

# Fire Engineering®

## Construction Concerns: Char Wood to Increase Fire Resistance

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For [www.fireengineering.com](http://www.fireengineering.com)

*Photos by author.*

In times past, and more recently with the development of “mass timber” structures, we were told that large-dimension wood structural members were fire-resistive even though they were combustible. We were told that this fire resistance is partially because of the difficulty in igniting these large-dimension wood structural members and partly because of the layer of char that would develop on them after ignition, which would insulate them from some of the heat and slow the combustion.

The char that forms on the surface of wood structural members is the same as the charcoal used for drawings in grade school art classes and similar to the charcoal we buy for outdoor cooking. It is lightweight and brittle and has little tensile, compressive, or shear strength. It is mostly carbon (fuel) with some ash (noncombustible material) content.

Photo 1 shows the charred surfaces of a bowstring truss after the fire was extinguished. This truss was made of unplanned dimensional lumber in sizes actually measuring 2- x 6-inch, 2- x 8-inch, and 2- x 12-inch. Even though the char may have provided limited thermal protection, it was not sufficient to prevent the truss members from burning through and collapsing the roof.



(1)

Photo 2 shows a brand from a structure fire that had been carried on the thermal column for a distance of nearly 100 yards before it landed on pavement. After cooling, it measured 3 x 5 inches and is more than one-inch thick; it was probably part of a piece of dimensional lumber before it burned. These brands are made of charcoal and ash.

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Photo 3 shows part of a load-bearing wood joist (unplanned dimensional lumber) from a residential structure fire. Although the surface was deeply charred, the joist failed anyway, probably because the char removed so much of the strength from the wood that it was no longer able to carry its load.



(3)

When operating at fires in buildings of heavy timber, mill, or mass timber, keep the following in mind:

- Since 1880, the heavy timber mill buildings have been required to include National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*, compliant automatic fire sprinklers. When buildings like these survive fires, it is more likely because of the operation of the fire sprinklers than the layer of char on the timbers.
- Heavy timber and mill buildings without automatic fire sprinklers are unlikely to survive the fire and contain so much fuel in the structure that the fire eventually dies down for lack of fuel to a level that the fire department is able to extinguish.
- The dimensions of the timber, manufactured timbers, or mass timber components were chosen to carry specified loads with a safety factor. When the surface chars, the wood turns from load-bearing to a lightweight combustible insulation (charcoal) with no load-bearing capacity. When enough of the surface chars (and deeply enough), the fire will literally have burned through the safety factor, and the structural members will collapse.
- Modern manufactured timber or mass timber structures must also be protected by automatic fire sprinklers.

We must not risk our lives and the lives of our firefighters on the statement that a layer of char formed on exposure to fire makes the timber product fire resistive, especially when it is not backed up with an automatic fire sprinkler system.



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