

# TIMBER FRAMING

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## CONTENTS

BOOKS: *How Structures Work* 2  
Ben Brungraber

DRAWING A FRAME IN SKETCHUP 5  
Ben Weiss

A VISIT TO THE FORBIDDEN CITY 12  
Tim Chauvin

PLAYHOUSE DESIGN AND SAFETY 20  
Sarah K. Highland

*On the front cover, Tian Tan, Prayer for Good Harvests Hall, within the Temple of Heaven in Beijing, southeast of the Forbidden City. The temple complex, built between 1406 and 1420 and expanded during the 16th century, sits on a three-tiered marble platform. Tian Tan is 104 ft. in diameter at its base and stands nearly 125 ft. tall. On the back cover, decorated eaves treatment on a hipped rectangular building. Corner bracket sets cantilever from a wall plate to support a round purlin and common rafters. The colorful enamel finish is applied to the last of three layers of mastic, resembling a cement plaster, coating all the frame timbers. In the background, the concave conical roof of the Imperial Vault of Heaven. Photos by Tim Chauvin. Story on structures of the nearby Forbidden City, page 12.*

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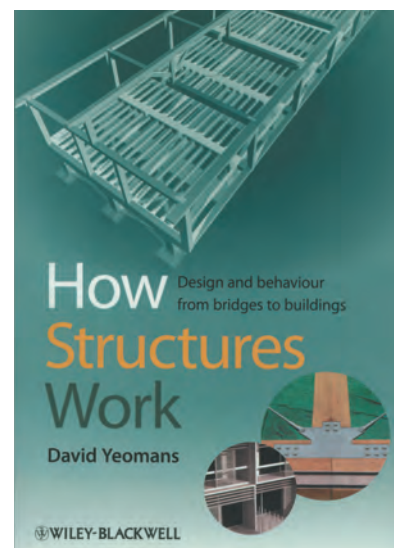


## BOOKS

How Structures Work

*How Structures Work: Design and Behaviour From Bridges to Buildings*, by David Yeomans. Chichester, West Sussex, UK, Wiley-Blackwell, 2009, 6¾ x 9½, 248 pp., profusely illustrated. Paper, \$59.95.

AS I read the brief bio on the back of this book, I was so struck by the similarities between the author's and my own career paths, interests and approaches to structural engineering that I thought, "I really ought to know this guy." A quick check of my Palm Pilot revealed that I had, in fact, met David Yeomans during at least one Carpenters Fellowship annual gathering in the UK. I wish that I had spent more time with him; his book *How Structures Work* is the most compelling on structures that I have ever read. And I have read a lot of books on structures.



As a structural engineer, historian and teacher, Yeomans met many non-engineers who worked with structures (such as archaeologists) and who would have benefited from knowing something about how structures work, giving rise to the book: "The idea was simply that something on building structures might be useful for people with little or no mathematics but whose work or subject of study involves understanding buildings." This makes for an interesting audience.

Most structures books are textbooks bought by students with little option; academics and professional engineers buy a few structures books that are not textbooks, generally dealing with their own specific field. The potential audience for a book on structures not intended for typical readers is much larger—but only if the author succeeds in de-mathing the narrative without gutting it of science. Yeomans has written the right book for this audience.

David Yeomans is a generalist who roams widely and sometimes seemingly at random through a remarkable range of structures and their behavior. Any small-format book of fewer than 250 pages that discusses wedged dovetails and drawbored pegs ("tortured," in his words) as well as the Centre Pompidou in Paris and Gustave Eiffel's bridges indicates an author easily bored with laborious and plodding linear thinking. *How Structures Work* includes quite a bit of arcana and human interest, too.

We learn immediately that Canadian civil engineers don a simple but significant steel ring when they receive their degrees, crafted from the ill-fated Québec Railway Bridge that saw two horrific and lethal failures during its construction about a hundred years ago. In other contexts, Yeomans explains that Galileo was the first to wade into scientific analysis of cantilevered beams—but had it wrong. Or he makes this disarming remark: "There always has to be a certain amount of guesswork in analysing a structure—only always be sure to call it engineering judgement."

The book opens with the chapter “Brackets and Bridges,” an early demonstration of the author’s uncanny ability to combine seemingly disparate topics in a single discussion. Simple wall brackets share behavior with some huge and famous bridges, and the author does a great job of using those similarities to wade into big structures. Large bridges are both the most obvious and the most revealing structures in most readers’ lives, as well as actually being among the simpler structural forms.

While they may be immense and crucial, bridges are such focused structures that most can be analyzed in two dimensions, even using hand analysis (vs. computer analysis) for at least preliminary calculations. This is in striking contrast to our ancient and supposedly simple principal-purlin, common-rafter roofs, which merit a computer if the analyst really wants to assess load sharing among the components.

The next two chapters deal with specific bridge types: arches and suspension bridges and then girder bridges. Again, the structural forms that many readers might have considered to be the more complex are revealed to be simple extensions of smaller and more familiar structures. Some of the most impressive structures that we have built or used are demystified.

We are introduced to some of the most potent tools in the structural engineer’s toolbox: equilibrium under action of forces, superposition of broken-down loadings, force polygons and other simple graphic techniques, the method of sections for analyzing trusses, indeterminacy and (my personal favorite) free-body diagrams (Fig. 1).

All of this potentially daunting material is presented concisely and unthreateningly. Sidebars of a sort (full-width boxes of text on gray screens) frequently appear for readers who can handle more detail or who cannot resist sidebars. One is reproduced in Fig. 2.

The building chapters are organized in components: Walls, Frames, Floors and Beams, and Roofs. The author describes several ways of looking at structural behavior that particularly resonate with my own, first when he discourses on the role that guessing plays in any design process. An experienced and talented designer in the throes of schematic design is actually considering a long list of options and quickly guessing whether they are worthy of investing analysis and drawing time. The better the first guess in any design, the faster that design will also converge on a workable version.

Second, Yeomans observes the flow of one structural form to another, describing, for instance, how knee braces when nested and accumulated become trusses; how corbels, extended, become arches; how suspension bridges and arches are really inverted forms of one another. His description of arch action and failure modes is as cogent as any I have read, and he points out that load paths in buildings can be so multiple and concealed as to defy even dedicated and experienced investigators.

The chapter on frames (“A Problem of Stability”) begins with this proposal: “A frame can be thought of in two ways: as a number of members connected together by joints, or as a number of joints connected together by members.” I have used that comparison so often that I wonder if I did not hear it from David Yeomans. His understanding of the moment resistance available in large-scale mortise and tenon joinery confronts a question many timber framers have posed, and which my own Ph.D. thesis addressed. He points out that these joints can, *if tight*, resist moment (the tendency to produce rotation about an axis or point), and do so in wood furniture—but not in buildings. If the moment capacity of a given timber-framed building’s mortise and tenon joints is the line of defense, the thing is coming down. “The buildings rely upon bracing while the furniture relies most often upon fixed joints. And yet both use essentially the same basic jointing method. The fact that in one case the joint can be made rigid while in the other it is a pinned [rotatable] joint is a matter of scale.”

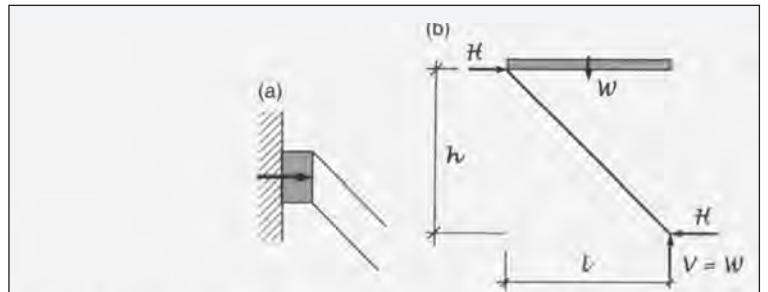


Figure 8.3 Rafter with a plumb cut at the top.

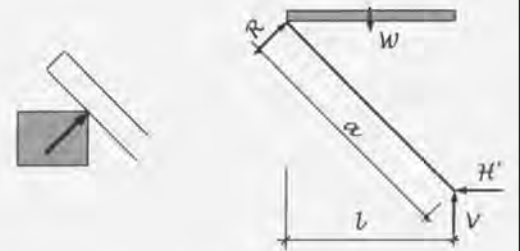


Figure 8.4 Rafter riding over the arris of a plate at the top.

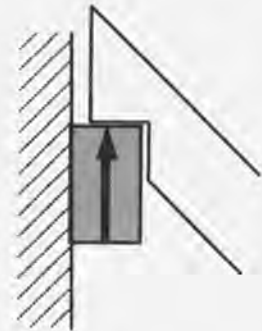


Figure 8.5 Rafter with a birdsmouth at the top.

All illustrations from David Yeomans, *How Structures Work*

Fig. 1. Alternative methods of supporting shed rafters at ridge, two with free-body diagrams showing resulting horizontal thrust to be countered at plate. Level seat (Figure 8.5) obviates such rafter thrust.

*How Structures Work* also tracks other flows in the field of structural engineering: how changing materials affected design and ambition, how history and culture influenced structural forms, how architecture and structure have interacted. Yeomans mentions several stunning instances of immediately post-World War II buildings where form was driven by some pretty breathtaking structural concepts. During those years when materials were in heavy demand and short supply, buildings followed load paths in pursuit of efficiency instead of architectural goals for floor plan and appearance; the designs were driven nearly exclusively by structural form and load flow. Our modern press to reduce embodied energy and carbon footprints, he suggests, might inspire similarly pleasing buildings, ones with exposed, celebrated and elegant supporting structures.

Each chapter of *How Structures Work* is headed by an erudite, pithy citation. The entirely glorious chapter on roofs (“Providing Shelter”) begins with this one from Henry Wotton’s *The Elements of Architecture* (1624): “... the house may now have leave to put on its hatte: having hitherto beene uncovered it self, and consequently unfit to cover others. Which point though it be the last of the art of execution, yet it is always in intension the first, for who would build but for shelter.” That chapter on roofs, alone, might make the book a completely worthwhile investment for any reader of this journal. The author’s comparison of rafter and purlin framing



schemes, as well as the load sharing between roofs with both components, is a model of clarity. Here is part of his discussion of a principal-rafter, principal-purlin, common-rafter roof:

The purlins will deflect under load and as they do so the [common] rafters will deflect with them. The rafter is like a two-span beam with a central support, but where that central support is a spring rather than being rigid. As the spring deflects downwards under load so will the beam, and the beam will be compelled to carry more of the load back to the end supports. The central support is shedding load, via the beam, to these two end supports. In the roof the purlin is the spring but it is not loaded by a single rafter but by a whole series of rafters along its length. It is not able to shed much of the load of the rafters close to its support because it deflects little there. It sheds more load from the rafters near the centre of the span where the deflection is greater. In fact in some roofs the purlin deflects so much that the rafters located towards the middle of a bay might find themselves completely unsupported by the purlin. The effect is that the load on the purlin is not uniform but falls off towards the middle.

A principal purlin is stiffer near its ends than in the middle of the bay, so the common rafters nearer the principal rafters (or gable ends) are more firmly supported at their midspans. Those common rafters out in the middle of the bays may not be feeling much support at all from the principal purlins.

Yeomans also does a fine job with collar struts and ties, including an explanation of why they are often misused by modern builders who ought, but seem not, to know better (Figs. 2–3).

Fig. 2. *Commentary.* At right, the book's Figure 8.14 compares the case of rafters jammed between rigid supports, where the collar is compressed as it reduces sag in the rafters (a), to the case of rafters tied only by the collar (b). The basic truth is that collars are struts in compression if the rafter feet are prevented from sliding out, but ties in tension if the rafters can move out. That is the governing matter in tension vs. compression. When we discuss the magnitude of that tension or compression, it's easier to start with the determinate case (b), as covered in Figure 8.15. The equilibrium equation boils down to  $C = Pa \div 2h$ . The  $C$  stands (perhaps unfortunately) for the tension in the collar tie. If the load  $P$  goes up so does this tension. If the span  $a$  increases, so does the tension. If the tie is lifted and  $h$  decreases, then the tension  $C$  goes up. You might remember that as  $h$  approaches zero in that denominator, the tension starts to blow up toward infinity—always a challenging design load.

—B.B.

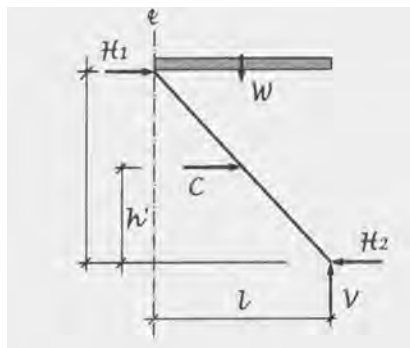


Fig. 3. *Commentary.* Above left, free-body diagram for a collar-strutted rafter with restraint at the base. This rafter does not boil down to a simple equation; its indeterminacy prevents that, while keeping engineers in some demand. Much could be written and plotted about the position of the collar in these situations. Suffice it to say that “the best,” the sweet spot, is at the mid-span of the rafter.

—B.B.

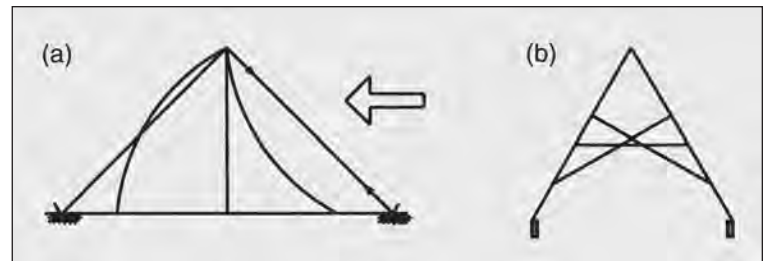


Fig. 4. Tent behavior of uncollared rafters under wind load (a) and remedy for tall roofs where collar will move with rafters (b).

Whether you are a structural engineer interested in great riffs on topics as sophisticated as the nature of bearing pressures on timbers cantilevered from masonry walls, or a timber framer seeking enlightenment on how seemingly identical common rafters can behave completely differently depending on how the support connections are cut (see Fig. 1), or how to use scissor timbers for wind bracing (Fig. 4), this book delivers the goods.

The reader can equally well read *How Structures Work* straight through or pick it up and wade in almost randomly. There are no two consecutive pages without some enlightenment. The illustrations are evocative without being busy. Readers can seek a specific structural engineering topic—few are not at least touched upon. This book can also provide more casual pleasure, picked up and read in short stretches, without concern about losing the stream of thought. (In this regard, I consider the work unquestionably the best structures book for bathrooms.) I heartily recommend your procuring, enjoying and holding on to this fine and deceptively simple book.

—R.L. (“BEN”) BRUNGRABER, PH.D., P.E.

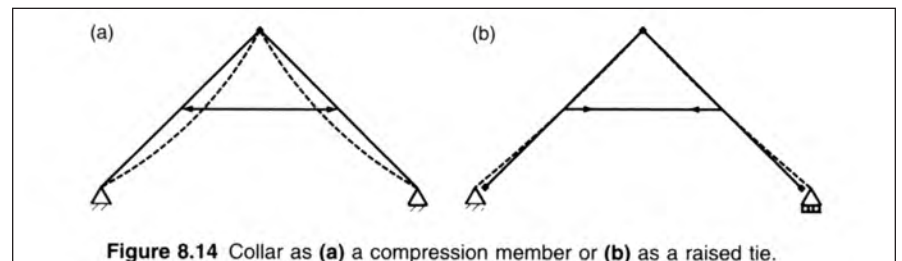


Figure 8.14 Collar as (a) a compression member or (b) as a raised tie.

### Containment by the collar

The force that has to be produced by the collar to contain the tendency for outward movement increases with the collar's height. With no restraint at the feet the A-frame becomes a statically determinate structure.

This can be seen simply by drawing a free body diagram for the principal rafter and taking moments about the apex of the roof. Assuming a vertical force  $P$  from the purlin halfway up the principal rafter,  $V = P$ , and the clockwise moment,  $V.a = P.a$ , while the anticlockwise moments are  $P.a/2 + C.h$ , from which  $C = P.a/2h$ , the smaller the value of  $h$  the larger  $C$  will have to be.

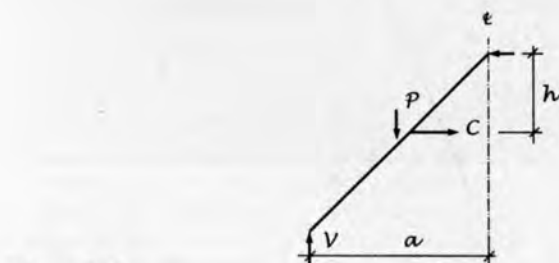


Figure 8.15

# Drawing a Frame in SketchUp

**G**OOGLE SketchUp is becoming very popular among timber framers, and with good cause. SketchUp is a great tool for drawing frames, detailing joinery, producing shop drawings—even designing entire houses. Using screen shots taken from an actual SketchUp exercise, this article demonstrates the basic techniques in drawing a frame. For an accompanying video, go to [www.youtube.com](http://www.youtube.com) and search on “Drawing a Timber Frame in SktechUp.”

SketchUp can be downloaded from [sketchup.google.com](http://sketchup.google.com). If you're new to SketchUp, there are some great beginners' tutorials on YouTube (search for “Getting Started with SketchUp”). There are also videos on each SketchUp tool (search for “SketchUp Toolbar Series”). At the very minimum, you should be comfortable with zooming, panning and orbiting before trying this tutorial.

I strongly suggest learning and using the SketchUp shortcut keys. Using shortcuts can have a dramatic effect on your efficiency. The shortcut key for each tool is noted in the article whenever a tool is used for the first time.

This article tutorial was written for PC users but will work fine for Mac users too. Simply use the Option key whenever the Control key is mentioned. If you use a single-button Mac mouse, use Control+Click whenever the instruction is “Right-click.” Better, acquire an inexpensive wheel mouse. Otherwise, zooming, panning and orbiting will be challenging.

**Create virtual timbers.** The most important skill needed to draw a timber frame is to be able to create timbers and make them into components.

*Create a 10-ft. 8x8 timber:*

1. Select the *Rectangle* tool (shortcut key **R**).
2. Move to the origin.
3. Click and drag diagonally between red and green axes (Fig. 1).
4. Type **8,8** (*Dimensions* box, Fig. 2) and press **Enter**.
5. Select the *Push/Pull* tool (shortcut key **P**).
6. Hover over the rectangle until its face becomes dotted (Fig. 3).
7. Click, then pull the face upward along the blue axis (Fig. 4).
8. Type **10'** and press **Enter**.

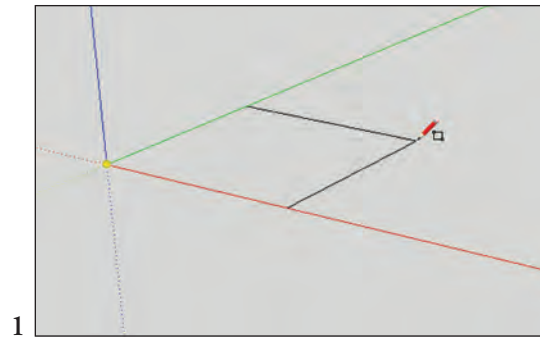
*Note: When entering dimensions, do not click in the Dimensions box—just type.*

If you are new to SketchUp, you'll quickly become frustrated with sticky geometry. Unless you make shapes (such as timbers) into self-contained units, their edges and faces can easily get modified when moving them or attaching other shapes to them. Therefore it's essential after creating a timber to convert it into a group or a component.

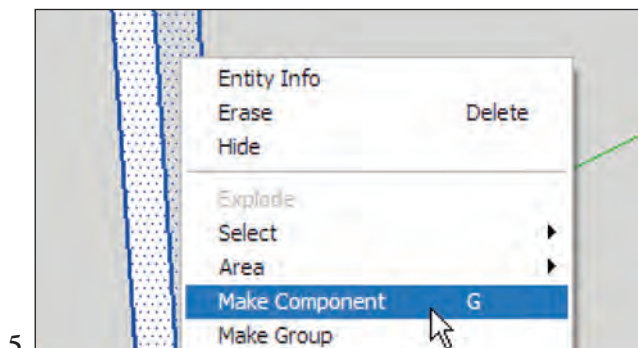
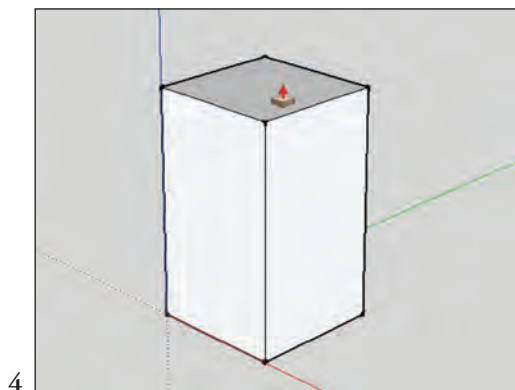
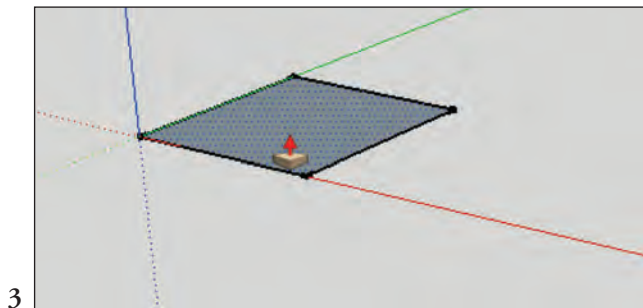
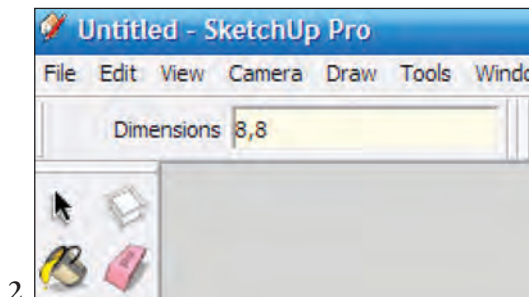
Groups and components have one major difference. Any time you copy a component, editing any of these components will edit all of them. Groups can also be edited, but each copy of a group is unique (editing one copy will not change others). I usually make timbers into components, since most timber frames have several timbers of the same size and dimension.

*Make the timber into a component:*

1. Select the *Select* tool (shortcut key **Spacebar**).
2. Triple-click on the timber to select the entire timber.
3. Right-click on the timber and select *Make Component* from the Context menu (Fig. 5).
4. In the *Create Component* dialog box, enter a meaningful name, such as **Post 8x8**, then click on the *Create* button.



All drawings Ben Weiss





**Move and copy timbers.** The next essential skill is being able to accurately move and reproduce the timbers. We'll start by making a 24x30-ft. concrete slab, which will help in positioning the timbers.

*Create a 24x30-ft. concrete slab:*

1. Select the *Rectangle* tool.
2. Move to the origin.
3. Click and drag diagonally between the red and green axes.
4. Type 24', 30' and press **Enter** (if the rectangle is oriented differently from Fig. 6, type 30', 24' to reverse its layout).
5. Triple-click on the rectangle to select it.
6. Right-click on the rectangle and select *Make Group* from the context menu.

**Create a bent.** Now let's create a simplified bent with four posts in the 24-ft. direction. We will use the slab as a guide for accurate movement and the *Array* feature to create evenly spaced posts.

*Create a 24-ft. "starter" bent:*

1. With the *Select* tool, click on the post (all edges become blue).
2. Select the *Move/Copy* tool (shortcut key M).
3. Press and release the **Ctrl** key to select *Copy* mode ("+" will appear next to the *Move* cursor).
4. Click on the inside-bottom corner of the post (Fig. 7).
5. Drag the copy of the post to the opposite corner (the post will snap to the corner) and click (Fig. 8).
6. Type /3 and two interior posts will appear (Fig. 9).

*Note: Creating arrays (which you just did by typing /3) is a great way to reproduce timbers when even spacing is desired.*

**Use the Tape Measure.** It's a good idea to verify the positions of created timbers. This can be done easily with the *Tape Measure* tool.

*Measure the new timbers:*

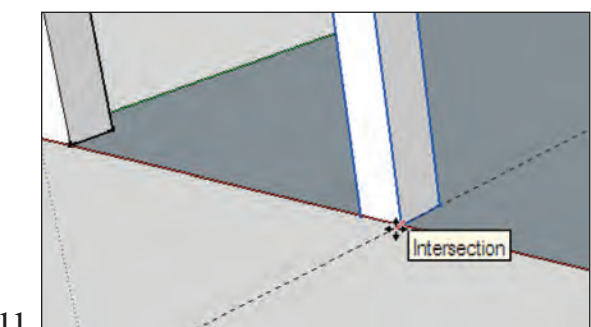
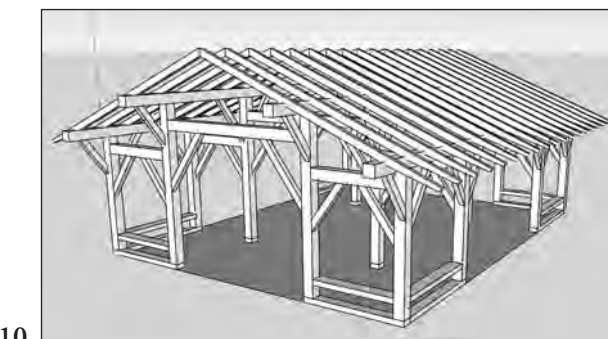
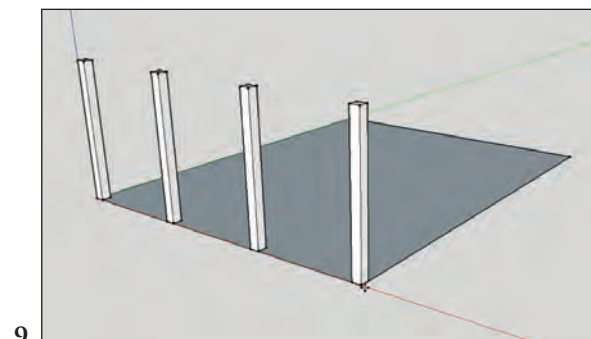
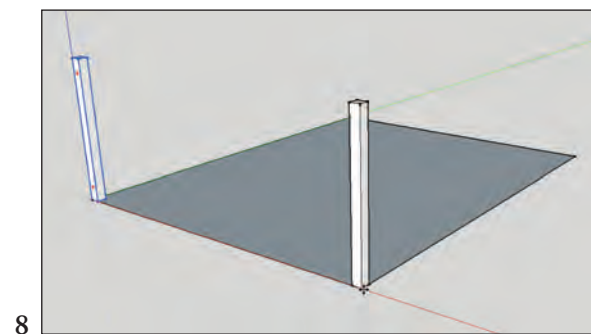
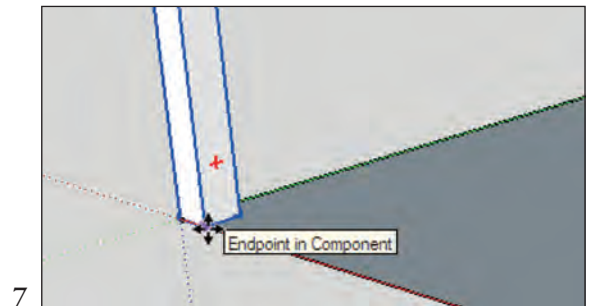
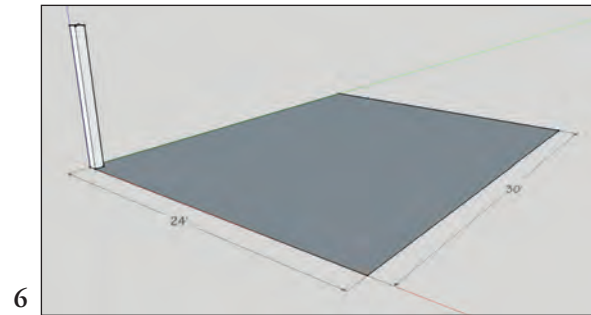
1. Select the *Tape Measure* tool (shortcut key T).
2. Move to the outside corner of the lefthand post and click.
3. Move to the outside corner of the righthand post.
4. A tool-tip should appear next to the cursor showing the distance to be 24 ft.
4. Use the same method to verify that inside-to-inside and outside-to-outside dimensions between all posts are identical (7 ft. 1<sup>5</sup>/<sub>16</sub> in. and 8 ft. 5<sup>5</sup>/<sub>16</sub> in. respectively).

**Create a realistic bent.** Obviously, a bent consisting solely of four posts will create challenges on raising day, so we'll need to design a more realistic bent. Let's draw a single-story, four-bent frame with wall and purlin plates for the rafters and a 5:12 roof pitch. This design is based on the Arunah Hill Pavilion, by Jack Sobon, which appears in the Guild book *Fourteen Small Timber Frames* (Fig. 10).

Unlike our "starter" bent's, the pavilion's posts are not evenly spaced. The center aisle is 10 ft. 8 in., the outer aisles 5 ft. 4 in.

*Move the interior posts:*

1. Select the *Tape Measure* tool.
2. Position the cursor on the left edge of the 30-ft. slab and click.
3. Drag a guideline (dashed) parallel to the slab edge. A red inference line will appear.
4. Type 6' 8" and press **Enter**. A stationary guideline will appear.
5. With the *Select* tool, click the left aisle post.
6. Select the *Move* tool and click on the bottom inside corner of the post.
7. Move the post to the guideline and click (Fig. 11).
8. Repeat on the other side to move the other aisle post.
9. Remove the guidelines by selecting *Delete Guides* from the *Edit* menu.
9. With the *Tape Measure* tool, verify outside-to-outside measurements: 6 ft. 8 in., 12 ft. and 6 ft. 8 in. respectively.



**Edit components.** The pavilion design calls for a wall plate height of 9 ft. 2 in. With 8x8 plates, that means we'll have to modify our outer posts to be 8 ft. 6 in. We'll change this post height again later (when we add sills), but practice is a good thing, right? That brings us to editing components and making unique components.

*Change the post height to 8 ft. 6 in.:*

1. With the *Select* tool, double-click on any post. A dotted outline will appear around the post (Fig. 12).
2. With the *Push/Pull* tool, hover over the top face of the timber.
3. Begin pushing the post down (Fig. 13), then type 1'6" and press **Enter**. This will result in an 8 ft. 6 in. post.
4. Right-click anywhere outside the post and select *Close Component* from the Context menu.
5. Use the *Tape Measure* to verify the post height.

**Make unique components.** As you change the height of one post, you'll notice that all four posts change height. The reason is that they're all copies of the same component. To get a sloped roof, we'll need to change the height of the two aisle posts, so we'll make those copies unique.

*Make the aisle posts unique components:*

1. With the *Select* tool, click on one of the aisle posts. A blue frame should appear around it.
2. Hold down the **Shift** key and click on the other aisle post. A blue frame should appear around both posts.
3. Right-click on either post and select *Make Unique* from the Context menu (Fig. 14).

**Make a guideline.** Before sizing the aisle posts, we'll need to determine their appropriate height, based on the 5:12 pitch of the roof. SketchUp will do the math for us. All we need to do is to make a guideline at that pitch and stretch the posts to meet it.

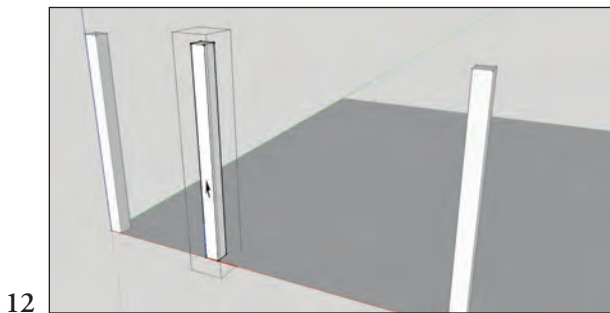
*Make a guideline for a 5:12 roof pitch:*

1. Select the *Protractor* tool (no shortcut key).
2. Position the tool on the outside of the lefthand post, along the 24-ft. side of the slab. The protractor will turn green.
3. Hold down the **Shift** key to lock the protractor's inference.
4. Move the tool to the upper left corner of the lefthand post and click.
5. Move your cursor to the top on the next post. A red inference line should appear (Fig. 15). Click.
6. Type 5:12 and press **Enter**. A sloped guideline should appear (Fig. 16).

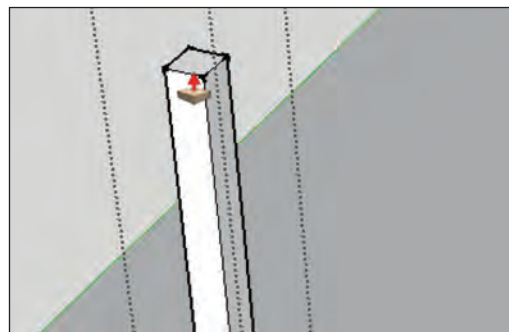
*Resize the aisle posts for the roof pitch:*

1. With the *Tape Measure* tool, click on the top left inside corner of the next post (Fig. 17).
2. Move the cursor straight up, watching for a blue inference line and holding down **Shift** to lock it (Fig. 18). When you've intersected the roof pitch guideline, click again. Another guideline and a cross at the intersection will appear.
3. Double-click on the post with the *Select* tool to edit it.
4. With the *Push/Pull* tool, pull the timber up until its outside corner snaps to the intersection point, then click (Fig. 19).
5. Right-click anywhere outside the post and from the Context menu select *Close Component*.
6. Remove the guidelines by selecting *Delete Guides* from the *Edit* menu.

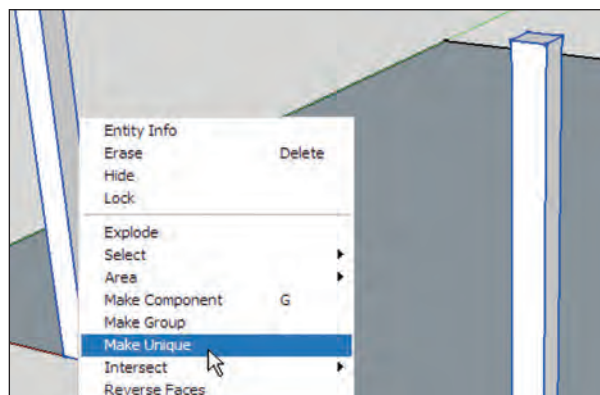
At this point, the aisle posts should be 11 ft. If you don't trust SketchUp's math, get out your trusty construction calculator (which you may be selling soon on eBay).



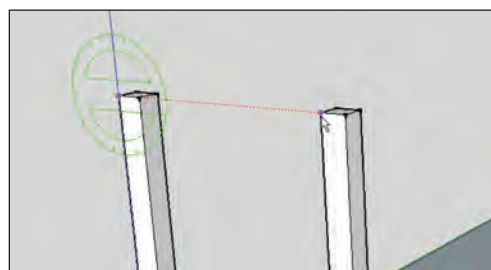
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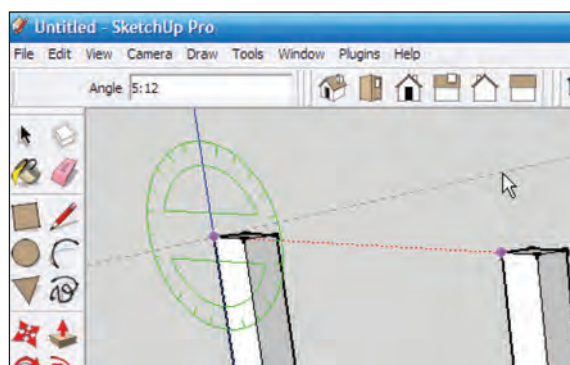
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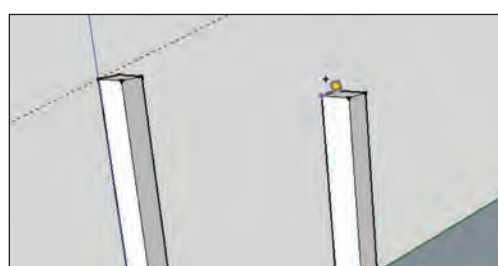
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**Draw beams.** Now that we have the proper post height, we can add the three tie beams that hold the bent together. We'll start with the outer ties, which are identical. Drawing beams can be a bit more challenging than posts, so I'll show two different approaches.

*Create an outer tie beam (8x8, 5 ft. 4 in.):*

1. Select the *Rectangle* tool.
2. On the inside face of an outer post, click on the upper left corner.
3. Begin dragging a rectangle and type 8,8. A square appears on the face of the post (Fig. 20).
4. With the *Push/Pull* tool, pull the rectangle toward the inner post until you snap to its outer edge, then click. The beam should span from outer to inner post (Fig. 21).
5. With the *Select* tool, triple-click on the beam.
6. Right-click on the beam, select *Make Component*, name it and click on the *Create* button.

*Copy the tie beam to opposite side of the bent:*

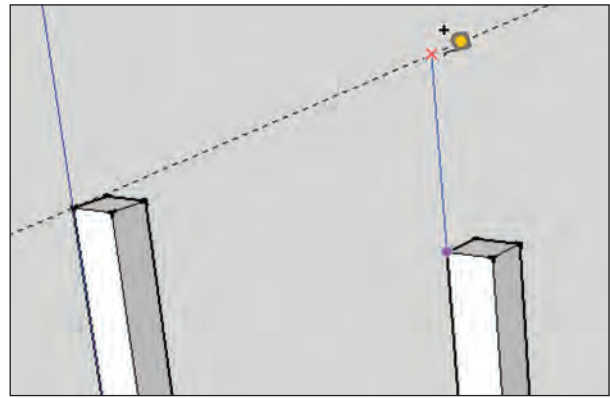
1. With the *Select* tool, click on the tie beam.
2. Select the *Move/Copy* tool and press **Ctrl** to initiate copy mode.
3. Click on a right-side corner of the tie beam.
4. As you move a copy of the tie, watch for a red inference line and hold down **Shift** when it appears.
5. Continue moving the copy until it touches the edge of the outside timber, then click (Fig. 22).

**Move beams.** The pavilion plan calls for the outer tie beams to be 6 in. below the top of the wall posts, so we'll need to move them down.

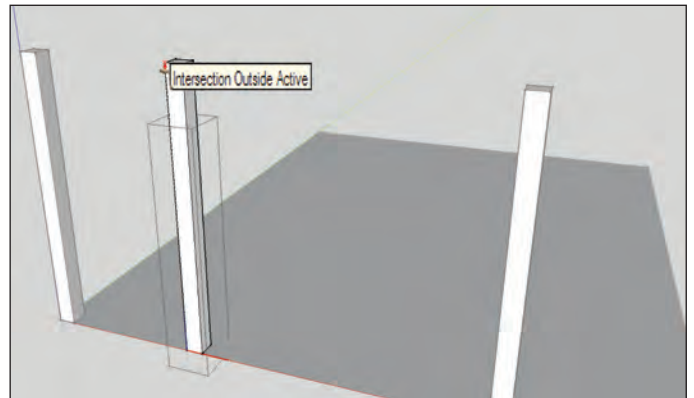
*Move the tie beams into position:*

1. With the *Select* tool, select both outer tie beams by clicking on the first beam and holding down **Shift** when clicking on the second (holding down **Shift** allows you to add to the current selection).
2. With the *Move* tool, click on an upper corner of either tie beam.
3. Move the beams down along the blue axis.
4. Type 6" and press **Enter**.

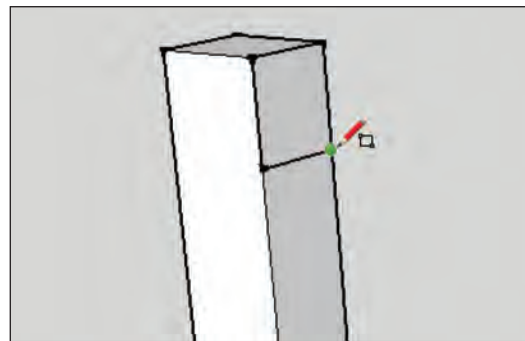
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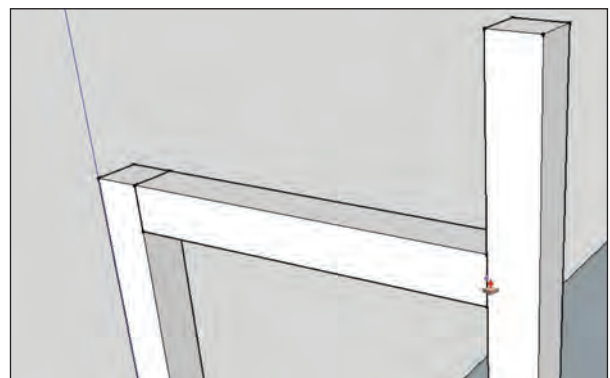
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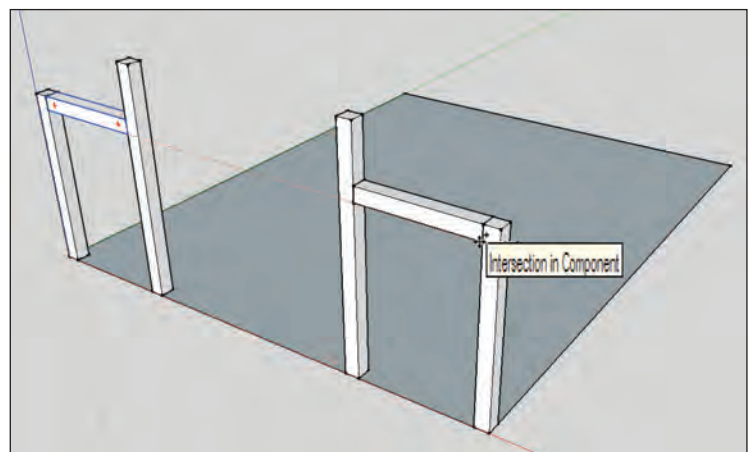
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**Draw beams by another method.** To create the center aisle tie beam, we'll use another method. You'll quickly find out there are many ways of doing the same thing in SketchUp (soon you'll have your own methodology). Knowing the distance between the aisle posts, we can create a post on the slab, then rotate it into a beam and move it into position.

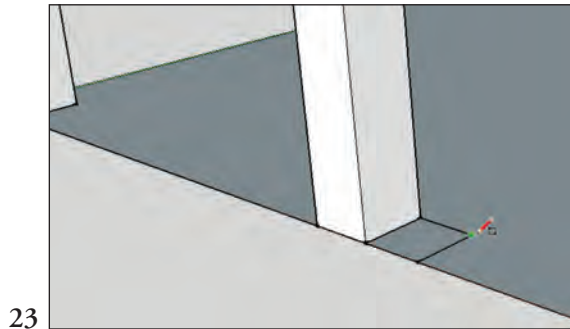
*Create the center aisle tie beam (8x8, 10ft. 8 in.):*

1. Select the *Rectangle* tool, move to the inside corner of an inner post and click.
2. Start drawing a rectangle on the slab, type 8,8 and press **Enter** (Fig. 23).
3. With the *Push/Pull* tool, pull up the timber, type 10'8" and press **Enter**.
4. Make the timber into a component and name it as before.
5. Click on the new tie with the *Select* tool.
6. Select the *Rotate* tool (shortcut key Q).
7. Position to the upper left corner of the tie (protractor should turn green), then click (Fig. 24).
8. Move down along the vertical edge of the tie and click.
9. Rotate the tie up until it snaps to horizontal (Fig. 25).
10. Use the *Move* tool to move the tie down to the top of the post and click.
11. Move the tie down 1 ft. by moving it toward the slab (lock the blue inference) and enter 1'.

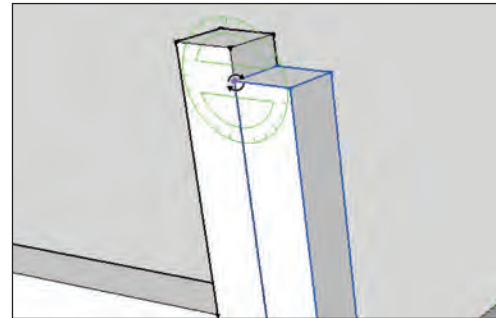
**Add bent braces.** The pavilion uses 4x5 knee braces pitched to define a 3-4-5 triangle with the posts and beams that they connect. The brace angle is approximately 37 degrees, but SketchUp will figure that out for us. All we need to know are the sides of the brace triangles (27 in. and 36 in.).

*Create an outer brace:*

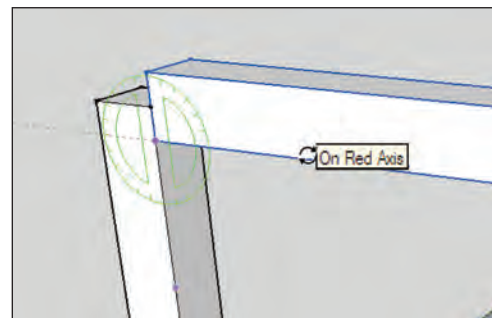
1. Using the *Tape Measure* tool, click on the midpoint of the left vertical edge of the lefthand tie beam (Fig. 26).
2. Move your cursor to the right and enter 27" in the *Length* box.
3. Click on the bottom edge of the central tie (Fig. 27).
4. Move your cursor downward and enter 36" in the *Length* box (to lock in on the blue axis, locate the cursor over the front face of the left inner post).
5. With the *Line* tool, draw a line from the inside of the post's guideline to the inside of the tie's guideline (Fig. 28).



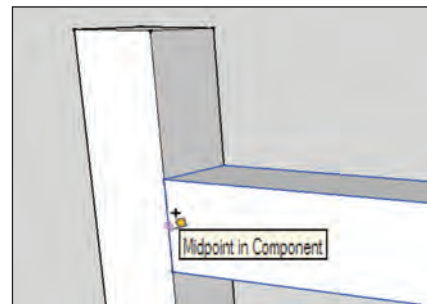
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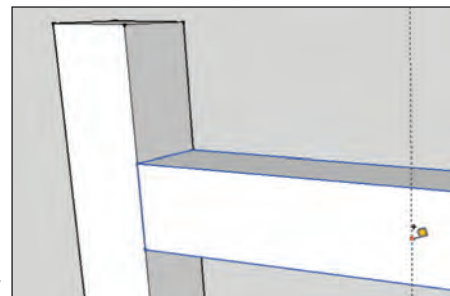
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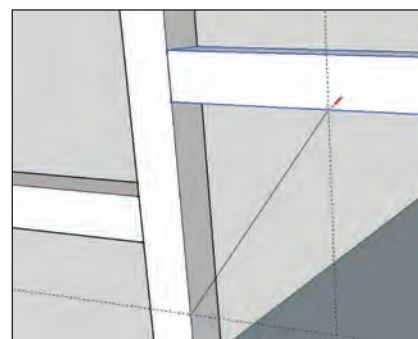
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6. Using the *Tape* tool, start on the line you just drew, move toward the intersection of post and tie and enter 5" in the Length box. To be in the proper plane, move the cursor over the front face of the post (Fig. 29).
7. Draw a line along the new guideline, in the same manner as the previous line.
8. To define the front plane of the brace, draw lines between the end points at the top and bottom of the brace (Fig. 30).
9. Orbit to the back side of the brace.
10. Using the *Push/Pull* tool, pull the back side of the brace toward the inside of the frame (Fig. 31) and enter 4" in the Length box.
11. With the *Select* tool, triple-click on the brace and make it into a component.
12. Delete the guidelines by selecting *Edit > Delete Guides*.

**Copy and flip.** The same procedure can be used to create the opposite brace but, since it's identical to the one you just created, it's easier to copy and flip it.

*Copy and flip the opposite brace:*

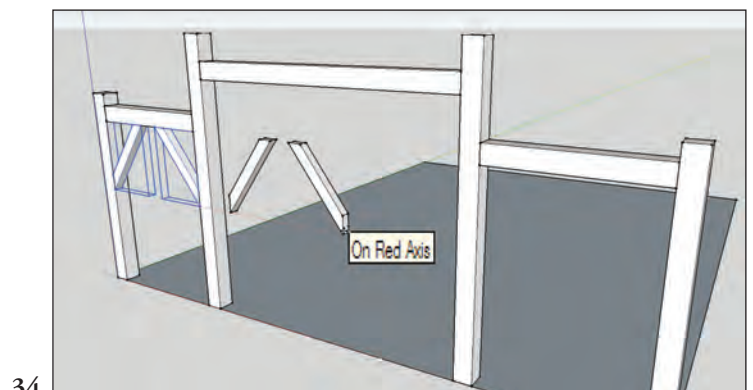
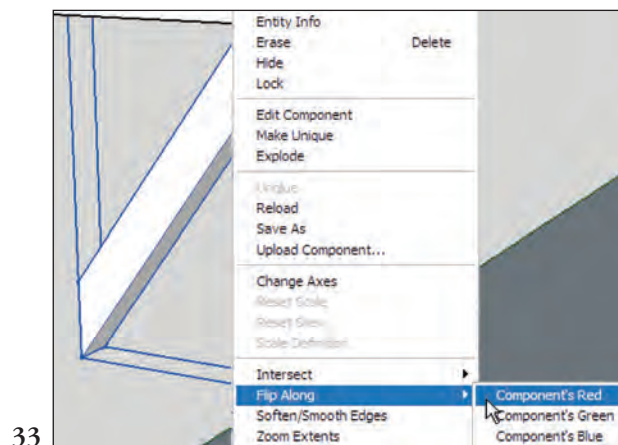
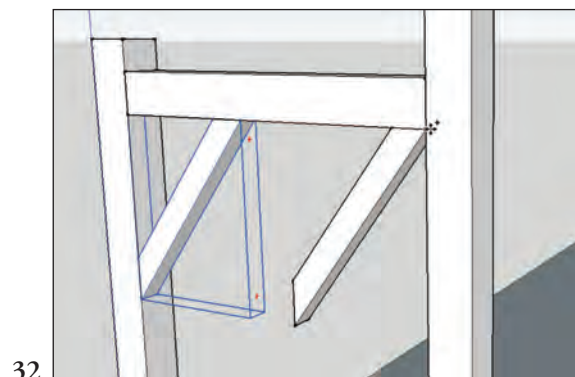
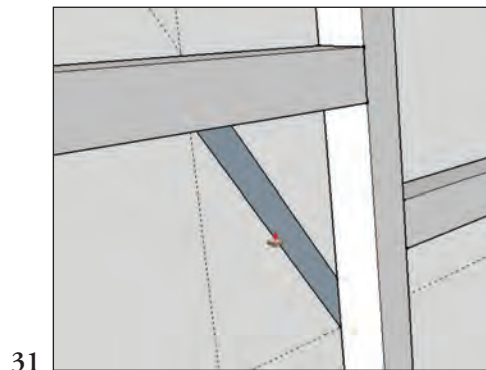
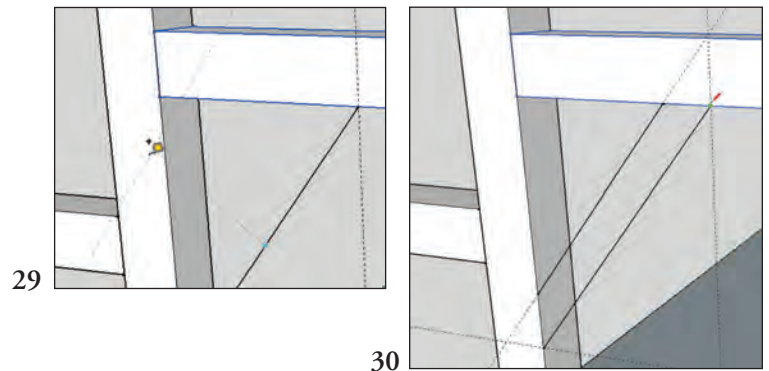
1. With the *Select* tool, click on the brace.
2. Using the *Move/Copy* tool, press **Ctrl** to enter copy mode.
3. Click in the upper right corner of the brace.
4. Drag a copy along the red axis until its upper right corner is at the intersection of the righthand aisle post and the tie beam, and click (Fig. 32).
5. With the *Select* tool, Right-click on the new brace and select *Flip Along > Component's Red* (Fig. 33). The new brace will flip the copy into proper position.

**Copy more than one object.** The braces on the opposite side of the bent are identical to the braces we just drew. The quickest and easiest way to create the new braces is to copy the two just drawn.

*Reproduce the outer braces:*

1. Select both braces using the *Select* tool (remember to use the **Shift** key to select more than one object).
2. With the *Move* tool, click on the lower right corner of the right brace (press **Ctrl** for copy mode).
3. Move the copied braces along the red axis (Fig. 34) until you reach the edge of the right post, then click.

Inner braces, with 36-in. horizontal and 48-in. vertical legs, are longer than outer braces, but they can be created and copied using the same techniques. Refer to the sections *Create an outer brace* and *Copy and flip the opposite brace*.





**Reproduce bents.** Fig. 35 shows the completed bent. Because the four bents of the pavilion are almost identical, we can quickly reproduce the first bent and position new bents accordingly. We start by grouping all the timbers in the bent.

*Group the timbers in the bent:*

1. Orbit so that all bent timbers rise above the slab.
2. With the *Select* tool, move to the right of the timbers and drag a selection rectangle around all bent timbers (make sure this selection rectangle does not intersect the slab).
3. Once the dotted rectangle appears around all timbers, release the mouse button (Fig. 36).
4. Right-click on any of the selected timbers and select *Make Group*.

*Reproduce the bents:*

1. Using the *Select* tool, click on the bent.
2. Select the *Move/Copy* tool and press **Ctrl**.
3. Click on the back bottom corner of the right post.
4. Drag the new bent until its selection point is at the back right corner of the slab and click (Fig. 37).
5. Type */3* and press **Enter**.

This technique (*Arrays*) spaces the bents evenly. According to the pavilion plan, however, the inner bents should be spaced 8 ft. (outside to outside) from the outer bents.

*Reposition the inner bents:*

1. Using the *Tape* tool, create a guideline 8 ft. from the front edge of the slab.
2. With the *Move* tool, click on the inside bottom edge and move the closer inner bent to the guideline (Fig. 38).
3. Repeat this process to reposition the other inner bent.

The reproduced bents are all identical, but the plan calls for braces to be aligned to the opposite side of bents 2 and 4. Realignment can be done easily using the *Flip Along* command.

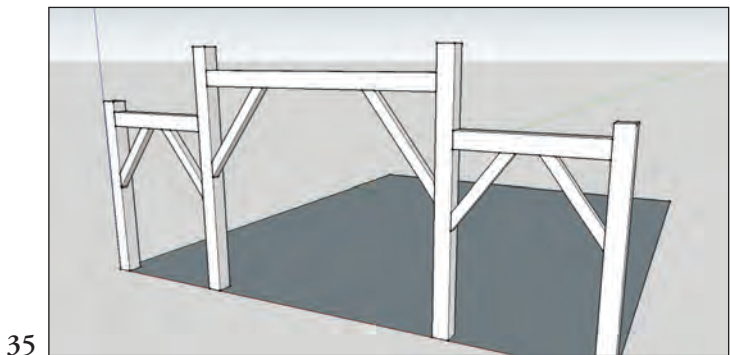
*Realign the braces in bents 2 and 4:*

1. With the *Select* tool, select bents 2 and 4 (Fig. 39).
2. Right-click on one of the bents and select *Flip Along > Green Direction* for the Context menu.

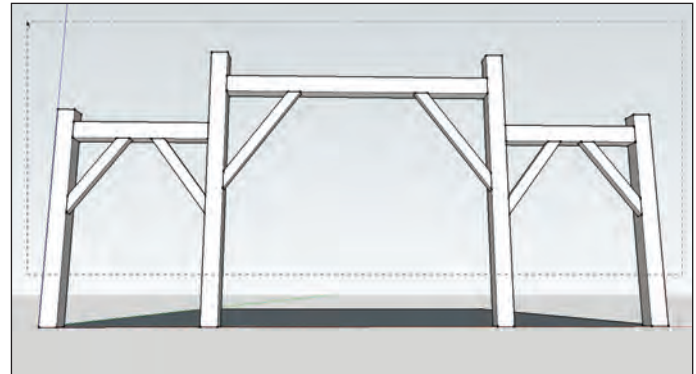
**C**ONGRATULATIONS! If you've been following along in SketchUp, you've created four bents, with all timbers accurately dimensioned and positioned. In the next issue we will complete the Arunah Hill Pavilion frame drawing by adding plates, sills, rafters and benches.

—BEN WEISS

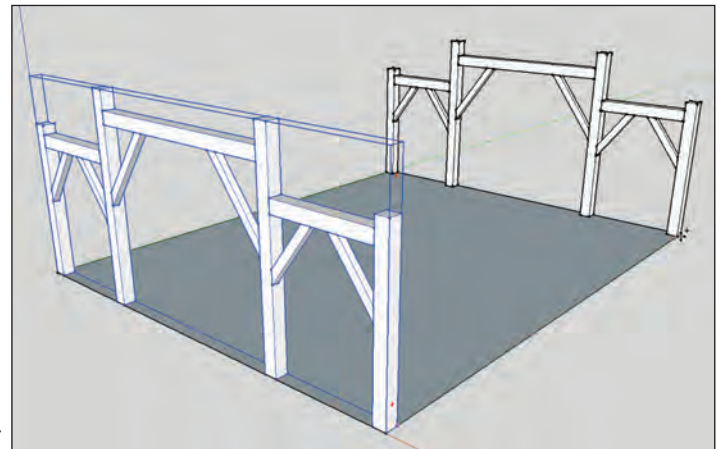
Ben Weiss ([zoomtext@gmail.com](mailto:zoomtext@gmail.com)) is an owner-builder in Dorset, Vermont.



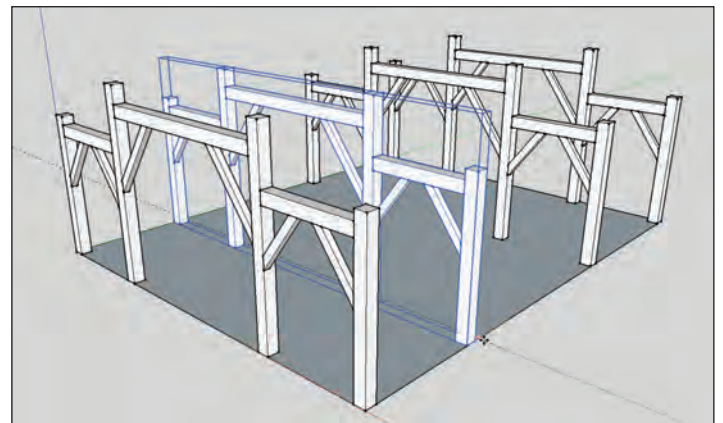
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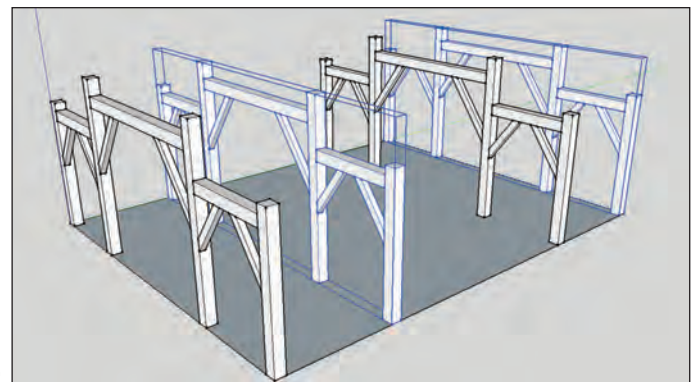
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# A Visit to the Forbidden City



Photos Tim Chauvin

Fig. 1. Tiananmen by night, where Mao Zedong proclaimed the establishment of the People's Republic of China in 1949. His portrait hangs just below where he stood. Tiananmen Square lies just south of this structure, while the Forbidden City proper is to the north.

**B**EFORE I first visited China in 2001, I knew virtually nothing about the country or Chinese timber framing. Even among professional timber framers I was not alone. China was essentially closed to the West during the early stages of the American timber frame revival in the 1970s and early '80s, so we paid it little attention if we even gave it a thought. Early America, Europe and Japan provided us with most of our inspiration and knowledge; we had direct access to examples and literature. As China opened itself to the world over the past three decades, we began to learn more of the country, its people and its timber frame traditions. This article discusses one spectacular group of timber-framed structures in central Beijing. The Chinese long referred to it as the Great Within. Today it is known officially as the Palace Museum. To most it is simply the Forbidden City.

The Yellow River Valley shows signs of human habitation as old as a million years. The earliest Chinese written history is on turtle shells carbon-dated to 1500 BCE. The earliest evidence of the Chinese timber frame tradition dates to 6000 BCE. China as a political entity traces its history back to the beginning of the Shang Dynasty about 1550 BCE. Even as its boundaries changed drastically over time, China's dynastic rule continued until the 1912 abdication of Pu Yi, the last Qing emperor.

For a time, China was a democratic republic. On October 1, 1949, Mao Zedong, the leader of the Chinese Communist Party, stood atop the timber-framed Tiananmen (Heavenly Peace Gate)

at the north end of Tiananmen Square and proclaimed the establishment of the People's Republic of China (Fig.1).

The CCP still controls China but, beginning soon after Mao's death in 1976, the country has steadily moved from a centrally planned and state-owned economy to become one of the most vibrant market economies in the world.

Beijing has not always been the capital of China. As dynasties and emperors came and went, the capital was moved numerous times for various reasons. In 1403, the new Ming emperor Yongle decided to move his capital from Nanjing to Beiping (Northern Peace) for strategic and sentimental reasons. In 1420, construction of his new capital, centered on the Forbidden City, was far enough along that the city was renamed Beijing (Northern Capital), and the emperor took up residence.

The Forbidden City, in the very center of Beijing just north of Tiananmen Square, was originally an administrative center for the empire and a home for the emperor. The nearly 180-acre compound is surrounded by both a moat and a wall. The moat is 170 ft. wide and the wall somewhat over 30 ft. high. At each of the wall's four corners stands one of four identical and inspiring Arrow Towers (Fig. 2).

The towers are described as having 72 ridges. If the term "ridge" refers to roof surfaces, they could very well add up to 72 since the far side of the building, unseen in the photo, has many more than we see here. Legend has it that the emperor could not be satisfied





Fig. 2. Identical Arrow Towers stand atop all four corners (northeast here) of the Forbidden City wall. According to legend, design derived from birdcage seen by architect in local market.

on the design of the towers and several architects were dismissed over their failure to find one he liked. Eventually one architect noticed a bamboo birdcage (or cricket cage; the story varies) in a market that became the inspiration for the final design.

As you approach the Forbidden City from any direction you can't help noticing the golden glazed roof tiles (gold being the color reserved for the emperor). The richly painted and detailed timbers of the gates and guard towers, also visible from a distance, give an indication of the intricate detail found within. The convexity of the roof surfaces and the upsweep and extension of the eaves as they approach the hips are emblematic of Chinese timber architecture.

As with most Chinese architecture and urban design, the main axis of the Forbidden City lies north-south, with south the more important cardinal point. The axis is, however, canted off true by about 2 degrees westward. The Chinese architects of the City certainly knew how to find true north, so this misalignment was probably intentional if for an unknown reason. We will follow the axis from south to north as we move through the City, as a visitor might have done three centuries ago.

Access to the City was strictly controlled. If you were found inside without proper documentation your life was potentially forfeit, hence the name Forbidden City. If you had proper documentation and were important enough, you entered the palace proper from the south through the most massive of the four main gates, Wumen or Meridian Gate (Fig. 3).

As the name suggests, this gate located the prime meridian for the Chinese of the time, perhaps like the Greenwich meridian for the British. Because the emperor was the Son of Heaven and the center of all things, his capital defined the center. From it all things flowed.

Wumen opens to the south with three principal portals. The taller central one was reserved for the emperor with two exceptions: the new empress could pass through it on the day she wed and the top three candidates from the triennial imperial examinations



Fig. 3. Wumen (Meridian Gate), centered in south leg of city wall and formal entry to Forbidden City. In formal Chinese architecture, south is most auspicious cardinal point. Seven connected timbered halls (three visible) stand atop masonry and rammed-earth platform.





Fig. 4. North of Wumen, paved courtyard with Golden Water River spanned by five marble bridges (emperor's at left). Taihemen to east, much smaller Zhengdumen to west.



Fig. 5. Taihemen (Supreme Harmony Gate). Bronze lion roof expressed high level of formality to visitors; only



Fig. 7. Taihedian (Supreme Harmony Hall ) sits on a three-tiered carved marble platform with the typical three stairways. Thought to be the largest timber-framed structure in China, its double eaves and full hips express the formality expected of the emperor's main audience hall.

processed through it after the results were announced. Anyone else would be relegated to using the side portals or another gate entirely, each of which had the same arrangement of portals. The north City gate is Shenwumen or Spiritual Valor Gate (sometimes called Divine Might Gate). The two side gates were called the East and West Flowery Gates. Civil officials passed through the more auspicious East Flowery Gate while military officials passed through the less auspicious West Flowery Gate.

Wumen has seven connected timber-framed halls that sit upon a masonry and rammed-earth platform at the height of the main walls. Although most platforms are shorter than Wumen's, nearly all historic Chinese buildings sit upon a raised platform of some type. The ridge of the main central pavilion of Wumen is at least 125 ft. above grade, making it the tallest structure in the palace. You cannot help being awed by the structure as you approach (which no doubt was the plan), having already passed through the somewhat smaller Tiananmen (Heavenly Peace Gate) and Duanmen (Upright Gate) from Tiananmen Square. Tiananmen and Duanmen, both outside the main wall, are not considered part of the Forbidden City itself.

Upon passing through Wumen you find yourself in the Outer Court, through which sweeps the artificial Golden Water River, fed by the moat (Fig. 4).

The river is spanned by five ornately carved marble bridges. Again, the central span is





s flank Marble triple stairways. Double-eaves the most important passed under it.



Fig. 6. Unidentified gate closely resembling Zhengdumen (Correct Conduct Gate). Single eaves indicated less importance. Visitors of lower status used such gates east and west of Taihemen.

reserved for the emperor. (All central passages are reserved for the emperor throughout the entire palace.) Beyond the river is a wide plaza leading to Taihemen (Supreme Harmony Gate), shown in Fig. 5.

Taihemen is flanked by the more diminutive Zhaodemen (Luminous Virtue Gate) and Zhengdumen (Correct Conduct Gate), the latter closely resembling the gate shown in Fig. 6.

Taihemen mirrors the central hall on Wumen but sits on a single-tiered marble platform reached by three stairways. It has nine bays, the central one considerably wider than the six flanking bays and the two outermost bays narrower. As is typical, the main entry of the building is the center bay of the long axis. Massive round wood columns lead from a stone plinth to a very complex and lavishly finished set of timbers that in turn support cantilevered eaves sweeping upward to the outstretched hips of the half-gabled, double-eaves roof.

In Chinese architecture, each element explains or hints at the use or formal importance of a building. Roof configurations offer very visible indications. The simple gable roof is the least formal and is mostly used for residences and small businesses. The next level is the half-gabled hip roof. More formal still is the fully hipped roof. As the level of importance further increases, a second eaves (and occasionally more) is added above the fully hipped lower roof. The upper roof can be either half-gabled or fully hipped. The fully hipped roof is again the more formal. Hence, Wumen's fully hipped double-eaves roof (Fig. 3) visibly expresses more importance and formality to the visitor than the half-gabled double-eaves roof of Taihemen (Fig. 5). Meanwhile, the side gates have only single-eaves, half-gabled hip roofs, reminders to those who pass under them that they are welcome but need to remember where they rank in the social and political hierarchy (Fig. 6).

Passing through Taihemen or the flanking lesser gates brings you to the back portion of the Outer Court, where you find the Three Front Halls. The first of the halls is Taihedian (Supreme Harmony Hall), which rests atop a three-tiered marble platform with ornately carved marble balustrades (Fig. 7).

This is the most formal of the halls within the palace. Each year's most important events and the emperor's most formal audiences with foreign envoys took place here. Befitting its importance, the roof of this massive structure is fully hipped with double eaves. It is the largest single timber structure in China, enclosing 28,350 sq. ft. The roof is supported by six rows of twelve massive wood columns. As usual the structure is entered via the central bay, which is wider than the four bays flanking it, and again the two end bays are less wide than the adjacent bays.

The current Taihedian was built in 1694 after the original was struck by lightning and burned to the ground in 1679. The ravages of time, weather and pollution have dulled the bright enamel finishes on its timbers and eroded the golden glaze of its roof tiles. When I last visited in 2007, the building was undergoing a complete refinishing and restoration, part of a 17-year effort to restore everything as nearly as possible to its original condition. If the work done to date is any indication, when completed the City will be spectacular.

It's a fairly consistent theme in Chinese culture, reflected in its architecture, that good things come in threes or multiples of three. (Nine and its square 81 are especially auspicious. Each of the massive gate leaves in the City has nine rows of nine brass bosses on each face.) The three-tiered marble platform that supports Taihedian also supports two other structures. Immediately behind Taihedian is the relatively diminutive Zhonghedian (Central Harmony Hall), square in plan with a single-eaves, pyramidal roof. Behind Zhonghedian is Baohedian (Preserving Harmony Hall), similar to Taihedian but smaller with a half-gabled double-eaves roof that reflects its lower status. Zhonghedian was essentially the emperor's "green room" for events in Taihedian. Baohedian was mostly used for event rehearsals and the final round of Imperial Examinations (Fig. 8).

Immediately behind the Three Front Halls lie the domestic quarters of the emperor and empress. This walled enclosure, known as the Inner Court, is entered through Qianqingmen





Fig. 8. Zhonghedian (Central Harmony Hall) at left and Baohedian (Preserving Harmony Hall) sit behind (north of) Taihedian on the continuation of the same marble platform. These two structures complete the Outer Court, which began at Wumen.

(Heavenly Purity Gate). As with the Outer Court, there are three halls on a raised platform of marble. The front hall is Qianqinggong (Heavenly Purity Palace), the emperor's main residence during the Ming Dynasty, used for various other functions by subsequent dynasties. It has a fully hipped, double-eaves roof and is smaller than Taihedian, but reflects the detail and general look of the larger structure (Fig. 9).



Fig. 9. Qianqinggong (Heavenly Purity Palace). Reached through Qianqingmen (Heavenly Purity Gate) north of Baohedian, the Inner Court was the emperor's residential compound during the Ming Dynasty. The palace, the emperor's personal residence, is served by a marble causeway with the same style of ornately carved balustrade seen in the Outer Court.

The middle hall is once again square in plan and relatively small with a single-eaves, pyramidal roof. This is Jiaotaidian (Celestial and Terrestrial Union Hall). The rear and northernmost building in this trio is Kunninggong (Earthly Tranquillity Palace), which served as the residence of the empress during the Ming Dynasty and other roles in later dynasties. This building is somewhat smaller than the front hall in this court but has much the same details and a fully hipped double-eaves roof.

Heading north from the Inner Court, one enters the formal gardens, which are just as amazing as the rest of the palace. By the time the casual visitor has reached the gardens, it's perhaps understandable that it's not easy to appreciate them, so great has been the visual stimulation of the buildings and courtyards.

Among the flowers and ancient trees are several pavilions, two quite striking in design and execution. One Thousand Autumns Hall and Ten Thousand Springs Hall, essentially twins, stand on stone plinths on the east and west sides, respectively, of the central axis of the garden (Fig. 10).

Surmounted by a drum, the pavilion plan is cruciform with additional squares inserted at each of the inside corners of the cross. Each of the 12 corners supports a hip, and the three parallel hips in each quadrant meet in plan to form valleys. The hips over the wider sections run up to ridges running parallel to the eaves. Short hips then drain down toward the inner corners of the cross. The roof surfaces slope down and in from the ridges, creating gutters that drain toward the valleys (Fig. 11, lower left quadrant).

Notice that each of the hip roofs is not a simple plane but is curved along its slope. The layout and construction complications of these intersecting hips and valleys are profound, though study of the plan reveals its origin in compass geometry. The first-level eaves line, for example, forms an octagon (Fig. 11, lower right quadrant).

Another way to look at this structure is to think of the four wide sections in plan as individual rectangles with fully hipped roofs. The four are pushed together to form a central square courtyard. The courtyard is then covered by the drum, the squares added to the inner corners of the cruciform plan and, finally, hips added to them.





Fig. 10. One Thousand Autumns Hall (with its twin, Ten Thousand Springs Hall), flanks the main pathway through the palace garden.

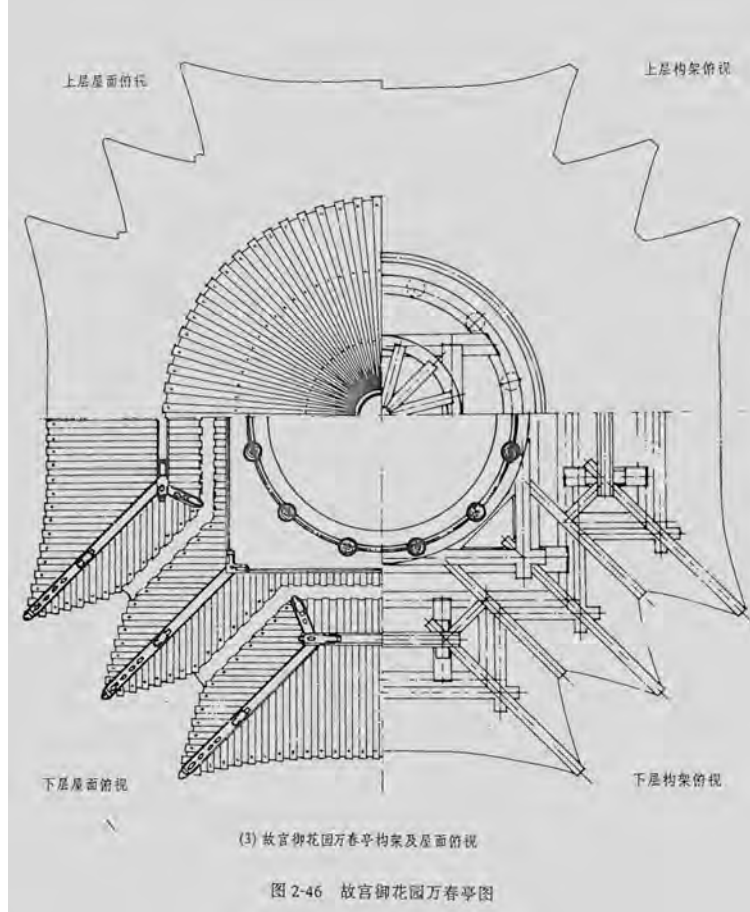


Fig. 11. Cutaway roof plan view, One Thousand Autumns Hall. Eaves framing points lie on octagon in compass-generated design.

All of this complexity is crowned by a concave conical roof supporting an ornate gold-leafed finial. Of all the buildings in the Forbidden City, I am most impressed with these Autumn and Spring pavilions.

Outside their surrounding walls and at either side of the Outer Court, the Inner Court and the Imperial Gardens are numerous buildings that serve many functions. In general they are of much simpler construction, ornamentation and style than the structures along the City's central axis. Many served as offices, storerooms and housing for concubines, palace eunuchs, maidservants, cooks and administrative staff. It's possible to spend several days wandering the labyrinth of paths and hallways throughout these side areas and not see every building, much less inspect them closely. Several sources suggest that there are 980 surviving buildings within the Forbidden City. Even if that number is high, it's probably safe to say that the Forbidden City holds the highest concentration of historic timber structures on earth.

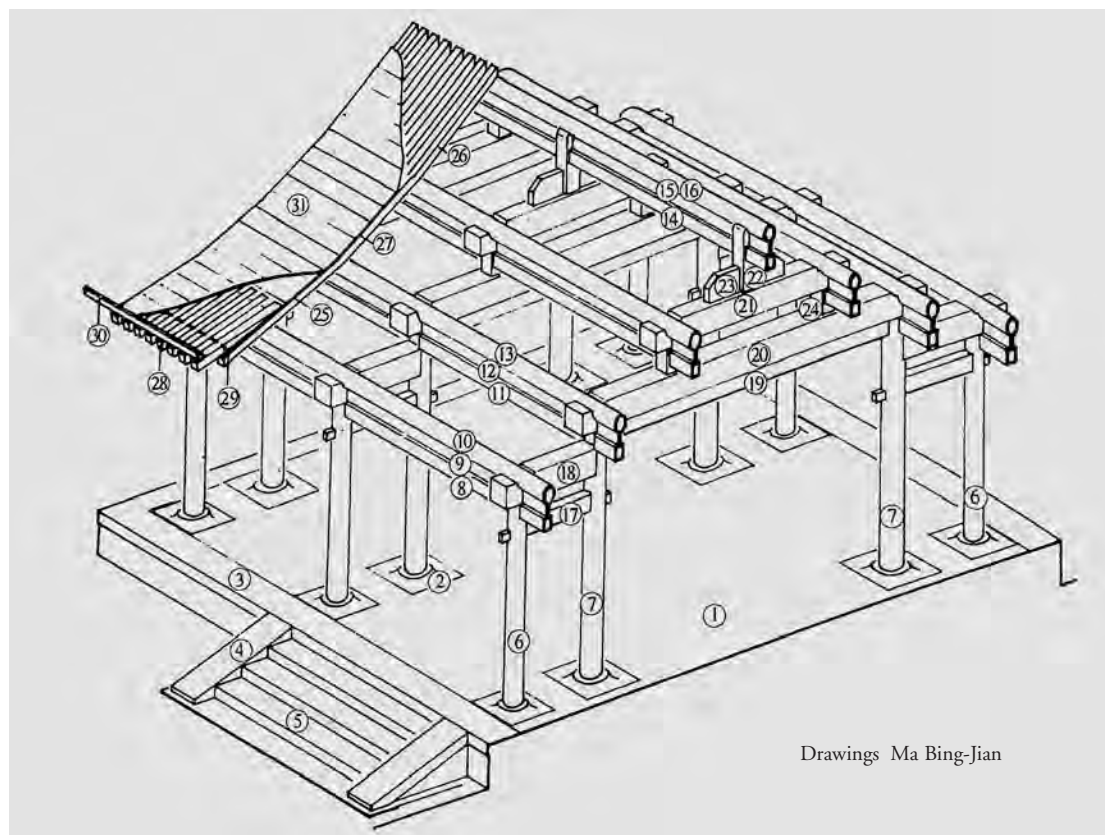
As you exit the Great Within to the north, you pass through Shenwumen (Spiritual Valor Gate) and once again cross the 170-ft. moat. As you look down the length of the moat, about 3000 ft., you can take a moment to reflect on what you've seen during the past few hours and realize how little one visit can cover. And the Forbidden City is by no means the only site with impressive timber-framed architecture within Beijing. As you reach Jing Shan Qian Jie (Prospect Hill Front Street) beyond the moat, you can look beyond to Jing Shan, an artificial mountain built of tailings from the moat. On its central peak stands Wancheng Ting, a substantial fully hipped, triple-eaves timber-framed pavilion, with distinctive wide-narrow-wide-narrow-wide arcade openings, begging for inspection (Fig. 12).

**A**LTHOUGH China is so large and geographically various that regional building styles are natural, the Beijing public timber buildings described here (as well as other Chinese timber buildings elsewhere) have certain characteristics in common. Fig. 13 shows an isometric cutaway of a prototypical



Fig. 12. View of Jing Shan (Prospect Hill), in a park just north of Shenwumen (Spiritual Valor Gate), the north exit of the Forbidden City. Atop the hill sits a triple-eaves pavilion flanked by smaller circular and octagonal pavilions, respectively, to east and west.





Drawings Ma Bing-Jian

1. Masonry platform
2. Stone plinth
3. Platform edge trim
4. Stair stringer
5. Stone stairway
6. Eaves column
7. Gold or interior column
8. Lower eaves girt
9. Infill board or spacer
10. Eaves purlin or wall plate
11. Lateral linking beam
12. Infill board or spacer
13. Principal purlin
14. Ridge-linking beam
15. Infill board or spacer
16. Ridge purlin
17. Through-tenoned linking beam
18. Head-holding girder
19. Accompanying linking beam
20. Base girder
21. Second girder
22. Ridge column
23. Back brace
24. Girder block
- 25-27. Common rafters
28. Flying rafter
29. Blocking between flying rafters
30. Eaves trim board
31. Board decking

Fig. 13. Isometric cutaway view of representative Chinese traditional timber frame. Labels acquired from several sources.

Chinese frame in the style we have been seeing, showing an entrance bay served by steps and one flanking bay, with a second flanking bay implied. (For additional drawings and details, see “Chinese Traditional Framing,” TF 16 and 17.)



Fig. 14. Duanmen (Upright Gate). Double eaves show clearly upward slope when approaching hip. Round common and square flying rafters step progressively outward as well, creating curve in both elevation and plan. Flying rafters change from square to increasingly rhomboid as they approach hip.

Round columns set on a variable grid form bays and aisles just as in Western frames. The number of bays is always odd, the central one wider than any flanking bays and housing the main entry. The columns rest on plinths, typically stone, and rise to a system of girders, ties and plates, generally doubled. Frame sections perpendicular to the ridge form what we in the West recognize as a bent. Some frames have a central column line that extends to the floor and supports the ridge.

Between an outside bent post and its adjacent inner post (e.g., 6 and 7 in the drawing), there are generally two ties (17 and 18), the upper one larger. The lower (17) is tenoned into the posts at both ends. The upper (18) is tenoned into the post at the inboard end. At the outboard end, the upper tie crosses the top of the outer bent post (6), engaging a square stub tenon. The wall plate (10) laps the upper bent timber.

Moving inward on the bent, girders (20 and 21) join principal purlins (11 and 13) and posts (7 and 24), in joinery similar to the arrangement at the eaves.

Running parallel to the ridge, the outermost files of columns (or walls) are connected lengthwise by mortised girts (8) surmounted by a plate (10). The plate is not normally continuous or scarfed but rather breaks at the posts. The two plate sections are then joined via a dovetail connection at their abutment. Alternately the wall plate and upper short tie are joined in various configurations and then enter a cruciform mortise on the post top. The lower girts can be connected to and support the plate via solid infill as shown here (9), or via blocks or complex bracket systems.

The ridge (16) is supported like the plates and purlins by a girt (14) and an infill board (15) or blocks. The ridge posts can extend to the floor but can also rise from a stout beam (21) and are stabilized by a transverse brace (23).

Plates and purlins always support common rafters that break at them. The commons (25-27) are generally closely spaced (under 2 ft. is not uncommon) and, more often than not, round. They are also straight. The convexity of the roof plane is not achieved by using bellied common rafters but rather by gradually increasing the



slope between adjacent purlins as they move inward from the eaves toward the ridge. The slope between the eaves plate and the first purlin may be as little as 4:12, while the slope from the last purlin to the ridge could be as much as 10:12, with intermediate spans having intermediate slopes. This change in slope is achieved either by moving the support posts and purlins closer together in plan as they approach the ridge (changing the run) or by increasing the differential height between purlins with each step inward (changing the rise), or both.

At the eaves of more formal or opulent buildings, an additional set of rafters, usually square in section, extends beyond the lower commons. These members are called flying rafters (28).

Each is bent upward at the eaves, further reducing the slope and adding another segment to the overall curve of the roof. Viewed in elevation, the inward end of a flying rafter is tapered along its sides, reaching a point at the upper end. As the flying rafters approach a hip, they also become more pointed in plan (Fig. 15).

The ones farthest from the hip have only a slight clipping of the rafter end in plan to allow clearance for adjacent flying rafters. Approaching the hip, the clipping becomes more pronounced, and those nearest the hip actually come to a point in plan as well as in elevation.

In addition to rotating, the flying-rafter ends also change elevation upward and extend farther beyond the wall as they approach the hip rafter. Each of the commons and each of the flying rafters in the fan changes pitch slightly as they move toward the hip. In the flying rafters, the “kink” also becomes more pronounced, further sweeping the eaves upward in a smooth curve to the hip. And, just to keep things interesting, the sides of all flying rafters are plumb while their upper and lower surfaces follow the pitch of the sweep to the hip. Their tops and bottoms are level at first and then progressively change pitch upward. Viewed end on, the resulting sections are rhomboid (Figs. 14 and 16).

In northern areas, where heavy mud tile bedding is used, flying rafters are most often nailed to the lower commons through a board decking. This decking can be the visible ceiling from below while it supports the heavy roof covering above. The clay mastic applied to the roof decking from above is worked to create a smoothly curved bed for the roof tiles, giving a final appearance of a continuous curve from eaves to ridge. As you move south in China, the mud bed and solid decking are dispensed with and replaced by curved roof tiles applied directly to skip-sheathing 1 to 2 in. thick, run vertically in lieu of common rafters. Individual tiles span the boards horizontally, with both visible to the interior. South China timber roofs also tend to have lower pitch from eaves to ridge as well as less concavity than their northern cousins. In conjunction with these differences, the roof tiles are heavy and irregular enough to mask any appearance of stepping.

—TIM CHAUVIN

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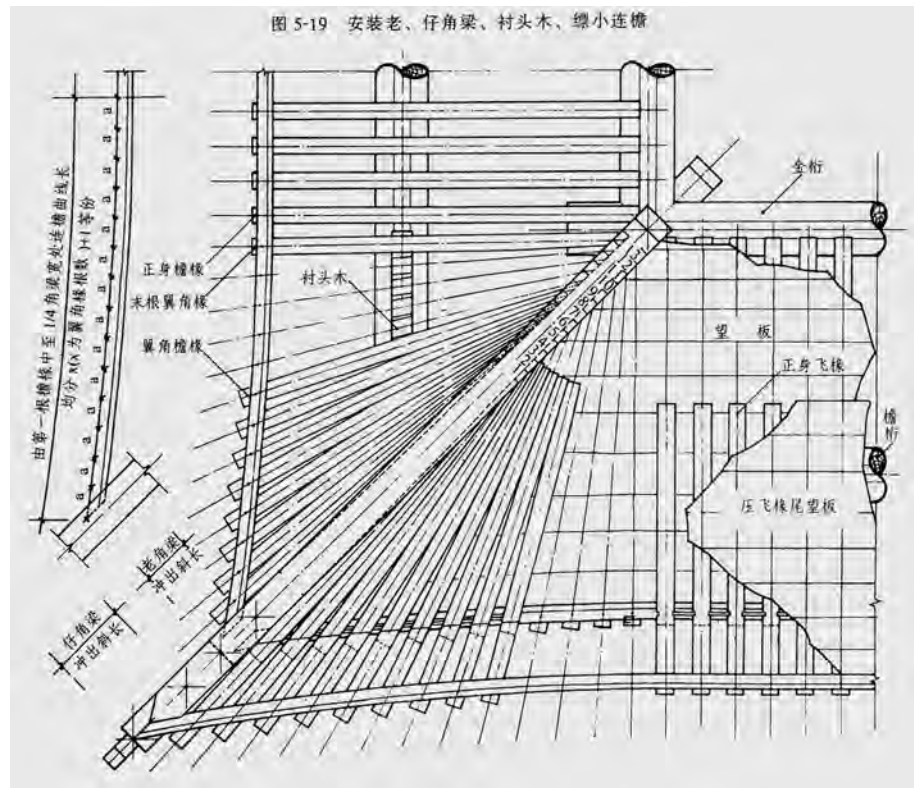


Fig. 15. Cutaway plan view of hip shows how round common rafters (left of hip) rotate and extend progressively beyond wall plate as they approach hip rafter. Flying rafters (right of hip) also swing toward the hip and extend farther beyond plate. Rafters must be tapered or clipped at upper ends to allow space for adjacent rafters as they rotate. Decking on round commons is visible from interior; decking applied to flying rafters is visible from beneath eaves.

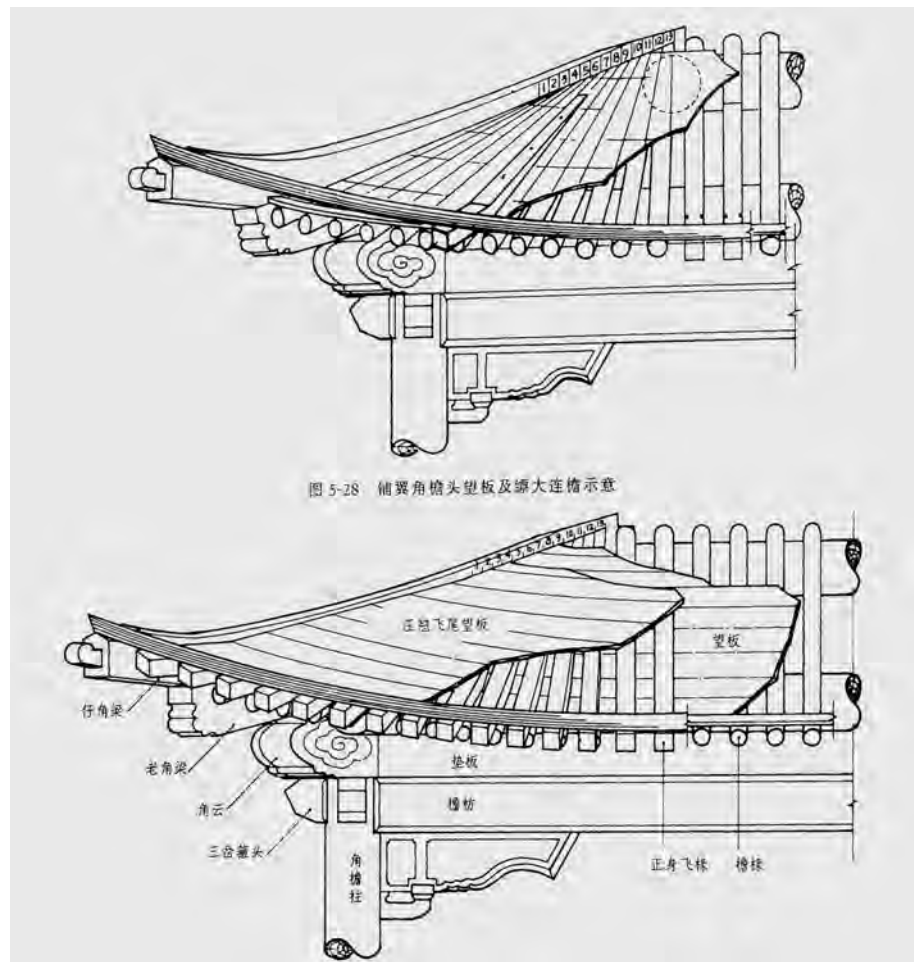


Fig. 16. Cutaway hip elevation. Upper view shows round common rafters and three representative flying rafters (note pronounced sawn kink in one toward hip). Lower view shows progressive change of rectangular section in full set of flying rafters.



# Play Structure Design and Safety



Rusty Keeler

Fig. 1. Carrying an earthfast wall frame to be erected at a playground in Garden City, Long Island. Author wears full-brim hat.

**H**OW many kids get to live in houses that inspire them? A childhood neighbor and I often talk about how the houses we grew up in influenced our sense of quality and integrity, and how they have returned again in our adult lives in the choices we have made about what to buy or build. So many children today grow up surrounded by strange materials pretending to be wood or stone, if they are even recognizable at all, but most of these kids still go to school playgrounds and to parks. What if they got to play in a little house just their size made of square and live-edge timber? Or perhaps they could discover that the sandbox they are playing in has pegs and tenons at the corners? Kids who love to figure out how things work (as I did) might find mental gears starting to whirl. They might also absorb some of that sense of quality and integrity that causes so many adults to exclaim in delight when they enter a plastered and timbered house.

For that matter, as a carpenter of frames for clients of relatively modest income, I usually follow an aesthetic of quiet functionality. Designing and building playhouses gives me a chance to play with a wider range of forms, and on a conveniently small scale. For playground clients I've cut my first timbered hip roofs, played with a Quaker shed form I've been intrigued by and ventured into wilder scribing. Perhaps I need playhouses as much as the kids do. For

over a decade I have been involved in playground design and construction, starting with a company that leads community raisings of very large and complex play areas. In recent years I have been collaborating with Rusty Keeler, a designer of play landscapes for small children, who has enthusiastically embraced the notion of timber-framed playhouses (Figs. 1 and 2).

Most carpenters have caught on to the fact that timber frames (until they are enclosed) are really jungle-gyms for grownups. In the last few years, the children's workshops at the Guild conferences have been sharing the fun with the kids by designing and building play structures with traditional pegged joinery. These forays have touched the edge of a large and tantalizing territory. With a prudent grounding in the safety and function issues unique to play structures, many wonderful possibilities can keep unfolding.

A playground is more than a place for children to have fun—it is part of how they learn about their bodies and their world. Little kids develop balance, strength and coordination as they move from climbing steps to climbing ladders to swinging hand-over-hand on a horizontal ladder. Playhouses can be the center of all manner of creative play, being house, castle, hideout or spaceship from one day to the next.



A timber-framed playhouse is not just a place for kids to play; it is an example of an aesthetic they often won't find elsewhere. It's also a puzzle to solve. How is this thing put together? What are those pegs doing? Giving kids buildings with a visible structural logic helps them make sense of a world still governed by gravity.

US agencies offer safety guidelines, analogous to building codes for houses, for the design, construction and maintenance of public play equipment. These guidelines are voluntary and they do not apply to private backyard play areas, but none of us wants kids to get seriously hurt, so it's in everyone's interest to know and follow the standards.

Both the Consumer Product Safety Commission (CPSC) and the American Society for Testing and Materials (ASTM) have developed overlapping playground safety guidelines, the ASTM version being the more comprehensive. For those who want to explore the subject in depth, the CPSC guidelines are easier to read and understand, and sufficiently detailed for most situations to be encountered by timber framers. The agency provides them free of charge. For the rest of us, I will outline the most critical safety issues, as well as special considerations for timber frame design.

**FALLS.** Most playground injuries result from falls. For this reason, a shock-absorbing groundcover is standard around all play equipment that enables a child to climb above ground level. Of the options available, wood chips are my preference for ease of installation, modest maintenance and—unlike shredded tires—edibility. The CPSC handbook defines tested wood fiber and inorganic groundcovers and discusses how thick they need to be for various heights of falls to protect against serious head injury. For instance, 6 in. of uniform wood chips can cushion falls from up to 7 ft. above grade.

But what about structures that aren't intended as climbers? Decorative gates or playhouses may have surfaces that fit the definition of a balance beam or play surface without intending to. Any surface wider than 2 in. and canted at less than a 30-degree slant is considered a "designated play surface." So, to be in compliance, either make lone beams no wider than 2 in. or rip a minimum-30-degree backing on top. The backing will aid in shedding weather as well as kids. (The recommendation does not apply to tie beams close under roofs, which are not really accessible to stand on.)

All of this may seem like a lot of fuss for a technicality, especially since most kids don't carry protractors with them while they are shinnying across a beam, but it may be worth the effort if your project has significant exposure to liability. Post tops must likewise be cut at a 30-degree slant or reduced to no more than 2x2 in. on the flat.

A similar restriction applies to roofs. If playhouse roofs are pitched at less than 7:12, they are regarded as play surfaces. Beyond basic compliance, use common sense. Make roofs fairly steep and don't locate them too near fences, trees or other means to get a leg up. Fewer kids will get up there and the shingles will last longer (Fig. 3).

**Protrusions.** Blunt or pointed objects sticking out of play equipment can hurt kids. For timber framers, this means pegs. It's usually not necessary to cut pegs flush—in fact, I like to leave them slightly proud to make them more obvious to kids (Fig. 4).

If a 1-in. peg is cut with less than  $\frac{3}{4}$  in. sticking out, it is not considered a protrusion hazard. To play it safe, one might want to cut a through peg to a  $\frac{3}{8}$ -in. projection at each end, in case kids start to experiment with inventing hammers. If a peg is located near the top of a slide or fire pole, it must be cut flush to avoid entangling jacket hoods or mitten strings and strangling a child. Sadly, deaths from entanglement on playground equipment have happened.

**Head Entrapments.** There is a special kind of strangulation hazard unique to small children, whose heads are disproportion-



Photos Rusty Keeler

Fig. 2. Complex of pole- and timber-framed play structures built largely by volunteers for a childcare center in Watertown, N.Y. Wood fiber groundcover protects children from fall injuries.



Fig. 3. At a Long Island daycare center, low tie beams with large 30-degree chamfers leave only 2 in. of flat surface, to avoid being considered a play surface that would call for shock-absorbent surfacing inside and outside the playhouse. But structure is incorrectly sited, too close to existing fence.



Fig. 4. Pegs are trimmed flush or proud enough to be easily spotted by kids but short enough to avoid creating a protrusion hazard.



ately large compared to their bodies, and who do not yet have the arm strength to lift their whole bodyweight. When a piece of play equipment has an opening large enough for a toddler's body to get through but not large enough for the head, the toddler can possibly strangle to death if hanging even slightly above ground level. For this reason, safety guidelines are stringent about openings of a certain size. Specifically, openings must be smaller than a 3½ in. x 6 in. rectangle or larger than a 9-in.-dia. circle. Incidentally, I now apply the 3½-in. rule to the spacing between balusters on house staircases, even though the residential building code may allow a wider spacing. Some design solutions become decorative (Fig. 5).

**Angles of Entrapment.** A variation on the head-trap theme, an angle of entrapment is an upward-facing V into which a child could put head or neck and possibly strangle. The V has both sides slanting upward and encloses an angle of 55 degrees or less. *Translation: most knee braces and certain other forms create angles of entrapment.* The simplest fix is to block them off entirely (Fig. 6).

A more aesthetically pleasing option can be to block off the bottom of the opening using a piece of wood that extends at least 7 in. from the point of the angle, measured parallel to the post. It is important to be sure that the space that is left after the block is inserted is large enough to let a 9-in. circle pass through it with margin to spare, or we are back with a standard head trap and must block the opening entirely.

The designers of the Guild Children's Discovery Workshop climbing wall at the 2005 Eastern Conference created (if perhaps unintentionally) an elegant solution to the brace entrapment problem. The frame is made of two A-frame "bents" with a long top beam connecting them and projecting past them. Diagonal braces spring from the crossbars of the As to connect with the ends of the beam (Fig. 7).

**Use Zones.** This recommendation is simply common sense: when installing play equipment, leave open and unobstructed space around each part. The minimum use zone around any structure is 6 ft., and the use zone gets larger the higher kids can climb on the structure. Even a playhouse should have this 6-ft. use zone, since kids will be running around it and trying to climb up all sides if they can.

**Equipment.** Ladders, stairs, fire poles, climbing ropes and other equipment all have specific rules for installation. Slides get special attention because historically there have been so many accidents associated with them. If you incorporate any of these into a project, take a look at the CPSC handbook.

**Playhouse Design.** For me, the biggest design challenge comes in making a playhouse as intimate as possible in scale while still meeting the structural demands of bracing and tying the frame. There isn't always room in a wall for knee braces, for instance. The easiest way to keep the walls from spreading under roof load is to use tie beams, but this solution limits how low and cozy the roof can be. Meanwhile, head traps have a way of sneaking into designs.

These constraints can be a wonderful opportunity to innovate and to play with new designs at a modest scale. Interrupted tie beams, scissor ties, Japanese bracing and ship's knees are all on the drawing board. Creative solutions always have to vie with simplicity, and sometimes the cleanest solution for bracing and tying a very small building is just to stick the posts in the ground. I even cheated once, using hidden metal brackets to brace a frame that sat on a gravel pad, but it left an uncomfortable taste in my mouth.

Kids in particular ought to have honest framing around them so they can start to get an intuitive feel for the physics at play in the buildings that shelter them. So much structure today is hidden behind Sheetrock that it's no wonder that people don't understand their houses. Exposed rafters, braces, live edges, through-tenons, pegs of a contrasting color, all can all give kids a lot to think about during their quieter moments (Figs. 8–11).



Sarah Highland

Fig. 5. Head entrapment in 5½-in. space between beams avoided by filling with 1-in. dowels, now a decorative feature.



Sarah Highland

Fig. 6. Earthfast, forked locust posts blocked against head entrapment in playhouse, Ithaca, N.Y. Note integrated benches.



Ken Rower

Fig. 7. Climbing frame designed by Chris Koehn and built in the Children's Workshop at the Guild's 2005 Eastern Conference.





Fig. 8. Hip-roofed tower at Garden City, L.I. With no room for knee braces, the posts are fast in the ground and X-braced below grade.



Photos Sarah Highland

Fig. 10. Completed, seasoned playhouse shown unroofed in Fig. 9, including built-in marimba made by Robert Salvado.



Fig. 9. Freestanding playhouse at elementary school in Ithaca, N.Y., before roofing.

Even with closely spaced rafter pairs, I always use nominal 2-in. tongued-and-grooved solid roof decking and 1x2 strapping under the roof shingles, to support climbers, ventilate the shingles and to assure that no nail points will reach inquiring fingers below. Open skip-sheathing is, of course, a lovely invitation to play at poking shingles from the inside.

**Materials.** A playhouse is probably not going to persist nearly as long as a residential house, given the realities of politics, land use, changes of ownership and fashion. This fact actually frees us up. It may not be necessary to use premium-grade cedar roof shingles if



Fig. 11. Marimba has bars of black locust, best sounding of species tested. Sound toys are good features for modern playgrounds.

pine is plentiful nearby. I make a priority of using local woods for playhouses, choosing naturally rot-resistant species when relevant. For example, we used black locust posts and deck framing, larch decking and white pine plates, rafters and shingles on the playground in Watertown, N.Y., shown earlier in Fig. 2. Perhaps one could carve the name of each species into an unobtrusive part of its timber, as a secret for a curious child to discover.

Pressure-treated wood in playgrounds has been the subject of much controversy in recent years. The industry responded to concerns about arsenic by switching to Alkaline-Copper-Quaternary



(ACQ) treatment (see TF 89). Quaternary compounds are biocides. Time will tell whether concerns similar to those over chromated copper arsenate, chloropentaphenol and creosote will be raised about ACQ. Assuming that small children will be hugging, tasting, rubbing their faces against and sometimes chewing on the things that they play with, I build for them using only wood that I would comfortably eat myself.

Finally, taking care to minimize splinters will address a concern common among parents. Choice of wood and boldly easing corners and arrises as well as community maintenance all play a part. Areas that get a lot of sun exposure can benefit from a nontoxic UV-protective finish, such as the one made by Land Ark.

**W**HAT about the tree on the other side of the playground fence? Why should we try to regulate artificial play environments when there is a whole world of unrestricted hazards out there? For that matter, many jungle-gyms and playhouses have been built over the years that have violated all manner of modern guidelines, but nevertheless have been the scene of lots of enjoyment and no serious accidents.

Once we start building special places for kids to play and telling them to go there and do it, we have an obligation to avoid building in known dangers. Kenneth Kuska of the National Playground Safety Institute makes a distinction between hazard and risk: play often can and should involve risk, which is a conscious choice made by the child to try something challenging, like going down a slide headfirst. On the other hand, hazards like head entrapments are not chosen or necessarily even recognized by kids or their caregivers. It is natural enough for kids to get scrapes and bruises, but they should not be getting slammed by heavy metal and plastic animal swings, nor should they be getting choked in a knee brace. The more public a play area is, the less control the builder has over who plays on it and how, and the more important it is to follow the safety handbooks.

For all that this may look like a formidable list of rules—and it's by no means the complete rundown—once you understand the ways to modify a timber frame to be in compliance there is still a wide range left for creative designs that are fun to play on. In fact, the simplest, most basic designs can often be the best: a playscape designer with years of experience once confided to me that while the adults got excited about large, fanciful arrays of platforms and towers, the kids seemed to focus most on the old standbys—swings, slides, balance beams, more swings—so design should focus on being safe, simple, elegant and, above all, playable.

—SARAH K. HIGHLAND

*Sarah Highland (sarabkh@lightlink.com) is a builder, designer and teacher in Ithaca, N.Y., with a strong interest in building with community.*

#### Resources:

- American Society for Testing and Materials. *Standard Consumer Safety Performance Specification for Playground Equipment for Public Use*. ASTM, 2001.
- Christiansen, Monty, and Hans Vogelsong, editors. *Play It Safe, An Anthology of Playground Safety*. Second Edition. National Recreation and Park Association, 1996.
- Keeler, Rusty. *Natural Playscapes: Creating Outdoor Play Environments for the Soul*. Redmond, Washington: Exchange Press, 2008.
- Kuska, Kenneth S., Kevin J. Hoffman, and Antonio Malkusak, *Playground Safety Is No Accident: Developing a Public Playground Safety and Maintenance Program*. National Recreation and Park Association, 2002.
- U.S. Consumer Product Safety Commission. *Handbook for Public Playground Safety*. CPSC, 2008. Available for free download at [www.cpsc.gov](http://www.cpsc.gov) or call 1-800-638-2772.



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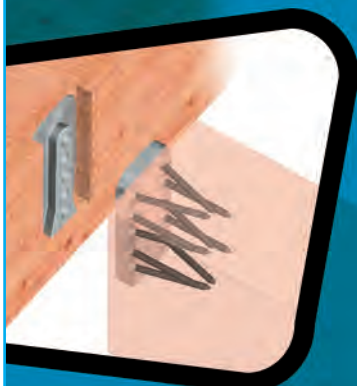
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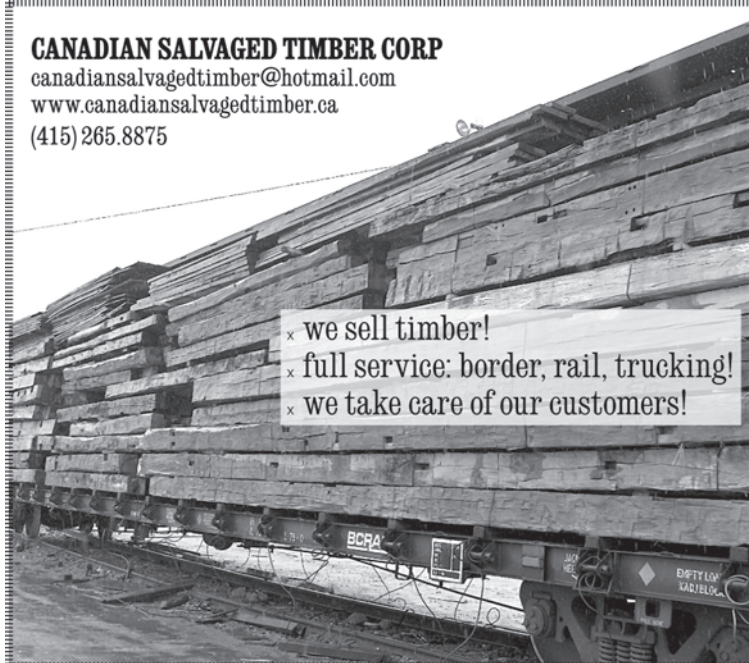
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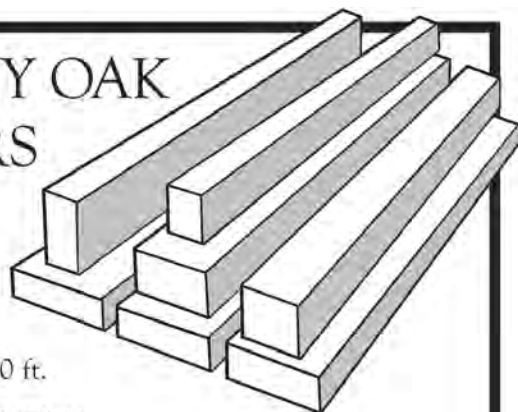
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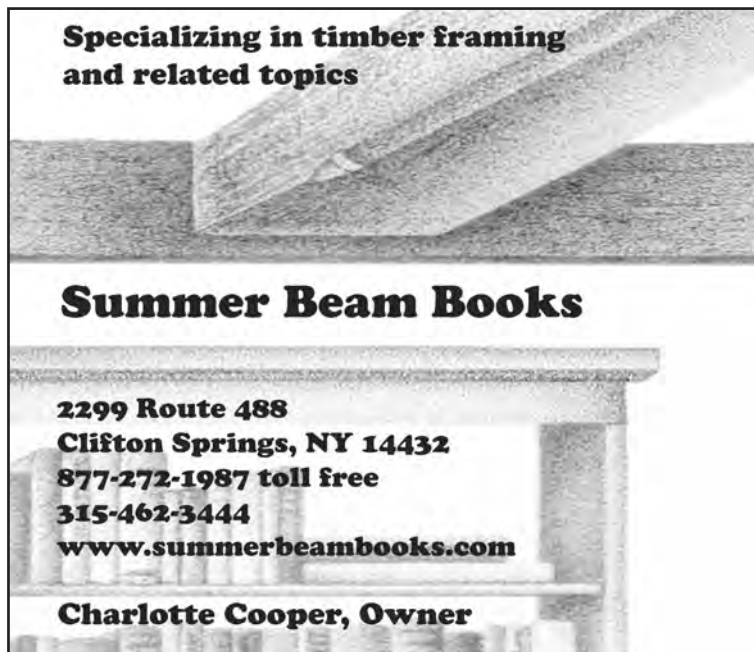


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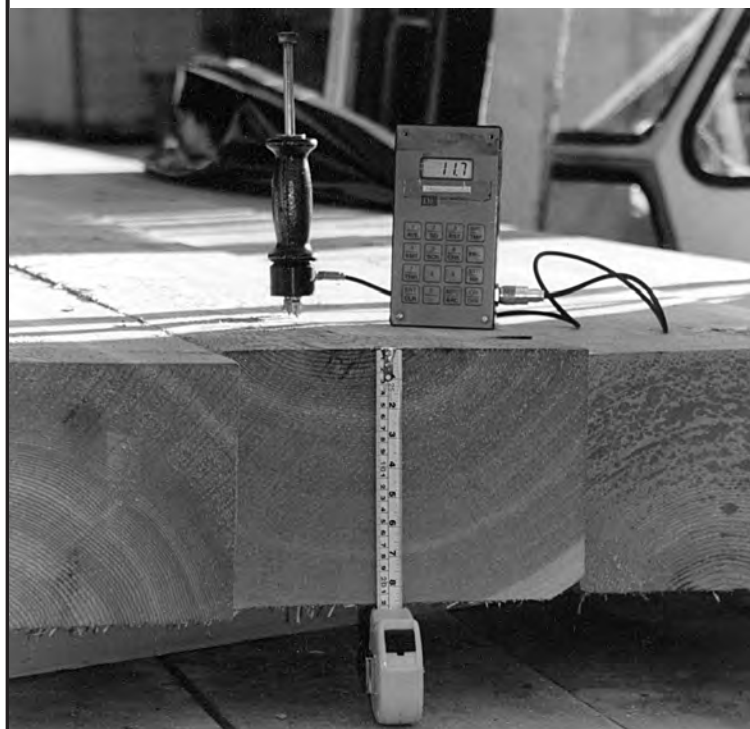
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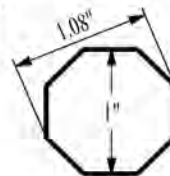
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