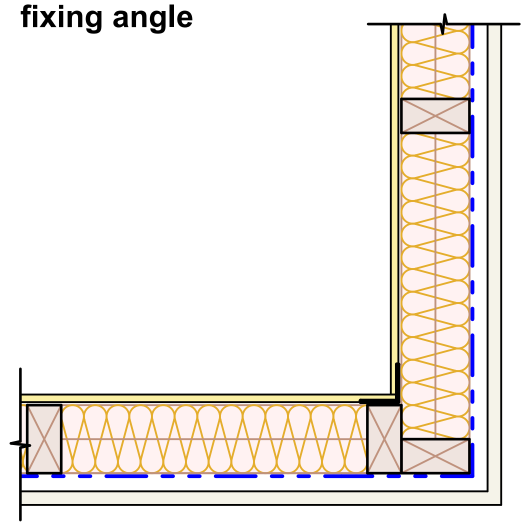
%timber content: 13.5%
R value 140mm framing: 3.528m^2K/W
R value 90mm framing: 2.415m^2K/W

19.02% better R value

Standard Corner



2 stud corner + fixing angle

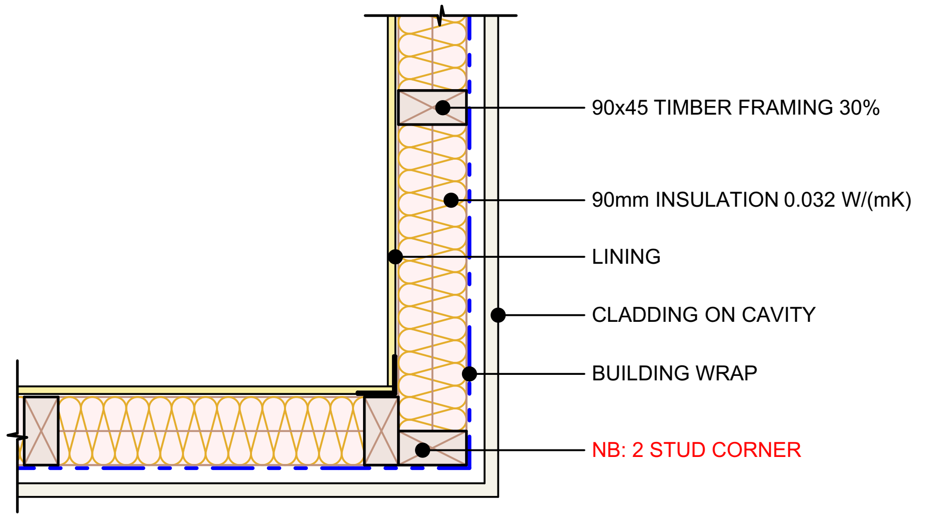


Walls - 90mm timber framing

- Typical construction, so all builders will be familiar
- 30% timber content doesn't meet code minimum R-values
- Interstitial condensation and mould risk due to lack of an airtightness layer
- Cantilevering a 90mm stud over adequate slab edge insulation can be challenging
- Addition of services cavity is a simple upgrade which increases performance, and enables the addition of a protected airtightness layer.
- An uninsulated cavity will be required to protect the airtightness layer if insulation is not required. If not using an airtightness layer then sealing the top and bottom plates can be an effective approach to increasing airtightness
- Still need to assess timber content and ensure 2 stud corners, etc.

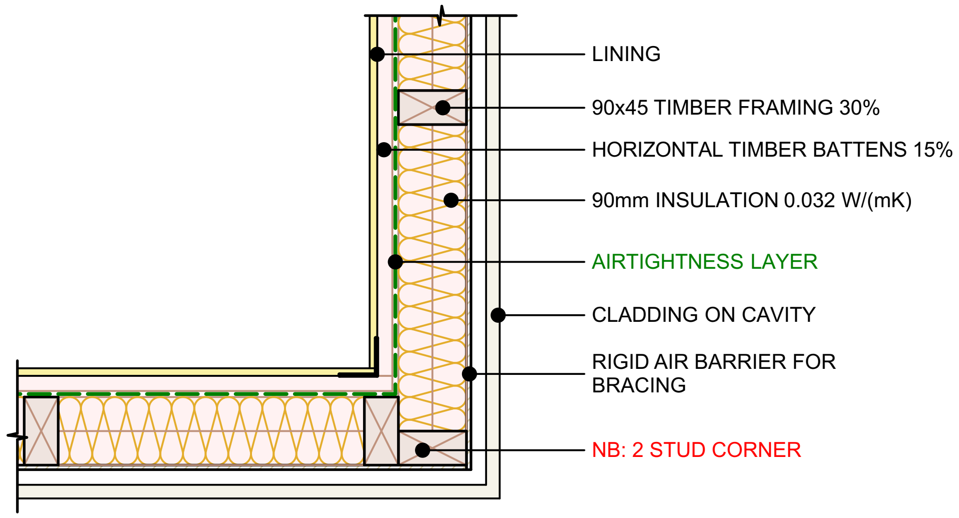
90mm FRAMING

R value: $1.83 m^2K/W$



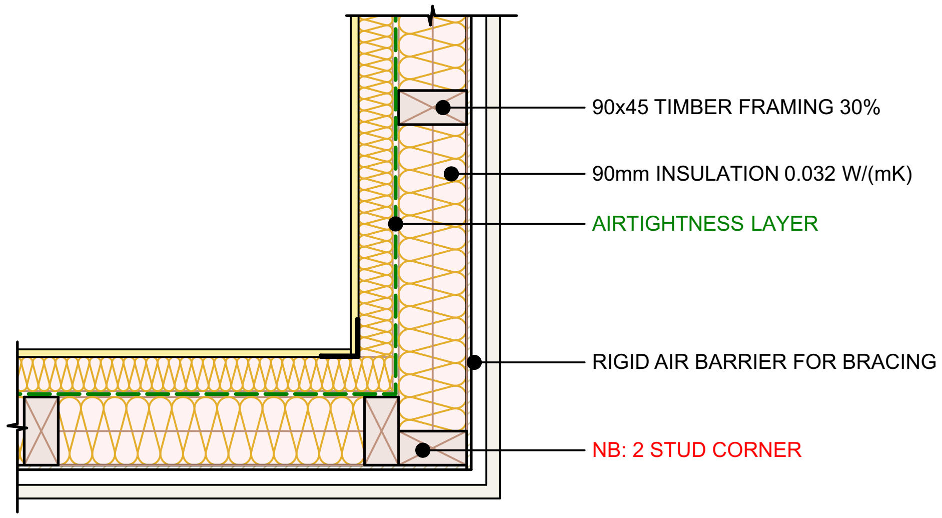
90mm FRAMING + 20mm SERVICES CAVITY, AIRTIGHTNESS LAYER & LINING

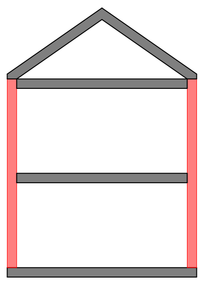
R value: $2.09 m^2K/W$



90mm FRAMING + 45mm INSULATED SERVICES CAVITY, AIRTIGHTNESS LAYER & LINING

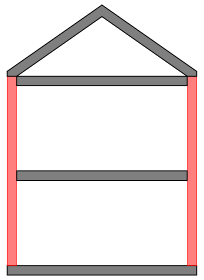
R value: $2.95 m^2K/W$





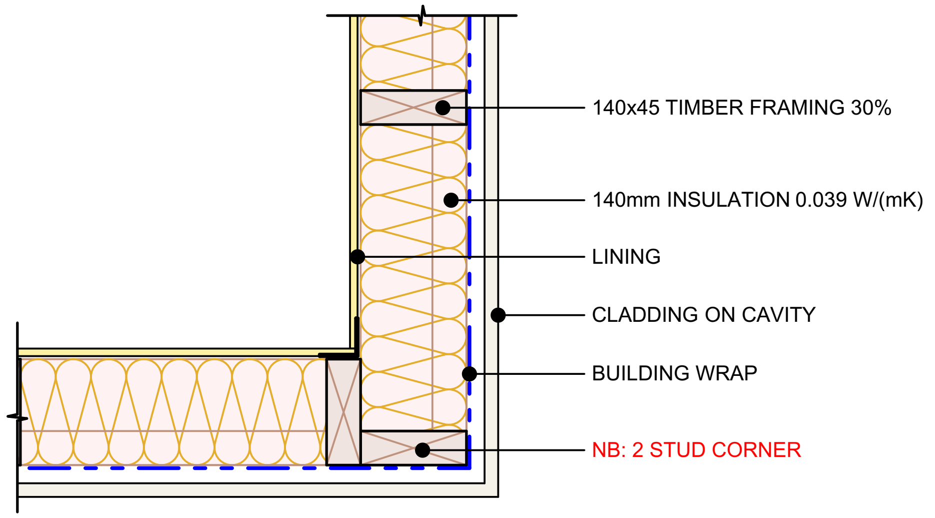
Walls - 140mm timber framing

- Typical construction, so all builders will be familiar
- Interstitial condensation and mould risk due to lack of an airtightness layer
- Can easily accommodate slab edge insulation overhang
- Addition of services cavity is a simple upgrade which increases performance, and enables the addition of a protected airtightness layer
- An uninsulated cavity will be required to protect the airtightness layer if insulation is not required. If not using an airtightness layer then sealing the top and bottom plates can be an effective approach to increasing airtightness
- Still need to assess timber content and ensure 2 stud corners, etc.



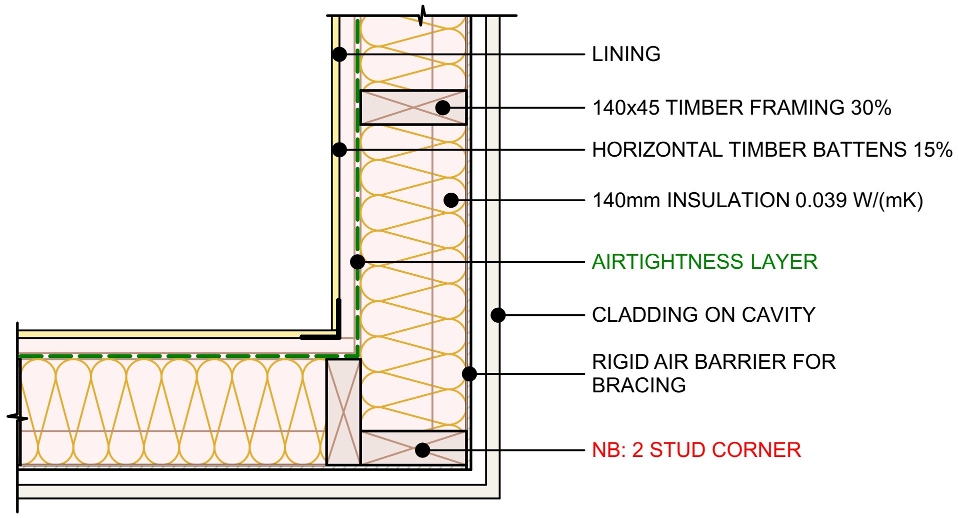
140mm FRAMING

R value: 2.46m²K/W



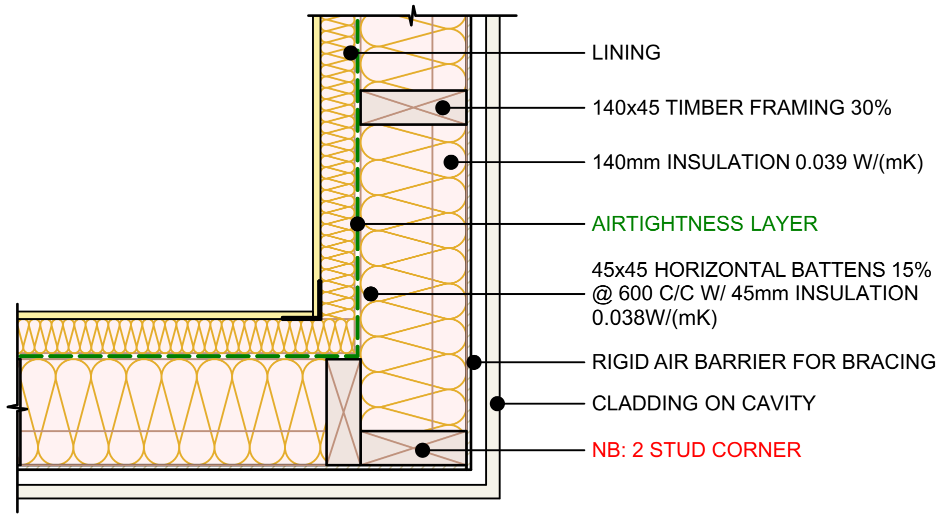
140mm FRAMING + 20mm SERVICES CAVITY, AIRTIGHTNESS LAYER & LINING

R value: 2.73m²K/W



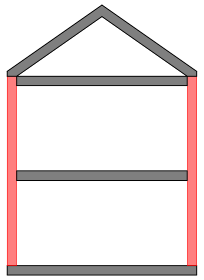
140mm FRAMING + 45mm INSULATED SERVICES CAVITY, AIRTIGHTNESS LAYER & LINING

R value: 3.03m²K/W



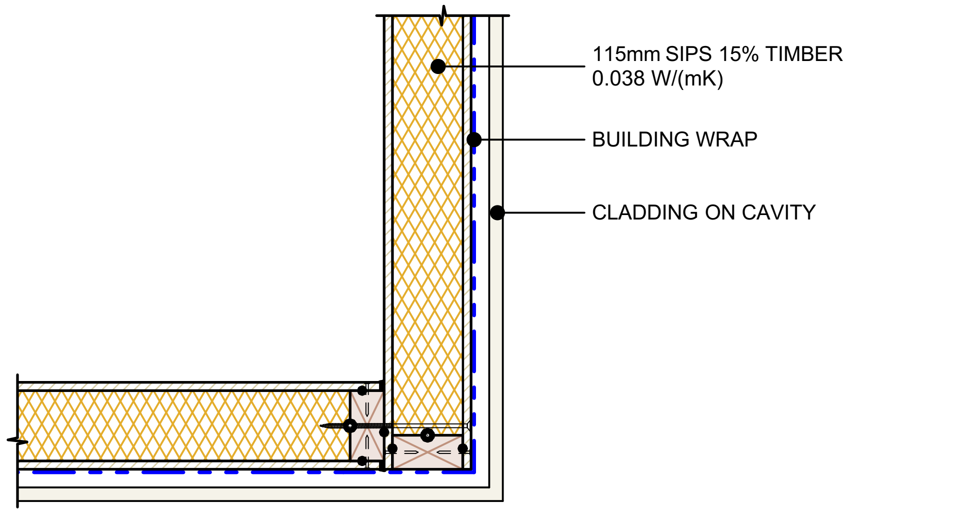
Walls - SIPs

- Less timber content than framing
- Insulation core options - EPS, PIR
- Faster on site, and prefabrication opportunities
- Can be exposed finish
- Can be higher carbon than timber walls
- More expensive material
- Less flexibility to change on site
- Running services in panels is not ideal.



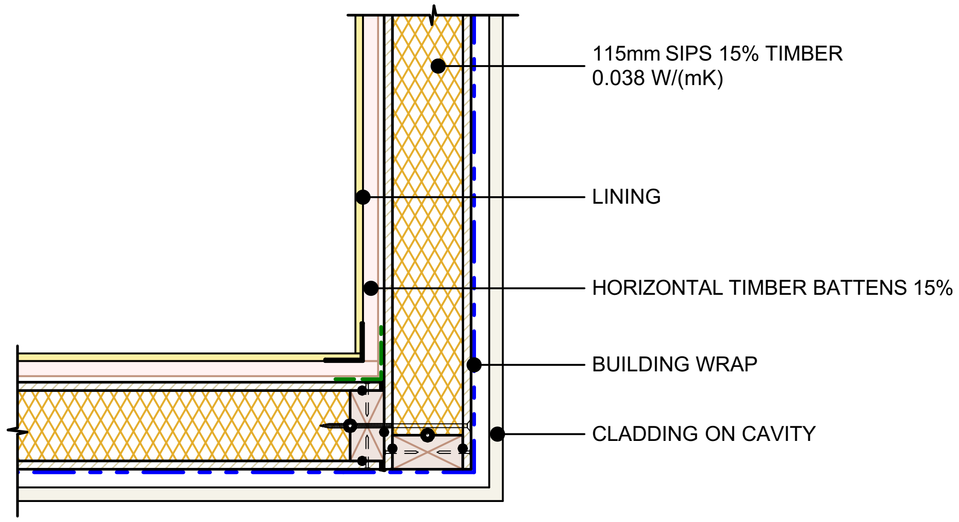
115mm SIPS - EXPOSED FINISH

R value: 2.28m^2K/W



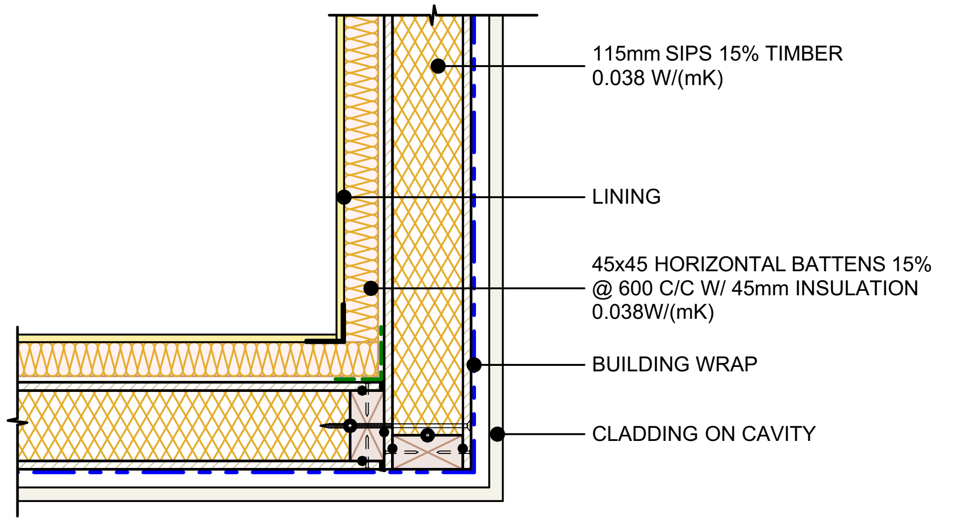
115mm SIPS + 20mm SERVICES CAVITY & LINING

R value: 2.52m^2K/W



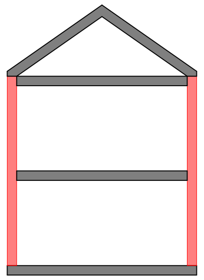
115mm SIPS + 45mm INSULATED SERVICES CAVITY & LINING

R value: 3.36m^2K/W



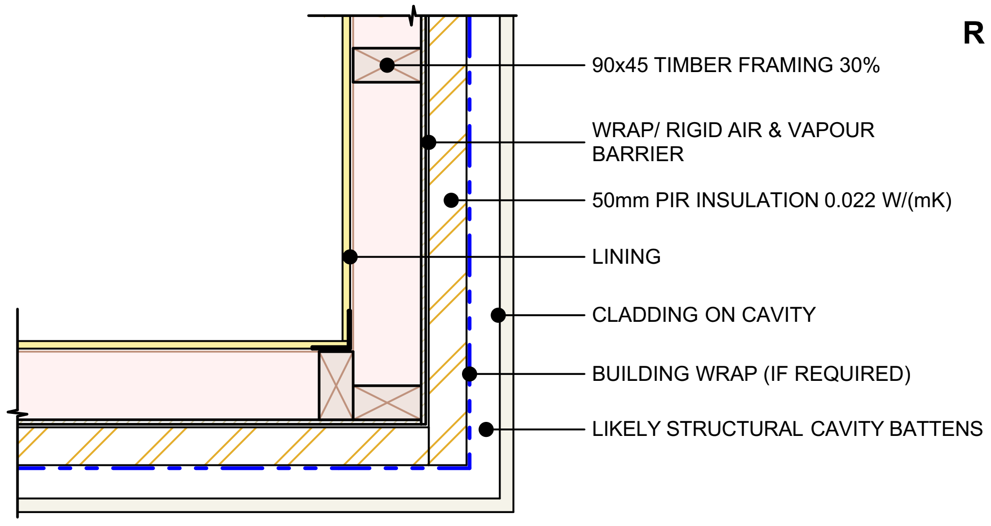
Walls - exterior insulation over timber framing

- Simple upgrade for minimal additional wall thickness
- Framing available for services circulation
- Airtightness and vapour control combined
- Insulation can run past slab edge and mid-floors
- Necessary to assess fire risk of different insulation products
- If insulating within framing too, the inner insulation R-value must be no more than 1/3 of the outer insulation R-value, to avoid the potential for Interstitial condensation (normally hygrothermal modelling is required to confirm this).
- Attention needs to be paid to not trapping moisture inside the frame. For this reason fibrous insulation is preferred.
- We strongly recommend hygrothermal modelling when combining different insulation types as in bottom detail.



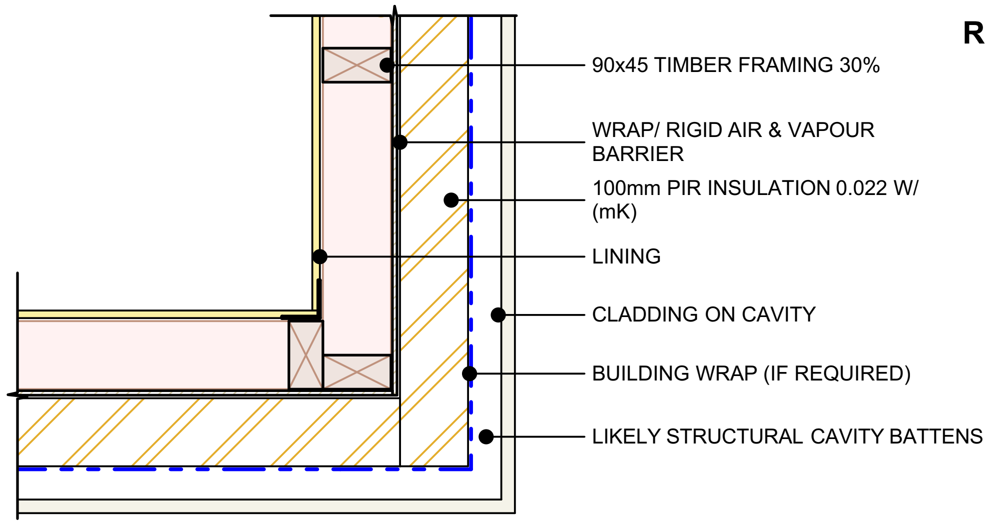
90mm FRAMING, 50mm EXTERIOR PIR

R value: 2.90m²K/W



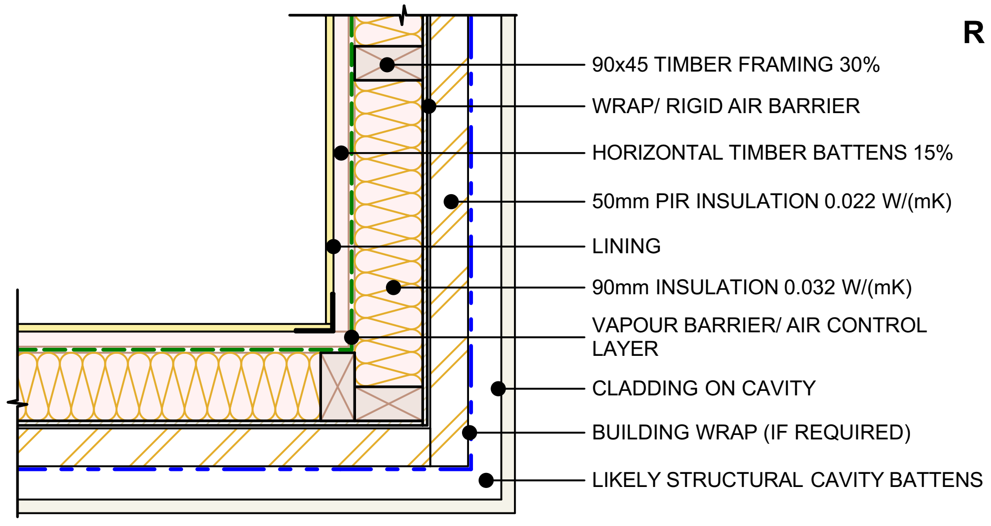
90mm FRAMING, 100mm EXTERIOR PIR

R value: 4.96m²K/W



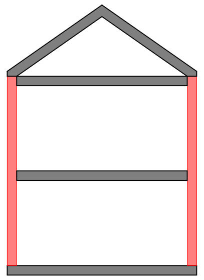
90mm INSULATED FRAMING + 20mm SERVICES CAVITY, 50mm EXTERIOR PIR

R value: 4.32m²K/W



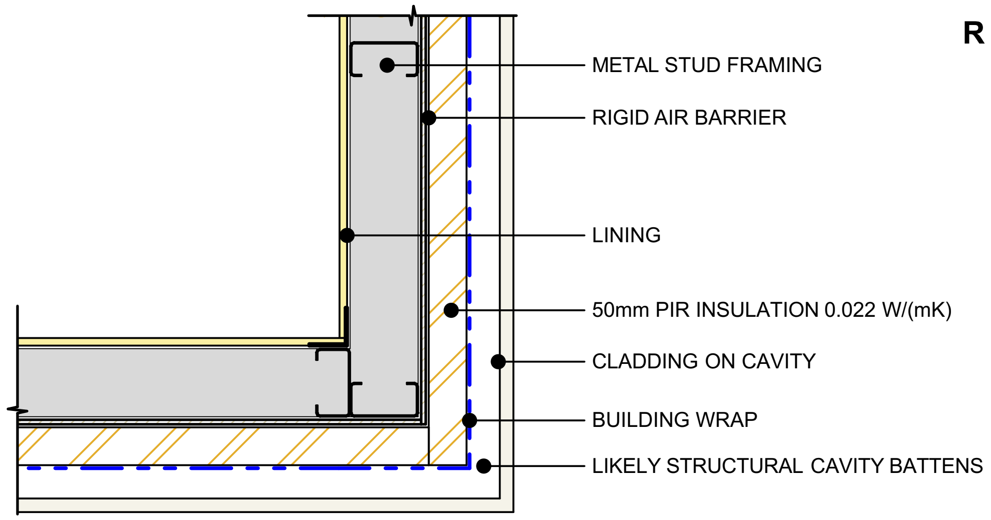
Walls - exterior insulation over metal and concrete

- Simple upgrade for minimal additional wall thickness
- Framing available for services circulation
- Airtightness and vapour control combined
- Higher embodied carbon in concrete and steel than timber
- Insulation can run past slab edge and mid-floors
- Necessary to assess fire risk of different insulation products
- With ICF getting the slab to wall connection detail can be tricky to avoid a thermal bridge
- Insulating concrete internally is not allowed in Homestar due to interstitial condensation risk.



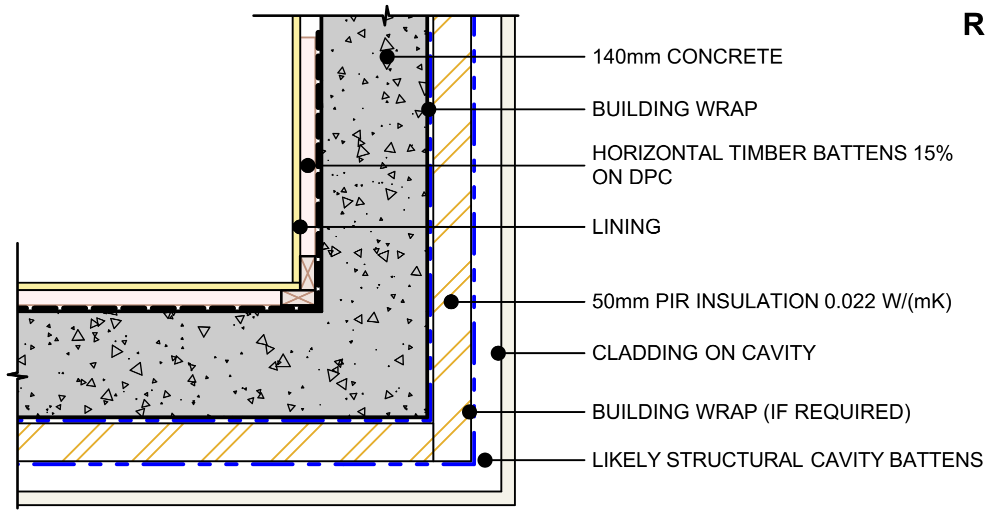
90mm ALUMINIUM FRAMING, 50mm EXTERIOR PIR

R value: 2.69m²K/W



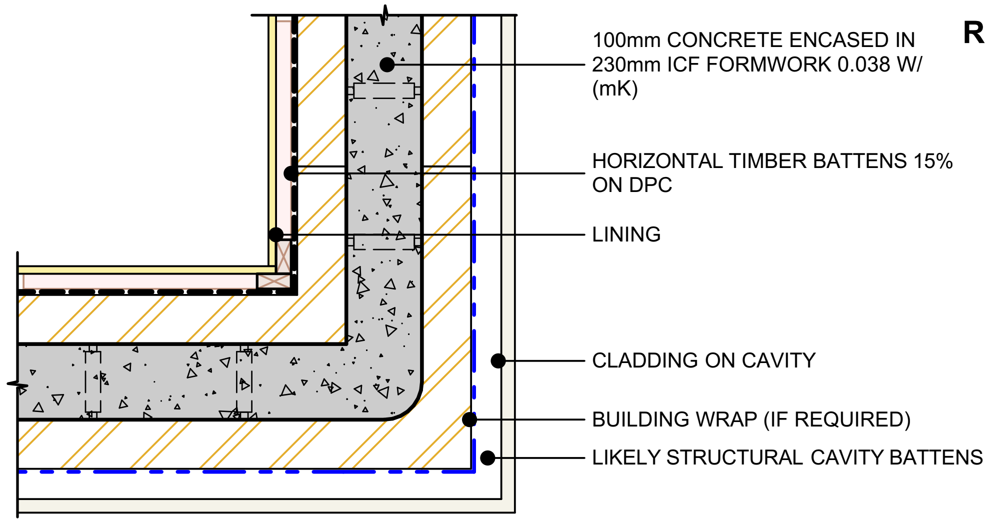
140mm CONCRETE + 20mm SERVICES CAVITY, 50mm EXTERIOR PIR

R value: 2.69m²K/W



230mm IFC BLOCKWORK + 20mm SERVICES CAVITY

R value: 3.84m²K/W

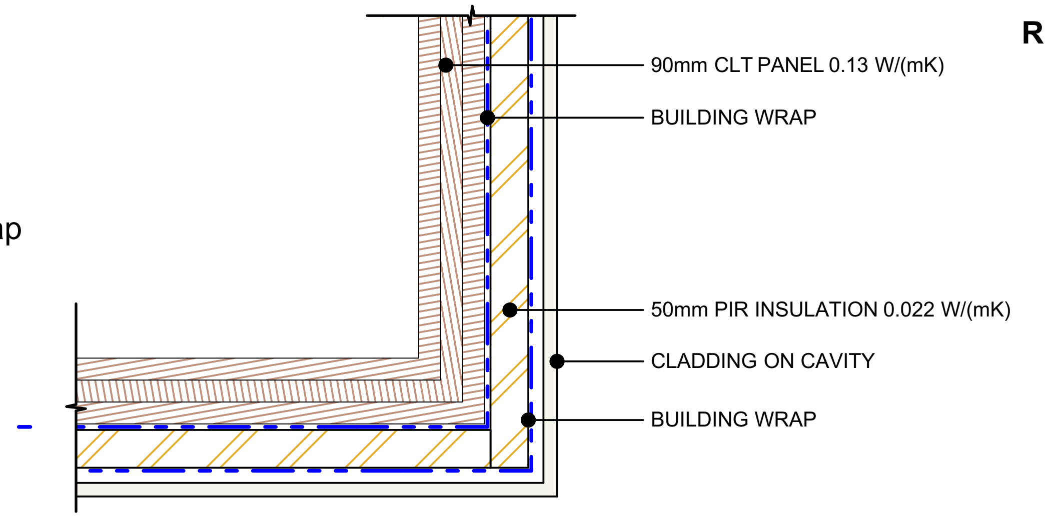


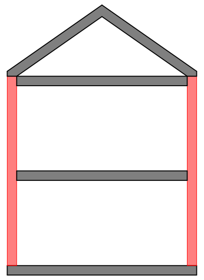
Walls - exterior insulation over CLT

- Airtightness and vapour control combined
- Insulation can run past slab edge and mid-floors
- Necessary to assess fire risk of different insulation products
- Services require careful coordination to ensure all runs are pre-routed, visible, or additional strap and lining to conceal them
- Can leave the CLT exposed internally, so no need for additional lining.

90mm CLT, 50mm EXTERIOR PIR

R value: 3.23m²K/W





Floors - suspended timber

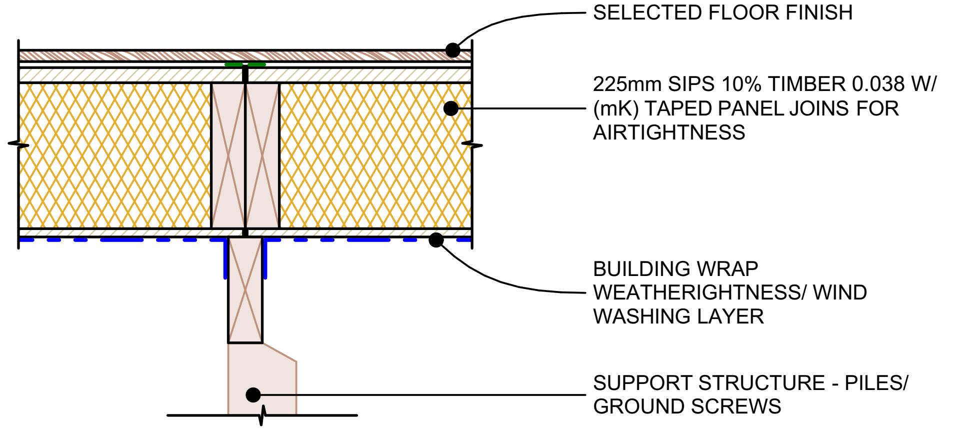
- Easy to achieve insulation requirements
- No slab edge thermal bridge to deal with
- Can access and maintain services beneath
- Minimises the amount of excavation and levelling required on steeper sites.

SIPs

- SIPs floor can achieve long spans, minimising the amount of piles/ bearers
- SIPs have less timber content than framing, so higher performance for the same thickness
- However, they will be higher carbon
- Insulation core options - EPS, PIR
- Faster on site, and prefabrication opportunities
- More expensive material
- Less flexibility to change on site.

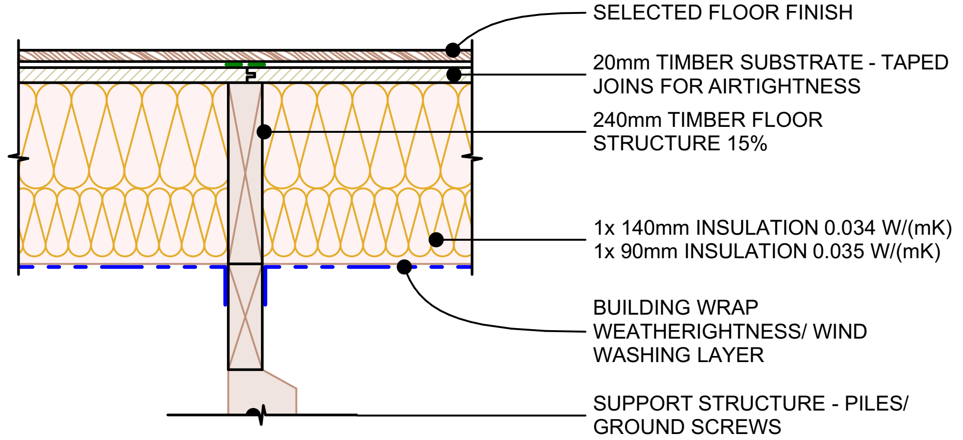
225mm SIPS FLOOR

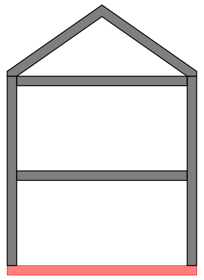
R value: 5.01m²K/W



240mm SUSPENDED TIMBER FLOOR

R value: 6.21m²K/W





Floors - concrete flat slab

Insulation on top of slab

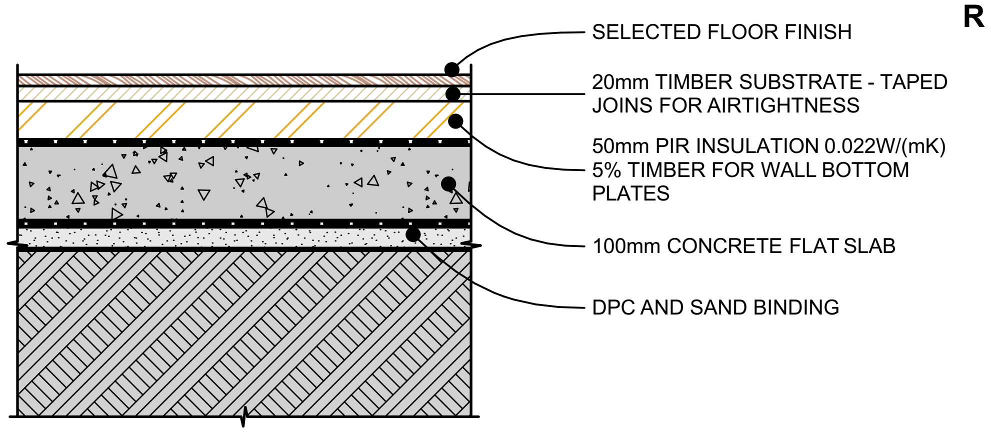
- Makes utilising masonry cladding easier as no thermal bridge, and no slab edge insulation required
- Need to deal with thermal bridge connections between slab and steel structure
- Higher embodied carbon than timber floors, even with lower embodied carbon options.

Insulation beneath the slab

- Standard construction
- Masonry cladding base detail won't meet fRsi requirements
- Means the thermal mass can be utilised, and de-materialisation through a concrete finished floor
- Higher embodied carbon, even with lower embodied carbon options.

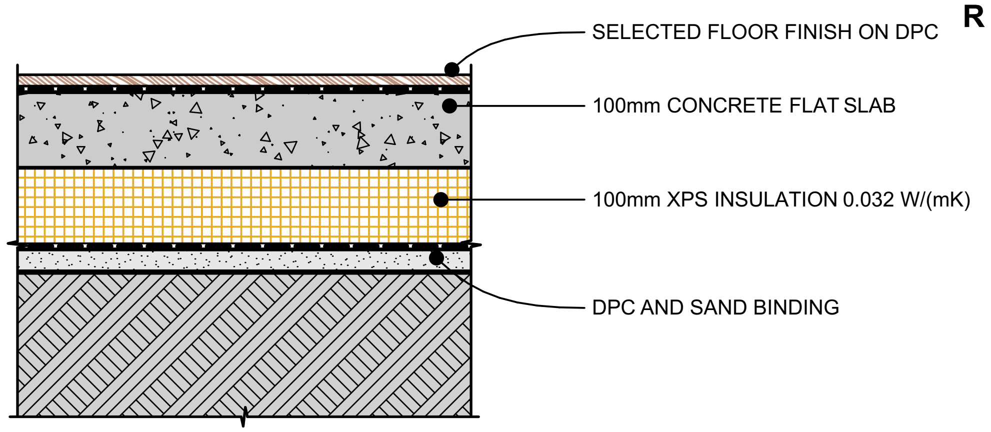
100mm SLAB, 50mm PIR INSULATION ON TOP

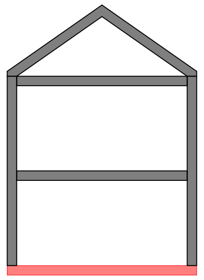
R value: 2.27m²K/W



100mm SLAB, 100mm XPS INSULATION BENEATH

R value: 3.34m²K/W





Floors - concrete waffle pod slab:

Insulation on top of slab

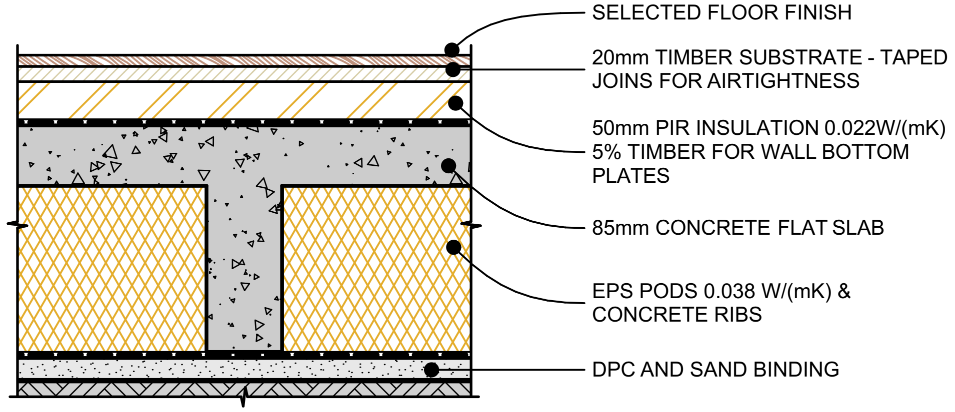
- Makes utilising masonry cladding easier as no thermal bridge, and no slab edge insulation required
- Need to deal with thermal bridge connections between slab and steel structure
- Higher embodied carbon than timber floors, even with lower embodied carbon options.

Insulation beneath the slab

- Standard construction
- Masonry cladding base detail won't meet fRsi requirements
- Means the thermal mass can be utilised, and de-materialisation through a concrete finished floor
- Higher embodied carbon than timber floors, even with lower embodied carbon options.

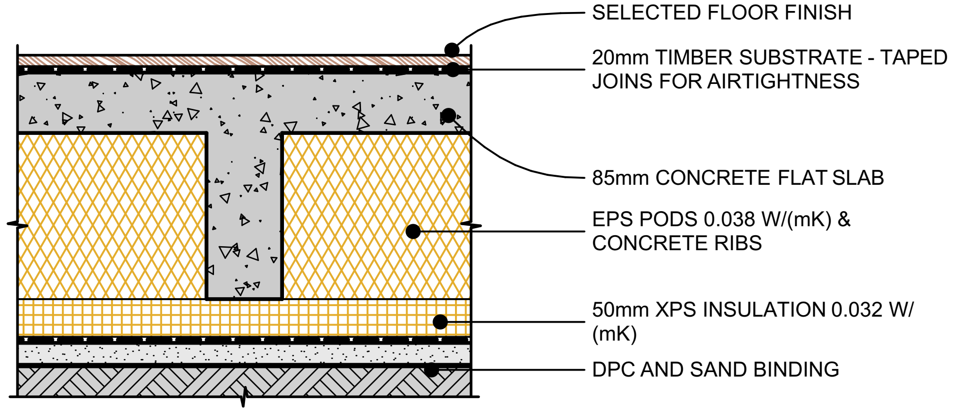
85mm CONCRETE 220mm WAFFLE POD SLAB WITH 50mm PIR INSULATION ON TOP

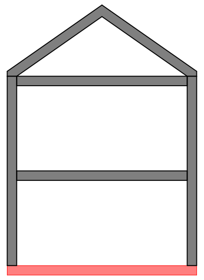
R value: 2.84m²K/W



85mm CONCRETE 220mm WAFFLE POD SLAB WITH 50mm XPS INSULATION BENEATH

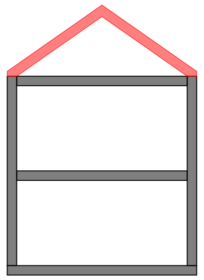
R value: 2.31m²K/W





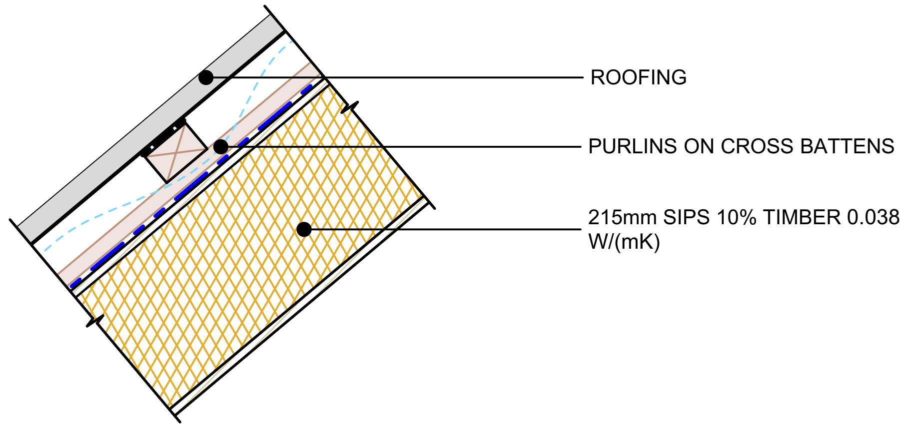
Roof - SIPs

- Less timber content than framing
- Insulation core options - EPS, PIR
- Faster on site, and prefabrication opportunities
- Can be exposed finish
- Can be higher carbon than timber framing
- More expensive material
- Less flexibility to change on site
- Running services in panels is not ideal.



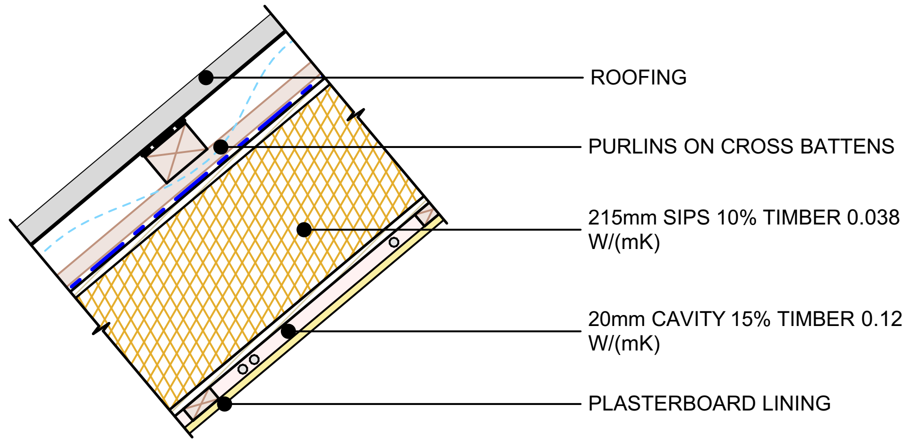
215mm SIPS - EXPOSED FINISH

***R value: 4.47*m²K/W**



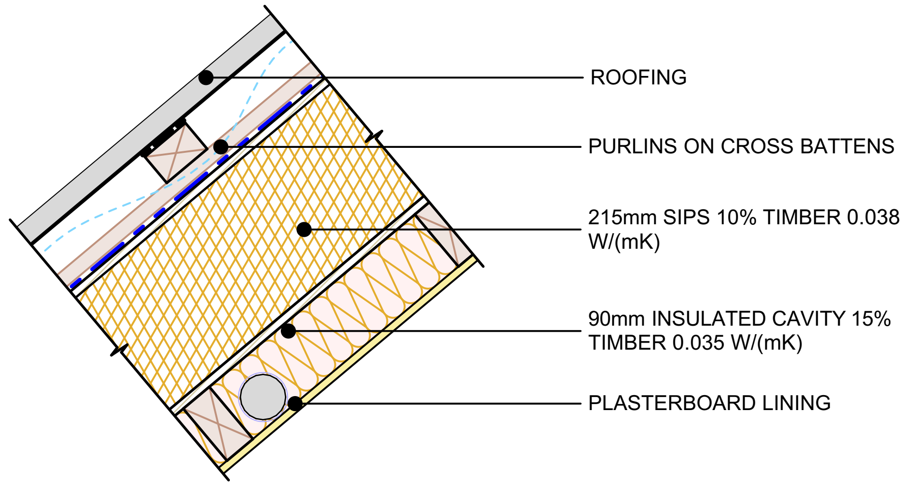
215mm SIPS + 20mm SERVICES CAVITY & LINING

***R value: 4.70*m²K/W**



215mm SIPS + 90mm INSULATED SERVICES CAVITY & LINING

***R value: 6.70*m²K/W**

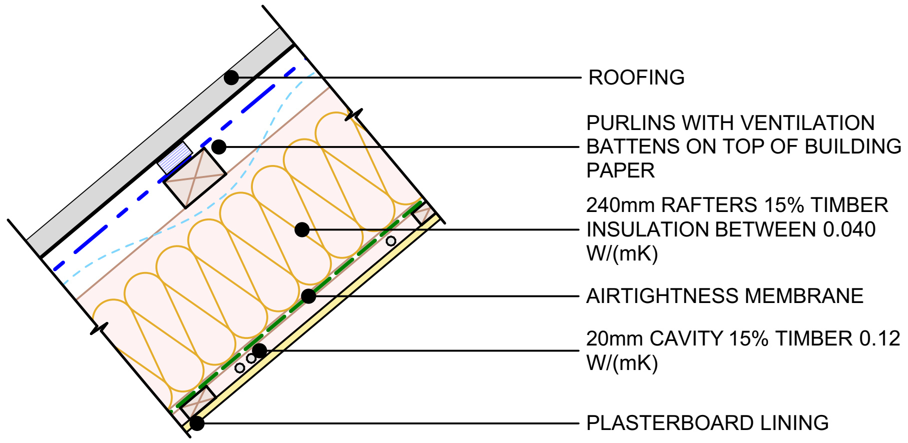


Roof - timber rafter skillion

- Typical construction, so all builders will be familiar
- Airtightness layer required due to high interstitial condensation and mould risk
- Achieving R6.6 can lead to increased thickness
- Addition of services cavity is a simple upgrade which can be insulated to increase performance if required, and enables the addition of an airtightness layer with protection from penetrations.

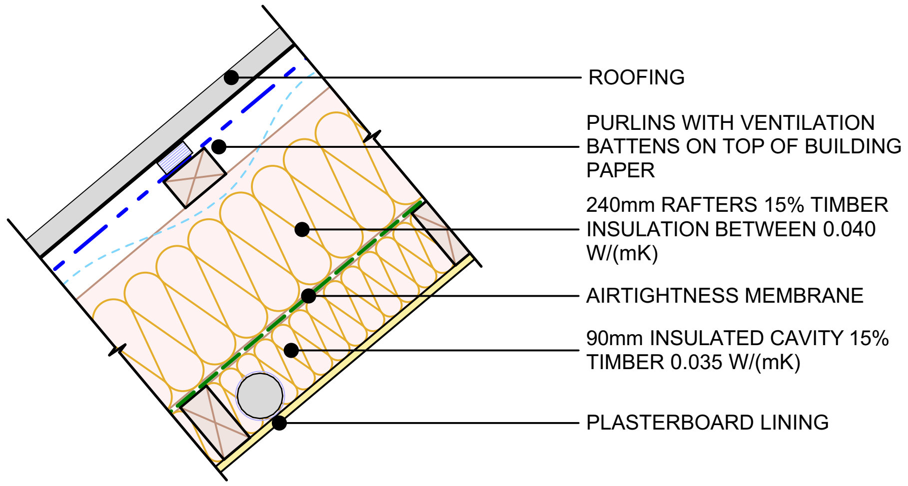
TIMBER RAFTER SKILLION - 20mm SERVICES CAVITY

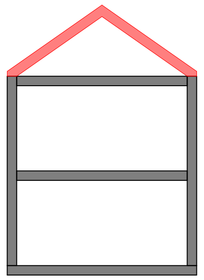
***R value: 4.38**m^2K/W*



TIMBER RAFTER SKILLION - 90mm SERVICES CAVITY

***R value: 6.43**m^2K/W*



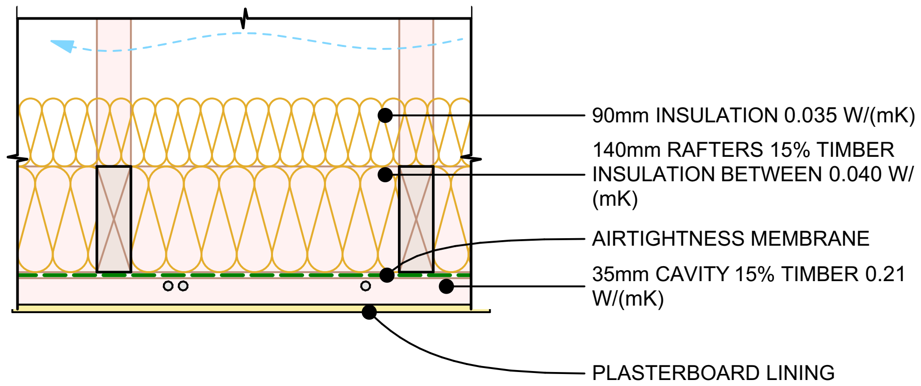


Roof - timber trusses and insulation at ceiling level

- Typical construction, so all builders will be familiar
- Airtightness layer required due to severe interstitial condensation and mould risk
- Achieving R6.6 can lead to increased thickness
- Consideration of the eave detail required, and minimum heel height to ensure minimum insulation thickness achieved
- Lots of room to add insulation once the minimum has been achieved. However, diminishing returns to consider once past a certain thickness
- Addition of services cavity is a simple upgrade which increases performance, and enables the addition of a protected airtightness layer.

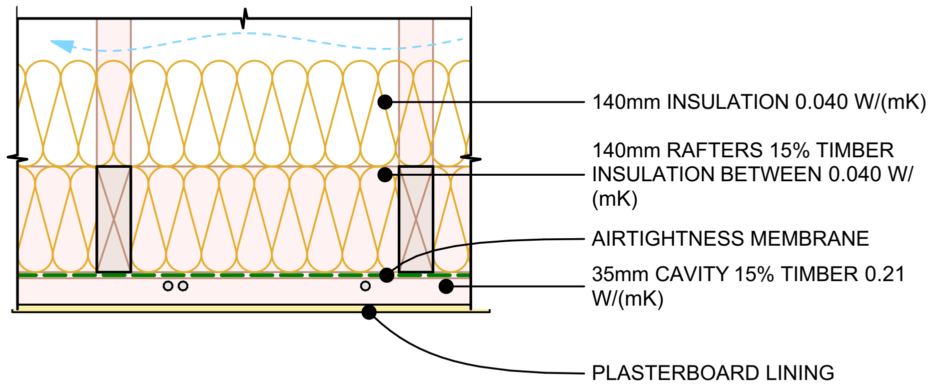
INSULATION BETWEEN & OVER 140mm TRUSSES + 20mm SERVICES CAVITY & LINING

***R value: 5.97*m²K/W**



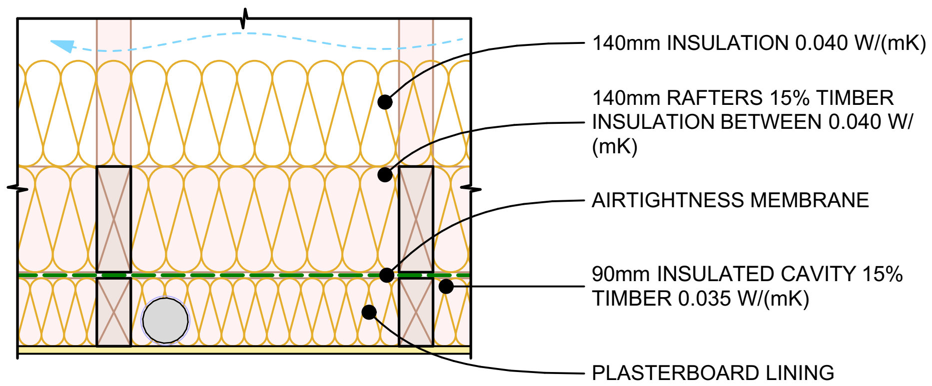
INSULATION BETWEEN & OVER 140mm TRUSSES + 20mm SERVICES CAVITY & LINING

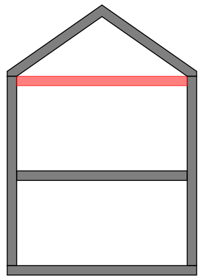
***R value: 6.88*m²K/W**



INSULATION BETWEEN 140mm TRUSSES + 90mm INSULATED SERVICES CAVITY & LINING

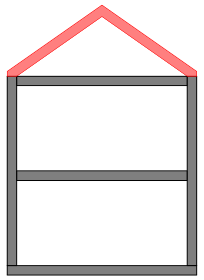
***R value: 8.76*m²K/W**





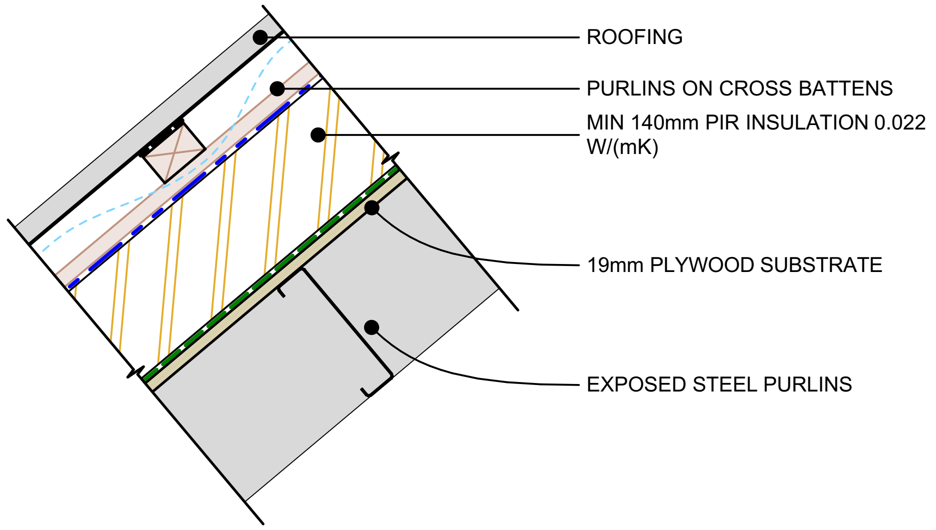
Roof - metal purlins and exterior insulation

- Typical construction, so all builders will be familiar
- Insulation must be external of the structure to avoid thermal bridging
- Substrate and airtightness layer combined
- Higher carbon than timber purlins
- Consideration of the eave detail required due to insulation being over the structure
- Addition of services cavity is a simple upgrade which increases performance, and enables the addition of a protected airtightness layer.



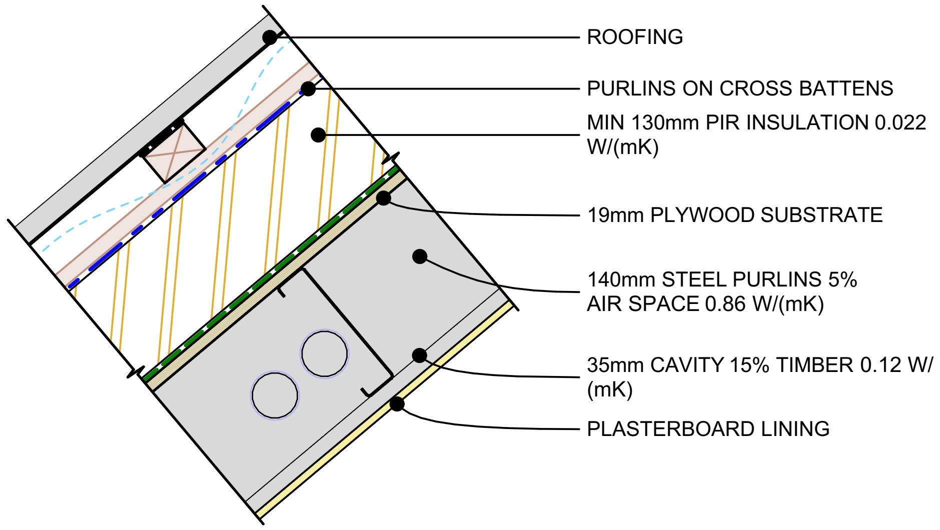
EXTERNAL INSULATION - EXPOSED STEEL RAFTERS

R value: 6.65m^2K/W



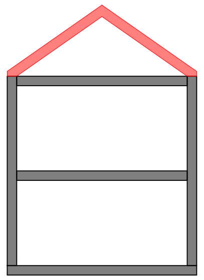
EXTERNAL INSULATION - ENCLOSED SERVICES CAVITY

R value: 6.52m^2K/W



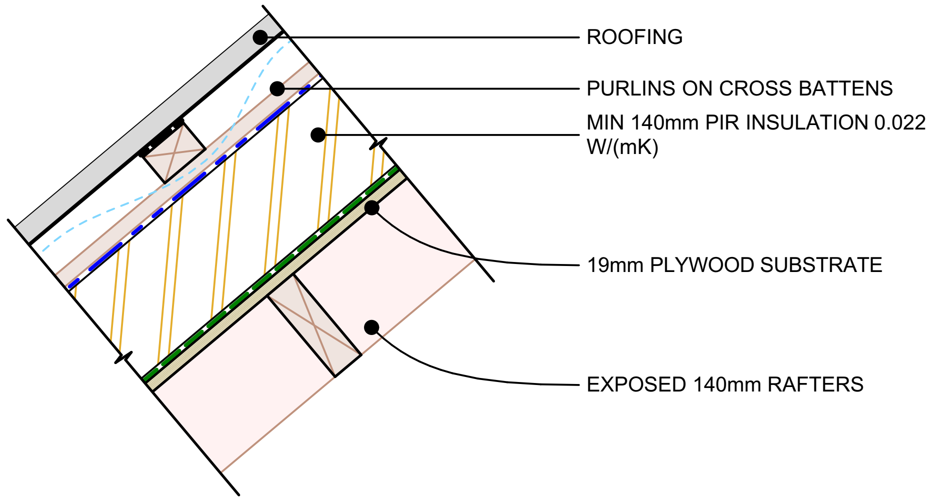
Roof - timber purlins and exterior insulation

- Typical construction, so all builders will be familiar
- Substrate and airtightness layer combined
- Consideration of the eave detail required due to insulation being over the structure
- Can achieve higher R-values with less thickness than a skillion roof
- Addition of services cavity is a simple upgrade which increases performance, and enables the addition of a protected airtightness layer.



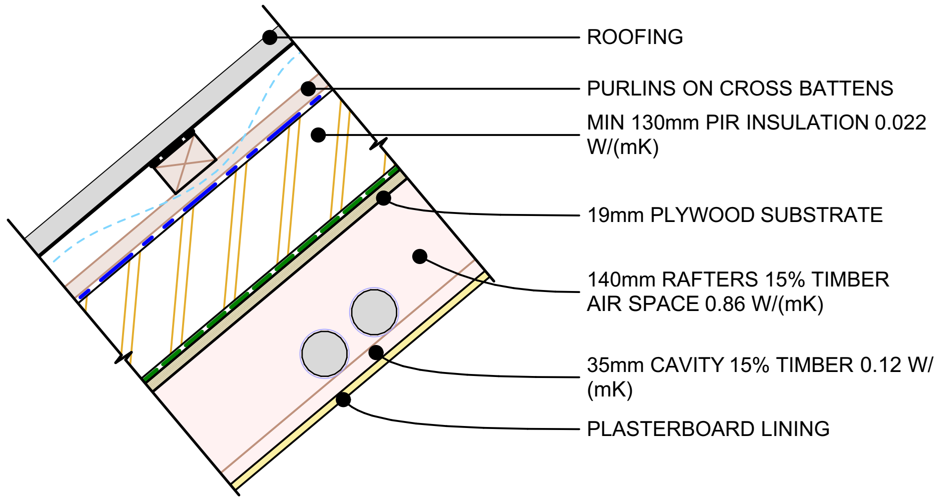
EXTERNAL INSULATION - EXPOSED RAFTERS

R value: 6.65m^2K/W



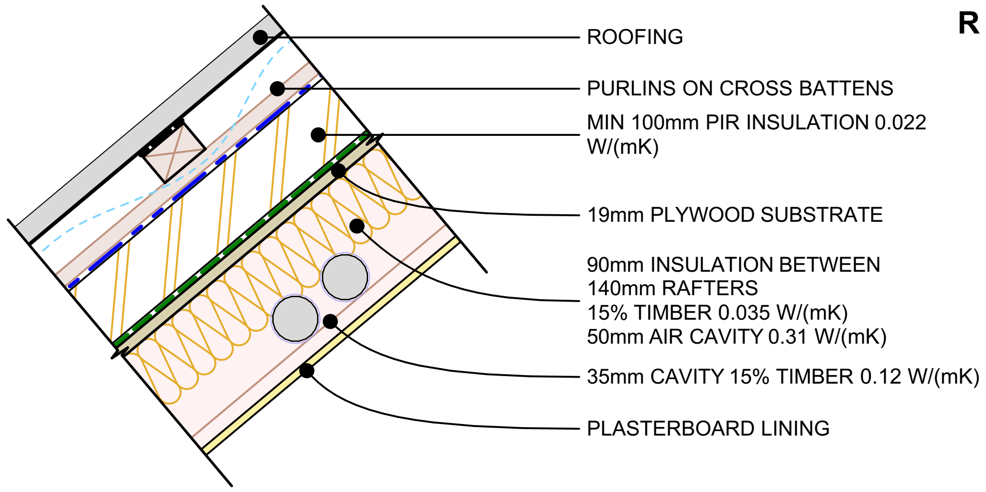
EXTERNAL INSULATION - ENCLOSED SERVICES CAVITY

R value: 6.66m^2K/W



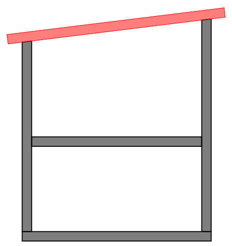
EXTERNAL INSULATION - INSULATED SERVICES CAVITY

R value: 7.28m^2K/W



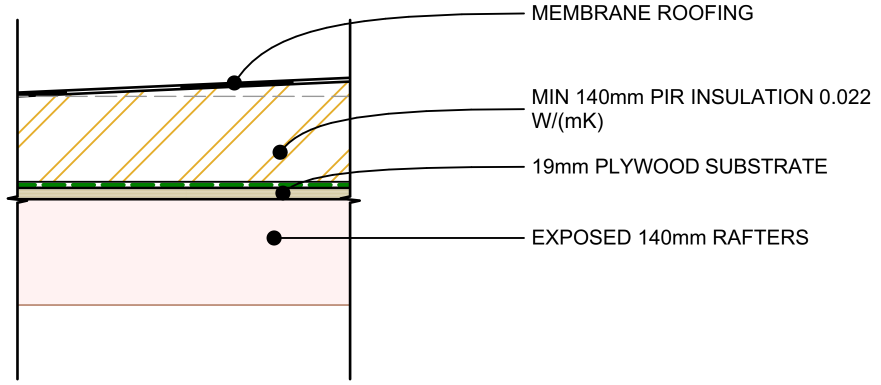
Roof - flat roof, warm roof

- Typical construction, so all builders will be familiar
- Substrate and airtightness layer combined
- Can achieve higher R-values with less thickness than a cold roof
- Services can just circulate within the structure, and additional insulation can be added if required with no additional thickness.
- External insulation with a services cavity presents a higher risk of interstitial moisture. Hygrothermal analysis (e.g. WUFI) is highly recommended in these instances.



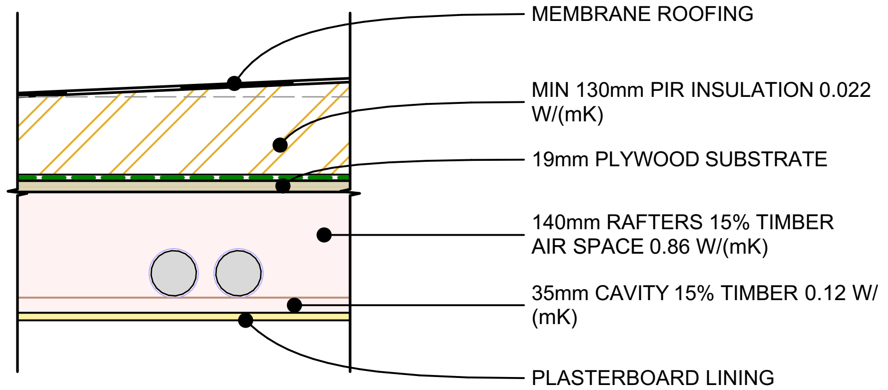
EXTERNAL INSULATION - EXPOSED RAFTERS

R value: 6.65m²K/W



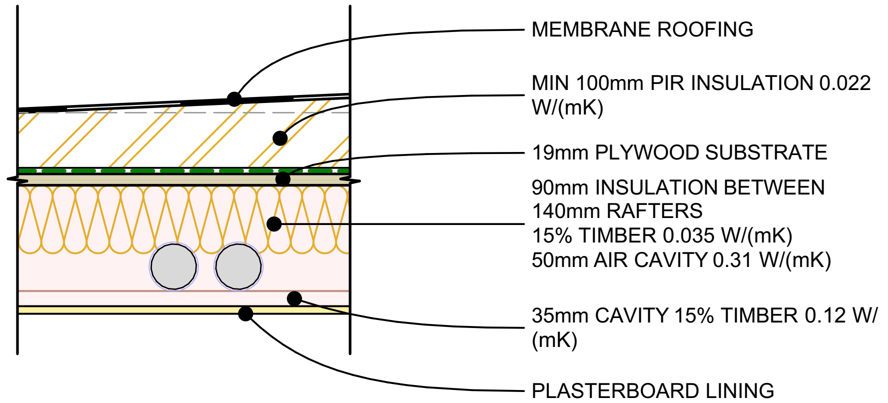
EXTERNAL INSULATION - ENCLOSED SERVICES CAVITY

R value: 6.66m²K/W



EXTERNAL INSULATION - INSULATED SERVICES CAVITY

R value: 7.28m²K/W

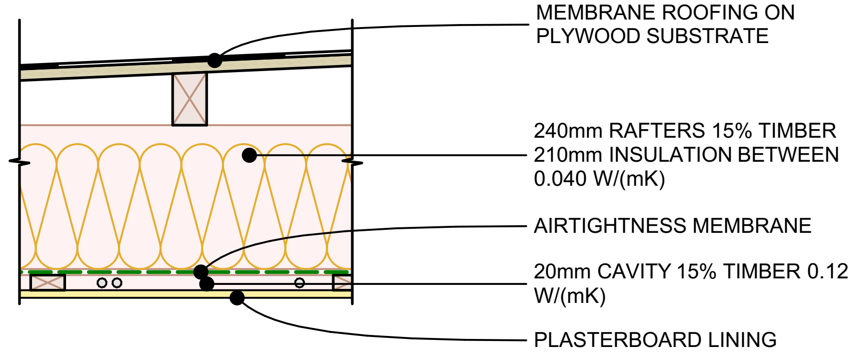


Roof - flat roof, cold roof

- Typical construction, so all builders will be familiar
- Requires airtightness layer due to significant interstitial condensation and mould risk
- Hygrothermal modelling recommended to assess moisture risk
- Services can just circulate within the structure, and additional insulation can be added if required with no additional thickness
- Addition of services cavity is a simple upgrade which increases performance.

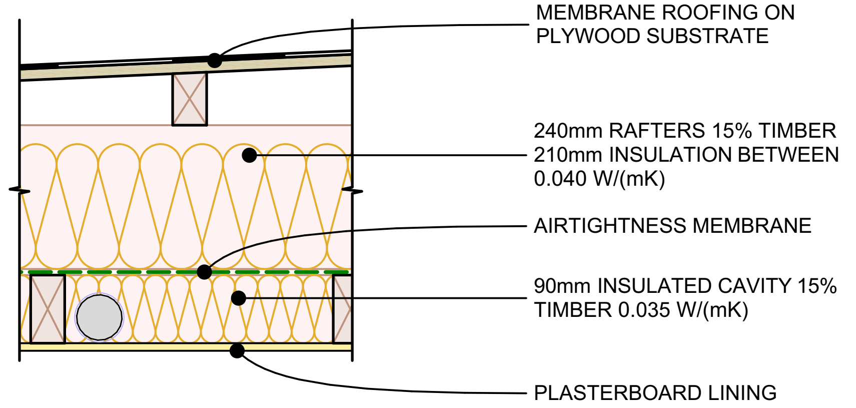
INSULATION BETWEEN RAFTERS

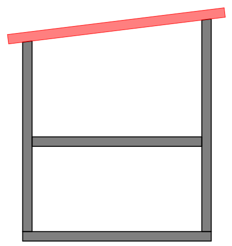
R value: 4.57m²K/W



INSULATION BETWEEN RAFTERS - 90mm SERVICES CAVITY

R value: 6.61m²K/W





Windows

- Windows are part of the thermal envelope, weathertightness barrier and the airtightness strategy, and as such must be integrated continuously to all three
- If a thermally broken window is installed in line with the cladding, the thermal break is being bypassed and so is not doing anything
- As well as thermal performance, the airtightness of the unit when closed must be considered - multi-point locking systems are far better than single point handles
- If including trickle vents consider the position - having them at the top will likely result in less drafts at user level, and less likelihood that they will be blocked.

01 A non-thermally broken aluminium frame installed in line with the cladding as per E2. The airtightness and insulation are both discontinuous.

02 A thermally broken window installed in line with the cladding - the thermal envelope is interrupted, leading to a thermal bridge. The junction between the timber reveal and aluminium window can also be weak for airtightness.

03 A thermally broken window installed back in line with the wall - the thermal envelope is nearly continuous, reducing any thermal bridging. The airseal still relies on the PEF rod and sealant

04 Here the window is recessed, and the joinery frame has a flange which is taped back to the WRB - this enables the shim gap around the window to be fully filled with insulation to remove any thermal bridging.

05 Another version of this is tape, which is used to connect the window to the WRB - this also enables the shim gap around the window to be fully filled with insulation to remove any thermal bridging.

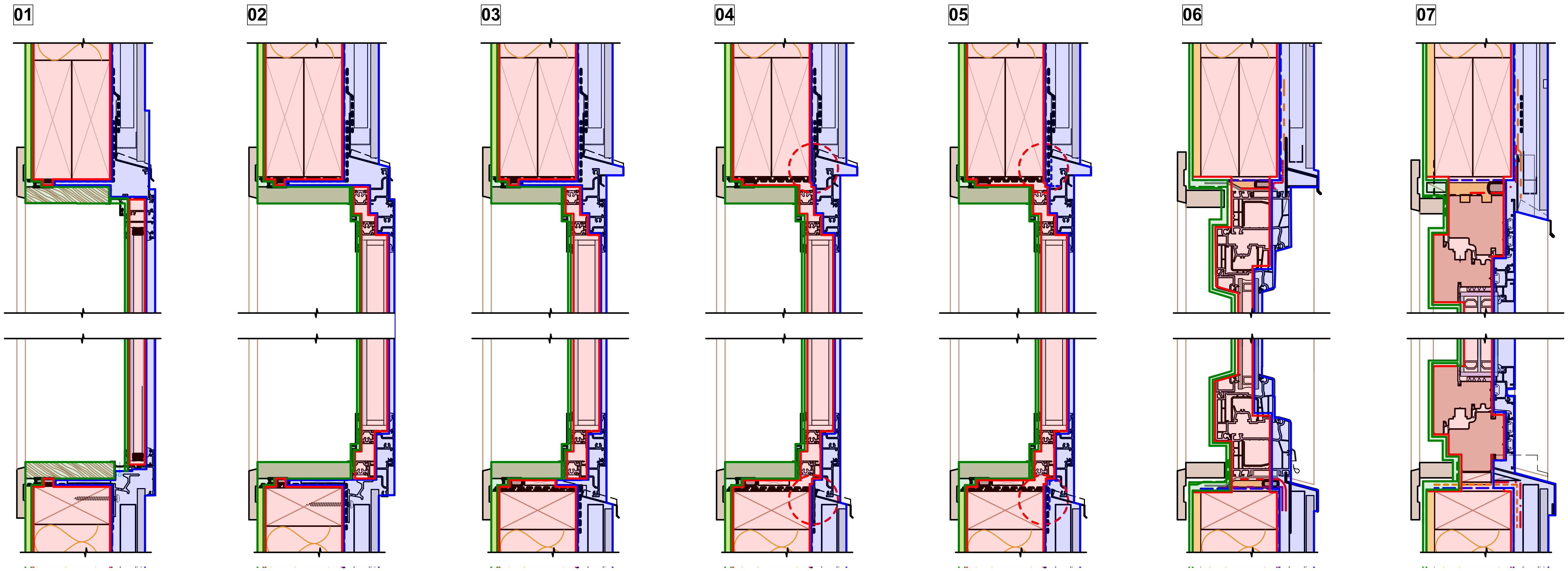
06 uPVC windows, installed in line with SIPs walls with proprietary flashings. All three control layers are unbroken.

07 Timber framed windows with aluminium facings, installed in line with SIPs walls. All three control layers are unbroken.

Airtightness

Insulation

Weathertightness



Glossary

Air and vapour control layer (AVCL)	This is a layer designed to control the air and vapour flow through a building assembly. Examples include specialist membranes and taped plywood or oriented strand board (OSB).
Air changes	The number of times that the total air volume in a home is completely removed and replaced with outdoor air, usually expressed per hour.
Airtightness	An assessment of the amount of unintended air leaks in the building envelope. Homestar uses the envelope area (Air permeability qE50 from ISO9972) as a reference for airtightness: m3 of air loss per m2 of envelope per hour @ 50pa pressure.
Annual electricity demand	'Delivered' energy includes everything associated with operational energy - excludes plug loads/appliances. It takes into account efficiency of any systems (e.g. demand might be 30 kWh/m²/yr, but using a heat pump with COP=3 means delivered energy is only 10 kWh/m²/yr).
Annual space heating demand/ heat demand	The amount of energy required to keep the building interior at a specified temperature.
Balanced ventilation	A balanced pressure ventilation system uses two fans to bring in the same amount of air as it removes. This ensures there is no pressure on the building envelope so no air is pushed or pulled through the building fabric.
Building performance	In the context of this guide this refers to the overall energy efficiency, user comfort and long-term durability of a building.
Climate zone	Designation of areas within New Zealand that share similar climatic characteristics.
CLT	Cross laminated timber - a form of mass timber construction.
Cold roof	Conventional New Zealand roof build-up where the structure of the roof (e.g. the rafters) is outside the thermal envelope.
Conditioned floor area (CFA)	Space within the thermal envelope of the dwelling that could maintain a temperature band of between 20-25°C for 365 days of the year. Refer to the Homestar Technical Manual for more details.
Continuous extract ventilation	Whole-dwelling ventilation system that extracts air continuously at a low rate.
Decentralised ventilation	A ventilation system that uses several fans in different locations to deliver and remove air in a building.
Ducted ventilation	A ventilation system that uses ducts to deliver and remove air in a building, with a single central fan unit.
ECCHO	The Homestar® energy analysis tool, ECCHO (Energy and Carbon Calculator for Homes), is a web app that allows users to calculate the heating and cooling demand, energy consumption, overheating risk, and carbon emissions of a home.
Embodied carbon	Embodied carbon is the carbon dioxide (CO_2) emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure.
Energy balance	The assessment of the amount of energy lost through the thermal envelope vs the amount of energy gained, with the difference made up by heating or cooling to maintain a balance.
Energy/ thermal modelling	Energy modelling of buildings is a process that uses computer software to simulate how a building will consume energy based on its design, materials, and systems.
EPD	Environmental Product Declaration, used to determine the environmental footprint of a product following life cycle assessment, verified independently.
Form factor	The ratio of total external surface area of the thermal envelope (including the floor slab area) to the conditioned floor area. Typically, a large building will have a lower form factor than a smaller one. A simpler shape will also have a lower form factor than a more complex shape. The lower the number, the less insulation needed in the same climate (everything else being equal).
Frequency of overheating	The amount of time in a year the interior spends at 25ºC or above. Note this can assume night and window ventilation, so if the building is modelled with more ventilation than used in practice it may overheat more than predicted.
fRsi	Temperature factor. Value between 0 and 1 that expresses how cold the inside surface of a junction is likely to get. The lower the number the higher the risk of mould. Numerically this is the difference between the interior surface temperature and the exterior air temperature, divided by the average temperature difference between interior and exterior.
g-value	Fraction of solar heat energy that enters a building compared to that which hits the outside of the glazing unit. Roughly equivalent to Solar Heat Gain Coefficient (SHGC) which is sometimes published instead for glazing units.
Heat loss area	The exterior area of the building that is between interior heated space and the exterior air, through which heat is lost - generally the walls, floor, roof and windows of a building. If a building is joined to another building, the adjoining area is not a heat loss area as it is attached to another heated space.
HECC	The Homestar Embodied Carbon Calculator developed by BRANZ for NZGBC, an easy to use tool for estimating the embodied carbon content of a typical home.
HPCDH	The High Performance Construction Details Handbook, a document that covers a wide range of typical thermal bridges, assemblies and build-ups used in New Zealand, produced by Passive House Institute New Zealand, BRANZ and Jason Quinn.
HVAC	Heating, ventilation, and air conditioning systems.
Hygrothermal modelling	Hygrothermal modelling uses a computer program to model the long-term effects of heat and moisture within and through parts of a building and assesses interstitial condensation risks.
Internal heat gain	The heating in a building from its occupants and the use of appliances within the thermal envelope.
kgCO²-e/m²	Kilgograms of carbon dioxide equivalent per square metre (of the home). A measurement of embodied carbon.
kWh	Kilowatt hour, a unit of energy. A 2kW portable heater on for one hour would use 2kWh (2000Wh) of energy. 1kWh = 3.6MJ (megajoules). A 1m² window in direct sunlight allows approximately 1kW of energy into the home.
kWh/m²/year (sometimes abbreviated to kWh/m²)	Kilowatt hours per m² per year. Measures the space heating demand compared with the usable or conditioned floor area (CFA in Homestar® v5, measured externally of the insulation; ICA or internal conditioned area in v4.1, measured internally of the insulation).

Life cycle assessment	Life cycle assessment (LCA) calculates the environmental footprint of a product or service over its lifecycle. LCA tools include HECC (for embodied energy only - see above), the BRANZ LCAquick tool and ETOOL LCD.
Low-e coatings	Low emissivity coating, most commonly on glass surfaces between double or triple pane windows. Low emissivity coatings reduce heat transfer by lowering the level of infrared radiation transmission. They achieve this by reflecting IR radiation and work best if there is both a physical gap and the coating is not covered with dirt or condensation (which is why they are commonly used in the sealed environment between glass panes). There are many types of low-e coatings and the thermal performance can vary significantly between them.
Mandatory minimum	Each Homestar® star band has a set of mandatory minimums that must be met. These dictate the performance levels we are aiming to achieve in each climate zone with each typology.
Mechanical ventilation with heat recovery (MVHR)	Also known as heat (or in some applications, energy) recovery ventilation or comfort ventilation. A whole-house ventilation system that exchanges heat between the exhaust air and the supply air. Fresh air is typically delivered to living areas (e.g. living room and bedrooms) and extracted from kitchens and bathrooms. MVHR units do not necessarily supply additional heat into the supplied air. However, a supply duct radiator, heat pump or electric coil can be used to add heat or coolth to the new air before or after it leaves the MVHR unit.
Negative pressure ventilation	A mechanical ventilation system that uses fans to remove the air within the building and de-pressurize it, pulling make up air into the building through trickle vents and open windows.
Positive pressure ventilation	A mechanical ventilation system that uses fans to push air into the building, pressurizing it. The air is then forced out of the building through any gap it can find. Positive pressure systems are not acceptable at any Homestar level.
psi value	Measure of heat loss (‘thermal bridging’) within a junction of two thermal elements, measured in W/mK. Represents the rate at which heat passes through a junction per metre per Kelvin temperature difference [W/m/K]: for example, the junction between two walls forming an external corner. The length of the junction (ie height of the corner) is multiplied by the psi value to calculate the heat loss coefficient for that corner.
R-value (m2K/W)	Thermal resistance rating used to determine a material or assembly’s ability to resist heat flow.
S/V	Surface to volume ratio - an assessment of the compactness of the building form.
Service cavity	A service cavity is a secondary cavity (that may or may not be insulated) usually to the inside of the structural elements and the AVCL (air and vapour control layer). It contains the wiring, plumbing etc to keep penetrations of the AVCL to a minimum. The service cavity is usually but not necessarily insulated. Commonly, the AVCL is tested for air leakage before insulating the service cavity or installing the interior finish.
Shading factor	A measure of how much solar heat gain enters through a window compared to an unshaded window.

Structural Insulated Panel (SIP)	A panellised off-site construction building system. The panels consist of an insulating foam core sandwiched between two structural facings, typically oriented strand board (OSB). The panels are cut to size in the factory and are delivered to site.
Thermal bridge	A location in the thermal envelope where the uniform thermal resistance is changed by higher conductivity materials or geometry change.
Thermal conductivity	A material's ability to transmit heat is measured by the thermal conductivity (or lambda value). Unlike R-value, the thermal conductivity of a material remains the same irrespective of the thickness of the material.
Thermal envelope	The surfaces that enclose the building's conditioned spaces, which may or may not include garages. This includes the floor area to the exterior. For tools such as ECCHO and PHPP, external dimensions are used. This means from the bottom of the insulation below the concrete slab to the top of the insulation in the ceiling.
Thermal mass	The ability of a body of material to absorb, store and subsequently release heat (due to its specific heat capacity and its mass).
Transmission heat loss	The loss of heat energy via the building components of the house.
Upfront carbon	The carbon emitted in the production phase of products and materials, from mining and processing of natural resources, transport to processing sites, and the manufacturing phases, before any construction begins.
U-value (W/m²K)	Thermal conductance, the inverse of thermal resistance (R-value). Describes the heat flow per m² of an assembly per degree Kelvin.
Ug-value	U-value at the centre of a pane of glass. Note that this is not the U-value of an entire window (Uw) which must be calculated to include the balances of losses through the glass and frame.
VLT	Visible light transmission. VLT is expressed as the percentage of light allowed through the glass.
Waffle pod	A structural slab system that is made up of concrete ribs with plastic or polystyrene pods between, and a concrete slab on top.
Warm roof	A roof build up where the insulation is on the exterior of the structure.
WRB	Water resistive barrier. This is typically the flexible wall underlay but this can be the top layer of a rigid air barrier product used under the ventilated rain-screen cladding. Used to designate the control layer in the building assembly that is intended to stop rainwater entry.