# WOOD TRUSS AWARENESS GUIDE

American Wood Council

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***The American Wood Council (AWC) is the voice of North American traditional and engineered wood products, representing over 75% of the industry. From a renewable resource that absorbs and sequesters carbon, the wood products industry makes products that are essential to everyday life and employs over one-third of a million men and women in well-paying jobs. AWC's engineers, technologists, scientists, and building code experts develop state-of-the-art engineering data, technology, and standards on structural wood products for use by design professionals, building officials, and wood products manufacturers to assure the safe and efficient design and use of wood structural components. For more wood awareness information, see www.woodaware.info.***



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***The purpose of this informational guide is to provide awareness to the fire service on the types of wood trusses and how they are used in the construction of residential buildings. This publication is one in a series of eight Awareness Guides developed under a cooperative agreement between the Department of Homeland Security's United States Fire Administration and the American Wood Council.***

# Wood Trusses

## PURPOSE OF THIS GUIDE

The purpose of this Awareness Guide is to provide the fire service with information on the types and properties of wood trusses and how they are used in residential construction (Figure 1).

## Figure 1 Roof Trusses

Trusses are the most frequently used system in residential roof construction. Truss placement requires skilled and trained crew members to properly and safely fabricate the roof system.

## WHAT IS WOOD TRUSS CONSTRUCTION?

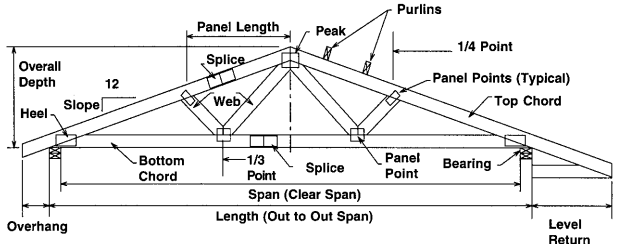
### Trusses—The Power of a Triangle

Trusses in buildings are easily identified by a triangulated framework of structural elements. Triangles are what distinguish a truss from other structural products. Trusses have been used in long span structures for hundreds of years. Their inherent structural efficiency makes them a cost-effective solution for many bridges, towers, and buildings. Metal plate connected wood trusses are the predominant type of truss used in residential construction. They are typically fabricated from 2x4 or 2x6 dimension lumber. Trusses built with larger dimension wood members can occasionally be found in custom-built homes.

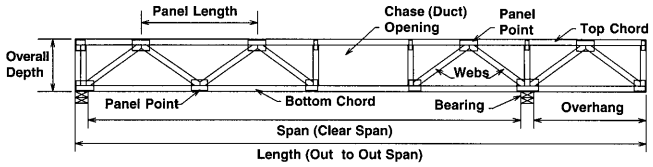
In a roof truss, the three sides (or perimeter elements) of the triangle are called "chords." The "webs" are wood pieces connecting the top and bottom chords. Chords and webs are the "members" or elements of the truss. The "connectors" joining chords and webs in modern trusses are usually metal-toothed plates.

Metal plate connected wood trusses were introduced in the mid-1950s. The most common application is in the roof assembly (Figure 2). Trusses used to form the roof assembly are referred to as "pitch chord," since the top chord is sloped. The bottom chord is typically horizontal, since it directly supports the ceiling. Complex roof structures can be assembled and sheathed using factory supplied trusses.

## Figure 2 Pitch Chord Truss



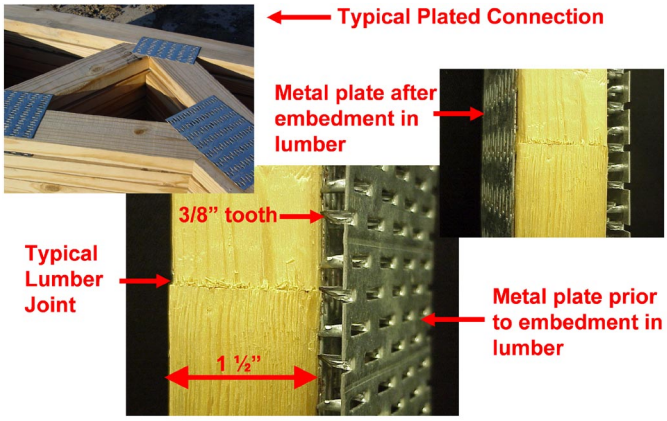

## Figure 3 Parallel Chord Truss




Parallel chord trusses (Figure 3) can also be used to form roof assemblies, but they are more commonly used to form floor assemblies.

*Photos and graphics courtesy of WTCA – Representing the Structural Building Components Industry. For more information, visit www.sbcindustry.com/firepro.php.*

## Figure 4 Metal Tooth Plate Connectors




Metal tooth plate connectors like those shown are used extensively in parallel and pitched chord trusses. The multi-tooth plates are embedded into the wood fiber using hydraulic presses.

### Metal Plate Connected (MPC) Wood Trusses

Metal plate connected wood trusses (Figure 4), are often referred to as *plated* trusses and are used for a wide variety of applications. Analysis, design, and manufacturing specifications are developed in accordance with standards of the Truss Plate Institute.

More details regarding metal plate connected wood trusses can be found in the *Metal Plate Connected Wood Truss Handbook*.[1]

### How a Truss Carries Load

The popularity and practicality of the truss is easy to understand—a simple triangle is naturally stable. Any force applied to a triangle will be transferred around the three sides of the triangle with limited movement or change of shape. As shown in Figures 2 and 3, web members connect the top and bottom chords.

Under gravity loads (live loads, snow loads), the top chord is in compression and the bottom chord is in tension. ("Live" loads include everything except the weight of the assembly itself.) However, high winds or earthquakes can result in the reversal of these forces in chord and web members. A truss designer checks the performance of each member under all anticipated load conditions.

### Bracing

There are two types of lateral bracing used in truss construction—temporary and permanent. Temporary bracing holds the trusses vertical during construction. Permanent bracing is used where required by the engineering analysis. The type and location of required bracing is indicated in the information provided by the truss manufacturer to the field when the trusses are delivered to the job site. For metal plate connected wood trusses, the most up-to-date bracing recommendations are provided in *Building Component Safety Information*[2].

### Redundancy—Load Redistribution

The historical performance of wood construction, whether exposed to hurricane force winds, earthquakes, or fire can be attributed to two factors, "structural redundancy within the truss" and "load redistribution across the floor or roof." There is structural redundancy within each truss. In other words, when one truss member fails, the loads are carried among the remaining truss members. Additionally, the entire roof or floor assembly will redistribute loads (through sheathing and/or bracing) to adjacent trusses if one truss loses strength or stiffness.

In engineering terms, the structural redundancy within the truss is provided by continuity of the chords from one panel to the next and by the rotational stiffness of the connections. While a truss's structural integrity is compromised when a single member is cut, this by itself will not usually cause catastrophic collapse. In fact, in most cases the truss will continue to carry most normal loads that are being applied to it. The cut member will generally cause noticeable defection that will warrant inspection. Total collapse would depend on many factors, such as load amount, span, spacing and integrity of the roof, floor or ceiling sheathing (membrane) and the degree of structural redundancy within the truss.

## HOW WOOD TRUSSES ARE MANUFACTURED

The manufacturing process for trusses ranges from considerable manual assembly to entirely automated processes. Trusses are designed using software that accurately calculates the structural load conditions in accordance with building code requirements. The calculation of forces within the truss elements and connector plates is based on the laws of physics and to a great extent is independent of the material. Selecting the proper grade and species of lumber and the correct plate size is a function of the calculated forces within the truss web and chord member.

## Figure 5 Truss Manufacturing Process

Trusses are manufactured on large horizontal tables called jigs. Truss members are held firmly in place while the entire assembly is moved through a hydraulic press. Roller pressure is applied to each plate to assure the teeth are properly embedded in the wood.

The web and chord elements are fabricated to exact dimensions. The pieces are arranged in their final orientation and the metal plates are applied using equipment capable of exerting high pressure to embed the metal plate teeth (Figure 5). Trusses are inspected for proper plate orientation and plate-teeth penetration depth prior to shipment to the job site.

## HOW ARE TRUSSES USED?

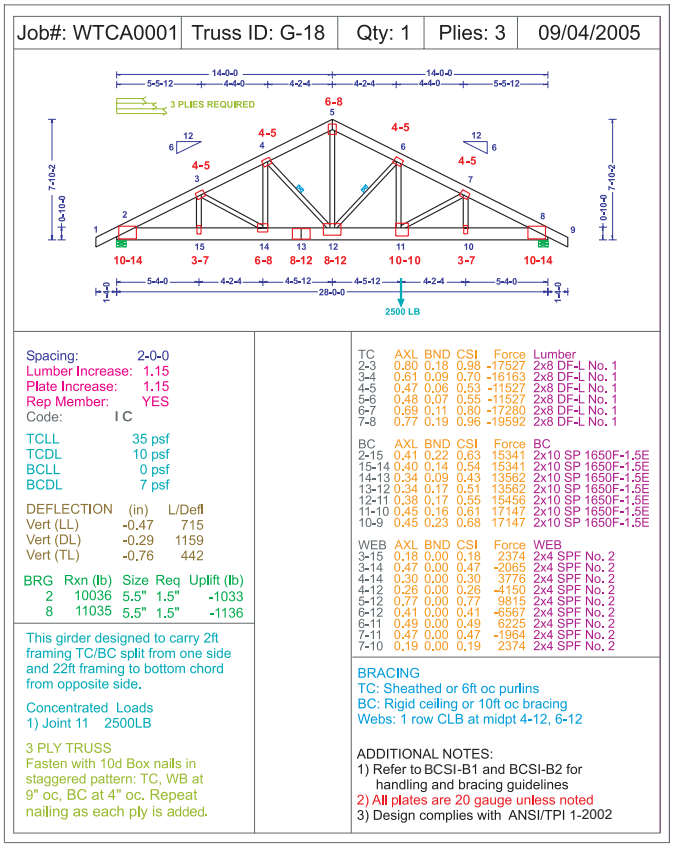
During construction is the best time to see how a truss roof system is configured and distributes loads (see Figures 8 through 11). Almost as soon as trusses are set in place, maybe even the same day, the roof sheathing is attached. This quick construction time limits the opportunity to see the framing method from outside the building.

### Elements of a Truss Inspection

*Comparing Structure to Approved Design Drawings*

The framing inspection provides the building inspector with an opportunity to review the plans and determine whether the structure matches the approved drawings (Figure 6). At the time of this inspection, the fire service has its best opportunity to review the framing and its proper installation. The trusses and their placement will be checked against the design documents. These documents show the minimum grade and species of each piece of lumber in the truss, the on-center spacing, points of bearing, and field required permanent bracing. Temporary bracing may be required during erection of the trusses to prevent roof collapse. Permanent bracing perpendicular to the span of the truss, which connects adjacent truss web elements, will be specified on the drawings to prevent buckling of specific long and slender members.

## Figure 6 Truss Design Drawings

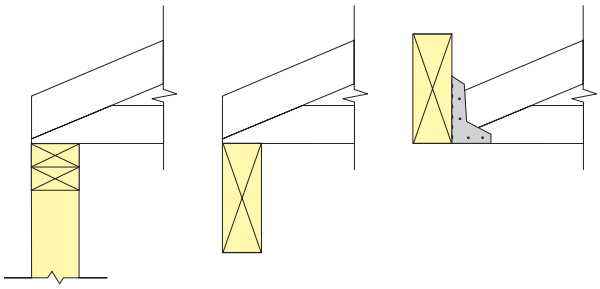



Truss design drawings are the graphic depiction of individual trusses prepared by the truss designer. The information is provided for assurance that the truss design meets specifications.

*Truss Support*

The truss must have proper bearing on (or support from) walls or girders. For structural purposes, the truss must be supported exactly where indicated on the truss design (Figure 7–on next page).

## Figure 7 Design Drawing of Truss Support



The truss design drawing illustrates which structural support is designated by the building designer to carry the truss reaction to the foundation.

*Truss Connections*

The truss must be properly connected to the bearing location. The building plans will specify how the truss must be connected to the structure.

*Truss Repair*

Truss damage, installation errors, or field modifications to accommodate roof openings for skylights, duct work, chimneys, and other purposes, must be repaired according to the specifications of the truss or building designer. There are no "standard" repair details available that cover every situation. Trusses and types of damage to them vary greatly, so each repair detail is prescribed on a case-by-case basis. Truss designers most often specify plywood or OSB gussets over damaged plates or joints, metal nail-on plates, lumber or repair frames over broken chords or webs, or truss plates applied by a portable press.

**For additional information, visit:**

www.sbcindustry.com/firepro.php
www.cdc.gov/niosh/fire

## Figure 8 Pan Ceiling Truss

Trusses can be used to create many different ceiling configurations. In this instance, trusses are used to create a "pan" or "tray" ceiling. From the exterior, the roof appears to be constructed on trusses. From the interior, it isn't so obvious.


## Figure 9 Transfer Truss

A "transfer" truss is designed to support roof loads from above and porch trusses framed into the side. The transfer truss is built into the wall assembly, so it is not obvious how the roof is supported.

## Figure 10 "Bonus" Room Above Garage

The space above this multi-car garage is being used as a "bonus" room. Once gypsum wallboard is attached to the bottom chord of the trusses, it will not be obvious there is a room above. The bottom chord members are laminated strand lumber (LSL), which are engineered to carry the floor load and span from the garage door header to the interior wall.

## Figure 11 View of Trusses from Inside Bonus Room

From inside the bonus room, the knee-walls, top chords, and engineered LSL bottom chords are visible.

### End Notes

1. *Metal Plate Connected Wood Truss Handbook*, 3rd Ed., WTCA, Madison, WI, 2002. www.sbcindustry.com/firepro.php
2. *Building Component Safety Information*, BCSI, WTCA, Madison, WI, 2003. www.sbcindustry.com/bcsi.php

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