Engineered Wood Products for Specifiers

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Engineered Wood Products for Specifiers

Presented By: LP® Building Products
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Description: Provides an overview of engineered wood products (EWPs) including the manufacturing process of different products, their cost effective applications, ease of installation and design and performance criteria.

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Learning Objectives

Upon completing this course, you will be able to:

- compare engineered wood products to their traditional lumber counterparts in beam and header applications, including their cost effective applications and ease of installation
- explain the manufacturing process of three different engineered wood products, and how the products are used in engineered wood floor systems
- discuss the properties, performance, and design criteria of engineered wood floor systems, and
- explain the material and resource efficiency of engineered wood products and discuss why, since natural forest resources are being exhausted, they represent the future of structural wood products.

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Click on title to view

What are Engineered Wood Products?

Overview of Engineered Wood Products (EWPs)

Engineered Wood Products (EWPs) are the result of the application of materials science and engineering technology to the process of optimum utilization of wood fibers.

They are becoming increasingly necessary as forest resources providing large sections in high grades and long lengths are exhausted. EWPs use these resources more efficiently and provide many practical and structural advantages. Though EWPs have been around now for over 30 years, they still represent the future of structural wood products because the category continues to grow - whether it's through new technologies or new users.

Introduction to the Products

EWPs, simply defined, are those products primarily used as alternatives for conventional softwood dimension lumber in markets where structural applications predominate.

In this presentation, the products focused on include Laminated Veneer Lumber (LVL), wood I-Joists, and Laminated Strand Lumber (LSL).

Applications

EWPs can be used most anywhere you use traditional lumber counterparts. They can be used for light commercial, industrial, residential and multi-family dwellings.

Some typical applications include:

- ridge beams
- hip and valley rafters
- floor joists and beams
- window and door headers
- columns
- studs
- tall walls
- stair stringers
- rim board

Essentially, EWPs can be used anywhere you use traditional lumber.

Advantages of Engineered Wood Products

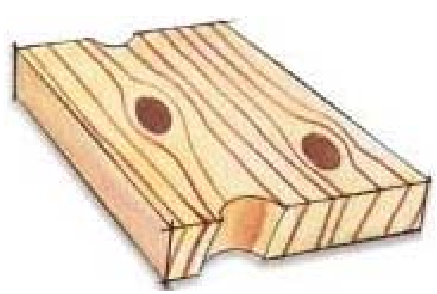
The advantages of EWPs come primarily from their efficiency and ease of installation. Their uniform strength properties enhance the design values, allowing for wider spans and more efficient design in their existing end uses. Also, more efficient conversion technologies allow higher product yield from the raw materials.

These efficiencies allow for reduced prices on the end product, which appeals to many builders, especially large production builders.

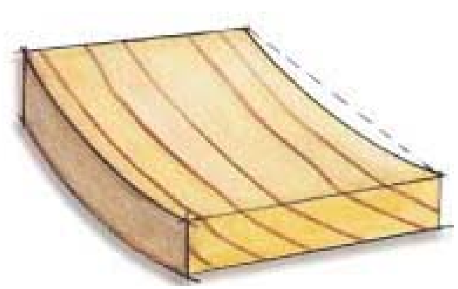
Why Use Engineered Wood Products?

The coefficient of variation is the most important thing to remember. With engineered wood products, the coefficient of variation decreases drastically for a more predictable performance when compared to traditional lumber.

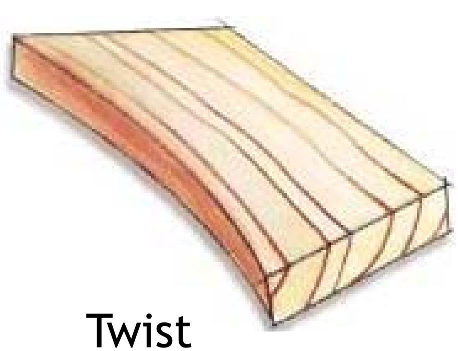
Essentially, it is the practice of taking the tree apart, removing the defects and putting it back together again.



Knot



Bow

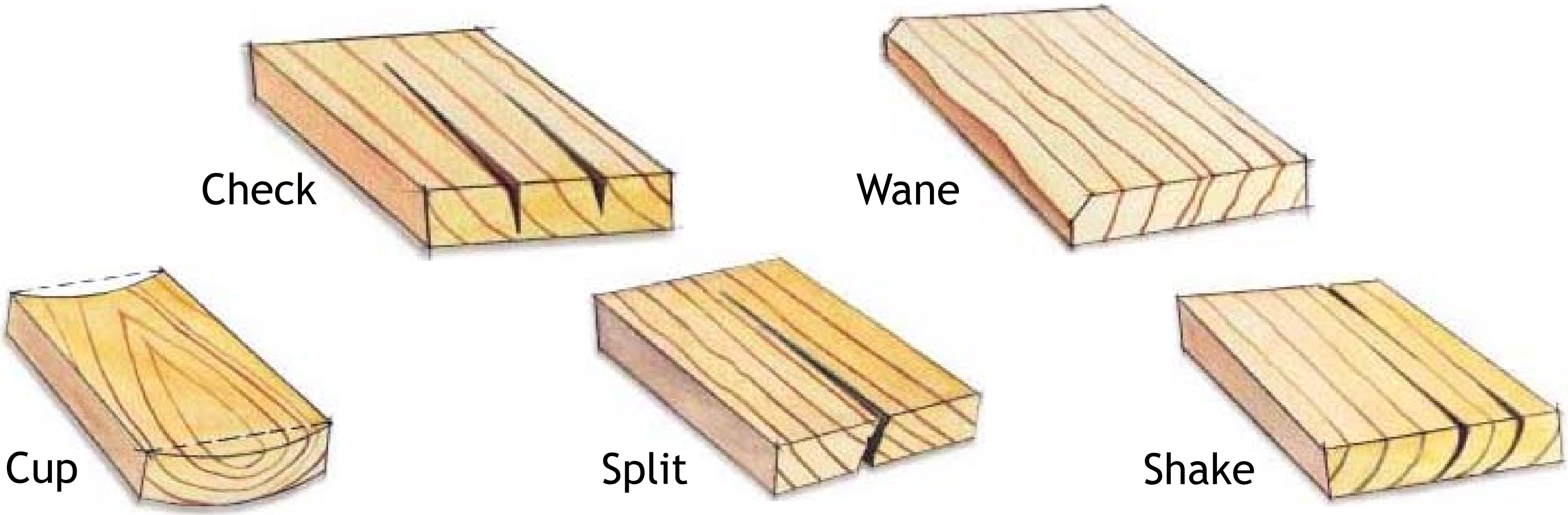


Twist

Why Use Engineered Wood Products? cont'd…

Performance – that is the best reason to use engineered wood products. They do two things:

1. solve the problems found in traditional lumber
2. do it in a cost effective manner



Why Use Engineered Wood Products? cont'd...

EWPs provide a viable alternative to traditional lumber products for residential and light-commercial construction.

EWPs are designed for superior performance. They are stronger than solid sawn lumber products, with less installation time. And, most of today's manufacturers also provide design and specification software tools to help enhance in-house design capabilities.

Environmental Commitments

EWPs and the Environment

Today's designer has more choices that are nondestructive to the environment. Among those choices is the use of engineered wood products, which are produced from small, easily renewable trees into stronger and superior products. EWPs utilize smaller, second growth trees, usually from aspen or poplar. The manufacture of these products greatly reduces the demand on Douglas fir and southern pine – typical old-growth trees.

Environmental Benefits

EWPs are durable, energy-efficient, recyclable, biodegradable and renewable. In fact, the engineered wood products industry will do more to save our old-growth forests than any other factor. If you're specifying or building with engineered wood products you are already offering your customers a green building choice. Most engineered wood products are manufactured with low off-gassing, safe resins for a safer, healthier indoor air quality.

- **Energy-Efficient**
  Wood I-Joists are more energy-efficient in use than steel and take less energy to produce.

- **Air Quality**
  As they grow, trees clean the air by converting carbon dioxide into oxygen.

Environmental Benefits cont'd…

- **Recyclability**
  Wood is recyclable, reusable and biodegradable.

- **Easy Renewability**
  Wood comes from a resource that is constantly being replenished. And engineered wood products make efficient use of that renewable resource, trees.

- **Performance Proven**
  Roof, wall and floor systems distribute energy from quakes and storms to the foundation of the structure. The natural resilience of wood framing can help withstand the forces of nature to keep the structure intact.

EWPs: Properties and Performance

Introduction

This course discusses two specific types of engineered wood products that are a perfect choice for beam and header applications. Laminated Veneer Lumber or LVL, Laminated Strand Lumber or LSL, and I-Joists.

They make great alternatives to lumber for builders because they are easy to install. They are designed to carry greater loads than their traditional lumber counterparts. They can span longer and farther – perfect for open spaces in modern architecture.

Laminated Veneer Lumber (LVL)

Laminated Veneer Lumber (LVL) is similar to a big, thick sheet of plywood, sliced into lumber-sized segments. LVL uses high grade veneers with the grain aligned for strength.

As a manufactured product, it is easy to reduce many of the flaws found naturally in solid lumber like defects such as knots and splits that are distributed at random, producing a very strong consistent material.

Laminated Veneer Lumber (LVL) cont'd...

The glue used in the manufacture of most LVL is water-resistant and the entire manufacturing process, from raw material to finished product, is subject to rigorous quality control checking and audited by independent third party inspection services.

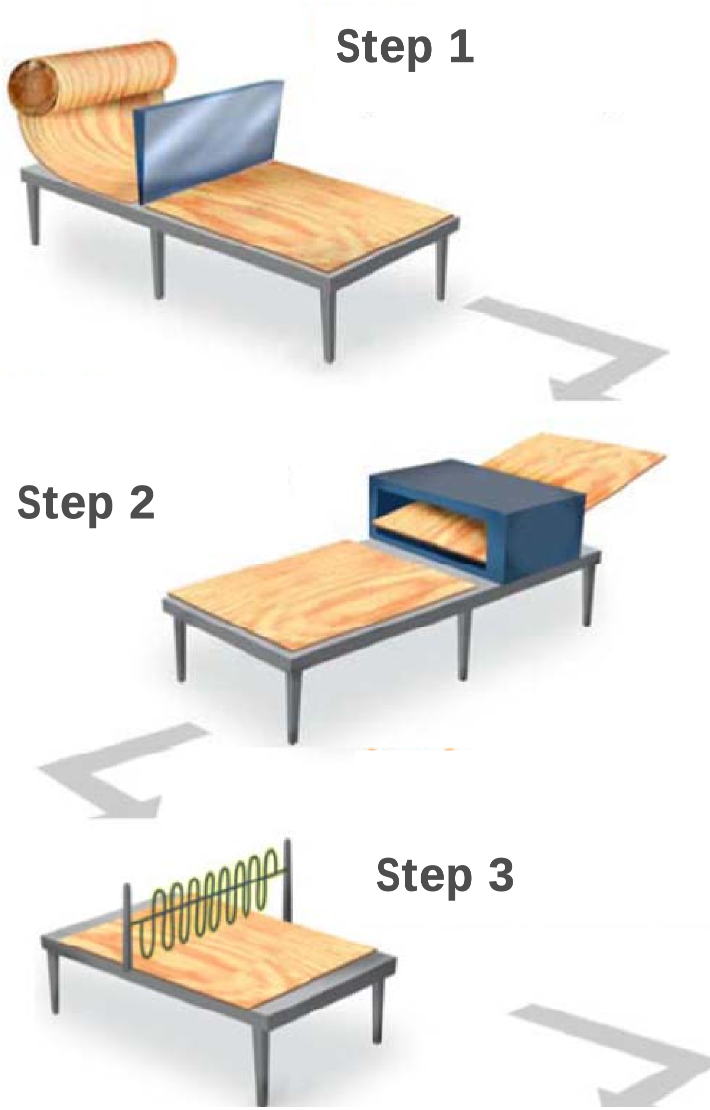
LVL beams are strong, consistent, and are available in a wide range of sizes. Where large sections are required, it is possible to assemble several smaller plies separately to simplify handling.

LVL Manufacturing Process

Step 1
The process begins with a rotary lathe slicing a sheet of veneer from a log.

Step 2
The sheets pass through a veneer drier, which gives them a uniform moisture content.

Step 3
An ultrasonic grader scans the dried veneer to identify wood's naturally occurring defects. In a subsequent step they will get dispensed so as not to affect the performance of the finished product.



LVL Manufacturing Process cont'd...

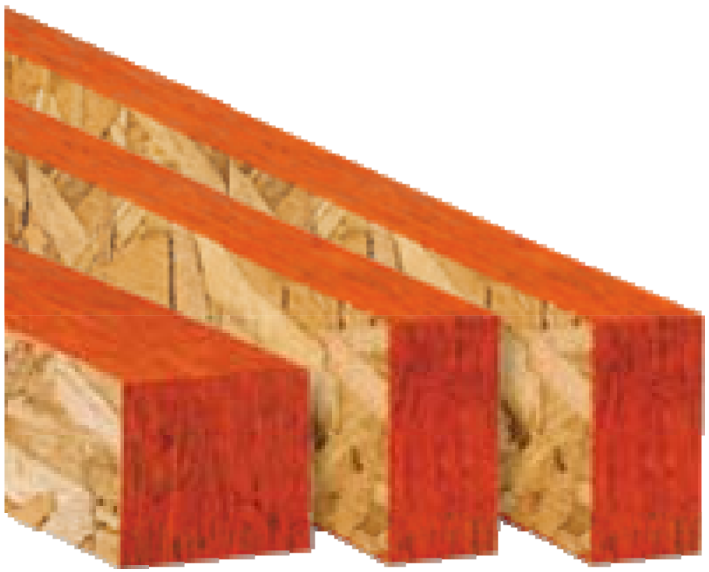
Step 4
A glue spreader uniformly coats wood strands and veneers with waterproof adhesive.

Step 5
At the lay up station, veneers are stacked for maximum strength using data from the ultrasonic grader. We are essentially taking the tree apart, removing the knots and other defects, and putting it back together. The veneer press uses heat and pressure to dry the adhesive.

Step 6
Finally, a cross-cut saw cuts the billet to length per customer specification and a rip saw cuts it to width.

Laminated Strand Lumber (LSL)

Like LVL, Laminated Strand Lumber (LSL)is also the perfect structural solution for beams and headers. LSL fits that niche where LVL might be over-kill.



LSL is a structural engineered wood product made from thin wood strands that are glued and pressed together. The longer length strands will be parallel to the finished product’s length – the key to its strength.

LSL is made with a steam injection press. This innovative manufacturing removes more moisture for even density gradient through the thickness of the product which means more resistance to warping, twisting, shrinking, and bowing.

Laminated Strand Lumber (LSL) cont'd...

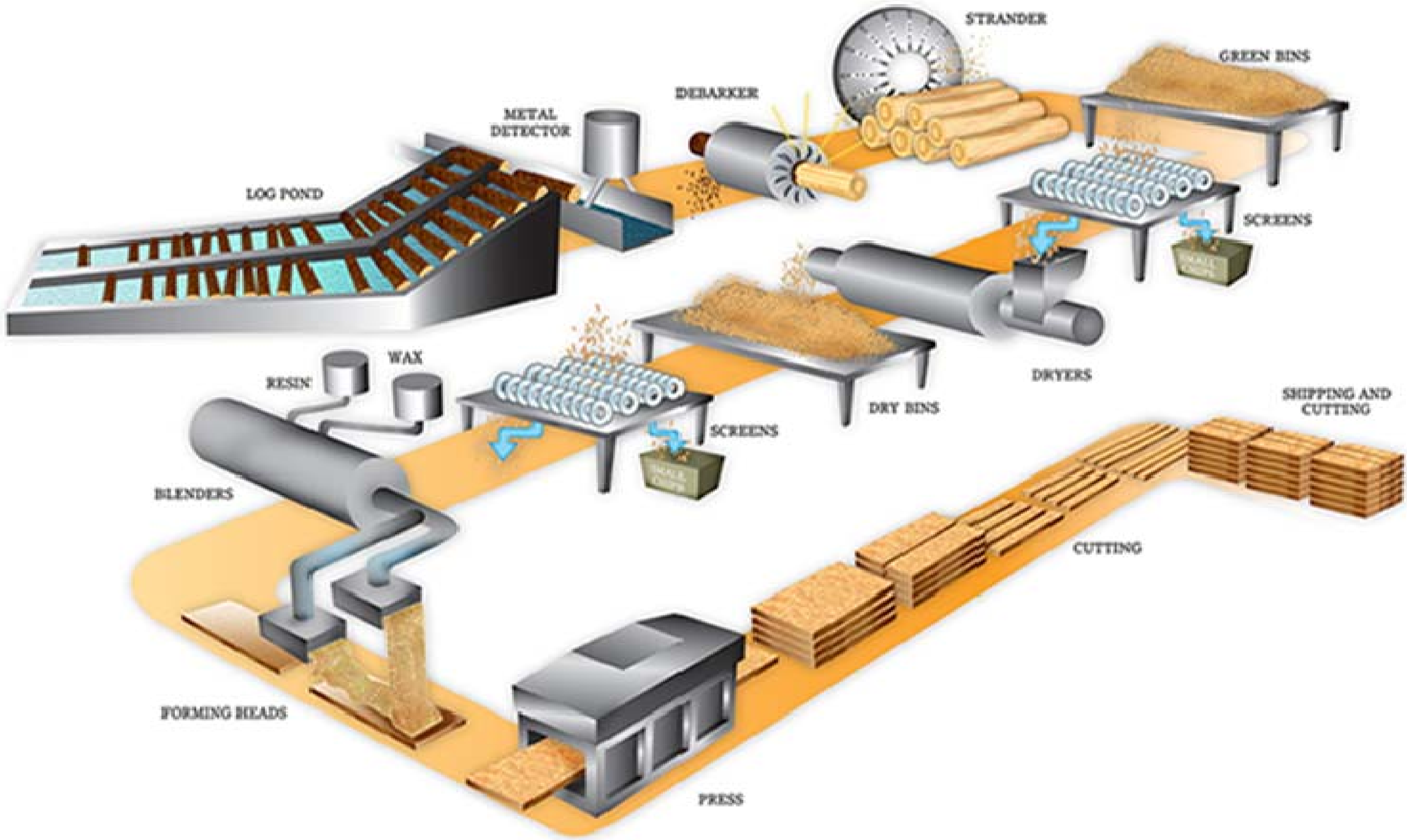
LSL is suitable for a wide variety of residential construction uses; its greater strength properties outperform traditional lumber in headers and beams, wall stud applications, roof beams and rafters, truss chords, rim board and stair stringers.

LSL Manufacturing Process

The LSL manufacturing process in fairly innovative with it's steam injection process. (see next slide for illustration of the manufacturing process)

- First, the logs come in from the log pond.
- Next, the logs go through the metal detector.
- The bark is then stripped from the logs through the de-barker.
- Then they go through the strander where rotating knives turn the logs into flakes.
- The flakes are then put into a green bin – just a holding bin before they go through the screens.
- The screening process essentially removes the shorter flakes that won't go into the finished product. The flakes that were screened out go back into the manufacturing process as fuel.
- Once they are screened, the flakes go through the dryer.
- Then off of the steam injection press where the billets are formed, and
- The billets are then cut, bundled, packaged, and shipped.

LSL Manufacturing Process cont'd…



I-Joists

The structural advantages of an "I" section have been used by engineers for many years, especially in the steel industry. If we were able to examine a section in the middle of a simple loaded joist, we would find that the top part and the bottom part of that section were doing most of the work, so it makes sense to put the majority of the materials at the top and bottom to form the flanges of I-Joists.

I-Joists cont'd…

These flanges are connected using a web manufactured from Oriented Strand Board (OSB). This too is an engineered wood product and differs from other similar looking products such as waferboard, flakeboard, or particle board. OSB has the wood strands arranged in layers, with most of the strands in the outer layers running vertically and the inner layers at random. The result is a product with both strength and stiffness, superior to plywood, and excellent choice of material for the web of an I-Joist.

The connection between the flange and the web is machine made by pressing the web into a specially shaped groove. Again, a high strength, water-resistant glue is used, and the entire manufacturing process of LVL is carried out under the same high standards of quality control and an independent inspection agency.

The end results are factory produced, machine made, high strength wood products with many advantages both during construction and actual service of the components.

I-Joists cont'd…

I-Joists are light, straight, and available in long lengths which can save time during installation. They do not need to be sorted, selected, and lapped on interior supports, this saves work with sheathing too. Provided they are correctly located, holes may be cut in the web to enable pipes and ducts to pass through. This is structurally accepted, whereas a large hole cut in a dimensional joist will weaken it significantly.

With a consistent machine-made I-Joist, you can expect a high quality structural system. Whereas regular joists can vary in both strength and stiffness, I-Joists are all the same. Dimensional joists can vary in depth and tend to shrink causing a squeaky floor. I-Joists are both stable and uniform in depth to eliminate those annoying squeaks.

I-Joist Manufacturing Process

Step 1

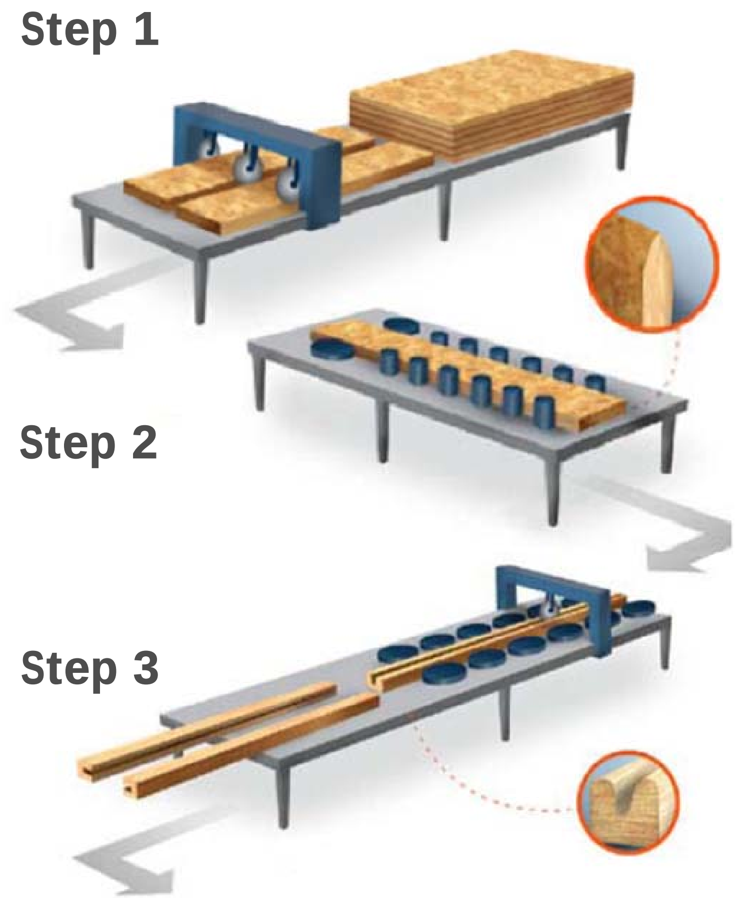
The I-Joist manufacturing process begins with a gang rip cutting webs of OSB to size. Some products are available in depths up to 24".

Step 2

The web passes through a feeder and then is precision machined and shaped.

Step 3

Meanwhile, LVL, LSL, or sawn wood is ripped and grooved to create flanges that will precisely match the web's shaped edge.



I-Joist Manufacturing Process cont'd...

Step 4

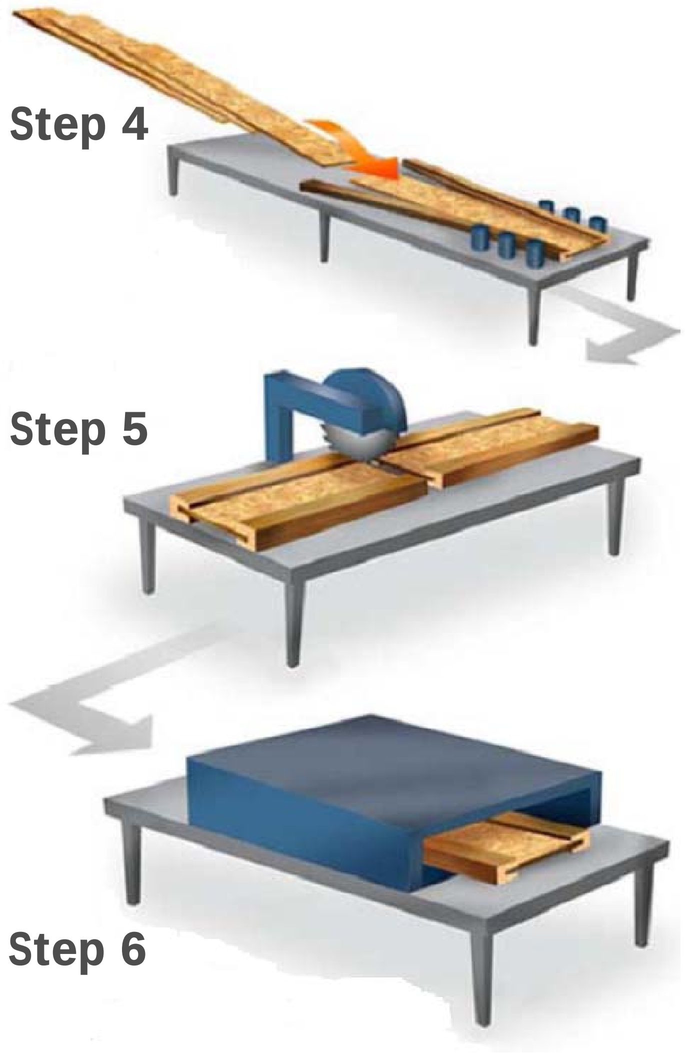
The web and flanges are assembled using waterproof adhesive.

Step 5

A cross-cut saw cuts the I-Joists to length.

Step 6

Finally, the I-Joists pass through the oven dryer, which dries the adhesive completely and provides a low, uniform moisture content for reduced shrinkage. Reduced shrinkage means fewer pops and squeaks – for floors that don't talk back.



Materials Comparison: EWP vs. Solid Sawn Lumber

One of the easiest ways to compare I-Joists to traditional lumber joists is in a typical floor installation. You will almost always use less engineered wood products versus traditional lumber pieces.

Traditional Floor System

- The traditional 2x10 lumber floor, spaced 16" o.c.
- Building this floor for a typical 30' x 50' house requires 145 pieces of material.
- After you cut up all the midspan blocking, the total grows to a total of 247 pieces. This usually provides an acceptable floor.
- However, there are some drawbacks:
  - High installation costs due to a lot of pieces and a lot of weight (approximately 8,800 pounds for the package), and
  - 2 x 10 lumber is typically not uniform or dimensionally stable and has more deflection than a continuous I-Joist floor.

Materials Comparison: EWP vs. Solid Sawn Lumber cont'd...

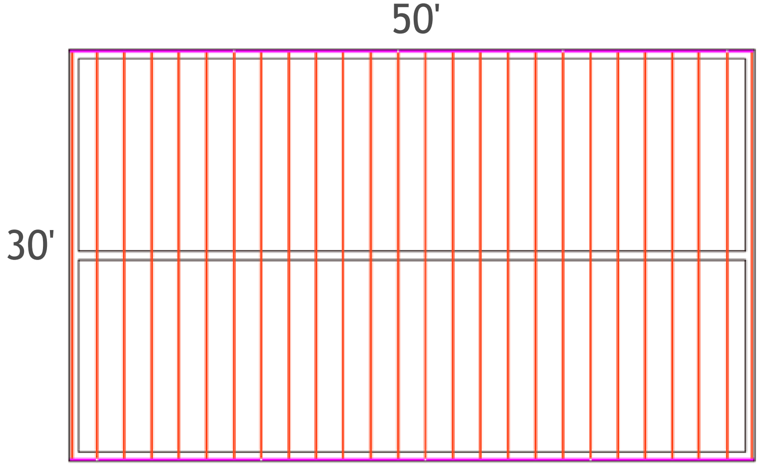
Engineered Wood Floor System

- The engineered wood floor, 11-7/8" I-Joists spaced 24" o.c.
- The engineered wood floor system is the best choice of all, requiring only 82 pieces of material for this typical 30' x 50' house.
- It is strong and stable, with an even lower installation cost due to fewer pieces.
- The 11-7/8" depth provides the least joist deflection of the two systems, and the 7/8" flooring reduces the concern about panel deflection between the joists.
- Yet the package only weighs in at approximately 6,900 lbs.

Framing Comparison

This example, and the one on the following slide, compares two 30' by 50' framed floors; one built with engineered wood products and the other with traditional lumber.

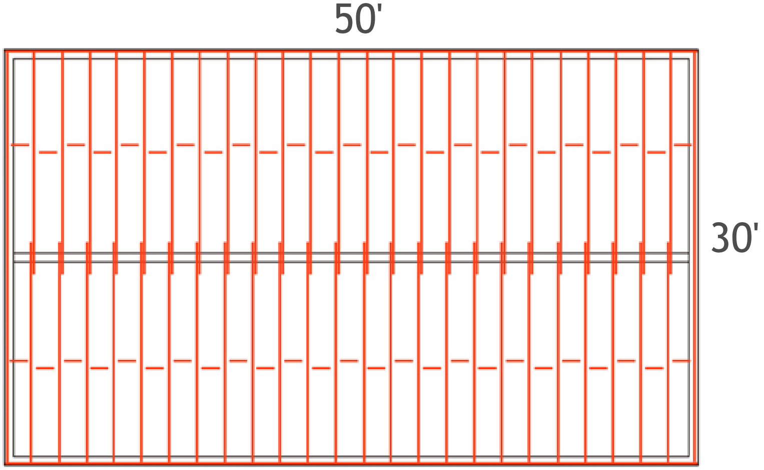
Engineered Wood Floor System



The engineered wood floor spaced 24" o.c.

- 26 pcs I-Joist x 11-7/8"
- 9 pcs 1-1/8" x 11-7/8" x 12' OSB rim board
- 47 pieces 7/8" T&G OSB
- 82 pieces total

Traditional Floor System

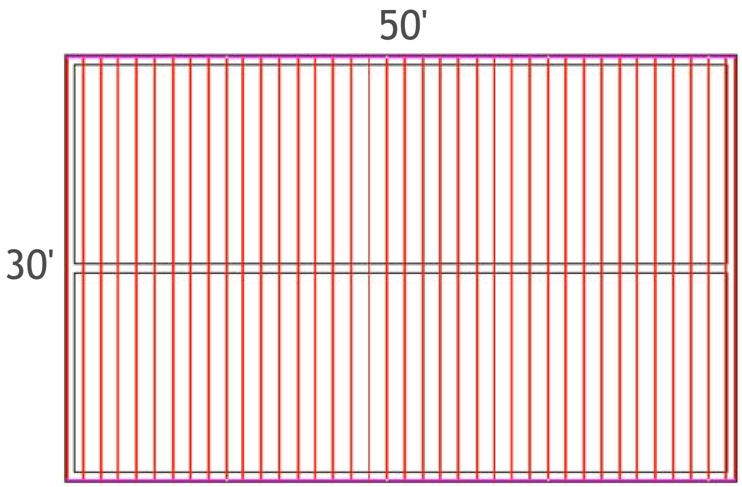


Traditional solid sawn 2x12 lumber floor spaced 24" o.c.

- 52 pieces 2" x 12" x 16' traditional lumber
- 5 pieces 2" x 12" x 14' traditional lumber
- 15 pcs 2" x 12" x 12' traditional lumber
- 47 pieces 7/8 " T&G OSB
- 119 pieces to handle
  (182 after blocking is cut)

Framing Comparison cont'd...

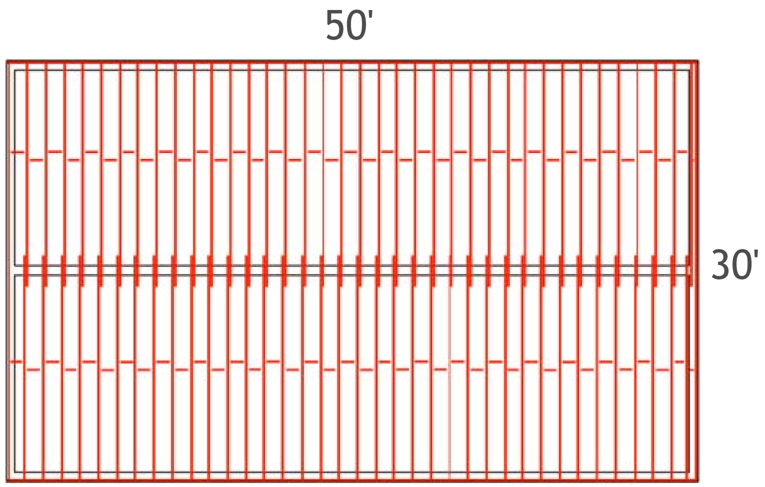
Engineered Wood Floor System



The engineered wood floor spaced 16" o.c.

- 39 pieces I-Joist x 9-1/2"
- 9 pieces 1-1/8 " x 11-7/8 " x 12’ OSB rim board
- 47 pieces 23/32” T&G OSB
- 95 pieces total

Traditional Floor System



Traditional solid sawn 2x10 lumber floor spaced 16" o.c.

- 78 pieces 2" x 10" x 16' traditional lumber
- 5 pieces 2" x 10" x 14' traditional lumber
- 15 pieces 2" x 10" x 12' traditional lumber
- 47 pieces 23/32 " T&G OSB
- 145 pieces to handle
  (247 after blocking is cut)

Performance of a Joist: Bending Moment, Shear, Deflection and Reaction

As with all bending elements, there are basically four criteria that most I-Joist manufacturers use to determine the performance of a wood I-Joist: bending moment, shear, deflection and reaction. Not only are these four criteria important for optimum structural performance, but they are also critical for safety performance as well.

Bending moment and deflection calculations typically include some composite action due to nailing or glue/nailing the sub-floor to the joist. Note: Not all manufacturers use the same thickness sub-floor in calculations for their span tables.

Reaction capacity at end or interior supports of I-Joists can be more sensitive than for standard, rectangular cross-section wood beams.

Interior and exterior reaction capacities are derived from testing and are dependent on the support length. Note: Not all manufacturers use the same support lengths in their tests, particularly for end reactions.

Design Stress Levels

Design stress levels are determined using statistical processes on actual tests. From a series of tests, we can determine the level which 95% of all values are expected to exceed. This is called the 5% exclusion value (E.V).

The 5% E.V. is then divided by a safety factor (2.1 in the case of bending stress) to determine the allowable stress. The safety factor can vary for different material properties (shear, tension, compression, etc) based on the expected variability of the property and other related factors. The exception to this is the MOE (material stiffness) which is typically based upon the MEAN value expected for the product.

Stress Development: EI

EI is a measure of the stiffness of an I-Joist. It is the product of “E” the stiffness of the materials in the web and flange and “I” is the “transformed” moment of inertia of the I-Joist which is related to the shape of the joist. It is difficult to compare E and I separately for an I-Joist so manufacturers combine them for you.

Most manufacturers represent EI in the same units, which makes direct comparisons relatively simple. As an example:

- Joist A is 1-3/4" wide x 11-7/8" deep LVL Flange with EI of 287 ($x10^6$) $lbs*in^2$
- Joist B is a 2-1/2" wide x 11-7/8" deep solid sawn flange with EI of 300 ($x10^6$) $lbs*in^2$, and
- Joist B is then 300/287= 104.5% stiffer than joist A (that is Joist B will deflect 95.5% as much as Joist A under identical loading and span).

Stress Development: K

K is a factor related to shear deflection in an I-Joist. Shear deflection occurs due to deformation of the web.

Shear deflection is a relatively minor component of deflection in an I-Joist (usually 5% to 20% of the total deflection).

Many manufacturers use different units and formulae to express and calculate shear deflection. This makes direct comparison of K factors difficult.

APA Performance Rated Rim Boards as Starter Joists

Rim board is the framing component that fills the space between the sill plate and the bottom plate of a wall. It is often overlooked, but it plays an integral role in a building as it "locks" the components together.

Engineered wood rim board is typically made from OSB, LSL, and LVL.

The benefit of using APA-rated engineered wood rim board is that it matches the depth of the I-Joist and other framing members between floors or between the floor and foundation to function properly. This will give you proper load transfer where it's used. Remember: Maximum vertical load carrying capacity is 4400 plf.

While lumber has been a traditional product used for rim board applications, it is not compatible with the new generation of wood I-Joists used in floor construction.

APA Performance Rated Rim Boards as Starter Joists: Application Notes

Rim boards can be installed in a direction not only perpendicular, but also parallel to the framing as starter joists. Design capacities of the rim boards are the same for both orientations with the exception that the vertical load capacity (V) should be reduced as follows unless the rim board (starter joists) is doubled or blocking panels are installed no more than 24 inches o.c. between the rim board (starter joists) and adjacent floor joist:

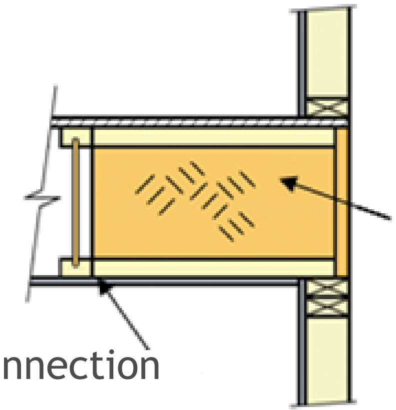
a) For 1-inch rim boards, use the bearing load capacity of 450 lbf/ft when the rim board depth is not greater than 18 inches, or 350 lbf/ft when the rim board depth is greater than 18 inches but does not exceed 24 inches.

b) For 1-1/8-inch rim boards, use the bearing capacity of 850 lbf/ft when the rim board depth is not greater than 18 inches, or 750 lbf/ft when the rim board depth is greater than 18 inches but does not exceed 24 inches.

Note that some starter joists are installed at a non-load-bearing end wall. As a result, it is not always necessary to use double rim boards or blocking panels for starter joists.

APA Performance Rated Rim Boards as Starter Joists: Application Notes cont'd…

Single OSB Rim



Approved Connection

*Floor Deck to Rim Board. Use 8d nails at 6" o.c.
*Rim Board to Top Plate: Toe nail 8d at 6" o.c.

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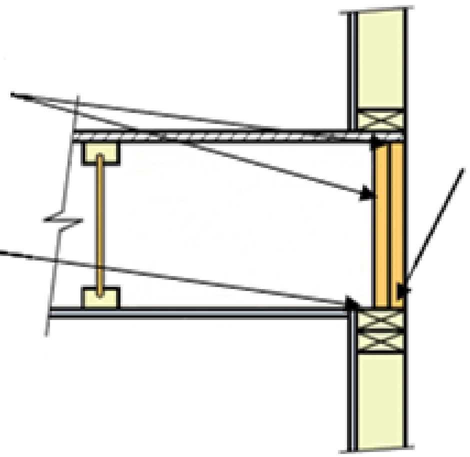
Two Ply OSB Rim



Use 2 rows 8d common at 12" o.c. staggered to attach two ply Rim.

When used as shear transfer, use same nail schedule as decking, or per Engineer's report.

*Floor Deck to Rim Board. Use 8d nails at 6" o.c.
*Rim Board to Top Plate: Toe nail 8d at 6" o.c.

Use one 8d common nail at 12" o.c. staggered from side to side (net 6" o.c.)

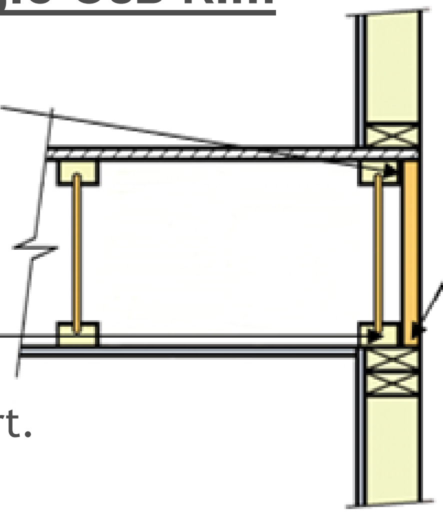
Note: Rim can be notched for anchor bolts. Blocking may be required by code.

APA Performance Rated Rim Boards as Starter Joists: Application Notes cont'd...

I-Joist and Single OSB Rim

Use 2 rows 8d common at 12" o.c. staggered to attach two ply Rim.

When used as shear transfer, use same nail schedule as decking, or per Engineer's report.



*Floor Deck to Rim Board. Use 8d nails at 6" o.c.
*Rim Board to Top Plate: Toe nail 8d at 6" o.c.

Use one 8d common nail at 12" o.c. staggered from side to side (net 6" o.c.).

Note: Rim can be notched for anchor bolts. Blocking may be required by code.

"*APA Performance Rated Rim Boards*", Data file number W345A is available from the APA publications department. Visit online at www.apawood.com (accessed on September 5, 2008).

Rim Board Product	Perpendicular and Blocked Starter Joists (plf)		Unblocked Starter Joists (plf)		Lateral Load Capacity
	d ≤ 16"	16"< d ≤ 24"	d ≤ 16"	16"< d ≤ 24"	PDF
1" OSB	3300	1650	450	350	180
1-1/8" OSB	4400	3000	850	750	180

Design Criteria and Data

Floor Performance

Floor performance is relatively subjective. How a floor performs or “feels” can vary greatly from one person to another based on their expectation and their experience with other floor systems. The following are some general guidelines and recommendations that may help in the design of a floor system and help provide acceptable performance to the end user.

The design of a floor system has two basic requirements:

- strength
- serviceability

- **Strength**, the most important, is the ability of the floor to carry all imposed loads.
- **Serviceability** refers to a floor systems resistance to deflection and how it performs or “feels” to the occupants. Excessive deflection can crack interior finishes such as gypsum ceilings or tile floors. A floor with poor “feel” may bounce or cause furniture to rattle as a person walks across a room.

Floor Performance cont'd...

In the past, strength and deflection were the only two criteria used to design a floor. Live load deflection was limited to a percentage of the span in an effort to avoid damage to interior finishes. That limit was 1/360 of the span, or L/360, under a uniformly distributed live load. L/360 was sufficient for the spans of traditional 2x10 and 2x12 framing which seldom exceed 16'-0".

With the advent of the I-Joist, light weight and available in long lengths, residential floor spans increased to the point where L/360 limit was no longer sufficient to provide a satisfactory floor. The more stringent limit of L/480 was advocated to decrease the amount of deflection permissible in the floor. However, some floors designed to L/480 were still susceptible to bounce and vibration.

Deflection limits are based on static (unmoving) loads that are uniformly distributed over the floor. However, bounce and vibration are the result of dynamic (moving) loads such as a person walking across a floor. When a person’s foot lands on the floor, that person’s weight impacts the floor causing the floor to deflect. This dynamic action causes **vibration**.

Vibration Control

In 1997, the National Research Council of Canada published a report outlining a method to design for vibration. This new criterion does not replace deflection limits, but is an additional part of the design process.

The vibration control calculation is based on a concentrated load of 1 kN (roughly 225 lbs.) placed at midspan of the joist, with all other loads removed. This load simulates a person walking at the critical location on the floor. The resulting deflection must not exceed an allowable amount that is based on the length of the span being designed.

All floors will vibrate when walked upon, but the perception of this vibration is dependent on the construction of the floor. This is because floors are not simply a collection of individual joists, but are a system, tied together by the components that make up the construction of a floor.

Vibration Control cont'd...

Vibration design accounts for such components as:

- the type of thickness of sheathing
- whether the sheathing is nailed only or glued and nailed to the joists
- the use of concrete topping
- the presence of a gypsum ceiling, and
- the addition of solid blocking or cross bridging.

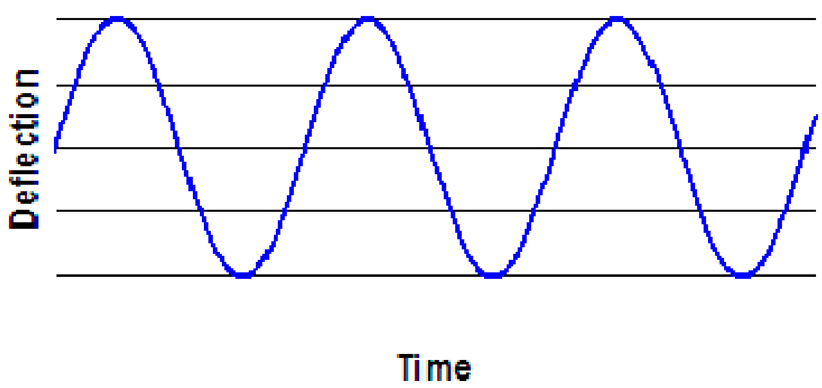
These components provide the means by which floors behave as a system through load sharing. The stiffer the components, the greater the ability of the floor to transfer some of the dynamic load to surrounding joists -- sharing the load. By reducing the amount of load on any one joist, the effects of vibration are reduced.

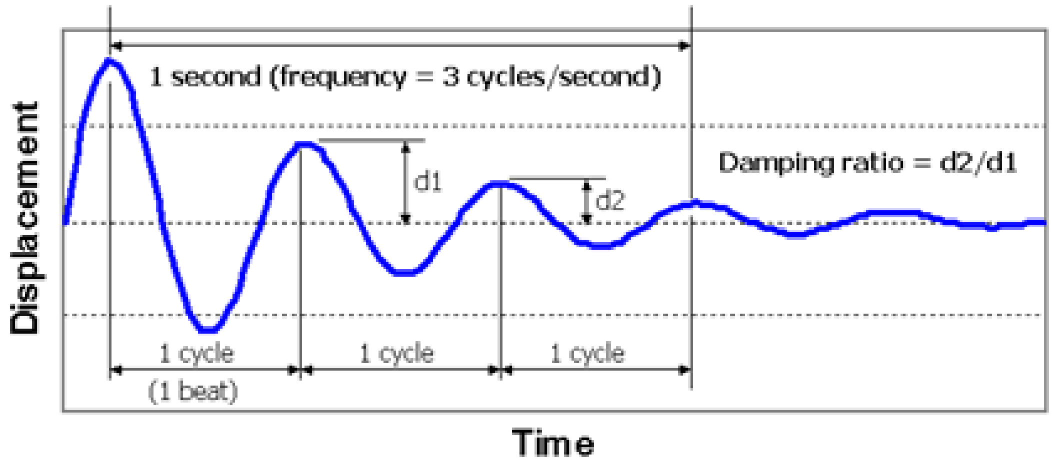
Vibration: Variables, Criteria, Design

- Vibration will occur in any floor system.
- The natural frequency of a floor is a function of its components.
- Human perception of “acceptable vibration” varies from individual to individual.
- Our goal is to minimize the likelihood of “unacceptable” vibrations from occurring.
- The components of vibration are:
  - amplitude and
  - frequency.
- Three variables effect these components:
  - system stiffness
  - system mass
  - system damping

Vibration Characteristics

- **Frequency** is the number of cycles per one second period.
- **Amplitude** is the amount of displacement or deflection at each peak or valley.
- **Damping** is a measure of how quickly the vibrations die-off.

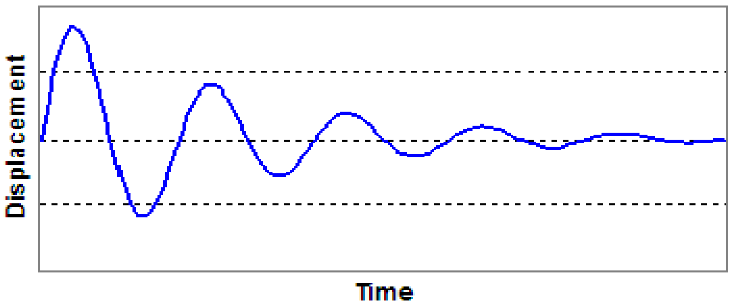




Vibration: System Stiffness

Increasing stiffness:

- increases frequency, and
- decreases amplitude.



Stiffness can be changed by:

- changing joist depth or spacing
- changing joist series
- gluing and nailing sub-floor
- increasing sub-floor thickness
- adding bridging, blocking, strapping or drywall, and
- adding toppings such as light weight concrete.

Vibration: Mass and Damping

Increasing **mass** decreases frequency.

Mass can be affected by:

- changing sub-floor thickness
- adding toppings such as light weight concrete or tile
- adding drywall, and
- adding stationary loads such as cabinets, appliances, furniture, etc.

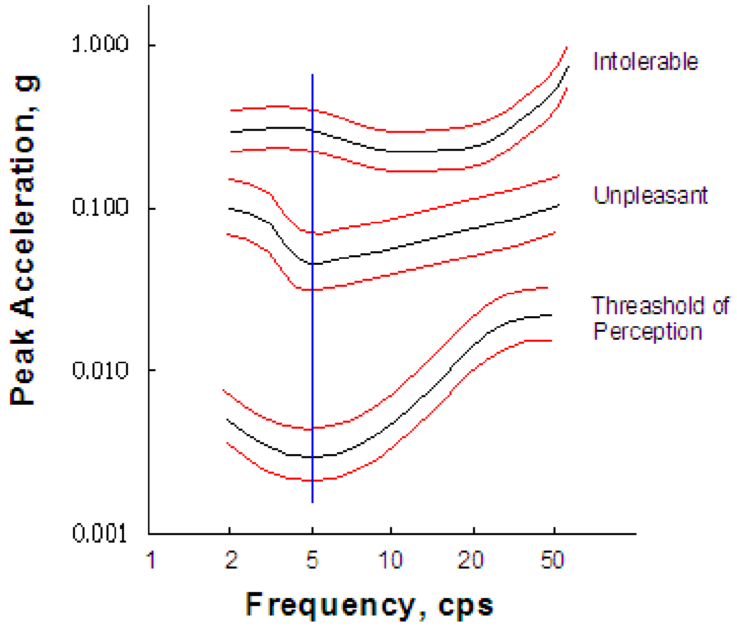
Damping relates to how quickly the vibrations in a floor system die out. It is more difficult to affect damping. Some types of bridging can improve damping characteristics.

★ Please remember the **exam password** VIBRATION. You will be required to enter it in order to proceed with the online examination.

Vibration: Frequency and Amplitude

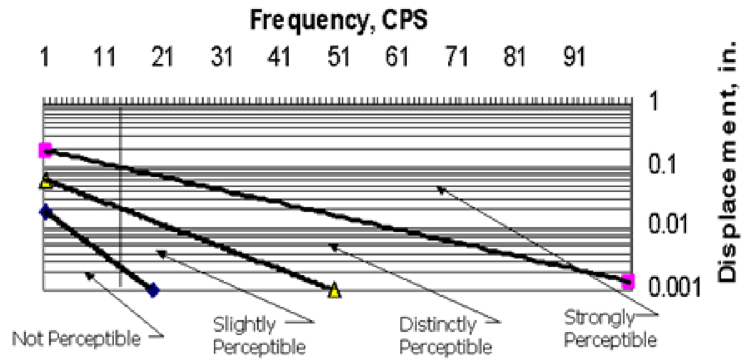
Frequency

Frequencies in the range of 5 cycles per second (hertz) tend to be more perceptible than higher or lower frequencies. Fortunately, most wood floor systems tend to have natural frequencies of 10 to 13 hertz.



Amplitude

Small amplitudes (or deflections) can be more annoying at higher frequencies than they might be at lower frequencies.



Vibration: Other Acceptable Factors

Many other factors affect the acceptability or perception of vibrations, including:

- other components (joists might be okay but the beams might not)
- adjacent rooms and use of room (lifting weights adjacent to the bedroom)
- receptors such as china cabinets may amplify the perception of vibrations, and
- water in fish tanks and toilets also act as receptors adding a visual aspect to vibrations.

Floor Performance: Design

When designing floors, deflection is one of the most important things to consider. While it's very important to adhere to the performance criteria set by your local codes, it is most important to go by all the manufacturer's recommendations as they are often more stringent than local codes.

L/480? L/600? L/800? L/1000? – How stiff is too stiff? In light of the interaction between all of the variables looked at in this presentation, it is not possible to say that any particular "L over" criteria is best.

Researchers in Canada have been studying the issue of vibration. They have examined hundreds of actual floor systems and devised a set of criteria based on a 225 pound point load. The allowable deflection decreases as the length of the joist increases.

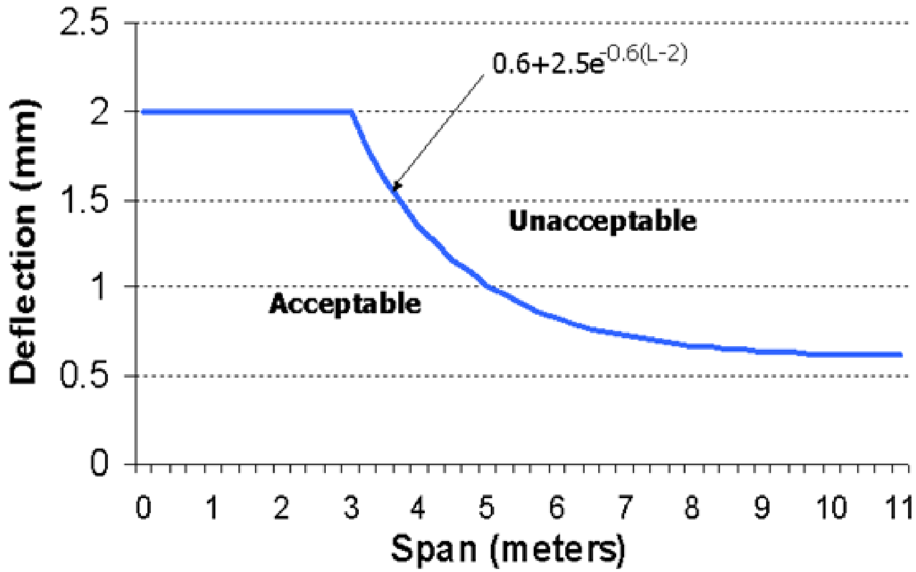
Floor Performance: Design cont'd...

These criteria give a reasonable estimate if a floor system will be acceptable or unacceptable to the majority of people.

Canadian Vibration Criteria

- Δ = 2.0mm (0.08") for spans > 3m (9' 10")
- Δ Varies 3m to 9.9m
- Δ = 0.6mm (0.02") for spans < 9.9m (32' 6")

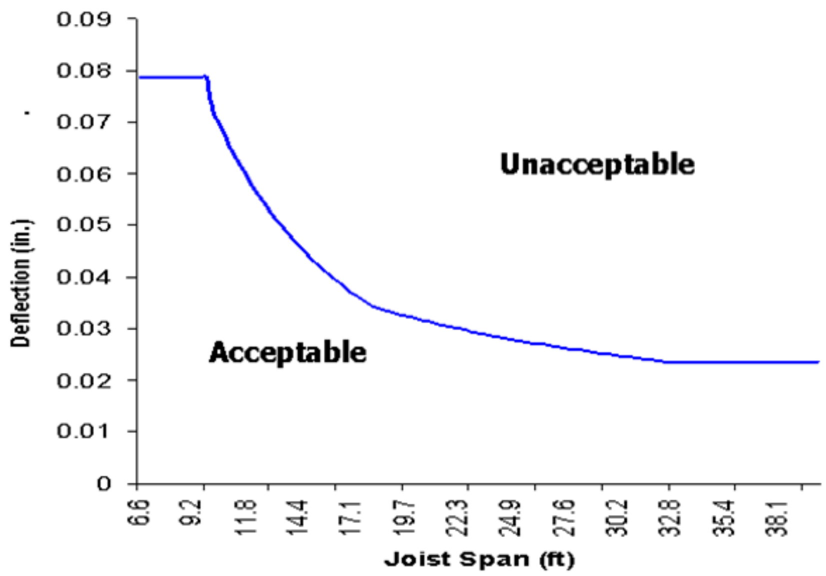
Here is a plot of criteria. Above the line is no good. Below the line acceptable.



Floor Performance: Design cont'd...

Here is a conversion to imperial units. Note the magnitude of the deflections are quite small. Also note, the allowable deflection decreases with increasing span which is just the opposite of the “L over” criteria.

Initial Deflection (225lbs load). In addition to the limits in the chart below, we have a methodology to take into account the effect of various floor components such as bridging, blocking, sub-floor thickness, concrete topping, drywall, etc., in our calculations.



Total Load Deflection Control

By limiting a floor’s total-load deflection to 1/2” including both the deflection due to the weight of the structure and the maximum design live load, this will significantly reduce the likelihood of creating an unsatisfied customer. A uniform dead load of 12 psf rather than the standard 10 psf can be used to better represent the types of floors being built. Deflection criteria are somewhat confusing because they obscure the actual allowable deflection (inches). The table below is provided as a tool. Example: an 18' long I-Joist designed with a deflection criteria of L/360 can deflect as much as 5/8".

Actual Deflection Based on Span and Deflection Criteria

	14’	16’	18’	20’	22’	24’	26’	28’	30’
L/240	11/16”	13/16”	7/8”	1”	1-1/8”	1-3/16”	1-5/16”	1-3/8”	1-1/2”
L/360	**7/16"**	**9/16"**	**5/8"**	**11/16"**	**3/4"**	**13/16"**	**7/8"**	**15/16"**	**1"**
L/480	3/8”	3/8”	7/16”	1/2"	9/16”	5/8”	5/8”	11/16”	3/4"

Proper Specification and Installation

- Using a live load deflection limit of L/480, instead of the code minimum L/360, should result in a stiffer floor. Note: some building codes require I-Joist spans greater than 20'-0" to be designed for L/480 live load deflection.
- Floors supporting loads such as lightweight concrete and ceramic may require special code and design consideration. Contact your local EWP dealer for details.
- Proper installation is essential to floor performance. Adequate bearing lengths, level supports and proper fastening of the sheathing to the I-Joists are all factors which lead to predictable floor performance.

Placement of Holes in I-Joists*

Flexibility is a key take away from the following slides of frequently asked questions and answers. Many builders/framers think that putting holes in I-Joists is a difficult task, so they turn to open-web trusses as an alternative. On the contrary. Cutting holes in I-Joists are just as flexible and actually simple to do. There is more flexibility in cutting a round hole than a square hole in an I-Joist, but it is possible to make cutting square holes easy too.

Q: Can I cut a 1-1/2" round hole anywhere in the web?

A: Yes. The only limitation is the 12" spacing between holes.

Q: Do all the holes need to be centered in the web?

A: For square or rectangular holes, *yes*. Round holes do not need to be. Simply maintain a 1/2" minimum clearance from the flange. This will allow you add the required slope for drain lines.

* Please read all of a manufacturer's installation and cutting information as individual requirements may vary.

Placement of Holes in I-Joists cont'd...

Q: Can a load be placed directly over a web hole?

A: Concentrated or point loads are not allowed directly over a hole.

Q: What forces or stresses determine the allowable hole sizes?

A: Shear determines the allowable hole size and shear is carried mainly by the web. This is why larger holes must be placed closer to mid-span, where shear is typically lowest.

Q: Can I put two 1-1/2" holes closer than a foot apart?

A: In most cases NO.

Q: What is the maximum number of web holes allowed in an I-Joist?

A: This varies from application to application and manufacturer’s specifications, but the best advise would be to use the manufacturer’s design/specification software. Cut as few holes as possible. One larger hole for several wires and/or pipes is usually preferable to several smaller holes.

Placement of Holes in I-Joists cont'd...

Q: Can I cut holes in a blocking panel or stability blocking?

A: It depends on whether the blocking is carrying vertical load. If so, do NOT cut any holes larger than 1-1/2", or use squash blocks if a larger hole is unavoidable. If not, such as in roof blocking for stability only, then larger holes may be cut.

Q: What if I have to drill multiple small holes in a short distance and possibly at different positions within the depth of the joist?

A: View these small holes as one large hole. Group the holes so that one large circular or rectangular hole encompasses the individual small holes, and use that large hole for checking the hole charts or for analysis using manufacturer’s design/specification software.

Placement of Holes in I-Joists cont'd...

Q: Why must rectangular holes be placed farther from bearing than round holes?

A: There are two reasons: First, the sharp corners of a rectangular hole create stress concentrations that lead to cracks developing at these points, typically at opposite corners. Second, a square hole of the same dimension as a circular hole, requires the removal of more web. To visualize this, draw a 6" square. Then draw a 6" circle within the square. You can see the difference. In mathematical terms, a 6" square has an area of 36 square inches while a 6" circle has an area just slightly more than 28 square inches. The result is 21% less web removed for the circular hole.

Light Commercial Floor Systems

Engineered wood products are just as easily used in light-framed commercial projects as they are in residential applications. In this presentation light-frame is defined as restaurants, multi-family apartments/condos, regional hotels, small office spaces, etc. I-Joists are perfect for light-commercial duty because of their high load carrying capacity.

There are several specific issues associated with the design/specification of light commercial floors as compared to residential floors. Since the majority of the I-Joist floor systems sold today are residential single or multi-family dwellings (houses, apartments or condos) manufacturers' software and training sessions are geared for residential construction. This presentation will attempt to list most, BUT NOT ALL, of the issues that apply specifically to the design/specification of light commercial floors.

The areas covered here include:
1) Applied or Design loads
2) Sheathing Design
3) Occupancy/Load Description

Light Commercial Floor Systems cont'd...

Applied or Design Loads

Define the Loads that the floor must support. Specifically look for:
a) Floor Live Load(s)
b) Floor Dead Load(s)
c) Partition Wall Dead Load
d) Safe Load(s)
e) Minimum Live Load Deflection Criteria or Limit, and
f) Minimum Total Load Deflection Criteria or Limit.

Next, review the architectural or engineering drawings for loads transferred down onto the floor system. Specifically look for:
a) Load Bearing Walls, and
b) Columns.

Light Commercial Floor Systems cont'd...

The following are some of the more typical loads, always check with the design professional associated with the project or with the appropriate local code body for the correct loads.

Common minimum commercial uniform floor live loads:
a) Office Buildings - offices, 50 psf
b) Office Buildings - lobbies, 100 psf*
c) Office Buildings - corridors above the 1st floor, 80 psf.
d) Office Buildings - safe load, 2000 lb concentrated load over a 2.5 ft. x 2.5 ft

Common minimum commercial uniform floor dead load components:
a) thicker) floor sheathing
b) concrete topping
c) double or triple layers of sheet rock for a fire assembly rating
d) sprinklers
e) mechanical equipment or ductwork

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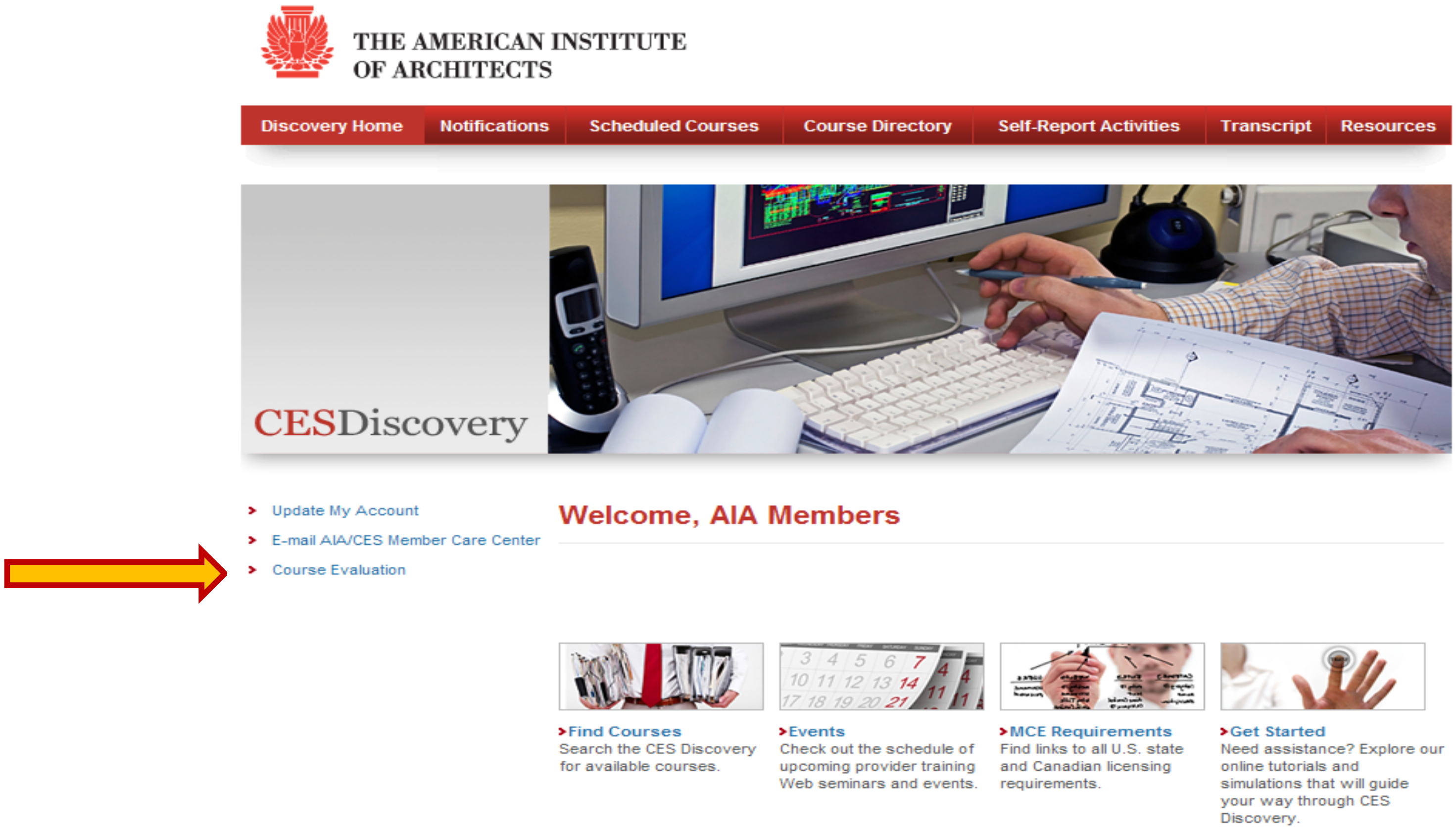

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