FRAMEBUILDING NEWS®

THE ONLY PUBLICATION SERVING THE POST-FRAME INDUSTRY FOR OVER 30 YEARS

WWW.FRAMEBUILDINGNEWS.COM

August 2021 • Vol. 33, Issue 4

TOP TO BOTTOM AG COMPONENTS

SPECIAL REPORT LUMBER PRICES

CASE STUDY: SPRING ACRES FARM

HOW TO PREVENT HEAT TRANSFER WITH BELOW-GRADE INSULATION

FIND US INSIDE

MAXIMIZE EFFICIENCY & MINIMIZE WASTE WITH THE CONVENIENCE OF AUTOMATION.

SWI's Reliable, Fast, & Easy-To-Operate Systems Ramp Up Any Sheet Metal Project.

Marxman Plus

The Marxman Plus Automatic Slitter provides all the capability and reliability of traditional Marxman machines with the added efficiency of **8 pairs of auto setting slitter blades**. It also includes a user-friendly interface that provides for **automatic part nesting**, waste minimization, and integration with a wide range of business software via ShopLink. Plus, with **speeds of up to 150FPM**, you'll be amazed to see just how efficient your operation can be!

Marxman Plus
Automatic Slittler

5,000kg (11,000 lbs) Recoiler

Recoiler/Rewinding Coil Threading System

SWI's recoiling system provides an effective, low-cost recoiling solution for occasional or frequent recoiling of **coils up to 5,000kg (11,000 lbs)**. Our recoiler is easy to operate, with quick, ergonomic coil insertion, automatic speed regulation, and simple controls. Not only is the recoiler simple to use, but it also gets the job done with speeds up to 150 FPM, easy-to-set guides, and pneumatic slitter cut off.

When coupled with SWI's Marxman slitters, the recoiler becomes an efficient tool for trim manufacturers.

SWI
MACHINERY

For Full Catalog or Quote:
(770) 766-0880 • info@swimachinery.com • SWImachinery.com

So many components

You will find this edition, once again, packed with usable information. There's loads of technical data and product data. I have no doubt you will find of interest the report from the National Association of Home Builders (NAHB). It explains why, even though lumber future prices have been dropping quite a lot in recent weeks, we're not yet seeing significant price drops at retail and wholesale levels. I'll give you a clue: As one builder recently told me, "The futures aren't here yet."

The longest feature in this issue dives into products that are used to build agricultural post-frame structures. They are arranged (roughly) in the order of top to bottom — roof to foundation. While we obviously aren't able to round up every component used in a post-frame building, we did pile in quite a few. Web addresses are included so you can easily find more information online. However, if you would like the companies to reach out to you directly, you can use the Products & Services form on page 48.

In the next edition, we will investigate load capacities for different wood species and engineered wood products. (The November edition! Where did the time go?!) We'll also have continuing coverage on long-span trusses from the SBCA.

You received this issue of Frame Building News packaged together with Garage, Shed & Carport Builder. If you would like to continue receiving that magazine, be sure to fill out the blow-in subscription card and mail it in. Or, you can subscribe online at https://garageshedcarportbuilder.com/subscribe-to-free-magazines/, or you can give Barb, our subscriptions specialist, a call at 920-471-4846 (leave a message if necessary). If you don't sign up, soon you will no longer receive that magazine, because it will be mailing on its own.

Until next time — be well.

Karen Knapstein

Karen Knapstein, Editor

CONTENTS

ON THE COVER:
Spring Acres Farm, a 24,000 sq. ft. equine facility, was built by the team at All Specialty Buildings. Photo courtesy of Spring Acres Farm.

Cover design by Kevin Ulrich

DEPARTMENTS

SHIELD WALL MEDIA LLC

CORRECTIONS:

In the Post-Frame Directory in the June edition, there was an error in the service area for Dracht Construction. The listing should have appeared as:

Dracht Construction Co.
23350 100th Ave.
Marion, MI 49665
231-825-0035
ed@drachtconstruction.com
drachtconstruction.com
Service Area: Central NW Michigan

RAM Buildings no longer uses a PO Box:

RAM Buildings, Inc.
592 Industrial Dr.
Winsted, MN 55395
320-485-2844
www.rambuildings.com
sales@rambuildings.com
Service Area: Minnesota, North Dakota

Crown Jade Design and Engineering has a new address:

Crown Jade Design and Engineering
4165 Crittenton Lane, Unit 7
Wellington CO 80549
970-472-2394
jademail@crownjade.com
Designer
Service Area: Colorado

Maxim Construction has an email change:

Maxim Construction LLC
303 N 13th St.
Paducah, KY 42001
270-408-6296
http://maximc.com
sally@maximc.com
Service Area: Kentucky

Frame Building News regrets the errors.

FRAMEBUILDING NEWS

Managing Editor:
Karen Knapstein
karen@shieldwallmedia.com; 715.513.6767

Editor: Sharon Thatcher

Circulation/Subscriptions:
Barb Prill
barb@shieldwallmedia.com; 920.471.4846

Digital Product and Data Engineer:
For help with online Classified Ads
& the Business Directory contact:
Steve Duberstein: steve@shieldwallmedia.com

Publisher: Gary Reichert
gary@shieldwallmedia.com; 715.252.6360

Executive/Advertising Assistant:
Kathy Budsberg
kathy@shieldwallmedia.com

Sales Assistant: Kathy Welk
kathyw@shieldwallmedia.com

Graphic Designers: Tom Nelsen, Kevin Ulrich

Frame Building News (ISSN 1079-0870) (Volume 33, Number 4) is published five times per year (January, April, June, August and November) by Shield Wall Media LLC, 150 Depot St., Iola, WI 54945. Periodical postage paid at Iola, WI, and at additional mailing offices. Canadian Agreement Number: 40665675. POSTMASTER: Send address changes to Frame Building News, Barb Prill, PO BOX 255, Iola, WI 54945. Mailed free to post-frame builders and their suppliers throughout North America. Others may subscribe: U.S. $21.98 for 1 yr, $39.98 for 2 yrs, $58.98 for throughout North America. Others may subscribe: U.S. $21.98 for 1 yr, $39.98 for 2 yrs, $58.98 for 3 yrs; Canada, $29.98 1 yr, $56.98 2 yrs, $84.98 3 yrs.

LUMBER PRICES

Why Builder Lumber Prices Remain Higher than Headlines Suggest

While the price of framing lumber has dropped roughly 50% over the past seven weeks according to Random Lengths, prices paid by builders have declined by a fraction of that amount. The disconnect — which has always existed — is inherent to the lumber supply chain.

This post outlines the reasons why when lumber market prices drop sharply there can be a long lag time before these full price reductions trickle down to builders and why higher prices reach builders with a much smaller lag time when the price of lumber increases.

Five stages of the dimensional lumber supply chain.

The Lumber Supply Chain

The supply chain for dimensional lumber typically consists of five stages.

1. Timber is harvested from the forest and shipped to a sawmill.
2. Saw logs are cut to dimension at the mill and shipped to a distributor.
3. The wholesaler delivers to lumber retailers such as lumberyards and building materials suppliers.
4. Customers purchase the product to use as a production input.
5. The end-user (e.g., home builder) constructs a home.

A lumber company may operate at one stage or multiple stages. In the latter case, the firm is said to be vertically integrated— such structure is commonplace in the lumber industry. For example, large lumber companies may own:

- timberlands from which they get logs,
- mills at which they cut (and may also plane) lumber, and
- a distribution network or building materials supply company.

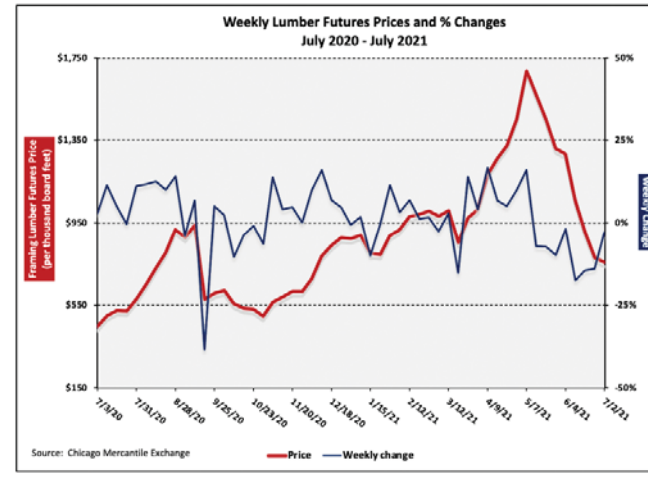
Sources of Price Timing Differences

Coverage of the recent fall in lumber prices — usually proxied by futures in the media — began in May. Indeed, the price of July lumber futures has declined 56% since peaking on May 10 and by 46% since May 14 (the final trading day of May 2021 futures contracts).

As the price declines began grabbing headlines, however, the price of lumber packages quoted to builders held at record highs. In economics jargon, prices paid by builders — or "street" prices — were "sticky." This dynamic is primarily due to dealers' inventory carrying costs and potentially large differences between the price at which inventory is bought and sold.

To maintain margins, retailers and wholesalers do their best to buy low and sell high. At the very least, they try to avoid buying high and selling low, which happens to be the biggest risk in an environment of rapidly falling prices. For example, had a lumberyard quoted a client at prevailing prices two weeks ago, it would be taking a 25% loss relative to current pricing. Thus, a supplier that quotes clients at current market prices will consistently lose money when prices are falling.

Suppliers' inventories will also tend to be tighter during periods of falling prices. Whatever inventory the business has on hand was expensive relative to current prices. This gives wholesalers and retailers incentive to run through that inventory while they can still get close to what they paid for it — and doing so without souring relationships with customers. And for reasons stated above, they will be "trigger shy" to buy more lumber than they are contractually obligated to provide to customers for fear of ending up with a load of inventory on which they will take a loss.



When Do Lower Prices Reach Builders?

Home builders and remodelers begin to get price relief once mill prices have substantially decreased for an extended period and/or stabilized. Note that large price decreases alone may not be sufficient. Prices must fall for long enough to materially lower a supplier's average costs after a run-up. Depending on the rate and consistency of price decreases and whether prices have stabilized at the lower level, it may take a few weeks to a couple of months for builders to see price relief on the order initially reported in the futures or cash markets.

The length of this "waiting period" varies with builder size, supplier size, and the specific builder-supplier relationship. Buy-

ing power is positively correlated with the size of a residential construction firm while the same is true for suppliers' seller power, all else equal. The relative difference in market power between the buyer and seller is crucial in determining how quickly lower prices transmit to a customer.

Personal and business relationships also influence timing. Home building is an industry that is highly dependent upon relationships both with customers as well as vendors (which is why most building materials dealers belong to their local builders association). The length and quality of a builder-vendor relationship can positively affect how soon the builder is quoted lower lumber prices.

Why Do Builders' Lumber Costs Increase with Market Prices?

In contrast to the dynamics of an environment with falling prices, higher prices reach builders with a much smaller lag when market prices are increasing. The same forces that lead to large lags relative to mill prices on the way down can help explain why builders' lumber costs may increase in tandem with mill prices.

Wholesalers tend to be "trigger happy" when prices skyrocket. As the cost of their inventory is low relative to cash prices during these periods, they will quote at or near current market prices. The environment is one in which wholesalers are assured to buy low and sell high.

However, wholesalers cannot predict when a bull market is going to end and buy their lumber according to how likely they believe it will last. As different buyers may have different forecasts, disparities in purchasing behavior can arise. A wholesaler that assumes lumber prices will keep rising for two months will buy more inventory than one assuming the run will last for two weeks.

Retailers generally have less buying power than wholesalers have selling power. In such a scenario, the retailer (e.g., lumberyard) is said to be a "price taker." As a result, their inventory costs tend to increase in step with market prices. These higher costs are passed on to builders in order to maintain positive operating margins. Thus, lumber retailers are less likely than wholesalers to realize outsized profits when prices are rising.

NAHB economist David Logan provides further analysis on the lumber supply chain in this Eye on Housing blog post: https://eyeonhousing.org/2021/07/why-builder-lumber-prices-remain-higher-than-headlines-suggest/. **FBN**

Source: *NAHBNow, the news blog of the National Association of Home Builders. Reprinted with permission. https://bit.ly/21Lumber*

Avoid the Deserted Island

Long-Span Trusses Spaced More Than 2' OC Need Additional Support

By Sean Shields, Structural Building Components Association

The image of being alone on a deserted island is regularly used to convey a sense of vulnerability. That scenario is meant to remind us that without our normal support structure for food, water, and companionship, a bad outcome is likely in our future.

Post-frame construction can often employ a roof truss system where the individual trusses are spaced greater than 2' on center (2' o.c.) and the trusses themselves are greater than 60' in length. During installation, then, each roof truss is on the equivalent of a deserted island. Each truss is incredibly narrow in relation to its depth and span, and as discussed often in the previous articles in this series, an individual long-span truss is susceptible to lateral bending that will cause the truss to twist and buckle.

When spaced more than 2' o.c., an individual long-span truss simply does not have the support structure it needs to perform as designed, and if left on that deserted island the likelihood of a bad outcome increases. This article will briefly look at the industry-developed best practices an installer should consider using to "rescue" each truss from its island during the erection process. This guidance can be found in greater detail in BCSI-B10, "Post Frame truss Installation, Restraint & Bracing."

Check All Your Boxes

Before installing the first roof truss in the system, the most important step is progressing through a checklist to verify the supporting foundation and walls the trusses will be installed upon is correct. Some of the key questions to ask are:

- Are all the load bearing supports (e.g. walls, columns, headers, beams, posts, etc.) plumb and properly braced?
- Are all bearing supports accurately installed at the locations shown on the building's construction documents?
- Are the tops of all bearing supports at the correct elevation;

are they straight along their length and parallel where designed?

• Have the appropriate ground bracing techniques for the first truss been determined?

Close attention to these details on every project eliminates potential contributing factors to many truss collapse outcomes. An uneven or improperly constructed bearing surface leads to uneven truss installations that can cause failure of an individual truss or the roof truss system. Further, attempting to fix any issue with the bearing surface once installation begins leads to significant project delays at best, and at worst, eventual structural failure.

Brace Your Walls

After the bearing surface of the trusses is determined to be correct per the building's construction documents, it is vital to brace the walls prior to roof truss installation to resist the loads being applied by the trusses. The last article in this series focused on ground bracing best practices to consider when installing the first set of trusses, and those techniques can be used for trusses spaced greater than 2' o.c.

BCSI-B10 provides an alternative approach, specifying diagonal wall ground bracing in the plane of the walls, as well as perpendicular to them (Figures 1 & 2).

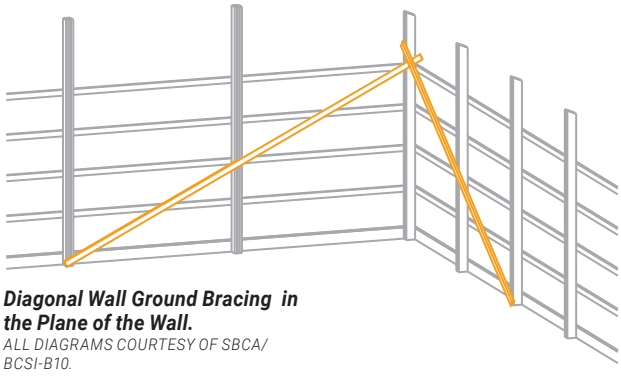
In addition, it is advisable during installation to install column-truss diagonal braces (Figure 3), or affix chains or cables together with turnbuckles or come-alongs, to resist movement of the wall base parallel to the end wall.

BCSI-B10 Summary Sheet – Post-Frame Truss Installation, Restraint & Bracing

The BCSI-B10 provides guidelines for the proper handling, installing, restraining and bracing of flat bottom chord trusses in engineered post-frame building system applications where trusses are spaced more than two feet on center and the trusses are up to 81 feet in length.

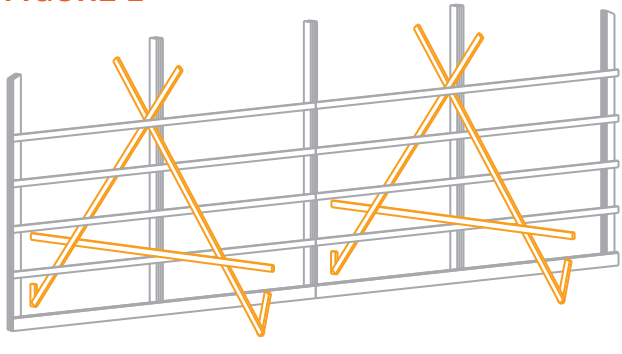
pubs.sbcacomponents.com

FIGURE 1



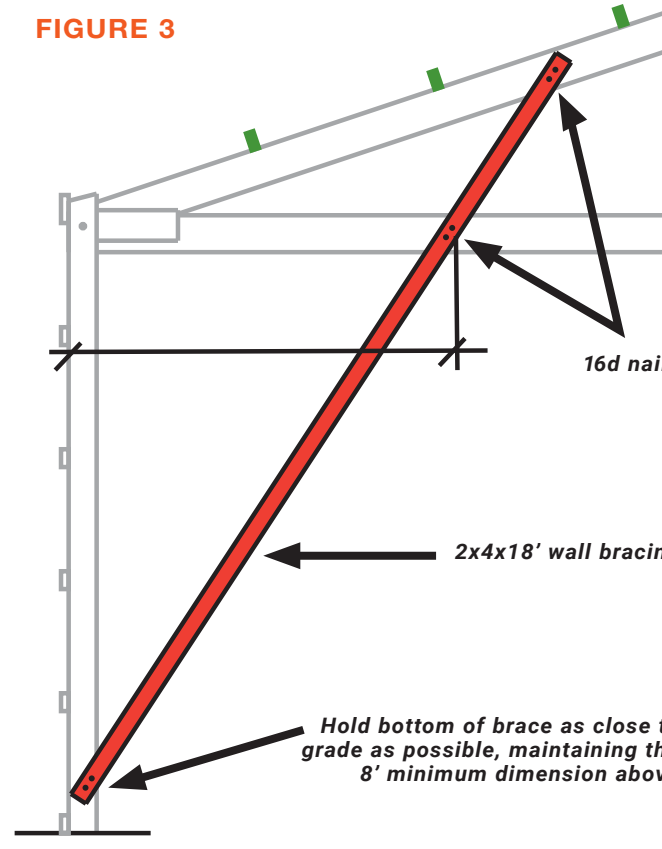
Diagonal Wall Ground Bracing in the Plane of the Wall.
ALL DIAGRAMS COURTESY OF SBCA/ BCSI-B10.

FIGURE 2



A-Frame Ground Bracing Perpendicular to the Wall

FIGURE 3



Column-Truss Bracing

Restrain and Brace Your Truss System

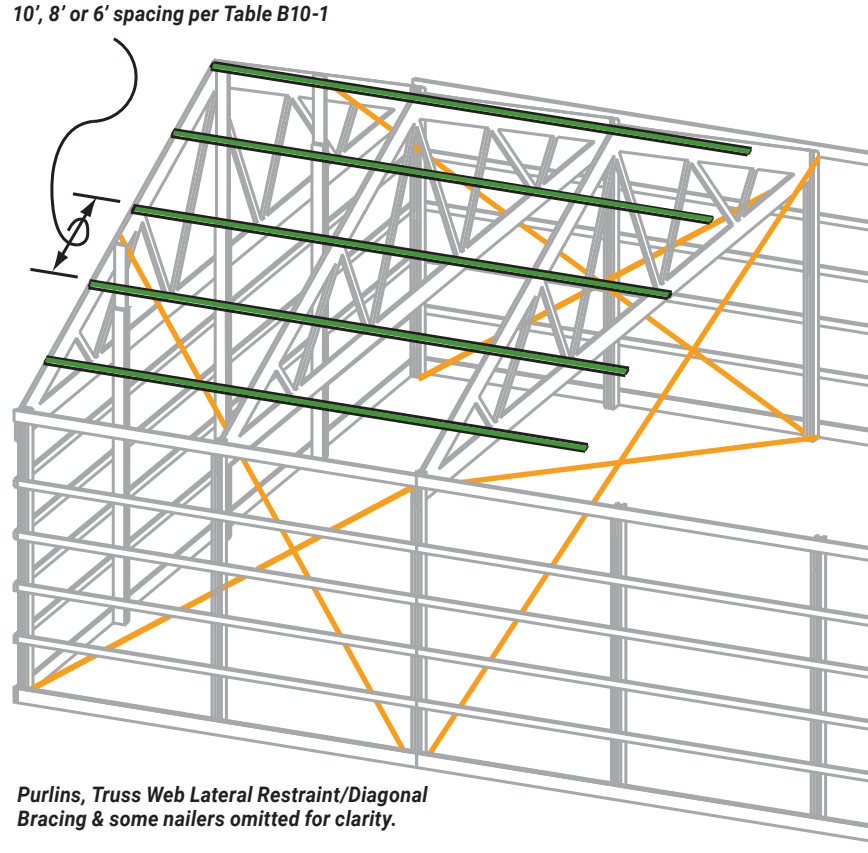
With the wall bearing sufficiently braced, the individual roof trusses will also need to be braced and restrained during installation to avoid out-of-plane buckling.

BCSI-B10 provides guidance on installing top chord temporary lateral restraint (TCTLR), which may be spaced 6', 8', or 10' apart along the length of the truss top chords (Figure 4). It's important to note that TCTLR should be applied using a minimum of 2-16d nails or equivalent, unless otherwise specified by the building designer.

In addition to the TCTLR, diagonal bracing needs to be applied to the top chord plane of the trusses to resist lateral movement of the entire roof truss system during installation. Diagonal braces should be applied to the TCTLR and run the span of at least four trusses on a building over 48' wide. It's important to note the diagonal bracing should also overlap, spanning two TCTLRs (Figure 5).

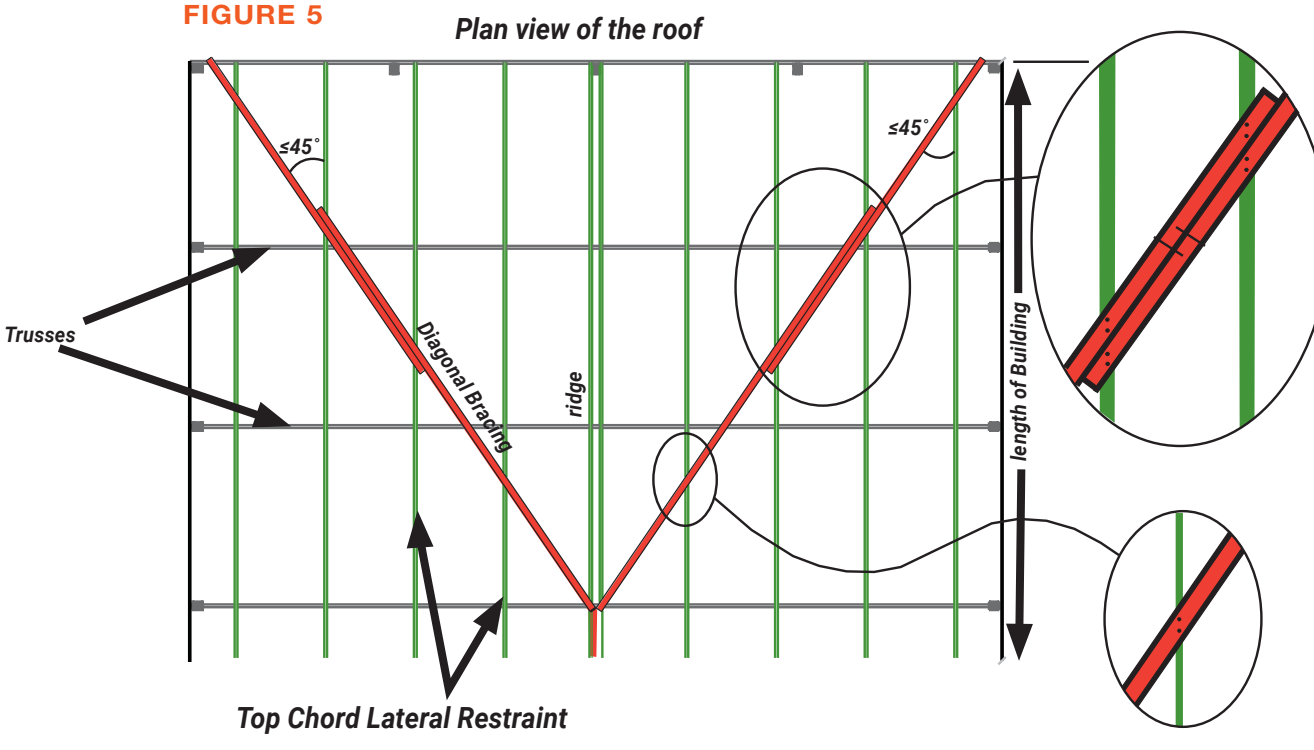
As an alternate to the diagonal bracing, permanent structural sheathing (e.g., plywood, OSB, corrugated aluminum, etc.) can be installed to provide this same resistance to lateral movement.

FIGURE 4



Purlins, Truss Web Lateral Restraint/Diagonal Bracing & some nailers omitted for clarity.

FIGURE 5



Simultaneously, a similar approach to bottom chord temporary lateral restraint and diagonal bracing should be followed.

Finally, consider bracing trusses vertically to prevent rollover, or rotation, during installation. This can be done by installing cross bracing between trusses (see Figure 6).

Use Sufficient Bracing

At first glance, all of this top chord, bottom chord, and web member restraint and bracing guidance may appear to be overly conservative. It's important to note that while BCSI-B10 is a very effective guide on how to approach temporary field bracing, it is not purely prescriptive because it is written to apply to a wide array of building types and construction methods contained within the frame-building industry.

As such, it remains up to the individual installer to determine which restraint and bracing approach is best suited for a particular building. The end goal is to "rescue" each of the long-span roof trusses from the island they are on when being installed more than 2' o.c. The multi-directional forces acting upon each truss as it's being handled during installation (e.g. wind, gravity, etc.) can quickly and easily cause a truss to bend out of plane. Once buckling starts, it can be incredibly difficult to counteract before damage occurs to the truss, the truss system, or the building itself.

Said another way, the basic approach of applying top chord lateral restraint during installation is typically not enough to ensure truss stability. As BCSI-B10 points out, this approach can too often make a bad situation worse in that the buckling of one truss in the system can cause the other trusses in the system to buckle with it (Figure 7). Installing sufficient diagonal restraint is key to avoiding this bad outcome. This is not only true for the top chords, but for the bottoms chords of the trusses as well.

Bottom Line

An individual roof truss is design to perform within a system. During installation, it's just sitting out on a deserted island and needs to be rescued. BCSI-B10 provides experience-based best practices on how to properly support each long-span truss during installation in a post-frame building to avoid unwanted outcomes such as damage to the truss itself, failure, or collapse. While this guidance may appear conservative, it is up to the installer to work with the building designer to determine the appropriate amount of lateral restraint and diagonal bracing to use during the construction of a particular roof system. ***FBN***

FIGURE 6

Cross Bracing Between Trusses

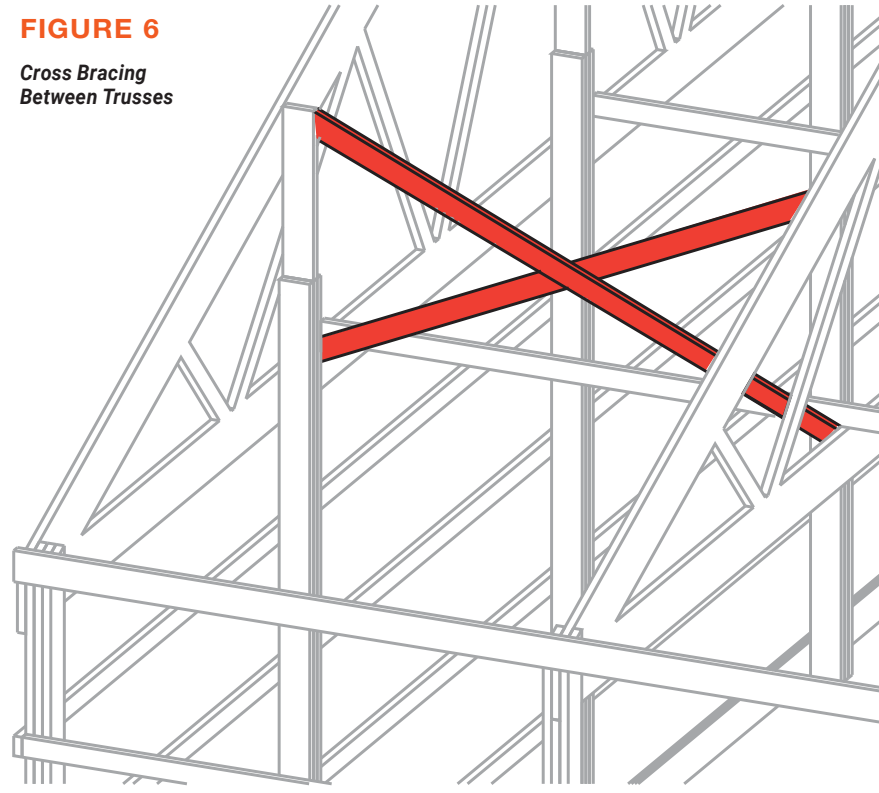
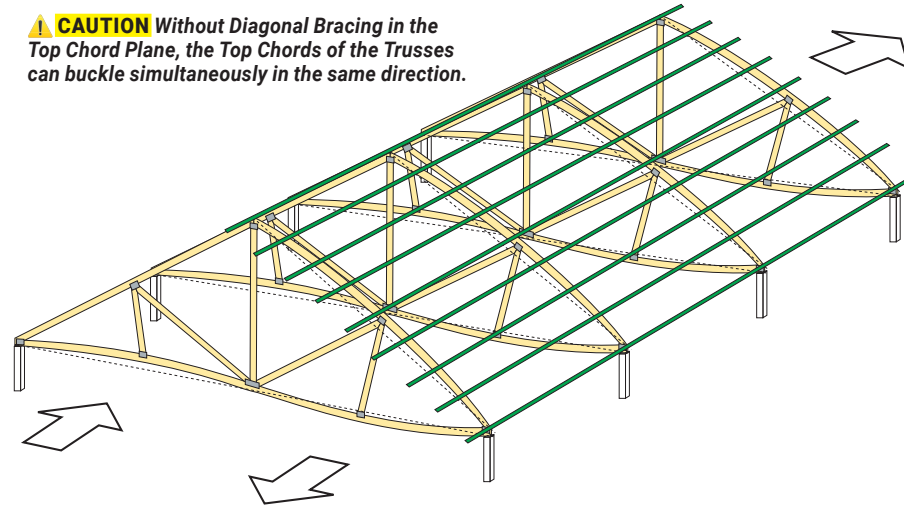


FIGURE 7

⚠ CAUTION Without Diagonal Bracing in the Top Chord Plane, the Top Chords of the Trusses can buckle simultaneously in the same direction.



Sean Shields *is Director of Communications for the Structural Building Components Association (SBCA, https://www.sbcacomponents.com) and has authored over a hundred articles focused on structural framing and off-site construction since 2004.*

Regional Wood Types & Properties

By Karen Knapstein

To get a better understanding of regional wood species and their characteristics, Alex Anderson, Forest Products Specialist with the Wisconsin Department of Natural Resources, explained the different wood types prevalent in each region of the United States. He also made clear the effect that growing conditions have on wood strength.

What Grows Where

"In the Midwest," Anderson explained, "we have mixed resources of hardwoods and softwoods. In Wisconsin, we're predominately hardwood — more hardwood than softwood. It's the same situation in the Northeast, where it's also a mix of hardwood and softwood."

The two regions growing the largest amount of softwood, which is used for dimensional lumber, are the Northwest and the Southeast. "The entire Northwest is almost entirely a softwood resource. The species common in that region are Douglas fir, several pine species, and white fir. The Coastal region has a pretty significant hardwood resource, as well as a few other softwood species that are prevalent in the American Northwest, such as western red cedar and hemlock," said Anderson.

The Southeast is rich in southern yellow pine (SYP), a group of pine species commonly used to produce dimension lumber. "Southern yellow pine has made huge advances in plantation-grown lumber," Anderson continued. "There have been huge advances genetically so they have really short rotation; it can be 20-30 years from planting to harvest. Most softwoods grown in the Midwest and West would have much longer rotation times compared to the South. The short rotation doesn't help the wood's strength properties, but it helps economics."

Strength Properties

Southern yellow pine is frequently cut into dimensional lumber. "Generally speaking," said Anderson, "slower-growing softwoods within same species are stronger than faster growing. (The opposite is true for hardwood species.) Southern yellow pine has really good strength properties so faster-growing SYP has better bending strength properties than a lot of other softwood species."

One of the key factors contributing to lumber strength is the grain. A growth ring is comprised of earlywood and latewood. Early in the tree's annual growth season, when the weather and climate are most favorable for growth, the xylum cells have thinner walls, producing the lighter-colored section of the ring called earlywood. By the end of the growing season, when growing conditions are less favorable, the cell walls become thicker and denser, resulting in a darker stripe (the latewood) that separates one tree ring from the next. The latewood is harder and less porous.

The tighter the matrix of rings, the more structural integrity the lumber has, which is why old-growth pine is much stronger than the southern yellow pine grown on plantations today. "In southern yellow pine, one of the major things to consider about strength is that the late wood is the really dense material and

The lighter area in the growth ring is earlywood; the darker is latewood. The ring density and more latewood make for stronger wood.

earlywood makes up the majority of the material because of the fast growth," explained Anderson. "That's how that loss in strength values came about when compared to old growth. The rings are further apart in contemporary wood. If you look at a weathered piece of wood, it looks wavy because the earlywood fibers deteriorate more easily than latewood does. It becomes more pronounced between parts of each growth ring. In a comparison of old growth southern yellow pine to a new one, there is far more earlywood than late wood in the faster-growing trees," Anderson explained.

Note on Lumber Production

Anderson estimates Wisconsin's biggest softwood lumber mill cuts about 100 million board feet of boards, dimension, and timbers. As a comparison, some Southern mills, which have considerably more softwood resources, produce three to four times that much. He's also confident it's not the loggers and landowners who are reaping the benefits of today's high lumber prices. **FBN**

Wood is a fibrous material. The fiber is a small tubular structure, incorporating nature's engineering to make it an efficient load-carrying member. The microstructure of the walls of a fiber present an interesting arrangement related to biological functions performed in the living tree and a contribution to the properties of wood as a material. Alignment of fibers primarily in longitudinal aspect in the tree is the main source of wood's anisotropic properties.

— Marra, G. 1979. Journal of Educational Modules for Materials Science and Engineering 1(4):699–710.

The First Look into Your Building

Plyco Performance ♦ Plyco Quality

Since 1951 Plyco has created construction opportunities for contractors with a complete line of entry doors that surpass building codes and customer expectations.

Plyco's entry doors are designed for post frame and metal building applications:

Structural Performance

Structural Performance

Plyco doors are tested to ASTM E330 for structural performance of exterior doors. Each Plyco door is engineered to specifications for a durable long lasting product

- Series 92: AAMA LC-PG40 - LW +/- DP 40 PSF (4070)
- Series 20 w/deadbolt: ASTM E330 DP +/- 60 psf (4070)
- Series 95 w/deadbolt: ASTM E330 DP +/- 75 psf (3070)

Wind/Air Infiltration Tested

Water Infiltration Tested

Extensive Product Testing

Third party testing assures our products meet and exceed the IBC Building code standards

- Air Infiltration: ASTM-E283
- Water Penetration: ASTM-E331
- Physical Endurance: AAMA 920

PLYCO

800.558.5895 ♦ www.plyco.com

WINDOWS ♦ WALK DOORS ♦ RIDGE VENTS ♦ FASTENERS ♦ HORSE STALLS
SLIDE DOOR TRACK & RAIL ♦ SPECIALTY PRODUCTS♦ PLY-FOIL ♦ CLOSURES

Hixwood Metal manufactures panels and trim for post-frame builders. PHOTO COURTESY OF HIXWOOD METAL

Top to Bottom

Roof to Foundation: A closer look at ag building components

By Frame Building News Staff

There are a lot of different materials and products that go into building a post-frame agricultural building. Here, we'll take a closer look at some of those products — from top to bottom. In some cases, you'll learn about specific products available from manufacturers, and in others, you'll learn more about what products "do."

IMPORTANT NOTE: Information varies among products – don't read into what's not there. For example, when reading about two similar products, one manufacturer may include warranty information while another does not. If warranty information is not present, it does NOT mean the product does not have a warranty. Contact the manufacturer or your supplier for complete product details.

STARTING AT THE TOP

AG-CO cupolas and weathervanes are made with ease of installation and low maintenance in mind. Cupolas are made of weather-resistant, high-density polyethylene and come in only two pieces. Each cupola base is molded with 3/12, 4/12, and 5/12 roof pitch lines to ensure the cupola fits at the proper angle. The base may be cut to any pitch up to 8/12. The company's weathervanes are handcrafted from 14-ga. steel. They are finished with a durable and scratch-resistant powder coat, then a clear coat that is baked on for additional protection. *[www.ag-co.com]*

Snap-Z manufactures standing seam metal ridge roof vents. The Snap-Z 1000 is made to fit 1" standing seam ribs; the Snap-Z 1500 is made to fit 1½" standing seam ribs; the Snap-Z 1750 is made to fit 1¾" standing seam ribs; and the Snap-Z 2000 is made to fit 2" standing seam ribs. The ridge vents are pre-cut and pre-drilled. They also offer ridge vents with

AG-CO manufactures solid polyethylene cupolas for installation on all types of buildings. PHOTO COURTESY OF AG-CO

pre-applied butyl tape to further speed installation time.

Standard Snap-Z ridge vents are made of 26-ga. steel in black. However, they are also available in colors in 24-ga. steel or .032" aluminum in black or colored. ***[standingseamroofvent.com]***

The **EZ Vent-N-Closure** is a water tight metal roof ridge vent with a built-in foam closure for use in metal roofs with standing seam, R-panels, ag panels, and corrugated panels. Standard vent closure sizes range from ¾"-2", with custom sizes available. ***[ezventnclosure.com]***

MWI Components offers specialized products for customers in the post-frame building industry. The company manufactures a full line of low- and high-profile ridge vents for post-frame buildings. The RV35 and RV35F Ridg-Vent® models, which are both low profile and rise only 4 ½" above the ridge, are designed to provide the ventilation required for horse, cattle, and poultry buildings (among others) when used in conjunction with an equal area of vented soffit or louvers. Additionally, the RV35F includes a clear fiberglass rain diverter, which acts as a skylight along the ridge for extra natural lighting. The company utilizes patented "klix-on" flashing that snaps on without the need for tools and fasteners. MWI Components also hems all metal edges for added strength and easier handling. ***[www.mwicomponents.com]***

ProfileVent®, manufactured by **Ventco,** is a strong, long-lasting single-layer ridge vent on a roll with a modified polyester fiber-based matting that is non-woven and non-wicking. The material is Class-A fire rated and is designed specifically for metal roofs. The ridge vent comes in rolls of 20', 50, and 100' lengths, and is profiled to fit more than 50 standing seam and through-fastened metal roofing panels. It fits under any ridge cap and any pitch of roof from 2/12 to 20/12. ProfileVent features glue spots to prevent slipping during installation and it carries a limited lifetime warranty. ***[profilevent.com]***

Dynamic Fastener's DYNA-FLASH® pipe flashings for metal roofs are designed for maximum resistance to all weather conditions. The pipe diameters can be seen clearly for proper fitting. The base is designed to mold to most panel configurations and roof pitches regardless of pipe location. EPDM flashings are available in 12 colors: Brown, Black, Dark Grey, Light Grey, White, Dark Green, Light Green, Dark Blue, Light Blue, Bright Red, Terra Cotta and Copper. High-temperature silicone flashings are available in Red and Grey. ***[www.dynamicfastener.com]***

Snow Stoppers LLC manufactures components for both standing seam and exposed fastener metal roofs. SSG Classic snow stoppers are designed for standing seam roofs. The components are made from 11-ga. 304 stainless steel and are at-

tached to the roof seam with two stainless set screws with hex heads.

The company's RMG Premium snow stoppers for exposed fastener roofs are made from 14-ga. stainless steel. They are fastened through the roof panel with three of the same screws that are used for fastening the panels themselves (1 ½" washered screws recommended). The RMG Premium snow stoppers are equipped with a rubber sticker on the bottom to cover the screw holes so everything is sealed off (no caulking or additional sealant is needed).

Both SSG and RMG stoppers have a 3½" tall profile and are powder coated; there are 25 standard colors with custom colors available. ***[717-598-0312]***

Dynamic Fastener's Dyna-Guard® snow retention system is designed to be used on virtually any style metal roof. It is an 8' long extruded aluminum rail with a T-shape profile and is installed by attaching non-ferrous clamps or mounts to a metal roof and bolting or screwing the system to clamps or mounts. Thirteen Dyna-Clamps® with round-point stainless steel set screws and Sno-Dams® are also offered. Sno-Dams attach to the back of Dyna-Guard and inhibit snow and ice from sliding underneath. Dyna-Clips® are available as a Dyna-Guard to Dyna-Clamp connection device when using unpunched Dyna-Guard. A 2" wide painted strip of metal from the same material as the roof is inserted in the Dyna-Guard for aesthetics. ***[www.dynamicfastener.com]***

Dyna-Guard from Dynamic Fastener prevents dangerous snow slides off metal roofs. PHOTO COURTESY OF DYNAMIC FASTENER

MWI Components manufactures solid soffit, center-vent, and full-vent soffit panels, as well as the steel trims needed to finish the soffit system. The 12" center vent panel provides 7.5 sq. in. of free area per foot, while the 12" full vent panel provides 15 sq. in. of free area per foot. Panels are also available in 24", providing twice the amount of free area per ft. (15 and 30 sq. in., respectively). Soffit panels are available in prepainted steel or aluminum. Precut lengths of 12", 24", and 144" are standard; however, special cut lengths are also available in sizes ranging from 7" to 144". ***[www.mwicomponents.com]***

The Lam-Ply Truss, manufactured by **Starwood Rafters** combines plywood, glu-lams, and dimensional lumber. The Lam-Ply Truss, which is stronger than a conventional web truss, can span up to 72'. The added strength allows the builder to space the trusses further apart, and the solid design also limits bird nesting. Agricultural applications include, but are not limited to, machinery storage, livestock facilities, and horse arenas. ***[starwoodrafters.com]***

MB-10A from **GSSI Sealant**s is an elastomeric butyl rubber sealant designed to seal the lapped seams of exposed metal panels and the end seams of standing seam metal roofs. It also meets or exceeds all sealing requirements for window glazing. The sealant is extruded onto silicone coated paper for ease of use. GSSI produces it in many different sizes and lengths to fit all application requirements. When applying butyl rubber sealant, all surfaces to be sealed should be clean and free of dust, dirt, oil, moisture, grease, etc. before applying tape. ***[www.gssisealants.com]***

PANELS

Applied during the metal forming process, **DripStop** is an anti-condensation membrane that also protects the steel panel by adding a layer of protection from the corrosive elements found in livestock confinement. Specially designed air pockets trap and store condensation and release it back into the air as humidity, thus preventing "rain" inside the building.

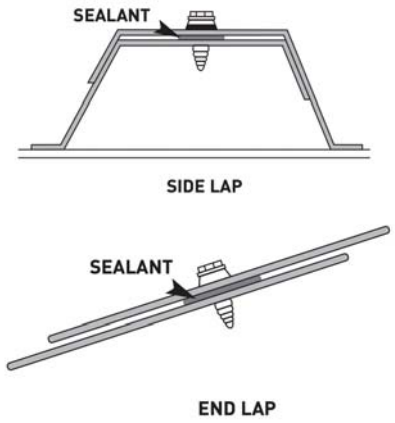
DripStop's Tony DelGhingaro pointed out the benefits for builders: "For builders, it saves time and money by eliminating one step of the construction process. As a bonus, it is also safer. Plus, owners have a maintenance free product that is both mold and tear resistant, while reducing sound effects." ***[www.dripstop.com]***

Raise them right in a stable home.

800-360-6467

MWI COMPONENTS

mwicomponents.com



Recommended butyl rubber sealant placement.
COURTESY OF GSSI SEALANTS.

Graber Post Buildings, Inc. manufactures a Board & Batten panel that requires no painting, sealing, or maintenance. The panel is rolled from 29- or 26-ga. steel and is available in 28 color options (22 flat colors and six textured colors). The panels are coated with the AkzoNobel CERAM-A-STAR 1050 paint system, which carries a 40-year paint warranty. Each panel, which is available in either a flat or embossed wood texture, provides 10" of coverage with 8" rib spacing. ***[www.graberpost.com]***

Hixwood Metal offers three distinct profiles: Super-Rib 100 with the 9" OC rib profile, Residential 100 with the 6" OC profile, and Snap-Loc 16" profile.

The company offers the 36" wide exposed fastener panels in three gauges: 29 ga., 28 ga., and 26 ga., as well as the Snap-Loc (non-exposed fasteners) in 24 ga. and 26 ga.

All the panels are available in the BeckryTech and the BeckryTex paint systems with a total of 35 colors available (20 smooth) and (15 textured).

Custom trim is made to spec on their two state-of-the-art Thalmann 21' twin-bend long folders. The company carries a huge inventory of stock trims which are available for immediate customer pickup. Materials come with a 40-year warranty with the best color retention available in a Highly Durable Polyester. ***[www.hixwoodmetal.com]***

> Know which side or what panels are UV protected so that you are not using a panel in a lighted situation that may lead to eventual deterioration.
>
> — MWI Components

Union Corrugating offers many exposed fastener roof and wall panels for post-frame (and other) buildings. The company's MasterRib® panel is available in either 26 ga. or 29 ga.; the profile features extra-wide stiffener ribs to increase strength. The panel also features an extra-large siphoning channel on the under-lap rib to provide extra leak resistance in the presence of extreme wind and rain loads. MasterRib is available in 20 paint colors, meets all IBC, Miami Dade and FL Building codes in addition to unpainted AZ55 Galvalume and unpainted G90 galvanized. All 29 ga. and 26 ga. painted panels carry a 45-year pass through warranty with no set back requirements at the sea coast. ***[unioncorrugating.com]***

Union Corrugating offers MasterRib exposed fastener panels in 26 ga. and 29 ga. steel. COURTESY OF UNION CORRUGATING.

McElroy Metal offers 30 different metal roof and wall panels in 20, 22, 24, 26 and 29 gauge. The company offers its own standard trims; additionally, many customers have their own trim designs that are programmed into and fabricated with the McElroy equipment.

McElroy uses Sherwin-Williams coatings and offers more than 60 standard colors. Coatings include Polyester, Silicone Modified Polyester and PVDF. Warranties, which cover fade, chalk, and film integrity, follow the performance of the coatings. PVDF has the best warranty. ***[www.mcelroymetal.com]***

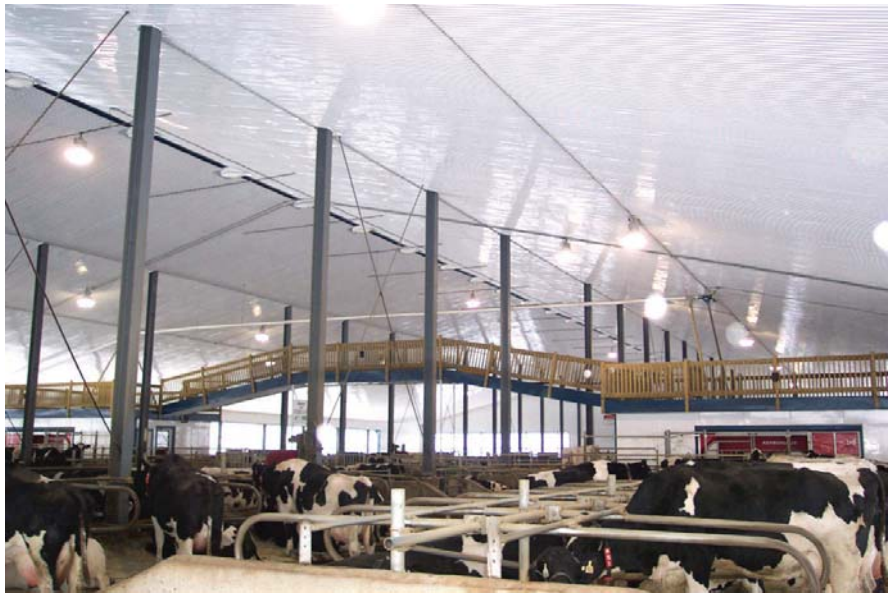
Direct Metals Inc. offers many polycarbonate and PVC panel options, including profiled and flat monolithic translucent panels. Profiled panels are available in 1.0mm, 1.5mm, and 2.0mm thicknesses. Custom panel profile-matching technology is available, where DMI can create a custom translucent panel using your CAD drawing (minimum orders apply). All panels are co-extruded with UV protection. ***[www.directmetalsinc.com]***

Graber Post Buildings has been supplying products and materials for horse barn construction since 1973. It also offers all sizes of tongue and groove lumber for stall construction. COURTESY OF GRABER POST BUILDINGS

McElroy Metal panels top off this upscale board and batten barn. PHOTO COURTESY OF MCELROY METAL

Onduline North America manufactures TUFTEX Master Series brand polycarbonate and PVC panels, which are available as daylighting and wall/ceiling liner solutions in agricultural and other post-frame buildings. Panels are available in 9" OC ag panel and 12" OC R panel profiles (38" wide, 36" coverage, lengths from 2½'-24'). ***[www.us.onduline.com/pro]***

Palram's SUNSKY® corrugated polycarbonate sheets are impact-resistant and high light transmitting panels for skylight, sidelight and roofing applications. Standard thicknesses available include .8mm (.032"),



Palram's AG-TUF corrugated PVC liner panels are chemical-resistant, maintenance-free panels for interior cladding of agricultural structures. PHOTO COURTESY OF PALRAM

Palram's SUNSKY panels are available in standard thicknesses of .8mm, 1mm, and 1.5mm. PHOTO COURTESY OF PALRAM

1mm (.039"), and 1.5mm (.059"). Other thicknesses are available with minimum order quantities. The SUNSKY panels are available in hundreds of profiles and match most existing metal profiles. If a custom profile is needed, the manufacturer can match nearly any metal profile using its MetalMatch technology. ***[www.palram.com/us]***

WINDOWS & DOORS

Plyco recommends its Commercial Thermal Break (CTB) sliding window for agricultural and light commercial use. The windows are constructed of a fully thermalized aluminum frame with standard insulated glass (CTB series) or LowE glass (CTBE series). Plyco windows are specifically designed for the metal-clad building industry and tested to rigorous third party testing requirements. For example, CTB500 horizontal slider meets the LC-PG30 performance standards (as tested to AAMA/WDMA/CSA101/I.S.2/A440-17). The CTB/CTBE windows are available with a Polar White, Hickory Moss, Bronze, or Brown polyester paint finish in horizontal slider fixed, vertical single hung, and fixed lite functions. ***[www.plyco.com]***

A.J. Manufacturing builds Main Street Vinyl™ (MSV) windows in white. Trim options include a nailing fin, 1" J-channel, or patented EZ-v™ trim and flashing. The windows can be made with clear insulated, low E insulated, or single glazed glass. Single-hung MSV windows are available in sizes 24x36 – 36x60; single slider MSV windows are offered in sizes 36x24 – 60x48; and fixed lite/picture windows come in sizes 24x24 – 48x48. ***[www.ajdoor.com]***

Plyco offers the most comprehensive door program for the post frame industry. The 95 and 20 Series are industry proven multi-purpose doors. The 95 features a kerf frame, while the 24 has a heavy duty panel. The 85 series combines those benefits into a unique door. For customers needing a high R value, the 92 series features a thermal break frame and door. Although many Plyco doors are third party tested for structural strength and air and water infiltration, the 92 is also tested for thermal properties and achieves an industry leading "total assembly" R value of 3.17 (NFRC 102-10). Other types of doors have aluminum or steel frames, and then steel, aluminum or fiberglass doors skins based on end use requirements. Most doors are available

in four colors (Polar White, Hickory Moss, Chocolate Brown, and Bronze). Stainless steel hinges are typically standard and an alcryn high performance three-fin top and bottom weather seal stays flexible in extreme temperatures. Plyco's supplemental hardware options make the door offering almost limitless. ***[www.plyco.com]***

Pre-hung interior PVC doors are among the products **Extrutech Plastics, Inc.** manufactures. The doors are made with a smooth, flat 1 ¾"-thick PVC door panel and solid PVC frame with a weather strip sealed edge in standard or custom sizes. They are made for use in high moisture or corrosion-prone areas where other types of doors just don't last. The doors resist mold, mildew, fungus, chemicals, pollutants, and other hazards. ***[https://epiplastics.com]***

I-Beam Sliding Doors manufactures sliding doors from 8' x 8' up to 60' x 24'. (Custom sizes are also available.) I Beam uses a 6,000-lb. capacity trolley and track system. Door kits are delivered to the desired location with all the necessary hardware. Frames are all delivered precut and pre-punched. The door and frames are constructed of lightweight aluminum I-beams that are designed to fit openings up to 48' wide by 20' high. Components are all ASTM E330 wind test certified (rated to withstand wind speeds of up to 115mph). ***[http://ibeamdoor.com/]***

Plyco Corporation specializes in doors made for post-frame and steel buildings. *PHOTO COURTESY OF PLYCO CORPORATION*

Polycarbonate and PVC expand/contract at a different rate than the substrates that they will be fastened to. The fastening holes must be oversized to allow for this or the panels will get wavy and it will lead to cracking and crazing over time.

— MWI Components

Schweiss Doors custom builds all its doors to any size. Bifold and hydraulic doors 100 ft. wide and even up to 60 ft. tall are not uncommon. The company custom designs and builds every door. Doors are built with all-steel 2x3, 14-ga. members with shop-welded connections. Hydraulic door frames are pre-hung inside their own sub-frame on all Schweiss doors.

There are two mounting choices: "flush mount," which mounts below or under the building header (you sacrifice some headroom with this method), or "exterior mount," where no headroom is lost. Gray primer paint is standard on Schweiss doors. However, they can be custom painted or powder coated. ***[www.bifold.com]***

No headroom is lost with the Incredible Swing Door from I Beam Sliding Doors. COURTESY OF I BEAM SLIDING DOORS

LINER PANELS

Palram's AG-TUF® corrugated PVC liner panels are chemical-resistant, maintenance-free panels for interior cladding of agricultural structures. AG-TUF UV is designed for corrosive environments and outdoor applications. Both are available in standard thicknesses, including .8mm (.032") and 1mm (.039"). They are available in standard Greca and 9" profiles. Other profiles are available with minimum order quantities. ***[www.palram.com/us]***

Extrutech Plastics (EPI) manufactures PVC wall and ceiling liner panels for agricultural applications. EPI's P2400 wall panel is 24" wide for walls; the P1600 panel is 16" wide for walls and ceilings; and the P1300 panel is 12" wide, also for use on walls and ceilings. All have a tongue and groove design with a nailing fin along one side for quick installation with no exposed fasteners. The panels have a bright white finish and do not support mold or mildew. ***[https://epiplastics.com]***

INSULATION

Covertech's rFoil 2500 Series and 2600 Series of metal and post-frame building insulation consist of a layer of polyethylene bubble boned to and sandwiched between a radiant barrier metalized foil and a white polyethylene sheet with washable UV-resistant facing. The 2200 Series is a layer of polyethylene bubbles bonded to and sandwiched between two radiant barrier metalized foil sheets. Both series block 97 percent of radiant heat transfer and prevent interior condensation. ***[https://rfoil.com]***

MWI Components' Infinity Shield™ foil insulation is offered in standard rolls of 4' x 125' Single Bubble Foil/Foil, Double Bubble Foil/Foil, Single Bubble White/Foil and Double Bubble White/Foil. They manufacture a no seam 6' x 125' roll of all the available SKUs. Their foil insulation features a standard crushed edge tab (2") that results in simplified overlapping. Infinity Shield won't compress, collapse, or disintegrate, and the ultra-white bubble — a result of additives throughout all layers of the bubble — provides an opaque finish. ***[www.mwicomponents.com]***

Hershey's the Metal Meister Hitz Halter insulation is manufactured from virgin materials, is coated with 3MIL poly film on both sides, and is treated with termiticide to deter termites and ants. It doesn't waterlog, and it doesn't compress under concrete, so it maintains its R-value.

It's mold resistant and suitable for all below-grade insulation installations, including basement and wall insulation and radiant heating applications (PEX tubing is fastened directly to the insulation panel with plastic staples). The insulation comes fan folded in 4' x 24' sections and quantities are shipped shrink-wrapped on 4' x 4' x 8' skids with runners, which are forklift- and storage-friendly. ***[HitzHalter@HersheysMM.com]***

FRAME & FOUNDATION ... AND MORE TRUSSES

Rigidply Rafters manufactures structural components for post and timber-frame construction. The company produces glulam treated posts, metalplated roof and floor trusses, glulam arches and beams, tongue and groove and V-groove decking, and offers a complete line of post-frame building materials. Among its services, Rigidply specializes in wide-span trusses, complicated roof systems, and over-sized width and/or length configurations.

Rigidply manufactures structural glue-laminated, finger-jointed posts with CCA-treated bases and untreated tops (standard). Standard stock sizes include 3-ply 2x6 (5 ¼" x 4 1/16") in standard lengths of 8'-36'; 3-ply 2x8 (7" x 4 1/16"), standard lengths of 10'-36'; 4-ply 2x6 (5¼" x 5 3/8"), standard lengths of 10'-36'; and 4-ply 2x8 (7" x 5 3/8"), standard lengths of 12'-36'. Other post sizes are available upon request; posts can be manufactured in lengths up to 60'. ***[www.rigidply.com]***

Richland Laminated Columns manufactures glu-laminated columns that are stronger, lighter, and straighter than solid sawn posts. They also manufacture nail-laminated columns. Ground contact ends are treated with CCA before lamination; Richland glulam posts are also available fully treated, as well as fully untreated. Using untreated wood above ground decreases the need for galvanized fasteners. Stock sizes are 3-ply 2x6, 4-ply 2x6, 3-ply 2x8, 4-ply 2x8, 5-ply 2x8 and 2x10 columns by request. Stock lengths up to 36 feet; up to 50 feet by request. ***[812-798-1178]***

The #1 pushback against pole barns is the wood post foundation in direct ground-contact. **Post Protector** eliminates the ground-contact and keeps the benefits that make post-frame great — simplicity, affordability, in-ground strength, DIY friendliness, and value. It's a simple "belt & suspenders" approach: Chemical protection envenoms wood fiber, so decay-fungi don't feed (rot); Post Protector is a simple slide-on physical barrier so decay-fungi never have access to the wood. [***www.postprotector.com]***

Post Protector is a slide-on barrier that separates the wood from decay-causing organisms. COURTESY OF POST PROTECTOR

Plasti-Sleeve is a clean-fitting, slide-on plastic sleeve that provides economical protection for in-ground posts. Made of polyethylene plastic, Plasti-Sleeve protects posts against decay-causing organisms and moisture. They come in more than 20 specialized sizes.

The same company offers Plasti-Skirt, which is a heavy-duty U-shaped plastic cover for skirt boards in post-frame construction. It acts as a barrier between corrosive treated woods and metal trims and siding. It also protects the skirt board from decay, concrete, moisture, animal waste, and other corrosive elements. ***[www.plastisleeve.com]***

PlanetSaver Industries developed GreenPost process to create an impermeable double barrier that keeps the wood treatment chemicals inside the wood post and moisture and pests away from the wood. The double barrier consists of a water-based asphalt emulsion plus a layer of polyethylene, which is heat cured.

PlanetSaver also offers a polyethylene sleeve that can be applied by builders to posts sourced elsewhere. It's as stable as the wrap that's applied to the GreenPost. The wrap is only applied to the area of the post that will be in the decay zone. "Once you put the post sleeve on, you don't have to worry about the post destabilizing because of rot. The only thing you have to worry about is what happens to your post above the ground," said PlanetSaver's Barry Hoffman. ***[www.planetsaverind.com]***

By getting the wood out of the ground, **Perma-Column** precast concrete columns, Sturdi-Wall anchor brackets, and Sturdi-Wall Plus anchor brackets eliminate the need for treated lumber columns. All Perma-Column products are ICC-ES certified to meet the International Building Code and the International Residential Code.

"One way to grow [the post-frame] industry is to provide ICC certification for our products so builders can work with the assurance that Perma-Column products meet national and international code requirements while consumers can feel more confident in their post-frame investment," said Perma-Column president Mark Stover. ***[www.permacolumn.com]***

FootingPad is a composite isolated footing system that has been designed to replace concrete footings beneath load-bearing posts. Made from a proprietary composition of engineered polypropylene (100% recycled) and fiberglass, the footing pads are molded with a rib pattern that effectively transfers the weight carried by the post to the supporting soil beneath the pad.

Paul Kluempers, General Manager at AG-CO, the company that manufactures FootingPad footers, explained, "By expanding the surface area the pad carries more load. The pad works because it's stronger than the soil."

FootingPad footers are lightweight, strong, and won't rot or degrade. "Our footers are made from an inert material. There's very

Schweiss manufactures hydraulic doors large enough to accommodate even the biggest ag equipment. *COURTESY OF SCHWEISS DOORS*

Richland Laminated Columns manufactures glulams, nail-lams, Perma-Column concrete piers, and offers a host of other supplies for post-frame builders. *Photo courtesy of Richland Laminated Columns.*

little change over time with the product. In general, it's resistant to any kind of environmental impact. Microbes and moisture in the soil are not going to break it down. It will last for a very long time."

They are made in five different sizes: 10", 12", 16", 20", and 24", with the three larger sizes most frequently used for post-frame buildings. ***[https://footingpad.com]***

FASTENERS: PUTTING IT ALL TOGETHER

Maze Nails offers a large assortment of post-frame nails, all of which are made of high-quality materials, leading to fewer bent nails, and fewer popped heads. Maze Brite Ring Shank Post-Frame Nails, which provide excellent holding power in treated posts and timbers, are available in lengths ranging from 2 " to 8". ***[www.mazenails.com]***

Direct Metals Inc. manufactures the DMI #12 diameter SCAMP 304 SS cap for attaching exposed-fastener metal panels. The #12 diameter provides increased holding strength versus traditional #10 diameter fasteners. The 304 SS cap and 304 SS bonded washer provide lifetime protection against red rust. The shank is coated with DMG85 corrosion resistant coating and it has been listed by Dade County as an acceptable solution for use in coastal applications. The Type 17 point is effective in OSB and other low density wood substrates. Powder coat paint is available in standard industry colors. A metal building self-drilling version is available for metal to metal applications. ***[www.directmetalsinc.com]***

The ZXL™ MB™ WoodBinder® metal to wood fastener from **ST Fastening Systems** will drill multiple thicknesses of steel commonly found in metal roof ridge cap applications. The drill point design consistently penetrates metal panels, which eliminates the need to punch the panel with a sharp point to start the drilling process. Zinc plating and clear chromate are standard on all of ST Fastening Systems' metal building and post frame building screws. The EPDM washer fits into the ZAMAC zinc aluminum alloy molded head. Available in 35 standard colors that match high volume metal panel paint colors. ***[www.stfasteningsystems.com]***

What Do You Recommend?

These are just a "few" of the products frequently used in agricultural post-frame structures. If you have a favorite product, we'd love to hear about what the product is and why you recommend it. Mail comments to Karen Knapstein, C/O Frame Building News, PO Box 255, Iola, WI 54945 or email karen@shieldwallmedia.com. ***FBN***

BUSINESS CONNECTIONS //

SPRING ACRES FARM

Colorado facility built for equine — and human — comfort

By Karen Knapstein

Spring Acres Farm is a 24,000+ sq. ft. equestrian center located in Parker, Colorado. The post-frame facility includes a riding arena, horse stables, office space, and much more.

Owner Stacey Kipper-Perrelli hired John Castanien and his crew at All Specialty Buildings (Calhan, Colorado) to build the facility. Posts, which were placed on 4' poured concrete footings, were installed 6' OC instead of the usual 8'. "We really wanted 6' on center for the added stability," said Kipper-Perrelli.

In all, there are three distinct sections to the facility: the arena section, the stall section, and a connecting passage between the two. The arena section measures 200' x 60', with 16' sidewalls. The stall section measures 196' x 42' with 14' sidewalls. The area connecting the two, which also houses large foaling stalls, measures 40' x 42' with 14' sidewalls.

American Building Components' (ABC) Imperial Rib® panel in Burnished Slate was used for the roof. The same panel, only in Clay, was used in the wall applications. ABC's interior wall liner panels in Polar White were used throughout for the ceilings, walls, and stalls.

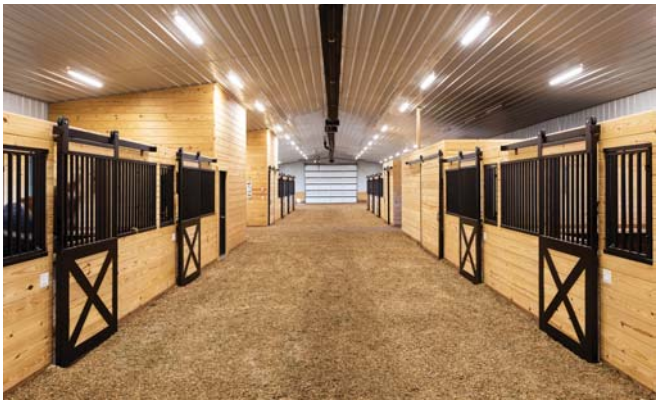
Equipped with condensation control and DripStop solutions that prevent water damage, the exposed-fastened metal panels are finished with a siliconized polyester coating that makes it suitable for all animal confinement uses.

Each stall is a stand-alone unit, with a post at each corner. Castanien built the stall system using posts, tongue and groove boards, and metal. The metal door frames and barred windows

were all custom-made by Bob McClure of Peak Manufacturing out of Elbert, Colorado. There are twelve 12' x 12' stalls in the stall section, plus two 12' x 16' stalls for foaling in the connecting section.

Each stall is equipped with an automatic waterer, electricity, and its own LED light on a dedicated switch. Additionally, two rows of bright LED lights line the aisle of the stall section to create a well-lit interior.

To supply the arena with natural light, 2' of clear polycarbonate was installed across the length of the section. The polycarbonate profile matches the metal panel profile. Two layers were installed: one on the inside and one on the outside, creating dead air space that is the depth of the wall. To assure adequate lighting at all times, three rows of LED lights were installed the length of the



building. A 4' tall tongue and groove railing finishes off the arena.

Since it's located in Colorado, keeping the facility warm enough to work comfortably with the prized horses year-round was a concern. That being the case, R-30 fiberglass batt insulation fills the wall cavities, and fiberglass insulation was blown in above the ceiling. Radiant heaters are tucked up in the raised cord trusses. Ventilation is achieved with awning-style windows, ridge vents, and fully vented soffits.

The roll-up doors on either end of the stall section, manufactured by Martin Garage Doors, measure 16' x 12', while the doors on either end of the arena section measure 16' x 14'. "We wanted the doors big enough for a semi to drive through," said Kipper-Perrelli. "It makes it easier for delivering hay and loading horses in a semi trailer."

Decorative cupolas supplied by Valley Forge Cupolas, Pennsylvania, dress up the ridge lines of the arena and stall sections. The arena section features a hexagonal lighted vinyl cupola that measures 60" wide by 92" high. Two 48" wide by 85" high cupolas flank the octagonal cupola over the arena section, and two more break up the ridge line of the stall section. All of the cupolas feature divided-lite windows and copper roofs.

Amenities for humans were also included in the design and construction. The 16' x 100' lounge area is used for entertaining. "It's finished off like a house," said Kipper-Perrelli. "It has a big great room with double-sided fireplace, a large kitchen, bathroom and office, with stamped concrete flooring throughout." There are large windows between the lounge and arena, so people can sit at the bar and eat or drink while watching the action in the arena. The facility was built with the comfort of everyone in mind. ***FBN***

Below-Grade Insulation, Part 2

Preventing Heat Transfer

By Dave Bohnhoff, PhD PE
Professor Emeritus, University of Wisconsin–Madison

EDITOR'S NOTE: This is part two of a two-part series that was originally published in Frame Building News in 2010. It addresses below-grade insulation inquiries we've received since the article was first published.

Below-grade insulation for post-frame buildings is installed to prevent structural damage from frost heave and to minimize building operating costs associated with excessive heat transfer. Causes of frost heave and options for controlling it were presented in Part I of this article, which was reprinted in the June 2021 issue of Frame Building News. Presented in this final portion of the article are requirements for heat transfer control, as well as design details and associated constructability issues for below-grade insulation of buildings with embedded posts.

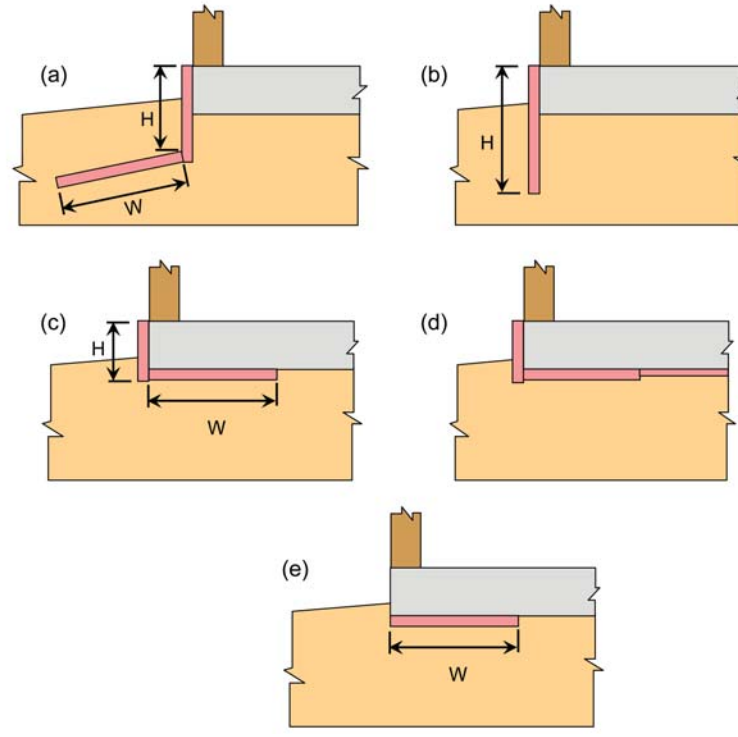


Figure 1. Below-grade insulation options for a concrete slab-on-grade: (a) vertical and horizontal wing insulation, (b) vertical insulation only, (c) insulation on outside and underside of perimeter edge, (d) insulation on the outside edge and entire underside of slab, (e) horizontal insulation only.

Introduction

Heat is technically defined as flow of energy due to a temperature variance. In buildings that are warmed or cooled (known as *conditioned buildings*), control of this energy transfer is a major design element. Although we have a long history of using thermal insulation to control heat transfer through above-grade building assemblies, use of thermal insulation to control below-grade heat transfer is a more recent development.

As was noted in the first article, virtually all conditioned post-frame buildings feature a concrete slab. For this reason, the location of below-grade thermal insulation in post-frame buildings is generally described relative to the concrete slab.

Five common insulation placement options are shown in **Figure 1**. This includes systems that utilize exterior horizontal wing insulation (**Figure 1a**), systems that feature only vertical exterior insulation (**Figure 1b**), systems in which insulation is placed under the concrete slab (**Figure 1c** and **Figure 1d**), and systems with horizontal insulation only (**Figure 1e**).

Quantifying heat loss

In order to efficiently insulate a building, an accurate estimate of heat transmitted through various elements of the building's thermal envelope (above-grade walls, windows, roofs, opaque doors, etc.) is required. The heat transmittance per unit time through such an element (including the transmission of heat through the boundary air films on both sides of the element) that is induced by a unit temperature difference between the environments

on both sides of the element, is defined as the U-factor or thermal transmittance of the element.

Common units on the U-factor are Btu/(h•ft²•°F). It follows that heat being transmitted through an element is obtained by multiplying the element's U-factor by the element's surface area and by the difference between inside and outside building air temperatures.

When air infiltration is blocked, heat transmission through an above-grade building element is fairly constant across the surface of the element; hence the U-factor does not vary appreciably with location. This is not the case for below-grade building elements. The amount of heat transmitted through a below-grade element depends on surrounding soil temperatures, which in turn depends on distances between the point in question and (1) the soil surface, (2) the ground water table, (3) surrounding buildings, and (4) other elements of the same building.

F-factors

Accurate determination of variations in heat transmission from location-to-location on a below-grade building element requires a three-dimensional thermal analysis with a fairly sophisticated piece of software. To avoid conducting such complex analyzes for every slab-on-grade floor, F-factors have been developed.

The F-factor for a slab is an approximation of the total amount of heat transmitted through the slab expressed per unit length of slab perimeter. Common units on the F-factor are Btu/(h•ft•°F). To estimate the heat being transmitted from an entire concrete slab-on-grade floor, the F-factor for the slab is simply multiplied by the slab's perimeter length and by the difference between inside and outside building air temperatures.

F-factors for concrete slabs-on-grade are determined via computer analyzes and depend on such design variables as soil thermal conductivity, soil thermal mass, insulation thermal resistance, insulation location, whether the slab is heated or unheated, slab position with respect to grade, location of the ground water table, slab area, slab shape, shading of the soil surface, and proximity to other building foundations that heat/cool the soil.

Table 1 Assembly F-Factors for Slab-On-Grade Floors[a]

Type of slab on grade[b]	Insulation description[c]	F-factor, Btu/(h• ft•° F) [d]							
		R=0	R=5	R=7.5	R=10	R=15	R=20	R=25	R=30
Unheated	None	0.73							
	12 in. horizontal w/o tb		0.72	0.71	0.71	0.71			
	24 in. horizontal w/o tb		0.70	0.70	0.70	0.69			
	36 in. horizontal w/o tb		0.68	0.67	0.66	0.66			
	48 in. horizontal w/o tb		0.67	0.65	0.64	0.63			
	12 in. vertical		0.61	0.60	0.58	0.57	0.57	0.57	0.56
	24 in. vertical		0.58	0.56	0.54	0.52	0.51	0.51	0.50
	36 in. vertical		0.56	0.53	0.51	0.48	0.47	0.46	0.46
	48 in. vertical		0.54	0.51	0.48	0.45	0.43	0.42	0.42
	Fully insulated slab		0.46	0.41	0.36	0.30	0.26	0.23	0.21
Heated	None	1.35							
	12 in. horizontal w/o tb		1.31	1.31	1.30	1.30			
	24 in. horizontal w/o tb		1.28	1.27	1.26	1.25			
	36 in. horizontal w/o tb		1.24	1.21	1.20	1.18			
	48 in. horizontal w/o tb		1.20	1.17	1.13	1.11			
	12 in. vertical		1.06	1.02	1.00	0.98	0.97	0.96	0.96
	24 in. vertical		0.99	0.95	0.90	0.86	0.84	0.83	0.83
	36 in. vertical		0.95	0.89	0.84	0.79	0.76	0.75	0.74
	48 in. vertical		0.91	0.85	0.78	0.72	0.69	0.67	0.66
	Fully insulated slab		0.74	0.64	0.55	0.44	0.37	0.33	0.27

(a) From ANSI/ASHRAE 90.1 Table A6.3. F-factors calculated assuming a 6-inch thick concrete slab with the bottom of the slab located at grade and a soil thermal conductivity of 0.75 Btu/(h• ft•° F)
(b) A heated slab-on-grade floor is a slab with a heating source either within or below it. An unheated slab-on-grade floor is a slab that does not meet the definition of a heated slab-on-grade floor.
(c) Horizontal insulation w/o tb refers to horizontal insulation without a thermal break (no vertical insulation on the outer slab edge) as shown in Figure 1e. Use vertical insulation values for cases shown in Figures 1a, 1b and 1c, with vertical insulation length equal to the sum of lengths H and W. In all cases the vertical portion of the insulation must extend to the top edge of the slab. For a slab to be fully insulated, the insulation must extend downward from the top of the slab and along the entire perimeter and completely cover the entire area under the slab.
(d) Interpolation of F-factors between R-values of insulation is allowed. Rated R-values are in units of h• ft²•° F/Btu.

Table 2 Assembly F-Factors for Slab-On-Grade Floors[a]

Soil thermal conductivity, Btu/(h• ft• F)	Insulation R-value, h• ft²• F/Btu	F-factors in Btu/(h• ft• F)			
		Unheated slab[b]			Heated slab[b]
		2 feet of vertical insulation[c]	4 feet of vertical insulation[c]	Fully insulated[d]	Fully insulated[d]
0.50	5	0.44	0.42	0.38	0.60
	10	0.40	0.36	0.31	0.47
	15	0.38	0.33	0.26	0.39
0.75	5	0.58	0.54	0.46	0.74
	10	0.54	0.48	0.36	0.55
	15	0.52	0.45	0.30	0.44
1.00	5	0.71	0.66	0.54	0.87
	10	0.67	0.60	0.41	0.63
	15	0.65	0.57	0.33	0.49
1.50	5	0.94	0.85	0.64	1.11
	10	0.88	0.78	0.47	0.71
	15	0.86	0.75	0.37	0.55

(a) F-factors calculated assuming a slab floor placed directly on the earth with the bottom of the slab at grade line
(b) A heated slab-on-grade floor is a slab with a heating source either within or below it. An unheated slab-on-grade floor is a slab that does not meet the definition of a heated slab-on-grade floor.
(c) Vertical insulation length is the sum of length H and W as shown in Figures 1a, 1b and 1c. The vertical portion of the insulation must extend to the top edge of the slab.
(d) For a slab to be fully insulated, the insulation must extend downward from the top of the slab and along the entire perimeter and completely cover the entire area under the slab.

Table 1 contains F-factors for slab assemblies as published in Table A6.3 of ANSI/ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings. These F-factors are from

Table 3 Thermal Conductivity Of Unfrozen Soils

Dry bulk density, γ_d, lbm/ft^3	Porosity, η	Thermal conductivity of dry soil k_{dry}, Btu/(ft• h• °F)	Moisture content, w, % dry basis	Saturation ratio, S_r	Kersten number, K_e	Thermal conductivity of moist soil, k, Btu/(ft• h• °F)		
Fine-Textured Soils With Sand Fraction < 0.40						q = 0	q = 0.15	q = 0.30
80	0.527	0.125	0	0.000	0.000	0.12	0.12	0.12
			5	0.122	0.106	0.19	0.19	0.19
			10	0.243	0.391	0.36	0.38	0.37
			15	0.365	0.597	0.49	0.52	0.49
			20	0.487	0.734	0.57	0.61	0.58
			25	0.608	0.829	0.63	0.67	0.64
			30	0.730	0.899	0.67	0.71	0.68
			35	0.852	0.951	0.70	0.75	0.71
			40	0.973	0.992	0.72	0.77	0.74
100	0.408	0.163	0	0.000	0.000	0.16	0.16	0.16
			5	0.196	0.287	0.37	0.39	0.38
			10	0.392	0.632	0.62	0.67	0.63
			15	0.588	0.816	0.75	0.81	0.77
			20	0.784	0.924	0.83	0.90	0.85
			25	0.980	0.994	0.88	0.95	0.90
120	0.290	0.201	0	0.000	0.000	0.20	0.20	0.20
			5	0.331	0.548	0.68	0.74	0.69
			10	0.662	0.863	0.95	1.05	0.97
			15	0.993	0.998	1.06	1.18	1.10
Coarse Grained Soils With Sand Fraction > 0.40						q = 0.5	q = 0.7	q = 0.9
100	0.408	0.163	0	0.000	0.000	0.16	0.16	0.16
			5	0.196	0.452	0.62	0.68	0.75
			10	0.392	0.672	0.84	0.93	1.04
			15	0.588	0.812	0.98	1.09	1.22
			20	0.784	0.914	1.08	1.21	1.35
			25	0.980	0.993	1.16	1.30	1.45
120	0.290	0.201	0	0.000	0.000	0.20	0.20	0.20
			5	0.331	0.616	1.00	1.13	1.28
			10	0.662	0.854	1.31	1.49	1.70
			15	0.993	0.998	1.49	1.71	1.95
140	0.172	0.240	0	0.000	0.000	0.24	0.24	0.24
			5	0.652	0.848	1.66	1.94	2.26
			7.5	0.978	0.992	1.90	2.22	2.60

k = $(k_{sat} - k_{dry})$• $K_e + k_{dry}$
K_e = exp{α•[1 - $S_r^{(\alpha - 1.33)}$]}
k_{sat} = thermal conductivity of saturated soil
k_{sat} = k_w^{η}• $k_s^{(1-\eta)}$
k_{dry} = thermal conductivity of dry soil
k_{dry} = -0.323 Btu/(ft• h• °F)• η + 0.295 Btu/(ft• h• °F)
α = 0.96 for coarse grained soils with sand fraction > 0.40
α = 0.27 for fine textured soils with sand fraction < 0.40
S_r = (w/100) / [(γ_w / γ_d) – (1/G_s)]
w = moisture content, % dry basis
η = porosity = 1 - γ_d/(G_s• γ_w)
γ_d = soil dry bulk density (a.k.a. dry unit weight)

γ_w = water density = 62.4 lbm/ft^3
G_s = specific gravity of soil solids = 2.71
k_w = thermal conductivity of water
= 0.34 Btu/(ft• h•° F)
= 1.28 Btu/(ft• h•° F) for ice
k_s = thermal conductivity of soil solids
k_s = k_q^{q} • $k_o^{(1-q)}$
q = quartz content, fraction of total solids
k_q = thermal conductivity of quartz
= 4.4 Btu/(ft• h• F)
k_o = 1.2 Btu/(ft• h• F) for q > 0.2
k_o = 1.7 Btu/(ft• h• F) for $q \leq 0.2$

research conducted by Ecotope Inc. of Seattle, Washington. The slab model was developed in 1988 by Mike Kennedy, who, along with fellow Ecotope coworkers David Baylon and Jonathan Heller, conducted numerous simulations over the next couple of years. The Ecotope group established their F-factors using climate data for typical 8-month heating seasons in Washington State. Table 1 values are for a soil thermal conductivity of 0.75 Btu/(h•ft•°F). **Table 2** contains F-factors generated by the Ecotope researchers for other soil thermal conductivities.

Nowhere in Tables 1 and 2 is an adjustment for slab shape or size mentioned. Consequently, a reader is inclined to believe that slab size and shape have only a minor influence on the magnitude of an F-factor. In reality, both slab size and shape can significantly impact the F-factor, as several researchers have shown. The F-factors in Tables 1 and 2 were obtained from simulations involving a residential-sized 30- by 45-foot slab, this since they were generated by Ecotope for use in estimating heat loss from residential buildings. Ironically, the Table 1 values are published in a document titled *Energy Standard for Buildings* ***Except*** *Low-Rise Residential Buildings*. During a recent conversion that I had with David Baylon on this topic, he warned me that the F-factors in Tables 1 and 2 would do an extremely poor job of predicting heat lost to the soil from very large slab-on-grade buildings (e.g., big box stores).

Insulation location

Not covering the outside vertical edge of a slab with insulation (Figure 1e) significantly increases heat transmission; for this reason, this case is treated independently in Table 1 from those with vertical insulation covering the outside edge of the slab (Figures 1a through 1d).

Vertical insulation length, as specified in the second column of Table 1 and in the header of Table 2, is equal to H as shown in Figure 1b or the sum of lengths H and W as shown in Figures 1a and 1c. In other words, Tables 1 and 2 draw no distinction between the insulation placements shown in Figures 1a-1c. As long as the insulations used in two different systems cover the vertical edge of the slab and have the same R-value and same total length (again, total length equals H+W in Figures 1a and 1c) the total heat transferred by the different systems is assumed to be identical. In reality, there are slight differences in heat transmission between the Figure 1a, 1b, and 1c locations, but the differences are not nearly as significant as the difference between one of these cases and a slab without the outside edge covered (Figure 1e).

Where a concrete slab directly overlies frost susceptible soils in a cold climate region, the insulation systems in Figures 1a and 1b are recommended.

Heated and unheated slabs

F-factors in Tables 1 and 2 are compiled for both heated and unheated slab-on-grade floors. A heated slab is one with a heating source either within or below it. Note that regardless of exactly where the heating source is located, the insulation is always assumed to be between the heat-

ing source and soil. An unheated slab-on-grade floor is a slab that does not meet the definition of a heated slab-on-grade floor.

The reason F-factors are higher for heated slabs is because a heated slab will be warmer than the design indoor temperature, and thus for a given indoor temperature, expect more overall heat loss from a heated slab.

Soil thermal conductivity

It is clear from Table 2 that soil thermal conductivity has a significant impact on F-factor values and thus care should be taken into account when estimating this value. Thermal conductivity *k* is the ability of a material to conduct heat, and although English units on thermal conductivity are identical to those of the F-factor, they really are not identical properties.

Table 3 contains *k* values for unfrozen soil that were obtained using the relationships at the bottom of Table 3. These equations were published by Sen Lu and colleagues (Lu, 2007). To determine *k* with these equations only requires knowledge of the soil's dry bulk density Υ_d, moisture content *w*, and quartz content *q*. Soil dry bulk density and moisture content are used to calculate soil porosity η and degree of soil saturation S_r. Quartz content is used to calculate thermal conductivity of the soil solids k_s. Quartz content is the fraction of dry soil that is quartz, and can be approximated as the fraction of the dry soil mass that is sand (although this tends to overestimate k_s). Knowledge of the quartz content is important because quartz has a thermal conductivity measureably higher than other common soil minerals.

Soil thermal conductivity *k* is calculated using the thermal conductivity of dry and saturated soil (k_{dry} and k_{sat}, respectively) and a normalized thermal conductivity K_e (i.e., the Kersten number). Note that k_{dry} is calculated from soil porosity η, whereas k_{sat} is a direct function of the thermal conductivity of liquid water k_w and the thermal conductivity of soil solids k_s. The relative contributions that k_w and k_s make to k_{sat} is a function of soil porosity. The Kersten Number K_e is a function of the degree of soil saturation S_r and a soil texture dependent parameter *a* which is set equal to 0.27 for fine textured soils with a sand fraction less that 0.40, and to 0.96 for coarse grained soils with a sand fraction greater than 0.40.

It is evident from Table 3 values that soil thermal conductivity increases with increases in dry bulk density, soil moisture and quartz content. On average, *k* is greater for coarse soils, largely because of its quartz content and higher dry bulk densities.

At 32 degrees Fahrenheit ice has a thermal conductivity of 1.28 Btu/(ft•h•°F), which is almost four times that of liquid water at the same temperature. For this reason, frozen soil will have a higher thermal conductivity than unfrozen soil of the same moisture content. The difference is relatively minor at low moisture content levels, but can be significant for soils with low dry bulk densities and high moisture contents. To approximate the thermal conductivity of a frozen soil, use the same equations with k_w set equal to ice's thermal conductivity of 1.28 Btu/(ft•h•°F).

In the absence of soil property data, thermal conductivity is generally approximated as 0.75 Btu/(ft•h•°F).

Table 4 ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

Insulation type[a]		Minimum insulation density, lbm/ft^3	Minimum R-value per inch of thickness, h• ft^2• ºF/Btu/in.	Minimum compressive strength at yield or 10% deformation[a], lbf/in^2	Allowable bearing capacity[b], lbf/ft^2	Maximum water vapor permeance for 1-inch thickness, U.S. perms	Maximum water absorption by total immersion, volume %
Expanded Polystyrene (MEPS)	II	1.35	4.0	15	NA	3.5	3.0
	IX	1.9	4.2	25	1200	2.5	2.0
Extruded Polystyrene (XEPS)	X	1.35	5.0	15	NA	1.5	0.3
	IV	1.6	5.0	25	1200	1.5	0.3
	VI	1.8	5.0	40	1920	1.1	0.3
	VII	2.2	5.0	60	2880	1.1	0.3
	V	3.0	5.0	100	4800	1.1	0.3

(a) The primary means for identifying ASTM C578 insulation type at a retail level is via the compressive strength at yield or 10% deformation. For example, Owens Corning's FoamulaR 150, 250, 400, 600 and 1000 are XEPS insulations with minimum compressive strengths of 15.0, 25.0, 40.0, 60.0, and 100.0 lbf/in^2, respectively and they are classified as ASTM C578 types X, IV, VI, VII and V, respectively.

(b) Allowable bearing capacity is based on ASTM C578 compressive strength at 10% deformation divided by a safety factor of 3.0 for conditions without cyclic loading (e.g., highway vehicle loading).

Insulation types

Control of below-grade heat transfer was revolutionized by the development of rigid, plastic foam board insulations. Base plastics include polystyrene, polyisocyanurate (also known as polyiso), and polyurethane. There are two main categories of polystyrene products: extruded/expanded polystyrene (XEPS or XPS) and molded/expanded polystyrene (MEPS or EPS). These two products are discussed in more detail here because they are the most widely used products for below-grade insulation. Polyisocyanurate and polyurethane boards are similar in formulation. They tend to be more expensive than polystyrene-based boards, but can withstand higher temperatures than polystyrene, thus making them more attractive for roofing applications.

XEPS is manufactured by melting polystyrene beads and mixing the resulting liquid with special additives and a blowing agent inside an extruder under a very specific temperature and pressure. The resulting hot viscous liquid is extruded through a die into a reduced-pressure environment, upon which the gaseous blowing agent expands, resulting in the formation of a uniform closed-cell foam sheet with smooth skins. Common trade-named products include Dow Chemical's Styrofoam (blue), Owens Corning's Foamular (pink), Pactiv Corporation's GreenGuard (green) and DiversiFoam Products' CertiFoam (yellow). MEPS board is produced from polystyrene resin beads that contain microscopic cells filled with a blowing agent (usually pentane or butane). The beads are exposed to steam under controlled pressure. The heat from this steam

Table 5 Prescriptive Perimeter Insulation Requirements for Slab-On-Grade Floors (ANSI/ASHRAE Standard 90.1-2007)

Slab-on-grade type[a]	Climate zone[b]	Assembly maximum F-factor, Btu/(h• ft• F)		
		Heated and/or cooled nonresidential spaces[c]	Heated and/or cooled residential spaces[c]	Semiheated spaces[d]
Unheated	1, 2, 3	0.730	0.730	0.730
	4, 5	0.730	0.540	0.730
	6	0.540	0.520	0.730
	7	0.520	0.520	0.730
	8	0.520	0.510	0.730
Heated	1, 2	1.020	1.020	1.020
	3	0.900	0.900	1.020
	4, 5	0.860	0.860	1.020
	6	0.860	0.668	1.020
	7	0.843	0.668	0.900
	8	0.688	0.668	0.900

(a) A heated slab-on-grade floor is a slab with a heating source either within or below it. An unheated slab-on-grade floor is a slab that does not meet the definition of a heated slab-on-grade floor.
(b) See table 6 and figure 2.
(c) A heated space within a building is a space heated by a system whose output capacity in Btu/h per square foot of floor area is greater than or equal to: 5 for climate zones 1 and 2; 10 for climate zone 3; 15 for climate zones 4 and 5; 20 for climate zones 6 and 7; and 25 for climate zone 8. A cooled space within a building is a space cooled by a system with a sensible output capacity exceeding 5 Btu/h per square foot of floor space.
(d) A semiheated space within a building is a space heated by a system whose output capacity is greater than or equal to 3.4 Btu/h per square foot of floor area but less than that required to be a heated spaced as given in footnote (c).

Table 6 Climate Zone Delineation Criteria

Climate zone[a]	Climate zone description	Annual degree-days[b], °F-day
1	Very hot	greater than 9000 CDD50
2	Hot	6300-9000 CDD50
3	Warm	less than 6300 CDD50 and less than 3600 HDD65
4	Mixed	less than 4500 CDD50 and less 5400 HDD65
5	Cool	5400-7200 HDD65
6	Cold	7200-9000 HDD65
7	Very cold	9000-12600 HDD65
8	Subarctic	greater than12600 HDD65

(a) See figure 2.
(b) CCD50 = annual cooling degree days calculated using a 50F base temperature. One cooling degree day (CDD) accumulates for every degree the average daily (24 hr) temperature is above 50F. HHD65 = annual heating degree days calculated using a 65F base temperature. One heating degree day (HDD) accumulates for every degree the average daily temperature is below 65F. For a 5 day period with outside daily temperatures of 64, 55, 46, 57, and 62F, a total of 38 CDD50 accumulate (38 = 14+5+0+7+12).

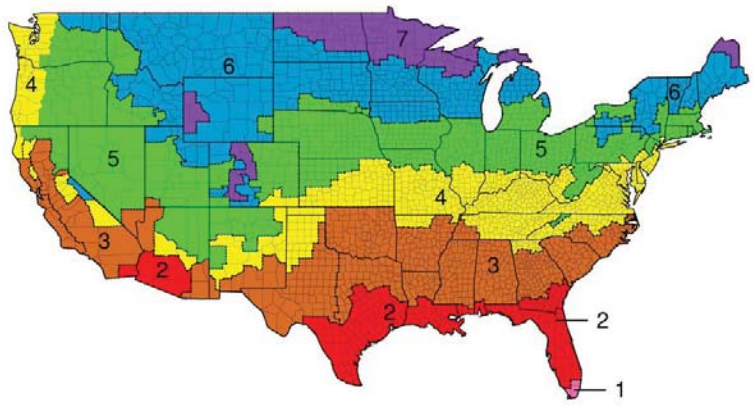


Figure 2. Climate Zones for the contiguous United States. All of Alaska is in Zone 7 except for the boroughs of Bethel, Dellingham, Fairbanks North Star, Nome, North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk which are in Zone 8. Zone 1 includes Hawaii, Guam, Puerto Rico and the Virgin Islands.

simultaneously softens the cell walls and expands the blowing agent, causing individual beads to increase in volume by up to 40 times. After a brief holding period to allow stabilization, the expanded closed-cell beads are poured into a large block mold. Steam is injected into the mold, and heat and pressure further expand and fuse the beads into a molded block. These blocks are cooled and then cut with hot wires to make the thinner sheets used for insulation. Because of its manufacturing process, MEPS is frequently referred to as bead board. Most people are familiar with EPS as a packaging product for which it is ideal, because it is lightweight (reduced shipping cost), shock absorbent, nonabrasive, not weakened or damaged by moisture exposure, and insulates package contents from temperature changes.

Specifications for various types of MEPS and XEPS are compiled in **Table 4**. Note that for a given density, XEPS exhibits a higher thermal resistance, higher compressive strength, lower water vapor permeance, and lower water absorption than MEPS. The lower properties for MEPS are attributable to microscopic pores between the closed-cell expanded beads. Because of the higher water permeance and adsorption of MEPS, there was a widespread belief among many in the building industry that MEPS deteriorated in the presence of wet soils subjected to freeze-thaw cycles. These concerns subsided after some U.S and Canadian field studies conducted in the 1990s showed long-term performance of MEPS to be just as good as XEPS. Today, many of the insulated concrete forms (ICFs) used for foundations are MEPS products.

In addition to the physical and thermal properties compiled in Table 4, it should be noted that MEPS and XEPS are unaffected by common soil acids, will not support mildew and fungus growth, and are decay and corrosion resistant.

The downsides of MEPS and XEPS are that they are deteriorated by ultraviolet radiation, easily damaged by certain solvents, melt at temperatures above 250

degrees Fahrenheit, incompatible with certain thermoplastics (polystyrene insulations are known to draw plasticizers out of thermoplastic membranes, causing permanent degradation), flammable, and subject to termite infestations. Where termite infestations are a potential problem, external applications of MEPS and XEPS may be prohibited, the insulations may need to be encased in concrete, or an inspection gap may be required between the insulation and wood-based building materials.

To combat physical damage and deterioration via sunlight, exposed exterior MEPS and XEPS are generally covered with a stucco coating, pressure-treated wood, brick, or aluminum flashing. When installed on the interior of a building, the flammability of these insulations requires that they be protected by a suitable "thermal barrier" or "ignition barrier" in accordance with the applicable code. In most cases, this need is met with a half-inch thick gypsum wall board covering.

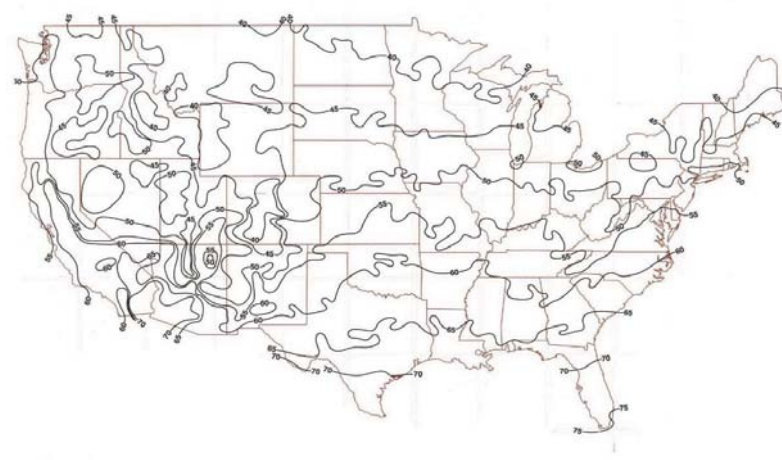


Figure 3. Mean average annual temperatures for the contiguous United States.

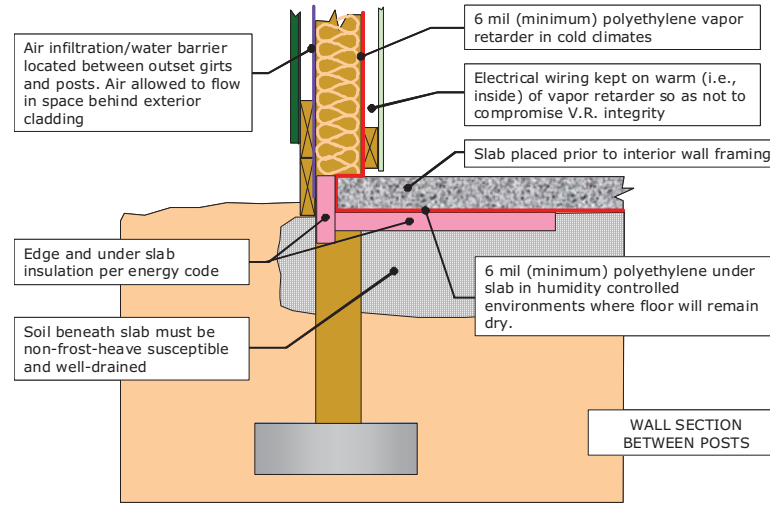


Figure 4. Insulation system for a heated post-frame building with embedded posts, outset girts, and slab edge insulation protected by splash plank. This system requires slab placement on well-drained, non-frost-heave susceptible soil.

Code requirements

Thermal insulation requirements embodied in energy conservation-related codes are largely based on the ANSI/ASHRAE Standard 90.1-2007. There are two different "compliance paths" outlined in ASHRAE 90.1-07: a prescriptive building envelope option and a building envelope tradeoff option.

Designers following the prescriptive building envelope option must make sure that each element of the building thermal envelop has a thermal transmittance (i.e., U-factor, F-factor) less than its code-prescribed value. Prescriptive thermal insulation requirements for slab-on-grade floors from ASHRAE 90.1-07 Table 5.5 are given in **Table 5**.

Designers following the ASHRAE 90.1-07 building envelope trade-off option must make sure the total heat transmission through the entire building thermal envelope does not exceed a code specified value. Via this option, a designer can utilize a concrete slab-on-grade with an F-factor that exceeds the applicable maximum prescribed value listed in Table 5 as long as the total performance of thermal envelope meets code requirements. The tradeoff option is popular as it provides greater flexibility in design, which makes it easier to lower overall building cost. Implementation of the building envelope trade-off option is facilitated with spreadsheet programs or special computer programs (e.g., REScheck, COMcheck).

Climate zones

As indicated in Table 5, thermal insulation requirements depend on temperature differences across a building envelope. The greater and more prolonged these temperature differences, the greater the insulation need, and the lower will be the prescribed maximum F-factor. This explains why the prescribed values in Table 5 are lower for heated and cooled spaces than for semi-heated spaces, and

why prescribed F-factors are lower for northern climate zones.

Climate zones referred to in Table 5 are shown in Figure 2 and defined in Table 6. Current zone differentiation is based on work done by Robert Briggs, Robert Lucas, and Todd Taylor of the Pacific Northwest National Laboratory (PNNL). The 2004 *International Energy Conservation Code (IECC) Supplement* was the first major publication to adopt the PNNL climate zones and it was subsequently adopted by ANSI/ASHRAE 90.1.

As Table 6 indicates, climate zones are primarily based on heating and cooling degree days. Although degree days dictate above grade insulation requirements, insulation requirements for controlling below-grade heat transfer are largely dictated by soil temperatures and thermal conductivities. Soil temperatures, in turn, are directly related to annual average dry bulb temperatures that are graphically displayed in **Figure 3**. A comparison of the climate zones in Figure 2 with the isotherms in Figure 3 explains why climate zones can be used to approximate soil temperatures.

Example selection

In accordance with ASHRAE 90.1-07 prescriptive building envelope requirements, what insulation options (total vertical plus horizontal insulation length and insulation R-value) can be used for an unheated concrete slab that supports a heated/cooled building located in climate zone 7 where the soil has a thermal conductivity of 0.75 Btu/(h•ft•°F)?

Table 5 requires that the F-factor not exceed 0.520 Btu/(h•ft•°F). Based on Table 1, this requirement can be met with 24 inches of R15 insulation (F-factor = 0.52), 36 inches of R10 insulation (F-factor = 0.51), or 48 inches of R7.5 insulation (F-factor = 0.51). Alternatively, the entire slab can be insulated with R5 insulation (F-factor = 0.46). Note that the 0.520 Btu/(h•ft•°F) requirement can not be met with an application featuring only horizontal insulation (Figure 1e).

Insulating heated slabs

The rule of thumb for insulation of heated slab-on-grade floors is to increase by 5 h•ft²•°F/Btu the R-value that would be prescribed for the slab if it was not heated, and also install insulation with a minimum R-value of 5 h•ft²•°F/Btu under the remainder of the slab. Please note that a number of energy specialists recommend that the remainder of a heated slab be insulated with an R-value of no less than 10 h•ft²•°F/Btu.

Installing below-grade insulation

Figures 4-**6** contain construction details for below-grade insulation of buildings with embedded posts. Prior to discussing these details, I would point out that these details are just as applicable to posts mounted on concrete piers, with the exception that thermal breaks should be added between any concrete slab and concrete pier. I would also note that below-grade insulation details for buildings with posts that are not embedded or are not placed on piers are not included here. Such posts are either placed on concrete stemwalls or slab-on-grade foundation systems, and common practices as they relate to insulating such concrete foundations are widely published elsewhere.

Figure 4 illustrates an insulation system that would not be placed in contact with frost-susceptible soils since soil located directly under the perimeter of the concrete slab could freeze and heave. There is absolutely no problem with this system as long as the concrete slab is placed on well-drained, nonfrost-heave susceptible soils, and the post footing is placed below the anticipated frost depth.

From both a cost and a constructability perspective, the system shown in **Figure 4** may be the best way to insulate a building with embedded posts. With the right soils, it is the ideal system for buildings with heated concrete slabs. When installing a heated slab, I strongly recommend placing insulation with a minimum R-value of 10 h•ft²•°F/Btu under the entire interior of the slab. In climate zones 3 and higher, energy codes will generally require that insulation under the exterior perimeter and along the outside edges of a heated slab have an R-value greater than 10 h•ft²•°F/Btu.

Figures 5 and **6** both show systems that can be used for conditioned post-frame buildings with embedded posts and slabs overlying frost susceptible soils. In Figure 5, girts are outset and insulation near grade is protected by splash plank. In Figure 6, girts are inset and insulation is located outside base girts.

The problem with using the insulation systems in Figures 5 and 6 for buildings with embedded posts is two-fold. First, they negate one of the major advantages of the embedded post foundation system and that is minimal excavation. Since below-grade vertical and horizontal wing insulation cannot be installed until after posts (or piers) have been embedded, when is the excavation for the insulation made?

One option is to begin building construction by digging a trench at a depth and width that will accommodate the horizontal wing insulation as well as compaction of soil on the inside of the vertical insulation. Once the trench is dug, post holes can be augered (this has the benefit of decreasing post-hole augering depth).

A second option is to trench alongside the exterior of the building after the exterior shell has been completed, but before interior concrete work has begun. The problem with this option is that there's no inside trench in which to run the typical compactor that would be used to compress soil against the inside of the vertical insulation.

A third option is to construct the building with the grade at least a full foot lower than the finish grade, with insulation placement done just before soil is added to bring it up to the final elevation. While this requires fill material to be placed inside the structure after the shell is complete, such a sequence may actually be beneficial in buildings featuring extensive under-slab plumbing, electrical, HVAC

and other systems.

The second problem with the insulation systems in Figures 5 and 6 when used in buildings with embedded posts involves installation of the vertical insulation. More specifically, how is the soil adequately compacted on both sides of the vertical insulation without compromising the integrity of the insulation system?

With concrete stemwall and slab-on-grade foundations, the vertical insulation is simply compacted against a vertical concrete surface. Such a surface does not exist between embedded posts. When compacting soil, it is important to keep the vertical insulation straight so as to maintain a tight joint between it and the horizontal wing insulation. This can be accomplished by temporarily fastening an inset girt against the inside of the vertical insulation while compacting soil against the outside surface.

Regardless of the insulation method used, make sure that a durable, opaque, weather-resistant covering or coating is used to protect exposed insulation from ultraviolet radiation, physical damage, and other sources of deterioration. Also make sure that compressive loads on insulation materials supporting building foundation loads do not exceed the allowable bearing capacities given in Table 5, and that the surface upon which any horizontal insulation is laid has been struck level. Production of a compact and level surface often requires that the surface be worked with a straight edge in between passes with a mechanical compactor.

Vapor retarding membranes and sand layers

Vapor retarding membranes are placed below concrete slabs to minimize the diffusion of water vapor and other gases from the soil into the building environment. When properly installed they can reduce indoor humidity levels; prolong the life of flooring materials; decrease mold growth potential; and reduce indoor concentrations of radon, methane and other unwanted gases.

In typical construction, a vapor retarding membrane is placed over a layer of pea gravel that serves as a capillary break between the soil and the membrane. After placing the membrane over the pea gravel, some builders cover it with a layer of sand and then place concrete on top of the sand layer. Depending on the intended purpose of the sand layer, it may be referred to as a blotter, cushion layer, or protection course.

The sand layer acts as a blotter when it is relied on to absorb excess water during concrete placement in an effort to reduce bleed water at the concrete surface. Although the term blotter is appropriate for this application, this is not a sound reason for installing a sand layer. Excess bleed water is a symptom of a water-to-cement ratio that is too high, and a sign that the concrete will have a relatively low strength and high permeability when cured.

Additionally, it has been shown to take slabs placed over sand 3 to 4 times longer to dry down to the same point as slabs placed directly on membranes. A prolonged wet slab can negatively impact the quality and schedule of flooring installations. In the end, a builder is much better off spending money on concrete additives and proper concrete curing than on a "blotter."

Sand layers serve as cushion layers and protection courses when they are installed to prevent accidental puncture of membranes during steel reinforcing and concrete placement. In this case, use of a sand layer can be avoided by using a thicker or more puncture resistant membrane (e.g., 10 or 15 mil polyethylene meeting ASTM E1745 Class A membrane requirements), or in the case of insulated slabs, by placing rigid insulation on top of the membrane. Please note that by placing the membrane on the moist side of the insulation the insulation is less likely to be compromised by water absorption.

Finally, an unlikely but potential problem introduced by placing a sand layer between a vapor retarding membrane and a concrete slab is that should water ever find its way into the sand layer, the membrane will help ensure that the water spreads out in the sand layer and stays there until it diffuses up through the concrete. In this case, the membrane is contributing to a problem that it was intended to help solve.

Summary

Use of F-factors for calculating heat transmission from concrete slab-on-grades was presented. These F-factors are a function of many variables including soil thermal conductivity, insulation thermal resistance, insulation location, whether the slab is heated or unheated, slab position with respect to grade, and total slab area and shape. Methods for calculating soil thermal conductivity were overviewed along with physical and thermal properties of MEPS and XEPS insulations. ANSI/ASHRAE Standard 90.1-2007 insulation requirements for concrete slab-on-grades were introduced, and three details for below-grade insulation of post-frame buildings with embedded posts were discussed, along with disadvantages of introducing a sand layer between a concrete slab and an underlying vapor retarding membrane. ***FBN***

Reference

Lu, S., Ren, T., Yuanshi, G., & Horton, R. (2007). An improved model for predicting soil thermal conductivity from water content at room temperature. *Soil Science Society of America Journal*, 71, 8-14.

Baylon, D. & Kennedy, M. (2007). Calculating the impact of ground contact on residential heat loss. *_Proceedings of the Tenth International Conference on Thermal Performance of the Exterior Envelopes of Whole Buildings X.* December 2-7, 2007, Sheraton Sand Key Resort, Clearwater Beach, Florida. Organized by the Oak Ridge National Laboratory (ORNL)

Galvanic Action

Using incompatible metal components results in premature corrosion

By Karen Knapstein

GALVANIC SERIES CHART METALS AND ALLOYS

+ CORRODED END ANODIC, LEAST NOBLE	Galvanic Series Chart Metals and Alloys
	Magnesium
	Magnesium alloys
	Zinc
	Aluminum 1100
	Cadmium
	Aluminum 2024-T4
	Steel or iron
	Cast iron
	Chromium-iron (active)
	Ni-Resist Cast Iron
	Type 410 Stainless steel (active)
	Type 304 Stainless steel (active)
	Type 316 Stainless steel (active)
	Lead tin soldiers
	Lead
	Tin
	Nickel (active)
	Inconel nickel-chromium alloy (active)
	Hastelloy Alloy C (active)
	Brasses
	Copper
	Bronzes
	Copper-nickel alloys
	Type 410 Stainless (passive)
	Monel nickel-copper alloys
	Silver solder
	Nickel (passive)
	Inconel nickel-chromium alloy (passive)
	Chromium-iron (passive)
	Type 304 Stainless steel (passive)
	Type 316 Stainless steel (passive)
	Hastelloy Alloy C (passive)
	Silver
	Titanium and titanium alloys
	Graphite
	Gold
− PROTECTED END CATHODIC, MOST NOBLE	Platinum

Table 1

When electrochemically dissimilar metals are in contact with one another, galvanic action occurs. The direct contact creates a conductive path for electrons and ions to move from one metal to the other; the result is accelerated corrosion.

For example, consider the Statue of Liberty. Lady Liberty has a copper surface on a cast iron frame. The two metals were originally separated by an insulating material. When that insulating material failed, the result was a great deal of galvanic corrosion.

Three conditions must exist for galvanic corrosion to occur:

1. There must be two electrochemically dissimilar metals present.
2. There must be an electrically conductive path between the two metals.
3. There must be a conductive path for the metal ions to move from the more anodic metal to the more cathodic metal.

If any one of these three conditions doesn't exist, galvanic action won't take place.

When dissimilar metals are in contact with each other in the presence of oxygen and moisture, the more noble metal (more resistant to corrosion) will corrode the less noble.

Galvanic corrosion should be a concern in the use of metal fasteners such as bolts, screws, and welds. According to an article in Preservation Science, "Because fasteners have a much smaller surface area than the materials they fasten, fasteners that take on the role of the anode will be at risk of rapid corrosion and thus should be avoided. For example, zinc-coated fasteners should only be used to connect steel coated with aluminum, zinc, and Galvalume, as these are very close on the Galvanic Series and are not generally at risk of corrosion when placed together. On the other hand, zinc-coated or aluminum-coated fasteners should not be used to attach copper or stainless-steel panels."

Andrew Mullen, President of Direct Metals, Inc., advised, "It is important to understand the differences between metal alloys and how bare dissimilar metals in certain environmental conditions can have serious reactions that promote premature corrosion and degradation."

To minimize the risk of galvanic corrosion occurring in fasteners, the surface metal on the fastener should be matched

Fastener Material Selection Based on the Galvanic Series of Metals

Table developed using information supplied by AISI Committee of Stainless Steel Producers.

KEY

A. The corrosion of the base metal is not increased by the fastener.
B. The corrosion of the base metal is slightly increased by the fastener.
C. The corrosion of the base metal may be considerably increased by the fastener material.
D. The plating on the fastener is rapidly consumed.
E. The corrosion of the fastener is increased by the base metal.

Table 2

BASE METAL	FASTENER MATERIAL: STEEL Zinc Plated	STAINLESS STEEL Type 410	STAINLESS STEEL Type 302, 304, 316	ALUMINUM
Zinc | Galvanized | ZN/Al Coated Steel	A	C	C	B
Aluminum	A	[1]Not Recommended	B	A
Steel / Cast Iron	A,D	C	B	A
Brass, Copper, Bronze	A,D,E	A	B	A,E
Stainless Steel 300 Series	A,D,E	A	A	A,E

[1] Because aluminum can expand a large distance, the high hardness of 410 SS case-hardened screws may lead to screw failure due to lack of ductility or stress corrosion cracking.

NOTE: Organic coating to the screw will improve the corrosion resistance. Environments can affect the rate of corrosion and change the activity of the metals. *COURTESY OF TRIANGLE FASTENER CORP.*

with the surface metal it will fasten. The most desired combination is to have a large anode with a small cathode; in other words, fasteners such as bolts and screws should be made of the metal less likely to corrode, or the more cathodic.

In the galvanic table shown (Table 1), the closer the metals are to one another on the list, the less likely they are to react to one another and experience galvanic corrosion.

If it's not possible to avoid using dissimilar metals, coatings play a critical role in eliminating the risk of galvanic action. A non-conductive coating acts as a barrier, removing the connection between them. Common coating practices that prevent galvanic corrosion include, but are not limited to, zinc plating, galvanizing, and powder coating.

John Sheridan, owner of Sheridan Metal Resources, teaches as part of his training course: "Aluminum has a similar protective coating as zinc, eliminating risk of corrosion. Galvanized steel is coated with a fine film of zinc, so this zinc-zinc contact poses no threats. Copper and zinc don't play nicely together. Copper runoff will stain the zinc. Steel that is non-galvanized should also be avoided, as the similar electron transfers between the metals will result in corrosion and deterioration. In addition, zinc is not compatible with oak, chestnut, red or white cedar, Douglas fir, and any woods with a pH less than 5."

There is a good chance you already knew from experience that some fasteners react badly to certain materials. Now you know why. Remember: Your supplier will be happy to help you select the appropriate fastener for whatever materials you're working with. ***FBN***

Preservative-Treated Lumber Applications

By Triangle Fastener Corporation

ACQ, Penta, CA or CBA preservative-treated lumber can be incompatible with certain types of fasteners. In those cases where any type of metal roof or wall cladding materials are being attached to preservative treated lumber, the following fasteners are not compatible: zinc plated screws, zinc-alloy headed screws, stainless capped screws, aluminum, copper and copper alloy. When attaching metal panels to those types of preservative-treated lumber, a moisture barrier should be used between the lumber and the panel material. Metal panel fasteners that are compatible with preservative-treated lumber are stainless steel fasteners, or hot dip galvanized nails manufactured to ASTM A153 class D or heavier. Other types of fasteners coated with proprietary anti-corrosive technologies are also available for use with preservative-treated lumber. In addition, zinc-plated screws can be used in CCA and MCQ pressure-treated lumber.

Compatibility Testing: Fasteners vs. Aluminum Panels

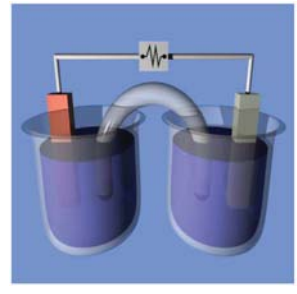
By Peter Graves, P.E., ST Fastening Systems

Purpose of test

To compare the electrochemical reaction between aluminum alloy roof panels, and several different metal and screw alloys to test the compatibility with the aluminum and determine the best screw for attaching aluminum roof panels in coastal environments

Background

Corrosion can be compared to an electrochemical reaction where one metal is eaten away in the presence of an electrolyte (moisture and oxygen). The metals are considered dissimilar depending on their position on a galvanic series chart. This chart is arranged in order of their relative electrical potential. The further apart the materials are on the list, the greater the risk of corrosion. As an example, lead acid batteries use this electro-chemical reaction to create electricity, where the dissimilar plates submerged in the battery "acid" create an electron transfer. The ion transfer is from the negative terminal (anode), to the positive terminal (cathode). The anode material "corrodes" sacrificing itself to the cathode. All that is needed is 2 dissimilar metals, and an electrolyte to create this reaction. This test documents the electrical difference between the aluminum panel in question, and the different metals listed when submerged in distilled water, and then again in 5% salt water.



Test Method

Glass containers were filled with equal amounts of distilled water, and an ion conductor was draped from one container to the other to complete a circuit between the solutions. This ion bridge keeps the solutions separated to limit the cross contamination of the ions dissolved in the container. A test strip of aluminum "panel" was alligator clipped to the negative probe on the multi-meter, one at a time, the list of test pieces shown were clipped to the positive probe of the multi-meter. The multi-meter was switched to record DC (direct current) with the aluminum strip submerged in one container, and the tested material were submerged, and the value on the multi-meter was recorded when it reached a consistent value. After each test, the solutions were dumped, the containers washed and refilled for the next comparison. The test was repeated several times and the range of values recorded. *[Figure 1, opposite page]*

Conclusion

The difference between voltages increased as much as 50% as the electrolytic solution changed from distilled water to salt water. The salt water is a better "electrically conducting solution" due to the salt (NaCl) in the water dissolving into its component ions (Na+ and Cl-). The movement of these negatively charged ions towards the anode, and positively charged ions towards the cathode increases the current flow. The current flow in a salt solution is proportional to the concentration of ions in the solution. The voltage recorded above, shows the smaller the difference in voltage, the more compatible that material is with the aluminum panel. It has been well documented that a metal corrodes quicker the closer it is to marine/ocean environments. In controlled environments, potential difference as great as 0.50 may be acceptable. In moderate environments, metals should have a difference of less than 0.25 volts. In severe coastal environments, the difference in voltage between materials in contact with each other should be below 0.15 volts to minimize corrosion from electro-galvanic reaction. Another factor related to the rate of corrosion of the anode is directly related to the area ratio of the two metals. If the surface area ratio of cathode to anode is doubled, the rate of corrosion of the anode is also doubled, while if the area ratio is halved, the rate of corrosion of the anode is halved.

Aluminum is on the anode side of stainless steel, and the area of the panel compared to the area of the screw is large, so the rate of corrosion would be rapid. Evident with the testing above, aluminum screws are the best solution to use with an aluminum panel, zinc coated carbon screws would react less than all the stainless steel screws tested assuming the zinc coating is not breached during installation. Interestingly the zinc coated screw displayed a lower voltage when tested in the salt solution than in the distilled water.

Summary

To summarize, in severe marine/ocean environments, aluminum fasteners are least likely to be the source of galvanic corro-

MATERIALS USED IN TESTING:

- Aluminum alloy roof panel
- Copper panel test plate
- #10 -14 Hardened Stainless Steel screw
- #10-14 304 Stainless Steel screw
- #14-10 410 Stainless Steel screw
- #10-32 316 Stainless Steel screw
- 5.5 x 35 mm Aztec International aluminum screw
- M5 x 50 mm True Stain hard wood screw
- #10-16/8 ST WoodBinder zinc coated screw
- Klein Tools MM1000 Digital Multi-meter
- Distilled water - specific gravity = 1.00 @ 74 degrees
- 5% solution salt water - specific gravity = 1.02 @ 74 degrees
- glass containers, salt bridge (ion conductor), alligator clips

Results (FIGURE 1)
The following results were recorded for each test as the multi-meter settled to display a constant voltage.

Material attached to the positive probe	Aluminum strip attached to ground probe	
	voltage in distilled water (V)	voltage in 5% Salt Solution (V)
Aluminum alloy roof panel	0.00 - 0.00	0.00 - 0.01
Copper panel test plate	0.45 - 0.46	0.52 - 0.56
#10 -14 Hardened Stainless Steel screw	0.45 - 0.55	0.70 - 0.82
#10-14 304 Stainless Steel screw	0.38 - 0.40	0.65 - 0.67
#14-10 410 Stainless Steel screw	0.33 - 0.38	0.43 - 0.57
#10-32 316 Stainless Steel screw	0.32 - 0.44	0.63 - 0.72
5.5 x 35 mm Aztec International aluminum screw	0.00 - 0.09	0.00 - 0.06
M5 x 50 mm True Stain hard wood screw	0.35 - 0.38	0.52 - 0.63
#10-16/8 Sealtite WoodBinder zinc coated screw	0.35 - 0.44	0.26 - 0.30

Test #0012-16, Date: 10-05-2016. COURTESY OF ST FASTENING SYSTEMS

sion from dissimilar metals when fastening aluminum panels to a structure. Consideration of galvanic corrosion of the screw and the substrate should be taken into account also. None of the other fasteners tested fall below the recommended 0.15 volts shown to minimize galvanic corrosive effects in severe conditions. Based on ST's experience, using carbon steel fasteners with aluminum panels exhibited a possibility that a portion of the galvanized coating will be removed during installation, resulting in an increased risk of dissimilar metal contact. ***FBN***

Peter Graves, P.E., *is Vice President of Engineering and Technical Services at ST Fastening Systems.*

From left, Shawn, Rob and Dustin Haddock break ground on S-5!'s new office campus in Colorado Springs, Colorado. *Photo by S-5!*

S-5! Breaks Ground On New Facility

In early July, S-5!, an authority on metal roof attachment solutions, broke ground on its new office space to provide sufficient space for its staff and to better serve its customers.

S-5!'s new corporate headquarters will be located on more than 4.5 acres in the Black Forest area of Colorado Springs where S-5! clamp-to-seam technology was birthed 30 years ago.

The two-story office building will sport metal finishes and a solar roof. The adjacent barn will be repurposed for S-5!'s video training center, prototype shop and test facilities.

The use of exterior materials will be harmonious with the rustic mountain rural and local architecture and feature a double-folded standing seam metal roof hosting a 50kW solar PV system and supported by hand-peeled log truss/columns. Corten steel (sometimes known as weathered steel) will provide a rustic appearance. A combination of natural stone (moss rock) and stucco will complete the natural earth-tone look and feel of the space.

The office will be used to bring the executive staff of S-5! together for better, creative collaboration, birthing product and marketing ideas and developing company initiatives.

"The entire site and construction is designed to resemble and feel like a residence, as this is our business culture and harmonizes with the Black Forest persona," said Rob Haddock S-5! CEO and founder. "We are excited to finally have the space we need to meet the demands for our growing business."

Andalina Torres, Levi's Building Components. *Photo by Levi's Building Components*

Levi's Building Components Hires New Production/ Operations Manager

Levi's Building Components has announced the hiring of Andalina Torres as Customer Service & Inside Sales Manager. She comes to Levi's with a more than 10 years of experience in sales and customer service. Torres is married with two children, and enjoys spending time watching movies and riding motorcycles.

Levi's Building Components is a nationally recognized supplier of metal roofing products located in Ephrata, Pennsylvania.

ABC Supply Co. Inc. Acquires the Assets of Gutter Source, LLC

Building products distributor ABC Supply Co. Inc. has acquired the assets of Gutter Source, LLC in Oklahoma City, Oklahoma. The acquisition includes Gutter Source's gutter supply business, located at 531 N. Ann Arbor Ave., and manufacturing facility, which will become part of American Construction Metals' (ACM) operations. In addition, many of Gutter Source's associates will join the ABC Supply and ACM teams, providing a seamless transition for existing customers.

Founded in 1992 by Darla Morley, Gutter Source became a leading gutter supplier in Oklahoma City and expanded its manufacturing capabilities in 2011. By acquiring Gutter Source, ABC Supply expands its footprint in Oklahoma to seven locations and strengthens its team of knowledgeable associates.

"We're happy to welcome the Gutter Source team to our ABC Supply family," said Jonathan Shepard, vice president of ABC Supply's Southwest Region. "With the additional location in Oklahoma City, we solidify ABC Supply's position as the leading supplier of rainware products in Oklahoma and strengthen our partnerships with area contractors."

ACM is a strategic business unit of ABC Supply specializing in manufacturing metal building products, including rainware products, soffit, fascia, and roofing and siding accessories.

Johnny Williams, Wood Insulating Company, recipient of the 2021 ExCEEd on the Job Award. *Photo by Wood Insulating Company, Inc.*

Owens Corning Names Johnny Williams as 2021 Certified Energy Expert Award Winner

Owens Corning® has named Johnny Williams of Wood Insulating Company, Inc., based in Anderson, South Carolina, as its 2021 ExCEEd on the Job Award Winner. The honor is provided annually to Certified Energy Expert® (CEE) professionals who have consistently exceeded the program's standards and practices with services dedicated to customer satisfaction, quality and excellence.

This year's honoree was nominated by Dodd Wood, the owner of Wood Insulating. "The Owens Corning CEE program and awards are a great incentive for our workers," said Wood. "Johnny embodies the program's standards, going above and beyond to give something extra to every project. We're not only proud of the job Johnny's done, but also the way he has inspired everyone here with this achievement. Humble, gracious and dedicated, Johnny has shown what's achievable when

things are done right."

"I love this job," said Williams. "At 73-years-of-age, it keeps me going. The people at this company are like my family. I'm honored that they nominated me for this award. It just shows what you can achieve when you put your heart into your work."

Sheet Metal Supply Celebrates 30th Anniversary

Sheet Metal Supply Ltd. recently celebrated its 30th anniversary with an employee gathering at the plant. "It's been an exciting 30 years, no doubt about that," said Phil Kweton, Founder of Sheet Metal Supply. "Through the years, we've increased our product offerings, added staff and recently, we moved into a state-of-the-art 80,000 square foot facility in Grayslake [Illinois]. We succeeded by using a very simple formula – Customer First!"

Ben Kweton, CSI-EP, Vice President of Sheet Metal Supply, says the company's first 30 years have been analogous to a tree putting down solid roots and providing a strong foundation upon which to grow stronger, branch out and have an occasional offshoot.

"We certainly hope to see most of the current trends in our industry continue, with metal being a very viable choice for both roofing and walls from both a cost standpoint, and more importantly, an aesthetic and environmental/LEED position as well," Ben Kweton said. "We're thankful to our customers for their continued support and the fine assembly of team members that keep the business pushing forward and keep this a safe, collaborative and productive workplace."

Bradbury Company Announces Expansion for Moundridge Plant

The Bradbury Co., Inc., is expanding its test and assembly facility by approximately 40% to increase manufacturing capacity and provide additional space for testing the custom-built production lines before shipping to customers' facilities.

The addition, which will extend 10' higher than the existing facility, will be engineered to house 30-ton cranes. Beginning

Bradbury Co. Moundridge, Kansas, plant.
Photo by Bradbury Co., Inc.

steps are taking place in the multi-phase expansion process that should be complete by February. In addition to increasing manufacturing space, Bradbury is adding to its labor force and is accepting applications for numerous careers at the global headquarters in Moundridge, Kansas.

"Bradbury manufactures equipment for a variety of industries," says Ryan Durst, Bradbury President. "We are expanding not only our assembly and testing facility but also our workforce. Our equipment utilizes the latest automation technology and we are always looking to add highly engaged people to our team. With the addition of robotics and advanced automation, our lines of equipment have lengthened and the additional floor space will accommodate our need to assemble, test and deliver these large systems to our customers. We are excited to complete this expansion project and add capacity to our company as we continue to grow and serve our customers."

Bradbury's fabrication shop, where the major components required for the assembly of Bradbury equipment are machined, houses 60 various CNC machines including horizontal lathes, vertical lathes, horizontal mills, vertical mills and boring mills. The custom equipment is built and tested in Bradbury's assembly and test facility. Careers are available in various positions throughout the company.

American Building Components to Sponsor Luke Bryan Farm Tour

American Building Components (ABC), part of the Cornerstone Building Brands (NYSE:CNR) family of brands, is joining country music superstar Luke Bryan as a sponsor of his 12th Farm Tour, which will bring concerts to the fields of local farms across six states September 9-18.

The son of a Georgia peanut farmer, Luke Bryan initially launched the Farm Tour in 2009 to salute the hard-working farmers who bring food to America's dinner tables. After a forced hiatus in 2020, the Farm Tour is back and set to bring hundreds of thousands of concertgoers to rural America.

"After the challenges we have all faced in the last year with so many people losing their jobs, struggling to put food on their tables, food supply chains jeopardized, grocery stores struggling to keep food on the shelves in some areas, it is so apparent to me, and I hope everyone, why our farmers are truly the backbone of our country," Bryan said. "They never stopped providing for all of us. Ever. It's time to thank our farmers, once again."

Bryan's Farm Tour brings full production concerts to working farms in rural communities that typically would not host larger scale shows. In addition to spotlighting the contributions of America's farmers, the Farm Tour also awards college scholarships to students from farm families attending a local college or university.

"ABC's business is rooted in American agriculture," said Vice President of Sales Matt Cox. "Since 1908, we have worked side by side with farmers to develop metal roofing and siding products to protect their livestock, crops and machinery. We understand the vital role farmers play in feeding, clothing and fueling our world and are honored to join Luke Bryan in paying tribute to their efforts."

Dates and locations for Farm Tour 2021 include:

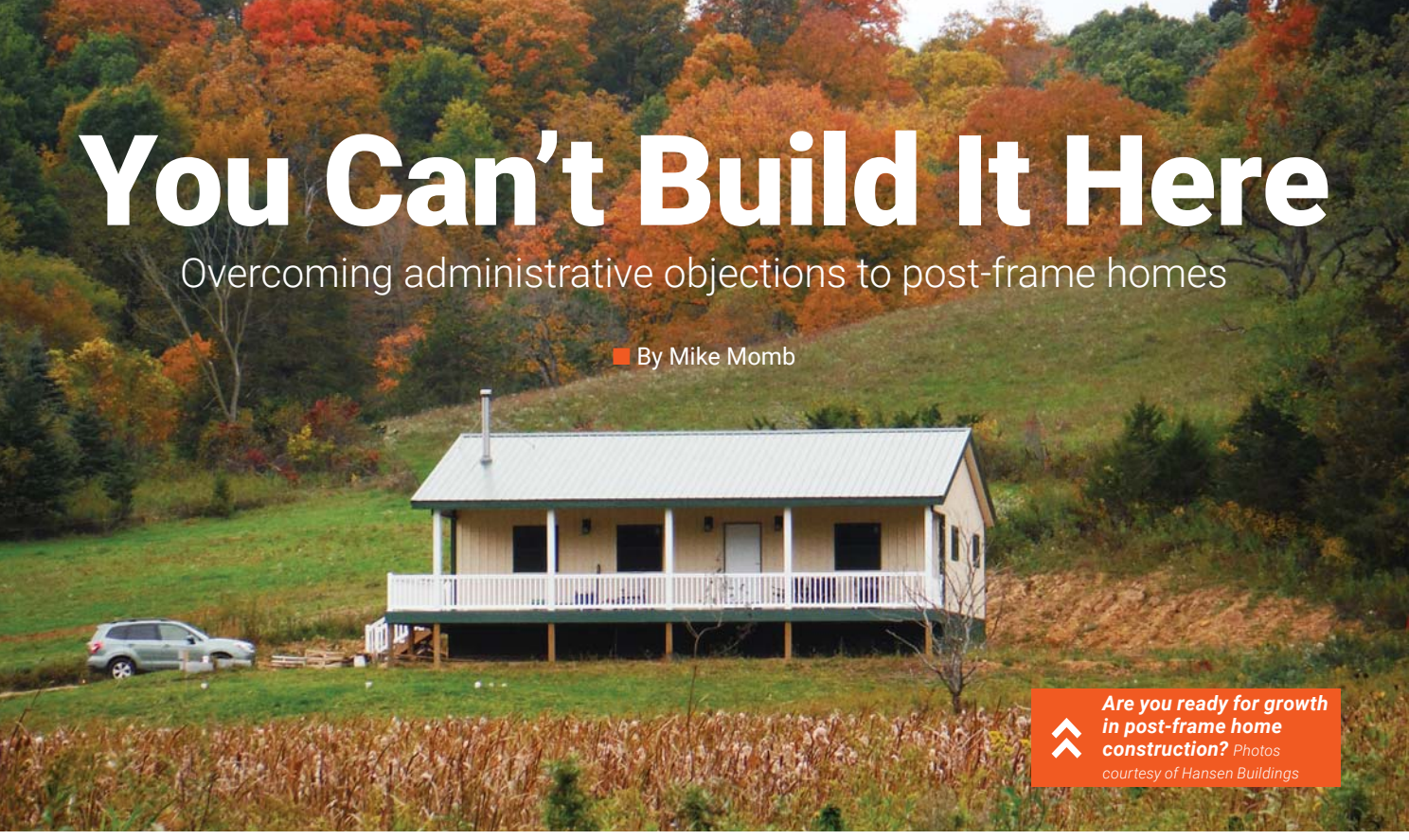
- Sept. 9 Marshall, Wisconsin, Statz Bros. Farm
- Sept. 10 Cedar Rapids, Iowa, Brown Farms
- Sept. 11 Chillicothe, Illinois, Three Sisters Park
- Sept. 16 Kingman, Ind., Martin Farms
- Sept. 17 Baltimore, Ohio, Miller Family Farms
- Sept. 18 Fowlerville, Michigan, Kubiak Family Farms.

More information is available at www.lukebryan.com/farm-tour. ***FBN***

You Can't Build It Here

Overcoming administrative objections to post-frame homes

By Mike Momb



Are you ready for growth in post-frame home construction? *Photos courtesy of Hansen Buildings*

When I first began selling pole barn kits in Oregon back in 1980, there was almost universally no permit required for farm buildings. As our service area expanded into states such as California and Nevada, engineering was required in most instances. However, there was never a concern about a pole building not being approved for use in any jurisdiction.

There were some "tough" building departments. Most providers and builders refused to even quote permitted pole buildings within Multnomah County, Oregon or King County, Washington — Just because they involved engineering and had plans examiners who were actually engineers themselves.

As our Pacific Northwest pole building industry evolved and expanded, we knew we had clients who were bootlegging our buildings into homes, but it wasn't until I built a shouse (shop/house) for myself in rural Spokane County, Washington nearly 30 years ago, where I actually participated in a post-frame building specifically designed for residential use.

In recent years, there has been an explosion of barndominiums across our country — many of these being post-frame homes. And why not? Post frame offers so many benefits over limitations of what is considered to be a more traditional structural system — stick (or stud wall) framed.

Perhaps stick-built construction's biggest advantage is builders and tradespeople are very comfortable working in and around stick framing. All registered architects and most building inspectors are very familiar with stick framing. The 2018 International Residential Code (IRC) provides a prescriptive "cook book" to follow for adequate structural assembly, within certain limitations. These include, but are not limited to, no story height of greater than 11' 7" (R301.3.1), no hurricane prone areas with a design wind speed of 130 mph or greater located south of Virginia, or 140 mph elsewhere (R301.2(5)B), and no ground snow loads over 70 psf (R301.2.3).

IRC802.10.2.1 further limits truss spans to a maximum of 36' and building lengths to 60' (measured perpendicular to truss span). Trussed roof slopes must be at least 3:12 and no greater than 12:12.

Wood is a very forgiving building material and, even when mis-cut, replacement material is usually only a short drive away. America's home building industry has built traditional, wood stick frame homes on site for decades.

Many builders, architects, carpenters and other subcontractors prefer to work on stick built homes as compared to alternative building systems, as it is what they are familiar with.

Because traditionally framed houses are so popular, dimensional lumber and stick-built framers are readily available.

Another advantage of stick-built homes is they allow for a great level of design freedom. One can design a home with various ceiling heights, angles and curves, niches and other details. Stick framing is one way to achieve those unique details at a fairly affordable cost.

Despite its popularity, stick framing does have some drawbacks. Because stick built homes are assembled outside, over several weeks, framing lumber is subject to outside moisture. If lumber gets too wet, it can shrink and warp as it dries and cause cracks in the attached drywall. This shrinking and warping can also make it difficult to properly insulate. To decrease risks of

potential moisture problems, exteriors are covered with an appropriate and well-sealed weather resistant barrier and lumber should be properly dried before drywall and insulation are installed.

Another drawback of a stick-built home is it usually takes several weeks to complete framing. Total amount of time it will take will obviously depend on the size and complexity of house plans and size, experience and availability of any particular framing crew.

A framing crew must precisely cut, assemble and erect framing components sometimes in adverse weather conditions. Working around adverse weather conditions is another challenge with stick framing.

Post-frame homes can save thousands of dollars in excavation, footing and foundation forming and concrete costs inherent to stick framing. This is due to use of isolated widely spaced wood columns either embedded or placed into brackets on concrete piers. Post-frame construction allows greater flexibility of design for wide door and window openings without requiring structural headers. It has fewer framing members touching both exterior and interior surfaces, reducing thermal transference issues. Deep wall cavities and use of raised heel trusses provide for an ability to super insulate. Material use is minimized by elimination of redundant members so often found in stud walls. Add to this: An average physically capable person, who can and will read instructions, can successfully erect their own beautiful home.

Today's fully engineered post-frame homes are not your grandfather's pole barn. Although steel siding and roofing will prove to be more cost effective and durable than any other cladding materials, any exterior surfacing is possible. As an example, one of our clients is building on Lake Havasu, Arizona with a concrete tile roof and stucco for exterior wall finishes.

Sadly, there are jurisdictions attempting to prevent "pole barn houses" in their neighborhoods. Scenarios usually go something like this: A potential homeowner inquires to their local building permit issuing authority and asks, "Can I build a pole barn home here?" Too often (in my opinion, one time is too often) the answer is a flat "no." Most of those who do move forward, automatically default to an easy route and build with stick frame instead.

What is not being asked by these potential post-frame home owners is, "Can you provide your written ordinance prohibiting fully engineered post-frame homes?"

Use of terms such as "pole barn" or "pole building" home, barndominium, shouse or shop/house oftentimes cause permitting waters to become clouded. Presenting as a "fully engineered post-frame home" dramatically decreases initial resistance.

My personal experience is well over 90% of these jurisdictions have no such written ordinance. And if it is not in writing, and duly approved by an elected governing body, then it does not exist. When pointed out no written prohibiting ordinance exists, this has always resulted in approval.

In those rare instances where an adopted written statute does appear, I have often appealed to legal counsel for the jurisdiction. I politely explain, in trying to rule out a 100% Code conforming structuring building system, they are attempting unlawfully to restrict free trade and this could result in a protracted (and expensive) legal battle they cannot win. Municipalities do not want to have to explain to their constituents how good money was thrown after bad. For me, in all but a single instance, this has resulted in approval to move forward.

Other courses of action would include taking this issue to the jurisdiction's governing body (city/town council or county commissioners) and requesting their statute be overturned or amended. This can proved to be a lengthy process as the wheels of progress move slowly.

Now my one single (and ongoing) challenge: Madison County, Illinois. In their Ordinance #: 2020-02 "Ordinance authorizing a text amendment to Chapter 93 of the Madison County Code of Ordinances":

93.025 "R-1" THROUGH "R-4" SINGLE-FAMILY RESIDENTIAL DISTRICTS

(F) "R-1", "R-2", "R-3", AND "R-4" Permitted uses.

(5) Single-family dwelling, <u>frame construction only.</u>

Madison County's Planning and Zoning Department's position is "frame" means stick frame only. I have reached out to Madison County State's Attorney's Office and as there is no pending actual permit application, they feel there is no compelling reason to address this issue.

Planning and Zoning Departments can regulate things such as setbacks, building footprints, heights, siding and roofing materials, even colors! However, it is unlawful to preclude any Code approved, engineered structural building system.

In my humble opinion, we will see entire subdivisions filled with post-frame homes, as affordable housing becomes less and less affordable. **FBN**

Mike Momb *has been Technical Director for Hansen Pole Buildings, LLC of Browns Valley, Minnesota for 19 years. His daily post-frame blog, as well as his weekly "Ask the Pole Barn Guru" column can be followed at www.HansenPoleBuildings.com/blog/.*

More Than a Hobby Shop

Multi-purpose building includes space dedicated to family gatherings

This Blunier Builders post-frame building serves multiple uses for the new owner. One section of the building, equipped with a large overhead door, is used for additional vehicle storage. The same section also serves as a basketball court for year-round use.

The remaining portion of the building consists of a kitchen, living room, and bathroom area used for entertaining during family gatherings in the cold months, and pool parties on the hot summer days.

Above the living area is a loft that overlooks the basketball court below. The loft is occupied by shuffle board, ping-pong, and foosball tables in addition to a seating area.

The gable porch that is supported by custom cedar trusses and cedar columns proved to be a unique and challenging feature to build. ***FBN***

https://blunierbuilders.com

PROJECT DETAILS

Builder:
Blunier Builders, Inc., Eureka, Illinois
Building Size: 40’ x 64’ x 16’
Doors: Plyco Corporation 20 Series
Foundation: 4’ deep concrete pier with stainless steel post brackets by Blunier Builders
Posts: Blunier Builders 3-ply 2x6 SYP
Roof Panels: McElroy Metal Kynar Max-Rib Ultra Steel
Wall Panels: McElroy Metal Kynar Max-Rib Ultra Steel
Insulation: 6” (R-19) batt
Trusses: Scissor trusses from Central Illinois Truss
Ventilation: McElroy Metal vented ridge and vented eaves
Windows: A.J. Manufacturing Harmony Series Vinyl Framed Windows
Additional Details: Plyco Corporation cupola and weathervane; Blunier Builders custom cedar porch trusses

GET MORE INFORMATION ABOUT PRODUCTS & SERVICES SEEN IN THIS ISSUE. HERE'S HOW:

If you are looking for more information from companies featured in this issue, fill out this form.

Mail the completed form to us, and we will have those companies get in touch with you. There's no need to fill out multiple forms; we'll do the legwork for you.

Name (please print)_____

Signature (required)_____

Company_____

Address_____

City_____State_____Zip _____

Telephone (_____)_____

E-mail_____Date _____

Please check one or more boxes to subscribe FREE/Renew for 3 years:

❑ *Garage, Shed & Carport Builder Magazine* ❑ *Frame Building News* ❑ *Metal Roofing Magazine*
❑ *Rural Builder* ❑ *Rollforming Magazine* ❑ *Roofing Elements Magazine*

I would like to receive my subscription: ❑ By Mail ❑ Digitally

❑ Check this box if you wish to receive our Builders' Express enewsletter and offers from our partners.
❑ Check this box if you wish to receive our Roofers' Express enewsletter and offers from our partners.
Email address is required to receive enewsletter.

CONTACT NAME & EMAIL (OR) NAME & PHONE NUMBER ARE REQUIRED. WITHOUT THIS INFORMATION WE WILL NOT PROCESS THE REQUEST.

SELECT A MAXIMUM OF 5 COMPANIES TO REQUEST INFORMATION FROM:

Company Name:_____PAGE: _____

Company Name:_____PAGE: _____

Company Name:_____PAGE: _____

Company Name:_____PAGE: _____

Company Name:_____PAGE: _____

I understand that by providing the above information I hereby consent to receive communication regarding my subscription via US Mail, telephone, and e-mail sent by Frame Building News.

Valid until November 30, 2021 **FN AUGUST 2021**

CHECK WHICH TITLE APPLIES TO YOU:

❑ President
❑ Owner
❑ Partner
❑ General Manager
❑ Sales Manager/Rep
❑ Engineer/Architect
❑ Vice President
❑ Foreman
❑ Installer
❑ Other_____

PLEASE CHECK THE PRIMARY CATEGORY THAT DESCRIBES YOUR BUSINESS:

❑ Builder, Dealer, Remodeler or Installer
❑ Roofing Contractor
❑ Metal Roofing Contractor
❑ Building Material Dealer/Distributor
❑ General Contractor/Remodeler
❑ Manufacturer/Rep of Manufacturer
❑ Architect/Specifier
❑ Construction Consultant/Engineer
❑ Building Owner/Developer
❑ Other (Please Specify)

_____

ENGAGED IN THE FOLLOWING APPLICATIONS:

❑ Gutters/Accessories
❑ Institutional
❑ Residential
❑ Agricultural
❑ Commercial
❑ Industrial

Send to: Barb Prill • P.O. BOX 255 • Iola, WI 54945; barb@shieldwallmedia.com

EVENTS CALENDAR //

Before making travel arrangements, check with the show producer to confirm there have been no changes to event dates, venue, or show hours.

September

13-16, FABTECH, McCormick Place, 2301 S. King Dr., Chicago, Illinois. fabtechexpo.com

21-23, Western Roofing Expo, The Mirage, Las Vegas, Nevada. www.westernroofingexpo.com

21-23, Associated General Contractors (AGC) Annual Convention, Orlando World Center Marriott, Orlando, Florida. convention.agc.org

21-23, Greenbuild International Conference + Expo, San Diego Convention Center, San Diego, California. https://informaconnect.com/greenbuild/

29-30, Shed Builder Expo, DeVos Place, Grand Rapids, Michigan. shedbuilderexpo.com

October

4-8, Building Component Manufacturers Conference, CHI Health Center, Omaha, Nebraska. https://bcmcshow.com/

6-8, METALCON, Tampa Convention Center, Tampa, Florida. www.metalcon.com

November

4-5, Garage, Shed & Carport Builder Show, Century Center, South Bend, Indiana. 715-252-6360; https://garageshedcarportbuilder.com/2021-gsc-builder-show/

16-18, DeckExpo, Kay Bailey Hutchison – Dallas Convention Center, Dallas, Texas. https://www.poolspapatio.com/en/deckexpo.html

16-18, International Pool / Spa / Patio Expo 2021, Kay Bailey Hutchison-Dallas Convention Center, Dallas, Texas. www.poolspapatio.com/en/home.html

December

6-8, Construction SuperConference, J.W. Marriott Bonnett Creek, Orlando, Florida. constructionsuperconference.com

2022

January

11, Wisconsin Lumber Dealers Leadership Conference, Glacier Canyon Conference Center, Wisconsin Dells, Wisconsin. www.nlassn.org/page/LeadershipCon, 888-544-6822

18-20, Frame Building Expo, Gaylord Opryland Resort & Convention Center, Nashville, Tennessee. nfba.org

February

1-2, NLA Expo Nebraska, Embassy Suites Hotel & Conference Center, LaVista, Nebraska. www.nlassn.org/page/expos, 888-544-6822

1-3, International Roofing Expo, New Orleans, Louisiana. theroofingexpo.com

3-4, NLA Expo Iowa, Sheraton West Des Moines Hotel, West Des Moines, Iowa. www.nlassn.org/page/expos, 888-544-6822

8-10, National Association of Home Builders (NAHB) International Builders' Show (IBS), Orange County Convention Center, Orlando, Florida. https://www.buildersshow.com/ ***FBN***

ADVERTISING INDEX //

ASK THESE ADVERTISERS ABOUT THEIR PRODUCTS TODAY!

CHECK WITH YOUR SUPPLIERS FOR

GARAGE • SHED • CARPORT BUILDER SHOW

SOUTH BEND, INDIANA

NOVEMBER 4-5, 2021

ENTRANCE FEE: $50 in advance - $60 at the door

TO EXHIBIT: gary@shieldwallmedia.com • 715-252-6360

TO REGISTER: www.garageshedcarportshow.com/show-registration

FOR HOTEL RESERVATION:
DoubleTree by Hilton South Bend
WEB: https://bit.ly/3rpLu76
PHONE: 1-800-HILTONS
ROOM RATE: $99
Group Code: TGC

ASC MACHINE TOOLS, INC · ASC · MADE IN THE USA · EST. 1949

GRABER POST BUILDINGS INC. GPB

smartbuild systems

QORA CLADDING | crafted by Arcitell®

KEVMAR MFG.

RICHLAND LAMINATED COLUMNS LLC

FREE PASSES!

DRIPSTOP
Condensation control

ASTAAMERICA
BY JANUS INTERNATIONAL

PPG

Ramco Supply

THE BRADBURY GROUP

Shed Windows and More®

APPLE
OUTDOOR
SUPPLY

SAFE-WAY
GARAGE DOORS
Make a Statement.

DYNAMIC FASTENER

Everything for the Metal Builder & Roofer®

FREE 140 Page Full Color Tool & Fastener Hand Guide provides prices, engineering data & details product offering.

DYNAMIC FASTENER is specifically geared to handle the needs of the Rural Building Contractor. We provide in-house custom color painting of screws and rivets with just a one or two day (days, *not* weeks) lead time. Over 100 million rivets, mostly pre-painted, & tens of thousands of power tools are stocked and sold at the lowest prices. Highest quality, top name brand fasteners are stocked and sold at the lowest prices. Same day shipment on orders received by 4:00 p.m. CST. We are a supplier to the largest metal building manufacturers.

We want to be ***YOUR*** source for screws, pre-painted rivets, anchors, flashings, Dyna-Guard® snow retention system, safety equipment, hand tools, power tools and accessories.

7 warehouses to serve your construction needs for tools and fasteners

(MAIN OFFICE)
Kansas City • Chicago • Houston • Las Vegas • Memphis • St. Louis • St. Paul

CALL 800-821-5448 or Order Online @ DYNAMICFASTENER.COM

Call for your Free Full Color 140 Pg. Hand Guide. Better yet, call us for your next tool or fastener requirement. Discover for yourself why your peers enjoy doing business with our company!