



Panelized Wall and Roof Systems: 2005

Reinventing the home construction process using assembly line automation and prefabricated panels

Summary

Manufacturers are reinventing the process of home construction using assembly line automation and prefabricated panels made from a wide variety of materials. The installed panels form a structural envelope that eliminates the need for conventional framing, provides integral insulation, and can be assembled swiftly by less skilled laborers. These advantages have spurred production and introduced a thermally efficient structural method of light construction to a broad market.




Panelized systems take many forms. The most widely used panels are made from an Expanded Polystyrene (EPS) core, adhered to Oriented Strand Board (OSB) or plywood skins. The foam alone has little strength, but when bonded to the plywood, acts as a bridge, or web, to augment structural capacity and resist buckling. These panels are commonly known as Structural Insulated Panels (SIPs) and are described in a separate PATH Technology Inventory article.

What's relatively new is the variety of materials being incorporated into panel systems, such as light gauge steel, aluminum concrete and fiberglass components. Different systems may offer advantages for particular building needs or circumstances, but all share the basic design of a building component with inherent structural and insulating capacity. The panels are assembled to form exterior walls or roofs with minimal additional framing. Many panels are lightweight, and can be designed to resist earthquakes, high winds, debris impact, moisture, and insect infestation.

Insulation capacity is an advantage of panel systems. There is general agreement that insulated panels provide better overall air tightness and thermal performance. Conventional wood framing creates a structure where a minor thermal bridge occurs at each vertical stud and gaps can exist between insulation batts and stud surfaces, that allow air leaks. Panel systems offer a dense, uniform and continuous air barrier with few thermal bridges, and little opportunity for internal convection.

Industrialization of the construction process is also an advantage for panel manufacturers. Panels can be produced in an automated factory environment, using computer controlled equipment, that transfers panel-cutting instructions

directly from digital CAD (computer aided design) drawings. The resulting components are precisely engineered and easy to inspect for quality control. Once the panels are shipped to the jobsite, they can be quickly assembled, speeding the onsite construction schedule and allowing homes to be placed under roof more quickly.

More information about panelized wall systems is available in a [ToolBase TechSpecs](#)  summary.

Below are some examples of panel systems currently used in single-family home construction:

Light Gauge Steel Framing and Foam Insulation

Thermasteel Corporation produces EPS core panels with steel framing elements. Steel channels are placed flat at 16" centers on both the interior and exterior panel sides. Placing the steel stud's web face flat on the panel surface creates a 2½" separation between the interior and exterior frame elements, for a high quality thermal break. This feature is important because thermal transfer is a critical limitation of standard light-gauge steel framing. The manufacturer states that exterior finishing materials can be installed without applying additional insulation sheathing usually required. Panels are manufactured in standard widths of 2' or 4', in standard lengths up to 12'. Panel thickness may be 3½" or 5½", and according to the manufacturer, with R-values of 15 or 23, respectively. The vertical panel edges are ship-lapped to improve thermal performance at the joints. As is typical for steel framing, all connections are made with self-tapping screws placed on 12" centers. A special foam-cutting tool is used for placing electric boxes and plumbing. At about 50 lbs., one person can carry single panels.

Construction with steel framing provides stable material cost, strength, flexibility, durability, non-combustibility, and resistance to infestation. Steel building techniques are most widely used in areas where termite infestation is a strong concern such as Hawaii and Florida.

Dynabilt technology International Corp. offers a panel system called Modutherm, using steel framing materials with a "polymeric insulated core". This manufacturer produces complete pre-designed house packages using Modutherm panels and steel truss roofing systems. The packages include everything from exterior wall finishes and roofing materials to plumbing fixtures and cabinets. Small starter models are priced under \$10,000, while traditional two story models of between 2,000 and 3,000 square feet are priced between \$50,000 and \$60,000.

Structural Concrete and Foam Insulation

The Monotech Building System uses EPS foam as the formwork and insulation for the building. Monotech's proprietary material, Monocrete is then applied on both sides of the foam panels creating the structural integrity of the system.

Monocrete is the only structural grade concrete specifically designed to adhere to polystyrene (EPS) based building materials without the need for reinforcing mesh, adhesives or rasping. Monocrete is applied by either a shotcrete or hand trowel process. The Monotech Building System's patented process is designed to reduce materials and labor costs by simplifying the construction process.

Aluminum, Steel, or OSB Skins with Foam Insulation




Structall Building Systems produces panels using a variety of skin materials. Their aluminum and steel skin designs feature a patented "Snap Lock" joint that quickly locks panels together. Some metal surfaces may need no additional finishes applied. They also produce a "Half-Snap" panel with their metal locking joint on one side, and an OSB plywood skin and spline joint on the other. The company features packages and custom design services for homes and room additions.

Concrete with Foam Core Insulation

TMG International manufactures a wall and roof panel system made from concrete with an EPS core. The design of the system, mainly used in Florida, resists termites and can withstand winds up to 140 mph. The wall panels mount directly to the foundation footers, with a concrete floor cast in place after the walls are assembled. Model floor plans use TMG panels for interior as well as exterior walls. Electric conduit and plumbing lines are placed in the floor area prior to casting the slab. TMG looks for a minimum order of 40 units to achieve optimal pricing of about \$25 per square foot, not including footers, roofs, and work by following and finishing trades. They provide engineering for the building design, documentation for permitting, and certification of wind resistance. The walls have exceptional sound ratings and two-hour fire resistance rating. The entire shell for a house is assembled in one day, using a crane for panel placement. Exterior walls provide a finished surface with simulated stucco, stone, or brick. Roof panels are finished with single layer of membrane roofing.

Fiberglass Skins, PVC Studs, and Foam Insulation

American Structural Composites uses fiberglass skins bonded to PVC columns or studs for the panel's backbone. The composite used in the housing system consists of polymer-based resins blended into a reinforcing matrix of structural glass fibers. Wall, roof, and floor panels consist of thin, but exceptionally strong, layers of composite on interior and exterior faces bonded to a composite truss-like member in the center. Panels can incorporate a number of textured interior finishes, and simulated brick, stucco, or stone exterior finishes. Panels are available in virtually any dimension, with spans up to 24 feet possible on the roof.

-  Because of the high insulation level throughout the panel and the little infiltration, only a small amount of heat can pass through the panels. Stick construction only has insulation between studs and not every location in the wall, and there are more gaps. Panels have a much smaller framing fraction and are insulated throughout, providing very little gap area for infiltration. This greatly improves the amount of energy required to heat and cool the home.
-  Because panels are made in a controlled environment, they can be inspected to ensure they meet code and manufacturer specifications. Panels are generally very strong, have high fire ratings, and allow very little infiltration. As such, they also limit sound infiltration.
-  The strength and fire ratings of panel construction offer a significant advantage over stick construction, especially considering the fact that they are made as such in the factory and come in one piece, whereas stick construction requires several components to be considered as strong and fireproof.

Ease of Implementation



Affordability is dependant upon economies-of-scale production with standard designs and minimum customization.

Most panel systems are customized. Availability hinges on a manufacturer's design and production turn around time, order backlog, and run time. Job proximity to manufacturing plant will also affect the cost, and any time delay imposed for transporting the panels.

Initial Cost

The cost of panelized wall systems (with integral insulation) start at 40% more than the costs of field framed 2x4 walls, however, labor, construction time, and energy use savings can offset this material cost increase in many U. S. markets.

Operational Cost

Not Applicable

U.S.Code Acceptance

Codes do not embody prescriptive methods for building with panel system. Typically, each manufacturer must obtain individual code approval for its product, and many have done so. Some jurisdictions require an engineer's review and seal of the structural design, which can usually be obtained through the manufacturer.

Field Evaluations

Howard Building Company: Rougemont, North Carolina

Hughes Construction: Lexington, North Carolina

Home Front, Inc.

Installation

Panels are usually planned in modules of 4' x 8' or greater, depending upon house design. Installation techniques for the panels are manufacturer-specific. Typically, connections along the top and bottom of the panel and at panel abutment edges are required. Detailed use guides are available at each manufacturer's website or upon request.

Warranty

Not Applicable

Benefits/Costs

Manufacturers can use automation and industrialized construction techniques to provide high quality, consistent, and reliable products. On site construction time and labor can be reduced. Some panel systems are lightweight, and can be designed to resist earthquakes, high winds, debris impact, moisture, and rodent and insect infestation. Insulated panels can also provide good thermal insulation and soundproofing.

Please visit Path's website at www.toolbase.org for additional and up to date information about this subject.