The HIVE High Performance House case study

Beacon

Contents

The High Performance House at HIVE

A show home

The High Performance House, built at the Home Innovation Village (HIVE) in Christchurch, brought together, showcased the benefits of off-site construction (lower build costs and speed and quality of construction) and excellent performance (warm, healthy, energy and water efficient, low running costs).

A collaboration

Conceived by New Zealand Steel, the project is a collaboration between industry partners - New Zealand Steel, Frametek-RFS, InsulPro, Fletcher Aluminium and Resene - and has been facilitated and project managed by Beacon Pathway.

Testing innovation

The house was part of a larger programme of innovation - the New Category of Home project - which aimed to find housing solutions which are high performing, modular, and suited to producing volume housing, but which also reduce the time and cost of construction.

The partners prototyped and tested an innovative new building system, Warmframe, and trialled it in the real-life build of the High Performance House. Warmframe combines the benefits of steel framing with a custom-made insulation system and double glazed window units to create a highly insulated wall. Claddings and innovative coating technologies could also be incorporated to maximise the benefits of off-site construction and ensure a high quality product.

High performing

The New Category of Home was not just about off-site construction and product trialling. It was designed to be a home with excellent performance (warm, healthy, energy efficient, low water use) which is affordable to buy and affordable to run.

Canterbury and off-site construction

The launch of HIVE, the country's first Home Innovation Village, was just the right timing for the High Performance House project.

HIVE was inspired by Canterbury's desperate need for new homes that are quick to build, strong and affordable, following the Canterbury earthquakes.

Facilitated by PrefabNZ, a non-profit incorporated society, HIVE showcased the benefits of off-site construction. Some of the homes at HIVE were built around prefabricated wall components; others were prefabricated in a factory. Off-site construction offers quicker delivery and assembly—in some cases in half the time of a traditional new-house build. Other benefits include higher quality manufacturing, a smoother compliance certification process, and less remedial work on-site. All of this means lower costs to the home buyer.

HIVE and the Warmframe house

The ability to easily build entire walls and/or buildings off-site is one of the benefits of Warmframe technology. This made it a great fit with HIVE.

The High Performance House was completely prefabricated in a factory and transported to the HIVE site.


PlaceMakers
Know how. Can do.
www.placemakers.co.nz
TEKTON
HouseWrap

The High Performance House at a glance

Its simple features included:

- Design for good solar gain
- High levels of ceiling, wall and floor insulation, much higher than in the Building Code
- Double glazed windows and doors with thermally broken aluminium frames and argon-filled glass panes
- Photovoltaic system with grid-tied inverter
- Solar water heating
- Wood pellet burner - efficient and economical winter heating
- 1000 litre rainwater tank
- Water efficient taps, toilet and appliances
- Ventilation of moisture in the kitchen and bathrooms
- Environmentally certified, low allergen and low VOC products
- Future flexible - used the High Performance Houses pavilion system and designed on Lifemark™ principles

The statistics

- The High Performance House was a single storey home designed to expand by adding further pavilions
- It had 2 bedrooms, 1 bathroom and a separate laundry
- It had a floor area of 96 m^2 (without garage)

Design

The High Performance House was designed by Salmond Architecture using their High Performance Houses designs. These use combinations of pavilions and links with a range of options in cladding, roof type and fit-out available to customise each home.

Pavilions can be oriented on the site to make the most of the sun or for the best views. They can be added as families grow or as part of a staged building programme. The many varied combinations mean High Performance Houses look unique and different.

Off-site construction

The home was originally designed with gables. However, as the house was to be moved as a whole unit and had to fit underneath a road overbridge, this design was replaced by a flat roof.

Both the architect and Beacon believe incorporating thermal mass is important for maintaining stable levels of warmth. Again, it was not possible to use thermal mass with the requirements for off-site construction.

Design compromises

The design process saw considerable discussion over the best ways to achieve a healthy and energy-efficient house. The High Performance House designs use mechanical ventilation systems which provide fresh air with the windows and doors closed. Beacon's research and demonstration home experience showed that New Zealand homes can be well designed for healthy indoor air using only passive ventilation.

Beacon also emphasises passive means of keeping homes warm in winter and cool in summer. For example, these include solar orientation, managing size of north and west facing windows, eaves and shading, and designing for cross-breezes in the home.

The final design represents a compromise between Beacon's recommendations and the High Performance House design.

Testing the thermal envelope

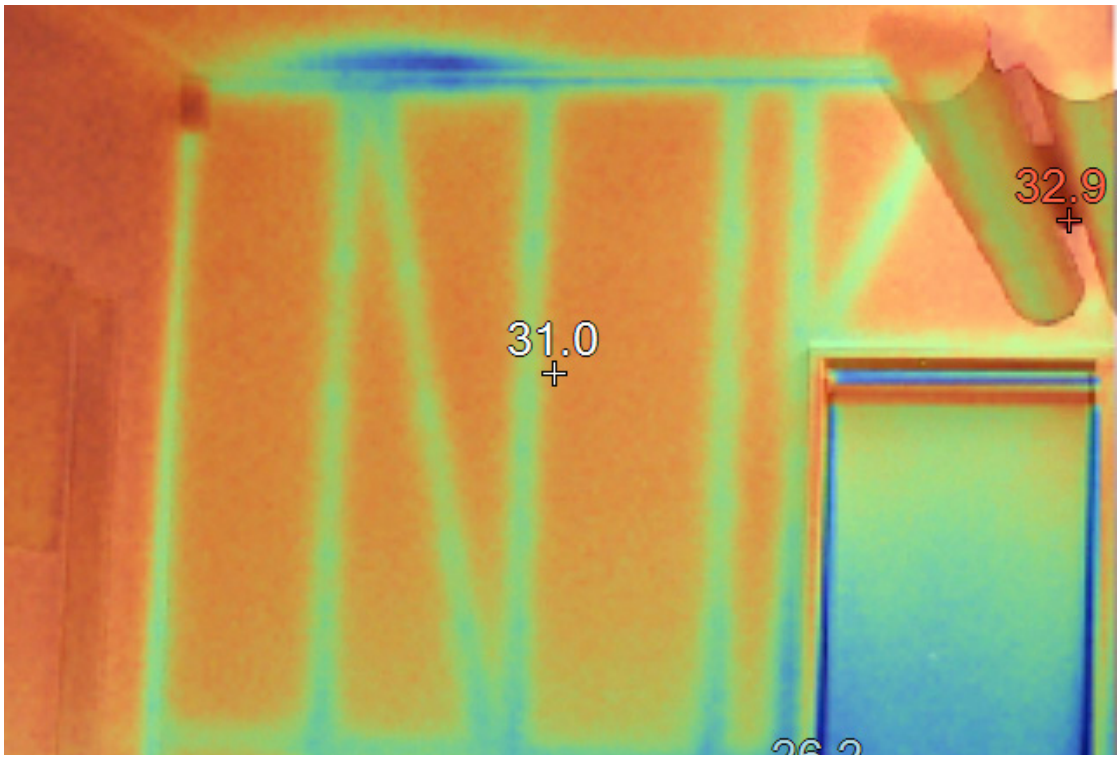
Thermal testing

The ceiling was 90mm steel frame with high density R3.2 between trusses and R1.8 ceiling blanket. Its oveall R value was 5.0-6.0

The walls were 90mm steel frame with high density R2.5 insulation in the main wall cavity and R0.6 between battens. Their overall R value was 2.7

Thermal imaging of walls

- Thermal imaging showed a high level of consistency in insulation with almost no deficiencies in walls. This indicates that the quality of insulation fitting is vital. The combination of products used in Warmframe allowed for a good compression fit and ensured no gaps between insulation and framing.
- Weak spots corresponded with weaknesses in the construction detail such as wall-to-wall and wall-to-ceiling joints.
- The best windows were no comparison to the wall in thermal performance. Living area design with excessive glazing was a weak spot for heating the living areas.



How the house performed

Over the period that the house was open as a show home, it was monitored using SPLASH Monitoring. This offered real-time animation updated every 10 seconds and available via their website.

SPLASH monitoring results were analysed for winter 2013. While the house was not occupied, but used as a show home (was only open and heated between 12pm-4pm Wednesday - Sunday), the data does give some indication of how the house performed during the time of occupation and the effectiveness of the heating.

Temperatures

Temperature levels in the house reflected the high level of insulation and high quality windows and showed substantial solar heat gain on sunny days.

Although the house was only occupied (and heated) for 4 hours/day, 5 days/week, the temperature profiles were better than many occupied and comprehensively heated homes. In particular, the master bedroom was a warm room, and even when the house was unoccupied for 2 days, frequently stayed above recommended minimums (16 degrees) overnight. The living room was colder and slow to heat up with the pellet burner (which was to be expected with the large amount of glazing) but also frequently stayed above recommended minimum temperatures (18 degrees) for a large part of the night, and even when unheated, often reached this temperature early in the afternoon. As a show home, the pellet burner was turned on at midday on the days when the house is occupied. Ideally, using the thermostat and timer function ensures heating is underway before the rooms are needed.

Solar gain in the north-facing master bedroom was high. Even on cold days when the house was unoccupied, the bedroom would often heat up to warm temperatures with solar heating. While this meant the bedroom was very warm in winter, there was a concern that the lack of shading on the northern façade, absence of good thick curtains, and the absence of cross ventilation would lead to substantial summer overheating. On some sunny days, even with the doors and windows open, the bedroom frequently recorded temperatures in the mid and late 20s and increasingly as the weather warmed, temperatures in the early 30s were reached. Temperatures above 28 degrees could be regarded as overheating in a New Zealand context.

Humidity

Relative humidity levels in both the living room and bedroom were very low - no level higher than 60% relative humidity was recorded, even when temperatures dropped substantially after several days of no occupancy. This indicated no inherent problems with dampness in the dwelling fabric. IHowever, the major generators of moisture (bathroom and kitchen use) were not occurring in this house.

Homestar rating

Based on the plans, the HIVE High Performance House received an 8 star Homestar™ design rating.


timber deck
timber entry deck
timber deck
Living
22 m²
Dining
17 m²
Kitchen
13 m²
P
F
Laundry
W
Bedroom 2
13 m²
Hallway
7 m²
Bedroom 1
16 m²
W
Bathroom
6 m²
HWC
6180
16180

Pavilion 1

The show home

The High Performance House was open to visitors in the HIVE Home Innovation Village from January 2013 – January 2014.

The HIVE concept

Established by PrefabNZ and the Christchurch City Council, the HIVE concept was that the area would showcase examples of prefabricated housing and demonstrate how prefabrication could be used for the rebuild of Christchurch. It was intended that all homes located at the site would meet a minimum of 6 stars in Homestar and be Lifemark Accredited.

Visitors

Over 7500 people went through the house while it was open.

Feedback from visitors

Surveys of visitors to the show home found that what they liked most was:

1. Spacious open plan design – particularly large living area
2. Lighting
3. Kitchen design
4. Warmth
5. Overall house design

Visitors often asked if the house had underfloor heating (it doesn't), as the oak flooring combined with underfloor insulation retained the heat so well. People were very interested in the insulation samples, and often amazed at the amount of insulation used throughout the house.

The pellet fire was always a feature of interest on colder days, with many commenting on its appealing flame and quietness.

The LED lighting proved quite a talking feature. While some visitors are well informed, others were very surprised to learn about the energy efficiency of LEDs.

Energy efficiency, in general, was a feature that appealed to many people, with features such as solar water heating and the photovoltaic system being of interest to many visitors.

The perception of "prefab"

One of the key issues which came through during the show home and sale phases was the general perception from the market that a prefabricated house should be cheap. Many people asked if the house was a kitset and expected it to be cheaper because of that.

Currently, the term "prefab" has more negative (cheap, shoddy, temporary) associations for people than positive. However, this house had high quality products and specifications and the additional costs that these bring. These are not apparently given enough value in consumer minds to outweigh the prefab perception.

In terms of price, most people visiting the house did have unrealistic expectations about construction pricing, thinking that $800-$1400/m^2 was a reasonable price.

The Real Estate agent found that market priced the house as being worth $150,000 - $180,000 – pricing for a relocatable ($1500-$1800m^2). They felt people viewed a prefabricated house as being a step above a portacom.

Find out more about Beacon

Our website includes all the research undertaken in Beacon's original government research contract, and information on current research and projects.
www.beaconpathway.co.nz

Check out our Facebook page:
www.facebook.com/beaconpathway

Check out the Beacon Blog
www.beaconpathway.blogspot.co.nz

Contact us:
verneyr@beaconpathway.co.nz
PO Box 47-141
Ponsonby
Auckland 1144

About this Report

Reference
Beacon Pathway (2020). HomeSmart Home case study.