Heavy Timber

When exposed to fire, heavy timber develops a charcoal layer at the rate of about 1/40th of an inch deep per minute of fire exposure. The charcoal is actually burnt wood, acting as an insulator to slow down the consumption of the wood inside. If the wood continued to burn at 1/40th inch per minute, 1 inch burns in 40 minutes, 2 inches in 80, and 3 inches - the burn-through point would take up to 120 minutes - TWO HOURS.
It’s considered Heavy Timber when...

• The minimum sizes are…
  – 6” x 8” for a column supporting a roof
  – 8” x 8” for a column supporting a floor
  – 6” x 10” for a floor beam
  – 8” x 8” for a roof truss member
  – 4” x 6” for a roof beam
  – 3” + 1” finish floor decking
  – 2” roof decking
  – ...According to the building code

Some additional fine print from codes...

• No concealed spaces between ceiling and floor, in walls, and roof.
• Stair treads & risers, made of 2” thick material
• Finished floors stop 1/2” short of exterior walls.
• Wood bearing partitions cannot support more than 2 floors and roof
• Built up members must be min. 3” thick
• Even as combustible construction, the code recognizes that timber framed buildings afford occupants more time to evacuate, and firefighters more time to fight a fire because the massive members don’t burn through and fail nearly as quickly as lightwood (stud) framing members.

• Due to this slow burn through (a function of the charring acting as insulation) the code gives type IV HT construction an additional two floors in height and twice the square footage than a type V-a construction type for a ‘B’ occupancy.

Where did Timber construction start?

• No one knows.
• Pit dwellings from 1000 AD have been found on the North American and European continents.
• Pit dwellings were simple constructions where the earth was shaped for protection, fallen trees or limbs lashed together to form overhead structure, and skins or vegetation placed over the structure to form shelter.
Crucks

- Cruck frames were a development of the pit house. Curved tree trunks were leaned together and lashed/joined to wall and roof framing to provide some lateral bracing.
- The shortage of curved trees began to limit the spread of these frames across England and Europe.

Next... braces

- The braced frame was the next development of timber following the cruck. It used curved braces between the verticals and horizontals to provide lateral resistance.
A common form of timber framing for smaller structures was to frame the walls with vertical members, raise it, then add roof members to enclose. An early form of the stud wall...only much heavier.
Studs at this close spacing have an impressive structural capacity, which goes mostly unutilized.

Bents

- This braced frame is the basis for most traditional timber frames constructed today.
- The frames are not assembled in place one piece at a time, but rather as site prefabricated structural assemblies called bents.
• The bent is pre-assembled on the ground, and with some people lifting, some pushing pike poles, and some pulling with ropes, the bent would be raised into place.

Tools for Timber Framing
Jobs for all ages

Due to the weight of the members and the special skills needed to layout and cut the joints, frame raisings could employ the older, more skilled, as well as the younger, stronger laborer.

Minimal refinement

These floor framing members have only been hewed flat on the top side, the bottom still has bark on it. It took so much labor to refine the logs into building components that only those surfaces absolutely needing refinement were worked.
Raising itself was done with a crew on one side of the bent pulling, and a crew on the other side pushing with pike poles. The foreman had to keep balance between the crews to prevent the bent from being pulled or pushed over onto the opposing crew.

Spaces between the bents are filled in with joists and purlins to carry the roof shingles.
The completed frame is a community achievement
Timber framing in our time

Power tools have made the components for the timber frame easier to refine, but the methods for joining and principles of construction are largely unchanged from the 1600’s

Here a timberwright lays out a knee brace to be inserted in a mortise cut in the column and beam to give the bent additional lateral stability.

When complete, the frame is laterally braced in both axis by the knee braces between the columns and beams.
Setting the frame requires
Saws for cutting off the
trunnels
Rubber bands
Sledge hammers &
The ‘beetle’ or ‘commander’
(the really big hammer)

These housed dovetail purlins are stockpiled on the site. They will be the pieces that drop into the bents to tie the frame together at the roof.
This mortise and tenon connection is the most common type of joint found in the timber frame.

Instead of nails or screws, trunnels (tree nails) are used to join the two members together.

Usually the tenon is cut shorter than the mortise (to allow for cross grain shrinkage)

And the holes for the mortise and tenon don’t line up! (a drawbore) They are offset by an 1/8 inch or so to pull the tenon tight into the morise (the drawbore draws the mortise into the tenon)…and keep it there.

This mortise and tenon joint is shouldered (the vertical is notched to receive the horizontal).

- Shouldering puts the full depth of the beam to work resisting shear…so the tenon doesn’t have to do all the work.
• This mortise and tenon is located at the point where the roof member meets the column. The single trunnel is all that's needed as most of the load puts the roof member into compression.

Today, it's common to find the frame being raised by a crane instead of pike poles and ropes...(fewer squished timber framers!)

The last bent is being positioned, it will be held in place by the second floor beam at a mortise & tenon joint, and by the roof purlins, which use a dropped in type of housed dovetail.
• Even with the crane, the crew struggles to fit the tenoned end of the beam into the mortise cut in the bent. That last bent is temporarily tilted away from the frame and braced until all the mortise and tenon joints are partially fitted. Then the last bent will be pulled into vertical with portable winches called "come alongs"

The "come alongs" are connected to the frame with strips of inner tube to keep the steel cable from scarring the timbers.

Trunnels are partially fitted, and will be "driven home" with a mallet.
Driving trunnels home with a mallet

“come along”

Once the trunnels are ‘driven home’ any projecting trunnel is cut off with a handsaw.
The completed frame is sanded and oiled like a fine piece of millwork.

This is the traditional time for the post-frame raising feast… I think here it was KFC.

To preserve the presence of the frame on the interior panels that are both sheathing, insulation and drywall are spiked to the frame.