STRESSED SKIN INSULATING CORE LOW-INCOME DEMONSTRATION HOUSE PROJECT: DESIGN PHASE PROGRESS REPORT

Energy Efficient Industrialized Housing Research Program

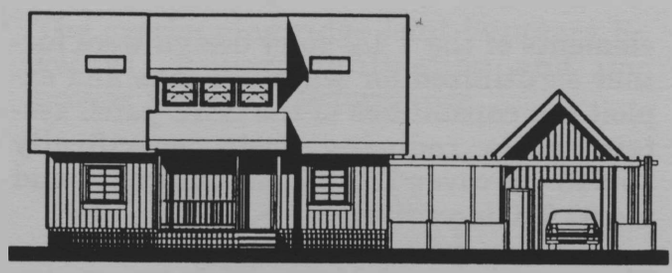
Center for Housing Innovation
University of Oregon

The goal of this project is to show that stressed skin insulating core (SSIC) panel construction can deliver good quality with high energy performance at lower first cost than conventional construction.The demonstration house, which will be built and tested this summer, was designed to match the annual energy performance of an "architecturally equivalent" conventionally framed house built to the Bonneville Power Administration's (BPA) stringent long term Super Good Cents energy standards but for $2,000 less. The standards, which result in a house that uses 40% less energy than an Oregon code house, are an R49 roof, R26 wall, R30 floors, and class 35 windows; and the goal was set because the BPA offers a $2,000 incentive to builders to offset the higher cost of meeting these standards.

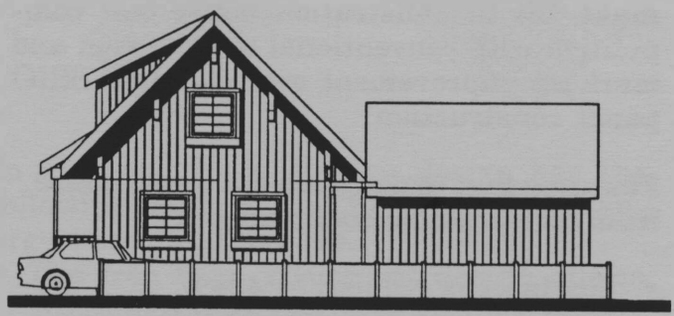
Design Process

Schematic design studies were completed which compared SSIC panel and conventional (reference) versions of five possible candidates. Based on preliminary structural, energy, and cost analyses, and investigations into foundation systems, panel configurations and sizes, and joinery and roof alternatives, the 1 1/2 story design was chosen as the design that optimizes the skin area for structural, thermal and cost performance. (See the elevations and floor plans to the right.)

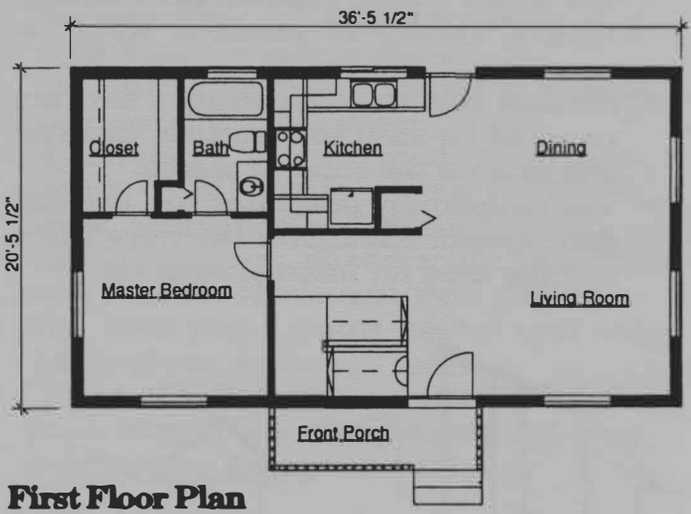
Since the SSIC version of the design approximately met the energy standards, and in fact exceeded the structural standards, but the total envelope cost was $3,546 more than the conventional version,



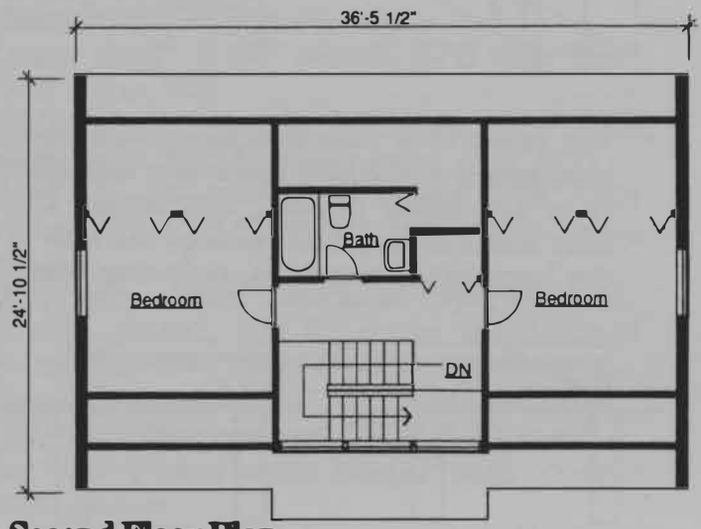
South Elevation



East Elevation



First Floor Plan



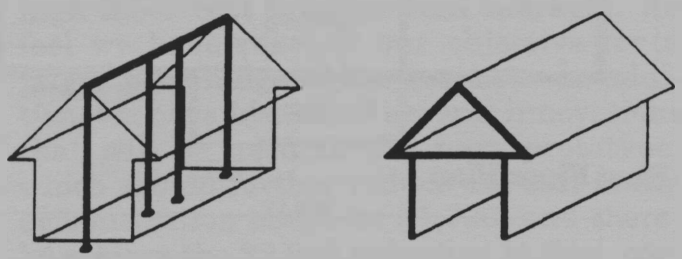
Second Floor Plan

elements of the 1 1/2 story design were further scrutinized for ways to refine and exploit the capabilities of the SSIC panel system while reducing costs, specifically $5,546 (to cover the $3,546 difference and the $2,000 incentive).

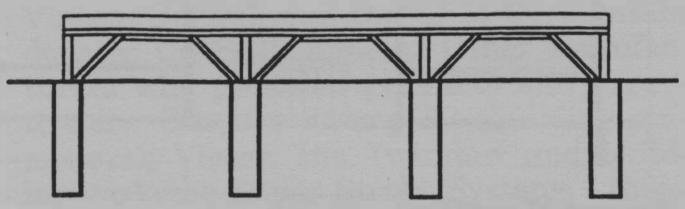
The results of this design process were a number of features and innovations that make the demonstration house cost competitive with conventional construction and mark an improvement over standard SSIC panel construction.

Features that distinguish the demo house from conventional construction:

- Site labor is reduced by 40+%.
- Project length is reduced by one week.
- The panel system replaces sawn lumber with a variety of plentiful wood resources.
- Because only three consecutive days are required for shell construction, this system extends the building season.
- The structurally integrated roof and 2nd floor system eliminates the ridge beam and the need for internal supports.



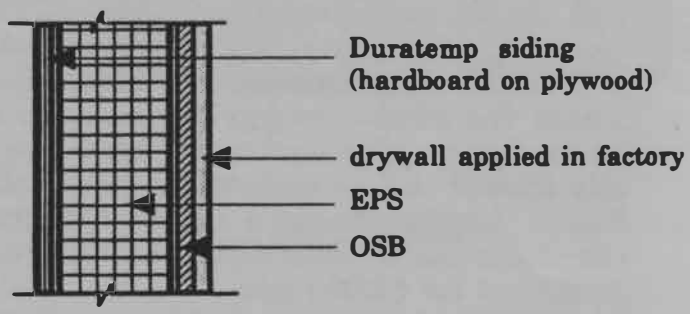
- The integrated floor and foundation system, using the 2-way spanning capability of the SSIC panels, distributes the floor loads evenly and reduces the size of the horizontal members, reducing cost.



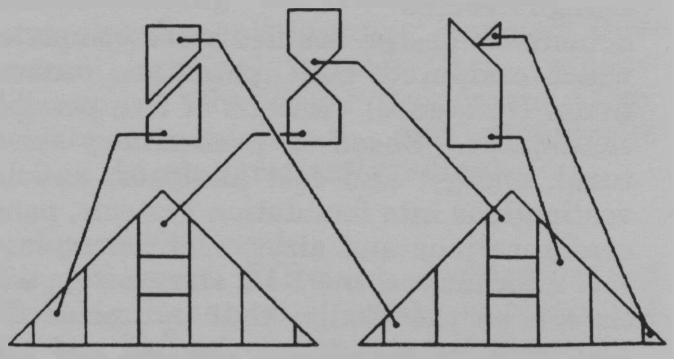
- Offsetting the wall-to-wall and floor-to-wall connections provides an increase of 28 square feet (2% of floor area).
- Flush mounted skylights eliminate thermal bridging due to curbs.

Features that distinguish the demo house from standard SSIC panel construction:

- The design optimizes the skin area for structural, thermal, and cost performance.
- Structural siding laminated directly to the insulation core eliminates a layer of OSB.

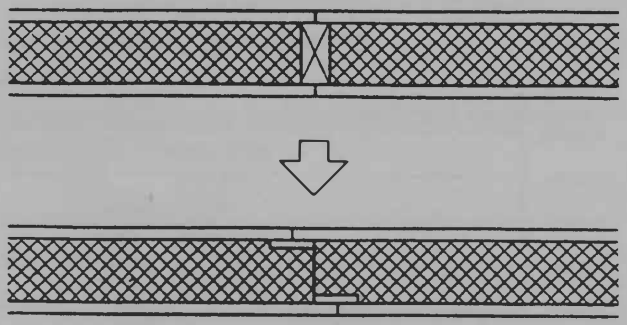


- Internal plumbing vents minimize envelope penetrations, reducing energy transfer through the shell.
- Panel cutoffs at the gable ends are reused at the opposite end of the building to reduce waste.

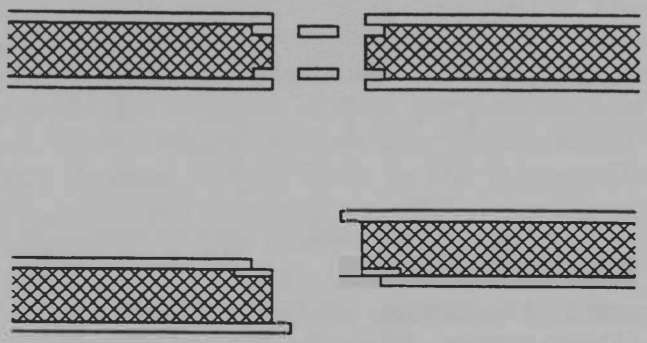


- Offsetting building corners reduces the impact of dimensional variations in long walls and floor panels.
- The house plan is based on the panel module to reduce waste.
- Locating panel joints at the exterior openings reduces panel waste.

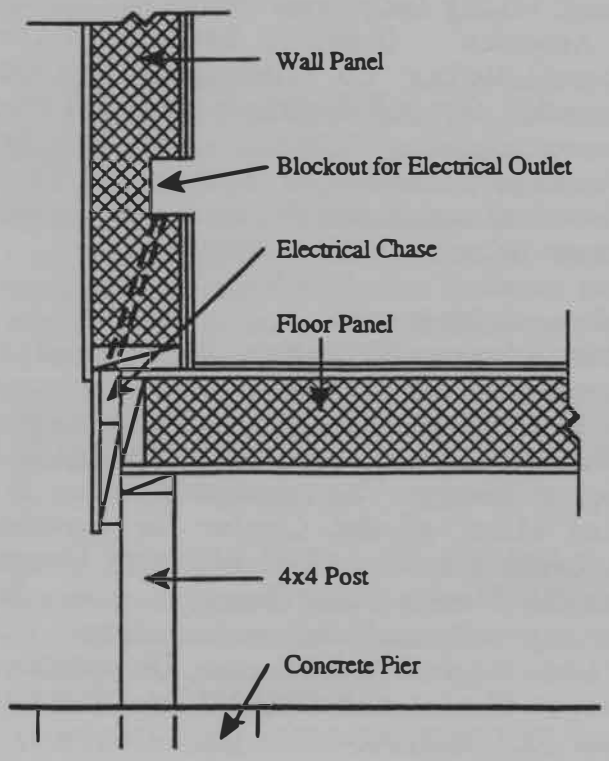
- Minimizing dimensional lumber in the floor and roof reduces thermal bridges.



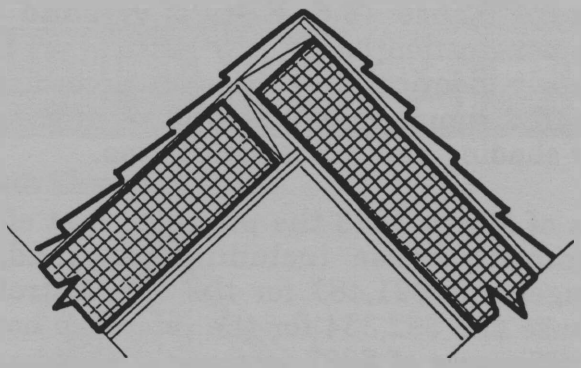
- Shiplap joints reduce installation by 20%, improve air tightness and reduce fasteners by one half.



- Exterior electrical chases minimize wiring in the panels and increase R-value, reducing installation cost by 5%.



- The overlapping ridge joint improves R-values, reduces infiltration and improves thermal performance.



In addition, the 1 1/2 story design has the following features that make the house energy smart and flexible.

- The free span structural design allows for maximum flexibility in arranging interior partitions.
- The open stair and kitchen provide long sight lines for spaciousness.
- The master bedroom is usable as a separate rental or office space.
- A minimum of two windows or skylights in all major rooms facilitates cross ventilation and daylighting.
- Eave overhangs shade south glazing, and shutters shade east/west glazing.
- The heat pump water heater uses exhaust air as an energy source.
- The ventilation system removes hot air from behind the refrigerator, reducing refrigerator energy consumption.

Energy-related Specifications

Lower floor: 6 3/8" panels, EPS core, 7/16" OSB skins, R22.

Walls: 8 1/4" panels, EPS core, 7/16" OSB inner skin, 5/8" Duraply outer skin, R30.

Roof: 10 1/4" panels, EPS core, 7/16" OSB skins, R38, R30 fiberglass batt insulation at eaves.

Windows: Vinyl casement type, class 35, double glazed, low-E, argon filled; vinyl framed, double glazed, operable, skylights.

Exterior doors: 1 3/4", R5, insulated steel.

HVAC: Thermasave VHPAC-80 ventilating heat-pump/water heater with electric heat backup.

Lighting: Compact fluorescent lighting.

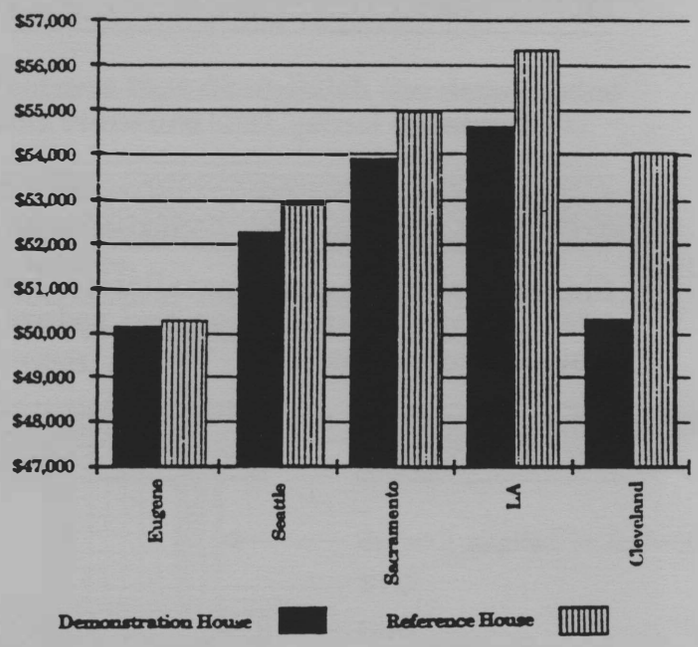
Projected Performance

As the design currently stands the conventional house (6.6 KBtu/sf,yr) and the demonstration house (6.3 KBtu/sf,yr) have nearly identical heating loads according to DOE 2 simulations. Cooling loads are met by shading and cross ventilation.

As of March 1993 the projected cost of the complete house including the land, in Eugene, is $91,487 for the demonstration house and $92,354 for the reference house, a difference of $867 in favor of the demonstration house. As would be expected, materials are a larger percentage of the demonstration house cost, whereas the labor percentage is larger for the reference house.

In terms of reaching our goal of $2,000 reduction in first cost, we fall $1,100 short in markets where labor costs are low and panel costs are high, such as Eugene, but surpass our goal by as much as $2,000 in metropolitan markets where labor costs are high and panel costs are low, such as Cleveland. (See the bar graph to the right.) Since most housing in the U.S. is built in high labor cost metropolitan markets, we feel we have reached our objective for a larger percentage of the market. In addition, we have identified several innovations that will be used in the next prototype, which should further reduce the cost of the demonstration house by $1,700, and thereby achieve the $2,000 reduction in first cost in markets throughout the United States.

Demonstration and Reference House Costs for Portion of the House Affected by the Panels



Project Sponsors

The design and analysis work for this project was funded by the U.S. Department of Energy. A large share of the cost for the site and construction was provided by St. Vincent dePaul, and the AFM Corporation donated the SSIC panels. Other manufacturers who provided products and expertise are Simpson Strong-Tie (building connectors); Viscor, Inc. (window and building gaskets); Super Struct Systems (honeycomb core interior panels); DEC International (Envirovent HVAC/water heating unit at cost); Stimson Lumber Co. (Duratemp siding panels); Studor International (internal plumbing vents); Trus Joist MacMillan (TJI and Parallam floor framing members); Owens Brockway Corp. (recycled glass cullet for paving base); Viking Industries (windows); Lights of America (lighting fixtures); Cadet Manufacturing Co. (electric heaters and controls); Seagull Lighting (compact fluorescent lighting); Levolor Corp. (window coverings); Challenger Equipment Corp. (electrical equipment); and Bonneville Power Administration (funding).

Acknowledgements

The Energy Efficient Industrialized Housing Research Program is sponsored by the Office of Building Technologies, Conservation, and Renewable Energy, U.S. Dept of Energy. The research program is a joint effort of the Center for Housing Innovation at the University of Oregon and the Florida Solar Energy Center. For further information, contact: Prof. G.Z. Brown, Dept of Architecture, University of Oregon, Eugene, OR 97403 USA (503) 346-5647 FAX (503) 346-3626. (Doc# 4792/PR 92-2)