Insulated Cold-Formed Steel Wall Panels: A case study of a contractor-manufacturer

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And

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Background and Acknowledgements

The objective of this project is to gather state-of-the-art information to enable builders and framers to better integrate steel-framed wall panel systems and processes into their design, construction and business models. This stage of the project consists of a series of case studies on contractors who are successfully using panelized construction in concert with cold-formed steel.

This report addresses a case study conducted on a contractor who also manufacturers and distributes a pre-insulated cold-formed steel panel system. The panels have foam insulation molded around structural supports made from cold-formed steel members, creating an insulated structural wall panel.

This case study is written mostly from the perspective of Premium Steel Building Systems of Roanoke, Virginia, the manufacturer-contractor who provides the panels and other components as well as design and construction services.

Newport Partners LLC conducted the observations and interviews with personnel from the manufacturer. Newport also collected downstream information from the perspective of a custom home builder – Roger Terry Construction – who has used Premium Steel’s panels and other services.

This case study and report were prepared by Mark Nowak and Matt Hawkins of Newport Partners LLC. We extend special thanks to Danny Feazell of Premium Steel and Roger Terry for their assistance. Funding for the project was provided through a cooperative agreement between the Steel Framing Alliance and the U.S. Department of Housing and Urban Development’s Office of Policy Development and Research.
Section 1 – General information and participants

Danny Feazell  
Premium Steel Building Systems 
Roanoke, Virginia

Roger Terry  
Roger Terry Construction  
Meadows of Dan, Virginia

This case study focuses on insulated structural steel wall panels supplied by Premium Steel Building Systems. Premium Steel has been supplying residential insulated structural steel wall panel framing packages since 1999. They also manufacture joists and trusses, and provide necessary design documents, installation training, and technical support.

Although the emphasis of this case study is on Premium Steel and their business approach, we also selected a builder to interview for this case study to address how Premium Steel interacts with its clients. In this case, the builder, Roger Terry Construction, is constructing a two-story custom home with a full basement. The home has 4,835 square feet of livable space, including an attached two-car garage. The home is being built in a rural area in Laurel Fork, Virginia.

Roger Terry typically builds one project at a time. Most of the projects are large custom homes but he also does some additions on occasion.

No special permits or exemptions were needed or granted by the local building department for this home. The home’s design required a professional engineer’s stamp, which was included in Premium Steel’s framing package price.
Section 2 – Business model and relationships

Premium Steel began as a supplier for ThermaSteel, a manufacturer of insulated structural wall panels. Premium Steel recognized that the insulated steel panel is an efficient framing material but a first-time user tends to require support and training. Therefore, Premium Steel developed a business model that encompasses not only providing material but also all related buildings services to its customers. Now Premium Steel takes a comprehensive, service-based approach to supplying framers and builders.

Premium Steel offers a continuum of services from simple material supplier to comprehensive turnkey construction, and levels of service in between. A builder can select as much support as is necessary or desired. On some projects, Premium Steel may only provide the wall panels. On others it provides the entire framing package. On some projects it installs the panels. On others it does all of the framing.

On the support side, Premium Steel provides design services, training and inspections. It produces all associated design documents related to framing, including wall, truss and joist framing plans. Premium Steel also works with other trades and subcontractors to accommodate and efficiently design mechanical and electrical systems.

Although wall panels are their main interest, Premium Steel often provides other framing materials. Its typical material framing package includes steel floor and roof trusses along with the insulated structural wall panels. The steel trusses are manufactured using a proprietary roll-forming system. Premium Steel used to purchase truss or joist systems, but once their volume level increased it became cost effective to internally manufacture these components.

The insulated structural steel wall panels are engineered and assembled in a factory by a third party manufacturer specifically for Premium Steel, then transported to the job-site with the rest of the framing package.

The panels can be installed on any type of foundation using conventional screws and pins. Premium Steel supplies steel tracks used for attaching the panels to the floor or foundation. Wall panels are attached to adjacent panels using connector plates secured with self-drilling, self-tapping screws. The screws and plates are included in the framing package provided by Premium Steel.

Premium Steel provides training, as part of the framing package, to its customers. The builder we interviewed has used the insulated panels on
previous projects but none as complex as the house under construction at the
time of this case study, Premium Steel was in continuous contact with the
builder to offer guidance and conducted field inspection to ensure proper
installation throughout the project.

Rounding out their comprehensive approach to service, Premium Steel works
with local building officials to make sure the designs and framing systems comply
with local codes and engineering standards. This reduces apprehension by new
users and provides additional options for home owners and builders to explore.

From the perspective of the builder we interviewed, the approach used by
Premium Steel allows him to use innovative building systems without the need
for significant capital investments. The use of panels plus the training and design
services provided by Premium Steel also removes much of the resistance to
switching from wood to steel framing materials.
Section 3 – Working with steel at the site

Builder/Framer

The builder used his own four person framing crew on the home under construction in Laurel Fork, VA during this case study. The building crew has worked with Premium Steel's panels in the past, mostly constructing additions. The crew had no previous experience working with steel joists or trusses, although all of them had experience framing with wood. None of the crew members had formal construction training, their knowledge and skills were developed on-the-job.

Home Characteristics

The home is a total of 4,835 square feet above grade including the garage space. It has two above grade stories. The full basement foundation is constructed with an insulated pre-cast wall system provided by Superior Walls of Central Virginia.

The home we observed was in the final stages of framing. Everything but the roof sheathing was complete.

The floor framing on both the first and second story are steel trusses spaced at 24 inches on center and sheathed with OSB.

All exterior walls are built with the insulated panel system. Interior walls are site-built from cold formed steel members provided by Premium Steel. Gypsum board will be attached to the interior of the wall panels and to partition studs. The exterior will be covered with rock or brick, depending on location and architectural intent. No exterior sheathing is necessary because all of the necessary lateral support is designed into the panels.

The roof trusses were installed at 24 inches on center and covered with OSB sheathing. After attaching the roof sheathing the seams were covered with weather barrier tape. The application of weather barrier tape is not considered part of Premium Steel’s standard framing package but was used to suit the owner’s preferences. Attic insulation will be installed after the ceilings are covered with gypsum board.

Interestingly, the roof system was an extremely complex rafter system. The builder was unable to find any wood truss manufacturers willing to fabricate trusses for the home. Premium Steel was the only company in the area willing to bid on the roof.
Panel System

The insulated wall panels are composed of cold-formed steel members integrated with expanded polystyrene insulation. Each panel is filled with polystyrene formed through a low pressure molding process. The wall panels have embedded studs at 16 inches on center. The panels serve as the structure and provide the insulation in one self-contained assembly.

The R-value of the panels varies according to thickness. For the 5-1/2 inch panels used at the Laurel Fork home, the manufacturer claims an R-value of 24. Sheathing and drywall will increase the overall R-Value where applied.

The wall panels are typically 8 to 10 feet in height, depending on the home’s characteristics. Panels are limited to 4 feet in length to keep them a manageable size for one or two people to move and install.

The wall panels are 5 ½ inches in width and manufactured with 25 gauge (18 mil) steel tracks and studs with G-90 Grade galvanized coating. The insulation is molded around the steel members, allowing for most headers and other supports to be molded into the panels.

The panels use an innovative design that prevents thermal bridging to improve the wall panel’s thermal performance. None of the vertical studs form a continuous thermal short through the panel. Rather, a thermal break is provided across the panels.

The panels are manufactured off-site and arrive at a job site in stacks on a flatbed truck. They are unloaded by hand. A panel is easily managed by one crew member. A typical 4 foot by 9 foot panel weights roughly 45 pounds.

Panels can be covered if they will be exposed to sunlight for an extensive period of time, but this is not necessary if they are installed within a few days of delivery.

Installation

The bottom tracks are applied to the OSB floor sheathing using pins or screws. A panel is then placed into the track, usually by one or two crew members. After the panel is in place, wood 2x4’s are used as temporarily bracing. The framers screw the panels to the top and bottom tracks. Adjacent panels are attached to each other using screws and steel connector plates.

The framers typically wait until a wall section is over 12 feet before securing the panels with screws in order to prevent problems if an alignment issue developments and because the bottom tracks are typically 12
feet in length. Tracks are cut to length in the factory and accommodate corners and architectural features, as necessary.

No major panel damage or framing problems occurred on the construction, according to the builder at laurel Fork. Four panels were slightly damaged but the panels were easily straightened by the crew and required no technical assistance from Premium Steel.

Headers
With conventional steel framing, headers are built-up from track and stud sections in a very time-consuming process. With the Premium Steel panels, Headers three feet or smaller in width are molded into the panels in the factory. For larger openings, Premium Steel provides notched ends and/or brackets on the supporting adjacent panels and a pre-manufactured header to drop over them.

Roof System
The steel trusses at Laurel Fork were provided by Premium Steel but the owner/contractor wanted a proprietary roof sheathing and weather barrier tape, instead of traditional OSB or plywood. The builder purchased the sheathing, weather barrier tape and fastening pins for the roof system.

Floor System
The steel floor trusses provided by Premium Steel can be installed at whatever spacing is needed to meet strength and deflection requirements for the selected spans. They are open web designs to accommodate plumbing and ductwork. OSB floor sheathing is screwed to the trusses.

Interior Non-Load Walls
The interior non-load bearing wall studs and tracks were fabricated by Premium Steel and framed on-site by the builder’s crew. The tracks and studs arrive cut to length and are attached using screws provided by Premium Steel. The stairs and most of the stairwell framing were constructed out of wood.
Section 4 – Capital requirements and costs

Framing System Costs
Premium Steel provided a comprehensive framing package to the builder. Included in the package price were design fees, exterior and interior framing, floor joists, roof trusses, and all the necessary screws, tracks and clips. Roof and floor sheathing was provided by the builder.

Panel and material costs are dependent upon the complexity of the home’s layout, foundation and building site characteristics. The following figures are intended to give a rough estimate of panel costs, based on the 4,835 square foot two-story custom home at Laurel Fork. Prices reflect cost applicable in the late 2007 time frame.

<table>
<thead>
<tr>
<th>Framing</th>
<th>Material</th>
<th>Approximate Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Floor Exterior Wall Panels</td>
<td>Panels, Tracks, Screws</td>
<td>$21,527</td>
</tr>
<tr>
<td>Second Floor Exterior Wall Panels</td>
<td>Panels, Tracks, Screws</td>
<td>$11,168</td>
</tr>
<tr>
<td>Interior Framing – Site Built</td>
<td>Studs, Tracks, Screws</td>
<td>$1,505</td>
</tr>
</tbody>
</table>

The complete framing package (panels, trusses, interior framing, accessories, and screws, but not sheathing) supplied by Premium Steel was purchased by the builder for approximately $16.33 per square feet. As with any construction project, costs vary depending on the complexity of the design and level of ‘upgrades’. For this observation, the rafter system was extremely complex and accounted for over 25% of the total framing package price.

Transportation was provided by Premium Steel and these costs were included in the framing package price. The builder used his framing crew and all-terrain forklift to unload the materials at the job site.

Equipment Costs for the Builder
The builder cited very little capital investment was necessary on his part. All of the major risk associated with capital investment is carried by Premium Steel. Since this crew typically works with wood, the builder did need to purchase the following items related to steel construction:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Gun</td>
<td>3</td>
<td>$900</td>
</tr>
<tr>
<td>Chop Saw</td>
<td>1</td>
<td>$250</td>
</tr>
<tr>
<td>Hot Knife</td>
<td>1</td>
<td>$250</td>
</tr>
</tbody>
</table>

* prices are estimates provided by the builder
The screw guns were needed to attach steel components together and sheathing to the steel trusses. The chop saw was purchased to cut and modify steel members as needed. Steel tracks, panels and interior non-load bearing framing members were shipped cut to length, but field modifications do arise. The hot knife was purchased to trim the polystyrene insulation. The majority of insulation trimming was related to creating channels for electrical wires, plumbing pipes, and mechanical systems.

On site, the builder had an electrical generator and rented an all-terrain forklift. These items are considered standard for home construction and would have been needed if the home was framed with steel, wood, or any other framing material.
Section 5 – Crews and on-site construction issues

On the Laurel Fork home, the builder used his in-house, four-person crew for the framing. The framing crew reported no major issues or concerns working with Premium Steel’s insulated steel wall panels, steel partitions, or trusses. One crew member stated that “it’s different, but a good system.” The crew thought there was too much wood at door and window opens.

This is a custom home with very exacting specifications. Thus, it does not represent a good opportunity to assess cycle time. The framers indicted that the framing has taken much longer than expected, but that the prolonged construction schedule can be attributed to the complicated roof framing system and not the materials that were used.

Trade contractors
The builder indicated that the electrician charged approximately 5% more to work with this system compared to a wood framed home. This charge was attributed to the increased time required to wire the home due to the use of the hot knife to create wire chases.

The interior drywall will be attached by the building crew. They did not express concerns with hanging gypsum board.

According to the builder, none of the other trade contractors modified their prices or expressed concerns over working with the steel materials or the insulated panels. However, there are far less trade contractors involved in this home than on a production project because the builder uses his in-house crew for much of the work.