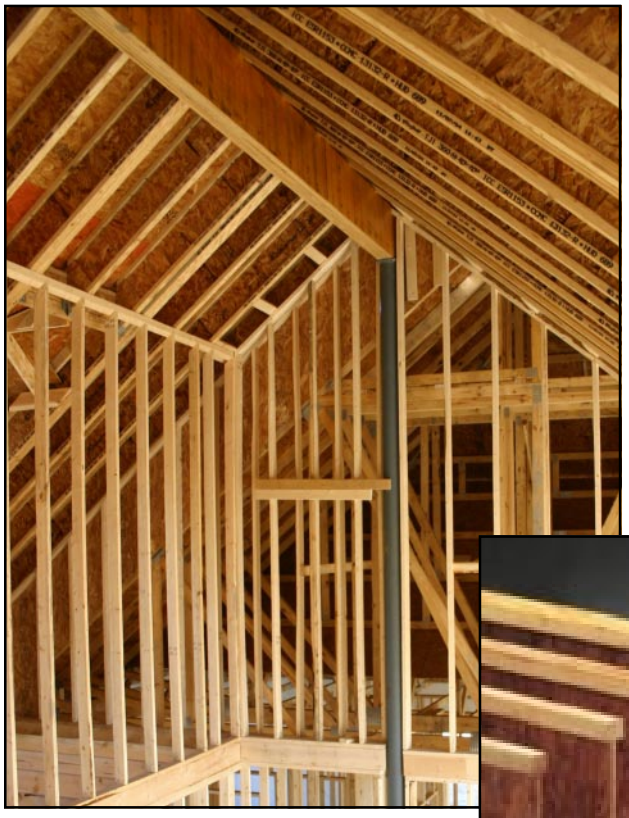
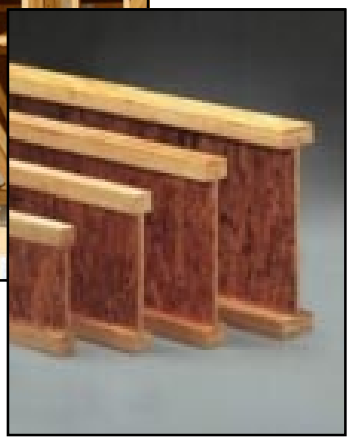
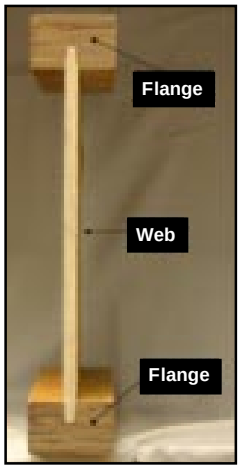
WOOD I-JOIST AWARENESS GUIDE







American Forest & Paper Association

American Wood Council

WOOD I-JOIST AWARENESS GUIDE

The American Wood Council is part of the wood products group of the American Forest & Paper Association (AF&PA). AF&PA is the national trade association of the forest, paper, and wood products industry, representing member companies engaged in growing, harvesting, and processing wood and wood fiber, manufacturing pulp, paper, and paperboard products from both virgin and recycled fiber, and producing engineered and traditional wood products. 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 I-joists 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 Forest & Paper Association.

Wood I-Joists

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 I-joists, how they are manufactured and how they are used in residential construction (Figure 1). It is important that the fire service understand the unique characteristics of wood I-joists and recognize their unique installation requirements.

Figure 1 I-Joists

I-joists are available in an assortment of depths, flange widths, and lengths. Their primary use is in residential floor assemblies.

I-JOISTS: LONG AND STABLE

What is a Wood I-Joist?

Shaped like the letter "I," I-joists are composed of two horizontal components called flanges and a vertical component called a web (Figure 2). Wood I-joists are used as a framing material primarily in floors, but may also be used as roof rafters where long length and high load capacity are required. They are used as an alternative to sawn lumber.

Figure 2 I-Joist Components

The I-joist is manufactured by combining engineered wood products into the shape of an "I." The manufacturing process requires close tolerance between the individual components.

I-joist performance and environmental benefits have increased their use in construction. Builders choose wood I-joists because they offer uniform dimension, light weight, and long span capability. Holes may be cut in the web, allowing ducts and utilities to be run through the joist. These holes must strictly follow manufacturers' recommendations and all applicable building code requirements.

Owing to engineering mechanics, the "I" shape allows the most efficient use of wood necessary to carry the design loads. This is achieved by placing more material with the required strength and stiffness in the flanges. Flanges are manufactured from end-joined, solid sawn lumber or structural composite lumber (SCL), while webs typically consist of oriented strand board (OSB) (see Figure 3 on next page). The web is of sufficient thickness to transfer loads to the flanges. (See the *Wood Structural Panel* and *Structural Composite Lumber Awareness Guides* at www.woodaware.info for more information.)

Figure 3 Types of I-Joists

I-joists are manufactured with a variety of web and flange products. The photo on the left shows a typical I-joist manufactured for modern housing: the web is oriented strand board (OSB). The flanges are structural composite lumber, such as laminated veneer lumber (LVL) or laminated structural lumber (LSL). The photo on the right shows I-joists with a plywood web and sawn-lumber flanges. This combination of materials was common in the 1980s and was replaced by OSB in the 1990s.

How I-joists are Manufactured

All web and flange materials are graded to ensure they will perform per applicable product standards. The flanges range from $1^{5}/_{16}$" to $1^{1}/_{2}$" thick and from $1^{1}/_{2}$" to $3^{1}/_{2}$" wide. Web material in typical residential I-joists is either $^{3}/_{8}$" or $^{7}/_{16}$" thick.

The manufacturing process begins by cutting the web into the proper rectangular shape. The web edges are shaped to match the groove cut into the flange. Webs are then glued, inserted into the flanges, and pressed together in a continuous process as illustrated in Figure 4. The assembled I-joist is cut to length and typically cured in special curing ovens to develop full adhesive strength. (More information on adhesives is found in the *Adhesive Awareness Guide* at www.woodaware.info.)

Quality control procedures ensure the web-to-flange joint is properly shaped and tight at all times. Sampling and testing of I-joists immediately after manufacturing further ensures the process remains within product specifications.

Figure 4 I-Joist Manufacturing Process

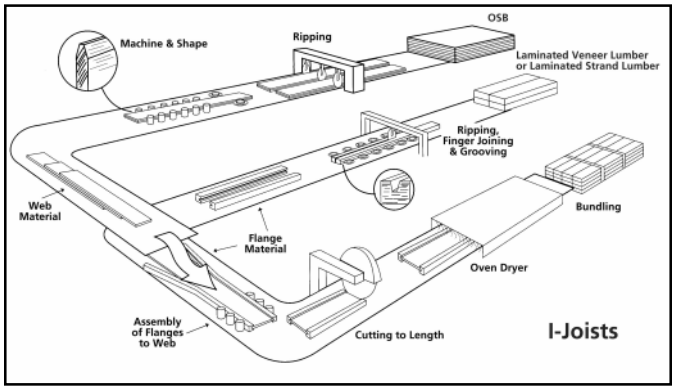


Illustration of the manufacturing process for I-joists. Web (OSB) and flange stock (lumber or LVL) is precision machined for assembly on separate lines. The materials are aligned with each other and fed through rollers that press the web tight into the flange groove. The fabricated I-joist is cut to length prior to drying. Lastly, the product is bundled for shipment.

I-Joist Use in Modern Residential Construction

For residential spans, I-joist depths from $9^1/_2$ to 16 inches typically are used. Because I-joists are manufactured in long lengths, a single continuous joist is often used to span the width of the house. Builders find efficiencies in using a single piece during construction. Like lumber joists, the I-joist must be end-supported by beams or bearings walls, and intermediate supports, depending on the total span (Figure 5).

Figure 5 I-Joists in Basement Floor Assembly

I-joists used in a typical basement floor assembly. In this figure, the I-joist spans from the exterior walls, over a steel beam to an interior bearing wall.

Most Important Performance Characteristics—Strength and Serviceability

Strength

I-joists must meet certain physical (dimensions) and mechanical property (strength) tests at the time of manufacture. For example, tests for bending, shear strength, tensile strength, fastener withdrawal strength, and increase in thickness and weight after soaking in water are performed.

Serviceability

I-joists are designed for serviceability considerations, such as deflection, vibration, creep, dimensional changes, and strength retention under normal conditions.

I-Joist Design

Span tables and other load charts are reviewed by the applicable evaluation services (e.g., International Code Council Evaluation Service) and state or local building code authorities. Once accepted, this design information can be used by designers, suppliers, builders, and building officials to select appropriate products and verify their adequacy.

Items which must be considered in the design of structures using I-joists include:

- *Strength and Stiffness*
  Members selected must have enough capacity to carry design loads without failing or deflecting beyond specified limits.
- *Connections*
  Members in the structure must be properly connected to ensure proper transfer of loads resulting from gravity, wind, and earthquakes forces to the foundation.
- *Modifications*
  Holes for mechanicals may be cut in I-joist webs as permitted by published hole charts (see manufacturers literature) or structural analysis. Holes that are too large or any damage to the flanges must be repaired or evaluated by the manufacturer.
- *Vibration*
  In addition to structural capacity, consideration is also given in design to how the floor system *feels* to the occupant. While criteria such as the evenness of the floor, vibration, and bounce are not required within building codes, they are often important design considerations.

The design of a residential structure may be required by state, regional or local building code requirements to be performed by a registered design professional. Other factors, such as building size and framing complexity may necessitate the use of a design professional. In some cases, single-family homes are designed and constructed using code-specified requirements for conventional construction, along with I-joist design information provided in the evaluation reports described earlier.

Is It an I-Joist or a Truss?

I-joist and truss terminology is often interchanged, such that the two products are thought of as being the same. Manufacturers, engineers, and builders, however, separate these two products based on their design and installation requirements, which are uniquely different. The following similarities and differences help to compare the features of I-joists and trusses:

Similarities

1. Share common component names. For example, both have top and bottom chords (flanges).
2. Make efficient use of wood fiber through design.

Differences

1. I-joists have fixed design properties, while trusses are commonly designed for each specific project.
2. I-joists are glued together with adhesives continuously along their length.

3. Truss web and chord members are typically attached together with metal connectors at specific locations.
4. Individual truss web members can be long and slender and require bracing against buckling.
5. Forces in the webs are distributed and transferred using differing structural mechanics.
6. I-joists can be manufactured anywhere in North America and transported through distribution channels to the job site. Trusses are generally not transported great distances, with manufacturing occurring within a regional area.

General Construction Practices

Examples of I-Joist Installation

I-joists are typically installed in a manner similar to sawn floor joists (Figures 6 and 7). They can also be used as roof rafters (see Figure 8 on next page). Although I-joist placement and installation appears similar to that of sawn lumber, careful attention should be paid to connection details and framing configuration.

Figure 6 I-Joist Floor Assembly

An I-joist floor assembly viewed from the floor below. When the ceiling is attached and finished, it won't be obvious that I-joists frame into a beam. I-joists must be held vertically in place wherever they are supported by a beam. This rigid alignment is frequently achieved by using blocking or joist hangers. By holding the member vertically, the full strength of the I-joist can be developed. Special attention should be directed at all connectors during the installation process.

Figure 7 I-Joist Floor Assembly Components

I-joist assemblies have many floor framing components similar to traditional solid sawn assemblies. The ends of an I-joist are capped with a rim joist, to hold the joist vertical and transfer loads from the wall, above. The rim joist is attached to a sill plate that is bolted or strapped to the top of the foundation.

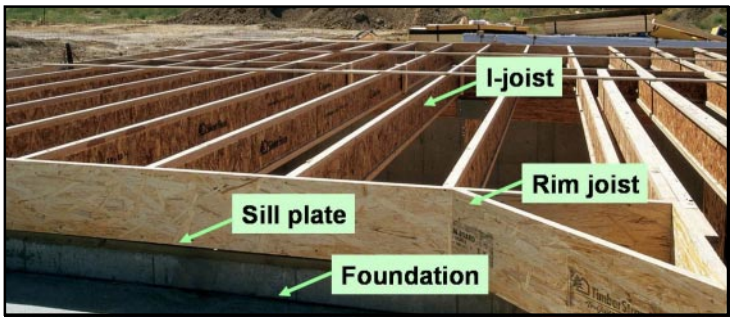


Figure 8 I-Joists Used as Roof Rafters

I-joists are used as roof rafters where high, open ceilings are desired, such as this $2^1/_2$-story room. The I-joists are supported at the ridge by an LVL ridge beam. Since there are no ceiling joists to resist outward thrust, the I-joists must be supported at both ends. The load on the ridge beam is carried by columns to the foundation.

Site Visits

Although residential construction is built from the ground up, framing is best inspected from the roof down. The most important structural characteristic common to all buildings and all types of construction is referred to as "load path continuity." The load path is the prescribed route that gravity loads—such as live, snow, and water ponding; and lateral loads—from wind and earthquakes—follow to the footings. For simple single-family dwellings, the roof, ceiling, and floor loads are collected by rafters or joists, which rest on exterior walls and interior beams or bearing walls. Figures 9 and 10 (see next page) illustrate typical layouts for floor and roof framing, respectively.

Proper installation and job site use are important considerations. I-joists are intended for dry-use applications. It is acceptable for structural framing to be exposed to rain during the construction process. However, prolonged exposure to rain or other moisture can cause damage to the I-joist. Whenever possible, products should be kept dry and protected from long-term exposure to the elements. Proper installation includes correct spacing of sheathing joints, care in fastening of the joists and sheathing, and providing adequate and level supports. All of these considerations are essential for proper system performance.

When visiting a building as part of a pre-planning or training exercise, the fire service should look for the following information:

1. The layout drawings, typically available at the job site. This document will include information about individual I-joist elements, including required spacing, and the specification and location of connections.
2. Whether the I-joists have proper bearing on walls, girders, or joist hangers. The layout drawings will show where the member must be supported. Web stiffeners should be attached where specified. Depending on the type of hanger, it may be necessary to have a nail in every hole, which meets the manufacturers requirements. Typically, screws are not permitted to be used as a replacement for nails.
3. Whether the I-joists are properly connected to the framing, using straps or other types of connectors.
4. Whether field modifications to accommodate wiring, plumbing or HVAC follow manufacturer's recommendations.

Figure 9 I-Joist Floor System Framing Detail Layout

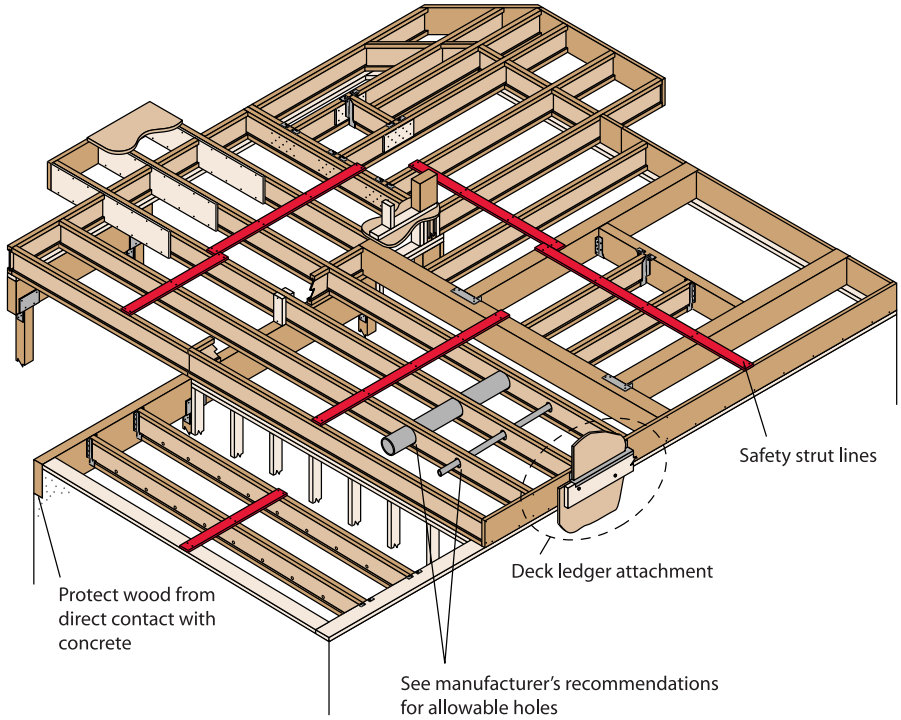
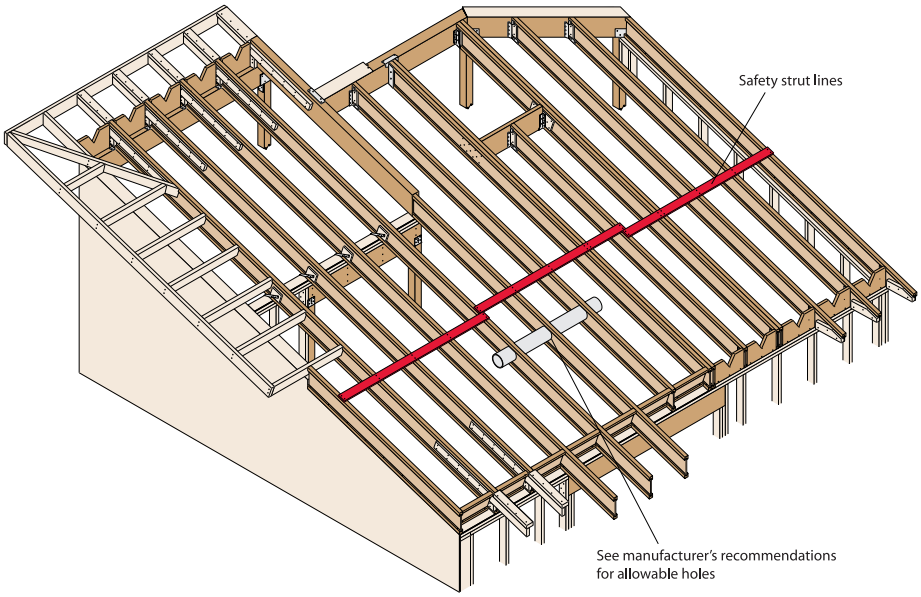


Figure 10 I-Joist Roof System Framing Detail Layout



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