HARDWICK POST & BEAM

Timber Framing Guide

for Architects and Designers

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Why is Hardwick Post & Beam the Architect's Choice?

Our timber frames offer the architect or designer new possibilities for creating visual appeal, a feeling of warmth and solidity, and interesting spaces. For clients seeking a distinctive building, the beauty of wood and fine craftsmanship, or cutting-edge energy efficiency, Hardwick Post & Beam offers an exciting alternative to conventional building. Timber framing lends itself equally to residential or public buildings, new construction or additions, and contemporary or traditional effects.

Founded in 1983 and in continuous operation under the same management ever since, our company has built and erected over 500 unique timber frames. Our product, our process and our experience combine to make your job easier and to ensure your client's satisfaction. Your goals for your next project are all we need to begin a great collaboration.

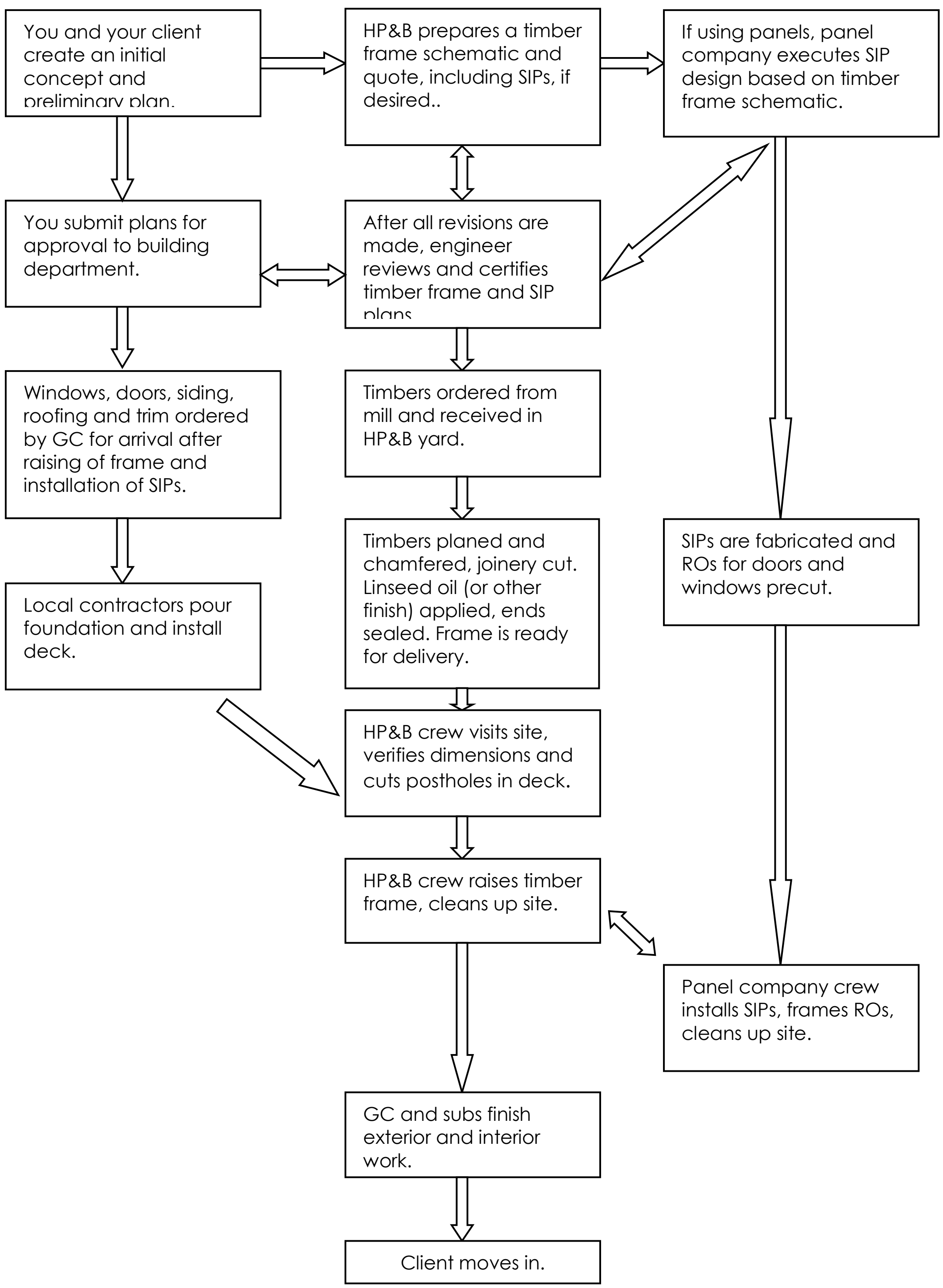
Our product

- Hardwick Post & Beam builds authentic timber frames with heavy timbers connected by dovetail mortise and tenons and other time-tested joinery, secured by large wooden pegs. The housed joints mask timber shrinkage and resist tension and compression stresses. Our frames are beautiful, universally admired and built to last for centuries, the ultimate in sustainability. Clients offer testimonials and referrals.
- Our timber frames combined with structural insulated panels (SIPs) are highly energy efficient. These panels are "sandwiches." Curtainwall panels are available with blue board for paint or plaster; in the middle is rigid foam insulation; on the exterior is sheathing for shingles or clapboards. Structural panels are also available, with sheathing on both sides and a choice of interior and exterior finishes.
- We can also assist you with other LEED-inspired energy saving and "net zero" ideas for clients interested in minimizing their energy footprint.
- We have the skills and versatility to accept unusual projects, large or small, and have never built the same frame design twice. In addition to design creativity, Hardwick Post & Beam works in a variety of woods and finishes with special details where needed.
- Clients typically choose Douglas fir or native red oak, but we also build frames out of eastern white pine, southern yellow pine, hemlock, and other woods according to the client's preference.

Our process

- Most of the work of producing a frame is cutting the joinery in our workshop. Because the cost of trucking the frame to the site is a small percentage of the total cost, we can work with architects and contractors anywhere in the U.S.
- We respect your client relationship and work as a sub-contractor to you on your project. All design consultation and construction drawings are done under your direction. Our communications with your client are pre-authorized and confidential.
- We provide a complimentary timber frame schematic and an accurate quote based on your preliminary design, so you know actual costs before making a commitment. Turn-around time on this and subsequent drawings is fast to help keep you on schedule.
- Typically we visit the job site prior to construction and continue collaboration with the architect or sub-contractors as needed throughout the project.
- Hardwick Post & Beam works in the traditional timber framer's manner with green lumber, saving drying time and expense and providing a margin of safety (the structural properties of most woods are improved as the erected timbers season). Our timber comes from sustainably managed forests and is primarily locally sourced. Established mill relationships assure reliability. Reclaimed timber is available if your client desires the look of aged wood or an historical feel.
- Unlike many of our competitors, Hardwick Post & Beam uses no CNC (computer numerical control) machinery. All timbers are crafted by hand, and the craftsmen work as a team.
- The team of craftsmen that cuts the frame also erects it on the client's site.
- For insulated buildings where structural insulated panels (SIPs) are used to enclose the frame, we manage the relationship with the panel company of your choice or recommend a panel company.

Working with Hardwick Post & Beam: A Flow Chart



Step by Step: From initial contact to a completed project

1. We like to be involved as early as possible in the design process to assist in incorporating architectural elements specific to timber frame construction. Once we have your design or sketches, at no charge **we will create a workable timber frame schematic based on your preliminary design and give you an exact quote** of the frame shown in the schematic. At the same time we can calculate the cost of enclosing the frame with SIPs (structural insulated panels), based on the dimensions and framing shown in the schematic, if you choose this wall system option. We usually present our proposal in person.

2. Typically **we visit the construction site** to see the topography, access from the road, and other factors that may impact construction. A site visit is particularly important to discussion of energy savings and "net zero" ideas for the project.

3. We understand that the final design may be very different from the preliminary on which the schematic is based. **A design expert is always available by phone or email to answer questions and provide assistance if you wish to modify the preliminary plan.** Our design team works with any of the standard auto-CAD formats, preferably with all pages incorporated into a single file. Zipped files should be emailed to newell@hardwickpostandbeam.com. CD format and snail-mail are alternatives. We can get back to you quickly with any changes you want to make to the preliminary design.

4. **Subsequently, we quote a design fee for construction drawings based on the final design of the project.** We offer licensed engineering certification and stamped structural drawings as needed. For inquiries and information, call Newell Pledger-Shinn at 413.477.6430 or email newell@hardwickpostandbeam.com.

5. **A 50% deposit on the timber frame secures your place in our schedule.** Hardwick Post & Beam is a specialized craft shop that takes on a limited number of projects and provides a high level of individual attention and customer service. We are in production year-round, but because most clients in colder climates want delivery in temperate weather, the demand for deliveries from spring to early fall is greater. We allocate design, engineering and production resources in the order that clients contract with us. To assure timely delivery it is best to plan your project with us as early as possible.

6. **The frame is cut in our workshop by a team of craftsmen skilled in traditional joinery.** The team is familiar with the entire frame and how each element fits within the whole. Each timber is cut, planned, and oiled by hand or otherwise finished according to specifications, and marked for set-up. Timber frame production time is typically three to four months from receipt of deposit to a handcrafted frame, bundled for shipment to the client's site.

7**. The same craftsmen who cut a frame in our shop erect it on the client's site.** They are intimately familiar with the frame from its conception and can answer any questions or respond to any problems without delay. Before the raising we go to the job site to verify all dimensions and cut the holes in the deck for posts to pass through to the foundation sills. **We arrange for the crane used to hoist the timbers and bents, and assume full responsibility for all aspects of the raising.** The raising of a Hardwick Post & Beam timber frame is typically a very satisfying experience for clients. They are inevitably impressed by teamwork of our craftsmen and we welcome their presence during the raising.

8. **If your design includes a SIP wall and roof system, typically the installation by an experienced panel crew follows the raising of the timber frame.** This crew frames the pre-cut rough openings for doors, windows and chimneys. It is the owner's or general contractor's responsibility to have the necessary lumber delivered to the job site for window and door framing. Once the installation is complete, the job site is cleaned up and all debris either removed by the panel company, bagged for transport by the owner or general contractor to the local recycling facility, or placed in a dumpster. The structure is now ready for roofing, siding and the installation of windows and doors. It is advisable to coordinate the roofing contractor's arrival with the departure of the panel crew.

Design Considerations

1. Full timber frame vs. timber frame hybrid

Combining timber frame with conventional framing in new construction is a possibility where a particular aesthetic effect is desired, and we welcome collaboration on such projects. Timber frame ells or additions to existing conventionally built structures also work very well.

Sometimes a hybrid frame is explored for new construction as a cost-saving measure, but taking into account design possibilities, the speed of raising the frame, the energy savings and the overall strength of the structure, the actual cost is comparable to conventional construction. It is often more straightforward to complete the entire structure in timber and SIPs. Where the hybrid option is the preferred choice, you may rely on us to help create a sound, aesthetically pleasing structure.

2. Utilizing structural insulated panels (SIPS)

Although this is just one of a number of wall system options, SIPS are an especially energy-efficient choice for both residential and commercial projects. These panels have an insulated core of either expanded polystyrene (EPS) or extruded polystyrene (XPS) or polyisocyanurate (PIR) sandwiched between layers of oriented strand board (OSB) or interior drywall, or combinations of these or other materials. Window and door openings are precision cut at the factory, saving time and eliminating waste material on the jobsite. Panels come in sizes of up to 8 ft. by 24 ft. to minimize handling and joints. No cutting or sizing of the panels is normally needed on the jobsite. High center of cavity R-values and tight construction to reduce thermal bridging make these wall systems extremely energy efficient. There is no off-gassing. Your client will experience savings of up to 60% on energy costs and high interior air quality.

3. Floor Systems

A Hardwick timber frame is generally erected on a deck built upon a minimum 10” thick stem wall foundation of reinforced concrete. The deck consists of TJI© engineered joists on 16” centers supporting a plywood or OSB subfloor. Crossbeams or girders are required where interior posts will be placed. These may be further supported by concrete or pressure-treated basement posts or lally columns provided by the local contractor.

Prior to raising the timber frame, our crew cuts the openings in the deck where posts will be placed and checks all dimensions. The posts pass through the deck and rest directly upon the pressure-treated sill plates on top of the stem wall and upon the girders. Local codes in areas where there is a high wind or seismic loading may require the installation of Simpson straps to further secure the posts to the foundation. Because Hardwick Post & Beam designs its frames to rest directly upon the foundation sill plates, there is no need for the local contractor to provide pressure-treated support posts around the perimeter of the foundation. Our frames may also be erected over slab foundations or crawl-space foundations that are of adequate strength.

4. Floor plan and post layout

Our posts are fully visible inside the structure and can be incorporated in the design to define areas within it. The great strength of a properly designed timber frame allows flexibility in the creating of open spaces; design possibilities are not restricted by the need for load-bearing walls. Second floor posts that line up with posts below add strength, but this alignment is not always required for structural integrity. Clear spans are governed by the load-bearing capacity of the timbers, which varies from species to species. We work primarily in sustainable Douglas fir and red oak. Our designers and engineers can assist in creating designs that conform to the characteristics of the specified timber.

Top plates and joists support the second floor system, and can be left exposed on the ceilings of the rooms below. The second floor decking can serve as the first floor ceiling, but consideration must be given to sound transmission. This design works best for small houses or where the use of the rooms generates little noise. One-inch tongue-in-groove spruce, pine or fir car decking can be used inexpensively to create a finished floor above and a ceiling below.

Alternatively, a second floor system of 8", 10" or 12" joists applied over the timber frame joists creates a sound and dust barrier and provides space for recessed lighting below and wiring and plumbing chases above. By adding four-inch square shims at intervals to the tops of the timber joists and plates and making corresponding cut-outs in the ceiling sheetrock, the sheetrock can be laid on prior to installing the TJI© joists, which rest upon the shims. This makes the sheetrock installation easier and faster by eliminating the need to cut and size it to fit between the individual timber joists. Painting the sheetrock prior to installing it adds further savings in time and effort. Soundboard can be installed to dampen noise.

5. Drywall and SIPs

To avoid difficulties and extra expense during construction, allow for the thickness of the interior finishes when designing a timber frame floor and wall plan. Hardwick Post & Beam and the panel company, if panels are used, will manufacture to the exact dimensions shown on your drawings. Standard SIP wall thicknesses vary, and this needs to be taken into account in their application to the exterior surfaces of the timber frame. For example, timber frame posts inset 4.5" on the stem wall to allow for a SIP overhang of 2", which in turn allows for 2" rigid insulation applied to the foundation in cold climates. SIP roofs are likewise applied directly over the rafters and purlins. Tongue and groove interior paneling or ceilings, if specified, are applied to the SIPs before installation. This typically adds 5/8' of thickness to the SIP, requiring a corresponding adjustment to the inset of the posts in your design. See http://www.foardpanel.com/TechnicalInformation.htm for fuller information SIP options, including dimensions and technical data. SIPs specified with interior drywall pre-applied, may be painted on the ground before installation where climate permits.

6. Plumbing

As with traditional stick-built construction, plumbing should be run through the interior walls of a timber frame structure. These are generally framed with 2"x4" or 2"x6" lumber, allowing the plumber to run the supply, waste and vent lines in interior partition walls in the traditional manner. Local codes may allow fixtures, such as a kitchen sink, to be placed on an exterior wall and to be vented by alternative means. If you design a SIP wall system, it may be furnished with pre-cut pipe chases.

7. Electrical

The wiring of floors, crawl spaces and interior partitions is identical to that of traditional stick-built construction where your design specifies 2"x4", 2"x6" or other standard exterior wall systems. If you choose a SIP wall system, three practical alternatives are available for wiring chases:

a) The electrician cuts openings in the interior surface of the SIP for switch plates and outlets, scoops out the insulation material and, using a flexible drill bit, creates a vertical chase to pass wiring through the insulation to horizontal wiring he has run below the floors; or

b) The carpenter builds out the baseboards to create space for horizontal wiring chases. This alternative has the advantage of facilitating the installation of new wiring for cable, internet or home entertainment areas that may be added later; or

c) The SIP manufacturer builds in a 1.5" horizontal wiring chases at outlet and switch height and vertical chases at 4' intervals to crawl space or ceiling locations you specify. This alternative, however, adds cost to the SIPs. Wiring chases may also be custom designed for outdoor lighting, ceiling fans, sconces and other electrical apparatus.

Locate the main breaker panel on an interior stud wall whenever possible to allow for the easiest access to spaces above and below.

Even electricians with no experience working with SIPs soon come to realize that timber frame/SIP wiring procedures are straightforward and accomplished without significant additional time or effort.

8. Heating and cooling

If your design includes SIPs with their high insulation value, this may permit you to reduce the size/capacity of the heating and cooling systems, as well as explore alternatives, such as solar and geothermal. In some cases, given the high cost of heating oil, electric baseboard heat may be practical in a timber frame/SIP design. The tightness of the timber frame/SIPs construction makes a mechanical ventilation system necessary. Your design should include an air-to-air heat exchanger system. For complete information on SIP insulations values and whole wall performance see: http://www.foardpanel.com/TechnicalInformation.htm. In rare cases, some hairline separation of drywall joints or painted surfaces adjacent to timber frame elements may occur as the frame seasons.

9. Roof pitch and timber frame trusses

A minimum roof pitch of 9/12 is recommended for the widest choice of timber frame truss styles. Hardwick Post & Beam will work with you to offer your client aesthetically appealing and structurally sound options. For principal rafter, common rafter, or shed roof systems that don't involve trusses, roof pitch can be as low as desired, though anything less than 4/12 may be inadvisable in snowy climates.

10. Fire resistance of timber frame construction

Among the advantages of true timber frame construction is greater resistance to fire and a lesser likelihood of early collapse. The NFPA Fire Protection Manual 2003, Sect 12, Chap. 11, in its evaluation of the fire resistance properties of different structural materials, states as follows:

"When wood structural members are subjected to fire, the ability to withstand the imposed loads is dependent to a degree upon the remaining undamaged cross-sectional area. The average rate of penetration of char when flame is impinged upon an exposed wood member is approximately 1.5 in. (38 mm) per hr. Beyond the char area to a distance not more than 1/4 in. (6 mm), the structural properties of wood may be affected by its exposure to high temperatures. The degree of strength loss in this small zone adjacent to the char is not exactly known but is presumed to be insignificant.

“Fire tests made on two solid sawn wood joists, 4”x14” (102 by 356 mm), nominal size, at the Southwest Research Institute showed that, after 13 min. of fire exposure, 80 percent of the original wood section remained undamaged and available to carry the load. In another test of two 7”x21” (178 by 533 mm) glued laminated beams, after 30 min. of fire exposure, 75 percent of the original wood section remained and continued to support the design load. The previous tests, as well as actual fire experience, substantiate the fact that ***large-dimension wood members will remain in place under fire conditions and continue to support design loads.*** (Emphasis added.) … Wood roof structures constructed with 2”x4” and 2”x6” members, have a history of lethal, sudden collapse, when exposed to fire. The practice in older, wood frame buildings was to diagonally cut the tops of wood beams within the bearing wall pocket so that in the event of failure due to fire, the weight of the member would not tear out the wall masonry and/or cause collapse.”

Hardwick Post & Beam crafts housed dovetail joints and haunches or shoulders in posts at key points of joinery to assure maximum structural strength, reducing the danger of premature collapse, gaining time for occupants to escape a fire and decreasing the risk to firemen entering the building.

Contact Us: We would like to hear about your project

We welcome inquiries at any stage. Information shared is confidential and your client relationship respected. Please call or email Craig Bridgman: cell 860.235.1423, craig@hardwickpostandbeam.com. Our postal address is: Hardwick Post & Beam, P.O. Box 225, Hardwick, MA 01037 and our fax number 413.477.0937

Glossary

Bay: In timber frame construction the space between two bents. Recommended spacing is between 10 and 14 feet, but smaller and larger spaces may be incorporated into a design.

Bent: A section of a timber frame consisting of posts, cross beams and braces usually assembled on the ground and raised into place on the foundation or sill beams.

Bird's mouth rafter seat: A common form of joinery, usually not pegged, that provides a bearing surface for rafters where they meet horizontal plates, resisting downward and outward forces.

Blind mortise and tenon: A joint in which the mortise is not cut all the way through the timber. It is used mainly where there is little or no pull-apart tension, such as girts between posts, or where gravity holds the construction together.

Braces: Short diagonal timbers used between vertical and horizontal members that form a triangle to stiffen the frame and resist racking. They are usually placed at two to four feet from the junction of the main timbers and tenoned into them. Also known as wind, sway or knee braces.

Buckling: The bending of a timber as a result of compression.

Cantilever beam: A horizontal timber that supports an overhang.

Checking: The splitting and cracking that may occur in certain species of wood as drying occurs.

Collar tie: A horizontal crosspiece tenoned between two opposing rafters and forming a triangle to stiffen the structure and resist racking.

Compression: The effect of resistance to a load, such as a beam resting on top of a post,that places a stress on the supporting timber and tends to reduce its volume or mass. See "Tension."

Crossbeam: The horizontal timber at the top of a bent between two posts.

Cross sill: A beam that rests on the end of a foundation and is joined to the long sills, which support the floor joists.

Crown: The convex side of a timber.

Crushing: Failure or deformation of a timber because of compression.

Curtain wall panel: A non-load-bearing SIP used to enclose the roof and sides of a timber frame. See "Structural insulated panel."

Deflection: The sag in a horizontal floor or roof timber. Building codes define permissible deflection. Also see "Crown."

Dovetail lap joint: A wedge- or V-shaped joint that resists pull-out and requires no pegging. (See Appendix: Joinery)

Drop: The decorative lower end, usually tear-shaped, of an upper story post.

Girder: A major timber spanning sills. Also see "Summer beam."

Girt: A horizontal timber tenoned crosswise or lengthwise between two posts.

Gunstock post: A vertical timber that is wider at the top than the bottom to provide extra timber for compound joinery.

Half dovetail joint: A dovetail joint flared on only one edge and used to connect collar ties to rafters.

Hammerbeam truss: A truss constructed of short, curved lateral timbers whose interior ends are supported by short posts suspended from the rafters joined by collar ties and strengthened with knee braces to create an open space below that extends virtually to the roof.

Housed mortise and tenon: A joint whose mortise is recessed to receive and support the end of the beam tenoned into it. (See Appendix: Joinery)

Housing: The shallow cut-out in a post or beam that receives the full end dimension of a beam joined to it. Usually added to a mortise and tenon joint to add support to the tenoned beam. (See Appendix: Joinery)

Kingpost truss: A truss with a single support post suspended from the ridge of the roof bisecting the structure and forming two right triangles. The kingpost truss may be strengthened with struts from its base to the rafters creating four isosceles triangles. Also see "Truss."

Knee brace: See "Braces."

Lap joint: a joint made by overlapping two timbers either at the ends or at a point where one crosses the other (through half lap). An equal amount of wood is removed from each timber so the two joined together are on the same plane.

Long sill: A beam that rests on the long dimension of the foundation and supports the floor joists.

Mortise: A hole or slot cut into a timber to receive a tenon in order to form a tight joint. (See Appendix: Joinery)

Open mortise and tenon: A narrow mortise open on three sides cut into the end of a timber into which a tenon is inserted to form a joint.

Peg: A dowel usually one to one and a half inches thick used to secure joints in timber frame construction.

Plate: A beam laid along the top of a wall to support the ends of joists and rafters laid at right angles to the wall.

Post and beam: Sometimes used to describe a non-traditional construction based on vertical and horizontal beams in layers, with each floor built independently from the others. Nails and metal brackets are used to connect the members. *Hardwick Post & Beam frames are true timber frame, not this kind of construction.*

Purlin: A horizontal connecting timber between two rafters.

Purlin plate: A horizontal timber mounted on secondary bents in large structures to give extra support to the rafters.

Queenpost truss: A truss with two supporting posts suspended from the rafters and fitted with a collar tie to form a usable rectangular under-roof space. Also see "Truss."

Racking: The distortion of a timber frame or its components by sideways forces, e.g., of wind, because of inadequate bracing or joinery failure.

Relish: The wood left between the peg hole and the end of a tenon that resists tension on the joint, or the wood left between the edge of a mortise and the end of the timber. Relish refers to the weakness of this wood in poorly designed or executed joints.

Ridge Beam: A horizontal timber supporting rafter pairs and forming the longitudinal line of a roof.

Ridge Beam / Common Rafter Frame: A construction in which rafter pairs meet and are fastened to a longitudinal timber supported centrally by posts.

Scarf joint: A lapped joint of varying configurations used to splice two timbers together to form a longer one or to repair damaged posts or sills by splicing in new timber.

Scissor truss: A type of roof support system with diagonal, crossing ties from eave posts to opposite rafters that allow for greater spans than rafters alone.

Shear failure: Slippage along the fibers or layers of a timber that reduces or destroys its load bearing capacity.

Shoulder (or Haunch): A narrow shelf or ledge cut at an angle into a mortise joint upon which the beam tenoned to it can rest for extra support.

Shouldered mortise and tenon: See “Shoulder.”

Sill beam: A timber that rests on the foundation and supports vertical and horizontal members of the upper frame. See “cross sill” and “long sill.”

Simple truss: See “Truss.”

Structural Insulated Panel (SIP): Sometimes called a “stress skin panel.” A flat, rectangular building component consisting of a core of insulation material sandwiched between two outer surfaces, usually OSB or drywall or both. Used to enclose a timber frame to reduce construction time and cost and to enhance the energy conservation properties of the finished structure. Also see “Curtain wall panel.”

Strut: A diagonal timber used as a support.

Summer beam: A heavy timber spanning from the center of a cross beam to an opposing cross beam with pockets for floor joists.

Sway brace: See “Braces.”

Tenon: A narrow projection made on the end of a timber by cutting away the surrounding wood. A tenon fits into a mortise on another piece, making a tight joint.

Tension: The stress on a joint or timber that results from pull-out forces exerted upon it. See “Compression.”

Timber Frame: Construction of large, heavy pieces of wood that are sawn or hewn and fitted together with traditional hand-worked joinery, usually secured with wooden pegs. As distinct from some post and beam construction, true timber frame structures use no nails or metal fasteners. See “Post and beam.”

Truss: An assembly of timbers that form a triangle or triangles under the roof to span distances impractical for a single beam or where floor space free of posts is needed, such as in a meeting hall or commercial space.

Wind brace: See "Braces."

Appendix

Joinery Illustrations and Truss Designs

(on following pages)

Joinery Illustrations

- Mortise & Tenon
- Shouldered Mortise & Tenon
- Wind Brace
- Housed Dovetail
- Drop-in Tusk Tenon
- Scarf Joints

Truss Designs

- Kingpost Truss
- Queenpost Truss
- Hammerbeam Truss
- Scissor Truss
- Curved Kingpost Truss