

## Avalon Discovery 3: Double Structural Insulated Panel Walls

Avalon Discovery 3 is a new, one and one-half-story, 244 m<sup>2</sup> (2,624 sq. ft.), detached home on a residential lot in a new suburban community in Red Deer, Alberta. As a winning project in the CMHC EQuilibrium™ Sustainable Housing Demonstration Initiative, the builder, Avalon Master Builder, designed and constructed this home with the intent that it is healthy and comfortable to live in, reduces energy use to a minimum, produces as much energy as it requires in a year, conserves resources, has low environmental impact and is marketable. One of the novel features of Avalon Discovery 3, which is highlighted in this EQuilibrium™ Housing InSight, is its use of a double layer of structural insulated panels (SIPs) for its exterior walls.

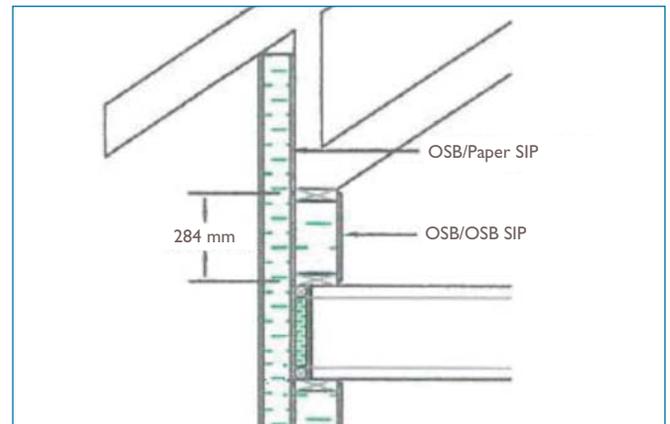
### Technical Specifications

The Avalon Discovery 3 home's exterior walls are composed of a double layer of pre-fabricated Emercor™ SIPs. The inside layer is installed as a standard 165 mm (6½ in.) thick SIP wall with an insulating value of RSI-7.7 (R-44). The second 102 mm (4 in.) SIP is rated at RSI-4.9 (R-28) and is fastened to the outside of the main SIP wall using cantilever screws (Figure 1). This yields an exceptional RSI-12.7 (R-72) wall.

The second SIP is not a true structural panel as only the outside face has an oriented strand board (OSB) layer; the conventional inside OSB layer is replaced with building paper. Both wall panels have a polyurethane core and foam-sealed joints, providing very well insulated, air-tight exterior walls. This wall system also constitutes the air and vapour barriers. Figure 2 shows a cross section of the Avalon Discovery 3 wall system at the second floor and roof junction.



**Figure 1** Cantilever screw used to attach external SIP panel



**Figure 2** Cross section of double SIP wall at 2nd floor and roof junction

The work sequence for installing the double SIP wall was as follows:

1. A 51 mm x 152 mm (2 in. x 6 in.) treated wood plate was nailed to the slab on grade concrete foundation as a base. Spray foam was applied underneath and on top of the plate and an adhesive was applied to both sides.
2. The inside layer panels were then tilted up and placed such that their bottom U-joint fit on top of the plate. The panels were then nailed to the plate.
3. Two OSB strips were caulked and then applied to the inside of the SIP OSB such that the strips extended beyond the SIP (Figure 3) to help join the panels together. Spray foam was then applied in the space between the two protruding OSB strips before the adjacent panel was put in place.
4. Once the first layer of SIPs was installed, the floor trusses for the second floor were lifted into place and the roof trusses were tied together.
5. The second SIP layer for the wall was fastened on the outside of the first layer with cantilever screws.

Note that different SIP installation/interconnection methods exist depending on the product manufacturer.



**Figure 3** Preparing SIP interconnection

## Implementation Considerations

The exterior SIP layer presented various challenges to the builder. The main issue was that as only the outside of the panels were clad in OSB, the panels experienced significant warping from the time of manufacturing to when the builder was ready to install them. To install the warped panels flush to the interior (structural) panels, a circular saw had to be used to score the outside of each panel through the OSB in both horizontal and vertical directions as to provide the necessary flexibility to eliminate the warping. The scored panels then required an extensive amount of adhesive and fasteners to be firmly installed.

## Cost Implications

The builder estimates that using the double SIP system increased costs over their standard exterior wall system by approximately \$50,000. This approximation is based on the costs of the panels (versus standard wall and insulation supply costs) as well as increased framing, electrical and other associated labour costs.

For future projects, the builder is considering simplifying the design by possibly using a single 114 mm (4½ in.) SIP, RSI-4.9 (R-28), which would provide an intermediate level of insulation between a typical 38 mm x 140 mm (2 in. x 6 in.) wall with an effective insulation value of RSI-2.9 (R-16.5), and the RSI-12.7 (R-72) of the double SIP wall used in the Avalon Discovery 3 house.

A cost-benefit and energy simulation analysis would have to be performed to determine the best approach. A cursory HOT2000 analysis of energy savings, which is presented in Table 1, shows that the single 114 mm (4½ in.) SIP would increase heating energy requirements over the double SIP wall by approximately 2,000 kWh, but would offer cost savings of over \$30,000 for the wall system.

The builder noted that:

*“Experience with the true cost of this exterior wall system indicates there does seem to be a law of diminishing returns with regards to exterior insulation values, and our best guess based on experience with this home in conjunction with our other Discovery homes and our standard homes is that the cost optimal exterior wall would be somewhere in the R-30 to R-35 [RSI-5.3 to RSI-6.2] range on a production building, and R-40 to R-45 [RSI-7.0 to RSI-7.9] for net-zero energy buildings, using as many traditional construction materials and practices as viable.”*

## Technology Benefits

### Energy Savings

Table 1 shows HOT2000 estimated annual auxiliary heating energy consumption of the Avalon Discovery 3 home with different wall construction strategies. By going from a standard wall to a single 114 mm (4½ in.) SIP wall, the heating energy drops 29%. By upgrading to a 165 mm (6½ in.) SIP wall, the heating energy drops an additional 10%. By adding a second 102 mm (4 in.) SIP layer, the heating energy drops a further 10%.

Wall Type	Estimated Annual Heating Requirements
38 mm x 140 mm stud wall (2 in. x 6 in.), RSI-2.9 (R-16.5)	10,300 kWh
Single 114 mm (4½ in.) SIP, RSI-4.9 (R-28)	7,330 kWh
Single 165 mm (6½ in.) SIP, RSI-7.7 (R-44)	6,290 kWh
Double SIPs, RSI-12.7 (R-72)	5,260 kWh

**Table 1** Varying heating energy consumption for different wall systems

### Occupant Comfort

The combination of the high insulation value of the double SIP wall with energy-efficient, triple-glazed windows is expected to offer improved occupant comfort by:

- Providing a higher indoor mean radiant temperature for equivalent room air temperature resulting in improved thermal comfort;
- Reducing drafts;
- Providing a more even distribution of temperatures; and,
- Reducing exterior noise transmission.

### Summary

The Discovery 3 design team made use of an innovative double SIP wall construction to reach an impressive RSI-12.7 (R-72) insulating value. The builder is considering using SIP exterior walls in future projects, but with a single layer to address some of the complexities encountered in this project and to optimize the costs and benefits of the wall system.

## Project Team

Primary contact: Ryan Scott  
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Developer: Melcor Developments Ltd.

For more information about this project and other EQUilibrium™ housing projects, visit CMHC's website at [www.cmhc.ca](http://www.cmhc.ca)

## EQUilibrium™

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The national EQUilibrium™ Sustainable Housing Demonstration Initiative, led by Canada Mortgage and Housing Corporation (CMHC), brings the private and public sectors together to develop homes that address occupant health and comfort, energy efficiency, renewable energy production, resource conservation, reduced environmental impact and affordability.

CMHC's EQUilibrium™ housing initiative offers builders and developers across the country a powerful new approach to establish a reputation for building affordable, premium quality healthy homes that will meet the needs of Canadians now and well into the future.

EQUilibrium™ housing combines a wide range of technologies, strategies, products and techniques designed to reduce a home's environmental impact to an absolute minimum. At the same time, EQUilibrium™ housing also features commercially available, on-site renewable energy systems to provide clean energy to help reduce annual energy consumption and costs.

### EQUilibrium™ Housing InSight

EQUilibrium™ Housing InSight present specific housing design strategies and technologies implemented in EQUilibrium™ housing demonstration projects.

### CMHC

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