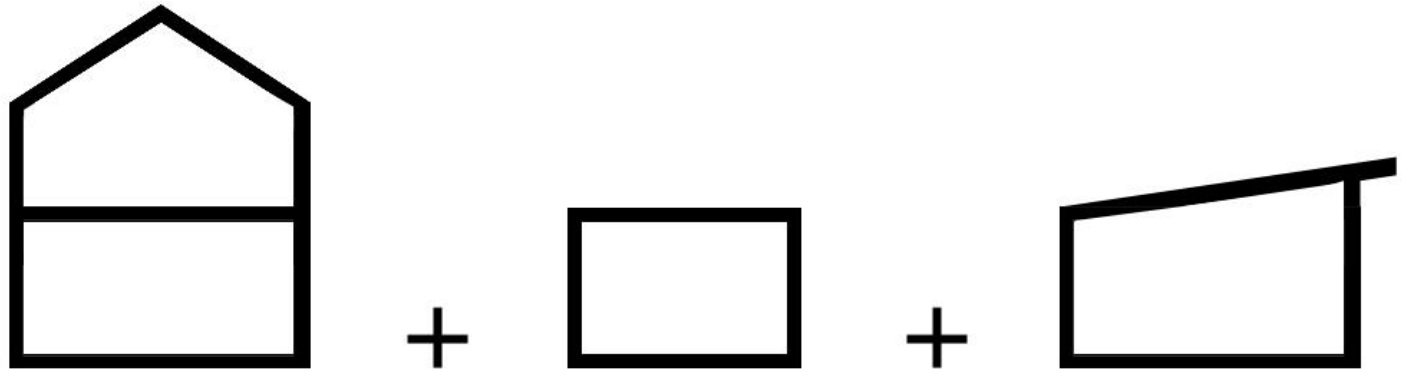


www.**highperformancehouse**s.co.nz

Anne Salmond anne@salmondarchitecture.co.nz

**Concrete block and timber framed house in Wanaka**

# high performance houses

- There are many elements that make up a well designed, comfortable, sustainable house
- These include optimal siting , orientation , planning, materials selection , window placement, shading , heat sources, landscaping and more
- For this presentation I am going to focus on the performance of the building envelope which separates inside from outside. Not its appearance but how it works.
- I will share with you some of the construction we have used to improve the performance of our houses
- There are other forums for technical detail so I will focus on sharing the practicalities of using alternative construction and the discuss the results we have achieved.



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# high performance houses

- Improve heath and comfort in homes by improving the performance of the thermal envelope.
- Better insulation = warmer in winter , cooler in summer
- Airtight construction  = draught free, quiet
- Moisture control layer = control condensation within structure to reduce mould growth and structural deterioration
- Ventilation controlled = good air quality



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**Timber framed house in Queenstown**

# Improving construction performance

- Three forms of construction have been trialed in our high performance houses

- First warmframe™ house in NZ at the HIVE prefabricated showhome park using light weight steel framing
- First Structural Insulated panel house in NZ using Kingspan Tek panels at Albertown
- Improved construction of timber framing to meet hph performance standards using modified conventional construction

# Warmframe™

# insulated steel framed construction

**Warmframe house at HIVE show home park**

# Warmframe™ construction

- Warmframe™ was developed by a team of industry partners working together
- Insulated steel frame construction
- Steel frame stays warm, eliminating thermal bridging
- Strong, light  and dimensionally stable
- Prefabricated framing can be built off site or on site



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**Prefabricated house with deck built on site**



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# First NZ building with warmframe™

- Structure is light weight steel framing
- Polyester insulation within framing
- Timber battens outside framing
- Polyester insulation between timber battens and outside steel framing.
- High insulation value R4 walls R5.5 roof /ceiling
- Timber bearers on piles or  insulated concrete slab floor
- Thermally broken aluminium windows set back in frame



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Steel framed house constructed off site



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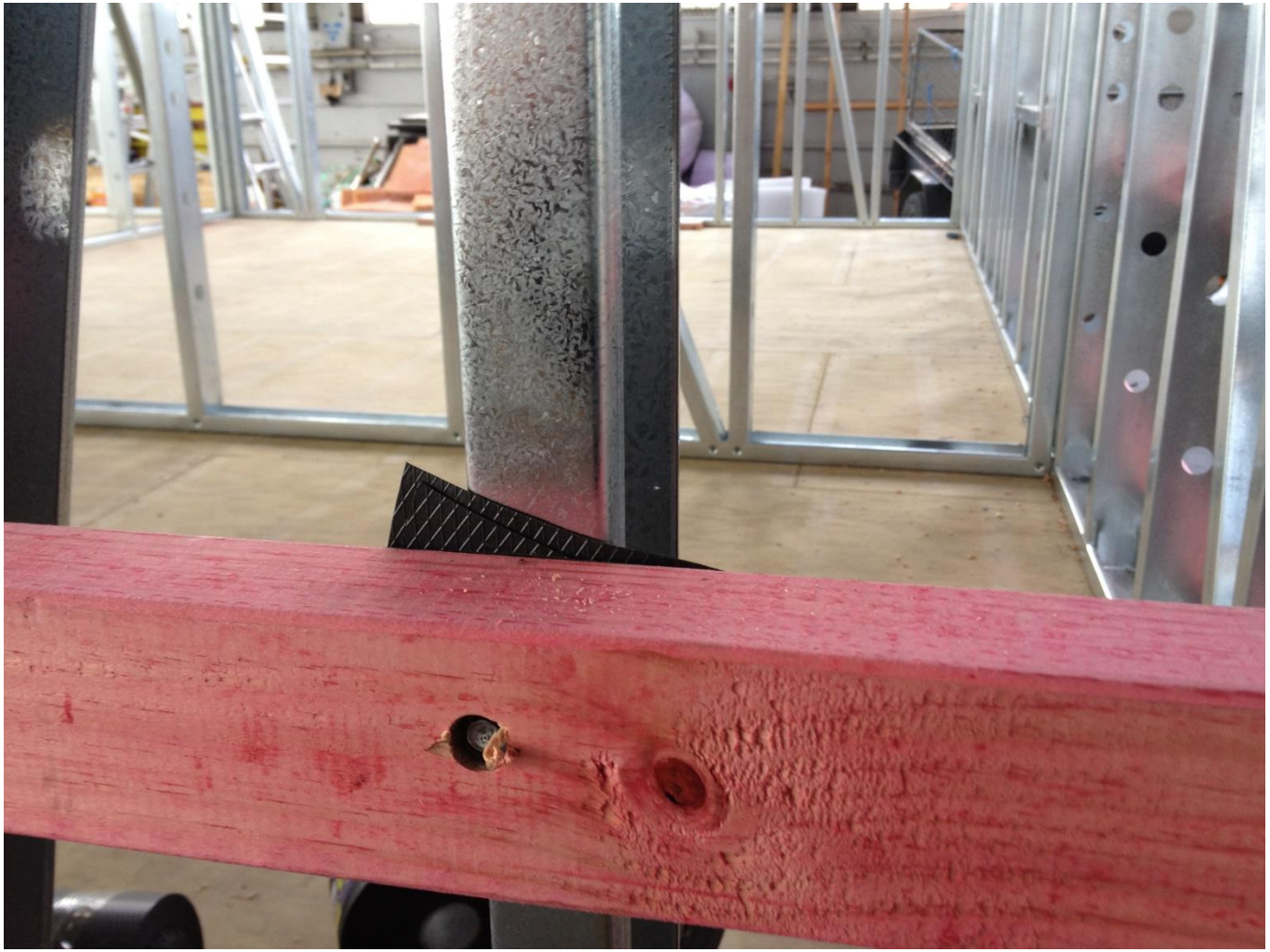

**Steel framing with timber battens**

**Polyester insulation outside steel framing**



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**Warmframe™ house on the move**



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**House delivered to site**



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**New location of HIVE house in Manchester Street, Christchurch**



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**Warmframe off site construction , Hobsonville**

**Off-site warmframe construction , Beacon Pathway**

# Steel frame construction : challenges

- Engineering of steel framing : timely delivery of engineering and shop drawings, changes.
- Too many different companies involved, poor communication and checking
- No lightweight steel framing code like NZ3604 so engineer needed for everything
- Delivery of damaged frames, inaccuracies in fabrication and subsequent delays.

**Warmframe™ construction on insulated slab**



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**Steel framed living pavilion , fast construction of frame**


**Thermally broken aluminium doors and windows**



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# High performance warmframe™houses

- Warmframe construction shows that steel can be effectively detailed for high performing housing
- Measured performance exceeded design performance
- Thermal imaging showed the steel frame was almost the same temperature as the inside of the house
- The only area that didn't perform was around incoming wiring to the switchboard. Design to allow extra space.
- Keep plumbing on inside walls where possible.
- Measured performance of thermally broken windows showed a temperature difference inside to outside of between 7 and 10 degrees

**Holmwood road town house under construction**

# High performance warmframe™houses

- Comfort levels reported as very high in both the HIVE house and the Holmwood Road house
- Underfloor heating hardly used. Power bill in winter reduced from $550/month to $150/month with no solar or PV panels
- Pellet burner output higher than required in HIVE house.
- Designing for higher insulation levels and good passive solar design delivers improved comfort and health and cost savings

# Structural Insulated Panels (SIP)


**High performance houses also constructed from SIP**



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# High performance SIP houses

- SIP panels are a composite panel with a structural OSB board on each side of a polyurethane or polystyrene core
- SIP provide a high level of insulation and an airtight construction
- With no air spaces in the wall there is no condensation within the structure
- HPH designed the first SIP house in NZ using Kingspan Tek panels and we have since worked with MagRoc , NZ SIP and Formance to design houses using structural insulated panels.

**SIP house at Lake Hayes**

# SIP panel construction for high performance houses

- Designed to suit SIP panel dimensions
- Energy efficient, high R value, warm
- Strong and dimensionally stable
- Prefabricated into panels off site
- Fast to erect using manual labour or hiab
- Well insulated with less thermal bridging
- Airtight construction, draught free , comfortable



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**SIP house using MagRoc panels**

**MagRoc panels being installed**

**Magnesium oxide panels with polystyrene core and conduits for services**

# First NZ building with SIP panels

- Imported Kingspan Tek panels from Germany
- Two layers 15mm oriented strandboard from FSC approved timber with 110 mm extruded urethane foam between
- Replaces framing, bracing and insulation
- R5 insulation value, airtight construction
- Prefabricated wall panels erected on site
- Timber structure, insulated concrete slab floor

## Albert Town house – concept plan

- Two shed roof  pavilions with link
- Corrugated steel roofing, cedar cladding
- Insulated floor slab, Hers Rating 7



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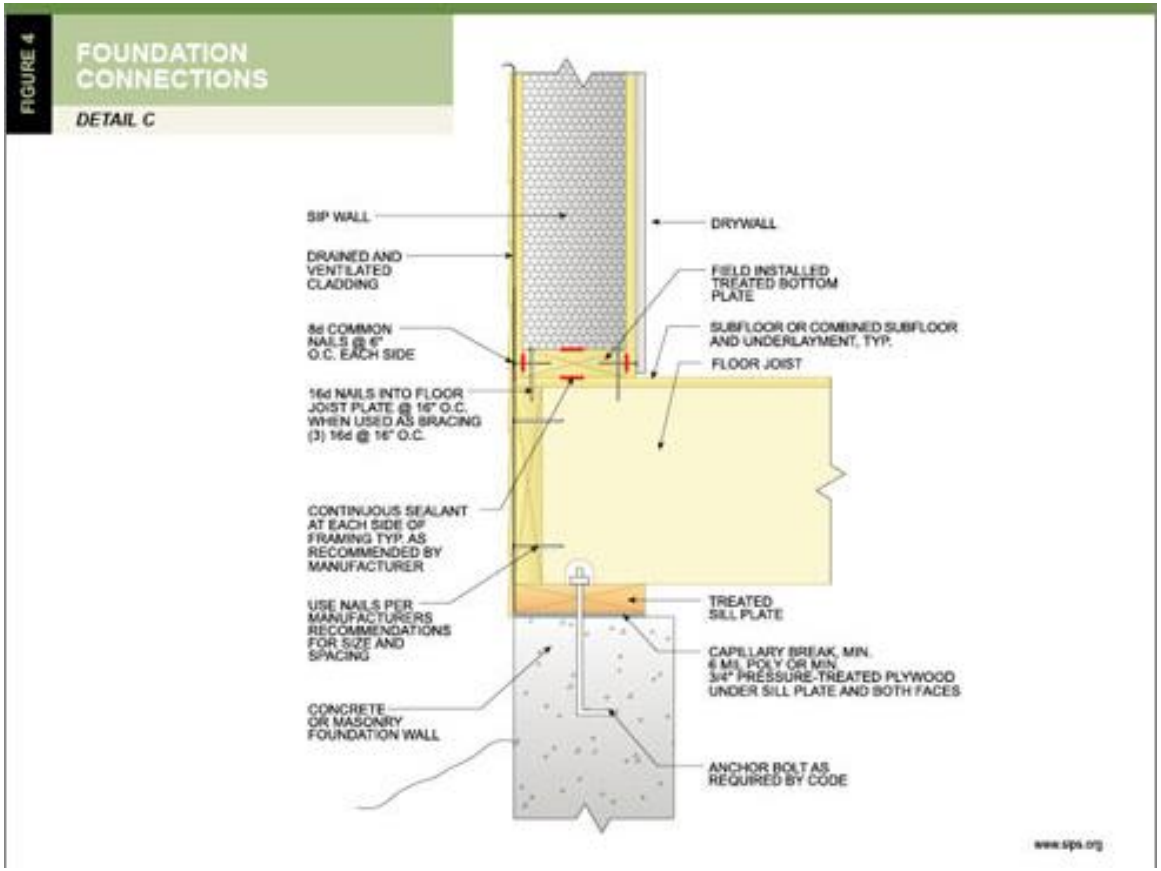
**First pavilion under construction**




## Foundation and timber floor



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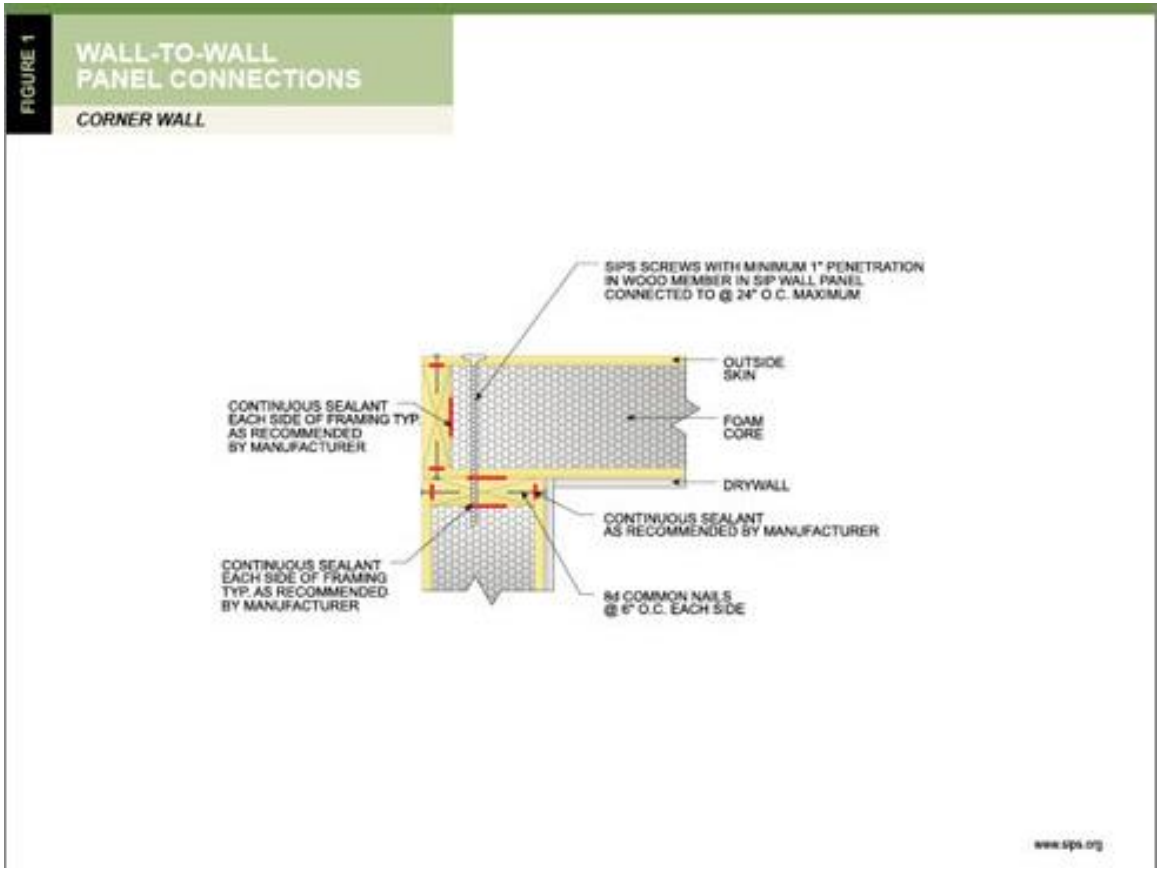
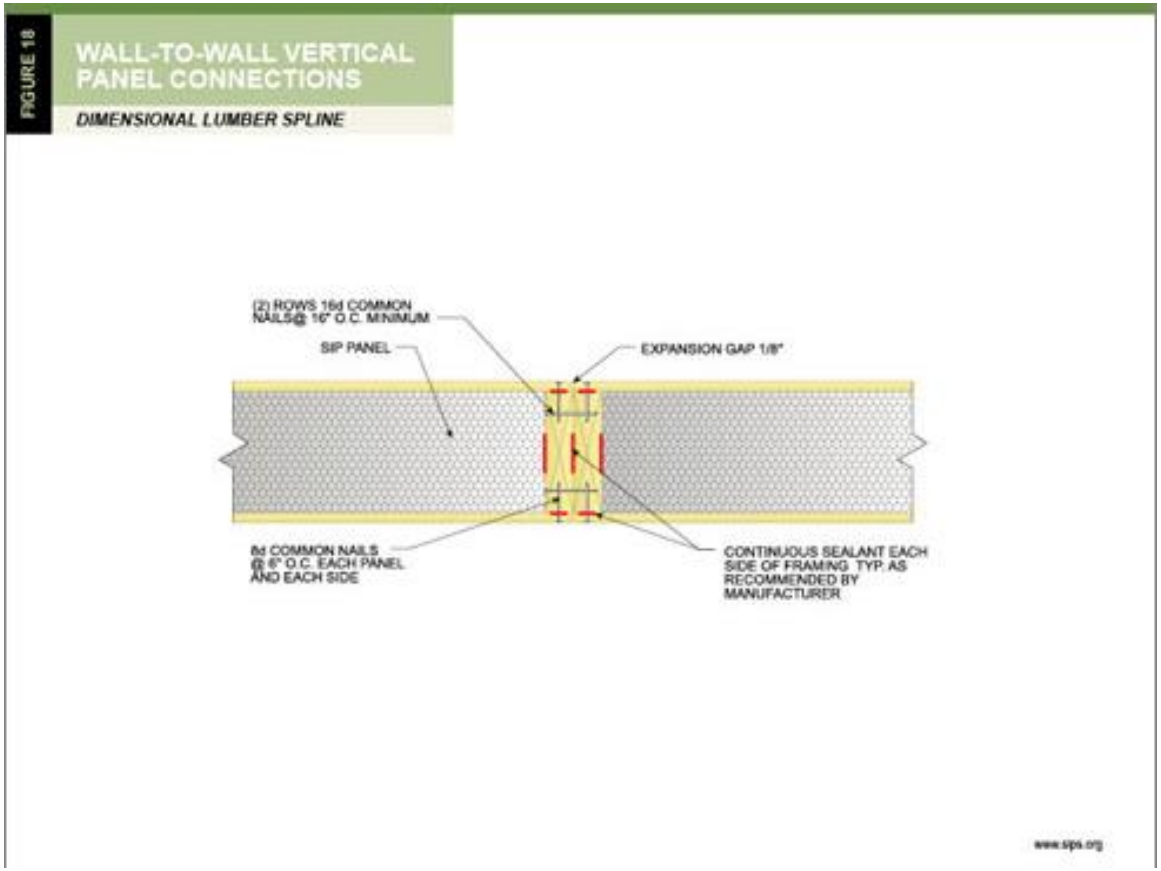
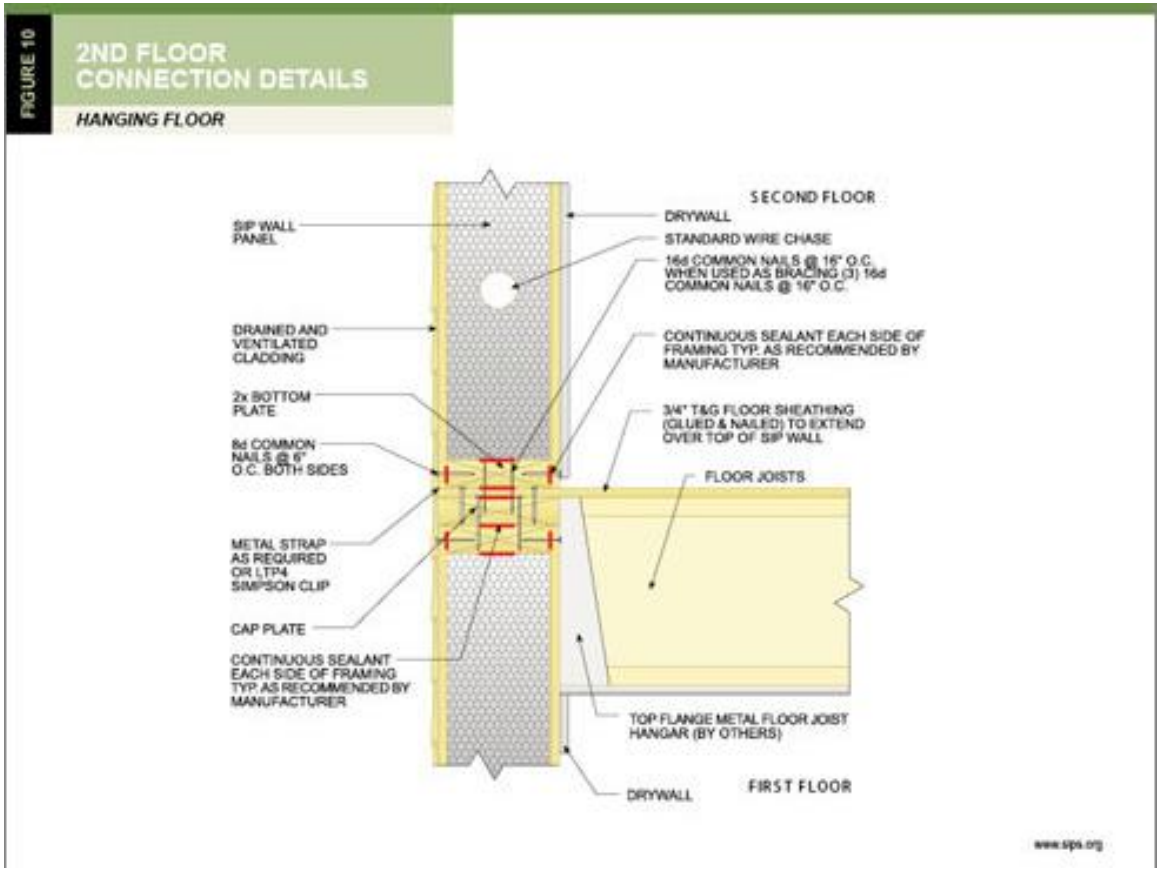



## Wall to wall conection - plan




## Wall to wall connection- section




## Continuous panel with joist hanger connection

Less thermal break



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COMPLETED SIP HOUSE

# Construction process

**Foundations**

- Foundations and insulated floor slab built first – critical that slab is level and square
- Holding down straps embedded in slab to resist uplift
- Where very high wind loads apply engineered holding down bolts required

## Concrete slab insulated with double bottom plate

- Treated bottom plate full width of panel 140mm
- Second bottom plate 110mm to fit within routed out edge of panel and bolted through

## Foam applied to all timber to panel junctions

- Liberally apply foam to fill any air gaps between timber and panel
- Important – make sure foam is not under done due to cost
- Foam supplied with the panels and paid for to ensure its appropriate  use

## Panels carefully lifted into place

- Panels are not too heavy, so can be placed without the use of equipment
- Very useful for difficult sites
- Panel slots over bottom plate and is hammered into place  to ensure a tight joint



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## Connection between panel and foundation

- Holding down straps in concrete  wrap up the side of the panel (bolts used where forces are higher)
- Treated bottom plate fixed to foundation, second bottom plate in panel

## Panel to panel joints liberally filled with foam

- Panel is self supporting until temporary braces fixed
- Monitoring to ensure foam is applied liberally

## Openings preformed for doors and windows

- ‘flatpacked’ panels with openings formed for windows and doors
- Allow for set downs in slab for doors
- Openings all timber lined off site



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**Timber to timber junctions have two rows of sealant applied before fixing to ensure a good seal**

- Two rows applied to cover depth of joint and to ensure some redundancy
- Don’t skimp on expensive sealant

## Corner detail

- Note foam at timber to panel joint

## Panel connection at corners

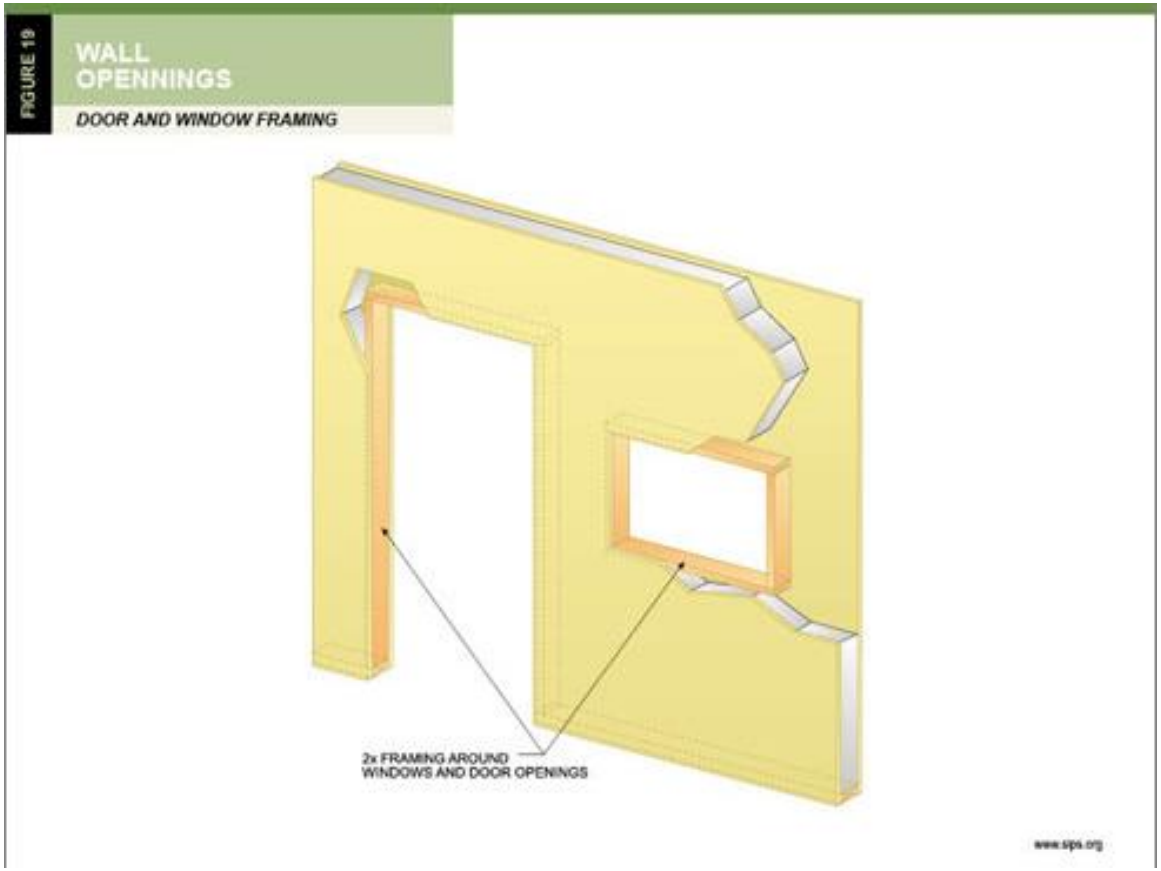
- Panel edged with 110x 40 timber
- Strand board fixed to that at close centers
- Long fixing nails provided with panels to connect corners

## Walls need temporary bracing until roof is on

- A good mornings work to get the first pavilion wall panels up
- Cover over the top of the panels to ensure they are kept dry until the roof goes on

## Lifting straps released when panel in place

- Note that the oriented strandboard can be used in either direction to minimise material wastage




## Wall openings

- Openings trimmed with timber 110mm x 45mm
- Windows installed conventionally in openings
- Opening sizes to 5mm tolerance so windows can be made without site measure



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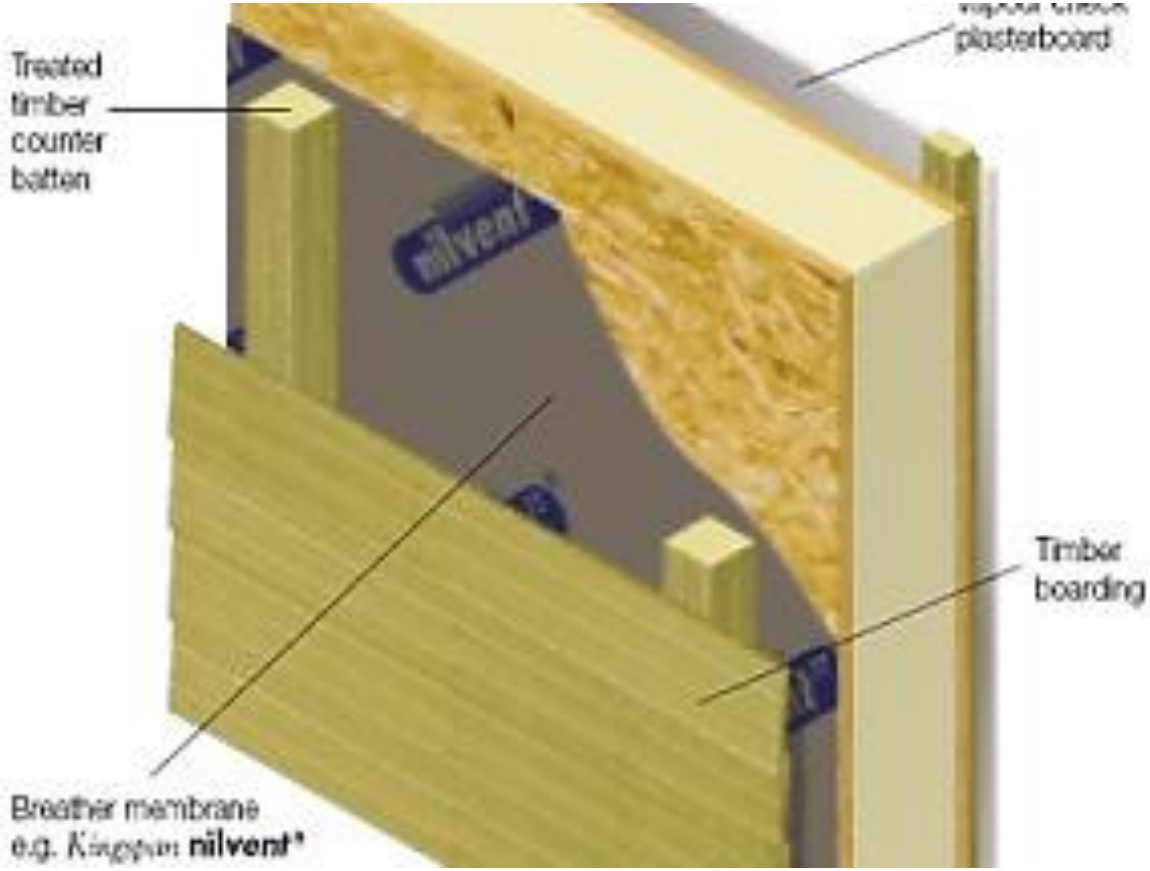
## Window openings are trimmed with timber

- Clive from Knightbuilt is the supplier of Kingspan Tek panels.
- This building was used as a training programme for builders who wished to be approved installers




## SIP panel replaces framing, insulation and bracing

- Exterior cladding is fixed over building paper and battens to form a ventilated cavity
- Interior cladding is plasterboard on battens, forming a cavity for wiring



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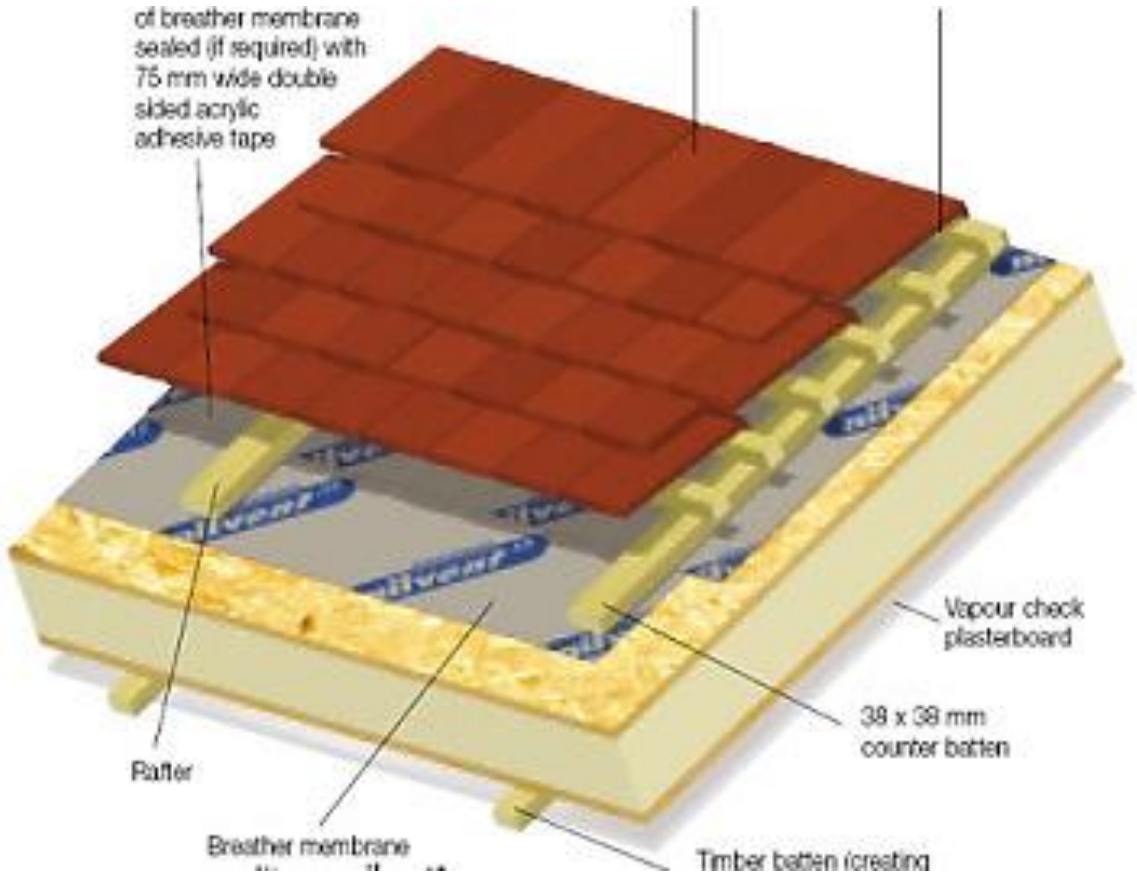


## Roof cladding installed over building paper and battens

- Prefinished corrugated steel  roofing was used
- Panel joints were sealed, building paper laid and battens fixed to give a ventilated cavity below the roofing



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## Roof assembly

- Whether roof cladding is steel or tiles assembly is similar
- Light weight  cladding such as cedar is used in the HPH but other claddings can be used with SIP panels – all installed over a vented cavity



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# Modified timber framed construction:

- Additional Insulation
- Airtightness
- Moisture control layer
- Thermally broken windows

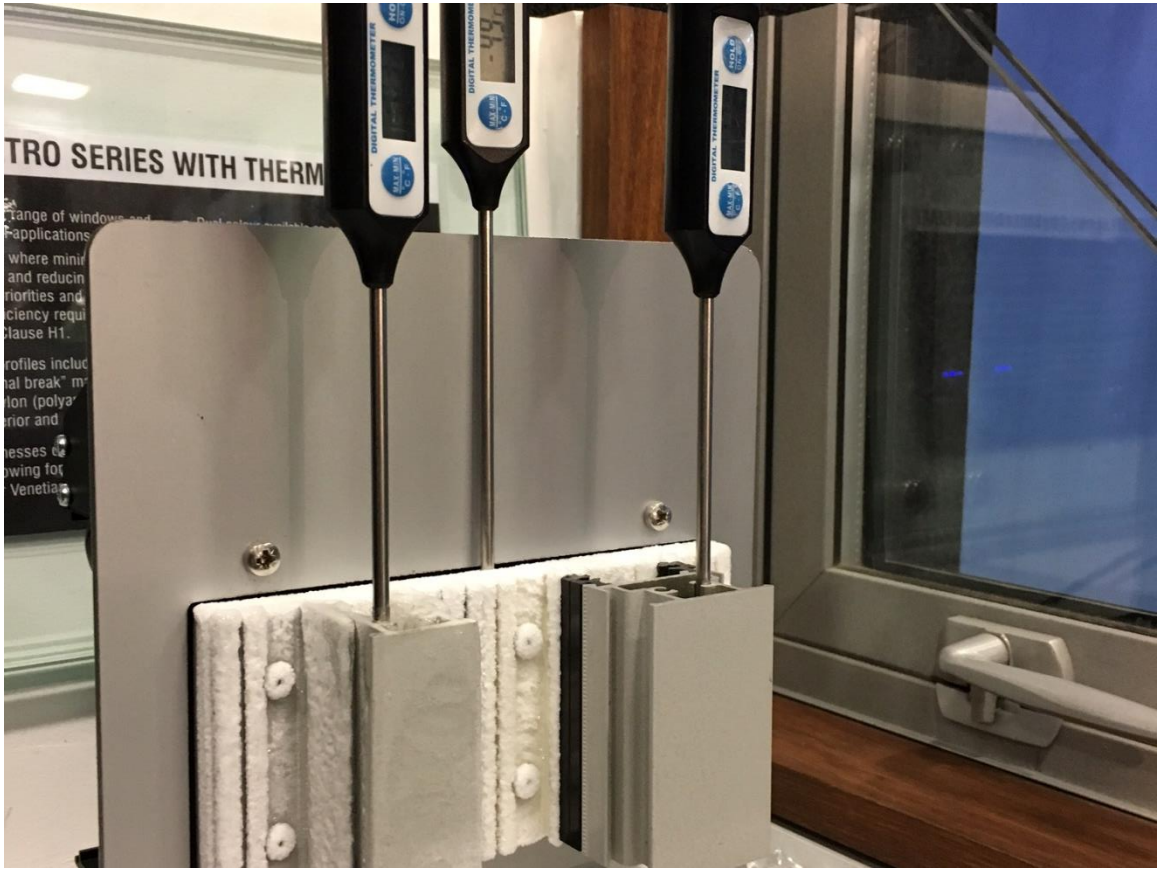
## Timber framed houses

# Modified Timber Construction

**Wall construction from outside to inside**

- Exterior cladding on battens and building paper
- Timber studs with insulation between and rigid air barrier on the outside
- Moisture control layer to prevent warm moist air entering the wall cavity and condensing inside it
- 45mm battens horizontally on the inside to form a cavity for plumbing and wiring and allow for further insulation
- Internal lining
- Windows installed set back to  align the thermal break with insulation in the wall

**Thermally broken window frame double glazed**




**Performance of window frame with and without thermal break – ice forming on standard frame**


**Temperature outside 0.49 °  standard frame inside 0.03 thermally broken frame inside  19.4 °**



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**Install moisture control layer over top of internal frames to provide continuous barrier**

**Ventilation system with heat recovery provides fresh filtered conditioned air to all living spaces.**

**HPH constructed from timber framing**



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# How do we know it works?

**Anecdotal evidence from home owners**

- Owners report the houses are comfortable, warm, draught-free and quiet
- Energy bills for replacement houses for the same household on the  same site were reduced to 1/3 or 1/4 of previous bills
- Health issues for upgraded houses were noticeably reduced
- One owner who bought the house after it was built said she couldn't believe how warm and comfortable the house is and "if I won lotto I wouldn't move"
- Post occupancy evaluation needed to provide qualitative evidence that is independent

**HPH constructed from timber framing**

# How do we prove it works?

**Measurement**

- Building modeling using software such as WUFI
- Blower door tests to demonstrate airtightness and allow any gaps to be remedied
- Temperature and humidity monitoring
- Energy monitoring with dashboard in the house for real time feedback to inform occupants of the impact of behaviour
- Thermal imaging to identify thermal bridging and any weakness in the thermal envelope
- Rating of houses using HERS, HomeStar, Lead etc

**HPH constructed from timber framing**



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# How do we value higher performance?

**Identify value and risk as well as cost**

- The initial cost of a high performing house is about 5% more
- What is the cost of leaky, draughty poorly insulated homes in energy , health, structural deterioration and lack of comfort?
- What are the measureable benefits of improving value for investment over the life of the house ?
- How can we ensure that all houses are rated/ measured/ certified to demonstrate their performance?
- How do we encourage local and national governments to legislate to encourage and ensure a better standard of construction?
- How do we measure and communicate the risks to home owners and the community of not building better?
- We and our children will be stuck with the houses we are building now so we need to raise the bar as fast as possible.

**HPH constructed from timber framing**

**HPH constructed from timber framing**



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# Future challenges : what can we do?

- Need to train valuers and real estate agents in the benefits of designing for higher performance so the  value of the investment in comfort, health and lower running costs can be realized.
- Need to measure performance and costs and construction timing to demonstrate benefits of a better way of building.  Collect and collate data from designers , builders and owners
- Record anecdotal evidence from owners to demonstrate advantages of new ways of building to meet higher performance specifications.
- Lobby local and central Government to focus on value for investment rather than low cost . Affordable housing needs to be affordable and comfortable  in use , not just lower intial cost.
- Commit to improving design and construction processes : education, legislation.

high performance houses

## Further information and suppliers details

www.**highperformancehouse**s.co.nz
www.warmframe.co.nz
*https://www.kiwiliving.nz/inspirational-**homes/christchurch-house**-ep-3*