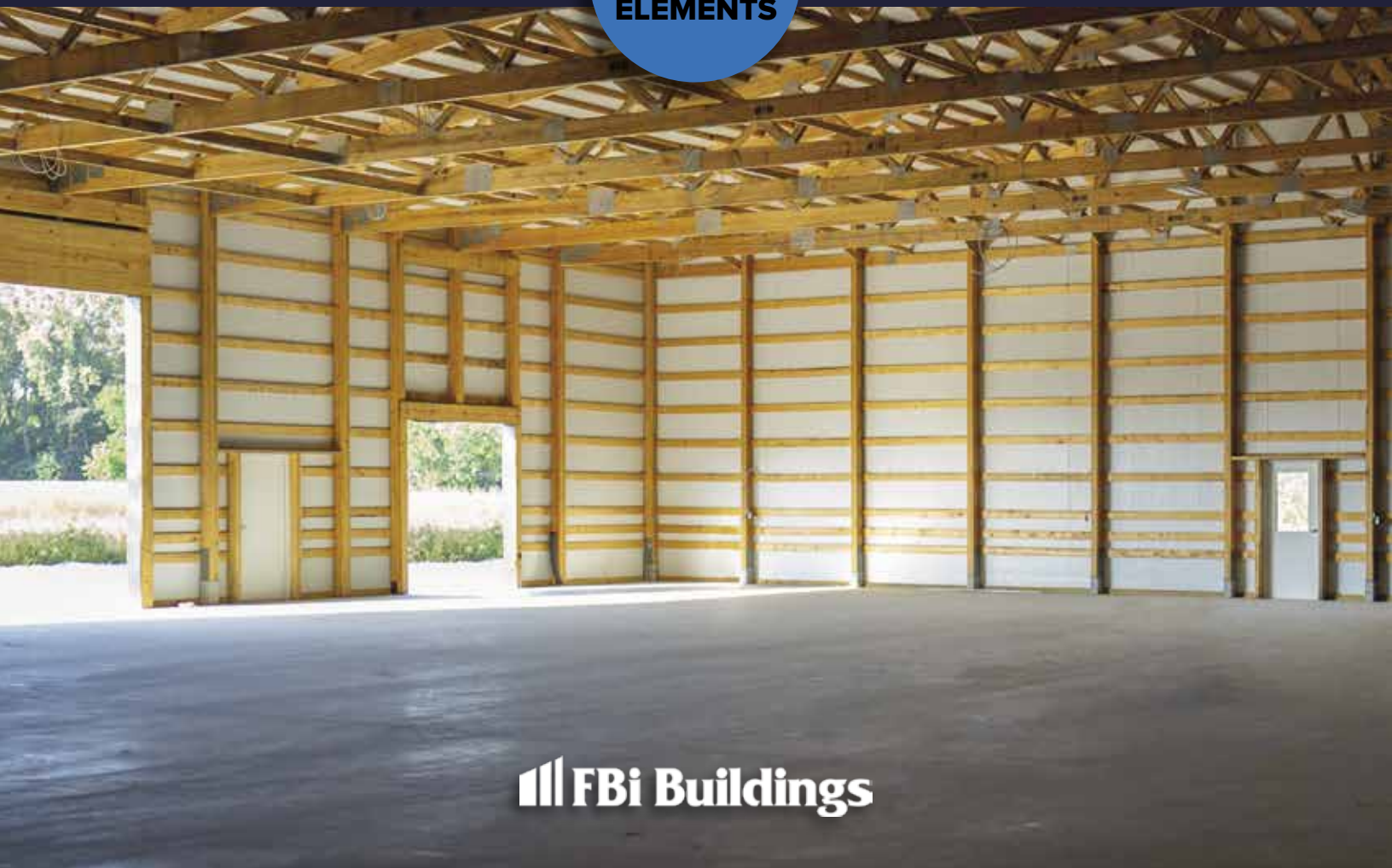
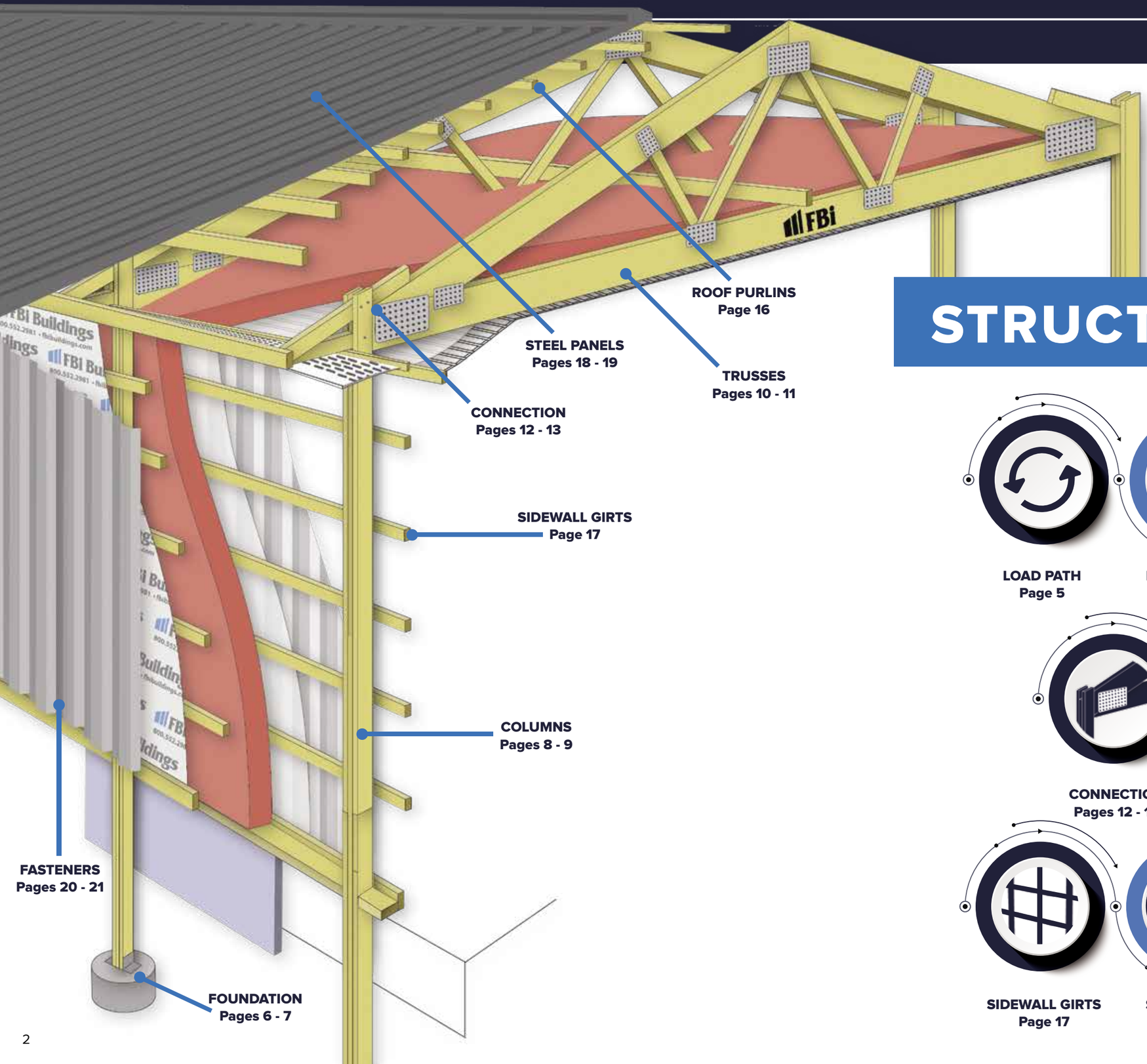
STRUCTURAL INTEGRITY

MAXIMIZE THE VALUE OF YOUR BUILDING INVESTMENT

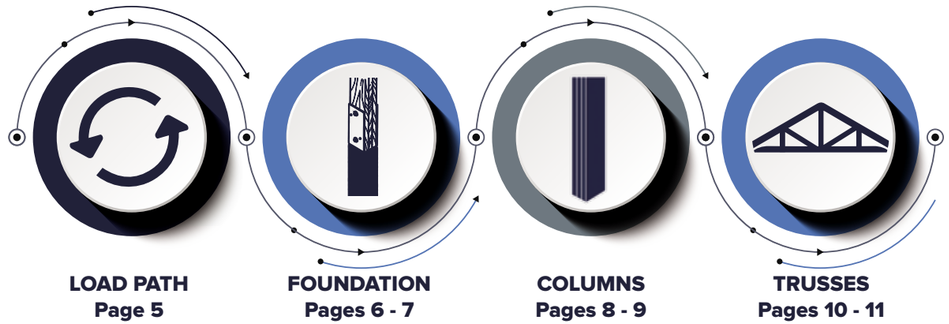
11
ELEMENTS

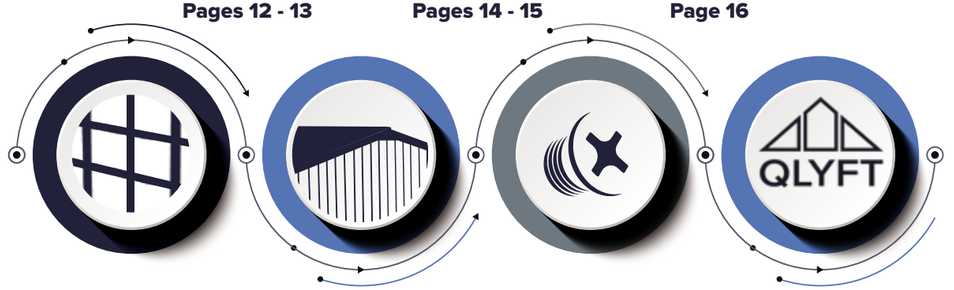


FBi Buildings



THE ELEVEN ELEMENTS OF STRUCTURAL INTEGRITY





SELECTING THE RIGHT

BUILDER IS IMPORTANT

Checklist on How to Choose the Best Builder for Your Project:

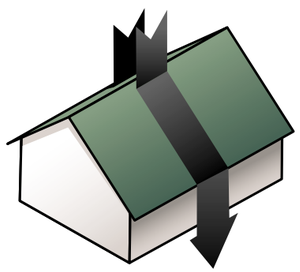
- ◯ Confirm that the builder has access to engineering resources.
- ◯ Find out who/where the trusses are manufactured.
- ◯ Knowledge of the skilled field labor and equipment required to build for longevity.
- ◯ Examine the builder's written warranty to ensure that the warranty is **non-prorated** and that the builder handles all warranty work.
- ◯ Ensure the builder is willing to provide a licensed engineer's stamp on all drawings that identify key building components.
- ◯ Ask about the builder's approach to risk management, does the builder have a written safety process, and ask to see documents regarding builder's insurance, workmen's compensation, and bonding.
- ◯ Ask for references; "ask around" about the reputation of the builder regarding quality of materials, craftsmanship and service after the sale.
- ◯ Find out how long they've been in business. Look for a long, successful track record and choose a builder that will still be around to service your building in the future.
- ◯ Determine how well your builder is prepared to help you through the planning process. See what resources and guidance they are willing or able to provide early in your project.

UNDERSTANDING WHY

STRENGTH IS IMPORTANT

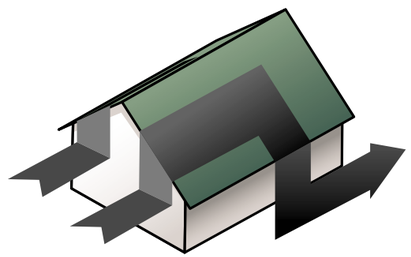
The load path transfers all vertical and lateral loads from one building component to another until they reach the foundation. Therefore, understanding the interaction between design loads and building materials is essential. Any pole barn, regardless of size and location, must be designed to resist the structural loads anticipated during its lifetime. These loads can be divided into two categories – *vertical and lateral.*

Vertical Load Path



Vertical loads: Loads acting in the up-and-down direction. Examples include building contents (e.g., decks, lofts, second stories), snowfall on the roof, and dead weight.

Lateral Load Path



Lateral loads: Loads that act in a direction parallel to the ground, such as high winds and seismic activity (i.e., earthquakes). However, these forces can work in any direction. Therefore, the pole barn must be designed to withstand parallel and perpendicular loads to any wall.

All structural loads must be able to pass from the areas in which the load is applied to the foundation.

SOLID BASES BY WHICH COLUMNS ARE SUPPORTED

Having a firm foundation consisting of properly installed footings is a critical component of structural integrity. Concrete footers must be:

- Adequately sized to support the intended structure and its design load depending on the soil-bearing pressure
- Extended below exterior grade to avoid frost action during the winter
- Properly installed over well-compacted soil
- Compliant with local building codes

Powder Concrete Mix *(Not Recommended)*

Avoid dry, powdered concrete mix as the basis for a load-bearing foundation. Powdered concrete requires ground moisture before it sets. Too little or too much moisture can cause instability *(shown right)*, thus, jeopardizing your building's structural integrity.

Pre-Cast Concrete Pad with Uplift Anchors *(Good)*

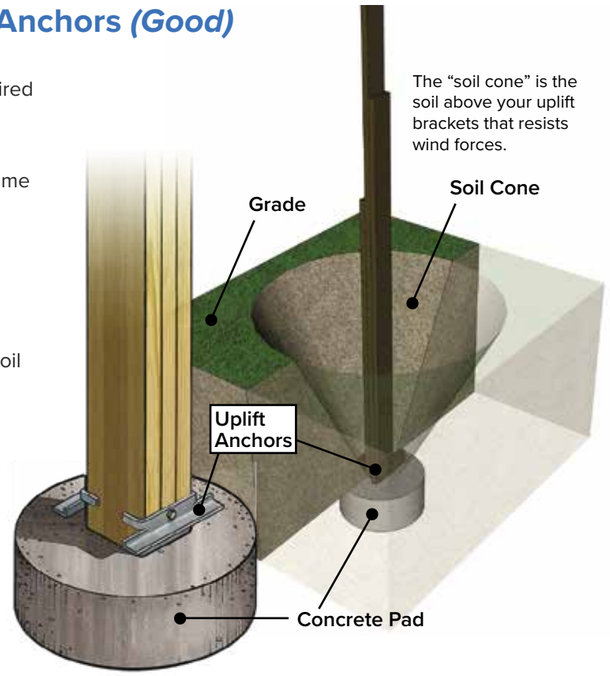
Uplift anchors are rigidly attached near the base of the embedded column to significantly increase the force required to pull the column out of the ground.

Poured-in-place or precast concrete pads provide solid, non-shifting, load-bearing support to prevent your post-frame building from sinking.

Option of Gravel Backfill

Be sure your builder offers you the option of crushed rock (gravel) for backfilling column holes. This option provides:

- More lateral and uplift resistance than backfilling with soil
- Less settling around the columns later (important if you have a concrete floor)



YouTube
Pole Barn Foundation Options

Pre-Cast Concrete Pad with Perma-Columns *(Better)*

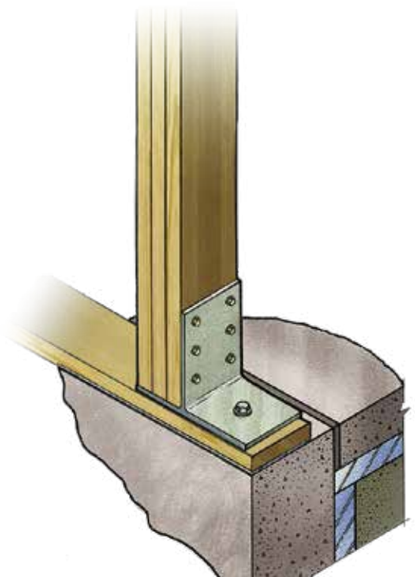
Alternatively, Perma-Columns are precast concrete posts representing the evolution of pole barn construction. They're sized to fit any laminated column or solid post.

This sustainable solution can withstand decay, insect damage, and rotting. No wood goes into the ground.

Using 10,000 PSI precast concrete, Perma-Columns are 3x stronger than standard concrete. Then, the posts are reinforced with a 60,000 PSI rebar welded to a ¼'' steel bracket.

Furthermore, they include microfibers to add shock resistance and durability. Microsilica enhances compressive strength and erosion resistance. A corrosion inhibitor protects the rebar reinforcement and brackets from rusting.

A final admixture provides freeze and thaw protection. Overall, this special mix guarantees a lifetime of durability. In addtion, you'll avoid expensive repair costs (i.e., rotten wood) by upgrading to Perma-Columns.



Column Bracketed to Concrete *(Better)*

If you opt for a continuous poured or block foundation, the columns should be firmly anchored to the base with specially designed brackets.

You want to ensure that the concrete is deep and thick enough to support the intended structure and exceed frost levels in your area. If not, the slab may be subject to frost heave.

THE BACKBONE OF BUILDING LOAD PATH

Columns, or posts, are integral parts of a post-frame building. They support the entire roof system and transfer all vertical loads to the footings. Also, posts are the backbone of your walls and assist in resisting horizontal loads caused by winds.

*Please remember that the diaphragm carries most of the wind load. Therefore, “oversized” columns won’t necessarily strengthen your post-frame building. However, having an engineered system will ensure peace of mind.

Treated Wood in Columns

The use of Chromated Copper Arsenate (CCA) wood preservative is EPA-approved for pole barn columns. Like newer treatments, such as Alkaline Copper Quaternary (ACQ), CCA has a long and proven history.

For maximum longevity, we recommend posts saturated with more than 0.80 lb./cu. ft. preservative. That’s 33% more than industry standards, which you’ll find at hardware stores and lumberyards.

Solid Columns

Typically a 4x4, 6x6, or 8x8 of solid wood, meaning it’s one solid piece. Unfortunately, these columns are difficult to treat because they are so thick. Therefore solid columns are susceptible to being affected by water, making them more likely to warp, crack, and rot.

2x6 Columns VS. 2x8 Columns

Once a building is taller than 16’, the columns may be increased from a 2x6-sized post (shown left) to a 2x8 post (shown right), depending on the building width and applicable snow load. This can also be referred to a 3-ply (2x6) column or a 4-ply (2x8) column.

Engineers may even recommend a 5-ply or 6-ply column in some larger buildings. When that happens, you may also see an upgrade to your trusses.

Laminated Posts

Typically, posts are made from 2x6, 2x8, or 2x10 lumber coated with preservatives and mechanically laminated with nails.

- Strong, stress-rated, and pressure-treated for longevity
- Highly resistant to twisting or warping
- Made from SYP with bending stress ratings of:
  - 1350 lbs./sq. in. (for 2x6 lumber)
  - 1950 lbs./sq. in. (for 2x8 lumber)
- Greater resistance to bending because there is very little chance of a knot being in the same place on all three pieces
- Stronger interlocking truss-to-column connections compared to connections made with solid posts
- Greater longevity because each layer of lumber is completely permeated with wood preservative and kiln-dried to lock in the treatment that prevents rot and termite damage

The grey circle to the right represents grade level.

Placing Columns at Appropriate Depth*

The column should be set below grade at an appropriate depth (typically 4ft) below the frost line and can maintain building strength. This placement ensures:

- Adequate resistance to lateral and uplift forces
- Columns won’t heave up due to frozen ground

YouTube
How to Choose Pole Barn Columns: Laminated vs. Solid

FBi Fact: FBi Buildings manufactures their own columns at their facility in Remington, IN.

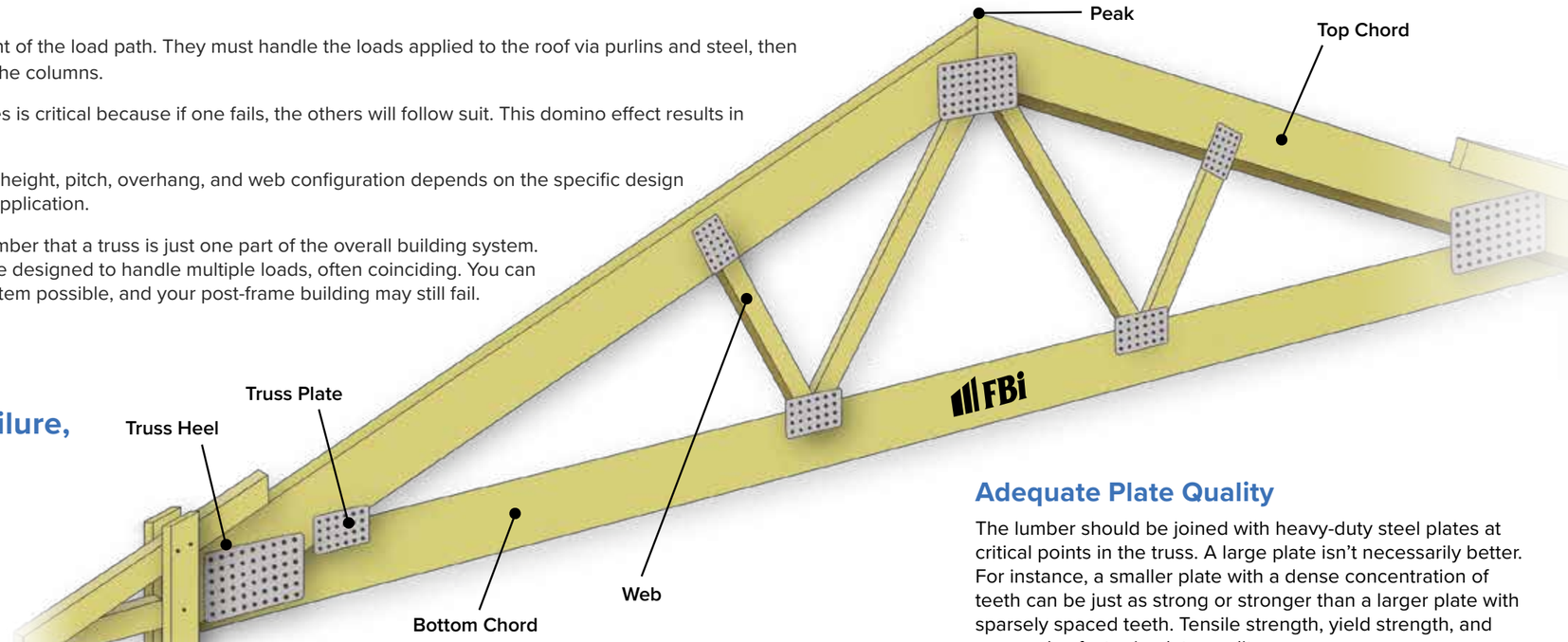
SPECIFIC TO EACH BUILDING & SUPPORTS THE ROOF

Trusses are a key component of the load path. They must handle the loads applied to the roof via purlins and steel, then effectively transfer them to the columns.

Having well-designed trusses is critical because if one fails, the others will follow suit. This domino effect results in building collapse.

The truss profile, span, heel height, pitch, overhang, and web configuration depends on the specific design conditions and will vary by application.

Note: It's important to remember that a truss is just one part of the overall building system. The entire pole barn must be designed to handle multiple loads, often coinciding. You can have the strongest truss system possible, and your post-frame building may still fail.



To avoid truss failure, we recommend considering the following steps:

Step 1

Truss Plant Certification by a Third Party

Select a post-frame builder whose truss plant is regularly certified by a third-party inspection service (such as the one provided by the Truss Plate Institute) to ensure the quality fabrication of all trusses.

Also important: You want to be confident that your trusses are manufactured under stringent quality control standards.

Step 2

Trusses Manufactured to Your Specified Load

Check that your trusses are job ordered and engineered for your pole barn. Your post-frame builder should be able to provide detailed drawings for your job that show material and construction specifications, plus load analysis. Ideally, your post-frame builder will have a professional in-house engineering staff that uses the latest computer-aided design and simulation systems to ensure strength and structural integrity.

ASCE 7 is a nationally recognized standard that defines snow loads for geographical areas, as well as a host of other criteria such as building exposure, thermal factors, importance categories, and the roof slope.

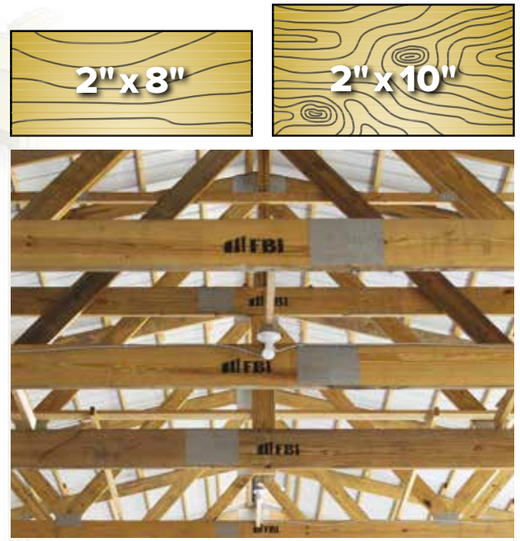
Adequate Lumber Quality

There are two ways to grade lumber: visually and mechanically. Lumber grade is important in two ways: aesthetics and design strength.

Engineers are primarily concerned with strength unless the wood is used as a "finish" or trim. Then, they use reference books, such as the National Design Specification for Wood Construction, to determine the design values for each lumber species and grade. These values show how much the wood fibers can handle in terms of bending, compressive, tensile, and shear stresses. Overall, the lumber grade has a substantial impact on the board strength.

Lumber Fact - Bigger is not always better. Fewer and smaller pieces of high-grade lumber can equal or exceed design loads of larger and more pieces of low-grade lumber.

Which is stronger? The 2" x 8" on the left or the 2" x 10" on the right? If the 2" x 8" piece is made of higher-grade lumber, it may be stronger in values such as bending, compression, and tension than the larger, 2" x 10" piece.



Adequate Plate Quality

The lumber should be joined with heavy-duty steel plates at critical points in the truss. A large plate isn't necessarily better. For instance, a smaller plate with a dense concentration of teeth can be just as strong or stronger than a larger plate with sparsely spaced teeth. Tensile strength, yield strength, and gauge also factor in plate quality.

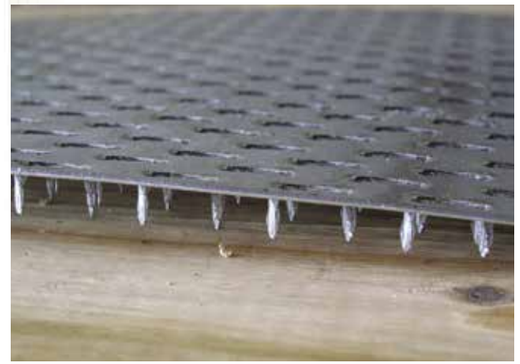
Careful Handling

How trusses are delivered to your job site is important. The more gently trusses are handled, the fewer times they're moved, and the greater the structural integrity.

Design Criteria

Get specific. Ask what design load the building is engineered to meet. Avoid ambiguous design specifications that only cover one part of the building e.g. steel gauge. Be sure to cover:

- Trusses meet or exceed the minimums for your area
- Potential future loads, such as drifting from future additions, ceiling materials, solar panels, lights, or storage areas



FBi Fact: FBi Buildings manufactures their own trusses at their facility in Remington, IN.

CRITICAL STRUCTURE POINT:

TRUSS-TO-COLUMN

Properly designed truss-to-column connections strenghten and stabilize the truss. It is vital that this aspect of the load path through which all roof loads are transferred to the ground be properly engineered and not left to the discretion of the builder.

Bearing Lumber

Follow the path to see how the loads are transferred from the roof to the columns to the foundation. High-quality construction and design optimize the use of bearing lumber and minimize points where the load transfer relies on the strength of fasteners.

Integrated Truss-to-Column Connections *(Recommended)*

Shown right, top

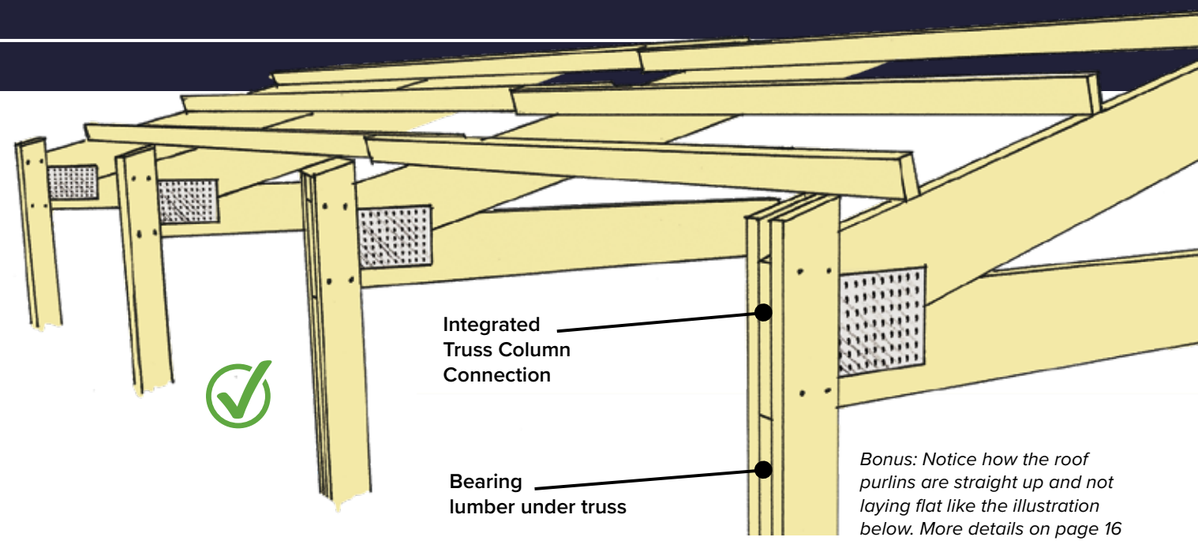
With an integrated or “saddled” connection, the truss is interlocked – not just attached to – the column. Secured from both sides with nails/screws/bolts, this truss-to-column design significantly increases the strength of the connection.

The results:

- A firm, interlocking wall system
- More efficient load transfer from the roof to the ground to efficiently transfer snow and wind loads
- Increases usable space in the building interior (doesn’t require knee bracing – a diagonal brace extending from the column to the bottom of the truss)

With overlapping connections, the truss simply sits on the top of or to the side of the column and relies on field-installed fasteners to transfer the loads.

FBi
Most Common Pole Barn Truss to Column Connections



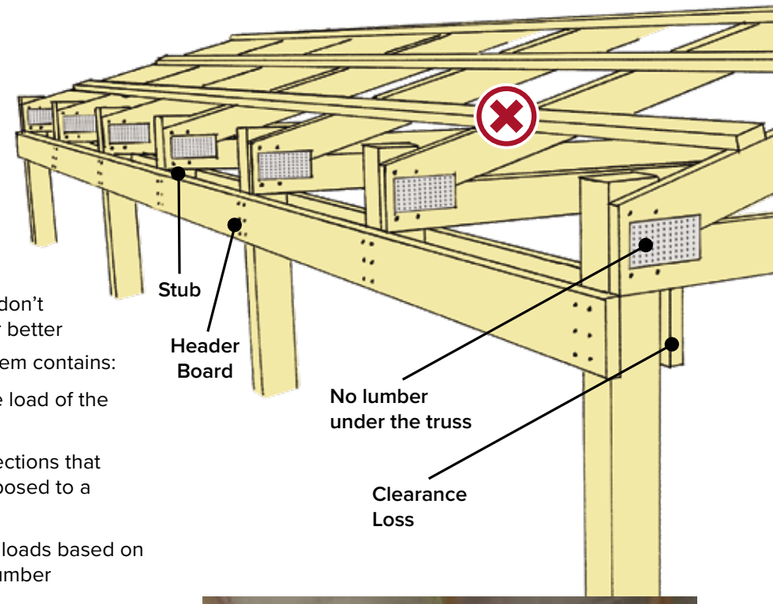
Bonus: Notice how the roof purlins are straight up and not laying flat like the illustration below. More details on page 16

4-foot O.C. Trusses Nailed into the Header *(Not Recommended)*

Shown right, middle

Post-frame buildings with 4’ on center trusses, continuous headers, and 8’ on center columns don’t necessarily constitute a stronger roof system or better truss-to-column connections. Typically, this system contains:

- Trusses that are designed to carry half of the load of the larger 8’ on center trusses
- More than twice the number of critical connections that need to be engineered and executed as opposed to a comparable 8’ on center truss system
- Connections that must be designed to carry loads based on strength of the fasteners, not load-bearing lumber
- Continuous headers that cause reduced clearance equal to the depth of the header
- Reduced bearing area for the trusses to set on



Knee Bracing *(Not Recommended)*

Shown right, bottom

Knee bracing is an outdated way to compensate for a weak truss connection. It also reduces the amount of usable space along side walls and can cause structural damage to the building if hit by accident.

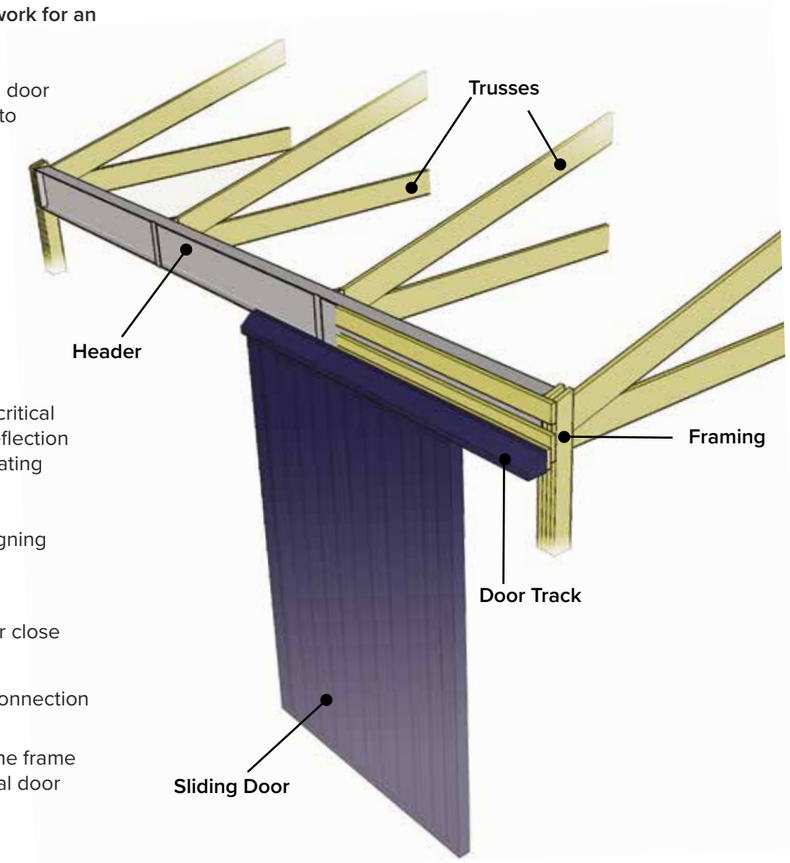
ENGINEERED ELEMENTS TO SUPPORT DOOR OPENINGS

Door frame outs in post-frame construction: the area of the post-frame building in which there is a framework for an open, sliding, or hydraulic door.

To accommodate snow and wind loads around door openings, the frame outs must be engineered to handle higher, concentrated loads.

A typical frame out includes:

- Foundation
- Jamb columns
- Header
- Blocking or bracing to connect the door to the building



The door frame must be rigid enough to align critical components for proper functioning. A slight deflection in the header could result in the door not operating correctly.

There are many criteria to consider when designing a door frame out, such as:

- Door type, size, and location
- The way and direction the doors will open or close
- Type of flooring
- Footing, header column, and header/truss connection

Your post-frame builder must be familiar with the frame out tolerances and forces to ensure a functional door system for years to come.

Door Header & Truss Support

Headers may be dimensional lumber, engineered wood, or steel. Some header designs provide more headroom or flexibility for a wider door opening.

- End trusses support doors on the end walls
- Sidewall doors and end doors shorter than the height of the end truss are generally supported by headers *(shown above)*

Note: Regardless of header type, be sure your frame out is engineered to hold the door, roof system, and the building around it.

Overhead Door Openings

When wind hits an overhead door, it transfers the load into the columns more so than on the header. With overhead doors, the deflection tolerance of the header isn't as critical, but it should still resist high winds.

Hydraulic Door Openings

Hydraulic doors can accommodate wider openings than overhead and sliding doors. When a hydraulic door opens, the top is pulled horizontally away from the post-frame building. The connection point at the top of the hydraulic cylinder applies a "twisting" force to the columns. Your post-frame builder must understand the implications of these loads.

Sliding Door Openings

When wind hits a sliding door, it transfers the load through the header, into the columns, and down into the foundation. The header or truss must be designed to resist the "buckling" inward force of the wind hitting the sliding door.

FBi
Which Type of Door is Best for Your Pole Barn?

PROVIDES STRENGTH TO THE ROOF & CARRY THE SNOW LOAD

Roof purlins provide framing for sheathing material attachment. Purlins must be designed and constructed to resist:

- Gravity loads, including weight of roofing material and snow
- Uplifting wind loads
- Loads imposed by laterally bracing rafters or the tops of trusses

Lumber Grade

When it comes to lumber grade, bigger isn't always better. Smaller purlins made from high-grade lumber may carry a heavier load than a larger purlin of low-grade lumber.

Proper Spacing

Check the specifications to make sure the purlin spacing has been designed to meet snow load requirements. Purlins should be spaced no farther than 24'' on center.

For gravity and wind loads, purlin spacing and size depend on how far apart the trusses are spaced. It's important that the maximum spacing be specified with the truss design.

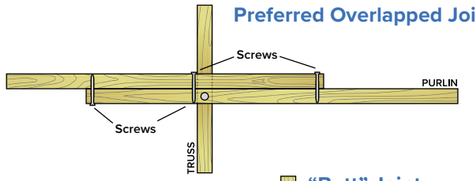
Be sure your post-frame builder accounts for the effects of truss bracing, chord forces, purlin strength, and diaphragm strength if using a wider span.

Pre-Drilled Purlins

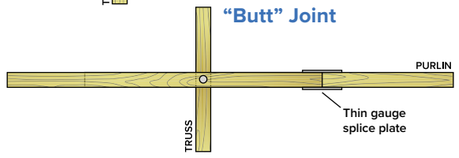
Pre-drilling the purlins before assembly ensures that the purlin is not "blown out" by nail guns during construction.

For added strength, it's recommended screwing the purlins together rather than nailing. *More explanation on page 21.*

Preferred Overlapped Joint



"Butt" Joint



Overlapping Ends *(shown above)*

This requires more lumber; however, overlapping purlin ends creates a stronger connection than butting the ends together.

Purlins on Edge

Purlins placed skinny side down make the piece more sturdy and increases the strength of the roof. Purlins laying flat on the trusses allows for more flexibility, therefore decreases the strength of the structure. *See illustration on page 13.*

YouTube
Post Frame Building Roof Purlins Installation Options

PROVIDES STRENGTH TO THE WALLS & CARRY THE WIND LOAD

Sidewall girts in post-frame construction: 2x4 or 2x6 secondary wall framing members are attached horizontally to columns to support the wall sheathing and carry wind loads. They also provide lateral support for the columns to resist buckling.

The number of girts and the spacing between them combined with the number and spacing of siding fasteners make a tremendous difference in the strength and stiffness of your post-frame building.

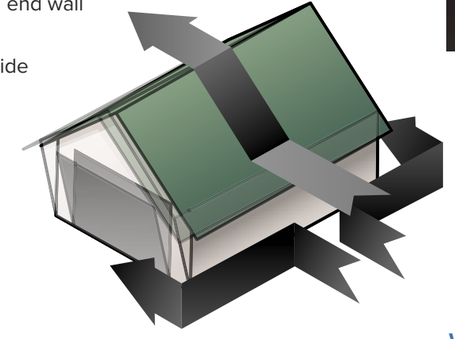
Understanding a "Shear Wall"

The wind impact on a poorly constructed post-frame building can cause it to lean or collapse. A shear wall is a reinforcement achieved with OSB sheets attached to the framing using multiple fasteners.

A post-frame building may need a shear wall when:

- It has a large opening on an end wall
- It is extra tall
- It is much longer than it is wide

Walls must be engineered to withstand all structural loads anticipated, including shear forces that can cause racking of the end walls.



YouTube
What is a Pole Barn Shear Wall and Why is it Important?

MOST COMMON MATERIAL

CORRUGATED STEEL

Wall siding panels in post-frame construction: wall siding panels are attached directly to the girts. As with roofing, the most common wall panel material for post-frame buildings is pre-painted corrugated steel.

Advantages of Steel

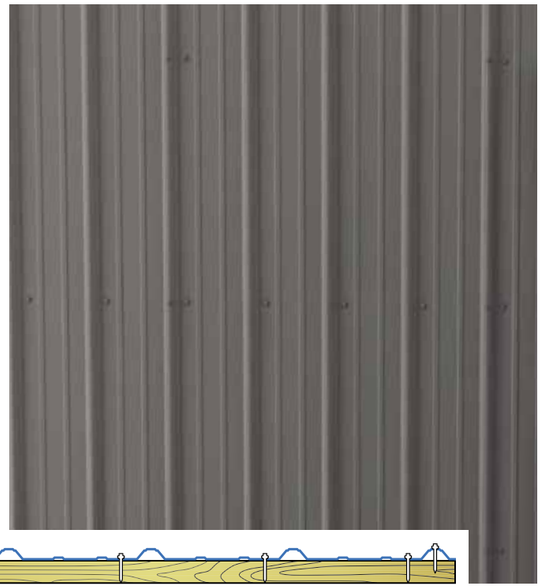
- Offers high strength
- Meets or exceeds all seismic code design standards
- It is more resistant to fire, floods, hurricanes, earthquakes, and other natural disasters (when used with properly installed, high-quality fasteners)

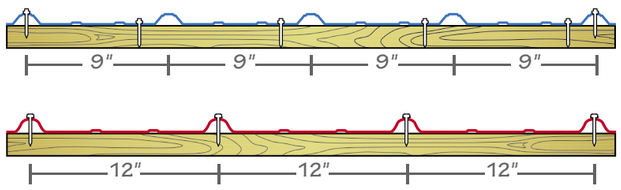
More Ribs = Stronger Steel

Generally, the more ribs (bends in the metal), the closer together, and the higher they are, the stronger the steel.

Closer Rib Spacing = More Fasteners

Since post-frame builders attach the steel at the ribs or the flat area near the ribs, the closer the rib spacing, the greater the number of allowable fasteners. The more fasteners used, the stronger the connection between the steel in the building frame.





YouTube
Steel Comparison Testing Video for Morton, Menards, & FBi Buildings

Steel is Measured in Two Ways:

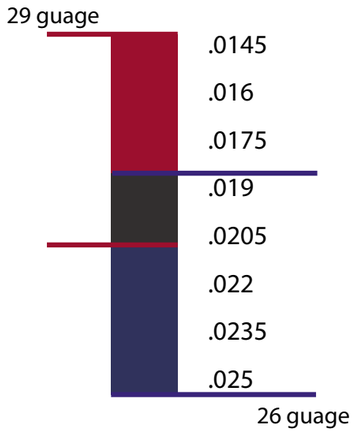
- Thickness (specified in gauge or inches)
- Yield strength is the amount of force required to cause permanent deformation. Hardness or resistance to denting is a function of yield strength.

High-Yield Strength

While the thickness of the steel is critical, it's only one part of the equation. Steel hardness is equally as important. Together, the hardness and thickness contribute to metal performance.

You want to ensure all the steel used in your post-frame building is full-hard, high-yield strength. This type of metal is nearly twice as hard as other steel and can improve pole barn structural integrity in two ways:

- Provide greater resistance to impact damage (e.g., hail or rocks)
- Facilitate heavier snow and wind loads



Grade	Gauge	Thickness (thousands of an inch)	Yield Strength (higher is better)	Maximum Uniform Load (higher is better)
Full-Hard	29	17.2	80,000 psi	160 psf
D-Grade	28	18.7	50,000 psi	122 psf
Commerical Quality	26	19.0	45,000 psi	132 psf

High-Quality Paint

Silicone-modified polyester (SMP) coatings are commonly used but don't provide the same protection against fading, chalking, and abrasion as Kynar 500®.

Right Photo:

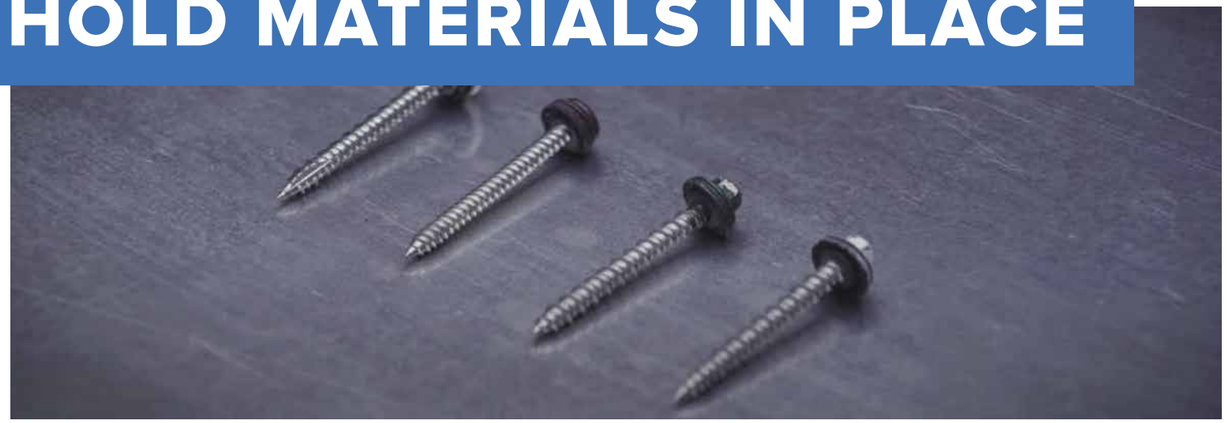
Silicone polyester coasted steel will chalk and fade as time goes by. The photo shown on the right shows how the different paint systems look after a 6-year period.

Siliconized Polyester *SHOWN ON LEFT*

Kynar 500® *SHOWN ON RIGHT*

FBi Fact: FBi Buildings was the first in our industry to use a Kynar 500® coating on all our steel panels.

RESTRAINTS THAT ATTACH & HOLD MATERIALS IN PLACE



In post-frame construction, the term “fastening system” refers to (A) the type of fastener used and (B) how/where it’s applied.

Much of the building strength comes from the diaphragm of steel formed by the roof and sides. The more securely the steel is affixed to the wood framing, the stronger the post-frame building.

In addition, the ability of a shear wall to resist lateral loads requires a well-constructed roof diaphragm. The two work together to transfer lateral loads through the shear wall to the foundation. The effectiveness of this system is only as good as the quality and quantity of connections.

What We Have Learned From Storms

During a storm, loss of roofing materials and sheathing is the leading cause of structural failure in wood framed buildings. The central reason behind these failures is inadequate fastening of sheathing to supporting members. Once the roof sheathing has been pulled off the roof framing, the diaphragm ceases to function, and the load path has been interrupted. This is why choosing the correct fastener is vital to your building’s structural integrity.

YouTube

Screw Comparison Video for Cleary, Morton, Menards, & FBi Buildings

Screws vs. Nails

When comparing pole barn builders, you should pay close attention to the fastening system each one uses to attach the steel siding and roofing. It’s worth your while to evaluate different offerings before making a purchase.

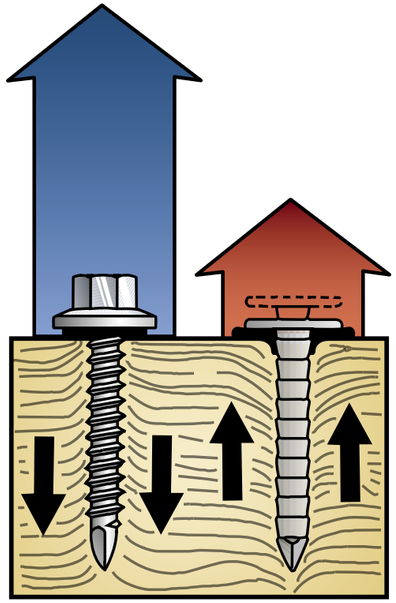
After all, the fastening system a professional builder uses can dramatically affect the structural integrity of your post-frame building. The right choice will provide a tight connection between wood and steel materials, ensuring a stronger structure that’ll still look good in the future.

When selecting a fastening system, we recommend using screws over nails. Why? Because the former has superior holding power compared to the latter (700 pounds vs. 250 pounds). But that’s only part of the story.

Wood fibers tend to return to their original position when a screw or nail is driven inside. Nails push the wood fibers downward, while screws pull the wood fibers upward. As the fibers return to their original position, they push the nails out and pull the screws tighter. *(shown right)*

When installing the fasteners into steel, post-frame builders have two choices: the top of the rib or the flat area in between the ribs. Connecting in the flat area is a tighter, more secure construction method. *(shown below)*

A firm, lasting grip maximizes seal effectiveness and strength. Next, look for a fastener encapsulating the rubber washer (the last line of defense against leaks). If your washer is exposed to weather elements, it’ll degrade over time and become less effective. Then, those pesky leaks will create a rotten and weakened structure.

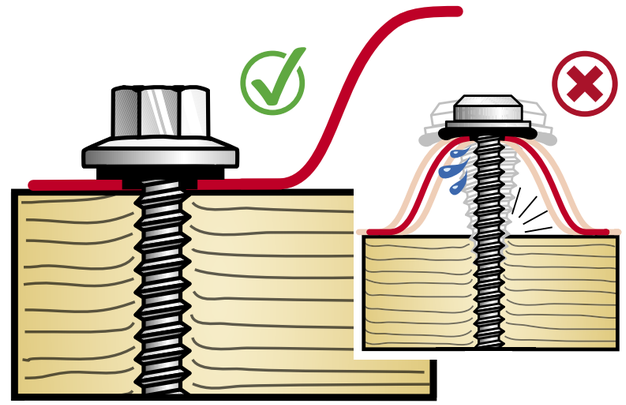


Wood fibers return to their orginal position when a screw or nail is driven into the fibers. Nails push the wood fibers down while screw fasteners pull the wood fibers up. When the fibers try to return to their original position, they will push out a nail and pull a screw tighter.

Fasteners Attached in Flat Area of Steel Panel

Installing the screw in the rib allows movement around the critical seal area, and that movement then compounds the potential for leaks. When a screw or nail is attached to the flat - instead of the ribbed area of the panel, a tighter connection is assured.

Since a post-frame building gets much of its strength from the steel panels, the tighter it is attached to the building, the better.



FBi Fact: FBi Buildings was the first to use stainless steel screw fasteners as a standard in all buildings.

LYFTING EXPECTATIONS

ONE BUILDING AT A TIME

The QLYFT building system was developed out of the desire to make sure field employees can work in the safest atmosphere possible, along with improving quality.

With the increased safety came numerous advantages over standard post-frame construction.

Enhanced Construction Quality

Constructions crews can install flashing, gutters, and overhangs at waist-level like never before.

This installation reduces damage, leaks, and repair work during/after the building process.

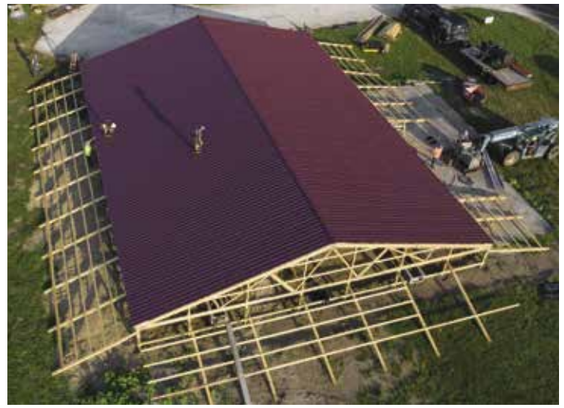
Transparent Inspection

The QLYFT building system lets customers inspect their roofs, gutters, trims, and trusses.

This level of transparency isn't available with conventional construction practices due to building height and safety concerns.

YouTube

How QLYFT Staging and Set Up Affects Your Building Construction



Less Strain on Materials

It's easier for construction crews to keep the trusses and walls straight, reducing the racking and twisting of building materials.

These components are plumbed and squared at 39 inches above the finished floor instead of 16 feet and higher.

Less Weather Delays

During QLYFT construction, your building is less vulnerable when the structure is assembled near ground level.

Because it's closer to the ground, the wind isn't as much of a hindrance when hanging trusses and running roof steel.

This building system is designed to lift roofs in windy conditions (up to 30 mph).

Reduced Power Line Costs & Delays

Because QLYFT construction occurs near ground-level, you can build closer to overhead hazards. It can save you time and money while increasing flexibility on building location.

QLYFT Components

The QLYFT building system is comprised of ten key parts that work together to raise your building.

1. Hydraulic Cylinders
2. Lasers
3. Controller
4. Power Unit
5. I-Beam Frames
6. Stinger Extension
7. Scissor Braces
8. Hinges
9. Safety Nets
10. Cut-Off Jig

Improved Crew Safety

Netting is installed along the lower roof system and exterior, meaning workers don't have to worry about scaling tall buildings or falling off.

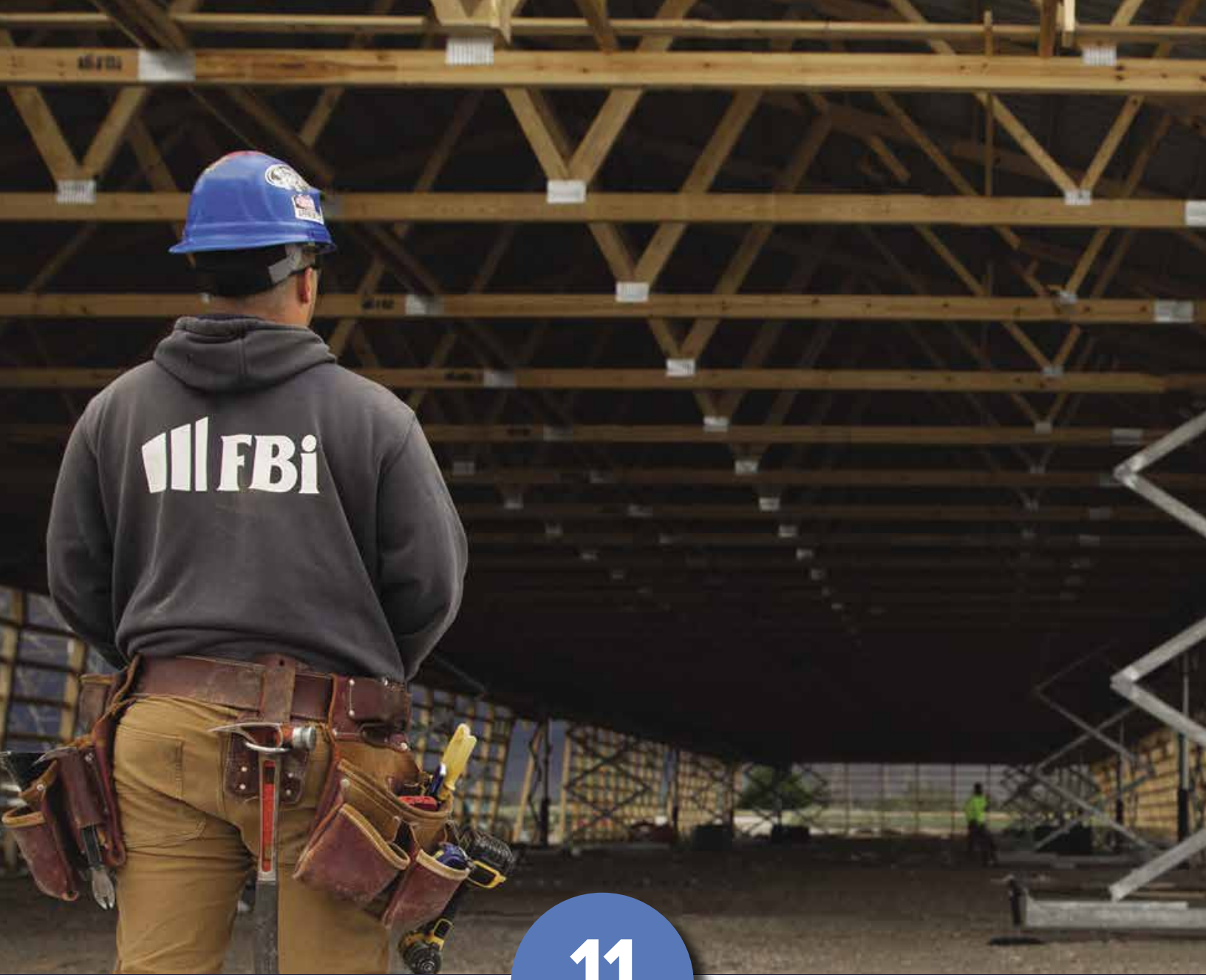
Instead, they can focus on quality construction.

The building process is also easier on one's body, resulting in lower turnover rates among tenured employees.

This crew experience allows for a level of construction quality that is unmatched.

FBi

FBi Fact: Launched in 2019, QLYFT has become the standard for FBi Buildings. Improving construction and empowering customers to *build with confidence.*



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ELEMENTS

FBi Buildings

3823 W 1800 S
Remington, IN 47977

800.552.2981 fbibuildings.com