EQuilibrium™ InSight

Now House™ Exterior Envelope Retrofit

Now House™ is the retrofit of a 1½ storey, 139 m² (1,496 sq. ft.), 60-year-old post-war detached home in an established neighbourhood of similar houses in Toronto, Ontario. As a winning project in the CMHC EQuilibrium™ Sustainable Housing Demonstration Initiative, the developer Now House™ Project Inc., retrofitted the house to increase energy efficiency, improve indoor air quality, produce energy through renewable sources and recover energy that would otherwise be lost from waste water and exhaust air. This EQuilibrium™ InSight looks at the many novel features that were implemented in order to improve the performance of the building envelope as part of the overall strategy to significantly reduce the energy consumption of the house.

Technical Specifications

Roof and Attic Space

As is frequently the case in these 1½ storey homes, a central portion of the attic space is finished, as depicted in Figure 1.

The original roof projected 305 mm (12") beyond the exterior wall on all sides of the home and consisted of:

- 10 mm (3/8") gypsum board in the bedroom;
- 38x89 mm (2"x4") wood rafters 406 mm (16") O.C.;
- 89 mm (3.5") of RSI-1.4 (R-8) rock-wool insulation between the rafters behind the sloped ceiling of the finished space, and 305 mm (12") layer of RSI-5.6 (R 32) fibreglass batt above the finished ceiling;
- 25x203 mm (1"x8"), 19 mm (¾") thick wood plank sheathing;
- Asphalt paper;
- Three layers of asphalt shingles;
- 25x76 mm (1"x3") wood furring (vented air space);
- Metal roofing.

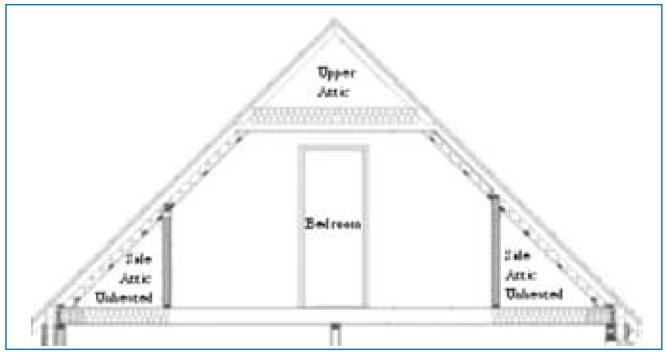

Figure 1 Cross-section of attic space

For the retrofit, the existing metal roof, 3 layers of asphalt shingles, 19 mm (¾") board sheathing, and the insulation were removed from the roof. The sloped roof section adjacent to the upstairs bedrooms was insulated with 76 mm (3") closed-cell spray foam RSI-3.2 (R-18) insulation. Thirteen mm (½") tongue and groove plywood roof sheathing was installed and covered with asphalt building paper. 38x89 mm (2"x4") horizontal wood strapping was placed 610 mm (24") O.C. before installing a new metal roof.

In the upper attic space above the bedrooms, the fibreglass batts were removed, 152 mm (7") spray foam RSI-5.3 (R-40) was applied. The batts were then placed on top of the spray foam. Gable vents were added at both ends of the upper attic.

Canada

EQuilibrium™ HEALTHY HOUSING FOR A HEALTHY ENVIRONMENT

CMHC SCHL HOME TO CANADIANS

Given the added weight of the solar photovoltaic system and solar thermal collectors that are fixed on racking attached to the south facing roof slope, new 38x152 mm (2"x6") wood rafters were installed adjacent to the existing rafters for reinforcement as depicted in Figure 2.

Figure 2 New rafters adjacent to existing rafters

Above Grade Exterior Walls

The Now House™ team designed the exterior envelope retrofit to provide:

- A significant increase in insulation;
- An insulation layer that minimized thermal bridging and provided a continuous air barrier;
- Minimal damage to the interior wall; and
- An economical approach to providing superior insulation levels.

The original walls were composed of:

- 9.5 mm (3/8") painted gypsum;
- 38x89 mm (2"x4") stud walls 406 mm (16") O.C.;
- 89 mm (3.5") of paper faced RSI-1.4 (R-8) rock-wool insulation within the stud space;
- 19 mm (¾") exterior wood sheathing;
- Asphalt building paper; and
- 25x203 mm (1"x 8") wood siding which was covered by asbestos board siding which in turn was covered by aluminum siding.

The solution developed by the Now House™ team allowed the interior of the wall (from sheathing to gypsum) to remain intact. The original cladding was removed to expose the exterior sheathing. Ladder-type vertical trusses were constructed of two 51x51 mm (2"x2") vertical elements separated by 140 mm (5.5") wide, 254 mm (10") high pieces of plywood that were attached to the sheathing 610 mm (24") O.C. These built-up trusses reduced wood consumption and minimised thermal bridging through the wall assembly. A 133 mm (5.25") thick layer of closed-cell spray foam was then applied between the trusses to add RSI-5.5 (R-31) insulation to the exterior wall. A 6 mm (¼") air space was left for drainage, and the wall was clad with fibre cement bevel board siding. The floor and ceiling joists were sealed and insulated at the perimeter of the house with 305 mm (12") of spray foam insulation.

Figure 3 shows the exterior wall as it was being filled with the spray foam insulation. The resulting total insulation value of the exterior walls at RSI-6.9 (R-39) is almost 5 times the insulation level of the pre-retrofit wall. Furthermore, the spray foam and other airtightening work reduced the forced air leakage of the house from 5.6 air changes per hour (ACH) to 2.6 ACH at 50 Pa.

Figure 3 Exterior wall under construction

Windows

All existing windows were replaced with fibreglass framed, double-glazed, low-emissivity coated, argon filled, windows. A south-facing window in the living room was made larger to increase interior light and passive solar heating. In the summer months, this window is covered with an exterior solar blind that blocks out 80% of the sun to reduce heat entering the home.

A window on the west side of the house was made smaller to accommodate new counter space in the kitchen.

Basement Exterior Walls

The original basement walls were composed of:

- Asphalt paper, 25x76 mm (1"x3") wood wall furring and 13 mm (½") painted gypsum (no gypsum board in the utility rooms);
- 254 mm (10") poured concrete; and
- Asphalt dampproofing.

The exterior perimeter of the foundation was excavated to the footings. The concrete was cleaned and covered with a layer of asphalt dampproofing. A 0.15 mm (6 mil) polyethylene waterproof membrane was added. Two 64 mm (2.5") thick layers of extruded polystyrene were installed for a total RSI-4.2 (R-25), followed by a dimpled plastic drainage membrane. Before backfilling, the drainage weeping tiles were replaced with perforated plastic with filter sock, 203 mm (8") gravel, and building paper cover.

The foundation was then backfilled 203 mm (8") higher then it was initially to improve drainage by increasing the slope away from the wall. The above grade basement wall, down to 203 mm (8") below grade, was finished with a 13 mm (0.5") cement board cover, which was attached through the drainage membrane and polystyrene to the foundation. The board was then parged with a cement finish.

Basement Slab

The original 76 mm (3") concrete basement slab was unfinished in the utility room, and was finished with carpet in the basement bedroom, hall, and laundry, and sheet vinyl in the bathroom. The original floor to ceiling height in the basement was 2.08 m (6'10").

For the retrofit, the basement slab under the new recreation room was modified as follows:

- The original concrete slab was removed;
- 102 mm (4") of gravel was removed (51 mm (2") minimum to remain);
- 0.15 mm (6 mil) poly vapour barrier was installed over the gravel;
- 51 mm (2") extruded polystyrene board RSI-1.8 (R-10) was installed over the poly;
- 25 mm (1") perimeter insulation RSI-0.9 (R-5) was added between the slab and the footing;
- 13 mm (½") of pex tubing (for radiant floor heating) tied to 152 mm x 152 mm x 0.15 mm (6" x6" x6 mil) welded wire mesh was installed on the board insulation; and then,
- 76 mm (3") concrete slab was poured.

The ceiling heights in the retrofitted portion of the basement increased to 2.3 m (7' 6"). The new recreation room is heated by radiant floor heating. A 152x406 mm (6"x16") concrete curb was added to separate the existing and new basement slab sections.

Implementation Considerations

A key objective of the exterior envelope retrofit was to minimise the impact of the work on the homeowner who remained in the home over the course of the project. This was achieved by working as much as possible from the exterior of the house.

Initially the whole basement was going to be retrofitted. However, the slab was thicker then initially expected at 178 mm (7"), so the team decided to remove only one third of the basement floor. At the owner's request, the floor was removed from the area used for recreation purposes and the new floor heated via radiant floor heating.

The existing metal roof and the aluminum siding were both removed with the intent of reusing them. However, product sponsors offered to donate new metal roofing and fibre cement siding. To improve the 'curb appeal' of the home following the extensive retrofit, the team chose to replace the roof and siding with the new materials and recycle the old.

Technology Benefits

Energy Savings

After the renovation is complete and all of the renewable energy and mechanical systems are commissioned, the Now House™ team estimates that the house will consume 97 kWh/m^2 or 13,500 kWh and generate 2,400 kWh of solar electricity. Including the onsite solar electricity generation, the estimated net-energy consumption is 58 kWh/m^2. This is impressive for a 60-year old house given that the national average consumption is roughly 250 kWh/m^2.

Occupant Comfort

The Now House™ team expects that the combination of the higher insulation values of the exterior envelope, the improved air tightness and a partial radiant floor in the basement will improve occupant comfort by providing:

- Higher indoor mean radiant temperature for equivalent room air temperature resulting in improved thermal comfort;
- Improved daylighting;
- Reduced cold drafts in the house; and
- Reduced exterior noise transmission.

The team also feels that the greater ceiling height in the basement increases the utility and appearance of the basement space.

Resource Conservation

Retrofitting the exterior building envelope of a 60-year old house to a level that makes it more energy efficient than most of the present day energy efficient houses showed how Canada's existing building stock could be renewed while achieving significant energy reductions. Rejuvenating an old building can, in many instances, conserve natural resources and avoid the significant embodied energy costs associated with a new building.

Summary

The Now House™ team found that one of the main challenges of retrofitting an existing house to meet the objectives of the EQuilibrium Housing Demonstration Initiative is to greatly improve the performance of the building envelope through increased insulation and reduced infiltration while minimising homeowner disturbances. The upgrades implemented on the Now House™, which focused on improving the building envelope from the exterior of the house met this challenge achieving impressive performance levels.

Project Team

Developer: The Now House™ Project Inc.
Primary contact: Lorraine Gauthier, President
lorraine@workworthdoing.com

For more information about this project and other EQuilibrium™ housing projects, visit CMHC's website at www.cmhc.ca

EQuilibrium™

What is EQuilibrium™ Housing?

The national EQuilibrium™ 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™ InSight

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

CMHC

CMHC has been Canada's national housing agency for more than 60 years. CMHC is committed to helping Canadians access a wide choice of quality, affordable homes and making vibrant and sustainable communities and cities a reality across the country. To find out more about how the Government of Canada and CMHC are working to build stronger homes and communities for all Canadians, call CMHC at 1-800-668-2642 or visit www.cmhc.ca

Printed in Canada
Produced by CMHC 15-12-09

This publication is intended to highlight housing technologies and practices the builder teams utilized to construct their projects under CMHC's EQuilibrium™ Sustainable Housing Demonstration Initiative. It is provided for general information purposes only and does not constitute an assessment, recommendation or an endorsement of any system, strategy, technique, technology, or product;. The predictions for building performance contained in the publication have been provided by the individual builder teams based on computer modeling and current understandings of best construction practices. Actual building performance may vary. Reliance on the information in this publication for the purpose of planning, design or construction activities would not be appropriate. If readers intend to engage in activities of that nature, they are advised to consult appropriate professional resources to determine what is safe and suitable in their particular case. Any reliance or action taken contrary to this advice is the full responsibility of the user. Canada Mortgage and Housing Corporation assumes no responsibility for any consequence, expense, claim, damage or loss arising from the use of the information contained in this publication.

66739