TIMBER FRAMING

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Site Safety

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On the cover, Jon Gourley and Jonathan Marlow of Carpenter Oak & Woodland (UK) use a work-positioning system while setting and fastening common rafters on a cruck-framed barn in Wales. Tensioned anchor lines run lengthways down the ridge. Comfortable staging surrounds three sides of the frame and a safety net is lashed a short distance below collar-beam level. Photo by Steve Lawrence.

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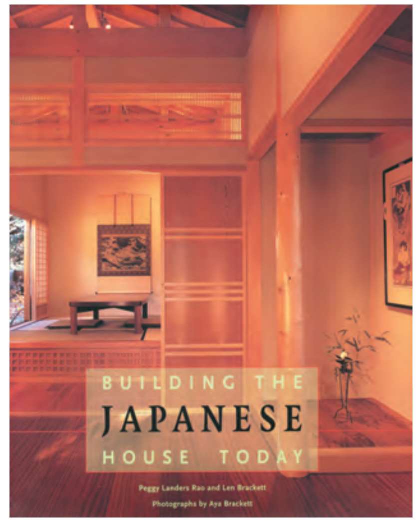
1985

BOOKS
Adapted Tradition

Building the Japanese House Today, by Peggy Landers Rao and Len Brackett with photographs by Aya Brackett. New York, Harry N. Abrams, 2005. 8¼ x 11¾, 223 pages, copiously illustrated, $40.



EIGHTEEN years ago, on a Saturday morning in Poultney, Vermont, Len Brackett addressed the Guild's third annual conference about his earlier five-year apprenticeship in Japan. His audience, profoundly impressed, even moved, gave him a standing ovation. Dennis Marcom aptly described the talk later as "someone talking about mothers to a group of orphans."

A lot of timber framers have since found mothers of sorts. Brackett has meanwhile steadily pursued his craft, which had begun in 1980 with the construction of his own very pure house in the Sierras, a beautiful, traditional Japanese dwelling willfully ignorant of American conventions of comfort and convenience. He has since adapted his work to those conventions and, of course, to the requirements of his clients and building codes.

With the assistance of a professional photographer (his daughter) whose skilled pictures should please any reader, and of a professional trade writer whose style might sometimes pique the professional reader, Brackett has now proffered an exposition of his ideas and practices in an opulent Harry Abrams book. The volume explicates the work of his firm East Wind (Higashi Kaze), Inc., in particular through a detailed sequential description of the design and construction of a single superb building, a multi-purpose guesthouse in a back garden in urban California.

For a book nominally written by two people, the narrative is oddly structured: coauthor Rao extensively quotes coauthor Brackett and writes about his work in the third person. The aim of the book, according to Rao, is "to demonstrate that Japan's extraordinary architectural tradition can be a realistic choice in the modern world." The purpose is unquestionably served, both for clients who want to live in a Japanese-style house (certainly the intended readership) and, through extensive technical illustrations of framing, finish, and insulation details, for builders who might be interested in working in the style.

The book's bright focus on the clients (we are told everything about them and their wishes and considerations; after Brackett, they are the leading dramatis personae in the story) awakens the

Erratum

In TF 76, page 13, Jack Sobon's exploded view of the new tying joint found in Ohio during the 2005 TTRAG Symposium was reversed with respect to the assembled view. The draftsman is blameless. The editor regrets the error.

question whether satisfying the needs of the client is the essential part of the builder's achievement. It's true, as Tedd Benson has argued for years, that our work is immediately about enhancing the lives of our clients, and there is no questioning the venerable principle that he who pays the piper calls the tune. But what we build is much more durable than our clients (Brackett builds "for two hundred years"), and the work belongs to the builder in a sense that it can never belong to the person who commissions it. In the long term, it may be that what's most valuable and durable about craftsmen's work is not how well it serves the particular specifications of the people for whom it was designed but how well it achieves general desiderata of fitness and beauty—not, for instance, whether a certain door is large enough to cover the client's collection of objects in the cupboard but rather how well the parts of the door are proportioned to each other and how well they are made to join together. The next owner will likely have a different collection or no collection but (if we are lucky) the same appreciation of beautiful doors.

Even with its concentration on the clients, this useful book is rich in information for everyone. Appendices include 20 pages of excellent architectural drawings and a helpful glossary of terms. The chapter titled "Wood" discusses methods of drying wood and offers good descriptions of the cedars (including *Chamaecyparis*), the pines and certain favored hardwoods, as well as the preferred cuts in the log to make for specific construction purposes. One idiosyncrasy (or an example of two coasts divided by a common language): in this book, wood with its annual growth rings at or approaching 45 degrees to the broad surface of the board is called quartersawn and wood with rings at or approaching 90 degrees to the broad surface is called riftsawn or vertical grain. And we are told that wood finished with the Japanese handplane is "impervious," eliminating "the need for paint, oil, sealer or wax." Of course, while its clean-cut fibers might not raise under water-wetting, no porous wood surface can be impervious to oily substances (and indeed later we learn that "fingerprints left during construction are almost impossible to remove").

The joinery chapter does not offer an exhaustive catalogue of Japanese joints, but carefully describes and illustrates the principal connections used in the guesthouse and covers layout and cutting procedures as well. Especially useful photos here.

"Groundwork and Framework" discusses the wisdom of hiring a general contractor (wise), managing sub-contractors (challenging), designing the foundation for the building (choices to make) and, in considerable detail, the frame-raising. Again the photos are apt and rewarding. (Conventional praise is offered for the durability of traditional Japanese timber frames in earthquakes, and their behavior during the Hanshin (Kobe) earthquake of 1995 is cited as evidence. But that evidence is very mixed, as reported in TF 36. To a fair-minded observer, earthquake-resistance does not seem to arise automatically from traditional Japanese framing.) This chapter also extends to roof coverings (here slate and copper), enclosure methods (infill between posts), insulation (isocyanurate) and doors and windows.

"Refinements" takes up lighting, the Japanese bath, flooring, plaster, *shoji, amado* (rain shutters, quite interesting), the *engawa* (wraparound veranda), built-ins (including a full American-style cabinet kitchen with today's obligatory black granite countertops) and furnishings (well designed by the client and a professional furniture-maker).

"On Being an Apprentice" opens with a large photograph of a smiling Hide Tadayuki, Brackett's teacher during his apprenticeship. (In this book, Tadayuki-san is the only person other than Brackett who is ever identified in the scores of photographs of people working, and that troubling anonymity extends to a full page of photos of the master plasterer brought from Japan to finish the house.) This final chapter of the book repeats two of the key points Brackett made in 1987. First, we are deceived if we think of ourselves as self-made: in fact, we owe everything to our teachers. And, second, a building system thoroughly worked out over a long time by intelligent craftsmen has answers to questions we haven't yet asked. The second point is not unrelated to the first. Our characteristic American pleasure and pride in what we think of as originality require us to reinvent and rediscover, and we live in a perpetual stylistic ferment, with little time left to refine and perfect. The craftsmen at East Wind are indeed privileged to concentrate on one style.

—Ken Rower

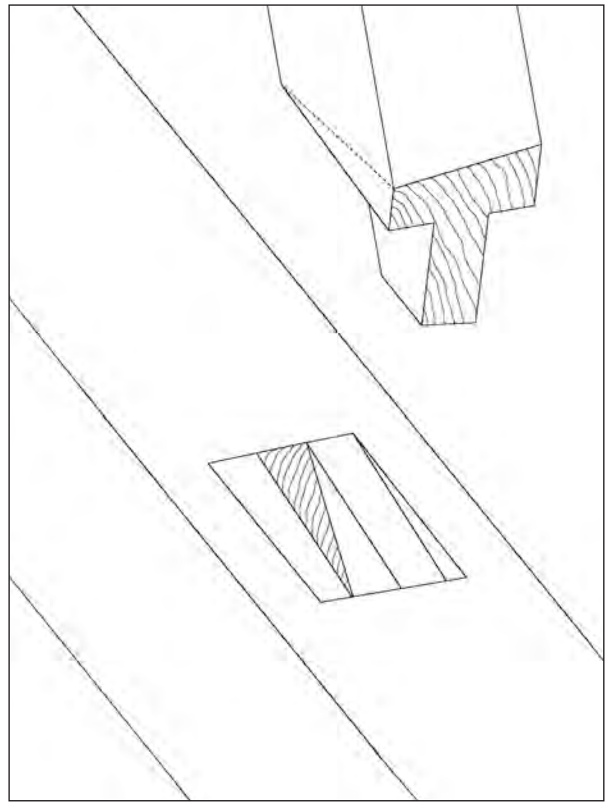
One wing of the two-part guesthouse, chief subject of the book.

Aya Brackett

Guesthouse roof framing, a mix of cedars, with Western red cedar boarding not quite complete.

TIMBER FRAMING FOR BEGINNERS

X. Introduction to Scribing 2



All photos and drawings Will Beemer

Fig. 1. Centered housed brace in irregular timber neatly achieved with scribe layout. Projection of brace nose above surface of meeting timber is called by its French name, "désabout." Diminished housing is 1 in. deep at the bearing end, tapers to zero at the surface.

IN Part 1 of this series on scribing (see TF 76), we ended by describing the plumb bob method of transferring intersections from one timber to another. For timbers coming together at 90 degrees, the technique is fairly straightforward once you learn how to measure (with dividers or eye) the amount a face is out of square, while using the plumb bob string as a true reference.

To describe the intersection of pieces coming together at other angles, such as a brace meeting a post, the technique is similar (with a few extra steps) but the results unexpected. Angled pieces meeting at out-of-square surfaces usually result in sloping lines that are hard to visualize. Let's look at a brace layout to illustrate.

Fig. 2 shows the uncut stock for a brace blocked up above a post it will join. Both pieces have been leveled, and you must be careful not to jostle the pieces or change their arrangement until all of the needed points have been marked, or "picked." Note that even though the brace is narrower than the post, both have centerlines (see "Lining the Timbers" in Part 1) that will meet when the pieces are assembled—in other words, the brace is to be centered on the post. The actual angle in degrees doesn't matter; whatever is structurally appropriate and aesthetically pleasing will do.

First you mark the four points on each timber that represent the intersection plane. Slide the plumb bob string down what will be the long (lower) edge of the brace until the string just touches the post. In our example, the string rides a bottom arris of the brace until it hits an upper arris of the post. In the figure, the string does not touch the lower arris of the post nor the upper arris of the brace (Fig. 2).

We are going to transfer the plane of the face of the post to the brace. Look at the centerline of the post and eyeball the half-width of the brace above and below the line to see about where the extremities of the brace will actually land on the face of the post. The distances from the string to the face of the post at these two points, *measured along the plane of the lower edge of the intersecting brace,* should be transferred up to the corners of the brace, keeping the pencil parallel to the edge of the post (Figs. 3 and 4).

This gives you the two lower points on the brace representing the plane of the post face; later you will move the plumb bob to the upper surface of the brace to get the other two points.

Note how the carpenter's pencil in Fig. 3 is flattened on one side for two or three in. back from the tip. This gives a flat plane to sight along and allows the lead to be flush with that plane. In this step you are only marking the plane of the post face on the brace, as if the brace were to be butted against the post, with no tenon. Later you will mark out for the bearing face of the tenon, which

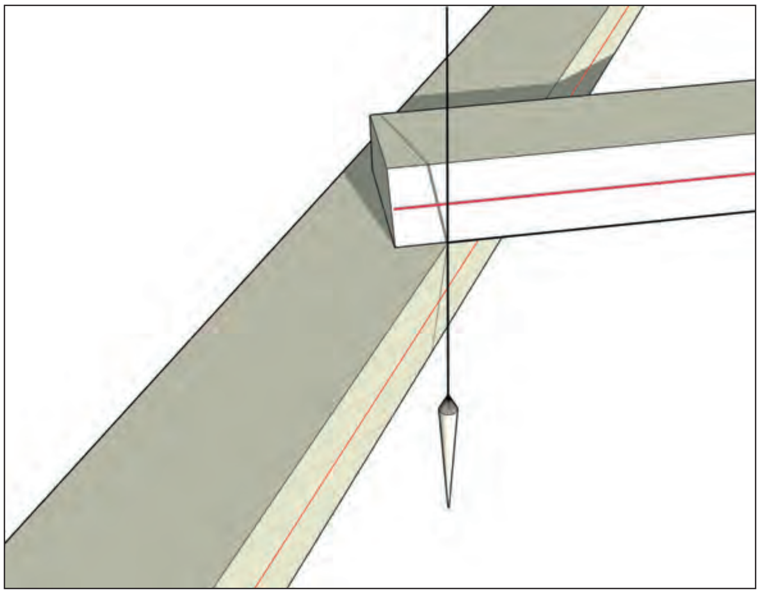


Fig. 2. Plumb bob layout for typical brace connection to post or beam.

will determine the actual cut and final housing location on the post. While the string is positioned at this lower intersection, you

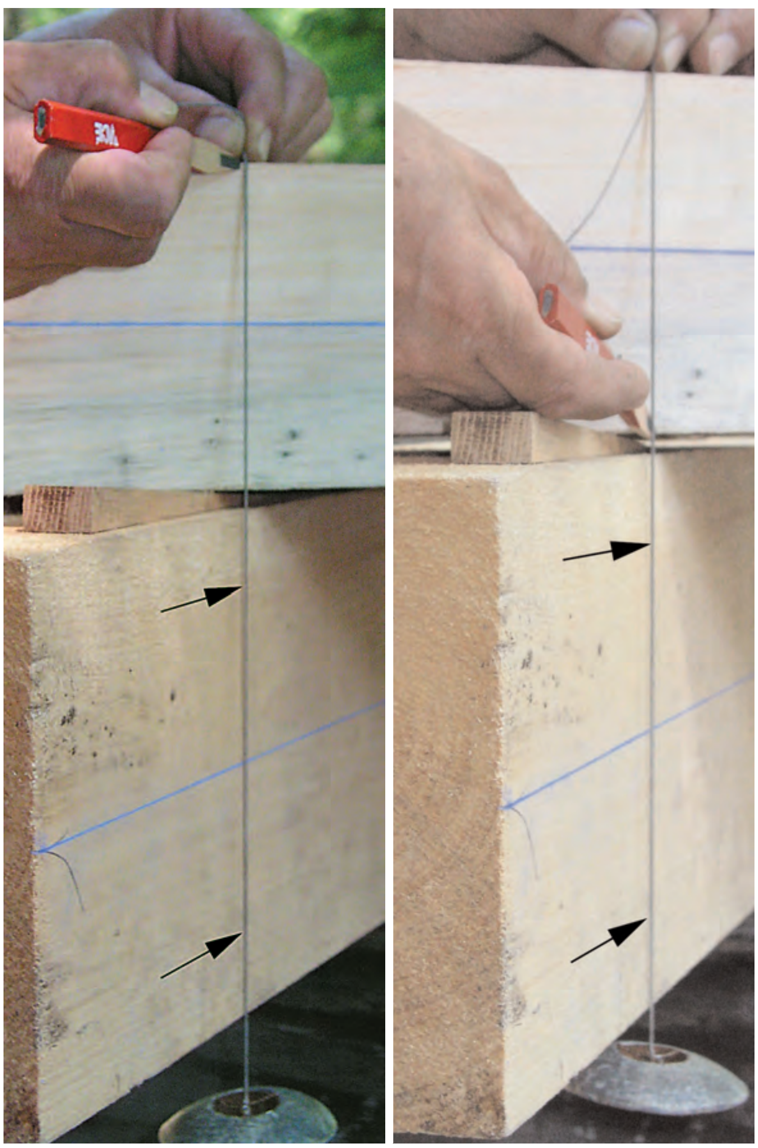


Fig. 4. Marking plane of post face on brace (photos reversed for consistency). Distances from string to face of post at superimposed arrows are transferred to corners of brace. In this case, twist of timbers puts string contact points at upper arris of brace and lower arris of post.

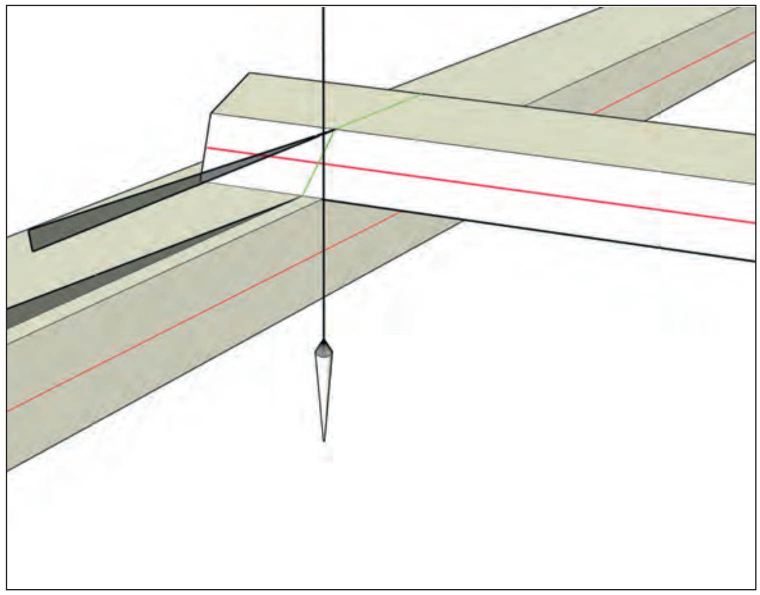
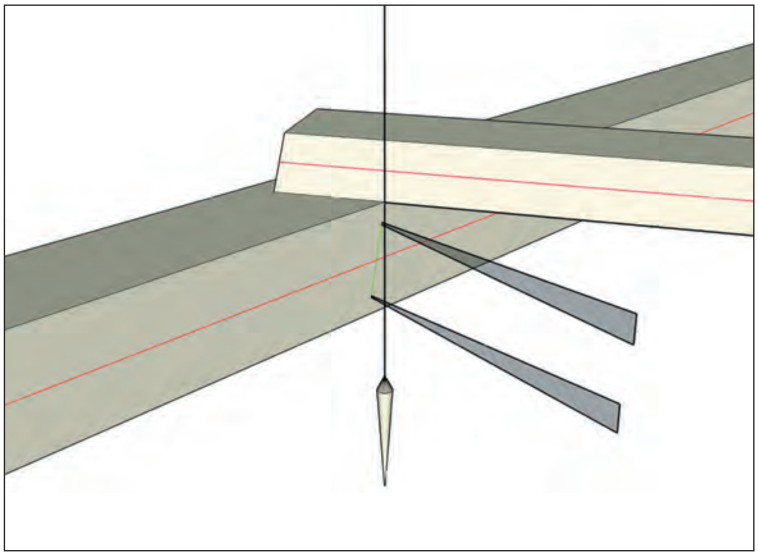


Fig. 3. Transferring plane of post face to future lower edge of brace.

can also mark the post for the lower or bearing end of the brace mortise. The bearing will be square to the face, as is usual practice, so hold the pencil at 90 degrees to the post surface and mark a plane square to the post face that represents the brace intersection. Since the brace will be "turning" to enter the post at 90 degrees,we make this initial mark at the last point (the string) for the brace to make that turn before diving below the surface of the post. Make marks at the top and bottom arrises of the post (Fig. 5).

Fig. 5. Marking the post for the housing for bearing end of brace. Pencil is held perpendicular since bearing will be square to the surface. Housing mark is temporary; brace may have to be clipped farther up to make sure bearing face begins before brace enters post, and housing shifted as well.

Later, after "picking" all of your points of intersection, you can connect these points with a line and mark the half-width of the brace above and below the centerline on the post (Figs. 5 and 6). Be sure to keep the pencil on the same side of the string as the intersecting timber and flush to it.



Fig, 6. Marking the brace width on the face of the post. Pencil must be kept on same side of string as brace.

Fig. 7. Using dividers to transfer the brace half-width to the face of the post. End lines have already been established by string.

Now comes an extra step: again keeping the pencil at 90 degrees to the post face and on the same side of the string, bring the pencil up and mark the brace to indicate the plane of the bearing face of the tenon and any additional abutment developed on the brace end to bear in a housing (Figs. 8 and 9).

It's important that these marks and the earlier marks you made on the brace to represent the plane of the post face do not cross, although they can touch. If they touch, the tenon's bearing shoulder will begin exactly at the face of the post. If the lines cross (as they do in Fig. 10), the brace will appear sunken below the surface of the post where the bearing shoulder begins. If they don't touch or cross, it means the start of the bearing shoulder will stand proud of the post surface. This is the situation we are looking for, since the joint will look much better this way. We can accomplish this by adding a *désabout*, an extra measure of nosing, to the bearing surface of the tenon. To do so, first slide the 90-degree mark up the brace a slight distance and then transfer this new mark down to the mortise face for the entrance of the housing (Fig. 11).

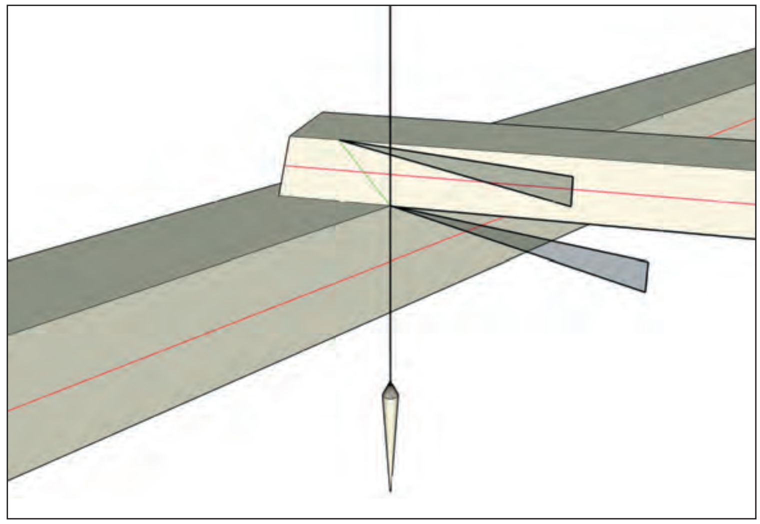


Fig. 8. Marking the brace to indicate the plane of the bearing face of the tenon and any additional abutment developed on the brace end to bear in a housing.

Fig. 9. Marking brace for bearing end of tenon. Pencil must be perpendicular to face of post since bearing housing is plumb to surface.

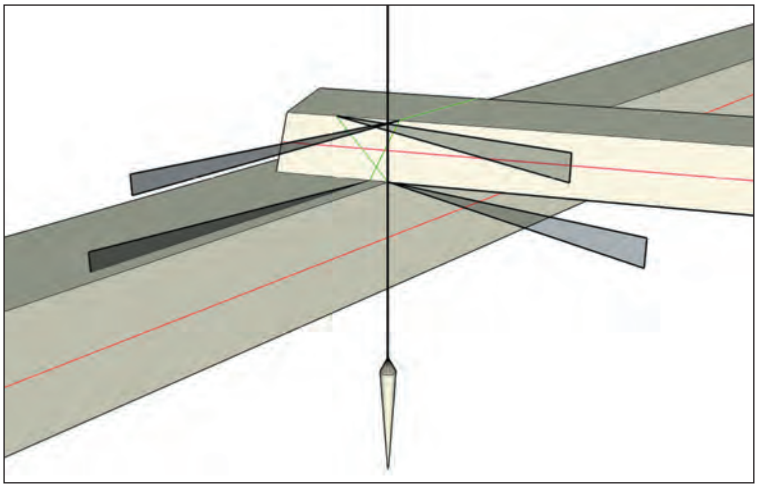


Fig. 10. Lines for bearing face of brace tenon cross lines representing face of post. Brace tenon would then begin well below surface of post.

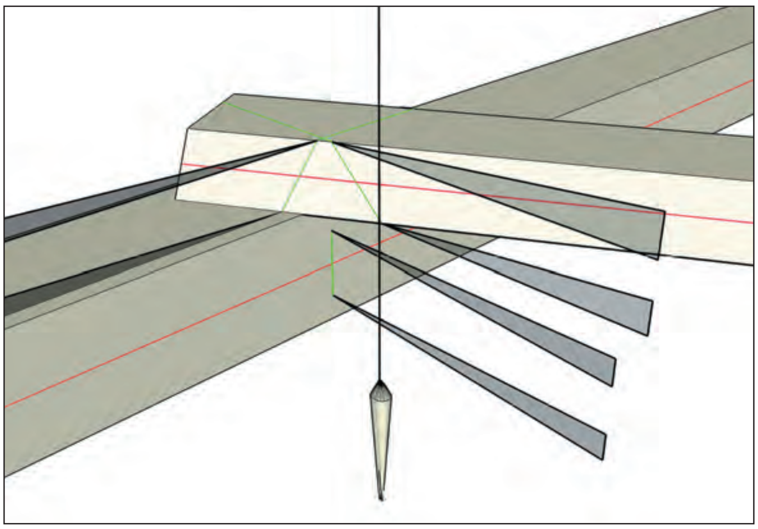


Fig. 11. Sliding plumb line up along brace arris until lines for bearing face of brace tenon do not cross post-face lines solves problem in Fig. 10, resulting in a dèsabout starting well proud of post face.

Figs. 12-14 show a new set of timbers, this time a deep rectangular brace to be joined to a squarish post flush with one side of the post. The problem is the same.

Fig. 12 shows the finished joint with a *désabout* (as well as a diminished housing, whose procedure is described overleaf). In Fig. 13, the pencil is oriented parallel to the post face, marking the offset from the string. Fig. 14 shows the string moved up the brace until the lines don't cross, with the bearing shoulder then marked on both the brace and the post below by holding the pencil at 90 degrees to the post face.

Fig. 12. Flush brace joint with désabout and diminished housing.

Fig. 13. Pencil indicating post-face line on brace is offset the distance from post face to string at housing location below, as measured along plane of lower face of brace. Mortise is already laid out.

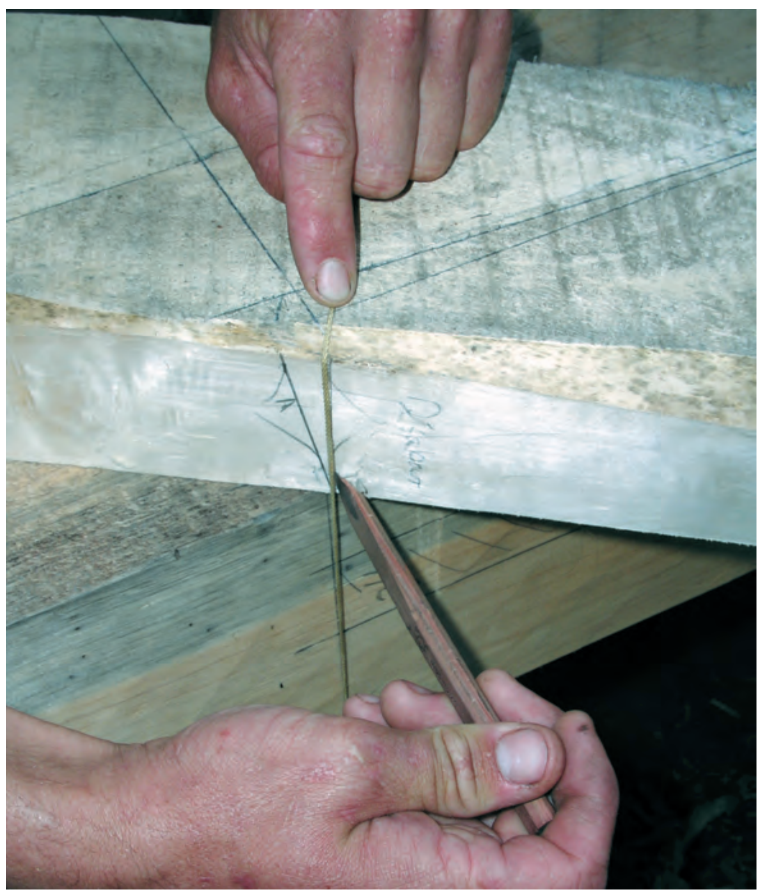


Fig. 14. Plumb bob string has been moved up brace arris from its position in Fig. 13 until lines don't cross. All lines shown in Figs. 13 and 14 have been laid out previously.

Returning to our original set of timbers and the centered brace connection, move the plumb bob to the upper side of the brace and repeat the process, marking the top of the mortise and the points on the brace where it enters the mortise (Fig. 15).

Fig. 15. Marking the upper side (or inside corner) of the brace.

You don't need to do the extra step for a bearing plane of the brace since that only occurs on the lower part of the tenon. Move the pencil down to the post and, this time keeping it in line with the plane of the brace and on the same side of the string as the brace, pick where the brace enters the top of the housing. Make sure you offset the pencil by the same amount the brace face is away from the string above.

Again, be careful not to change the orientation of the pieces or jostle them out of level until the above process is complete. Once all of the points are picked, you can remove the pieces from the assembly. Connect all the dots on the surfaces to show the planes

Fig. 16. Connecting the points representing the post-face line. Straightedge happens to be a French-style homemade mortise and tenon gauge. In use, centerline marked by v-cuts registers on joinery centerlines.

more clearly. Fig. 16 shows the post-face line being drawn on the brace with a straightedge.

Next we need to lay out the housing for the brace, which we will make to fit a 1-in. diminished shoulder on the brace. These sloped housings (like that seen in Fig. 12 on the previous page) are often an indicator of scribed layout, since the upper end of the housing and the corresponding shoulder on the brace can exit their surfaces more gracefully when the timbers are out of square. However, diminished housings might not be immediately visible on centered braces like our current example.

Take your framing square and lay it along the post-face line on the brace and strike a 90-degree line to represent the bearing edge of the tenon, aligning it to the "extra" set of marks you made on the brace edges (Fig. 17).

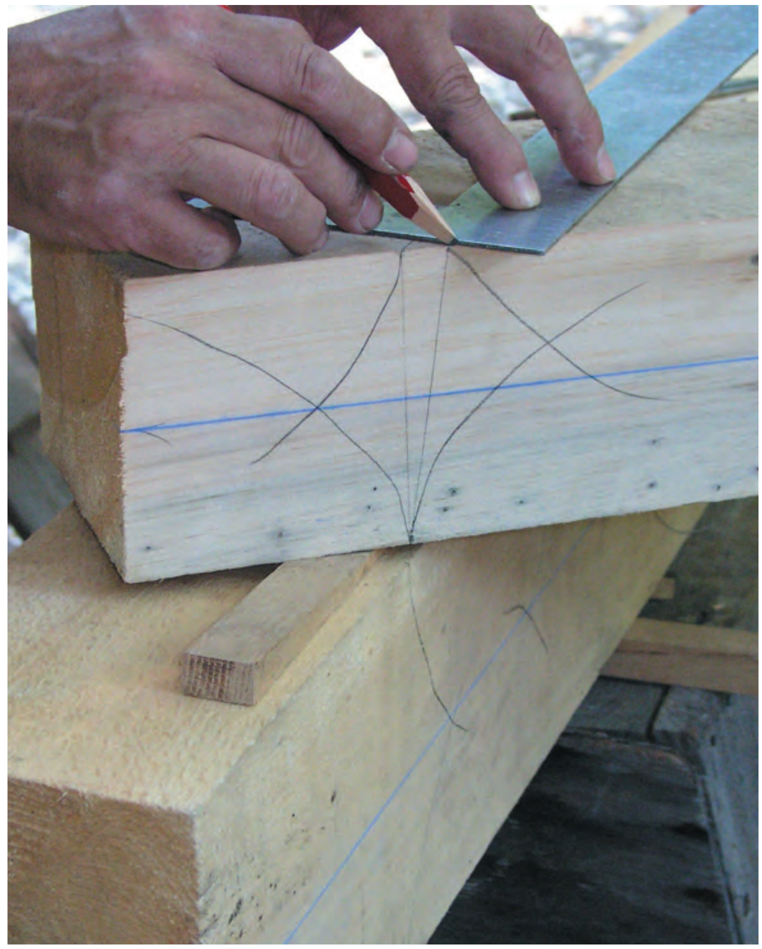


Fig. 17. Bearing shoulder laid out on brace. Line is square to post-face line and drawn from dèsabout line on top arris. Process will be repeated from lower point (where lines touch) on other side of brace.

Lay out the length of the tenon (usually 3-4 in. plus the housing depth) and mark the end of the tenon with a line parallel to the line representing the surface plane of the post. To lay out the diminished shoulder, come back the depth of the housing along the bearing edge of the tenon line from the post-face line. This depth is conveniently 1 in., which allows you to use a combination square blade as a gauge. Connect this point to the upper end of the post-face line to establish the sloped shoulder of the brace where it bears inside the housing (Fig. 18).

Repeat the process on the other side of the brace. The three lines described in the previous paragraph are the cut lines on the brace.

Use a gauge representing the tenon thickness to lay out the tenon on the brace and the mortise on the post. The housing width on the post can be laid out using dividers (as shown earlier in Fig. 7), and the housing depth will be 1 in. deep at its lowest point

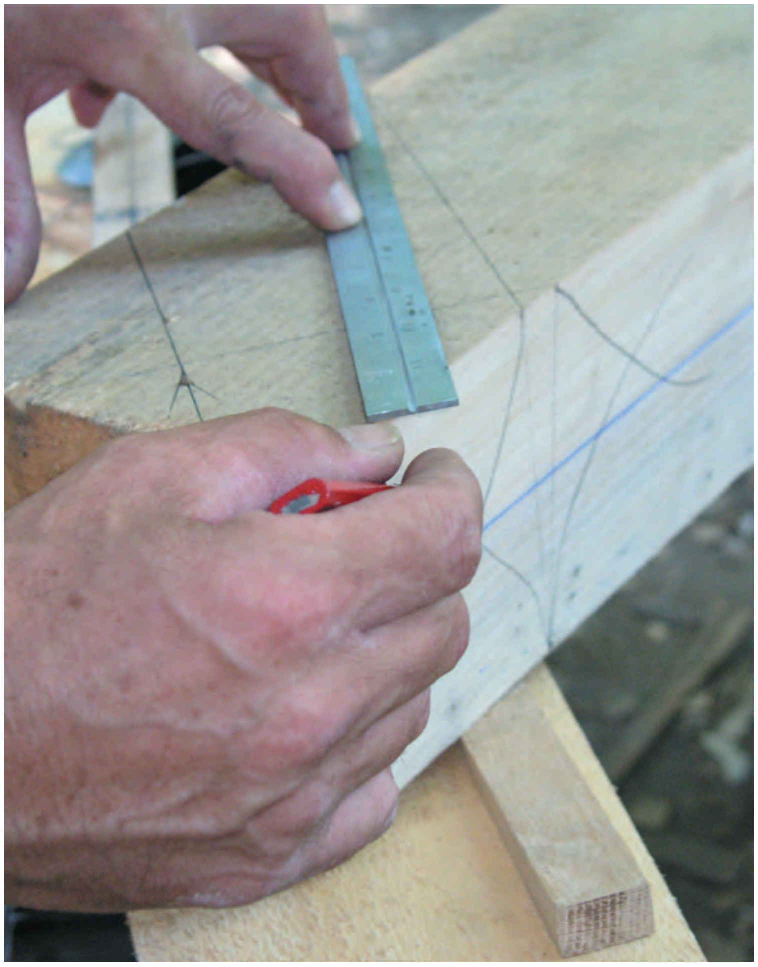


Fig. 18. Straightedge 1 in. wide laid along line of diminished shoulder after use as gauge to measure back 1 in. along bearing shoulder line from the post-face line, then pivoting to connect this new point with top point. This is the cut line for the tenon shoulder. During assembly of centered (blind-housed) brace, you can tell brace is fully seated when penciled post-face line meets post face.

Fig. 19. Cruck frame built at the Heartwood School in Washington, Massachusetts, in a two-week workshop this summer, during which photos for this article were taken. All pieces in the 12x14-ft. frame were scribed except the rafters, which were square-ruled. Floor members were scribed using tumbling (see previous article in this series), wall and bent members, including cruck blades, were plumb-bob scribed, while the round-to-square connections in the upper part of the cruck were bubble scribed (the subject of the next article). Frame was a mix of hardwoods (mostly cherry) and softwoods; booked-matched cruck blades furthest from camera are Eastern white pine; blades nearest camera are spruce and aspen. Jack Sobon, who taught the workshop along with Dave Carlon, Josh Jackson and the author, designed the frame.

(parallel to the post face), diminishing to nothing where it exits the post face at the top end. For reference, the slope can be laid out lightly on the side of the post even though this centered housing won't be open on the sides. For such centered housings, diminished haunches are easiest cut with hand tools because you can come in from the top end with a slick or chisel, checking the angle with a straightedge or bevel gauge. Note that, because of our out-of-square and irregular surfaces, we make the housing parallel to the cross-surface of the post (making it easier to cut), resulting in the shoulder of the brace often appearing somewhat skewed.

As with most scribing, these techniques are best learned in the field since the process involves so much 3-D visualization, and the third dimension can be hard to see in photographs and drawings. It's a great exercise to practice with small timber off-cuts. Plane them out of square and intersect them at arbitrary angles to test your ability to lay out mortise and tenon joints and diminished haunches. This experience will increase your versatility and confidence as a timber framer.

SO, in an old frame, how can you tell if the frame was scribed? There are numerous good indications such as marriage marks, particularly on braces. Identical carpenter's marks on both sides of a brace joint (usually the lower joint) indicate the brace can only go in that location since it was scribed to fit there. Square rule braces, in contrast, are usually interchangeable and unmarked. Diminished housings for braces and major load-bearing beams, which allow discrepancies in squareness and size to be less obvious at the joints, are common in scribe rule frames but not definitive since some square rule builders prefer them as well. A better indication is the systematic absence of housings for minor or non-load-bearing members. Square rule frames generally house all connections.

A final indication is the presence of so-called two-foot marks on the outside faces of posts and other timbers that appear in two assemblies such as a bent and a wall. This reference mark (often a circle or S-shape with a line through it) is usually found near the top of a post and 2 ft. down from the top of the adjoining plate. This mark establishes a datum that can be used to align the timber in both scribe assemblies and accounts for variations in plate height.

—Will Beemer

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Site Safety for Timber Framers

All photos Steve Lawrence

Double lanyards allow Jon Gourley of Carpenter Oak & Woodland (UK) to pass an obstacle (intermediate anchor) on a cruck roof in Wales without disconnecting from his safe anchorage on a tensioned anchor line system. A fall-arrest rig like Jon's—full-body work harness, double lanyards, carabiners and a shock-absorbing cell (visible on Jon's back)—costs less than $250 and should last for about five years if not damaged or used in a major fall.

PUTTING up frames is the best part of a timber framer's job, but it's also the most dangerous. When we leave the confines of our workshops, we enter the world of general construction. Last year more than a thousand construction workers were killed on jobsites in the US, and more than 36,000 days were lost to work-related injuries.

All these accidents make construction expensive too: the Occupational Safety and Health Administration (OSHA) performed some 40,000 site inspections last year and issued $82.4 million in penalties, mainly to construction companies. Each violation that an employer knowingly commits will cost between $5,000 and $70,000 in fines, but that is only the beginning, as we all know.

Ask yourself these questions:

What is the most you stand to gain when you or one of your employees chooses an unsafe work method like walking a wall top plate without fall protection, or slinging a truss over the heads of your colleagues?

What is the most you stand to lose in the same situation?

While we're not going to take the risks out of timber framing altogether, we can certainly mitigate them. There have been some exciting developments in the equipment and techniques available to us, and proficiency with these tools gives us a competitive edge. This article is about sharing those tools and encouraging you to run safe, well-planned frame raisings.

With the right approach, framers can safely and legitimately accomplish pretty much any work task to the satisfaction of regulatory bodies like OSHA, and without incurring any great costs to your business. In fact, the most powerful tools at your disposal are absolutely free.

Your obligations under the OSHA Act. Before diving into specific strategies for site safety, it's important to understand how our actions (or non-actions) fit the context of health and safety law and what that means to us as designers, framers, foremen and company owners. For the purpose of this article I've focused on the OSHA Act, which governs US construction, but there is a remarkable symmetry between US, Canadian and European legislation. Each of these sets of standards begins with a similar statement of duties that emphasizes our shared responsibilities for health and safety. Understanding that each of us has obligations under the OSHA Act is key to understanding contemporary regulations and determining the best approach. Under the Act's Section 5, Duties, each employer "shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees; shall comply with occupational safety and health standards promulgated under this Act; [and] 29 USC 654b, each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct."

The part of the OSHA Act that particularly relates to us as timber framers is Section 1926, Safety and Health Regulations for Construction, Subpart C. It's here that we find the specific regulations relating to site safety, spelled out in 1152 individual standards. You can peruse the whole enchilada online by going to osha.gov/pls/oshaweb/owastand.display_standard_group?p_toc_level=1&p_part_number=1926.

You will discover that every employer is obligated to provide his or her employees with a safe work environment, safe and certified tools, all necessary safety gear and personal protective equipment (PPE), training and instructions, supervision and a work plan. And you will find that every employee is legally obliged to comply with OSHA's regulations. Finally, we all have a duty of care, in the English legal phrase, that obliges us to look out for one another's safety, and especially for the safety of those who are less experienced than we are, and not simply to turn a blind eye to unsafe work conditions.

What makes construction so dangerous? Understanding the hazards that we commonly face on site allows us to create effective strategies for reducing our risks. So how do we know what these are? OSHA staff gathers information relating to workplace injuries and fatalities during inspections and investigations, and combines this with information from over 100 other federal agencies to produce a comprehensive database that can be searched and filtered for specific information relating to each industry. This information is publicly available from OSHA Statistics and is accessible online at osha.gov/oshstats/index.html.

Here's some of what we can learn from these statistics:

Falls from Height. Still the number one cause of fatality. However, it's not spectacular falls from ridge beams that are killing carpenters, but very preventable falls from unsecured ladders and poorly set up scaffolds, walking off unprotected edges and stepping into traps (uncovered holes in the working deck).

Moving Equipment and Machinery. Another common cause of fatality is being struck by heavy machinery such as forklifts, skid steerers and trucks. A common hazard in our work is found at the pinch-point between the moving ballast of a crane and some fixed object like the corner of a frame or a crane's outrigger.

Falling Objects. We wear hardhats on site because our heads are so vulnerable to serious injury from dropped objects. Timber framers are required to work aloft as we assemble our frames, and we often need to carry bracing materials, comealongs, pegs, hand tools and various other pieces of equipment with us to do our job. Dropped debris and pegs are common on timber framing sites.

Electrical Hazards. Poorly maintained power tools, frayed, nicked or worn power cords and damp working conditions combine to make electrical shock hazards very high during site work.

Remote Working. In the event of an accident on site, rapid transportation to medical care is essential for the treatment of shock. Limited communications and extended transport times are major factors in our ability to provide effective first aid.

Cuts and Punctures. An obvious hazard for timber framers who work with so many sharp-edged power and hand tools each day. Chainsaws deserve special mention.

Strains and Sprains. Resulting from poor body mechanics when rolling or lifting heavy timbers.

These common hazards pose a threat to our safety, but what about our health? Is there really a difference? Sure. The health in "Health & Safety" relates to those hazards that are not the result of an accident. Consider the following common hazards:

Exposure to the Elements. Our site work takes place in all types of environments and at all times of the year. From the extreme cold of Alaska and the Prairies to the wet winters of the Pacific Northwest, to the deserts of California, Texas and New Mexico: each region has its own particular environmental hazards. No big deal? Consider that almost 54,000 Americans will be diagnosed with melanoma (skin cancer) this year. It is the fastest growing form of cancer, and construction workers are at the top of the list.

Infection. There are several ways that we can come into contact with infectious diseases on site, such as through contact with contaminated soil or water or exposure to contaminated blood during first aid—or even through contact with bat, rodent or bird feces, all commonly found in old timber buildings.

Repetitive Strain Injuries. Simple things like the way we hold a mallet or the height that we set our sawhorses can have a real effect on our health.

Hazardous Substances and Dust. Although timber framers work with relatively few hazardous substances in general (synthetic glues, fuel, paint, timber preservatives, etc.), our exposure increases enormously when we venture on site. Modern building methods incorporate many hazardous chemicals that can be present (though not always visible) in solid (including particulate), liquid and gaseous form on building sites. We must also remember that dry wood dust (and the dust from some species of green wood), the kind produced by circular saws, grinders and sanders, is a respiratory hazard.

Recognition of hazards gives us the opportunity to prepare for them, but to be fully prepared we must also consider the *likelihood* of encountering a specific hazard. This allows us to order our actions and develop strategies for managing risk. The process of considering the likelihood and severity of specific hazards is called *Risk Assessment*. Taking steps to reduce the likelihood or severity of specific hazards is called *Risk Management*. We'll discuss these processes in more detail later on.

Rock-solid solutions. Staying safe on site isn't rocket science. Nor is it a matter of following regulations for regulations' sake. It is a matter of six principles. In my opinion, these are the fundamentals of safe site work for timber framers:

1. Good Planning
2. Good Communication
3. Good Training
4. Good Documentation
5. Good Gear
6. Good Practice

Good Planning is the single most effective tool for staying alive on site. Just as a timber frame requires a set of detailed drawings to specify its construction, site work and raising sequences also need careful planning if they are to be safe, fast and professional. Good frame design is one part of this process and should take into account the lay of sequential joinery like scarf joints and the order of the frame erection. Early planning decisions can make the difference between a swift and painless raising and a long hard night for your crew. They can also save you buckets of money. The tools of choice for this planning process are written documents that record your ideas in a format that can be read by others: method statements, risk assessments, lifting plans and fall protection plans.

The *method statement* describes what you're planning to do on site (OSHA calls it a Plan). It should be a simple, step-by-step, written plan that outlines what's going to happen when you arrive on site and generally how you're going to put the building together. It should include basic information about where the site is and what sort of equipment is to be used, and it can also explain who's who on the site team. Method statements should deal with the big picture rather than the nitty-gritty. It's impossible to specify all the lit-

It takes practice and training, but this netting (here lashed just below the collar braces in the cruck frame) can be deployed in about 30 minutes by a team of four. Safety nets can catch, in addition to people, debris like the pegs dropped into this one.

tle details ahead of time, and it would make for an unnecessarily long-winded document. Method statements are meant to be read by others, so they should be written in plain language, and technical terms should be avoided wherever possible. It often helps to include a couple of frame drawings with a method statement; a picture paints a thousand words.

The *risk assessment* considers the severity of hazards associated with the work described in the method statement: risk of getting squashed by a dropped frame, risk of getting killed by a fall from height, etc. It also explains how you intend to mitigate the potential for an accident: for example, only trained riggers will sling loads, anyone working at height will be properly trained to use a harness and will tie in, etc. Risk assessments also consider the likelihood of an accident. Sure, the crane jib could snap and we all might die a horrible headline-making death, but the likelihood is that North American crane jibs won't snap off very often, because of the stringent requirements for inspection, testing and certification. Although a broken jib would be a real hazard (severe), the likelihood is so remote (low) that it's not worth worrying about under normal conditions. Writing a risk assessment forces us to consider potential problems before they happen and, more important, it gives us the opportunity to reconsider how to do something while there's still time to change the proposed work method. These two factors (severity of the hazard and the likelihood of an occurrence) represent the overall risk. Next, you propose your measures to mitigate these risks (use of personal protective equipment, trained staff, etc.) and reconsider: can you manage the risks and make them acceptable?

The *lifting plan* is similar to a method statement (and for little jobs the two can be combined), but it deals specifically with lifting operations. It should explain the sequence of important lifts, the crane or gin-pole locations and the safe working loads (SWL) or capacities of the equipment that's being used; and it should note the maximum weights of loads and the boom-reaches anticipated. I like to use a plan drawing or sketch of the site for these things so that I can show where the crane will sit for different picks. If any weird and wonderful lifting gear is going to be used, for instance a spreader-bar, then this is the place to spell it out. (It can be useful to include a schedule of all lifting tackle so that dimensional compatibility and SWL are double-checked, avoiding "surprises" while on site). It's also important to name the people who will rig for lifts, signal cranes and supervise the whole process. If we have consulted with a lifting engineer, then this is a good place to include a copy of the engineer's letter of approval.

If a method statement calls for working aloft, then the *fall-protection plan* should begin by describing what precautions you will take to prevent falls in the first place (fall prevention). It should briefly describe any fall protection systems that will be used and name the people who will supervise, install and inspect those systems. Like the lifting plan, this one might include a letter from an engineer approving certain timbers as okay for use as anchors.

Note that these four documents belong hand-in-hand, and changes to one should always mean a quick review of the others to ensure that they're all still in alignment. What's important here is that someone, anyone, goes through these processes, and not that they make a pretty set of documents. I can't emphasize this enough: it doesn't have to be pretty; it's the process that counts. But writing it all down is far easier than trying to remember it all, and it serves another objective I'll come back to later.

Good Communication. It's no good figuring out how to run a slick frame raising if you forget to tell anyone what you plan to do. Briefings with your crew can save you time and make your life easier on raising day. It's a good idea to give your crew copies of the Big Four documents (method, risk, lifting and fall-protection plans) to read before sitting down to a pre-site briefing, and a rough agenda can be a useful reminder of the topics you want to cover in your briefing. An agenda may or may not help streamline the actual meeting, but it does give you a checklist of things that otherwise might be forgotten: who's going to take photos, who's going to pack the coffee and cookies and other essential stuff. It's always the case that a good site team will suggest ways to work more safely and effectively when you hold these meetings, so keep an open mind about the work method and be prepared to make amendments.

I like to send a copy of our lifting plan to the crane company before a job kicks off, and I usually send the whole package to the client, architect, engineer and general contractor too. It gives them all a chance to understand what's going to happen when we arrive on site with the frame, and it gives us one last chance to make sure everything will be ready. When you've written a couple of these things and the process is familiar, then you might want to consider copying in the local OSHA office too.

Jonathan Marlow of Carpenter Oak & Woodland rigged to move around freely on the roof of the cruck frame. Lateral movement is freely possible along the full-length tension line anchored parallel to the ridge of the building. Vertical changes of work position are allowed by the adjustable body lanyard (note extra line passing through jamming device and disappearing behind the bright green drill body). Ropes are protected against wear by sliding sheaths. Individual lanyards secure each tool. Compare fall-arrest rig worn in photo on page 10.

Realize that OSHA is only interested in saving lives and preventing workplace injuries. How many builders say hello to their neighborhood OSHA inspector? If you do, the inspectors are usually so impressed (some might say shocked) that they will bend over backward to help you, and OSHA has a lot to offer: free on-site consultation, training resources, publications, resource library, material safety data, confidential planning advice and more.

(The Guild recently took this kind of approach with a rendezvous at Salem, Oregon, where 50 of us put together a large public structure for the Rotary Club. We made contact with OSHA and sent them a set of our planning documents by e-mail about a week ahead of our arrival. OSHA then met our instructors on site before the event and explained their priorities for the job, while we had the opportunity to introduce ourselves and reassure them we intended to run a safe event. We showed them the drawings and walked around the site together while explaining our strategies for staying safe. A few days later we invited them back to meet our volunteers and to answer questions regarding the regulations and standards that apply to our work. The local inspectors were so impressed with this approach that they wrote us a thank-you letter and copied it to the head of the Oregon OSHA. One of the inspectors came back twice more in his own time just to say hi. Now just ask yourselves what that kind of reputation could do for your own company.)

While sending documents out is helpful, remember that there's no substitute for getting folks together to sit around a table (or tailgate) and simply talk things through. Again, it's the process that counts.

Good Training. It takes years of practice and training to learn how to cut a nice frame, and the same is true of putting one together safely on site. Unlike mistakes in a workshop, where a new piece of timber can be the answer, mistakes on site can be deadly and can easily endanger a number of people simultaneously. Working with cranes, scaffolds, lifting tackle, bracing and rigging requires specialist skills and practice. So what are the basics? Well, at a bare minimum, common sense dictates that every person on site should be fully trained to use each and every piece of equipment that they'll be asked to use during a raising (it's also the law), and someone should be fully trained to deal with an emergency (first aid and basic rescue techniques).

The most commonly overlooked training subjects are Rules and Regulations, Scaffolds and Ladders, Slinging and Rigging, Fall Prevention and, not least, First Aid.

Rules and Regulations. Do you know when it's okay to wear short pants at work, when you need to wear your hardhat and when you don't, what needs to be in your first aid kit, how often you should inspect a lifting sling, what size guardrails you need on a live edge or when you should retire a harness? Well, OSHA says it's your job to know about these things and to be doing something about them every time you step on site—even on a simple residential job. How about Controlled Access Zones, Aerial Work Platforms and Qualified Persons? It's jargon, of course, and you probably use these things already, but knowing your way around the basic rules and regulations can save you a lot of hassle and save you plenty of time when it comes to dealing with an uptight site agent or OSHA

For Jonathan and Jon, the safety net backs up the fall-arrest or the free-range gear and provides protection during ascent, setup and descent.

inspector. A good introduction to the OSHA regulations is a must for anyone in a supervisory position these days.

Scaffolds and Ladders. Falling off unsecured ladders and toppling off unguarded edges still rank as the top killers of carpenters on US jobsites. It's the really basic stuff that seems to kill the most people: failing to securely tie off ladder tops, failing to put guardrails around the top lift of a scaffold, not covering traps or holes. While it's all so basic, it's also common to be lazy about these simple things. Training your crew will reinforce their importance and help to develop a company culture where it's okay to say, "Hang on a minute, let me just tie that ladder off first."

Slinging and Rigging. The jargon-filled world of slinging and rigging can appear to the uninitiated like a secret society (complete with mysterious hand-signals), but it doesn't take long to pick up the basics. Calculating simple loads and understanding safe working loads soon become second nature for most people, and choosing the right shackle or sling becomes no more difficult than picking out the right chisel. However, if you're one of many framers out there who still relies on crane operators to know best, or who just lift 'til the bell rings, then you may be taking far greater risks than you realize. Don't believe me? Take a few minutes to read the small print on the back of most crane-rental agreements, and you'll see who's really responsible for that quarter-million bucks' worth of equipment and any damage that it does. More to the point, though, it's very easy to make a rigging mistake that can result in a dropped load. The answer is simple: book a couple of your people on a rigging course and let them have some fun for a day or two. You may be surprised just how much stress, time and money a good rigger can save you at a frame raising.

Fall Prevention. Falling from a height poses the single greatest risk to a carpenter. If you work aloft, and most framers do, then sooner or later the odds are that you'll take a tumble. Simply putting a harness on is not the answer. Harnesses, lanyards and anchors all require special skills to be used safely. Falling is the easy part; it's being ready for what happens next that takes training. Self-rescue and assisted rescue from a deployed lanyard need to be practiced ahead of time. So spend a Saturday afternoon hanging from the workshop ceiling with a local instructor. It's fun, it's cheap and it could save your neck.

First Aid. It goes without saying that there should be a qualified first-aid attendant on every site team, and my guess is that most crews have one these days. But having the ticket in a back pocket is no substitute for a bi-annual refresher course and a bit of practice at the real thing. Also, CPR and other first-aid techniques are continually changing and evolving, so it's wise to keep in touch with the latest. Not sure how much experience your first aid attendant has? Well there's one thing you can count on: the first time they're confronted with a real emergency on site, they'll wish they'd spent a little more time refreshing!

Good Documentation. We've already considered a couple of reasons to have a written plan for the site, and obviously such a plan also makes it easier to communicate with other contractors on the job. There's another reason to keep a tidy record: to watch your backside. The litigious nature of the workplace is a reality that we've got to consider these days, and having a clean set of documents to back up your approach to site safety is going to help in the aftermath of an accident. If you're going to do the work of preparing this information, then you might as well keep a good record of what you've done. Let's look at some of the more obvious stuff to include in a health and safety file, and then look at how this can help on site. Other than the obvious Big Four documents that we've mentioned already (these will be new for each job, of course), the key things to include are company health and safety policy, insurance certificates, training and inspection records, minutes of briefings and induction notes.

Company H&S policy. Does your company have a policy of keeping its timber framers healthy and safe? Well, this is the place to spell it out so that everyone knows where he or she stands and whom they can turn to with a question or concern. It should also be condensed into a one-page (or less) summary that you feel comfortable about posting on the wall and giving to everyone on your crew.

Company H&S policies vary greatly from company to company, depending upon size and available resources. At a minimum, they should make clear who's responsible for safety at different stages of your shop and site work, and how that person goes about keeping people safe. If you don't have a current H&S policy, then consider jotting down the basics and letting your rough notes evolve into something more formal over time. It doesn't have to be pretty!

Insurance certificates. Are you insured? Okay, then put copies of your certs in the H&S file. Not insured? Well, I'm not trying to sell you anything, but . . . *are you nuts*?

Training and inspection records. Have you done some training? Well, prove it by putting copies of your training records or certificates in your H&S file. Inspection records are a different kettle of fish: these show that you have had your site equipment (slings and lifting tackle, harnesses, lanyards, etc.) inspected and maintained (you probably do most of this yourself), and how frequently.

Minutes of briefings. The next time you have a pre-site briefing or sit down with your crew, make a few notes and throw them into your job-file as a record of all the important things you've discussed. One reason we use an agenda for our pre-site meetings is that it leaves a simple record of what topics have been discussed. Bullet-point minutes of meetings are a good idea if you're covering a lot of ground and, if kept accessible, can also help your team refer back to important decisions and instructions.

If you take the time to discuss a safety issue with your crew, then make a few simple notes about who was there and what was discussed, date the notes and throw them into your H&S file. If you cover something really important, then consider asking your team to initial your notes as a record that they were there and understood what was discussed. Yikes? Ask yourself what a really professional outfit would do, and why.

Induction notes. These are used to record the introduction of crew members to the requirements of a particular site or circumstance. When you take the time to show someone around your workshop for the first time, that is also an *induction*. Basic site inductions should include (as a minimum) locations of H&S equipment (first-aid box, fire extinguishers, and the like); introductions to the first-aid attendant, the general contractor and other personnel; the location of the nearest phone in case of emergency; and any specific requirements for getting people safely to the hospital. You've probably come across site inductions if you've ever worked on a big construction site and know that you're expected to sign something to show that you've received the information (sometimes you get a sticker to put on your hardhat), and this signature is kept on file.

Other notes. Some other useful items to keep on file include special manufacturers' instructions for lifting and access equipment and a chart of standard hand signals for cranes, as well as contact information for H&S consultants and OSHA. You can put whatever you want into a H&S file, but my advice is to keep it as simple and small as possible so that it's more likely to be read.

Good Gear. If you're still protecting your bean with a tin hat when you go on site, then you should leave a few equipment catalogues in the outhouse so that you can get a feel for some newer gear. In particular, personal protective equipment and access equipment have undergone massive development during the past ten years or so. Much of this development has been led by European manufacturing companies like Petzl. These companies have virtually created the new roped-access industry: a hybrid of rigging, climbing and the age-old art of the steeplejack.

Personal protective equipment (PPE) should really be the last line of defense against an injury because by the time you need your PPE, something else has probably gone wrong (a hammer on the head, a fall from a top plate, a chainsaw in somebody's foot), but that just makes us dumber for not wearing it. Flick through pretty much any timber framing book or magazine and you can find scores of folks wearing nothing but a cheesy grin on their head and standing under a suspended frame, or working below their buddies (who wouldn't dream of letting a couple of pegs fall out of their pouch now would they—or the mallet). New PPE is comfortable, lightweight and effective. Examples include safety sunglasses that let you see the crane on a bright day (UK timber framers can just skip ahead in the catalogues to the new rain-gear section); new hardhats designed for the sort of side impact that occurs in a fall; lightweight sneakers with Kevlar toe-caps that let you scoot around on raising day.

Fall-Protection. Modern fall-arrest gear is highly evolved and affordable. With the addition of new, lightweight safety nets, any timber framing company (large or small) can protect itself during a raising. The sense of security that the new equipment gives the raising crew lets them move faster and more confidently at heights. In addition to the cushy harnesses and double-lanyards now available (they're even designed for back-clipping, which used to be very dangerous), there's a whole new generation of easy-to-use anchor lines and work-positioning gear specifically made for construction workers.

Good Practice. This means bringing all of the above to bear on common work tasks. Good practice recognizes the right thing to do and the right time to do it, then chooses to work in a safe and professional manner. Perhaps the greatest obstacle to good practice is the common misunderstanding that cutting corners or using poor work habits will somehow speed a job up and save time and money. But as carpenters we should already know the wisdom of the adage "Measure twice, cut once." Good housekeeping is another obvious example: its easy for us to neglect cleaning up our worksites when we're focused on a task or working to a deadline, but working in a messy or cluttered environment slows people down and causes fatigue. Frustrated, fatigued carpenters are more likely to produce poor workmanship or suffer injuries that will in turn slow a job down and increase costs. Experienced timber framers know that taking shortcuts on site rarely saves time in the long run. It's far more effective to build good habits into our daily routines (like checking one another's layout and sweeping up at the end of each day) and to work in a methodical way. Simply put, good practice is what separates the professionals from the cowboys. The first and most significant step toward site safety is simply accepting that it's cool to be safe. When we accept that safe work practices define a professional framer, our entire approach to site safety changes. It becomes as natural for an experienced hand to say, "Hey, buddy, that doesn't look safe, let's do it this way instead" as it is to offer a tip for mortise layout: just another part of the job.

—Gordon Macdonald

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Resources:
Occupational Safety & Health Administration (OSHA), www.osha.gov
American National Standards Institute (ANSI), www.ansi.org
Where to find Canadian standards and regulations:
Occupational Health & Safety (OHS), Workers' Compensation Board (WCB). www.worksafebc.com
Other useful sites:
International Organization for Standardization (ISO), www.iso.org
Industrial Roped Access Trade Association (IRATA), www.irata.org
Petzl Equipment, www.petzl.com

The Allenstown Meetinghouse

Ken Rower

The Allenstown, N.H., Meetinghouse (1815). Small windows are placed high in wall to clear ascending pews. Modern roof will be replaced.

AGAINST all odds, the 1815 Allenstown Meetinghouse stands today within the bounds of central New Hampshire's Bear Brook State Park, awaiting restoration. The building has escaped disaster on at least three occasions. Its frame was reportedly being raised when New England was devastated by the Great Gale of 1815, the worst hurricane to strike the region before 1938. Nearly a century later, in the spring of 1914, a stray spark from a passing locomotive ignited a forest fire a mile northwest of the building. The flames burned unchecked toward the southeast, consuming large quantities of standing pine and sawn and stacked lumber in the woods, until they neared the meetinghouse. The structure was saved only by the heroic exertions of a crew of fifty men who dug a fire trench around the cherished local landmark. And early on the morning of July 15, 1985, a passing motorist noticed smoke wafting from behind the structure. By the time local fire departments arrived, flames set by an arsonist had traveled up a rear corner of the building and filled the attic, consuming some roof timbers and changing the rest to a charred skeleton. Miraculously, the ceiling plaster, applied over split-board lath, shielded the auditorium from the heat. Everything below the level of the wall plates survived—soaked and covered with soot, but intact.

A modest, one-story building measuring about 43 ft. wide by 36 ft. deep, Allenstown's is one of the smallest and most humble of New Hampshire's meetinghouses. In most New England towns, meetinghouses were large, two-story buildings with high galleries or balconies, built to serve the needs of both religion and town government in an age before church and state were separated. Usually the most imposing buildings in the community, meetinghouses were generally characterized by high pulpits of elaborate joinery. Their interiors were often made resplendent by painted graining and marbling. By contrast, Allenstown's has a low, box-like pulpit and simple, unpainted interior woodwork. Its kinship with larger contemporaries is shown only in the privately owned box pews that fill the perimeter of the auditorium and in the slanted floors that rise from each side of a central aisle, recalling the sloping second-story galleries of the larger buildings.

The Allenstown meetinghouse may be characterized as the public building of a poor town. The town has sandy soils conducive to the growth of pine trees but not to successful farming. When the structure was framed in 1815, Allenstown had about 390 inhabitants, only a fraction of the population of neighboring communities with richer soils. While meetinghouses of the same modest pretensions were certainly built in other rural New England towns, Allenstown's has special value as one of the last surviving examples of the most basic type. There are other one-story meetinghouses in New Hampshire, but no other that served the full range of civic and religious uses characteristic of town-built meetinghouses.

Despite its humble architecture, the old building had found a place in the hearts of townspeople even as population, government, and religion shifted to a growing mill village some five miles away after 1860. The town ultimately decided that it could no longer rationally keep and maintain a primitive structure that was so far removed from the new center of activity. In 1908, the town voted to transfer all its rights in the building to Buntin Chapter, Daughters of the American Revolution. But the town's vote bore the stipulation that "the chapter shall restore the building as far as possible to its original condition, and shall at all times keep it in repair." Buntin Chapter's faithful fulfillment of this charge in 1909 was one of the earliest deliberate instances of architectural preservation in New Hampshire.

THE Allenstown Meetinghouse is special for another reason. Just as it has no surviving duplicate in its small size and simple design, it has no known equivalent in its framing. Despite its unorthodox nature, the frame was skillfully fashioned.

Collection Carol Martel

Before the fire: view toward pulpit showing slanted pews, chamfered post and sagging ceiling.

The surviving timbers are smoothly hewn and connected with close-fitting joints that equal the best carpentry of the region.

The slanted floors on each side of the building's central aisle rest on heavy, sloping joists rising from girders at each side of the aisle to intersect the gable walls of the building. The ends of the floor joists rest atop ledger girts tenoned into the four posts of each end wall. Set on short tenoned studs a few feet above the end sills of the building, these ledger girts act almost like second sills, locking the posts together at a point well above their feet and imparting great stiffness to each end wall.

This framing system is reminiscent of the method used to support the sloping galleries of two-story meetinghouses. But placed within a one-story frame, the girts impart greater rigidity to the end walls of the structure than would girts at the upper level of a two-story meetinghouse. The combination of substantial sills, low girts and heavy slanted joists creates a series of triangular frames within the building, akin to the panels of trusses. This stiffening floor membrane undoubtedly helped to keep the end walls plumb and square when the roof of the building, including the long wall plates, was lost to fire.

If the gable wall framing of the Allenstown Meetinghouse was in effect a foreshortened version of the end-wall framing of a two-story meetinghouse, the roof frame was a different matter altogether. It had no known precedent or equivalent in the region, either in meetinghouses or in dwellings.

Before about 1835, the standard domestic roof frame in the Merrimack River Valley of central New Hampshire repeated a pattern that had been established in the 17th century along the coast, some 50 miles to the east. Such a frame employs pairs of principal rafters placed above posts in the front and rear walls of the structure and, usually, halfway between such posts. The feet of each pair of rafters are mortised into tie beams that span the structure from front to back, resting upon the front and rear wall plates. In the other direction, parallel to the ridge, sets of common purlins span the bays from rafter to rafter, trenched into the upper surfaces of the rafters and pinned in place. Usually spruce poles hewn flat on top, individual purlins are generally long enough to cross two, three, or four rafters before meeting an overlapping purlin that continues to the opposite end of the building. Sawn roof boards fastened by nails run from ridge to eaves across the longitudinal purlins. Such a dwelling frame is said to have a principal rafter, common purlin roof.

The roof frames of meetinghouses in the region are typically more elaborate. To span the 40- or 50-ft. width of the meetinghouse auditorium without support from below, such frames add a variety of members. These may be as simple as diagonal struts that connect the tie beams and the rafters. More commonly seen are fully developed, substantial kingpost and queenpost trusses like those described and illustrated in the recent Historic American Truss series (see especially TF 71 and 72). The kingposts or queenposts in such frames are linked together by a series of longitudinal ties and struts that run through the building's attic, parallel to the ridgepole. The only exceptions to the truss pattern are the rafters in the end walls, which are of course supported by the wall framing of the gables rather than by truss elements.

But even with the added structural elements of the kingpost or queenpost roof frame, the characteristic meetinghouse roof in central New Hampshire remains based on the regional template of a regular series of principal rafters, tie beams, and common purlins.

INSOFAR as it has been conjecturally reconstructed on paper, the lost original roof frame of the Allenstown Meetinghouse differs markedly from this template. A Guild workshop at the building in May benefited from photographs taken shortly after the fire by Roland Martel of Allenstown as well as from a timber schedule prepared then by Neil English, a joiner and timber framer from nearby Epsom, who had had the advantage of measuring the original frame, charred though it was, with a view to reproducing it accurately.

From the evidence of 20 years ago and the insights of the workshop emerged a portrait of a frame that combined the familiar with the unique. Like most dwellings in the region, the frame had six sets of rafters, including the two sets in the gable walls. In keeping with all known roof frames of the region before 1835, the Allenstown roof was composed of hewn rafters with purlins let into their upper surfaces. Roof boards ran from ridge to eaves. The rafters in the gable walls of the building were supported by the usual wall studding, although they were also tenoned at their feet near the ends of the gable tie beams (still extant), in the manner of trussed rafters. In these respects, the frame was identical to others found from the New Hampshire seacoast to the eastern edge of the Connecticut River Valley.

The four inner sets of rafters in the roof frame, however, were supported by two methods, each apparently unprecedented. The outermost of these sets of rafters, placed some 11 ft. from the end walls of the building, rested above tie beams that ran through the building from front to rear. We do not know whether the feet of these rafters were tenoned into the ends of their tie beams, as in the traditional local frame or indeed in the end walls of this frame. It may be instead that the median ties were tenoned or twin-tenoned into the inner faces of the front and rear wall plates, with the rafter feet resting on top of the plates in some form of birdsmouth joint. Or it may be that the rafter feet were after all tenoned to the tops of their ties, with the ties then half-lapped or lap-dovetailed over the plate.

In any case, the two tie beams were exposed below the plastered ceiling of the auditorium. Each was supported at its midpoint by a hewn octagonal wooden column. These columns survive intact, including top tenons, rising from lateral timber girders below the slanted floors on each side of the room.

The innermost of the rafter sets, invisible in photographs that show the auditorium before the fire, presumably were located above the pairs of wall posts that now flank the front doorway and the rear pulpit in the front and rear walls of the building. Apparently lacking tie beams altogether (according to Neil English's timber schedule), these rafters presumably rested atop the front and rear wall plates, held by birdsmouth joints. With no ties at their feet, these rafters would have exerted spreading forces on the front and rear wall plates. All the rafters would have been subjected to bending stresses from wind and snow loading.

These undesirable tendencies were apparently resisted by two means. First, the front and rear wall plates of the building appear to have been heavy rectangular members laid flatwise to resist the lateral components of the forces from the rafter feet.

Second, the four sets of rafters above the auditorium ceiling were apparently supported at midlength by the unusual expedient of running longitudinal trestles beneath them. Dimly and partially visible in post-fire photographs, these trestles appear to have had vertical legs that rested on the two tie beams of the roof frame, themselves supported by the octagonal columns at their midpoints. The top plates of the trestles apparently passed beneath the lower surfaces of the four rafter couples, and the undersides of the rafters were presumably notched to bear on the upper surface of the trestle plates. However, it's possible that the trestle posts tenoned directly into the undersides of their respective rafters. In either case, the posts appear to have been stiffened by diagonal braces like those that connect posts and wall plates in the lower frame of the building.

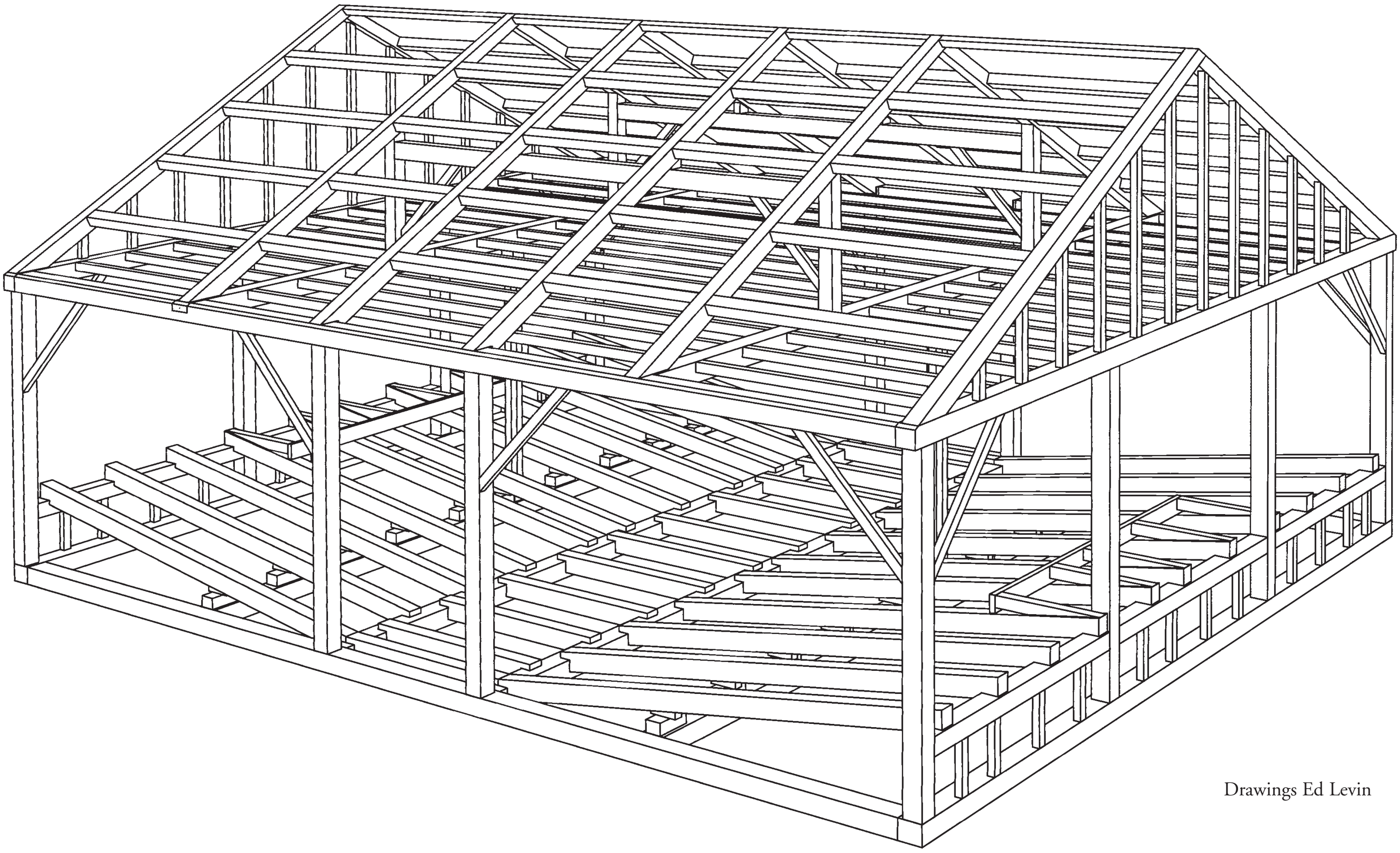
The ceiling of the auditorium was framed with longitudinal joists that supported a covering of split-board lath and a coat of lime-sand plaster with animal hair as a binder. On the evidence of the empty joist pockets intact in each of the end wall ties of the building, the ceiling joists were 4x4 members placed about 2 ft. 8 in. on center. A 20-year-old notation by Neil English indicates that the joists were sawn from oak. Daringly, they spanned the 10-ft. intervals between the gable walls of the building and the inner tie beams above the octagonal posts. Incredibly, they also spanned the interval of more than 20 ft. between the inner tie beams, where they supported the uninterrupted, flat ceiling above the center of the building.

This method of supporting the roof and ceiling plaster was bold and ultimately proved to be unwise. One-coat lime-sand plaster on split wooden lath boards weighs about six lbs. per sq. ft. The total weight of the auditorium ceiling was therefore some 8,400 lbs. Pre-fire photographs show that the 20-ft.-long 4x4 joists had sagged under the combined weight of lath and plaster. Still more dramatic, the inner tie beams themselves had sagged on each side of the central octagonal columns. The weight of the ceiling lath and plaster, combined with the point loading imposed by the feet of the two trestles, had caused the overstressed but resilient tie beams to assume a gentle Cupid's bow.

It's notable that there are no posts in the front or rear walls of the building beneath the ends of these heavily loaded tie beams. The only support for the front and rear wall plates between the ends of the building and the pulpit bay are common studs, most of them framing the window openings in the walls. Thus, the accumulated roof load transmitted from the rafters to the trestles, from the trestles to the tie beams and from the tie beams to the wall plates, was carried to the building's foundation through the relatively light fabric of the studded walls. This seeming lack of structural correspondence between the roof and wall systems was common in dwellings of the same period and region, where roof frames having six pairs of rafters were usually supported by wall frames with four sets of posts.

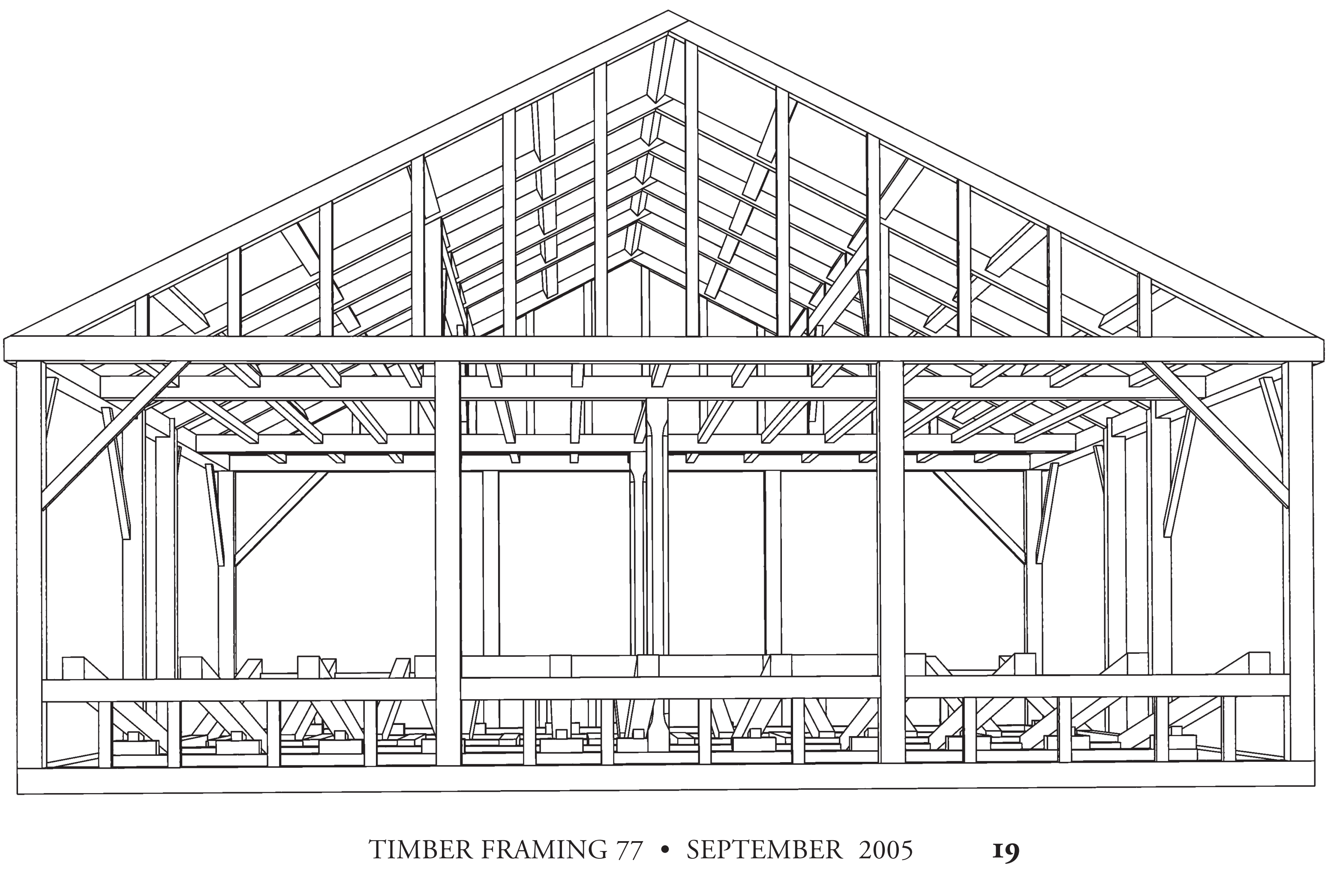
Having survived more than its share of threats over the years, the Allenstown Meetinghouse is destined for a brighter future. Buntin Chapter, DAR, cared for the meetinghouse from 1908 to 1991, finally transferring the building to the state after finding itself unable to raise the funds necessary to replace a temporary roof of prefabricated trusses with a duplicate of the original. The New Hampshire Division of Parks and Recreation then maintained the building as part of Bear Brook State Park from 1991 until 2004, repairing sections of the building's sills and replacing some window sashes that were destroyed at the time of the fire. In 2003, Allenstown adopted a master plan that renewed the community's commitment to its cultural resources. In March 2004, the state transferred title to the building, together with an early cemetery across the road, to the town that originally had built and owned the structure. Today, the town and several private organizations have committed themselves to the restoration of the building and to its future use as an educational asset for the community and the state. —James Garvin

James Garvin (james.garvin@dcr.nh.gov) is State Architectural Historian with the New Hampshire Division of Historical Resources, co-author with Donna-Belle Garvin of Instruments of Change: New Hampshire Hand Tools and their Makers, 1800-1900 *and* On the Road North of Boston: New Hampshire Taverns and Turnpikes, 1700-1900, *and author of* A Building History of Northern New England.

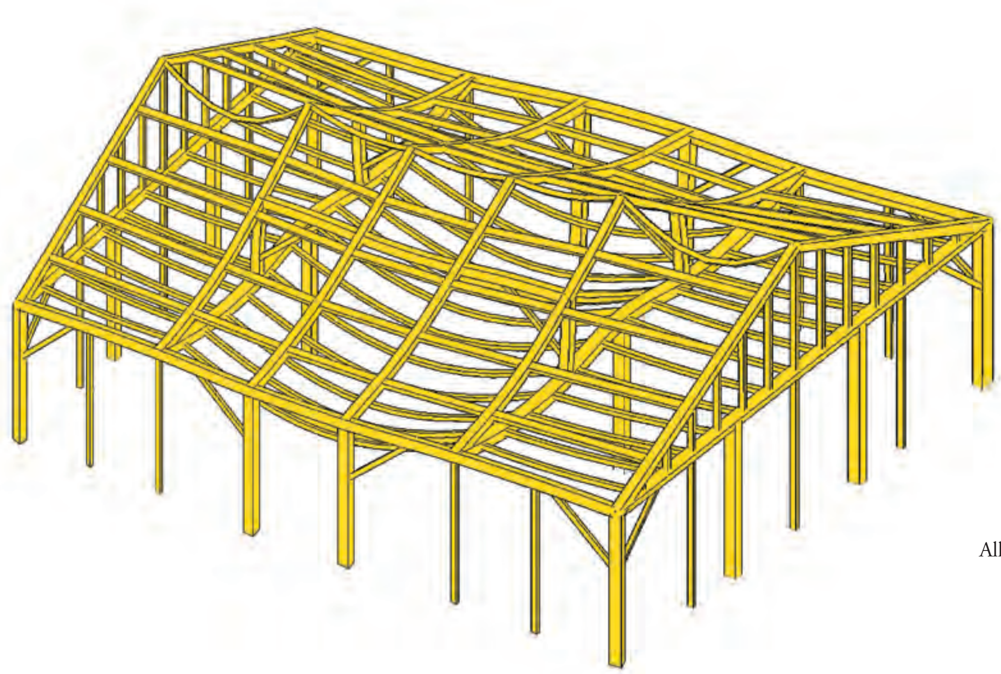


Drawings Ed Levin

Perspective views of Allenstown Meetinghouse timber frame (wall studs removed for clarity). Floor and wall framing established by survey. Roof framing conjectural based on survey and photographic evidence from 1985. In perspective above, alternate methods are shown for median tying joints at the front plate. In one case, tie beam is assumed to lap across plate and receive foot of the principal rafter into its upper half. In the other, tie beam is assumed to tenon into inner face of plate, and rafter is stepped into top of plate. Mortises for gable end rafter feet and ends of plates are found in intact end tie beams.



Engineering Allenstown



All drawings Ed Levin

Fig. 1. Deflected shape of conjectural reconstruction of Allenstown, N.H., meetinghouse roof.

THE structure of the Allenstown Meetinghouse employs some idiosyncratic framing, with unusually long spans to be found in the floor and the roof. One wonders how the timber frame behaved under load and whether this behavior can speak to open questions about members and connections.

To check this out, I used my frame reconstruction drawings (see page 19) as the basis for a Finite Element Analysis (FEA) model. The model was loaded with the dead weight of the timber, lath and plaster ceiling, roof boards and roofing, etc., plus snow load. Results are summarized below.

Joists. In the end bays, 4x4 pine ceiling joists on 32-in. centers carried the dead load of their own weight plus lath and plaster, an easy task over the nine and a half ft. span. But, since there are no inner tie beams at the door-post position, the central ceiling joists spanned 20 ft. 6 inches, far beyond capacity for a 4x4, even in oak. The model shows midspan joist deflection of almost 3 in., four times the typical modern L/360 limit for plastered ceilings. But while these long joists may have been excessively springy, they seemed to have been strong enough, with predicted bending maxing out at 1172 psi, less than the *NDS* allowable bending maximum for No. 1 Northern red oak. Of course, this analysis assumes no attic floor, no attic storage and no attic traffic.

Purlins. Maximum purlin clear span was a modest 10 ft. and, compared to the ceiling joists, the purlins measured a robust 6x5 in. On the other hand, purlins were laid on 4-ft. centers, and combined dead and live unit design load is nine times that on the joists (55 psf vs. 6 psf), so that purlin line load is 14.5 times joist line load (217 lb/ft compared to 15 lb/ft).

When all this is sorted out, the purlins come out ahead. Worst case, a simple span purlin deflects ⅝ in. out of plane at midspan, just about twice the L/360 allowable, and develops midspan bending stress of 1193 psi (the limit for select structural Eastern white pine is 1050 psi). Making the purlins continuous across two roof bays stiffens up the roof, reducing deflection to ½ inch (≈L/240) and bending to around 1000 psi. Further lengthening the 6x5s to cover three bays has no appreciable effect on performance. One down side of long continuous purlins is additional local bending maximums over the center rafter(s). These maximums occur right at the joints where the purlins halve over the rafters, so that bending moment peaks right where purlin section is significantly reduced. Since stress is force per unit area, the result is a local spike (orspikes) in bending stress ranging up to 2500 psi (Fig. 2).

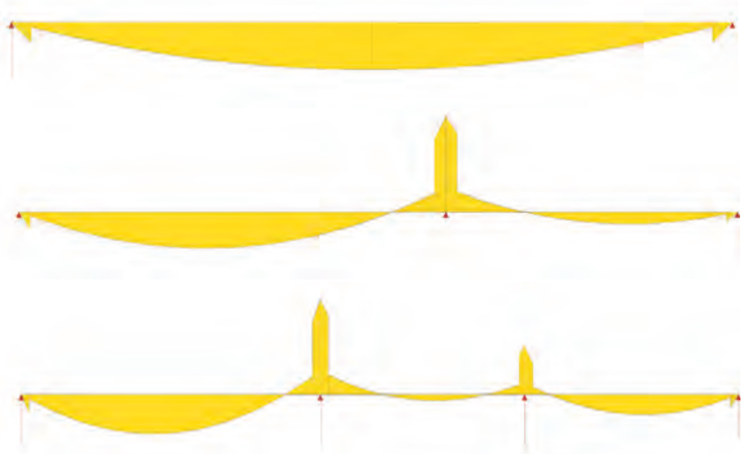


Fig. 2. Bending diagram for 6x5 purlin spanning single bay 10 ft. 4 in.(top), spanning 17 ft. 4 in. over two bays (middle) and spanning 24 ft. 8 in. over three bays (bottom). Spikes in graph represent bending at joints where net timber section is reduced, bending stress increased.

Trestles. Each of the two trestles used a pair of 7x7x6 posts, a 7x8x22 girt and a couple of 3x4x6 braces. The trestle girts resembled purlin-plates such as one might find providing midspan support to barn rafters, the difference being that in Allenstown the girt

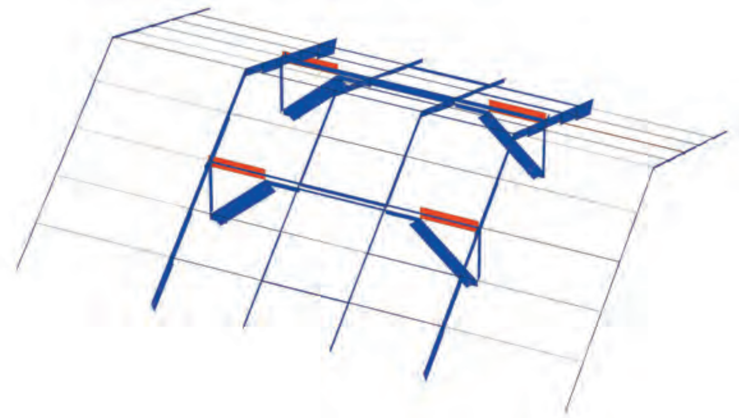


Fig. 3. Roof axial loads, conjectural Allenstown Meetinghouse frame. Compression in blue, tension in red.

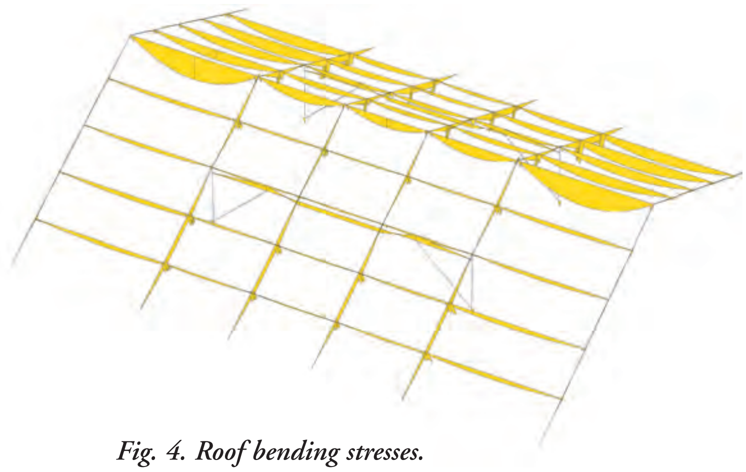


Fig. 4. Roof bending stresses.

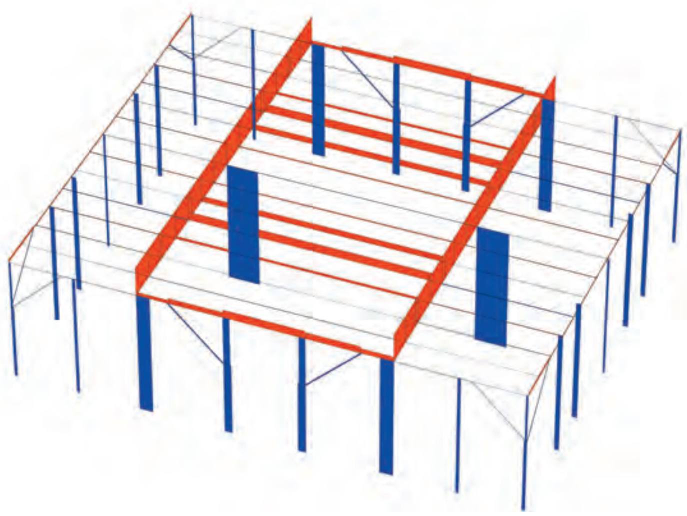


Fig. 5. Wall and tie axial loads, Allenstown Meetinghouse frame.

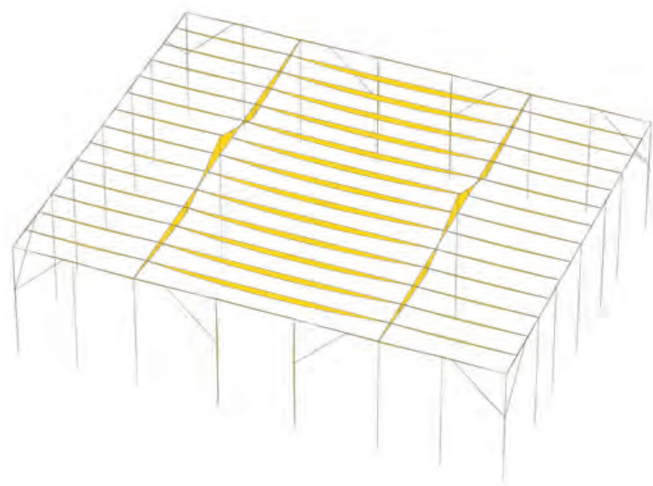


Fig. 6. Wall and tie bending stresses.

load was not posted down to the foundation, but rather carried on the tie beams. The girts picked up load near midspan from the innermost rafters, carrying it out to intermediate tie beams via posts and braces. Connecting principals above to ties below, the posts also enabled load sharing between rafter and beam, forming the beginnings of a queenpost truss. The method of connection between rafter and girt is not known, and might have been as simple as the block and wedge arrangement used in the sloping floors to transfer load from joists to sleepers (photo page 23, bottom left).

The trestle girts transferred 8000 pounds from midspan out to braces and posts, resulting in girt bending of 1006 psi and midspan deflection of 1.86 in. (L/135). The model shows much of this load being channeled down the braces to the posts, putting the braces in compression to the tune of 7745 pounds each (and imparting 3000 pounds of tension at each girt-to-post joint). This axial load is not out of line for brace section and length, but is a bit much given the limited bearing area available on a 3x4 tenon and shoulder, indicating that perhaps more of the midspan load traveled to the posts via the girts, less along the braces. Load paths notwithstanding, each post delivered around 8800 pounds of load to its tie beam, roughly half from inner and half from outer intermediate rafters.

Rafters. Resultant loads for all intermediate rafters are roughly comparable, testifying to the effectiveness of the load-sharing promoted by the trestles. Outer and inner rafters sustained, respectively, 1198 and 1254 psi bending stress (spiking to 3110 and 3230 psi at purlin trenches where rafter net section is reduced), associated with resultant deflections of 1.75 and 1.87 inches, roughly three times the allowable based on L/360.

Tie Beams. Simultaneously supported by and supporting end wall studs, the gable end tie beams feel little or no load. Both floor and roof loads are carried down the studs, alleviating both bending and axial tension. Intermediate tie beam load comes both from the floor and the roof, the former as a continuous load from the ceiling joists, the latter via point loads at the landing points of the trestle posts, as discussed above.

To restrain accumulated rafter thrust, model ties felt end tension of 7745 pounds, a tying load that would challenge whatever joinery was employed. Predicted tie beam bending stress was 2286 psi at the feet of the trestle posts and 3857 psi over the central octagon posts, readings which have *not* been augmented to reflect reduced net section. Deflections just over 1.5 in. (L/132) were found roughly midway between octagon posts and outer walls.

Conclusions. It's pretty clear from our study that the original 1815 timber frame of the Allenstown Meetinghouse would not meet modern codes because of excessive bending stress and deflection, plus some challenging tension loads. Vastly different standards govern building today. However, code design values have large safety factors built in, and it's probably fair to say that, given the quality of the timber and careful execution of the joinery, none of the remaining timbers in the meetinghouse frame is in danger of failing or falling down, an assertion supported by the building's long survival.

But what of the contemplated reconstruction? Can we in good conscience duplicate framing that falls woefully short of code compliance on multiple fronts? Would the regulatory authorities allow such a thing? I don't have the answers. But I do suspect that with relatively minor and unobtrusive modifications to joinery, timber sizes, grade and perhaps species, we could reconstruct a roof for the Allenstown Meetinghouse that the original builders would both recognize and respect. —Ed Levin

Recovering Allenstown

EARLY in May, in preparation for a Guild workshop the following week, I met State Architectural Historian Jim Garvin and preservation carpenter Neil English at the Allenstown Meetinghouse. In 1985, Neil had surveyed the charred remains of the roof frame, making notes on the pre-fire structure and preparing a timber list for its replacement. At the workshop, two dozen of us spent the day playing detective, hoping to rebuild the meetinghouse roof on paper, both for history's sake and in the hopes of a full restoration of the roof structure. Early in August, I visited again, this time with Ken Rower, editor of this journal, and my son and 11-year-old assistant Nate, to get more and measured information, especially under the floor. Jim Garvin met us there and did yeoman service in the crawlspace.

We remain, metaphorically, on the road to Allenstown, a place out of time and a world away, a small white building in a clearing among sand flats and pine foersts. Eventually we'll get most of the way to the truth, far enough to satisfy the original builders were they to come back and see the roof frame we might build.

Up to the plates, we have everything of the meetinghouse save a portion of the northwest corner that burned away, although much of the framing in question is buried beneath lath and plaster, clapboards and floorboards. What we can see of the original undercarriage (sills, sloping floor joists) is substantially complete, save for sill replacements. But from the tops of the wall posts upward, all was lost, except in the end walls, where the gable ties remain.

We must admit that we can have little to say about roof joinery in the building. The bulk of the evidence went up in smoke, and the bit that is left is largely inaccessible behind provisional repairs. We can make informed speculation, but must defer a more rigorous treatment of joinery pending further dissection of the remains.

The Sloping Floor. Found nowhere else, this most interesting feature parallels the sloping second-floor balconies typical in larger meetinghouses of the time. The Allenstown Meetinghouse door, located at the midpoint of the front (south) wall, opens on a 7-ft.-wide level corridor, framed at sill level with joists on roughly 36-in. centers, leading directly to the pulpit at the rear. To either side, the floor slopes up to the left and right at 1:6½ or about 9 degrees, framed with 7x8 joists also on 36-in. centers offset from those in the center. These joists rise from 10x8 girders aligned with posts flanking door and pulpit to 8x7 ledgers tenoned into end wall posts 28 in. above the sills. End-wall studs are in turn tenoned into these ledgers from above and below. (See drawings on page 19.)

Seven feet out from their spring point, the sloping joists are supported on a second pair of 10x8 girders, breaking the 17 ft.-6 in. span at the 60:40 point. Like their sisters, these girders are framed at sill level, leaving an 8-in. space between outer girder top and sloping joist bottom. Connection between girder and joist here is made by an impromptu arrangement of blocking and wedges. In addition to performing their primary job, the sloping joists also impart great rigidity to the frame in the lengthwise direction.

Pews cover the sloping floors, and box pews 4 to 5 ft. wide line the walls along the outer perimeter of the sloped areas. These box pew floors are level, built for the most part on auxiliary framing sandwiched invisibly between floorboards above and below. Between the prick posts at east and west gable ends, however, there is a section of level pew floor framing that can be seen from below and is shown in the accompanying frame reconstruction drawings on page 19.

Finally, it's worth mentioning that the entire floor structure is framed with select old-growth pine, finely hewn and carefully joined, and that all members run full length, including the 36-ft. and 43-ft. girders and sills.

Cornice and Intermediate Rafters. The Neil English inventory lists two 8x10x43-ft. plates. Early in the 19th century, typical carpentry oriented rectangular stock flatwise, suggesting that the plates were likely laid on their wide sides. This contention is supported by the lengths, position and layout of long wall posts and end wall ties, and by the remaining principal rafter mortises in the ties which show the rafters extending outside the wall plane. Careful examination of exterior photos taken before the fire shows front and rear fascia boards standing proud three or four inches. Likewise, interior shots including the 8x8 pulpit posts show a roughly 2-in.-thick vestigial post teazle running up past the inner edges of the plate. Thus, by preponderance of evidence, we deduce flatwise plates with their outer edges set 4 in. outside the wall plane as defined by the outer post surfaces.

End joints in the end tie beams make it clear that the ties received tenons from principals, plates and posts. Photos show the next pair of tie beams in (those over the octagon posts, 10 ft. 6 in. in from the ends) set flush with the bottom of the plates. These ties were either tenoned (or twin-tenoned) into the plates, or half-lapped over them. (Both layouts are depicted in the frame drawings on page 19.) In the latter case, the principal rafters entering above presumably tenoned into the tie beams, the standard arrangement. Otherwise the rafters must have birdsmouthed over the plates. Posts are conspicuously absent from the composition here, although there are studs buried in the outer walls under these intermediate tie beams. Still, this was not unusual for the time, when it was common practice to land intermediate principals on plates away from posts.

But, moving on to the inner pairs of principals, we come to a unique bit of framing. Here we have posts, plates and principals, but no tie beams. Presumably the rafters birdsmouthed down over the plates, perhaps with a bit of help from the post teazles. So what kept the plates from bowing outward under rafter thrust over the 21-ft. span between inner tie beams? Well, first of all, it's not clear that the eaves didn't spread. The before-fire pictures that come down to us aren't taken from a vantage where plate curvature would be apparent. And presumably the carpenters who installed the current "temporary" roof would have straightened the eaves to line up their store-bought trusses.

The Trestles. Absent queenposts, struts, collars or other stiffening devices, the principal rafters over door and pulpit posts faced an unsupportably long span, and would clearly have failed without help. They got some from another of Allenstown's anomalous frame features, what we are calling trestles. These consisted of 7x7x6 posts, 7x8x22 lintels and 3x4x6 braces, and were reared on the inner tie beams near mid-run of the rafters. Similar devices apparently exist elsewhere in New Hampshire, and attic box frames to support hip roofs can be found in contemporary continental European carpentry. But nothing quite like the layout in Allenstown.

We take trestle timber sizes and lengths from Neil English's parts list. For location and framing details there is one dark, fuzzy interior photo of the attic taken after the fire that apparently shows one end of one of the trestles. This picture seems to indicate queen posts tenoned into the rafters, girts tenoned into the queen posts, braces joining posts and girts, with the whole wall section aligned under the second purlin down from the roof peak. The trestles are additional evidence that the Allenstown framers weren't bashful

Tie beams over octagonal posts appear to have been set flush with the bottoms of the long plates, the latter burned away in this view..

Two citizens inspect the remains of the meetinghouse. Intact end wall, ceiling joists and one tie beam visible. Box and bench pews survived.

Remains of one trestle adding rafter support. It's not clear whether the trestle posts were joined directly to rafters or capped by their own sort of purlin plate.

Photos Roland Martel

Entirely roofless after stabilization, the meetinghouse's gable ends have been removed, probably for safety, taking considerable evidence with them.

Ken Rower

Heavy sloping joists rise from girders under central aisle.

Lisa Sasser

At upper end, joists rest on ledger, a kind of second sill on short posts.

about going for the long span: 21-ft. ceiling joists and trestle girts and 20-ft. principal rafters, all with little or no midspan support, with the trestles themselves landing far from post locations on 35-ft. tie beams. As we have seen in the engineering discussion preceding, we will have to be less daring in following their footsteps as we recover Allenstown. —Ed Levin

Reverse Top Plate Assembly

CALIFORNIA gold mine and Nevada silver mine cable buildings house the hoist, the engine that raises or lowers the cage or skip bucket of a deep mine by driving a large drum around which the cable is wound. Although the Pioneer Mine in Plymouth, California, shown in the drawings here was torn down in March 2005, a cable building owned by the New London Mine, a mile or so away, still has the hoist and cable cabin, where the operator was isolated so he could hear the bells for hoisting and emergencies.

What makes these utilitarian structures remarkable is the location of their continuous top plates.

Unlike barns, these structures required clear spans—hence trusses were used. The Pioneer Mine cable building was built with 6x6 sawn Douglas fir, no timbers longer than 14 ft. with the exception of the tie beams at 34 ft. Even in the building's dilapidated condition, the trusses had no sag as observed from a ladder. The trusses had housings for the struts where they connected to the principal rafter or top chords and a small straining beam at the lower chord. The lower chord also had a housing for the foot of the upper chord. These housings are standard in timber truss engineering (Fig. 1).

What sets this building apart from ordinary truss construction is that the posts are housed into the trusses and the braces are housed into the post and lower chord. Beveled washers of 45 degrees with cleated faces hold the inside with a cast iron washer and ⅝-in. bolt completing the compression. This provision suggests that the entire cross-frame including rafters was raised as a bent. The continuous scarfed top plate was then laid on top of the trusses as the drawings indicate (Fig. 2). Continuous purlin plates could be added in the same fashion.

The New London Mine has the same feature using Howe trusses. Piper's Opera House (1883) in Virginia City, Nevada, employs the same construction (see TF 71). The Gould and Curry Silver Mine in Six Mile Canon, Nevada, has an ore and furnace house using the reverse assembly with common rafters. But this arrangement is puzzling, with none of the advantages of the truss and purlin roof.

Drawings Jack A. Sobon

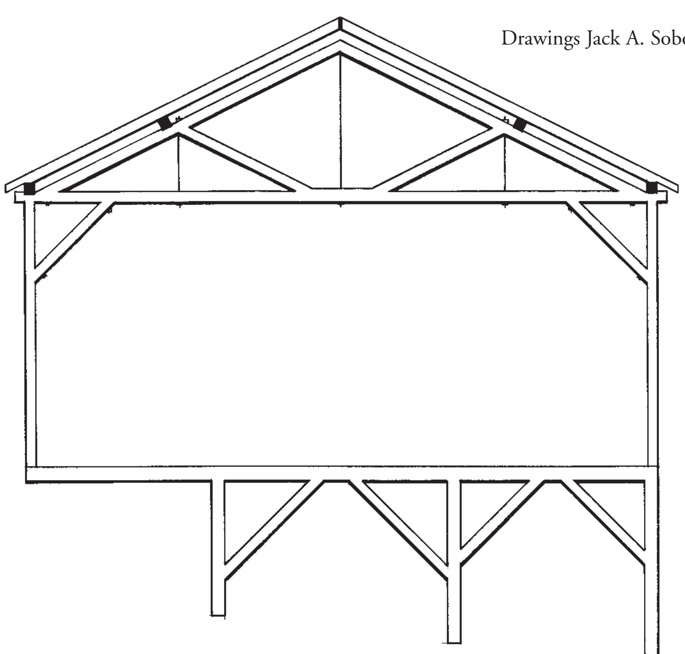


Fig. 1. Cross section of Pioneer cable building framing.

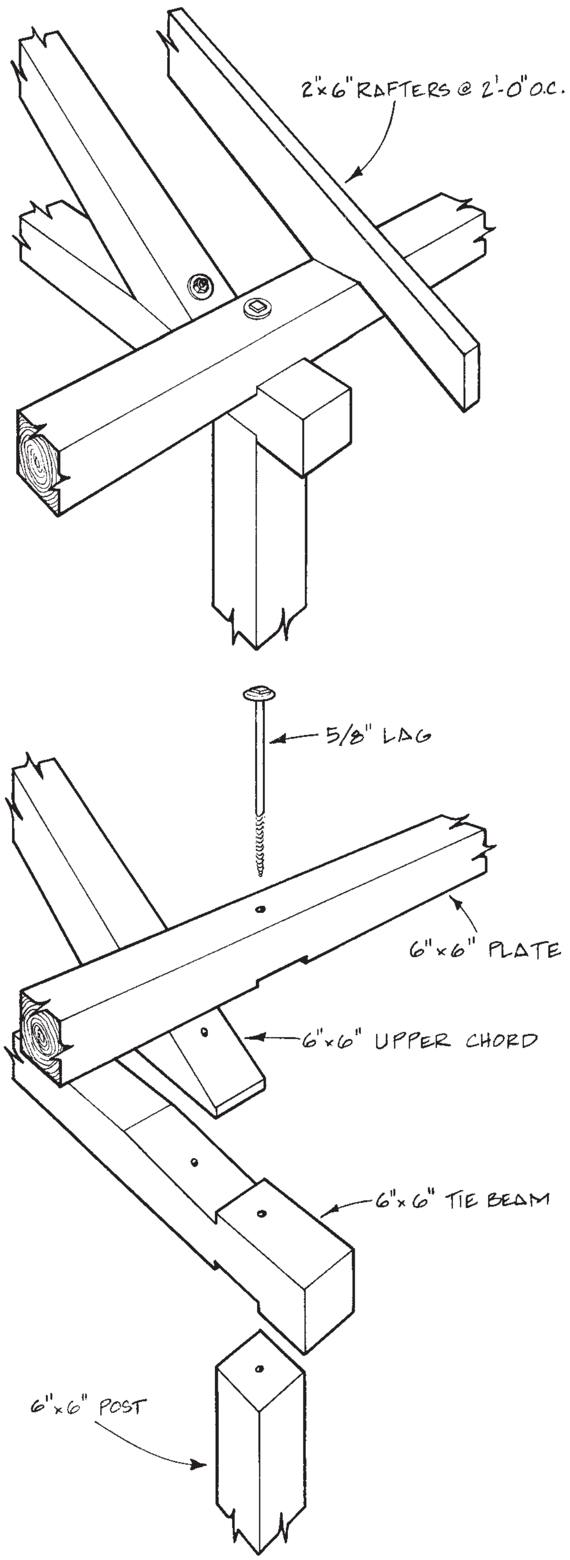
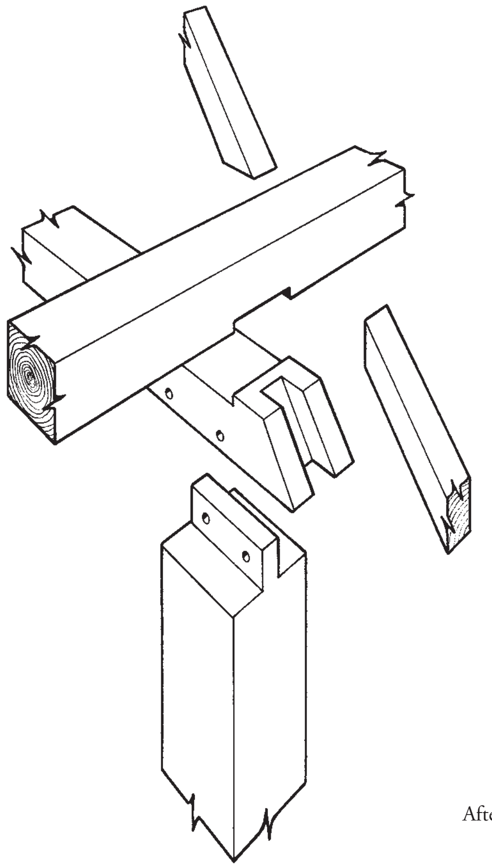


Fig. 2. Reverse top plate assembly, Pioneer cable building.

Cecil Hewett coined the term “reverse assembly’” in 1962, to indicate “a system of rearing transverse framing units, the lengthwise timbers of which (top plates) are laid last. In these cases the tie beams are under the top plates.” I have found few precedents for this configuration since Great Coxwell Barn (Berkshire, UK), built in the late 13th century and discussed in Walter Horn and Ernest Born's 1965 volume *The Barns of the Abbey of Beaulieu at its Granges of Great Coxwell and Beaulieu-St-Leonard's* (Fig. 3).



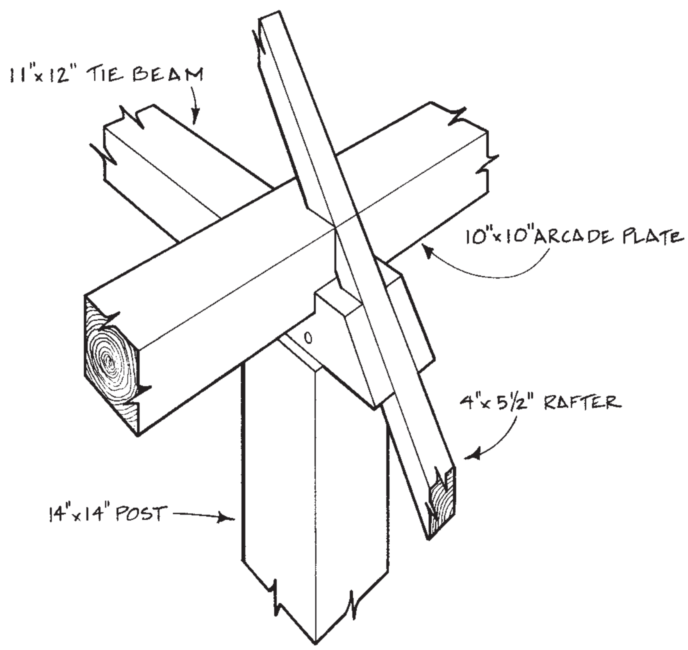
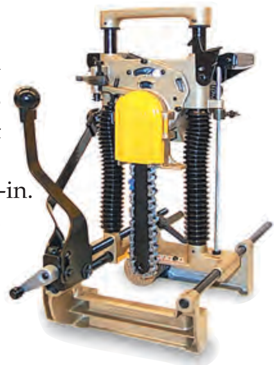


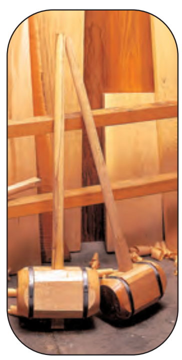
Fig. 3. Reverse top plate assembly, Great Coxwell Barn, late 13th century. The method was also used in other medieval Cistercian barns.

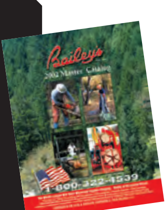
The reverse assembly of the top plate was an unusual construction even in the 13th century, as noted by Horn and Born. It was Ter Doest in Belgium (ca. 1230) and reappears occasionally up to the 17th century in French market halls. We can only suppose that reverse assembly became common in our own Far West industrial timber framing in the late 19th and early 20th centuries because of its ease of combining full-bent raisings with continuous top plates.

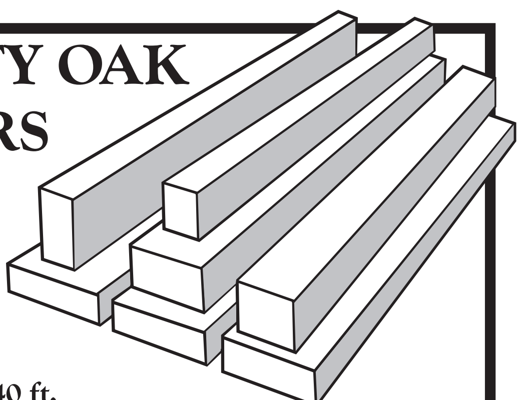
—Paul Oatman

Paul Oatman (paul.oatman@volcano.net) is a contractor and timber framer in California and researches timber framing in the Western US.









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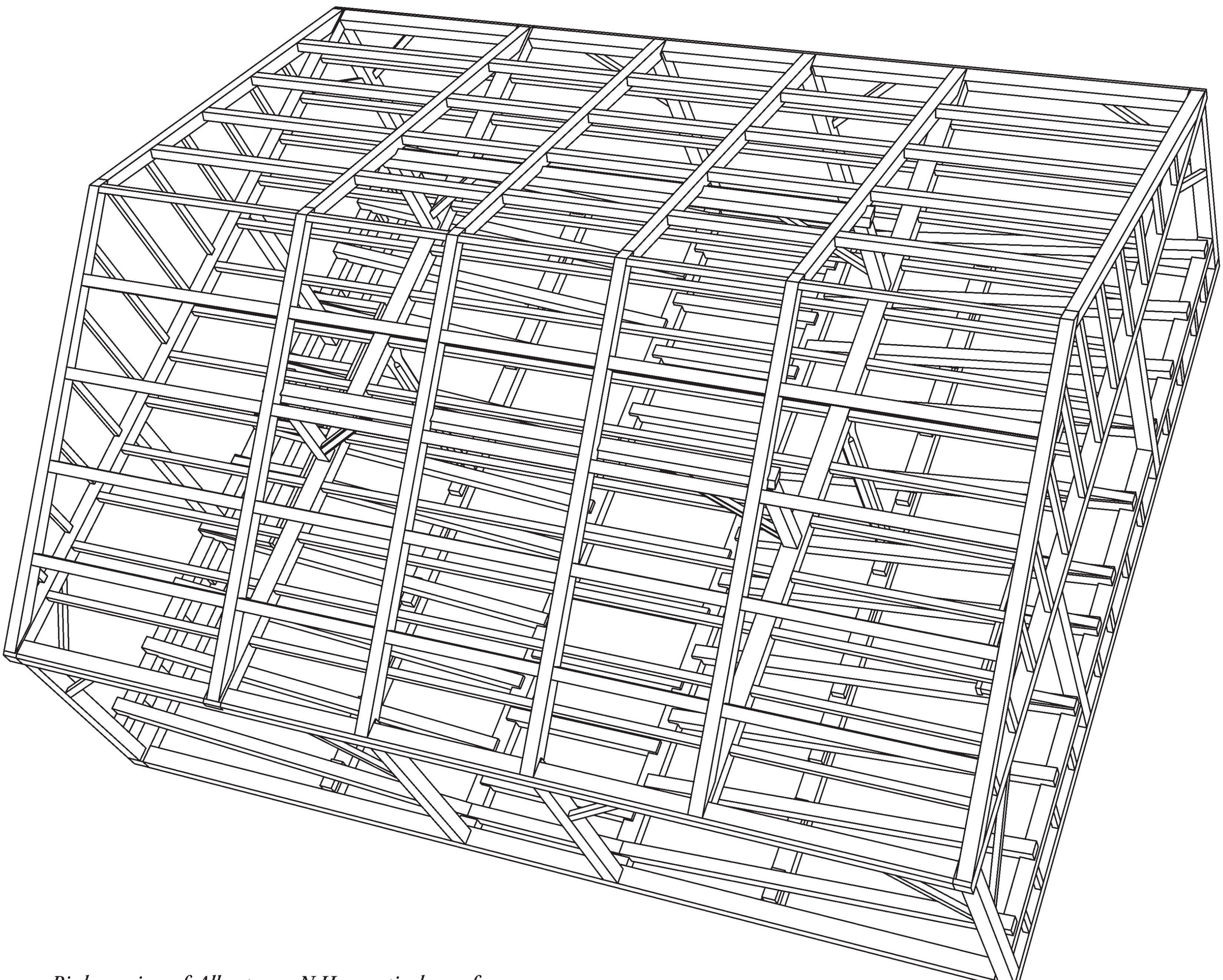

Birdseye view of Allenstown, N.H., meetinghouse frame (1815), including conjectural reconstruction of roof frame entirely lost to fire in 1985. Story page 16.

Ed Levin